REPORT

Colac Otway Shire - Erosion Management Overlay Review

Submitted to:

Colac Otway Shire
2-6 Rae Street
Colac VIC 3250

Submitted by:

Golder Associates Pty Ltd
Building 7, Botanicca Corporate Park, 570 – 588 Swan Street, Richmond, Victoria 3121, Australia

+61 3 8862 3500

20141513-004-R-Rev0

30 October 2020

Distribution List

1 Copy - Colac Otway Shire

1 Copy - Golder Associates Pty. Ltd.

List of Abbreviations

Abbreviations

AGS	Australian Geomechanics Society
ASMG	A.S. Miner Geotechnical
CCMA	Corangamite Catchment Management Authority
COS	Colac Otway Shire
DELWP	Department of Environment, Land, Water and Planning
DEM	Digital Elevation Model
DPI	Department of Primary Industries
EMO	Erosion Management Overlay
GSV	Geological Survey of Victoria
LIDAR	Laser imaging, detection, and ranging
LGA	Local Government Area
NDMP	Natural Disaster Mitigation Program
UoB	University of Ballarat

Geological Units

Qc3	Slump deposits	Neo	Newer Volcanic Group
Qa1	Alluvium	Nbb	Black Rock Sandstone
Qm1	Swamp and lake deposits	Nb	Brighton Group
Ql1	Lunette deposits	Nbr	Red Bluff Sandstone
Qd1	Inland dune deposits	Nhg	Gellibrand Marl
Qa2	Alluvial terrace deposits	Nhc	Clifton Formation
Ql2	Lake deposits	Py	Yaugher Volcanic Group
Qc1	Colluvium	Pd	Demons Bluff Group
Na	Incised alluvium	Pwe	Pember Mudstone
Nep1	Newer Volcanic Group – tuff rings	Pxvb	Eastern view and Boonah formations
Nes	Newer Volcanic Group – scoria deposits	Pww	Wiridjil Gravel
Neo2	Newer Volcanic Group – stony rises basalt	Pwm	Moomowroong Sand
		Koe	Eumeralla Formation

Executive Summary

Colac Otway Shire (COS) has engaged Golder Associates Pty. Ltd. (Golder) to undertake a review of the Erosion Management Overlay (EMO) for the Shire. The overall objective of the review is to streamline and simplify the EMO to reduce the administrative burden it currently presents to Council and applicants whilst ensuring that risk management is appropriate, effective and commensurate with the level of risk.

The review focussed on three key elements:

- identifying opportunities to remove areas from the extent of the EMO mapping;
- identifying opportunities to modify the EMO schedule to increase exemptions and reduce submission requirements, and;
- providing strategies for Council to reduce the burden associated with administering the EMO.

Review of the EMO mapping was undertaken by initially performing a desktop review and referring to past studies, geological mapping and remote sensing information, including LiDAR derived digital elevation models. This was followed up with field mapping to observe the geomorphology across the EMO area and to establish correlations between geology, terrain and landslide susceptibility. Based on this assessment, criteria defining areas within the current EMO without susceptibility to landslide and for which there is assessed to be a basis for their removal from the EMO were developed. Two broad terrain units were identified, approximately divided between the Otway Ranges to the south, underlain by Cretaceous age sandstones and siltstones and younger Paleogene sedimentary deposits and volcanics to the north. Slopes in the southern terrain unit have been assessed as susceptible to landslide where they are steeper than 9° and due to less favourable underlying geology slopes in the northern terrain unit have been assessed as susceptible to landslide where they are steeper than 5°. A revised EMO has been developed by applying these criteria, which results in a reduction in the area affected by the EMO of about 7.5% compared to the current EMO.

Revisions to the Schedule to the EMO have been recommended, including:

- Further exemptions for minor development including some outbuildings and agricultural facilities.
- The removal of the requirement for a geotechnical assessment where there are no credible landslide hazards.
- An alternative approach to the requirement for geotechnical assessment associated with subdivision which requires the identification of development constraints within the subdivision rather than a landslide risk assessment which is currently the case.
- A requirement for geotechnical practitioners who undertake geotechnical assessments within COS to hold a chartership noting that this is in line with incoming Victorian registration requirements for engineers.

In addition, we understand that DELWP has transitional arrangements to update templates for planning schedules and the revised schedule will be updated in accordance with these arrangements.

Improvement to the efficiency of the administration of the EMO by:

- Reviving or renewing simple checklists and internal GIS tools to assist statutory planners with their assessment of EMO applications and providing training in their use.

- Providing simple information to geotechnical practitioners and applicants to clearly communicate the requirements for geotechnical assessments and landslide risk assessments submitted in accordance with the EMO.

Table of Contents

TABLES

FIGURES (ATTACHED)

PLATES (IN TEXT)

APPENDICES

APPENDIX A
Site Visit Observations

APPENDIX B
Revised EMO mapping

APPENDIX C
Example EMO assessment checklist for planners

APPENDIX D
Suggested Revised Schedule to the EMO

APPENDIX E
Important Information

1.0 ENGAGEMENT

Golder Associates Pty Ltd (Golder) in conjunction with AS Miner Geotechnical Pty Ltd (ASMG) has been engaged by Colac Otway Shire (COS) to undertake a review of the COS Erosion Management Overlay (EMO). The review is broad ranging, and considers multiple aspects of the implementation and administration of the EMO, including:

- The extent and appropriateness of the mapping on which the EMO is based.
- The exemptions and requirements for a geotechnical assessment and landslide risk assessment triggered under the schedule to the EMO.
- The efficiency with which the EMO is administered by Council.

The study is being undertaken in general accordance with Golder proposal P20141513-001-P-Rev0 dated 27 March 2020. Golder was engaged to undertake the proposed scope of works under Contract Q18/19 69 executed between Golder and COS on 14 May 2020.

2.0 BACKGROUND

COS has significant areas prone to landslide and other slope degradation processes. The EMO is the key planning control used to manage risk from landslide within the Shire. Under the provisions of the EMO, some development types require a geotechnical assessment or landslide risk assessment to be provided in support of planning applications. The intent of these assessments is to ensure that proposed development will not cause or be at an unacceptable risk from slope instability.

As part of a planning scheme review undertaken in 2017, a recommendation was made that the EMO be reviewed as a high priority. The review is intended to seek ways in which the implementation and management of the EMO can be streamlined through (for example) rationalisation of controls, mapping improvements and changes to planning permit exemptions.

Some of the concerns conveyed to Golder from Council with respect to the EMO include:

- How the requirements of the EMO are interpreted.
- The seemingly large number of permit applications triggered by the EMO and large area of the Shire (about 65%) which is affected by the EMO.
- The quality and effectiveness of geotechnical assessment and landslide risk assessment reports provided in support of planning applications subject to the EMO.
- Inconsistencies in the technical advice Council provides to applicants and their engineers.
- The present day suitability of the mapping on which the EMO is based, noting that most of the mapping was undertaken in the 1990's using what is perceived to be a 'broad brush' approach and could be refined to better represent landslide susceptible areas.
- Imbalance between the level of landslide risk and requirements under the provisions of the EMO.
- Applicability of the EMO to land that could otherwise be made exempt, including public land such as national parks.

The overall objective of the review is to streamline and simplify the EMO to reduce the administrative burden it currently presents to Council and applicants whilst ensuring that risk management is appropriate, effective,

commensurate with the level of risk and in keeping with the Planning Policy Framework of the Colac Otway Planning Scheme.

3.0 OBJECTIVES

Based on our understanding of the background and need for the review, the specific objectives of the EMO review are:

- To reduce unnecessary administrative burden associated with the implementation and management of the COS EMO.
- To review the EMO mapping with a view to better align administrative requirements with the level of landslide risk.
- To review the schedule to the EMO to assess grounds for simplifying controls and providing further exemptions.
- To recommend other strategies that could be used by Council to reduce the administrative burden of managing the EMO, for example training strategies, internal planning tools for statutory planners and guidelines for geotechnical practitioners setting out the requirements and expectations of geotechnical reports provided in support of planning applications.

4.0 METHOD OF REVIEW

The EMO review has been undertaken through a series of defined tasks, 1 through 6 which are briefly summarised below.

Task 1: Project inception meeting and EMO Feedback

A meeting was held with Council with a view to further understanding the issues and concerns associated with the existing EMO, its implementation and administration. The feedback gathered from this meeting was documented and guided the review process. In addition to the meeting a survey was provided to Council to gather written feedback. The general feedback received is summarised in Section 6.1.

Task 2: Desktop review of information and data acquisition

There have been a series of previous studies undertaken to inform the COS EMO, including the development of a landslide inventory. This information informs previous landslide susceptibility within COS and was reviewed as background to setting criteria for removal of land from the EMO mapping. The desktop review and its outcomes are described in Section 5.0.

Task 3: Review of mapping and field assessment

A key element of the EMO review is to assess, and where appropriate, recommend removal of areas from the existing EMO. Information obtained from the desktop review was used to develop criteria for reducing the extent of the EMO in COS. This was followed up with a 4-day field visit to gather further information and to test the criteria developed to identify areas that could be removed from the EMO. Following the field visit, the

technical criteria on which the extent of the EMO could be adjusted was finalised. A revised EMO was then produced. The mapping review is described in Section 7.0.

Task 4: Review and revise schedule to the EMO

The schedule to the EMO sets out the requirements for a planning application, including what type of development might qualify for an exemption and what geotechnical information must be submitted in support of a planning application. Based on feedback from Council, a number of issues were identified with the existing EMO, in particular around exemptions and the requirement for applicants to submit a geotechnical report (either a landslide risk assessment or geotechnical assessment) in situations that do not appear to warrant it. The issues identified and changes made to the existing schedule to address those issues is set out in Section 8.0.

Task 5: Develop other strategies for reduce Council's administrative burden.

Feedback was received around the burden that administration of the EMO and assessment of applications has placed on Council and in particular statutory planners. Means by which the administration of the EMO could be streamlined have been developed and provided as options for Council to consider. Precedent from other Councils has been referred to here. Strategies are suggested in Section 9.0.

Task 6: Deliverables

A written deliverable (this report) has been prepared along with an electronic deliverable showing the recommended revised extent of the EMO.

5.0 HISTORICAL DEVELOPMENT OF THE COS EMO

Natural hazards and in particular landslides have long been recognised as a significant constraint to development in COS. Risks associated with landsides and their management have been a focus of COS since the late 1970's following the involvement of the Town and Country Planning Board in the region. Formal involvement at a local government level commenced in 1984 through the establishment of the Shire of Otway's (Ocean Road) Interim Development Order (IDO) which gave responsibility of planning for residential areas to the Shire's planning officers.

Further changes have occurred since that time as a result of state legislation and planning law reform with the current Victorian Planning Provisions (VPP's) governing responsibility for planning issues including development in areas prone to landslide. This responsibility now lies directly with COS as the responsible authority.

A history of recent changes to the COS EMO has been previously documented in ASMG (2011) and ASMG (2013). These changes have included revisions to the COS landslide inventory and landslide susceptibility mapping which have led to modifications to the recommended spatial extent of the EMO overlay. Some of these revisions have been acted upon and included as amendments to the planning scheme whilst others have not been adopted. These are summarised in Table 1 (studies undertaken to inform the EMO) and Table 2 (amendments implemented to the EMO).

Table 1: Summary of Historical Development of the EMO

Date	Report	New susceptibility maps	New EMO recommended	Comments
2006	CCMA landslide and erosion susceptibility mapping project (ASMG Report no 306/01/06).	New inventory and susceptibility maps provided.	Draft recommendations for new EMO including moderate and higher susceptibility classes.	Due to the fact that the suggested draft EMO1 remained in raster format, it contained a myriad of isolated "islands" and "holes", which were deemed unacceptable for a planning control map. Recommendations were made to resolve this.
2008	Refinement of the Proposed EMO as supplied by the CCMA. (ASMG Report no: 426.1/01/07).	Simple geology and slope maps used to delineate landslide susceptibility combined with field verification in 6 specific development areas only.	The final EMO1 merged the geology-slope models in the 6 areas of interest with the previous Corangamite CMA model in all remaining areas.	Incompleteness of inventory and need to verify in other areas were seen as a major limitation in extending the revision to other areas beyond the 6 specific development areas.
2010	NDMP Project: landslide mapping and susceptibility project. (ASMG Report No: 477/02/10).	Use of new inventory, input data sets and a more sophisticated modelling process resulted in new susceptibility maps.	No recommendation made for new EMO.	Whilst the improved methods worked well in other Local Government Areas, limitations in overall landslide inventory restrict the success of revision in COS.
2011	Revision of Colac Otway Shire's Erosion Management Overlay ASMG report No 517/01/10.	No new inventory but revised geology/slope angle method used to assist with identification of susceptible areas.	New EMO was developed using traditional geomorphic mapping using expert judgement and available data sets to redraw boundaries.	Whilst utilising a more basic method due to limited budget, the resulting new EMO was much more cartographically pleasing and contained many less isolated "outliers" and "holes" in the final product.
2013	Coordinated Landslide Data and Inventory Project including improved landslide susceptibility mapping. ASMG report No 557a/01/13.	New inventory and new susceptibility maps provided for shallow landslide, deep seated landslide and rockfall.	Recommendation to use the existing EMO with some modifications to capture newly identified landslides. No removal of areas from the EMO.	Changes included alignments with official COS LGA boundary, inclusion of new mapped landslides and some additional areas added as a result of new susceptibility modelling. The proposed changes only resulted in a net increase to the EMO of 6 ha. However, it is understood that these changes were never formally adopted.

Table 2: Summary of COS EMO Amendments

Amendment Number	In operation from	Brief Description
C8	28 Sep 2006	The amendment inserts a new local policy to guide decision making for land to which the Schedule 1 to the Erosion Management Overlay applies, extends the application of the Erosion Management Overlay across the southern portion of the municipality, replaces the existing Schedule 1 to the Erosion Management Overlay with a new schedule and amends Clause 61.03 to insert new EMO maps into the scheme.
C54	23 Feb 2012	The amendment corrects various planning scheme zone mapping errors and amends the EMO mapping. In particular amends Planning Scheme Map Nos. 7, 9, 10, 11, 12, 13, 15, 16, 17, 18, 19, 20, 21, 23, 24, 25, 29 and 30; and amends Planning Scheme Map Nos. 11EMO, 12EMO, 13EMO, 14EMO, 15EMO, 16EMO, 17EMO, 18EMO, 19EMO, 20EMO, 21EMO, 22EMO, 23EMO, 24EMO, 25EMO, 26EMO, 27EMO, 28EMO, 29EMO and 30EMO.
C68	31 Jan 2013	The Amendment extends the application of the EMO and replaces Schedule 1 to the EMO with a new Schedule.
C74	19 Feb 2015	The amendment implements the recommendations of the Apollo Bay Settlement Boundary and Urban Design Review 2012 by updating urban design initiatives for the Apollo Bay town centre, confirming the location of the settlement boundary, rezoning part of an industrial estate in response to its proximity to residential areas, rezoning land to Neighbourhood Residential Zone and applying a Development Plan Overlay (DPO) to land at the northern end of Apollo Bay, amending the DPO schedule for the Mariners Vue estate, applying a common DDO schedule to both the Mariners Vue estate and a new residential area, listing the Apollo Bay Settlement Boundary and Urban Design Review 2012 as a reference document in the planning scheme and updating sections of the Local Planning Policy Framework relevant to Apollo Bay.

6.0 DESKTOP REVIEW AND DATA ACQUISITION

The following sets out the information obtained during the desktop review and how that information has informed the EMO review.

6.1 Survey and feedback from COS

Feedback on issues that Council has experienced related to the administration of the EMO was gathered via a survey form and through online meetings. A summary of the key feedback gathered through this process is set out below. This feedback provided direction to the review process including mapping revisions and changes to the schedule to the EMO.

EMO Mapping

There are areas within the current extent of the EMO, that appear to be essentially flat land. Geotechnical assessments and landslide risk assessments in these areas typically indicate low risk. There may be a basis for the removal of some of these areas from the EMO. Specific areas mentioned that may fall into this category include:

- Areas to the north of the EMO area, including around Barwon Downs, Forrest and Gellibrand.
- Areas near the COS boundary where the EMO planning controls apply to COS but there are no planning controls in the adjacent shire. Pennyroyal was mentioned as one such area.
- There could be a basis for the removal from the EMO mapping of public land.

EMO Schedule and Exemptions

- There are potentially discrepancies between the requirements of VicSmart applications and requirements of the EMO that may need to be resolved.
- There could be a greater number of exemptions, in particular for minor development such as sheds and farm buildings.
- The requirements for subdivisions where no buildings are proposed may be too onerous, in particular given a separate application is required for future development within the subdivision.
- The schedule does not clearly articulate what level of landslide risk the application must demonstrate. Consideration could be given to including clearly defined risk criteria in the schedule.
- There may be a need to achieve consistency between the EMO and other planning schedules.
- The requirement for the applicant to provide Form A is seen as a positive.
- There have been cases where no permit application is required for the conversion of non-habitable buildings to habitable buildings.

EMO Administration

- There have been difficulties in the past implementing conditions under the EMO. Forms C and G have been used in the past.
- Not all Council planning staff receive training in the EMO and its implementation, which to some extent is a function of staff turnover.
- Checklists and training sessions have been tried in the past and there are no barriers to reinvigorating this approach.
- Planners sometimes have difficulty in reviewing information contained in landslide risk assessment reports because they don’t necessarily have an engineering background. Additional third party review of planning applications would be a feasible approach.

6.2 Previous Landslide Studies in COS

In order to better understand and manage development in areas prone to landslides within the COS local government jurisdiction, various studies including the collation of landslide inventories through remote and on-ground mapping and landslide susceptibility mapping have been conducted since the 1980's. The following provides a summarised history of landslide inventory and landslide susceptibility in COS based on earlier work by ASMG (2013).

6.2.1 Previous Landslide Inventory Development

Whilst individual data sources on landslides have been produced since the early 1980's, formal inventories have only commenced after 2000 and have been associated with the work undertaken or supervised by Dr. Peter Dahlhaus at the University of Ballarat (UoB) and more recently undertaken by ASMG. Some of this work has been completed on a commercial basis but much of the more recent inventory work has been collated during research into landslides within the region as part of the numerous projects funded by various organisations such as the CCMA, COS, the former Victorian Department of Primary Industries (DPI) and the Attorney General's Department – Emergency Management Australia.

Table 3 sets out these various landslide inventory studies. A more comprehensive description of aspects of each study is provided in the earlier report by ASMG (2013).

Table 3: Summary of Previous Landslide Inventory Studies in COS

Data Source and Commissioning Organisation	Year	Areas Assessed	Number of Landslides	AGS 2007a Landslide Zoning Classifications				
				Type of Assessment	Characterisation Method	Zoning Level	Scale of application	Purpose
Cooney GSV	1980	Otway Ranges/ Shire wide	702	Inventory	Basic	Preliminary	Captured at 1:16,000 but displayed at 1:100,000	Information
Dahlhaus UoB	2001	Colac Otway Shire	860	Inventory	Basic	Preliminary	Various as per individual data sources	Information
McVeigh UoB	2001	Colac Otway Shire		Inventory	Basic	Preliminary	Various as per individual data sources	Information
Feltham UoB	2004 and 2005	Colac Otway Shire and other shires in CCMA		Inventory	Basic	Preliminary	1:25,000 orthographic photos used with on screen capture at 1:5,000	Information
ASMG/ Roberts COS	2006	Coastal areas in COS		Inventory/ terrain Classification	Intermediate	Intermediate	1:25,000	Information
ASMG/ Roberts COS	2007	Apollo Bay/Birregurra Barwon River		Inventory/ terrain Classification	Intermediate	Intermediate	1:25,000	Information
ASMG/ DPI	2007	Colac Otway Shire/CCMA		Inventory	Basic (to Intermediate)	Preliminary	Variable as multiple data sources used.	Information
ASMG NDMP	2008	Colac Otway/ CCMA Shire	2426	Inventory (small to very large slides)	Basic (to Intermediate)	Preliminary	Variable as multiple data sources used.	Information

Data Source and Commissioning Organisation	Year	Areas Assessed	Number of Landslides	AGS 2007a Landslide Zoning Classifications				
				Type of Assessment	Characterisation Method	Zoning Level	Scale of application	Purpose
ASMG NDMP	2009	Colac Otway/ CCMA Shire	336 additional	Inventory (large and very large slides)	Basic	Preliminary	1:5,000 to 1:10,0000	Information
ASMG Research	2012	Victoria wide with some COS	A few only in Apollo Bay	Inventory	Basic	Preliminary	Variable as multiple data sources used.	Information
ASMG COS	2013	Colac Otway Shire	464 additional for a total of 3226	Inventory (large and very large slides)	Basic	Preliminary	1:5,000 to 1:10,0000	Information

Whilst the combined landslide inventory currently includes over 3000 landslides in the COS local government area, this cannot and must not be assumed to be a complete inventory of all landslides. Due to limitations of capture methods, including the quality and scale of imagery, inaccessibility of some areas for field assessments and incomplete recording of historical occurrences, there will be many landslides of all types and sizes that exist but have not been captured as part of the current inventory.

In addition, the majority of the information within regional databases has been captured with the aid of remote means such as aerial photography or LiDAR based DEM interpretations. As such very little is known about these landslides other than their spatial extent. Information about date of occurrence, the pre failure topography, depth of sliding, speed of travel and groundwater conditions at the time of failure are absent from the records.

It is known that the cause of many of the largest landslides is related to weak interbeds of siltstone and mudstone within the stronger sandstones of the Eumeralla Formation but this information is rarely available. In addition, conditions at the time of failure such as groundwater levels or seismic activity are also mostly not obtainable. As such, whilst the number of entries in the COS regional database is significant, essentially not much is known about these landslides except for their distribution within the surface geological units, noting that there are further inaccuracies associated with the geological boundaries (refer discussion in Section 7.1.2).

Notwithstanding the limitations associated with both landslide inventory and susceptibility maps, it can be deduced from the current information that the Gellibrand Marl (Nhg) and the Eumeralla Formation deposits (Koe) are the units in which most landslide have occurred within COS. However, it must be acknowledged that landsliding can occur in any geological unit if thresholds for slope angle, material strengths, groundwater pressures and imposition of external loadings are exceeded.

6.2.2 Previous Landslide Susceptibility Mapping

Many of the early landslide studies in the Colac Otway region included not only maps of landslides and landslide inventory but comments on landslide susceptibility. The earliest work by Cooney (1980) and Wood (1982) developed an understanding of landslide susceptibility as it relates to the most widespread of the geological units, the Cretaceous age Eumeralla Formation. These studies lead to the development of slope thresholds for landslide potential and were basic in their approach.

Later studies expanded on this to include more detailed relationships between various geologies and categories of susceptibility again based on slope angle (Dahlhaus 2001, McVeigh 2001 and Feltham 2004/5). More involved methodology was then trialled ranging from multi variable approaches (ASMG 2007, 2008, 2009) to data mining techniques (Flentje, 2008).

Later approaches sought to better utilise increased knowledge regarding the types of landslides contained within the inventory to develop individual landslide susceptibility maps using a variety of approaches for shallow seated, small to large landslides, deep seated large and very large landslides and rockfall susceptibility (ASMG 2013).

Finally the most recent assessment of landslide susceptibility (Golder 2019 and 2020) and the mapping described in this report has sought to utilise a geomorphic terrain based approach in combination with detailed site observations of geology, lithology, structure and orientation at a local scale for a number of the coastal settlements including Wye River and Skenes Creek.

A detailed chronological listing of the various landslide susceptibility approaches is shown in Table 4. Further details on methodology are provided in ASMG (2006), ASMG (2013), Golder (2019) and Golder (2020).

Each method has its own limitations, and has differing accuracy at different scales and whilst all approaches must be viewed as an imperfect prediction of landslide susceptibility which defines where landslides exist (the mapped occurrences) and where landslides could potentially occur (the assessment of where they might occur based on past performance and correlation of like conditions). As such there can be no right or correct answer but only approaches that better model the spatial distribution of both past and future occurrences.

The combination of mapped landslides contained in the landslide inventory and areas susceptible to landslides (usually moderate, high and very high susceptibility classes) provided by the various landslide susceptibility mapping outputs is used to define the spatial extent of areas that require management by COS under the requirements of Victorian Planning Scheme.

Table 4: Summary of Previous Landslide Susceptibility Zoning in COS

Data Source and Commissioning Organisation	Date	Area Mapped	Methodology	AGS 2007a Landslide Zoning Classifications*			
				Type of Landslide Zoning	Zoning Level	Scale of application	Purpose
Cooney GSV	1980	Torquay to Port Campbell	Landslide Zonation using three class system	Susceptibility (Large and very large Landslides)	Preliminary	Regional at nominal 1:50,000 to 1:100,000	Advisory
Dahlhaus and Miner COS	2000	Cretaceous deposits of the Otway Ranges	5 class geology-slope only	Susceptibility (Small to very large landslides)	Preliminary	Regional at nominal 1:50,000 to 1:100,000	Advisory
Dahlhaus COS	2003	Wye River, Separation Creek and Kennett River	Continuous relative potential based on slope angle, aspect and orientation of discontinuities	Susceptibility (Small to very large landslides)	Intermediate to Advanced	Local at 1:75,000	Information to Advisory
Pirvic DPI	2003	CCMA wide	Imperfect algorithm based on soil landform adjusted through panel judgement	Susceptibility (Small to very large landslides)	Preliminary	Regional at 1:100,000	Information
Feltham Ballarat Uni	2005	CCMA wide	GIS based numerical weighting method	Susceptibility (Small to very large landslides)	Preliminary	Regional at 1:100,000 to 1:250,000	Information
ASMG CCMA	2006	CCMA wide	Composite index method using multi variates	Susceptibility (Small to very large landslides)	Intermediate	Regional at nominally 1:25,000 but probably more appropriate at 1:50,000	Advisory
ASMG COS	2008	COS and cogg	Revised geology slope method	Susceptibility (Shallow landslides)	Basic	Regional at 1:25,000	Advisory
ASMG NDMP	2010	CCMA included targeted townships for COS	Multi variate/geology slope	Susceptibility (small to very large landslides)	Intermediate	Regional at 1:25,000 to 1:50,000	Information
Flentje NDMP	2010	COS	Data mining approach	Susceptibility (Small to very large landslides)	Intermediate to Advanced	Regional at 1:25,000 to 1:50,000	Information

Data Source and Commissioning Organisation	Date	Area Mapped	Methodology	AGS 2007a Landslide Zoning Classifications*			
				Type of Landslide Zoning	Zoning Level	Scale of application	Purpose
ASMG COS	2011	COS	Revised geology/ slope threshold angles	Susceptibility (Shallow landslides)	Basic	Regional at 1:25,000 to 1:50,000	Information to Advisory
ASMG COS	2013	COS	Shallow landslide (threshold approach)	Susceptibility (Shallow landslides)	Basic	Regional at 1:25,000 to 1:50,000	Information to Advisory
ASMG COS	2013	COS	Deep seated landslides, rockfall GIS modelling,	Susceptibility (deep, large to very large landslides)	Basic	Regional at 1:25,000 to 1:50,000	Information to Advisory
ASMG COS	2013	COS	Rockfall (MRT approach)	Susceptibility (landslides-rockfall)	Basic	Regional at 1:25,000	Information to Advisory
Golder and ASMG COS	2019	Wye River and Separation Creek	Terrain mapping and engineering judgement	Susceptibility (Small to very large landslides)	Basic to Intermediate	Local at 1:10,000	Information to Advisory
Golder and ASMG COS	2020	Skenes Creek, Grey River and Kennett River	Terrain mapping and engineering judgement	Susceptibility (Small to very large landslides)	Basic to Intermediate	Local at 1:10,000	Information to Advisory

6.3 Available Information

During the various studies and reviews undertaken to assess landslides in COS, a number of landslide-related GIS parameter datasets have been acquired and used along with mapped landslides to assist the modelling process and to identify areas without landslide susceptibility that could be removed from the EMO.

As a result, the following landslide-related datasets have been previously developed and collated during various studies and were available for the assessment set out in this report. These are set out below.

Elevation – Digital Elevation Model (DEM):

- State-wide 20 m DEM (VicMap Elevation) sourced from DELWP.
- 10 m DEM (VicMap Elevation) sourced from DELWP.
- Composite 5 m DEM that is based on a mosaic of the best available LiDAR data sourced from the several LiDAR projects funded by CCMA, DELWP and other partners. This dataset has been used in mapping terrain units, resampled to 10m for ease of processing.
- 1 m Future Coasts coastal LIDAR (2008) sourced from DELWP.

Second derivative layers generated from both the 5 m and 10 m DEMs again based on same versions as described above:

- Slope angle
- Slope aspect

Second derivative layers generated from the 5 m DEM which was resampled to 10 m for the terrain mapping process:

- Flow length
- Flow accumulation
- Plan curvature
- Profile curvature
- Topographic wetness index

Raster layers (10 m) converted from spatial vector data (polygons)

- Geology - Geoscience Victoria (GSV) seamless Geology at 1:50,000 scale
- Vegetation - EVC classes at 1:100,000 scale
- Land Use – 1:100,000 scale
- Geomorphic Terrain Units (3rd tier) at 1:100,000 scale
- Soil Landform units at 1:250,000 scale
- Land Systems at 1:250,000 scale

Other parameter datasets that have been used in the terrain mapping process (and converted into raster layers) (10 m) including:

- Rainfall - annual values based of grid of 500 m
- Proximity to geological structure (faults) – 100 m buffer and based on geology dataset
- Proximity to water courses - (using a 50 m buffer) and based on VicMap 25K data
- Proximity to water bodies - (using a 50 m buffer) and based on VicMap 25K data
- Proximity to coastline - (using a 50 m buffer) and based on VicMap 25K data

Aerial imagery has also been used as a reference dataset, which is publicly available from DELWP in the form of web mapping services (WMS) and is based on data that is typically 5 to 10 years old.

6.4 Geology

The geological units underlying COS are presented on the geological map in Figure 2 and tabulated in Table A1 in Appendix A along with field observations setting out characteristics of each unit. For the purposes of assessing areas with potential to be removed from the EMO, the geological units have been grouped based on similar geomorphological properties and susceptibility to landslide. The following groupings have been adopted:

- Early Cretaceous Eumeralla Formation (Koe), comprising sandstone, mudstone, conglomerate and minor coal. This unit underlies most of the southern part of the COS including the Otway Ranges.
- Late Cretaceous to Eocene deposits: Moornowroong Sand (Pwm), Wiridjil Gravel (Pww), Eastern view and Boornah formations (Pxvb) and Pember Mudstone (Pwe) materials. This material is exposed at the ground surface to the north of the Otway Ranges.
- Eocene to Oligocene deposits: Yaugher Volcanics Group (Py) materials and the older Demons Bluff Group (Pd) unit. This unit is not extensive at the ground surface, present as isolated ‘islands’ to the north of the Otway ranges.
- Oligocene to Pliocene deposits: Gellibrand Marl (Nhg) and Clifton Formation (Nhc) materials and the overlying (younger) Red Bluff Sandstone (Nbr), Brighton Group (Nb) and Black Rock Sandstone (Nbb) deposits. These deposits are predominant on the north side of the Otway Ranges and are known to be susceptible to landslide.
- Miocene to Holocene volcanics: Geologically recent volcanic deposits including Nep1, Nes, No2 and Neo units. These areas are generally present to the north of Colac and have low susceptibility to landslide.
- Pliocene to Holocene deposits: Generally, geologically recent alluvial, lacustrine, aeolian and colluvial deposits including Qc3, Qa1, Qm1, Ql1, Qd1, Qa2 Ql2, Qc1 and Na units.

6.5 Geomorphology

The surface geomorphology of the area is an expression of the underlying geological units, geological structure and regional topographic gradients. Drainage and erosion patterns generally reflect structural geological patterns, for example, faults, folds and bedding planes, with maximum stable slope angles typically a function of the geological unit and structure.

On a large scale the geological units on the flanks of the Otway Ranges area are broadly similar. The southern flank of the Otway Ranges, draining directly down towards the coast, has a steeper overall gradient than the northern flank, which drains to inland areas with a less direct drainage path to the coast, lessening the drainage gradient. The northern flank of the Otway Ranges has been less deeply incised due to the shallower drainage gradient. This terrain generally has shallower slope angles and less prevalence of landsliding.

Geomorphological mapping has previously been undertaken within the COS area for various purposes including Pitt (1981) and Rees (2000). Pitt (1981) divides the area into relatively detailed geomorphological units linked to geology and provides typical soil, landscape, vegetation attributes and describes typical soil deterioration for each unit, including brief notes on erosion and landslide susceptibility.

The geomorphological units described by Pitt (1981) have been combined and refined based on landslide susceptibility observed in remote desktop mapping and field observations and has been used to assist in the development of the ‘terrain units’ for this study. The result is two broad terrain units. The terrain units were further refined based on the fieldwork site observations and landslide mapping described in Section 7.0, with the resultant terrain units shown in Figure 3. The slope angle at which each of these terrain units was assessed as susceptible to landslide was assessed as set out in Section 7.0.

7.0 REVIEW OF MAPPING AND FIELD ASSESSMENT

The following sets out the process undertaken to review the extent of the existing EMO and to identify areas without landslide susceptibility that could be removed from the EMO.

7.1 Field visit observations

7.1.1 Methodology

The field assessment was carried out between 20 and 23 July 2020 by Stuart Colls of Golder and Tony Miner of ASMG. The focus of the field assessment was the region within the current EMO bound roughly to the north by the townships of Irrewillipe, Elliminyt, Warncoort and Birregurra, and to the south by the townships of Chapple Vale, Carlisle River, Gellibrand, Forrest, Barwon Downs and Pennyroyal. Figures 4 and 5 (attached) show the field routes traversed on each day (from an accommodation base in Gellibrand) and locations where field observations (e.g. photographs) were recorded.

This region was selected as the focus of the field assessment based on feedback from COS (refer to Section 6.1) about priorities for the limited field time available and areas where COS indicated that a high proportion of geotechnical reports submitted in support of planning applications indicated ‘Low’ risk to development within the current EMO. The results of the desktop assessment and geomorphological mapping also indicated significant areas of relatively flat land in this region which could potentially be removed from the revised EMO.

The field assessment did not include coastal areas, the general Otway Ranges, central Colac nor north of about the Princes Highway within COS, given the desk study did not indicate there to be significant

opportunity for revision of the EMO extent in these areas. However, the proposed revision to the EMO includes some recommendations for the coastal townships of Skene's Creek, Kennett River, Grey River, Wye River and Separation Creek based on the recent Golder/ASMG (2019) and Golder/ASMG (2020) studies (refer Table 4) in these townships.

Observations made during the field assessment are summarised in Section 7.1.2, which should be read in conjunction with the following information in Appendix A:

- A summary table of the geological units indicated to be present near the area of the field assessment, based on information obtained from the Victorian State Government GeoVic online mapping application (1:50,000 scale seamless surface geology), including the geological age, a brief description and the map sheet abbreviation for each unit based on the GeoVic information.
- Selected photographs taken during the field assessment.

The photographs in Appendix A are summarised using the following geological groupings as set out in Section 6.4.

Section 7.1.2 also includes summary comments relating to properties within the current EMO where COS has indicated that recent geotechnical reports indicate 'Low' risk, and where there are apparent inconsistencies between the landslide susceptibility assumed in COS compared to the adjoining local government areas of Corangamite and Surf Coast Shire.

In reviewing the observations summarised in Section 7.1.2 it is also important to recognise the following limitations:

- Observations were restricted to areas visible from public property, e.g. road reserves.
- Weather conditions at times impeded observations. The weather during the field assessment was typically partly cloudy or overcast with occasional showers and maximum temperatures of about 11°C to 12°C. Whilst these conditions were generally favourable for visual assessment there were periods of morning fog and low cloud or rain which limited visibility.
- The presence of vegetation and other obstructions can make it difficult to visually identify evidence of landslides such as headscarps or undulating/hummocky slopes. Generally, photographs of landslide features in Appendix A are of farmland or logged/cleared areas that are free of trees, but this should not be taken as indicating that these are the only areas where landslide features may be present.

7.1.2 Observations

Key observations made during the field visit are summarised as follows. Photo references can be cross referenced to Appendix A.

- There are large, relatively flat areas (slopes of less than about 5 degrees) in the northeast part of the field assessment area that are within the current EMO but which do not appear to be susceptible to landslide (e.g. Photos 42, 45, 49 and 50). The surface geology in these areas typically comprises Gellibrand Marl (Nhg) or Demons Bluff Group (Pd) materials.
- The Gellibrand Marl (Nhg) and Yaugher Volcanics Group (Py) materials generally appear to have a higher susceptibility to landslide than the other geological units (see comments on alluvial/colluvial and below), i.e. evidence of landslide was observed on relatively shallow slopes (e.g. Photos 35, 46 and 52), with some landslides observed on slopes ranging from about 5 degrees to 9 degrees.
- The susceptibility to landslide of the Eumeralla Formation (Koe) materials increases with increasing slope angle. Evidence of landslide was not observed on slopes shallower than about 9 degrees and was increasingly evident on slopes steeper than about 14 degrees (e.g. Photo 4), with a transition between these slope angles where landslide was present in some areas but not others with the variability potentially attributable to factors such as drainage (e.g. increased susceptibility at the toe of the slope near watercourses) or lithography (e.g. siltstone and areas with a deep weathering profile more susceptible than sandstone or shallow rock areas). Photos 5 to 8 illustrate the range in Koe slopes observed, with steep, hummocky slopes indicative of landslide generally observed within the north part of the Otway Ranges (Photo 6) and generally planar, shallower slopes in the area near Barongarook West (Photo 7). Photo 8 indicates the increased potential for instability near drainage features on otherwise generally planar slopes.
- The Late Cretaceous to Eocene deposits (Pwm, Pww, Pxvb and Pwe materials) often appear to be present as a shallow capping or drape over the underlying Koe (Photo 16) and their susceptibility to landslide generally appears to be governed by the susceptibility of the underlying materials. Subject to the accuracy of the geological mapping (see further comments below), there is some evidence to suggest the Pwm materials are more susceptible to landside than the Pwm, Pxvb and Pwe materials (e.g. Photos 27 and 28). In the area southeast of Barongarook there appear to be more extensive deposits of Pww materials that have been quarried/mined, presumably as a sand resource (Photo 14). There are also some relatively flat slopes in the area southeast of Barongarook that are in the current EMO but do not appear to be susceptible to landslides (e.g. Photo 17). Some anomalous topography observed in hillshade images of Pww areas are also inferred to represent historical sand mining. However, it was not practical to access these areas during the field assessment.
- Evidence of slope instability and the failure of a retaining wall was observed on a modified (cut) slope in Pxvb materials east of Pennyroyal, close to the boundary between COS and Surf Coast Shire (Photo 32). There did not appear to be evidence of landslide on the natural slope (about 8 degrees) but slumping of the modified slope at about 12 degrees was observed. Hummocky ground and some evidence of hillside creep (misaligned power poles) was observed on a slope of about 6 degrees to 8 degrees in what appeared to be wet ground in Pwm materials near Chapple Vale (Photo 27). The Late Cretaceous to Eocene deposits are predominantly sandy and in some areas are cemented (Photo 11 to Photo 15). Temporary batter slopes associated with quarry activities and road cuttings were observed at angles of up to about 50 degrees.
- The susceptibility to landslide of the Demons Bluff (Pd) and Nbr/Nb/Nbb deposits (predominantly Black Rock Sandstone, Nbb, in the field assessment area) as assessed in the field appears to be variable, with some of this variability attributed to the accuracy of the geological mapping as well as the nature of these

geological units and the materials they overlie. For example, slopes in the vicinity of Springs Road, southeast of Colac (Photo 40), where the geological mapping indicates that the Pd overlies Late Cretaceous to Palaeocene (Pww) materials, generally appear to have a lower susceptibility to landslide than the slopes in similar mapped geological conditions near Yeodene (e.g. Photos 41 and 44). Some of this difference may be the result of topography and drainage conditions which have permitted deeper erosion near watercourses that drain into the sea via Barwon River and Gellibrand River rather than to Lake Colac or Lake Corangamite to the north. However, the geology map indicates that Gellibrand Marl (Nhg) materials may overlie the Demons Bluff Group (Pd) near Yeodene and the increase in susceptibility in this area could be due to the incorrect mapping of Nhg as Pd. Where a cap of Black Rock Sandstone (Nbb) materials overlies Gellibrand Marl (Nhg) (e.g. Photo 53), the susceptibility of Nbb to landslide appears to be governed by the susceptibility of the Nhg.

- There are some other areas where the mapped geology (Figure 2) does not appear to be consistent with the geomorphology observed during the field assessment, as follows:
  - The extent of Pww near Tomahawk Creek, southwest of Irrewillipe East. The relatively shallow slope of incised valleys away from the flat ‘cap’ of Nbb materials is consistent with slopes in Nhg materials elsewhere and not the Pww indicated in GeoVic. Note the Geological Survey of Victoria 1:250,000 scale ‘Colac’ map sheet dated 1996 indicates more extensive Nhg (then labelled Tmi) in this area.
  - The mapping of Wirdjil Gravel (Pwm) materials. The Pwm materials exposed in road cuttings in the northeast part of the field assessment area (e.g. near Spring Creek, Barongarook West, Photo 12) appear very different (more clayey and a different colour) to the Pwm materials exposed near Chapple Vale in the southwest part of the field assessment area (Photo 13), noting this unit is described as comprising quartz sand with minor clay (Table A1 in Appendix A). The geomorphology of the areas mapped as Pwm in these areas is also different, with generally steeper valley sides near Chapple Vale compared to Barongarook West, and evidence of landslides on the east side of Spring Creek near Barongarook West (Photo 28). Given there is a capping of Nbb mapped near Barongarook West, it is possible there are Gellibrand Marl (Nhg) materials that have not been mapped or mapped incorrectly as Pwm. It is also possible that the Pwm materials have landslide susceptibility similar to the Nhg unit but this alternative seems unlikely based on the different geological age and lithology of the units as indicated by the published geological information.
  - The mapping of Eastern View Formation (Pxvb) materials on the east side of Deans Marsh Creek, Rifle Butts Road, Whoorel, appears inconsistent with the geomorphology and evidence of colluvium and landslides (Photo 48) on slopes that are generally less than 10 degrees. The materials in this area appear to be more consistent with Gellibrand Marl (Nhg), or Black Rock Sandstone (Nbb) overlying Nhg as is mapped on the west side of Deans Marsh Creek nearby.
  - The extent of Demons Bluff Group (Pd) near Yeodene. The evidence of landslide on slopes below the nominal contact between Gellibrand Marl (Nhg) materials over the Pd materials (Photos 41, 43 and 44), and the differences in geomorphology in areas mapped as Pd near Springs Road and Yeodene (see previous comment) suggests that the Nhg materials may be more prevalent than has been mapped in this area.
  - There are also areas where the surface geology may only comprise a thin layer, e.g. Wirdjil Gravel (Pww) or Moomowroong Sand (Pwm) over Koe (Photo 29) or Black Rock Sandstone (Nbb) over Gellibrand Marl (Nhg) and the geomorphology and landslide susceptibility is governed by the underlying materials rather than the surface geology.

- There are typically colluvial and/or alluvial materials present at the toe of slopes and near drainage features such as gullies and watercourses, with the extent of these deposits not completely recorded on the geological maps. The landslide susceptibility of the colluvium/alluvium generally appears to be similar to that of the Gellibrand Marl (Nhg) and Yaugher Volcanic Group (Py) units, i.e. a higher susceptibility than the Koe and Pww materials. Photos 56 and 58 provide examples of colluvial or alluvial deposits near the toe of slopes and drainage features.

'Low' risk properties identified by COS

Several properties identified by COS as being within the current EMO but with recent geotechnical assessment of 'Low' risk to development were visited during the field assessment. Generally, these properties are in areas where there is a significant break in slope partway across the property, i.e. part of the property is on relatively flat ground and part of the property is on steeper slopes. If the proposed development was on the 'flat' part of the property an assessment of 'Low' risk appears reasonable (removal of these 'flat' areas from the current EMO is part of the recommended revision). However, the slope/geology of at least part of the property meant inclusion of at least part of the property within the EMO is justified.

Photo 49 illustrates a property identified by COS as having a risk assessed as 'Low', where there is relatively flat land on the west side of the property and steeper slopes down to the Barwon River East Branch further east. Photos 9 and 45 show two different properties located near the intersection of McPaddens Road and Creamery Road, Barwon Downs, where COS indicated assessments had been undertaken which indicate 'Low' risk. Photo 45 shows gentle slopes (underlain by Demons Bluff Group materials) where an assessment of 'Low' risk appears reasonable. However, the undulating, steeper Koe slopes in Photo 9 indicate that inclusion of the property in the EMO is warranted. If the development that was the subject of the assessment is located on a relatively flat part of the site the risk may also be 'Low'. However, it is important to recognise that development on one part of the site may also require the construction of access roads or service infrastructure where consideration of the landslide risk is important.

Some properties were also observed where the assessment of 'Low' risk (we have not been provided with a copy of the risk assessment reports) may not be justified by the site conditions. For example, a property assessed as 'Low' risk near the intersection of Cashins Road and Robinsons Road, Kawarren, is in an area of hummocky terrain underlain by Demons Bluff Formation (Pd) and Yaugher Volcanics (Py) materials (at the right hand side of the valley in Photos 35 and 36).

Landslide susceptibility of neighbouring local government areas

At the request of COS, limited observations for evidence of landslide were made in the adjacent Corangamite Shire to the west (from Coradjil Road), and Surf Coast Shire to the east (east of Pennyroyal). These limited observations were made in areas where the published geology is similar to areas susceptible to landslide and included in the current EMO within COS.

Photo 52 indicates hummocky ground in Corangamite Shire that is consistent with landslide or a series of landslides within Gellibrand Marl (Nhg) materials. Photo 31 shows slopes mapped as colluvium below Eastern View Formation (Pxvb) materials east of Pennyroyal, in Surf Coast Shire. The failed retaining wall at the toe of the road cutting in Photo 32 is also within Surf Coast Shire (close to the boundary with COS). Based on our limited field observations in these 'border' areas we consider the geological and geomorphological processes observed in COS to be similar on land in adjacent local government areas that should warrant management of landslide risk via an EMO.

7.2 Delineation of Terrain Units

Observations from the field assessment, in conjunction with the desktop information review and geomorphological mapping, were used to define the following two terrain units within the field assessment area that form the basis for identifying areas within the current EMO that do not have susceptibility to landslide.

In line with the overall objective of the EMO review to streamline and simplify the EMO to reduce the administrative burden it currently presents to Council and applicants whilst ensuring that risk management is appropriate, effective and commensurate with the level of risk, the focus of terrain unit delineation was on identifying areas with similar geomorphological behaviour that do not appear to be susceptible to landslide and could potentially be excluded from the current EMO is warranted. The delineation of the following terrain units also considers the limited time available for field assessment and limitations on access to parts of the field assessment area, i.e. the units are not defined solely by geological and geomorphological characteristics.

The terrain unit delineation is shown in Figure 2.

Terrain Unit 1 – Eumeralla Formation and associated materials

Terrain Unit 1 is defined as the parts of the field assessment area where susceptibility to landslide appears to be governed by the Eumeralla Formation (Koe) materials. These areas are summarised as follows:

- Areas where the published surface geology comprises Koe.
- Areas where the published surface geology comprises Late Cretaceous to Eocene deposits (Moornowroong Sand, Pwm, Wiridjil Gravel, Pww, Eastern view and Boornah formations, Pxvb and Pember Mudstone, Pwe) and there is sufficient confidence from the field assessment and associated studies that the mapped geology is consistent with the observed geomorphology.
- Colluvium or alluvium within drainage features within the above areas.

Terrain Unit 1 includes the following areas:

- The central part of the field assessment area extending from northeast of Carlisle River to Eliminyt, and including the area mapped as Wiridjil Gravel (Pww) near the sand quarry southeast of Barongarook. The northwest boundary of this central part of Terrain Unit 1 is taken as the alignment of the Ferguson Hill Anticline and Deans Creek Monocline geological structures. The northern boundary is the northern extent of the mapped Eumeralla Formation (Koe) and Pww units. The east and southeast boundary is typically the mapped geological boundary between Pww and Demons Bluff Group (Pd) units. The south boundary (west of Gellibrand) is the southern extent of the mapped Koe unit.
- The Late Cretaceous to Eocene deposits along the foothills of the Otway Ranges in the southeast part of the field assessment area, extending from the area east of Gellibrand to Pennyroyal (approx.), between the mapped extent of Koe to the south and Demons Bluff Group (Pd) or Gellibrand Marl (Nhg) to the north. The southwest extent of this part of Terrain Unit 1 is effectively governed by the limited field assessment undertaken in areas of similar mapped geology southwest of Gellibrand.

Terrain Unit 2 – All other areas within the field assessment area

Terrain Unit 2 is defined as the parts of the field assessment area outside Terrain Unit 1. Terrain Unit 2 includes the following areas:

- Areas where the mapped surface geology comprises Yaugher Volcanics Group (Py), Demons Bluff Group (Pd), Gellibrand Marl (Nhg), Clifton Formation (Nhc), Red Bluff Sandstone (Nbr), Brighton Group (Nb) and Black Rock Sandstone (Nbb) deposits.

- Areas where the published surface geology comprises Late Cretaceous to Eocene deposits (Moornowroong Sand, Pwm, Wiridjil Gravel, Pww, Eastern view and Boornah formations, Eastern View Formation (Pxvb) and Pember Mudstone, Pwe) and there is not sufficient confidence from the field assessment and associated studies that the mapped geology is consistent with the observed geomorphology.
- Colluvium or alluvium within drainage features within the above areas.

7.3 Basis of Criteria for Adjusting EMO Mapping

7.3.1 General

In line with the overall objective of the EMO review, to streamline and simplify the EMO, a focus is to identify areas within the current EMO that are not susceptible to landslide. The criteria used to identify non-susceptible areas were then applied to other parts of the field assessment area to develop a consistent approach to revising the EMO. We have also separately reviewed the extent of the EMO in the coastal townships of Skene's Creek, Kennett River, Grey River, Wye River and Separation Creek that have been the subject of recent detailed assessment by Golder and ASMG. The basis for the landslide susceptibility assessments undertaken in these separate areas is set out below. Although similar methods have been used to identify landslide susceptible areas that were used in the development of the original EMO extent, modern computing methods allow this to be undertaken with more precision than has been undertaken previously.

7.3.2 Field assessment area

The approach taken to defining areas not susceptible to landslide was based primarily on the mapped geology and slope, which is generally consistent with previous approaches to assessing landslide susceptibility in COS. However, given concerns about the accuracy of the published geological maps as well as the discrepancy between surface geology and geomorphology in areas where there may only be a thin surface cover or cap over another geological unit, assessment of areas ***not*** susceptible to landslide was based on a combination of the Terrain Units described in Section 7.2 and the slope, as follows:

- Terrain Unit 1: Slopes shallower than 9 degrees (about 15.8%) not susceptible to landslide.
- Terrain Unit 2: Slopes shallower than 5 degrees (about 8.7%) not susceptible to landslide.

Previous mapped landslides are considered susceptible to landslide regardless of the slope. Although it is unknown if all previous landslides have the potential to reactivate, experience in the Colac-Otway area indicates that landslide reactivation frequently occurs and so a precautionary principle has been used which assumes all land previously identified as subject to landslide is included. The basis for the assessment of Terrain Units 1 and 2 is summarised as follows:

Terrain Unit 1

- Field assessment observations and geomorphological mapping do not show evidence of landslides on slopes shallower than about 9 degrees.
- Previous assessments of landslide susceptibility such as Dahlhaus and Miner (2000) and ASMG (2013) (refer Table 4) which indicate a very low susceptibility to landslide at a slope angle of less than 9 degrees, based predominantly on assessments in Eumeralla Formation materials, and thresholds of

the minimum slope angle for landslide susceptibility in the Terrain Unit 1 materials have been assessed to be typically in the range of 10 degrees to 15 degrees.

Terrain Unit 2

- Field assessment observations and geomorphological mapping which do not show evidence of landslides on slopes shallower than about 5 degrees.
- Previous assessments of landslide susceptibility including ASMG (2013) which indicate thresholds of the minimum slope angle for landslide susceptibility in the Gellibrand Marl (Nhg) and Yaugher Volcanics (Py) materials have typically been assessed to be in the range of 5 degrees to 10 degrees. 'Geology of Victoria' published in 2003 by the Geological Society of Victoria, indicates that most landslides in Nhg materials occur on slopes of 6 degrees to 14 degrees.
- Uncertainty in the mapped geology, particularly in the area northwest of Ferguson Hill Anticline and near Yeodene where there appears to be the potential for Nhg or geomorphologically similar materials to be present but not mapped, and the practical limitations on the field assessment, which limit the potential to apply the Terrain Unit 2 criteria more widely.

The inclusions of previous mapped landslides as areas susceptible to landslide is based on the historical evidence or interpretation of previous instability.

7.3.3 Coastal townships

The Golder/ASMG reports for Wye River/Separation Creek (2019) and Skene's Creek, Kennett River and Grey River (2020) included an assessment of landslide susceptibility based predominantly on geology (including lithology and structure where able to be assessed), slope angle and slope aspect and informed by field assessments undertaken on a street by street basis within each township. Areas assessed as having a very low, very low to low or low susceptibility to landslide have been excluded from the revised EMO mapping recommended in Section 7.7. These areas have the following general characteristics:

- Wye River and Separation Creek: Gentle to flat slopes (typically less than 5 degrees) underlain by alluvium.
- Kennett River and Grey River: Gentle to moderate slopes ranging from less than 5 degrees to about 14 degrees underlain by Eumeralla Formation (Koe) materials and gentle to flat slopes underlain by alluvium.
- Skene's Creek: Gentle to moderate slopes, typically less than 10 degrees (up to about 14 degrees) underlain by Eumeralla Formation (Koe) or Wiridjil Gravel (Pww) materials and gentle slopes underlain by alluvium or dune sands.

The approach taken for these coastal townships may result in the exclusion of some properties from the EMO that would otherwise have been included if the approach used for the current field assessment was applied to the townships. These exclusions are justified on the basis of the more detailed assessment undertaken in these townships than in the current field assessment area.

7.4 Method of Terrain Mapping

The general approach to assessment of the landslide susceptible areas is similar to previous studies on landslide susceptibility for EMO purposes, for example Dahlhaus and Miner (2000).

Mapping of areas recommended for removal from the current EMO was undertaken manually using the ESRI ArcMap software program and applied to areas to the north of the Otway Ranges, as shown in Figure 1. Various spatial information was used to inform this process, including:

- Use of hillshade and slope angle DEM derivatives to identify geomorphological features that indicate ground that may have been previously impacted by movements associated with landslide, either identified during this study or in previous studies.
- Areas where slopes are less than those indicated in Section 7.3 for Terrain Units 1 and 2.

The mapping was generally undertaken at a scale of between 1:5,000 and 1:10,000. In some cases practical judgement was used to remove small or narrow areas of non-susceptible areas surrounded by susceptible areas.

The mapped areas were then removed from the current EMO, to form the revised EMO which is included in Appendix B. To smooth the manually drawn boundaries and to provide some mitigation against mapping uncertainty, the resultant revised EMO boundaries have had a 10 m buffer extension applied.

In addition to the manual process described above, recent revisions to the EMO in the coastal townships of Skene's Creek, Kennett River, Grey River, Wye River and Separation Creek, as discussed in Section 7.3.3, have also been incorporated into the revised EMO. These are shown as special sheets in Appendix B.

7.5 Inclusion of public land

Public land, meaning land administrated by a public land manager is included in the EMO mapping. Consideration was given to its removal however, it is recommended that the mapping include public land for the following reasons:

- There is potential for landslide hazards that originate in public land to cause an impact to land that is privately owned. Identifying land in susceptible areas is therefore of relevance to the assessment of land that is not publicly owned.
- If public land in landslide susceptible areas is sold and made private, there will no requirement to amend the EMO.
- The identification of land that is susceptible to landslide is a useful resource to public land managers who are required to undertake landslide risk assessment for the land they administer.

In lieu of removing public land from the EMO mapping, it is recommended that exemptions for public land be included in the EMO schedule in order to remove planning permit triggers associated with public land

7.6 Comparison Between the Existing and Proposed Extent of Mapping

The recommended changes to the EMO would remove areas from the EMO as set out in Table 5.

Table 5: Summary of Recommended changes to the EMO

	Current EMO	Recommended EMO	Reduction
Area (ha)	183,956	169,435	14,522 (7.9%)
Land Parcels (approx.) (No.)	7,873	7,371	502 (6.4%)

The proposed EMO affects about 30% of properties within COS.

7.7 Recommended Mapping to EMO

The recommended revised EMO is included in Appendix B. The existing EMO has been superimposed over the recommended EMO for comparative purposes.

8.0 REVISION OF SCHEDULE TO THE EMO

Based on the feedback received from Council with respect to the EMO schedule, Table 6 sets out key improvements that could be made to the EMO and suggested modifications to address these changes.

Table 6: Summary of Suggested EMO Schedule Changes

Shortcoming or Issue with Current EMO	Suggested Modifications
Poor quality of some geotechnical reports provided in support of planning applications.	Include minimum qualification levels for geotechnical practitioners under the definition of geotechnical practitioner, including a requirement to hold a chartership.
Current lack of clarity around risk acceptance criteria.	AGS 2007 defines acceptance criteria for 'New Development' and recommends acceptance criteria based on new development. Assume all development that is subject to a planning application under the EMO falls within the definition of New Development. This provides one criteria for loss of life. Remove reference to existing development and existing slopes. Include tolerable limits for risk to property in the schedule so as to remove reference to external guidelines.
Conversion of non-habitable buildings to habitable buildings.	Include change in building use from non-habitable to habitable under the definition of new development which therefore triggers a permit requirement.
Exemptions for minor development.	Yarra Ranges Council underwent a process to amend the schedule to the EMO in 2014. One of the objectives of this amendment was to expand exemptions for minor development. Similar exemptions to those adopted by Yarra Ranges have been recommended with the intent of removing application requirements for minor development. In addition, a

Shortcoming or Issue with Current EMO	Suggested Modifications
	discretionary clause is provided for council to exempt minor development from the requirement to provide a geotechnical assessment if the proposed development does not change existing landslide risk.
Exemptions for buildings associated with agriculture and farming.	Apply exemption for most agricultural buildings unless they trigger a permit due to the size of earthworks or there is an associated risk to life due to the form of construction and level of occupancy.
Consistency with VicSmart requirements with respect to building size and associated permit trigger.	Remove building size from the definition of exemptions for non-habitable outbuildings. Retain minimum of 20 m^2 for dwelling extensions due to the increased risk to life and property associated with this form of development.
Exemptions for subdivisions.	Provide exemptions for subdivisions that do not create new building envelopes, including subdivision of land into lots each containing an existing building and boundary realignment.
Exemption for public land.	Provide an exemption for land administered by a public manager. This assumes that the public land manager has their own processes and procedures for the management of landslide risk.
Exemptions for other minor development not otherwise covered by the schedule to the EMO.	The list of exemptions set out in the schedule cannot practically be an exhaustive list. Include provision for council to apply an exemption for other minor development that is judged to not significantly alter the existing landslide risk on the property. Provision is included for Council to seek third party expert advice on the justification for an exemption.
Removal of the requirement for a geotechnical assessment in some cases.	It is acknowledged that there will be some margin of error in the landslide susceptibility mapping on which the EMO is based. For example, there may be development proposed near the top of a ridgeline, on essentially flat land that does not have landslide susceptibility. Include provision for Council to waive the requirement for a geotechnical assessment in some cases. Guidance must be provided on when a waiver might be applicable, in a form that could easily be assessed by planners. Include provision for Council to require the applicant to demonstrate qualification for a waiver to the requirement to provide a geotechnical report. Modify compulsory conditions to reflect that not all permits issued under the EMO will have an accompanying geotechnical assessment.
Subdivision	Remove the requirement for a geotechnical assessment or landslide risk assessment for non-exempt subdivision. Replace this with a requirement for a landslide hazard assessment which seeks to identify hazards that could affect future development within the subdivision and which recommends constraints on development. Future development within the subdivision would be

Shortcoming or Issue with Current EMO	Suggested Modifications
	subject to the requirements of the EMO schedule which may require a separate development specific schedule.

A draft EMO schedule is included in Appendix D which seeks to address the points sets out in Table 6. This is a draft which is intended to identify areas in which the schedule could be modified. However, we note that this uses the soon to be superseded template and we therefore expect that further modification of the schedule will be required through the process of updating in accordance with the revised templates. However, the draft schedule in Appendix D is intended to set out the recommended updates in principle

9.0 STRATEGIES FOR EFFICIENT EMO IMPLEMENTATION

The following provides suggestions to Council for improvements to the efficiency in which the EMO is administered.

9.1 Objectives of Efficient EMO Implementation

Based on our discussions with statutory planners, the following are objectives of efficient EMO implementation by Council:

- Reduce as far as practical requirements for planners to critically assess geotechnical reports for which they do not have the expertise.
- Ensure the quality of geotechnical reports provided in support of planning applications is of a suitable standard.
- Provide tools to assist planners to assess the applications under the schedule to the EMO, for example to assess requirements for a landslide risk assessment based on geology, slope angle and past landslide.
- Ensure planners are able to simply interpret the requirements under the EMO and to communicate those requirements to applicants.

9.2 Previous Strategies

A number of previous guidelines, internal procedures manuals, policies and GIS tools have been provided for the use of COS statutory planning department over the past 20 years. Initial work was commissioned by COS whilst later outcomes were developed from various activities and projects undertaken by the former Department of Primary Industries (DPI) and the Corangamite Catchment Managements Authority (CCMA). A summary of previous guidelines and procedures provided to COS is set out in Table 7. The current status of these guidelines and internal procedures manuals is unknown at this time although much of the content is still thought to be relevant to the internal management of planning issues under the EMO and if not in current use could be revived.

Table 7: Summary of previous tools provided to COS to assist with EMO assessment.

Date	Title	Prepared By	Contents	Comments
July 2001	Land Stability Assessment (LSA) Guidelines and Procedures	Dahlhaus Environmental Geology P/L and PJ Yttrup and Assocs P/L as commissioned by COS	Part A was intended to be a Public LSA Guideline whilst Part B was EMO LSA assessment procedure for internal COS use only. The table of contents for the procedure included: ■ Procedure flow chart ■ Site detail (recording) sheet for planners ■ Public information ■ GIS search procedure ■ Preliminary on site assessment checklist for planners ■ Requirements for LSA reports ■ LSA report credibility checklist ■ Interim evaluation criteria for use with AGS 2000 ■ GIS data capture procedures ■ Land stability General Information ■ AGS 2000 ■ EMO – Schedule 1	Most of the intent in this early document was for planners to undertake an initial assessment of the site and to access GIS information to assist with their assessment. This included information on geology, slope and previous nearby assessments. There were checklists for assessing both the site characteristics to determine the need for a LSA report and for assessing the “credibility” of submitted reports within the technical limitations of planners.
June 2006	Erosion Management Overlay 1 – Landslides	Initially prepared by Dahlhaus Environmental Geology P/L and modified by A.S.Miner Geotechnical for CCMA and DPI	The document included three sections as follows: 1. Schedule 1 to the EMO Draft January 2006. 2. Policy on the use and application of the Erosion Management Overlay EMO1 3. Landslide Risk Management Internal Procedures Manual and Associated document for EMO1 – ASMG 311/06/06 Dated June 2006 The table of contents for the revised procedures manual included: ■ Procedure flow chart ■ Planning permit process checklist	The intent of the planning process had changed significantly by this time with the use of the onsite checklist for low and very low risk sites now undertaken by the consultants and not the planners. This was intended to reduce technical burden on the planners that the previous process had implied.

Date	Title	Prepared By	Contents	Comments
			■ GIS search tool ■ Requirements for geotechnical reports for low and very low risk sites (checklist) ■ Requirements for landslide risk management (LRM) geotechnical reports ■ Credibility checklist for LRM reports ■ Interim evaluation criteria for use with AGS 2000 ■ Evaluation procedures ■ Forms (G1 and G2) ■ GIS data capture procedures ■ Public information ■ Land instability in COS - general information ■ AGS Landslide Risk Management Concepts and Guidelines 2000 ■ AGS Practice Note and Commentary (in development) 2006 ■ AGS Slope Maintenance and Management and Data Sheets (2006) ■ EMO – Schedule 1	Inclusions from the development of what would become AGS2007 were also added including the use of Forms G1 and G2 which were early forerunners to the more recent Form A and Form G. Public information was a summary of the planning process and provisionally included a list of consultants working in the shire which was later removed as being contentious due to restraint of trade concerns

In addition to these manuals and procedures meant as tools to assist planners, a number of training sessions and workshops were provided to COS planners over the same periods and these are set out in Table 8.

Table 8: Summary of training and internal tools previously provided to COS

Date	By	Training Type	Comment
2001	Uni of Ballarat	Deployment and use of GIS tool delivered to planning department. Output comprised a 2 page summary of a site with geology, slope and any nearby previous assessments.	Delivered as part of the initial procedures manual.
2006	CCMA/ DPI	Formal handover and presentation to COS planning department of draft EMO schedule and overlay. Procedures manual, policies, inventory and landslide susceptibility maps.	Detailed explanation and discussion provided to planning dept. at this time.
May 2008	CCMA and ASMG	Full day training session for planners and works crews on landslides including site tour into the Otway Ranges.	Provided as part of the CCMA soil health strategy as a follow up to the EMO handover.
2013	COS and ASMG	Fact finding trip and workshop to Shire of Yarra Ranges.	Organised by planning department to review other LS EMO provisions.
May 2015	ASMG	Planners get together meeting in Colac as organised by COS planning department.	Review and refresher of issues relating to the administration of the EMO.
Nov 2015	COS and ASMG	Information session and consultants meeting with planning department to discuss requirements in COS following Wye River bushfires	Initiated due to concerns from planning department about the quality of reports following Wye River fires.
2016	ASMG	Review of LRM tools including GIS procedures tool and assessment of COS public information web site.	Review of previous GIS tool and discussion regarding development of an information portal for the public and consultants to enhance quality of the LRM reports.
May 2017	ASMG	Full day landslide training meeting and site tour with COS works crews, engineering staff and planners In Apollo Bay	Overall review of the landslide issues, challenges faced including

Date	By	Training Type	Comment
			road maintenance and building issues
June 2017	ASMG	Planning workshop to discuss issues with the EMO, possible revision to forms and internal GIS resources	Organised by Contract planning consultant for COS planning department
Oct 2017	ASMG	Landslide overview at COS Otway Building forum attended to by planners and building staff	Presentation of landslide issues throughout the COS LGA area including reference to bushfires
August 2019	ASMG	Presentation on landslide and Planning issues to Planning Staff in Apollo Bay	Coordinated lunchtime presentations during full day COS planning filed trip organised by planning manager

9.3 Example from Other Councils

The Shire of Yarra Ranges has a process in place to assist planners to assess applications triggered by the EMO. The following sets out the key elements of this process.

Training for Planners

All statutory planners attend an EMO training course. The training courses are run every 6 months meaning new planners will typically attend a training course within a few months of their commencement. The training covers:

- Basics on landslide hazards, why there are landslide hazards within the shire and why there is a requirement to manage landslide hazards through the planning scheme.
- The basis of clauses set out in the EMO schedule.
- A checklist has been developed for assessing applications submitted under the EMO. Planners are taken through the checklist and using real examples taught how to assess the application and complete the checklist.
- What information to look for in a geotechnical assessment report or landslide risk assessment report.
- A field trip is undertaken to show planners various types of landslide hazards within the shire and development at risk from landslide to provide background knowledge to assist in understanding geotechnical assessment reports.

Assessment Checklists

Yarra Ranges Council has developed flow chart to assist planners in assessing EMO applications. This is indicated in Plate 1. Each of the steps set out in the flow chart has guidance information attached and a checklist, included at Appendix C, is provided to help the planner ensure each step has been covered. The checklist can be placed on file as evidence of the assessment process. A brief summary of the requirements to be implemented by the statutory planner at each stage in the assessment is set out subsequently.

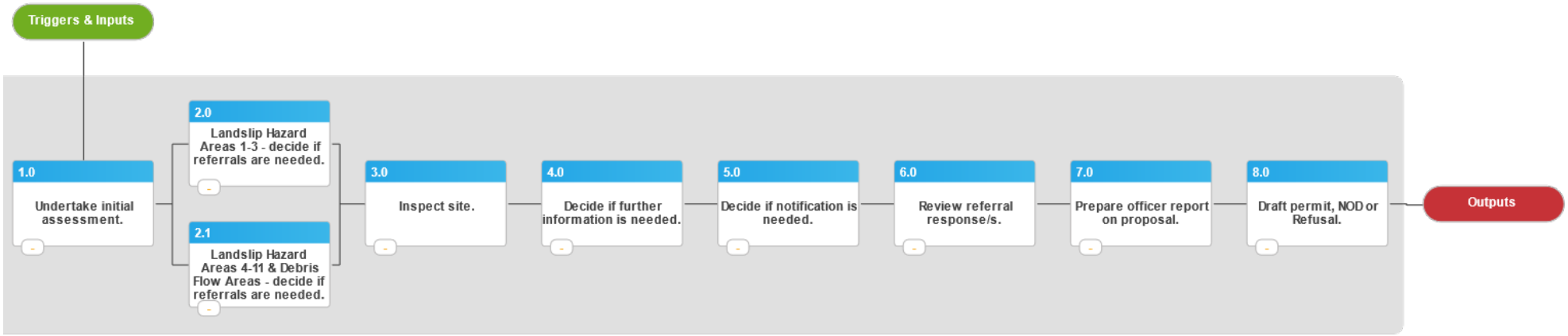


Plate 1: Flow chart used by Statutory Planners in Yarra Ranges to assess planning applications triggered by the EMO.

1.0 Assessment that basic application requirements have been met, whether an exemption might apply or whether it meets VicSmart requirements. Yarra Ranges maintains a list of geotechnical practitioners who have previously provided acceptable geotechnical reports in support of planning applications. Part of the initial assessment is to check if the practitioner who has prepared the report has previously demonstrated their competence to do so. If not, the report is referred for independent peer review. Parts A and B of the checklist are completed at this stage.

2.0 Yarra Ranges Council has an internal tool which assists planners to identify the geology and slope angle on the application site. This links to the requirements in the EMO schedule which trigger a risk assessment. For higher risk sites that would usually require a risk assessment, the checklist prompts the planner to refer the report for independent peer review. For lower risk sites, the planner is prompted to review the report themselves. The planner uses the checklist to ensure that the report contains the information required to meet the requirements as set out in the schedule to the EMO. If the planner is uncertain as to whether the report meets the requirements of the EMO, they are prompted to seek independent peer review. Part C and D of the checklist is competed at this stage.

3.0 The planner inspects the site and completes Part E of the checklist. This step is intended to detect existing unsafe earthworks on the site.

4.0 Further information is requested from the applicant. This may be triggered by the outcomes of a peer review, or if the planner does not consider there to be sufficient information available for them to address all of the checklist items.

5.0 Prompts the planner to decide if notification is needed.

6.0 Prompts the planner to review referral responses and to incorporate into their decision accordingly. There is also a step here which prompts review and update of the list of geotechnical practitioners. This could include adding a new practitioner who has not previously provided a report for an application within the shire, or removing a practitioner if third party peer review indicates the work to be of an unacceptable standard. Part F of the checklist is completed at this stage.

7.0 Prompts planner to prepare their report on the proposal with reference to the decision guidelines set out in the schedule to the EMO. Part G of the checklist is completed at this stage.

8.0 Prompts the planner to prepare a draft permit and provides guidance on drafting the permit and on appropriate conditions.

Yarra Ranges typically processes 100 to 150 applications per year triggered by the requirements of the EMO. Of those about 30 are referred for third party independent review. The process set out above has been in place for about 5 years and modified once over that time.

9.4 Improving the Quality of Geotechnical Reports

Based on feedback provided, some planning applications in COS have been accompanied by poor quality geotechnical reports which has ultimately led to delay in the application assessment process. The poor quality of reports can be related to several factors, including a lack of information to inform the report and a poor interpretation of the data available. The suggested EMO schedule in Appendix D is intended to set out what information should be acquired to inform the assessment. However, poor interpretation of the data is a matter of practitioner competence, which is more difficult to address.

Whilst this is not unique to COS, it may be more of a problem in COS than metropolitan councils because there are fewer geotechnical practitioners who service the area. Poor quality geotechnical reports are an industry wide issue which is being addressed at state and national level through the introduction of more rigorous requirements for engineers to be registered and to demonstrate competence. However, there are some strategies that can be adopted at Council level, which are set out below.

Problems with Geotechnical Reports

In our experience, problems with poor quality geotechnical reports are generally related to the following:

- The geotechnical practitioner is not aware of the requirements of the EMO and consequently does not address them in their report.
- Applicants are not aware of the requirements of the EMO and do not brief their geotechnical engineer, nor check they are capable of providing the appropriate service.
- Geotechnical engineers undertake work outside of their area of expertise, in some cases unwittingly.

Potential Actions for Council

Ultimately some of the key shortcomings associated with geotechnical reports are related to a lack of understanding or communication of the requirements under the EMO through all parties involved in the application process. Some strategies suggested to potentially address this could include:

- Developing simple fact sheets that set out in lay terms the requirements of a geotechnical report or landslide risk assessment which can be made available to applicants. This is intended to help applicants ask for the right service when they engage a geotechnical practitioner. Some of the procedures manuals previously provided to COS provide examples of fact sheets.
- Require through modification to the EMO schedule a minimum qualification for geotechnical practitioners who undertake geotechnical assessments and landslide risk assessments. Based on engineer registration schemes currently available, consideration could be given to requiring engineers to hold a chartership. Holding a chartership, for example CPEng does not mean the engineers has been assessed as having specific competence in landslide risk assessment, however at risk of losing their chartership, a chartered engineer is obliged to only perform work within their field of expertise.
- Continue to use Form A, however include a requirement that the geotechnical practitioner cite their qualification on the form and enforce this requirement.
- Provide tools to assist geotechnical practitioners to undertake landslide risk assessment in COS. This could include maintaining public access to the landslide inventory and furthermore, introducing a process whereby the landslide inventory is maintained and updated when new information on landslide becomes available.
- Provide information sheets intended for geotechnical practitioners which set out in simple terms the requirements of the EMO, including checklists consistent with those provided in AGS 2007. This could be accompanied by information sessions or seminars for geotechnical practitioners.
- Maintain a list of geotechnical practitioners that have a proven record of providing geotechnical assessments to an acceptable standard. Where assessments are provided from practitioners not on the list, seek independent review of their report with a view to adding them to the list.

9.5 Summary of Key Suggested Measures

The measures set out above have previously been recommended to COS in some form and some have been partly implemented in the past. It may be a matter of reviving or slightly modifying previous strategies rather than preparing new strategies which could lead to efficient implementation of these measures.

- Provide training for statutory planners in the EMO and how to assess applications under the EMO.
- Develop or reinvigorate existing tools to assist planners in assessing EMO applications, including checklists and mapping to indicate where the more onerous requirement of a landslide risk assessment compared to a geotechnical assessment might be required.
- Make available public information which clearly sets out the requirements for geotechnical assessments and landslide risk assessments under the EMO.
- Raise the minimum qualification requirements for geotechnical practitioners, noting that similar changes are imminent at a state government level.
- Clearly define requirements for when third party review should be sought.

10.0 CONCLUSIONS

The review of the COS EMO indicates the following opportunities to streamline and simplify the EMO to reduce the administrative burden it currently presents to Council and applicants whilst ensuring that risk management is appropriate, effective and commensurate with the level of risk.

- Adopt revised EMO mapping which removes areas of the EMO for which technical assessment indicates there is no significant susceptibility to slope instability. A reduction in the area affected by the EMO of about 7.5% is expected to be achieved.
- Modify the EMO schedule to:
  - Include further exemptions.
  - Remove the requirement for a geotechnical assessment where there are no credible landslide hazards.
  - Introduce different geotechnical reporting requirements for subdivision.
  - Improve the qualifications required for geotechnical practitioners who undertake geotechnical assessments within COS.
- Improve the efficiency of the administration of the EMO by:
  - Implementing simple checklists and internal tools to assist statutory planners to assess EMO applications and providing training in their use.
  - Providing simple information to geotechnical practitioners and applicants to clearly communicate the requirements for geotechnical assessments and landslide risk assessments submitted in accordance with the EMO.

11.0 IMPORTANT INFORMATION

Your attention is drawn to the document ‘Important information relating to this report’ which is included in Appendix E of this report. The statements presented in that document are intended to inform a reader of the report about its proper use. There are important limitations as to who can use the report and how it can be used. It is important that a reader of the report understands and has realistic expectations about those matters. The Important Information document does not alter the obligations Golder has under the contract between it and its client.

Signature Page

Golder Associates Pty Ltd

Darren Paul
Principal Engineering Geologist

DRP/DLG/drp

A.B.N. 64 006 107 857

https://golderassociates.sharepoint.com/sites/125004/project files/6 deliverables/20141513-004-r/20141513-004-r-rev0-cos emo review.docx

12.0 REFERENCES

AGS (2000) “Landslide Risk Management Concepts and Guidelines” AGS Sub-Committee on Landslide Risk Management. Australian Geomechanics Vol 35, No 1 March 2000 also reprinted in Australian Geomechanics Vol 37 No 2, May 2002.

AGS (2007) “Landslide Risk Assessment and Management” Guidelines, Commentaries and GeoGuides. AGS Sub-Committee on Landslide Risk Management. Australian Geomechanics Journal. Vol 42 No 1 March 2007.

ASMG (2006) “Landslide and Erosion Susceptibility Mapping in the CCMA region”. Consultant’s Report No 306/01/06 Dated 30th June 2006. Prepared for University of Ballarat.

ASMG (2006a). “Aerial photo Interpretation and mapping of Landslides in selected areas of the Colac Otway Shire”. Consultant’s Report No 308/01/06 31 March 2006 Prepared by A.S.Miner Geotechnical (unpublished)

ASMG (2006c) “EMO Implementation for Colac Otway Shire. Summary Report” Consultant’s Report No 330/01/06. 30th June 2006. Prepared for Corangamite Catchment Management Authority

ASMG (2007a) “Erosion and Landslide Inventory for the CCMA Region” . Report No 357.1/01/07. 30 June 2007 Consultants Report b A.S. Miner Geotechnical.

ASMG (2007b) “CCMA Erosion and Landslide Trend Mapping Project Using Aerial Photo Interpretation”. Report 356.1/01/07 July 2007 Consultants Report. A.S. Miner Geotechnical.

ASMG (2008) “Refinement of the proposed EMO Overlay as supplied by the CCMA”. Consultant’s Report 426.1/01/07 Dated 21 Dec 2007. Prepared for COS by A.S. Miner Geotechnical.

ASMG (2009) “Refined Inventory for Corangamite Region”. Consultant’s Report unpublished. A.S. Miner Geotechnical.

ASMG (2010) “Landslide Mapping and Susceptibility Project”. Consultant’s Report No 477/02/10. Dated 27 April 2010. Prepared in association with DPI for project partners

ASMG (2011) ‘Revision of Colac Otway Shire’s Erosion Management Overlay”. Consultant’s Report No 517/01/10. Dated 31 January 2011.

ASMG (2013) “Coordinated Landslide Data and Inventory Project including Improved Susceptibility Mapping” Consultants Report No 557a/01/13

CLARKSON, T and MINER A.S. (2005). “Discussion paper for the review and implementation of the Colac Otway Shire Erosion Management Overlay. Final Draft Report”. DPI internal report.

COONEY, A.M. (1980). "Otway Range landslide susceptibility study - first progress report. Geological Survey of Victoria Unpublished Report 1980/76. Prepared for Colac Otway Shire

COONEY A.M. (1982). "Geological hazards in parts of the Parishes of Kaanglang, Krambruk and Wongarra, Shire of Otway". Geological Survey of Victoria Unpublished Report 1982/105.

DAHLHAUS P.G. & MINER A.S. 2000. “Colac Otway Shire Land Capability Assessment: Review of Landslide Risk Management - Interim Report.” Dahlhaus Environmental Geology Pty Ltd; P.J. Yttrup & Associates Pty Ltd, 52p.

DAHLHAUS P.G. & MINER A.S. 2000. “Colac Otway Shire Land Capability Assessment: Atlas of GIS information”., Dahlhaus Environmental Geology Pty Ltd; P.J. Yttrup & Associates Pty Ltd.

DAHLHAUS P.G. & MINER A.S. 2001. “Colac Otway Shire. Landslide Risk Management. Final Report.” Consulting report, Dahlhaus Environmental Geology Pty Ltd, 74p.

DAHLHAUS P.G., MINER A.S., & BRIGGS W. 2003. “Colac Otway Shire. Coastal Community Revitalisation Project. Kennett River, Separation Creek and Wye River.” Consulting Report, Dahlhaus Environmental Geology Pty Ltd, 119p.

DAHLHAUS P.G. 2005. “Preliminary Mapping for an Erosion Management Overlay for the City of Greater - Geelong.” Consultants Reports August 2005.

FELTHAM W. 2004 "CCMA Landslide and Erosion Database". Major project B. Sci (Hons) University of Ballarat

FELTHAM W. 2005. “CCMA Landslide and Erosion Database. Version 2”. Research Report. Ballarat University July 2005.

FELTHAM W. 2005a. “Erosion in the Corangamite Region.” Bachelor of Applied Science Honours Thesis. Geology Department. University of Ballarat.

FELTHAM W 2006 "Additional mapping works. Selected Areas of Corangamite CMA" unpublished

FLENTJE P (2010) "Peer Review Landslide Mapping and Susceptibility Project'. 5 May 2010.

GOLDER and ASMG (2019). "Wye River and Separation Creek, Great Ocean Road, Victoria. Post Bushfire Landslide Risk Assessment". Consultant's Report No 18101896-002-R-Rev0. 1 March 2019. Prepared for Colac Otway Shire.

GOLDER (2020). "Kennett/Grey River, Great Ocean Road, Victoria. Geotechnical Assessment of Community Resilience". Consulates Report No 19126225-002-R-Rev0. 2nd April 2020. Prepared for The Department of Environment, Land Water and Planning

GOLDER (2020). "Skene's Creek, Great Ocean Road, Victoria. Geotechnical Assessment of Community Resilience". Consulates Report No 19126225-003-R-Rev0. 2nd April 2020. Prepared for The Department of Environment, Land Water and Planning.

GSV (2010). Victoria - Databases and Seamless Geology DVD. GeoScience Victoria, Department of Primary Industries. Melbourne, Victoria.

MINER A.S, FLENTJE P, MAZENGARB C and WINDLE, D (2010) “Landslide recognition using LIDAR derived Digital elevation Models-Lessons learnt from selected Australian Examples”. IAEG Geology and the Environment Congress, Auckland, 5-10 September, 2010.

MINER A.S, VAMPLEW P., WINDLE D, FLENTJE P and WARNER P. (2010) " A comparative study of various data mining techniques as applied to the modelling of landslide susceptibility on the Bellarine Peninsula, Victoria, Australia”. IAEG Geology and the Environment Congress, Auckland, 5-10 September, 2010

McVEIGH J.A. 2001. “A Landslide Database for Southwest Victoria.” Bachelor of Applied Science (honours). Geology University of Ballarat. MRT (2004). “The Tasmanian Landslide Hazard Map Series: Methodology.” Tasmanian Geological Survey Record 2005/04. Mineral Resources Tasmania

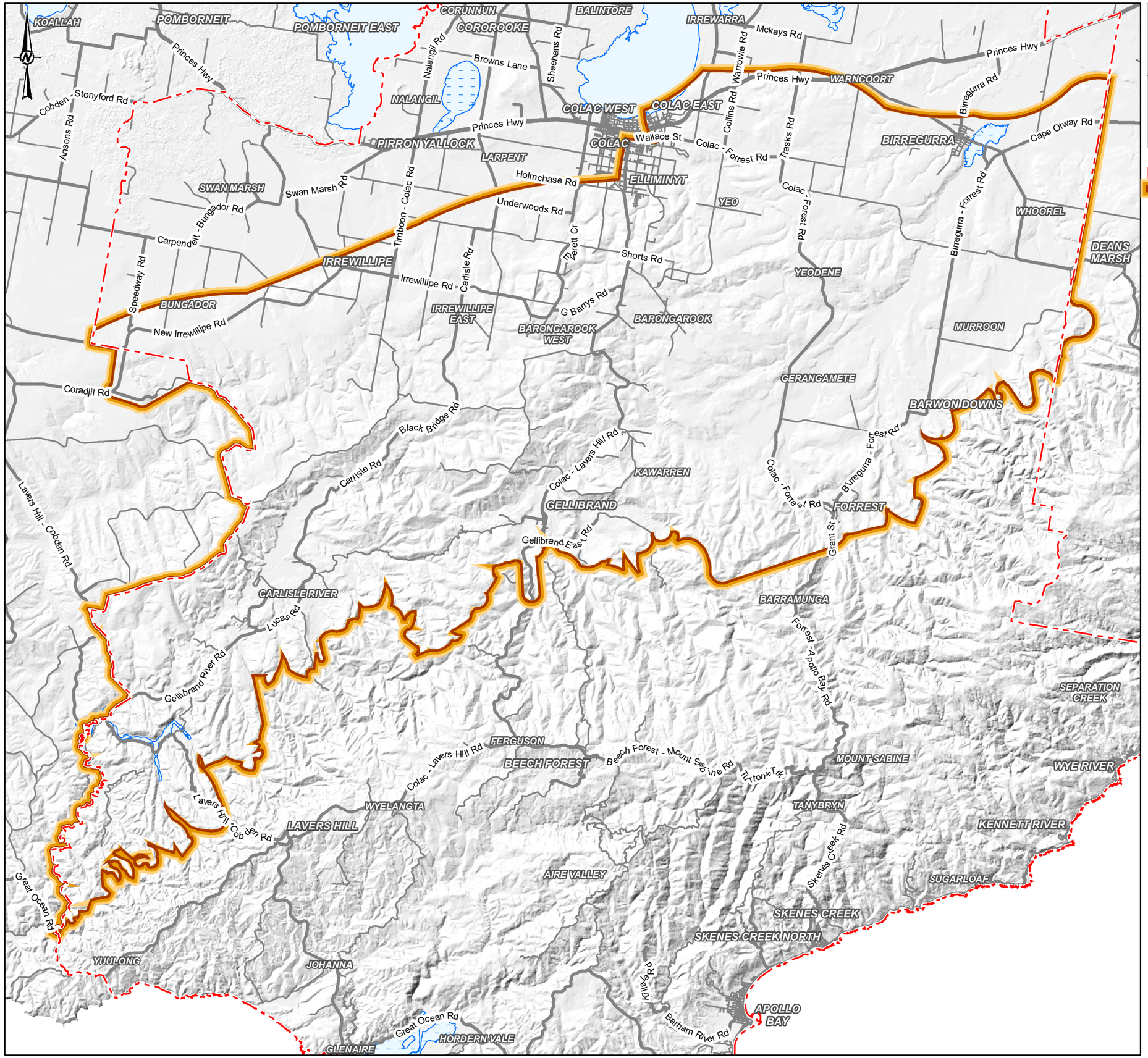
NEILSON, J.L., PECK, W.A., WOOD, P.D., DAHLHAUS, P.G., MINER, A.S., BRUMLEY, J.C., KENLEY, P.R., WILSON, R.A., WILLMAN, C.E. and ROWAN, J.N. (2003). Geological Hazards. Geology of Victoria. W. D. Birch, (ed.) Geological Society of Australia Special Publication 23. Geological Society of Australia, Victorian Division, Melbourne. 573-592 pp.

PITT, A.J. (1981) A study of lands in the catchments of the Otway Ranges and adjacent plains. Soil Conservation Authority of Victoria Report TC-14, Soil Conservation Authority.

REES, D.B. (2000) Land Systems of Victoria. Edition 3. Technical Report No. 56, Centre for Land Protection Research, Bendig

VAMPLEW, P (2009) Landslide data analysis Using Data mining techniques for extracting important landslide attributes. Preliminary report Data mining and Infomatics Research Group at the Centre for Information and Applied Optimization University of Ballarat.

VARNES DJ (1978) “Slope Movement Types and processes”. In Special report 176: Landslides Analysis and Control (R Schuster and R Kriek eds) TRB National Research Center) Washington DC.C.



NOT FOR CONSTRUCTION

DRAFT

0 2,500 5,000 7,500 10,000 12,500

1:200,000 METRES

NOTE(S)

1. Projection: GDA 1994 MGA Zone 54.

REFERENCE(S)

1. Property, elevation, hydro and road data sourced from VicMap, dated 2017.
2. Backgroundimagery sourced from ESRI online basemaps.

CLIENT
COLAC OTWAY SHIRE

PROJECT
EROSION MANAGEMENT OVERLAY REVIEW

TITLE
ASSESSEMENT AREA

CONSULTANT
GOLDER

YYYY-MM-DD	2020-09-08
DESIGNED	GM
PREPARED	CRG
REVIEWED	DRP
APPROVED	DRP

PROJECT NO.	CONTROL	REV.	FIGURE
20141513	004-R	0	1

KEY MAP

LEGEND

- Colac Otway Shire
- EMO Field Assessment Area

Geological units

- Qxr
- Qm1 - Swamp and lake deposits
- Ql2 - Lake deposits
- Ql1 - Lunette deposits
- Qhd
- Qg
- Qdl1
- Qc3 - Slump deposits
- Qc1 - Colluvium
- Qa2 - Alluvial terrace deposits
- Qa1 - Alluvium
- Nhg - Gellibrand Marl
- Nhc - Clifton Formation
- Nes - Newer Volcanic Group – scoria deposits
- Nep1 - Newer Volcanic Group – tuff rings
- Neo2 - Newer Volcanic Group – stony rises basalt
- Neo - Newer Volcanic Group
- Nbr - Red Bluff Sandstone
- Nbb - Black Rock Sandstone
- Nb - Brighton Group
- Na - Incised alluvium
- Koe - Eumeralla Formation
- -Py - Yaugher Volcanic Group
- -Pxvb - Eastern view and Boonah formations
- -Pww - Wiridjil Gravel
- -Pwm - Moomowroong Sand
- -Pwe - Pember Mudstone
- -Pnn
- -Pd - Demons Bluff Group

NOT FOR CONSTRUCTION

DRAFT

0 2,500 5,000 7,500 10,000 12,500

1:200,000 METRES

NOTE(S)

1. Projection: GDA 1994 MGA Zone 54.

REFERENCE(S)

1. Property, elevation, hydro and road data sourced from VicMap, dated 2017.
2. Backgroundimagery sourced from ESRI online basemaps.
3. Geological Units from GeoScience Victoria, dated 2010.

CLIENT
COLAC OTWAY SHIRE

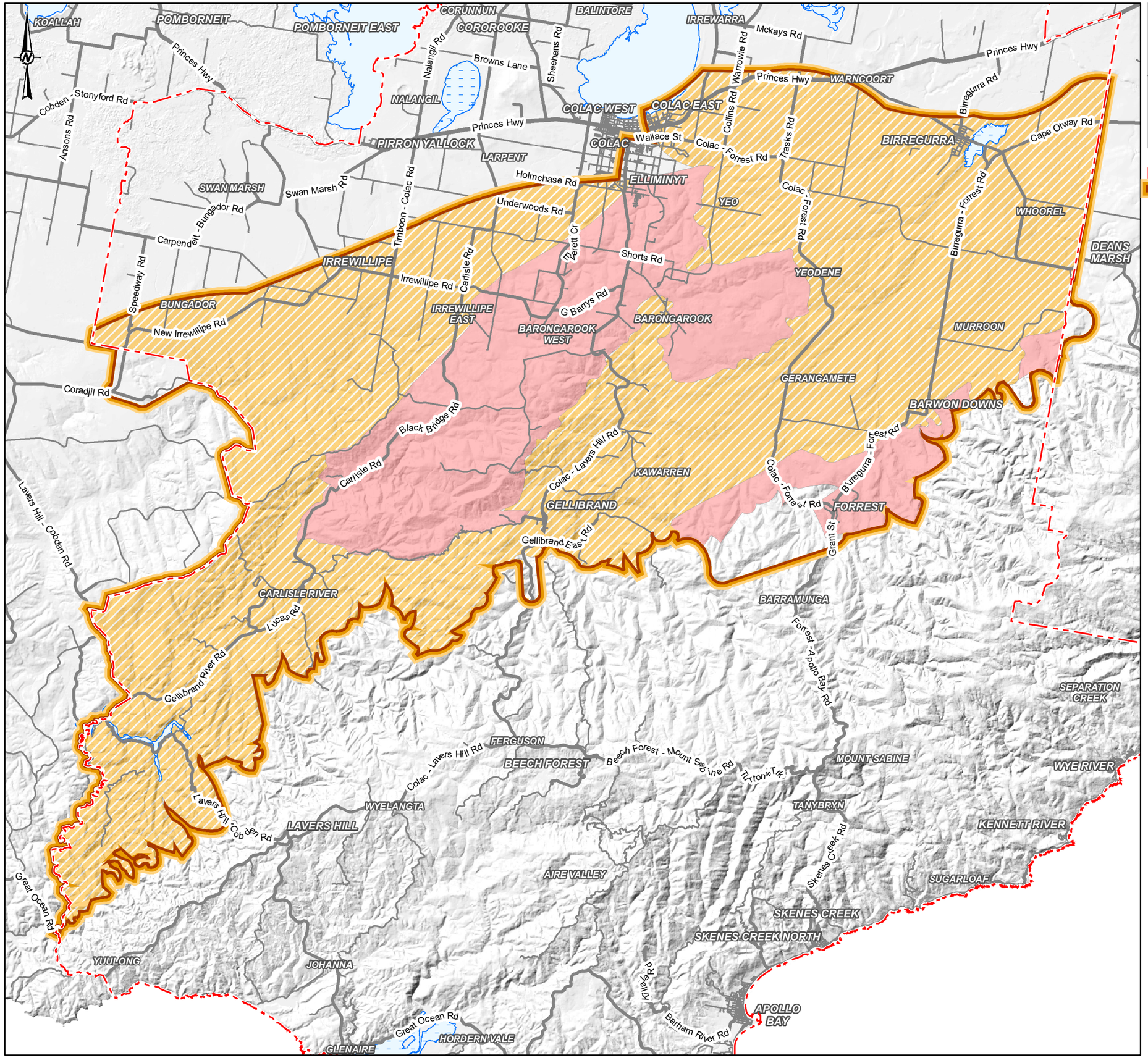
PROJECT
EROSION MANAGEMENT OVERLAY REVIEW

TITLE
ASSESSMENT AREA MAPPED GEOLOGY

CONSULTANT
GOLDER

YYYY-MM-DD	2020-09-08
DESIGNED	GM
PREPARED	CRG
REVIEWED	DRP
APPROVED	DRP

PROJECT NO.	CONTROL	REV.	FIGURE
20141513	004-R	0	2



KEY MAP

LEGEND

- Colac Otway Shire
- EMO Assessment Area

EMO - Terrain Units

- Unit 1
- Unit 2

NOT FOR CONSTRUCTION

DRAFT

0 2,500 5,000 7,500 10,000 12,500

1:200,000 METRES

NOTE(S)

1. Projection: GDA 1994 MGA Zone 54.

REFERENCE(S)

1. Property, elevation, hydro and road data sourced from VicMap, dated 2017.
2. Backgroundimagery sourced from ESRI online basemaps.
3. Geological Units from GeoScience Victoria, dated 2010.

CLIENT
COLAC OTWAY SHIRE

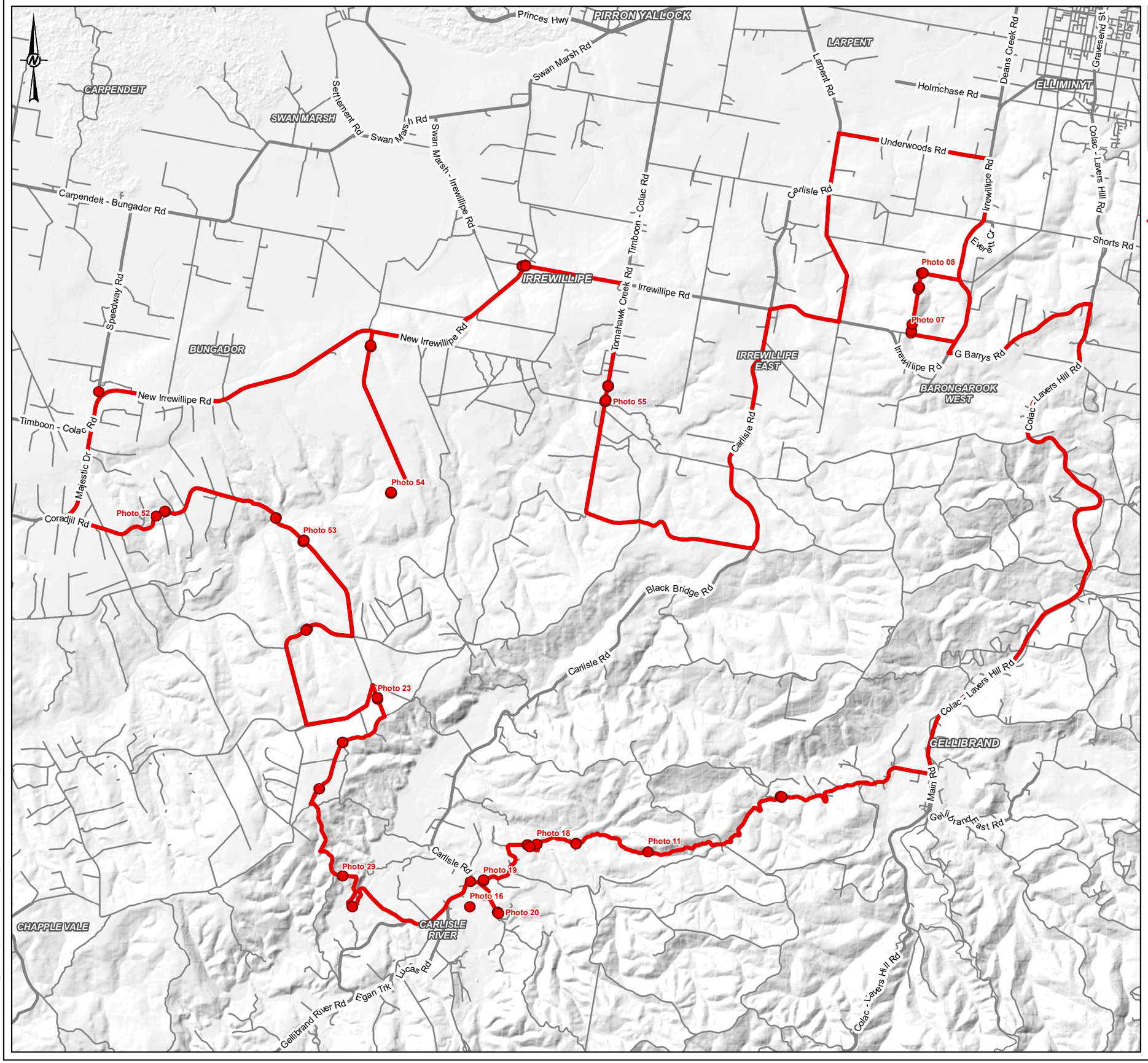
PROJECT
EROSION MANAGEMENT OVERLAY REVIEW

TITLE
TERRAIN UNITS

CONSULTANT
GOLDER

YYYY-MM-DD	2020-09-08
DESIGNED	GM
PREPARED	CRG
REVIEWED	DRP
APPROVED	DRP

PROJECT NO.	CONTROL	REV.	FIGURE
20141513	004-R	0	3



KEY MAP

LEGEND

Observations Locations with Photo ID and date

20/07/2020

Observation Routes with date

20/07/2020

NOT FOR CONSTRUCTION

DRAFT

0 1,250 2,500 3,750 5,000 6,250

1:99,000 METRES

NOTE(S)

1. Projection: GDA 1994 MGA Zone 54.

REFERENCE(S)

1. Property, elevation, hydro and road data sourced from VicMap, dated 2017.
2. Backgroundimagery sourced from ESRI online basemaps.

CLIENT

COLAC OTWAY SHIRE

PROJECT

EROSION MANAGEMENT OVERLAY REVIEW

TITLE

GOLDER AND ASMG FIELDWORK TRAVERSE ROUTES AND OBSERVATION LOCATIONS 20/07/2020

CONSULTANT

GOLDER

YYYY-MM-DD	2020-09-10
DESIGNED	GM
PREPARED	CRG
REVIEWED	DRP
APPROVED	DRP

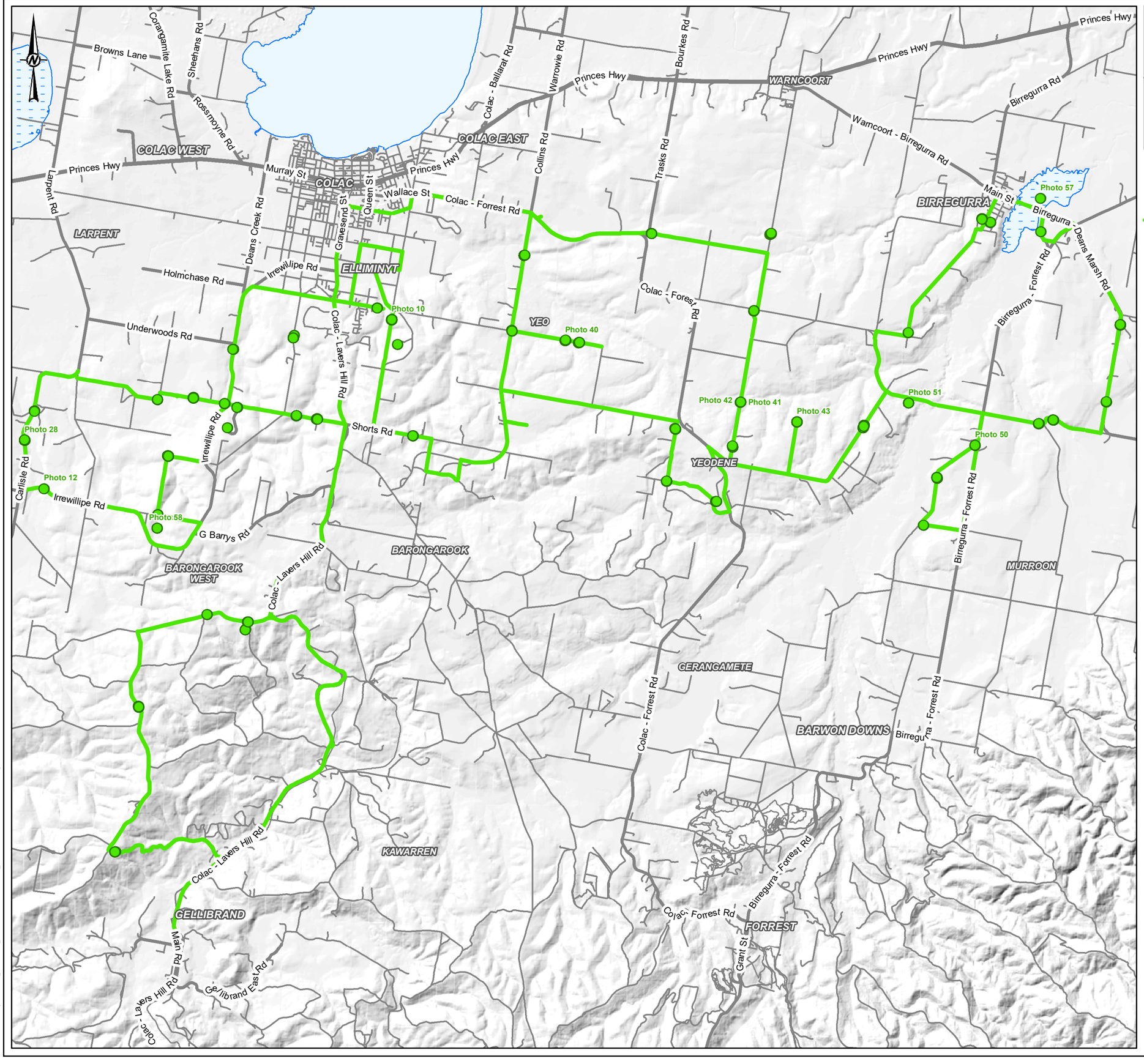
PROJECT NO.	CONTROL	REV.	FIGURE
20141513	004-R	0	4a

IF THIS MEASUREMENT DOES NOT MATCH WHAT IS SHOWN, THE SHEET SIZE HAS BEEN MODIFIED FROM: ISO A3

25mm

0

PATH: B:\Colac Otway Shire\EMO_Revisions\99_PROJECTS\20141513\Doc\02_PRODUCTION\MXD\20141513-004-R-Fig 4.mxd PRINTED ON: 2020-09-10 AT 4:35:18 PM



KEY MAP

LEGEND

Observations Locations with Photo ID and date

21/07/2020

Observation Routes with date

21/07/2020

NOT FOR CONSTRUCTION

DRAFT

0 1,250 2,500 3,750 5,000 6,250

1:101,000 METRES

NOTE(S)

1. Projection: GDA 1994 MGA Zone 54.

REFERENCE(S)

1. Property, elevation, hydro and road data sourced from VicMap, dated 2017.
2. Backgroundimagery sourced from ESRI online basemaps.

CLIENT

COLAC OTWAY SHIRE

PROJECT

EROSION MANAGEMENT OVERLAY REVIEW

TITLE

GOLDER AND ASMG FIELDWORK TRAVERSE ROUTES AND OBSERVATION LOCATIONS 21/07/2020

CONSULTANT

GOLDER

YYYY-MM-DD	2020-09-10
DESIGNED	GM
PREPARED	CRG
REVIEWED	DRP
APPROVED	DRP

PROJECT NO.	CONTROL	REV.	FIGURE
20141513	004-R	0	4b

IF THIS MEASUREMENT DOES NOT MATCH WHAT IS SHOWN, THE SHEET SIZE HAS BEEN MODIFIED FROM ISO A3

25mm

0

PATH: B:\Colac Otway Shire\EMO_Revisions\99_PROJECTS\20141513Doc\02_PRODUCTION\MXD\20141513-004-R-Fig 4.mxd PRINTED ON: 2020-09-10 AT 4:35:31 PM

KEY MAP

LEGEND

Observations Locations with Photo ID and date

22/07/2020

Observation Routes with date

22/07/2020

NOT FOR CONSTRUCTION

DRAFT

0 2,250 4,500 6,750 9,000 11,250

1:180,000 METRES

NOTE(S)

1. Projection: GDA 1994 MGA Zone 54.

REFERENCE(S)

1. Property, elevation, hydro and road data sourced from VicMap, dated 2017.
2. Backgroundimagery sourced from ESRI online basemaps.

CLIENT

COLAC OTWAY SHIRE

PROJECT

EROSION MANAGEMENT OVERLAY REVIEW

TITLE

GOLDER AND ASMG FIELDWORK TRAVERSE ROUTES AND OBSERVATION LOCATIONS 22/07/2020

CONSULTANT

GOLDER

YYYY-MM-DD	2020-09-10
DESIGNED	GM
PREPARED	CRG
REVIEWED	DRP
APPROVED	DRP

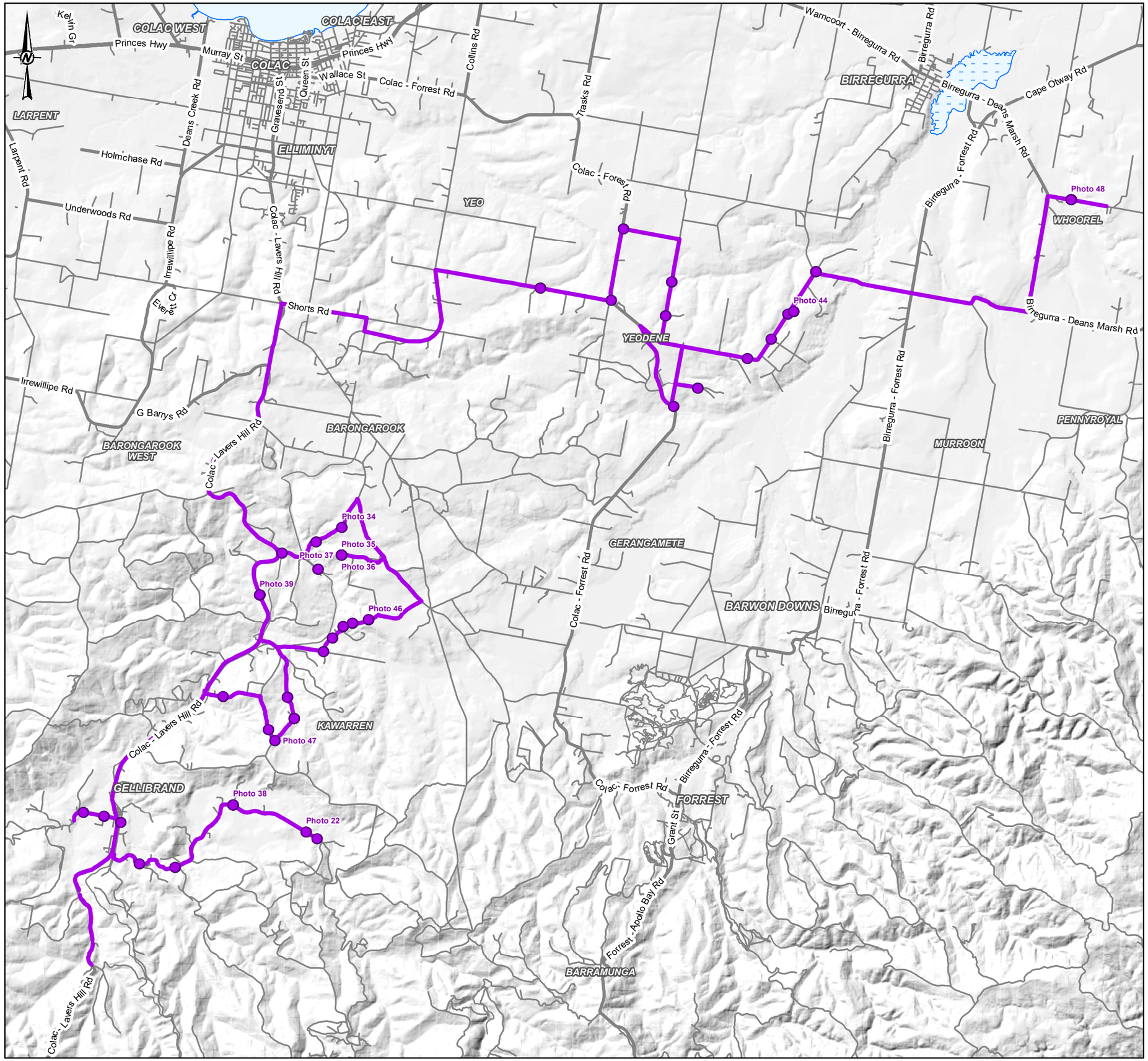
PROJECT NO.	CONTROL	REV.	FIGURE
20141513	004-R	0	4c

IF THIS MEASUREMENT DOES NOT MATCH WHAT IS SHOWN, THE SHEET SIZE HAS BEEN MODIFIED FROM ISO A3

25mm

0

PATH: B:\Colac Otway Shire\EMO_Revisions\99_PROJECTS\20141513\Doc\02_PRODUCTION\MXD\20141513-004-R-Fig 4.mxd PRINTED ON: 2020-09-10 AT 4:35:47 PM



KEY MAP

LEGEND

Observations Locations with Photo ID and date

23/07/2020

Observation Routes with date

23/07/2020

NOT FOR CONSTRUCTION

DRAFT

0 1,300 2,600 3,900 5,200 6,500

1:103,500 METRES

NOTE(S)

1. Projection: GDA 1994 MGA Zone 54.

REFERENCE(S)

1. Property, elevation, hydro and road data sourced from VicMap, dated 2017.
2. Backgroundimagery sourced from ESRI online basemaps.

CLIENT

COLAC OTWAY SHIRE

PROJECT

EROSION MANAGEMENT OVERLAY REVIEW

TITLE

GOLDER AND ASMG FIELDWORK TRAVERSE ROUTES AND OBSERVATION LOCATIONS 23/07/2020

CONSULTANT

GOLDER

YYYY-MM-DD	2020-09-10
DESIGNED	GM
PREPARED	CRG
REVIEWED	DRP
APPROVED	DRP

PROJECT NO.	CONTROL	REV.	FIGURE
20141513	004-R	0	4d

APPENDIX A

Site Visit Observations

Geological units

Table A1 summarises the geological units generally present within the area of the field mapping.

Table A1: Summary of geological units

Geological age	Abbreviation*	Name	Description
Holocene	Qc3	Slump deposits	Colluvial deposits of diamictite, clay, clayey silt, rubble
Pleistocene to Holocene	Qa1	Alluvium	Fluvial deposits of gravel, sand, silt
	Qm1	Swamp and lake deposits	Lacustrine deposits of Carbonaceous mud, silt, clay, minor peat
	Ql1	Lunette deposits	Aeolian deposits of clay, clayey silt, silty clay, minor fine-grained sand
	Qd1	Inland dune deposits	Aeolian deposits of sand, silt and clay
Pleistocene	Qa2	Alluvial terrace deposits	Alluvial terrace deposits of gravel, sand and silt
Pliocene to Holocene	Ql2	Lake deposits	Lacustrine deposits of carbonaceous clay and silt, fine to coarse grained sand, gravel
	Qc1	Colluvium	Colluvial deposits of diamictite, gravel, sand, silt, clay, rubble
Pliocene to Pleistocene	Na	Incised alluvium	Fluvial deposits of gravel, sand, silt, minor ferricrete
Miocene to Holocene	Nep1	Newer Volcanic Group – tuff rings	Tuff rings (pyroclastic sediment)
	Nes	Newer Volcanic Group – scoria deposits	Hawaiite, basanite, nephelinite, mugearite, trachybasalt, trachyandesite
	Neo2	Newer Volcanic Group – stony rises basalt	Tholeiitic to alkalic basalt, basanite
	Neo	Newer Volcanic Group	Tholeiite, basanite, basaltic icelandite, hawaiite, mugearite, minor scoria and ash, fluvial sediments
Miocene to Pliocene	Nbb	Black Rock Sandstone	Marine deposits of sand, sandstone, conglomerate, minor sandy limestone, local ironstone
	Nb	Brighton Group	Coastal fluvial deposits of gravel, sand and silt
	Nbr	Red Bluff Sandstone	Fluvial deposits of sandstone and conglomerate
Oligocene (Chattian) to Miocene	Nhg	Gellibrand Marl	Calcareous silty clay and clayey silt, minor fine to coarse grained shelly calcarenite beds
Oligocene to Miocene	Nhc	Clifton Formation	Shallow marine and minor beach and near shore calcarenite
Eocene	Py	Yaugher Volcanic Group	Basalt, tuff, microgabbro, minor sedimentary rocks
Eocene to Oligocene	Pd	Demons Bluff Group	Carbonaceous pyritic silt to fine sand, clay and clayey sand
Palaeocene to Eocene	Pwe	Pember Mudstone	Marine deposits of silty clay, clayey silt and sand
	Pxvb	Eastern view and Boonah formations	Mudstone, sandstone, conglomerate, lignite
Late Cretaceous to Palaeocene	Pww	Wiridjil Gravel	Fluvial deposits of quartz sand, silt, clay, pebbles, rare cobbles
	Pwm	Moomowroong Sand	Coastal fluvial deposits of quartz sand, minor clay
Early Cretaceous	Koe	Eumeralla Formation	Sandstone, mudstone, conglomerate, minor coal

*Earth Resources Victoria 1:50,000 scale seamless geology

The following general geomorphological groupings have been adopted for the photographs presented below:

- Early Cretaceous Eumeralla Formation (Koe).
- Late Cretaceous to Eocene deposits: Moornowroong Sand (Pwm), Wiridjil Gravel (Pww), Eastern view and Boornah formations (Pxvb) and Pember Mudstone (Pwe) materials.
- Eocene to Oligocene deposits: Yaugher Volcanics Group (Py) materials and the older Demons Bluff Group (Pd) unit.
- Oligocene to Pliocene deposits: Gellibrand Marl (Nhg) and Clifton Formation (Nhc) materials and the overlying (younger) Red Bluff Sandstone (Nbr), Brighton Group (Nb) and Black Rock Sandstone (Nbb) deposits.
- Miocene to Holocene volcanics: Geologically recent volcanic deposits including Nep1, Nes, No2 and Neo units. *No areas of Miocene to Holocene volcanics (generally outcropping near and north of Colac) were observed during the field mapping.*
- Pliocene to Holocene deposits: Generally, geologically recent alluvial, lacustrine, aeolian and colluvial deposits including Qc3, Qa1, Qm1, Ql1, Qd1, Qa2 Ql2, Qc1 and Na units.

Early Cretaceous Eumeralla Formation (Koe)

Photo 1: Foothills of the Otway Ranges, from McPaddens Road, Murroon. The Otway Ranges predominantly comprise Koe materials with some younger geological units present at the base of the hills.

Photo 2: Koe materials exposed in a cutting, Wickhams Road, Murroon.

Photo 3: Typical slopes in Koe materials west of Wickhams Road, Murroon.

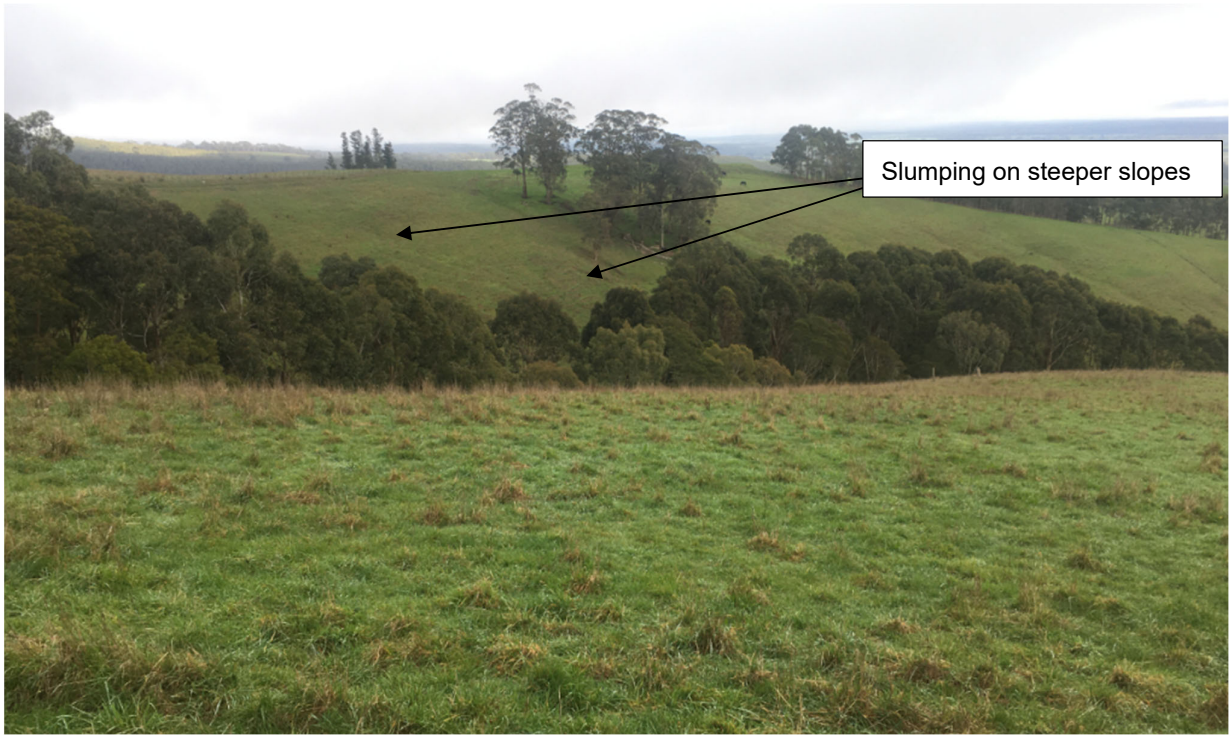


Photo 4: Evidence of slumping on steeper slopes in Koe materials west of Wickhams Road, Murroon.

Photo 5: Undulating logged Koe slope from Ridge Road (between Forrest and Kawarren).

Photo 6: Steep, hummocky logged Koe slope from Ridge Road (between Forrest and Kawarren).

Photo 7: Generally planar slopes in Koe materials east of Polleys Road, Barongarook West.

Photo 8: Evidence for erosion and minor slumping on steeper slopes above waterways on otherwise planar slopes in Koe materials east of Polleys Road, Barongarook West. Note there also appears to be some slumping of the inferred dam fill embankment further up the slope.

Photo 9: Undulating Koe slopes, southeast of the intersection of McPaddens and Creamery Road, Barwon Downs.

Photo 10: Valley south of Belvedere Drive, Elliminyt.

Late Cretaceous to Eocene deposits

Photo 11: Sand (inferred Pwe, but close to the geological boundary with Pwm) exposed in a road cutting on the Gellibrand-Carlisle River Road.

Photo 12: Pwm (based on geology map) materials exposed in a road cutting on Irrewillipe Road, Barongarook West.

Photo 13: Pwm materials exposed in a road cutting on Lavers Hill-Cobden Road near its intersection with the Gellibrand River Road.

Photo 14: Pww materials exposed in a quarry on Westwood Track, southeast of Barongarook.

Photo 15: Partly cemented Pww materials exposed in a road cutting quarry (Sand Pit Road, Chapple Vale).

Photo 16: Inferred drape of Pww sand (grey sand) over Koe materials exposed in a road cutting on the RWC Pumping Station Track, Carlisle River. The mapped surface geology in this area is Pww.

Photo 17: Generally gentle, forested slopes in the area underlain by Pww southeast of Barongarook (Golden Hole Road).

Photo 18: Evidence for hillside creep (tilting trees) on slopes of about 20 degrees to 28 degrees in Pww materials, Gellibrand-Carlisle River Road.

Photo 19: Slope (up to about 14 degree) in Pww materials, Carlisle River. Minor slumping observed in some parts of the slope.

Photo 20: Slopes in Pww materials, track near Cole Creek, Carlisle River.

Photo 21: Pww materials over Koe, Mahers Road, Barwon Downs.

Photo 22: Inferred Pww materials (grey sand exposed in scrapes) over Koe materials (forested slopes in background), Gellibrand East Road.

Photo 23: Pww slope near the intersection of Middle Road and Pipeline Road.

Photo 24: View towards Forrest from Rivendell Lane. Inferred Pww cap over Koe materials.

Photo 25: Hummocky Pww slopes on the north side of Chapple Creek, near Chapple Vale.

Photo 26: Gentle Pww slopes, Chapple Vale.

Photo 27: Hummocky, wet ground (Pwm) west of Lavers Hill-Cobden Road near its intersection with Gellibrand River Road, near Chapple Vale. Slope about 6 degrees to 8 degrees.

Photo 28: Slumps in materials mapped as Pwm, east of Carlisle Road near its intersection with Irrewillipe Road, Barongarook West.

Photo 29: Ridgeline in area mapped as Pwm, inferred to comprise a shallow thickness of Pwm over Koe materials, RWC Pumping Station Track, Carlisle River.

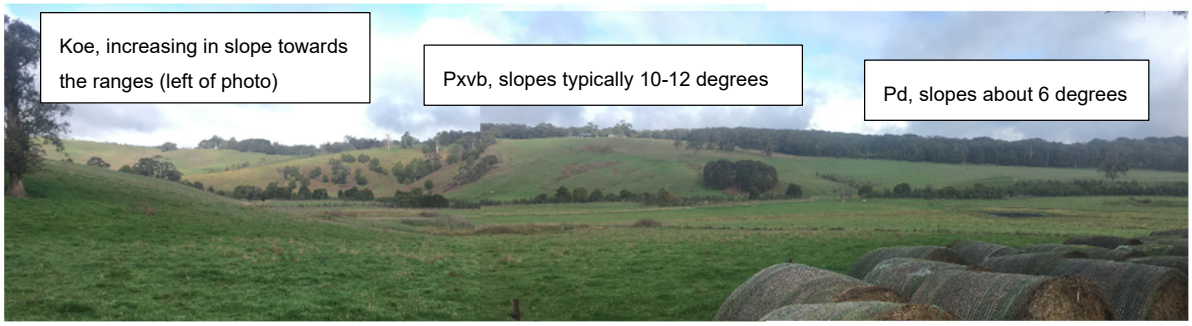


Photo 30: Approximate transition from Koe to Pxvb and then Pd materials, Griffin Road, Barwon Downs

Photo 31: Hummocky Pxvb/colluvial slopes in Surf Coast Shire, east of Pennyroyal

Photo 32: Failed retaining wall at toe of road cutting in Pxvb materials, Pennyroyal Station Road. Natural slope about 8 degrees, modified slope about 12 degrees.

Eocene to Oligocene deposits

Photo 33: Py materials exposed in a cutting, Gellibrand Valley Road, west of Gellibrand.

Photo 34: Pd materials over Pww, Robinsons Road, Kawarren.

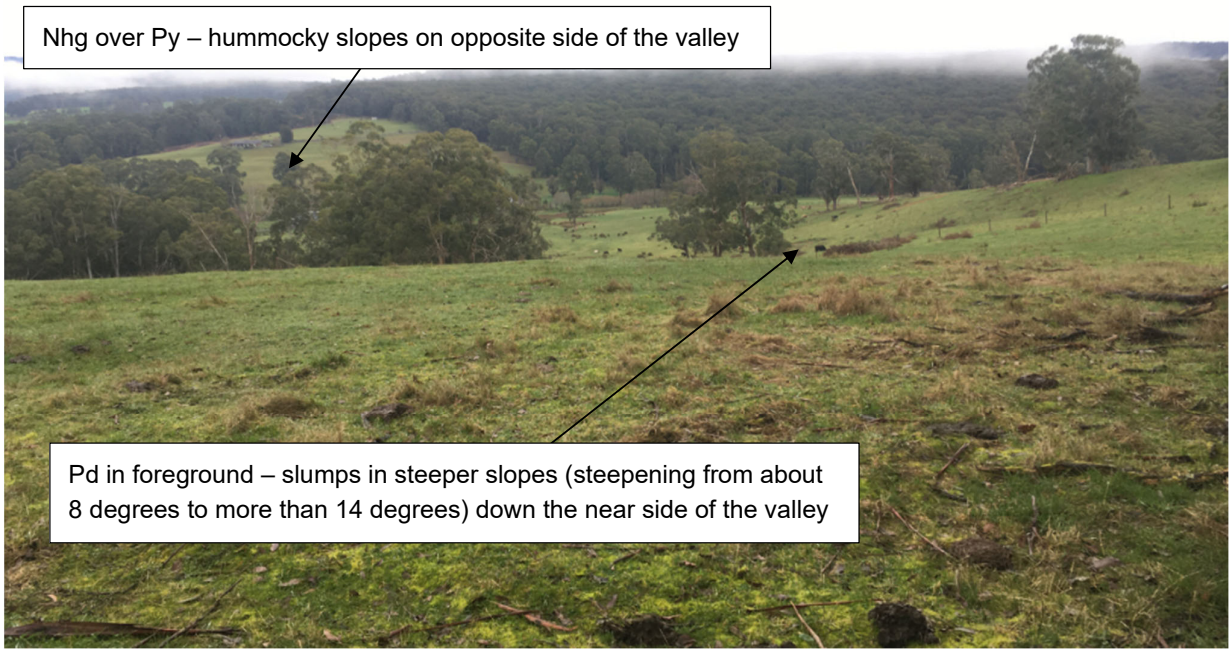


Photo 35: Pd materials over Py and then Nhg, south of Wares Road, Kawarren.

Photo 36: Close-up of the slumping visible in steeper Pd slopes in previous photograph, and hummocky slopes further downslope (view from Wares Road to Cashins Road).

Photo 37: Flat slopes (Pd) on the north side of Wares Road, Kawarren.

Photo 38: Historical landslide scarps and hummocky ground (Nhg over Py and Pd, with colluvium below slope) below Frys Road/Ridge Road, Kawarren, viewed from Gellibrand East Road.

Photo 39: Hummocky ground near the mapped interface of Py over Pd, east side of Colac-Lavers Hill Road, north of Kawarren. Slopes range from about 8 degrees to 20 degrees.

Photo 40: Gentle slopes in Pd, Springs Road, southeast of Colac.

Photo 41: Hummocky slopes below the mapped contact between Nhg over Pd, De La Rues Road, Yeodene.

Photo 42: Gentle Pd slopes, De La Rues Road, Yeodene (currently within EMO).

Photo 43: View from Pd in the foreground to a hummocky hillslope underlain by Nhg on the opposite side of the valley, Mcdonalds Road, Yeodene.

Photo 44: Hummocky ground consistent with Nhg slopes observed downslope of the mapped contact between Nhg over Pd, Birregurra-Yeodene Road, Yeodene.

Photo 45: Gentle Pd slopes, view northwest from the intersection of McPaddens and Creamery Road, Barwon Downs.

Oligocene to Pliocene deposits

Photo 46: Headscarp and hummocky ground (mapped as Qc3) below large historical slide on gentle Nhg slopes, Mcdonalds Road, Kawarren.

Photo 47: Undulating/hummocky slope comprising Qc3 derived from Nhg, Kawarren East Road near Bull Hill Road, Kawarren.

Photo 48: Hummocky slopes north of Rifle Butts Road, Whoorel, east of Deans Marsh Creek. The geology map indicates colluvium (Qc1) below Pxvb. However, the materials appear to comprise Nhg.

Photo 49: Relatively flat Nhg area east of Dewings Bridge Road, Barwon Downs.

Photo 50: Relatively flat Nhg area near Telegraph Road, Murroon.

Photo 51: Colluvium below Nhg, Colac-Lorne Road near the Barwon River.

Photo 52: Hummocky ground indicative of landslides within Nhg, Coradjil Road (Corangamite Shire).

Photo 53: Hummocky slopes mapped as Nbb over Nhg, Coradjil Road.

Photo 54: Nbb capping over Nhg (mapped as Pww on the geology map but appears to be Nhg), south end of Tin Dish Road, Irrewillipe.

Photo 55: Tomahawk Creek Road, Irrewillipe. Mapped as Nbb over Pww however the relatively gentle, hummocky lower slopes are inferred to be Nhg materials.

Pliocene to Holocene deposits

Photo 56: Dewings Bridge Road near the crossing of the Barwon River East Branch. Example of Qa1/Nhg slumps on gentle slopes near watercourses.

Photo 57: Alluvium overlying Nhg, Brae.

Photo 58: Inferred colluvium in the base of a watercourse, Ackerlys Road near Polleys Road, Barongarook West.

Photo 59: Hummocky slopes in inferred colluvium at the base of a Pww slope, Lavers Hill-Cobden Road, Chapple Vale.

APPENDIX B

Revised EMO Mapping

Legend

- Proposed EMO1
- Current EMO1
- COS LGA Boundary
- Property Boundary

BURNIP CREEK
PIRRON YALLOCK CREEK
Carpendeit-Bungador Road
Bungador
Speedway Road
TIRRENGOWA DRAIN
New Irrewillipe Road
Timboon-Colac Road
Majestic Road
DANGER CREEK
TOMAHAWK CREEK

1 2 3 4 5 6 7 8 9 10 11 12 13 14 15

Scale 1:50,000
(at A3 page size)
0 0.5 1 2
Kilometres
N

Filename: 1161_EMO_Map_Series_20201008.mxd
Map Created: 21/10/2020

Client:	Colac Otway Shire
Project:	Erosion Management Overlay Review
Title:	Proposed EMO Changes

a.s.miner geotechnical Consulting Engineers
GOLDER

Report No. 1161

Map 1

Legend

- Proposed EMO1
- Current EMO1
- COS LGA Boundary
- Property Boundary

Princes Highway
Pirron Yallock
PIRRON YALLOCK CREEK
Swan Marsh-Stoneyford Road
Swan Marsh
Swan Marsh Road
Settlement Road
Carpendeit-Bungador Road
Swan Marsh-Irrewillipe Road
Timboon-Colac Road
SPRING GULLY
MACK CREEK
Irrewillipe
Tomahawk Creek
Irrewillipe Road
Tomahawk Creek Road
New Irrewillipe Road
Irrewillipe East
Carlisle Road
MURREE CREEK
TOMAHAWK CREEK
Black Bridge Road
GUM GULLY CREEK
GELLIBRAND RIVER
Cattle-Colac Road

1 2 3 4 5 6 7 8 9 10 11 12 13 14 15

Scale 1:50,000
(at A3 page size)
0 0.5 1 2
Kilometres
N

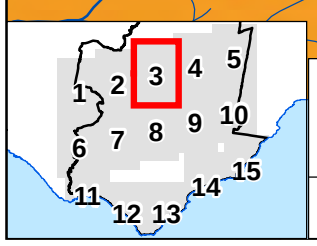
Filename: 1161_EMO_Map_Series_20201008.mxd
Map Created: 21/10/2020

Client:	Colac Otway Shire	a.s.miner geotechnical Consulting Engineers	GOLDER
Project:	Erosion Management Overlay Review		
Title:	Proposed EMO Changes	Report No. 1161	**Map 2**

Legend

- Proposed EMO1
- Current EMO1
- COS LGA Boundary
- Property Boundary

Princes Highway
Kelvin Grove Road
Corororooke Road
Rossmoyne Road
DEANS CREEK
Murray Street
Princes Highway
Queen Street
Wallace Street
Colac
Colac-Forrest Road
Corangamite Street
Gravesend Street
BARONGAROOK CREEK
Larpent Road
Larpent
Deans Creek Road
Holmechase Road
Irrewillipe Road
Elliminyt
Main Street
Underwoods Road
BARONGAROOK CREEK WEST BRANCH
Forans Road
Everett Ricketts
Shorts Road
Barongarook West
Carlisle Road
G Barrys Road
BOUNDARY CREEK
Barongarook
Colac-Lavers Hill Road
SPRING GULLY
MURREE CREEK
TEN MILE CREEK
DIVIDING CREEK
YAHOO CREEK
Black Bridge Road
GUM GULLY CREEK
LOVE CREEK
Kawarren



Scale 1:50,000
(at A3 page size)

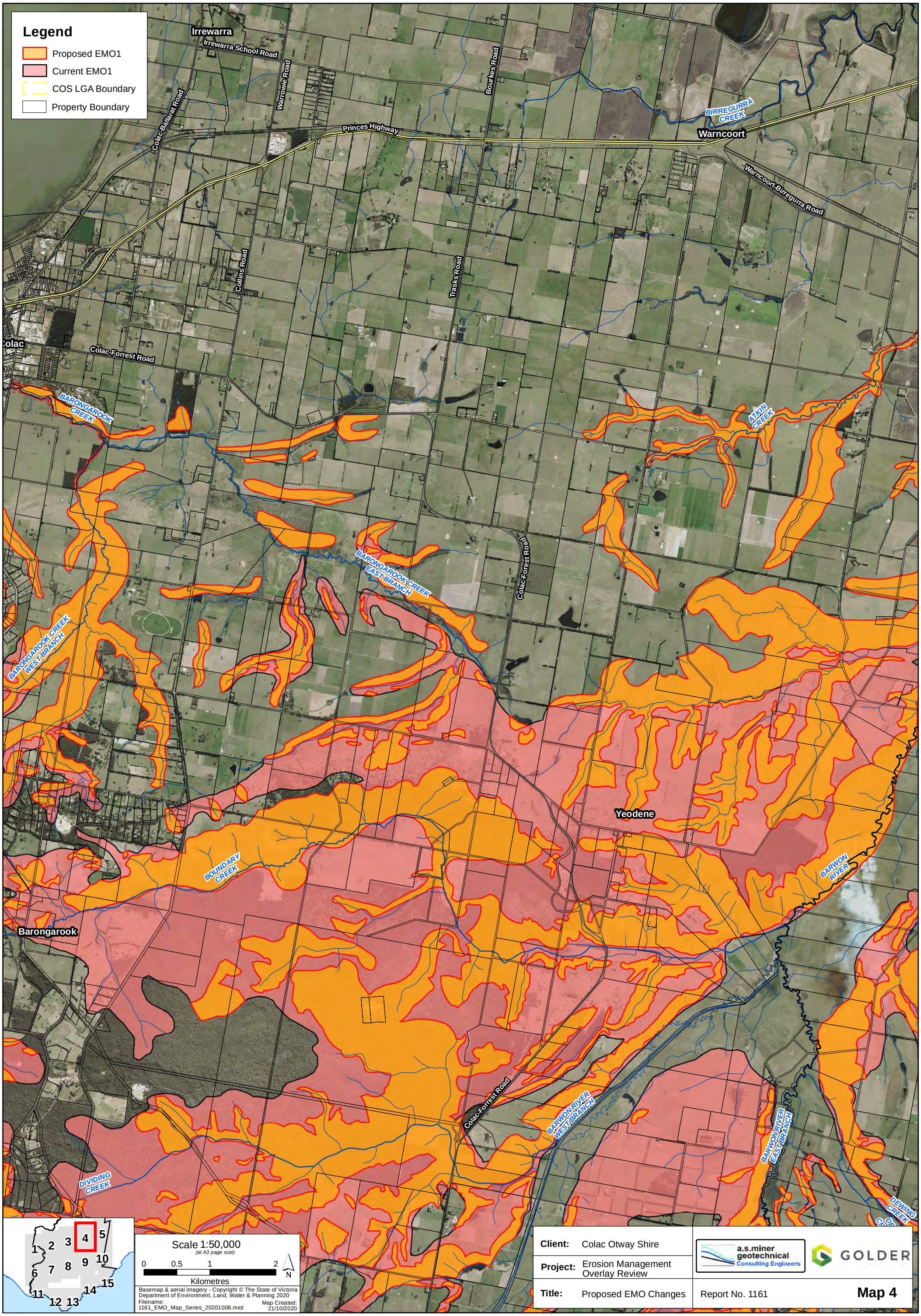
0 0.5 1 2
Kilometres

N

Filename: 1161_EMO_Map_Series_20201008.mxd

Map Created: 21/10/2020

Client:	Colac Otway Shire	a.s.miner geotechnical Consulting Engineers	GOLDER
Project:	Erosion Management Overlay Review		
Title:	Proposed EMO Changes	Report No. 1161	**Map 3**


Legend
Proposed EMO1
Current EMO1
COS LGA Boundary
Property Boundary
Irrewarra
Irrewarra School Road
Warrowie Road
Bourkes Road
Colac-Ballarat Road
Princes Highway
BIRREGURRA CREEK
Warncoort
Warncoort-Birregurra Road
Collins Road
Trasks Road
Colac
Colac-Forrest Road
BARONGAROOK CREEK
ATKIN CREEK
BARONGAROOK CREEK EAST BRANCH
BARONGAROOK CREEK WEST BRANCH
Yeodene
BOUNDARY CREEK
BARWON RIVER
Barongarook
BARWON RIVER WEST BRANCH
BARWON RIVER EAST BRANCH
DIVIDING CREEK
DEWING CREEK
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15
Scale 1:50,000
(at A3 page size)
0 0.5 1 2
Kilometres
N
Basemap & aerial imagery - Copyright © The State of Victoria Department of Environment, Land, Water & Planning 2020
Filename: 1161_EMO_Map_Series_20201008.mxd
Map Created: 21/10/2020
Client: Colac Otway Shire
Project: Erosion Management Overlay Review
Title: Proposed EMO Changes
a.s.miner geotechnical Consulting Engineers
GOLDER
Report No. 1161
Map 4

Legend

- Proposed EMO1
- Current EMO1
- COS LGA Boundary
- Property Boundary

Princes Highway
Princes Highway
BIRREGURRA CREEK
Birregurra Road
Warncoort-Birregurra Road
Roadknight Street
ATKIN CREEK
Birregurra
Cape Otway Road
BARWON RIVER
MATTHEWS CREEK
Whoorel
Birregurra-Deans Marsh Road
DEANS MARSH CREEK
Birregurra-Forrest Road
PENNYROYAL CREEK
BARWON RIVER EAST BRANCH
WURDI BOLUC INLET CHANNEL
Murroon
Pennyroyal

1 2 3 4 5 6 7 8 9 10 11 12 13 14 15

Scale 1:50,000
(at A3 page size)
0 0.5 1 2
Kilometres
N

Filename: 1161_EMO_Map_Series_20201008.mxd
Map Created: 21/10/2020

Client:	Colac Otway Shire
Project:	Erosion Management Overlay Review
Title:	Proposed EMO Changes

a.s.miner geotechnical Consulting Engineers
GOLDER

Report No. 1161

Map 5

Legend

- Proposed EMO1
- Current EMO1
- COS LGA Boundary
- Property Boundary

Gellibrand River Road
SANDY CREEK
SHEEPYARD CREEK
GELLIBRAND RIVER
Gellibrand River Road
CRINOLINE CREEK
Gellibrand River Road
CHAPPLE CREEK
Chapple Vale
CHAPPLE CREEK NORTH BRANCH
Devondale
CHAPPLE CREEK SOUTH BRANCH
Lavers Hill-Cobden Road
ATKINSON CREEK
BRYANT CREEK

1 2 3 4 5 6 7 8 9 10 11 12 13 14 15

Scale 1:50,000
(at A3 page size)

0 0.5 1 2
Kilometres

N

Filename: 1161_EMO_Map_Series_20201008.mxd
Map Created: 21/10/2020

Client:	Colac Otway Shire	a.s.miner geotechnical Consulting Engineers	GOLDER
Project:	Erosion Management Overlay Review		
Title:	Proposed EMO Changes	Report No. 1161	**Map 6**

Legend

- Proposed EMO1
- Current EMO1
- COS LGA Boundary
- Property Boundary

Black Bridge Road
GELLIBRAND RIVER
Carlisle-Colac Road
RUSTY CREEK
Carlisle River
BOGGY CREEK
Moomowroong Road
Lucas Road
COLE CREEK
Egan Track
Gellibrand River Road
SANDY CREEK
CRINOLINE CREEK
LEAHY CREEK
CARLISLE RIVER
CAMP CREEK
ARKINS CREEK
ARKINS CREEK EAST BRANCH
ARKINS CREEK WEST BRANCH
YOUNGS CREEK
CHAPPLE CREEK NORTH BRANCH
CHAPPLE CREEK SOUTH BRANCH
CIANCIO CREEK
YOUNG CREEK
Wyelangta
Colac-Lavers Hill Road
Stalker

1 2 3 4 5 6 7 8 9 10 11 12 13 14 15

Scale 1:50,000
(at A3 page size)

0 0.5 1 2
Kilometres

N

Filename: 1161_EMO_Map_Series_20201008.mxd
Map Created: 21/10/2020

Client:	Colac Otway Shire
Project:	Erosion Management Overlay Review
Title:	Proposed EMO Changes

a.s.miner geotechnical Consulting Engineers

GOLDER

Report No. 1161

Map 7

Legend

- Proposed EMO1
- Current EMO1
- COS LGA Boundary
- Property Boundary

Kawarren
Gellibrand
Banool
Wimba
Mt.Devitt
Dinmont
Charleys Creek
Ferguson
Weeaproinah
Beech Forest

Colac-Lavers Hill Road
Gellibrand-Carlisle Road
Main Road
Gellibrand East Road
Beech Forest-Lavers Hill Road
Gardner Street
Beech Forest-Mount Sabine Road
Dehnerts Track

YAHOO CREEK
TEN MILE CREEK
LOVE CREEK
PORCUPINE CREEK
GELLIBRAND RIVER
LARDNER CREEK
ASPLIN CREEK
CHARLEYS CREEK
LARDNER CREEK WEST BRANCH
LARDNER CREEK EAST BRANCH
MCDONALD CREEK
LITTLE LARDNER CREEK
CARLISLE RIVER
CAMP CREEK
LITTLE AIRE CREEK

Scale 1:50,000
(at A3 page size)
0 0.5 1 2
Kilometres
N

Filename: 1161_EMO_Map_Series_20201008.mxd
Map Created: 21/10/2020

Client:	Colac Otway Shire
Project:	Erosion Management Overlay Review
Title:	Proposed EMO Changes

a.s.miner geotechnical Consulting Engineers
GOLDER

Report No. 1161

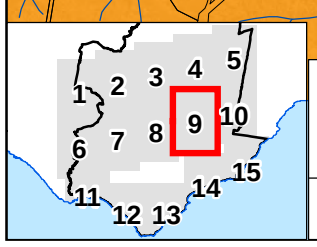
Map 8

Legend

- Proposed EMO1
- Current EMO1
- COS LGA Boundary
- Property Boundary

Barwon Downs
Forrest
Upper Gellibrand
Barramunga

DEWING CREEK
DEN CREEK
PORCUPINE CREEK
Colac-Forrest Road
Birregurra-Forrest Road
CALLAHAN CREEK NORTH BRANCH
KING CREEK
Grant Street
BARWON RIVER EAST BRANCH
ROADKNIGHT CREEK
SANDSTONE CREEK
NOONDAY CREEK
Forrest-Apollo Bay Road
BARWON RIVER WEST BRANCH
ASPLIN CREEK
BARRAMUNGA CREEK
MONDAY CREEK
GELLIBRAND RIVER
OLANGOLAH CREEK



Scale 1:50,000
(at A3 page size)

0 0.5 1 2
Kilometres

N

Filename: 1161_EMO_Map_Series_20201008.mxd

Map Created: 21/10/2020

Client:	Colac Otway Shire
Project:	Erosion Management Overlay Review
Title:	Proposed EMO Changes

a.s.miner geotechnical Consulting Engineers

GOLDER

Report No. 1161

Map 9

Legend

- Proposed EMO1
- Current EMO1
- COS LGA Boundary
- Property Boundary

Murroon
Pennyroyal
Barwon Downs
Birregurra-Forrest Road
MATTHEWS CREEK
WURDI BOLUC INLET CHANNEL
DEN CREEK
CALLAHAN CREEK SOUTH BRANCH
DEWING CREEK
CALLAHAN CREEK NORTH BRANCH
MACKIE CREEK
KING CREEK
SEYMOUR CREEK
BARWON RIVER EAST BRANCH
BARWON RIVER WEST BRANCH
CUMBERLAND RIVER
GARVEY CREEK
JAMIESON

1 2 3 4 5 6 7 8 9 10 11 12 13 14 15

Scale 1:50,000
(at A3 page size)
0 0.5 1 2
Kilometres
N

Filename: 1161_EMO_Map_Series_20201008.mxd
Map Created: 21/10/2020

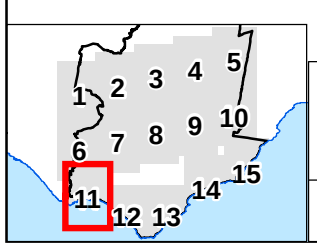
Client:	Colac Otway Shire	a.s.miner geotechnical Consulting Engineers	GOLDER
Project:	Erosion Management Overlay Review		
Title:	Proposed EMO Changes	Report No. 1161	**Map 10**

Legend

- Proposed EMO1
- Current EMO1
- COS LGA Boundary
- Property Boundary

BRYANT CREEK
GELLIBRAND RIVER
ATKINSON CREEK
NARIEL CREEK
SKINNER CREEK
CHAPPLE CREEK SOUTH BRANCH
MELBA GULLY
Great Ocean Road
JOHANNA RIVER
STAFFORD CREEK
MILANESIA CREEK
RUNNING CREEK
KNOWLEDGE CREEK
DEEP CREEK
POYNTON CREEK
BROWN CREEK

Lavers Hill
Crowes
Wangerrip
Yuulong
Johanna Heights
Lower Gellibrand
Great Ocean Road
Johanna



Scale 1:50,000
(at A3 page size)

0 0.5 1 2
Kilometres

N

Filename: 1161_EMO_Map_Series_20201008.mxd

Map Created: 21/10/2020

Client:	Colac Otway Shire
Project:	Erosion Management Overlay Review
Title:	Proposed EMO Changes

a.s.miner geotechnical Consulting Engineers

GOLDER

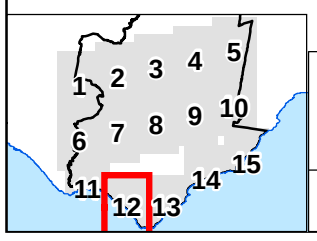
Report No. 1161

Map 11

Legend

- Proposed EMO1
- Current EMO1
- COS LGA Boundary
- Property Boundary

FORD RIVER WEST BRANCH
FORD RIVER EAST BRANCH
REDWATER CREEK
CLEARWATER CREEK
STAFFORD CREEK
WAIT A WHILE CREEK
FORD RIVER
HOLY WATER CREEK
Johanna
JOHANNA RIVER
BROWN CREEK
Great Ocean Road
AIRE RIVER
CALDER RIVER
Glenaire
BLIND CREEK
Hordern Vale
DEEP CREEK
DUCK CREEK
Lighthouse Road
PARKER RIVER



Scale 1:50,000
(at A3 page size)

0 0.5 1 2
Kilometres

N

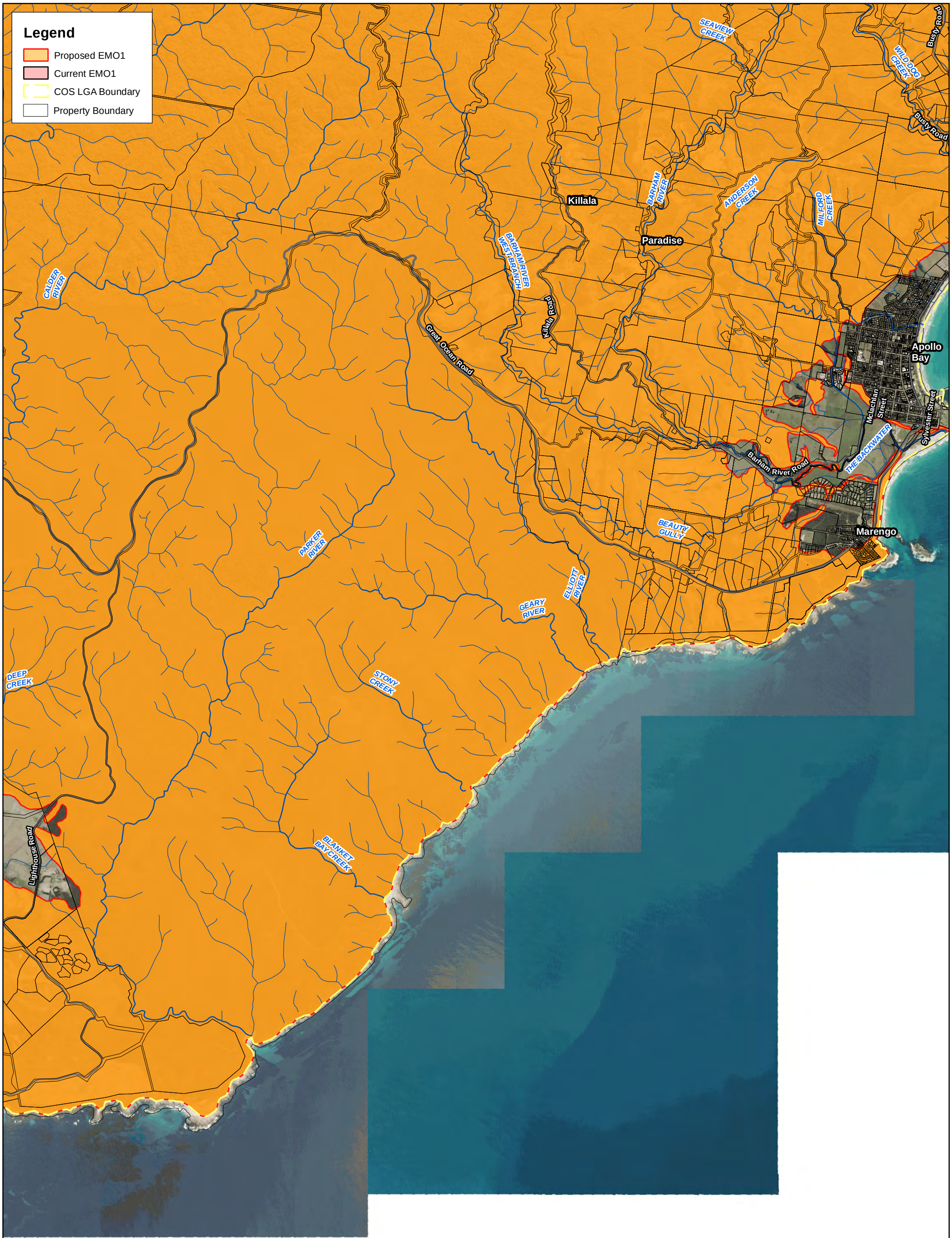
Filename: 1161_EMO_Map_Series_20201008.mxd
Map Created: 21/10/2020

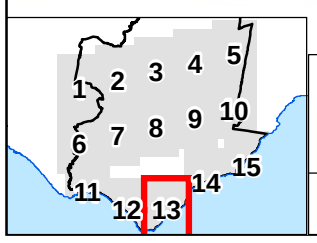
Client:	Colac Otway Shire
Project:	Erosion Management Overlay Review
Title:	Proposed EMO Changes

a.s.miner geotechnical Consulting Engineers
GOLDER

Report No. 1161

Map 12





Scale 1:50,000
(at A3 page size)

0 0.5 1 2

Kilometres

N

Filename: 1161_EMO_Map_Series_20201008.mxd

Map Created: 21/10/2020

Client:	Colac Otway Shire	a.s.miner geotechnical Consulting Engineers / GOLDER	
Project:	Erosion Management Overlay Review		
Title:	Proposed EMO Changes	Report No. 1161	**Map 13**

Legend

- Proposed EMO1
- Current EMO1
- COS LGA Boundary
- Property Boundary

Haines Junction
Tanybryn
Skenes Creek North
Skenes Creek
Wongarra
Apollo Bay
Marengo

OLANGOLAH CREEK
KENNETT RIVER
GREY RIVER
CARISBROOK CREEK
NETTLE CREEK
SUGARLOAF CREEK
BARHAM RIVER EAST BRANCH
WILD DOG CREEK
IRVING CREEK
SKENES CREEK
PETTICOAT CREEK
BROWN CREEK
VON MUELLER CREEK
SMYTHE CREEK
WHALEBONE CREEK
STONY CREEK
MILFORD CREEK
BARHAM RIVER
THE BACKWATER

Turons Road
Skenes Creek Road
Busy Road
Wild Dog Road
Great Ocean Road
Mclachlan Street
Sylvester Street

Scale 1:50,000
(at A3 page size)

0 0.5 1 2
Kilometres

N

Filename: 1161_EMO_Map_Series_20201008.mxd
Map Created: 21/10/2020

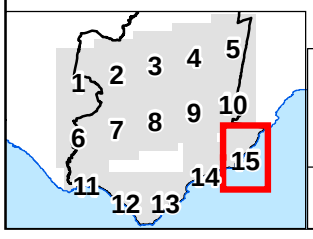
Client:	Colac Otway Shire	a.s.miner geotechnical Consulting Engineers / GOLDER	
Project:	Erosion Management Overlay Review		
Title:	Proposed EMO Changes	Report No. 1161	**Map 14**

Legend

- Proposed EMO1
- Current EMO1
- COS LGA Boundary
- Property Boundary

JAMIESON CREEK
SEPARATION CREEK
KENNETT RIVER EAST BRANCH
KENNETT RIVER WEST BRANCH
WYE RIVER
MONASH GULLY
HITCHCOCK GULLY
GREY RIVER
KENNETT RIVER
CARISBROOK CREEK
ORCHARD CREEK
SHRAPNEL GULLY
SAUSAGE GULLY

Separation Creek
Wye River
Kennett River
Grey River
Cassidy Drive
Great Ocean Road
Great Ocean Road



Scale 1:50,000
(at A3 page size)

0 0.5 1 2

Kilometres

N

Filename: 1161_EMO_Map_Series_20201008.mxd

Map Created: 21/10/2020

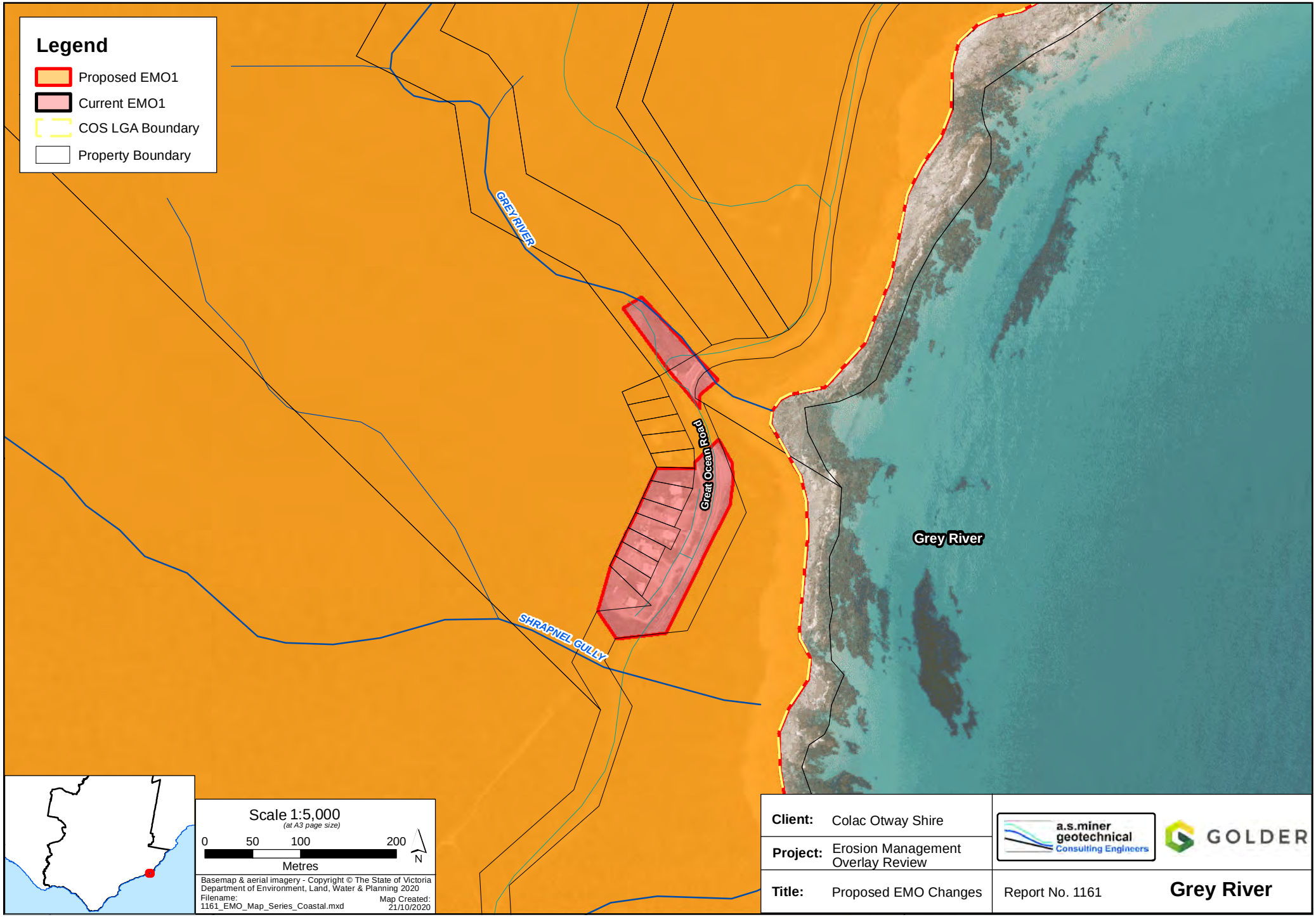
Client:	Colac Otway Shire
Project:	Erosion Management Overlay Review
Title:	Proposed EMO Changes

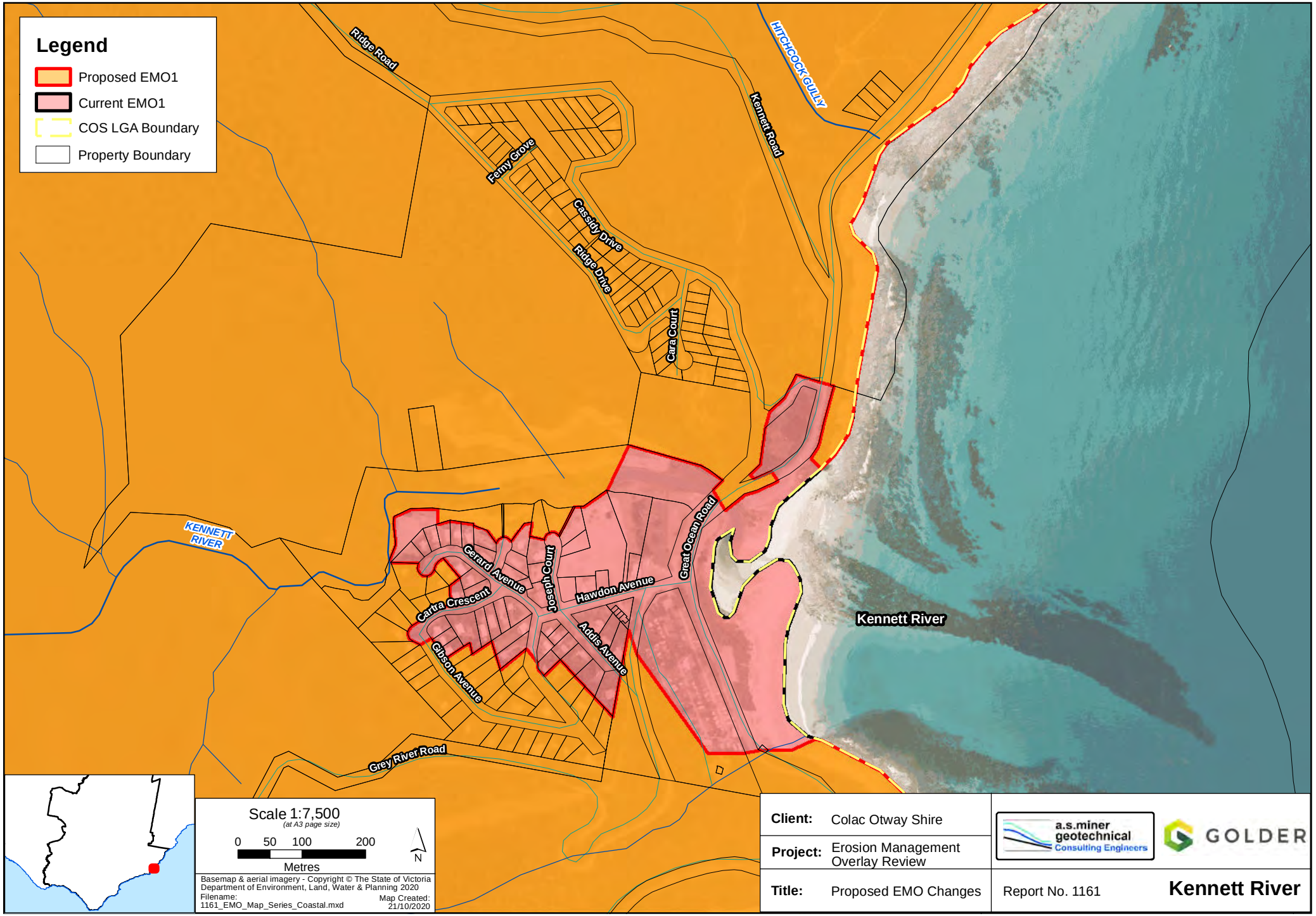
a.s.miner geotechnical Consulting Engineers

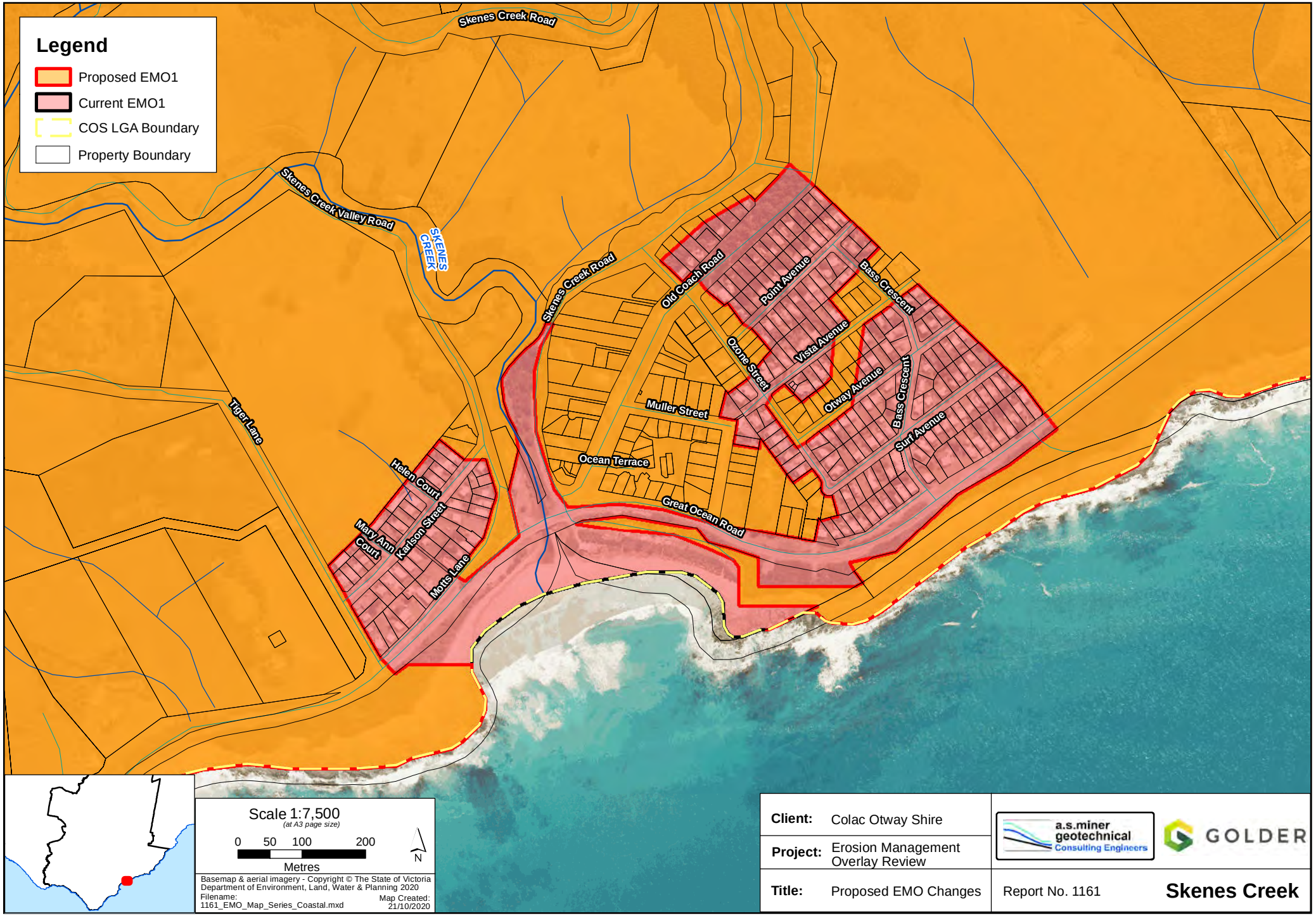
GOLDER

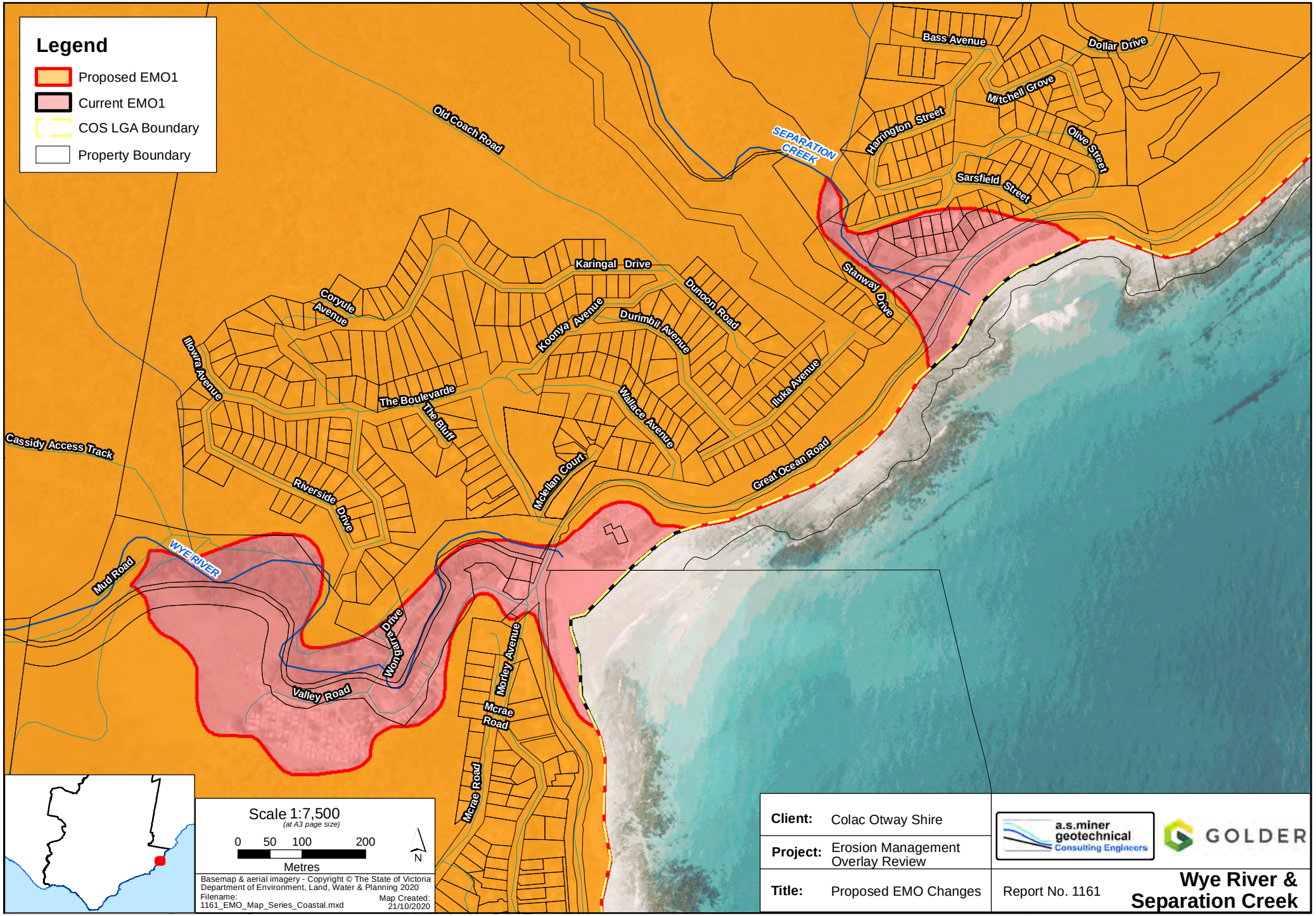
Report No. 1161

Map 15


Legend
Proposed EMO1
Current EMO1
COS LGA Boundary
Property Boundary
GREY RIVER
Great Ocean Road
SHRAPNEL GULLY
Grey River
Scale 1:5,000
(at A3 page size)
0 50 100 200
Metres
N
Basemap & aerial imagery - Copyright © The State of Victoria Department of Environment, Land, Water & Planning 2020
Filename: 1161_EMO_Map_Series_Coastal.mxd
Map Created: 21/10/2020
Client: Colac Otway Shire
Project: Erosion Management Overlay Review
Title: Proposed EMO Changes
a.s.miner geotechnical Consulting Engineers
GOLDER
Report No. 1161
Grey River


Legend
Proposed EMO1
Current EMO1
COS LGA Boundary
Property Boundary
Ridge Road
Ferny Grove
Cassidy Drive
Ridge Drive
Cara Court
HITCHCOCK GULLY
Kennett Road
KENNETT RIVER
Gerard Avenue
Joseph Court
Great Ocean Road
Hawdon Avenue
Cartra Crescent
Addis Avenue
Gibson Avenue
Grey River Road
Kennett River
Scale 1:7,500
(at A3 page size)
0 50 100 200
Metres
N
Basemap & aerial imagery - Copyright © The State of Victoria Department of Environment, Land, Water & Planning 2020
Filename: 1161_EMO_Map_Series_Coastal.mxd
Map Created: 21/10/2020
Client: Colac Otway Shire
Project: Erosion Management Overlay Review
Title: Proposed EMO Changes
a.s.miner geotechnical Consulting Engineers
GOLDER
Report No. 1161
Kennett River


Legend
Proposed EMO1
Current EMO1
COS LGA Boundary
Property Boundary
Skenes Creek Road
Skenes Creek Valley Road
SKENES CREEK
Skenes Creek Road
Old Coach Road
Point Avenue
Bass Crescent
Vista Avenue
Ozone Street
Otway Avenue
Bass Crescent
Surf Avenue
Muller Street
Ocean Terrace
Great Ocean Road
Tiger Lane
Helen Court
Mary Ann Court
Karlson Street
Motts Lane
Scale 1:7,500
(at A3 page size)
0 50 100 200
Metres
N
Basemap & aerial imagery - Copyright © The State of Victoria Department of Environment, Land, Water & Planning 2020
Filename: 1161_EMO_Map_Series_Coastal.mxd
Map Created: 21/10/2020
Client: Colac Otway Shire
Project: Erosion Management Overlay Review
Title: Proposed EMO Changes
a.s.miner geotechnical Consulting Engineers
GOLDER
Report No. 1161
Skenes Creek


Legend
Proposed EMO1
Current EMO1
COS LGA Boundary
Property Boundary
Old Coach Road
SEPARATION CREEK
Bass Avenue
Dollar Drive
Mitchell Grove
Harrington Street
Olive Street
Sarsfield Street
Karingal Drive
Coryule Avenue
Koonya Avenue
Durimbil Avenue
Dunoon Road
Stanway Drive
Illowra Avenue
The Boulevarde
The Bluff
Illuka Avenue
Wallace Avenue
Cassidy Access Track
Riverside Drive
Mcellan Court
Great Ocean Road
WYE RIVER
Mud Road
Wongara Drive
Valley Road
Morley Avenue
Mcrae Road
Mcrae Road
Scale 1:7,500
(at A3 page size)
0 50 100 200
Metres
N
Basemap & aerial imagery - Copyright © The State of Victoria Department of Environment, Land, Water & Planning 2020
Filename: 1161_EMO_Map_Series_Coastal.mxd
Map Created: 21/10/2020
Client: Colac Otway Shire
Project: Erosion Management Overlay Review
Title: Proposed EMO Changes
a.s.miner geotechnical Consulting Engineers
GOLDER
Report No. 1161
Wye River & Separation Creek

APPENDIX C

Example EMO Checklists for Planners

	Information to be checked	Relevant section of planning scheme	Yes, No, NA or O (other)	Comments/ Description (Required for all Yes, and possibly O answers)
PART A - BASIC INFORMATION				
A.1	Planning Application No:			
A.2	Site address:			
PART B - PLANNING SCHEME REQUIREMENTS & SUBMITTED INFORMATION				
B.1	Is the development exempt from a planning permit under the EMO?	Clause 44.01 and part 4.0 of schedule		
B.2	Does the proposal meet the VicSmart requirements?	Clause 92.04		
B.3	Are the development plans drawn to scale, dimensioned and based on survey? Are the submitted plans consistent with the geotechnical report? Do the plans accurately show existing development and conditions (as applicable) including: • Contours/site levels within 10 metres of the proposed development and a notation indicating the maximum slope (%) within that area; • Buildings; • Water tanks and dams on both the subject lot and immediately adjacent lots; • Cut and/or fill and retaining walls;	Part 5.0 of schedule to Clause 44.01		

	• Stormwater drainage, subsurface drainage, water supply pipelines and sewerage pipelines; • Location of existing trees within 10 metres of the proposed development. Do the plans show adequate details of the proposed development including: • Site plan and building plans and elevations; • Any cut and/or fill, including height/depth and batter angles (NB: if none shown is this accurate?); • Any retaining walls where the cut is greater than 1 metre, including an engineer's design; • Any effluent disposal system, including septic tank and effluent lines; • Any vegetation to be removed.			
B.4	Does the geotechnical report include the following information? • Site description including slope angle; • Confirmation of geology by providing borehole data or mapping; • Identification of any existing earthworks, including height and batter angle; • Commentary on the stability of the earthworks; • Discussion about whether there is any evidence of previous landslide or instability on the site; • The provision of site and development specific advice for the mitigation of landslide hazards eg drainage, retaining walls;	Part 5.0 of schedule to Clause 44.01		

	• Recommendation or provision of an Landslip Risk Assessment or a conclusion that one is not required; • The geotechnical practitioner's qualifications and experience.			
B.5	If the geotechnical report concludes that an LRA is needed, does it include the following information? • A section on the risk to life; • A section on the risk to property; • A statement as to whether the assessed risk is tolerable.	Part 5.0 of schedule to Clause 44.01		
B.6	Is the application accompanied by a fully completed Declaration & Verification Statement including: Section 4 - Must include a list of all of the submitted development plans and evidence that the geotechnical practitioner has sighted them. Section 6 – The professional status of the practitioner (either Chartered Professional Engineer, Chartered Professional Geologist or Registered Professional Geologist) must be stated and the form must be signed. (NB: If the last box in Section 5 is ticked 'No', or is blank, the practitioner is declaring the risk to be unacceptable and the application must be referred to Golder Associates).			
B.7	Is the practitioner signing the statement on the list of geotechnical practitioners who have recently completed reports in Yarra Ranges? (see Promapp link)			

B.8	If the practitioner is not on this list, has the geotechnical and/or landslip risk assessment been referred to Golder Associates for review?			
PART C – IDENTIFYING HAZARD CODE AND WHETHER IN DEBRIS FLOW AREA				
C.1	What Landslip Hazard Areas category/categories applies/apply to this property?			
C.2	Is the property in a debris flow area?			
PART D - CHECK OF GEOTECHNICAL REPORT (only complete this section if land application was NOT referred to Golder Associates)				
D.1	Is the report's conclusion generally consistent with the "Comments" associated with the relevant Landslip Hazard Area?			
D.2	Does the report conclude that a Landslip Risk Assessment is not required?			
PART E - SITE INSPECTION				
E.1	Date of site visit:			
E.2	Are there any existing site cuts within 5 metres of the proposed development on this property or an adjoining one?			
E.3	Is there any unretained cut steeper than 2H:1V within 10 metres of the proposed development? (As a guide, this is a 28° angle from the horizontal and is about the steepest angle a person can walk up.)			
E.4	Does this site cut exceed 0.6 metres in depth?			

E.5	If the site cut exceeds 0.6 metres in depth, is there an existing retaining wall exceeding 1.0 metre in height? Is this information shown on the submitted plans and considered in the geotechnical report?			
E.6	If the proposal includes vegetation removal, is this shown accurately on the submitted plans.			
PART F - REFERRAL TO GOLDER ASSOCIATES (ONLY complete this section if application was referred to Golder Associates)				
F.1	Do Golders Associates consider the Geotechnical Report &/or Landslip Risk Assessment has/have address all required issues?			
F.2	Does Golder Associates consider the proposal to be satisfactory?			
PART G – EMO ASSESSMENT				
G.1	Is the proposal acceptable having regard to the EMO decision guidelines?	Part 7.0 of schedule to Clause 44.01		
G.2	Have the following permit conditions been applied: PC-PLAN21 The permitted development must be undertaken in accordance with the recommendations contained in the geotechnical engineering report by <<variable>>, dated <<variable>>. A copy of this report forms part of this permit. PC-PLAN12A Prior to the occupation of any building or structure or the commencement of any use authorised by the permit, the applicant must submit to the responsible authority a statement	Part 8.0 of schedule to Clause 44.01		

	made by the Geotechnical Practitioner who prepared the Geotechnical Assessment or Landslip Risk Assessment, stating that the conditions have been complied with and the permitted development is suitable to be used or occupied for the purpose for which the permission has been granted. REVISED All stormwater generated from the permitted development must be directed to the legal point of discharge **to the satisfaction of the responsible authority**. Has the following condition been applied, if applicable: To the satisfaction of the responsible authority, retaining walls with a height of one metre or higher must be designed by an engineer with suitable qualifications and experience. If the wall will not be accessible after construction of the building/structure, the wall must have a design life greater than the design life of the proposed development/structure or a minimum of 50 years. Where the retaining wall will be accessible after construction of the building/structure, the wall must have a minimum design life of 25 years.			

APPENDIX D

Suggested Revised Schedule to the EMO

31/12/2020

SCHEDULE 1 TO CLAUSE 44.01 EROSION MANAGEMENT OVERLAY

Shown on the planning scheme map as **EMO1**.

NAME OF SCHEDULE

1.0 Erosion management objectives to be achieved

31/12/2020

- To manage the risk from landslip.
- To ensure that development can be carried out in a manner which will not adversely increase the landslip risk to life or property affecting the subject land or adjoining or nearby land.
- To ensure that development is not carried out unless the risk associated with the development is a Tolerable Risk or lower.
- To ensure that applications for development are supported by adequate investigation and documentation of geotechnical and related structural matters.
- To ensure that development is only carried out if identified geotechnical and related structural engineering risks to life and property are effectively addressed.

2.0 Statement of risk

31/12/2020

Colac Otway Shire contains areas of land which are susceptible to landslip, including land within the Otway Ranges, coastal areas along the Great Ocean Road and farming areas in the Forrest and Gellibrand areas.

The occurrence of landslips within Colac Otway Shire has historically caused damage to property and presents an ongoing risk to life and property. A number of geotechnical studies have been undertaken, in various forms across the Colac Otway Shire to document historical landslip occurrences and to identify areas susceptible to future landslide occurrence. Areas assessed as susceptible to landslip form the basis of the Erosion Management Overlay.

All land included in the Erosion Management Overlay has been identified as prone to landslip and to warrant specific review of risk from landslip prior to the issue of a planning permit. The control of environmental factors and development such as vegetation cover, drainage, rock, soil disturbance and effluent and stormwater disposal are important in managing the risk of landslip.

3.0 Definitions

31/12/2020

AGS Guidelines 2007 means:

- Guideline for Landslide Susceptibility, Hazard and Risk Zoning for Land Use Planning and Commentary (Parts A and B).

- Practice Notes Guideline for Landslide Risk Management and Commentary (Part C and D).

Geotechnical Practitioner means a specialist Geotechnical Engineer or Engineering Geologist who is degree qualified, is a member of a professional institution, and who has achieved professional status as a:

- Chartered Professional Engineer (CPEng); or
- Chartered Professional Geologist (CPGeo); or
- Registered Professional Geologist (RPGeo);

with experience in the management of slope stability problems and landslip risk management as a core competence to the satisfaction of the Responsible Authority.

Landslip, as defined by the AGS Guidelines 2007, or "landslip", as defined by the Victorian Planning Provisions means the movement of a mass of rock, debris or earth down a slope. This includes debris flow, which is the rapid flow of water saturated soil or rock debris.

New Development, includes any new structure or change to an existing slope or existing structure that results in an increase in the floor area, overall change in footing loads or change in building use from non-habitable to habitable. Does not include subdivision.

Tolerable Risk – For new development is a risk within a range that society can live with so as to secure certain net benefits. It is a range of risk regarded as non-negligible and needing to be kept under review and reduced further if possible. The maximum tolerable risk:

- For loss of life for the person(s) most at risk, is taken as having a probability of no greater than 10^{-5} (1:100,000) per annum calculated in accordance with the AGS Guidelines 2007;
- For property loss is assessed qualitatively using the AGS Guidelines 2007 and specifically Appendix C to that document and is selected depending on the new development type in accordance with Table 1.

Table 1 - Maximum tolerable risk to property.

New Development Type	Maximum Tolerable Risk
Essential facilities, including hospitals, medical and surgery facilities, emergency services facilities, designated emergency shelters and facilities, buildings and facilities containing toxic or explosive materials in sufficient quantity capable of causing hazardous conditions that extend beyond property boundaries.	Low
All other new development, including residential dwellings.	Moderate

Acceptable Risk – For New Development is risk for which, for the purposes of life or work, is acceptable as it is with no regard to its management. Society does not generally

consider expenditure in further reducing such risks justifiable. An acceptable risk level for new development is one order of magnitude or category lower than the criteria for tolerable risk.

4.0 Permit requirements and exemptions

31/12/2020

A permit is required for all new development and subdivision unless the proposed new development meets one of more of the following exemptions:

- Earthworks, including cut and fill either separately or as part of a buildings or works proposal, that are no greater than 1.0 metre in height or depth.
- The removal or destruction of vegetation, either separately or as part of a buildings or works proposal, provided:
  - The roots below ground level are retained, or;
  - The vegetation removal is associated with timber production where all timber production activities comply with the Code of Forest Practices for Timber Production (Revision No.2 November 1996) or as amended from time to time in accordance with section 55 of the Conservation, Forests and Lands Act 1987, and/or the Timber harvesting Prescriptions for Environmental Protection – Otway Region Private Land Native Forests and Plantations, where details of management of landslip risk have been provided to the satisfaction of the Responsible Authority.
- A domestic water holding structure including pools, spas and ponds, but excluding rainwater tanks with a capacity of not more than 5000 litres provided it is constructed at ground level or above.
- Construction of a fence of:
  - Post and wire construction; or
  - Paling construction, supported by posts and rails, where the base of the fence is at least 75 mm above the ground surface.
- A temporary building or structure:
  - Used for the storage of building materials and equipment; or
  - Where the land on which the temporary structure is located has a slope angle of less than 5 degrees at and within 20 m of the temporary structure; and;
  - The temporary structure is not in place for more than 1 year.
- Extensions to an existing building provided:
  - The increase in the floor area, inclusive of additional storeys and outdoor living areas attached to a dwelling does not exceed 20 square metres, and;
  - Stormwater from the roof is drained to the legal point of discharge.
- A retaining wall provided the wall:
  - Does not exceed one metre in height, and;
  - Is not associated with other building construction work, and;

- Does not provide landslip protection for any adjoining land.

- Buildings and works, including vegetation removal, undertaken by or on behalf of a public land management authority provided that a geotechnical assessment or landslide risk assessment has been undertaken by a geotechnical practitioner in accordance with AGS Guidelines 2007.
- A non-habitable structure ancillary to a dwelling including carports, gazebos, outdoor entertaining areas, unroofed decks, sheds and buildings and facilities associated with agricultural activities, provided:
  - the structure is constructed of lightweight, flexible materials (not bricks, concrete blocks or similar).
  - The structure is not occupied frequently or for extended periods.
  - The site of the structure has not been previously affected by landslide.
  - The slope of the land at and within 20 m of the proposed structure is less than:
    - 9 degrees (15%) in Gellibrand Marl, Narrawaturk Marl, Demons Bluff Formation and the Yaugher Volcanic Group the unnamed coastal lagoon deposits and lake and swamp deposits; or
    - 11 degrees (20%) in all other geologies including the spatially extensive Eumeralla Formation (Otway Group).

5.0 Application requirements

31/12/2020

An application for a planning permit must be accompanied by, to the satisfaction of the Responsible Authority:

- Development Plans
- A Landslide Hazard Assessment if the application is for subdivision and the subdivision will allow the number of dwellings on the whole of the land could be used for to increase.
- A written Geotechnical Assessment if the application is for new development and the application is for:
  - Non-exempt new development including outbuildings and earthworks, on land having a natural slope angle of more than 5 degrees at and within 20 m of the proposed new development, or;
  - The site has been previously affected by landslide, or;
  - A Geotechnical Practitioner has not otherwise provided written advice to the satisfaction of the Responsible Authority to indicate the development is not affected by credible landslide hazards.

- A written Landslip Risk Assessment in addition to a Geotechnical Assessment if any of the following apply:

- the Geotechnical Assessment or other landform data (a detailed site survey) indicates natural slopes on or immediately adjacent to the subject lot which:
  - are steeper than 9 degrees (15.8%) in Gellibrand Marl, Demons Bluff Formation and Narrawaturk Marl & the Yaugher Volcanic Group the unnamed coastal lagoon deposits and lake and swamp deposits; or
  - are steeper than 14 degrees (25%) in all other geologies including the spatially extensive Eumeralla Formation (Otway Group); or
  - exhibit evidence of possible or past landsliding on or immediately adjacent to the site; or
  - where, in the opinion of the Responsible Authority, the Geotechnical Assessment is not sufficient to determine that the development can be carried out in a manner which will not adversely increase the landslip risk to life or property affecting the subject lot or adjoining or nearby land.

Development Plans

Development plans must be drawn to scale and dimensioned, showing as appropriate:

- The proposed new development or subdivision, including as appropriate a site plan and building elevations, access, any proposed cut and fill, retaining wall or effluent disposal system.
- Any existing development, including buildings, water tanks and dams on both the subject lot and adjacent land (as appropriate).
- Any existing development on the subject lot(s), including cut and fill, stormwater drainage, subsurface drainage, water supply pipelines, sewerage pipelines or effluent disposal installations and pipelines and any otherwise identified geotechnical hazard.
- Details and location of existing vegetation, including any vegetation to be removed.

Landslip Hazard Assessment for Subdivision

Where subdivision is proposed, a landslide hazard assessment should be prepared by a Geotechnical Practitioner in accordance with the methodology set out in the AGS Guidelines 2007 parts A and B to the satisfaction of the Responsible Authority. The objective of the Landslip Hazard Assessment is to identify hazards which could affect future development within a proposed subdivision and to recommend constraints on subdivision and future development. The Landslip Hazard Assessment should include as a minimum:

- A definition of scope establishing the purpose and scope of the hazard assessment.
- A data gathering / desk top phase assembling relevant data and recording the sources of data referred to.

- Completion of investigations sufficient to establish a geotechnical model, identify geomorphic processes and associated process rates.
- Inspection of the site and surrounds including field mapping of the geomorphic features.
- A landslide inventory map covering the proposed subdivision and relevant surrounding areas and associated information on landslides in the inventory such as classification, location, time of sliding (if known), volume and a description of validation and limitations of the inventory.
- A landslide susceptibility zoning map(s) prepared in accordance with the AGS Guidelines 2007 and with related information on how susceptibility was determined and a description of validation and limitations of the zoning.
- General comment regarding the nature of the landslide hazards, frequency and potential impacts or consequences and their implications for levels of associated risk should be included.
- Recommendations as to whether the proposed subdivision is viable in its current format and an indication of areas that in the opinion of the geotechnical engineer:
    - are not suitable for development;
    - are suitable for development subject to constraints or risk mitigation and an indication of those constraints;
    - are suitable for development without constraints.
- A discussion of potential impacts to adjacent land.
- Be accompanied by a Geotechnical Declaration and Verification Form (Form A).

Future non-exempt new development on subdivided land will require a separate permit and will be subject to a separate application in accordance with the provisions of the EMO.

Geotechnical Assessment for New Development

Where a geotechnical assessment is required, it must be prepared by a suitably qualified and experienced Geotechnical Practitioner in accordance with the methodology described below and with reference to the AGS Guidelines 2007 Parts C and D. The Geotechnical Assessment must be for the development proposed in the application and include, to the satisfaction of the Responsible Authority:

- Details of the Geotechnical Practitioner and their qualifications and experience including but not limited to experience in the management of slope instability problems and landslip risk management.
- A statement that the assessment is based on field survey measurements which have been undertaken not more than 12 months prior to the relevant application for development.
- A detailed site description.
- Site assessment plans and cross-sections of the subject lot within the landslip impact zone and related land from survey and field measurements with contours and ground slopes as measured shown and drawn to scale and dimensioned.

- A detailed assessment of subsurface conditions, including the underlying geology.
- A statement indicating whether there are natural slopes on or immediately adjacent to the subject lot which exhibit evidence of possible or past landslip.
- Details of all site investigations and any other information used in preparation of the geotechnical report.
- A statement indicating whether subsurface investigation involving boreholes and/or test pit excavations or other methods is necessary to adequately assess the geotechnical/geological model for the subject lot and details of all such investigations, boreholes, test pits or other methods.
- A statement indicating that in the opinion of the Geotechincal Practitioner, the risks for all slope instability hazards identified, are of an acceptable risk level (as defined above) and will remain at an acceptable risk level over the design life of the development such that a Landslip Risk Assessment (as described in the following section) is not required.
- A statement indicating whether or not development should only be approved subject to conditions, and if so state recommendations of what conditions should be required including but without limitation conditions relating to:
    - The determination of appropriate footing levels and foundation materials in any structural works, including all footings and retaining walls.
    - The location/s of and depth/s of earth and rock cut and fill.
    - The construction of any excavations and fill and the method of retention of such works.
    - Any details of surface and sub-surface drainage.
    - The selection and design of a building structure system to minimise the effects of all identified geotechnical hazards.
    - Retention, replanting and new planting of vegetation.
    - Any drainage and effluent discharge.
    - Any necessary ongoing mitigation and maintenance measures and any recommended periodic inspections, including performance measures.
    - The time within which works must be completed after commencement and the location/s and period in which materials associated with the development can be stockpiled.
    - Any requirements for geotechnical inspections and approvals that may need to be incorporated into a construction work plan for building approval.
- A statement on whether or not a Landslip Risk Assessment is required.
- Be accompanied by a Geotechnical Declaration and Verification Form (Form A).

Landslip Risk Assessment for New Development

Where required, a written Landslip Risk Assessment (LRA) must be prepared by a suitably qualified and experienced Geotechnical Practitioner in accordance with the methodology

set out in the AGS Guidelines 2007 parts C and D. The Landslip Risk Assessment must be for the development proposed in the application and include, to the satisfaction of the Responsible Authority:

- A copy of the Geotechnical Assessment prepared for the subject land and proposal and, if not prepared by the Geotechnical Practitioner preparing the Landslip Risk Assessment, contain a response by the Geotechnical Practitioner preparing the Landslip Risk Assessment that the finding and conclusions of the Geotechnical Assessment are agreed with.
- Contain all the requirements of a Geotechnical Assessment if the need for an Landlsip Risk Assessment is triggered by the Landslip Risk Assessment slope thresholds above.
- If the Geotechnical Practitioner preparing the Landslip Risk Assessment does not agree with the findings and conclusions of the Geotechnical Assessment for the subject land and proposal, another Geotechnical Assessment must be prepared by that Geotechnical Practitioner.
- An assessment underpinned by field survey and measurements which have been undertaken not more than 12 months prior to the lodgement of the application for a planning permit.
- A full assessment of the risk posed by all reasonably identified geotechnical hazards which have the potential to either individually or cumulatively impact upon people or property on the subject lot or related land, in accordance with the AGS Guidelines 2007.
- A full assessment of the risk posed by future vegetation removal for bushfire protection if undertaken to the maximum extent permissible under the conditions of any planning permit and under permit exemptions in the Planning Scheme, in accordance with the AGS Guidelines 2007.
- A conclusion as to whether the subject lot/s are suitable for the proposed development. This must be in the form of a specific statement that the subject lot/s are suitable, or can be made suitable, for the proposed development and that the subject lot/s and/or the proposed development will not adversely increase the risks associated with landslip. The report must specify all conditions required to achieve this objective.
- Be accompanied by a Geotechnical Declaration and Verification Form (Form A).

6.0 Independent Review

31/12/2020

The Responsible Authority may require a Geotechnical Assessment and any Landslip Risk Assessment that has been submitted with an application to be reviewed by an independent Geotechnical Practitioner.

7.0 Transitional Requirements

31/12/2020

Any planning permit application that was lodged with Council prior to the revised EMO approval date does not need to meet the requirements of the new schedule.

8.0 Decision guidelines

31/12/2020

The following decision guidelines apply to an application for a permit under Clause 44.01, in addition to those specified in Clause 44.01 and elsewhere in the scheme which must be considered, as appropriate, by the responsible authority:

- Whether a Geotechnical Assessment, Landslide Risk Assessment or Landslide Hazard Assessment is required.
- Whether the estimated risk to property and life is tolerable.
- The currency of the geotechnical information provided. Geotechnical reports greater than one year old from the time of application will not be accepted unless accompanied by a letter from the Geotechnical Practitioner confirming report conclusions are still applicable.
- Whether proposed new development can be carried out in a manner which will not increase to an unacceptable level the possibility of landslip affecting the site or adjoining or nearby land.
- The recommendations of the Geotechnical Assessment, Landslip Risk Assessment or Landslide Hazard Assessment and any other information accompanying the application.
- The recommendations of any Independent Review of the Geotechnical Assessment, Landslip Risk Assessment or Landslide Hazard Assessment.
- Whether the proposed removal of vegetation is required to facilitate a permitted use or development of the land, and if there is any practical alternative form of development which would result in less disturbance to the existing vegetation.
- The impact of future vegetation removal for bushfire protection and whether any such vegetation removal would result in an increase to the risk to property and/or the risk to life as measured against the tolerable risk criteria defined in the AGS Guidelines 2007.
- The risks associated with the development requiring ongoing monitoring and maintenance of all mitigation measures.
- The risks associated with non-compliance with any conditions of any permit which may be subsequently issued.
- Effluent disposal considerations including any Environment Protection Authority requirements for on-site disposal in unsewered areas.

9.0 Permit Conditions

31/12/2020

If a Landslide Hazard Assessement for subdivision is required, any permit must also contain the following condition:

- The approved subdivision must be carried out on the site in accordance with the recommendations of the Landslide Hazard Assessment (title/date/author), or the Geotechnical Practitioner engaged to review the assessment submitted with the application.

If a Geotechnical Assessment or Landslide Risk Assessment for new development is required, any permit issued must also contain the following condition:

- The approved development must be carried out on the site in accordance with the recommendations of the Geotechnical Assessment (title/date/author) or, where applicable, the Landslip Risk Assessment (title/date/author) or any Geotechnical Practitioner engaged to review those assessments submitted with the application.

10.0 Reference Documents

31/12/2020

- Guidelines for Landslide Susceptibility, Hazard and Risk Zoning for Land Use Planning, Journal of Australian Geomechanics Society, Vol. 42: No 1, March 2007.
- Commentary on Guidelines for Landslide Susceptibility, Hazard and Risk Zoning for Land Use Planning, Journal of Australian Geomechanics Society, Vol. 42: No 1, March 2007.
- Practice Note Guidelines for Landslide Risk Management 2007, Journal of Australian Geomechanics Society, Vol. 42: No 1, March 2007
- Commentary on Practice Note Guidelines for Landslide Risk Management 2007, Journal of Australian Geomechanics Society, Vol. 42: No 1, March 2007.
- Guideline for Development of Sites Prone to Landslide Hazard, Final draft submitted to Australian Building Codes Board, prepared by Australian Geomechanics Society, 2004.
- New report

APPENDIX E

Important Information

GOLDER

IMPORTANT INFORMATION RELATING OF THIS REPORT

The document ("Report") to which this page is attached and which this page forms a part of, has been issued by Golder Associates Pty Ltd ("Golder") subject to the important limitations and other qualifications set out below.

This Report constitutes or is part of services ("Services") provided by Golder to its client ("Client") under and subject to a contract between Golder and its Client ("Contract"). The contents of this page are not intended to an do not alter Golder's obligations (including any limits on those obligations) to its Client under the Contract.

This Report is provided for use solely by Golder's Client and persons acting on the Client's behalf, such as its professional advisers. Golder is responsible only to its Client for this Report. Golder has no responsibility to any other person who relies or makes decisions based upon this Report or who makes any other use of this Report. Golder accepts no responsibility for any loss or damage suffered by any person other than its Client as a result of any reliance upon any part of this Report, decisions made based upon this Report or any other use of it.

This Report has been prepared in the context of the circumstances and purposes referred to in, or derived from, the Contract and Golder accepts no responsibility for use of the Report, in whole or in part, in any other context or circumstance or for any other purpose.

The scope of Golder's Services and the period of time they relate to are determined by the Contract and are subject to restrictions and limitations set out in the Contract. If a service or other work is not expressly referred to in this Report, do not assume that it has been provided or performed. If a matter is not addressed in this Report, do not assume that any determination has been made by Golder in regards to it.

At any location relevant to the Services conditions may exist which were not detected by Golder, in particular due to the specific scope of the investigation Golder has been engaged to undertake. Conditions can only be verified at the exact location of any tests undertaken. Variations in conditions may occur between tested locations and there may be conditions which have not been revealed by the investigation and which have not therefore been taken into account in this Report.

Golder accepts no responsibility for and makes no representation as to the accuracy or completeness of the information provided to it by or on behalf of the Client or sourced from any third party. Golder has assumed that such information is correct unless otherwise stated and no responsibility is accepted by Golder for incomplete or inaccurate data supplied by its Client or any other person for whom Golder is not responsible. Golder has not taken account of matters that may have existed when the Report was prepared but which were only later disclosed to Golder.

Having regard to the matters referred to in the previous paragraphs on this page in particular, carrying out the Services has allowed Golder to form no more than an opinion as to the actual conditions at any relevant location. That opinion is necessarily constrained by the extent of the information collected by Golder or otherwise made available to Golder. Further, the passage of time may affect the accuracy, applicability or usefulness of the opinions, assessments or other information in this Report. This Report is based upon the information and other circumstances that existed and were known to Golder when the Services were performed and this Report was prepared. Golder has not considered the effect of any possible future developments including physical changes to any relevant location or changes to any laws or regulations relevant to such location.

Where permitted by the Contract, Golder may have trained subconsultants affiliated with Golder to provide some or all of the Services. However, it is Golder which remains solely responsible for the Services and there is no legal recourse against any of Golder's affiliated companies or the employees, officers or directors of any of them.

By date, or revision, the Report supersedes any prior report or other document issued by Golder dealing with any matter that is addressed in the Report.

Any uncertainty as to the extent to which this Report can be used or relied upon in any respect should be referred to Golder for clarification.

golder.com