ABM
ASSOCIATION OF BAYSIDE MUNICIPALITIES

Final Report | 2014

Port Phillip Bay
Managing Better Now program

# REPORT 02

## COASTAL PROCESSES AFFECTING PORT PHILLIP BAY

Preliminary modelling and GIS-based assessment

This report has been prepared by Cardno Victoria Pty Ltd for the Association of Bayside Municipalities as part of the Managing Better Now program.

## ASSOCIATION OF BAYSIDE MUNICIPALITIES

The Association of Bayside Municipalities represents the ten councils with frontage to Port Phillip Bay. As coastal councils we are acutely aware of the need to protect and manage Port Phillip Bay for our local communities, and for the benefit of all Victorians, tourists and the unique ecosystems it supports.

As the appointed Committee of Management for much of the Port Phillip Bay coast, councils play a vital role in the environmental management of Port Phillip Bay, as the foreshore manager, strategic land use planning authority; asset manager; and service provider to Parks Victoria or other Committees of Management, and more.

The ABM vision is a healthy Port Phillip Bay that is valued and cared for by all Victorians.

## ABM MEMBER COUNCILS:

## ACKNOWLEDGEMENTS

The Association of Bayside Municipalities acknowledges funding from Member councils and state government to enable the Managing Better Now program. Thank you to the staff from ABM Member Councils and Melbourne Water for providing technical input and feedback on the reports.

The Association of Bayside Municipalities recognising the substantial support from Cardno in preparing the reports, and presenting the outputs and recommendations over many years.

# EXECUTIVE SUMMARY

The *Managing Better Now* program is an initiative of the Association of Bayside Municipalities.

Launched in 2013, the program aimed to better understand the dynamics and coastal processes of Port Phillip Bay using data modelling and analysis to:

- Improve knowledge of coastal processes in Port Phillip Bay, and their effects on vulnerable sections of the coast.
- Understand present and future risks and hazards.
- Inform the management of coastal processes impacting Port Phillip Bay 'now' and into the future.
- Contribute to a future coastal hazard assessment for Port Phillip Bay.

Outputs from the Managing Better Now program are designed to support better decision making, clearer investment, management and planning by ABM Member Councils and other bay stakeholders in:

- beach protection,
- local coastal hazard and risk assessment,
- foreshore and infrastructure management,
- maintenance planning and response to weather extremes, and
- coastal climate adaptation.

Using a 'step by step' approach, the program was undertaken in phases with work proceeding as funding and resources were secured.

Phases 1 and 2 examined the programs, strategies and approaches used to manage the coastline, beaches and immediate foreshore areas, identifying gaps in knowledge.  Phases 3, 4 and 5 gathered existing information and invested in data modelling and analysis of new essential data, mapping and modelling – compiling a series of reports aimed at better understand the dynamics of Port Phillip Bay.

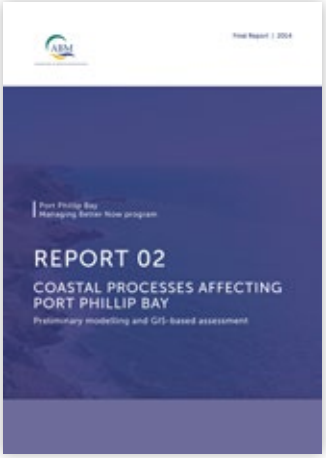
As coastal mangers, the ABM recognises the importance of using the best available information, and values working in partnership to improve understanding of the processes and systems affecting Port Phillip Bay

The following reports comprise the Managing Better Now series, and are available on the ABM website at www.abm.org.au.

# REPORT **Snapshots**

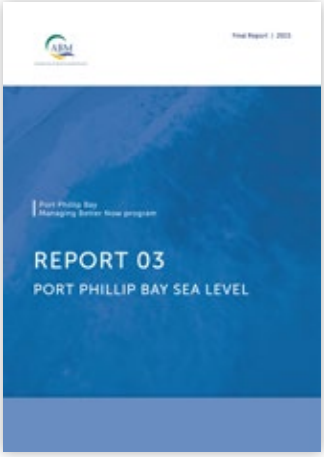

## Report #1: Coastal Processes Affecting Port Phillip Bay - preliminary data collection and gap analysis

Identification of existing spatial and non-spatial information to inform a coastal hazard assessment. This included spatial data layers, over 200 technical reports, images and 60 strategies and plans relevant to Port Phillip Bay. More than 200 GIS data layers were identified and stored on an online GIS portal, made available to ABM councils.




## Report #2: Coastal Processes Affecting Port Phillip Bay – preliminary modelling and mapping of coastal asset location and proximity to the Port Phillip Bay shoreline; and GIS-based assessment of width and volume of erodible land along Port Phillip Bay.

- **Part 1:** Preliminary modelling and mapping of coastal asset location and proximity to the Port Phillip shoreline. Purpose of this study was to use readily available spatial information layers identified in Report 1 to locate and map coastal assets at a bay-wide scale, and improve understanding of the proximity of assets to the Port Phillip Bay shoreline. This work was not intended to be a comprehensive study or replace a local hazard study. It provided a demonstration of the type of analysis that can be undertaken using readily available spatial data layers, informing local studies by individual coastal land managers such as the effects of coastal storms on sections of shoreline, the effects of coastal inundation on parts of the coast, the quality of drainage networks and associated infrastructure to model water flow, availability of information for assets of significance, their values, etc.
- **Part 2:** Spatial Analysis of area (width) and volume of erodible land along Port Phillip Bay. Three methodologies were used to demonstrate the calculation of area and volume of sand between the mean sea level (taken as the shoreline) and three different landward extents. The landward extents are based on existing infrastructure such as roads or houses; horizontal distances (eg, within 5 metres, 10 metres, etc.); or vertical elevation (eg, 0.5 metres, 1.0 metres, etc.) from the shoreline. Information about physical processes or hazards, including sediment transport rates, wave impacts, shoreline erosion rates or other such information was not available. The approach used is of generic and demonstrative nature and can be applied around Port Phillip Bay; and substantially enhanced if coupled with information about coastal processes and coastal hazard information.




## Report #3: Port Phillip Bay Sea Level

Analysis of existing historical sea level data for Port Phillip Bay measuring sea levels over an extended period at multiple locations. Data was collected from Port of Melbourne Corporation, National Tidal Centre, Victorian Regional Channel Authority and Melbourne Water. Data was subjected to extreme value analysis to develop values for sea level with Annual Exceedance Probabilities at 1%, 2%, 5% and 10% (corresponding to Annual Recurrence Intervals of 100, 50, 20 and 10 years).

The results are intended to support the setting of values for planning and design, not replace decisions made by the appropriate responsible authorities. Results may be useful in establishing regional variations; undertaking assessments of the appropriate values in setting planning benchmarks and design criteria; investigating potential risks; supporting planning, design and assessment of future coastal vulnerability considering climate change.


## Report #4: Port Phillip Bay Wave Climate

Wave modelling for the whole of Port Phillip Bay using a tested and consistent approach. The modelling incorporated annual and seasonal occurrence of wave conditions, highlighting the marked seasonal variability in wave conditions over Port Phillip Bay resulting from seasonal wind changes. The longshore component of wave power was also computed for the entire shoreline providing insights into the annual and seasonal variability of potential sediment transport around Port Phillip Bay.

Modelling results can be used to understand phenomena observed on a specific beach, or to review broad bay-wide scale processes.

In addition to the data presented in the report, detailed frequency of occurrence matrices for each of the 248 data extraction points have been provided as tables which can be accessed via a Geographic Information System. Contact the ABM for further information.


## Report #5: Port Phillip Bay Storm Bite Analysis

Building on the previous studies of waves and sea levels in Port Phillip Bay, this project modelled likely volumes and extent of storm bite erosion on 20 beach profiles in Port Phillip Bay between Little River and Sorrento, under varying storm conditions. Results inform changes in beach profile following an individual storm event, and the magnitude of the storm event.

This report provides a first-pass risk assessment of coastal erosion that can be used to identify and prioritise areas of concern; focus more detailed studies on areas of intolerable risk level; and to understand what level of coastal erosion might be expected in a 'typical' or an 'extreme' storm event.

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## Glossary

| Abbreviation | Definition |
|---|---|
| AHD | Australian Height Datum. The Australian Height Datum is a geodetic datum for altitude measurement in Australia, "In 1971 the mean sea level for 1966-1968 was assigned the value of zero on the Australian Height Datum at thirty tide gauges around the coast of the Australian continent" |
| DEM | Digital Elevation Model |
| DEPI | Victorian state government Department of Environment and Primary Industries |
| Geomorphology | study of landforms and processes shaping those landforms |
| GIS | Geographical Information System |
| HWM | High Water Mark. Highest level water reached by high tide, averaged over a period of time. |
| LiDAR | Light Detection and Ranging. This is a remote sensing technology that measures distance by use of a laser. Alternatively it can also mean a topographic data layer created by using this method. |

## Appendices

| | |
|---|---|
| Appendix A | Definition of GIS |
| Appendix B | GIS Data Types |
| Appendix C | Data Sources and Types |
| Appendix D | Baseline Data Layers for this study |
| Appendix E | Data Accuracy |
| Appendix F | Vicmap Address (by Zone, LGA and Planning Zone) |

# 01. Introduction

## Report 02: Coastal processes affecting port phillip bay

Report #2 of the Association of Bayside Municipalities' Managing Port Phillip Bay Better Now program aims to build understanding of available coastal asset information and Geographical Information System (GIS) based modelling and mapping techniques suitable for hazard and risk assessments.

This report uses existing data layers and modelling techniques to demonstrate the capability of GIS for this kind of work. Information about the frequency or magnitude of coastal hazards was not available for this study and was therefore not considered in this work. Using examples, this project

The project used readily available information and a selection of GIS data layers collated during Phase 1 of the Managing Better Now program (refer to Report #1) to:

- Action 1: Model and map the proximity of a range of coastal assets in relation to the Port Phillip Bay shoreline.
- Action 2: Demonstrate how to model the impacts of a coastal hazard on erodible shorelines.

Output from these actions generated a series of new GIS data layers for Port Phillip Bay – a combination (overlay) of asset and zone data layers, showing the total number of assets per zone along the entire bay.

To improve on this work, the effects of coastal hazards on different parts of Port Phillip Bay needs to be better understood and mapped. Once that work is complete and potential effects of hazards better understood, those hazard maps can be combined with the output from this work to better identify assets potentially at risk from coastal hazards. Adding more detailed information for example about the condition of coastal protection structures or details of drainage networks, will further improve the modelling. Such detailed work, however, is subject to a local coastal hazard assessment.

# Action 01
# Spatial Analysis of coastal asset proximity along the Port Phillip Bay coastline

## 1.1 Introduction

The purpose of Action 1 was to better understand where close assets or groups of assets are located, with regards to erodible sections of the Port Phillip Bay shoreline. It was decided to model this for ten 10-metre wide corridors, located landwards of the 0m contour AHD. A distance of 100m landwards of the shoreline was therefore used for the modelling. This method was used to analyse the data. Another method is to use height above mean sea level rather than landward distance. Either approach is valuable in its own way. However, when combined with information about the effects of hazards this information become very meaningful in a local hazard assessment context.

A Geographical Information System (GIS), ESRI's ArcGIS, was used for all analysis and mapping to create a series of new GIS data layers. More general information about GIS and data sources and types can be found in Appendix A and Appendix B.

The tasks undertaken can be broadly divided into the following key steps:

1. Identification of easily erodible versus more erosion resistant sections of the Port Phillip Bay coastline.
2. Creation of 10m "impact" zones, ranging from 0m Australian Height Datum (AHD) to 100m inland. The 0m AHD contour was selected because it is close to mean sea level and readily available as a GIS data layer.
3. GIS analysis and mapping of coastal assets inside the ten zones.
4. GIS analysis of administrative responsibilities of those assets assessed in (3). Included were local government boundaries, and in addition (for some layers), land managers and/or planning zones.

   It must be emphasised that this work does not consider the effects of coastal processes, such as wind waves, storm impacts or sediment transport. The results obtained here are of preliminary nature only. The analysis does provide a first overview of the location of coastal assets in proximity to Port Phillip Bay.

## 1.2 Data Sources and Data Layers utilised

Of those GIS data layers identified and collated for Report #1, approximately 20 layers were used for this task. The data can be broadly grouped into: a) baseline data layers, b) asset data layers, and c) administrative data layers.

### 1.2.1 Baseline data layers

Baseline data include layers required to identify sections of coast that are either easily erodible or erosion resistant, or protected. Data required for this task includes:

- Geology
- Geomorphology (landform)
- Coastal protection structures
- Land elevation

### 1.2.2 Asset data layers

Asset Data layers include data that contains information about a range of assets, including man-made, natural and cultural assets. Examples are the DEPI Vicmap series of layers, but also information about RAMSAR sites, boating facilities, or VEAC reserves. Refer to Appendix D for more details and Appendix E for information about the accuracy of different data layers.

### 1.2.3 Administrative data layers

Administrative data layers include those layers defining boundaries of administration, such as land managers, local government areas or planning zones.

Each of the data layers utilised were sourced from third parties (mainly DEPI) and their spatial data was not modified or gaps filled for this project, or new spatial information collected. However, database information of some layers was regrouped, for example certain asset types or zones were grouped into categories more suitable for this project. Refer Sections 1.3 and 1.4 for more detail.

Section 1.4 will comment in more detail on individual data layers, their origin, purpose and content. It will also comment on information that is, or appears, to be missing from the respective data layers. Suggestions will be made how those data layers could be improved for the purpose of the Managing Better Now program.

## 1.3 Methodology

The following sections describe the methodologies adopted for this task. ESRI's ArcGIS software was used for all analysis and mapping. Key steps undertaken are outlined in sequential order.

### 1.3.1 Creation of baseline data layer

The first step was to create a baseline data layer which included the areas of interest – shorelines that are erodible but currently protected by a coastal structure.

A number of GIS functions were used to combine information from the Port Phillip coastline data layer (Vicmap data) with information about geology (DEPI Geology 1: 250,000) and geomorphology (Smartline mapping) to identify sections of coastline that are a) easily erodible and b) more erosion resistant. In addition, information about existing coastal protection structures was also joined and land elevation considered. This process resulted in two baseline data layers which were used for all subsequent analyses. These data layers are:

- Scenario A: no consideration was given to the existence of protection structures, and
- Scenario B: consideration was given to the existence of coastal protection structures.

Figure 1 shows the sections of Port Phillip Bay coast selected for Scenario B. This selection is based primarily on information available from the geology, geomorphology, coastal protection and coastal elevation data layers. The information selected for both scenarios may contain some mapping error in the original data layers but also subjectivity in the definition of erodible and erosion resistant features. Ground-truthing should therefore be undertaken prior to a more localised assessment of coastal impacts in Phase 4.


Figure 1: Port Phillip Bay shoreline potentially susceptible to landward migration (consideration of coastal structures)

Areas around the Yarra River mouth, Mordialloc Creek, Patterson River, Martha Cove, Werribee River, Little River and Hovells Creek were included in the selections, resulting in a total shoreline length of 402km for Scenario A) and 325km for Scenario B). These values are based on existing mapping. The upstream extent was selected based on a best estimate, however requires a more detailed analysis of the upstream extent of tidal influences for Phase 4.

Table 1 shows sections of coastline and length of coastal protection structures for each of the ten bayside local government areas. Information about the protection structures may have changed since this data layer was created and should be verified prior to a local coastal hazard assessment.

Table 1: Length of coastline per LGA and length of coastal protection structures (both in kilometres). Coastal Protection structures are defined as: Breakwater, Groyne, Revetment and Seawall in this report.

| LGA | Shoreline length (km) | Breakwater length (km) | Groyne length (km) | Revetment length (km) | Seawall length (km) |
|---|---|---|---|---|---|
| Bayside | 19 | 1.16 | 1.04 | 2.38 | 5.63 |
| CoGG | 120 | 1.65 | 0.81 | 6.87 | 7.50 |
| CoPP | 14 | 0.65 | 0.98 | 1.82 | 8.36 |
| Frankston | 9 | 0.00 | 0.05 | 0.89 | 0.89 |
| Hobsons Bay | 25 | 2.50 | 0.41 | 4.06 | 5.18 |
| Kingston | 13 | 0.17 | 0.05 | 0.65 | 3.82 |
| Melbourne | 5 | 0.00 | 0.00 | 3.75 | 0.00 |
| Mornington | 64 | 0.97 | 1.10 | 3.28 | 9.60 |
| Queenscliff | 38 | 0.15 | 0.28 | 4.12 | 2.25 |
| Wyndham | 27 | 0.05 | 0.24 | 3.55 | 0.21 |

It was decided to use Scenario B for all data analysis undertaken, as it represents the current situation of the bay more realistically than Scenario A. However, results from the modelling for Scenario A will also be presented for comparison with Scenario B.

Two series of landward zones with a width of 10m each were created for both scenarios, using GIS functions (buffer function). The area covered by these zones is between the 0m contour line and 100m inland from this line. These 'zones' were then utilised as the basis for all subsequent data processing and analysis. A close-up of a GIS layer showing these zones is shown in Figure 2.

0 – 10m (Zone 1)
0 – 20m (Zone 2)
0 – 30m (Zone 3)
0 – 40m (Zone 4)
0 – 50m (Zone 5)
0 – 60m (Zone 6)
0 – 70m (Zone 7)
0 – 80m (Zone 8)
0 – 90m (Zone 9)
0 – 100m (Zone 10)

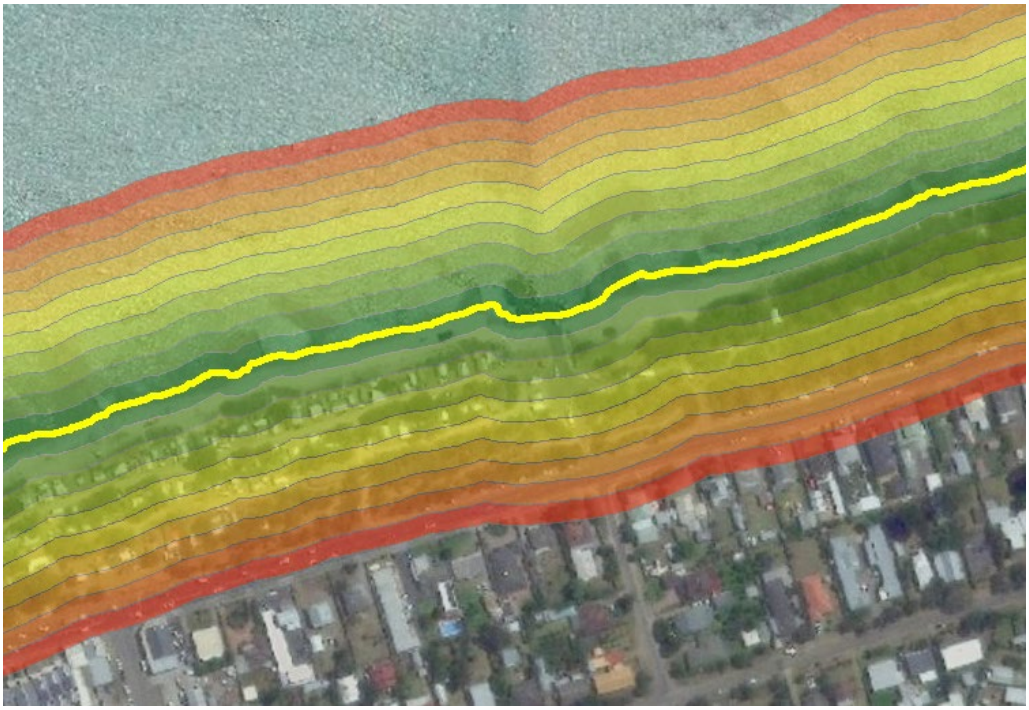


Figure 2: Close-up of GIS-generated landward zones, ranging from 0 – 100m inland in 10m increments

While the focus of this work is on assets located landward of the 0m contour AHD, the zone layers can also be created to capture assets located seaward of the 0m AHD, such as piers, jetties or other features (refer Figure 2).

Another data layer that provides additional information about the potential exposure to hazards is contour (elevation) lines. Figure 3 below shows the 5m (blue) and 10m (red) contour AHD around Port Phillip Bay, in comparison with the 100m landward zones layer. Both data layers are readily available and can be used separately or in combination. Consideration will need to be given to both, distance and elevation in a local study, depending on the type of hazard and its anticipated impact.

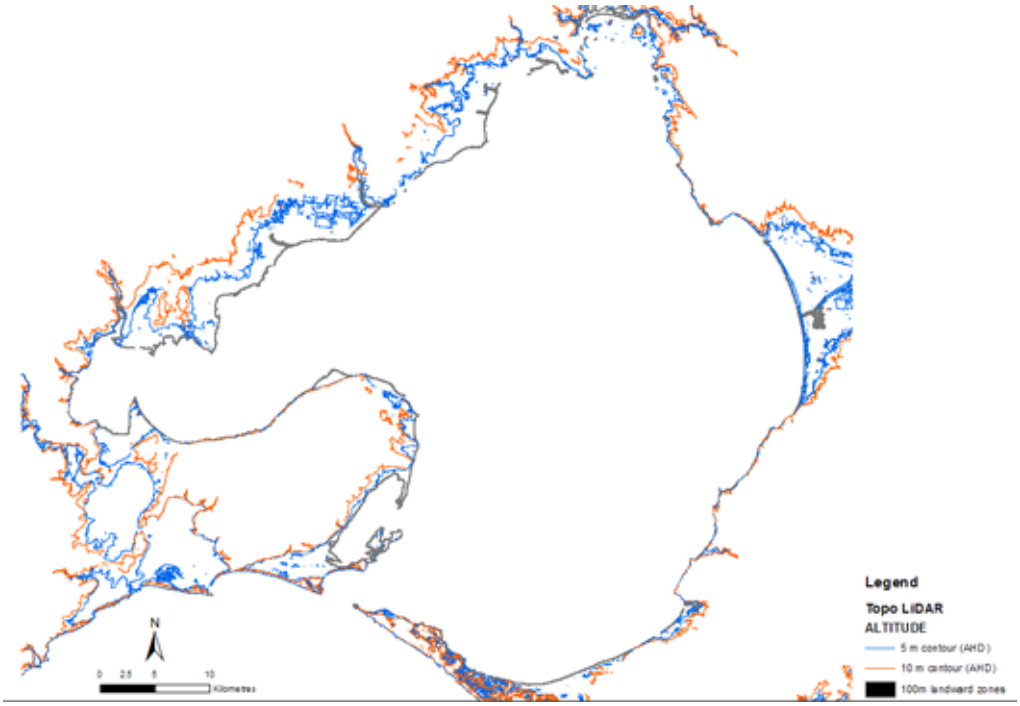
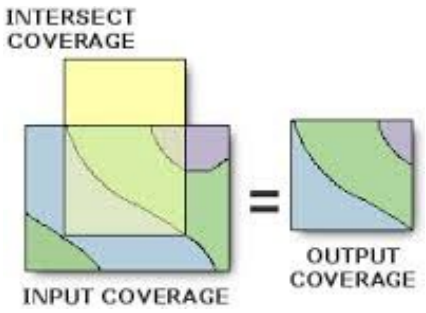



Figure 3: 5m (blue) and 10m (red) height contours compared with 100m landward zones layer (black).

### 1.3.2 Asset Data analysis

Following the creation of baseline data layers for Scenarios A and B, and the ten landward zones for these scenarios, individual asset data layers were combined (overlaid) with the landward zone layers. The GIS intersect function was used for this task to compute the geometric intersection of the input features (asset data) and landward zones layer. Features or portions of features which overlap in both layers are saved in a new output layer (Figure 4).

Figure 4: Schematic sketch of the ArcGIS intersect function.




This function was used repeatedly for all asset layers. Results from this analysis were then further combined with administrative layers to gain some understanding of the administrative responsibility for those assets (Section 1.3.3 below).

### 1.3.3 Administrative Layers

The third step in the data analysis used outputs from the Asset Data Analysis (Section 1.3.2 above) in combination with administrative layers (LGA boundaries and/or land managers and/or planning zones). The GIS intersect function was used again to combine the asset and administrative data and outputs created a series of new GIS layers.

Results derived from this analysis are presented in Section 4.

## 1.4 Results – Port Phillip Bay

Results from the modelling and mapping in Section 3 are summarised and presented for the entire Port Phillip Bay area.

In summary, these results give an overview of different assets and their geographical location with respect to the Port Phillip Bay coastline. The results are presented for Scenario B, in tabular and chart format and include map examples. Results for Scenario A are also presented for comparison.

Scenario A) – no consideration of protection structures, referred to as Scenario A) from here on

Scenario B) – consideration of protection structures, referred to as Scenario B) from here on

Results are presented for the following spatial asset data layers:

1. Vicmap Address – by number of address points per zone
2. Vicmap Property – by total area per zone
3. Vicmap Roads – by length of road per zone
4. Vicmap Rail – by length of rail per zone
5. Vicmap Features of Interest – by number of features per zone
6. Boating Facilities – by number of facilities per zone
7. RAMSAR Sites – by length of coastline
8. Land Managers (Public Land Management) - by length of coastline
9. VEAC Reserves – by length of coastline

The analysis and mapping undertaken for this selection of layers can in principle be repeated for many other spatial data layers of interest. The purpose, in this instance, is to demonstrate this type of GIS analysis by means of examples. Opportunity exists for individual land managers to identify high priority data layers required for a local hazard assessment and determine if those data are of sufficient quality, or, if additional information needs to be collected.

### 1.4.1 Vicmap Address

*Format of data: points*

Vicmap Address is Victoria's authoritative geocoded database of property address points. This data layer was utilised to identify the number of address points located within each of the ten modelling zones. This data layer contains information about road name and locality and can be linked to the Vicmap property database via a unique number. This kind of data is used for example by the Country Fire Authoity for fire emergency planning. The data layer is primarily maintained by local government, in cooperation with the DEPI Vicmap Program. It is updated on an ongoing basis and re-distributed regularly. Like other Vicmap data layers, the address points data layer can be downloaded from the Victorian Government data portal (data.vic.gov.au). Vicmap Address contains a wealth of information, including unit/house number, road name, and locality. Of interest for this project is information about bathing boxes as an address point. However, the data layers contain such information only for Bayside and Frankston, other information is not (yet) captured or included here.

The Vicmap Address GIS data layer was used to determine the number of address points located within each of the ten zones, per LGA and per planning zone. A sample is shown in Figure 5.

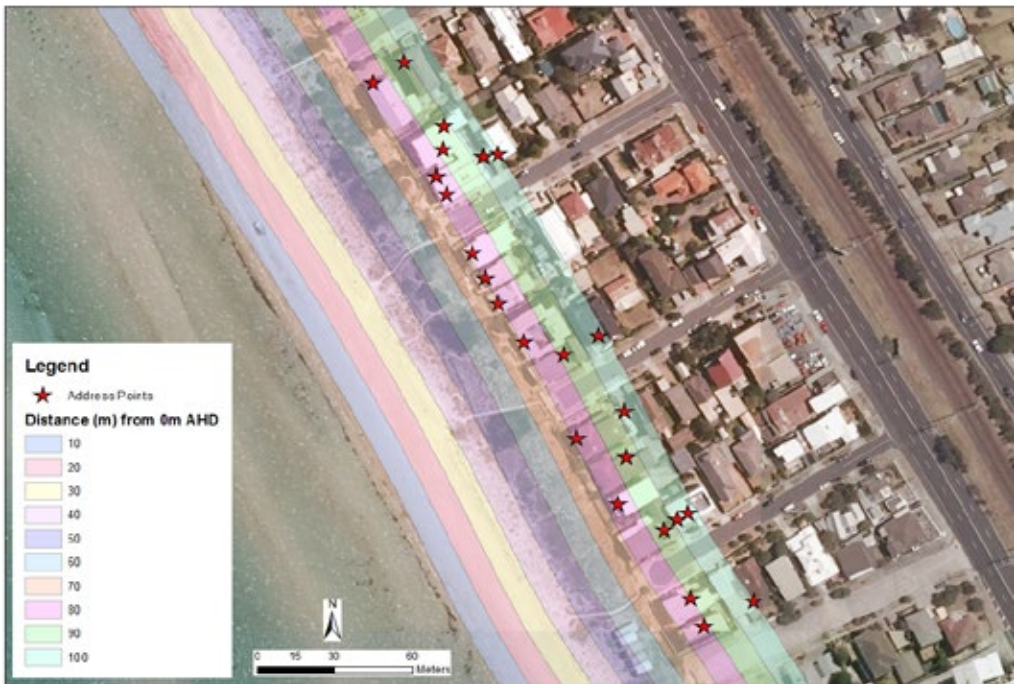



Figure 5: Sample of GIS modelling output for Vicmap Address. The figure shows the location of individual address points per zone.

Table 2 shows the number of address points located within each zone, by LGA. One address point has been identified for Frankston, 3 for Greater Geelong, 59 for Kingston, etc.. In total, 104 address points were identified for Zone 1 for the entire bay, 397 for Zone 2, 790 for Zone 3, etc..

In total, 6,985 address points are located within the ten zones around Port Phillip Bay. This compares with 10,259 address points for Scenario A.

Table 2: Number of Address Points per Zone

| Zone | LGA_NAME | FREQUENCY | Zone | LGA_NAME | FREQUENCY | Zone | LGA_NAME | FREQUENCY |
|---|---|---|---|---|---|---|---|---|
| 1 | FRANKSTON | 1 | 5 | BAYSIDE | 2 | 8 | BAYSIDE | 6 |
| 1 | GREATER GEELONG | 3 | 5 | FRANKSTON | 3 | 8 | FRANKSTON | 23 |
| 1 | KINGSTON | 59 | 5 | GREATER GEELONG | 65 | 8 | GREATER GEELONG | 104 |
| 1 | MELBOURNE | 1 | 5 | HOBSONS BAY | 3 | 8 | HOBSONS BAY | 9 |
| 1 | MORNINGTON PENINSULA | 22 | 5 | KINGSTON | 357 | 8 | KINGSTON | 551 |
| 1 | QUEENSCLIFFE | 18 | 5 | MELBOURNE | 18 | 8 | MELBOURNE | 6 |
| **Total** | | **104** | 5 | MORNINGTON PENINSULA | 216 | 8 | MORNINGTON PENINSULA | 178 |
| 2 | FRANKSTON | 3 | 5 | QUEENSCLIFFE | 3 | 8 | PORT PHILLIP | 112 |
| 2 | GREATER GEELONG | 13 | 5 | WYNDHAM | 1 | 8 | QUEENSCLIFFE | 8 |
| 2 | HOBSONS BAY | 1 | **Total** | | **668** | 8 | WYNDHAM | 1 |
| 2 | KINGSTON | 126 | 6 | BAYSIDE | 7 | **Total** | | **998** |
| 2 | MORNINGTON PENINSULA | 221 | 6 | FRANKSTON | 9 | 9 | BAYSIDE | 68 |
| 2 | QUEENSCLIFFE | 6 | 6 | GREATER GEELONG | 101 | 9 | FRANKSTON | 38 |
| 2 | WYNDHAM | 27 | 6 | HOBSONS BAY | 2 | 9 | GREATER GEELONG | 119 |
| **Total** | | **397** | 6 | KINGSTON | 149 | 9 | HOBSONS BAY | 8 |
| 3 | FRANKSTON | 54 | 6 | MELBOURNE | 6 | 9 | KINGSTON | 427 |
| 3 | GREATER GEELONG | 3 | 6 | MORNINGTON PENINSULA | 138 | 9 | MORNINGTON PENINSULA | 240 |
| 3 | HOBSONS BAY | 7 | 6 | QUEENSCLIFFE | 4 | 9 | PORT PHILLIP | 9 |
| 3 | KINGSTON | 206 | 6 | WYNDHAM | 1 | 9 | QUEENSCLIFFE | 27 |
| 3 | MORNINGTON PENINSULA | 457 | **Total** | | **417** | 9 | WYNDHAM | 1 |
| 3 | PORT PHILLIP | 5 | 7 | BAYSIDE | 15 | **Total** | | **937** |
| 3 | QUEENSCLIFFE | 4 | 7 | FRANKSTON | 23 | 10 | BAYSIDE | 94 |
| 3 | WYNDHAM | 54 | 7 | GREATER GEELONG | 120 | 10 | FRANKSTON | 54 |
| **Total** | | **790** | 7 | HOBSONS BAY | 4 | 10 | GREATER GEELONG | 221 |
| 4 | BAYSIDE | 2 | 7 | KINGSTON | 196 | 10 | HOBSONS BAY | 14 |
| 4 | FRANKSTON | 8 | 7 | MELBOURNE | 6 | 10 | KINGSTON | 339 |
| 4 | GREATER GEELONG | 66 | 7 | MORNINGTON PENINSULA | 183 | 10 | MELBOURNE | 2 |
| 4 | HOBSONS BAY | 17 | 7 | PORT PHILLIP | 1 | 10 | MORNINGTON PENINSULA | 246 |
| 4 | KINGSTON | 316 | 7 | QUEENSCLIFFE | 5 | 10 | PORT PHILLIP | 4 |
| 4 | MORNINGTON PENINSULA | 655 | **Total** | | **553** | 10 | QUEENSCLIFFE | 29 |
| 4 | PORT PHILLIP | 3 | | | | 10 | WYNDHAM | 1 |
| 4 | QUEENSCLIFFE | 4 | | | | **Total** | | **1004** |
| 4 | WYNDHAM | 46 | | | | | | |
| **Total** | | **1117** | | | | | | |

Note: Only LGA and zones containing address points are shown in this table. Zones with '0' values are not included.



This information can be further analysed, for example using planning zones. An example is given in Appendix F which lists the frequency of address points per zone, LGA and planning zone.

Since no hazard information was utilised for this (or any other) analysis, it must be recognised that not all address points identified here would be at risk from a hazard at the same time or at all. If information about areas most likely affected by coastal hazards was available this would have allowed narrowing the analysis down to those sections of concern. This will be a key task for local hazard assessments in Phase 4.

Additional information that would enhance this analysis in the context of a risk assessment is information about the value of the individual asset(s). It would allow for example for a cost-benefit analysis and inform adaptation options.

### 1.4.2 Vicmap Property

*Format of data: polygons*

The Vicmap Property data layer is a spatial data layer that consists of polygons representing Victoria's land parcels (cadastre). It was used to determine the area of properties located within each of the ten zones. A property parcel was included in the analysis and statistics if it was shown to be included in a zone, no matter the proportion of a parcel affected. Like the Vicmap Address data layer, this layer is maintained by local government in cooperation with DEPI Vicmap. It contains, amongst other and partly in separate tables, information about:

- Parcel and Property Polygon views;
- Parcel and Property Identifiers - parcel descriptors (including Standard Parcel Identifiers (SPI)), Council reference numbers;
- Registered and proposed parcels;
- Crown and Freehold land differentiation;
- Cadastral Road Casements;
- Easements
- Unique Feature Identifiers, date stamps and data quality information.

This data layer was analysed for the total area of properties per zone, by LGA. Table 3 shows the total area within each zone, by LGA.

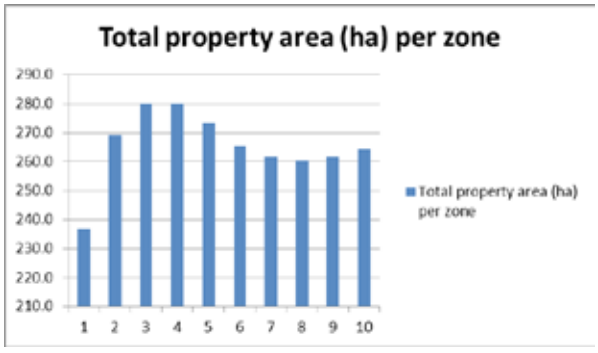
Significant changes of the total area between Zone 1 to 2 and 2 to 3.

Table 3: Total property area per Zone by LGA

| Zone | LGA_NAME | Length (m) | Zone | LGA_NAME | Length (m) | Zone | LGA_NAME | Length (m) |
|---|---|---|---|---|---|---|---|---|
| 1 | BAYSIDE | 25.5 | 5 | BAYSIDE | 1593.4 | 8 | BAYSIDE | 2669.9 |
| 1 | FRANKSTON | 25.0 | 5 | FRANKSTON | 403.5 | 8 | FRANKSTON | 393.3 |
| 1 | GREATER GEELONG | 2036.2 | 5 | GREATER GEELONG | 7650.3 | 8 | GREATER GEELONG | 5810.1 |
| 1 | HOBSONS BAY | 696.8 | 5 | HOBSONS BAY | 2155.7 | 8 | HOBSONS BAY | 1589.4 |
| 1 | KINGSTON | 1507.3 | 5 | KINGSTON | 5183.4 | 8 | KINGSTON | 3860.2 |
| 1 | MELBOURNE | 2578.2 | 5 | MELBOURNE | 1886.1 | 8 | MELBOURNE | 2765.3 |
| 1 | ORNINGTON PENINSU | 289.2 | 5 | MORNINGTON PENINSULA | 8537.4 | 8 | MORNINGTON PENINSULA | 9448.0 |
| 1 | QUEENSCLIFFE | 357.7 | 5 | PORT PHILLIP | 339.7 | 8 | PORT PHILLIP | 151.6 |
| 1 | WYNDHAM | 109.6 | 5 | QUEENSCLIFFE | 892.8 | 8 | QUEENSCLIFFE | 1560.4 |
| **Total** | | **7625.6** | 5 | WYNDHAM | 3089.2 | 8 | WYNDHAM | 982.2 |
| 2 | BAYSIDE | 187.3 | **Total** | | **31731.5** | **Total** | | 29230.6 |
| 2 | FRANKSTON | 20.7 | 6 | BAYSIDE | 2126.2 | 9 | BAYSIDE | 2676.4 |
| 2 | GREATER GEELONG | 7522.0 | 6 | FRANKSTON | 300.0 | 9 | FRANKSTON | 442.9 |
| 2 | HOBSONS BAY | 2389.1 | 6 | GREATER GEELONG | 6337.3 | 9 | GREATER GEELONG | 5523.3 |
| 2 | KINGSTON | 1680.0 | 6 | HOBSONS BAY | 2045.1 | 9 | HOBSONS BAY | 1474.6 |
| 2 | MELBOURNE | 4519.6 | 6 | KINGSTON | 6814.7 | 9 | KINGSTON | 3557.6 |
| 2 | ORNINGTON PENINSU | 1546.9 | 6 | MELBOURNE | 2510.8 | 9 | MELBOURNE | 3794.1 |
| 2 | PORT PHILLIP | 101.6 | 6 | MORNINGTON PENINSULA | 11228.2 | 9 | MORNINGTON PENINSULA | 7430.3 |
| 2 | QUEENSCLIFFE | 828.5 | 6 | PORT PHILLIP | 137.0 | 9 | PORT PHILLIP | 125.8 |
| 2 | WYNDHAM | 1758.0 | 6 | QUEENSCLIFFE | 1720.5 | 9 | QUEENSCLIFFE | 2192.1 |
| **Total** | | **20553.6** | 6 | WYNDHAM | 3294.0 | 9 | WYNDHAM | 517.4 |
| 3 | BAYSIDE | 505.6 | **Total** | | **36513.8** | **Total** | | **27734.5** |
| 3 | FRANKSTON | 147.5 | 7 | BAYSIDE | 2534.8 | 10 | BAYSIDE | 2325.3 |
| 3 | GREATER GEELONG | 9519.5 | 7 | FRANKSTON | 217.1 | 10 | FRANKSTON | 665.4 |
| 3 | HOBSONS BAY | 3537.8 | 7 | GREATER GEELONG | 5864.3 | 10 | GREATER GEELONG | 5156.1 |
| 3 | KINGSTON | 2242.7 | 7 | HOBSONS BAY | 1654.6 | 10 | HOBSONS BAY | 1524.0 |
| 3 | MELBOURNE | 1897.0 | 7 | KINGSTON | 5437.6 | 10 | KINGSTON | 3323.3 |
| 3 | ORNINGTON PENINSU | 1871.7 | 7 | MELBOURNE | 2780.8 | 10 | MELBOURNE | 2574.3 |
| 3 | PORT PHILLIP | 367.4 | 7 | MORNINGTON PENINSULA | 8574.6 | 10 | MORNINGTON PENINSULA | 7353.6 |
| 3 | QUEENSCLIFFE | 719.2 | 7 | PORT PHILLIP | 178.7 | 10 | PORT PHILLIP | 118.8 |
| 3 | WYNDHAM | 3688.4 | 7 | QUEENSCLIFFE | 1371.3 | 10 | QUEENSCLIFFE | 1894.4 |
| **Total** | | **24496.8** | 7 | WYNDHAM | 1196.2 | 10 | WYNDHAM | 408.1 |
| 4 | BAYSIDE | 878.5 | **Total** | | **29809.8** | **Total** | | **25343.3** |
| 4 | FRANKSTON | 320.3 | | | | | | |
| 4 | GREATER GEELONG | 8348.1 | | | | | | |
| 4 | HOBSONS BAY | 2211.1 | | | | | | |
| 4 | KINGSTON | 2881.4 | | | | | | |
| 4 | MELBOURNE | 1941.6 | | | | | | |
| 4 | ORNINGTON PENINSU | 3931.9 | | | | | | |
| 4 | PORT PHILLIP | 122.8 | | | | | | |
| 4 | QUEENSCLIFFE | 1082.1 | | | | | | |
| 4 | WYNDHAM | 3440.1 | | | | | | |
| **Total** | | **25157.9** | | | | | | |

Table 4: Total Property Area per Zone

| Zone | Total property area (ha) per zone |
|---|---|
| 1 | 236.9 |
| 2 | 269.2 |
| 3 | 280.1 |
| 4 | 280.1 |
| 5 | 273.3 |
| 6 | 265.3 |
| 7 | 261.6 |
| 8 | 260.4 |
| 9 | 261.6 |
| 10 | 264.4 |
| All Zones Total | **2652.9** |



A total area of about 2,650ha is covered in this scenario, which compares with 3,165 ha for Scenario A.

Other information useful in the context of a more detailed study would include:

- History of land prices to predict future values
- Any restrictions that may apply (eg height or type of building)
- Soil type
- Groundwater flows
- Any potential contamination
- Current and proposed future zoning

### 1.4.3 Vicmap Roads

*Format of data: lines*

Vicmap Roads is part of Vicmap Transport and is a GIS layer of the road network of Victoria. The road network is a line data layer and differentiates between different types of roads. The Vicmap Roads data layer was analysed for the total length of road per zone. It was not differentiated between different road types at this point in time. However, selecting only certain road types may be more appropriate at the local scale. Table 5 shows the total length of roads within each zone by LGA, while Table 6 lists the information by zone and shows that the longest section of roads runs between 50-60m from the coast.

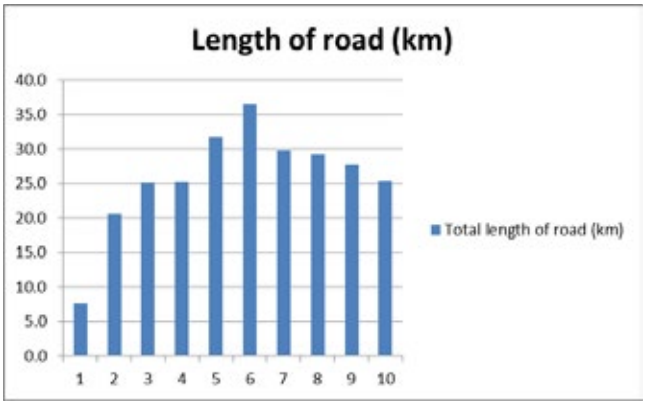
Table 5: Length of Roads per Zone by LGA *

| Zone | LGA_NAME | Length (m) | Zone | LGA_NAME | Length (m) | Zone | LGA_NAME | Length (m) |
|---|---|---|---|---|---|---|---|---|
| 1 | BAYSIDE | 25.5 | 5 | BAYSIDE | 1593.4 | 8 | BAYSIDE | 2669.9 |
| 1 | FRANKSTON | 25.0 | 5 | FRANKSTON | 403.5 | 8 | FRANKSTON | 393.3 |
| 1 | GREATER GEELONG | 2036.2 | 5 | GREATER GEELONG | 7650.3 | 8 | GREATER GEELONG | 5810.1 |
| 1 | HOBSONS BAY | 696.8 | 5 | HOBSONS BAY | 2155.7 | 8 | HOBSONS BAY | 1589.4 |
| 1 | KINGSTON | 1507.3 | 5 | KINGSTON | 5183.4 | 8 | KINGSTON | 3860.2 |
| 1 | MELBOURNE | 2578.2 | 5 | MELBOURNE | 1886.1 | 8 | MELBOURNE | 2765.3 |
| 1 | ORNINGTON PENINSU | 289.2 | 5 | MORNINGTON PENINSULA | 8537.4 | 8 | MORNINGTON PENINSULA | 9448.0 |
| 1 | QUEENSCLIFFE | 357.7 | 5 | PORT PHILLIP | 339.7 | 8 | PORT PHILLIP | 151.6 |
| 1 | WYNDHAM | 109.6 | 5 | QUEENSCLIFFE | 892.8 | 8 | QUEENSCLIFFE | 1560.4 |
| **Total** | | **7625.6** | 5 | WYNDHAM | 3089.2 | 8 | WYNDHAM | 982.2 |
| 2 | BAYSIDE | 187.3 | **Total** | | **31731.5** | **Total** | | 29230.6 |
| 2 | FRANKSTON | 20.7 | 6 | BAYSIDE | 2126.2 | 9 | BAYSIDE | 2676.4 |
| 2 | GREATER GEELONG | 7522.0 | 6 | FRANKSTON | 300.0 | 9 | FRANKSTON | 442.9 |
| 2 | HOBSONS BAY | 2389.1 | 6 | GREATER GEELONG | 6337.3 | 9 | GREATER GEELONG | 5523.3 |
| 2 | KINGSTON | 1680.0 | 6 | HOBSONS BAY | 2045.1 | 9 | HOBSONS BAY | 1474.6 |
| 2 | MELBOURNE | 4519.6 | 6 | KINGSTON | 6814.7 | 9 | KINGSTON | 3557.6 |
| 2 | ORNINGTON PENINSU | 1546.9 | 6 | MELBOURNE | 2510.8 | 9 | MELBOURNE | 3794.1 |
| 2 | PORT PHILLIP | 101.6 | 6 | MORNINGTON PENINSULA | 11228.2 | 9 | MORNINGTON PENINSULA | 7430.3 |
| 2 | QUEENSCLIFFE | 828.5 | 6 | PORT PHILLIP | 137.0 | 9 | PORT PHILLIP | 125.8 |
| 2 | WYNDHAM | 1758.0 | 6 | QUEENSCLIFFE | 1720.5 | 9 | QUEENSCLIFFE | 2192.1 |
| **Total** | | **20553.6** | 6 | WYNDHAM | 3294.0 | 9 | WYNDHAM | 517.4 |
| 3 | BAYSIDE | 505.6 | **Total** | | **36513.8** | **Total** | | **27734.5** |
| 3 | FRANKSTON | 147.5 | 7 | BAYSIDE | 2534.8 | 10 | BAYSIDE | 2325.3 |
| 3 | GREATER GEELONG | 9519.5 | 7 | FRANKSTON | 217.1 | 10 | FRANKSTON | 665.4 |
| 3 | HOBSONS BAY | 3537.8 | 7 | GREATER GEELONG | 5864.3 | 10 | GREATER GEELONG | 5156.1 |
| 3 | KINGSTON | 2242.7 | 7 | HOBSONS BAY | 1654.6 | 10 | HOBSONS BAY | 1524.0 |
| 3 | MELBOURNE | 1897.0 | 7 | KINGSTON | 5437.6 | 10 | KINGSTON | 3323.3 |
| 3 | ORNINGTON PENINSU | 1871.7 | 7 | MELBOURNE | 2780.8 | 10 | MELBOURNE | 2574.3 |
| 3 | PORT PHILLIP | 367.4 | 7 | MORNINGTON PENINSULA | 8574.6 | 10 | MORNINGTON PENINSULA | 7353.6 |
| 3 | QUEENSCLIFFE | 719.2 | 7 | PORT PHILLIP | 178.7 | 10 | PORT PHILLIP | 118.8 |
| 3 | WYNDHAM | 3688.4 | 7 | QUEENSCLIFFE | 1371.3 | 10 | QUEENSCLIFFE | 1894.4 |
| **Total** | | **24496.8** | 7 | WYNDHAM | 1196.2 | 10 | WYNDHAM | 408.1 |
| 4 | BAYSIDE | 878.5 | **Total** | | **29809.8** | **Total** | | **25343.3** |
| 4 | FRANKSTON | 320.3 | | | | | | |
| 4 | GREATER GEELONG | 8348.1 | | | | | | |
| 4 | HOBSONS BAY | 2211.1 | | | | | | |
| 4 | KINGSTON | 2881.4 | | | | | | |
| 4 | MELBOURNE | 1941.6 | | | | | | |
| 4 | ORNINGTON PENINSU | 3931.9 | | | | | | |
| 4 | PORT PHILLIP | 122.8 | | | | | | |
| 4 | QUEENSCLIFFE | 1082.1 | | | | | | |
| 4 | WYNDHAM | 3440.1 | | | | | | |
| **Total** | | **25157.9** | | | | | | |

* All road types listed in Figure 6 below are included in this analysis.

Table 6: Length of Roads per Zone*

| Zone | Total length of road (km) |
|---|---|
| 1 | 7.6 |
| 2 | 20.6 |
| 3 | 25.2 |
| 4 | 25.2 |
| 5 | 31.7 |
| 6 | 36.5 |
| 7 | 29.8 |
| 8 | 29.2 |
| 9 | 27.7 |
| 10 | 25.3 |
| All Zones Total | 258.9 |




* All road types listed in Figure 6 below are included in this analysis.

In summary, the total length of all roads is nearly 30% less in Scenario B than is in Scenario A (358km).


Figure 6: Road types included in Vicmap Roads GIS data layer.

Other information that would add value to the analysis is information about road ownership / management, cost for construction or repair, height of road. For example, chance of being inundated and therefore cutting certain areas with single road access off, maintenance cost, or history of repair/maintenance.

### 1.4.4 Vicmap Rail

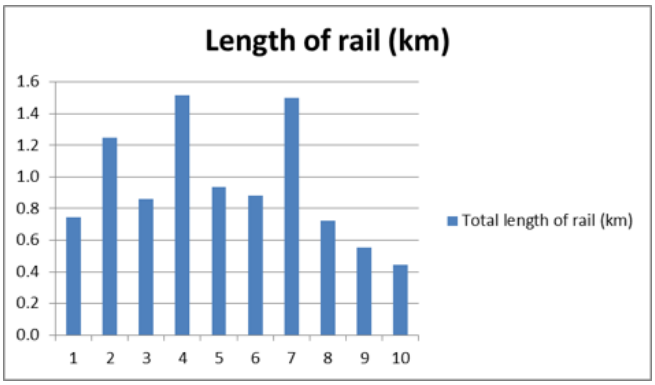
*Format of data: lines*

This layer is also part of Vicmap Transport and contains information about railway features, including railway yards, railway bridges, railway tunnels, railways and tramways.

Similar to the Vicmap Roads data layer, the Vicmap Rail data were analysed for the total length of rail per zone. It was not differentiated between different rail types in this initial analysis phase.

Table 7: Length of Rail per Zone *

| Zone | Total length of rail (km) |
|---|---|
| 1 | 0.7 |
| 2 | 1.2 |
| 3 | 0.9 |
| 4 | 1.5 |
| 5 | 0.9 |
| 6 | 0.9 |
| 7 | 1.5 |
| 8 | 0.7 |
| 9 | 0.6 |
| 10 | 0.4 |
| **All Zones Total** | **9.4** |




In summary, the total length of rail features is about 9.4km. This compares with 10.2km of rail features for Scenario A.

### 1.4.5 Vicmap Features of Interest

*Format of data: points*

The Vicmap Features of Interest data layer is a spatial data layer that consists of a range of features such as education centres, community centres, care facilities, emergency facilities, power facilities, towers, landmarks, geographical and locality points. These are features that are not included in other Vicmap products. This data layer could therefore be described as an accumulation of features not belonging to other Vicmap data layers (Figure 7).


Figure 7: Vicmap Features of Interest Feature Types

The *Vicmap Features of Interest* data layer contains a range of assets. Analysis was undertaken to assess the number of individual features a) for all zones combined and b) per individual zone. Table 8 shows the total number of features within ALL zones combined, Table 9 for each zone. It may be more suitable to group these features into different classes or agree on a more suitable naming convention. It is understood from the product description for this data layer that many feature classes are incomplete. Missing information may therefore have to be sourced from other organisations or collected, if required for local assessments.

Table 8: Total number of Features of Interest for all Zones combined

| FEATSUBTYP | FREQUENCY | | FEATSUBTYP | FREQUENCY |
|---|---|---|---|---|
| adit (entrance to mine) | 2 | | office | 2 |
| boating club | 1 | | playground | 19 |
| club house | 3 | | police station | 1 |
| coast guard | 4 | | retirement village | 1 |
| fire station | 1 | | rotunda | 2 |
| fire station (forest industry) | 1 | | secondary school | 2 |
| hall | 1 | | senior citizens | 1 |
| lifesaving club | 13 | | survey monument | 2 |
| monument | 1 | | tank | 2 |
| neighbourhood safer place | 2 | | tourist information centre | 1 |

Table 9: Frequency of Features of Interest per Zone

| Zone | FEATSUBTYP | FREQUENCY | | Zone | FEATSUBTYP | FREQUENCY |
|---|---|---|---|---|---|---|
| 1 | adit (entrance to mine) | 1 | | 6 | lifesaving club | 2 |
| 2 | club house | 1 | | 6 | playground | 3 |
| 2 | survey monument | 1 | | 6 | tourist information centre | 1 |
| 3 | adit (entrance to mine) | 1 | | 7 | coast guard | 1 |
| 3 | boating club | 1 | | 7 | lifesaving club | 1 |
| 3 | coast guard | 1 | | 7 | office | 1 |
| 3 | monument | 1 | | 7 | playground | 4 |
| 3 | office | 1 | | 8 | fire station | 1 |
| 3 | rotunda | 1 | | 8 | fire station (forest industry) | 1 |
| 4 | coast guard | 1 | | 8 | lifesaving club | 2 |
| 4 | lifesaving club | 3 | | 8 | neighbourhood safer place | 1 |
| 4 | playground | 2 | | 8 | playground | 3 |
| 5 | club house | 2 | | 8 | retirement village | 1 |
| 5 | lifesaving club | 3 | | 8 | senior citizens | 1 |
| 5 | playground | 1 | | 10 | coast guard | 1 |
| 5 | rotunda | 1 | | 10 | hall | 1 |
| 6 | lifesaving club | 2 | | 10 | police station | 1 |
| 6 | neighbourhood safer place | 1 | | 10 | secondary school | 2 |
| 6 | playground | 6 | | 10 | tank | 2 |
| 6 | survey monument | 1 | | | | |

### 1.4.6 Boating Facilities

*Format of data: points*

This GIS data layer shows the geographic location of boating facilities in Port Phillip Bay. These point features include boat clubs, boat ramps, jetties, marinas, piers and other features and is currently being finalised. The boating facilities data layer was made available by the Central Coastal Board. It was analysed for individual facility types by zone.

Table 10 shows the type of boating facility and frequency per zone. This data layer contains information about the number of lanes per boat ramp, general facilities such as club house, toilet block and safety access among others.

Table 10: Frequency and Type of Boating Facilities per Zone

| Zone | TYPE | FREQUENCY | Zone | TYPE | FREQUENCY |
|---|---|---|---|---|---|
| 1 | Boat Ramp | 7 | 5 | Marina | 1 |
| 1 | Informal | 1 | 5 | Multipurpose | 2 |
| 1 | Marina | 1 | 5 | Yacht Club | 3 |
| 1 | Multipurpose | 3 | 6 | Multipurpose | 1 |
| 1 | Yacht Club | 1 | 6 | Yacht Club | 1 |
| 2 | Multipurpose | 1 | 7 | Multipurpose | 1 |
| 2 | Yacht Club | 4 | 7 | Yacht Club | 2 |
| 3 | Boat Ramp | 1 | 8 | Marina | 1 |
| 3 | Informal | 1 | 8 | Yacht Club | 4 |
| 3 | Yacht Club | 2 | 9 | Marina | 1 |
| 4 | Marina | 1 | 9 | Multipurpose | 2 |
| 4 | Multipurpose | 1 | 9 | Pier/Jetty | 1 |
| 4 | Yacht Club | 2 | 10 | Multipurpose | 2 |
| 5 | Jetty | 1 | | | |

Additional information of value would include the number of wet- and dry berths, number of car parks adjacent to each boat ramp, or direction/exposure of ramp (such as main wind or wave direction or accessibility during low or high tide).

### 1.4.7 RAMSAR Wetland Areas

*Format of data: polygon*

This layer defines Ramsar wetland areas in Port Phillip Bay. The layer is based on the RAMSAR100 layer (scale 1:100,000) but has been realigned and updated to improve its accuracy. It has been updated to match current Vicmap parcel, road, hydro and water area data as well as using high-resolution digital aerial photography to improve its precision to 1:25 000.

RAMSAR wetlands are low-lying areas and are therefore more likely affected by (temporary) coastal inundation which is likely to extend much further inland than the modelled 100m. An initial analysis of the length of RAMSAR wetland coastline per LGA is show below in Table 11. Figure 8 below shows the mapped RAMSAR wetlands for Port Phillip Bay, including the 5m (blue) and 10m (red) contour AHD.

Table 11: Length of RAMSAR shoreline by LGA. Note: only Geelong, Queenscliffe and Wynham have RAMSAR site within their jurisdiction in Port Phillip Bay.

| LGA | Length (km) |
|---|---|
| Geelong | 67.2 |
| Queenscliffe | 7.7 |
| Wyndham | 15.4 |

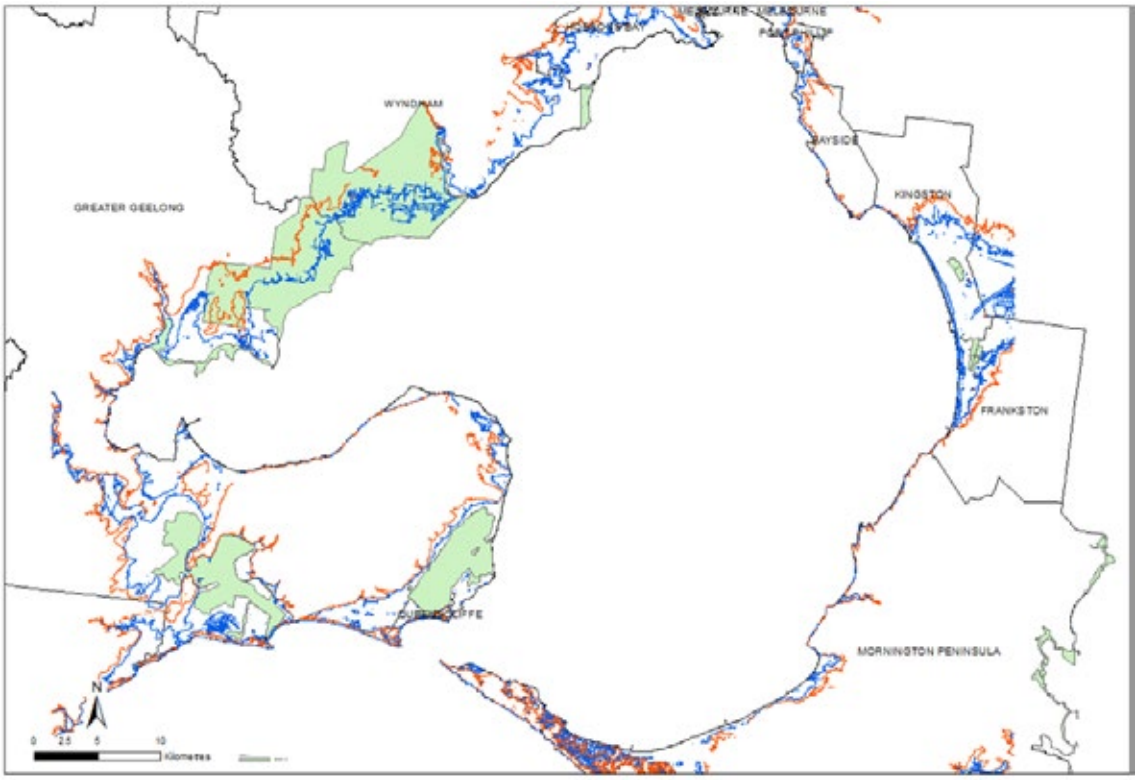



Figure 8: RAMSAR sites in Port Phillip Bay.

### 1.4.8 Public Land Management

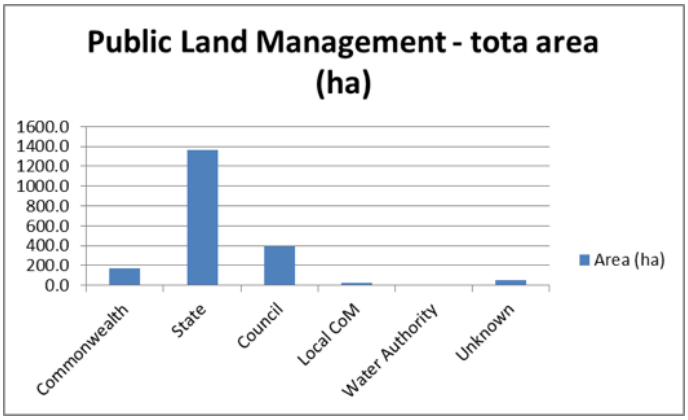
*Format of data: polygon*

The Public Land Management data layer was analysed for total area combined in all ten zones and their respective managers.

Table 12 gives an overview of the key land managers and the total area they manage within 100m of the coast along Port Phillip Bay. The key management authorities are state government authorities, followed by council and commonwealth.

Table 12: Total area (ha) of Public Land affected for all Zones

| Management | Area (ha) |
|---|---|
| Commonwealth | 170.7 |
| State | 1369 |
| Council | 389.8 |
| Local CoM | 19.7 |
| Water Authority | 0.0 |
| Unknown | 52.4 |
| **Total area (ha)** | **2002** |




The total area managed by these authorities is about 2,000ha which compares with a total area of about 2,350ha for Scenario A, refer Table 13 for details.

Table 13: Total area (ha) of Public Land affected for all Zones for Scenario A

| Management | Area (ha) |
|---|---|
| Commonwealth | 182.1 |
| State | 1478 |
| Council | 601.5 |
| Local CoM | 22.9 |
| Water Authority | 15.5 |
| Unknown | 53.2 |
| **Total area (ha)** | 2353 |

Of interest for this data layer is the length of coastline per land manager, however, the coastline does not always overlap spatially with land manager information. This could have a number of reasons, including inaccuracies in the spatial data layers land management of those sections has not been mapped yet. This needs to be investigated further in time for a local assessment (refer Figure 9).

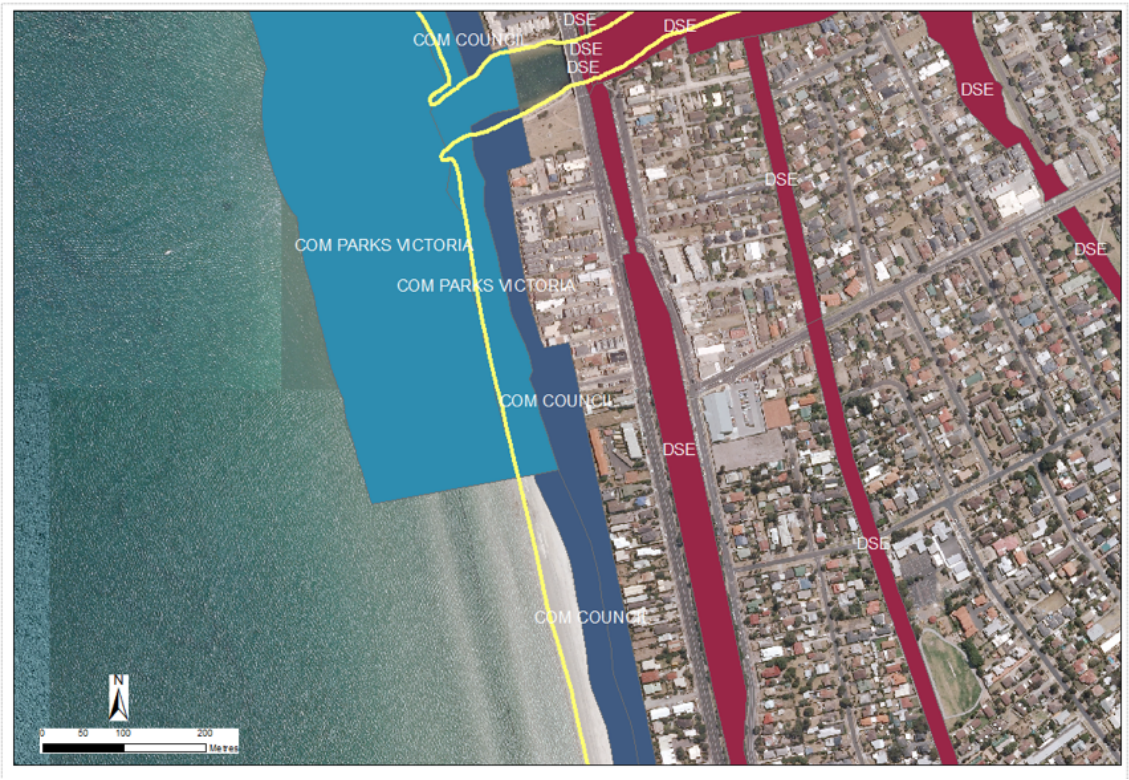



Figure 9: Land Management (here North Aspendale), showing that some sections of coastline (yellow line) do not overlap with the land manager layer.

### 1.4.9 VEAC Reserves

*Format of data: polygon*

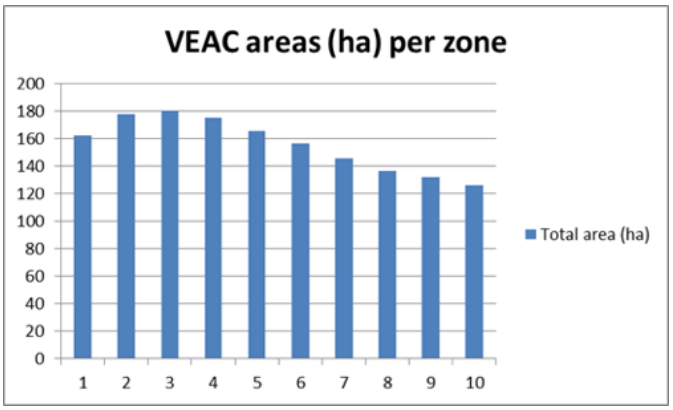
The VEACRECS25 layer shows the public land use for each Crown parcel. It portrays recommendations resulting from studies conducted by the Victorian Environmental Assessment Council (and former Environment Conservation Council and Land Conservation Council). Recommendations shown are as approved or varied by Government, and include subsequent formal amendments and revocations. Land use categories have been assigned to all Crown land parcels. The Vicmap Property layer was used as the base. Boundaries are based on the best available information at the time.

The VEAC Reserves data layer was analysed for the total area per zone (in ha).

Table 14 shows the total area within each zone. The area per zone decreases gradually with distance from the 0m contour. The total area for this scenario is 1559 ha, compared with 1854 ha for Scenario A.

Table 14: Total area of VEAC reserves per Zone

| Zone | Total area (ha) |
|---|---|
| 1 | 163 |
| 2 | 178 |
| 3 | 181 |
| 4 | 175 |
| 5 | 166 |
| 6 | 157 |
| 7 | 146 |
| 8 | 136 |
| 9 | 132 |
| 10 | 126 |
| **Total** | **1559** |



# Action 02
# Spatial Analysis of area and volume between 0m contour AHD and different landward extents

## 2.1 Introduction

The purpose of this action was to introduce different GIS methodologies to determine information about the area and sand volume from the 0m contour AHD (or approximately mean sea level) to different landward extents by means of three different approaches. The DEPI Future Coasts LiDAR Digital Elevation Model (DEM) and DEPI aerial photography was utilised in a Geographic Information System (GIS) to calculate area of beach/dune and sediment volume along a section of the Port Phillip Bay shoreline. Similar to Action 1, information about physical processes or hazards, including sediment transport rates, wave impacts, shoreline erosion rates or other such information was not available. The approach used here is of generic and demonstrative nature.

This report describes the modelling approaches and their application by means of an example for the Aspendale Beach area, by way of demonstration only. Aspendale was selected because it is a sandy beach with dune heights greater than 5 metres within close proximity to the shoreline. These methods can be applied elsewhere around Port Phillip Bay and are substantially enhanced if coupled with information about coastal processes and coastal hazard information.

## 2.2 Datasets utilised

Four key datasets were utilised for the work undertaken here, these being:

- VICMAP Coastal Elevation 1m (also known as Future Coasts Topographic LiDAR DEM)
- Aerial imagery for the Port Phillip Bay region (2007)
- Geoscience Australia Smartline coastal geomorphic mapping
- Geology

Other data layers utilised were:

- Vicmap Property
- Vicmap Roads
- DEPI Coastal Protection Structures

### 2.2.1 Vicmap Elevation - Coastal Topographic 1m DEM and 0.5m Contours (Future Coasts LiDAR DEM)

The Vicmap Coastal DEM is a high resolution representation of natural landform features along the coast of Victoria. It was captured at 1m grid resolution and contour lines with an interval of 50cm. Data was collected as part of DEPI's Future Coasts Program, using a plane fitted with a laser scanner. The data can be utilised for applications such as sea level rise modelling, landscape analysis, planning, hazard mitigation and environmental modelling. The vertical accuracy of the dataset is on average accurate to within +/-15cm and is currently the best available information for all of Port Phillip Bay. The data represent the elevation of the land, eg. trees, houses and other features above the ground were removed from the raw data capture. The data was made available for this project by DEPI as a series of over 320 2x2km tiles. These individual tiles were merged into a seamless DEM of approximately 20 Gigabyte in size (refer Figure 10). As shown in Figure 1, the dataset contains gaps, and efforts are being made to fill these.

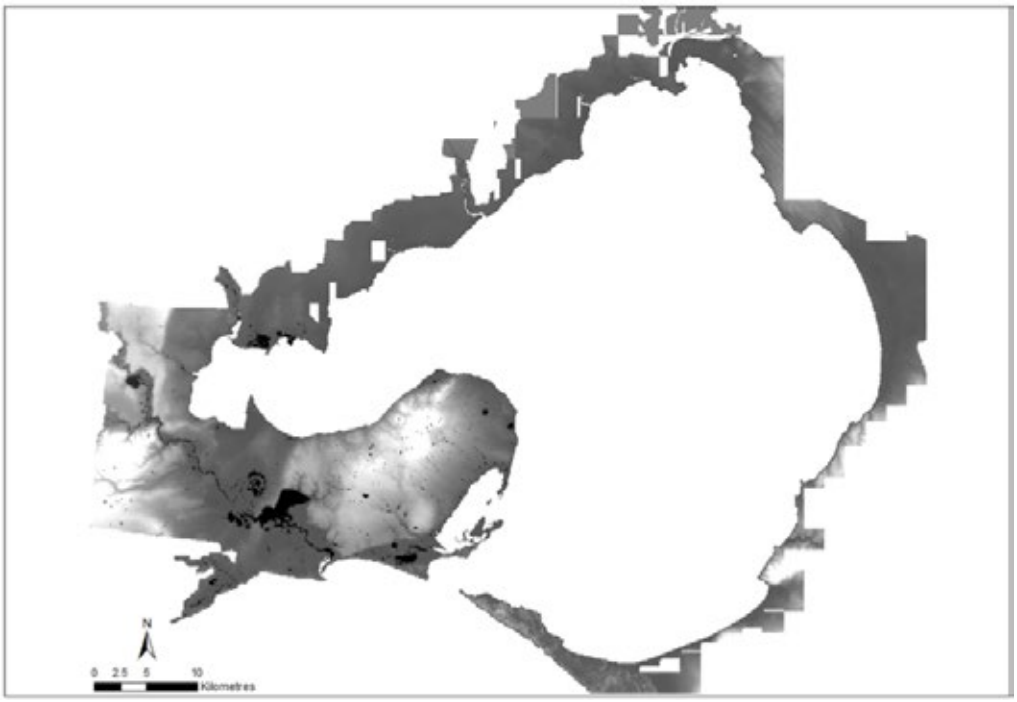



Figure 10: Vicmap Elevation Coastal Topographic 1m DEM mosaic (Source: DEPI Vicmap).

### 2.2.2 2006/2007 Port Phillip Region and Urban Development Project Imagery

This image was captured as part of the DEPI Coordinated Imagery Program (CIP) in November 2006 and covers the Melbourne and Geelong Metropolitan areas and Mornington Peninsula. The dataset has an on-ground resolution of 0.35m (each pixel being 35x35 cm in size) and a spatial accuracy of about 1-2m (ie, a feature shown on the image may be within a radius of 1-2m from where it is show on the image). It was delivered as a single image of approximately 20 Gigabyte in size (refer Figure 11).

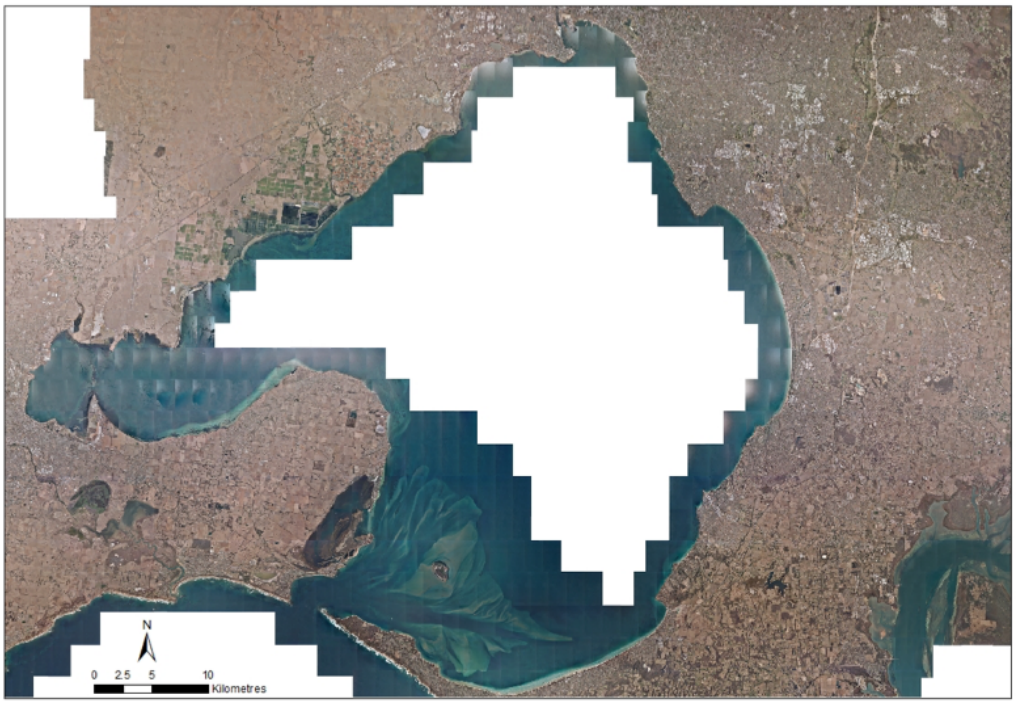



Figure 11: 2007 Port Phillip Bay aerial image (Source: DEPI Coordinated Imagery Program)

### 2.2.3 *Smartline* Coastal Geomorphological Mapping

The *Smartline* Coastal Geomorphic Map of Australia is a detailed map of the coastal landform types ('geomorphology') of continental Australia and most adjacent islands (excluding the Great Barrier Reef). As a geomorphic map, it represents the topography of the coast. It also indicates the composition of differing coastal landforms – varying rock types, sand, mud, boulders, beach rock, and so on. The map classifies coastal landforms into differing combinations of form and material. This in turn is indicative of the differing natural processes by which each coastal landform has developed.

*Smartline* represents this information in the form of a single line map representing the coastline, split into segments wherever the coastal landform type changes. Each distinctive segment of the shoreline is tagged or attributed with multiple attribute fields describing the landform types of that segment of the coast. The coastal characteristics recorded refer to those at the precise location of the line itself (typically High Water Mark); a coastal zone nominally extending up 500m inland; and offshore of the High Water Mark. The line can be divided into long or short segments representing different coastal landforms, allowing the Smartline to record variations in coastal type to a high degree of detail.

### 2.2.4 DEPI Geology 1:250,000

This dataset contains primary geological data, namely outcropping/sub-cropping geological rock units and boundary types separating rock units. Other geological features (e.g. fault or dyke) are included where the feature forms a boundary to rock units. The data has been collected by the Geological Survey of Victoria. Although at a coarse scale of 1:250,000, it is currently the best bay-wide geological mapping and provides basic information about soft versus hard rock shorelines.

## 2.3 Modelling approaches

Three different modelling approaches are demonstrated for this task. The purpose is to assess the suitability of different GIS modelling approaches in combination with readily available spatial data.

Given the absence of detailed hazard information, the models are for demonstrative purposes only and have the intention to explain how a GIS can be used in combination with readily available data to model and map the impacts of coastal hazards.

The modelling and therefore quality of the outputs would be improved with additional hazard information and other local information such as past behaviour of the coast, magnitudes and erosion rates of coastal storms, beach monitoring information, information about sand grain sizes or other local data available. In the absence of this information the approach can only be described in generic terms and the most suitable approach (or combination of approaches) needs to be determined for individual local assessments.

The three approaches can be summarised as follows:

**APPROACH 1:** Determination of the seaward-most extent of infrastructure along the bay and calculation of the area and volume of the zone between this line and the 0m contour AHD (refer Figure 12 for a conceptual sketch). This approach focusses on the area and volume of the land between the 0m contour and existing assets/infrastructure.

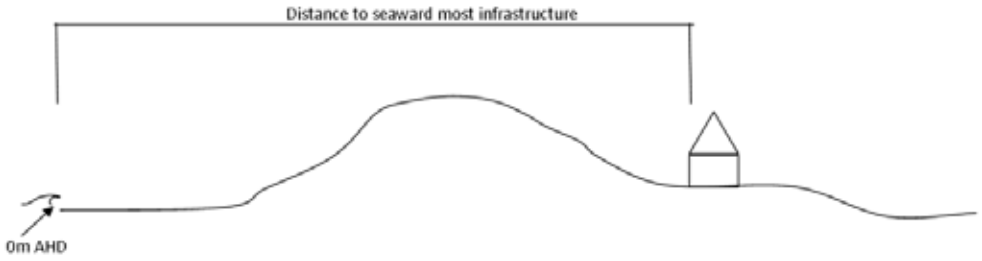



Figure 12: Approach 1 - calculation of area and volume between 0m contour AHD and assets/infrastructure closest to 0m contour AHD.

**APPROACH 2:** Modelling of horizontal 5m zones starting at the 0m contour AHD to a given inland distance (for this example 100m inland from the shoreline). Calculation of the area and volume per (horizontal) zone, ie 0-5m, 0-10m, 0-15m, etc.. This approach was used to determine area and volume per 5m zone and is considered to be suitable for long, flat profiles where the height of the land changes slowly (refer Figure 13 for a conceptual sketch).

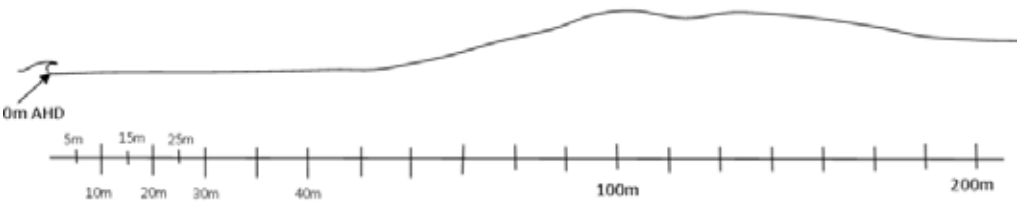



Figure 13: Approach 2 - area and available volume calculations in 5m horizontal intervals landward from the 0m contour AHD.

## APPROACH 3:

Modelling of zones based on height and distance between the 0m contour AHD and higher elevations (here 0.5m intervals to a height of 5m AHD). This approach uses changes in elevation in contrast to horizontal distances used for Approach 2. The calculation of the area and volume for this third approach is based on 0.5m height intervals, ie, 0-0.5m AHD, 0-1.0m AHD, 0-1.5m AHD, 0-2.0m AHD, 0-2.5m, ..., 0-5.0m (refer Figure 14 for a conceptual sketch). This approach is considered more suitable for short, steep profiles where the height of the land changes quickly.


Figure 14: Approach 3 - area and available volume calculations in 0.5m vertical intervals landward from the 0m contour AHD.

Each approach generates a series of GIS data layers with information about area and volume per area modelled.

*Note: It must be emphasised that no consideration was given to the effects of coastal processes or hazards due to the lack of such information. All modelling results are therefore of a conceptual nature. However, if combined with measured or modelled information about coastal processes or hazards, each approach is considered more suitable for coastal risk assessments than at present.*

### GIS MODELLING METHOD:

An aerial image of Port Phillip Bay image was utilised to trace a new GIS layer showing the approximate landward boundary of existing infrastructure or property boundaries, termed 'infrastructure free zone' in this report. A number of areas (polygons) were created for Port Phillip Bay and the area at Aspendale chosen for this modelling example. The extent of the area chosen for this example has a shoreline length of 3.27km and an area of 17.6 hectares (refer Figure 15).

Figure 15: Extent of infrastructure free zone utilised for this modelling example for the Aspendale area. The entire area shown in yellow was modelled. The insert shows a close-up of part of the area.

This zone was used to extract height values from the Vicmap Coastal Elevation LiDAR DEM to the extent shown in Figure 17.

## 2.4 Detailed Methodology

### 2.4.1 Approach 1: Calculation of area and volume between 0m contour AHD and infrastructure closest to shoreline

**PURPOSE:**

To calculate the area and volume between the 0m contour and infrastructure closest to the shoreline (called 'infrastructure free zone' for the purpose of this report).

As shown in the conceptual sketches in Figure 12 and Figure 16, this model was used to provide an estimate of the area and volume of sand for the area between the shoreline and existing infrastructure.

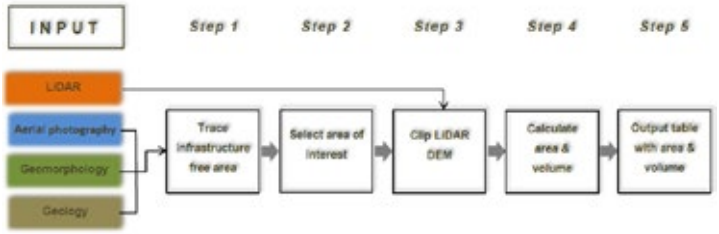



Figure 16: Conceptual sketch showing methodology of Approach 1


Figure 17: Clipped Vicmap Elevation LiDAR DEM

The GIS was then utilised to calculate area and volume of the extracted DEM (here above 0m AHD). This function calculates the area and the total volume. Table 15 below shows the results of this analysis. The area chosen for this example has a volume of about 288,000$m^3$ for the entire area.

Table 15: Area and volume calculations for the Aspendale example.

| Refernce Height (m) | Reference | Area (ha) | Volume (m3) |
|---|---|---|---|
| 0 | ABOVE | 17 | 288,771 |

Having calculated the available volume for the entire area of interest, it is possible to use these values to determine an average volume of sand per metre beach. These values are often utilised in conjunction with storm demands (for example, a 1 in 50-year storm in area A erodes approximately X $m^3$ of sand per meter beach). These calculations are shown in Table 16.

Table 16: Calculation of average sand volume per metre beach

| Length of Shoreline (m) | Total volume for entire section (m3) | Average Volume (m3) per metre beach |
|---|---|---|
| 3277 | 288771 | 88.1 |

The average volume of sand per metre beach is approximately 88$m^3$.

By way of comparison, storms that eroded the New South Wales coast in 1974 were estimated to have had a storm demand of approximately 200-250m3 per meter beach. Such information does not appear to exist for Victoria. However, having information about storm demand and average dune height allows for a quick calculation of approximate coastal recession rates.

Nevertheless, caution must be taken when using these results, in particular in areas where the width of the 'infrastructure free zone' or the dune height changes significantly along a section of the shoreline. To get value from these calculations, detailed local knowledge, historical information, observations and/or process model results need to be taken into account.

### 2.4.2 Approach 2: Modelling of horizontal 5m zones landward of the 0m contour

#### PURPOSE:

To calculate the area and volume in 5m intervals landward from the 0m contour (see Figure 13 and Figure 18).

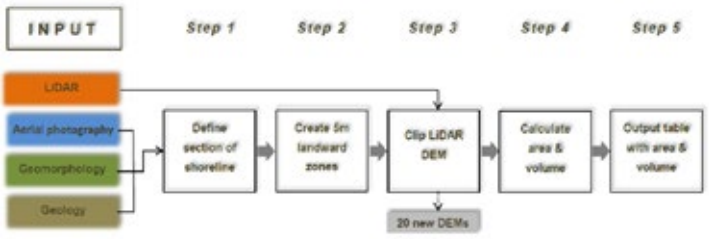



Figure 18: Conceptual sketch showing methodology of Approach 2

#### GIS MODELLING METHOD:

This approach uses the Vicmap Coastal Elevation LiDAR DEM in combination with the aerial image, geomorphology and geology layers. The first step is to define the section of shoreline of interest, here a 3.27km long section along Aspendale Beach (Figure 19).

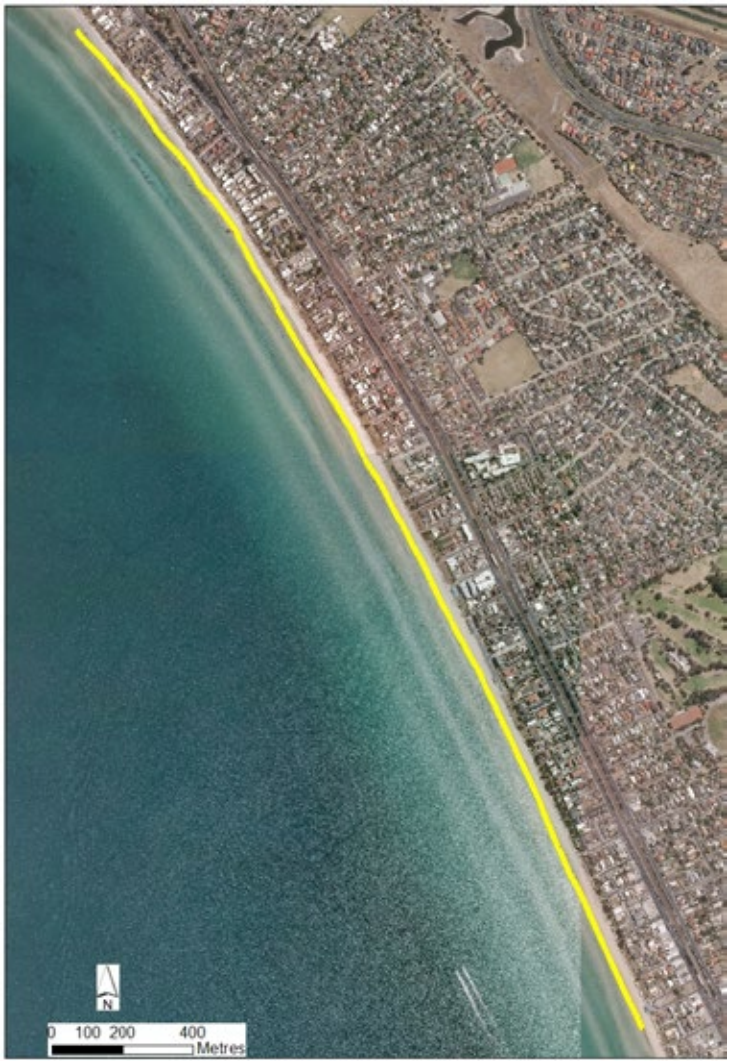



Figure 19: Section of shoreline included in the modelling.

GIS functions are then used to calculate the cumulate impacts to 100m distance from the 0m contour AHD, in 5m increments, ie, 0-5m, 0-10m, 0-15m, ..., 0-100m, as shown in Figure 20.


Figure 20: 5m horizontal zones landward of 0m contour AHD to determine width and volume per zone. Insert showing zoomed-in section of the area of interest.

Each zone is then used to calculate the cumulate area and volume to 100m from the shoreline. The results of those calculations are shown in Table 17.

Table 17: GIS calculations for area and volume for 5m horizontal increments to 100m from the 0m contour AHD.

| Zone | Horizontal Distance from 0m contour AHD | Area (ha) | Volume (m3) |
|---|---|---|---|
| 1 | 0 -5 | 1.1 | 3025.9 |
| 2 | 0 -10 | 2.7 | 10901.3 |
| 3 | 0 - 15 | 4.4 | 22249.5 |
| 4 | 0 - 20 | 6.0 | 37300.1 |
| 5 | 0 - 25 | 7.6 | 56828.5 |
| 6 | 0 - 30 | 9.3 | 81725.2 |
| 7 | 0 - 35 | 10.9 | 112235.7 |
| 8 | 0 - 40 | 12.6 | 148734.0 |
| 9 | 0 - 45 | 14.2 | 191297.2 |
| 10 | 0 - 50 | 15.8 | 240610.5 |
| 11 | 0 - 55 | 17.5 | 296705.0 |
| 12 | 0 - 60 | 19.1 | 356872.8 |
| 13 | 0 - 65 | 20.8 | 418312.4 |
| 14 | 0 - 70 | 22.4 | 479434.9 |
| 15 | 0 - 75 | 24.1 | 540142.2 |
| 16 | 0 - 80 | 25.7 | 600742.4 |
| 17 | 0 - 85 | 27.4 | 661159.1 |
| 18 | 0 - 90 | 29.0 | 721424.4 |
| 19 | 0 - 95 | 30.7 | 781726.4 |
| 20 | 0 - 100 | 32.3 | 842828.1 |

Similar to Approach 1, this information can be used to determine an approximate average volume (m3) per metre beach per zone, as shown in Table 18.

Table 18: GIS Volume calculation output for volume per zone and metre shoreline.

| Zone | Horizontal Distance from 0m contour AHD | Volume per Zone (m3) | Average volume (m3) per metre shoreline |
|---|---|---|---|
| 1 | 0 -5 | 3025.9 | 0.9 |
| 2 | 0 -10 | 10901.3 | 3.3 |
| 3 | 0 - 15 | 22249.5 | 6.8 |
| 4 | 0 - 20 | 37300.1 | 11.4 |
| 5 | 0 - 25 | 56828.5 | 17.3 |
| 6 | 0 - 30 | 81725.2 | 24.9 |
| 7 | 0 - 35 | 112235.7 | 34.2 |
| 8 | 0 - 40 | 148734.0 | 45.4 |
| 9 | 0 - 45 | 191297.2 | 58.4 |
| 10 | 0 - 50 | 240610.5 | 73.4 |
| 11 | 0 - 55 | 296705.0 | 90.5 |
| 12 | 0 - 60 | 356872.8 | 108.9 |
| 13 | 0 - 65 | 418312.4 | 127.7 |
| 14 | 0 - 70 | 479434.9 | 146.3 |
| 15 | 0 - 75 | 540142.2 | 164.8 |
| 16 | 0 - 80 | 600742.4 | 183.3 |
| 17 | 0 - 85 | 661159.1 | 201.8 |
| 18 | 0 - 90 | 721424.4 | 220.1 |
| 19 | 0 - 95 | 781726.4 | 238.5 |
| 20 | 0 - 100 | 842828.1 | 257.2 |

Like the modelling for Approach 1, this approach did not take into consideration any information about coastal processes or the frequency or magnitude of coastal hazards and is therefore conceptual. Similar to Approach 1, this GIS Model can be used for coastal risk assessments, provided sufficiently detailed information is available describing coastal processes.

### 2.4.3 Approach 3: Modelling of vertical 0.5m zones above the 0m contour AHD

#### PURPOSE:

To calculate the area and volume between the 0m contour and different heights. As shown in the conceptual sketch in Figure 14 and Figure 21, this approach is used to estimate the area and volume of sand per 0.5m vertical increment above mean sea level.

#### GIS MODELLING METHOD:

Like Approach 2, this approach uses the Vicmap LiDAR DEM in combination with the aerial image, geomorphology and geology layers (refer conceptual sketch in Figure 21).

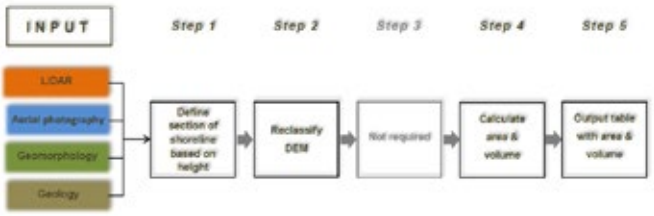



Figure 21: Conceptual sketch showing methodology of Approach 3

The first step in this modelling approach is to reclassify and create subsets of the LiDAR DEM at 0.5m height intervals, ie, 0-0.5m, 0-1m, 0-1.5m, etc. (Figure 22), to create new subset DEMs (ten for this example). Area and volume per newly created DEM are then calculated and tabulated (Table 19).

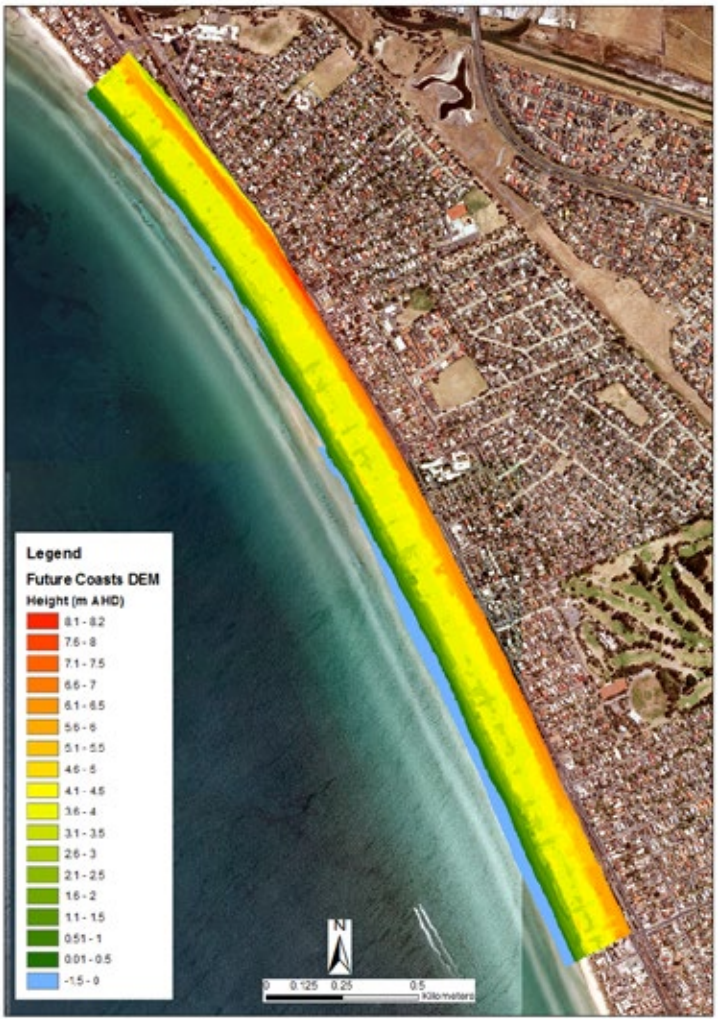



Figure 22: Classification of the Future Coasts DEM in 0.5m (vertical) intervals.

Table 19: GIS Volume calculation output for area and volume per height interval

| Height (m AHD) | Plane_Height | Reference | Area (m2) | Volume (m3) |
|---|---|---|---|---|
| 0-0.5 | 0 | ABOVE | 32501 | 7713 |
| 0-1.0 | 0 | ABOVE | 63162 | 28917 |
| 0-1.5 | 0 | ABOVE | 90161 | 62211 |
| 0-2.0 | 0 | ABOVE | 109886 | 94608 |
| 0-2.5 | 0 | ABOVE | 136362 | 152351 |
| 0-3.0 | 0 | ABOVE | 155318 | 202773 |
| 0-3.5 | 0 | ABOVE | 185499 | 300762 |
| 0-4.0 | 0 | ABOVE | 384182 | 1038779 |
| 0-4.5 | 0 | ABOVE | 471148 | 1400151 |
| 0-5.0 | 0 | ABOVE | 495514 | 1513996 |

As shown for Approaches 1 and 2, this approach can also be used to determine an approximate average volume ($m^3$) per metre beach per zone, as shown in Table 20.

Table 20: GIS Volume calculation output for area and volume per zone.

| Height (m AHD) | Volume (m3) | Average volume (m3) per metre shoreline |
|---|---|---|
| 0-0.5 | 7713 | 2.4 |
| 0-1.0 | 28917 | 8.8 |
| 0-1.5 | 62211 | 19.0 |
| 0-2.0 | 94608 | 28.9 |
| 0-2.5 | 152351 | 46.5 |
| 0-3.0 | 202773 | 61.9 |
| 0-3.5 | 300762 | 91.8 |
| 0-4.0 | 1038779 | 317.0 |
| 0-4.5 | 1400151 | 427.3 |
| 0-5.0 | 1513996 | 462.0 |

As described for Approaches 1 and 2, this approach is also of conceptual nature since it does not take into consideration any information about coastal processes or direction, frequency or magnitude of hazards.

# 02. Discussions and recommendations

A number of readily and freely available GIS layers were utilised in a GIS to gain a preliminary understanding of the geographic location and number of different types of assets along the shores of Port Phillip Bay. Sections of the shoreline were classified into 'more easily erodible' and 'erosion-resistant' and the presence and absence of protection structures was considered in the GIS modelling. In addition, a GIS was utilised to model the area and volume of sand between the 0m contour AHD and different landward extents. The purpose of the work was to demonstrate modelling and mapping techniques suitable for a local coastal hazard assessment, assuming that information about hazards and local information is available.

The work undertaken here is believed to be the first comprehensive work undertaken for the entire Port Phillip Bay, using a number of asset data layers. It has provided an overview of the geographic location and number of assets per area of interest (here 10m zones) and a series of new data layers were created.

It was shown that the GIS models in combination with existing information are suitable for this type of work. However, it must be emphasised that in the absence of detailed information about coastal processes and hazards, the data generated so far is not suitable for detailed coastal management and planning purposes. To add a greater level of confidence in modelling results, and to undertake this work at a more localised level, it is necessary to combine the GIS models with information about (local) coastal processes causing shoreline change, amongst other local data.

It is important to document questions in relation to the work undertaken here and to liaise with a wide range of information custodians (including the in-house asset and GIS managers) to determine the information readily available, but also to identify information gaps at the local scale. These gaps may include conditions of coastal protection structures or drainage networks and associated infrastructure, information about values of properties or assets, locational information that is currently captured incompletely, in many different GIS data layers or non-spatial documents, or accurate information about land or asset managers and their management responsibilities.

Other information of value for a more detailed study includes (historical) information about coastal hazards, historical photos, including aerial photos, priority assets, tangible and non-tangible asset values, beach sediment sizes, detailed geological or geotechnical mapping, besides others. Aspects that will need to be considered are the age, purpose and accuracies of those data already available, and if they are suitable for the respective local study. Consideration must also be given to the cost and benefit of improving and / or collecting new data or undergoing rigorous data quality checking.

The immediate proposed next actions from here are:

- Identify key areas of concern within each LGA
  - » Key data layers need to be identified that are required for a local study to address these concerns. Those data layers need to be checked for accuracy and completeness of both, the spatial features and the layers' attribute information. This will determine if missing features can be sourced from existing sources or if new data need to be collected.
  - » Information about a broad range of information is available from the Report #1. GIS and asset managers within each organisation are also very likely to hold additional, often very detailed and high quality data required for local studies.
    - › These may include GIS layers or non-spatial information about drainage networks, assets and their values, land values, information about location and condition of protection structures, sewer locations, etc...
- To model the coastal processes affecting and shaping Port Phillip Bay
  - » Generating this information will significantly improve our understanding of priority areas for a more detailed assessment.

# 03. Appendices

## Appendix A – Definition of GIS

A GIS can essentially be described as software to collate data and manipulate digital thematic data layers. Each thematic layer typically contains a range of information attributes, such as length or area of each feature, their geographic location, specific feature information, land manager information and so on.
An example is shown in Figure 23 below of the spatial extent and rich attribute attached to features in the Public Land Management (PLM25) data layer. Figure 23b lists some of the attribute information for this data layer, containing information about a general description, the feature's name, source of information, land manager, land management act, LGA name, area, perimeter and other information.

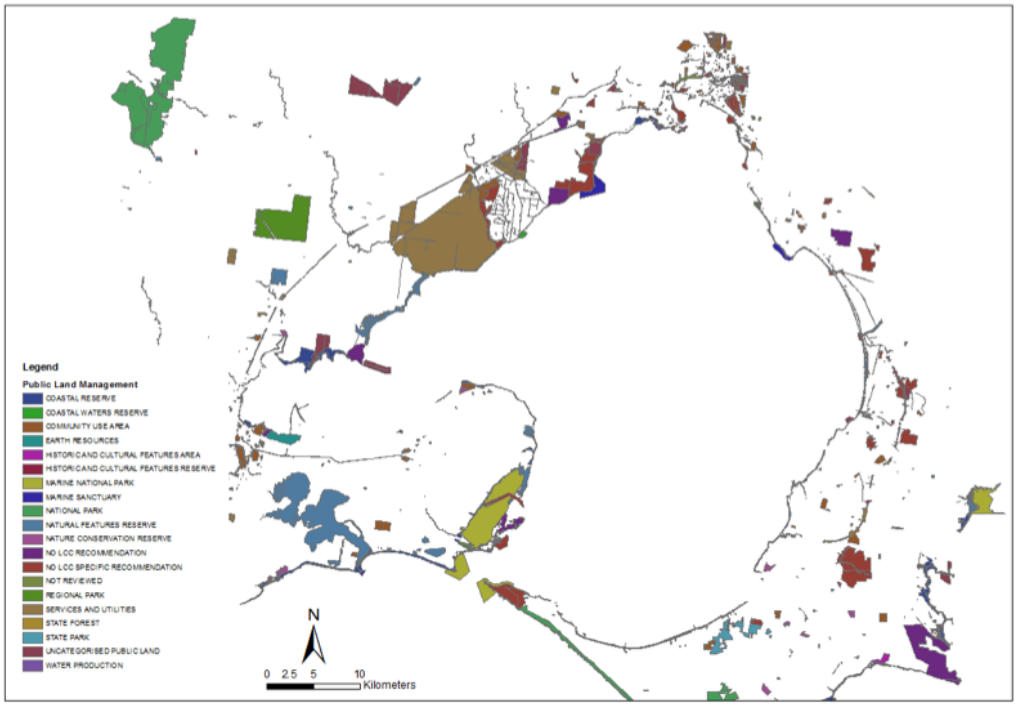



Figure 23: GIS thematic layer and associated attribute information.

Public Land Management

| GENER_DES | POLY_SOURC | NAME | NAME_SOURC | MMGT_ONGRD | REC_CAT | MNG_SPEC | ACT | LGA_NAME | AREA_m2 | PERIMETER |
|---|---|---|---|---|---|---|---|---|---|---|
| CROWN | VICMAP CROWN PARCEL | NOT REVIEWED - FORMER CITY OR RURAL CITY | VEACRECS TABLE | COMMUNITY USE AREA | COMMUNITY USE AREA | COM COUNCIL | CROWN LAND (RESERVED) | BAYSIDE | 2023.4961 | 181.055292 |
| MARINE | VICMAP CROWN PARCEL | NO NAME | WATER FRONTAGE HOLDING LAYER | PUBLIC LAND WATER FRONTAGE | NATURAL FEATURES RESERVE | COM COUNCIL | CROWN LAND (RESERVED - AS TO PART) | BAYSIDE | 700.31752 | 199.306647 |
| MARINE | VEACRECS25 | SANDRINGHAM BEACH PARK | VEACRECS | COASTAL RESERVE | COASTAL RESERVE | COM COUNCIL | CROWN LAND (RESERVED - AS TO PART) | BAYSIDE | 36.892282 | 37.666002 |
| CROWN | VICMAP CROWN PARCEL | NO NAME | WATER FRONTAGE HOLDING LAYER | PUBLIC LAND WATER FRONTAGE | NATURAL FEATURES RESERVE | COM COUNCIL | CROWN LAND (RESERVED) | BAYSIDE | 55.11198 | 44.182839 |
| MARINE | VICMAP CROWN PARCEL | NO NAME | WATER FRONTAGE HOLDING LAYER | PUBLIC LAND WATER FRONTAGE | NATURAL FEATURES RESERVE | DSE | CROWN LAND (UNRESERVED) | BAYSIDE | 2500.0889 | 437.065997 |
| CROWN | VICMAP CROWN PARCEL | ELSTER CREEK DRAIN | WATER FRONTAGE HOLDING LAYER | PUBLIC LAND WATER FRONTAGE | NATURAL FEATURES RESERVE | WATER AUTHORITY LAND | CROWN LAND (RESERVED) | BAYSIDE | 5357.7438 | 669.174458 |
| CROWN | VICMAP CROWN PARCEL | ELSTER CREEK DRAIN | WATER FRONTAGE HOLDING LAYER | PUBLIC LAND WATER FRONTAGE | NATURAL FEATURES RESERVE | WATER AUTHORITY LAND | CROWN LAND (RESERVED) | BAYSIDE | 4712.0035 | 680.105705 |
| CROWN | VICMAP CROWN PARCEL | ELSTER CREEK DRAIN | WATER FRONTAGE HOLDING LAYER | PUBLIC LAND WATER FRONTAGE | NATURAL FEATURES RESERVE | WATER AUTHORITY LAND | CROWN LAND (RESERVED) | BAYSIDE | 2385.4871 | 417.495598 |
| MARINE | VICMAP CROWN PARCEL | NO NAME | WATER FRONTAGE HOLDING LAYER | PUBLIC LAND WATER FRONTAGE | NATURAL FEATURES RESERVE | COM COUNCIL | CROWN LAND (RESERVED - AS TO PART) | BAYSIDE | 8660.2241 | 2376.726232 |
| MARINE | VICMAP CROWN PARCEL | NO NAME | WATER FRONTAGE HOLDING LAYER | PUBLIC LAND WATER FRONTAGE | NATURAL FEATURES RESERVE | COM COUNCIL | CROWN LAND (RESERVED - AS TO PART) | BAYSIDE | 10.371615 | 22.987328 |
| MARINE | VICMAP CROWN PARCEL | NO NAME | WATER FRONTAGE HOLDING LAYER | PUBLIC LAND WATER FRONTAGE | NATURAL FEATURES RESERVE | COM COUNCIL | CROWN LAND (RESERVED - AS TO PART) | BAYSIDE | 62.83743 | 108.365515 |
| CROWN | VM PARCEL EDITED WITH 25K | RICKETTS POINT MARINE SANCTUARY | PRIMS | MARINE SANCTUARY | MARINE SANCTUARY | PARKS VICTORIA | NATIONAL PARKS ACT 1975 | | 28.140577 | 33.852809 |
| MARINE | VICMAP CROWN PARCEL | NO NAME | WATER FRONTAGE HOLDING LAYER | PUBLIC LAND WATER FRONTAGE | NATURAL FEATURES RESERVE | COM COUNCIL | CROWN LAND (RESERVED - AS TO PART) | BAYSIDE | 110.55288 | 136.531822 |
| MARINE | VICMAP CROWN PARCEL | NO NAME | WATER FRONTAGE HOLDING LAYER | PUBLIC LAND WATER FRONTAGE | NATURAL FEATURES RESERVE | COM COUNCIL | CROWN LAND (RESERVED - AS TO PART) | BAYSIDE | 180.81247 | 205.075341 |
| MARINE | VICMAP CROWN PARCEL | NO NAME | WATER FRONTAGE HOLDING LAYER | PUBLIC LAND WATER FRONTAGE | NATURAL FEATURES RESERVE | COM COUNCIL | CROWN LAND (RESERVED - AS TO PART) | BAYSIDE | 4391.6508 | 614.484868 |
| CROWN | VM PARCEL EDITED WITH 25K | RICKETTS POINT MARINE SANCTUARY | PRIMS | MARINE SANCTUARY | MARINE SANCTUARY | PARKS VICTORIA | NATIONAL PARKS ACT 1975 | | 2859.2382 | 496.613473 |
| MARINE | VICMAP CROWN PARCEL | NO NAME | WATER FRONTAGE HOLDING LAYER | PUBLIC LAND WATER FRONTAGE | NATURAL FEATURES RESERVE | COM COUNCIL | CROWN LAND (UNRESERVED) | BAYSIDE | 23.499487 | 39.238309 |
| MARINE | VICMAP CROWN PARCEL | NO NAME | WATER FRONTAGE HOLDING LAYER | PUBLIC LAND WATER FRONTAGE | NATURAL FEATURES RESERVE | DSE | CROWN LAND (UNRESERVED) | BAYSIDE | 262.84452 | 132.513506 |
| MARINE | VICMAP CROWN PARCEL | NO NAME | WATER FRONTAGE HOLDING LAYER | PUBLIC LAND WATER FRONTAGE | NATURAL FEATURES RESERVE | COM COUNCIL | CROWN LAND (UNRESERVED) | BAYSIDE | 35.070268 | 37.329063 |
| MARINE | VICMAP CROWN PARCEL | NO NAME | WATER FRONTAGE HOLDING LAYER | PUBLIC LAND WATER FRONTAGE | NATURAL FEATURES RESERVE | COM COUNCIL | CROWN LAND (UNRESERVED) | BAYSIDE | 188.03735 | 118.600092 |
| CROWN | VICMAP CROWN PARCEL | MORDIALLOC MENTONE BEACH PARK | VEACRECS TABLE | COASTAL RESERVE | COASTAL RESERVE | COM COUNCIL | CROWN LAND (RESERVED - AS TO PART) | KINGSTON | 172780.39 | 5333.50092 |
| CROWN | VICMAP CROWN PARCEL | NOT REVIEWED - FORMER CITY OR RURAL CITY | VEACRECS TABLE | SERVICES AND UTILITIES | SERVICES AND UTILITIES | DEPT OF JUSTICE | CROWN LAND (RESERVED) | BAYSIDE | 1257.2400 | 162.448778 |
| CROWN | VICMAP CROWN PARCEL | NOT REVIEWED - FORMER CITY OR RURAL CITY | VEACRECS TABLE | SERVICES AND UTILITIES | SERVICES AND UTILITIES | DEPT OF JUSTICE | CROWN LAND (UNRESERVED) | BAYSIDE | 1205.6632 | 160.453674 |
| CROWN | VICMAP CROWN PARCEL | SANDRINGHAM BEACH PARK | PLM100 | COASTAL RESERVE | COASTAL RESERVE | COM COUNCIL | CROWN LAND (RESERVED) | | 1462.6253 | 290.535924 |
| COMMONWE | PLAN ZONE | | | COMMONWEALTH LAND | NO LCC RECOMMENDATION | COMMONWEALTH | | | 93360.994 | 1629.295471 |
| CROWN | VICMAP CROWN PARCEL | NOT REVIEWED - FORMER CITY OR RURAL CITY | VEACRECS TABLE | COMMUNITY USE AREA | COMMUNITY USE AREA | COM COUNCIL | CROWN LAND (RESERVED) | BAYSIDE | 32589.797 | 744.596843 |
| CROWN | VICMAP CROWN PARCEL | ELSTER CREEK DRAIN | WATER FRONTAGE HOLDING LAYER | PUBLIC LAND WATER FRONTAGE | NATURAL FEATURES RESERVE | WATER AUTHORITY LAND | CROWN LAND (RESERVED) | BAYSIDE | 826.49423 | 170.554946 |
| MARINE | VICMAP CROWN PARCEL | GREEN POINT RESERVE | VEACRECS TABLE | COASTAL RESERVE | COASTAL RESERVE | COM COUNCIL | CROWN LAND (RESERVED) | BAYSIDE | 122.72091 | 160.843417 |
| CROWN | VEACRECS25 | BEACH ROAD VERGE - BEACH PARK | VEACRECS | COASTAL RESERVE | COASTAL RESERVE | DSE | GOVERNMENT ROAD | BAYSIDE | 1979.1435 | 389.039774 |
| MARINE | VEACRECS25 | SANDRINGHAM BEACH PARK | VEACRECS | COASTAL RESERVE | COASTAL RESERVE | COM COUNCIL | CROWN LAND (RESERVED - AS TO PART) | BAYSIDE | 721.06862 | 302.772057 |
| CROWN | VEACRECS25 | NOT REVIEWED - FORMER CITY OR RURAL CITY | VEACRECS | SERVICES AND UTILITIES | SERVICES AND UTILITIES | DEPT OF TRANSPORT | CROWN LAND VESTED IN VICTORIAN RAIL T | BAYSIDE | 379.93262 | 92.105025 |
| CROWN | VICMAP CROWN PARCEL | NOT REVIEWED - FORMER CITY OR RURAL CITY | VEACRECS TABLE | COMMUNITY USE AREA | COMMUNITY USE AREA | COM COUNCIL | CROWN LAND (RESERVED) | BAYSIDE | 23944.700 | 703.827035 |
| CROWN | VEACRECS25 | SANDRINGHAM BEACH PARK | VEACRECS | COASTAL RESERVE | COASTAL RESERVE | DSE | CROWN LAND (RESERVED - AS TO PART) | BAYSIDE | 557.48073 | 253.602311 |
| MARINE | VEACRECS25 | SANDRINGHAM BEACH PARK | VEACRECS | COASTAL RESERVE | COASTAL RESERVE | COM COUNCIL | CROWN LAND (RESERVED - AS TO PART) | BAYSIDE | 26.17687 | 31.310371 |
| MARINE | VEACRECS25 | SANDRINGHAM BEACH PARK | VEACRECS | COASTAL RESERVE | COASTAL RESERVE | COM COUNCIL | CROWN LAND (RESERVED - AS TO PART) | BAYSIDE | 1147.9796 | 195.914724 |
| CROWN | VEACRECS25 | SANDRINGHAM BEACH PARK | VEACRECS | COASTAL RESERVE | COASTAL RESERVE | COM COUNCIL | CROWN LAND (RESERVED - AS TO PART) | BAYSIDE | 190314.04 | 7068.201461 |
| MARINE | VICMAP CROWN PARCEL | NO NAME | WATER FRONTAGE HOLDING LAYER | PUBLIC LAND WATER FRONTAGE | NATURAL FEATURES RESERVE | COM COUNCIL | CROWN LAND (RESERVED) | BAYSIDE | 268.73640 | 149.096177 |
| MARINE | VICMAP CROWN PARCEL | NO NAME | WATER FRONTAGE HOLDING LAYER | PUBLIC LAND WATER FRONTAGE | NATURAL FEATURES RESERVE | COM COUNCIL | CROWN LAND (RESERVED) | BAYSIDE | 73.006815 | 94.615163 |
| MARINE | VICMAP CROWN PARCEL | NO NAME | WATER FRONTAGE HOLDING LAYER | PUBLIC LAND WATER FRONTAGE | NATURAL FEATURES RESERVE | COM COUNCIL | CROWN LAND (RESERVED) | BAYSIDE | 6.857252 | 16.512686 |
| MARINE | VM PARCEL EDITED WITH 25K | MIDDLE BRIGHTON PIER AND BREAKWATER | PRIMS | PORT AND COASTAL FACILITY | NO LCC SPECIFIC RECOMMENDATION | COM PARKS VICTORIA | CROWN LAND (RESERVED) | BAYSIDE | 193873.32 | 2244.327925 |
| MARINE | VICMAP CROWN PARCEL | NO NAME | WATER FRONTAGE HOLDING LAYER | PUBLIC LAND WATER FRONTAGE | NATURAL FEATURES RESERVE | COM COUNCIL | CROWN LAND (RESERVED) | BAYSIDE | 94.853376 | 144.33204 |
| MARINE | VICMAP CROWN PARCEL | NO NAME | WATER FRONTAGE HOLDING LAYER | PUBLIC LAND WATER FRONTAGE | NATURAL FEATURES RESERVE | COM COUNCIL | CROWN LAND (RESERVED) | BAYSIDE | 1656.8103 | 990.570011 |
| CROWN | VICMAP CROWN PARCEL | NO NAME | WATER FRONTAGE HOLDING LAYER | PUBLIC LAND WATER FRONTAGE | NATURAL FEATURES RESERVE | COM COUNCIL | CROWN LAND (RESERVED) | BAYSIDE | 2224.9388 | 461.224404 |
| CROWN | VICMAP CROWN PARCEL | NOT REVIEWED - FORMER CITY OR RURAL CITY | VEACRECS TABLE | COMMUNITY USE AREA | COMMUNITY USE AREA | COM COUNCIL | CROWN LAND (RESERVED) | BAYSIDE | 1714.9694 | 185.309915 |
| CROWN | VEACRECS25 | NOT REVIEWED - FORMER CITY OR RURAL CITY | VEACRECS | COMMUNITY USE AREA | COMMUNITY USE AREA | DEPT OF EDUCATION | CROWN LAND (RESERVED) | BAYSIDE | 695.58391 | 115.559314 |
| MARINE | VICMAP CROWN PARCEL | NO NAME | WATER FRONTAGE HOLDING LAYER | PUBLIC LAND WATER FRONTAGE | NATURAL FEATURES RESERVE | COM COUNCIL | CROWN LAND (RESERVED - AS TO PART) | BAYSIDE | 356.56020 | 152.459617 |
| MARINE | VICMAP CROWN PARCEL | | LIMS | UNCATEGORISED PUBLIC LAND | UNCATEGORISED PUBLIC LAND | COM COUNCIL | CROWN LAND (RESERVED) | | 59850.775 | 4787.340775 |
| CROWN | VICMAP CROWN PARCEL | RAILWAY WALK SOUTH | LIMS | | SERVICES AND UTILITIES | DSE | GOVERNMENT ROAD | BAYSIDE | 154.78873 | 109.297491 |
| MARINE | VICMAP CROWN PARCEL | SANDRINGHAM BEACH PARK | PLM100 | COASTAL RESERVE | COASTAL RESERVE | COM COUNCIL | CROWN LAND (RESERVED) | | 11439.694 | 990.07795 |
| MARINE | VICMAP CROWN PARCEL | NO NAME | WATER FRONTAGE HOLDING LAYER | PUBLIC LAND WATER FRONTAGE | NATURAL FEATURES RESERVE | COM COUNCIL | CROWN LAND (RESERVED - AS TO PART) | BAYSIDE | 2262.5479 | 555.927753 |
| CROWN | VICMAP CROWN PARCEL | NOT REVIEWED - FORMER CITY OR RURAL CITY | VEACRECS TABLE | SERVICES AND UTILITIES | SERVICES AND UTILITIES | DEPT OF HEALTH | CROWN LAND (RESERVED) | BAYSIDE | 3628.7265 | 230.45199 |

5 (0 out of 5792 Selected)

GIS software also allows for combining different data layers (Figure 24) and analysing the contents of those multiple layers. Assuming one data layer contains information about boating facilities and another layer contains information about the geographic extents of local government areas, GIS can be used to determine the number of boating facilities per local government area. This of course assumes that the information required for this task is already available in GIS format.

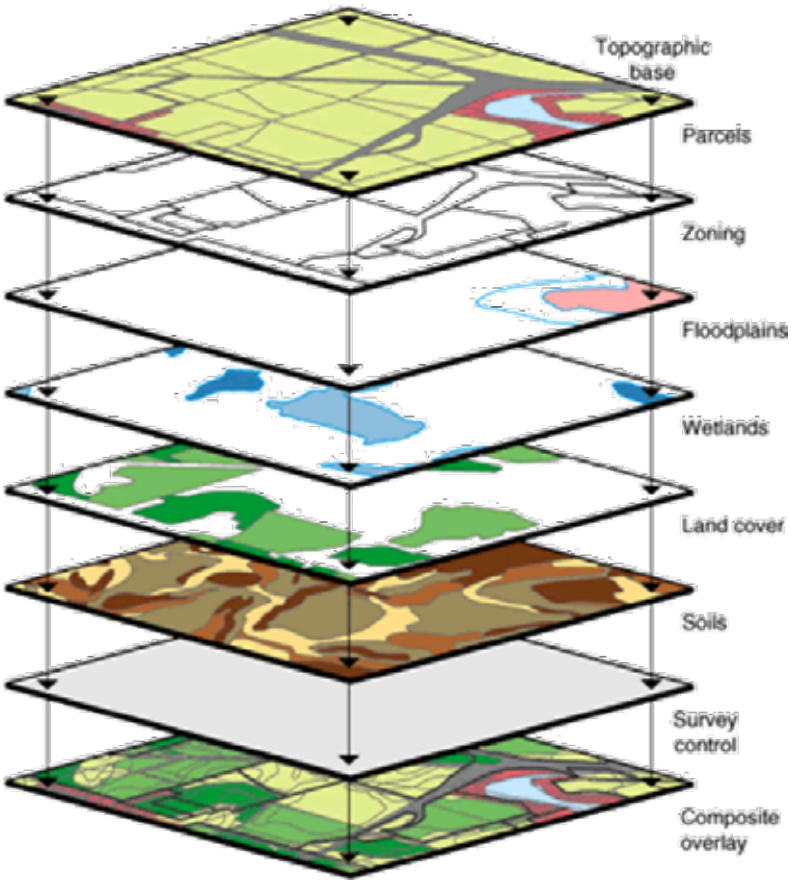



Figure 24: Concept of multiple GIS data layer.

## Appendix B – GIS Data Types

In GIS data analysis, one differentiates between vector (consisting of point, line or area/polygon features) and raster data (for example the Vicmap Coastal LiDAR DEM, aerial photography or satellite imagery) (Figure 25). Most GIS software allows for the analysis of both data types and often even the conversion from one type to the other. The data layers utilised in this project are predominantly vector data, with the exception of the Vicmap Coastal Elevation LiDAR data layer and aerial photography, which are raster data.

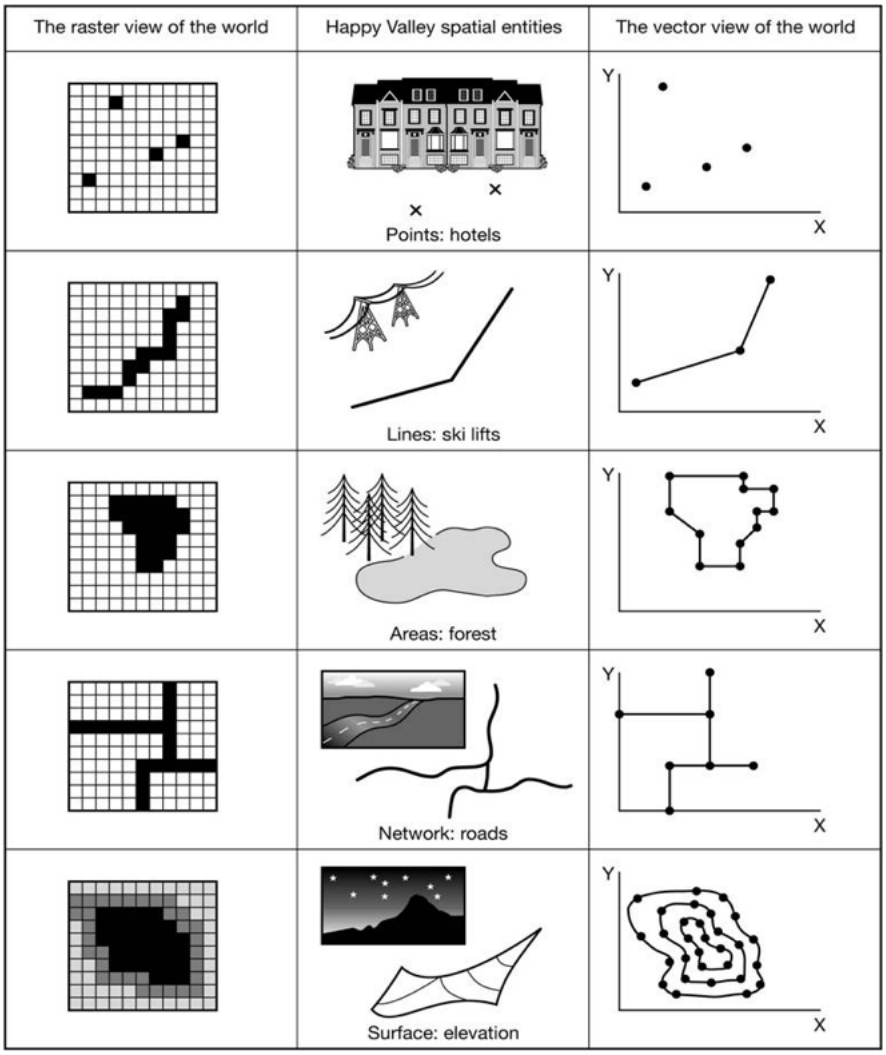



Figure 25: GIS Data types

## Appendix C – Data Sources and Types

List of data layer used for Actions 1 & 2, and their respective data types.

| Source & Name of Data layer | Data Type |
|---|---|
| DEPI Coastline (0m contour AHD, extracted from Vicmap Coastal Elevation LiDAR DEM) | Vector (Line) |
| DEPI Vicmap Elevation LiDAR DEM) | Raster |
| Geoscience Australia Smartline coastal geomorphic mapping | Vector (area) |
| DEPI Geology | Vector (area) |
| DEPI Vicmap Property | Vector (area) |
| DEPI Vicmap Address | Vector (Point) |
| CEPI Vicmap Roads | Vector (Line) |
| DEPI Vicmap Rail | Vector (Line) |
| DEPI Vicmap Features of Interest | Vector (Point) |
| DEPI Wetlands | Vector (area) |
| DEPI Ramsar Sites | Vector (area) |
| DEPI Pulic Land Management | Vector (area) |
| DEPI VEACRES 25 | Vector (area) |
| ESTA Markers | Vector (Point) |
| DEPI Coastal Protection Structures | Vector (Line) |
| CCB Boating Facilities | Vector (Point) |
| | |
| DEPI Local Government Areas | Vector (area) |
| DEPI Land Managers | Vector (area) |
| DTPLI Planning Zones | Vector (area) |
| 2006/2007 DEPI aerial image | Raster |
| ESRI aerial imagery | Raster |

Figure 26: Data Sources and Types

## Appendix D – Baseline and Administrative Data Layers utilised for this study

As outlined in the introduction, a number of 'baseline' layers were utilised to derive the modelling scenarios. Like all other data layers, these baseline data layers are readily available from DEPI. In total three data layers built the foundation of the modelling scenarios, these being:

### VICMAP ELEVATION - COASTAL TOPOGRAPHIC 1M DEM AND 0.5M CONTOURS (FUTURE COASTS LIDAR DEM)

The Vicmap Coastal DEM is a high-resolution representation of natural relief features along the coast of Victoria. It consists of a Digital Elevation Model (DEM) at 1x1m resolution (ie, one elevation "point" represents the average height per square metre) and contours with an interval of 50cm. These data were collected as part of DEPI's Future Coasts Program, and can be used as an input for sea level rise modelling, landscape analysis, planning, hazard mitigation and environmental modelling. These data are already being used in projects across Victoria, including modelling the impact of sea level rise.

### DEPI GEOLOGY 1:250,000

This data layer contains primary geological data, namely outcropping/sub-cropping geological rock units and boundary types separating rock units. Other geological features (e.g. fault or dyke) are included where the feature forms a boundary to rock units. The data have been collected by the Geological Survey of Victoria. Although at a coarse scale of 1:250,000, it is currently the best bay-wide geological mapping and provides basic information about soft- vs erosion-resistant shorelines.

### SMARTLINE COASTAL GEOMORPHOLOGICAL MAPPING

The Smartline Coastal Geomorphic Map of Australia is a detailed map of the coastal landform types – or 'geomorphology' – of continental Australia and most adjacent islands (excluding the Great Barrier Reef). As a 'geomorphic' map, it represents the topography of the coast. It also indicates the composition of differing coastal landforms – varying rock types, sand, mud, boulders, beach rock, and so on. The map classifies coastal landforms into differing combinations of form and material. This in turn is indicative of the differing natural processes by which each coastal landform has developed.

The Smartline represents this information in the form of a single line map representing the coastline, which is split into segments where-ever the coastal landform type changes. Each distinctive segment of the shoreline is tagged or attributed with multiple attribute fields describing the landform types of that segment of the coast. The coastal characteristics recorded refer not only to those at the precise location of the line itself, but to a coastal zone nominally extending up 500m inland and offshore. The line can be divided into long or short segments representing different coastal landforms, allowing the Smartline to record alongshore variations in coastal type to a high degree of detail.

### DEPI COASTAL PROTECTION STRUCTURES

This GIS data layer shows the geographic location of coastal protection structures (seawalls, groynes, revetments, breakwaters, wharfs). These data were initially collected in 2008, using GPS. The data were checked and converted to a GIS data layer in 2011, using current aerial photography.

### ADMINISTRATIVE DATA LAYERS

Several data layers were utilised to further analyse the data processes.

- Local Government Boundaries
  - » This layer is part of the Vicmap Admin data layer series. It contains the polygons for the authoritative LGA boundary data layer and is aligned to Vicmap Property.
- DEPI Land Managers (Public Land Management)
  - » This data layer contains information about public land on ground management, land manager, reserve information and legal information. This data layer was updated in June 2013 but contains some errors, and should therefore be used with caution.
- DTPLI Planning Zones
  - » This data layer contains polygon features representing land use zones (such as residential, industrial or rural) for all Victorian planning schemes. Each area contains information on scheme code, zone number, zone status, zone code, LGA name and LGA code.

## Appendix E – Data Accuracy and Completeness

All data analysis is only be as good as the data that are available for the respective tasks and data are typically captured for a specific purpose, and at a specific resolution or scale. The Geology data layer, for example, was captured at a scale of 1:250,000 (ie, 1cm on a map represents 2,500m on the ground) and . The Future Coasts Topographic LiDAR DEM on the other hand captures the surface of the land at 1x1m resolution, and the 2007 aerial image of Port Phillip Bay was captured at 0.35m on ground resolution.

Data layers collected at coarser scales (eg, Geology) do not depict a high level of detail on the ground but are small in file size and therefore easier and faster to process in a GIS. High-resolution data layers on the other hand (eg, Future Coasts LiDAR DEM or 2007 aerial image) give a high degree of detail and accuracy. However, those data layers are large in size (the 2007 image of Port Phillip Bay is about 20 Gigabyte in size) and data processing can be lengthy.

Many spatial data layers are compiled using a number of different sources and are potentially prone to spatial and/or attribute errors. This is particularly the case where manual data entry is required or information is reliant on other, often old sources. The Smartline Coastal Geomorphological Mapping data layer for example and was developed based on a desktop review of existing information, including aerial photos, geological maps, geomorphological mapping. The data layer was developed for the entire Australian coastline based on best available information, however, only limited field verification has been undertaken to date. Still, it is the only available spatial data layer for Victoria containing such comprehensive information.

Other examples include the Vicmap Address data layer which contains information about bathing boxes only for two local government areas, namely Bayside and Frankston. Bathing boxes located elsewhere around the bay are not (yet) included in this data layer.

It is therefore important that different organisations collecting data are willing to share their information and actively contribute to authoritative data sources.

Analysis and interpretation of all spatial data layers must therefore be undertaken with care and all results interpreted with a good understanding and acknowledgement of potential limitations. It is critical to understand the ‘fitness for purpose’ of individual data layers, especially when used for decision making.

# Appendix F – Analysis of Vicmap Address data, by landward zone, LGA and planning zone

| Zone | LGA_NAME | Zone_ABM | FREQUENCY | Zone | LGA_NAME | Zone_ABM | FREQUENCY | Zone | LGA_NAME | Zone_ABM | FREQUENCY |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | FRANKSTON | Public Land | 1 | 5 | BAYSIDE | Residential | 2 | 8 | BAYSIDE | Public Land | 1 |
| 1 | GREATER GEELONG | Public Land | 3 | 5 | FRANKSTON | Public Land | 3 | 8 | BAYSIDE | Residential | 5 |
| 1 | KINGSTON | Public Land | 6 | 5 | GREATER GEELONG | Industrial | 1 | 8 | FRANKSTON | Residential | 22 |
| 1 | KINGSTON | Residential | 8 | 5 | GREATER GEELONG | Public Land | 8 | 8 | FRANKSTON | Special Purpose | 1 |
| 1 | KINGSTON | Special Purpose | 42 | 5 | GREATER GEELONG | Residential | 55 | 8 | GREATER GEELONG | Public Land | 15 |
| 1 | KINGSTON | Utility | 3 | 5 | GREATER GEELONG | Rural | 3 | 8 | GREATER GEELONG | Residential | 89 |
| 1 | MELBOURNE | Special Purpose | 1 | 5 | HOBSONS BAY | Industrial | 1 | 8 | GREATER GEELONG | Rural | 1 |
| 1 | MORNINGTON PENINSULA | Public Land | 13 | 5 | HOBSONS BAY | Public Land | 1 | 8 | GREATER GEELONG | Special Purpose | 1 |
| 1 | MORNINGTON PENINSULA | Residential | 7 | 5 | HOBSONS BAY | Special Purpose | 1 | 8 | HOBSONS BAY | Industrial | 3 |
| 1 | MORNINGTON PENINSULA | Special Purpose | 2 | 5 | KINGSTON | Public Land | 10 | 8 | HOBSONS BAY | Residential | 5 |
| 1 | QUEENSCLIFFE | Special Purpose | 18 | 5 | KINGSTON | Residential | 251 | 8 | HOBSONS BAY | Utility | 1 |
| 2 | FRANKSTON | Public Land | 2 | 5 | KINGSTON | Special Purpose | 96 | 8 | KINGSTON | Commercial | 3 |
| 2 | FRANKSTON | Special Purpose | 1 | 5 | MELBOURNE | Special Purpose | 18 | 8 | KINGSTON | Public Land | 4 |
| 2 | GREATER GEELONG | Public Land | 9 | 5 | MORNINGTON PENINSULA | Public Land | 182 | 8 | KINGSTON | Residential | 538 |
| 2 | GREATER GEELONG | Residential | 1 | 5 | MORNINGTON PENINSULA | Residential | 20 | 8 | KINGSTON | Special Purpose | 5 |
| 2 | GREATER GEELONG | Rural | 1 | 5 | MORNINGTON PENINSULA | Special Purpose | 14 | 8 | KINGSTON | Utility | 1 |
| 2 | GREATER GEELONG | Special Purpose | 3 | 5 | QUEENSCLIFFE | Public Land | 1 | 8 | MELBOURNE | Industrial | 6 |
| 2 | HOBSONS BAY | Public Land | 1 | 5 | QUEENSCLIFFE | Residential | 2 | 8 | MORNINGTON PENINSULA | Commercial | 9 |
| 2 | KINGSTON | Public Land | 5 | 5 | WYNDHAM | Rural | 1 | 8 | MORNINGTON PENINSULA | Public Land | 32 |
| 2 | KINGSTON | Residential | 40 | 6 | BAYSIDE | Public Land | 1 | 8 | MORNINGTON PENINSULA | Residential | 128 |
| 2 | KINGSTON | Special Purpose | 79 | 6 | BAYSIDE | Residential | 6 | 8 | MORNINGTON PENINSULA | Rural | 3 |
| 2 | KINGSTON | Utility | 2 | 6 | FRANKSTON | Residential | 9 | 8 | MORNINGTON PENINSULA | Special Purpose | 5 |
| 2 | MORNINGTON PENINSULA | Public Land | 175 | 6 | GREATER GEELONG | Industrial | 1 | 8 | MORNINGTON PENINSULA | Utility | 1 |
| 2 | MORNINGTON PENINSULA | Residential | 1 | 6 | GREATER GEELONG | Public Land | 4 | 8 | PORT PHILLIP | Residential | 112 |
| 2 | MORNINGTON PENINSULA | Special Purpose | 44 | 6 | GREATER GEELONG | Residential | 91 | 8 | QUEENSCLIFFE | Public Land | 2 |
| 2 | MORNINGTON PENINSULA | Utility | 1 | 6 | GREATER GEELONG | Rural | 3 | 8 | QUEENSCLIFFE | Residential | 5 |
| 2 | QUEENSCLIFFE | Public Land | 3 | 6 | GREATER GEELONG | Utility | 3 | 8 | QUEENSCLIFFE | Utility | 1 |
| 2 | QUEENSCLIFFE | Special Purpose | 3 | 6 | HOBSONS BAY | Utility | 2 | 8 | WYNDHAM | Rural | 1 |
| 2 | WYNDHAM | Public Land | 27 | 6 | KINGSTON | Public Land | 8 | 9 | BAYSIDE | Residential | 68 |
| 3 | FRANKSTON | Public Land | 54 | 6 | KINGSTON | Residential | 132 | 9 | FRANKSTON | Residential | 37 |
| 3 | GREATER GEELONG | Public Land | 3 | 6 | KINGSTON | Special Purpose | 9 | 9 | FRANKSTON | Special Purpose | 1 |
| 3 | HOBSONS BAY | Industrial | 3 | 6 | MELBOURNE | Industrial | 5 | 9 | GREATER GEELONG | Public Land | 1 |
| 3 | HOBSONS BAY | Public Land | 3 | 6 | MELBOURNE | Special Purpose | 1 | 9 | GREATER GEELONG | Residential | 118 |
| 3 | HOBSONS BAY | Utility | 1 | 6 | MORNINGTON PENINSULA | Public Land | 76 | 9 | HOBSONS BAY | Industrial | 2 |
| 3 | KINGSTON | Public Land | 2 | 6 | MORNINGTON PENINSULA | Residential | 32 | 9 | HOBSONS BAY | Public Land | 1 |
| 3 | KINGSTON | Residential | 122 | 6 | MORNINGTON PENINSULA | Rural | 5 | 9 | HOBSONS BAY | Residential | 4 |
| 3 | KINGSTON | Special Purpose | 82 | 6 | MORNINGTON PENINSULA | Special Purpose | 25 | 9 | HOBSONS BAY | Utility | 1 |
| 3 | MORNINGTON PENINSULA | Public Land | 392 | 6 | QUEENSCLIFFE | Public Land | 2 | 9 | KINGSTON | Commercial | 2 |
| 3 | MORNINGTON PENINSULA | Residential | 4 | 6 | QUEENSCLIFFE | Residential | 2 | 9 | KINGSTON | Public Land | 5 |
| 3 | MORNINGTON PENINSULA | Rural | 3 | 6 | WYNDHAM | Rural | 1 | 9 | KINGSTON | Residential | 419 |
| 3 | MORNINGTON PENINSULA | Special Purpose | 57 | 7 | BAYSIDE | Public Land | 2 | 9 | KINGSTON | Special Purpose | 1 |
| 3 | MORNINGTON PENINSULA | Utility | 1 | 7 | BAYSIDE | Residential | 13 | 9 | MORNINGTON PENINSULA | Commercial | 8 |
| 3 | PORT PHILLIP | Public Land | 3 | 7 | FRANKSTON | Residential | 20 | 9 | MORNINGTON PENINSULA | Public Land | 21 |
| 3 | PORT PHILLIP | Special Purpose | 2 | 7 | FRANKSTON | Special Purpose | 3 | 9 | MORNINGTON PENINSULA | Residential | 196 |
| 3 | QUEENSCLIFFE | Special Purpose | 3 | 7 | GREATER GEELONG | Public Land | 6 | 9 | MORNINGTON PENINSULA | Special Purpose | 11 |
| 3 | WYNDHAM | Public Land | 54 | 7 | GREATER GEELONG | Residential | 109 | 9 | MORNINGTON PENINSULA | Utility | 4 |
| 4 | BAYSIDE | Public Land | 2 | 7 | GREATER GEELONG | Rural | 6 | 9 | PORT PHILLIP | Residential | 9 |
| 4 | FRANKSTON | Public Land | 4 | 7 | HOBSONS BAY | Industrial | 3 | 9 | QUEENSCLIFFE | Public Land | 5 |
| 4 | FRANKSTON | Special Purpose | 4 | 7 | HOBSONS BAY | Public Land | 1 | 9 | QUEENSCLIFFE | Residential | 19 |
| 4 | GREATER GEELONG | Industrial | 1 | 7 | KINGSTON | Commercial | 6 | 9 | QUEENSCLIFFE | Special Purpose | 2 |
| 4 | GREATER GEELONG | Public Land | 69 | 7 | KINGSTON | Public Land | 5 | 9 | QUEENSCLIFFE | Utility | 1 |
| 4 | GREATER GEELONG | Residential | 4 | 7 | KINGSTON | Residential | 178 | 9 | WYNDHAM | Rural | 1 |
| 4 | GREATER GEELONG | Rural | 2 | 7 | KINGSTON | Special Purpose | 6 | 10 | BAYSIDE | Public Land | 2 |
| 4 | GREATER GEELONG | Special Purpose | 18 | 7 | KINGSTON | Utility | 1 | 10 | BAYSIDE | Residential | 92 |
| 4 | HOBSONS BAY | Industrial | 14 | 7 | MELBOURNE | Industrial | 2 | 10 | FRANKSTON | Public Land | 2 |
| 4 | HOBSONS BAY | Public Land | 3 | 7 | MELBOURNE | Special Purpose | 4 | 10 | FRANKSTON | Residential | 51 |
| 4 | KINGSTON | Public Land | 7 | 7 | MORNINGTON PENINSULA | Commercial | 3 | 10 | FRANKSTON | Special Purpose | 1 |
| 4 | KINGSTON | Residential | 268 | 7 | MORNINGTON PENINSULA | Public Land | 47 | 10 | GREATER GEELONG | Public Land | 11 |
| 4 | KINGSTON | Special Purpose | 41 | 7 | MORNINGTON PENINSULA | Residential | 114 | 10 | GREATER GEELONG | Residential | 131 |
| 4 | MORNINGTON PENINSULA | Public Land | 387 | 7 | MORNINGTON PENINSULA | Rural | 2 | 10 | GREATER GEELONG | Rural | 2 |
| 4 | MORNINGTON PENINSULA | Residential | 4 | 7 | MORNINGTON PENINSULA | Special Purpose | 16 | 10 | GREATER GEELONG | Special Purpose | 81 |
| 4 | MORNINGTON PENINSULA | Rural | 1 | 7 | MORNINGTON PENINSULA | Utility | 1 | 10 | HOBSONS BAY | Industrial | 6 |
| 4 | MORNINGTON PENINSULA | Special Purpose | 261 | 7 | PORT PHILLIP | Residential | 1 | 10 | HOBSONS BAY | Public Land | 4 |
| 4 | MORNINGTON PENINSULA | Utility | 2 | 7 | QUEENSCLIFFE | Public Land | 4 | 10 | HOBSONS BAY | Residential | 3 |
| 4 | PORT PHILLIP | Public Land | 3 | 7 | QUEENSCLIFFE | Residential | 1 | 10 | HOBSONS BAY | Utility | 1 |
| 4 | QUEENSCLIFFE | Public Land | 3 | | | | | 10 | KINGSTON | Commercial | 1 |
| 4 | QUEENSCLIFFE | Special Purpose | 1 | | | | | 10 | KINGSTON | Public Land | 5 |
| 4 | WYNDHAM | Public Land | 46 | | | | | 10 | KINGSTON | Residential | 333 |
| | | | | | | | | 10 | MELBOURNE | Commercial | 2 |
| | | | | | | | | 10 | MORNINGTON PENINSULA | Commercial | 17 |
| | | | | | | | | 10 | MORNINGTON PENINSULA | Public Land | 15 |
| | | | | | | | | 10 | MORNINGTON PENINSULA | Residential | 193 |
| | | | | | | | | 10 | MORNINGTON PENINSULA | Special Purpose | 18 |
| | | | | | | | | 10 | MORNINGTON PENINSULA | Utility | 3 |
| | | | | | | | | 10 | PORT PHILLIP | Residential | 4 |
| | | | | | | | | 10 | QUEENSCLIFFE | Residential | 27 |
| | | | | | | | | 10 | QUEENSCLIFFE | Utility | 2 |
| | | | | | | | | 10 | WYNDHAM | Rural | 1 |

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