# THE AUSTRALIAN COASTAL SMARTLINE GEOMORPHIC AND STABILITY MAP VERSION 1: PROJECT REPORT

smartline
coastal data segmentation

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## SUMMARY

This report describes a project undertaken by the authors during 2007 – 2009, under contract from Geoscience Australia and for the Department of Climate Change, to produce a nationally-consistent geomorphic and landform stability map of the entire Australian coastline, using a GIS line format referred to here as the 'Smartline' format.

The Department of Climate Change (formerly the Australian Greenhouse Office) is currently undertaking a National Coastal Vulnerability Assessment for Australia. Geoscience Australia has been contracted by DCC to undertake the technical analyses involved in this task. A key part of coastal vulnerability assessment is the identification (through mapping) of coastal substrates and landforms (i.e., geomorphic types) that have greater or lesser sensitivity to potential coastal impacts of climate change and sea level rise, such as accelerated erosion and shoreline recession, increased slumping or rock fall hazards, changing dune mobility, and other hazards.

Based on the their earlier successful development of a method of rapidly compiling coastal geomorphic data for Tasmania in a GIS line map format, and analysing this to identify potentially unstable Tasmanian coasts, Chris Sharples and Richard Mount (working through the University of Tasmania) were contracted by Geoscience Australia to compile coastal geomorphic information for the whole Australian coastline in a similar format, which is here referred to as the 'Smartline' coastal mapping format.

The key tasks involved in undertaking the production of a detailed nationally-consistent coastal 'Smartline' geomorphic and stability map for Australia have included:

- Development of a suitable geomorphic and stability classification (by review, modification and improvement of a system previously used for Tasmania);
- Classification workshop (peer review of proposed classification);
- Data audit & acquisition;
- Development of geo-processing techniques to facilitate data capture from (many, extensive) existing datasets;
- Assembly of geomorphic mapping (compilation of existing data into a consistent Smartline format); including a range of data-checking and 'cleaning' procedures; and
- Derivation of stability classes by queries.

The key outputs of this project include:

- A form & fabric based geomorphic classification designed to utilise the advantages of a 'Smartline' map format;
- Production of Smartline geomorphic mapping for the entire Australian coast; and
- Production of a coastal landform stability classification from Smartline geomorphic classes.

The Smartline coastal geomorphic mapping format is expected to be of value for a range of purposes in addition to its immediate use for coastal vulnerability assessment.

Smartline mapping can be used in two fundamental ways:

1. through ongoing analysis of the Smartline geomorphic data to produce derived datasets (e.g., coastal stability classes, oil spill sensitivity classes, etc); and

2. As a useful mapped framework on which to attach additional coastal datasets (e.g., linkage with ABSAMP beach database).

Public availability of the Smartline Dataset for wide range of uses was an early commitment of the Department of Climate Change and Geoscience Australia, and this objective is being realised through making the dataset available on the 'OzCoasts' website maintained by Geoscience Australia. The Smartline data model has been designed to be accessible and understandable. Nonetheless, there is undoubtedly value in providing training courses in Smartline application as a way of facilitating widespread use of the dataset by helping people to appreciate how to get the maximum value out of the dataset.

Given the anticipated future usefulness of the Australian Coastal Smartline Geomorphic mapping, it is desirable that additional work be undertaken in future to continue to upgrade the quality and coverage of the information contained in the Smartline dataset.

# 1.0 INTRODUCTION

This report describes a project undertaken by the authors during 2007 – 2009, under contract from Geoscience Australia and for the Department of Climate Change, to produce a nationally-consistent geomorphic and landform stability map of the entire Australian coastline, using a GIS line format referred to here as the ‘Smartline’ format.

This report describes the process and methods used to produce the map, recommended future upgrades to the mapping, and identify some of its potential future applications. A detailed user manual, metadata, data model and attribute tables for the Smartline (v.1) are provided in a separate volume (Sharples & Mount 2009).

A number of additional projects undertaken concurrently for Geoscience Australia and the Department of Climate Change are separately documented in their respective project reports.

## 1.1 *Project Overview*

The Department of Climate Change (DCC) is working with the Geoscience Australia (GA) to assess Australia’s coastal vulnerability to climate change. An early objective of the Department is to deliver a “First Pass” national vulnerability assessment of the Australian Coast and priority coastal systems (natural and artificial) by late 2009. This will identify potential risks and priorities and build foundation capacity towards future, more detailed assessments.

A key part of coastal vulnerability assessment is the identification and mapping of coastal substrates and landforms (i.e., geomorphic types) that have greater or lesser sensitivity to potential coastal impacts of climate change and sea level rise, such as accelerated erosion and shoreline recession, increased slumping or rock fall hazards, changing dune mobility, and other hazards. These physical sensitivities can be broadly referred to as shoreline instabilities, and the ability to identify shores prone to such instabilities requires not simply topographic mapping, but also *geomorphic* mapping which indicates substrate types (hard rock, semi-lithified sediment, sand, mud, etc) and landform types (beaches, cliffs, shore platforms, rocky slopes, etc), in addition to topographic information such as shoreline slope gradients.

Assessment of the potential rates and magnitudes with which these hazards may affect particular coastal sites requires detailed measurement and modelling of a range of locally-variable geomorphic factors (e.g., wave climate & energy, exposure, local bathymetry, local bedrock topography, littoral drift & sediment budget, etc). This is beyond the scope of a first pass vulnerability assessment; however, an important initial step is to be able to identify the location of all those shorelines which may be sensitive in some significant degree to such hazards. This requires the availability of coastal geomorphic maps which classify coastal landforms in terms of those physical characteristics which make coasts more or less sensitive to these hazards. The maps also need to be in a format that enables the rapid and flexible extraction of the required information, such as a well designed GIS spatial database.

Prior to the present project, a significant number of geomorphic or geomorphology-related maps existed for various discrete sections of the Australian coast. These have been prepared for a wide range of purposes, by numerous researchers and agencies, and they exist in a variety of paper and electronic formats, at differing scales and resolutions. Moreover, these maps classify and map coastal landforms using a variety of different geomorphic or geological classification schemes, and there was no consistently-classified geomorphic mapping of the entire Australian coastline, except at scales too coarse to be of practical use in vulnerability assessment, or in formats not capable of identifying specific sensitive locations (e.g., Galloway *et al.* 1984).

In order to provide the basis for a National Coastal Vulnerability Assessment, the Department of Climate Change contracted Geoscience Australia to prepare a geomorphic map of the Australian coastline using a nationally-consistent geomorphic classification that is capable of being readily interrogated to identify shorelines potentially sensitive to a range of physical hazards related to climate change and sea-level rise. Geoscience Australia in turn coordinated a team of coastal geomorphic and mapping specialists in the Spatial Science Group, School of Geography and Environmental Studies, University of Tasmania to undertake the bulk of the practical work involved in creating a nationally-consistent coastal geomorphic classification system and map. The team has been led by Dr Richard Mount (GIS and remote sensing specialist) and Chris Sharples (coastal geomorphologist). Geoscience Australia providing oversight and additional geomorphological specialists to the project, and will be the repository and data managers for the mapping data sets produced by the project.

Because of the tight timeframes for a First Pass vulnerability assessment, as well as a desire not to repeat work already done by others, the mapping program only utilised new mapping (mainly interpretation of satellite imagery) in a very few limited high priority areas where no other relevant geomorphic mapping pre-existed (mainly some parts of WA and NSW). Instead, the primary tasks for the project were to identify the various geomorphic mapping datasets which have previously been created for various parts of the Australian coast, to extract or translate the relevant geomorphic data from each into a single nationally-consistent geomorphic classification scheme, and to combine these into a single national map. Whilst the scale and resolution of the resulting nationally-consistent map varies depending on the scale and availability of pre-existing geomorphic mapping of different parts of the Australian coast, the critical advantage of the map is the provision, for the first time, of a seamless coastal geomorphic map of the whole Australian coastline which is classified in a single nationally-consistent way, enabling ready analysis for purposes such as the National Coastal Vulnerability Assessment.

The map format and classification for the national coastal map is based on the a GIS line map format previously used to prepare geomorphic and coastal vulnerability mapping for the entire Tasmanian coastline (over 6,000 km at 1:25,000 scale) by Sharples (2006). This mapping format – which the project team had termed the "Smartline" format - does not provide some of the advantages of polygon or grid maps, however it has its own important advantages. These include the ability to allow rapid capture of multiple-attribute information which can be very spatially-detailed in the along-shore direction, and the ability to be readily interrogated (e.g., by GIS queries) to provide a wide range of information such as the identification of sensitive ("potentially unstable") shoreline segments. The form- and fabric-based geomorphic classification used for the earlier Tasmanian map has been reviewed, modified and adapted to capture the broader range of mainland Australian coastal types.

As has been the case with the original Tasmanian map, the format and classification of the map will allow application to a broad range of research and management purposes beyond the coastal vulnerability assessment for which the map is initially required.

An additional component of the National Coastal Smartline Geomorphic and Stability Mapping Project has been to tag the map with beach number attributes so as to enable the map to be linked directly to the Australian Beach Safety and Management Program (ABSAMP) database maintained by Surf Life Saving Australia (SLSA), which contains a wealth of geomorphic data on over 12,000 Australian Beaches. This data has been compiled over many years by Dr Andy Short of Sydney University, and the ability to link this dataset directly to the Smartline map via a simple shared beach number attribute will considerably enhance the maps' utility for ongoing coastal vulnerability assessments, in addition to a range of other beach management and research applications.

Because this project has involved utilising map data previously captured by a range of other workers and owned by a range of federal, state and territory agencies, the management of data licensing issues has been a key concern for this project. Consequently, the University of Tasmania project team appointed a project worker specifically to negotiate data licensing and intellectual property issues with the various data custodians around Australia, in association with Geoscience Australia. The final nationally-consistent coastal geomorphic and stability map produced by this project is a public domain data set managed by Geoscience Australia which embodies full attribution of the various original mapping sources used to build the final map.

## 1.2 *Background*

A great deal of geological, landform, Quaternary sediment, soils, land systems and habitat mapping exists for many parts of the Australian coast, much of which contains geomorphic (landform) information relevant to coastal vulnerability assessment and other purposes. However these maps exist in a wide range of differing map formats, at differing scales and with different classification systems in different parts of the coast. This makes it difficult to integrate relevant information across these datasets at a national scale.

There has been a long – recognised need for a detailed, nationally-consistent map of Australian coastal landforms, to serve a range of purposes at national and regional scales, including research, ecosystem and coastal hazards management and other purposes.

Prior to this work, the most detailed nationally-consistent map available was an early GIS map produced by CSIRO (Galloway *et al.*1984). However this map was constructed by dividing the coast into 10 kilometre segments, sampling the landform types within each segment, and recording the proportion of various types in each segment. Whilst this created a dataset capable of many powerful analyses, it was not capable of identifying specific landforms (e.g., particular beaches) on the map. This sort of information is essential for purposes such as coastal vulnerability assessment.

A 1997 workshop organised by Environment Australia explored the possibilities and problems for creating detailed nationally – consistent coastal geomorphic and vegetation mapping. A proposal by Trevor Graham (then of the Australian Geological Survey Organisation, AGSO) for rapidly producing a national coastal landform and Quaternary sediment polygon map was a notable highlight of this workshop. However the workshop outcomes were unfortunately not followed through to actual production of a national coastal geomorphic map (Gina Newton *pers. comm*., Trevor Graham *pers. comm*.).

More recently, growing awareness of the reality of global climate change and the consequent likelihood of significant physical impacts on the coast via sea-level rise and other changes in coastal processes has led to a more urgent awareness of the need for detailed nationally – consistent coastal geomorphic mapping as one of the essential inputs for a National Coastal vulnerability Assessment. The Australian Greenhouse Office (precursor of the Department of Climate Change) held an expert workshop in Canberra during 2005 to explore requirements and methods for undertaking a National Coastal vulnerability Assessment. Amongst other things, this workshop highlighted an approach to coastal geomorphic and vulnerability mapping which had been undertaken in Tasmania, using a line map format to rapidly compile geomorphic data and then analyse this to identify potentially unstable shores (the final report of this work was subsequently produced as Sharples 2006).

Subsequently, an Expert Advisory Group convened by the Australian Greenhouse Office recommended in early 2007 that the mapping method of Sharples (2006) be used as the basis for compiling a coastal geomorphic map for the entire Australian coast, based on combining available previous mapping from many sources, and that this be used to generate a “First Pass” coastal stability assessment for the whole of Australia.

Chris Sharples in collaboration with Dr Richard Mount, based at the University of Tasmania, were contracted to undertake the work, which is described and documented in this report. The project team have been sub-contracted to undertake this project by Geoscience Australia as part of their contract with the Department of Climate Change (formerly Australian Greenhouse Office) to undertake the scientific and technical aspects of preparing a National Coastal Vulnerability Assessment for Australia.

## 1.3 *Project Components and Outputs*

The key tasks involved in undertaking the production of a detailed nationally-consistent coastal 'Smartline' geomorphic and stability map for Australia are listed below and described in more detail in subsequent parts of this report:

The major tasks have included:

- Development of a suitable geomorphic and stability classification (by review, modification and improvement of a system previously used for Tasmania);
- Classification workshop (peer review of proposed classification);
- Data audit & acquisition;
- Development of geo-processing techniques to facilitate data capture from (many, extensive) existing datasets;
- Assembly of geomorphic mapping (compilation of existing data into a consistent Smartline format); including a range of data-checking and 'cleaning' procedures; and
- Derivation of stability classes by queries.

The key outputs of this project include:

- A form & fabric based geomorphic classification designed to utilise the advantages of a 'Smartline' map format;
- Production of Smartline geomorphic mapping for the entire Australian coast; and
- Production of a coastal landform stability classification from Smartline geomorphic classes.

The custodian of the Smartline dataset is Geoscience Australia, and it is a public domain dataset which is available publically on the 'Ozcoasts' website maintained by Geoscience Australia.

## 1.4 *Future Directions and Uses of Smartline Coastal Mapping*

The Smartline coastal geomorphic mapping format, as realised in the current production of a complete, detailed nationally-consistent geomorphic map of the whole Australian coast, is expected to be of value for a range of purposes in addition to its immediate use for coastal vulnerability assessment.

Smartline mapping can be used in two fundamental ways:

3. through ongoing analysis of the Smartline geomorphic data to produce derived datasets (e.g., coastal stability classes, oil spill sensitivity classes, etc); and

4. As a useful mapped framework on which to attach additional coastal datasets (e.g., linkage with ABSAMP beach database).

Current uses of Smartline coastal data (both the current national Smartline and the earlier Tasmanian dataset of Sharples 2006) include:

- Generation of shoreline instability classes for further analysis of coastal hazard risks in the National Coastal Vulnerability Assessment being undertaken by Geoscience Australia for the Department of Climate Change;
- Linkage with ABSAMP beaches database (providing a spatial framework for this national beaches database); and
- Generation of shoreline oil spill sensitivity classes for the Oil Spill Response Atlas.

Some potential future uses of Smartline data include:

- Potential integration of geomorphic data with wave climate indices (for "Second Pass" national coastal vulnerability assessment);
- A starting point for local - level coastal vulnerability assessments (the Smartline geomorphic data is generally quite spatially-detailed data);
- As a framework for recording and analysis of historic shoreline change data.
- Use of data in Shoreline Condition analysis (Tasmania, planned by Aquenal for NRM).

Public availability of the Smartline Dataset for wide range of uses was an early commitment of the Department of Climate Change and Geoscience Australia, and this objective is being realised through making the dataset available on the 'OzCoasts' website maintained by Geoscience Australia. The Smartline data model has been designed to be accessible and understandable. The Data Model is structured to allow the use of detailed info, but also to be capable of being greatly simplified if needed.

*Future Directions:*
In the process of compiling the Smartline v.1, a number of deficiencies and limitations in the data available for incorporation into the dataset were apparent to the project team. These are described in Section (4.2) of this report. Given the anticipated future usefulness of the Australian Coastal Smartline Geomorphic mapping, it is desirable that additional work be undertaken in future to upgrade the quality and coverage of the information contained in the Smartline dataset (to version 2.0 and beyond).

Although the Smartline data model is a simple and logical one, there is undoubtedly value in providing training courses in Smartline application as a way of facilitating widespread use of the dataset by helping people to appreciate how to get the maximum value out of the dataset.

## 1.5 *Glossary of Terms and Acronyms*

ABSAMP Australian Beach Safety and Management Database. Database created by Surf Life Saving Australia (SLSA), which incorporates geomorphic data compiled by Prof. A. Short for all Australian beaches.

AHD Australian Height Datum. Theoretically this datum is intended to lie at mean sea level, however ongoing sea-level rise means that AHD now lies a little below mean sea level in many areas.

AMSA Australian Maritime Safety Authority. Agency responsible for the production of the Oil Spill Response Atlas (OSRA), from which significant amounts of coastal geomorphic mapping was incorporated into the Smartline.

ARENITE Sand-grade lithified sedimentary rock (e.g., sandstone, calcarenite, etc).

DEM Digital Elevation Model. A widely used GIS format which represents surfaces (e.g., of land) as a grid, each cell of which has a defined location and elevation.

DEPARTMENT OF CLIMATE CHANGE (DCC) The Australian Commonwealth Government Agency concerned with mitigation of and adaptation to global climate change. Formerly the Australian Greenhouse Office.

EROSION Removal of material (e.g., from a sediment body or landform) by natural processes (e.g., wave action). See also 'Recession'.

EXPOSURE The term 'exposure' is used in two different contexts in this work:
1. In relation to Smartline geomorphic attributes, 'exposure' is used as an indicator of the degree to which a shoreline segment receives whatever swell-wave energies impinge on the broader coastal region of which the segment is part.
2. In relation to risk and hazard terminology

GEOMORPHOLOGY The study of landforms, their forms, genesis, development and processes.

GEOMORPHIC Pertaining to geomorphology.

GEOSCIENCE AUSTRALIA (GA) The Australian Commonwealth government agency concerned with the geo-sciences, including geological, geomorphic, geographic and topographic mapping and geohazard assessment functions.

GIS Geographical Information System. Digital mapping and analysis of mapped information, including point, line & polygon vector data, raster & image data, and Digital Elevation Model (DEM) formats.

GREENHOUSE OFFICE, THE (AGO) See ‘Department of Climate Change’.

HOLOCENE The stage of geological time between the end of the Last Glaciation (about 10,000 years ago) and the present. The Holocene effectively equates to the present interglacial climatic phase.

IPCC Intergovernmental Panel on Climate Change. An international organisation established in 1988 by the World Meteorological Organisation and the United Nations Environment Programme, for the purpose of reviewing and reporting on the current state of scientific understanding of and research into global climate change and its effects, including sea-level rise.

MHWM Mean High Water Mark, i.e., the mean of high water over a long period of time.

MLWM Mean Low Water Mark, i.e., the mean of low water over a long period of time.

OSRA The Oil Spill Response Atlas, maintained by the Australian Maritime Safety Authority (AMSA). This dataset comprises digital mapping of a wide variety of coastal features and attributes, including shoreline type (landform) mapping which has been used in preparation of the Smartline coastal landform map.

PLEISTOCENE The stage of geological time spanning most of the last 2 million years up until the end of the Last Glaciation 10,000 years ago. The Pleistocene has been marked by a succession of glacial and interglacial climatic phases which have caused sea level to repeated rise and fall over a vertical range of about 130 metres, and have exerted a strong influence on coastal landform development globally.

QUATERNARY The period of geological time spanning most of the last 2 million years up to and including the present. The Quaternary Period is sub-divided into the Pleistocene (older) and Holocene (recent) stages.

RECESSION Opposite to progradation: landwards movement of a shoreline due to removal of sediment or rock material by erosion.

RETURN PERIOD Average period of time between occurrences of a specified type of event. It is important to note that the return period is an average period only; i.e., a 50-year return period event does not necessarily occur regularly every 50 years. For example, two 50-year return period events could occur in one year, then not for another 100 years.

SENSITIVITY The susceptibility of coastal landforms to the impacts of coastal hazards such as sea-level rise and storm waves. Such impacts may include physical instability (erosion, progradation) and/or inundation. The term sensitivity is used here in the sense of Allen (2005). Note that Sharples (2006) previously used “vulnerability” in the sense that ‘sensitivity’ is now used here; in contrast, “vulnerability’ is now used here in a broader sense (see “vulnerability”).

SLSA Surf Life Saving Australia; National organisation which funded geomorphic studies of all Australian beaches by Prof. Andy Short, and the compilation of this data into the ABSAMP database (see above).

STABILITY The *susceptibility* or *sensitivity* of coastal landforms to physical change (erosion, progradation, etc); in this sense the term is used in a narrower sense than 'sensitivity', which encompasses both the susceptibility of coastal landforms to physical change and also to other impacts such as inundation. Thus, the stability of a landform depends primarily on its fabric (hard or soft constituents) and only secondarily on its topography (steep, low-lying, etc), whereas its sensitivity to inundation may depend primarily on its topography.

STORM SURGE A temporary increase in sea level at the shore due to a combination of low barometric pressures and energetic onshore wind and waves. The magnitude of a storm surge is also strongly dependant on the tidal phase at the time of the peak surge.

SUPRATIDAL Areas above the High Water Mark which are (only) occasionally inundated by the sea (e.g., during storm surges). Classified as a "Backshore" landform area for the purposes of the Smartline Geomorphic classification.

SUSCEPTIBILITY Equivalent to the meaning of "Sensitivity" as given above, more commonly used in this sense in the geomorphic literature than is "susceptibility, and sometimes used interchangeably with "sensitivity" in this report.

VULNERABILITY Used in the sense of the Allen report, standard DCC terminology for this project. Means the whole of sensitivity, exposure, assets at risk, and capacity to adapt. Note the term vulnerability was previously used by Sharples (2006) in the more restricted sense that "sensitivity" is now used here.

## 1.6 *Acknowledgements*

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# 2.0 PROCESSES IN CREATING A NATIONALLY- CONSISTENT COASTAL SMARTLINE GEOMORPHIC MAP

## 2.1 *Identifying the purpose*

First Pass Coastal Vulnerability Assessment in the first instance, but with a view to the map being subsequently useful for a wide range of other purposes.

## 2.2 *Determining the mapping format*

GIS line map format – Smartline – was considered to be the only method capable of being prepared for the whole country in the required time-frame

## 2.3 *Determining the landform classification style*

Descriptive form & fabric based classification – simple enough to acquire nationally in available time, useful enough to serve a wide range of purposes; genetic or morpho-dynamic classifications do not exist for all Australian coastal landforms, and would be time consuming to assign to all mapped coastal landforms in any case.

Nonetheless, where genetic or morpho-dynamic classifications do exist, the map format allows this data to be linked to the primary descriptive classifications. This has been done during this project in the case of Andy Short's morpho-dynamic Australian beach classifications, since Short has compiled his beach classification data into a database (ABSAMP) wherein each beach has a unique identifier number. By attributing these numbers to each beach in the Smartline coastal landform map, it has been possible to simply link the ABSAMP beach database to the Smartline coastal landforms map, using beach number as a common field. This has effectively added an extensive beach morpho-dynamic dataset to the Smartline map, and other coastal landform datasets will similarly be capable of being linked to the Smartline map as they become available in the future.

## 2.4 *Designing the landform classification categories and attributes*

Based on a system originally developed in Tasmania, with modifications and adaptations to:

- improve on limitations discovered through several years experience working with the precursor Tas system; and

- encompass the broader range of mainland Australian coastal landform types <<note significant differences between southern (temperate zone micro/mesotidal) and northern (tropical meso/macrotidal) Australian coastal landforms>>.

A key element in designing the coastal landform classification system was to ensure that it would be capable of identifying all important Australian coastal geomorphic instability categories, especially those related to climate change and sea-level rise. This involved three elements or stages:

1. Review the full range of Australian coastal landform types (from a form- and fabric-based perspective)
2. Review the broad ways in which Australian coastal landforms undergo physical instability, especially wrt CC/SLR, and list the "*Fundamental Stability Factors*" (geomorphic characteristics) which define each instability category
3. Design the landform classification to be capable of distinctively classifying all of (1), whilst also being capable of distinctively identifying all of (2) by queries on the landform classification to draw out landforms having each distinctive mix of the "*Fundamental Stability Factors*" which define each category in (2).

**National Coastal Smartline Classification Workshop**

The draft classification was peer-reviewed in a national workshop at UTas, attended by coastal geomorphic experts from widely varying regions of Australia's coasts. The outcomes report for that Workshop is reproduced as Appendix Two of this Report.

## 2.5 *Choice of base line maps*

It was not considered appropriate to use a single base line map for the entire country, primarily because doing so would result in loss of resolution and detailed information in some regions. The best scale at which a single consistent base map is available for the entire Australian coastline is Geoscience Australia's 100K scale Geodata National coastline map. However, considerably more detailed coastal line maps are available for some parts of the Australian coastline, and some of these have already been used as base maps for coastal geomorphic mapping (e.g., Tasmania 25K); hence use of the 100K GA map for these areas would have resulted in loss of previously-mapped resolution and geomorphic data.

Instead, a variety of scale base line maps were used for different parts of the national coast, the aim being to capture the best available topographic and geomorphic data available for each part of the coast. The following criteria were used to select the appropriate base line maps for use in each state or region:

- Best available scale(s)
- Most recent maps
- Maps considered most appropriate by relevant agencies and coastal specialists in each jurisdiction.

Maps chosen to be listed here!

**Smartline map scales and coastal length statistics**: The National Coastal Geomorphic Smartline uses the best scale of base coastline (generally HWM) mapping available for each State. This varies from 100K (NT) to 25K or better (Vic. & Tas.), and in addition some state maps incorporate internal portions with differing scales. It was decided to use the best available map scales in each coastal region in order to enable the most detailed possible capture of coastal geomorphic data where-ever sufficiently detailed data exists.

However it should be noted that the down-side of this decision is that coastline length statistics derived from the National Coastal Smartline will not be directly comparable between all parts of the map (apparent coastal lengths increase with increasingly detailed map scale, since increasing lengths of line work are used to represent finer details of coastal plan forms). The best scale at which the entire Australian coastline can be represented at a single uniform scale is the Geoscience Australia Geodata 100K map; however this provides significantly coarser detail than is actually available for some parts of the coast. Hence a decision to use this scale of base map for the entire coast for reasons of scale and coastal length consistency would have resulted in significant loss of coastal topographic and geomorphic data in some areas.

## 2.6 *Discovery and acquisition of data sources*

A data co-ordinator (Tore Pedersen) was appointed to the project team with the primary tasks of:

- Searching for relevant data;
- Negotiating data supply with custodians nation-wide; and
- Data licensing.

**Data Sources for Key Attribute Fields**

The short time-frames and continental scope of this project has allowed only minor new data capture (from fieldwork, satellite photo interpretation and manual digitising of existing paper mapping) for a few priority locations in WA, NSW and Tasmania[1]. Instead, the data used in compiling the first version of the Australian coastal geomorphic Smartline map has perforce been derived almost entirely from pre-existing digitised (GIS) datasets in vector or grid formats, which were amenable to automated (as opposed to manual) data interpretation and extraction methods. Section (2.7) following outlines the 'automated' techniques used to transfer relevant data from these pre-existing GIS datasets into the Smartline. While some potentially useful datasets are known which do not exist in a suitable digital format (vector or grid data) - for example 100K coastal geomorphic mapping of the Victorian coast - sufficient relevant mapping now exists in digital form that most fields of the Smartline map were able to be populated for most of the Australian coast[2].

For most states, the data required to populate certain key geomorphic attribute fields was found to be most readily available from certain data source types, as summarised below:

***Intertidal landforms***

In most states the AMSA Oil Spill Response Atlas (OSRA) mapping has proven to be the most comprehensive source of intertidal coastal landform map data, mostly as line mapping but also as intertidal polygon mapping in Victoria and New South Wales. The OSRA mapping project was principally concerned with the intertidal zone, where most damage from oil spills is concentrated.

Beach data compiled by Dr A. Short, both in a series of books and as GIS point location files (Google Earth .kml files) provided to the Smartline project by Dr Short, also provided a particularly comprehensive source of data specifically focussed on (intertidal) beaches (sandy, shingle and boulder grade) throughout the Australian coast.

In some regions good quality Quaternary or regolith mapping includes mapping of intertidal landforms such as individual beaches, & rocky shore platforms, however such high-quality mapping covers only very limited parts of the Australian coast. Other geological mapping (i.e., depicting both bedrock and Quaternary geology) may provide some intertidal landform information (beaches, rocky shorelines) in parts of the coast where the mapping is provided at more detailed scales (e.g., 50K or 100K).

***Beach Numbers (ABSAMP_ID)***

Primary purpose was to link the national coastal landform map to the ABSAMP database, which provides a wealth of geomorphic, safety and management data on Australian beaches. From a geomorphic perspective, the advantage is that by doing this, the simple form-fabric coastal landform classification in the national coastal line map is linked to the morpho-dynamic (genetic) classification developed by Andy Short. Data sources were Andy short book and .kml files supplied to the project by Andy Short.

***Backshore landforms***

In most states only limited information on Backshore landforms is provided by Oil Spill Response Atlas (OSRA) shoreline type (landform) maps, since the primary focus of OSRA mapping was on the intertidal zone. Where backshore landform mapping has been provided, this has usually been a result of state data providers going beyond the brief of the OSRA project to provide additional information.

Geological mapping (bedrock plus Quaternary cover) has been the single most important source of pre-existing backshore landform information at the national level. At scales of 1:250,000 or better, such mapping usefully identifies the important first-order distinction between hard (bedrock) and soft

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[1] The main exception to this rule is that beaches have been manually numbered by reference to the series of books on Australia's beaches published by Dr A. Short and the Surf Lifesaving Association of Australia. Although this was one of the most time-consuming tasks of this project, it was considered worthwhile as a means of creating a common field which will allow direct linking of the Smartline with the extensive ABSAMP database containing information on every beach in Australia.

[2] The main exceptions were: Subtidal landform information is only sparse available; Intertidal slope and exposure data were not available for some states; backshore landform information gaps in WA where only paper/raster geol maps are available at 250K.

(sediment) backshore landform terrains, and moreover commonly distinguishes specific important backshore landforms such as extensive dune fields or alluvial plains.

Other data sources more specifically focussed on Backshore landform types have been used where they have been available, albeit the coverage of each type is generally quite limited in the national context. Purpose-mapped Quaternary geology and regolith mapping at scales of 1:100,000 or better provided detailed information on Backshore landforms, but was only available for limited parts of the Australian coast. Other mapping from which backshore landform information has been derived for limited parts of the Australian coast include Regional Ecosystems mapping (Queensland), Land Systems and Land Units mapping (NT), and mapping of coastal landforms on the south coast of WA which was undertaken for the Smartline project by WA Department of Conservation Officers.

***Backshore Profile***
The SRTM DEM was used to extract profiles – see method in Appendix One

***Subtidal landforms***
Limited info – mainly from OSRA mapping, some from Quaternary or regolith mapping (e.g., Regolith-landform mapping in SW WA); A better source of data (albeit still incomplete) is available from subtidal habitat mapping (e.g., SEAMAP in Tas), however this was considered beyond the scope of this project (partly because a parallel project was simultaneously compiling Oz Habitat maps into a unified national dataset).

***Bedrock Geology***
Geological maps (where not showing 'Quaternary cover'). Bedrock beneath Quaternary cover was previously interpreted for Tasmania using expert judgement, however in the time available this could not be done for the whole of mainland Aust. Where-ever existing solid geology interpretations existed (e.g., WA) these were used to determine the bedrock geology beneath superficial cover sediments, however where the available geological mapping showed only superficial Quaternary cover, the geology attribute was recorded as 'Unclassified'. Note that whilst this is less desirable than being able to interpret the underlying geology, it is at least the case that geology (bedrock) type is classified where-ever rocky coastal landforms actually occur (i.e., where the bedrock protrudes at the coast).

## 2.7 *Transferring Geomorphic Data to Smartline from Pre-existing Digital Coastal Geomorphic Mapping*

Relevant information was captured by a variety of means (below) from the range of pre-existing source data maps from which the nationally consistent map was compiled. The Smartline was segmented where-ever the source maps showed a change in any relevant attribute, and the original source data fields and classifications were transferred from the source dataset to the Smartline for later reclassification into the nationally-consistent Smartline classification (see further below).

In general, manual data transfer has of necessity been avoided during this project since it would have been impractical given the large amount of data to be captured and the short time available for the project. Instead a number of techniques for automated transfer of data (attributes and line segmentation) from pre-existing line, polygon and grid data sets to the final coastal Smartline map have been developed by the project team[3]. Fully manual data transfer has been used for capturing only one dataset – the ABSAMP beach numbers – owing to the high value of this attribute (enabling linkage of the Smartline to the ABSAMP database), and lack of feasible data capture alternatives[4]. A

[3] Several web and literature searches, including a search of resources available on the ESRI website, failed to identify any available GIS tools suitable for the tasks required.

[4] Whilst a point-data GIS file of beach number locations was supplied to the project by Dr Short, and could have easily been incorporated into the Smartline, this would have allowed attributing of only one line segment per beach with the appropriate number. In fact, many beaches are represented by multiple line segments within the

partly manual data transfer procedure has also been used for transferring data from older OSRA line maps to new line maps for Western Australia (consultancy by Julie Bowyer).

The major methods used to transfer data from original digital (vector or grid) GIS data sources into the Smartline map are outlined below, and more detail is provided in Appendix One.

- **Manual Data Transfer:**
  - **Beach Numbering:** Used Andy Short books & .kml files (converted to shapefiles). Used student & other labour to manually attribute the beaches – very big job. Original numbering concatenated to SLSA format by Luke Wallace. (SLSA format supplied by Norm Farmer).
  - **OSRA Data transfer for WA:** Julie Bowyers work

- **Automated Transfer of Existing Line Map Data to the Smartline**: OSRA Shoreline Classification line format maps were also used as the base line maps for Victoria, Queensland and South Australia; in these cases the OSRA geomorphic data (one of the most important sources of existing coastal geomorphic data) was in effect already attributed to the Smartline base maps of those states to start with. However, in some cases it was necessary to transfer data from one line map to another. Two important cases were encountered, namely the case where the source and target line-maps are co-incident, and that where they are offset or non-co-incidental. Different techniques were used in each case:

  - ***Simple Spatial Join technique (intersecting or merging lines using standard ArcMap tools)*** could be used where the source and target maps were co-incident to within the tolerance of the spatial join tool. This technique was most commonly used to merge multiple versions of state Smartlines after they had been attributed with different attributes derived from different sources.
  - ***Transfer of Data from non-co-incident lines:*** However line maps didn't always co-incide (e.g., due to being prepared at different scales or by different methods) – note techniques used to transfer data:
    - ***Automated transfer*** e.g., from old Tas shoreline to new LIST shoreline; due to dodgy Arcview reprojection, my re-projected old map was offset about 1.5m from the new LIST shoreline; more-over the new LIST shoreline included some actual shoreline changes (ports, etc) and some additions (some estuaries, etc) – transfer performed with Luke Wallace's script Line_Transfer.py
    - ***Manual Data Transfer*** (e.g., from WA OSRA maps to new LANDGATE shoreline by Julie Bowyer)

- **Automated Transfer of Polygon Map Data to the Smartline:** Polygon mapping information was transferred to the line map by several techniques, each of which was suited to specific types of data sources and required attributes:
  - ***ESRI Flat buffer technique*** developed by Michael Lacey (refer to Appendix): for transferring attributes of <u>all</u> polygons occurring within a 500m distance of shoreline map (eg, Victorian OSRA, WA Landform/regolith maps, others (NSW OSRA?); – used standard ArcMap tools and data manipulation using Access Databases. Error correction (due to overlapping polygons etc) basically done by visual inspection and manual correction of results
  - ***Proximal attribute capture by Identity tool and progressive line buffer expansion*** Technique developed by Dom & Luke (refer to Appendix One) – used for transferring attributes of landform or bedrock type closest to shoreline for Backshore Proximal, bedrock Geology and some intertidal attributes. Progressive concentric buffering of

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Smartline, and it is more useful if all segments belonging to a certain beach can be attributed with the ABSAMP number for that beach. This requires judgemental decisions (based on information in Dr Short's series of beach books) which could not reliably be made in an automated way.

polygon map shoreline to transfer attributes to Smartline required because Smartlines and polygon shorelines often do not line up (due to being digitised at different scales).
  - ***Distal polygon intersection using Identity tool*** Technique developed by Dom & Luke (refer to Appendix One) – used for identifying the dominant polygon type within 500m of the shoreline by overlaying ESRI Flat buffers and then eliminating incorrect captures (used for Backshore distal landform extractions from Geological, Quaternary and ecosystem mapping)

- **Automated Transfer of Backshore Profile Data from DEM (grid) to the Smartline:** Technique developed by Dom & Luke (refer to Appendix: Script Profiler_3.py)

## 2.8 *Smartline Data reclassification and merging*

Once attributes have been transferred from the source datasets to the base coastal Smartline map for each state (usually to multiple copies of the Smartline, one for each source or related group of source maps), the following processes were carried out:

- ***Consistent Reprojection*** The original transfer of source data attributes into the Smartline occurred in a variety of map projections, depending on the source map projection. All Smartlines containing derived data fields were therefore converted to Albers/GDA94 projection for consistent data processing.

- Checked all Smartlines for each state co-incident (after re-projection, as position errors can creep into re-projection process) – necessary for later unioning

- ***Attribute Reclassification*** Reclassification of attributes in each Smartline to new classification (done before unioning, to avoid ending up with Smartlines having too many confusing attributes) using:
  - Relevant feature classifications and codes (as transferred from source maps to Smartline) listed in tabular form as .xls spreadsheet.
  - Reclassification spreadsheets.xls developed by Chris, relating each source map feature class to the appropriate final class in the Smartline classification. Some were a one-to-one correspondences, others were more complex (usually multiple source attributes being equivalent to a single final attribute class). (THIS WAS A SLOW BOTTLENECK since the determination of appropriate final classes for source feature classes was a judgemental matter:- it required reading the relevant source attribute class descriptions and judging how each is best represented in the new classification – HOW TO MAKE MORE EFFICIENT NEXT TIME??)
  - In each Smartline copy, new fields were generated in accordance with the Smartline Data Model, and these were populated with attribute classes created by reclassification of the relevant source data fields. These tasks were achieved mostly by use of an automated query generator (final tool name & description?) produced by Luke to produce reclassified Smartline attribute fields from the original source data attribute fields (albeit some less time-consuming parts of the reclassification processes were undertaken manually)
  - at the same time, fields were attributed with source & scale metadata
  - For some attribute fields, information suitable to populate certain attribute fields was obtained from more than one source map. In these cases, multiple temporary attribute fields (with slightly different names) were created for the same attributes and each was populated from one of the data sources (e.g., if data relevant to the Backshore Proximal landforms in a state was obtained from three different data sources, that data might originally be reclassified into attribute fields in separate versions of the Smartline, named *Backprox1*, *Backprox2* and *Backprox3* respectively).

    - Beach Numbers were converted to the precise format used in the ABSAMP Database, by adding standard prefixes including leading zeros, and concatenating these with the beach number itself and suffixes where relevant[5].

- ***Smartline Versions Merged into One*** Unioning of all Smartlines (each containing data derived from different sources) for each state with reclassified attributes; in some cases this yielded multiple versions of the same attribute field (derived from different source data); thus initial multiple attribute fields of the same types were given temporary attribute names to distinguish them from each other.

- ***Resolved Multiple Versions of Attributes*** For each merged state Smartline, where several versions of any one attribute field were present, procedures were run to eliminate duplicates of particular attributes for each line segment. A procedure was used which:
    - First created final version of attribute fields to be populated from their multiple temporary attribute field versions (eg, create final *Backprox_n,v,r,s* fields to populate with resolved attributes from *Backprox1, Backprox2, Backprox3,* etc).
    - Then, identified simple cases where only one usable attribute class option existed for a given coastal segment across several alternative equivalent attribute fields (i.e., all versions of an attribute but one were "Unclassified" for that coastline segment)
    - Then, where conflict remained between several alternatives for each field (in specific records/line segments), used a system of decision rules – based on deciding which source datasets take priority for (are likely to have most accurately mapped) particular attribute types and fields – to resolve multiple alternative attributes into a single final attribute. (For example, dedicated Quaternary Geology or Geomorphology mapping would be preferred over other geological mapping for indicating the presence or absence of dunes, as that sort of information would have been more of a priority for those compiling the former types of maps, but less for those preparing the latter).
    - "Other things being equal" decision rules to resolve multiple datasets included (not always applied consistently):
        - Better scale mapping trumps poorer scale
        - Datasets more likely to focus on a feature of interest trump those less likely to (i.e., reliability of dataset for type of feature being mapped is important).
        - Records of sediment trumps records of "bedrock terrain" only (i.e., important to record sediment where-ever any is present)
        - Records of sediment *type* trumps records of sediment undiff.
        - Records of sediment *landform type* trumps records of sediment type only
        - Records of geomorphic type considered more important than recording Artificial shoreline types (but artificial shores recorded when other important info about a segment is not thereby lost)
    - Using the decision rules and running queries, the final attribute fields are populated from the multiple temporary fields until the final fields are populated for all coastal segments (attribute records) which are classified in any of the multiple attribute versions. The temporary multiple attribute fields are then deleted.

## 2.9 *Data Cleaning and Manual Updates*

At this point, all the data that has been obtained from multiple source datasets have been merged into a single Smartline. The data has all been reclassified into a single consistent system and is presented in a single consistent set of attribute fields. At this stage the Smartline geomorphic map compilation

[5] When the beach numbers were originally attributed to beach segments based on the numbering system used in the Short series of beach books, the precise numbering format used in the ABSAMP database was unknown, although it was understood the actual numbers were the same. Hence the beach numbers were originally digitised in three fields (for a number, prefix and suffix) to make it easier to modify the format later if necessary. When the actual numbering system used was specified by SLSA, it was a simple matter to modify and concatenate the numbers, prefixes and suffixes so as to precisely comply with the ABSAMP format.

process is theoretically complete; however a range of further "data cleaning" procedures were performed to make the data set easier to use, and a number of checks were undertaken to identify and eliminate detectable errors. In a limited number of cases some manual data upgrades were also undertaken where it was considered that a quick manual edit could significantly improve the quality of the dataset. The following section lists all these procedures, and further specifics are provided in individual state process descriptions following

***Data Cleaning***

- Dissolved line segments on the final attribute fields, removing any remaining temporary or un-necessary legacy attribute fields & significantly reducing shapefile sizes (the geoprocessing techniques created many small adjoining segments with the same attributes). In some cases, certain legacy attribute fields of specific use to state users were retained temporarily in copies of some state Smartlines, for the benefit of state users, however these legacy fields were eliminated from the final master versions provided to GA & DCC.
- Attribute fields (in the .dbf files) were saved in the same order as provided in the Smartline data model, to allow easier reading of the attribute table.
- Merged all remaining line segments shorter than 10m with the adjacent segment having the least attribute differences (retaining the attributes of the larger adjoining segment for the new merged segment). Very short line segments ('snippets') are an artefact of the data processing and merging procedures used, and are unlikely to represent real feature differences on the ground.

***Data extrapolations (considered reasonable inferences):***

- Backshore and Intertidal bedrock "undiff" landforms reclassified to "hard bedrock" or "soft bedrock" equivalents depending on *Geology1* type.
- Generated *Backshore sediments to below SL* classes using Profile (i.e., IF backshore distal & proximal = soft sediments and Backprof = 100, 110 or 120 THEN Backshore seds = 'seds to below sea level'). This was done on the reasonable but undemonstrated basis that low-lying sediment plains at the coast are most likely to comprise soft sediments extending to below sea level. The identification of such sediment accumulations is important, as these are the areas most prone to coastal recession, however in the absence of comprehensive drilling and geophysical data such coastal types are difficult to unequivocally demonstrate. Hence, for the purposes of a First Pass coastal sensitivity assessment, identification of recession-prone shores on a precautionary basis by the inferential means described here was considered justifiable by the project team.
- IF Backprox = bedrock terrain' or 'cliffs' and Backdist = "Unclassified", then Backdist made = 'Bedrock Terrain' (and attributed with *_r* Source_ID 237, indicating an extrapolation by C. Sharples).
- Where shoreline segments have a Beach Number (ABSAMP_ID, = Andy Short data), any that were classed as "sandy shores" were reclassed as "sandy beaches".

***Manual Data updates:***

- (A few only) obviously anomalous backshore profile classes modified manually (done for Tas (1 location Droughty Pt), *etc*?)
- Some "Low" exposure values from OSRA mapping manually sub-divided into "Very Low" and "Low" in accordance with current exposure classification (Done for Qld, *&etc*?)
- In general, manual addition of data attributes was avoided, because there is a lot that could be done, so where does one stop if one starts this? Really, this is work is the next stage in producing *auscstgeo_v2* beyond the present project. However, some data was manually attributed in a few cases were it was considered the data was important to the present project:
  - **WA**:

    - Data on calcarenite distribution and depth of sandy backshore sediments wrt sea level for some Perth shores were manually added from (Jones *et al* 2005 - Source_ID 238).
    - *Geology1* & *Geology2* of small area of coast at Conto Springs (north of Cape Leeuwin) were re-attributed based on 2007 field observations by C. Sharples (and given *_r* Source_ID 219 indicating fieldwork by C. Sharples)
    - Large NW coast gaps in backshore data filled in from Google Earth and 250K raster geological maps (no suitable vector data available).
- **NSW:**
    - C. S. used Google earth satellite imagery plus manual reference to CCA Quaternary mapping to check and attribute a significant number of gaps in the NSW data.
- **Tas:**
    - Macquarie Harbour (sea kayak trip – couldn't stop myself recording some new data so had to use it)

Although it should be noted that large parts of the Tasmanian portion of this map were previously attributed manually by C. Sharples, based on fieldwork, this work was performed prior to the current project and simply formed part of the existing Tasmanian dataset from which the present National project commenced.

## 2.10 *Checking procedures*

***Manual Data Checks***

*Geomorphic Logic Checks*

- For any shore segment where *Intertd1_* was a tidal flat of any sort AND *Intertd2_* was a sandy shore or beach, these attributes were reversed – ie, *Intertd1_* became 'sandy shore' or 'beach' and *Intertd2_* became the 'tidal flat' attribute (for consistency).
- Checked for segments (records) where *Intertd1_* and *Intertd2_*, or *Subtid1_* and *Subtid2_*, both have the same information for a given shoreline segment; in such cases, deleted the second of each such record and retained the first.
- More (to be listed)

***Logic Checks***
The following logic checks were applied to each finished state Smartline
Plus more done later by Tore Pedersen and Jessica Benjamin – to be listed

Attribute Errors

1. Frequency tables for the _v and _n fields of each smartline field. Serves as a check for attribution errors in this fields i.e. there should be no multiples in the frequency tables. Also looking for empty _v or _n fields.
2. Frequency tables for the _v, _n, _r and _s fields. Check for the errors within the _r and _s fields. Typical errors include spaces before and after values as well as spaces in fields that are supposed to be empty.
3. Check ABSAMP_ID field for appropriate numbers, especially looking for state suffix with no number due to island suffix being missed or incorrect.
4. Checked each verbal attribute class descriptor had only one version in use (i.e., looked for & corrected any slight mis-spellings of *_v* verbal descriptors).
5. Checked all scale attribute fields (*_s*) use upper class "K", as in "10K", etc (SI standard); some had lower class "k" and were corrected.
6. Checked all classified landform attribute fields (*_n* & *_v*) have accompanying source & scale data (*_r* & *_s*).

7. Checked all landform attribute field records are recorded as “unclassified” (not null) where we have no data (however reference *_r* and scale *_s* fields for these records are left empty).

Spatial Errors

The following steps were be completed by constructing a geodatabase and checking for topological errors.

1. Smartline output checked against initial smartline input, does it contain all the features have any features moved.
2. Check for multipart features that may have entered during one of the many dissolves completed.
3. Check for self overlays, i.e. problems in the merge process.

Spatial Validity

1. Check for extremely short segments (<1m) and see how they differ from surrounding segments are the segments valid. If appropriate merge into segment with the least differences. Redissolve.

Check no required fields have been lost within dissolving processes.

Finally produce spreadsheet reporting on the stats for each of the Smartline fields. (line_checker.mxd)

Subsequent topology and attribute consistency (spelling, etc) checks were done by Jessica Benjamin & Tore Pedersen – to be listed here in full.

## 2.11 *State Shoreline overlap trimming*

With the exception of Tasmania, it was noted that the base shoreline maps used for each state’s portion of the National Smartline map overlapped, were offset or failed to meet by some metres at each state border. Comparison of each state coastline with satellite imagery for each border zone indicated that the shoreline maps for each state appeared to accurately reflect topographic features near each border; hence these mis-matches are probably not due to mapping inaccuracies but rather are an artefact of the differing map scales used for each state baseline map. Each state’s Smartline has been trimmed to end at that states border as delineated by the 100K Geodata map, which is the best scale of mapping available as a uniform dataset for all states. This has left a number of small offsets and gaps between the maps at each states border, mostly in the order of tens of metres, however no attempt has been made to arbitrarily close these gaps with new joining line segments at the state boundaries since this would introduce a new source of real inaccuracy into the maps.

The mismatches which were found at each state boundary are indicated in the table following:

| **Boundary** | **Mismatch** |
|---|---|
| WA – NT<br>(Landgate – 100K Geodata maps) | ~90 metre gap at boundary, NT shoreline stops short of WA boundary. |
| NT – Qld<br>(100K Shoreline class – 100K Geodata maps) | 1.00 km gap at boundary, shorelines fall short of border. |
| Qld – NSW<br>(100K Shoreline class – 50K Drainage shoreline) | Both maps extend many kilometres beyond the respective state boundaries, however the two maps are only offset by ~8 metres at the 100K Geodata state boundary |
| NSW – Vic<br>(50 K Drainage shoreline – 25 K Shoreline) | NSW map overlaps Vic for 13 km, Vic overlaps NSW by 0.7 km, mapped shorelines offset from each other by 44m gap at 100K Geodata map state border. |

| | |
|---|---|
| Vic – SA<br>(25 K shoreline – SA new shoreline) | Both maps extend a few metres beyond respective state borders (as per 100K Geodata map), with a ~50m offset (separation) at the border. |
| SA – WA<br>(SA new shoreline – Landgate) | The maps overlap the state borders by ~180 metres, with ~70 metre offset at the 100K Geodata border |

The trimmed state Smartline shapefiles were not merged into a single national shapefile but rather have been retained as individual state map tiles. However it is a simple task to create a merged national Smartline at any time if desired.

## 2.12 *Stability Classes*

Generated from geomorphic attributes by queries. The basis for the Stability classes is described in the Smartline Data Model and Manual (Sharples and Mount 2009). More will be said here!

## 2.13 *Final Re-projection*

Following completion of map editing tasks – which were performed using shapefiles projected into Albers Projection - the completed Smartlines were supplied as to Geoscience Australia in two versions to suit GA protocols (Hill 2004), as follows:

- Un-projected Geographical co-ordinate version (GDA94 datum); and
- Projected co-ordinate version: Lambert Conformal Conic projection (GDA94 datum)

# 3.0 FUTURE DEVELOPMENT OF NATIONALLY-CONSISTENT SMARTLINE COASTAL GEOMORPHIC MAPPING

## 3.1 *Constraints on the Production of the Australian Coastal Smartline v.1 Map*

Some key issues and decisions affected the production of v.1:

***Exclusion of Estuaries & tidal lagoons***
Excluded as a deliberate early limit on the scope of the project, which would have ballooned considerably if these re-entrants were included. Re-entrant geomorphic information was included where it already existed in easily-used line map formats (e.g., Queensland OSRA mapping), but was not used in areas (e.g., NSW) where doing so would have required manual data digitising (since the automated geo-processing methods developed for this project worked well on open coasts but not so well in closely convoluted waterways.

***Data Gaps***
Some were major (e.g., large stretches of the WA coast had no intertidal or backshore landform mapping in any usable (vector GIS data) form; some relevant data existed in raster 250K geological maps or in satellite imagery (Google Earth), and whilst some of this was manually incorporated into the Smartline during the final phases of preparation, project time and resources did not permit completion of this manual work – which was in any case beyond project specifications).

Key data gaps are noted in Section (3.2) below. and Appendix Five.

***Subtidal Landforms***
During the current (2007-2008) Smartline project, Subtidal landform (substrate) information was regarded as lower priority for the purposes of the project, and was only obtained for limited parts of the Australian coast. However, since most of the relevant data is available as physical habitat mapping, and since a current parallel project is compiling a national consistently-classified subtidal habitat map in polygon format (Mount *et al.* 2007), it will be simpler to derive the subtidal data needed for the Smartline from this habitat mapping when it is available, as a future exercise to upgrade the Smartline map.

***Subtidal Slope***
In principle useful, not attempted due to major extra work required, plus lack of clear basis for categorising sub-tidal slopes into simple broad categories

## 3.2 *Known Issues to be Resolved and Updates to be Incorporated into Future Smartline Versions (post - 1.0)*

During the process of compiling and editing the Australian Smartline Coastal Geomorphic Map (version 1), a variety of data issues and problems were identified. Many such issues were resolved during preparation of the Smartline v.1, however a variety of issues could not be resolved within the scope of this project. It is recommended that these be addressed in future updates of the Smartline.

The more important or general issues for future resolution are listed below whilst a number of more specific (or less important) issues are listed in Appendix Five.

*Classification review:*
Although the Smartline landform classification has a fairly logical and consistent structure, some redundancies, inconsistent spellings and usages, etc, have crept in due to the need to periodically add classifiers & classes as we worked through the states. Sometimes slightly different classes have been used in different states for landform types that could more simply be described using the same class in all states. Some class terms (verbal descriptors) are a bit awkward - and sometimes inconsistent with

related class descriptors - and could be simplified & rationalised. Now that all states are complete, it would be useful to revisit the classification and resolve any redundancies and inconsistencies, re-order classifiers more logically if possible, etc.

*Coastal Re-Entrants (Estuaries, Tidal lagoons, etc):*
Many were missing from v.1 base maps, and some of those that were on v.1 base maps did not have geomorphic attributes due to lack of suitable source datasets and/or geoprocessing issues. All coastal re-entrants, lagoons & estuaries should be added to the Smartline to (theoretically) tidal limits, and attributed with geomorphic attributes - by manual methods from geological maps if necessary. Give all re-entrants Exposure = 'Very Low' attribute.

*Data gap identification & error corrections:*
Numerous data gaps for particular attributes on particular coastal stretches were noted during version 1 compilation, mainly due to source data limitations. Some evident data errors were also noted, arising from a variety of causes. Many data gaps and errors were corrected during version 1.0 compilation, however it is obvious that more remain to be identified and / or corrected. It is desirable to systematically check the entire national coast (manually) for obvious errors and gaps (using Google Earth & geological maps for reference) and endeavour to manually correct obvious errors and fill gaps (unclassified attributes of any sort) using the best available data.

*Beach Numbering:*
Systematically manually check all beach numbers (against Google Earth & Andy Short books); identify any missing numbers and attribute Smartline with numbers as necessary; correct any incorrectly numbered Smartline segments.

*Use ABSAMP Database to Upgrade Smartline attributes:*
Extract relevant beach coastal data (incl. dunes info) for all numbered beaches from linked ABSAMP Database and attribute to existing Smartline (this will in many cases add new data to previously unclassified Smartline attributes; however where there are existing attributes these should be checked against the ABSAMP data and replaced if found to be incorrect, or retained if ABSAMP indicates they are already correct).

Note it was originally hoped to perform this operation during preparation of Smartline v.1, however this was not possible due to delays in accessing the ABSAMP database.

*Inconsistent Attributes:*
A known issue with the Smartline v.1 is that there are cases where different attributes of the same shore segments record "hard rock" landforms for one or more attributes, and “soft rock” or “undifferentiated rock” landforms for one or more other attributes. In some cases this will be valid – e.g., hard rock *Geology1* bedrock landforms overlain by soft rock *Geology2* landforms - but in most cases there is an inconsistency that needs to be resolved. In all cases, the landform types (hard or soft) should be consistent with the *Geology1* and *Geology2* attributes. In many such cases, inconsistencies & overlaps in the assignment of ‘hard’, ‘soft’ and ‘undifferentiated’ bedrock landform types to various attributes within the same shoreline segments has caused some inconsistencies in the stability classifications assigned to those segments.

Similarly, there are cases where some attributes of a shoreline segment record sediments of a specific type (mud, sand, etc), whilst other attributes of the same segment record sediments as being of “undifferentiated” type. In many such cases, the “undiff” sediment can and should reasonably be classified into a specific sediment class based on other attributes of the same segment. This needs to be done manually (by reviewing and updating the map as appropriate). In many cases, inconsistencies & overlaps in the assignment of specific and ‘undifferentiated’ sediment types to various attributes within the same shoreline segments has caused some inconsistencies in the stability classifications assigned to those segments.

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## APPENDIX ONE:  GEO-PROCESSING TECHNIQUES

Documentation of methods used for transferring line, polygon & DEM map attributes to the Smartline maps, and merging Smartline datasets..  This Appendix comprises documentation of geo-processing techniques referred to in this Report Sections (2.7) & (2.8).

## A1.1 *Polygon Data Extraction Technique for Victoria*

Geo-Processing Technique description by Michael Lacey

**Method for transferring OSRA shapefile geomorphic attributes to the Victorian coastline polyline.**

**Summary**

A method was developed for transferring attributes from adjacent polygon and polyline layers into a coastline smartline. The method involved first splitting the coastline layer at vertices then buffering these to capture attributes of intersecting layers at a distance of up to 500 metres from the line. Data was captured using spatial joins. Exported join tables were reformatted using a series of Python scripts before the data was compiled in an Access database. The compiled data table was joined to the coastline according to inter-vertex segment. A dissolve step then recombined adjoining segments with identical attributes.

This method can be adapted for other similar purposes.

**Introduction**

Oil Spill Response Atlas (OSRA) data is the main source of geomorphic information used in compiling the coastal geomorphic smartline. Formats for OSRA data vary by state and in Victoria it is in the form of several polygon and polyline layers. To use this data it was necessary to develop a method for transferring attributes of the various adjoining layers into the chosen coastline. Following is a description of the method that was used.

**The data**

OSRA Victorian shapefiles were used as the source of attributes and as the target coastline (Table 1). Shapefiles were retained in the projection in which they were received.

***Table 1.*** *OSRA shapefiles used in transfer or geomorphic attributes to coastline*

| Shapefile | Projection | Purpose |
|---|---|---|
| vcst25g_a | GCS_Aust_1966 | Used as the target coastline and source of some attributes |
| ci_levee | AGD66 Zone55 | Attribute source |
| k_levees | none | Attribute source |
| plat_east | None | Attribute source |
| plat_west | None | Attribute source |
| substrata4g | None | Attribute source |
| gl_shore | GCS_Aust_1966 | Attribute source |
| mal_inlet | None | Attribute source |
| portland2_g | None | Attribute source |
| shal_inlet_g | None | Attribute source |
| v_shore12_g | GCS_Aust_1966 | Attribute source |

**Software**

Geoprocessing was conducted with ArcGIS 9.2. Attribute table data was reformatted with Python 2.4 scripts using the PythonWin interface. The reformatted attribute table was compiled using Microsoft Access 2003.

**Formatting of layers for attribute transfer**

**A) Preparation and buffering of coastline layer**

Initial formatting and buffering of a copy of the coastline layer followed the steps shown in Figure 1. The initial coastline layer had 1715 segments (numbered 0 to 1714). After splitting at vertices the output feature vcv.shp had 155987 segments. Copies of the original FID and Vertex FID were retained as attributes as they were needed at later steps in the processing.

***Figure 1**. Formatting and buffering of coastline prior to attribute transfer*

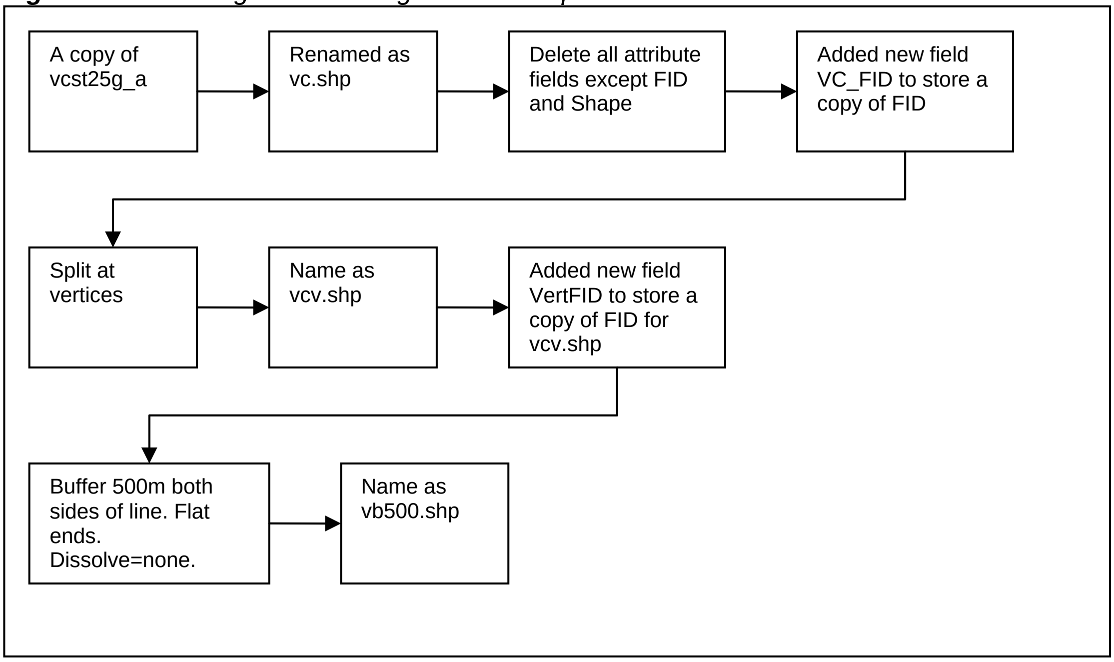
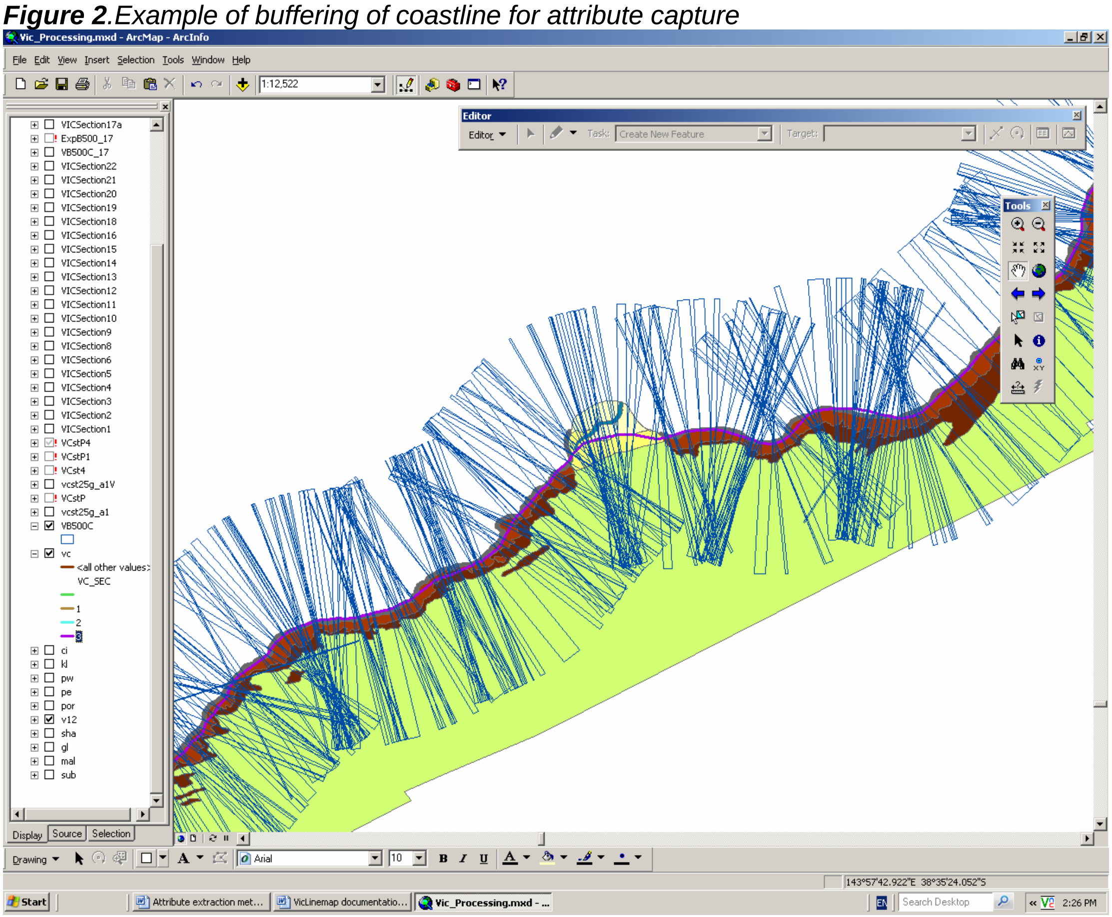



Figure 2 is an example of the resultant buffered line (blue rectangles) in relation to the coastline (purple) and other associated polygons (other colours).

***Figure 2**.Example of buffering of coastline for attribute capture*



**B) Preparation of shapefiles for attribute capture**
Edited copies the OSRA attribute shapefiles were produced prior to spatial joins for transferring attributes (Table 2). The purpose of this editing was to reduce file size and complexity to facilitate more efficient geoprocessing The following changes were made:

- removed superfluous fields that contained information that could later be re-attached from look-up tables (with care taken to ensure that no attribute information was lost)
- contents of remaining fields were reduced to the minimum number of characters.
- an extra field named SFL (shape file layer, field type: text, 3 characters) was added to identify the layer and this layer ID was added to each record

***Table 2.*** *Edited input shapefiles*

| Shapefile | Renamed | Retained fields | SFL code |
|---|---|---|---|
| ci_levee | ci | FID, SHAPE | CI |
| k_levees | kl | FID, SHAPE | KL |
| plat_east | pe | FID, SHAPE, AS2482 | PE |
| plat_west | pw | FID, SHAPE, AS2482 | PW |
| substrata4g | sub | FID, SHAPE, HABITAT, LITH_NO | SUB |
| gl_shore | gl | FID, SHAPE, SHORECODE, REL_EXP, SUBSTRATE | GL |
| mal_inlet | mal | FID, SHAPE, SHORECODE, REL_EXP, SUBSTRATE | MAL |
| portland2_g | por | FID, SHAPE, SHORECODE, REL_EXP, SUBSTRATE | POR |
| shal_inlet_g | sha | FID, SHAPE, SHORECODE, REL_EXP, SUBSTRATE | SHA |
| v_shore12_g | v12 | FID, SHAPE, SHORECODE, REL_EXP, SUBSTRATE | V12 |

Some-where here list the cross referenced information for the tables.

A group of VBA scripts used with the field calculator assisted in producing abbreviated field entries.

**Transfer of the attributes to the line**
Spatial joins were used to transfer attributes from the attribute layers to the buffered coastline segments. In this process an entry was added to the join table for each feature intercepted by each buffer polygon, resulting in multiple records for each buffer polygon. Geoprocessing steps were as outlined in Figure 3. The output was in the form of a collection of tables in csv (comma separated value) format.

To facilitate processing the coastline was split in to manageable length sections prior to spatial joins, mostly between 3000 and 10000 segments in length. Processing time was significantly greater for some parts of the coast where vertices were closely spaced and where adjoining buffer polygons had a large amount of overlap (eg Figure 4). Many of these parts of the coast were processed in sections of less than 1000 segments.

***Figure 3****.Geoprocessing steps to transfer attributes to coastline segments*

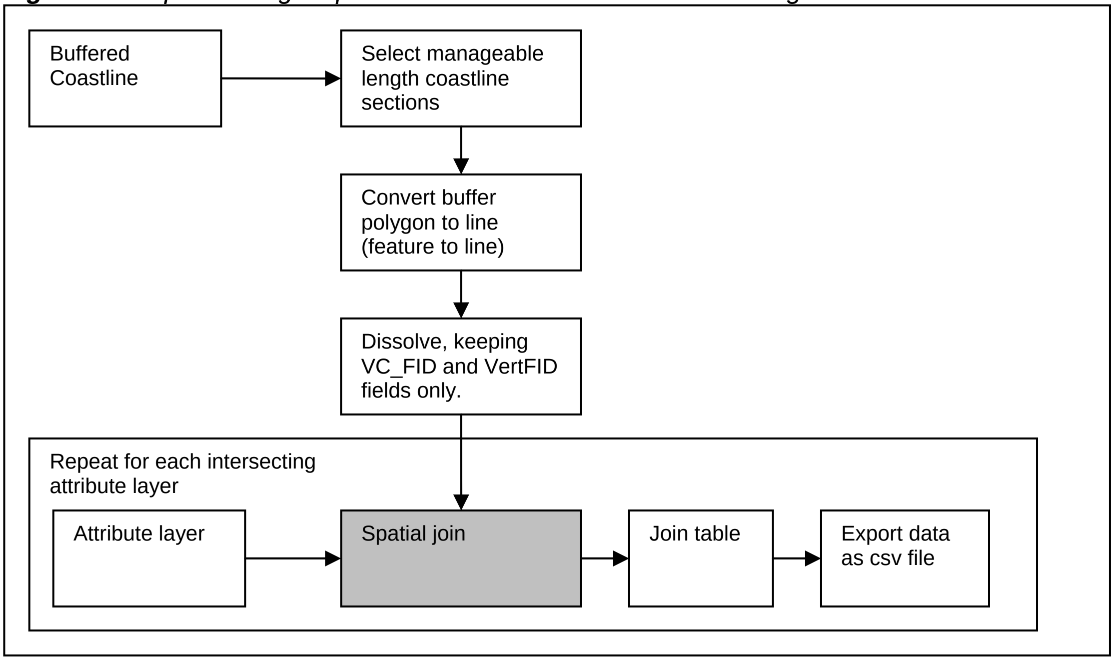
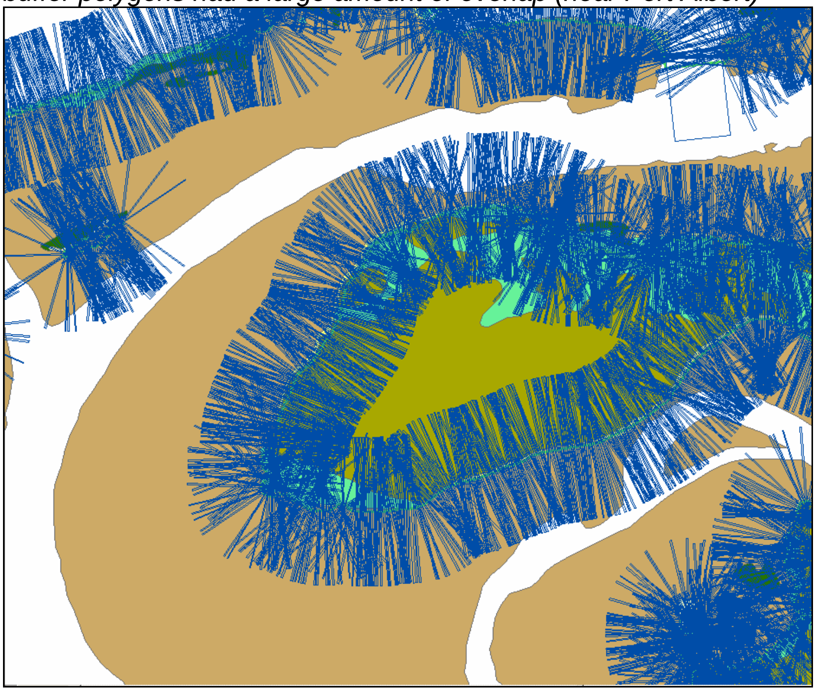



***Figure 4****.Example of section of the coast where vertices were closely spaced and where adjoining buffer polygons had a large amount of overlap (near Port Albert)*



**Attribute processing**
Exported join tables contained multiple entries for each coast segment, at least one entry for each polygon or polyline intersected. In addition each coastline section was joined with two or more of the attribute containing shapefiles. The final output required that all of this data be condensed to a single multi-attribute table entry for each coast segment.

Reformatting was conducted in two steps. In the first step, a series of Python scripts were used to reformat the join tables from a format with multiple entries per segment into single entry tables with multiple attribute fields. Table 3 lists the scripts used for specific attribute layers, with details of the input and output attribute fields.

***Table 3.*** *Reformatting of attribute tables: Python scripts used, input and output attribute fields*

| **Joined attribute layer** | **Python script used to process join table** | **Input attribute fields** | **Output attribute fields** |
|---|---|---|---|
| V12, POR, SHA, MAL, GL | Reconstruct_Table_POL.py | VC_FID, VertFID, SHORECODE, R_EXP, SBS, SFL | VC_FID, VertFID, SFL, Rel_Exp, Substrate_200, Substrate_600, SC_99, SC_100, SC_200, SC_400, SC_450, SC_500, SC_600, SC_650, SC_900, SC_950, SC_1000, SC_1100, SC_1200, SC_1400, SC_1500, SC_1600, SC_1650, SC_1800, SC_1900, SC_2000 |
| SUB | Reconstruct_Table_SUB.py | VC_FID, VertFID, LITH_NO, HAB | VC_FID, VertFID, SFL, LN_61, LN_62, LN_63, LN_64, LN_65, LN_68, LN_90, H_b, H_c, H_hr, H_lp, H_s, H_u |
| CI, KL | Reconstruct_Table_Levee.py | VC_FID, VertFID, | VC_FID, VertFID, SFL |
| PW, PE | Reconstruct_Table_Plat.py | VC_FID, VertFID, AS2482 | VC_FID, VertFID, PLAT, SFL |

A summary of the specific rules for attribute processing are as follows:

- For all layers:
  - The first entry of VertFID, VC_FID and SFL were used.
- For main polygon layers (V12, POR, SHA, MAL and GL):
  - A new attribute field was created for each SHORECODE category. The code where present was transferred to the field, which was otherwise set to zero.
  - Where SHORECODE was 200 or 600, substrate was captured as Substrate_200 or Substrate_600.
  - The most common R_EXP (relative exposure) was selected.
- For substrate layer:
  - A new attribute field was created for each LITH_NO category. The code where present was transferred to the field, which was otherwise set to zero.
  - A new attribute field was created for each HAB (habitat) category except 'l' (land). The code where present was transferred to the field, which was otherwise set to '-'. HAB where it is 'l' is ignored
- For platform layers (PW, PE):
  - Where AS2482 is 4007 or 0 this is transferred to the PLAT attribute. An AS2482 code of 4002 is ignored.
- For levee layers (CI, KL):
  - No additional attributes

**Compiling the Attribute Table**

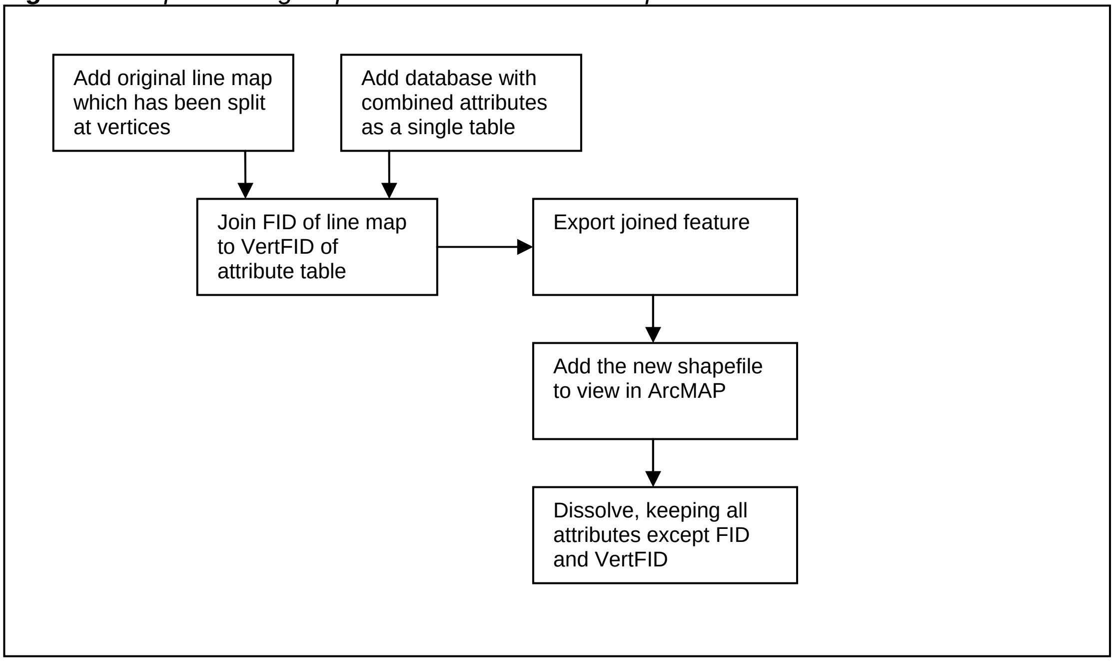
The next step was to compile each of the reformatted attribute tables into a single table prior to rejoining with the selected coastline layer. Reformatted tables were compiled for the whole coastline in an Access database (CombineAttributeTables.mdb).

Four database tables were used to compile substrate, platforms, levees and polygon group entries. An additional table contained a copy of VertFID and VC_FID for all segments in the coastline. Substrate, platforms, levees and polygon group tables were compiled by importing all of the reformatted csv files produced in the previous step into the relevant table. Use of VertFID as the primary key ensured that there were no duplicates. A series of database queries then progressively combined all of the data into a single query table. Using a make-table query, this single query table was then exported to an empty second database (vcv5.mdb) as a table. This second database was used as the attribute source to be joined to the line map.

**Assembling the Line Map**

The line map was assembled in ArcMAP. The general steps are shown in Figure 5. Starting with a new empty map, a copy of the original line map split at vertices and the combined attribute database were added. The attribute table was then joined to the line map shapefile, joining the VertFID field of the attribute table to the FID field of the shapefile. The resulting joined feature was then exported and then added to the map view. A dissolve step then effectively reversed the split at vertices where adjoining segments had identical attributes. This dissolve retained all attributes except FID and VertFID.

***Figure 5****.Geoprocessing steps to assemble the linemap from base line and attribute database*




**Postscript: Assessment of suitability**
This approach is most successful where the coastline is straight or where the curvature is such that buffer polygons remain perpendicular to the general run of the coast. For some sections of the coast this approach may be unsuitable or at least may require follow-up processing. These include:

- Places where buffer polygons cross the coast two or more times such as near narrow bays, spits, offshore islands or headlands (eg. Figure 6).
- Places where the coastline is irregular such that some buffer polygons lie at an acute angle to the coast or in a very different direction to adjoining buffer polygons (eg. Figure 7).

In both cases attributes may be incorrectly captured. In the second case the irregular capture of attributes may also mean that numerous short segments remain after the final dissolve step.

***Figure 6****.Example of where buffer polygons have intersected the coast twice (near entrance of Port Philip Bay)*

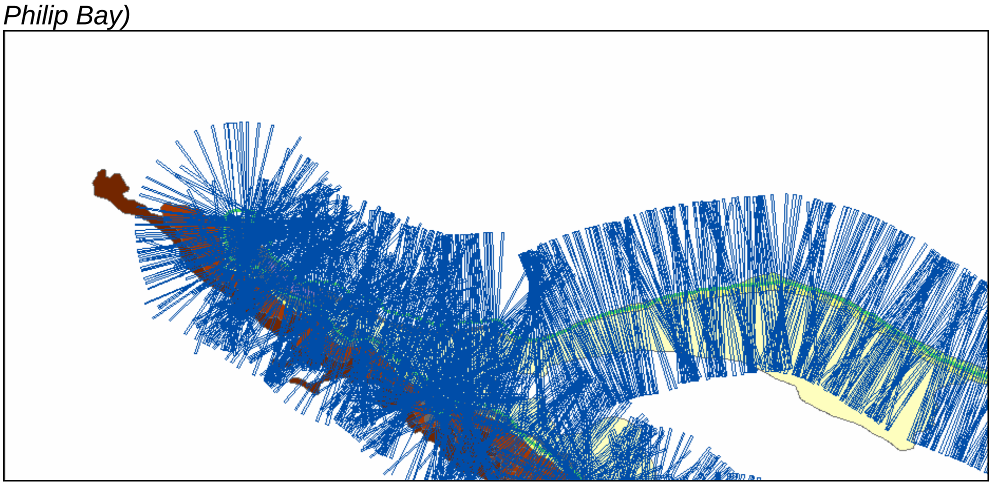
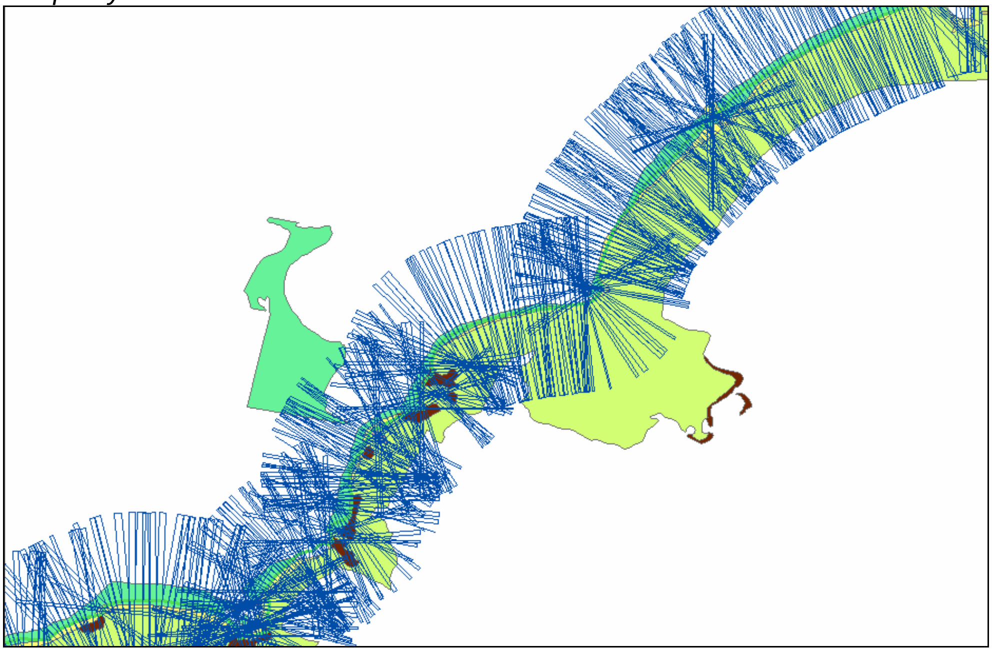


***Figure 7****.Example showing how buffer polygons can lie at acute angles to the coast (NW side of Port Philip Bay*



## A1.2 *Extraction of Proximal Backshore Attributes from Vector Polygon Source Maps*

Geo-Processing Technique description by Dom Jaskierniak and Luke Wallace

# Calculating the proximal value

The proximal values attributed to the Smartline from a particular dataset represent the value of a polygon that occurs adjacent to each coastal line feature. The polygon dataset that is used in the attribution of a particular proximal feature can be identified through the corresponding FILE_ID field. Under the following methodology, the Smartline will be divided in such a way that the changes in the polygon dataset will be represented within the Smartline.

The first stage of attributing the coastline with proximal values involved using the "Identity" tool (available in ArcGIS) to extract the proximal values for the Smartline segments that overlay a polygon feature with a desirable attribute value. However, the identity tool was not able to capture appropriate attribute values for every line segment as some underlying polygons contained undesirable attribute values (for example an ocean polygon) or the line did not overlay an existing polygon. The main cause of misattributed coastline was the discrepancy in the representation of the coast by the polygon dataset and the coast represented by the Smartline (Figure 1).

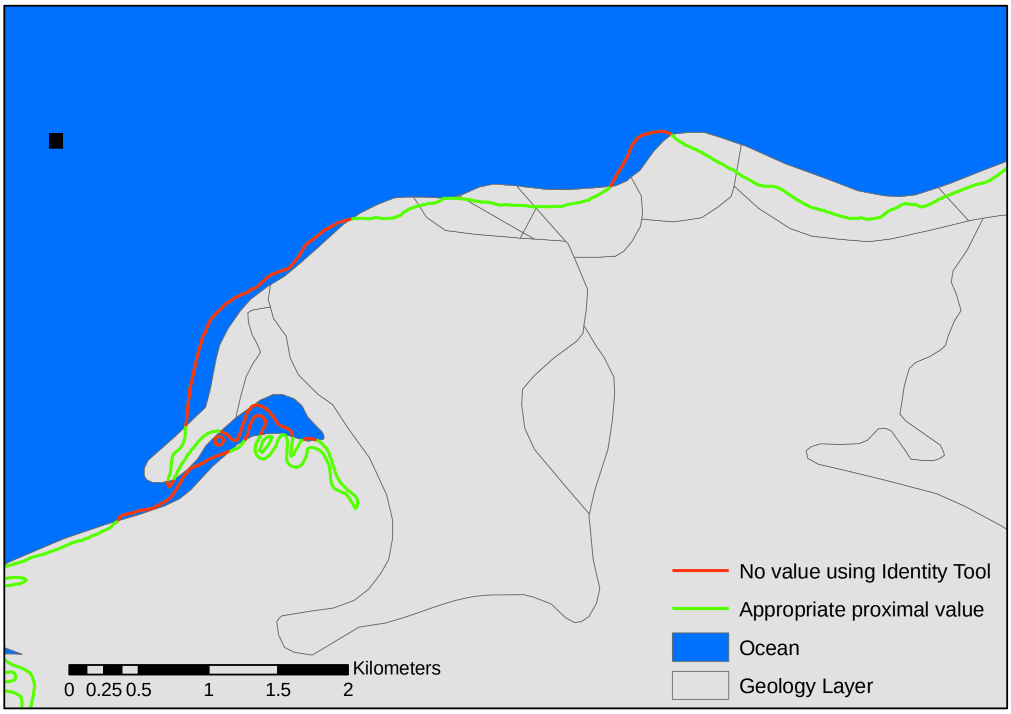



**Figure 1** An example of a polygon layer with the coastline not being identical to the smartline. Note the line segments initially attributed with no value.

The Smartline segments attributed with an undesirable (or no) proximal value (shown in figure 1 as the red lines) from the use of the identity tool still needed to be attributed with an appropriate value if one existed within a distance of 500m of this segment. Assigning a polygon feature value to such a Smartline segment required the following iterative procedure. First, the ocean polygon (polygon/s representing all undesirable polygon values) was selected and converted into a line feature; this gave a line feature class directly adjacent to the coast of the polygon layer. This line was attributed with the information from the coincident polygons along the coast, resulting in a line representing the 'land' polygons adjacent to the coast. This line feature class was buffered at a distance of 100m. This process effectively widened the coastal line with the aim of capturing previously unattributed Smartline segments.

To attribute the remaining line segments each Smartline feature was first split at its vertices to reduce the length of the line features and enable a more accurate transference of information onto the Smartline. Each individual buffer feature was then used to select all the intersecting Smartline segments. The segments were then attributed with the value of the buffer feature that selected it. This process was iterated incrementally using 250 metre and 500 metre buffers to identify and appropriately assign proximal values onto the remaining Smartline segments which were initially attributed with an incorrect value (as demonstrated in figure 2).

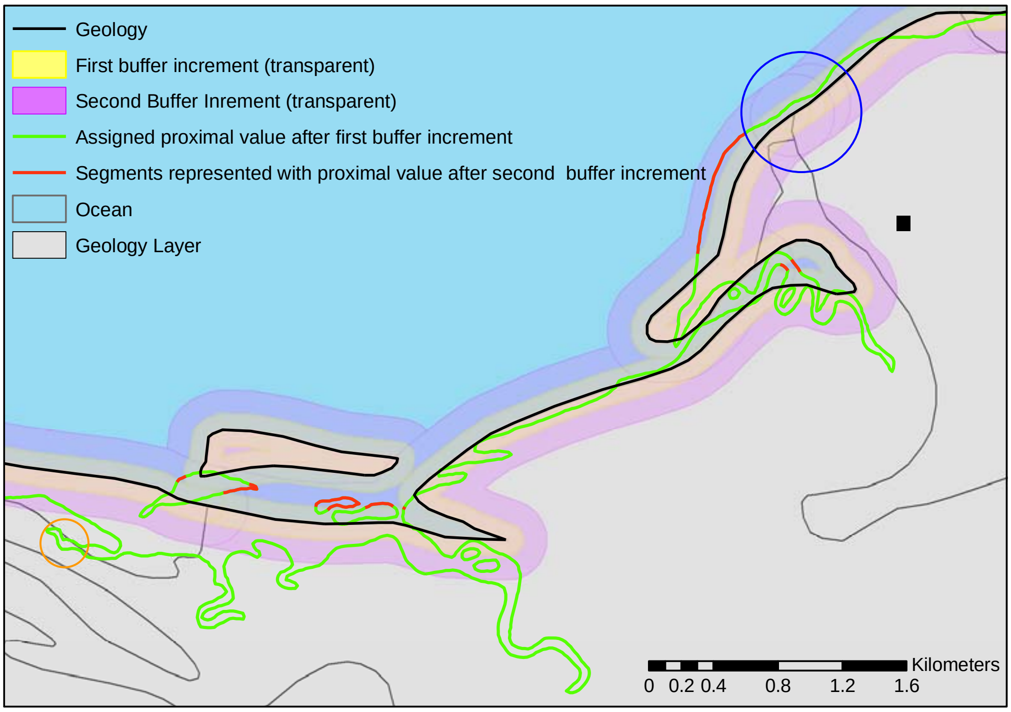



**Figure 2:** Illustration showing how line segments overlaying the ocean are represented with a polygon layer value.

Included in the output of this methodology are two fields giving an indication of the buffer used to attribute a line feature and the precision of the output. The "BUFFER" field provides an integer number representing the iteration at which the feature was attributed. This field gives an indication of the relative accuracy of the polygon dataset and the Smartline at the location of the feature as a larger Buffer value suggests a larger discrepancy, this field also provides an initial indication of the accuracy of the output dataset. The "COUNT" field provides an indication of the precision of the methodology. The outlined methodology iterates through each buffer feature and assigns the line segments overlaying the buffer with the buffers attribute value so if the same line segment is selected more than once, then the line segment is assigned the value corresponding to the last buffer that was selected. Therefore keeping track of the number of times the attribute of a particular feature has been updated provides an indication of the repeatability of the solution.

It should also be recognised that in some cases the methodology may assign the wrong polygon value when the Smartline has an offset inland from the coastal polygon layer. This is demonstrated with an orange circle in figure 2 where the line segment captures the proximal value not adjacent to the coast. This problem again occurs for datasets with a large offset between the Smartline coast and the coast represented by the polygon dataset. A once over visual check of the more problematic datasets has been made to correct these problems manually.

### A1.3 *Extraction of Distal Backshore Attributes from Vector Polygon Source Maps*

Geo-Processing Technique description by Dom Jaskierniak and Luke Wallace

# Calculating the distal value

The Smartline distal value is derived from the same polygon feature layer as the proximal value, however, the distal represents the attribute value of the largest cumulative polygon area within a buffer directly inland from each Smartline feature. The proximal divisions were used to define a distal feature as it is assumed that the proximal features provide an appropriate representation of the natural variation in the underlying polygon data set. The use of proximal features also allowed the excessively large datasets that would have been incurred when using evenly spaced line features to be avoided.

The process involved creating an undissolved 500 metre flat buffer of each Smartline feature and clipping the buffer with a land polygon as demonstrated by the resultant green polygons in Figure 3. The identity tool was applied to the clipped buffer extracting the attributes of all polygon features and superimposing these on each flat buffer polygon. An area calculation was performed for each polygon within each buffer and the results were dissolved based on the required fields. The results in the field "DISTAL" represent the attribute value with the largest area.

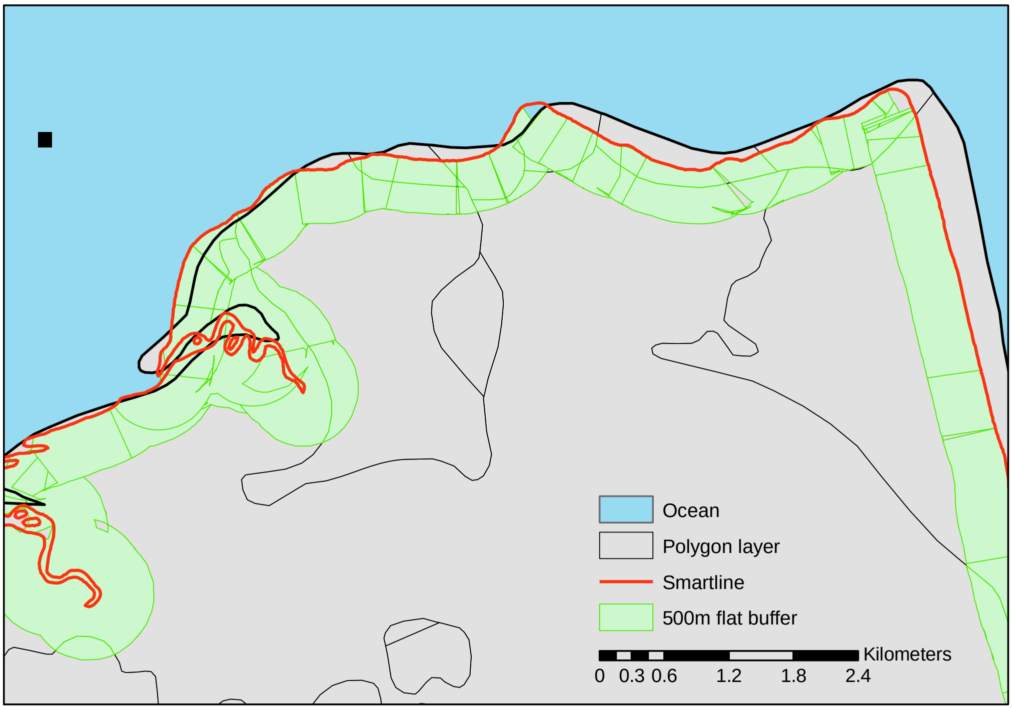



**Figure 3** An example of the buffers used to calculate the distal value and attribute this to the Smartline.

The methodology also provides an indication of the number of geology types contained within the buffer given in the field "DISTAL TYPES (GEOLOGY!)". This provides an indication of the variability in attribute values for each segment If there are many unique attribute values representing a segment then the distal value may be insignificantly larger in area than the next largest attribute value.

### A1.4 *Extraction of Backshore Profile Class Attributes from Digital Elevation Model Source Datasets*

Geo-Processing Technique description by Dom Jaskierniak and Luke Wallace

Note that the source DEM used was SRTM; the coarseness of the DEM was considered an advantage for this application, as the intention is to average out the backshore topography, which the SRTM has effectively already partly done.

# Calculating the profile

The development of a coastal profile map of Australia involves creating points perpendicular to the coast at 50m increments to determine the first peak from the coast within 500 metres. Extracted elevation values were used to calculate the slope between the "first peak" from the coast (or 500 metres from the coast if there was no peak within this distance), and the coast itself. The calculated average slope was incorporated into the Smartline using the following classification system:

**Table 1:** Classification system for deriving the coastal profiles

| Code | Description | Slope |
|---|---|---|
| 000 | Very Flat | 0-3$^{o}$ |
| 100 | Flat | 3-6$^{o}$ |
| 200 | Gentle- Moderate Slope | 6-20$^{o}$ |
| 300 | Steep slope | >20$^{o}$ |
| 400 | High Cliffs | Sea Cliffs > 50 metres |

Note changed later to avoid leading zeros (CS)

The procedure firstly required the coastal profile to be determined for a 100K coastal line with the results then being transferred over to the higher resolution Smartline. The 100K coastal line reduced the likelihood of the data extraction point having an orientation parallel to the broader coastal direction. The 100k line was therefore used as the detail in the Smartline was inappropriate for the methodology.

For each States 100K coastal line the coordinates of the two end points of each segment were retrieved. Based on these coordinates the lines bearing and midpoint coordinates were also calculated. The segment direction in relation to the coast also needed to be identified for each coastal line segment in order to determine the correct side of the land. This process involved accessing the geometry attributes of the segment and determining if the start of the segment is the end of the previous segment. If this is not the case then the direction of the line was flipped before proceeding. The orientation of a perpendicular line to the coast was then calculated by incrementing the previously calculated bearing of the coastal segment 90$^{o}$ in the direction of the land as shown in the figure below.

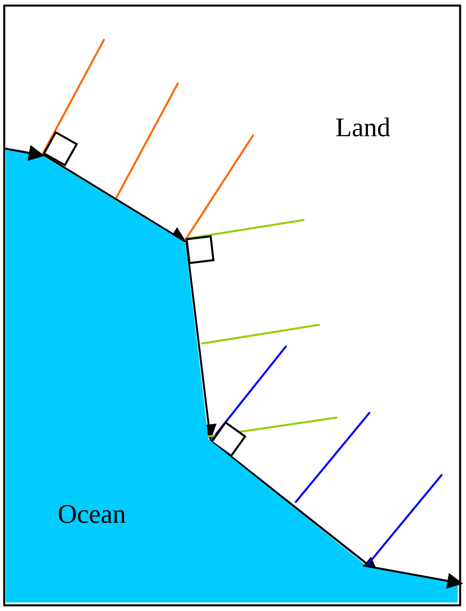



**Figure 4** Illustration of three perpendicular lines to the coast for each line segment.

For each coastal line segment, three sets of points (one for each of the two end points and the mid point) were created using the previously calculated bearing and an incremental distance of 50 metres, with the last point of each point array located 500 metres from the coast.

The above outlined procedure requires the user to provide the Python Code with a parameter field stating whether the very first feature of the iteration procedure has land on the right hand side or left hand side of the line in relation to the direction of the segment (i.e. figure 4 has the land on the left hand side). This procedure was suitable for coastal line segments representing the main continental land mass but a solution was further developed to quantify the coastal profile for islands off the mainland. The procedure involved creating a point three metres to the left of the midpoint of the first (randomly selected) coastal line segment of an island. The generated point was used to determine whether the point is contained by an island polygon and hence determine the line direction. The result is subsequently used to create an array of points perpendicular and inland to each line segment contained in an island.

The array of points generated for all the segments of the coastal line were then clipped out of a land polygon to result in an array of points needing to be assigned an elevation value. This process involved using a DEM and the ArcGIS tool Extract Value To Points.

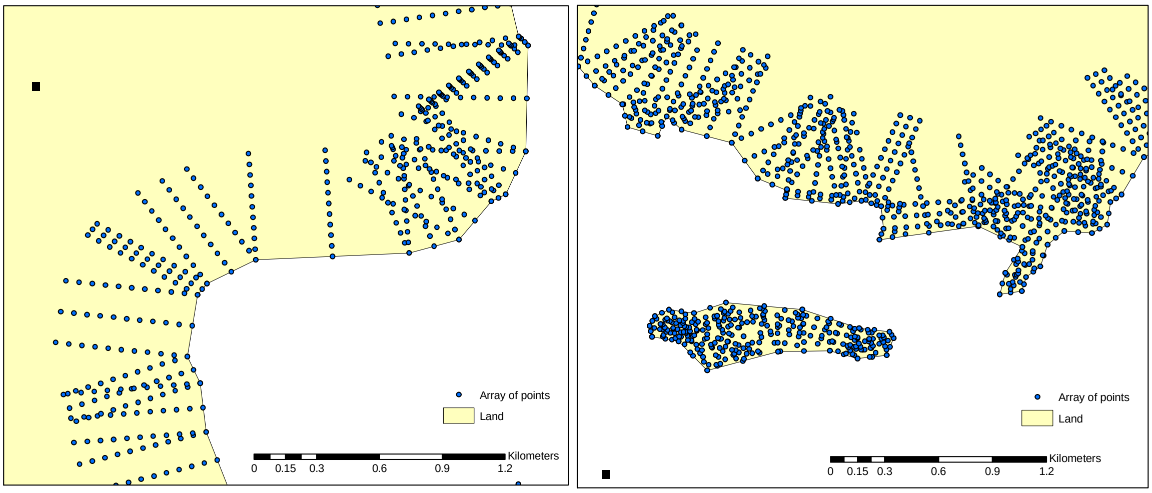



**Figure 5**. Example of coast line with array of points

On occasions after this clipping procedure part of the array of points is located on land but not representative of the line segment being assigned a slope value. This occurs when there is a water body between the line segment and 500m perpendicular to that segment. Due to this the distance between adjacent points was checked to identify any gaps greater than 50m. Such a gap is an indication of a water body between points and therefore the slope will be calculated only based on the distance and elevation of points prior to this gap.

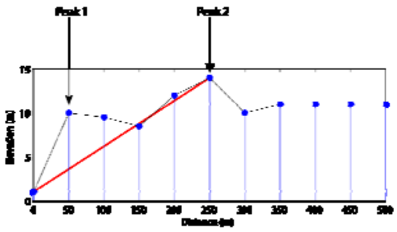
In order to determine the backshore profile of a line segment the "maximum" elevation point and the distance too that point for each of the start, middle and end point arrays were averaged. To determine the "maximum" elevation of an individual point array a logic was used to that involved moving through each point in the array and determining if its elevation is greater than that of the previous highest point, if this was the case then this point was set to be the highest point, once all points had been visited the slope to the highest point could be determined. However, within this logic a set of rules were used in the following situations:

- To avoid using points that occurred after a gap of 50m and therefore unrelated to the line. This was avoided by simply checking the distance between adjacent points and stoping if this distance was more 50m.

- In capturing high sea cliffs, if the elevation at 100m was greater than 50m the segment was immediately assigned a code of 400 (see Table 1).

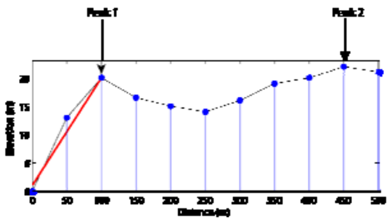
- To use the first peak if it was sufficient but to avoid capturing fore dunes. If the first peak was greater than 15m, then a check on subsequent points to see if a drop of greater than 20% had occurred, if this was the case then the search stoped and the first peak was used. This check was implemented to avoid using secondary peaks that do not describe the backshore profile. The following examples show situations where this check may be employed.

**Example 1**



There are two clear peaks, however, a drop after the first peak of 20% is not obtained so the second peak will be used.

**Example 2**



Again two peaks occur with the second peak being of a greater magnitude however a drop of 20% is obtained so the first peak will be used.

Once the 1:100k line had been attributed with a backshore profile value, it was transferred to the final 1:25k Smartline using spatial join technique based on an incremental buffering system. Buffers of 100, 200 and 300m were used to incrementally transfer the profile values to segments of the Smartline line depending on the distance to the nearest segment of the 1:100km line.

## A1.5 *Technique used for Combining Multiple Line Map Shapefiles of a State*

Geo-Processing Technique description by Michael Lacey

For each state Smartline, data from various sources was originally captured and reclassified in separate line shapefiles, which were then merged to give the final Smartline with all attribute fields (see section 2.8). The following text describes the procedure of merging shapefiles for Victoria, however essentially the same process was used for each state.

# Documentation for combining Victorian Smartlines

The following lines were combined to produce auscstgeo_vic_v1_beta1.shp

| Line number | File names of lines to be combined |
|---|---|
| 1 | VC_Data5_Reclass_Dissolve.shp |
| 2 | VCstP4_BeachNo_Reclass_Dissolve.shp |
| 3 | VCstP4_GDA_Reclass_Dissolve.shp |
| 4 | Vic_Profile_reclass_Dissolve.shp |
| 5 | Victoria_Distal_reclass_dissolve.shp |
| 6 | Victoria_Proximal_reclass_dissolve.shp |
| 7 | Victoria_bedrock_reclass_dissolve.shp |

***Steps to combine lines 1 and 2***

**Erase**
VC_Data5_Reclass_Dissolve.shp
VCstP4_BeachNo_Reclass_Dissolve.shp
**Output**
VC5_VC4BN_Er.shp
*Outcome:* Eight segments different, (1 extra, 1 duplicate, others shifted)

Next delete all fields from VC5_VC4BN_Er.shp then add ABSAMP_ID field (String 10) to VC5_VC4BN_Er.shp

Update beach numbers on VC5_VC4BN_Er.shp (this required spliiting one segment)
Delete extraneous segments from VCstP4_BeachNo_Reclass_Dissolve.shp
Delete one duplicate segment from each of VC_Data5_Reclass_Dissolve.shp and VC5_VC4BN_Er.shp

**Merge**
VCstP4_BeachNo_Reclass_Dissolve.shp
VC5_VC4BN_Er.shp
**Output**
VCstP4_BeachNo_Reclass_Dis2.shp

**TestErase**
VCstP4_BeachNo_Reclass_Dis2.shp
VC_Data5_Reclass_Dissolve.shp
*Outcome:* Nothing remaining
Test erase the other way around also revealed no segments.

**Intersect**
VC_Data5_Reclass_Dissolve.shp
VCstP4_BeachNo_Reclass_Dis2.shp
**Output**
VC5_VC4BN_Intersect.shp

***Steps to combine lines 3 and 4***
**Erase**
VCstP4_GDA_Reclass_Dissolve.shp
Vic_Profile_reclass_Dissolve.shp
**Output**
VCstP4_GDA_Profile_Er.shp
*Outcome:* 6 segments missing from Profile

Also test erase the other way around. Outcome: No segments. Therefore, only profile segments missing.

Next delete all fields from VCstP4_GDA_Profile_Er.shp then add *Backprof_n* field (*String 3*) to VCstP4_GDA_Profile_Er.shp

**Merge**
Vic_Profile_reclass_Dissolve.shp
VCstP4_GDA_Profile_Er.shp
**Output**
Vic_Profile_reclass_Dis2.shp

**Intersect**
VCstP4_GDA_Reclass_Dissolve.shp
Vic_Profile_reclass_Dis2.shp
**Output**
VCstP4_GDA_Profile_Intersect.shp

***Steps to combine lines 5 and 6***
**Erase**
Victoria_Distal_reclass_dissolve.shp
Victoria_Proximal_reclass_dissolve.shp
**Output**
V_Distal_Proximal_Er.shp
*Outcome:* Nothing remaining
Same outcome when erased in opposite order.

**Intersect**
Victoria_Proximal_reclass_dissolve.shp
Victoria_Distal_reclass_dissolve.shp
**Output**
V_Proximal_Distal_Intersect.shp

***Steps to combine lines 7 with combined 5+6***
**Erase**
V_Proximal_Distal_Intersect.shp
Victoria_bedrock_reclass_dissolve.shp
**Output**
V_Prox_Dist_bedr_Er.shp
*Outcome:* 138 segments remaining
Nothing remained when erased in opposite order.

Next delete all fields from V_Prox_Dist_bedr_Er.shp then add *Geol12_n* field (*String 6*) to V_Prox_Dist_bedr_Er.shp

**Merge**
Victoria_bedrock_reclass_dissolve.shp
V_Prox_Dist_bedr_Er.shp
**Output**
Victoria_bedrock_reclass_dis1.shp

**Intersect**
V_Proximal_Distal_Intersect.shp
Victoria_bedrock_reclass_dis1.shp
**Output**
V_Prox_Dist_bedr_Intersect.shp

***Steps to combining combined 3+4 with combined 5+6+7***
**Erase**
VCstP4_GDA_Profile_Intersect.shp
V_Prox_Dist_bedr_Intersect.shp
**Output**
V_34_567_Er.shp
*Outcome:* 9 segments remaining
Nothing remained when erased in opposite order. Therefore need to add to V_Prox_Dist_bedr_Intersect.shp

Next delete all fields from V_34_567_Er.shp then add *Geol12_n* field (*String 6*) to V_34_567_Er.shp

**Merge**
V_Prox_Dist_bedr_Intersect.shp
V_34_567_Er.shp
**Output**
V_Prox_Dist_bedr_Intersect_M.shp

Update missing attributes from V_Prox_Dist_bedr_Intersect_M.shp by copying attributes from surrounding segments

**Intersect**
VCstP4_GDA_Profile_Intersect.shp
V_Prox_Dist_bedr_Intersect_M.shp
**Output**
V_34_567_Intersect.shp

***Steps to combining combined 1+2 with combined 3+4+5+6+7***
**Erase**
VC5_VC4BN_Intersect.shp
V_34_567_Intersect.shp
**Output**
V_All_Er.shp
*Outcome:* 7 segments remaining (the same segments which were encountered when joining lines 1 and 2, excluding the duplicate segment).
When erased in opposite order 23 segments associated with the shifted segments remained.

Next delete all fields from V_All_Er.shp then add *Geol12_n* field (*String 6*) to V_All_Er.shp

**Merge**
V_34_567_Intersect.shp
V_All_Er.shp
**Output**
V_34_567_Intersect_M.shp

Manually copy attributes from shifted segments in V_34_567_Intersect_M.shp to segments in the correct positions, then delete the shifted segments.

**Intersect**
VC5_VC4BN_Intersect.shp
V_34_567_Intersect_M.shp
**Output**
V_All_Intersect.shp

**Dissolve**
V_All_Intersect.shp
Removing all FID fields added in the previous intersect steps.
Singlepart.
**Output**
V_All_Intersect_Dissolve.shp

Open Smartline_Tools_v10 and add V_All_Intersect_Dissolve.shp
Set up new field list in excel for fields to be added
Modify code in Smartline_Tools to point to the new field list.

In ArcCatalog rename V_All_Intersect_Dissolve.shp as auscstgeo_vic_v1_beta1.shp then copy auscstgeo_vic_v1_beta1.shp to
Z:\ACV-GEO\SMARTLINES\VIC\D_Semi-final\auscstgeo_vic_v1_beta1.shp

ML 30/07/08

## APPENDIX TWO: CLASSIFICATION WORKSHOP REPORT

This Appendix provides the original text of the Outcomes Report prepared following a National workshop convened in Hobart for the purpose of peer-reviewing the proposed Smartline Geomorphic and Stability Classification systems (as described in Section 2.4).

Note that the report refers to the Australian Greenhouse Office (AGO); this has subsequently been replaced by the Department of Climate Change.

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# National Workshop 5th – 7th September 2007, Hobart
# Workshop Outcomes Report

Notes prepared by Chris Sharples
16th November 2007

## *Background*

**The Project**
The Australian Greenhouse Office (AGO) of the Department of the Environment and Water Resources is working with the States and Territories through the Intergovernmental Coastal Advisory Group (ICAG) to assess Australia's coastal vulnerability to climate change. An early objective of the Department is to deliver a "First Pass" national vulnerability assessment of the Australian Coast and priority coastal systems (natural and artificial) by late 2008. This will identify risks and priorities and build foundation capacity towards future, more detailed assessments.

A key part of coastal vulnerability assessment is the mapping of coastal landforms (geomorphic types) that have greater or lesser susceptibility (or "sensitivity") to the impacts of climate change and sea level rise, such as accelerated erosion and shoreline recession, increased slumping, or other hazards. Geomorphic maps exist for various sections of the Australian coast, however these have been prepared for a wide range of purposes and they exist in a variety of paper and electronic formats, at differing scales and resolutions, and using differing geomorphic classification schemes. There is no consistently-classified geomorphic mapping of the entire Australian coastline, except at scales too coarse to be of practical use in vulnerability assessment, or in formats not capable of identifying specific sensitive shores (e.g., Galloway *et al.* 1984).

In order to provide the basis for a First Pass vulnerability assessment of the whole Australian coastline, the Australian Greenhouse Office has contracted Geoscience Australia to prepare a geomorphic map of the Australian coastline using a nationally-consistent geomorphic classification that is capable of being readily interrogated to identify shorelines potentially sensitive to a range of physical hazards related to climate change and sea-level rise. Geoscience Australia has in turn coordinated a team of coastal geomorphic and mapping specialists in the Spatial Science Group, School of Geography and Environmental Studies, University of Tasmania to undertake the bulk of the practical work involved in creating a nationally-consistent coastal geomorphic classification system and map.

The project team has contracted with Geoscience Australia to provide the final national coastal geomorphic map in a GIS line map format, referred to by the project team as a "Smartline" map, in which coastal landforms will be classified in form and fabric based categories (rather than as genetic or morpho-dynamic types). This format is based on a coastal landform map previously created for the Oil Spill Response Atlas (OSRA) and subsequently used for a coastal vulnerability assessment of Tasmania (Sharples 2006). Because of tight timeframes for the AGO's First Pass national coastal vulnerability assessment, it is not proposed to undertake new coastal geomorphic mapping; rather the aim of the project is to identify the various map datasets containing geomorphic information that have previously been created for various parts of the Australian coast, to extract or translate the relevant geomorphic data from each into a single nationally-consistent geomorphic classification scheme, and to combine these into a single national map. Whilst the scale and resolution of the resulting nationally-consistent map will vary depending on the scale and availability of pre-existing geomorphic mapping of different parts of the Australian coast, the critical advantage of the map will be the provision, for the first time, of a seamless coastal geomorphic map of the whole Australian coastline which is classified in a single nationally-consistent way, enabling ready analysis for purposes such as the national coastal vulnerability assessment.

**Workshop Purpose**

However, for the purposes of creating a national coastal geomorphic map it is necessary to review and modify the Smartline coastal geomorphic classification system previously used for the Tasmanian map, in order to encompass the broader range of Australian coastal landform types (many of which do not occur in Tasmania), and to ensure that the map will be capable of identifying the full range of Australian coastal landforms that may be susceptible to sea level rise and climate change impacts of various sorts. In addition, it is opportune to eliminate a variety of inefficiencies and awkward aspects of the earlier classification system, which have become apparent through several years experience working with the system.

Perhaps equally important, it is critical to the project's success that the final map and its classification system be considered a useful product by coastal workers and data managers in the various jurisdictions around Australia. The final map has the potential to be applied for a broad range of purposes in the future, not only the First Pass coastal vulnerability assessment that will be its immediate application. Hence it was considered important to have input into the map development process from coastal geomorphologists, GIS data managers and coastal managers drawn from a representative spread of jurisdictions and with expertise in a range of differing coastal environments around Australia.

A workshop was held in Hobart in early September 2007, with the following major aims:

- to familiarise a representative group of relevant coastal workers from around Australia with the aims of the project;
- to give a wide range of jurisdictional representatives from around Australia a stake in the project and its outcomes;
- to obtain advice on the range of Australian coastal landform types susceptible to climate change and sea level rise in different broadly-defined ways – these classes of coastal landform types need to be capable of being identified unambiguously from the Smartline coastal map; and
- to review and modify the proposed Smartline coastal geomorphic mapping classification, to ensure it will work, be capable of classifying a broad range of Australian coastal landform types, and be a useful system for ongoing future use.

**Workshop format**

The main business of the workshop took place over two days at the Sandy Bay (Hobart) campus of the University of Tasmania, with an optional third day for delegates who wished to explore aspects of the mapping project in more detail. In brief, the workshop program comprised:

**Wednesday 5$^{th}$ September 2007**

*Morning*:

Stefanie Pidcock (Australian Greenhouse Office) provided an overview of the AGO's broader coastal vulnerability assessment and adaptation program, within which the coastal geomorphic mapping project is one component.

Chris Sharples presented an outline of the proposed "Smartline" coastal geomorphic map classification system, and the proposed categories of sensitive coastal types to be identified by the resulting coastal stability mapping. Initial broad discussion of these ensued.

Spatial Science group leader at the University of Tasmania, Jon Osborn, welcomed delegates to the University, and provided a brief background to the Centre for Spatial Information Science, within which much of the mapping project is being conducted.

*Afternoon:*
The afternoon was spent on a field trip, visiting a variety of coastal landform types around Storm Bay on the "Wild Thing" fast boat. Chris Sharples explained the application of the proposed classification to coastal types observed in the field, and highlighted a variety of different coastal instabilities evident around Storm Bay.

*Evening:*
Delegates were wined and dined at Da Angelos restaurant in Battery Point

**Thursday 6th September 2007**
*All day:*
Having introduced and explained the proposed geomorphic map classification system to delegates on Wednesday, the whole of Thursday was spent examining, critiquing and modifying the classification, through the format of a facilitated workshop. Facilitation was provided by Kim Willing (professional facilitator and former southern Tasmania Coastcare co-ordinator). The outcomes of the workshop discussions were recorded by Kim Willing, Jenny Newton, Chris Sharples, and in group discussion records. These outcomes are summarised in this report (below) and form the basis for the revised classification currently being finalised by Chris Sharples.

**Friday 7th September 2007**
*All day:*
Friday was an optional workshop day, for those delegates able to stay, and was intended for further exploration of issues as appropriate following the main workshop on Thursday. This somewhat experimental approach proved worthwhile, with a number of useful impromptu presentations pertinent to the project (John Hudson on the NSW Comprehensive Coastal Assessment mapping, Sel Sultmann on Queensland coastal hazard setback issues, Chris Sharples demonstrating the existing Tasmanian coastal map and some of its uses). Our data co-ordinator used the opportunity to pick delegates brains about regional coastal geomorphic datasets, nobody was allowed to talk about the Bruun Rule (in order to avoid violence), and several other useful discussions were held. Delegates departed around mid-afternoon.

Overall, the workshop successfully fulfilled its purposes. In organisational terms, the event proceeded smoothly and without glitches, due to the excellent organisational work by Jenny Newton. Jenny is thanked for making the workshop run as smoothly as it did. Thanks also go to Kim Willing for ensuring that the main workshop session ran well, and produced a range of useful outcomes as recorded below.

**Workshop Delegates**
In addition to the UTas core project team (Chris Sharples, Richard Mount, Jenny Newton, Mick Russell, Michael Lacey and Tore Pedersen), the workshop was attended by the following invited delegates:

| | |
|---|---|
| Stefanie Pidcock | Australian Greenhouse Office |
| Trevor Dhu | Geoscience Australia |
| Brendan Brooke | Geoscience Australia |
| Darren Skene | Geoscience Australia |
| Wayne Stephenson | Vic University of Melbourne |

| | |
|---|---|
| Matthew Royal | SA  Dept. of Environment and Heritage |
| Doug Fotheringham | SA  Dept. of Environment and Heritage |
| Ian Eliot | WA  Dept. of Environment & Conservation |
| Renee Bartolo | NT   Dept of Environment & Water Resources |
| Sel Sultmann | Qld.   Environmental Protection Agency |
| David Hopley | Qld.   James Cook University |
| John Hudson | NSW  Dept. of Planning |
| Colin Woodroffe | NSW  University of Wollongong |
| Pamela Abuodha | NSW  University of Wollongong |
| Jason Bradbury | Tas  Dept. Primary Industries & Water |
| Chris Rees | Tas  Dept. Primary Industries & Water |
| Mark Brown | Tas  Dept. Primary Industries & Water |

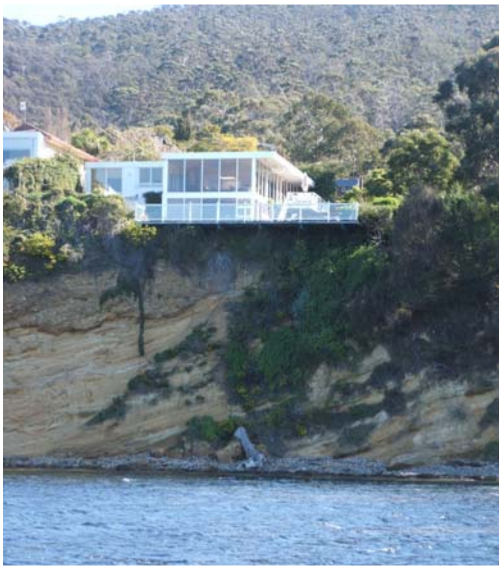
A number of other relevant people were invited and could not attend, however it is intended that they will be "kept in the loop" as the project progresses.  Several of these people include:

| | |
|---|---|
| Trevor Graham | Qld  GeoCoastal Consultancy |
| Guy Boggs | NT  Charles Darwin University |
| Ewan Buckley | WA Dept. of Environment & Conservation |
| David Ball | Vic  Dept. Primary Industries |

It is intended to keep workshop delegates "in the loop" for the remainder of the project, particularly by inviting further comment on this outcomes report and the revised Smartline classification (to be completed and circulated), and subsequently on the classes of "sensitive" shorelines to be identified using the Smartline map.

**Workshop Scenes**

Workshop delegates enjoying normal Tasmanian winter weather in the "Wild Thing" on Storm Bay (Photo: Kim Willing).



An example of rather "adventurous" coastal living viewed by delegates, on a cliff of semi-lithified slump-prone clayey Tertiary-age sediments at Taroona, near Hobart (Photo: Kim Willing).

Workshop delegates…late Thursday, after a hard days work (Photos: Kim Willing). Also attended but not in photos: Chris Sharples, Kim Willing, Stef Pidcock, Colin Woodroffe, Trevor Dhu, Brendan Brooke, Mick Russell..

Brendan Brooke and Ian Eliot consider the proposed classification (Photo: Kim Willing).

David Hopley, Colin Woodroffe and Mick Russell applying the proposed classification to coral coasts (Photo: Kim Willing).

## *Summary of Outcomes*

As noted above, the main purposes of the workshop were to:

- seek participants input to the development of an appropriate classification for mapping coastal landforms in a "Smartline" GIS format; and to

- develop a listing of Australian coastal landform types sensitive (or otherwise) to sea level rise and climate change; such a listing needs to group sensitive landforms in ways suited to identifying them using the Smartline landform classification system.

The main workshop outcomes and issues raised in relation to these two purposes are listed below[6]. In addition a number of other relevant points that emerged from workshop discussions are also listed. It should be noted that this report only provides a brief list of outcomes; however these will be more fully developed in revised versions of the classification system and sensitive type's inventory, which are to be circulated to workshop attendees at a later date.

**Coastal Smartline Map Geomorphic Classification**

The workshop did not raise objections to or major problems with the basic structure of the proposed Coastal Smartline Geomorphic Map, which can be summarised as:

- Mapping attributes of coastal zone landforms (both landwards and seawards of the HWM) onto a segmented line map representing the coastline;

- Classifying and describing coastal landforms in terms of a simple tidal zonation (subtidal landforms, intertidal landforms, backshore landforms, etc). Tidal zonation is a feature of virtually all coasts; hence this provides a logical basis for a nationally-consistent coastal landform classification.

- Classifying the landforms of each tidal zone in a descriptive fashion, based on form (cliff, platform, slope, etc) and fabric (hard, soft, sand, mud, bedrock, etc), rather than in terms of genetic or morpho-dynamic types (e.g., barrier, dissipative beach, etc, etc).

- Classifying landforms in a hierarchical fashion, with broad high level classes and detailed sub-divided classes, such that coasts can be classified at the broader levels where little information is available, or at more detailed levels where better information exists; however in either case, the same consistent classification is being used.

- Use of broad (simple) but geomorphically - meaningful classes, allowing rapid data capture yet providing useful information.

However, much discussion centred on details of the proposed classification within this basic structure, and key issues raised are listed below (note these considerations will be addressed and incorporated into the revised classification which will be distributed after this outcomes report):

- ***Rigorous Classification by Form and Fabric*** Rigorous classification of coastal landforms in terms of only form and fabric, without using genetic classifications, is not as easy as it sounds! It was pointed out that some of the supposed "form & fabric" - based landform classes in the draft classification are in fact genetic or morpho-dynamic types (e.g., the distinction between "colluvial" boulder shores and boulder "beaches" in the draft classification is actually based on their genesis. In terms of form and fabric, both are simply "boulder shores". Similarly, terms like "tidal flat" have genetic implications, and a purely form & fabric equivalent would simply be

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[6] These outcomes are summarised from notes taken by Chris Sharples, Jenny Newton and Kim Willing during the workshop, and from notes and documents kindly provided by some of the workshop participants.

something like “sediment flats”). It may be difficult to entirely eliminate genetic classifications from the final classification, since many are common terms for distinctive and widely - recognised coastal landform types, however usage of commonly-used genetic terms should be restricted as far as possible to lower and more detailed levels of the hierarchical landform classification (for example, “beach” is a genetic classification (“wave-deposited sediment body”) which is so widely used and understood that it seems impractical not to use it in the classification at some level).

- ***Supratidal Zone Classification Needed*** The tidally-based zones proposed in the first draft classification did not comfortably encompass supratidal environments (e.g., infrequently inundated tidal flats, saltmarsh and saltpans). These occasionally-inundated coastal zones are important features along large parts of the Australian coast, especially parts of South Australia and northern macrotidal coastal flats exposed to occasional cyclonic storm surges. It was suggested that a “Supratidal Landforms” field be incorporated into the classification in recognition of the distinctiveness and widespread occurrence of this coastal zone. Where supratidal zone landforms do not have significant expression (e.g., sloping shores on micro-tidal coasts), the “Supratidal” field can have a null attribute value.

- ***Classification Hierarchy Organising Principles:–***
***“Fabric (hardness)” over “Form” over “Other Useful Categories”*** Within each tidally-based zone, landforms should be classified in a hierarchy of form & fabric – based criteria. The highest level in the hierarchy should be the “hardness” of the coastal landform fabric (i.e., ranging from hard bedrock landforms, through semi-lithified / semi-consolidated or weathered substrates to soft (sandy or muddy) landforms). The second or subsidiary level of classification should be the form (cliffed, sloping, platforms/flats/terraces, etc). Further subsidiary levels of classification many depend on a range of miscellaneous other criteria and purposes as convenient and appropriate – lower levels in the hierarchy can be considered as “modifiers” and might include a variety of other useful categorisations including genetic classifications where these are widely used and difficult to entirely avoid (as noted above) – e.g., “beach”, “talus”, etc. A classification hierarchy which emphasises fabric (hardness) over form is well suited to coastal sensitivity / susceptibility assessments where a primary issue is the erodibility or physical stability of the coast.

- ***Change “Bedrock” field to “Geology” or “Geological Substrate”*** The “bedrock” attribute as defined in the draft classification is the substrate which was present prior to development of the present shoreline (even if only by short periods, e.g., calcarenite shores). As such, some “bedrock” types may still be soft or only semi-lithified sediments. Some geologists may object to unlithified sediments being called bedrock, hence the “bedrock” attribute should be renamed as the “Geology” or “Geological Substrate” attribute. (CS leans towards simply using the term “Geology’ because it is shorter, yet sufficiently broad as to mean whatever you want it to mean! Any comments?)

- ***Calcarenite Coast Issues*** Calcarenite shores (common around the southern half of Australia except Tasmania) raise some unusual issues for the proposed coastal landform classification since, whilst these limestones are generally geologically young and products of coastal (aeolian and groundwater) processes, they are also hard rocks and were typically formed somewhat prior to the present (late Holocene) shoreline, which has eroded into them or been deposited over them. There was some discussion around whether calcarenites should be regarded as the coastal bedrock (under the “Geology” attribute) or as a product of coastal processes (and so classified as coastal landform types, but not regarded as a bedrock type in the sense defined above).

  The writer (CS) considered the outcome of discussion to be that the hard calcarenites should be regarded as a bedrock type, into which the present shore has either eroded (forming rocky shore landforms) or over which recent coastal sands have been deposited. However since calcarenites are geologically-young sedimentary veneers – which may be quite thin - over other bedrock types, it is often the case that the underlying bedrock and the calcarenites are both exposed in the coastal zone. This complexity (multiple distinct bedrock types at the shoreline) seems to be a more persistent feature of calcarenite shores than most other shorelines.  Where this is the case, two quite different bedrock types are controlling coastal landform development; hence *both* need to be recorded as bedrock geology types.  As initially drafted, the bedrock geology classification for the Smartline map is only adapted to recording one primary bedrock geology type for any given coastal segment;  hence *Chris Sharples is to propose as simple as possible a means of identifying two bedrock types (calcarenite plus another underlying type) in the revised classification* (suggestions welcome!).

- ***"Biological Character" Field*** The draft classification had proposed incorporating a field which was to be termed "Biological Character', that was to indicate coasts where certain biological communities are characteristic of certain landform types (e.g., mangroves on intertidal mudflats). However, the underlying reason for proposing this approach in the first place was really that for many coasts the only mapping available which indicates coastal landforms is habitat mapping which only indicates them indirectly (by referring to "mangroves", "saltmarsh", etc). Thus it was thought that recording the "Biological Character" would be a way of indicating where coastal substrates and landforms were inferred from mapping of their associated biota.

  However, it was agreed that in the end this approach would merely produce a "half-hearted" habitat map embedded in a geomorphic map.  It was considered better to simply acknowledge that better habitat mapping exists separately (and can be overlain when required), maintain the geomorphic mapping as *dedicated* geomorphic mapping free of half-hearted habitat mapping attempts, and simply have an attribute which indicates where the mapped landforms have been inferred from mapping of their biological character (i.e., where intertidal mudflats are inferred from mapping of mangroves, then map them as mudflats (not mangroves), but with an attribute indicating how that inference was made).

- ***Coral Coasts***   In an ostensible exception to the above, where coral materials form significant structural components of a coastline (e.g., coral rubble beaches, cemented coral breccias, etc), such coasts will be recognised as coral coasts:  *not* in virtue of being coral habitats, but rather in terms of their having structural coralline substrates.  Where a shoreline is eroded into cemented coral breccias', for example, the bedrock geology may be classed as "coralline limestone".

- ***Landform Classification Diversity and Consistency*** It was noted that the landform classification used must be capable of describing all major Australian coastal landform types, and should also ideally be capable of incorporating unusual variants, e.g., stromatolites (as structural shoreline elements), cemented guano backshores ("phosphatic sandstones"), and other rare coastal landform elements. The hierarchical nature of the classification should allow this, but examples such as the preceding should be used to test the capacity of the draft classification in this way.

  The final mapping should be consistent with existing mapping (note that this latter condition theoretically should result automatically from the map compilation method, which relies on extracting information from existing maps).

**Sensitive Coastal Landform types to be identified by a Coastal Smartline Map**
Discussion of the sorts of sensitive landforms which should be identifiable from the Smartline map overlapped with much of the discussion of the Smartline classification itself, and many of the preceding points are relevant.  Further points in relation to identification of sensitive landforms included:

- ***Susceptibility, Sensitivity or Stability?***  Colin Woodroffe noted that the term "susceptibility" is widely used in the geomorphic literature to refer to the propensity of particular landforms to physical change,  however the Allen Report to AGO uses "sensitivity" to convey this meaning; consequently it is proposed to use the terms "sensitivity" and "susceptibility" interchangeably, with a glossary note stating the usages adopted.

It was also noted that the terms “sensitivity” or “susceptibility” should be preferred over “stability / instability” since these latter can be understood in a variety of ways that are not necessarily appropriate to the purposes of this project. Nevertheless, the term “coastal stability” has some currency with the AGO’s Expert Advisory Group on Coastal Vulnerability, and is likely to continue to be used to some degree; thus the usage of this term should also be defined in a glossary.

- ***Basis for Classing Sensitive Coastal Types*** The classification of sensitive coastal landform types should fundamentally distinguish types in terms of their *style* of response to sea level rise and climate change, not in terms of the *degree* of their response (in general, the degree of response will vary widely within a sensitivity type).

- ***Classification of Sensitive Coastal Types*** In conformity with the Smartline landform classification itself, sensitive coastal landform types will be categorised using a hierarchy that takes *fabric* (hard to soft substrates) as the primary or highest level of classification, and then sub-divides by broad *forms*, followed by other modifiers as appropriate or needed.

- ***Incorporation of Process Distinctions in Sensitivity Categories*** Notwithstanding the above, it is important to be aware of both broad distinctions and relationships in the geomorphic processes controlling the sensitivity of particular coastal landforms. Thus “dunes” should be classified as part of “Sandy Shores” for sensitivity purposes (due to the strong linkage between dune mobility and other sandy coast processes), whereas the extensive tidal flats of northern Australia should be considered separately to those of South Australia (Spencer Gulf, etc) because the much greater tidal ranges in northern Australia result in different processes and sensitivities affecting what might otherwise be considered similar landforms in terms of the Form and Fabric.

  Hence, and considering the general Smartline strategy of classifying landforms in terms of Fabric and Form first, then other modifiers second, it is proposed to classify Sensitive landform types firstly in form and fabric terms, and then draw finer distinctions based on process distinctions (e.g., there will be a high-level category of “Intertidal flats”, with finer divisions such as macrotidal tropical cyclone-influenced (?) intertidal flats).

- ***Coral Coasts*** Although the Great Barrier Reef itself has been excluded from the present mapping project (see below), many other Australian coasts have fringing coral reefs, offshore coral cays, and other coralline elements. Information provided by David Hopley during the workshop will be used to draft a list of sensitive coral coast types, designed to be capable of being identified by the Smartline geomorphic map.

**Other Issues**
A range of other pertinent matters were raised at the workshop, as follows:

- ***The term “Smartline”*** Chris Sharples noted that the term “Smartline” is being used to describe the map format being used (for reasons identified in the draft Data Model). It should be noted that this term, at least at the present, is not a trademark or other form of copyrighted term, but merely a word coined to describe the format used. As such, it is the project teams understanding that there should not be any legal impediment to using the word, despite the recent proliferation of “Smart” words and products[7].

- ***Referring to the Map*** Where appropriate, the map to be produced by this product should be simply referred to as a “Coastal Smartline Map” or “Coastal Smartline Geomorphic Map”.

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7 Not only are there smart cards, smart phones, smart cars, smart maps, smart tags, etc, but we have recently discovered a South Australian finance company offering a “Smartline” of credit….

- ***Communication and Managing Expectations*** It is important to manage public, agency and political expectations about what the final map will be, and what it will be capable of being used for. The planned Coastal Smartline Map will be a very useful dataset for appropriate purposes, of which one will be its use as a strategic tool highlighting coastal sensitivities and priorities nationally. However if expectations over what the map can do are allowed to become over-inflated, subsequent dis-appointment might result in the map being dis-regarded even though it will remain very useful for appropriate purposes. Expectations should be managed by clear unambiguous statements of what the mapping is and can be used for, both in project documentation and metadata, and in other communications with stakeholders. It was suggested that, prior to the final mapping becoming available on the OzCoasts website, there should be some preceding information on the website alerting people to the forthcoming mapping, and explaining in crystal clear terms what it will and won't be.

- ***Glossaries*** Project reports should include up-front glossaries clearly stating the definitions of key terms used in our reports, especially those (like "sensitivity" and "vulnerability") that may be subject to multiple meanings.

- ***Data Source Referencing*** It is very important that data sources be referenced properly (note: apart from referencing all sources in project reports, it is intended to provide full reference and source information in either the map attribute tables themselves, or a linked database).

- ***Inclusion of Estuaries*** There was some discussion of the extent to which estuaries should be included in the Smartline map to be prepared for GA / AGO; given the short time frames for the project and the great total shoreline length of Australian estuaries, it was agreed that estuarine coasts could generally only be included in the mapping where suitable existing mapping could easily be incorporated. It was suggested that a certain estuary width be used as a cut-off for inclusion in the map, however a suitable cut-off width is yet to be decided on. In practice, it is likely that the cut-off point for estuaries will be the point at which the base coastal line maps used for the project cut-off estuaries, since this is often very close to the open coast anyway.

- ***Inclusion or Exclusion of Islands and the Great Barrier Reef*** Similarly, it is not possible to include mapping of all offshore islands in the Smartline project, and some lower size limit for islands to be included needs to be set. It was noted that prior discussions with the AGO had established that the Great Barrier Reef would not be formally included in this project since a separate coastal vulnerability assessment process was underway for the GBR. However it is clearly desirable for the GBR to ultimately be included in the Coastal Smartline Map – and the landform classification being prepared for the map should encompass GBR shoreline types – so that the map will be ready for incorporation of the GBR whenever resources become available to do so.

- ***Extent of "Coastal Zone" being Mapped*** It was noted that use of the term "Coastal Zone" should be mostly avoided (except in "quotes") in this project, since it is defined in differing ways in planning legislation and policies in the various states. Nonetheless some workshop discussion centred on the distance inland and offshore of the intertidal zone that the coastal "zone" should be considered for the purpose of classifying subtidal and backshore landforms and profiles in the Coastal Smartline Map. In regard to inland extent, one significant problem is that certain landforms of distinctively coastal origin may extend many kilometres inland in some coastal regions (e.g., transgressive dune fields, coastal lagoons and wetlands, etc). Incorporating such information into a Smartline coastal map becomes progressively more awkward with increasing distance inland. Beyond a certain point, it is "smarter" to use a polygon mapping format to map the distribution of coastal landforms that extend a great distance inland. The Smartline format is better suited to describing the geomorphic character of a coastal "zone" of relatively restricted width (e.g., less than 1 kilometre).

The writer (CS) is not sure that any final consensus was reached on this issue; however the notion of considering subtidal and backshore landforms and profiles to 500 metres offshore and inland (of HWM) was discussed, and this appears to be an optimal distance that allows the geomorphic character of a coastal "zone" to be usefully characterised by a Coastal Smartline Map, yet does not normally introduce excessive complications due to the increasing diversity of landform types that are likely to be present (and need mapping...) as one considers greater distances offshore or inland.

Whilst the adoption of a 500 metre inland "cut-off" will result in some distinctively coastal landforms that extend further inland being omitted from the Smartline map, nevertheless a good characterisation of the coastal landforms present will normally be achieved, with the identification and mapping of unusually wide coastal landform zones being a task better suited to polygon mapping. A suggestion was raised that backshore profiles be measured as the average slope inland from the back edge of Backshore Proximal landforms to the 500m inland reference distance (this obtains a generalised backshore profile which ignores complications such as a single high foredune fronting an extensive low coastal plain, where it is the gradient of the plain - not the foredune - that we want to measure). In practice the method which has been adopted in this project (for reasons of practical data processing using Australia-wide datasets) is to simply use the National 90m DEM to measure the overall gradient from the shoreline to a point 500m inland (at many thousands of closely spaced intervals along the coast). While occasional anomalies occur in areas of complicated topography, the 90m DEM is well suited to this particular purpose since it has already significantly "generalised" the coastal topography (features such as single foredunes are "smeared out" and effectively disappear unless they are very large). The method has yielded good agreement with the intent of the backshore profile attribute in most areas.

In the case of the subtidal zone, it is proposed that the Subtidal Landform attribute will simply refer to the first significant subtidal landform types found below the MLWM, regardless of how far offshore they extend; however the Subtidal Profile is proposed to be defined as the average (overall) gradient over the 500m offshore from the MLWM.

## References

Galloway, R.W., Story, R., Cooper, R. and Yapp, G.A., 1984: *Coastal Lands of Australia. Natural Resources Series No. 1*, Division of Water and Land Resources, CSIRO, Canberra, ACT.

Sharples, C. 2006: *Indicative Mapping of Tasmanian Coastal Vulnerability to Climate Change and Sea-Level Rise: Explanatory Report 2nd Edition*; Report to Department of Primary Industries & Water, Tasmania, 173 pp plus accompanying mapping.

## APPENDIX THREE: DATA SOURCES

This Appendix provides details of all data sources used in the compilation of the Smartline version 1.0 (as described in Section (2.6) of this report). The 'Reference_ID' number is the source Reference ID number used to identify each source in the Smartline attribute tables (see data Model in Sharples & Mount 2009). This table is a summarised version of a more extensive Sources Database which is supplied as a stand-alone file capable of being linked directly to the Smartline Attribute Table itself.

| Reference ID | Dataset Title | File Name | File Type | Data Type | ANZLIC ID | Region or Jurisdiction | CUSTODIAN | NOTES | DESCRIPTION |
|---|---|---|---|---|---|---|---|---|---|
| 1 | QUEENSLAND GEOLOGICAL MAPPING (Polygonised vector) Data- 1:100 000 SHEET AREAS- MARCH 2007 | 7768_r.shp | ESRI shapefile | Vector - Polygon | - | QLD | QLD Department of Mines and Energy | Lakefield | -TO BE COMPLETED MANUALLY |
| 2 | QUEENSLAND GEOLOGICAL MAPPING (Polygonised vector) Data- 1:100 000 SHEET AREAS- MARCH 2007 | 7868_r.shp | ESRI shapefile | Vector - Polygon | - | QLD | QLD Department of Mines and Energy | Jeannie River | - |
| 3 | QUEENSLAND GEOLOGICAL MAPPING (Polygonised vector) Data- 1:100 000 SHEET AREAS- MARCH 2007 | 7869_r.shp | ESRI shapefile | Vector - Polygon | - | QLD | QLD Department of Mines and Energy | Cape Melville | - |
| 4 | QUEENSLAND GEOLOGICAL MAPPING (Polygonised vector) Data- 1:100 000 SHEET AREAS- MARCH 2007 | 7964_r.shp | ESRI shapefile | Vector - Polygon | - | QLD | QLD Department of Mines and Energy | Rumula | - |
| 5 | QUEENSLAND GEOLOGICAL MAPPING (Polygonised vector) Data- 1:100 000 SHEET AREAS- MARCH 2007 | 7965_r.shp | ESRI shapefile | Vector - Polygon | - | QLD | QLD Department of Mines and Energy | Mossman | - |
| 6 | QUEENSLAND GEOLOGICAL MAPPING (Polygonised vector) Data- 1:100 000 SHEET AREAS- MARCH 2007 | 7966_r.shp | ESRI shapefile | Vector - Polygon | - | QLD | QLD Department of Mines and Energy | Helenvale | - |
| 7 | QUEENSLAND GEOLOGICAL MAPPING (Polygonised vector) Data- 1:100 000 SHEET AREAS- MARCH 2007 | 7967_r.shp | ESRI shapefile | Vector - Polygon | - | QLD | QLD Department of Mines and Energy | Cooktown | - |
| 8 | QUEENSLAND GEOLOGICAL MAPPING (Polygonised vector) Data- 1:100 000 SHEET AREAS- MARCH 2007 | 7968_r.shp | ESRI shapefile | Vector - Polygon | - | QLD | QLD Department of Mines and Energy | Cape Flattery | - |
| 9 | QUEENSLAND GEOLOGICAL MAPPING (Polygonised vector) Data- 1:100 000 SHEET AREAS- MARCH 2007 | 8061_r.shp | ESRI shapefile | Vector - Polygon | - | QLD | QLD Department of Mines and Energy | Kirrama | - |
| 10 | QUEENSLAND GEOLOGICAL MAPPING (Polygonised vector) Data- 1:100 000 SHEET AREAS- MARCH 2007 | 8062_r.shp | ESRI shapefile | Vector - Polygon | - | QLD | QLD Department of Mines and Energy | Tully | - |
| 11 | QUEENSLAND GEOLOGICAL MAPPING (Polygonised vector) Data- 1:100 000 SHEET AREAS- MARCH 2007 | 8063_r.shp | ESRI shapefile | Vector - Polygon | - | QLD | QLD Department of Mines and Energy | Bartle Frere | - |
| 12 | QUEENSLAND GEOLOGICAL MAPPING (Polygonised vector) Data- 1:100 000 SHEET AREAS- MARCH 2007 | 8064_r.shp | ESRI shapefile | Vector - Polygon | - | QLD | QLD Department of Mines and Energy | Cairns | - |
| 13 | QUEENSLAND GEOLOGICAL MAPPING (Polygonised vector) Data- 1:100 000 SHEET AREAS- MARCH 2007 | 8159_r.shp | ESRI shapefile | Vector - Polygon | - | QLD | QLD Department of Mines and Energy | Rollingstone | - |
| 14 | QUEENSLAND GEOLOGICAL MAPPING (Polygonised vector) Data- 1:100 000 SHEET AREAS- MARCH 2007 | 8160_r.shp | ESRI shapefile | Vector - Polygon | - | QLD | QLD Department of Mines and Energy | Ingham | - |
| 15 | QUEENSLAND GEOLOGICAL MAPPING (Polygonised vector) Data- 1:100 000 SHEET AREAS- MARCH 2007 | 8161_r.shp | ESRI shapefile | Vector - Polygon | - | QLD | QLD Department of Mines and Energy | Cardwell | - |
| 16 | QUEENSLAND GEOLOGICAL MAPPING (Polygonised vector) Data- 1:100 000 SHEET AREAS- MARCH 2007 | 8162_r.shp | ESRI shapefile | Vector - Polygon | - | QLD | QLD Department of Mines and Energy | Innisfail | - |
| 17 | QUEENSLAND GEOLOGICAL MAPPING (Polygonised vector) Data- 1:100 000 SHEET AREAS- MARCH 2007 | 8163_r.shp | ESRI shapefile | Vector - Polygon | - | QLD | QLD Department of Mines and Energy | Cooper Point | - |
| 18 | QUEENSLAND GEOLOGICAL MAPPING (Polygonised vector) Data- 1:100 000 SHEET AREAS- MARCH 2007 | 8259_r.shp | ESRI shapefile | Vector - Polygon | - | QLD | QLD Department of Mines and Energy | Townsville | - |
| 19 | QUEENSLAND GEOLOGICAL MAPPING (Polygonised vector) Data- 1:100 000 SHEET AREAS- MARCH 2007 | 8260_r.shp | ESRI shapefile | Vector - Polygon | - | QLD | QLD Department of Mines and Energy | Palm Islands | - |
| 21 | QUEENSLAND GEOLOGICAL MAPPING (Polygonised vector) Data- 1:100 000 SHEET AREAS- MARCH 2007 | 8753_r.shp | ESRI shapefile | Vector - Polygon | - | QLD | QLD Department of Mines and Energy | Connors Range | - |
| 22 | QUEENSLAND GEOLOGICAL MAPPING (Polygonised vector) Data- 1:100 000 SHEET AREAS- MARCH 2007 | 8754_r.shp | ESRI shapefile | Vector - Polygon | - | QLD | QLD Department of Mines and Energy | Carmila | - |
| 23 | QUEENSLAND GEOLOGICAL MAPPING (Polygonised vector) Data- 1:100 000 SHEET AREAS- MARCH 2007 | 8755_r.shp | ESRI shapefile | Vector - Polygon | - | QLD | QLD Department of Mines and Energy | Mackay | - |
| 24 | QUEENSLAND GEOLOGICAL MAPPING (Polygonised vector) Data- 1:100 000 SHEET AREAS- MARCH 2007 | 8852_r.shp | ESRI shapefile | Vector - Polygon | - | QLD | QLD Department of Mines and Energy | Marlborough | - |
| 25 | QUEENSLAND GEOLOGICAL MAPPING (Polygonised vector) Data- 1:100 000 SHEET AREAS- MARCH 2007 | 8853_r.shp | ESRI shapefile | Vector - Polygon | - | QLD | QLD Department of Mines and Energy | Saint Lawrence | - |
| 26 | QUEENSLAND GEOLOGICAL MAPPING (Polygonised vector) Data- 1:100 000 SHEET AREAS- MARCH 2007 | 8952_r.shp | ESRI shapefile | Vector - Polygon | - | QLD | QLD Department of Mines and Energy | Princhester | - |
| 27 | QUEENSLAND GEOLOGICAL MAPPING (Polygonised vector) Data- 1:100 000 SHEET AREAS- MARCH 2007 | 8953_r.shp | ESRI shapefile | Vector - Polygon | - | QLD | QLD Department of Mines and Energy | Shoalwater | - |
| 28 | QUEENSLAND GEOLOGICAL MAPPING (Polygonised vector) Data- 1:100 000 SHEET AREAS- MARCH 2007 | 9050_r.shp | ESRI shapefile | Vector - Polygon | - | QLD | QLD Department of Mines and Energy | Bajool | - |
| 29 | QUEENSLAND GEOLOGICAL MAPPING (Polygonised vector) Data- 1:100 000 SHEET AREAS- MARCH 2007 | 9051_r.shp | ESRI shapefile | Vector - Polygon | - | QLD | QLD Department of Mines and Energy | Rockhampton | - |
| 30 | QUEENSLAND GEOLOGICAL MAPPING (Polygonised vector) Data- 1:100 000 SHEET AREAS- MARCH 2007 | 9052_r.shp | ESRI shapefile | Vector - Polygon | - | QLD | QLD Department of Mines and Energy | Bayfield | - |
| 31 | QUEENSLAND GEOLOGICAL MAPPING (Polygonised vector) Data- 1:100 000 SHEET AREAS- MARCH 2007 | 9053_r.shp | ESRI shapefile | Vector - Polygon | - | QLD | QLD Department of Mines and Energy | Peninsula Range | - |
| 32 | QUEENSLAND GEOLOGICAL MAPPING (Polygonised vector) Data- 1:100 000 SHEET AREAS- MARCH 2007 | 9149_r.shp | ESRI shapefile | Vector - Polygon | - | QLD | QLD Department of Mines and Energy | Calliope | - |

| Reference ID | Dataset Title | File Name | File Type | Data Type | ANZLIC ID | Region or Jurisdiction | CUSTODIAN | NOTES | DESCRIPTION |
|---|---|---|---|---|---|---|---|---|---|
| 33 | QUEENSLAND GEOLOGICAL MAPPING (Polygonised vector) Data- 1:100 000 SHEET AREAS- MARCH 2007 | 9150_r.shp | ESRI shapefile | Vector - Polygon | - | QLD | QLD Department of Mines and Energy | Gladstone | - |
| 34 | QUEENSLAND GEOLOGICAL MAPPING (Polygonised vector) Data- 1:100 000 SHEET AREAS- MARCH 2007 | 9151_r.shp | ESRI shapefile | Vector - Polygon | - | QLD | QLD Department of Mines and Energy | Cape Capricorn | - |
| 35 | QUEENSLAND GEOLOGICAL MAPPING (Polygonised vector) Data- 1:100 000 SHEET AREAS- MARCH 2007 | 9249_r.shp | ESRI shapefile | Vector - Polygon | - | QLD | QLD Department of Mines and Energy | Miriam Vale | - |
| 36 | QUEENSLAND GEOLOGICAL MAPPING (Polygonised vector) Data- 1:100 000 SHEET AREAS- MARCH 2007 | 9250_r.shp | ESRI shapefile | Vector - Polygon | - | QLD | QLD Department of Mines and Energy | Rodds Bay | - |
| 37 | QUEENSLAND GEOLOGICAL MAPPING (Polygonised vector) Data- 1:100 000 SHEET AREAS- MARCH 2007 | 9347_r.shp | ESRI shapefile | Vector - Polygon | - | QLD | QLD Department of Mines and Energy | Childers | - |
| 38 | QUEENSLAND GEOLOGICAL MAPPING (Polygonised vector) Data- 1:100 000 SHEET AREAS- MARCH 2007 | 9348_r.shp | ESRI shapefile | Vector - Polygon | - | QLD | QLD Department of Mines and Energy | Bundaberg | - |
| 39 | QUEENSLAND GEOLOGICAL MAPPING (Polygonised vector) Data- 1:100 000 SHEET AREAS- MARCH 2007 | 9349_r.shp | ESRI shapefile | Vector - Polygon | - | QLD | QLD Department of Mines and Energy | Mitchell Creek | - |
| 41 | QUEENSLAND GEOLOGICAL MAPPING (Polygonised vector) Data- 1:100 000 SHEET AREAS- MARCH 2007 | 9446_r.shp | ESRI shapefile | Vector - Polygon | - | QLD | QLD Department of Mines and Energy | Maryborough | - |
| 42 | QUEENSLAND GEOLOGICAL MAPPING (Polygonised vector) Data- 1:100 000 SHEET AREAS- MARCH 2007 | 9447_r.shp | ESRI shapefile | Vector - Polygon | - | QLD | QLD Department of Mines and Energy | Pialba | - |
| 43 | QUEENSLAND GEOLOGICAL MAPPING (Polygonised vector) Data- 1:100 000 SHEET AREAS- MARCH 2007 | 9541_r.shp | ESRI shapefile | Vector - Polygon | - | QLD | QLD Department of Mines and Energy | Murwillumbah | - |
| 44 | QUEENSLAND GEOLOGICAL MAPPING (Polygonised vector) Data- 1:100 000 SHEET AREAS- MARCH 2007 | 9542_r.shp | ESRI shapefile | Vector - Polygon | - | QLD | QLD Department of Mines and Energy | Beenleigh | - |
| 45 | QUEENSLAND GEOLOGICAL MAPPING (Polygonised vector) Data- 1:100 000 SHEET AREAS- MARCH 2007 | 9543_r.shp | ESRI shapefile | Vector - Polygon | - | QLD | QLD Department of Mines and Energy | Brisbane | - |
| 46 | QUEENSLAND GEOLOGICAL MAPPING (Polygonised vector) Data- 1:100 000 SHEET AREAS- MARCH 2007 | 9544_r.shp | ESRI shapefile | Vector - Polygon | - | QLD | QLD Department of Mines and Energy | Caloundra | - |
| 47 | QUEENSLAND GEOLOGICAL MAPPING (Polygonised vector) Data- 1:100 000 SHEET AREAS- MARCH 2007 | 9545_r.shp | ESRI shapefile | Vector - Polygon | - | QLD | QLD Department of Mines and Energy | Laguna Bay | - |
| 48 | QUEENSLAND GEOLOGICAL MAPPING (Polygonised vector) Data- 1:100 000 SHEET AREAS- MARCH 2007 | 9546_r.shp | ESRI shapefile | Vector - Polygon | - | QLD | QLD Department of Mines and Energy | Wide Bay | - |
| 49 | QUEENSLAND GEOLOGICAL MAPPING (Polygonised vector) Data- 1:100 000 SHEET AREAS- MARCH 2007 | 9547_r.shp | ESRI shapefile | Vector - Polygon | - | QLD | QLD Department of Mines and Energy | Happy Valley | - |
| 50 | QUEENSLAND GEOLOGICAL MAPPING (Polygonised vector) Data- 1:100 000 SHEET AREAS- MARCH 2007 | 9548_r.shp | ESRI shapefile | Vector - Polygon | - | QLD | QLD Department of Mines and Energy | Waddy Point | - |
| 51 | Geology of the Ayr | geolp.shp | ESRI shapefile | Vector - Polygon | ANZCW 070300 3168 | QLD | Geoscience Australia | - | - |
| 52 | Geology of the Burketown | geolp.shp | ESRI shapefile | Vector - Polygon | ANZCW 070300 3154 | QLD | Geoscience Australia | - | - |
| 53 | Geology of the Galbraith | geolp.shp | ESRI shapefile | Vector - Polygon | ANZCW 070300 3152 | QLD | Geoscience Australia | - | - |
| 54 | Geology of the Mornington | geolp.shp | ESRI shapefile | Vector - Polygon | ANZCW 070300 3150 | QLD | Geoscience Australia | - | - |
| 55 | Geology of the Normanton | geolp.shp | ESRI shapefile | Vector - Polygon | ANZCW 070300 3155 | QLD | Geoscience Australia | - | - |
| 57 | Geology of the Westmoreland | geolp.shp | ESRI shapefile | Vector - Polygon | ANZCW 070300 3153 | QLD | Geoscience Australia | - | - |
| 58 | QUEENSLAND GEOLOGICAL MAPPING (Polygonised vector) Data-REGIONAL - MARCH 2007 | boba_r.shp | ESRI shapefile | Vector - Polygon | - | QLD | QLD Department of Mines and Energy | Bowen Basin | - |
| 59 | QUEENSLAND GEOLOGICAL MAPPING (Polygonised vector) Data-REGIONAL - MARCH 2007 | caka_r.shp | ESRI shapefile | Vector - Polygon | - | QLD | QLD Department of Mines and Energy | Carpenteria Karumba Basins | - |
| 60 | QUEENSLAND GEOLOGICAL MAPPING (Polygonised vector) Data-REGIONAL - MARCH 2007 | cype_r.shp | ESRI shapefile | Vector - Polygon | - | QLD | QLD Department of Mines and Energy | Cape York Peninsula | - |
| 61 | QUEENSLAND GEOLOGICAL MAPPING (Polygonised vector) Data-REGIONAL - MARCH 2007 | hopr_r.shp | ESRI shapefile | Vector - Polygon | - | QLD | QLD Department of Mines and Energy | Hodgkinson Province | - |
| 63 | QUEENSLAND GEOLOGICAL MAPPING (Polygonised vector) Data-REGIONAL - MARCH 2007 | quee_r.shp | ESRI shapefile | Vector - Polygon | - | QLD | QLD Department of Mines and Energy | Queensland Geology | - |
| 64 | QUEENSLAND GEOLOGICAL MAPPING (Polygonised vector) Data-REGIONAL - MARCH 2007 | tost_r.shp | ESRI shapefile | Vector - Polygon | - | QLD | QLD Department of Mines and Energy | Torres Strait | - |
| 65 | Geology of the Cambridge Gulf | geolp.shp | ESRI shapefile | Vector - Polygon | ANZCW 070300 3147 | WA | Geoscience Australia | - | - |
| 67 | 1:50 000 environmental map - ALBANY (2427-I, 2428-II, 2527-IV, 2528-III) | m24271gp.shp | ESRI shapefile | Vector - Polygon | ANZWA 122000 0165 | WA | WA Department of Industry and Resources | - | - |

| Reference ID | Dataset Title | File Name | File Type | Data Type | ANZLIC ID | Region or Jurisdiction | CUSTODIAN | NOTES | DESCRIPTION |
|---|---|---|---|---|---|---|---|---|---|
| 68 | 1:50 000 environmental map - BROOME_ROEBUCK PLAINS (3362 II and PT 3362 III and 3361 IV) | m33622gp.shp | ESRI shapefile | Vector - Polygon | ANZWA 122000 0424 | WA | WA Department of Industry and Resources | - | - |
| 69 | 1:50 000 urban map - Bunbury - Burekup (2031-III, 2031-II) | m20313gp.shp | ESRI shapefile | Vector - Polygon | ANZWA 122000 0183 | WA | WA Department of Industry and Resources | - | - |
| 70 | 1:50 000 environmental map - BUSSELTON (1930-I) | m19301gp.shp | ESRI shapefile | Vector - Polygon | ANZWA 122000 0185 | WA | WA Department of Industry and Resources | - | - |
| 71 | 1:50 000 environmental map - FREMANTLE (2033-I, 2033-IV) | m20334gp.shp | ESRI shapefile | Vector - Polygon | ANZWA 122000 0171 | WA | WA Department of Industry and Resources | - | - |
| 72 | 1:50 000 environmental map - LAKE CLIFTON - HAMEL (2032-II, 2032-III) | m20322gp.shp | ESRI shapefile | Vector - Polygon | ANZWA 122000 0182 | WA | WA Department of Industry and Resources | - | - |
| 73 | 1:50 000 urban map - Harvey - Lake Preston (2031-I, 2031-IV) | m20311gp.shp | ESRI shapefile | Vector - Polygon | ANZWA 122000 0187 | WA | WA Department of Industry and Resources | - | - |
| 74 | 1:50 000 urban map - Mandurah (2032-IV) | m20324gp.shp | ESRI shapefile | Vector - Polygon | ANZWA 122000 0188 | WA | WA Department of Industry and Resources | - | - |
| 75 | 1:50 000 urban map - Moore River - Cape Leschenault (1935-II, 2035-III) | m20353gp.shp | ESRI shapefile | Vector - Polygon | ANZWA 122000 0189 | WA | WA Department of Industry and Resources | - | - |
| 77 | 1:50 000 environmental map - PERTH (2034-II, 2034-III, 2134-III) | m20342gp.shp | ESRI shapefile | Vector - Polygon | ANZWA 122000 0175 | WA | WA Department of Industry and Resources | - | - |
| 78 | 1:50 000 urban map - Pinjarra (2032-I) | m20321gp.shp | ESRI shapefile | Vector - Polygon | ANZWA 122000 0190 | WA | WA Department of Industry and Resources | - | - |
| 79 | 1:50 000 environmental map - ROCKINGHAM (2033-II, 2033-III) | m20333gp.shp | ESRI shapefile | Vector - Polygon | ANZWA 122000 0176 | WA | WA Department of Industry and Resources | - | - |
| 80 | 1:50 000 environmental map - ROTTNEST ISLAND (1934-II, 2034-III, 1933-I, 2033-IV) | m19331gp.shp | ESRI shapefile | Vector - Polygon | ANZWA 122000 0177 | WA | WA Department of Industry and Resources | - | - |
| 81 | 1:50 000 environmental map - TORBAY (2427-IV, 2428-III) | m24274gp.shp | ESRI shapefile | Vector - Polygon | ANZWA 122000 0179 | WA | WA Department of Industry and Resources | - | - |
| 82 | 1:50 000 environmental map - YALLINGUP (1930-IV, 1830-I) | m19304gp.shp | ESRI shapefile | Vector - Polygon | ANZWA 122000 0180 | WA | WA Department of Industry and Resources | - | - |
| 83 | 1:50 000 environmental map - YANCHEP (2034-IV) | m20344gp.shp | ESRI shapefile | Vector - Polygon | ANZWA 122000 0181 | WA | WA Department of Industry and Resources | - | - |
| 84 | 1:100 000 geological map - ARROWSMITH-BEAGLE ISLANDS (1938), first edition | m1938_gp.shp | ESRI shapefile | Vector - Polygon | ANZWA 122000 0003 | WA | WA Department of Industry and Resources | - | - |
| 85 | 1:100 000 geological map - COCANARUP (2830), first edition | m2830_gp.shp | ESRI shapefile | Vector - Polygon | ANZWA 122000 0015 | WA | WA Department of Industry and Resources | - | - |
| 86 | 1:100 000 geological map - DAMPIER (2256), first edition | m2256_gp.shp | ESRI shapefile | Vector - Polygon | ANZWA 122000 0005 | WA | WA Department of Industry and Resources | - | - |
| 87 | 1:100 000 geological map - DE GREY (2757), first edition - version 2 | m2757_gp.shp | ESRI shapefile | Vector - Polygon | ANZWA 122000 0673 | WA | WA Department of Industry and Resources | - | - |
| 88 | 1:100 000 geological map - HILL RIVER-GREEN HEAD (1937 and 1938), first edition | m1937_gp.shp | ESRI shapefile | Vector - Polygon | ANZWA 122000 0002 | WA | WA Department of Industry and Resources | - | - |
| 89 | 1:100 000 geological map - MINGENEW-DONGARA (1939 and part 1839), first edition | m1939_gp.shp | ESRI shapefile | Vector - Polygon | ANZWA 122000 0004 | WA | WA Department of Industry and Resources | - | - |
| 90 | 1:100 000 geological map - PARDOO (2857), first edition - version 2 | m2857_gp.shp | ESRI shapefile | Vector - Polygon | ANZWA 122000 0672 | WA | WA Department of Industry and Resources | - | - |
| 91 | 1:100 000 geological map - PRESTON (2156), first edition | m2156_gp.shp | ESRI shapefile | Vector - Polygon | ANZWA 122000 0110 | WA | WA Department of Industry and Resources | - | - |

| Reference ID | Dataset Title | File Name | File Type | Data Type | ANZLIC ID | Region or Jurisdiction | CUSTODIAN | NOTES | DESCRIPTION |
|---|---|---|---|---|---|---|---|---|---|
| 92 | 1:100 000 geological map - RAVENSTHORPE (2930), first edition | m2930_gp.shp | ESRI shapefile | Vector - Polygon | ANZWA 122000 0020 | WA | WA Department of Industry and Resources | - | - |
| 93 | 1:100 000 geological map - ROEBOURNE (2356), first edition | m2356_gp.shp | ESRI shapefile | Vector - Polygon | ANZWA 122000 0078 | WA | WA Department of Industry and Resources | - | - |
| 94 | 1:100 000 geological map - SHERLOCK (2456), first edition | m2456_gp.shp | ESRI shapefile | Vector - Polygon | ANZWA 122000 0008 | WA | WA Department of Industry and Resources | - | - |
| 95 | 1:100 000 geological map - WEDGE ISLAND (1936), first edition | m1936_gp.shp | ESRI shapefile | Vector - Polygon | ANZWA 122000 0001 | WA | WA Department of Industry and Resources | - | - |
| 96 | 1:250 000 geological map - BALLADONIA (SI51-03), first edition | mi5103gp.shp | ESRI shapefile | Vector - Polygon | ANZWA 122000 0126 | WA | WA Department of Industry and Resources | - | - |
| 97 | 1:250 000 geological map - BUSSELTON-AUGUSTA (part SI50-05 and part SI50-09), first edition | mi5005gp.shp | ESRI shapefile | Vector - Polygon | ANZWA 122000 0131 | WA | WA Department of Industry and Resources | - | - |
| 98 | 1:250 000 geological map - DAMPIER_BARROW ISLAND (SF50-02 & PT SF50-01), second edition | mf5002gp.shp | ESRI shapefile | Vector - Polygon | ANZWA 122000 0453 | WA | WA Department of Industry and Resources | - | - |
| 99 | 1:250 000 geological map - PERTH (SH50-14 and part SH50-13), first edition | mh5014gp.shp | ESRI shapefile | Vector - Polygon | ANZWA 122000 0130 | WA | WA Department of Industry and Resources | - | - |
| 100 | 1:250 000 geological map - ROEBOURNE (SF50-03), second edition | mf5003gp.shp | ESRI shapefile | Vector - Polygon | ANZWA 122000 0096 | WA | WA Department of Industry and Resources | - | - |
| 101 | 1:250 000 geological map - WINNING POOL - MINILYA (SF50-13 and part SF49-16), second edition | mf5013gp.shp | ESRI shapefile | Vector - Polygon | ANZWA 122000 0129 | WA | WA Department of Industry and Resources | - | - |
| 102 | 1:500 000 Interpreted bedrock geology of Western Australia | Geology_500K.shp | ESRI shapefile | Vector - Polygon | ANZWA 122000 0374 | WA | WA Department of Industry and Resources | - | - |
| 103 | Extractive Geology of the Outer Darwin Area 1:100K Geological Dataset in MapInfo Format | DwnExtract_GeolUnitPoly_R_100 | MapInfo | Vector - Polygon | - | NT | NT Department of Primary Industry, Fisheries and Mines | - | - |
| 104 | NTData (Digital Geology of the Northern Territory) | C5215GEO.E00 | ESRI Arc interchange format | Vector - Polygon | ANZNT 000100 0070 | NT | Geoscience Australia | Bathurst Island 250K Map Sheet | - |
| 105 | NTData (Digital Geology of the Northern Territory) | D5203GEO.E00 | ESRI Arc interchange format | Vector - Polygon | ANZNT 000100 0070 | NT | Geoscience Australia | Fog Bay 250K Map Sheet | - |
| 106 | NTData (Digital Geology of the Northern Territory) | D5207GEO.E00 | ESRI Arc interchange format | Vector - Polygon | ANZNT 000100 0070 | NT | Geoscience Australia | Cape Scott 250K Map Sheet | - |
| 107 | NTData (Digital Geology of the Northern Territory) | D5211GEO.E00 | ESRI Arc interchange format | Vector - Polygon | ANZNT 000100 0070 | NT | Geoscience Australia | Port Keats 250K Map Sheet | - |
| 108 | NTData (Digital Geology of the Northern Territory) | C5216GEO.E00 | ESRI Arc interchange format | Vector - Polygon | ANZNT 000100 0070 | NT | Geoscience Australia | Melville Island 250K Map Sheet | - |
| 109 | NTData (Digital Geology of the Northern Territory) | C5313GEO.E00 | ESRI Arc interchange format | Vector - Polygon | ANZNT 000100 0070 | NT | Geoscience Australia | Cobourg Peninsula 250K Map Sheet | - |
| 110 | NTData (Digital Geology of the Northern Territory) | D5301GEO.E00 | ESRI Arc interchange format | Vector - Polygon | ANZNT 000100 0070 | NT | Geoscience Australia | Alligator River 250K Map Sheet | - |
| 111 | NTData (Digital Geology of the Northern Territory) | C5315GEO.E00 | ESRI Arc interchange format | Vector - Polygon | ANZNT 000100 0070 | NT | Geoscience Australia | Wessel Islands 250K Map Sheet | - |
| 112 | NTData (Digital Geology of the Northern Territory) | D5311GEO.E00 | ESRI Arc interchange format | Vector - Polygon | ANZNT 000100 0070 | NT | Geoscience Australia | Roper River 250K Map Sheet | - |
| 113 | NTData (Digital Geology of the Northern Territory) | C5316GEO.E00 | ESRI Arc interchange format | Vector - Polygon | ANZNT 000100 0070 | NT | Geoscience Australia | Truant Island 250K Map Sheet | - |
| 114 | NTData (Digital Geology of the Northern Territory) | D5304GEO.E00 | ESRI Arc interchange format | Vector - Polygon | ANZNT 000100 0070 | NT | Geoscience Australia | Gove 250K Map Sheet | - |

| Reference ID | Dataset Title | File Name | File Type | Data Type | ANZLIC ID | Region or Jurisdiction | CUSTODIAN | NOTES | DESCRIPTION |
|---|---|---|---|---|---|---|---|---|---|
| 115 | NTData (Digital Geology of the Northern Territory) | D5308GEO.E00 | ESRI Arc interchange format | Vector - Polygon | ANZNT 000100 0070 | NT | Geoscience Australia | Port Langdon 250K Map Sheet | - |
| 116 | NTData (Digital Geology of the Northern Territory) | D5312GEO.E00 | ESRI Arc interchange format | Vector - Polygon | ANZNT 000100 0070 | NT | Geoscience Australia | Cape Beatrice 250K Map Sheet | - |
| 117 | NTData (Digital Geology of the Northern Territory) | D5316GEO.E00 | ESRI Arc interchange format | Vector - Polygon | ANZNT 000100 0070 | NT | Geoscience Australia | Pellew 250K Map Sheet | - |
| 119 | Arnhem Bay 250K Geology | AB_GeolUnitPolygon_R_250 | MapInfo | Vector - Polygon | - | NT | NT Department of Primary Industry, Fisheries and Mines | - | - |
| 120 | Auvergne 250K Geology | AU_LithOutcrop_250K | MapInfo | Vector - Polygon | - | NT | NT Department of Primary Industry, Fisheries and Mines | - | - |
| 121 | Blue Mud Bay 250K Geology | BM_GeolUnitPolygon_R_250 | MapInfo | Vector - Polygon | - | NT | NT Department of Primary Industry, Fisheries and Mines | - | - |
| 122 | Darwin 250K Geology | DW_GeolUnitPolygon_R_250 | MapInfo | Vector - Polygon | - | NT | NT Department of Primary Industry, Fisheries and Mines | - | - |
| 123 | Milingimbi 250K Geology | Milin_Geology_R_250 | MapInfo | Vector - Polygon | - | NT | NT Department of Primary Industry, Fisheries and Mines | - | - |
| 124 | Mount Young 250K Geology | MY_GeolUnitPolygon_R_250 | MapInfo | Vector - Polygon | - | NT | NT Department of Primary Industry, Fisheries and Mines | - | - |
| 125 | Urapunga and Roper River 250K Geology | UR_GeolUnitPolygon_R_250 | MapInfo | Vector - Polygon | - | NT | NT Department of Primary Industry, Fisheries and Mines | - | - |
| 126 | Robinson River 250K Geology | RR_GeolUnitPolygon_R_250 | MapInfo | Vector - Polygon | - | NT | NT Department of Primary Industry, Fisheries and Mines | - | - |
| 127 | Metallogenic Series - Gosford-Lake Macquarie 1:100 000 9131 & 9231 Provisional | Provisional_Gosford_Lake_Macquarie_100K_MGAz56.shp | ESRI shapefile | Vector - Polygon | - | NSW | NSW Department of Primary Industries | - | - |
| 128 | Newcastle Coalfield Regional Geology 1:100,000 geological map | NewcastleCF100rockunit_MGAz56.shp | ESRI shapefile | Vector - Polygon | - | NSW | NSW Department of Primary Industries | - | - |
| 129 | Port Hacking 1:100,000 geological map | PortHacking100RockUnit_MGAz56.shp | ESRI shapefile | Vector - Polygon | - | NSW | NSW Department of Primary Industries | - | - |
| 130 | Sydney 1:100 000 Geological Series Sheet 9130 (Edition 1) 1983 | Sydney100Surficial_MGAz56.shp | ESRI shapefile | Vector - Polygon | - | NSW | NSW Department of Primary Industries | - | - |
| 131 | Wollongong 1:100,000 geological map | Wollongong100RockUnit_MGAz56.shp | ESRI shapefile | Vector - Polygon | - | NSW | NSW Department of Primary Industries | - | - |
| 133 | NSW Statewide Geological Database - NSW Attribute Data Set contains Southern CRA, Upper NE, Lower NE, Bohena, Sydney, Central & standard geological mapping datasets | Bedrock_250K_Geology_GCS94.shp | ESRI shapefile | Vector - Polygon | - | NSW | NSW Department of Primary Industries | - | - |
| 136 | Botany Bay Foreshores | botanybayshoreline.shp | ESRI shapefile | Vector - Polygon | - | NSW | NSW Maritime | - | - |
| 137 | Sydney Harbour Boulderfields | BoulderFields.shp | ESRI shapefile | Vector - Polygon | - | NSW | NSW Maritime | - | - |
| 138 | Shoreline Type (Extreme) | shoreline-coast-extreme-geo.shp | ESRI shapefile | Vector - Polygon | - | NSW | NSW Maritime | - | - |
| 139 | Shoreline Type (Extreme) (Estuary) | shoreline-estuary-extreme-geo.shp | ESRI shapefile | Vector - Polygon | - | NSW | NSW Maritime | - | - |
| 140 | Sydney Harbour Foreshores | sydneyshoreline.shp | ESRI shapefile | Vector - Polygon | - | NSW | NSW Maritime | - | - |
| 141 | Junction Bay, Northern Territory (1:250 000 Geological Series Sheet SC 53-14) | junction.ecw | ERMapper Enhanced Compression Wavelet | Raster - Image | - | NT | | Scanned, rectified and made available for download via NT Department of Primary Industry, Fisheries and Mines website | - |
| 142 | Regolith–landform resources of the Cowaramup–Mentelle 1:50 000 sheet | regolith.shp | ESRI shapefile | Vector - Polygon | - | WA | WA Department of Industry and Resources | - | - |
| 143 | Regolith–landform resources of the Geraldton 1:50 000 sheet | regolith.shp | ESRI shapefile | Vector - Polygon | - | WA | WA Department of Industry and Resources | - | - |
| 144 | Record 2002/10 - Regolith-Landform Resources of the Karridale-Tooker and Leeuwin 1:50 000 Data Package | regolith.shp | ESRI shapefile | Vector - Polygon | - | WA | WA Department of Industry and Resources | - | - |

| Reference ID | Dataset Title | File Name | File Type | Data Type | ANZLIC ID | Region or Jurisdiction | CUSTODIAN | NOTES | DESCRIPTION |
|---|---|---|---|---|---|---|---|---|---|
| 145 | Geological rock types and rock type lines (1:100,000) (GEOL100) | geol100_polygon_geo_gda94.shp | ESRI shapefile | Vector - Polygon | ANZVI0803002487 | VIC | VIC Department of Primary Industries | Bairnsdale_(SJ55-07)_and_Sale_(SJ55-11) | - |
| 146 | Geological rock types and rock type lines (1:100,000) (GEOL100) | geol100_polygon_geo_gda94.shp | ESRI shapefile | Vector - Polygon | ANZVI0803002487 | VIC | VIC Department of Primary Industries | Mallacoota_(SJ55-08) | - |
| 147 | Geological rock types and rock type lines (1:100,000) (GEOL100) | geol100_polygon_geo_gda94.shp | ESRI shapefile | Vector - Polygon | ANZVI0803002487 | VIC | VIC Department of Primary Industries | Portland_(SJ54-11)_and_Colac_(SJ54-12) | - |
| 148 | Geological polygons and lines (1:250,000) (GEOL250) | geol250_polygon_geo_gda94.shp | ESRI shapefile | Vector - Polygon | ANZVI0803002488 | VIC | VIC Department of Primary Industries | Bairnsdale_(SJ55-07)_and_Sale_(SJ55-11) | - |
| 149 | Geological polygons and lines (1:250,000) (GEOL250) | geol250_polygon_geo_gda94.shp | ESRI shapefile | Vector - Polygon | ANZVI0803002488 | VIC | VIC Department of Primary Industries | Mallacoota_(SJ55-08) | - |
| 150 | Geological polygons and lines (1:250,000) (GEOL250) | geol250_polygon_geo_gda94.shp | ESRI shapefile | Vector - Polygon | ANZVI0803002488 | VIC | VIC Department of Primary Industries | Portland_(SJ54-11)_and_Colac_(SJ54-12) | - |
| 151 | Geological polygons and lines (1:250,000) (GEOL250) | geol250_polygon_geo_gda94.shp | ESRI shapefile | Vector - Polygon | ANZVI0803002488 | VIC | VIC Department of Primary Industries | Melbourne_(SJ55-05)_and_Queenscliff_(SJ55-09) | - |
| 152 | Geological polygons and lines (1:250,000) (GEOL250) | geol250_polygon_geo_gda94.shp | ESRI shapefile | Vector - Polygon | ANZVI0803002488 | VIC | VIC Department of Primary Industries | Warragul_(SJ55-10) | - |
| 153 | Coastal shoreline types and habitats for the Victoria coast | V_BUFF_CST.SHP | ESRI shapefile | Vector - Polygon | - | VIC | VIC Department of Primary Industries | - | - |
| 154 | Coastal shoreline types and habitats mapped as part of the Coastal Resource Atlas program for Victoria (1990-98) | V_SHORE12_G.shp | ESRI shapefile | Vector - Polygon | - | VIC | VIC Department of Primary Industries | - | - |
| 155 | Coastal Classification | coast25_dd94.shp | ESRI shapefile | Vector - Line | ANZVI0803002019 | VIC | VIC Department of Sustainability and Environment | - | - |
| 156 | Marine Substrata Classifications (SUBSTRATA100/) | substrata4g.shp | ESRI shapefile | Vector - Polygon | ANZVI0803002001 | VIC | VIC Department of Primary Industries | - | - |
| 157 | Geology 100k - Detailed Surface Geology (polygon features) | gl100k_poly.shp | ESRI shapefile | Vector - Polygon | ANZSA1002000004 | SA | PIRSA | - | - |
| 165 | Andy Short's Google Earth beach locations | Western Australia.kmz | Google Earth KMZ | Vector - Point | - | National | Andy Short | - | - |
| 166 | Comprehensive Coastal Assessment Coastal Quaternary Geology | NCCA_quaternary_unit1_polygons.shp | ESRI shapefile | Vector - Polygon | - | NSW | NSW Department of Primary Industries | - | - |
| 167 | Comprehensive Coastal Assessment Coastal Quaternary Geology | SCCA_quaternary_unit1_polygons.shp | ESRI shapefile | Vector - Polygon | - | NSW | NSW Department of Primary Industries | - | - |
| 169 | Geomorphology Landform of Darwin Harbour | darland_g94.shp | ESRI shapefile | Vector - Polygon | ANZNT0001000157 | NT | NT Department of Natural Resources, Environment and The Arts | - | - |
| 171 | Osra Shoreline Types, NT | cliffs_g94.shp | ESRI shapefile | Vector - Line | ANZNT0001000264 | NT | NT Department of Natural Resources, Environment and The Arts | - | - |
| 172 | Osra Shoreline Types, NT | shore_type_g94 | ESRI shapefile | Vector - Polygon | ANZNT0001000264 | NT | NT Department of Natural Resources, Environment and The Arts | - | - |
| 173 | Northern Territory Land Units Surveys Dataset | North_NT_94.shp | ESRI shapefile | Vector - Polygon | ANZNT0903000054 | NT | NT Department of Natural Resources, Environment and The Arts | - | - |
| 174 | Northern Territory Land Units Surveys Dataset | South_NT_94.shp | ESRI shapefile | Vector - Polygon | ANZNT0903000054 | NT | NT Department of Natural Resources, Environment and The Arts | Received a clipped version of this shape file, called "LS_Sth_Clip.shp" | - |
| 175 | Land Resources of the Lower Finnis, Northern Territory | dunde_25.shp | ESRI shapefile | Vector - Polygon | ANZNT0782000010 | NT | NT Department of Natural Resources, Environment and The Arts | - | - |
| 176 | Land Resources of the Greater Darwin Area, Northern Territory | gtrdw_25.shp | ESRI shapefile | Vector - Polygon | ANZNT0001000223 | NT | NT Department of Natural Resources, Environment and The Arts | - | - |

| Reference ID | Dataset Title | File Name | File Type | Data Type | ANZLIC ID | Region or Jurisdiction | CUSTODIAN | NOTES | DESCRIPTION |
|---|---|---|---|---|---|---|---|---|---|
| 177 | Land Resources of the Adelaide - Mary River Floodplain, Northern Territory | plain_50.shp | ESRI shapefile | Vector - Polygon | ANZNT 090300 0029 | NT | NT Department of Natural Resources, Environment and The Arts | - | - |
| 178 | Land Resources of Point Stuart Station, Northern Territory | ptstu_50.shp | ESRI shapefile | Vector - Polygon | ANZNT 078200 0104 | NT | NT Department of Natural Resources, Environment and The Arts | - | - |
| 179 | Land Resources of Tiwi Islands Land Capability Study, Northern Territory | tilcs_100.shp | ESRI shapefile | Vector - Polygon | ANZNT 078200 0098 | NT | NT Department of Natural Resources, Environment and The Arts | - | - |
| 180 | Land Resources of Wagait Aboriginal Reserve, Northern Territory | war_50.shp | ESRI shapefile | Vector - Polygon | ANZNT 090300 0030 | NT | NT Department of Natural Resources, Environment and The Arts | - | - |
| 182 | Coastal Shoreline Classification | SA_ShorelineClassificationRealigned_Nov2007.mdb | ESRI Personal Geodatabase | Vector - Line | - | SA | SA Department for Environment and Heritage | Smartline base map for SA | - |
| 183 | Tasmanian Shoreline Geomorphic Types Digital Line Map Version 4.0 (2006) | tascoastgeo_v4gda.shp | ESRI shapefile | Vector - Line | ANZTA 001500 0054 | TAS | TAS Department of Primary Industries & Water | - | - |
| 184 | LIST Hydline Digital Topographic Series | coastline.shp | ESRI shapefile | Vector - Line | ANZTA 000500 0138 | TAS | TAS Department of Primary Industries & Water | Smartline base map for TAS | - |
| 192 | 1.2.5 Flood Tide WA | tidalflat.shp | ESRI shapefile | Vector - Line | - | WA | WA Department of Planning and Infrastructure | - | - |
| 193 | 2.1.23 Breakwater WA | bwater.shp | ESRI shapefile | Vector - Line | - | WA | WA Department of Planning and Infrastructure | - | - |
| 194 | 2.1.01 Cliffs of WA | cliffs.shp | ESRI shapefile | Vector - Line | - | WA | WA Department of Planning and Infrastructure | - | - |
| 195 | 2.1.03 Sand Beach of WA (Linear representation) | sandy.shp | ESRI shapefile | Vector - Line | - | WA | WA Department of Planning and Infrastructure | - | - |
| 196 | TOPO101: Coasttyp- WA coastline beach type large scale | shorelin.shp | ESRI shapefile | Vector - Line | - | WA | WA Department of Planning and Infrastructure | - | - |
| 198 | 2.1.10 (0.5m) Resolution Shoreline classification (Linear representation) | washoreline.shp | ESRI shapefile | Vector - Line | - | WA | WA Department of Planning and Infrastructure | - | - |
| 199 | 2.2.1 Exposed rocky shores WA | rock.shp | ESRI shapefile | Vector - Line | - | WA | WA Department of Planning and Infrastructure | - | - |
| 201 | 2.1.18 Mudflats WA | mudflats.shp | ESRI shapefile | Vector - Polygon | - | WA | WA Department of Planning and Infrastructure | - | - |
| 202 | 2.1.17 Saltmarshes WA | saltm.shp | ESRI shapefile | Vector - Polygon | - | WA | WA Department of Planning and Infrastructure | - | - |
| 204 | Mosaic of SRTM DEM Version 2 | aust_srtm_geodetic.ers | ERMapper Raster Dataset | Raster - DEM | - | National | Australian Centre for Remote Sensing | - | - |
| 205 | Victorian coastline and borders at 1:25:000 scale (VIC25_ARC/VIC25ARC) | vcst25g_a.shp | ESRI shapefile | Vector - Line | ANZVI0 803002 866 | VIC | VIC Department of Sustainability and Environment | Section needed to be added, approx 3km stretch from westernmost extent of data set to Vic border | - |
| 206 | Coastal shoreline types in Shallow Inlet | shal_inlet_g.shp | ESRI shapefile | Vector - Polygon | - | VIC | VIC Department of Primary Industries | - | - |
| 207 | Coastal shoreline types in Lakes Entrance region and eastern Gippsland Lakes | gl_shore_g.shp | ESRI shapefile | Vector - Polygon | - | VIC | VIC Department of Primary Industries | - | - |
| 208 | Coastal shoreline types in Mallacoota Inlet | mal_inlet_g.shp | ESRI shapefile | Vector - Polygon | - | VIC | VIC Department of Primary Industries | - | - |
| 209 | Coastal shoreline types in Portland Harbour and its surrounds | portland2_g.shp | ESRI shapefile | Vector - Polygon | - | VIC | VIC Department of Primary Industries | - | - |
| 212 | Survey and Mapping of 2003 Remnant Vegetation Communities and Regional Ecosystems<br><br>of Queensland, Version 5.0 (December 2005) | re05_54.e00 | ESRI Arc interchange format | Vector - Polygon | - | QLD | QLD Environmental Protection Agency | - | - |

| Reference ID | Dataset Title | File Name | File Type | Data Type | ANZLIC ID | Region or Jurisdiction | CUSTODIAN | NOTES | DESCRIPTION |
|---|---|---|---|---|---|---|---|---|---|
| 213 | Survey and Mapping of 2003 Remnant Vegetation Communities and Regional Ecosystems of Queensland, Version 5.0 (December 2005) | re05_55.e00 | ESRI Arc interchange format | Vector - Polygon | - | QLD | QLD Environmental Protection Agency | - | - |
| 214 | Survey and Mapping of 2003 Remnant Vegetation Communities and Regional Ecosystems of Queensland, Version 5.0 (December 2005) | re05_56.e00 | ESRI Arc interchange format | Vector - Polygon | - | QLD | QLD Environmental Protection Agency | - | - |
| 215 | Survey and Mapping of 2003 Remnant Vegetation Communities and Regional Ecosystems of Queensland, Version 5.0 (December 2005) | re05_extra54.e00 | ESRI Arc interchange format | Vector - Polygon | - | QLD | QLD Environmental Protection Agency | - | - |
| 216 | Physical Shoreline Classification of Queensland | shoreline_class.shp | ESRI shapefile | Vector - Line | - | QLD | QLD Environmental Protection Agency | - | - |
| 217 | Revel Munro 1:50,000 Airphoto interpretation (1978) | N/A | N/A | N/A | - | TAS | - | - | - |
| 218 | Chris Sharples 1:10,000 - 1:40,000 Airphoto interpretation (2000) | N/A | N/A | N/A | - | TAS | - | - | - |
| 219 | Chris Sharples field inspections 2000-2008 | N/A | N/A | N/A | - | National | - | Field work done by Chris Sharples | - |
| 220 | Frances Mowling field inspections 2005-2006 | N/A | N/A | N/A | - | TAS | - | - | - |
| 221 | Short, Andrew D. (2006) Beaches of the Tasmanian Coast and Islands: A guide to their nature, characteristics, surf and safety. Sydney University Press: Sydney, 283pp. ISBN 1-920898-12-3 | N/A | N/A | N/A | - | TAS | - | - | - |
| 222 | Geological Survey of Tasmania: Published maps, unspecified (25K/50K/250K) | N/A | N/A | N/A | - | TAS | - | - | - |
| 223 | Burnie 1967 1 mile Geological Map (Geological Survey) | N/A | N/A | N/A | - | TAS | - | - | - |
| 224 | Dover 1:50,000 Geological Map (Farmer & Forsyth 1993) | N/A | N/A | N/A | - | TAS | - | - | - |
| 225 | St Helens 1:50,000 Geological Map (McGlenaghan et al. 1987) | N/A | N/A | N/A | - | TAS | - | - | - |
| 226 | Calder Geological Map 1:25,000 2006 (Calver) | N/A | N/A | N/A | - | TAS | - | - | - |
| 227 | Devonport Geological Map 1:25,000 2006 (Calver) | N/A | N/A | N/A | - | TAS | - | - | - |
| 228 | Ulverstone Geological Map 1:25,000 2006 (Calver) | N/A | N/A | N/A | - | TAS | - | - | - |
| 229 | Wynyard Geological Map 1:25,000 2006 (Calver) | N/A | N/A | N/A | - | TAS | - | - | - |
| 230 | Sorell 1:50,000 Geological Map (Gulline 1982) | N/A | N/A | N/A | - | TAS | - | - | - |
| 231 | Western Australia- South Coast Coastal Landform Mapping | SmartlineCoast_sthcst_20080107.shp | ESRI shapefile | Vector - Line | - | WA | WA Department of Environment and Conservation | Mapping done by Ewan Buckley, Ian Eliot and Michael Higgins, WA DEC | - |
| 233 | GEODATA COAST 100K 2004 | cstntcd_l.shp | ESRI shapefile | Vector - Line | ANZCW 070300 6621 | National | Geoscience Australia | Smartline base map for NT | - |
| 234 | WA MHWM Coastline (extract from Landgate Topographic data set) | Topo_Coastline.mdb | ESRI Personal Geodatabase | Vector - Line | - | WA | WA Landgate | - | - |
| 235 | NEW SOUTH WALES DTDB HYDROGRAPHY THEME MEDIUM SCALE DRAINAGE | NSW25K_MeanHighWaterMark | ESRI shapefile | Vector - Line | ANZNS 040400 0872 | NSW | NSW Department of Lands | - | - |
| 236 | NEW SOUTH WALES DTDB HYDROGRAPHY THEME MEDIUM SCALE DRAINAGE | NSW25K_HydroArea | ESRI shapefile | Vector - Polygon | ANZNS 040400 0872 | NSW | NSW Department of Lands | - | - |
| 237 | Data added or edited by C. Sharples during version 1 production, by extrapolation or inference from related attribute data. | N/A | N/A | N/A | - | National | - | - | - |
| 238 | Jones, T., Middelmann, M. And Corby, N. (2005) Natural Hazard Risk in Perth, Western Australia. Department of Industry, Tourism and Resources and Geoscience Australia. | N/A | N/A | N/A | - | WA | - | - | - |
| 239 | Combination of data extracted from files 153 and 154 | See files 153 and 154 | - | - | - | VIC | - | - | - |
| 240 | Combination of data extracted from files 154 and 155 | See files 154 and 155 | - | - | - | VIC | - | - | - |
| 241 | Combination of data extracted from files 155 and 209 | See files 155 and 209 | - | - | - | VIC | - | - | - |
| 242 | Combination of data extracted from files 146 and 153 | See files 146 and 153 | - | - | - | VIC | - | - | - |
| 243 | Combination of data extracted from files 147 and 153 | See files 147 and 153 | - | - | - | VIC | - | - | - |
| 244 | Combination of data extracted from files 149 and 153 | See files 149 and 153 | - | - | - | VIC | - | - | - |
| 245 | Combination of data extracted from files 150 and 153 | See files 150 and 153 | - | - | - | VIC | - | - | - |
| 246 | Combination of data extracted from files 151 and 153 | See files 151 and 153 | - | - | - | VIC | - | - | - |
| 247 | Combination of data extracted from files 152 and 153 | See files 152 and 153 | - | - | - | VIC | - | - | - |

| Reference ID | Dataset Title | File Name | File Type | Data Type | ANZLIC ID | Region or Jurisdiction | CUSTODIAN | NOTES | DESCRIPTION |
|---|---|---|---|---|---|---|---|---|---|
| 248 | Combination of data extracted from files 150 and 154 | See files 150 and 154 | - | - | - | VIC | - | - | - |
| 249 | Combination of data extracted from files 151 and 154 | See files 151 and 154 | - | - | - | VIC | - | - | - |
| 250 | Combination of data extracted from files 152 and 154 | See files 152 and 154 | - | - | - | VIC | - | - | - |
| 251 | Combination of data extracted from files 150 and 209 | See files 150 and 209 | - | - | - | VIC | - | - | - |
| 252 | NSW landforms mapped using Google Earth imagery by Michael Lacey | N/A | N/A | Raster - Image | - | NSW | - | - | - |
| 253 | MANGROVE MAPPING BYNOE HARBOUR | mangb_25.shp | ESRI shapefile | Vector - Polygon | - | NT | - | - | - |
| 254 | MANGROVE MAPPING DARWIN HARBOUR | mangd_25.shp | ESRI shapefile | Vector - Polygon | - | NT | - | - | - |
| 255 | Regionalisation of Mangrove Communities along the Northern Territory Coast | ntman_250.shp | ESRI shapefile | Vector - Polygon | - | NT | - | - | - |
| 256 | Tyler, I.M., Griffin, T.J. & Playford, P.E. (1992) Yampi. Australia 1:250,000 Geological Series, Sheet SE 51-3, Second Edition. Geological Survey of Western Australia, Department of Minerals and Energy | se5103.jpg | JPEG Image | Raster - Image | - | WA | - | Paper / raster versions only available at time of Smartline compilation | - |
| 257 | Resource Management and Conservation Division (2007) Arthur-Pieman Conservation Area Vehicle Tracks Assessment: Geoconservation and Biological Values. Report to Parks and Wildlife Service, Tasmania. Department of Primary Industries and Water, Hobart | N/A | N/A | Map - Hard Copy | - | TAS | - | Used info in Appendix 3: "Sites of Geoconservation Significance", p.198-199 | - |
| 258 | Landforms mapped using Google Earth imagery by Chris Sharples | N/A | N/A | Raster - Image | - | National | - | - | - |
| 259 | Wilde, S.A. & Walker, I.W. (1984) "Pemberton-Irwin Inlet". Australia 1:250,000 Geological Series, Sheet SI50-10 and part of Sheet SI50-14. Geological Survey of Western Australia (un-georeferenced raster) | si5010.jpg | JPEG Image | Raster - Image | - | WA | - | Paper / raster versions only available at time of Smartline compilation | - |
| 260 | Van de Graff, W.J.E., Butcher, B.P. & Hocking, R.M. (1983) "Shark Bay - Edel". Australia 1:250,000 Geological Series, parts of Sheets SG 49-8 and part of Sheet SG 49-12. Geological Survey of Western Australia | sg4908.jpg | JPEG Image | Raster - Image | - | WA | - | Paper / raster versions only available at time of Smartline compilation | - |
| 261 | Hocking, R.M., Van de Graff, W.J.E., Butcher, B.P. & Blockley, J.G. (1982) "Ajana". Australia 1:250,000 Geological Series, Sheet SG 50-13. Geological Survey of Western Australia | sg5013.jpg | JPEG Image | Raster - Image | - | WA | - | Paper / raster versions only available at time of Smartline compilation | - |
| 262 | Playford, P.E., Willmott, S.P., Johnstone, D., Horwitz, R.C. & Baxter, J.L. (1971) "Geraldton - Houtman Abrolhos". Australia 1:250,000 Geological Series, Sheet SH 50-1 and part of Sheet SH 49-4. Geological Survey of Western Australia | sh5001.jpg | JPEG Image | Raster - Image | - | WA | - | Paper / raster versions only available at time of Smartline compilation | - |
| 263 | Van de Graff, Hocking, R.M., Butcher, B.P. & Walker, I.W. (1982) "Yaringa". Australia 1:250,000 Geological Series, Sheet SG 50-9. Geological Survey of Western Australia | sg5009.jpg | JPEG Image | Raster - Image | - | WA | - | Paper / raster versions only available at time of Smartline compilation | - |
| 264 | Denman, P.D. & Van de Graff, W.J.E. (1981) "Quobba". Australia 1:250,000 Geological Series, Sheet SG 49-4. Geological Survey of Western Australia | sg4904.jpg | JPEG Image | Raster - Image | - | WA | - | Paper / raster versions only available at time of Smartline compilation | - |
| 265 | Hocking, R.M., Denman, P.D., Van de Graff, W.J.E., Butcher, B.P., & Moore, P.S. (1985) "Wooramel". Australia 1:250,000 Geological Series, Sheet SG 50-5. Geological Survey of Western Australia | sg5005.jpg | JPEG Image | Raster - Image | - | WA | - | Paper / raster versions only available at time of Smartline compilation | - |
| 266 | Towner, R.R., Gibson, D.L. & Crowe, R.W.A. (1981) "Mandora". Australia 1:250,000 Geological Series, Sheet SE 51-13. Bureau of Mineral Resources & Geological Survey of Western Australia | se5113.jpg | JPEG Image | Raster - Image | - | WA | - | Paper / raster versions only available at time of Smartline compilation | - |
| 267 | Towner, R.R., Gibson, D.L. & Crowe, R.W.A. (1981) "Munro". Australia 1:250,000 Geological Series, Sheet SE 51-14. Bureau of Mineral Resources & Geological Survey of Western Australia | se5114.jpg | JPEG Image | Raster - Image | - | WA | - | Paper / raster versions only available at time of Smartline compilation | - |
| 268 | Gibson, D.L., Towner, R.R. & Crowe R.W.A. (1983) "LaGrange". Australia 1:250,000 Geological Series, Sheet SE 51-10. Bureau of Mineral Resources & Geological Survey of Western Australia | se5110.jpg | JPEG Image | Raster - Image | - | WA | - | Paper / raster versions only available at time of Smartline compilation | - |
| 269 | Guppy, D.J., Lindner, A.W., Brunnschweiler, R.O., Gibson, D.L., Towner, R.R., & Crowe, R.W.A. (1982) "Broome". Australia 1:250,000 Geological Series, Sheet SE 51-6. Bureau of Mineral Resources & Geological Survey of Western Australia | se5106.jpg | JPEG Image | Raster - Image | - | WA | - | Paper / raster versions only available at time of Smartline compilation | - |

| Reference ID | Dataset Title | File Name | File Type | Data Type | ANZLIC ID | Region or Jurisdiction | CUSTODIAN | NOTES | DESCRIPTION |
|---|---|---|---|---|---|---|---|---|---|
| 270 | Hickman, A.H. & Gibson, D.L. (1981) "Port Hedland - Bedout Island". Australia 1:250,000 Geological Series, Sheet SF 50-4 and part of Sheet SE 50-16. Bureau of Mineral Resources & Geological Survey of Western Australia | se5016.jpg | JPEG Image | Raster - Image | - | WA | - | Paper / raster versions only available at time of Smartline compilation | - |
| 271 | Van de Graaff, W.J.E., Denman, P.D., Hocking, R.M., Baxter, J.L. (1980) "Yanrey - Ningaloo". Australia 1:250,000 Geological Series, Sheet SF 50-9 and part of Sheet SF 49-12. Geological Survey of Western Australia | sf5009.jpg | JPEG Image | Raster - Image | - | WA | - | Paper / raster versions only available at time of Smartline compilation | - |
| 272 | Van de Graaff, W.J.E., Denman, P.D., Hocking, R.M. (1981) "Onslow". Australia 1:250,000 Geological Series, Sheet SF 50-5 and part of Sheet SF 49-8. Geological Survey of Western Australia | sf5005.jpg | JPEG Image | Raster - Image | - | WA | - | Paper / raster versions only available at time of Smartline compilation | - |
| 273 | Williams, I.R., Ryan, G.R. & Halligan, R. (1968) "Yarraloola". Australia 1:250,000 Geological Series, Sheet SF 50-6. Bureau of Mineral Resources & Geological Survey of Western Australia | sf5006.jpg | JPEG Image | Raster - Image | - | WA | - | Paper / raster versions only available at time of Smartline compilation | - |