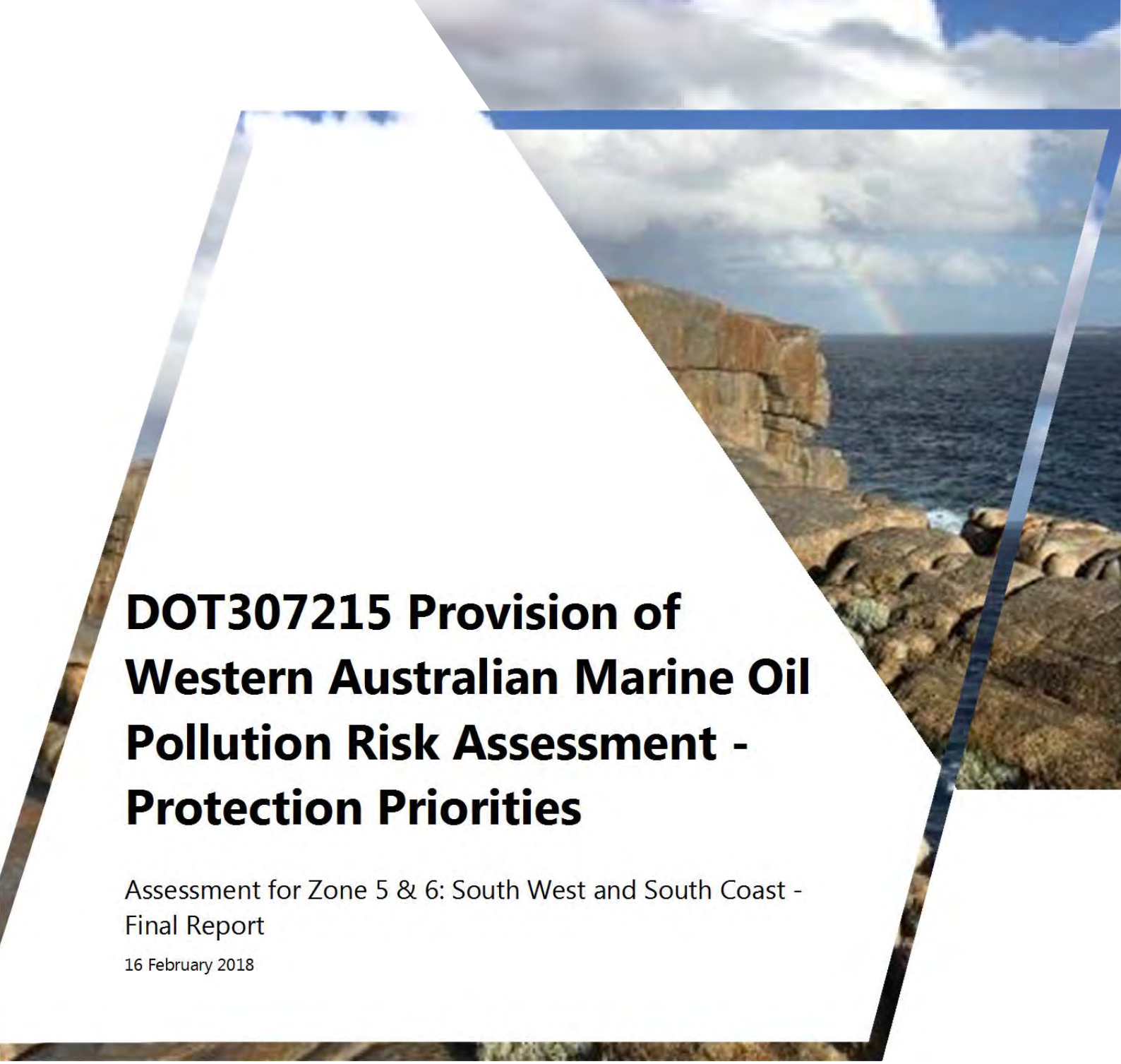

DOT307215 Provision of Western Australian Marine Oil Pollution Risk Assessment - Protection Priorities

Assessment for Zone 5 & 6: South West and South Coast - Final Report

16 February 2018

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This report is dedicated to Dr Barry Wilson, a pioneer in the field of marine conservation who passed away on 13 June 2017.

Dr Wilson was a well-known biogeographer and zoologist who created Western Australia's marine conservation system. This system now protects many locally, nationally and internationally significant marine environments. The additional recommended marine parks and reserves areas proposed in "A Representative Marine Reserve System for Western Australia" (often referred to as the Wilson Report), prepared by the Marine Parks and Reserves Working Group, which he Chaired, have been incorporated into this report.

The Wilson Report was the result of seven years' work in which Barry and fellow scientists prepared a blueprint for WA's marine reserve system across the state's 13,500 km coastline from the Kimberley to Eucla, and was one of the most significant marine conservation documents released anywhere in Australia and probably the world (WAMSI, 2017).

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Executive Summary

The Western Australian Department of Transport (DoT) is the Hazard Management Agency (HMA) for marine oil pollution in Western Australia (WA). As the HMA, DoT ensures the capacity of the State to respond to an oil spill is commensurate with the risk.

In order to understand the state's spill risk profile, the DoT is conducting a state-wide marine oil pollution risk assessment. The risk assessment is comprised of two components. The first component identifies the aspects (e.g. fauna, flora, etc.) that are present in each shoreline cell, and evaluates which aspects would be most affected and thus need to be prioritised for protection in the event of an oil spill (i.e. protection priority). These protection priorities were ranked using a five-tier scale, Very Low to Very High (Table 0-1).

Table 0-1: Protection priority ranking

Protection Priority	Ranking
Very High	5
High	4
Medium	3
Low	2
Very Low	1

The second component assesses the likelihood, size, location and type of potential marine oil pollution. The second component is being undertaken by Navigatus Consulting (Navigatus). Navigatus is also combining the protection priority component with the spill likelihood component to give an overall marine oil pollution risk profile for the state. This overall risk profile for the state will identify the key environmentally sensitive areas that are most at risk of being affected by an accidental release of marine oil. The output from Navigatus's assessment is not addressed in this report.

The results of this project will be used to decide how to allocate resources on a regional, state and national level, and will undergo scrutiny by regional, state and national agencies. Data collected on protection priorities may assist in decision-making both when preparing and responding to marine oil pollution incidents.

For the purposes of this project, state waters have been divided into seven zones (see Figure 1-1) and each zone has been divided into ~10 km by ~20 km areas called shoreline cells. The project is being rolled out on a zone-by-zone basis over the next two to five years. The first protection priorities zone completed was the Pilbara (Zone 2), which was originally finalised in August 2016, and was followed by assessments of the Midwest zone and Swan zone (Zones 3 and 4). However as the Midwest and Swan zone assessments were being finalised, the protection priority rankings developed during the initial Pilbara zone assessment were resulting in the majority of the shoreline cells in the three zones being prioritised as High or Very High for protection in the event of an oil spill.

While the outcome demonstrates that the WA coastline has many highly vulnerable receptors to marine oil pollution, it does not achieve the objective of the project, which is a state-wide

assessment that identifies the '*key environmentally sensitive areas that are most at risk of being affected by an accidental release of marine oil*'. As a result, a State Wide Overview was undertaken to investigate the drivers for these High and Very High rankings. It was identified that a few key state-wide datasets and their priority rankings were driving the majority of the high rankings. These datasets were for the Protected Fauna and Protection Areas categories.

The outcome of the State Wide Overview assessment was a set of more detailed criteria for assigning protection priority rankings for Protected Fauna and Protection Areas data, and has been incorporated into the later assessments. This report presents the results of the assessment for the South West and South Coast zones using this refined ranking method (Figure 1-2).

This report presents the scope, method and discussion of outputs for the protection priorities identified for environmental, social, cultural and economic areas of significance which may be impacted by a marine oil spill. This report also presents the multi-criteria analysis (MCA) that has been conducted on the geospatial data collected for each category to identify the key areas of protection priority. It also recommends areas for improvement.

The protection priorities assessment for the South West and South Coast zones has demonstrated that there are many vulnerable and important receptors that will need to be considered in the event of an oil spill in either of these two zones. The South West zone comprises 21 shoreline cells, and the South Coast zone comprises 67 shoreline cells.

The cumulative assessment for all five categories has resulted in two (2) shoreline cells in the **South West** zone being ranked Very High for protection from floating oil, and three (3) shoreline cells being ranked Very High for protection from dissolved oil. A further 16 shoreline cells have been ranked High for protection from floating oil in this zone, and 11 have been ranked High for protection from dissolved oil. The remaining shoreline cells have been ranked Medium for protection from both floating and dissolved oil.

The presence of a Ramsar wetland (Vasse Wonnerup) has driven the Very High ranking of two shoreline cells for protection from floating oil in the South West zone. These two, plus a third shoreline cell have also been ranked Very High for protection from dissolved oil, due to a seawater intake at the Binningup Desalination Plant. Ramsar wetlands are internationally-protected for conservation and sustainable use and management, and therefore have been ranked Very High in the Protection Areas category. Seawater intakes for a desalination plant have been ranked Very High because it would cost an estimated $20M-$100M to replace all the membranes in a reverse osmosis plant, and also cost the State many more millions of dollars to source drinking water while it is being replaced.

Sixteen (16) shoreline cells in the South West zone have been ranked High for protection from floating oil due to the presence of sensitivities from a combination of categories: Protected Fauna; Protection Areas; and Economic. Protected Fauna in these cells include the Endangered loggerhead turtles, Critically Endangered and Endangered birds such as the curlew sandpiper and Indian yellow-nosed albatross, breeding areas for the Endangered southern right whale, and a migration pathway for other protected whale and mammal species. Protection Areas include marine parks, Nationally Important Wetlands and nature reserves. Eleven (11) shoreline cells in this zone have been ranked High for protection from dissolved oil, predominantly due to the presence of Protection Areas. These include the Ngari Capes Marine Park and several Nationally Important Wetlands. There are no Protected Fauna present that would be ranked High for protection from dissolved oil.

In the **South Coast** zone, the cumulative assessment has resulted in four (4) shoreline cells being ranked Very High for protection from floating oil and two (2) shoreline cells being ranked Very High for protection from dissolved oil. Fifty seven (57) shoreline cells in this zone have been ranked High for protection from floating oil and thirty four (34) have been ranked High for protection from dissolved oil. The remaining shoreline cells have been ranked a Medium priority.

The Very High ranking has been given to two shoreline cells for protection from both floating oil and dissolved oil due to the presence of a Ramsar wetland (Lake Gore). The other two shoreline cells ranked Very High for protection from floating oil is due to the presence of Protected Fauna, namely roosting areas for the Critically Endangered birds: the curlew sandpiper (*Calidris ferruginea*) and eastern curlew (*Numenius madagascariensis*).

More than 80% of the shoreline cells in the South Coast zone have been ranked High for overall protection from floating oil. This is due to the presence of Protected Fauna, Cultural Heritage and recognised Protection Areas in this zone. High-priority ranked Protected Fauna aspects include the likely presence of breeding areas for the Endangered southern right whale and a migration pathway for the Endangered blue whale. There is also the likely presence of Endangered loggerhead turtles, and the known presence of Critically Endangered and Endangered birds such as the curlew sandpiper and the Indian yellow-nosed albatross.

Several other Critically Endangered terrestrial fauna species are found along the South Coast zone, including the western ground parrot (*Pezoporus flaviventris*), western ringtail possum (*Pseudocheirus occidentalis*), Gilbert's potoroo (*Potorous gilbertii*) and brush tailed bettong/woylie (*Bettongia penicillata ogilbyi*). However where all terrestrial species have been investigated and reported to not use the coastal zone, it became evident that they would not be impacted by a marine oil spill. As a result, they have been ranked Very Low for protection from oil, despite their threatened status.

Cultural Heritage in the South Coast zone ranked High for priority protection in the event of a marine oil spill incident includes the National Heritage listed Fitzgerald River-Ravensthorpe Range area, and Cape Riche. The Protection Areas include the extensive Recherche Archipelago Nature Reserve as well as several Nationally Important Wetlands.

A High priority ranking has been given to 35 shoreline cells for protection from dissolved oil due to the presence of the same Protected Fauna, Cultural Heritage and recognised Protection Areas as described above for protection from floating oil. All other shoreline cells have been ranked Medium for priority protection from dissolved oil. The Protected Fauna mainly consist of the known presence of the Critically Endangered curlew sandpiper and eastern curlew, as well as the presence of breeding and calving areas for the Endangered southern right whale. The Cultural Heritage aspects are predominantly Commonwealth and State protected shipwrecks and marine archaeology, and the Medium priority Protection Areas consist of 'Strict Nature Reserve' marine and terrestrial reserves and ecologically important seagrass banks.

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Acknowledgements

Advisian would like to thank the following people who had valuable input into this project:

The Steering Committee:

- Department of Transport (DoT):
  - Emily Gifford – Team Leader Planning and Public Information | Marine Safety; and
  - Ralph Talbot-Smith – Manager Cartographic Services | Coastal Infrastructure.
- Department of Parks and Wildlife:
  - Stuart Field – Principal Policy Officer in the Office of the Director General;
  - Steve Rowlands – Parks and Wildlife Data Manager;
  - Dr Fran Stanley – Deputy Director of Science and Conservation;
  - Bob Hagan – Regional Manager | Southwest Region;
  - Luke Bentley – Regional Manager | Warren Region;
  - Greg Mair – Regional Manager | South Coast Region; and
  - Jonathon Pridham – Regional Wildlife Officer | South Coast Region.
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- Chevron: Dr Travis Elsdon – Marine Environmental Advisor;
- Blue Sands Environmental: Lucy Sands – Principal Consultant;
- South Coast Natural Resource Management: Dylan Gleave – Coastal and Water Program Leader;
- Department of Fisheries: Carli Telfer – Senior Management Officer | Biodiversity Branch;
- Environmental Protection Authority (EPA): Gordon Motherwell – Senior Environmental Officer | Infrastructure Assessments Branch; and
- Southern Ports Authority: Catherine Field – Esperance Environmental Officer.

Department of Transport personnel:

- Emily Gifford – Team Leader Planning and Public Information | Marine Safety;
- Matt Verney – Manager Maritime Environmental Emergency Response | Marine Safety;
- Sharon Hu – Senior Geospatial Information Analyst | Coastal Infrastructure;
- Steven James – Manager Geographic Information | Coastal Infrastructure; and
- Rodney Hoath – Director Coastal Information | Coastal Infrastructure.

Navigatus Consulting personnel:

- Kevin Oldham – Service Director | Project Delivery; and
- Matt Bilderbeck – Service Manager and Modelling Development.

Advisian team members and other Advisian personnel:

- Annette Jacobs – Project Manager and Multi-Criteria Analysis (MCA) Specialist;
- Kate Swain – Senior Environmental Specialist;
- Mark Peel – Geospatial Information Systems (GIS) Specialist;
- Nadene Claydon – Marine Specialist and Report Author; and
- Dan Hunter – Environment and Society Team Manager.

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Appendix B – South Coast Zone

Acronyms and Abbreviations

AFMA	Australian Fishing Management Authority
AMSA	Australian Maritime Safety Authority
BIA	Biologically Important Area
CALM Act	WA State *Conservation And Land Management Act 1984*
CAMBA	China and Australia Migratory Bird Bilateral Agreement 1986
CAMRIS	Coastal and Marine Resources Information System
CAPAD	Collaborative Australian Protected Areas Database
CD	Conservation Dependent
CR	Critically Endangered
DAA	WA State Department of Aboriginal Affairs
DEC	WA State Department of Environment and Conservation (now called DPaW)
DMP	WA State Department of Mines and Petroleum
DoF	WA State Department of Fisheries
DoT	WA State Department of Transport
DotE	Commonwealth Department of the Environment
DPaW	WA State Department of Parks and Wildlife
ELG	Environment Liaison Group
EN	Endangered
EPA	Environmental Protection Authority
EPBC Act	Commonwealth *Environment Protection and Biodiversity Conservation Act 1999*
ESC	Environmental Scientific Coordinator
ESI	Environmental Sensitivity Index
FHPA	Fish Habitat Protection Area
GDP	Gross Domestic Product
GIS	Geospatial Information System
GSP	Gross State Product
HMA	Hazard Management Agency
IMO	International Maritime Organisation
IPIECA	Global oil and gas industry association for environmental and social issues
IUCN	International Union for Conservation of Nature
JAMBA	Japan and Australia Migratory Bird Bilateral Agreement 1974
KEF	Key Ecological Feature
MCA	Multi-Criteria Analysis

MFB	Marine Futures Biodiversity
MSC	Marine Stewardship Council
NOAA	National Oceanic and Atmospheric Administration
OGP	International Association of Oil and Gas Producers
OS	Other Specially Protected Fauna (under the WC Act)
OSRA	Oil Spill Response Atlas
PMST	Protected Matters Search Tool
RoKAMBA	Republic of Korea and Australia Migratory Bird Bilateral Agreement 2004
SNES	Species of National Environmental Significance
SPRAT	Species Profile and Threats
TBC	To Be Confirmed
TSA	Tourism Satellite Account
UNESCO	United Nations Educational, Scientific and Cultural Organization
VU	Vulnerable
WA	Western Australia
WAM	Western Australian Museum
WC Act	WA State *Wildlife Conservation Act 1950*

Key Terminology

Attribute table	An attribute table has been produced for each shoreline cell summarising the protection priority for each category, for both floating and dissolved hydrocarbons (as the consequence may be different for different forms of a hydrocarbon), and an overall ranking along with a brief description of the priority. This is the deliverable to the Risk Consultant.
Categories	There are five categories for assessment of protection priority: Protected Fauna; Protection Areas; Cultural Heritage; Economic and Social; Amenity and Recreation. Each cell has been assessed for its protection priority for each of these five categories from Very Low, Low, Medium, High to Very High. These are provided in the form of an attribute table to the Risk Consultant who will integrate these into their model, along with oil spill likelihood and other hydrocarbon spill characteristics, to develop an overall risk ranking for each shoreline cell.
Coastal compartments	Coastal compartments are a physical framework for marine and coastal planning. They are a hierarchy of planning units based on geological features which has been devised by the Departments of Environment and Conservation, Planning, and Transport, and have served as a basis for the shoreline cells (Eliot *et al.,* 2011). There are primary, secondary and tertiary compartments. The tertiary coastal compartments are what the shoreline cells have been based on. The distinction between coastal compartments and shoreline cells has been made to try to avoid confusion when the results of this project are used by the DoT in collaboration with other government agencies that have protocols based on the coastal compartments.
Coastal zone	The coastal zone is defined as the area of the sea, including the water up to the mean high water mark which includes the intertidal zone and the debris beach habitat.
Components	Risk is comprised of two components: consequence and likelihood. Advisian's scope focusses on the first component, while Navigatus is providing the second component and will be combining both components to give an overall risk ranking.
Data	Data refers to geospatial data (shapefiles) that has been collected and processed using a Geospatial Information System (GIS) to rank and process the data based on its attributes as outlined in this report. These data layers have been overlain with the shoreline cells to provide an output of the overall ranking for each category for each shoreline cell. This system has been used to process extensive and complex sets of geographical data layers with a consistent ranking and geographical accuracy.
Risk Consultant	The Risk Consultant is Navigatus Consulting. Navigatus is assessing the likelihood, size, location and type of potential marine oil pollution for state waters. Navigatus is also incorporating the protection priority outputs from the Protection Priority ranking process with the spill characteristics, to give an overall risk profile for the state.
Sensitive receptors	Sensitive receptors are those receptors that have been identified as sensitive to marine oil pollution and grouped into the five categories. For example, within Protected Fauna, sensitive receptors are birds, mammals, invertebrates, fish and reptiles.
Shoreline cells	Each zone has been divided into geographical units of approximately 10 km x 20 km that are each analysed for priority ranking based on the protection priorities identified in the cell. There are 21 shoreline cells in Zone 5 *South West,* and 68 shoreline cells in Zone 6 *South Coast* (**Error! Reference source not found.**).
Zones	The WA state waters have been divided into seven (7) zones: Zone 1 *Kimberley*; Zone 2 *Pilbara*; Zone 3 *Midwest*; Zone 4 *Swan*; Zone 5 *South West;* Zone 6 *South Coast*; Zone 7 *Federal Offshore Features* (Figure 1-1).

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1 Introduction

Oil spills in the marine environment can have wide spread impact and long-term consequences on wildlife, fisheries, coastal and marine habitats, human health and livelihood, as well as recreational resources of coastal communities (Gilbert, 1999). In Western Australia (WA), the WA Department of Transport (DoT) is responsible for ensuring the State has the capacity to respond to an oil spill in WA state waters. They are designated as the Hazard Management Agency (HMA) for marine oil pollution in Western Australia. As the HMA, the DoT also ensures the capacity of the State to respond to an oil spill is commensurate with the risk.

To better understand the state's spill risk profile, the DoT is conducting a state-wide marine oil pollution risk assessment. The risk assessment comprises two components. The first component evaluates protection priorities of the receiving environment in order to assess potential consequences of oil pollution. The second component assesses the likelihood, size, location and type of potential marine oil spill. Navigatus Consulting is undertaking the second component, and is also combining the protection priority component with the spill likelihood component to give an overall marine oil pollution risk profile for the state. This overall risk profile will identify the key environmentally sensitive areas that are most at risk of being affected by an accidental release of marine oil. The output from Navigatus's assessment is not addressed in this report.

The results of this project will be used to decide how to allocate resources on a regional, state and national level, and will be scrutinised by regional, state and national agencies. Data collected on protection priorities may assist in decision-making both when preparing for and responding to marine oil pollution incidents.

For the purposes of this project, state waters have been divided into seven zones (see Figure 1-1). The project is being rolled out on a zone-by-zone basis over the next two to five years. The first protection priorities zone completed was the Pilbara (Zone 2), originally finalised in August 2016, which was followed by assessments of the Midwest and Swan (Zones 3 and 4). However as the Midwest and Swan zone assessments were being finalised, the protection priority rankings developed during the initial Pilbara zone assessment were resulting in much of the shoreline cells in the three zones being prioritised as High or Very High for protection in the event of an oil spill.

While the assessment demonstrates that the WA coastline has many receptors that are highly vulnerable to marine oil pollution, it does not achieve the objective of the project, which is a state-wide assessment that identifies the '*key environmentally sensitive areas that are most at risk of being affected by an accidental release of marine oil*'. As a result, a State Wide Overview was undertaken to investigate the drivers for these High and Very High rankings. It was identified that a few key state-wide datasets were driving the majority of the rankings. These datasets were for the Protected Fauna and Protection Areas categories.

The outcome of the State Wide Overview assessment was a set of more detailed criteria for assigning protection priority rankings for Protected Fauna and Protection Areas data. These revised rankings have been incorporated into the assessment of the South West and South Coast zones, and this report presents the results of that assessment.

This report also describes the scope, method and discussion of outputs for the protection priorities identified for environmental, social, cultural and economic areas of significance that may be impacted by a marine oil spill. It also presents the multi-criteria analysis (MCA) that has been done

on the geospatial data collected for each category, in order to identify the key areas of protection priority. It summarises these priorities and also recommends areas for improvement.

Figure 1-1: Western Australian Marine Oil Pollution risk assessment zones

1.1 Scope

The scope was broken down into four steps:

1. **Acquire information:** Advisian was required to identify, acquire and collate environmental information to assess the ecological, cultural and economic value of spatial units encompassing state waters. Part of this process was to develop a set of categories that group the data in a simple and logical format for ease of use.
2. **Design a system for presenting information:** Information was required to be compiled as an attribute table and will be uploaded to a WebMap Application being developed by the Risk Consultant. The table summarises the outputs by category for a designated sector of state waters. The sectors are geospatial units that have been developed by the Risk Consultant and termed 'shoreline cells' for this project.
3. **Conduct assessment:** All available, relevant spatial data collected was required to be ranked in order of its protection priority in the occurrence of a marine oil pollution event, and processed using a weighting by area and importance for each shoreline cell.
4. **Provide outputs:** A report has been prepared outlining the method and an attribute table summarising the outputs of the assessment by shoreline cell. The attribute table will be used by the Risk Consultant to upload protection priority information into a WebMap Application.

In addition to the above, a Steering Committee was introduced to facilitate identifying and collecting relevant data, and to ensure appropriate rankings and processing.

The project scope is summarised in a flowchart in Figure 1-2.

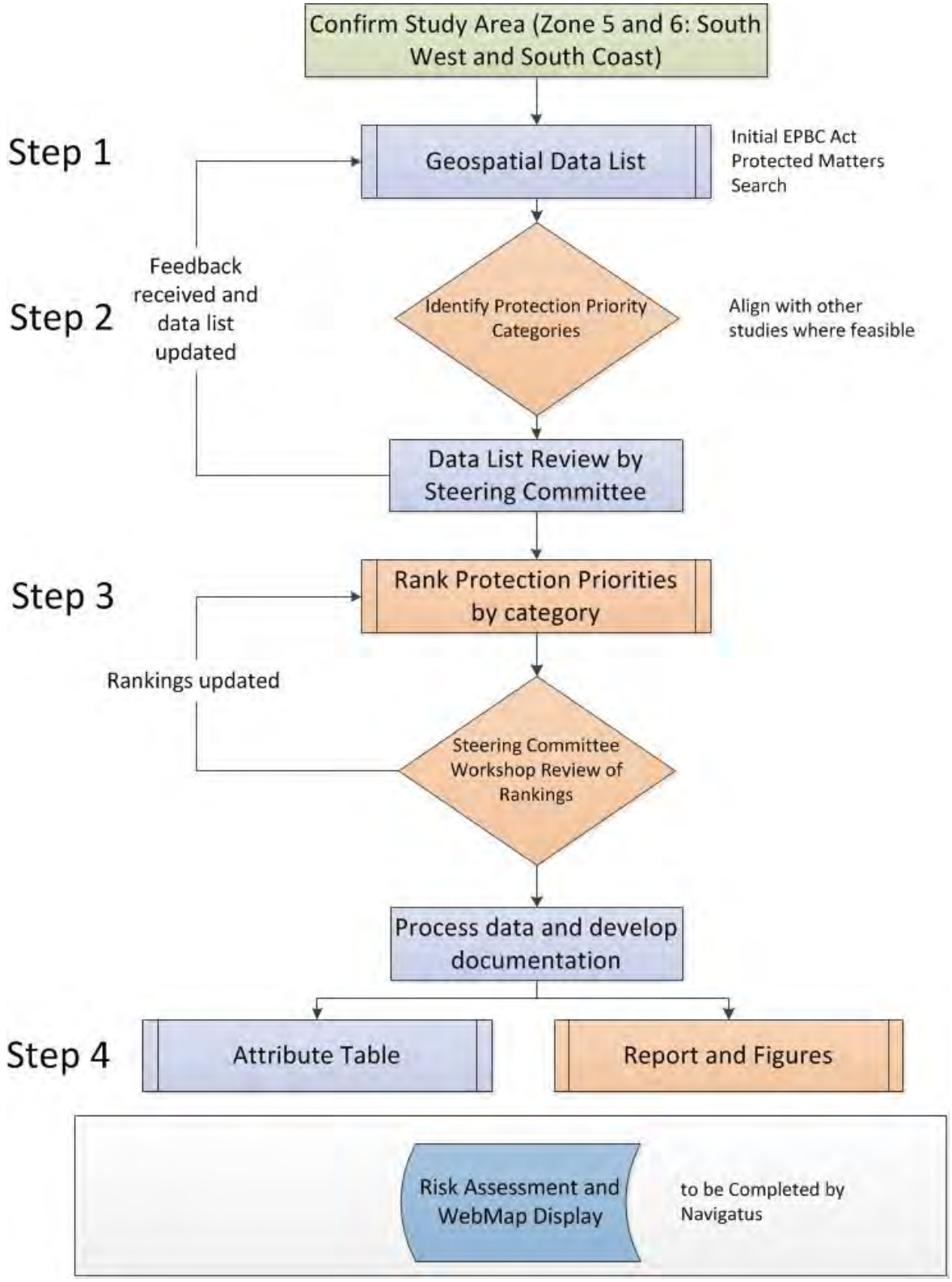

Figure 1-2 Protection priorities project component flowchart

1.2 Protection Priority Categories

The main outcome from step 1 was to develop a set of categories that group protection priorities, following a simple and logical format of similar aspects with respect to vulnerability to a marine oil spill. This approach is based on the Australian Maritime Safety Authority's (AMSA) National Plan for Maritime Environmental Emergencies (the National Plan), as well as similar oil spill risk assessments that have been undertaken.

A number of protection priorities are set out in the National Plan, which is managed by AMSA. The National Plan, along with identifying sensitive receptors, describes how governments and industry will co-operate to respond to shipping casualties and maritime spills. The National Plan has been developed with the Commonwealth and State/Northern Territory government agencies as well as shipping, ports, offshore petroleum production and exploration, oil, salvage and chemical industries. Protection priorities as set out in the National Plan include habitat and cultural resources, rare and/or endangered flora and fauna, commercial resources and amenity areas (AMSA, 2016).

A similar oil spill risk assessment undertaken in New Zealand categorised priorities into five value types (Navigatus, 2005; 2015). These are: species; habitats; social; amenity and recreation; cultural and heritage; and economic. Another similar assessment undertaken in Victoria used the same five categories (Navigatus, 2011).

For Western Australia, five categories were also selected based on the list above, with an amendment from 'habitats' to 'protection areas'. This was changed to allow areas designated for protection (for example a World Heritage area, or a Key Ecological Feature) to be included. Protection areas identify an area of ecological function beyond the individual habitats that it may comprise, which may not otherwise be included in the assessment.

As an outcome of the above reviews, and taking into account the Western Australian environment, five categories of interest were defined for assessing the effects of a marine oil pollution event for this project. These are:

1. Protected Fauna;
2. Protection Areas;
3. Cultural Heritage;
4. Economic; and
5. Social, Amenity and Recreation.

1.3 Shoreline Cells

Step 2 required designing a system for presenting information. This involved dividing Western Australia's state waters into sectors to geospatially summarise the information in a WebMap Application. The sectors are geographical units that have been developed by the Risk Consultant. These units have been termed 'shoreline cells' for this project, and are loosely based on the tertiary planning units (coastal compartments) that have been devised by the Departments of Environment and Conservation, Planning, and Transport (Eliot *et al.,* 2011). These are approximately 10 km x 20 km and have been called 'shoreline cells' to distinguish them from the 'coastal compartments' developed by Eliot *et al.* (2011).

The primary, secondary and tertiary coastal compartments were devised as a physical framework for marine and coastal planning, and are currently used by other State departments such as the Department of Parks and Wildlife (DPaW) for oiled wildlife response planning. The coastal compartments define the principal coastal regions and coastal compartments discernible around the Western Australian coast based on known geologic features, landforms, ocean processes and sediment distribution (Eliot *et al.,* 2011). The shoreline cells being assessed for the South West and South Coast zones are illustrated in **Error! Reference source not found.**. There are 21 shoreline cells in the South West zone, and 68 in the South Coast zone.

The shoreline cells used in this assessment were provided to Advisian by Navigatus, and it is understood that each shoreline cell's landward boundary is approximately the mean high water mark. This boundary was selected as it is the approximate distance inland that a marine oil spill is expected to affect if the oil washes up on the beach.

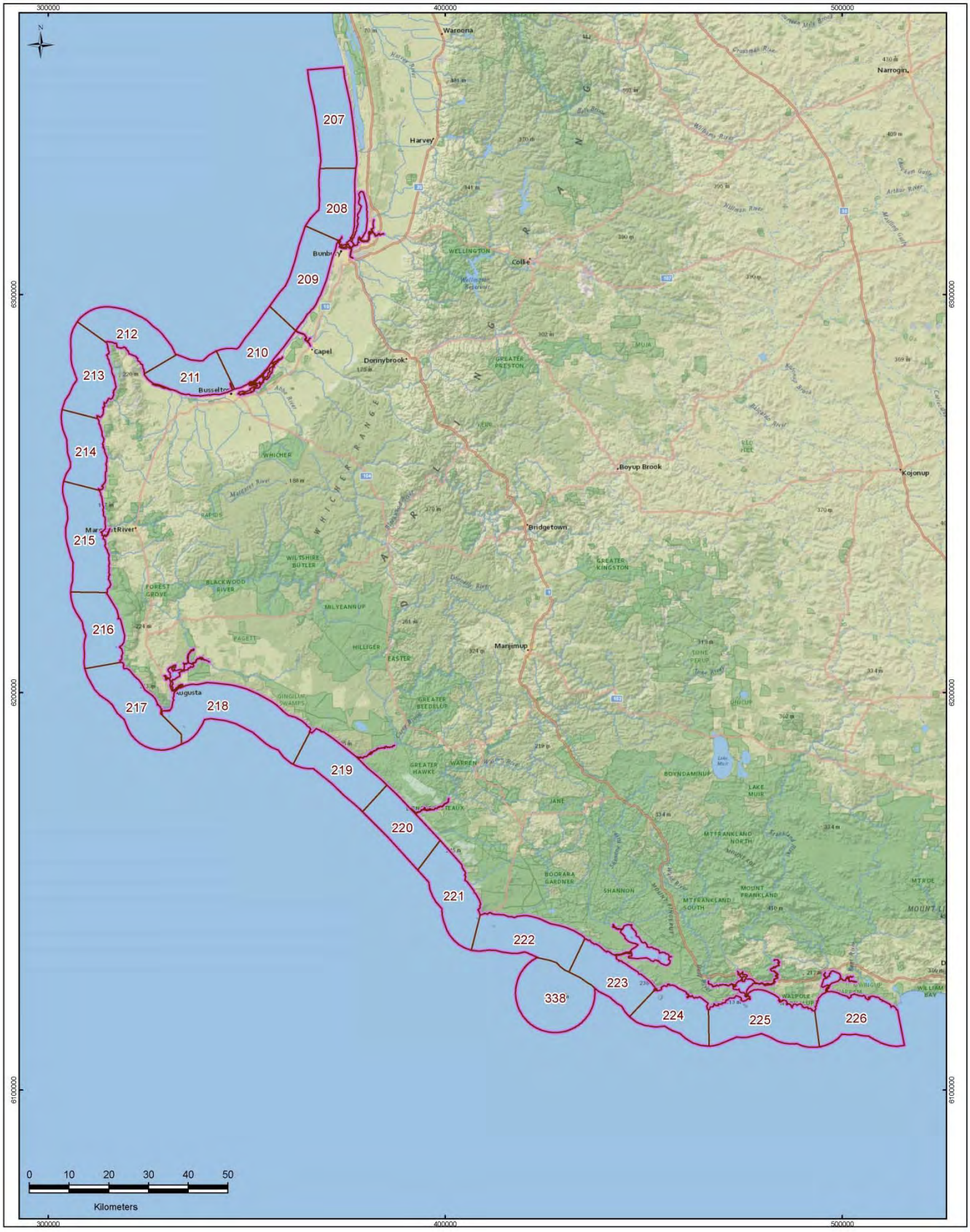

Figure 1-3 South West Zone shoreline cells

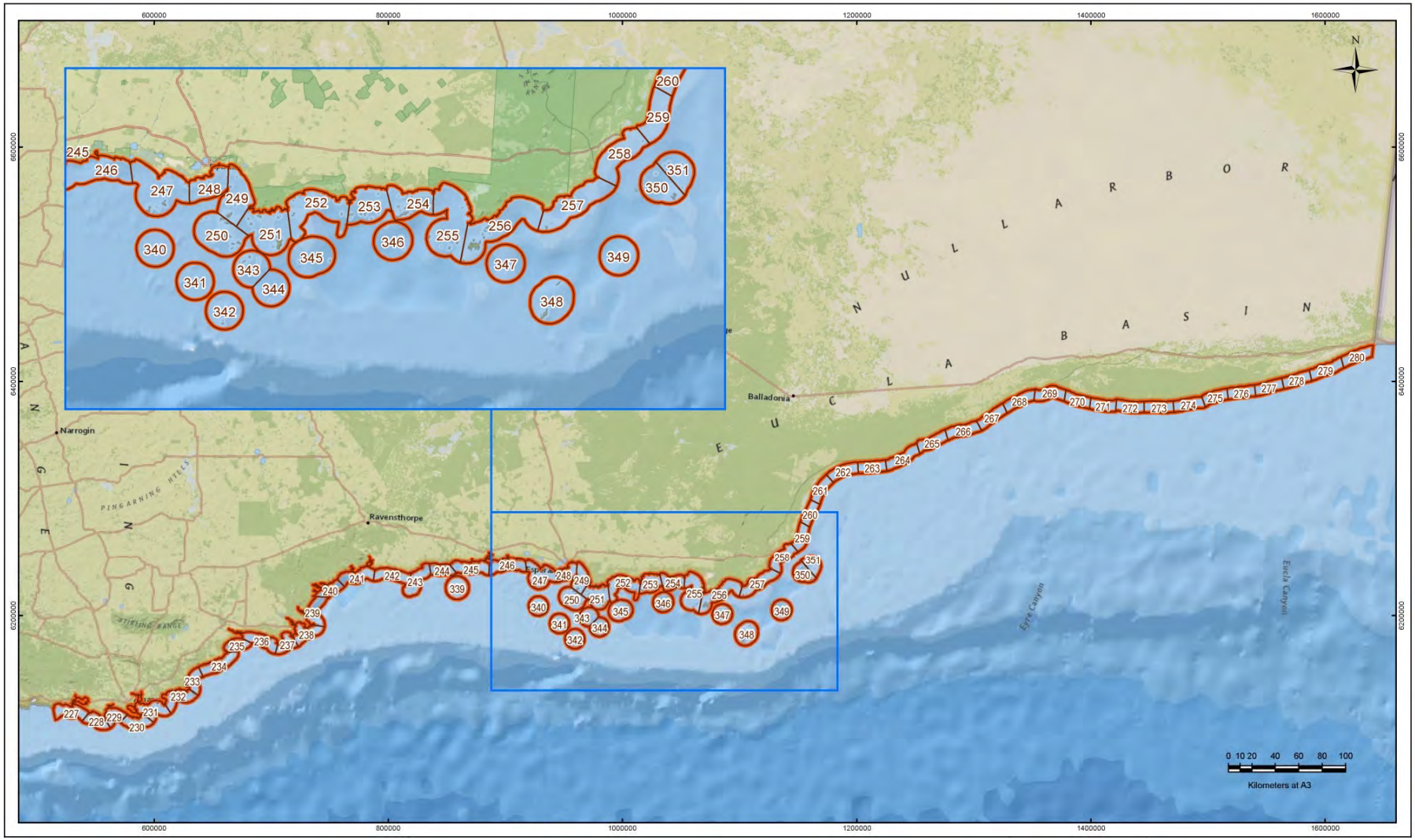

Figure 1-4 South Coast Zone shoreline cells

1.4 Marine Oil Pollution Effects

The assessment of ranking data (step 3) requires an understanding of vulnerability and susceptibility to marine oil pollution, for the different sensitive receptors identified, in order to give each a ranking for protection priority. This has been challenging because the impact will depend on the sensitivity of the receptor to marine oil, as well as the quantity of oil spilled and the characteristics and properties (type) of oil. The potential effects that have been considered are summarised below.

There are many different types of hydrocarbons that may cause marine pollution, and each has its own complex properties. Oil types range from heavy fuel oils from large shipping vessels to marine diesel from supply vessels, to light condensates and crude oils from offshore and nearshore pipeline or platform leaks, and well blowouts (e.g. Montara). Once released into the marine environment, hydrocarbons are subject to weathering and assimilation in the marine environment (Figure 1-5). The timing for this process depends on their complex properties (physical and chemical characteristics), as well as a number of other variables including: the amount spilled; the prevailing climatic and sea conditions; and how long the hydrocarbons remain at sea or wash ashore. Weathering is the process of physically and chemically changing hydrocarbons through spreading, evaporating, dispersing, emulsifying, dissolving, oxidising and biodegrading (French-McCay & Payne, 2001). Oil spill responses can also influence these processes.

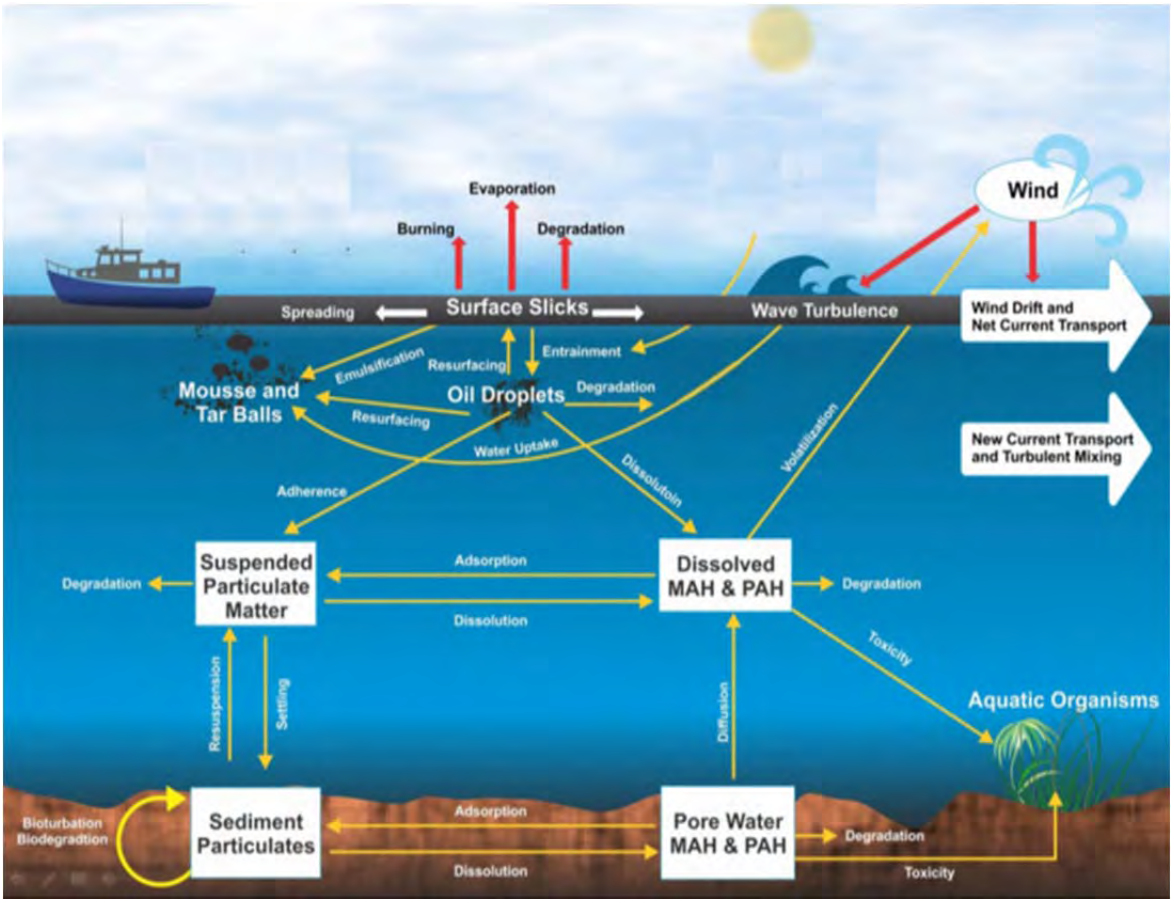

Figure 1-5: Hydrocarbon weathering and biodegradation processes

The effect of each type of hydrocarbon varies, depending on both its physical and chemical properties. In general, there are three different forms modelled and assessed for their effects: floating; entrained; and dissolved. Floating occurs because hydrocarbons are typically lighter than water so they float on the surface, often referred to as a 'slick'. Entrained hydrocarbons are small droplets of oil in the water column. These can be various sizes and occur when the hydrocarbons have been released sub-surface, or where floating oil has been mixed into the water column by waves. 'Dissolved' is the soluble component of a hydrocarbon that causes toxic effects, depending on the concentration and duration of exposure. In general, these effects and impacts are summarised below for each of the five categories.

For this assessment, the physical effects of entrained oil are considered to have been captured in the 'floating' component of this assessment. Therefore only two sets of rankings have been used: one for the effects of floating hydrocarbons; and one for the effects of dissolved hydrocarbons.

Hydrocarbons may impact the environment (fauna and flora) by one or more ways (ITOPF, 2011):

- Physical smothering, which impacts physiological functions;
- Chemical toxicity, which causes lethal or sub-lethal effects or impairs cellular functions;
- Ecological changes, primarily losing key organisms from a community and opportunistic species taking over habitats; and/or
- Indirect effects, such as losing habitat or shelter and consequently eliminating ecologically important species.

The impacts of hydrocarbons on a cultural heritage site may include:

- Physically degrading a site; and
- Reducing the amenity and emotion of an environmental site that is protected for Indigenous and European heritage reasons.

From an economic perspective, hydrocarbons can:

- Temporarily disrupt operations, resulting in reduced income, for example a port or an oil & gas facility; and
- Cause long-term economic loss, such as the impact on a fish stock, both through indirect loss of stock and perceived tainting of stock by the oil.

Hydrocarbons may impact on social, amenity and recreational aspects by:

- Reducing the amenity of a site such as a beach or a coral reef;
- Restricting access to a site during clean-up and rehabilitation; and/or
- Giving a perceived loss of amenity due to negative perceptions associated with an 'oil spill'.

1.5 Steering Committee

A Steering Committee was established to facilitate identifying and collecting relevant data, and to ensure appropriate rankings and processing. This developed through DoT's presentation of the project to the Environment Liaison Group (ELG) of which DoT is a member. Feedback from the ELG on the concept of the project emphasised the importance of the data collection phase. A Steering Committee was therefore established to facilitate liaison with multiple agencies throughout the project. The Steering Committee was comprised of:

- A DoT representative;
- A project team representative(s);
- Multi government agency representatives; and
- Independent representatives (as required).

The Steering Committee members for the South West and South Coast zones are presented in Table 1-1.

Table 1-1: Steering Committee members for the South West and South Coast zones

Department	Name	Title
Department of Transport	Emily Gifford	Acting Team Leader Planning and Public Information | Marine Safety
	Ralph Talbot-Smith	Manager Cartographic Services | Coastal Infrastructure
Department of Parks and Wildlife	Stuart Field	Principal Policy Officer in the Office of the Director General
	Steve Rowlands	Parks and Wildlife Data Manager
	Bob Hagan	Regional Manager | Southwest Region
	Luke Bentley	Regional Manager | Warren Region
	Greg Mair	Regional Manager | South Coast Region
	Jonathon Pridham	Regional Wildlife Officer | South Coast Region
	Dr Fran Stanley	Deputy Director of Science and Conservation
AMSA	Paul Irving	Senior Scientific Coordinator | Marine Environment Pollution Response
Chevron	Dr Travis Elsdon	Marine Environmental Advisor
Blue Sands Environmental	Lucy Sands	Principal Consultant
EPA	Gordon Motherwell	Senior Environmental Officer | Infrastructure Assessments Branch

Emily, Ralph, Stuart, Paul, Fran and Gordon were engaged for the initial Pilbara zone assessment, and Emily, Ralph, Stuart, Paul and Gordon were also engaged for the Midwest and Swan zones. The following individuals and organisations were also invited to be on the Steering Committee, but were unable to participate due to their commitments:

- South West Catchment Council:
  - Emily Hugues-dit-Ciles – Senior Scientist & Environmental Program Manager; and
  - Damien Postma – Chief Executive Officer.
- South West Development Commission:
  - Patrick Warrand – Assistant Director | Industry & Business; and
  - Alan Cross – Regional Development Coordinator.
- Department of Fisheries: Carli Telfer – Senior Management Officer | Biodiversity Branch.

The Steering Committee was asked to:

- Review the list of collected data to ensure it is the best available and, if gaps were identified or datasets missing completely, advise on possible alternate sources of information;
- Direct Advisian to relevant points of contact for additional data, streamlining the process where possible; and
- Provide advice at a workshop to review the selection and weightings of each criterion for multi-criteria analysis.

The Steering Committee was provided with the following documentation:

- Terms of Reference that outlined the engagement and commitments to the project (sent prior to 18 April 2017);
- Data List report (301012-09591-EN-REP-0011) (sent 8 April 2017) for review and identification of additional data; and
- Workshop Discussion Paper (301012-09591-EN-EN-REP-0012) (sent 4 May 2017) as preparation for the workshop.

A workshop was held with the Steering Committee on 9 May 2017 to review the available data and the priority ranking process. The priority rankings were explained and agreed for these and future zones; these rankings are provided in Section 3. A number of additional data requirements were also identified in the workshop. This is discussed in Section 2.

Following the State Wide Overview assessment, the Steering Committee members involved in the three previously assessed zones (Pilbara, Midwest and Swan) were also engaged to review and assess the revised protection priority rankings.

The Steering Committee provided valuable input, data identification, clarification and experience to the project. Their comments have been incorporated into this assessment where applicable. It is anticipated that the composition of the Steering Committee will remain largely constant as the project moves across the two remaining zones, with local subject matter experts added as appropriate.

In the Workshop on 9 May 2017, the following issues were also discussed:

- Protected fauna – Sea lions, sea dragons, and endemic fish in the estuaries along the coastline were a particular concern. As these species may not be listed as Critically Endangered, the Steering Committee was concerned that they would not be properly protected, and felt it was important to specifically consider these fauna in this section of the assessment. Their distribution has been included, but because this is a State Wide Overview assessment, the rankings have not been altered specifically for these species;
- Protection areas – Tufa and limestone springs were raised as areas not being covered in the datasets. These areas are unique and fragile ecosystems, and potentially sensitive to oiling. Following the workshop, DPaW sent data to Advisian to evaluate and include in the assessment. These areas are mainly in marine parks, so have been allocated a High priority ranking as a Protection Area. The Recherche Archipelago was also of concern, as it is an important area but not formally protected. The area is, however, a proposed marine park and therefore has been ranked a High protection priority in this category;
- Seasonality – There was some debate on this, and it was agreed that, because an oil spill could occur at any time, the worst consequence would be adopted. As this assessment will feed into the current oil spill response process, the collected data could be used in the initial screening phase to identify any sensitive receptors in the projected spill path. The data could then be used to identify local experts who would provide the relevant response information. This is particularly relevant where there may also be considerable inter-annual seasonal variability;
- Corals and seagrass – There was concern that corals were being ranked higher than seagrass, particularly in the temperate regions where seagrasses were a higher priority than corals. However, a large proportion of seagrass is located in marine parks and has been given a higher priority as a Protection Area, and therefore the rankings for seagrass were not changed;
- Cultural heritage – Specific areas of high cultural significance were discussed, as the Committee was concerned about their protection. These areas exist in both the South West and South Coast zones. The heritage is mostly buildings and, although these are located along the coastline, they are all above the intertidal zone and therefore less likely to be affected by oil in the marine environment. Therefore the rankings for this section have remained the same as the State Wide Overview assessment;
- Economic – Aquaculture is considered to be a growing industry in a number of areas, most notably Bremer Bay. It was noted that these areas should be prioritised for future economic growth, so any areas proposed for future aquaculture have been included in this assessment;
- Tourism – This was a high concern in the South West and South Coast zones, as there are many towns which rely on tourism, and the Steering Committee was concerned that they may be affected greater than other areas in the state. There was a lengthy discussion about how to represent this concern, such as getting boat ramp traffic data or population numbers during different times of the year. This however was still likely to show lower numbers in comparison to the rest of the state, and would still have a lower ranking due to income. As this section of the assessment compares the economic impact over the state, the rankings have remained the same; and

- Social amenity and recreation – No aspects were ranked Very High in this section; all rankings stopped at Medium. It was suggested that a ranking of Very High be allowed for, even if no parameter met those requirements. It was determined after the workshop that altering the rankings for this purpose did not add value to the ranking system.

2 Geospatial Data

2.1 EPBC Act Protected Matters Search Tool

An assessment to identify and gather environmentally and culturally important areas was initially undertaken using the *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act) Protected Matters Search Tool (PMST). This is an online interactive map maintained by the Commonwealth Department of the Environment (DotE). The search tool was used to generate a report that helped determine whether matters of national environmental significance or other matters protected by the EPBC Act are likely to occur in the area.

The area searched included the South West and South Coast zones, from up to 5 km inland to the approximate state waters boundary (Figure 2-1).

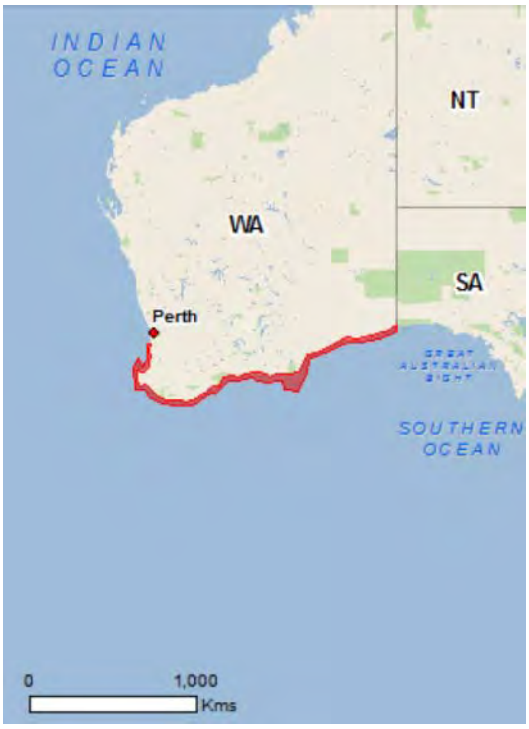

Figure 2-1: EPBC Act Protected Matters search tool area of search

The report provided the following information on the identified Matters of National Environmental Significance:

- World Heritage Properties;
- National Heritage Places;
- Wetlands of International Importance;
- Commonwealth Marine Areas;
- Listed Threatened Ecological Communities;
- Listed Threatened Species; and

- Listed Migratory Species.

Other matters protected by the EPBC Act:

- Commonwealth Land;
- Commonwealth Heritage Places;
- Listed Marine Species;
- Whales and Other Cetaceans;
- Critical Habitats;
- Commonwealth Reserves Terrestrial; and
- Commonwealth Reserves Marine.

Extra information:

- State and Territory Reserves;
- Regional Forest Agreements;
- Invasive Species;
- Nationally Important Wetlands; and
- Key Ecological Features (Marine).

The generated PDF report gives a link to the Resource Data, which was the publically available geospatial data (shapefiles) for each key area identified above. The Resource Data webpage for each dataset also provided metadata, such as an abstract of the data, acronyms and data structure, the creation and revision date, history and access constraints. These datasets were downloaded and incorporated into this assessment.

The EPBC Act PMST Report varies in some instances from the data incorporated in the report. This is likely due to the dataset being constantly updated and refined through fauna distribution and habitat surveys. The raw geospatial data was taken as the most up-to-date information, and used in this report.

2.2 Other Data Sources

Other data sources were those not publically available and also not in geospatial format. One example of this was information and ratings of beaches from Surf Life Saving WA. In this instance, beach popularity information was identified and a geospatial shapefile created for the beaches from a google maps location file.

2.3 Steering Committee Review of Data List

The geospatial layers outlined in Table 2-1 have been included in the assessment for the South West and South Coast zones. Table 2-1 summarises the layers, their high level attributes, and when the data was last updated.

The Steering Committee was asked to review the data collected to date and indicate whether:

1. A more up-to-date dataset existed and where it could be sourced from;
2. There was considered to be a data gap and if an alternate source of information for this data existed; and
3. Any data was missing and possible sources for this data.

The data in Figure 1-2 has been grouped into the five categories: protected fauna; protection areas; cultural heritage; economic; and social/amenity/recreation, to facilitate the identification of the type of area use that is being assessed.

Some datasets listed in Table 2-1 appear 'old', with a date more than a decade prior to this assessment, for example the Fish Habitat Protection Area (2001), the DotE Directory of Important Wetlands in Australia (2008), and the DoT Shipping and Pilotage Ports (2010). These datasets are not out of date; they reflect that the purpose and geospatial extents defined in the dataset have not changed.

The Steering Committee was then asked to provide further datasets as required for inclusion in the assessment, and these datasets received by Advisian are also presented in Table 2-1.

Table 2-1: Data included in this assessment, custodians and data update information

Layer	Section	Data Source	Last Updated
Protected Fauna			
Birds	3.1.1	▪ Commonwealth Department of the Environment (DotE) Biologically Important Areas (BIA) for marine species	▪ 4 Jan 2016
Mammals	3.1.2		
Invertebrates	3.1.3		
Fish	3.1.4	▪ DotE Species of National Environmental Significance (SNES)	▪ 5 Oct 2016
Reptiles	3.1.5	▪ WA's Department of Parks and Wildlife (DPaW) for fauna	▪ 14 Oct 2016
		▪ WA's Department of Fisheries (DoF) Seasonally Protected and Totally Protected Fish	▪ Nov 2016
		▪ Sea lion breeding sites – DPaW and DoF dataset	▪ 15 May 2014
Protection Areas			
World Heritage Areas	3.2.1	▪ DotE World Heritage Areas	▪ 14 Oct 2015
Terrestrial Protection Areas	3.2.2	▪ DotE Collaborative Australian Protected Areas Database (CAPAD) – terrestrial	▪ 30 Jun 2014
		▪ DPaW CAPAD terrestrial dataset update	▪ Jun 2016
		▪ Department of Defence lands	▪ 15 Dec 2016
Marine Protection Areas	3.2.3	▪ DotE CAPAD – marine	▪ 30 Jun 2014
		▪ DPaW CAPAD marine dataset update	▪ Jun 2016
Ramsar and Nationally Important Wetlands	3.2.4	▪ DotE Ramsar Wetlands of Australia	▪ 16 Feb 2015
		▪ DotE Directory of Important Wetlands in Australia	▪ 15 Oct 2008
Key Ecological Features	3.2.5	▪ DotE Marine Key Ecological Features	▪ 16 Sep 2015
Coastal and Intertidal Habitats	3.2.6	▪ DoT Oil Spill Response Atlas (OSRA) WA shorelines Environmental Sensitivities Index (ESI)	▪ Apr 2011
		▪ DPaW Marine Habitats	▪ May 2015
		▪ Coastal and Marine Resources Information System (CAMRIS) Benthic Substrate dataset	▪ 23 Jan 2008
		▪ DPaW Tufa datasets	▪ May 2017
Coral, Seagrass, Algae and Filter Feeding Communities	3.2.7	▪ OSRA ESI – coral	▪ Apr 2011
		▪ Coastal and Marine Resources Information System Seagrass	▪ 10 Mar 2015
		▪ DPaW Marine Habitats - algae	▪ May 2015

Layer	Section	Data Source	Last Updated
Fish Habitat Protection Areas (FHPAs) and Fisheries Prohibited Areas	3.2.8	▪ DoF Fish Habitat Protection Areas ▪ DoF Closed waters – marine reserves	▪ 2 Mar 2016 ▪ 2 Mar 2016
Protected Areas for Aquaculture	3.2.9	▪ DoF Fish Habitat Protection Areas	▪ 2 Mar 2016
Cultural Heritage			
World Heritage Properties	3.3.1	▪ DotE World Heritage Areas	▪ 15 Oct 2015
National Heritage	3.3.1	▪ DotE National Heritage List	▪ 11 Feb 2016
Commonwealth Heritage Places	3.3.1	▪ DotE Commonwealth Heritage – public	▪ 23 Feb 2016
State Protected Heritage	3.3.2	▪ State Register ▪ Conservation Orders ▪ Heritage Agreements ▪ Town Planning Scheme ('Heritage List') ▪ Municipal Inventory	▪ 10 Oct 2016 ▪ 10 Oct 2016 ▪ 10 Oct 2016 ▪ 10 Oct 2016 ▪ 10 Oct 2016
Shipwrecks and Maritime Archaeology	3.3.3	▪ DotE Australian National Shipwrecks ▪ WA Museum Recorded Shipwrecks	▪ 3 Feb 2016 ▪ 28 Jan 2016
Economic			
Aquaculture	3.4.1	▪ DoF Aquaculture Licences	▪ 9 Mar 2016
State Managed Commercial Fisheries	3.4.2	DoF individual shapefiles for each fishery: ▪ Abalone Managed Fishery ▪ Finfish trapping in oceanic waters ▪ Hardy Inlet Lawful Nets Order ▪ Leatherjacket Fish Trapping King George Sound ▪ Mackerel Managed Fishery ▪ Marine Aquarium Managed Fishery ▪ Open Access South Coast Demersal Scalefish ▪ Purse Seine Net Development Zone ▪ South Coast Crustacean Managed Fishery ▪ South Coast Estuarine Managed Fishery ▪ South Coast Herring Trap net fishery ▪ South Coast Open Access Netting ▪ South Coast Salmon Fishery ▪ South West Trawl Limited Entry Fishery	▪ All data received 5 May 2017

Layer	Section	Data Source	Last Updated
		▪ Specimen Shell Managed Fishery ▪ Vasse and Wonnerup Netting Restrictions ▪ West Coast Demersal Scalefish Fishery ▪ West Coast Estuarine Fishery ▪ West Coast Purse Seine Limited Entry Fishery ▪ Octopus Interim Managed Fishery	
Commonwealth Managed Fisheries	3.4.3	Australian Fishing Management Authority (AFMA): ▪ West Coast Rock Lobster Managed Fishery ▪ Western Tuna and Billfish Fishery; ▪ Southern Tuna and Billfish Fishery ▪ Western Skipjack Tuna Fishery; ▪ Southern Bluefin Tuna Fishery. ▪ Small Pelagic Fishery ▪ Southern Squid Jig Fishery ▪ Southern and Eastern Scalefish and Shark Fishery	▪ All data from March 2016
Other Commercial Operations	3.4.4	▪ None identified	▪ N/A
Tourism	3.4.7	▪ Tourism WA	▪ Jun 2017
Ports and Shipping	3.4.6	▪ DoT Shipping and Pilotage Ports ▪ Landgate Port Authorities	▪ 25 Oct 2010 ▪ 23 Nov 2016
Water Intake Locations	3.4.7	▪ DoT Water Intake Location ▪ DoF Water Intake Locations	▪ 17 Dec 2012 ▪ 12 Dec 2016
Social, Amenity and Recreation			
Recreational Fishing/Boating Zones	3.5.1	▪ DotE CAPAD – marine	▪ 30 Jun 2016
Beaches	3.5.2	▪ Surf Life Saving WA beach popularity information ▪ Department of Planning – Town location and population size ▪ Beaches listed on Western Australia's Top Ten Beaches ▪ DMP Coastal Landforms dataset	▪ May 2016 ▪ Nov 2016 ▪ Jun 2016 ▪ May 2016

2.4 Data Cut-Off and Summary of Inclusion

The Steering Committee's initial review of the data list for the South West and South Coast zones was intended to identify all additional data layers, and a cut-off date of 20 June 2017 was applied to allow time to run the processing for this report.

In the future, it is anticipated that when the other zones are assessed over the next two to five years, additional datasets may become available for these and other zones. Upon completion of the final zone, it may be advisable to review the early zones to assess the need to include additional datasets.

2.5 Data Excluded

During assessment of the Pilbara zone, the following datasets were identified but have since been excluded for the following reasons. This precedent has continued to be carried into the remaining zones, including the South West and South Coast.

1. State Protected Indigenous Cultural Heritage

The WA Department of Aboriginal Affairs (DAA) holds a list of Aboriginal Heritage places protected or assessed under the WA *Aboriginal Heritage Act 1972*. The Aboriginal Heritage Inquiry System details the location and extent of each place protected under the Act. To preserve confidentiality, the exact location and extent of some places are not displayed on the map; however a shaded region (usually with an area of at least 4 km^2) indicates where the place is generally located.

During the Steering Committee Workshop for the first zone assessed (the Pilbara zone), on 16 May 2016, it was raised that the DAA list is largely incomplete, as it only identifies areas that have been registered through Native Title Determinations. The dataset was agreed to be removed to avoid the false impression that this sensitivity is covered.

In the absence of state-specific protection priority data for each shoreline cell, DoT would need to consult with the DAA independently in the event of an oil spill. This precedent is being carried through to the remainder of the zones being assessed.

2. Coastal Landforms

To supplement the OSRA ESI dataset, the WA State Department of Mines and Petroleum (DMP) Coastal Landforms dataset was identified for incorporation into this assessment. On review of the Coastal Landforms dataset, it was determined that it didn't add any value in identifying coastline portions needing protection (Protection Areas), so it was omitted. This was because it was difficult to assign a protection priority, as the dataset is not consistent in its interpretation of sandy/rocky and inundated shoreline areas.

The Coastal Landforms dataset was however used to identify and include potential recreation beaches in the Social, Amenity and Recreation category. This is because there was no other Beach data available for the South West and South Coast zones.

3. Oil and Gas Operators

A number of oil and gas operations occur in WA state waters and near the coast, including subsea pipelines. Subsea pipelines were not evaluated as a protection priority as their operation is not expected to be affected in an oil spill. Facilities that operate in state waters may experience economic loss through a safety requirement to shut facilities if an unrelated oil spill enters their operational zone.

Offshore oil and gas facilities have not been included as they do not fall in the shoreline cells. However, associated infrastructure aspects operating in the shoreline cells are included, namely port facilities and seawater intakes. Refer to Section 3.4.4 and Section 3.4.5.

3 Ranking of Protection Priorities

Each of the sensitive receptors has been given a classification from Very Low to Very High in order to rank their protection priority in the event of an oil spill, for comparison between the sensitivities (Table 3-1). The rankings have a numerical value as well as a classification. The gradation in this ranking has been selected to balance the relative importance of aspects being ranked. Five levels have been deemed appropriate for relative ease of ranking each of the sensitivities.

When assigning a ranking, a key consideration was whether the sensitivity was *vulnerable* and/or *sensitive* to a marine oil spill. These considerations of how vulnerable the receptor may be to floating or dissolved oil, as well as how sensitive it is, have been included below for each receptor. This was critical to assigning correct rankings for the purposes of the project. For example, coral is highly *sensitive* to marine oil, however if the oil is floating on the surface of the sea and it is a calm day, then the coral is not as *vulnerable* to the oil, as the oil will pass above the coral and not affect it. If the oil was dissolved in the water column, then the coral would be *vulnerable* to it. These considerations of different states of vulnerability have been reflected in the occasional differences between the rankings for floating and dissolved oil priorities.

In addition, the information provided in the datasets themselves was incorporated when allocating protection priority rankings. For example, data confidence, reliability, accuracy and geospatial extent have been included in some instances where this information is available, in order to correctly reflect the key areas that require priority.

Table 3-1: Protection priority ranking

Protection Priority	Ranking
Very High	5
High	4
Medium	3
Low	2
Very Low	1

There were many discussions held in the Steering Committee Workshop (see Section 1.5) regarding these points, and the overall consensus of rankings agreed with the Committee are reflected in the rankings in this report. It also reflects the revised rankings proposed as an outcome of the State Wide Overview assessment, which were reviewed and endorsed by the core Steering Committee.

3.1 Protected Fauna

Australia's shoreline is home to a vast number of fauna, many of which are endemic to Australia, and some species are of international, regional and local importance. In WA, threatened fauna are protected under Commonwealth and State legislation as well as International agreements, and are listed under the International Union for Conservation of Nature (IUCN) Red List. Key legislation includes:

- Commonwealth EPBC Act which includes nationally significant fauna, and fauna protected under the following international agreements:
  - Japan and Australia Migratory Bird Bilateral Agreement (JAMBA) 1974;
  - China and Australia Migratory Bird Bilateral Agreement (CAMBA) 1986; and
  - Republic of Korea and Australia Migratory Bird Bilateral Agreement (RoKAMBA) 2007.
- Western Australian *Wildlife Conservation Act 1950* (WC Act) which includes fauna of regional and local significance to the state.

The protection priority rankings include the method developed during the initial assessment of the Pilbara zone: assessing the threatened status of a species listed under both the EPBC Act[1] and the WC Act[2], and taking whichever is highest. The ranking also takes into account the biological importance of an area to a species, and the possible long term consequences the spill can have at a species level.

The Biologically Important Areas (BIAs) for species were used in this assessment because some fauna are more susceptible to an marine oil spill at different phases of their lifecycle. For example, breeding areas were given the highest importance, while roosting (in the case of birds), feeding and migrating areas were given lower levels of importance, as the likelihood of a bird coming into contact with the oil and the likely effects of oiling decreased during these activities. Similarly, the likelihood of whales being affected during feeding and migrating is lower than when it is active in its breeding and aggregation areas with its young.

The datasets used for the Protected Fauna category provided the opportunity to incorporate data confidence, reliability, accuracy and geospatial extent into the rankings. These are described in the tables for each fauna type in the sections below. In general, for the Species of National Environmental Significance (SNES) data, species that are 'known', 'likely' and 'may be' in an area are given different weightings, with 'known' the highest and 'may be' the lowest. For the DPaW fauna data, the survey method and certainty of identification were used to distribute the weightings (e.g.

[1] The EPBC Act has six conservation categories, three of which have been used in this assessment. The six categories are Extinct, Extinct in the Wild, Critically Endangered (CR), Endangered (EN), Vulnerable (VU) and Conservation Dependent (CD). Only CR, EN and VU have been used in this assessment. Extinct and Extinct in the Wild were omitted as, of the seven species listed as Conservation Dependent, these are all fish and no key data was located for these species.

[2] Under the WC Act, 11 conservation categories exist. In addition to those listed in the EPBC Act, there are six more used, including CD. The other five are Other specially protected fauna (OS), and Priority species, listed as P1 to P4. For a definition of these please see: https://www.dpaw.wa.gov.au/images/documents/plants-animals/threatened-species/Listings/conservation_code_definitions.pdf

caught, trapped or sighted and 'Very Certain, 'Western Australian Museum (WAM) Vouchered' or 'Certain', which are provided in the dataset and give the highest confidence, while 'secondary signs' and 'fossil' were the lowest along with 'not sure' and 'not defined'.

The ranking does not exclude species from being responded to if they are not formally protected; all fauna will be responded to in an oil spill. The process used in this assessment identifies those areas of greatest priority where there are known areas of significant fauna requiring protection.

The ranking also takes into account the effect oil can have on the fauna type. For example, where birds are able to be greatly impacted by oil, whales are less likely to be affected at an individual level due to a number of factors. This is discussed more in the sections below.

In all zones, the terrestrial fauna data was interrogated further, including a review of all birds, mammals, reptiles and invertebrates data. The fauna habitat information from secondary credible sources was evaluated to determine if they spend any part of their lifecycle in the coastal zone. The secondary sources evaluated included the Species Profile and Threats (SPRAT) database (http://www.environment.gov.au/cgi-bin/sprat/public/sprat.pl), Commonwealth and State Recovery Plans (http://www.environment.gov.au/biodiversity/threatened/recovery-plans, https://www.dpaw.wa.gov.au/plants-and-animals/threatened-species-and-communities/threatened-animals) and published EPA reports and records (http://www.epa.wa.gov.au/).

Any fauna which was found to use the coastal zone kept its ranking according to classification, habitat use and record certainty. Any fauna which was found to not use the coastal zone was given a ranking of Very Low for both floating and dissolved oil. This ranking was assigned because the fauna is highly unlikely to be impacted by an oil spill as it does not use the coastal zone; by giving it the lowest ranking possible, the data is still considered in the assessment but does not influence the planning of an oil spill response.

This is discussed more in the sections below.

3.1.1 Birds

Description

WA has an enormous number and diversity of bird species. Almost 550 species of birds have been recorded in the state; 387 have been recorded breeding (Birdlife WA, 2016). Seventeen (17) of these species are endemic to Western Australia, while many others migrate annually to feed, breed and escape the northern winter. The South West and South Coast zones are home to about 84 species, with 25 of these formally protected. The zones play an important role in providing habitat for both endemic species and travelling migratory birds which are protected under JAMBA and CAMBA agreements.

Bird distribution, species and conservation status (legislated) data was obtained as discrete observation locations from the DPaW's NatureMap database, the DotE SNES dataset, and generalised distribution polygon information from the DotE BIA database.

Key bird species recorded in the South West and South Coast zones include Critically Endangered (CR) birds: the curlew sandpiper (*Calidris ferruginea*); the eastern curlew (*Numenius madagascariensis*); and western ground parrot (*Pezoporus flaviventris*).

Endangered (EN) birds include the Indian yellow-nosed albatross (*Thalassarche carteri*), sooty albatross (*Phoebetria fusca*), black-browed albatross (*Thalassarche melanophris*), Carnaby's cockatoo (*Calyptorhynchus latirostris*), Baudin's cockatoo (*Calyptorhynchus baudinii*), Australasian bittern (*Botaurus poiciloptilus*), Hutton's shearwater (*Puffinus huttoni*), lesser sand plover (*Charadrius mongolus*) and western whipbird (*Psophodes nigrogularis nigrogulaira*).

Vulnerable (VU) species include the Recherche Cape Barren goose (*Cereopsis novaehollandiae grisea*), the forest red-tailed black cockatoo (*Calyptorhynchus banksii naso*), the flesh-footed shearwater (*Puffinus carneipes*) and great knot (*Calidris tenuirostris*).

Distribution

At the time of this report, the CR curlew sandpiper and/or its habitat was known to occur in Shoreline Cells 209, 210, 218, 227, 231, 245, 258 to 263 and 268 to 275, which are predominantly in the South Coast zone. The eastern curlew was known to occur in Shoreline Cells 231, 245, 258 to 263 and 268 to 275, in the South Coast zone. The western ground parrot was known to occur in Shoreline Cells 227, 231, 233 to 235, 239 and 254.

The EN Indian yellow-nosed albatross and/or its habitat was known to occur in Shoreline Cells 208, 209, 211, 212, 213, 230, 231 and 233, which are located in the South West and South Coast zones. The Australian lesser noddy was known to occur in Shoreline Cells 208 and 211. Both of these cells are in the South West zone. The sooty albatross was known to occur in one cell in the South West zone (Shoreline Cell 211) and one cell in the South Coast zone (Shoreline Cell 230). The black-browed albatross was known to occur in Shoreline Cells 209, 211, 212, 218 and 230 to 233.

The Carnaby's cockatoo was known to occur in Shoreline Cells 207, 208, 211, 212, 215, 227, 231, 233, 234, 240 to 242, 244, 245, 248 and 252, which are located in both the South West and South Coast zones. The Baudin's cockatoo was known to occur in Shoreline Cells 212, 214, 218, 225, 227, 229, 231, 234, 241 and 243. The Australasian bittern was known to be present in Shoreline Cell 210, and Hutton's shearwater in Shoreline Cell 231. The lesser sand plover was observed in Shoreline Cells 211, 218, 227, 231, 238, 258 and 269. The western whipbird was only known to occur in Shoreline Cells 232 and 242 in the South Coast zone.

The VU Recherche Cape Barren goose was confirmed present in Shoreline Cells 212, 213, 246 to 252, 254 to 257, 342, 343, 346 and 349 to 351. The forest red-tailed black cockatoo was confirmed present in Shoreline Cells 208, 211, 212, 218, 219, 225, 227, 229 and 231 and the flesh-footed shearwater was verified present in Shoreline Cells 216, 218, 221, 222, 229, 231, 238, 240, 248, 249, 251, 253 to 256, 268, 269 and 350. The great knot was verified present in Shoreline Cells 208, 231, 238 and 259. All of these species are present in both the South West and South Coast zones.

Discussion

The bird protection priority ranking considers the threatened status of a species and its biological use of the area, as well as the certainty of the data available. For the SNES data, species that are 'known', 'likely' and 'may be' in an area have been given different weightings, while for the DPaW data, the survey method and certainty of identification have been used (e.g. caught, trapped or sighted and 'Very Certain, 'WAM Vouchered' or 'Certain', which were provided in the dataset). For the threatened status of a species, its highest protection listing under either the EPBC Act or the WC Act has been used. This is because while some species may not be threatened on a national

level, they could be on a state level. This process ensures species that are protected only at a State level under the WC Act are included in the assessment.

The ranking also takes into account the biological importance of an area to a species, elevating the priority of an area that could contain high numbers of that species, and activities associated with breeding, which is when the species is most vulnerable. This reflects the possible long term consequences the spill can have at a species level if a spill occurred at critical breeding sites during breeding season.

The ranking also considers the major impact heavy oiling can have on fauna, especially birds (French-McCay *et al.*, 2002; 2004; 2006). When oiled, birds' feathers lose their waterproofness and their insulation, which can lead to hypothermia, dehydration, drowning and starvation. Birds coming into contact with layers of oil on the surface will be significantly affected, so, floating oil was deemed to have a greater effect on birds than dissolved oil. Birds can also be poisoned via secondary means, such as ingestion through preening or through feeding on contaminated prey such as benthic invertebrates.

The rankings for protection priority for birds are presented in Table 3-2. The table includes details about data confidence, reliability, survey method type, accuracy and geospatial extent.

Based on Table 3-2, Shoreline Cells 227, 231, 233 to 235, 239 and 254 have been ranked Very High for protection from floating oil and High for protection from dissolved oil, because of the verified presence of the western ground parrot. However, the western ground parrot is a terrestrial species that, although it has a geospatial layer which overlaps with the shoreline cells, it does not use the coastal zone (DoEE, 2017a; DPaW, 2014). Its habitat is recorded as being low, dry or swampy near-coastal heathland. This species therefore is unlikely to be impacted by a marine oil spill, and as such has been ranked as a Very Low priority species for protection from both floating and dissolved oil.

Because no other higher priority Protected Fauna was present to give a higher ranking, Shoreline Cells 209, 210, 218, 227, 231, 245, 258 to 263 and 268 to 275 have been given a ranking of High for protection from floating oil and Medium for protection from dissolved oil, for the general presence of the CR curlew sandpiper and eastern curlew. Shoreline Cells also given this ranking include 208, 209, 211, 212, 213, 231 and 233 for the presence of the Indian yellow-nosed albatross, 208 and 211 for the presence of the Australian lesser noddy, 211 and 230 for the presence of the sooty albatross, and 209, 211, 212, 218 and 230 to 233 for the presence of the black-browed albatross. Other shoreline cells ranked High for protection from floating oil and Medium for protection from dissolved oil for birds include Shoreline Cell 231 for the Hutton's shearwater, and 211, 218, 227, 231, 238, 258 and 269 for the lesser sand plover.

Other species that would have been ranked High for protection from floating oil and Medium for protection from dissolved oil are the EN Carnaby's cockatoo and EN Baudin's cockatoo, EN Australasian bittern, and the western whipbird. Upon further investigation, these are all terrestrial only species, with the cockatoos having habitats that include coastal trees and vegetation (DoEE, 2017b; DPaW, 2013a; DoEE, 2017c; DEC, 2008a), and the bittern favouring permanent and seasonal freshwater habitats (DoEE, 2017e; TSSC, 2011). The western whipbird occurs in mallee vegetation (DoEE, 2017f; TSSC, 2009a). These three species are not known to use the coastal zone. Therefore these species are unlikely to be impacted by a marine oil spill, and have been ranked Very Low priority for protection from both floating and dissolved oil.

Because no other higher priority Protected Fauna was present to give a higher ranking, Shoreline Cells 212, 213, 246 to 252, 254 to 257, 342, 343, 346 and 349 to 351 have been ranked Medium for protection from floating oil and Low for protection from dissolved oil, due to the confirmed presence of the VU Recherche Cape Barren goose. Shoreline Cells 216, 218, 221, 222, 229, 231, 238, 240, 248, 249, 251, 253 to 256, 268, 269 and 350 have been given this ranking for the flesh-footed shearwater, and Shoreline Cells 208, 231, 238 and 259 for the great knot.

Shoreline Cells 208, 211, 212, 218, 219, 225, 227, 229 and 231 have also been given this ranking for the VU forest red-tailed black cockatoo, however as with the other threatened cockatoos listed above, these species have habitats that include coastal trees and vegetation and are not known to use the coastal zone (DoEE, 2017d; DEC, 2008a). Therefore these species are unlikely to be impacted by a marine oil spill, and have been ranked Very Low priority for protection from both floating and dissolved oil.

Table 3-2: Birds protection priority ranking

<table>
<tr><th rowspan="2">Value Measure</th><th colspan="2">Ranking</th><th rowspan="2">Main Factors Considered in Ranking</th></tr>
<tr><th>Floating</th><th>Dissolved</th></tr>
<tr><td colspan="4">Birds</td></tr>
<tr><td>Critically Endangered species, if:
Breeding, nesting, aggregation or translocated population Known to occur in the area
Caught, trapped or sighted Very Certain/WAM Vouchered/Certain</td><td>5</td><td>4</td><td rowspan="3">Species considered: All SNES listed birds, State protected species in the DPaW database, and DotE species listed as having BIAs in the area.
Importance: Birds that have a higher threatened status were ranked higher. The BIAs considered to be the most important/vulnerable for birds are breeding/nesting habitats, while all other areas including foraging, migration and resting areas were ranked as ‘known habitat’ and given a lower importance.
This is to reflect the higher vulnerability of a bird during nesting, including the vulnerability of its</td></tr>
<tr><td>Critically Endangered species, if:
Breeding, nesting, aggregation or translocated population Likely to occur
Migration route, foraging, roosting, species or species habitat Known to occur
Secondary signs Very Certain/WAM Vouchered/ Certain
Caught, trapped or sighted Moderately Certain, Not Defined or Not Sure
Endangered species, if:
Breeding, nesting, aggregation or translocated population Known to occur
Caught, trapped or sighted Very Certain/WAM Vouchered/Certain</td><td>4</td><td>3</td></tr>
<tr><td>Critically Endangered species, if:
Migration route, foraging, roosting, species or species habitat Likely to occur in the area
Hair/skin or unknown method Very Certain/WAM Vouchered/Certain
Secondary signs Moderately Certain, Not Defined or Not Sure</td><td>3</td><td>2</td></tr>
</table>

Value Measure	Ranking		Main Factors Considered in Ranking
	Floating	Dissolved	
Endangered species, if: ▪ Breeding, nesting, aggregation or translocated population Likely to occur or low density in the area ▪ Migration route, foraging, roosting, species or species habitat Known to occur in the area ▪ Distribution, known core range or foraging Known to occur in DPaW database ▪ Secondary signs Very Certain/WAM Vouchered/ Certain ▪ Caught, trapped or sighted Moderately Certain, Not Defined or Not Sure Vulnerable species, if: ▪ Breeding, nesting, aggregation or translocated population Known to occur in the area ▪ Caught, trapped or sighted Very Certain/WAM Vouchered/Certain			young, and also the aggregation of the birds in certain areas during these times.
Critically Endangered species, if: ▪ Migration, connecting habitat or unknown, significant habitat Known to occur, high density ▪ Distribution, resting, nesting or foraging Likely to occur/low density ▪ Distribution, known core range or foraging May occur ▪ Breeding and aggregation Former Range ▪ Dead Very Certain/WAM Vouchered ▪ Hair/skin or unknown method Moderately Certain, Not Defined or Not Sure Endangered species, if: ▪ Distribution (low density), resting, nesting or foraging Likely, inter-nesting buffer, Known to occur ▪ Migration route, foraging, roosting, distribution, known core range, species or species habitat Likely to occur in the area ▪ Hair/skin or unknown method Very Certain/WAM Vouchered/Certain ▪ Secondary signs Moderately Certain, Not Defined or Not Sure Vulnerable species, if: ▪ Breeding, nesting, aggregation or translocated population Likely to occur or low density in the area	2	1	

Value Measure	Ranking		Main Factors Considered in Ranking
	Floating	Dissolved	
▪ Migration route, foraging, roosting, species or species habitat Known to occur in the area ▪ Distribution, known core range or foraging Known to occur in DPaW database ▪ Secondary signs Very Certain/WAM Vouchered/ Certain ▪ Caught, trapped or sighted Moderately Certain, Not Defined or Not Sure Conservation Dependent, Other specially protected fauna and P1-P4 species, if: ▪ Breeding, nesting, aggregation or translocated population Known to occur in the area ▪ Caught, trapped or sighted Very Certain/WAM Vouchered/Certain			
Critically Endangered species, if: ▪ Extinct in the area, dead, fossils, subfossil, historical record All Endangered, Vulnerable and Other species with a conservation code with all other information.	1	1	
Terrestrial birds which do not use the coastal zone for any instance of their lifecycle, and do not use the marine or intertidal zone as any component of their habitat.	1	1	This is researched through two sources which cite no use of the coastal zone, one of which is SPRAT.
Data List ▪ DotE Species of National Environmental Significance (SNES) ▪ DPaW Protected Fauna ▪ DotE Biologically Important Areas (BIAs)			

3.1.2 Mammals

Description

Western Australia's coastline spans more than 13,500 km and is home to some of the world's most interesting marine and terrestrial mammals. Many are found nowhere else in the world.

Mammal distribution, species and conservation status (legislated) data was obtained as discrete observation locations from the DPaW's NatureMap database, the DotE Species of National Environmental Significance (SNES) dataset, and generalised distribution polygon information from the DotE Biologically Important Areas (BIA) database.

Marine mammals that frequent the South West and South Coast zones and are high priority include the EN blue whale (*Balaenoptera musculus*), pygmy blue whale (*Balaenoptera musculus*

brevicauda), sei whale (*Balaenoptera borealis*), the humpback whale (*Megaptera novaeangliae*), the VU Australian sea lion (*Neophoca cinerea*) and EN southern right whale (*Eubalaena australis*).

Isolated shoreline cells of the South West and South Coast zones are also home to the CR western ringtail possum, Gilbert's potoroo and the woylie or brush-tailed bettong, the EN dibbler and black-flanked rock-wallaby, and the VU quokka, chuditch, greater bilby and Recherche rock wallaby.

Distribution

The EN blue whale has been known to be present in Shoreline Cells 211 to 213 and 215 in the South West zone, and the pygmy blue whale was known to occur in Shoreline Cells 207 to 238, 338, 341 to 344, 348 and 349. The sei whale was only confirmed in Shoreline Cell 211 between Busselton and Dunsborough in the South West zone. The humpback whale was known to congregate in Shoreline Cells 207 to 214 and 217 to 222.

The VU Australian sea lion's verified presence or breeding sites are located in Shoreline Cells 208, 212, 226, 227, 231 to 235, 239 to 243, 245 to 247, 249, 252, 254 to 258, 260, 268, 339, 342, 343, 345, 346 and 348 to 351.

The southern right whale breeding area is known to occur across the entire southern coastline of Western Australia, from north of Perth to beyond the WA-SA state border.

The CR western ringtail possum has been known to be present in the terrestrial environment in Shoreline Cells 207 to 212, 214, 215, 218, 225, 227, 229, 231 and 232. The CR woylie or brush-tailed bettong was known to occur in Shoreline Cells 225, 239 and 240. The CR Gilbert's potoroo was only present in one Shoreline Cell, 232, due to being released in the area. The dibbler was confirmed to be present in Shoreline Cells 233, 240 and 249, and the black-flanked rock-wallaby was confirmed to be present in Shoreline Cells 225, 239 and 240.The quokka was confirmed present in Shoreline Cells 210, 212, 213, 215, 219, 220, 223, 225, 227 and 231 to 233, and the chuditch in Shoreline Cells 211, 213, 225, 238, 241, 242, 244 and 249. The greater bilby was only confirmed present in one Shoreline Cell, 238, in the South Coast zone, and the Recherche rock wallaby was also only in the South Coast zone, in Shoreline Cells 250, 251 and 255.

Discussion

Marine mammals in the South West and South Coast zones could come in direct contact with floating oil, or potentially ingest dissolved hydrocarbons when feeding. Physical oiling can burn and irritate the eyes of whales and sea lions. Cetaceans are more likely to be affected when the body of the mammal becomes coated in oil while surfacing to breathe. Cetaceans may also ingest dissolved oil when feeding in open water, but as they are impacted more by direct contact at the surface, floating oil is deemed to have a greater impact on mammals than dissolved oil.

The rankings for protection priority for mammals are presented in Table 3-3. The table incorporates data confidence, reliability, survey method type, accuracy and geospatial extent.

Because no other higher priority Protected Fauna was present to give a higher ranking, Shoreline Cells 211 to 213 and 215 have been ranked High for protection from floating oil and Medium for protection from dissolved oil, for the known presence of the EN blue whale. Shoreline Cell 211 has also been given this ranking for the sei whale.

Shoreline Cells 207 to 238, 338, 341 to 344, 348 and 349 have been ranked Medium for protection from floating oil and Low for protection from dissolved oil, for the confirmed presence of the pygmy blue whale. Shoreline Cells 207 to 214 and 217 to 222 have also been given this ranking as known congregation areas for humpback whales, and Shoreline Cells 208, 212, 226, 227, 231 to 235, 239 to 243, 245 to 247, 249, 252, 254 to 258, 260, 268, 339, 342, 343, 345, 346 and 348 to 351 for the known presence and known breeding areas of the Australian sea-lion.

The southern right whale is listed as Endangered, with "Breeding, calving or aggregation known to occur in the area", across most of southern Western Australia. Due to the large number of shoreline cells affected in the South West and South Coast zones, it was deemed unlikely that it would be affected at a species level in an oil spill, as the spill would have to affect the whole southern coast of Australia, from Tasmania to Perth. Therefore other species with smaller areas should be prioritised in an oil spill. This single species has been re-ranked as lower than the prescribed value, and shoreline cells have been ranked Medium for protection from floating oil and Low for protection from dissolved oil for all distributions of the EN southern right whale, including calving, breeding and aggregation. Therefore, all cells in the South West and South Coast zones have been given a maximum ranking of Medium priority for the protection of the southern right whale.

The CR western ringtail possum is a terrestrial-based mammal that lives in forests, especially near coastal areas of peppermint (*Agonis flexuosa*) woodland and peppermint/tuart associations (DPaW, 2017; TSSC, 2013). This species is not known to use the coastal zone. Therefore this species is unlikely to be impacted by a marine oil spill, and has been ranked Very Low priority for protection from both floating and dissolved oil.

The CR woylie is reported to rest during the day in a well-concealed nest, built over a shallow depression that is most commonly constructed of long strands, preferably grasses, but also other material such as strips of bark (in the forest) or dried seagrass and/or triodia (in arid coastal areas) (Christensen and Leftwich, 1980; DEC, 2012a). As the seagrass is dried, it is not in the intertidal area; it would be above the mean high water mark so would not be affected by a marine oil spill. It is therefore unlikely that this species would be impacted by a marine oil spill, and as such has been ranked Very Low priority for protection from both floating and dissolved oil.

The CR Gilbert's potoroo is only present in Shoreline Cell 232. The species habitat consists of long-unburnt, dense shrubland on the valley slopes that contains sufficient fungi to support the species population (TSSC, 2016a; DPaW, 2016). This species is not known to use the coastal zone. Therefore this species is unlikely to be impacted by a marine oil spill, and has been ranked Very Low priority for protection from both floating and dissolved oil.

The EN dibbler is confirmed to be present in Shoreline Cells 233, 240 and 249. The species is known to exist in WA in isolated locations that occupy a diverse range of habitats, including island and mainland populations (DoEE, 2017g; TSSC, 2015). Capture sites seem to have a similar vegetation structure, and Baczocha and Start (1997) suggested that dibblers "...seem to prefer vegetation with a dense canopy >1 metre high which has been unburnt for at least 10 years". It is noted however, that Boullanger and Whitlock Islands are separated by about 300 m of shallow water and are periodically linked by a sandbar (DoEE, 2017g). As such, dibblers are probably able to move between the islands during periods of very low tide (Friend, 2004; Wolfe *et al.,* 2004). Based on this information, it has been determined that dibblers are not known to use the coastal zone, and presumably only use the sandbar to move between the islands. As such, the species is

unlikely to be impacted by a marine oil spill, and has been ranked as a Very Low priority for protection from both floating and dissolved oil.

The EN black-flanked rock-wallaby exists in scattered populations restricted to sites with suitable rocky habitat with caves and crevices (DoEE, 2017h; DPaW, 2013). This species is not known to use the coastal zone. Therefore this species is unlikely to be impacted by a marine oil spill, and has been ranked a Very Low priority for protection from both floating and dissolved oil.

The VU quokka's habitat varies depending on the population location. In all instances however, it requires terrestrial vegetation and fresh water throughout the year (DoEE, 2017i; DEC, 2013). This species is not known to use the coastal zone. Therefore this species is unlikely to be impacted by a marine oil spill, and has been ranked a Very Low priority for protection from both floating and dissolved oil.

The VU chuditch or western quoll populations are now restricted to Western Australia, in an estimated 5% of their former range (DoEE, 2017j; DEC, 2012b). These solitary roaming animals occur in varying densities in jarrah (*Eucalyptus marginata*) forests and woodlands in the south-west corner of WA, and in woodlands, mallee shrublands and heaths along the south coast (DEC, 2012). In the forest, insects and other large invertebrates comprise the bulk of their diet, though some mammals, birds and lizards are also included, and occasionally pulp around the seeds of Zamia as well as small fruits and parts of flowers (Hancock, 1991). This species is not known to use the coastal zone. Therefore this species is unlikely to be impacted by a marine oil spill, and has been ranked a Very Low priority for protection from both floating and dissolved oil.

The VU bilby is known from a single, certain night sighting in Shoreline Cell 238. The species range has declined, with the predominant locations now desert areas of Northern Territory, Queensland and Western Australia (TSSC, 2016b; Pavey, 2006). It is an omnivore and digs for terrestrial insects such as termites, ants and spiders, as well as seeds, bulbs and fungi (TSSC, 2016b). Its current habitat consists of open tussock grassland growing on uplands and hills, mulga woodland/ shrubland growing on ridges and rises, and hummock grassland growing on sand plains and dunes, drainage systems, salt lake systems and other alluvial areas (Pavey, 2006). This species is not known to use the coastal zone. Therefore this species is unlikely to be impacted by a marine oil spill, and has been ranked a Very Low priority for protection from both floating and dissolved oil.

The VU Recherche rock wallaby is known from three populations, distributed on three islands in the Recherche Archipelago in the South Coast zone. These are Mondrian Island, Westall Island and Wilson Island (DPaW, 2013b). It is a sub-species of the black-footed/black-flanked rock wallaby (DPaW, 2013b). Recherche Archipelago consists of steep granitic islands with tors, rock-piles and deep crevices available for shelter. The rock wallaby shelters in crevices and caves in the granite down to the water's edge, especially where faulting of the granite results in multi-entranced radiating passages, and forages on vegetation (DPaW, 2013b). Although it may come close to the sea, it is not considered part of its habitat, so it is unlikely it would be impacted by a marine oil spill. Therefore these species has been ranked a Very Low priority for protection from both floating and dissolved oil.

Table 3-3: Mammals protection priority ranking

Value Measure	Ranking		Main Factors Considered in Ranking
	Floating	Dissolved	
Mammals			
Critically Endangered species, if: ▪ Breeding, calving, congregation, aggregation or translocated population Known to occur in the area ▪ Caught, trapped or sighted Very Certain/WAM Vouchered/Certain ▪ Not southern right whale	5	4	**Species considered:** All SNES listed mammals, State protected species in the DPaW database, and DotE species listed as having BIAs in the area.
Critically Endangered species, if: ▪ Breeding, calving, congregation, aggregation or translocated population Likely to occur ▪ Migration route, foraging, species or species habitat Known to occur ▪ Secondary signs Very Certain/WAM Vouchered/ Certain ▪ Caught, trapped or sighted Moderately Certain, Not Defined or Not Sure ▪ Not southern right whale Endangered species, if: ▪ Breeding, calving, congregation, aggregation or translocated population Known to occur ▪ Caught, trapped or sighted Very Certain/WAM Vouchered/Certain	4	3	**Importance:** Mammals that have a higher threatened status were ranked higher. The BIAs considered to be the most important/ vulnerable for mammals are breeding/ aggregation/resting areas due to the presence of large numbers of a species, or the presence of calves and juvenile mammals, while all other areas including foraging and migration areas were ranked as 'known habitat' and given a lower importance.
Southern right whale: all breeding / calving information. Critically Endangered species, if: ▪ Migration route, foraging, species or species habitat Likely to occur in the area ▪ Hair/skin or unknown method is Very Certain/ WAM Vouchered/Certain ▪ Secondary signs Moderately Certain, Not Defined or Not Sure Endangered species, if: ▪ Breeding, calving, congregation, aggregation or translocated population Likely to occur or low density in the area ▪ Migration route, foraging, species or species habitat Known to occur in the area ▪ Distribution, calving buffer, inter-nesting, known core range or foraging Known to occur in DPaW database ▪ Secondary signs Very Certain/WAM	3	2	

Value Measure	Ranking		Main Factors Considered in Ranking
	Floating	Dissolved	
Vouchered/ Certain ▪ Caught, trapped or sighted Moderately Certain, Not Defined or Not Sure Vulnerable species, if: ▪ Breeding, calving, congregation, aggregation or translocated population Known to occur in the area ▪ Caught, trapped or sighted Very Certain/WAM Vouchered/Certain			
Critically Endangered species, if: ▪ Migration, connecting habitat or unknown, significant habitat Known to occur or high density ▪ Distribution or foraging Likely to occur/low density ▪ Distribution, calving buffer, known core range or foraging May occur ▪ Breeding, calving and aggregation Former Range ▪ Dead Very Certain/WAM Vouchered ▪ Hair/skin or unknown method Moderately Certain, Not Defined or Not Sure Endangered species, if: ▪ Distribution (low density), resting, nesting or foraging Likely, Known to occur ▪ Migration route, foraging, distribution, calving buffer, known core range, species or species habitat Likely to occur in the area ▪ Hair/skin or unknown method Very Certain/WAM Vouchered/Certain ▪ Secondary signs Moderately Certain, Not Defined or Not Sure Vulnerable species, if: ▪ Breeding, calving, congregation, aggregation or translocated population Likely to occur or low density in the area ▪ Migration route, foraging, species or species habitat Known to occur in the area ▪ Distribution, calving buffer, known core range or foraging Known to occur in DPaW database ▪ Secondary signs Very Certain/WAM Vouchered/ Certain ▪ Caught, trapped or sighted Moderately Certain, Not Defined or Not Sure	2	1	

Value Measure	Ranking		Main Factors Considered in Ranking
	Floating	Dissolved	
Conservation Dependent, Other specially protected fauna and P1-P4 species, if: ▪ Breeding, calving, congregation, aggregation or translocated population Known to occur in the area ▪ Caught, trapped or sighted Very Certain/WAM Vouchered/Certain			
Critically Endangered species, if: ▪ Extinct in the area, dead, fossils, subfossil, historical record All Endangered, Vulnerable and Other species with a conservation code with all other information.	1	1	
Terrestrial mammals which do not use the marine or intertidal zone for any instance of their lifecycle, and do not use the marine or intertidal zone as any component of their habitat.	1	1	This is researched through two sources which cite no use of the marine/intertidal zone, one of which is SPRAT.

Data List

- DotE Species of National Environmental Significance (SNES)
- DPaW Protected Fauna
- DotE Biologically Important Areas (BIAs)
- Sea lion breeding sites (DoF, 2014)

3.1.3 Invertebrates

Description

Invertebrates are all animals that lack a backbone. They include marine invertebrates such as crustaceans, coral, sponges, jellyfish and octopus (to name a few), as well as terrestrial invertebrates such as snails, bees and spiders. WA is home to numerous invertebrate species, however no invertebrates found in state waters are legislatively protected. While coral is an invertebrate, it is included under Protection Areas as a key benthic habitat (refer to Section 3.2).

Invertebrate distribution, species and conservation status (legislated) data was obtained as discrete observation locations from the DPaW's NatureMap database, the DotE Species of National Environmental Significance (SNES) dataset, and generalised distribution polygon information from the DotE Biologically Important Areas (BIA) database.

Protected invertebrate species were identified in the South West and South Coast zones, including CR Banksia brownii plant-louse (*Trioza barretae*), EN Tingle pygmy trapdoor spider (*Bertmainius tingle*), Western Australian pill millipede (*Cynotelopus notabilis*), Walpole burrowing crayfish (*Engaewa walpolea*) and VU millipedes (*Atelomastix culleni, Atelomastix flavognatha, Atelomastix dendritica, Cyliosoma sarahae, Atelomastix longbottomi* and *Atelomastix melindae*).

Distribution

The invertebrates in the South West and South Coast zones were only present in a few isolated shoreline cells. The Banksia brownii plant-louse was present only in Shoreline Cell 231 in the Albany area. The EN Tingle pygmy trapdoor spider was located in Shoreline Cell 225, Walpole burrowing crayfish in Shoreline Cell 225, and the EN Western Australian pill millipede in Shoreline Cells 225 and 227. The other millipedes were scattered in the South Coast zone in Shoreline Cells 237, 239, 249, 251 and 252.

Discussion

As some protected terrestrial invertebrates have habitats along the coast, a protection priority ranking has only been adopted for terrestrial invertebrates that use or have habitats in the intertidal zone, and therefore may become oiled. The effect on terrestrial invertebrates such as snails, moths, spiders and bees is expected to be fatal if an oil spill washes up on shore and coats their habitat. Dissolved oil will have no effect.

The rankings also incorporate data confidence, reliability, survey method type, accuracy and geospatial extent. The protection priority rankings adopted for this assessment are presented in Table 3-4.

Based on the rankings below, and because no other higher priority Protected Fauna was present to give a higher ranking, Shoreline Cells 225 and 227 were ranked High for protection from floating oil because of the EN Western Australian pill millipede. However this species is generally known from deep litter and under logs as well as under rocks (Holloway, 1956; Jeekel, 1981; Main *et al.*, 2002). It occurs in high-rainfall habitats along the southern coast of south-western Australia, and is not reported to use the coastal zone. Therefore this species is unlikely to be impacted by a marine oil spill, and has been ranked a Very Low priority for protection from both floating and dissolved oil.

Shoreline Cell 225 has two certain records of the EN Walpole burrowing crayfish. This species is endemic to southern Western Australia, and is known from only three locations near Walpole (DoEE, 2017k; TSSC, 2009b; DEC, 2008b). It is a freshwater crayfish and is not known to use the coastal zone. Therefore this species is unlikely to be impacted by a marine oil spill, and has been ranked a Very Low priority for protection from both floating and dissolved oil.

Shoreline Cell 225 has two records of the Tingle pygmy trapdoor spider. These are Moderately Certain secondary signs and a WAM Vouchered specimen. The spider subspecies nests either in soil or in the fibrous bark of red tingle trees (*Eucalyptus jacksonii Maiden*), from which they get their name (Main, 1991). The species is not reported to use the coastal zone. Therefore this species is unlikely to be impacted by a marine oil spill, and has been ranked a Very Low priority for protection from both floating and dissolved oil.

The CR Banksia brownii plant-louse was present only in Shoreline Cell 231 in the Albany area, and reported from a caught or trapped specimen. It is a sap-sucking bug that is only found in banksia (TSSC, 2000). The species is not reported to use the coastal zone. Therefore this species is unlikely to be impacted by a marine oil spill, and has been ranked a Very Low priority for protection from both floating and dissolved oil.

VU millipedes *Atelomastix culleni, Atelomastix flavognatha, Atelomastix dendritica, Cyliosoma sarahae, Atelomastix longbottomi* and *Atelomastix melindae* are recorded in Shoreline Cells 237, 239, 249, 251 and 252. These species are shown to have extremely localised distributions, and occur in discontinuous habitats such as mountain ranges, islands, granite outcrops or fragments of wet forest (Cullen & Harvey, 2010). None are reported to use the coastal zone. Therefore these species are unlikely to be impacted by a marine oil spill, and have been ranked a Very Low priority for protection from both floating and dissolved oil.

Table 3-4: Terrestrial Invertebrates protection priority ranking

Value Measure	Ranking		Main Factors Considered in Ranking
	Floating	Dissolved	
Terrestrial Invertebrates			
Critically Endangered species, if: ▪ Breeding, congregation, aggregation or translocated population Known to occur in the area ▪ Caught, trapped or sighted Very Certain/WAM Vouchered/Certain	5	1	**Species considered:** No invertebrates found in WA state waters are legislatively protected. Therefore, all SNES listed terrestrial invertebrates, State protected species in the DPaW database, and DotE species listed as having BIAs in the area. **Importance:** Terrestrial invertebrates may be in the area and tend to be concentrated in highly localised areas. In an oil spill, their coastal habitats may become oiled and this is expected to be fatal. Dissolved oil is not expected to have an impact. Invertebrates that have a higher threatened status were ranked higher. The BIAs considered to be the most important/vulnerable for invertebrates are breeding/nesting habitats, while all other areas including
Critically Endangered species, if: ▪ Breeding, congregation, aggregation or translocated population Likely to occur ▪ Migration route, foraging, species or species habitat Known to occur ▪ Secondary signs Very Certain/WAM Vouchered/ Certain ▪ Caught, trapped or sighted Moderately Certain, Not Defined or Not Sure Endangered species, if: ▪ Breeding, congregation, aggregation or translocated population Known to occur ▪ Caught, trapped or sighted Very Certain/WAM Vouchered/Certain	4	1	
Critically Endangered species, if: ▪ Migration route, foraging, species or species habitat Likely to occur in the area ▪ Hair/skin or unknown method Very Certain/WAM Vouchered/Certain ▪ Secondary signs Moderately Certain, Not Defined or Not Sure Endangered species, if: ▪ Breeding, congregation, aggregation or translocated population Likely to occur or low density in the area ▪ Migration route, foraging, species or species habitat Known to occur in the area ▪ Distribution, known core range or foraging	3	1	

Value Measure	Ranking		Main Factors Considered in Ranking
	Floating	Dissolved	
Known to occur in DPaW database ▪ Secondary signs Very Certain/WAM Vouchered/ Certain ▪ Caught, trapped or sighted Moderately Certain, Not Defined or Not Sure Vulnerable species, if: ▪ Breeding, congregation, aggregation or translocated population Known to occur in the area ▪ Caught, trapped or sighted Very Certain/WAM Vouchered/Certain			foraging and migration areas were ranked as 'known habitat' and given a lower importance. This is to reflect the higher vulnerability of an invertebrate during breeding, including the vulnerability of its young, and also the aggregation of the species in certain areas during these times.
Critically Endangered species, if: ▪ Migration, connecting habitat or unknown, significant habitat Known to occur, high density ▪ Distribution, nesting or foraging Likely to occur/low density ▪ Distribution, known core range or foraging May occur ▪ Breeding and aggregation Former Range ▪ Dead Very Certain/WAM Vouchered ▪ Hair/skin or unknown method Moderately Certain, Not Defined or Not Sure Endangered species, if: ▪ Distribution (low density), nesting or foraging Likely or Known to occur ▪ Migration route, foraging, distribution, known core range, species or species habitat Likely to occur in the area ▪ Hair/skin or unknown method Very Certain/WAM Vouchered/Certain ▪ Secondary signs Moderately Certain, Not Defined or Not Sure Vulnerable species, if: ▪ Breeding, congregation, aggregation or translocated population Likely to occur or low density in the area ▪ Migration route, foraging, species or species habitat Known to occur in the area ▪ Distribution, known core range or foraging Known to occur in DPaW database ▪ Secondary signs Very Certain/WAM Vouchered/ Certain ▪ Caught, trapped or sighted Moderately Certain, Not Defined or Not Sure	2	1	

Value Measure	Ranking		Main Factors Considered in Ranking
	Floating	Dissolved	
Conservation Dependent, Other specially protected fauna and P1-P4 species, if: ▪ Breeding, congregation, aggregation or translocated population Known to occur in the area ▪ Caught, trapped or sighted Very Certain/WAM Vouchered/Certain			
Critically Endangered species, if: ▪ Extinct in the area, dead, fossils, subfossil, historical record All Endangered, Vulnerable and Other species with a conservation code with all other information.	1	1	
Terrestrial invertebrates which do not use the marine or intertidal zone for any instance of their lifecycle, and do not use the marine or intertidal zone as any component of their habitat.	1	1	This is researched through two sources which cite no use of the marine/intertidal zone, one of which is SPRAT.
Data List ▪ DotE Species of National Environmental Significance (SNES) ▪ DPaW Protected Fauna ▪ DotE Biologically Important Areas (BIAs)			

3.1.4 Fish

Description

Western Australia is home to more than 1,600 fish species. Many are fished for commercial and recreational purposes, but also collected for home and international aquariums.

Fish species, distribution and conservation status (legislated) data was obtained as discrete observation locations from the DPaW's NatureMap database, the DotE Species of National Environmental Significance (SNES) dataset, and generalised distribution polygon information from the DotE Biologically Important Areas (BIA) database. Information on Totally Protected fish species was sourced from the DoF, however this was not accompanied by geospatial data therefore the location of species has been drawn from the previously three mentioned geospatial databases.

Protected fish in the South West and South Coast zones which have been identified as high priority include the CR western spotted galaxias (*Galaxias truttaceus*), EN black-striped dwarf galaxias (*Galaxiella nigrostriatal*) and salamander (*Lepidogalaxias salamandroides*). Protected fish also includes sharks, with species found in the South West and South Coast zones including the VU great white shark (*Carcharodon carcharias*).

'Totally protected' and 'seasonally protected, totally protected' fish species, protected under the *State Fish Resources Management Act 1994*, have also been included in this section. In the South West and South Coast zones, these are not identified in the attribute table.

It is worth noting here that fish habitat protection areas are included in the Protection Areas category in Section 3.2.8. Also, fishing areas associated with economic and tourism enterprises are included in the Economic category in Section 3.4.

Distribution

Within the South West zone, the Salamander was found in Shoreline Cell 221, the black-striped dwarf galaxias in Shoreline Cell 222, and the western spotted galaxias was found in Shoreline Cell 231.

Within the South West and South Coast zones, the great white shark was present in Shoreline Cells 207, 208, 211, 230, 232, 249 and 252.

Discussion

Fish are affected by hydrocarbons through physical smothering impacting on physiological functions, or by chemical toxicity causing lethal or sub-lethal effects or impairing cellular functions. The worst impacts will occur through chemical toxicity on smaller species such as pipefish. This could lead to hydrocarbons accumulating in tissues, and in the worst instance could lead to mortality or sub-lethal stress.

The species conservation category and its use of the area, such as breeding or aggregation areas, versus 'normal range', were used to determine its ranking presented in Table 3-5. The rankings also incorporate data confidence, reliability, survey method type, accuracy and geospatial extent.

Based on the rankings below, because no other higher priority Protected Fauna was present to give a higher ranking, Shoreline Cell 231 has been ranked Medium for protection from floating oil and High for protection from dissolved oil, due to the presence of the CR western spotted galaxias. However, upon further inspection, this is a freshwater species. The western spotted galaxias has previously inhabited the King River and Kalgan River, which both exit into the ocean and overlap Shoreline Cell 231 (DoEE, 2017l; DEC, 2008c). The species is usually found around plants, rocks or logs on the shore margins of still or flowing freshwater rivers, streams and lakes, where it feeds on aquatic and terrestrial insects (Morgan et al., 1998). The species does not appear to use the intertidal zone for foraging or habitat, and the likelihood of oil entering the rivers is low due to the river flushing from inland towards the sea. As a result, these species have been ranked a Very Low priority for protection from both floating and dissolved oil.

The EN black-striped dwarf galaxias has been caught or trapped in Shoreline Cell 222. This species of fish is unusual because it aestivates in the sediments of seasonal wetlands when the wetlands dry over summer (Galeottie *et al.,* 2008, 2010). Although once thought to be more extensively distributed in coastal wetlands between Moore River and Albany, it is now only found in three remnant populations on the Swan Coastal Plain and wetlands between Augusta and Albany. This fish prefers open water and, as it matures, is more likely to be found in areas of acrophytic or riparian vegetation (Galeottie *et al.*, 2008; 2010). The information reviewed supports the conclusion that the black-striped dwarf galaxias is a freshwater fish that does not use or inhabit the marine or

intertidal zone. Therefore this species is unlikely to be impacted by a marine oil spill, and has been ranked a Very Low priority for protection from both floating and dissolved oil.

The EN salamander is a freshwater fish endemic to south-western Australia (Allen and Berra, 1989). The species is found in pools in sandy peat flat areas. These waters are usually darkly tannin stained and often very acidic (pH 3.0-6.5). When pools start to dry up in summer, the fish constructs a small burrow where it aestivates until heavy rains fall in winter (Australian Museum, 2014). This freshwater fish is not reported to use or inhabit the marine or intertidal zone. Therefore this species is unlikely to be impacted by a marine oil spill, and has been ranked a Very Low priority for protection from both floating and dissolved oil.

Shoreline Cells 207, 208, 211, 230, 232, 249 and 252 have been ranked Low for the great white shark for protection from floating oil, and Medium for protection from dissolved oil.

Table 3-5: Fish protection priority ranking

Value Measure	Ranking		Main Factors Considered in Ranking
	Floating	Dissolved	
Fish			
Critically Endangered species, if: ▪ Breeding, congregation, aggregation or translocated population Known to occur in the area ▪ Caught, trapped or sighted Very Certain/WAM Vouchered/Certain	4	5	**Species considered:** All SNES listed fish, State protected species in the DPaW database, and DotE species listed as having BIAs in the area. **Importance:** Fish that have a higher threatened status were ranked higher. The BIAs considered to be the most important/vulnerable for fish are breeding/ aggregation habitats, as oil will have more of an effect on juvenile fish, while all other areas including foraging and normal range areas were ranked as 'known habitat' and given a lower importance.
Critically Endangered species, if: ▪ Breeding, congregation, aggregation or translocated population Likely to occur ▪ Migration route, foraging, species or species habitat Known to occur ▪ Secondary signs Very Certain/WAM Vouchered/ Certain ▪ Caught, trapped or sighted Moderately Certain, Not Defined or Not Sure Endangered species, if: ▪ Breeding, congregation, aggregation or translocated population Known to occur ▪ Caught, trapped or sighted Very Certain/WAM Vouchered/Certain	3	4	
Critically Endangered species, if: ▪ Migration route, foraging, species or species habitat Likely to occur in the area ▪ Hair/skin or unknown method Very Certain/WAM Vouchered/Certain ▪ Secondary signs Moderately Certain, Not Defined or Not Sure Endangered species, if:	2	3	

Value Measure	Ranking		Main Factors Considered in Ranking
	Floating	Dissolved	
▪ Breeding, congregation, aggregation or translocated population Likely to occur or low density in the area ▪ Migration route, foraging, species or species habitat Known to occur in the area ▪ Distribution, known core range or foraging Known to occur in DPaW database ▪ Secondary signs Very Certain/WAM Vouchered/ Certain ▪ Caught, trapped or sighted Moderately Certain, Not Defined or Not Sure Vulnerable species, if: ▪ Breeding, congregation, aggregation or translocated population Known to occur in the area ▪ Caught, trapped or sighted Very Certain/WAM Vouchered/Certain			
Critically Endangered species, if: ▪ Migration, connecting habitat or unknown, significant habitat Known to occur, high density ▪ Distribution or foraging Likely to occur/low density ▪ Distribution, known core range or foraging May occur ▪ Breeding and aggregation Former Range ▪ Dead Very Certain/WAM Vouchered ▪ Hair/skin or unknown method Moderately Certain, Not Defined or Not Sure Endangered species, if: ▪ Distribution (low density) or foraging Likely, Known to occur ▪ Migration route, foraging, distribution, known core range, species or species habitat Likely to occur in the area ▪ Hair/skin or unknown method Very Certain/WAM Vouchered/Certain ▪ Secondary signs Moderately Certain, Not Defined or Not Sure Vulnerable species, if: ▪ Breeding, congregation, aggregation or translocated population Likely to occur or low density in the area ▪ Migration route, foraging, species or species habitat Known to occur in the area	1	2	

Value Measure	Ranking		Main Factors Considered in Ranking
	Floating	Dissolved	
▪ Distribution, known core range and foraging Known to occur in DPaW database ▪ Secondary signs Very Certain/WAM Vouchered/ Certain ▪ Caught, trapped or sighted Moderately Certain, Not Defined or Not Sure Conservation Dependent, Other specially protected fauna and P1-P4 species, if: ▪ Breeding, congregation, aggregation or translocated population Known to occur in the area ▪ Caught, trapped or sighted Very Certain/WAM Vouchered/Certain			
Critically Endangered species, if: ▪ Extinct in the area, dead, fossils, subfossil, historical record All Endangered, Vulnerable and Other species with a conservation code with all other information.	1	1	
Freshwater fish which do not use the marine or intertidal zone for any instance of their lifecycle, and do not use the marine or intertidal zone as any component of their habitat.	1	1	**Importance:** This is researched through two sources which cite no use of the marine or intertidal zone.
Data List ▪ DotE Species of National Environmental Significance (SNES) ▪ DPaW Protected Fauna ▪ DotE Biologically Important Areas (BIAs)			

3.1.5 Reptiles

Description

Western Australia's marine and coastal environment contains unique, diverse and fragile ecosystems and species – from tropical waters in the north, to temperate waters in the south. Reptile distribution, species and legislated protection classification data was obtained as discrete observation locations from the DPaW's NatureMap database. This data is contained in the SNES dataset obtained from DotE, and generalised distribution polygon information obtained from the Biologically Important Areas (BIA) database.

Reptiles in the South West and South Coast zones include the EN loggerhead turtle (*Caretta caretta*).

Distribution

The EN loggerhead turtles are known to occur in Shoreline Cells 207 to 211, 213 to 218, 224 to 228, 247, 251 and 269.

Discussion

The assessment for impacts on reptiles considered that physical oiling by floating oil irritates sensitive organs such as eyes. There is a chance for chemical toxicity via ingestion, particularly for marine reptiles such as turtles that feed or aggregate in shallow water habitats where oil can accumulate. As a result, floating oil was deemed to have more of an effect on reptiles than dissolved oil. This is also because reptiles hold their breath underwater and are unlikely to ingest dissolved oil directly.

In the protection priority ranking for reptiles (Table 3-6), the conservation category as well as the above considerations have been taken into account. The species' key uses such as nesting and breeding have also been considered. Note too that the SNES dataset uses the terminology nesting/breeding which implies aggregation of a species. 'Aggregation' is used in the BIA dataset and is referenced in the other Protected Fauna rankings used in this category. Aggregation of a species in a single area allows a large number of the species to be impacted if that area is affected, for example by an oil spill. Therefore the nesting/breeding areas (aggregation) have been given a higher ranking than foraging and inter-nesting. The priority rankings can be found in Table 3-6 and consider data confidence, reliability, survey method type, accuracy and geospatial extent.

Because no other higher priority Protected Fauna was present to give a higher ranking, Shoreline Cells 207 to 211, 213 to 218, 224 to 228, 247, 251 and 269 have been ranked High for protection from floating oil and Medium for protection from dissolved oil, for the protection of the loggerhead turtles.

Table 3-6: Reptiles protection priority ranking

Value Measure	Ranking		Main Factors Considered in Ranking
	Floating	Dissolved	
Reptiles			
Critically Endangered species, if: ▪ Breeding, congregation, aggregation or Translocated population Known to occur in the area ▪ Caught, trapped or sighted is Very Certain/WAM Vouchered/Certain	5	4	**Species considered:** All SNES reptiles listed as well as State protected species listed on the DPaW database and DotE species listed as having BIAs in the area. **Importance:** Reptiles that have a higher threatened status were ranked higher. The BIAs considered to be the most important/vulnerable for reptiles are breeding/nesting habitats and aggregation areas, while all other areas including foraging, migration and inter-nesting areas were ranked as 'known habitat' and given a lower importance. This is to reflect the higher vulnerability of a reptile during nesting, including the vulnerability of its young, and also the aggregation of the reptiles in certain areas during these times.
Critically Endangered species, if: ▪ Breeding, congregation, aggregation or Translocated population Likely to occur ▪ Migration route, foraging, species or species habitat Known to occur ▪ Secondary signs are Very Certain/WAM Vouchered/Certain ▪ Caught, trapped or sighted is Moderately Certain, Not Defined or Not Sure Endangered species, if: ▪ Breeding, congregation, aggregation or Translocated population Known to occur ▪ Caught, trapped or sighted is Very Certain/WAM Vouchered/Certain	4	3	
Critically Endangered species, if: ▪ Migration route, foraging, species or species habitat Likely to occur in the area ▪ Hair/skin or unknown method is Very Certain/WAM Vouchered/Certain ▪ Secondary signs are Moderately Certain, Not Defined or Not Sure Endangered species, if: ▪ Breeding, congregation, aggregation or Translocated population is Likely to occur or low density in the area ▪ Migration route, foraging, species or species habitat known to occur in the area ▪ Distribution, inter-nesting, known core range and foraging Known to occur in DPaW database ▪ Secondary signs are Very Certain/WAM Vouchered/Certain ▪ Caught, trapped or sighted is Moderately Certain, Not Defined or Not Sure Vulnerable species, if:	3	2	

Value Measure	Ranking		Main Factors Considered in Ranking
	Floating	Dissolved	
▪ Breeding, congregation, aggregation or Translocated population is Known to occur in the area ▪ Caught, trapped or sighted is Very Certain/WAM Vouchered/Certain			
Critically Endangered species, if: ▪ Migration, connecting habitat and unknown, significant habitat Known to occur, high density ▪ Distribution, resting, nesting, foraging, inter-nesting buffer, low density/Likely to occur ▪ Distribution, inter-nesting, known core range and foraging May occur ▪ Breeding and aggregation Former Range ▪ Dead, Very Certain/WAM Vouchered ▪ Hair/skin, unknown method is Moderately Certain, Not Defined or Not Sure Endangered species, if: ▪ Distribution (low density), nesting, foraging likely, inter-nesting buffer, Known to occur ▪ Migration route, foraging, distribution, inter-nesting, known core range, species or species habitat Likely to occur in the area ▪ Hair/skin or unknown method is Very Certain/WAM Vouchered/Certain ▪ Secondary signs are Moderately Certain, Not Defined or Not Sure Vulnerable species, if: ▪ Breeding, congregation, aggregation or Translocated population is Likely to occur or low density in the area ▪ Migration route, foraging, species or species habitat Known to occur in the area ▪ Distribution, inter-nesting, known core range and foraging Known to occur in DPaW database ▪ Secondary signs are Very Certain/WAM Vouchered/Certain ▪ Caught, trapped or sighted is Moderately Certain, Not Defined or Not Sure Conservation Dependent, Other specially protected fauna and P1-P4 species, if: ▪ Breeding, congregation, aggregation or Translocated population Known to occur in	2	1	

Value Measure	Ranking		Main Factors Considered in Ranking
	Floating	Dissolved	
the area ▪ Caught, trapped or sighted is Very Certain/WAM Vouchered/Certain			
Critically Endangered species, if: ▪ Extinct in the area, dead, fossils, subfossil, historical record All Endangered, Vulnerable and Other species with a conservation code with all other information	1	1	
Terrestrial reptiles which do not use the marine or intertidal zone for any instance of their lifecycle, and do not use the marine or intertidal zone as any component of their habitat.	1	1	**Importance:** This is researched through two sources which cite no use of the marine/intertidal zone, one of which is SPRAT.
Data List ▪ DotE Species of National Environmental Significance (SNES) ▪ DPaW Protected Fauna ▪ DotE Biologically Important Areas (BIAs)			

3.2 Protection Areas

Protection areas consist of habitats and ecosystems that are important for protection (such as unique ecosystems) or for supporting locally, regionally and internationally important flora and fauna. Habitats include mangroves, coral, seagrass, wetlands, fish spawning grounds, or Key Ecological Features (KEF). Protection areas include both areas formally protected through State or Commonwealth legislation, and important habitats identified through ecological and scientific literature, e.g. seagrass, mangroves and coral.

When assessing the first zone, it was recognised that, due to a number of political, land tenure, time and funding constraints, there may be areas that are equivalent to one of the protection area categories but do not have the legal status of a protected area. It was agreed that if an area has been recommended as a marine park or national park, but for legal or land tenure (or other) reasons is not yet (at the time of the assessment) legally designated as one, it should be included in the assessment for protection under the marine park/national park, etc., protection ranking. Also, if an area cannot legally become a marine park/national park, etc., for similar reasons as outlined above, but it has been demonstrated that the area has the ecological value equivalent to a formally recognised park, it should be included in the assessment.

There were two such areas identified in 'A Representative Marine Reserve System for Western Australia', a report by the Marine Reserves Selection Working Group (Wilson *et al.*, 1994). These are Cowrie Beach (Shoreline Cell 97) and Robe (Shoreline Cell 111). These are discussed further in Section 3.2.3, Marine Protection Areas.

3.2.1 World Heritage Areas

Description

Australia has 14 World Heritage areas. These are places or areas that the United Nations Educational, Scientific and Cultural Organization (UNESCO) has agreed are worthy of special protection, because they represent the best examples of the world's cultural and natural heritage and are considered to be of outstanding value to humanity (UNESCO, 2008).

There are two categories for heritage protection: cultural heritage; and natural heritage. This section includes World Heritage areas listed for their natural heritage value only, and those listed for both their natural and cultural heritage values. Areas listed on the UNESCO World Heritage List for only their cultural heritage have been included in the Cultural Heritage priority ranking (see Section 3.3.1).

The DotE World Heritage Areas dataset was used to delineate the World Heritage areas in the South West and South Coast zones. There are no World Heritage sites in these shoreline cells.

The UNESCO World Heritage Council does not list areas only nominated for World Heritage Listing. At the time of this report, globally there are 44 World Heritage Area nominations, with 40 assessed and four incomplete. There are a further 37 proposed for review in 2017 (UNESCO, 2017). There are three areas on the Tentative List, proposed by Australia in 2017, however these are not in Western Australia.

Distribution

The DotE World Heritage Areas dataset was used to delineate the World Heritage Areas in the South West and South Coast zones. There were no World Heritage sites in these shoreline cells.

Discussion

There are ten criteria against which a site can be nominated for inclusion in the list of World Heritage areas. While some sites fulfil more than one criterion, for the purposes of the overall assessment, all recognised World Heritage areas have been ranked equally (highest ranking) as it is considered that a loss or impact on the site would be a loss or impact of global significance.

As a site selected for its outstanding natural value, all World Heritage areas have been given the highest priority for protection from the effects of both floating and dissolved oil. As there are no World Heritage areas in the South West or South Coast zones, there are no shoreline cells with the protection priority ranking listed in Table 3-7.

Table 3-7: World Heritage Properties protection priority ranking

Value Measure	Ranking		Main Factors Considered in Ranking
	Floating	Dissolved	
World Heritage Properties (Natural and Natural & Cultural Heritage)			
All World Heritage areas	5	5	**Importance:** World Heritage areas have the highest priority for protection from the effects of both floating and dissolved oil.

Data List

- World Heritage Areas (DotE World Heritage Areas)

3.2.2 Terrestrial Protection Areas

Description

Terrestrial protection areas are those specified in Commonwealth or State law – such as national parks, nature reserves, conservation parks, Indigenous protected areas and miscellaneous reserves – to preserve the natural and cultural characteristics of an area. Nearly two thirds of the protected areas in Australia are publicly owned and managed by the Australian government or State and Territory governments. These include over 9,700 protected areas covering more than 103 million hectares or 13.4 per cent of Australia (DotE, 2013). The largest component of this is in WA where 35.64 million hectares are protected across 1,562 areas, which is 34.51% of the total National Reserve Network (DotE, 2013). The majority of this land is managed by DPaW.

Terrestrial protection areas have been identified through the DotE Collaborative Australian Protected Areas Database (CAPAD). The dataset is updated every two years and, while the previous version is dated 2014, DPaW was able to provide an updated marine and terrestrial dataset for lands vested in its department (from July 2016). Within CAPAD, the conservation areas under the WA *Conservation and Land Management Act 1984* (CALM Act) include IUCN protected areas categories. IUCN is the International Union for Conservation of Nature which has created a set of categories that have been internationally adopted as the standard for defining and recording protected areas. The conservation categories listed in the CALM Act are:

IA (Strict Nature Reserve): Protected areas that are strictly set aside to protect biodiversity and also possibly geological/geomorphological features, where human visitation, use and impacts are strictly controlled and limited to ensure protection of the conservation values. Such protected areas can serve as indispensable reference areas for scientific research and monitoring.

IB (Wilderness Area): Protected areas that are usually large unmodified or slightly modified areas, retaining their natural character and influence, without permanent or significant human habitation, which are protected and managed to preserve their natural condition.

II (National Park): Protected areas that are large natural or near-natural areas set aside to protect large-scale ecological processes, along with the complement of species and ecosystems characteristic of the area, which also provide a foundation for environmentally and culturally compatible, spiritual, scientific, educational, recreational and visitor opportunities.

III (National Monument): Protected areas that are set aside to protect a specific natural monument which can be a landform, sea mount, sub-marine cavern, geological feature such as a cave, or even a living feature such as an ancient grove. They are generally quite small protected areas and often have high visitor value.

IV (Habitat/Species Management Area): Protected areas that aim to protect particular species or habitats and whose management reflects this priority. Many Category IV protected areas will need regular, active interventions to address the requirements of particular species or to maintain habitats, but this is not a requirement of the category.

V (Protected Landscape/Seascape): Protected areas where the interaction of people and nature over time has produced an area of distinct character with significant ecological, biological, cultural or scenic value: and where safeguarding the integrity of this interaction is vital to protecting and sustaining the area and its associated nature conservation and other values.

VI (Protected area with sustainable use of natural resources): Protected areas that conserve ecosystems and habitats, together with associated cultural values and traditional natural resource management systems. They are generally large, with most of the area in a natural condition, where a proportion is under sustainable natural resource management and where low-level, non-industrial use of natural resources compatible with nature conservation is seen as one of the main aims of the area.

Other types of reserves including 5(1)(g) Reserves: Within the meaning of the CALM Act: land reserved under the *Land Act 1933* which is vested in the Conservation Commission of WA that is not a national park, conservation park, nature reserve, marine park or marine nature reserve. Immediately before the commencement of the CALM Act: was vested in, or under the control and management of the National Parks Authority but not as a national park. (On the proclamation of the CALM Act, all these reserves were automatically vested in the Conservation Commission of WA). These reserves have a wide variety of purposes, but are normally related to recreation, wildlife conservation, infrastructure and historical features. These are managed by the WA Department of Parks and Wildlife and can have any of the above IUCN classifications for management.

5(1)(h) Reserves: Within the meaning of the CALM Act: land reserved under the *Land Administration Act 1997* which is vested in the Conservation Commission of WA that is not a national park, conservation reserve, nature reserve, marine park or marine nature reserve. Immediately before the commencement of the CALM Act: was vested in, or under the control and management of the National Parks Authority but not as a National Park. (On the proclamation of the CALM Act all these reserves were automatically vested in the Conservation Commission of WA). These reserves have a wide variety of purposes, but are normally related to recreation, wildlife conservation, infrastructure and historical features. These are managed by the WA Department of Parks and Wildlife and can have any of the above IUCN classifications for management.

Indigenous Protected Areas: Indigenous community owned and managed lands in Australia. They form the second largest component of the National Reserve System, covering three per cent of Australia. These can have any of the above IUCN classifications for management.

Miscellaneous Reserves: Defined by the WA Department of Mines and Petroleum in its description of land type categories in TENGRAPH® as Freehold land held by the Executive Director of DPaW. Under Section 131 of the CALM Act, this freehold land can be sold by DPaW. These can have any of the above IUCN classifications for management.

Distribution

In the South West Zone, IUCN IA (Strict Nature Reserve) areas are in Shoreline Cells 208 to 211, 213, 216 to 218, 221, 222, 224 and 226. IUCN II areas are in Shoreline Cells 208 to 210, and 212 to 226, and 5(1)(h) reserves are in cells 209, 210, 216, 221, 222, 224 and 226.

In the South Coast Zone, IUCN IA (Strict Nature Reserve) areas are in Shoreline Cells 227, 229 to 233, 235, 238, 239, 242 to 275, and 339 to 351. Shoreline Cell 280 includes an IB Wilderness Protection Area, and IUCN II National Parks occurs in Shoreline Cells 227 to 233, 237 to 241, 245, 246, 249, 251, 252, 254, 255 to 257 and 280. 5(1)(h) reserves are in Shoreline Cells 230, 231 and 247, and IUCN IV and V are in Shoreline Cells 231, 232 and 245. Shoreline Cell 280 also has an IUCN VI National Park.

Discussion

The land tenure of the conservation parks, national parks and nature reserves has a long standing protection status in Australian legislation. The proposed ranking for these legislated terrestrial protection areas is presented in Table 3-8. As noted in Section 3.2, it has been recognised that due to a number of political, land tenure, time and funding constraints, there may be areas that are proposed or scientifically recognised to be important areas, but are yet to become or will never be able to become formally protected, and therefore are not legally recognised as such. These would have been included in this assessment as their equivalent legal protection category, if any had been identified.

In the first zone assessed, it was highlighted that the designated boundary of a terrestrial protection area may be either to the mean high water mark, or to the mean low water mark. If the boundary was to the mean low water mark, the area for protection included the intertidal zone. Therefore the effects of marine pollution in the intertidal zone needed to be considered in the Terrestrial Protection Area assessment. In response, the terrestrial parks have been divided into parks that include the intertidal zone and those that have a boundary to the mean high water mark (terrestrial only), and the potential impacts ranked accordingly.

When processing and reviewing the data in the South West and South Coast zones, it was apparent that there are no terrestrial conservation areas needing to be split for the areas inside and outside of the intertidal zones, to facilitate applying separate rankings. The distinction has however been incorporated, in anticipation that it may become a consideration when assessing the other zones.

During the Steering Committee review, national parks recommended for inclusion were those proposed by Wilson et al. (1994), however this data was not available in a suitable format for

incorporation and has not been included into the attribute table. It is referenced in this assessment in this text only.

Based on the rankings in Table 3-8, IA and IB areas have been ranked High for protection from floating oil, and Medium for protection from dissolved oil. These include Shoreline Cells 208 to 211, 213, 216 to 218, 221, 222, 224 and 226 in the South West zone, and 227 to 233, 235, 237 to 275, 280 and 339 to 351 in the South Coast zone.

Shoreline Cells 208 to 210, 212 to 233, 237 to 241, 245, 246, 249, 251, 252, 254 to 257 and 280 have been ranked Medium for protection from floating oil and Low for protection from dissolved oil, for the presence of IUCN II, III and IV protection areas. Some of the areas given the IUCN II, II or IV grade, in Shoreline Cells 231, 232 and 245, do not include the intertidal zone and have been ranked Low for protection from dissolved oil.

The 5(1)(h) reserves in cells 209, 210, 216, 221, 222, 224 and 226, 230, 231 and 247, IUCN IV and V in Shoreline Cells 231, 232 and 245 and IUCN VI in Shoreline Cell 280 have been ranked Low for protection from floating oil, and Very Low for protection from dissolved oil.

Table 3-8: Terrestrial Protection Areas protection priority ranking

Value Measure	Ranking		Main Factors Considered in Ranking
	Floating	Dissolved	
National and State Terrestrial Protection Areas			
All conservation areas and proposed conservation areas as defined under the WA *Conservation and Land Management Act 1984* (conservation park, national park, nature reserve) ranked IUCN IA (Strict Nature Reserve) and IB (Wilderness Area) *Includes the intertidal zone*	4	3	**Importance:** A Strict Nature Reserve is mainly managed for scientific research. Wilderness Areas are managed for their wilderness protection. Both are key examples of unspoilt areas of wilderness with restricted human access. These pristine areas are the most important to protect from anthropogenic impacts such as an oil spill.
Same as above but: *Does not include the intertidal zone*	3	N/A	
All conservation areas and proposed conservation areas as defined under the WA *Conservation and Land Management Act 1984* ranked IUCN II (National Park), III (National Monument), IV (Habitat/Species Management Area), V (Protected Landscape/Seascape) *Includes the intertidal zone*	3	2	**Importance:** National Parks, National Monuments, Habitat/ Species Management Areas and Protected Landscape/Seascape are typically larger areas protected to preserve a larger ecosystem or feature. Therefore the impacts from an oil spill are expected to be less as the areas are larger.
Same as above but: *Does not include the intertidal zone*	2	N/A	
All conservation areas and proposed conservation areas as defined under the WA *Conservation and Land Management Act 1984* ranked IUCN VI (Managed Resource Protected Area) and all other types: 5(1)(g) reserves, 5(1)(h) reserves, Indigenous Protected Areas, Miscellaneous Reserves and Regional Parks *Includes the intertidal zone*	2	1	**Importance:** All other reserved areas have land tenure not as secure as conservation areas described above. Managed Resource Protected Areas typically have a level of human interaction and recreation. Managed mainly for conservation, they still have an element of disturbance through sharing their natural resources with the public.
Same as above but: *Does not include the intertidal zone*	1	N/A	
Data List ▪ DotE CAPAD – Terrestrial (30 June 2014) with DPaW update (30 June 2016)			

3.2.3 Marine Protection Areas

Description

Marine protection areas in WA state waters are areas specified in State law such as marine parks, marine reserves, fish habitat protection areas and reef protection areas. Marine protection areas are used alongside fisheries management to conserve aquatic biodiversity and contribute to a sustainable marine environment. Commonwealth protected areas may also be put in place, however these are in waters between three and 200 nautical miles off the WA coast under Commonwealth legislation (i.e. adjacent to state waters).

Marine protection areas have been sourced from the Commonwealth DotE CAPAD Marine dataset. The CAPAD Marine dataset provides both spatial and text information about government, Indigenous and privately protected areas for continental Australia. State and Territory conservation agencies supplied the DotE with data current to 30 June 2014 for inclusion. It is updated by the DotE every two years, however DPaW was able to provide an updated marine and terrestrial dataset for lands vested in its department, correct up to 30 June 2016. The WA DoF has also provided updated datasets for areas managed for fisheries. Protected areas offshore include:

- 5(1)(g) Reserves;
- Fish Habitat Protection Areas;
- Marine Management Areas;
- Marine Nature Reserves;
- Marine Parks; and
- Nature Reserves.

These reserves are then classified by the IUCN system described in Section 3.2.2 for terrestrial protection areas. Fish Habitat Protection Areas, along with Closed Waters areas, are described in Section 3.2.8.

Distribution

Shoreline Cell 225 includes an IUCN II Marine Park, and an IUCN VI Marine Park is in Shoreline Cells 209 to 218.

IUCN II Commonwealth marine reserves are present in Shoreline Cells 210, 211, 215, 216, 219, 220, 226, 239, 240, 244, 245, 259, 267 to 270, 339, 350 and 351. IUCN VI Commonwealth Marine reserves are present in Shoreline Cells 209 to 219, 224 to 226, 238, 239, 243 to 246, 256 to 258, 280, 339, and 347 to 350.

The Ngari Capes Marine Park covers Shoreline Cells 210 to 218, and the Walpole and Nornalup Inlets Marine Park is in Shoreline Cell 225. The Recherche Archipelago Nature Reserve is a proposed marine park, and falls in Shoreline Cells 246 to 259 and 340 to 351.

Discussion

The land tenure for marine nature reserves, marine parks or marine management areas has had a long-standing protection status in Australian legislation. The proposed ranking for marine protection areas is presented in Table 3-9. As discussed in Section 3.2.2 (Terrestrial Protection Areas), the designated boundary of a marine protection area may be either to the mean high water mark, or to the mean low water mark, and thus may or may not include an intertidal zone. As such, the potential impact could be different depending on the boundary. Therefore the marine parks have been divided into parks that include the intertidal zone (i.e. that have a boundary to the mean high water mark), and those that only go to the mean low water mark (i.e. subtidal only). This is reflected in the rankings in Table 3-9.

As noted in Section 3.2, it has been recognised that due to a number of political, land tenure, time and funding constraints, there may be areas that are proposed to become marine protection areas but are not yet legally recognised as such. These have been identified and described above for consideration as marine parks in the future, and have been included in the assessment.

The Ngari Capes Marine Park covers Shoreline Cells 210 to 218, and the Walpole and Nornalup Inlets Marine Park is in Shoreline Cell 225. The Recherche Archipelago Nature Reserve is a proposed marine park, and falls in Shoreline Cells 246 to 259 and 340 to 351. These have all been ranked High for protection from floating oil, and Medium for protection from dissolved oil.

IUCN II Marine Park and Commonwealth marine reserves are in Shoreline Cells 210, 211, 215, 216, 219, 220, 225, 226, 239, 240, 244, 245, 259, 267 to 270, 339, 350 and 351, and have been ranked Medium for protection from floating oil, and Low for protection from dissolved oil.

IUCN VI Marine Park and Commonwealth Marine reserves are in Shoreline Cells 209 to 219, 224 to 226, 238, 239, 243 to 246, 256 to 258, 280, 339, and 347 to 350, and have been ranked Low for protection from both floating and dissolved oil.

Table 3-9: Marine Protection Areas protection priority ranking

Value Measure	Ranking		Main Factors Considered in Ranking
	Floating	Dissolved	
National and State Marine Protection Areas			
All conservation areas and proposed conservation areas as defined under the WA *Conservation and Land Management Act 1984* (marine nature reserve, marine park or marine management area) ranked IUCN IA (Strict Nature Reserve) and IB (Wilderness Area) *Includes intertidal zone*	4	4	**Importance:** Strict Nature Reserves are mainly managed for scientific research. Wilderness Areas are managed for their wilderness protection. They are key examples of unspoilt areas of wilderness with restricted human access. These pristine areas are the most important to protect from anthropogenic impacts such as an oil spill.
A-Class Reserve vested under the *Fish Resources Management Act 1994*	4	4	
Same as above, but: *Subtidal only*	3	4	
All conservation areas and proposed conservation areas as defined under the WA *Conservation and Land Management Act 1984* ranked IUCN II (National Park), III (National Monument), IV (Habitat/Species Management Area), V (Protected Landscape/Seascape)	3	3	**Importance:** The land tenure of the conservation parks, national parks and nature reserves have a long standing protection status in Australian legislation. National Parks, National Monuments, Habitat/Species Management Areas and Protected Landscape/Seascape are typically larger areas protected to preserve a larger ecosystem or feature. Therefore the impacts from an oil spill are expected to be less as the areas are larger.
Same as above, but: *Subtidal only*	2	3	
All conservation areas and proposed conservation areas as defined under the WA *Conservation and Land Management Act 1984* ranked IUCN VI (Managed Resource Protected Area) and all other types (existing and proposed): 5(1)(g) reserves, 5(1)(h) reserves, Indigenous Protected Areas, Miscellaneous Reserves	2	2	**Importance:** All other reserved areas have land tenure not as secure as conservation areas described above. Managed Resource Protected Areas typically have a level of human interaction and recreation. Managed mainly for conservation, they still have an element of disturbance through sharing their natural resources with the public.
Same as above, but: *Subtidal only*	1	2	
Data List ▪ DotE CAPAD – Terrestrial and Marine (30 June 2014) with DPaW update (30 June 2016)			

3.2.4 Wetlands

Description

There are two levels of protected wetlands in Australia: Ramsar wetlands; and Wetlands of National Importance.

Ramsar wetlands are wetlands of international importance identified under the Ramsar Convention for conservation and sustainable use and management. The Ramsar Convention aims to halt the worldwide loss of wetlands and to conserve, through wise use and management, those that remain. Ramsar wetlands are protected in Australia under the EPBC Act as a matter of national environmental significance. They are wetlands identified as representative, rare or unique, or important for conserving biological diversity, and are often recognised for supporting international and migratory bird species. Under the Ramsar Convention, a wide variety of natural and human-made habitat types, ranging from rivers to coral reefs, can be classified as wetlands. Wetlands include swamps, marshes, billabongs, lakes, salt marshes, mudflats, mangroves, coral reefs, fens, peat bogs, or bodies of water – whether natural or artificial, permanent or temporary. There are even underground wetlands.

Nationally important wetlands are those wetlands that are recognised for their national significance. In Australia, these are also protected under the EPBC Act and are listed for one or more of six reasons:

1. It is representative of a biogeographic region in Australia;
2. It plays an important ecological or hydrological role in the natural functioning of a major wetland system/complex;
3. It is important as the habitat for animal taxa at a vulnerable stage in their lifecycles, or provides a refuge when adverse conditions such as drought prevail;
4. It supports 1% or more of the national populations of any native plant or animal taxa;
5. It supports native plant or animal taxa or communities which are considered endangered or vulnerable at the national level; and/or
6. It is of outstanding historical or cultural significance.

Ramsar wetlands were identified using the DotE Ramsar Wetlands of Australia geospatial dataset, and nationally important wetlands were identified using the Directory of Important Wetlands in Australia spatial database.

Distribution

Two Ramsar wetlands are located in the South West and South Coast zones: the Vasse-Wonnerup system in the South West zone in Shoreline Cells 209 and 210 (around Busselton); and the Lake Gore wetland in Shoreline Cells 246 and 247 in the South Coast zone to the west of Esperance.

Discussion

Ramsar wetlands are wetlands of international importance protected under the EPBC Act for management and protection as a matter of national environmental significance. Because such a site is selected for its international importance, and a wetland is likely to be significantly affected in the long term due to its complex remediation, it has been given the highest priority for protection from both floating and dissolved oil. Nationally important wetlands have been given the second highest ranking for the same reasons. These rankings are presented in Table 3-10.

There is some duplication between the listings of Ramsar wetlands and nationally important wetlands. Wetlands are also included as a shoreline type in the OSRA ESI dataset. However, where coastline characteristics are identified of national or international significance (e.g. a wetland), this higher ranking has prevailed (Table 3-10).

Shoreline Cells 209, 210, 246 and 247 have been ranked Very High because of the presence of Ramsar wetlands.

Table 3-10: Ramsar and Nationally Important Wetlands protection priority ranking

Value Measure	Ranking		Main Factors Considered in Ranking
	Floating	Dissolved	
Ramsar Wetlands			
All Ramsar wetlands	5	5	**Importance:** Ramsar wetlands are internationally important, protected under the EPBC Act for management and protection as a matter of national environmental significance.
All nationally important wetlands	4	4	**Importance:** Wetlands which are classified as nationally important.

Data List

- DotE Ramsar Wetlands of Australia (22 April 2015)

3.2.5 Key Ecological Features

Description

Marine Key Ecological Features (KEFs) are elements of the marine environment that, based on current scientific understanding, are considered to be regionally important, either for the region's marine biodiversity or for ecosystem function and integrity.

KEFs have been identified in this assessment using the National Key Ecological Features geospatial database obtained from the DotE. While all KEFs are in commonwealth waters, the shoreline cell boundaries have the potential to overlap with some commonwealth waters, and therefore some KEFs.

While the following KEFs are located near the South West and South Coast zones, they are not in the shoreline cells: 'Ancient coastline at 90-120 m depth'; the 'Commonwealth marine environment surrounding the Recherche Archipelago' and the 'Commonwealth marine environment in and adjacent to Geographe Bay'

The western rock lobster (*Panulirus cygnus*) is the dominant large benthic invertebrate in the South West bioregion. It is also an important part of the food web on the inner shelf, particularly as a juvenile, when it is preyed upon by octopus, cuttlefish, baldchin groper, blue groper, dhufish, pink snapper, wirrah cod and breaksea cod. The western rock lobster is also particularly vulnerable to predation during seasonal moults in November-December, and to a lesser extent during April-May. The high biomass of western rock lobster and its vulnerability to predation suggest it is an important trophic pathway for a range of inshore species that prey upon juvenile lobsters. The western rock lobster is defined as a key ecological feature due to its presumed ecological role on the west coast continental shelf.

Distribution

The spatial boundary of the western rock lobster KEF includes commonwealth waters in the South West marine region, to a depth of 150 m, north of Cape Leeuwin. It overlaps with shoreline cells 207-217 in the South West zone.

Discussion

KEFs are considered to be regionally important, either for the region's marine biodiversity or for ecosystem function and integrity, so have been given the rankings proposed in Table 3-11.

Shoreline cells 207-217 have been ranked a Low for protection from floating oil and a Medium for protection from dissolved oil as a result of the western rock lobster KEF being present.

Table 3-11: Key Ecological Features protection priority ranking

Value Measure	Ranking		Main Factors Considered in Ranking
	Floating	Dissolved	
Key Ecological Features			
Key Ecological Features	2	3	**Importance:** As a site selected for regional marine importance, KEFs are given the third highest priority for protection from dissolved oil as all features are submerged. They are given a lower priority for floating oil.

Data List

- DotE Marine Key Ecological Features (16 September 2015)

3.2.6 Coastal and Intertidal Habitats

Description

WA has many unique and nationally, regionally and locally important coastal and intertidal habitats. These include ecologically important mangroves in the north to white sandy beaches in the south, and rocky landscapes to sheltered intertidal flats in between.

The data representing coastal habitats predominantly came from the Oil Spill Response Atlas (OSRA) developed by AMSA and maintained by the DoT. These layers are represented by 'WA Shoreline ESI' data where ESI stands for Environmental Sensitivities Index. The spill contingency

planning requirements of the USA *Oil Pollution Act of 1990*, and similar legislation passed by many states in the US, require information on the location of sensitive resources to be used as the basis for establishing protection priorities. As such, a standardised system has been developed in the US known as the ESI. The index categorises the shoreline into its type and sensitivity to marine oil pollution. It is widely accepted around the world as the standard for sensitivity rating, used when planning a response to shoreline contact from an oil spill.

The Marine Futures Biodiversity (MFB) project (Government of Australia, 2008) mapped the biodiversity of nine key regions along the WA coastline including Abrolhos Island, Broke Inlet, Geographe Bay, Jurien Bay, Middle Island (Recherche Archipelago), Mount Gardner, Point Ann (Fitzgerald National Park), Rottnest Island and Southwest Cape. Geographe Bay and Southwest Cape fall in the South West zone, and Broke Inlet, Middle Island, Mount Gardner and Point Ann are all in the South Coast zone. This data is available online through the Seamap Australia project, and hosted on the Australian Ocean Data Network (aodn.org.au) which is maintained by the University of Tasmania.

The Department of Mines and Petroleum (DMP) Coastal Landforms dataset was also identified for inclusion in this section, however as described in Section 2.5, this was excluded from the first zone assessment. This was because it was difficult to assign a protection priority, as the dataset is not consistent in its interpretation of sandy/rocky and inundated shoreline areas equivalent to the ESI or DPaW Marine Habitat datasets above.

Distribution

The coastal characteristics of the South West and South Coast zones are dominated by fine to medium grained sand beaches with sheltered rocky shores and seawalls, and exposed rocky cliffs and wave cut platforms. There are no mangroves or intertidal flats, except a mangrove population in Bunbury in the South West zone.

During the Steering Committee workshop, tufa environments were highlighted as features potentially sensitive to oil spill. Data was received from Steering Committee members for including the habitats into the assessment. This data was in point form, and many of these were outside the shoreline cells as many tufa environments are in the supratidal zone, above the intertidal zone, and are therefore not at risk of being affected by a marine oil spill. However, any data points in the shoreline cells have been ranked the same as the exposed rocky cliffs. These were found in the Ngari Capes marine protection area in the South West, and near the Fitzgerald River region in the South Coast, in Shoreline Cells 215, 216, 226 and 227.

Discussion

For the various types of shoreline (and riverine or lacustrine) ecosystems, the widely accepted ESI can be adapted for each country. The ESI, ranging from 1 (low sensitivity) to 10 (very high sensitivity), integrates the:

- Shoreline type (grain size, slope), which determines the capacity of oil penetration and/or burial on the shore, and movement;
- Exposure to waves (and tidal energy), which determines the natural persistence time of oil on the shoreline; and
- General biological productivity and sensitivity.

For this assessment the ten levels of the ESI have been adopted from the IPIECA/IMO/OGP (2012).

Shorelines of sheltered tidal flats that incorporate mangrove and swamp habitats are more susceptible to the long term impacts of both floating and dissolved oil, while rocky exposed shorelines are the least susceptible. Shorelines which include beaches and sandy areas are considered to be moderately difficult to rehabilitate, moderately ecologically sensitive, and also are likely to contain areas used for human resources purposes such as beaches and archaeological sites.

The ESI categories 'mangroves' and 'sheltered intertidal flats' have been ranked by their abundance in the shoreline cells. The abundance was calculated based on its area in each shoreline cell, with an area of mangroves greater than 3000 ha deemed to be the most important (and ranked the highest, with a ranking of High for protection from both dissolved and floating oil). A graduated scale modelled on the Victorian example was then applied, with sheltered tidal flats >3000 ha and mangroves between 1000-3000 ha ranked Medium for protection from both dissolved and floating oil. Where there were less than 1000 ha mangroves and between 1000-3000 ha sheltered tidal flats, these have been ranked Low for protection from both floating and dissolved oil.

The DPaW marine habitats dataset predominantly shows areas of seagrass and coral which are included in the following section on Coral, Seagrass, Algae and Filter Feeding Communities (Section 3.2.7).

Tufa environments were ranked Medium for protection from both floating and dissolved oil, and were only found in Shoreline Cells 215, 216, 226 and 227. All other information showed tufa was further inland than the intertidal zone.

Table 3-12: Coastal and Intertidal Habitat protection priority ranking

Value Measure	Ranking		Main Factors Considered in Ranking
	Floating	Dissolved	
Shoreline Geomorphology and Coastal Landforms			
ESI 10: 10A Salt and brackish water marshes; 10B Freshwater marshes; 10C Swamps; 10D Mangroves with >3,000 ha per shoreline cell	4	4	**Importance:** Based on the NOAA and IPIECA/IMO/OGP Environmental Sensitivities Index, the classifications and rankings have been adopted from the above and take into account: 1. Shoreline Classification – ranked according to a scale relating to sensitivity, natural persistence of oil, and ease of clean up. 2. Biological Resources – including oil-sensitive animals and rare plants, and habitats which are used by oil-sensitive species or are themselves sensitive to oil spills, such as submersed aquatic vegetation and coral reefs. 3. Human-Use Resources – specific areas that have added sensitivity and value because of their use, such as beaches, parks, marine sanctuaries, water intakes and archaeological sites. See http://response.restoration.noaa.gov/sites/default/files/ESI_Guidelines.pdf for further discussion regarding the classifications.
ESI 7, 8 and 9: 7 Exposed tidal flats; 8A Sheltered scarps in bedrock, mud or clay and sheltered rocky shore; 8B Sheltered, solid man-made structures; 8C Sheltered riprap; 8D Sheltered rocky rubble shores; 8E Peat shorelines; 9A Sheltered tidal flats >3,000 ha per shoreline cell; 9B Vegetated low banks; 9C Hypersaline tidal flats; 10D Mangroves with between 1,000 and 3,000 ha per shoreline cell	3	3	
ESI 3, 4, 5 and 6: 3A Fine- to medium-grained sand beaches; 3B Scarps and steep slopes in sand; 4 Coarse-grained sand beaches; 5 Mixed sand and gravel beaches; 6A Gravel beaches (granules and pebbles); 6B Riprap structures and gravel beaches (cobbles and boulders) CAMRIS marc, calcareous clay, gravel, sand silt, mud pelagic clay and volcanic grit; 10D Mangroves <1,000 ha per shoreline cell; 9A Sheltered tidal flats with between 1,000 ha and 3,000 ha per shoreline cell	2	2	
ESI 1 and 2: 1A Exposed rocky shore; 1B Exposed, solid man-made structures; 1C Exposed rocky cliffs with boulder talus base; 2A Exposed wave-cut platforms in bedrock, mud or clay; 2B Exposed scarps and steep slopes in clay; and 9A Sheltered tidal flats with <1,000 ha per shoreline cell	1	1	
Data List ▪ DoT OSRA ESI dataset (April 2011) ▪ DPaW Marine Habitat dataset (May 2015) ▪ DPaW Tufa Locations (May 2017)			

3.2.7 Coral, Seagrass, Algae and Filter Feeding Communities

Description

Corals are significant benthic primary producers that play a key role in the ecosystem of many reef environs and have an iconic status in the environment. Corals are invertebrates, typically forming colonies of individual polyps. They contain photosynthetic unicellular algae called zooxanthellae and are therefore reliant on sunlight for their survival. Corals can be grouped into the following categories:

- Scleractinian corals (hard corals) – reef building corals;
- Non-scleractinian corals (sometimes referred to as calcified soft corals) – generally not considered to be reef building; and
- Soft corals belonging to the order *Alcyonacea* – non-reef building.

There are no coral habitats in the South West or South Coast zones.

Seagrasses are important primary producers in tropical inshore waters as they provide energy and nutrients for detrital grazing food webs. They are also directly grazed by protected animals such as dugongs and green turtles, and provide refuge areas for fishes and invertebrates (DEC, 2007). In particular, seagrass is highly important in the temperate South West and South Coast zones.

Algae are important primary producers. They support diverse and abundant fauna of small invertebrates that are the principal food source for many inshore fish species.

Coral, seagrass, algae and filter feeding community distribution has been determined from the OSRA ESI data layer, the DPaW Marine Habitat dataset and the CAMRIS Seagrass dataset.

It is noted that seagrass and algae fall under the definition of 'fish' in the *Fish Resources Management Act 1994*, however all mapped seagrass and algae have been included in this section rather than in Section 3.2.8.

Distribution

No coral reefs or coral habitat are present in the South West or South Coast zones.

Seagrass is located in most shoreline cells along the South West and South Coast zones, and although this is an important habitat in these zones, many of these larger populations are in marine protection areas. Due to the large number of shoreline cells where seagrass is present, it was determined that the ranking would remain the same as the rest of the state for these zones.

Algae including macroalgae have been mapped and confirmed to be present in Shoreline Cells 210 to 218 in the South West zone, and in Shoreline Cells 245 to 258 and 340 to 357 in the South Coast zone. These areas are associated with the Ngari Capes and Recherche Archipelago regions.

Filter feeding community distribution has not been extensively mapped, with limited geospatial data available. No filter feeding communities were mapped as part of the DPaW Marine Habitat dataset in the South West or South Coast zones.

Discussion

Temperate seagrasses as found in the South West and South Coast zones can be relatively slow growing. They are an important food source for associated fauna, with seagrasses in intertidal areas at greater risk of impact from oil. Taylor and Rasheed (2011) found that seagrass meadows are not significantly affected by an oil spill when compared to the non-impacted, reference seagrass meadow. For this reason, seagrass has been ranked lower than coral, but still ranked Medium as it provides important habitat for threatened turtles, fish and invertebrates.

Algae typically colonises an area when coral is killed because of an oil spill. The impacts of dissolved oil are greater than floating oil in the cellular level poisoning of algae growth, but the impacts on algae are secondary as the algae supports fauna species and provides food sources for fish. The literature appears to support the observation that the direct impacts on algae from oil are limited and they recover readily following an oil spill event (Lobban and Harrison, 1994). For these reasons, algae has been given a ranking below that of coral and seagrass.

Filter feeding communities play important roles in purifying water, creating habitat and controlling shoreline erosion. These communities are often wide spread and diverse, with impacts from a spill including degradation, impaired reproduction and growth development.

These are summarised in the rankings table below (Table 3-13). Based on this table, the majority of shoreline cells in the South West and South Coast zones have been ranked Low for protection from floating oil and Medium for protection from dissolved oil, due to the presence of seagrass.

Table 3-13: Coral, Seagrass and Algae protection priority ranking

Value Measure	Ranking		Main Factors Considered in Ranking
	Floating	Dissolved	
Coral, Seagrass and Kelp			
Coral	3	4	**Importance:** Corals are particularly sensitive to dissolved hydrocarbons.
Seagrass	2	3	**Importance:** Seagrasses are grazed by protected animals and provide refuge areas for fish and invertebrates.
Algae and filter feeding communities	1	2	**Importance:** Algae and filter feeding communities including sponges are important primary producers, and support diverse and abundant fauna of small invertebrates that are the principal food source for many inshore fish species.

Data List

- Coral reef data in the OSRA ESI data layer (April 2011)
- DPaW Marine Habitat dataset (May 2015)
- CAMRIS coastal seafloor distribution (23 January 2008)

3.2.8 Fish Habitat Protection Areas and Closed Waters

Description

The WA DoF is responsible for managing State commercial fisheries off the coast of WA in state waters and in commonwealth waters (under the Offshore Constitutional Agreement). Fish and their habitats in a particular area can also be given special protection and management by including them in a Fish Habitat Protection Area (FHPA). These areas are set aside under section 115 of the *Fish Resources Management Act 1994* for the following purposes:

- The conservation and protection of fish, fish breeding areas, fish fossils or the aquatic ecosystem;
- The culture and propagation of fish and experimental purposes related to that culture and propagation; and/or
- The management of fish and activities relating to the appreciation or observation of fish.

The distribution information has been determined from the CAPAD fish habitat protection areas data and the DoF habitat protection areas.

In addition, areas can be closed under section 43 of the *Fish Resource Management Act 1994* (FRMA). This prohibition can include closed waters (Marine Reserves), gear restrictions, species restrictions and designated fishing zones.

Distribution

There are no Fish Habitat Protection Areas from the CAPAD dataset which fall in the South West or South Coast zones.

There are no areas closed to fishing under section 43 of the FRMA (1994) which fall in the South West or South Coast zones.

Discussion

FHPAs protect the continuing sustainability of a particular species, or multiple species. Fish in a key habitat exposed to dissolved aromatic hydrocarbons are at risk of toxic effects. They are less likely to become physically oiled by floating oil. Areas closed under section 43 of this Act are protected for environmental conservation, and all areas have a prohibition of fishing equivalent to a sanctuary, and have therefore been given a higher ranking for protection. These rankings are presented in Table 3-14.

There are no FHPAs from the CAPAD dataset or areas closed to fishing under section 43 of the FRMA (1994) in the South West or South Coast zones.

Table 3-14: Fish Habitat Protection Areas protection priority ranking

Value Measure	Ranking		Main Factors Considered in Ranking
	Floating	Dissolved	
Fish Habitat Protection Areas			
Areas closed under section 43 of the *Fish Resource Management Act 1994*	4	4	**Importance:** Areas closed under section 43 of this Act prohibit fishing. This prohibition can include closed waters (Marine Reserves), gear restrictions, species restrictions and designated fishing zones.
Fish Habitat Protection areas in the CAPAD dataset	3	3	**Importance:** Fish habitat protection areas protect the continuing sustainability of a particular species, or multiple species. Fish in a key habitat exposed to dissolved aromatic hydrocarbons are at risk of toxic effects. Fish are less likely to become physically oiled by floating oil.

Data List

- CAPAD fish habitat protection areas (June 2014)
- DoF FRMA (1994) Prohibition on Commercial Fishing areas (November 2016)

3.2.9 Aquaculture and Pearling Areas

Description

Aquaculture is defined as the cultivation of marine and freshwater organisms for human use or consumption. Aquaculture in Western Australia includes abalone, barramundi, black bream, coral, live rock, marine finfish, marron, mussels and oysters, pearls, prawns, redclaw crayfish, silver perch, trout and yabbies (Aquaculture Council of WA, 2016). Protection areas for aquaculture would include livestock collection locations, for example wild spat collection for cultivating pearls.

Aquaculture areas identified for protection either legally or informally were sought from the WA DoF. Note that the economic assessment of aquaculture licence areas is included in Section 3.4.

Distribution

There are no legally protected aquaculture or pearling areas in WA waters. No informal aquaculture protection areas have been identified in the South West or South Coast zones.

Discussion

Aquaculture wild stocks would be for abalone, coral, live rock, mussels, and wild spat for pearls. These are sessile, so would be impacted more by dissolved oil than by floating oil because they are filter feeders.

All other wild aquaculture stocks for fish, prawns, crayfish, trout and yabbies could be resourced from a number of areas and even from other aquaculture farms. The rankings for future inclusion of areas are presented in Table 3-15.

Table 3-15: Aquaculture and Pearling Areas protection priority ranking

Value Measure	Ranking		Main Factors Considered in Ranking
	Floating	Dissolved	
Aquaculture and Pearling Areas			
Wild stocks for aquaculture	2	3	**Importance:** Wild aquaculture stock would be impacted more by dissolved oil than by floating oil because these wild stocks are sessile filter feeders.
Data List ▪ DoF, 5 May 2017			

3.3 Cultural Heritage

Defining cultural heritage for inclusion in this heading for this project has been challenging. This is due to our evolving understanding of what heritage is. This definition continues to expand as people come to realise that cultural and natural heritage are closely integrated. Heritage is still regarded as consisting of 'special places', but there is an emerging recognition by Indigenous and non-Indigenous Australians of intangible heritage and cultural landscapes, and of the importance of heritage as a part of people's locality and identity (Beeton *et al.,* 2006).

From a cultural heritage perspective, there is currently strong interest in recognising intangible heritage, gaining a better understanding of how Indigenous people value land and landscape, and involving communities in identifying strong and special associations with place (Beeton *et al*., 2006). For this assessment, the current cultural heritage listing of places has been used, as identified by Australian legislation.

There are different levels of heritage listing in Australia – world, national, state/territory and local. At the highest level are places on the World Heritage List which are protected for their contribution to the global natural or cultural heritage, or both. For example, Uluru-Kata Tjuta National Park is protected for both its natural and cultural heritage contribution. On a local heritage list there might be a local nature reserve protected for local Indigenous cultural purposes or the local Post Office (AHC, 2009).

There are many heritage lists in Australia. Some are kept by the different levels of government while other lists are maintained by community or professional organisations. The main government list for WA is outlined in Table 3-16 (taken from AHC, 2009).

Table 3-16: Australian heritage lists by level of administration

Level of Administration	Heritage List
UNESCO	World Heritage – the list is maintained by the World Heritage Centre of the United Nations Educational, Scientific and Cultural Organisation (UNESCO), based in Paris
Commonwealth	National Heritage Commonwealth Heritage *[Register of the National Estate (which was phased out in 2012 and is now an historic list)]* Historic Shipwrecks Register
State and Territory	WA – Register of Heritage Places Generally – some states and territories also maintain a separate Indigenous site register WA state protected shipwrecks
Local	WA – Municipal Inventory

In addition to meeting different levels of criteria for protection (a collection of principles, characteristics and categories used to help decide if a place has heritage value), there is also a question of the threshold for heritage listing. The threshold is the level of heritage value that a place must demonstrate to be included on a heritage list. The heritage lists at each level use different thresholds to decide what places to include. These levels have been used to determine their level of protection priority. Examples of the thresholds used at different levels are indicated in Table 3-17. These are discussed further in each section below.

Table 3-17: Threshold levels for heritage lists in Australia

Level of Administration	Heritage List	Threshold
UNESCO	World Heritage	Outstanding universal value
Commonwealth	National Heritage	Outstanding heritage value to the nation
	Commonwealth Heritage	Significant heritage value
State and Territory	State and Territory Heritage	Importance or significance in the state or territory
Local	Local Heritage	Importance or significance to the local community

3.3.1 Commonwealth Protected Heritage

Description

Commonwealth protected heritage is that which has outstanding heritage value to the nation of Australia. There are three types of properties which are Commonwealth protected in Australia:

1. World Heritage Areas;
2. National Heritage Areas; and
3. Commonwealth Heritage Places.

The datasets used to determine the distribution of Commonwealth protected heritage properties included the DotE's World Heritage areas, National Heritage List and Commonwealth Heritage List, which are publicly accessible.

It is noted that heritage places can be on multiple lists. Values of places on the Commonwealth Heritage List might be protected under more than one provision of the EPBC Act. For example, a Commonwealth Heritage Place might also be on the National Heritage List or the World Heritage List.

In this context, the cultural aspect means the Indigenous cultural aspect, the non-Indigenous cultural aspect, or both.

Distribution

In the South West and South Coast zones, there are no World Heritage areas on the World Heritage List (DotE, 2016).

There are two National Heritage Places in the South Coast zone: Cape Riche, located in Shoreline Cells 234 and 235; and the Fitzgerald River-Ravensthorpe Range area in Shoreline Cells 238 to 241. Both are listed as Natural Heritage Places.

No Commonwealth heritage places are listed in the South West or South Coast zones.

Discussion

World Heritage Areas

In 2005, Australia had 14 World Heritage areas. These are places or areas that the United Nations Educational, Scientific and Cultural Organization (UNESCO) has agreed are worthy of special protection because they represent the best examples of the world's cultural and natural heritage.

Due to two categories for protection – cultural heritage and natural heritage – only World Heritage areas listed for their cultural heritage values have been included in the assessment under this section. Areas listed on the UNESCO World Heritage List, for their natural heritage only and joint natural and cultural heritage, have been included in the Protection Areas priority ranking (refer to Section 3.2.1).

All World Heritage Places have been given the protection priority rankings for floating oil and dissolved oil presented in Table 3-18.

There are no World Heritage Areas in the South West or South Coast zones.

National Heritage Places

Data on National Heritage Properties has been sourced from the DotE. This data provides location and attribute information for places nominated to and included in the National Heritage List, as determined by the Australian Government and managed by the DotE Wildlife Division. As described in Table 3-17 above, National Heritage listed properties are protected for their outstanding heritage value to the nation, so they require a high level of protection, only one level below World Heritage areas.

The National Heritage List of properties includes the place name, class (Indigenous, natural, historic) and status. Places subject to confidentiality agreements are included in this data, but the location is generalised to the bounding 250k map sheet. Note that all confidential agreements are inland and do not affect the outcome of this project. The location data for nominated places that have been rejected, are ineligible, removed or destroyed are not included in this assessment.

All National Heritage Places have been given the protection priority rankings presented in Table 3-18. Based on these rankings, the two National Heritage Places found in the South Coast zone – Cape Riche, located in Shoreline Cells 234 and 235, and the Fitzgerald River-Ravensthorpe Range area in Shoreline Cells 238 to 241 – have been ranked High for protection from both floating and dissolved oil. There are no National Heritage Places in the South West zone.

Commonwealth Heritage Places

The Commonwealth Heritage List includes natural, Indigenous and historic heritage places owned or controlled by the Australian Government and protected under the EPBC Act. Places with Commonwealth Heritage values are protected under section 26 of the EPBC Act ("Protection of environment from actions involving Commonwealth land") which protects against "significant impact on the environment in…Commonwealth land", which specifies that "the heritage values of a place are part of the environment". These include places connected to defence, communications, customs and other government activities that also reflect Australia's development as a nation. As described in Table 3-17 above, Commonwealth Heritage Places are protected for their significant heritage value to the nation and are therefore considered to be of a Medium priority ranking, behind National Heritage places and World Heritage areas.

Places currently nominated or being assessed are not included in the list, and have therefore not been included in this assessment as they are not yet protected under the EPBC Act. Places subject to confidentiality agreements are also not included in this data.

Heritage areas comprised of artefacts relating to the rock or ground surface have been ranked higher for protection from floating oil than from dissolved oil, however those sites associated with the natural environment have been ranked equally high for protection from floating and dissolved oil. All Commonwealth Heritage Places have been given the protection priority rankings presented in Table 3-18.

There are no Commonwealth Heritage places in the South West or South Coast zones.

Table 3-18: Commonwealth Protected Heritage Properties protection priority ranking

Value Measure	Ranking		Main Factors Considered in Ranking
	Floating	Dissolved	
World Heritage Properties (Cultural Heritage)			
All World Heritage Areas	5	5	**Importance:** As a site selected for its outstanding universal value, all World Heritage areas have been given the highest priority for protection from both floating and dissolved oil.
National Heritage Places			
Indigenous and historic heritage places	4	3	**Importance:** As a site selected for its outstanding cultural value to the nation, these National Heritage Areas have been given a high priority for protection from floating oil, as these sites are nationally important and could be impacted physically by floating oil. A slightly reduced priority ranking for protection from dissolved oil has been given, as these sites are less likely to be affected by dissolved oil.
Natural heritage places	4	4	**Importance:** As a site selected for its outstanding natural heritage value to the nation, these National Heritage Areas have been given a high priority for protection from both floating and dissolved oil, as these sites are nationally important and could be impacted physically by either floating or dissolved oil.
Commonwealth Heritage Places			
Indigenous and historic heritage places	3	2	**Importance:** As a site selected for its significant cultural heritage value, these Commonwealth Heritage Areas have been given a medium priority for protection from floating oil, as these sites are nationally significant and could be impacted physically by floating oil. A slightly reduced priority ranking for protection from dissolved oil has been given, as these sites are less likely to be affected by dissolved oil.
Natural heritage places	3	3	**Importance:** As a site selected for its significant natural heritage value, these Commonwealth Heritage Areas have been given a medium priority for protection from floating and dissolved oil, as these sites are nationally significant and could be impacted physically by either floating or dissolved oil.

Data List

- DotE National, Commonwealth and Natural Heritage (Public) (January 2016)
- DotE World Heritage Areas (October 2016)

3.3.2 State Protected Heritage

Description

Places are listed for protection at a state level under the *Heritage of Western Australia Act 1990*. There are a number of different types of listings under the Act. Those included in this assessment are intended to include the places on the State Register, Conservation Order and Heritage Agreement lists. The different types of WA State Statutory Listings are provided in Table 3-19.

Table 3-19: Western Australia State Statutory Listings and other listings

Type	Organisation	Legislation	What is Listed	No. of Places in WA
State Statutory Listings				
State Register	Heritage Council (assisted by the State Heritage Office)	*Heritage of Western Australia Act 1990*	Places of state significance included in the State Register of Heritage Places	1,400
Conservation Order	Heritage Council (assisted by the State Heritage Office)	*Heritage of Western Australia Act 1990*	Places of state significance or potential state significance (special cases)	5
Heritage Agreement	Heritage Council (assisted by the State Heritage Office)	*Heritage of Western Australia Act 1990*	Places protected by long-term agreement between the parties	100
Town Planning Scheme ('Heritage List')	Local Governments	*Planning and Development Act 2005*; Local Planning Schemes	Places of local heritage significance	9,000
Other Listings				
Local Government Inventory (Municipal Inventory)	Local Governments	Mandated under the *Heritage of Western Australia Act 1990* but controlled by Local Governments	Places of local significance	20,000
List of Classified Places	The National Trust of Australia (WA)	The *National Trust of Australia (WA) Act 1964*	Places of local, state or national significance	2,300

Town Planning Scheme 'Heritage Listed' places, Municipal Inventory places and those on the List of Classified Places have been excluded as there are too many (>30,000 in total).

Places listed on the State Register, Conservation Order list and Heritage Agreement list along with their geospatial datasets were sourced from data.wa.gov.au, provided by the State Heritage Office.

The DAA Aboriginal Heritage Listed Places dataset was also identified for inclusion in this section. However, as described in Section 2.5, this was deliberately excluded from the first zone assessed

(Pilbara zone) due to the DAA list being largely incomplete, as it only identifies areas that have been registered through Native Title Determinations. The dataset was agreed to be removed to avoid a false impression that this sensitivity is covered.

In the absence of state-specific protection priority data for each shoreline cell, DoT would need to consult with the DAA independently in the event of an oil spill. This precedent is being carried through to the remainder of the zones being assessed.

Distribution

There are ten sites listed on the State Register in the South West zone, and 13 sites in the South Coast zone. The majority of the sites are associated with the larger towns along the coastline in Shoreline Cells 208 (Bunbury), 210 to 211 (Busselton), 215 (Margaret River region), 217 and 218 (Cape Leeuwin), 230 to 233 (Albany), 248 (Esperance) and 280 (Eucla).

There are no Heritage Agreement sites or Conservation Order listed sites in the South West or South Coast zones.

Discussion

The majority of State protected heritage are buildings or man-made historical places protected for their value to state history. However there are some natural sites, so the terrestrial and marine sites have been ranked equally high for protection from floating and dissolved oil. The rankings for protection priority for these sites are presented in Table 3-20.

Based on these rankings, Shoreline Cells 208, 210 to 211, 215, 217 and 218, 230 to 233, 248 and 280 have been ranked Medium for protection from both floating oil and dissolved oil, due to State protected heritage places in these cells. These cells do however have a higher ranked priority in them in the Cultural Heritage category, so the presence of the State protected heritage place does not appear in the attribute table.

Table 3-20: State Properties protection priority ranking

Value Measure	Ranking		Main Factors Considered in Ranking
	Floating	Dissolved	
State Heritage Places			
State protected heritage places	3	3	**Importance:** As a site selected for its significant cultural and/or natural heritage value, these State Heritage Areas have been ranked Medium priority for protection from floating and dissolved oil, as these sites are significant to the state and could be impacted physically by either floating or dissolved oil.

Data List

- DotE National Heritage (Public) (22 January 2016)
- State Heritage Office State Register dataset (October 2016)
- Conservation Orders dataset (October 2016)
- Heritage Agreement dataset (October 2016)

3.3.3 Shipwrecks and Maritime Archaeology

Description

The *Commonwealth Historic Shipwrecks Act 1976* protects all shipwrecks that are more than 75 years old. The Australian National Shipwrecks Database records all known Maritime Cultural Heritage (shipwrecks, aircraft, relics and other underwater cultural heritage) in Australian waters. Historic shipwrecks (>75 years) are protected under the *Historic Shipwrecks Act 1976*. Other wrecks that are not yet historic are protected under the *Navigation Act 2012*. This data has been sourced from the DotE and was last updated 3 February 2016. All shipwrecks have been recorded in this dataset, so this assessment only used ships wrecked prior to 1941.

The *State Maritime Archaeology Act 1973* protects pre-1900 maritime archaeological sites on state lands and in state waters, such as protected bays, harbours and rivers. Maritime archaeological sites include shipwrecks, early maritime infrastructure, land sites associated with exploration, maritime industries (such as whaling and pearling camps) and shipwreck survivor camps. The WA Museum is responsible for administering both Acts in WA, so these datasts were sourced from them.

Distribution

There are 110 Commonwealth protected shipwrecks and marine archaeology sites along the South West and South Coast coastline, about half of which are also protected under State legislation. These wrecks are found continuously along the coastline, with a third of the wrecks located in the Albany region in Shoreline Cell 231.

There are 34 shoreline cells in the South West and South Coast zones which contain Commonwealth protected shipwrecks. The shipwrecks and marine archaeology sites include shipwrecks along the majority of the South West coastline, and on the west side of the South Coast, with less wrecks present in the Great Australian Bight shoreline cells.

Discussion

All shipwrecks, aircraft, relics and other underwater cultural heritage provide national heritage history, however it is not anticipated that floating or dissolved oil will destroy the wrecks. Any shipwreck protected under Commonwealth Maritime Cultural Heritage has been ranked higher than under State protection mechanisms, which is reflected in the rankings given in Table 3-21.

Table 3-21: Shipwrecks protection priority ranking

Value Measure	Ranking		Main Factors Considered in Ranking
	Floating	Dissolved	
Nationally Protected Shipwrecks			
Commonwealth Maritime Cultural Heritage	3	3	**Importance:** All shipwrecks, aircraft, relics and other underwater cultural heritage provide national heritage history, but it is not anticipated that floating or dissolved oil will destroy the wrecks, so they have been ranked as Medium priority for protection from both dissolved and floating oil.
State Protected Shipwrecks			
WA protected shipwrecks and maritime archaeology	2	2	**Importance:** These shipwrecks provide state heritage history, but it is not anticipated that floating or dissolved oil will destroy the wrecks or maritime archaeology, so they have been ranked as Low priority for protection from both dissolved and floating oil.

Data List

- DotE Australian National Shipwrecks Database (3 February 2016)
- WA Museum State Protected Shipwrecks (June 2016)

3.4 Economic

Western Australia sources a great deal of wealth from its coastal assets. For example, WA's shipping exports were worth an estimated $127 billion in 2015-16. This was a 38 per cent contribution to the nation's exports, with more than half of Australia's total trade tonnage handled by WA ports (DoT, 2016). Aquaculture and fisheries also bring in significant profits to the state and are considered for protection in this assessment.

The following information has been assessed for economic factors in each zone:

- Aquaculture;
- State Managed Fisheries;
- Commonwealth Managed Fisheries;
- Other Commercial Operations;
- Tourism;
- Ports and Shipping; and
- Water Intake Locations.

To standardise the comparison, a ranking system was devised using the economic value per year in relation to Western Australia's gross state product (GSP). The GSP was $249 billion in 2014-15, contributing 15% of Australia's gross domestic product (GDP) (DSD, 2015). The economic estimates presented here have not allowed for any changes in pricing, and have been used as an indication at the time of this assessment. This is summarised in Table 3-22 which presents the assumed priority ranking based on economic value per year. The table also includes the time taken for fisheries and aquaculture stocks to recover.

Table 3-22: Economic determination used to priority rank economic values

Economic Annual Value	Ranking	Description
>$1B (>0.5% of State GDP) Or $501M-$1B (0.25-0.5% of State GDP) and recovery of species is >11 years	5	State managed commercial fisheries, Commonwealth managed commercial fisheries, ports and shipping, marine aquaculture and tourism. State Managed Fisheries are reported per region. Therefore the economic value for the fishery for that region is what has been used.
$501M-$1B (0.25-0.5% of State GDP) and recovery of species is <10 years Or $101M-$500M (0.05-0.25% of State GDP) and recovery of species is >11 years	4	
$101M-$500M (0.05-0.25% of State GDP) and recovery of species is <10 years Or $21M-$100M (0.01-0.05% State GDP) and recovery of species is >11 years	3	
$21M-$100M (0.01-0.05% State GDP) and recovery of species is <10 years Or <$20M (<0.01% State GDP) and recovery of species is >11 years	2	
<$20M (<0.01% State GDP) and recovery of species is <10 years	1	

3.4.1 Aquaculture

Description

Aquaculture is defined as the cultivation of marine and freshwater organisms for human use or consumption. Aquaculture in Western Australia includes abalone, barramundi, black bream, coral, live rock, marine finfish, marron, mussels and oysters, pearls, prawns, redclaw crayfish, silver perch, trout and yabbies (Aquaculture Council of WA, 2016).

Aquaculture in WA is managed through the licencing of permits through the DoF, so licence areas and geospatial locations were obtained from them. It should be noted that, for confidentiality reasons, the type of aquaculture being undertaken could not be provided.

Distribution

One aquaculture licence exists in the South West zone, in Shoreline Cell 218 in Augusta-Flinders Bay. In the South Coast zone, there are several aquaculture licences: two in Shoreline Cell 227, near Denmark; several in Shoreline Cell 231 (King George Sound and Oyster Harbour in Albany); and two in Shoreline Cell 238 (Bremer Bay, Back Beach). There is also a single license located in Shoreline Cell 249 (Wylie Bay).

Discussion

The economic impact of disruption to aquaculture depends on the marine stock being cultured, with different stock having different recovery rates. Depending on the type of aquaculture, the effects of an oil spill will also vary. For pearl oysters, it is acknowledged that an oil spill is unlikely to affect all licence areas at once. If an oil spill affects an oyster fishery, it is likely that the year's catch will be impacted and it will take three to four years to recover (DoF, 2013). However for finfish, it may take six to ten years following an oil spill for hatching to mature and reach a size appropriate for market. In a spill, dissolved oil is expected to have the highest impact, but the total impact will depend on their age and maturity.

Coral and live rock are widely varied, and the diversity of coral and associated species provides considerable flexibility in the range of culture systems and technologies that can be employed. As these species are subsurface, they are expected to be affected greater by dissolved oil than floating oil, with a year's worth of stock lost or affected. The species vary from very common to very rare, so recovery time is just as varied.

The pearling industry was valued at $78 million in 2015 (Fletcher et al 2017). The individual values for other aquaculture types are not available for confidentiality reasons. However, the total value of the aquaculture industry in Western Australia not including pearls and algae was $13 million in 2014/15. Therefore for this assessment, as there are no pearling leases in the South West and South Coast zones, all aquaculture licence areas have been given a single protection priority ranking (Table 3-23).

Based on the rankings in Table 3-23, Shoreline Cell 218 in the South West zone and Shoreline Cells 227, 231, 238 and 249 in the South Coast zone have been ranked Very Low for protection from floating oil and Low for protection from dissolved oil.

Table 3-23: Aquaculture protection priority ranking

Type (in each Region)	Ranking		Main Factors Considered in Ranking
	Floating	Dissolved	
Aquaculture Licenced Areas			
Aquaculture licenced areas	1	2	**Importance:** Aquaculture industry except pearls and algae was valued at $13M per annum in 2014/15 (Fletcher et al 2017), > 11 years to recover

Data List

- DoF aquaculture licence areas (March 2015)

3.4.2 State Managed Commercial Fisheries

Description

The WA State managed commercial and recreational fishing sectors contributed $1.5 billion to WA's Gross State Product in 2014/15 (DoF, 2015e).The gross value of Western Australia's fishery and aquaculture production was $490 million in 2015/16 (Mobsby, D and Koduah, A 2017).

State managed commercial fisheries are administered by the WA Department of Fisheries (DoF), so individual shapefiles for each fishery were sourced from them for this assessment.

The following State managed commercial fisheries are in the South West and South Coast zones:

- Abalone Managed Fishery;
- Finfish trapping in oceanic waters;
- Hardy Inlet Lawful Nets Order;
- Leatherjacket Fish Trapping, King George Sound;
- Mackerel Managed Fishery;
- Marine Aquarium Managed Fishery;
- Open Access South Coast Demersal Scalefish;
- Purse Seine Net Development Zone;
- South Coast Crustacean Managed Fishery;
- South Coast Estuarine Managed Fishery;
- South Coast Herring Trap Net Fishery;
- South Coast Open Access Netting Fishery;
- South Coast Salmon Fishery;
- South West Trawl Limited Entry Fishery;
- Specimen Shell Managed Fishery;
- Vasse and Wonnerup Netting Restrictions;
- West Coast Demersal Scalefish Fishery;
- West Coast Estuarine Fishery;
- West Coast Purse Seine Limited Entry Fishery; and
- Octopus Interim Managed Fishery.

The commercial information for each State managed commercial fishery includes data around its annual value in millions of dollars, unless three or less licences have been issued. In this case, the value is not publically available. This information is available in the DoF's Status of Fisheries Annual Reports. In the 2015-16 Annual Report, this was not reported for any of the fisheries, so the 2014-15 Annual Report was used.

Distribution

There are many smaller fisheries in the shoreline cells, which are a lower priority in terms of economic loss for the state of Western Australia. However, larger fisheries which would have a high impact on the economy of the state and which cover a larger number of shoreline cells are discussed below.

Abalone Managed Fishery income was $1.2M in 2014. The fishery operates in shallow coastal waters along WA's western and southern coasts. Roe's abalone is found in commercial quantities from the South Australian border to Shark Bay, although it is not uniformly distributed throughout this range. It would take 10-20 years to fully recover to natural levels, though it can translocate in some cases. For example, in Kalbarri after the 2011 heatwave that killed 99.9% of the population (Australian Seafood Cooperative Research Council, 2016). The Abalone Managed Fishery is distributed across all of the shoreline cells in Western Australia, including the South West and South Coast zones.

The Marine Aquarium Managed Fishery can target more than 950 species, however the number of species is often much lower. Operators are also permitted to take coral, live rock, algae, seagrass and invertebrates. Fishing is primarily dive-based using handheld nets in shallow water. It operates

throughout all WA coastal waters, with the effort spread over a total gazetted area of 20,781 km^2 in 2014-15 (DoF, 2015c). Over the past few years, the fishery has seen popular areas around the Capes region in the South West, Perth, Geraldton, Exmouth and Dampier. Catches are relatively low in volume due to the special handling requirements of live fish, but also often yield a higher value. Despite the South West Capes area being popular for this fishery, it has been ranked Low priority due to the broad number of species targeted and the large area where targeted species can be caught.

The South Coast Open Access Netting Fishery targets herring, trevally, garfish, King George whiting and other whiting species. The total annual open-access net catch recorded on the South Coast ranged from 18-323 tonnes between 2000 and 2013. The majority of open-access net catch recorded on the South Coast between 2000 and 2013 comprised of Australian herring (89.9%) and southern sea garfish (6%). Beach seine dominated South Coast open-access net catch between 2000 and 2013, however open-access gillnet catch has been higher than beach seine catches since 2011. This fishery is in all shoreline cells in the South West and South Coast zones, so has been ranked lower due to the large area covered.

Discussion

To determine the economic impact of an oil spill on a commercial fishery, fish stock recovery time was assessed to determine the overall impact of an oil spill on the fish stock, and the net loss the fishery would encounter as a result.

The recovery time of fish and crustacean fishing stocks depends on the lifecycle of the catch, as well as the form of impacting oil. A fishery will not be affected greatly by floating oil but will be affected by dissolved oil. Some stock will take two years or more to recover, such as lobsters which take four years to reach maturity, in which case it will have an economic loss of more than one year, depending on the species.

Rankings by annual value have been indicated in Table 3-22, with recovery of fisheries also considered and ranked.

Based on these rankings, all shoreline cells in the South West and South Coast zones have been ranked Very Low for protection from both dissolved and floating oil due to the low economic income of the fisheries present.

Table 3-24: State Managed Commercial Fishing protection priority ranking

Value Measure	Ranking		Description
	Floating	Dissolved	
State Managed Fisheries			
>$1B (>0.5% of State GDP) Or $501M-$1B (0.25-0.5% of State GDP) and recovery of species is >11 years AND ten shoreline cells or less	4	5	State Managed Fisheries income is reported by the WA DoF per region per year. This has been coupled with the time for a species to recover, typically taken as number of years to reach maturity and reproduce, which allows sustainable commercial fishing to recommence. If the catch area (i.e. the area that catch is actually taken from in the license area) described in the Status of Fisheries report is greater than ten shoreline cells (the size of the smallest zone), then the ranking is lowered by one level.
$501M-$1B (0.25-0.5% of State GDP) and recovery of species is <10 years Or $101M-$500M (0.05-0.25% of State GDP) and recovery of species is >11 years AND ten shoreline cells or less Or >$1B (>0.5% of State GDP) Or $501M-$1B (0.25-0.5% of State GDP) and recovery of species is >11 years AND more than ten shoreline cells	3	4	
$101M-$500M (0.05-0.25% of State GDP) and recovery of species is <10 years Or $21M-$100M (0.01-0.05% State GDP) and recovery of species is >11 years AND ten shoreline cells or less Or $501M-$1B (0.25-0.5% of State GDP) and recovery of species is <10 years Or $101M-$500M (0.05-0.25% of State GDP) and recovery of species is >11 years AND more than ten shoreline cells	2	3	
$21M-$100M (0.01-0.05% State GDP) and recovery of species is <10 years Or <$20M (<0.01% State GDP) and recovery of species is >11 years AND ten shoreline cells or less Or $101M-$500M (0.05-0.25% of State GDP) and recovery of species is <10 years Or $21M-$100M (0.01-0.05% State GDP) and recovery of species is >11 years AND more than ten shoreline cells	1	2	
<$20M (<0.01% State GDP) and recovery of species is <10 years	1	1	

Data List

- DoF (5 May 2017)

3.4.3 Commonwealth Managed Fisheries

Description

Commonwealth fisheries contributed approximately $400 million in gross value of product to Australia in 2015-16 (AFMA, 2016). The fisheries are typically in commonwealth waters (from the state waters boundary to the Exclusive Economic Zone, 200 nautical miles from land), and administered by the federal Australian Fishing Management Authority (AFMA).

The permit area for each fishery is often a very large portion of Australia's Exclusive Economic Zone, so the area of concentrated fishing effort for each fishery has been obtained from AFMA for the years of 2000 to 2015. This data allows a smaller area of economic importance to be identified for the fishery, rather than the entire permit area.

There are five Commonwealth managed fisheries which occur in either or both of the South West and South Coast zones. These are:

1. Western Tuna and Billfish Fishery;
2. Skipjack Tuna Fishery;
3. Southern Bluefin Tuna Fishery;
4. Small Pelagic Fishery;
5. Southern and Eastern Scalefish and Shark Fishery; and
6. Western Rock Lobster Fishery

Distribution

The Western Tuna and Billfish Fishery licence area covers all commonwealth waters west of the northern tip of Queensland, covering all Northern Territory waters, and all WA waters and the commonwealth waters off South Australia. The fishery targets striped marlin, swordfish, albacore, bigeye tuna and yellowfin tuna, however, economic surveys have not been conducted for this fishery since 2001-02 because of the low level of fishing activity. During 2014 and 2015, 95 fishing permits were issued, but only three vessels were active in 2015 with a total catch of only 440 tonnes. The areas of concentrated fishing effort between 2000 and 2015 for these fisheries were Shoreline Cells 207, 212 to 226 and 338 in the South West zone, and Shoreline Cells 227 to 232, 236 to 243, 247 to 257 and the island Shoreline Cells 339 to 349 in the South Coast zone.

The Skipjack Tuna Fishery covers the entire sea area around Australia, out to 200 nm from the coast. It is split into two sectors: the Eastern Skipjack Tuna Fishery; and the Western Skipjack Tuna Fishery. There has been no fishing effort in either of the skipjack tuna fisheries since the 2008-09 fishing season, due to the variability in the availability of stock and the prices received for the product.

The Southern Bluefin Tuna Fishery covers the entire sea area around Australia, out to 200 nm from the coast. They are most commonly caught off the New South Wales and South Australia coastline, and no areas of concentrated fishing effort overlap with any shoreline cells in the South West or South Coast zones.

The Small Pelagic Fishery extends from southern Queensland to southern Western Australia. Species targeted in this fishery include Australian sardine, blue mackerel, jack mackerel and redbait. Some of these species can also be taken in the Western Tuna and Billfish Fishery. The real value is confidential, however the predominant areas of fishing effort are off the east and west coasts of Tasmania. Some areas of effort have been recorded in Shoreline Cells 236 to 243 and 339 to 342.

The Southern and Eastern Scalefish and Shark Fishery was the second largest Commonwealth fishery in terms of production value, accounting for 20 per cent of the gross value of product (GVP) of Commonwealth fisheries in the 2014-15 fishing year (ABARES, 2016). The fishery brought in $68 M in the 2014-15 financial year, a decrease from $72.2 M in 2013-14. The fishery targets a variety of fish, squid and shark as it is an amalgamation of four fisheries: the South East Trawl; Great Australian Bight Trawl; Southern Shark Non-Trawl; and South East Non-Trawl. It covers the southern waters from Cape Leeuwin in the west through the Great Australian Bight, to north of Brisbane off the Queensland coast. The area of concentrated fishing effort for this fishery overlaps Shoreline Cells 236 to 243 and 339 to 342, all in the South Coast zone.

The West Coast Rock Lobster Fishery targets the western rock lobster, on the west coast of WA between Shark Bay and Cape Leeuwin, using baited traps (pots) (DoF, 2015c). The West Coast Rock Lobster Fishery is an important sector of the WA economy, with the commercial catch from the current reporting season valued ex-vessel at $359M. Employment is now year round. During the year, four main processing establishments, located in the Perth metropolitan area (two), Geraldton (one) and Cervantes (one), service practically every location where fishing occurs (DoF, 2015c). The rock lobster matures at six to seven years old, so is expected to take 12-15 years to recover. The West Coast Rock Lobster Fishery is distributed across half of the shoreline cells in the South West zone.

Discussion

Using the rankings from Table 3-25, all shoreline cells in the South West zone have been given a protection priority ranking of Very Low for protection from both floating and dissolved oil, due to the presence of Commonwealth managed fisheries, except for the West Coast Rock Lobster Managed Fishery and the Southern and Eastern Scalefish and Shark Fishery.

The Southern and Eastern Scalefish and Shark Fishery, while it is worth $21 M-$100 M annually, targets a wide variety of species with various recovery times. It is therefore not considered as high risk, as there are multiple species to target. Shoreline Cells 236 to 243 and 339 to 342 in the South Coast zone have therefore been ranked Very Low for protection from floating oil and Low for protection from dissolved oil.

The Skipjack Tuna Fishery has had no fishing effort in the last eight years, so shoreline cells in the South West or South Coast zones have been ranked Very Low for protection from both floating and dissolved oil for this fishery.

The Southern Bluefin Tuna Fishery has no areas of concentrated fishing effort which overlap with any shoreline cells in the South West or South Coast zones. Therefore no shoreline cells have been ranked for protection for this fishery.

The Small Pelagic Fishery has had low fishing effort in the South West or South Coast zones. Therefore, these zones have been ranked Very Low for protection from both floating and dissolved oil for this fishery.

The West Coast Rock Lobster Managed Fishery overlaps with shoreline cells 208-217 in the South West zone. These shoreline cells have been ranked Low for protection from floating oil and Medium for protection from dissolved oil, using the rankings in Table 3-25.

Table 3-25: Commonwealth Managed Fisheries protection priority ranking

Value Measure	Ranking		Description
	Floating	Dissolved	
Commonwealth Managed Fisheries			
>$1B (>0.5% of State GDP) Or $501M-$1B (0.25-0.5% of State GDP) and recovery of species is >11 years	4	5	Commonwealth Managed Fisheries income is reported by the Australian Fisheries Management Authority (AFMA) annually. This has been coupled with the time for a species to recover, typically taken as number of years to reach maturity and reproduce, which allows sustainable commercial fishing to recommence. Effort of fishing has also been provided by AFMA on a 10 km by 10 km grid for each fishery.
$501M-$1B (0.25-0.5% of State GDP) and recovery of species is <10 years Or $101M-$500M (0.05-0.25% of State GDP) and recovery of species is >11 years	3	4	
$101M-$500M (0.05-0.25% of State GDP) and recovery of species is <10 years Or $21M-$100M (0.01-0.05% State GDP) and recovery of species is >11 years	2	3	
$21M-$100M (0.01-0.05% State GDP) and recovery of species is <10 years Or <$20M (<0.01% State GDP) and recovery of species is >11 years	1	2	
<$20M (<0.01% State GDP) and recovery of species is <10 years	1	1	

Data List

- Fishing effort for Western Tuna and Billfish Fishery (March 2016)
- Fishing effort for Western Skipjack Tuna Fishery (March 2016)
- Fishing effort for Southern Bluefin Tuna Fishery (March 2016)
- Fishing effort for Small Pelagic Fishery (March 2016)
- Fishing effort for Southern Squid Jig Fishery (March 2016)
- Fishing effort for Southern and Eastern Scalefish and Shark Fishery (March 2016)
- Commonwealth Managed Fisheries concentrated areas of fishing effort and fishery status report (AFMA, 2016)

3.4.4 Ports and Shipping

Description

Ports are used to import and export goods, and generate substantial economic income for WA. WA's exports accounted for more than 876 million tonnes in 2015-16, which accounted for 41 per cent of Australia's merchandise exports that year (DoT, 2016). Exports to China alone were worth $54.1 billion.

Western Australia's trading ports are managed by either port authorities governed by the *Port Authorities Act 1999* or non-port authorities ports governed by the *Shipping and Pilotage Act 1967* and the *Marine Harbours Act 1981*. The boundaries for each port were sourced from the WA DoT.

Shipping channels have not been included in this assessment. They are primarily in open ocean, so are not captured in the shoreline cells. In addition, vessels can generally manoeuvre around a spill, so their impact is difficult to quantify. However, where a shipping channel enters a port, this has been included in the assessment.

Distribution

Bunbury Port is in the South West zone, in Shoreline Cell 208. In 2015 it reported a tonnage throughput of 16.25 million tonnes.

Within the South Coast zone there are two ports, which are Albany and Esperance. Albany, located in Shoreline Cell 231, has a throughput of 4.6 million tonnes which is much smaller than Esperance, located in Shoreline Cells 248 and 249, which reported a tonnage throughput of 15.3 million tonnes.

Discussion

Ports are used to import and export goods. The impact of an oil spill on ports relates to the safety requirement to reduce or cease operating to allow spill recovery activities to occur. This results in a direct net loss to the operators in a port. Economic impact to a port has been based on the annual tonnage of throughput, as the economic values are not publically available for all ports in Western Australia. The annual reports are based on tonnes of export and import. The commercial significance based on tonnage throughput is presented in Table 3-26.

The two largest ports (Bunbury and Esperance) have been given the highest ranking for protection priority for economic reasons, due to the value of their export. They are ranked a medium for floating and dissolved oil. Albany was ranked the lowest in these zones, with the lowest tonnage throughput and is ranked a low for floating and dissolved oil.

Table 3-26: Ports protection priority ranking

Value Measure	Ranking		Main Factors Considered in Ranking
	Floating	Dissolved	
Ports			
>401 million tonnes annually	5	5	**Importance:** Significant import and export for the state, resulting in an estimated very high economic value equivalent to >$1B annually, in line with Table 3-22.
101-400 million tonnes annually	4	4	**Importance:** Major import and export for the state, resulting in an estimated high economic value equivalent to $501M-$1B annually, in line with Table 3-22.
11-100 million tonnes annually	3	3	**Importance:** Medium import and export for the state, resulting in an estimated moderate economic value equivalent to $101M-$500M annually, in line with Table 3-22.
1.1-10 million tonnes annually	2	2	**Importance:** Minor import and export for the state, resulting in an estimated low economic value equivalent to $101M-$500M annually, in line with Table 3-22.
<1 million tonnes annually	1	1	**Importance:** Very minor import and export for the state, resulting in an estimated very low economic value equivalent to <$20M annually in line with Table 3-22.

Data List

- Southern Ports Authority Annual Report (2016)
- DPI Port Authorities (October 2010)

3.4.5 Water Intake Locations

Description

In some industries, seawater is sucked from the ocean for various processes. These include potable water created via reverse osmosis, cooling water for large machinery, and fresh seawater for aquaculture. Oil sucked into an intake can damage the operating facility and, depending on the facility, this damage could be significant. The DoT has created a dataset of known locations of prescribed premises that intake ocean water. The dataset includes locations of known major outfalls and proposed major industrial developments that may require seawater intakes.

This dataset has been supplemented with DoF aquaculture and research facility seawater intake locations.

In this assessment, only intake locations were deemed to be potentially affected by an oil spill, so outfalls have not been included in this assessment.

Distribution

There are three saltwater intake areas in the Albany Aquaculture Park for the WA Shellfish Hatchery, in Shoreline Cell 231.

There are three desalination plant intakes in Shoreline Cell 207 which are associated with Water Corporation's Binningup desalination plant.

Discussion

Water intakes will generally stop operating to limit the impact the oil spill will have on their facility. While the intake locations are fixed and are impacted equally by floating oil and dissolved oil, the scale of the impact is very low due to the likely dilution and monitoring processes in place at these facilities.

A reverse osmosis desalination plant may be able to stop pumping for a time. The production loss is not readily quantified, however their repair and maintenance as a result of oil impact is substantial. These have been given the highest ranking for water intakes, with a High for protection from floating oil and a Very High for protection from dissolved oil impact. The desalination plant intake in Shoreline Cell 207 has been given this protection priority.

The saltwater intakes for the Albany Aquaculture Park in Shoreline Cell 231 have been ranked Low for protection from both floating and dissolved oil.

Table 3-27: Seawater Intake Locations protection priority ranking

Value Measure	Ranking		Main Factors Considered in Ranking
	Floating	Dissolved	
Water Intake Locations			
Reverse osmosis potable water plant seawater intakes	4	5	**Importance:** The seawater intake points in WA are positioned at the mid water depth and normally offshore so as to reduce the potential for an oil slick to be drawn in. These intakes can be shut down and rely on dams to supply product for short periods, however, they are very vulnerable to oil destroying the membranes. It is estimated that it will cost $20M-$100M to replace all membranes in a reverse osmosis plant, and cost the State many more millions of dollars to source drinking water while it is being replaced.
Cooling water intakes for power stations	3	3	**Importance:** Cooling water intakes are far less sensitive and can keep running during light oiling. Where they are at the surface, a boom around the intake would be enough to keep them running; where they are below the surface, it is assumed that the dissolved or entrained oil would be at a low enough concentration that they can keep running.
Salt works seawater intakes	2	2	**Importance:** If an oil spill occurred, salt water intake would cease and production would stall until the potential for contamination had passed. A salt works facility has detectors on the intakes to screen for any contamination, to allow pumping into the evaporation ponds to cease and not contaminate the salt being produced.
Aquaculture seawater intakes	2	2	**Importance:** Onshore aquaculture facilities would lose their stock. This is expected to have a 'low' economic impact as the onshore aquaculture facilities are small.
Seawater intakes for LNG facilities	2	2	**Importance:** These are proposed intakes only and not operational, so have been ranked lower than operational cooling water intakes. LNG facilities use sea water for cooling. Cooling water intakes are less sensitive and can keep running during light oiling. Where they are at the surface, a boom around the intake would be enough to keep them running; where they are below the surface, it is assumed that the dissolved or entrained oil would be at a low enough concentration that they can keep running.

Data List

- OSRA seawater intake locations and types (April 2011)
- DoF Aquaculture and research facility intake and outfall locations (December 2016)

3.4.6 Other Commercial Operations

A number of other commercial operations occur in WA state waters and near the coast. This includes oil and gas operations, salt works, power stations and mining facilities. Subsea pipelines have not been included in this assessment as their operation is not expected to be affected by an oil spill.

Oil and gas facilities in state waters may experience economic loss through a safety requirement to shut facilities if an unrelated oil spill enters their operational zone. Offshore oil and gas facilities have not been included as they do not fall in the shoreline cells, however associated infrastructure aspects are included (see Section 2.5 for further information).

Other commercial operations such as salt works and power stations have been accounted for through their infrastructure associated with the marine environment, which are port facilities and seawater intakes. Refer to Section 3.4.4 and Section 3.4.5. Salt works are covered under seawater intakes, as are power stations and other facilities that use seawater either in a cooling process or for other purposes.

It was not feasible to capture proposed (future) oil and gas developments in this study because there was no way to determine the scale of the impact and thus determine a protection priority ranking.

3.4.7 Tourism

Description

Tourism is a key economic driver, generating more than 97,000 jobs and injecting $10 billion into the Western Australian economy by Gross State Product (Tourism WA, 2016). Coastal and waters tourism is a significant portion of this income due to the majority of the towns, infrastructure and sites located along the coast. A distinction has been made in this assessment between activities that draw tourists to a site and generate economic income, and those activities undertaken by locals for recreational purposes. This section assesses activities that generate economic income via tourist activities in the South West and South Coast zones such as:

- Whale and dolphin watching;
- Scuba diving and snorkelling;
- Beach activities such as surfing;
- Sailing; and
- Hotel revenue.

Tourism Research Australia (TRA) publishes data annually on the income from tourism (TRA, 2016). In August 2016, Tourism Research Australia released an update for 2014-15 on the Tourism Satellite Account (TSA).

A TSA is a set of statistical tables, based on data from the Australian Bureau of Statistics, which measure the contribution of tourism to the Australian economy. The TSA reports the contribution of tourism to the economy in relation to total output, value added and employment. TSAs need to be developed because there is no tourism 'industry' identified in the current national accounting framework.

Data for income from tourism is available per Local Government Area tourism region. In the South West and South Coast zones, the following regions have been assessed:

- Albany;
- Augusta/Margaret River;
- Bunbury;
- Busselton;
- Denmark;
- Dundas;
- Esperance;
- Harvey; and
- Manjimup.

No information for tourism was available for the following regions:

- Capel;
- Dardanup;
- Narnup;
- Jerramungup; and
- Ravensthorpe.

Distribution

The contribution from tourism ranges from less than $15 million per annum in Dundas to $453 million per annum in the Busselton area. The total revenue from tourism in Western Australia is $10,954 million, of which 14.6% comes from the South West and South Coast zones (TRA, 2016).

Discussion

To produce an opportunity cost for tourism to include in this assessment, the value of the tourism in millions of dollars per annum has been assigned to the shoreline cell where each of the major centres are located in the regions. Realistically, in an oil spill, the impact on tourism is expected to be locally restricted to the shoreline cell where the impact occurs. It is important to identify the shoreline cells which contribute to the economy via tourism and thus be aware that, when planning a response to an oil spill, secondary impacts to tourism may be the result. The rankings for protection priority are presented in Table 3-28.

Based on these rankings, most shoreline cells in the South West and South Coast zones have been ranked Very Low for protection from both floating and dissolved oil, as each shoreline cell in the zones provides a fairly minor portion of the state's tourism.

Table 3-28: Tourism protection priority category

Tourism Area	Ranking		Main Factors Considered in Ranking
	Floating	Dissolved	
Tourism Region key population centre >10% of State income from tourism	3	3	Income from tourism as a proportion of the state-wide tourism revenue is greater than 10%, indicating a significant contribution by tourism in that shoreline cell.
Tourism Region key population centre 5-10% of State income from tourism	2	2	Income from tourism as a proportion of the state-wide tourism revenue is 5-10%, indicating a significant contribution by tourism in that shoreline cell.
Tourism Region key population centre <5% of State income from tourism	1	1	Income from tourism as a proportion of the state-wide tourism revenue is less than 5%, indicating that the priority for protection at a state level is less than for other areas contributing more revenue.

Data List

- TRA 2016 for TSA boundaries and tourism statistics for 2015

3.5 Social, Amenity and Recreation

The social, amenity and recreational importance of an area has been assessed by considering:

- Town population;
- Recreational fishing/boating zones;
- Jetties, marinas and yacht clubs;
- Snorkelling sites; and
- Beaches.

The towns located in the South West and South Coast zones, along with their population size, are listed in Table 3-29. Towns have been ranked Very Low in this section.

Table 3-29: Towns in the South West and South Coast zones and their approximate populations

South West		South Coast	
Town	Population	Town	Population
Bunbury	~31,000	Albany	~34,000
Busselton	~36,000	Esperance	~10,000
Dunsborough	~4,000	Hopetoun	~1,000
Augusta	~1,300	Denmark	~3,000
Walpole	~500	Bremer Bay	~600
Myalup	~400	Eucla	~400
Binningup	~1,000		
Yallingup	~1,000		
Gracetown	~500		
Windy Harbour	~500		
Peaceful Bay	~350		

3.5.1 Recreational Fishing/Boating Zones

Description

Fishing and boating are key recreational activities undertaken in WA. These activities are often associated with marine management areas and marine parks. The marine park data has been sourced from the DotE CAPAD Marine dataset and an updated DPaW CAPAD dataset. These two datasets include areas in the marine park category, with designations including:

- Sanctuary Zones;
- Recreational Zones;
- Special Purpose Zones; and
- General Use Zones.

Distribution

In the South West and South Coast zones, there are several Commonwealth Marine Reserves (IUCN VI) which have designated fishing and boating zones. These include areas in the Geographe area (Shoreline Cells 209 to 212), south-west corner (Shoreline Cells 212 to 220, 224 to 226, 243 to 246 and 339), the Bremer region (Shoreline Cells 238 to 240), Eastern Recherche (Shoreline Cells 256 to 259 and 247 to 351), Twilight region (Shoreline Cells 267 to 270) and Great Australian Bight (Shoreline Cell 280). The Ngari Capes Marine Park designated fishing and boating zones are located between Shoreline Cells 209 and 218 in the South West zone. The Walpole-Nornalup Marine Park designated fishing and boating zones are located in Shoreline Cell 225, also in the South West zone. In the South Coast zone, the Far West Coast Marine Park designated fishing and boating zones are located in Shoreline Cell 280, the last cell before the South Australian border.

Discussion

The marine park and management areas are used for water-based recreational pursuits. The impact from an oil spill will be a tendency to avoid the area, with flow-on effects in local regional commercial benefit. Floating oil will visually detract from people pursuing fishing or water sports in these areas; dissolved oil may impact on species and decrease the catch for an area. The significance of an oil spill is largely related to the amount of oil which comes ashore and is present in the fishing and recreational zones, and its impact on visual amenity. The rankings for recreational fishing/boating zones are presented in Table 3-30.

Since these zones are generally smaller subsets located in a marine park category which is used for the full range of recreational pursuits, the category level has been assigned a relatively low weighting.

Table 3-30: Recreational Fishing/Boating Zones protection priority ranking

Value Measure	Ranking		Main Factors Considered in Ranking
	Floating	Dissolved	
Multi-Use Zones (for boating and fishing)			
Marine Management Areas	2	2	**Importance:** Floating oil will visually detract people from pursuing fishing in these areas. Dissolved oil may impact on species and decrease the fishing for an area.
Marine Parks	2	2	**Importance:** Floating oil will visually detract people from pursuing fishing in these areas. Dissolved oil may impact on species and decrease the fishing for an area.
Marine Nature Reserve	2	2	**Importance:** Floating oil will visually detract people from pursuing marine recreation in these areas. Dissolved oil may impact on species and decrease the fishing/species to observe, and the visual amenity of an area.

Data List

- DotE CAPAD Multi-user zones in marine management areas or marine parks (June 2014)
- DPaW CAPAD (June 2016)

3.5.2 Beaches

Description

WA has some of the most iconic beaches in Australia. From the unique Shell Beach at Monkey Mia in the north to the pure white sandy beaches near Esperance in the south, many people who live in WA choose to do so to be near the beach. Beaches are used for recreation, amenity and social events, and may be significant to local residents as well as tourists. The dataset for patrolled beaches in WA was obtained from Surf Life Saving WA, who provided annual visitor statistics of their patrolled beaches. However, in the South West and South Coast zones, the importance of beaches is not just based on the number of people who frequent them, but also their isolated and picturesque nature. For this reason, the list of top ten beaches in Western Australia by WA Tourism has been used as the main driver for ranking the beaches in these zones.

The protection priority of beaches associated with tourism has been captured indirectly in Section 3.4.7. Tourism is where the experience associated with a major centre includes experiences associated with beach-based activities (e.g. fishing from shore).

The beaches in the Coastal Landforms dataset from the DMP were used to identify 'sandy' in the shoreline geomorphology, because the more popular beaches tend to be those with wide sandy beaches (i.e. fine- to medium-grained sand beaches). This was used as a proxy for actual visitation data to identify shoreline cells with potentially popular beaches.

Distribution

Within the South West and South Coast zones, there are five beaches ranked by Tourism WA in the top ten beaches in Western Australia. In the South West zone, these are Yallingup Beach (Shoreline Cell 213) and Redgate Beach (Shoreline Cell 215) in the Margaret River region. In the South Coast zone, these beaches are Greens Pool and Elephant Cove at Denmark (Shoreline Cell 227), Little Beach in Two Peoples Bay at Albany (Shoreline Cell 232), and Lucky Bay at Esperance (Shoreline Cell 251).

Several beaches also had recorded attendance of more than 100,000 visitors, including Smiths Beach, Yallingup, Meelup and Bunker Bay, all in the Margaret River/Busselton/Dunsborough region in the South West zone.

Shoreline cells around towns also include a number of other beaches in the DMP Coastal Landforms dataset.

Discussion

Beaches in the context of social aspects are mainly used for recreation, and may be significant to local residents as well as tourists. The dataset regarding number of visitors for patrolled beaches was obtained from Surf Life Saving WA, which included several beaches in the South West and South Coast zones.

There are no 'Blue Flag' beaches in Australia (Denmark, 2016), and there is no standardised system for ranking beaches in Australia in terms of amenity, patronage and popularity.

Priority has been ranked based on the number of people that visit the beach. As the estimated number of visitors was not provided for all beaches and, in the South West and South Coast zones, the importance of beaches is also due to their isolated and picturesque nature, the top ten beaches by Tourism WA has been used as the main driver for ranking the beaches in these zones.

Shoreline cells with beaches near towns have also been ranked Low for protection from dissolved oil and Very Low for protection from floating oil based on Table 3-31.

All other beaches listed in shoreline cells have been ranked Very Low for protection from both dissolved and floating oil based on Table 3-31.

Table 3-31: Beaches protection priority ranking

Value Measure	Ranking		Main Factors Considered in Ranking
	Floating	Dissolved	
Beaches			
Beaches with >1 million visitors a year Or, in the South West and South Coast zones, in the Top Ten Beaches by Tourism WA	3	2	**Importance:** The ranking is based on the amenity impact of floating oil being more socially unacceptable and more visually impacting than dissolved oil.
Beaches with >100,000 visitors a year Or, in the South West and South Coast zones, beaches in the vicinity of a town	2	1	
Beaches with 100,000 visitors a year And all other beaches along the South West and South Coast zones	1	1	

Data List

- Top ten beaches, Western Australia (www.westernaustralia.com, 2016)
- Surf Life Saving patrolled beaches (2016)
- DMP Coastal Landforms dataset (May 2016)

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4 Summary of Protection Priority Rankings

The following tables summarise the value indicators (e.g. threatened mammals, marine protection areas, commercial fishing areas, etc.) used for each of the five categories for floating hydrocarbons (Table 4-1) and dissolved hydrocarbons (Table 4-2). They illustrate the comparative protection priorities between the five categories for the shoreline cells.

Table 4-1: Summary of value indicators and their protection priority for floating hydrocarbons

	Very Low	Low	Medium	High	Very High
Protected Fauna	▪ CR species if extinct (birds, mammals, invertebrates, reptiles) ▪ Normal range for EN species (fish) ▪ Normal range for VU, Migratory or Marine species (mammals and fish) ▪ All areas Known for VU species (invertebrates) ▪ All other conservation codes (birds) ▪ Terrestrial species which do not use the coastal zone for any instance of their life cycle and do not use the coastal zone as any component of their habitat.	▪ Known/migration area for CR species which are Very Certain or Moderately Certain (birds, mammals) ▪ Normal range for EN species (birds, mammals and terrestrial invertebrates) which are Moderately Certain ▪ Normal range for VU, Migratory or Marine species (birds, furry marine mammals) which is Certain or Moderately Certain ▪ Breeding/aggregation area for VU, CD and P1-P4 Migratory or Marine species and normal range for CR species (fish) Certain ▪ Foraging and inter-nesting for VU species (Certain) and all Migratory and Marine species and all CD, P1-P4 species (invertebrates, reptiles) Certain and Moderately Certain	▪ Likely/Moderately Certain habitat for CR species. Breeding areas for EN species (birds) if Moderately Certain ▪ Breeding/aggregation for VU species if sighting Very Certain (birds) ▪ Breeding/aggregation area for VU, normal range for CR species (mammals, furry marine mammals and terrestrial invertebrates) Certain and Moderately Certain ▪ Normal range for EN species (furry marine mammals) ▪ Southern right whale – all calving/breeding information ▪ Breeding/aggregation area for CR species (fish) Moderately Certain and EN species Very Certain or Certain ▪ Foraging and inter-nesting for EN species and nesting/breeding area for VU species (reptiles) Certain or Very Certain	▪ Known habitat for CR species. Breeding area/migration route for EN species (birds) and sighting is Certain ▪ Breeding/aggregation area for EN species (birds, mammals, furry marine mammals and terrestrial invertebrates) is caught/trapped or sighting Very Certain or Certain ▪ Normal range for CR species (furry marine mammals) and Certain or Very Certain ▪ Foraging and inter-nesting for CR species and nesting/breeding area for EN species (reptiles) Certain or Moderately Certain ▪ Breeding/aggregation area for CR species (fish) and caught, trapped or sighted and Certain/Very Certain	▪ Breeding area for CR species (birds and terrestrial invertebrates) which are caught/trapped and sighting is Very Certain/WAM Vouchered/ Certain ▪ Breeding/calving/ congregation aggregation area for CR species (mammals and furry marine mammals) Certain and Very Certain ▪ Nesting/breeding area for CR species (reptiles) where sighting is Very Certain
Protection Areas	▪ ESI 1 and 2: 1A Exposed rocky shore; 1B Exposed, solid man-made structures; 1C Exposed rocky cliffs with boulder talus base; 2A Exposed wave-cut platforms in bedrock, mud or clay; 2B Exposed scarps and steep slopes in clay; 9A Sheltered tidal flats with <1,000 ha per shoreline cell ▪ All terrestrial and marine conservation areas and proposed conservation areas ranked IUCN VI: 5(1)(g) reserves; 5(1)(h) reserves; Miscellaneous reserves which do not include the intertidal zone ▪ Shoreline types: Exposed rocky shore; Exposed, solid man-made structures; Exposed rocky cliffs with boulder talus base; Exposed wave-cut platforms in bedrock, mud or clay; Exposed scarps and steep slopes in clay ▪ Algae and filter feeding communities	▪ ESI 3, 4, 5 and 6: 3A Fine- to medium-grained sand beaches; 3B Scarps and steep slopes in sand; 4 Coarse-grained sand beaches; 5 Mixed sand and gravel beaches; 6A Gravel beaches (granules and pebbles); 6B Riprap structures and gravel beaches (cobbles and boulders) ▪ CAMRIS marc, calcareous clay, gravel, sand silt, mud pelagic clay and volcanic grit; 10D Mangroves <1,000 ha per shoreline cell; 9A Sheltered tidal flats with between 1,000 ha and 3,000 ha per shoreline cell ▪ All terrestrial and marine conservation areas and proposed conservation areas ranked IUCN II, III, IV or V which do not include the intertidal zone ▪ All terrestrial and marine conservation areas and proposed conservation areas ranked IUCN VI, 5(1)(g) reserves; 5(1)(h) reserves; Miscellaneous reserves which include the intertidal zone ▪ Seagrass ▪ Fish habitat protection areas ▪ Key ecological features	▪ ESI 7, 8 and 9: 7 Exposed tidal flats; 8A Sheltered scarps in bedrock, mud or clay and sheltered rocky shore; 8B Sheltered, solid man-made structures; 8C Sheltered riprap; 8D Sheltered rocky rubble shores; 8E Peat shorelines; 9A Sheltered tidal flats >3,000 ha per shoreline cell; 9B Vegetated low banks; 9C Hypersaline tidal flats; 10D Mangroves with between 1,000 and 3,000 ha per shoreline cell ▪ All terrestrial and marine conservation areas and proposed conservation areas IUCN IA, IB which do not include the intertidal zone ▪ All terrestrial and marine conservation areas and proposed conservation areas ranked IUCN II, III, IV or V which include the intertidal zone ▪ Coral	▪ ESI 10: 10A Salt and brackish water marshes; 10B Freshwater marshes; 10C Swamps; 10D Mangroves with >3,000 ha per shoreline cell ▪ All terrestrial and marine conservation areas and proposed conservation areas IUCN IA or IB which include the intertidal zone ▪ A-class reserve vested under the *Fish Resource Management Act 1994* ▪ Nationally Important wetlands ▪ Areas closed under the *Fish Resources Management Act 1994*	▪ Ramsar wetlands

	Very Low	Low	Medium	High	Very High
Cultural Heritage		▪ State protected shipwrecks	▪ Commonwealth National Indigenous and historic heritage places and Natural heritage places ▪ State heritage protected places ▪ Commonwealth Maritime Cultural Heritage	▪ Commonwealth National and Indigenous and historic heritage places and Natural heritage places	▪ World Heritage areas
Economic	▪ Aquaculture licensed areas ▪ Ports throughput <1 million tonnes annually ▪ <$20M (<0.01% State GDP) and recovery of species is <10 years ▪ All other fisheries ▪ Commonwealth managed fisheries ▪ Majority of State managed commercial fishing locations ▪ Tourism Region key population centre <5% of State income from tourism	▪ Ports throughput 1.1-10 million tonnes annually ▪ $101M-$500M (0.05-0.25% of State GDP) and recovery of species is <10 years; OR $21M-$100M (0.01-0.05% State GDP) and recovery of species is >11 years AND ten shoreline cells or less; OR $501M-$1B (0.25-0.5% of State GDP) and recovery of species is <10 years; OR $101M-$500M (0.05-0.25% of State GDP) and recovery of species is >11 years AND more than ten shoreline cells are aquaculture licence areas ▪ Intake locations for saltworks/ aquaculture seawater intakes ▪ Tourism Region key population centre 5-10% of State income from tourism	▪ Ports throughput 11-100 million tonnes annually ▪ $501M-$1B (0.25-0.5% of State GDP) and recovery of species is <10 years; OR $101M-$500M (0.05-0.25% of State GDP) and recovery of species is >11 years AND ten shoreline cells or less; OR >$1B (>0.5% of State GDP); OR $501M-$1B (0.25-0.5% of State GDP) and recovery of species is >11 years AND more than ten shoreline cells ▪ Cooling water intakes for power stations ▪ Tourism Region key population centre >10% of State income from tourism	▪ Ports throughput 101-400 million tonnes annually ▪ >$1B (>0.5% of State GDP) OR $501M-$1B (0.25-0.5% of State GDP) and recovery of species is >11 years AND ten shoreline cells or less ▪ Reverse osmosis potable water plant seawater intakes	▪ Ports throughput >401 million tonnes annually
Social, Amenity and Recreation	▪ Beaches with 100,000 visitors a year or less	▪ Marine Parks, Marine Management Areas and Marine Nature Reserve ▪ Beaches with >100,000 visitors a year or beaches in a town region	▪ Beaches with >1 million visitors a year or in the Top Ten beaches of Western Australia		

Table 4-2: Summary of value indicators and their protection priority for dissolved hydrocarbons

	Very Low	Low	Medium	High	Very High
Protected Fauna	▪ Other Known areas for VU, CR, EN species (birds) if Moderately Certain ▪ Southern right whale: all calving information ▪ Normal range for EN species and normal range for VU, Migratory or Marine species (mammals and fish) ▪ Normal range for VU (furry marine mammals) ▪ All areas for terrestrial invertebrates ▪ Foraging and inter-nesting for VU species and all Migratory and Marine species (reptiles) ▪ CR species if extinct (birds, mammals, invertebrates, reptiles, fish) ▪ Terrestrial species which do not use the coastal zone for any instance of their life cycle and do not use the coastal zone as any component of their habitat.	▪ Known habitat for CR species, Moderately Certain. Breeding area for VU, EN species Very Certain (birds) ▪ Southern right whale – all calving/breeding information ▪ Normal range for CR species. Breeding area for VU species (mammals and fish) Certain or Moderately Certain ▪ Normal range for EN species. Breeding/aggregation areas for VU (furry marine mammals, fish) Certain or Moderately Certain ▪ Nesting/breeding area for VU species (reptiles, fish) Certain, Moderately Certain	▪ Known habitat for CR species. Breeding areas for EN species (birds) ▪ Breeding/aggregation area for EN species (mammals, furry marine mammals and fish) Very Certain, Certain ▪ Known habitat for CR species migration or foraging Moderately Certain to occur (Fish) ▪ Normal range for CR species (furry marine mammals) Known or Very Certain ▪ Foraging and inter-nesting for CR species and nesting/breeding area for EN species (reptiles) Certain or Very Certain	▪ Breeding and nesting area for CR species (birds, mammals, furry marine mammals) which are Certain ▪ Nesting/breeding area for CR species (reptiles) Certain or Very Certain Breeding and EN species (fish) Very Certain	▪ Known habitat for CR species breeding, congregation Caught or Certain (fish)

	Very Low	Low	Medium	High	Very High
Protection Areas	▪ ESI 1 and 2: 1A Exposed rocky shore; 1B Exposed, solid man-made structures; 1C Exposed rocky cliffs with boulder talus base; 2A Exposed wave-cut platforms in bedrock, mud or clay; 2B Exposed scarps and steep slopes in clay; 9A Sheltered tidal flats with <1,000 ha per shoreline cell ▪ All terrestrial conservation areas and proposed conservation areas as defined under the WA *Conservation and Land Management Act 1984* ranked IUCN VI (Managed Resource Protected Area) and all other types: 5(1)(g) reserves; 5(1)(h) reserves; Indigenous protected areas; Miscellaneous reserves ▪ All terrestrial conservation areas and proposed conservation areas as defined under the WA *Conservation and Land Management Act 1984* ranked IUCN VI (Managed Resource Protected Area) and all other types: 5(1)(g) reserves; 5(1)(h) reserves; Indigenous protected areas; Miscellaneous reserves ; *Includes in the intertidal zone* ▪ Shoreline types: Exposed rocky shore; Exposed, solid man-made structures; Exposed rocky cliffs with boulder talus base; Exposed wave-cut platforms in bedrock, mud or clay; Exposed scarps and steep slopes in clay ▪ Algae and filter feeding communities	▪ ESI 3, 4, 5 and 6: 3A Fine- to medium-grained sand beaches; 3B Scarps and steep slopes in sand; 4 Coarse-grained sand beaches; 5 Mixed sand and gravel beaches; 6A Gravel beaches (granules and pebbles); 6B Riprap structures and gravel beaches (cobbles and boulders) ▪ CAMRIS marc, calcareous clay, gravel, sand silt, mud pelagic clay and volcanic grit; 10D Mangroves <1,000 ha per shoreline cell; 9A Sheltered tidal flats with between 1,000 ha and 3,000 ha per shoreline cell ▪ All marine conservation areas and proposed conservation areas as defined under the WA *Conservation and Land Management Act 1984* ranked IUCN VI (Managed Resource Protected Area) and all other types: 5(1)(g) reserves; 5(1)(h) reserves; Indigenous protected areas; Miscellaneous reserves ▪ All terrestrial conservation areas and proposed conservation areas ranked IUCN II (National Park), III (National Monument), IV (Habitat/Species Management Area), V (Protected Landscape/Seascape) ▪ Algae and filter feeding communities	▪ ESI 7, 8 and 9: 7 Exposed tidal flats; 8A Sheltered scarps in bedrock, mud or clay and sheltered rocky shore; 8B Sheltered, solid man-made structures; 8C Sheltered riprap; 8D Sheltered rocky rubble shores; 8E Peat shorelines; 9A Sheltered tidal flats >3,000 ha per shoreline cell; 9B Vegetated low banks; 9C Hypersaline tidal flats; 10D Mangroves with between 1,000 and 3,000 ha per shoreline cell ▪ All terrestrial conservation areas and proposed conservation areas (conservation park, national park, nature reserve) ranked IUCN IA (Strict Nature Reserve) and IB (Wilderness Area) which includes the intertidal zone ▪ All marine conservation areas and proposed conservation areas (conservation park, national park, nature reserve) ranked IUCN IA (Strict Nature Reserve) and IB (Wilderness Area) , subtidal only ▪ All conservation areas and proposed conservation areas as defined under the WA *Conservation and Land Management Act 1984* ranked IUCN II (National Park), III (National Monument), IV (Habitat/Species Management Area), V (Protected Landscape/Seascape) ▪ Fish habitat protection areas ▪ Seagrass ▪ Key ecological features	▪ ESI 10: 10A Salt and brackish water marshes; 10B Freshwater marshes; 10C Swamps; 10D Mangroves with >3,000 ha per shoreline cell ▪ All marine conservation areas and proposed conservation areas (conservation park, national park, nature reserve) ranked IUCN IA (Strict Nature Reserve) and IB (Wilderness Area) which includes the intertidal zone ▪ A-class reserve under the *Fish Resource Management Act 1994* ▪ Nationally Important Wetlands ▪ Shoreline types: Sheltered scarps in bedrock, mud or clay and sheltered rocky shore; Sheltered, solid man-made structures; Sheltered riprap; Sheltered rocky rubble shores; Peat shorelines ▪ Coral ▪ Areas closed under the *Fish Resources Management Act 1994*	▪ Ramsar wetlands

	Very Low	Low	Medium	High	Very High
Cultural Heritage		▪ Indigenous and historic heritage places ▪ State protected maritime archaeology	▪ Commonwealth heritage places, National Indigenous and historic heritage places ▪ State protected heritage places ▪ Commonwealth Maritime Cultural Heritage	▪ National Heritage Properties, natural heritage places ▪ Commonwealth heritage places, natural heritage	▪ World Heritage areas
Economic	▪ Ports throughput <1 million tonnes annually ▪ <$20M (<0.01% State GDP) and recovery of species is <10 years ▪ Commonwealth managed fisheries ▪ Majority of State managed commercial fishing locations ▪ Many State and all Commonwealth managed fisheries locations ▪ Tourism Region key population centre <5% of State income from tourism	▪ Aquaculture licensed areas ▪ Ports throughput 1.1-10 million tonnes annually ▪ $21M-$100M (0.01-0.05% State GDP) and recovery of species is <10 years; OR <$20M (<0.01% State GDP) and recovery of species is >11 years AND ten shoreline cells or less; OR $101M-$500M (0.05-0.25% of State GDP) and recovery of species is <10 years; OR $21M-$100M (0.01-0.05% State GDP) and recovery of species is >11 years AND more than ten shoreline cells ▪ Aquaculture licence areas ▪ Water intake locations for aquaculture seawater intakes ▪ Tourism Region key population centre 5-10% of State income from tourism	▪ Ports throughput 11-100 million tonnes annually ▪ $101M-$500M (0.05-0.25% of State GDP) and recovery of species is <10 years; OR $21M-$100M (0.01-0.05% State GDP) and recovery of species is >11 years AND ten shoreline cells or less; OR $501M-$1B (0.25-0.5% of State GDP) and recovery of species is <10 years; OR $101M-$500M (0.05-0.25% of State GDP) and recovery of species is >11 years ▪ Cooling water intakes for power stations ▪ Tourism Region key population centre >10% of State income from tourism	▪ Ports throughput 101-400 million tonnes annually ▪ $501M-$1B (0.25-0.5% of State GDP) and recovery of species is <10 years; OR $101M-$500M (0.05-0.25% of State GDP) and recovery of species is >11 years AND ten shoreline cells or less; OR >$1B (>0.5% of State GDP) OR $501M-$1B (0.25-0.5% of State GDP) and recovery of species is >11 years AND more than ten shoreline cells ▪ Reverse osmosis potable water plant seawater intakes	▪ Ports throughput >401 million tonnes annually ▪ >$1B (>0.5% of State GDP); OR $501M-$1B (0.25-0.5% of State GDP) and recovery of species is >11 years AND ten shoreline cells or less
Social, Amenity and Recreation	▪ All town sites ▪ Beaches with <1 million visitors a year ▪ Beaches in the vicinity of a town and all other beaches	▪ Recreational fishing/boating zones ▪ Marine Parks, Marine Management Areas and Marine Nature Reserve ▪ Beaches with >1 million visitors a year or in the Top Ten Beaches of Western Australia			

5 Analysis Method

5.1 Overview of Multi-Criteria Analysis

Using a multi-criteria analysis approach, the data layers identified for inclusion have been assigned a ranking from one (Very Low priority) to five (Very High priority) for protection from the effects of both floating and dissolved hydrocarbons, as outlined in Section 3. These rankings have then been used to produce a map showing Very Low (dark green) to Very High (red) priorities of the shoreline cells for each category, for protection from both floating and dissolved hydrocarbons. Figure 5-1 illustrates the process. Each layer has been ranked, then combined to give an overall shoreline cell map showing the highest priority areas for protection.

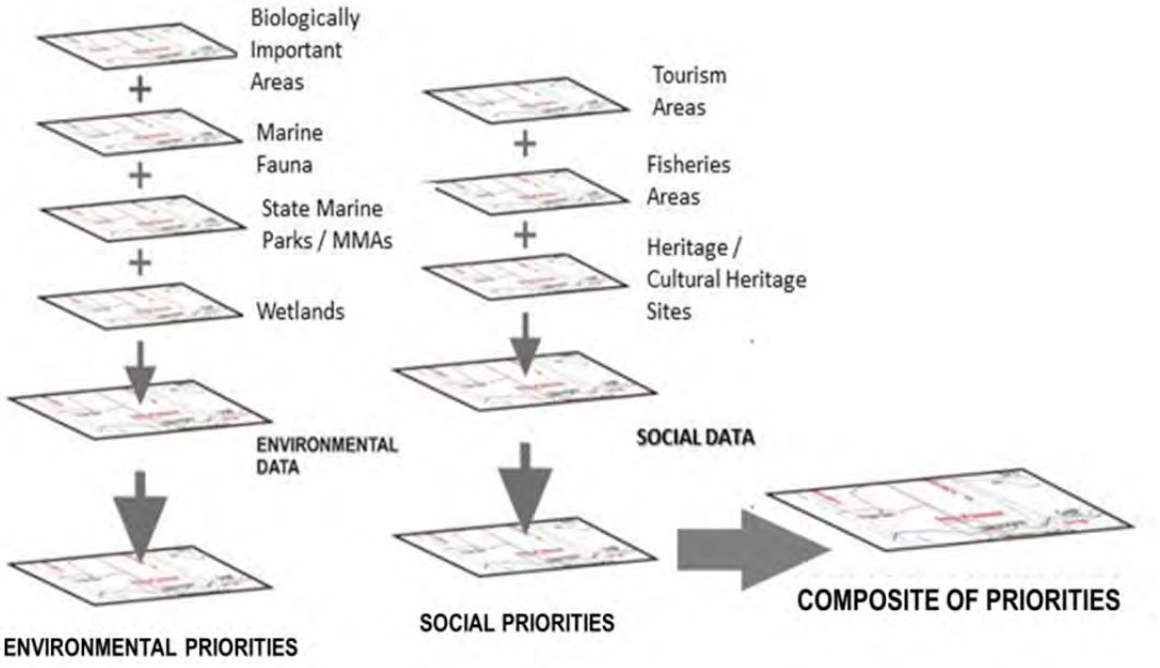

Figure 5-1: Example illustration of composite of ranked geospatial data

The map has been derived from the ranking information developed when weighting the criteria, including revised rankings developed during the State Wide Overview assessment. These define more detailed criteria for assigning protection priority rankings for Protected Fauna and Protection Areas categories data, to include more criteria. While the original weightings were agreed by the Steering Committee in the workshop held on 16 May 2016, the revised rankings have also been reviewed by the key Steering Committee members.

The weighted importance of all criteria has been ranked from Very Low to Very High, and the shoreline cell layer has been overlain and "clipped" or "cookie cut" to each shoreline cell, with the information extracted from the overall weighted layer and put into an attribute table (see Section 5.2).

The reasons this method was selected for this project were:

- Known and standard method previously used with success;
- Produces a single output for each overall highest priority ranking of 'floating oil', 'dissolved oil' and 'overall;
- Produces data identifying the shoreline cells with the highest protection priority and the identity of the aspect which caused the highest ranking; and
- No scripting in the geoprocessing is required to achieve this output.

The geoprocessing which occurred to collate the multiple shapefile attributes and assign the weightings identified were as follows:

1. For each of the shapefiles in a sub-category (e.g. all the shapefiles comprising 'Protected Fauna'), the weighting has been assigned in a new column and appended to each of the shapefiles.
2. The data in each of the sub-categories has been clipped to the shoreline cells' outlines, and processed per category (i.e. Protected Fauna, Protection Areas, etc.).
3. All the sub-categories contained in Protected Fauna have been combined into a newly created single Protected Fauna category shapefile, which is the same shape as the shoreline cell and assigned the weighting equal to the highest weighting.
4. The categories have all been treated this way until six new shapefiles were created in each shoreline cell representing Protected Fauna, Protection Areas, etc., all being categorised from Very Low to Very High.
5. This process has been repeated for floating oil and dissolved oil rankings for each category.
6. The overall ranking for each shoreline cell is the highest ranking value of any of the categories in each shoreline cell, identified for protection from 'floating oil' and 'dissolved oil'.

This has been used to create the map outputs as contained in Appendix A, as well as the attribute table containing the data pertaining to the highest ranked aspect from each category in each shoreline cell.

Three rankings for each category, for each cell, will be provided in the form of an attribute table to the Risk Consultant for inclusion in a WebMap Application. An extract from the first two shoreline cells in the attribute table is presented in Section 5.2.

5.2 Analysis Output: Attribute Table

The attribute table will be provided in Microsoft Excel format, with nine columns containing the following headings and information:

1. Shoreline Cell ID – Each shoreline cell has a unique identification number. This has been provided by Navigatus as an attribute in the 'WAMOPRA Coast Cells' shapefile dataset.
2. Category ID – There are six category rankings that will be provided for each shoreline cell. These are: Protected Fauna; Protection Areas; Cultural Heritage; Economic; Social, Amenity and Recreation; and Overall. These have been given a number from one to six.

3. Category Name – There are six categories: Protected Fauna; Protection Areas; Cultural Heritage; Economic; Social, Amenity and Recreation; and Overall.
4. Floating Ranking – This is the overall ranking from one to five of the single highest ranked protection priority at risk from being impacted by floating hydrocarbons in each shoreline cell. This ranking has been assessed and a ranking assigned for each category.
5. Dissolved Ranking – This is the overall ranking from one to five of the single highest ranked protection priority at risk from being impacted by dissolved hydrocarbons in each shoreline cell. This ranking has been assessed and a ranking assigned for each category.
6. Overall Ranking – This is the overall highest ranking for each category between the 'Floating Ranking' and the 'Dissolved Ranking'.
7. Brief Description Floating Oil – This is a brief description of the priority(ies) identified that have given the category its highest priority ranking for protection from floating hydrocarbons. NOTE: Limit is 256 characters.
8. Brief Description Dissolved Oil – This is a brief description of the priority(ies) identified that have given the category its highest priority ranking for protection from dissolved hydrocarbons. NOTE: Limit is 256 characters.
9. Data Source – This is the source of the data that has given the cell its ranking either for protection from floating or dissolved hydrocarbons.

An extract from the attribute table is provided in Table 5-1.

Table 5-1: Attribute table format (Extract, Shoreline Cell number 265)

Shoreline Cell ID	Category ID	Category Name	Floating Ranking	Dissolved Ranking	Overall Ranking	Brief Description Floating Oil	Brief Description Dissolved Oil	Data Sources
265	1	Protected Fauna	3	2	3	Southern right whale (*Eubalaena australis*): Breeding known to occur in the area	Great white shark (*Carcharodon carcharias*): Species or species habitat known to occur in the area	DotE SNES (22 February 2017); DPaW Protected Fauna (2 March 2017); DotE BIA (26 April 2016)
265	2	Protection Areas	4	3	4	IUCN IA (Nature Reserve)	IUCN IA (Nature Reserve)	DotE CAPAD, 2014
265	3	Cultural Heritage	NA	NA	NA	NA	NA	NA
265	4	Economic	2	3	3	Abalone, Small Pelagic, Southern and Eastern Scalefish and Shark, Southern Bluefin Tuna, Southern Tuna and Billfish, Western Skipjack, Finfish trapping in oceanic waters, Marine Aquarium, Open Access South Coast Demersal Scalefish, South Coast Crustacean, South Coast Open Access Netting, South Coast Salmon, Specimen Shell and Octopus Interim Managed Fisheries	Abalone, Small Pelagic, Southern and Eastern Scalefish and Shark, Southern Bluefin Tuna, Southern Tuna and Billfish, Western Skipjack, Finfish trapping in oceanic waters, Marine Aquarium, Open Access South Coast Demersal Scalefish, South Coast Crustacean, South Coast Open Access Netting, South Coast Salmon, Specimen Shell and Octopus Interim Managed Fisheries	Department of Fisheries, FRDC Project No. 2000/127
265	5	Social, Amenity and Recreation	NA	NA	NA	NA	NA	NA
265	6	Overall	4	3	4	IUCN IA (Nature Reserve)	IUCN IA (Nature Reserve)	DotE CAPAD, 2014

6 Oil Spill Risk Assessment

The attribute table containing the protection priorities information for each shoreline cell will be input into the Oil Spill Risk assessment by Navigatus for the DoT. This step will occur once an Oil Spill Risk ranking has been produced for floating oil and dissolved oil for each shoreline cell. The combination of the 'likelihood' (the oil spill risk) and the 'consequence' (the protection priority) for each of the protection categories (Protected Fauna, Protection Areas, Cultural Heritage, etc.) will be displayed in a WebMap Application.

A sample of this WebMap output of the combined efforts of this project and that of the oil spill risk modelling, as presented on the New Zealand Marine Oil Spill Risk Assessment website accessed via http://mosra15.navigatusconsulting.com/login, is shown in Figure 6-1.

The data created by this project will be used to populate the entries against each of the shoreline cells under each category (Protected Fauna, Protection Areas, etc.), and the corresponding colour of the cell according to its ranking in each category, from Very High to Very Low.

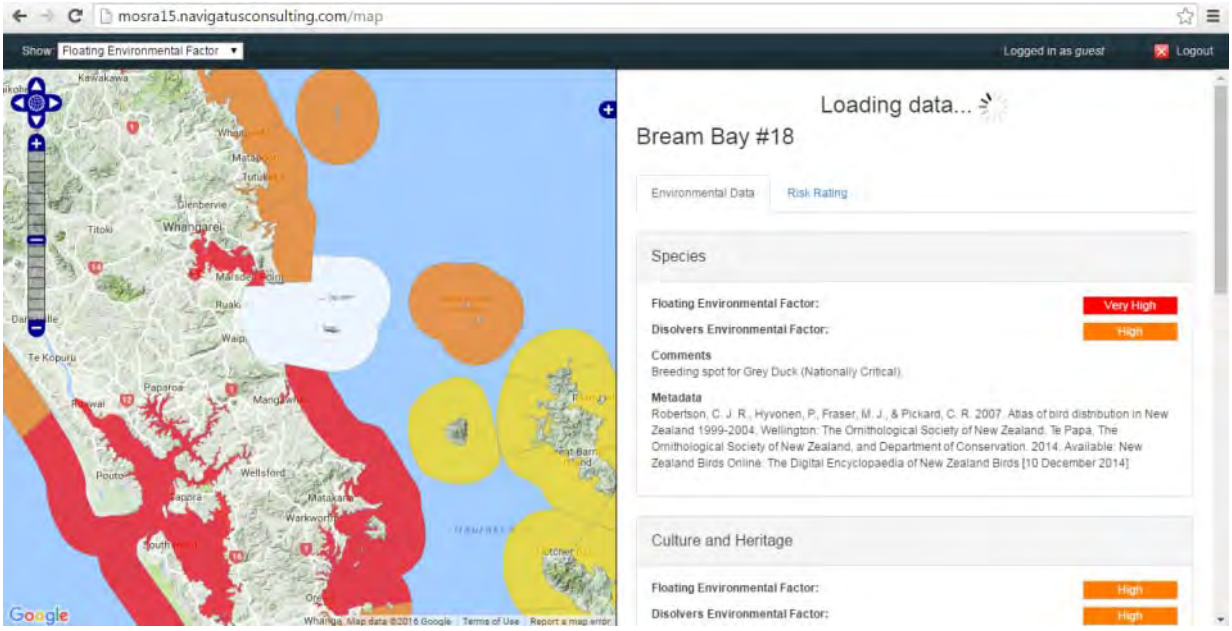

Figure 6-1: Marine Oil Spill Risk Assessment WebMap sample by Navigatus for New Zealand (accessed 31 July 2016)

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7 Results

Shoreline cell maps which display the cumulative effect of all the protection priorities are included in **Error! Reference source not found.** to Figure 7-6. These maps summarise the protection priorities that have been identified as a result of this project.

Included in Appendix A is a series of maps that provide additional granularity which underpins the results of the assessment. The maps are presented for each category (i.e. Protected Fauna; Protection Areas; Cultural Heritage; Economic; and Social, Amenity and Recreation). Summary maps depict the shoreline cells in the South West and South Coast zones, ranked (and coloured) based on the highest ranking of any aspect present in the shoreline cell, irrespective of its spatial coverage in that shoreline cell. Two summary maps are included for each category, one each for floating oil and dissolved oil protection priority rankings.

When the protection priorities are reviewed for the cumulative rankings of floating oil, dissolved oil and overall oil impacts for each of the categories, the following has become apparent:

- No shoreline cells in the South West zone have been ranked Very High for protection of Protected Fauna from the impacts of floating oil or dissolved oil (Appendix A: Figure A1 and Figure A2). Fifteen (15) shoreline cells in this zone have been ranked High for protection from floating oil and none have been ranked High for protection from dissolved oil;
- Two (2) shoreline cells in the South Coast zone have been ranked Very High for protection of Protected Fauna from the impacts of floating oil. These cells are located in the regions of Denmark and Albany. These have been prioritised for known roosting areas of the Critically Endangered curlew sandpiper and eastern curlew (Appendix B: Figure B1 and Figure B2). Twenty one (21) have been ranked High for protection of Protected Fauna from floating oil. These include the likely presence of the migration pathway for the Endangered blue whale. There is also the likely presence of Endangered loggerhead turtles, and the known presence of Critically Endangered and Endangered birds such as the curlew sandpiper and the Indian yellow-nosed albatross. No shoreline cells in this zone have been ranked Very High for protection from dissolved oil due to Protected Fauna, but two shoreline cells have been ranked High for the presence of the Critically Endangered birds mentioned above;
- Two (2) shoreline cells in the South West zone have been ranked Very High for protection of Protection Areas from floating oil and dissolved oil, a further 11 have been ranked High, for both floating and dissolved oil. Four have been ranked High for floating oil and Medium for dissolved oil. The remainder are ranked Medium and Low. The Very High ranking for both floating oil and dissolved oil protection are due to a Ramsar wetland (Vasse-Wonnerup system) in Shoreline Cells 209 and 210. The shoreline cells that have been ranked High are to protect marine and terrestrial classified Strict Nature Reserves (classified as IUCN IA);
- Two (2) shoreline cells in the South Coast zone have been ranked Very High for protection of Protection Areas from floating oil and dissolved oil, and all other shoreline cells have been ranked High except Shoreline Cells 228, 234, 236, 237 and 276 to 279, which have been ranked Medium. The Very High rankings for protection from both floating oil and dissolved oil are due to a Ramsar wetland (Lake Gore) in Shoreline Cells 246 and 247. The shoreline cells which have been ranked High include Strict Nature Reserves;

- The effect of the ranking of economic impacts in the South West zone sees one shoreline cell being ranked Very High for protection from dissolved oil and high for floating oil. This is due to the Binningup Desalination Plant in Shoreline Cell 207 (Appendix A: Figure A7 and Figure A8). The other economic protection priorities are primarily for the fisheries in the zone, though the highest have been ranked Medium;
- No shoreline cells in the South Coast zone have been ranked Very High or High for protection from floating or dissolved oil. Most cells have been ranked Low, with two (2) cells (Shoreline Cells 248 and 249) being ranked Medium for the presence of Esperance Port (Appendix B: Figure B7 and Figure B8). The other economic protection priorities are primarily for the fisheries in the zone, though the highest have been ranked Low;
- Fifteen (15) shoreline cells have been ranked Medium in the South West zone due to Cultural Heritage. This ranking is associated with the presence of Commonwealth protected shipwrecks in those shoreline cells (Appendix A: Figure A5 and Figure A6);
- Twenty five (25) shoreline cells have been ranked Medium in the South Coast zone due to Cultural Heritage. Like the South West zone, these rankings are associated with the presence of Commonwealth protected shipwrecks in those shoreline cells (Appendix B: Figure B5 and Figure B6);
- The highest Social, Amenity and Recreation ranking in the South West zone is Medium, in three shoreline cells, due to two Top Ten beaches and one marine park (Appendix A: Figure A7 and Figure A8);
- One (1) shoreline cell in the South Coast zone has been ranked High for the Social, Amenity and Recreation aspects due to an IUCN IA marine park, and three shoreline cells have been ranked Medium for Top Ten beaches (Appendix B: Figure B7 and Figure B8);
- The cumulative ranking for all categories in the South West zone resulted in a Very High ranking for two (2) shoreline cells for protection from floating oil and three (3) shoreline cells for protection from dissolved oil effects. Sixteen (16) have been ranked High for protection from floating oil and 11 for protection from dissolved oil (Figure 7-3); and
- The cumulative ranking for all categories in the South Coast zone is Very High for four (4) shoreline cells for protection from floating oil, and two (2) shoreline cells for protection from dissolved oil effects. Fifty seven (57) have been ranked High for protection from floating oil and 34 for protection from dissolved oil (Figure 7-3).

Protected Fauna

The **Protected Fauna** category had the most comprehensive dataset coverage of all the categories. The datasets incorporated in this category included the DotE SNES and BIA polygons, and discrete points in the DPaW dataset.

No shoreline cells in the South West zone have been ranked Very High for protection from floating oil or dissolved oil impacts on protected fauna. Fifteen (15) shoreline cells have been ranked High for protection from floating oil. These protection priorities include the presence of Endangered loggerhead turtles, Critically Endangered and Endangered birds such as the curlew sandpiper, eastern curlew and Indian yellow-nosed albatross, breeding areas for the Endangered southern right whale, and migration pathway for other protected whale and mammal species.

Two (2) shoreline cells in the South Coast zone have been ranked Very High for protection of Protected Fauna from the impacts of floating oil. These cells are located in the regions of Denmark and Albany. The key species which use the majority of the coastline and are driving this Very High

classification in the Protected Fauna category are roosting areas for the Critically Endangered birds: the curlew sandpiper and eastern curlew. Other High protection priorities in this zone are breeding areas for the Endangered southern right whale and migration pathway for the Endangered blue whale. There is also the likely presence of Endangered loggerhead turtles, Critically Endangered and Endangered birds such as the curlew sandpiper and Indian yellow-nosed albatross.

Protection Areas

There were 13 datasets used to identify **Protection Areas** across all zones in WA, including the South West and South Coast zones. The most comprehensive of these are the DotE compiled CAPAD datasets for marine and terrestrial areas and the updated dataset by the WA DPaW. Other key datasets were for internationally and nationally important wetlands (Ramsar wetlands and Nationally Important Wetlands datasets). These are Commonwealth provided datasets and identify key areas for protection in the event of an oil spill. The key dataset identified for future improvement was the OSRA ESI dataset. This is a state-wide dataset but it has a portion of areas 'unclassified' and others classified as 'island'. The DPaW Marine Habitats dataset was extremely useful as it is highly detailed and well classified, however it is only for marine and coastal areas under DPaW management. Whilst this covers a significant portion of state waters, it was still recognised as a limited dataset.

The Protection Areas which have been ranked Very High are associated with Ramsar wetlands, and the areas which have been ranked High are those with habitat protected under Commonwealth and Federal legislation. Where the coastline has been ranked High for protection from dissolved oil, these are the areas which contain important wetlands and IUCN-type IA Nature Reserves.

Cultural Heritage

The key state-wide datasets used in this category were the DotE provided World Heritage Areas dataset, National Heritage Areas dataset, Commonwealth Heritage Places, the Australian National Shipwrecks Database, and the State provided **Cultural Heritage** datasets for the same heritage. These are comprehensive and cover the Commonwealth and State protected cultural heritage values of WA.

The impact on Cultural Heritage including shipwrecks and maritime archaeology is the same for protection from dissolved oil and floating oil for all shoreline cells in the South West and South Coast zones. Twenty five (25) shoreline cells have been ranked Medium for shipwrecks in the South Coast. In the South West zone, 15 shoreline cells have been ranked Medium for shipwrecks.

Economic

The key datasets used to identify the **Economic** priorities for protection were the Ports and Shipping datasets and State and Commonwealth Managed Fisheries datasets. These datasets are comprehensive and state-wide. Individual geospatial shapefiles for the fisheries took a long time to incorporate into the rankings due to the different management of species under each fishery. It made this process quite complicated.

One shoreline cell in the South West zone has been ranked Very High priority for protection from dissolved oil, and a High for protection from floating oil, due to the presence of a saltwater intake at a desalination plant. In respect to fisheries impact, all shoreline cells in the South West and

South Coast zones have been ranked Very Low for protection from both dissolved and floating oil due to the low economic income of the fisheries present.

Social, Amenity and Recreation

Three state-wide datasets were key to identifying **Social, Amenity and Recreation** values in the South West and South Coast zones. These were the multi-use zones of the marine parks and reserves in the DotE CAPAD Marine and DPaW updated CAPAD datasets (2016). The other key data was popularity information for WA beaches, sourced from Surf Life Saving WA, and the DMP's Coastal Landforms dataset for sandy beaches, which was also used as a proxy for potentially popular beaches.

The assessment of protection priority for Social, Amenity and Recreation aspects indicates that the South West and South Coast zones have an overall Low priority ranking for protection from floating and dissolved oil, except in five shoreline cells where five of the Top Ten beaches are located.

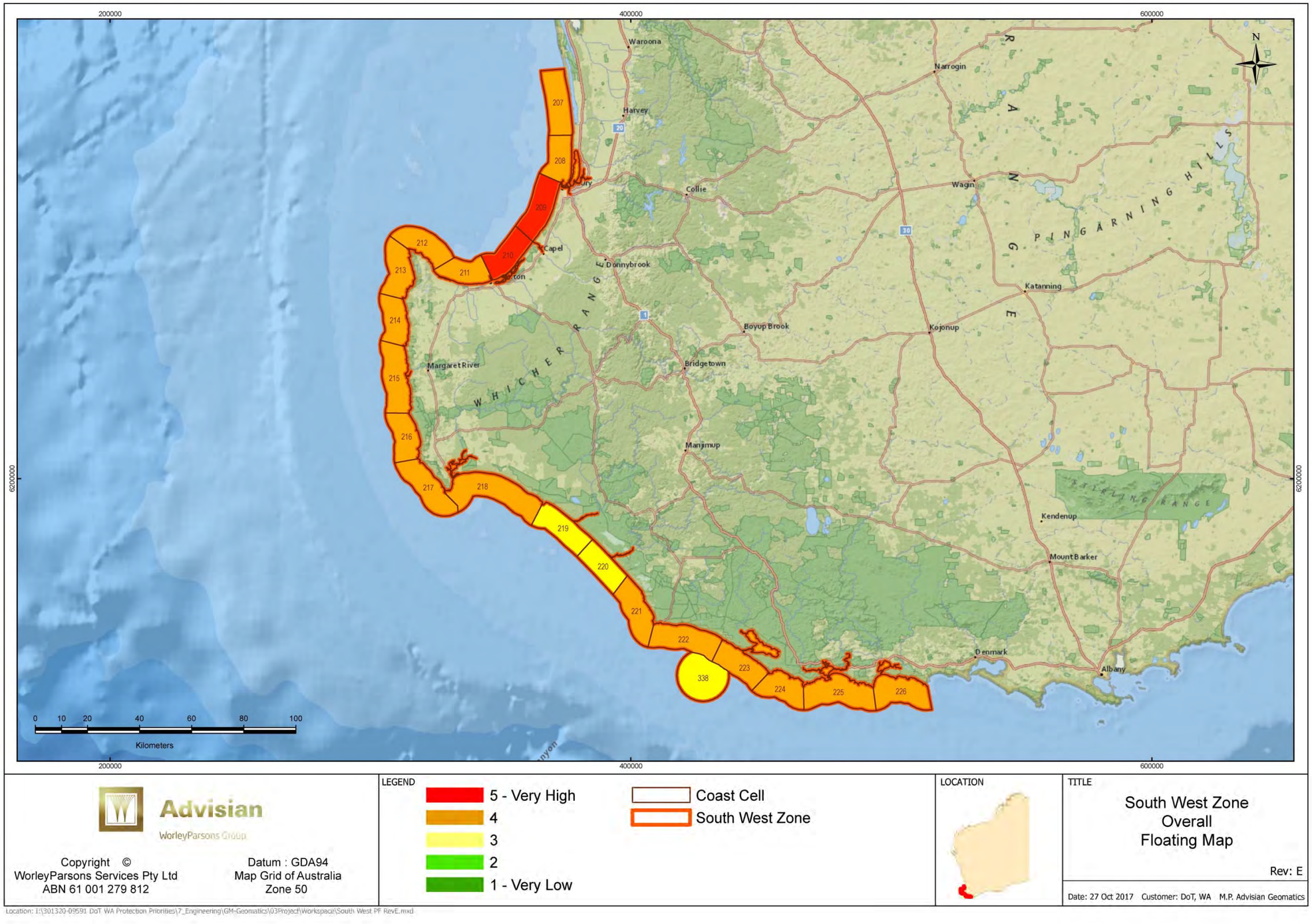

Figure 7-1: South West Cumulative (including all category rankings) shoreline cell protection priority ranking for floating hydrocarbons effects

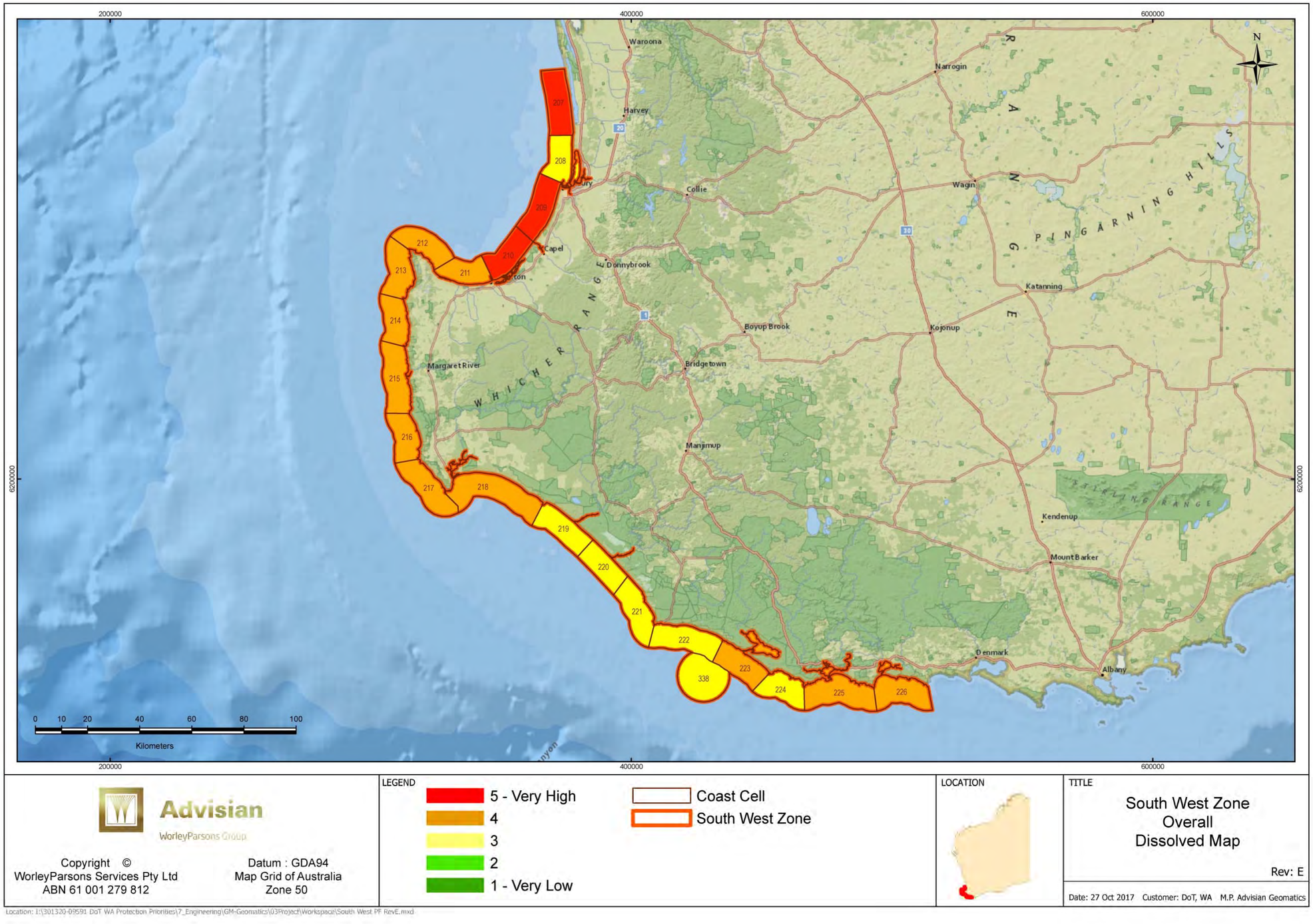

Figure 7-2: South West Cumulative (including all category rankings) shoreline cell protection priority ranking for dissolved hydrocarbons effects

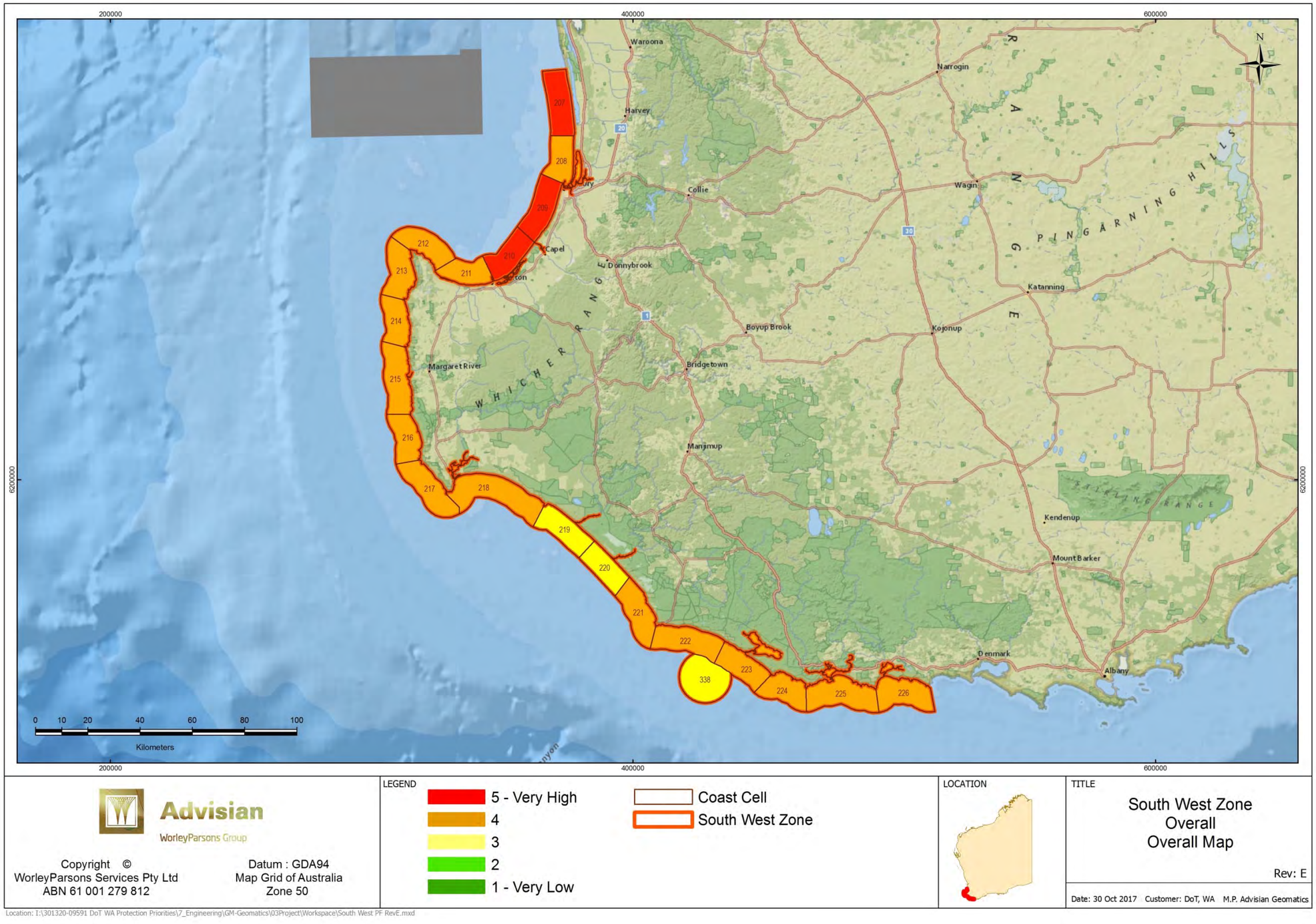

Figure 7-3: South West Cumulative (including all category rankings) shoreline cell protection priority ranking, for both floating and dissolved effects

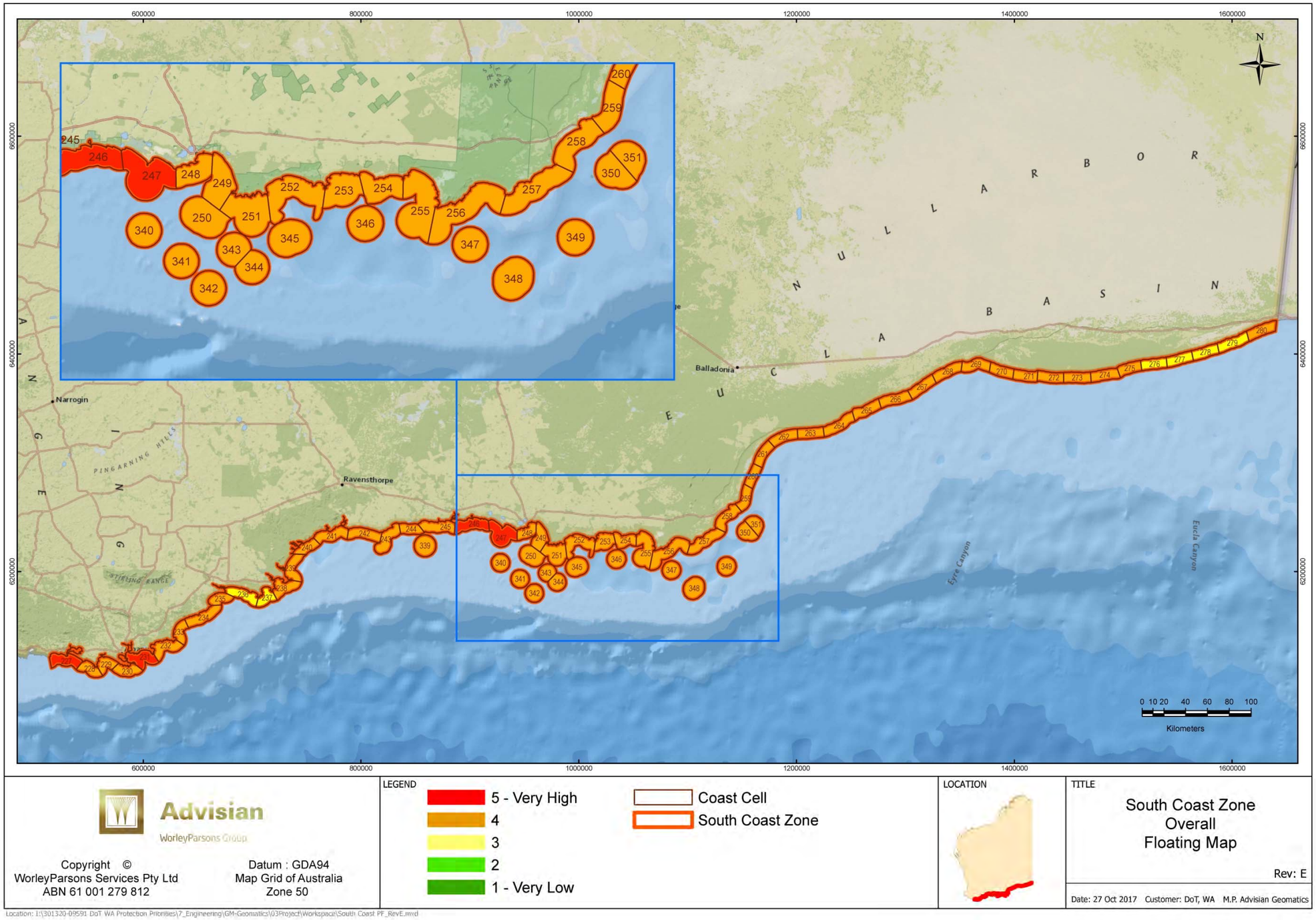

Figure 7-4: South Coast Cumulative (including all category rankings) shoreline cell protection priority ranking for floating hydrocarbons effects

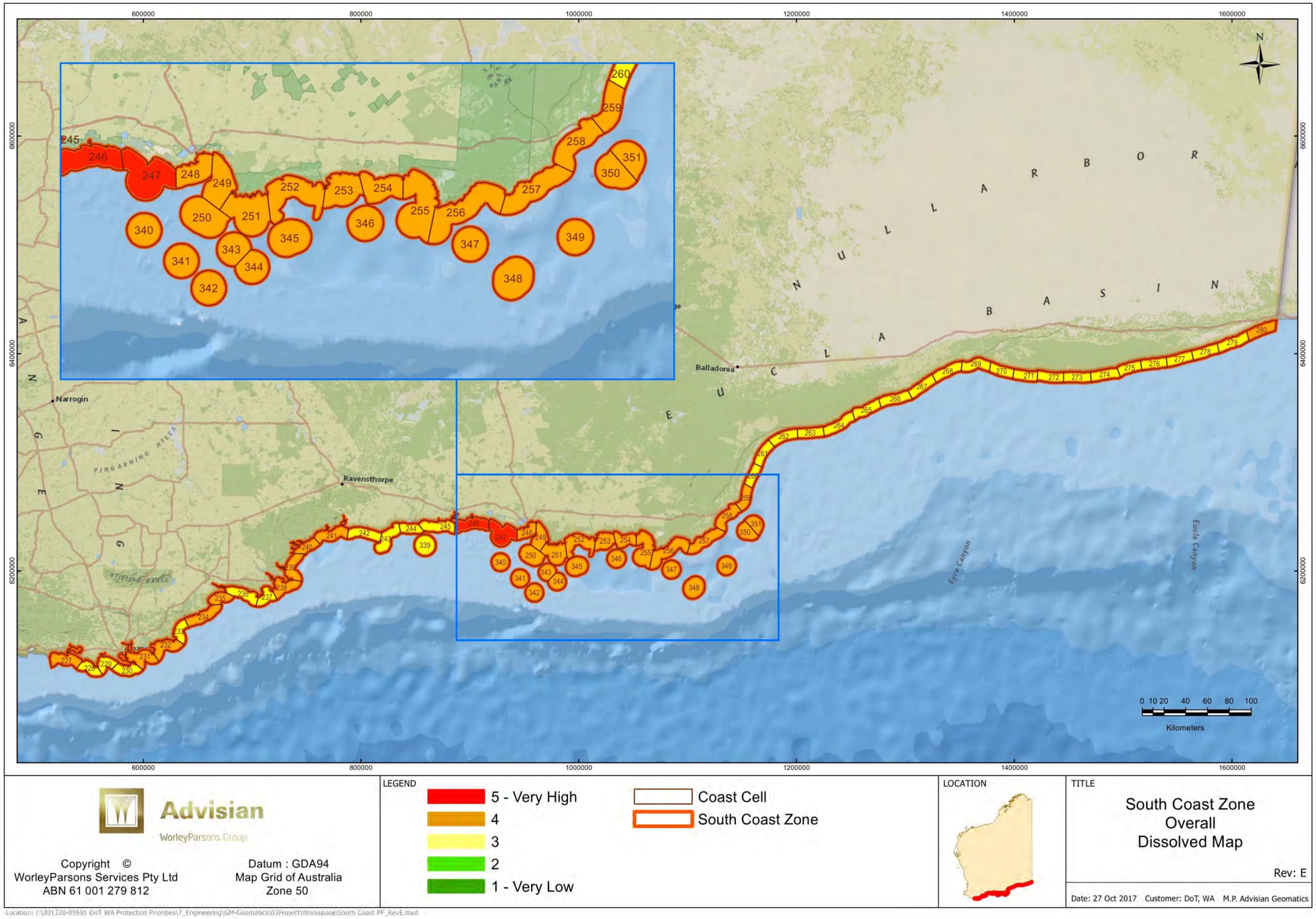

Figure 7-5: South Coast Cumulative (including all category rankings) shoreline cell protection priority ranking for dissolved hydrocarbons effects

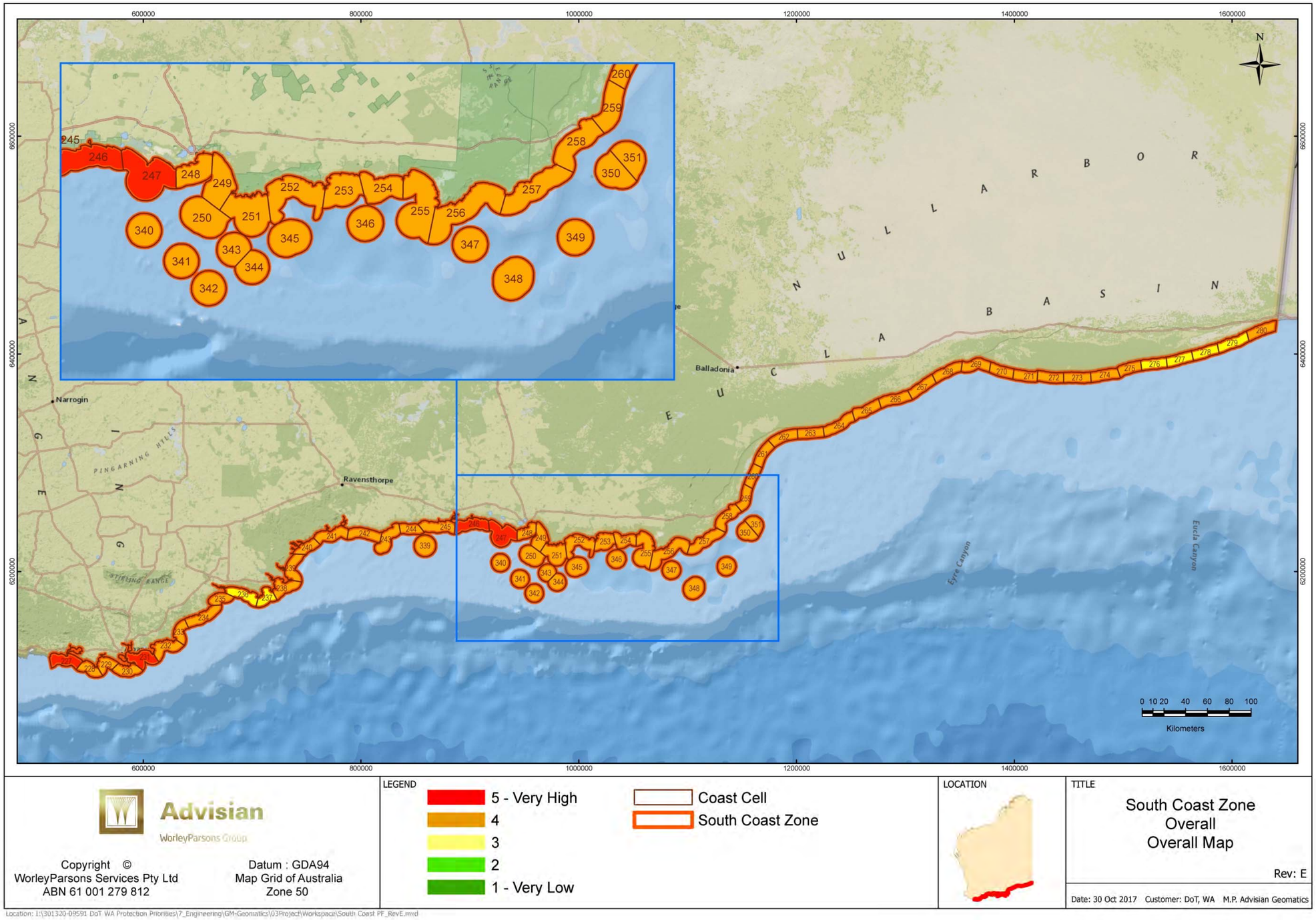

Figure 7-6: South Coast Cumulative (including all category rankings) shoreline cell protection priority ranking, for both floating and dissolved effects

8 Discussion

The key discussion points from the South West and South Coast zones are grouped into five key areas:

1. Dataset Comparison;
2. Data Compilation including BP Datasets;
3. Protected Areas including Seagrass and Tufa Locations;
4. Relevant Discussion from Previous Zones; and
5. Terrestrial Fauna Data Treatment.

8.1 Dataset Comparison

More than 60 datasets have been incorporated for use in the South West and South Coast zones. These have been sourced from various government departments, tertiary institutes and private organisations, and adapted for use for the project. Through the project's intimate exploration of the data on a large regional scale, there has been a question raised about comparing different datasets between zones. For example, the Pilbara zone completed in August 2016 has had many regional scale studies undertaken in the area, such as the Pilbara Oiled Wildlife Response Plan, while other zones may not.

The South West and South Coast zones have therefore relied on data sourced from studies done in the marine and coastal protected areas by DPaW, fisheries related investigations by the DoF, as well as the DoT ESI dataset for regional comparison. Though there have been some gaps with the ESI dataset (some areas 'unclassified'), in general the predominant coastal characteristics have been identified (e.g. exposed sea cliffs).

The coastal marine habitats are best defined in the marine parks and coastal marine protection areas provided by DPaW and the DoF, where they have been extensively studied. The South West and South Coast zones have a marine network that generally well represent and protect the zone's key habitats. These are based on many of the areas identified in the Wilson *et al.* (1994) report, which recommended a 'representative' marine system for WA. The additional areas identified in the report which have not become formally protected as part of this marine reserve system have also been incorporated into this assessment, to ensure all areas for protection have been included.

There have been plans to undertake broad-scale mapping of the WA coastline in order to map marine habitats, coastal habitats and bathymetry. While the raw LiDAR data has been captured, this has yet to be processed. A review of the general classifications in the multiple habitat datasets identified through this project could be useful in creating a broad set of general classification criteria. This can be used to create a dataset that is compatible with the existing information, for future refinement of this project's outcomes.

8.2 Data Compilation including BP Datasets

During the initial data list and compilation stages, it was highlighted that extensive studies had been done by BP and universities for the Great Australian Bight and Recherche Archipelago areas. However, Advisian was unable to gather this information due to data sharing agreements. Several

state-wide assessments have been undertaken along the coast of Western Australia, and as the resolution of the shoreline cells is quite large and broad, the existing datasets have shown to be informative enough to rank these shoreline cells appropriately.

However, if this information becomes available in the future, it may be beneficial to review the current rankings, particularly for the protected areas.

8.3 Protected Areas including Seagrass and Tufa Locations

Universities including the University of Western Australia (UWA) and Murdoch University were contacted during the data collection period following the Steering Committee Workshop, to obtain their input and advice for temperate seagrasses and other datasets in the zones. However, this additional data only supported the information already used through the protected fauna and habitat datasets, and did not affect the overall ranking of shoreline cells.

Advice was also sought from Erik Paling and Diana Walker at UWA regarding the importance of temperate seagrass, however they were unavailable to provide information. When the seagrass data was assessed, though, it was apparent that many cells contained seagrass, and were also ranked High due to marine parks and protection areas. Therefore, to rank the protection areas higher than areas which may only be protected for seagrass, it was determined that seagrass only would remain a Medium ranking. This is also discussed in Section 3.2.7 of this report.

As discussed in Section 3.2.6, tufa locations were also discussed in the Steering Committee workshop and concern was raised. These locations were also included in the assessment of the shoreline morphology.

8.4 Relevant Discussions from Previous Zones

It was discussed in the Steering Committee Workshop for the previous Pilbara zone assessment whether, in an oil spill, an environmental priority with a lower rating than an economic one, would result in the environment not being protected in favour of the economic priority. While the project has included economic factors, in a spill, the decisions made regarding the appropriate response will be based on situational best judgement and likely environmental impacts, not economic ones. Economics has been included, as the Incident Controller will want to know what the potential economic impacts may be, as well as other impacts, so they are considered holistically.

8.5 Terrestrial Fauna Data Treatment

Terrestrial fauna rankings were reviewed where coastal species are shown as geospatially present in a shoreline cell, but are not known to use the coastal zone. These species are therefore not expected to be affected by marine oil in the event of a spill. In this context, the coastal zone is defined as the area of the sea, including the water up to the mean high water mark, which includes the intertidal zone and the debris beach habitat (e.g. dried seagrass).

This issue has likely occurred where the geospatial boundary of the fauna data overlaps with the landward boundary of the shoreline cells. The landward boundary of the shoreline cells is an estimation of the mean high water mark, and theoretically only captures the fauna that has habitat in the intertidal zone. However, the accuracy of the boundaries of the shoreline cells and terrestrial fauna is limited.

In all zones, the shoreline cells have been reviewed to determine how the geospatially present terrestrial fauna use the intertidal and coastal environment across their lifecycle, as defined above. The information from two credible sources was evaluated to determine if each species spends any part of their lifecycle in the coastal zone. The sources evaluated included the Species Profile and Threats (SPRAT) database (http://www.environment.gov.au/cgi-bin/sprat/public/sprat.pl), Commonwealth and State Recovery Plans (http://www.environment.gov.au/biodiversity/threatened/recovery-plans, https://www.dpaw.wa.gov.au/plants-and-animals/threatened-species-and-communities/threatened-animals), and published EPA reports and records (http://www.epa.wa.gov.au/).

This review resulted in amendments to the treatment of data records for terrestrial birds, mammals, reptiles and invertebrates. Terrestrial fauna species have been investigated to determine whether they are actually vulnerable to oil spills, i.e. likely to be exposed and impacted through primary contact, exposure through breeding habitat/egg laying, ingestion of prey items, etc. The following has therefore been applied:

- Any fauna which was found to use the coastal zone retained its ranking in accordance with the ranking system in Section 3; and
- Any terrestrial fauna which was found to not use the coastal zone was given a ranking of Very Low for protection from both floating oil and dissolved oil, because the fauna has been determined as not at risk of being impacted by a marine oil spill.

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9 Conclusions

The following are key conclusions of this study:

- The South West and South Coast zones are highly vulnerable to marine oil pollution, both from floating and dissolved hydrocarbons;
- The prevalence of protected areas including marine reserves along the majority of the coastline is a driver for key vulnerability areas in the South West and South Coast zones;
- The Steering Committee provided invaluable input and advice regarding the suitability of datasets and ranking of criteria, while also addressing the desire to be robust and transparent in identifying protection priorities;
- This is a static assessment and further data, information, locations and priority rankings can change in the future;
- Additional consideration has had to be made for terrestrial fauna that geospatially appear in the shoreline cells. Where these fauna where investigated and shown not to use or inhabit the marine or intertidal zone, these were deemed unlikely be impacted by a marine oil spill, and have been ranked as a Very Low priority for protection from both floating and dissolved oil;
- This assessment will not replace the role of the Environmental Scientific Coordinators (ESCs) in an oil spill. The ESCs will still be called upon in an oil spill, with full information required to be sought by the Incident Controller in the spill; and
- This report and assessments are intended as a guide only, and are intended to enhance the process and reduce the response time in the event of an oil spill off the South West and South Coast shoreline.

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Appendix A South West Zone Shoreline Cell Maps

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Protected Fauna

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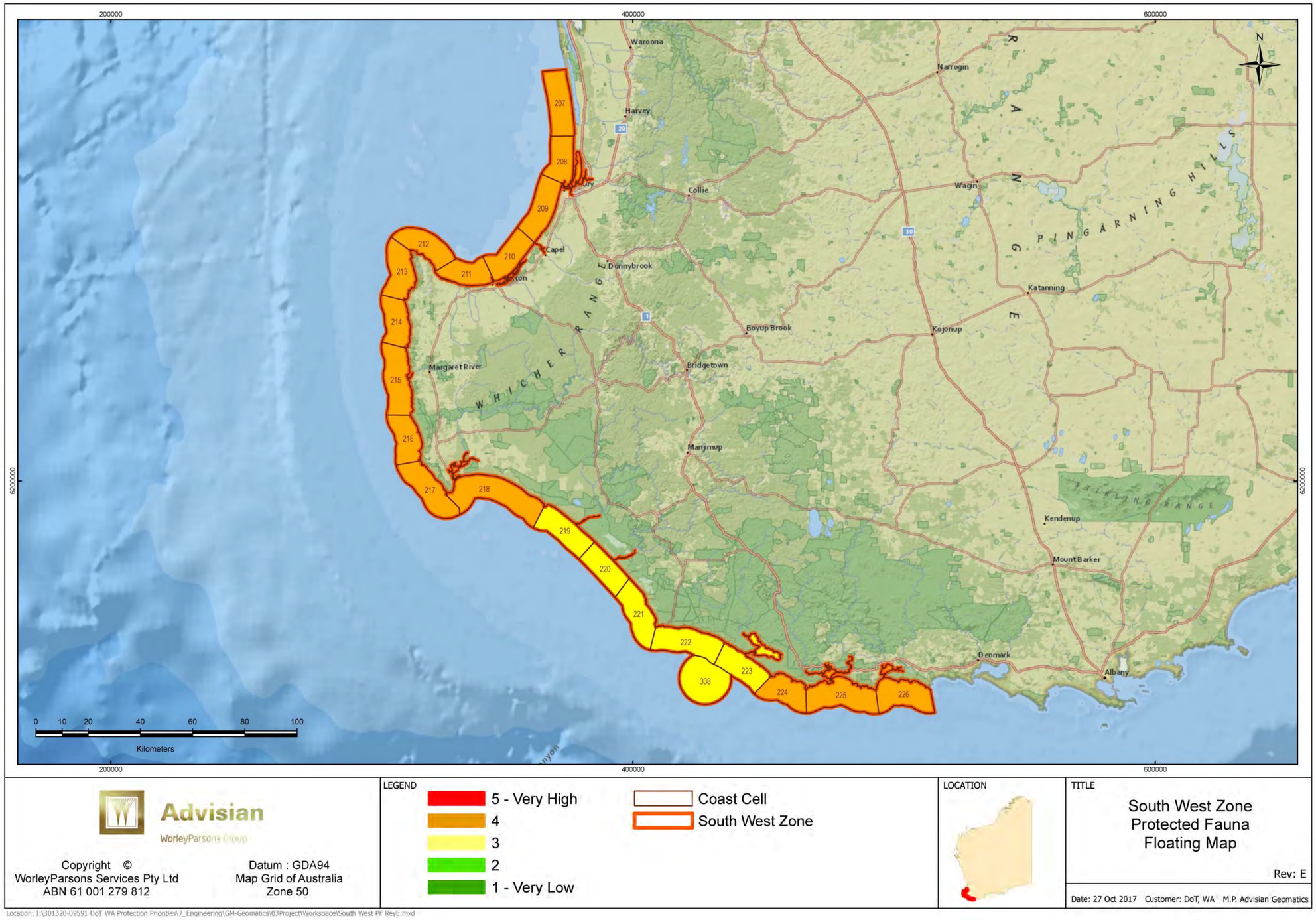

Figure A1: Protected fauna shoreline cell protection priority ranking for floating hydrocarbons effects

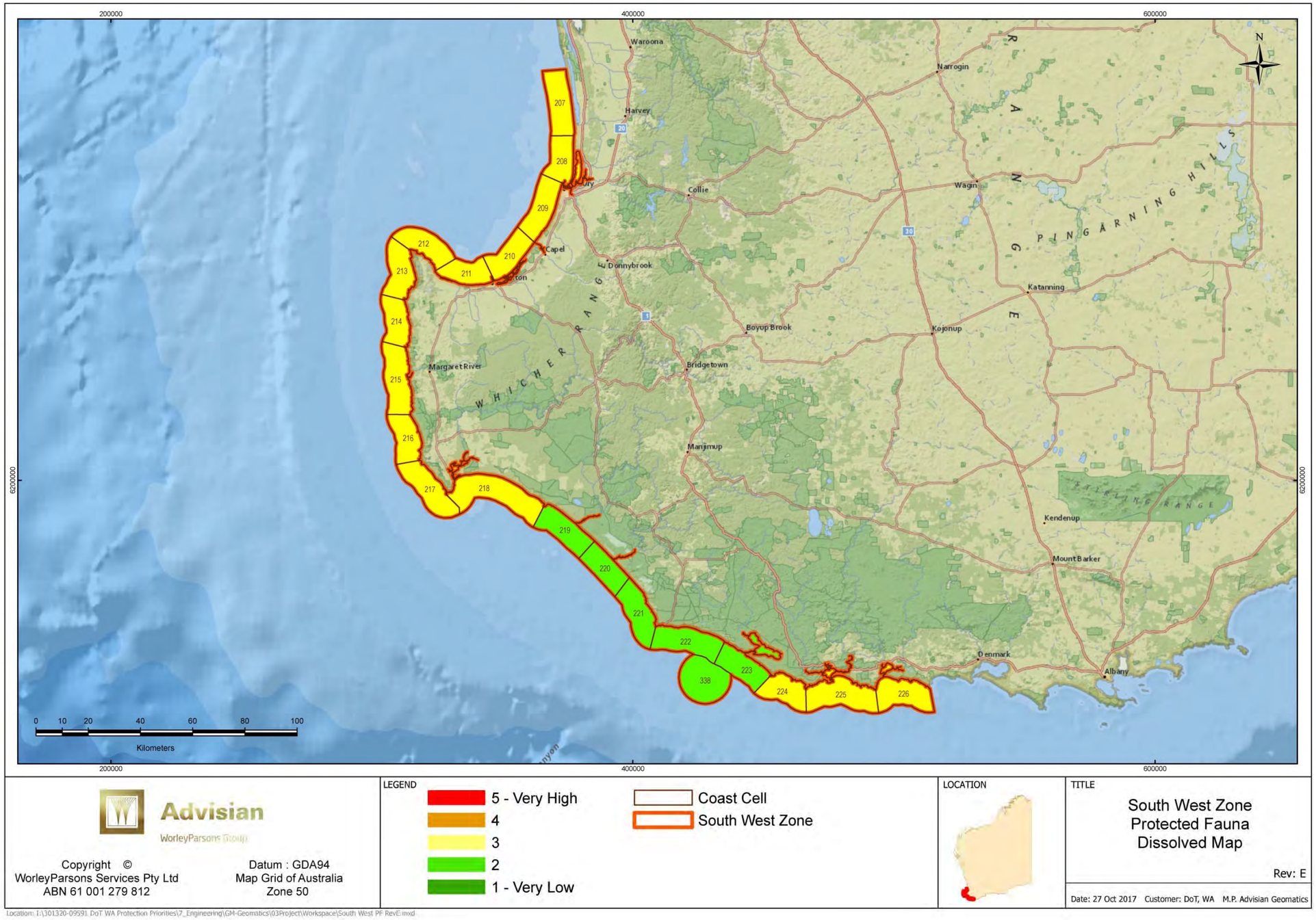

Figure A2: Protected fauna shoreline cell protection priority ranking for dissolved hydrocarbons effects

Protection Areas

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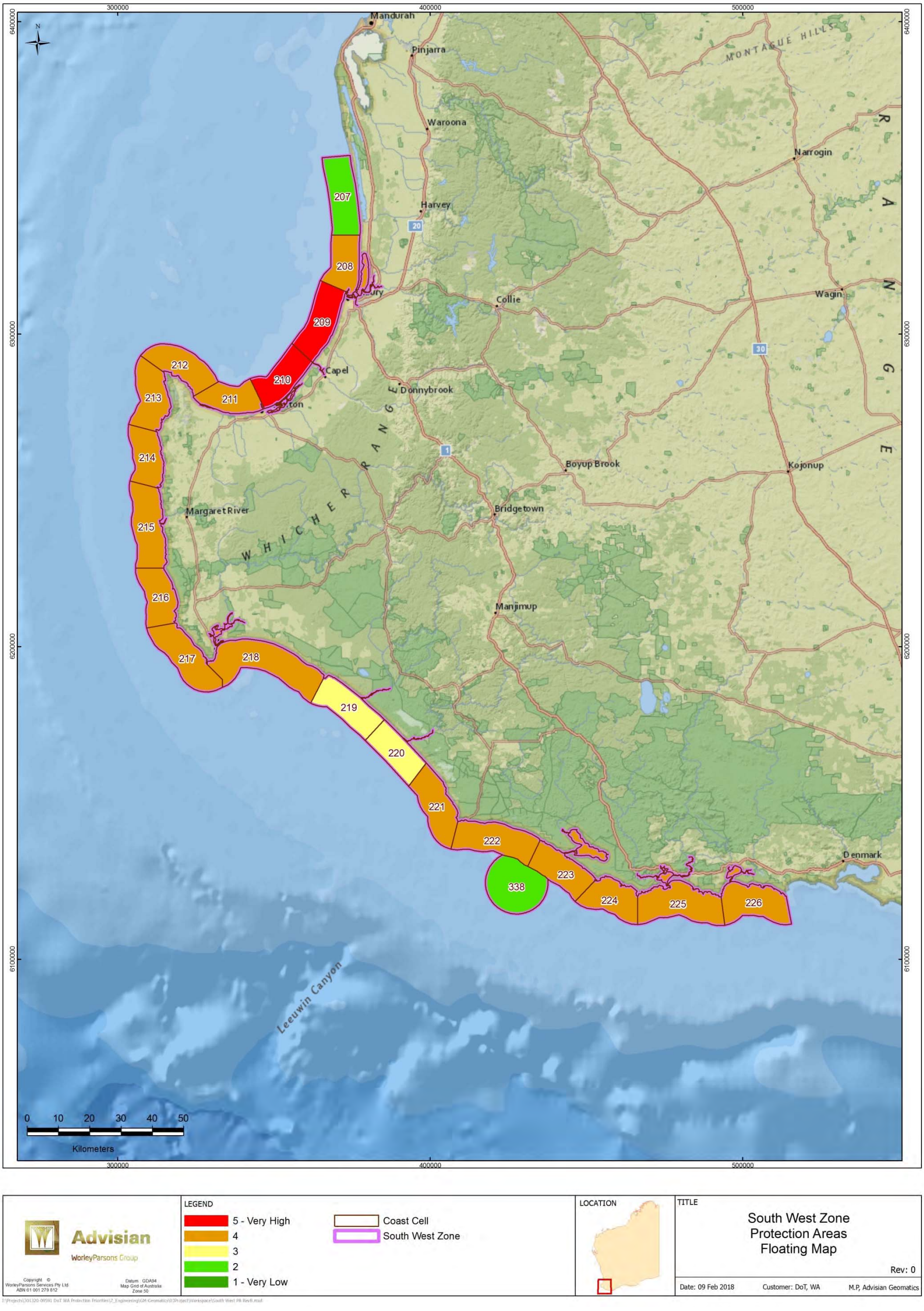

Figure A3: Protection areas shoreline cell protection priority ranking for floating hydrocarbons effects

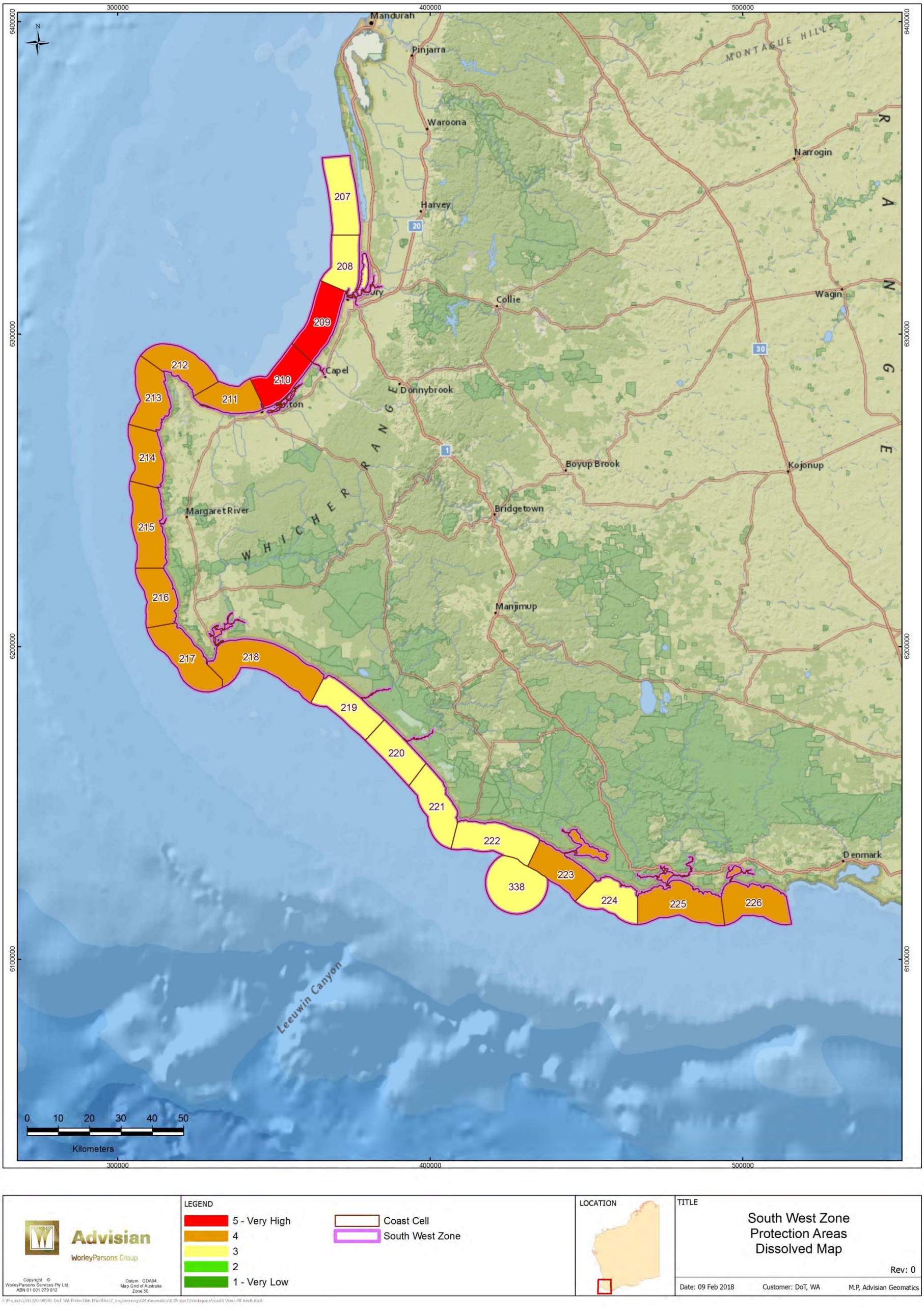

Figure A4: Protection areas shoreline cell protection priority ranking for dissolved hydrocarbons effect

Cultural Heritage

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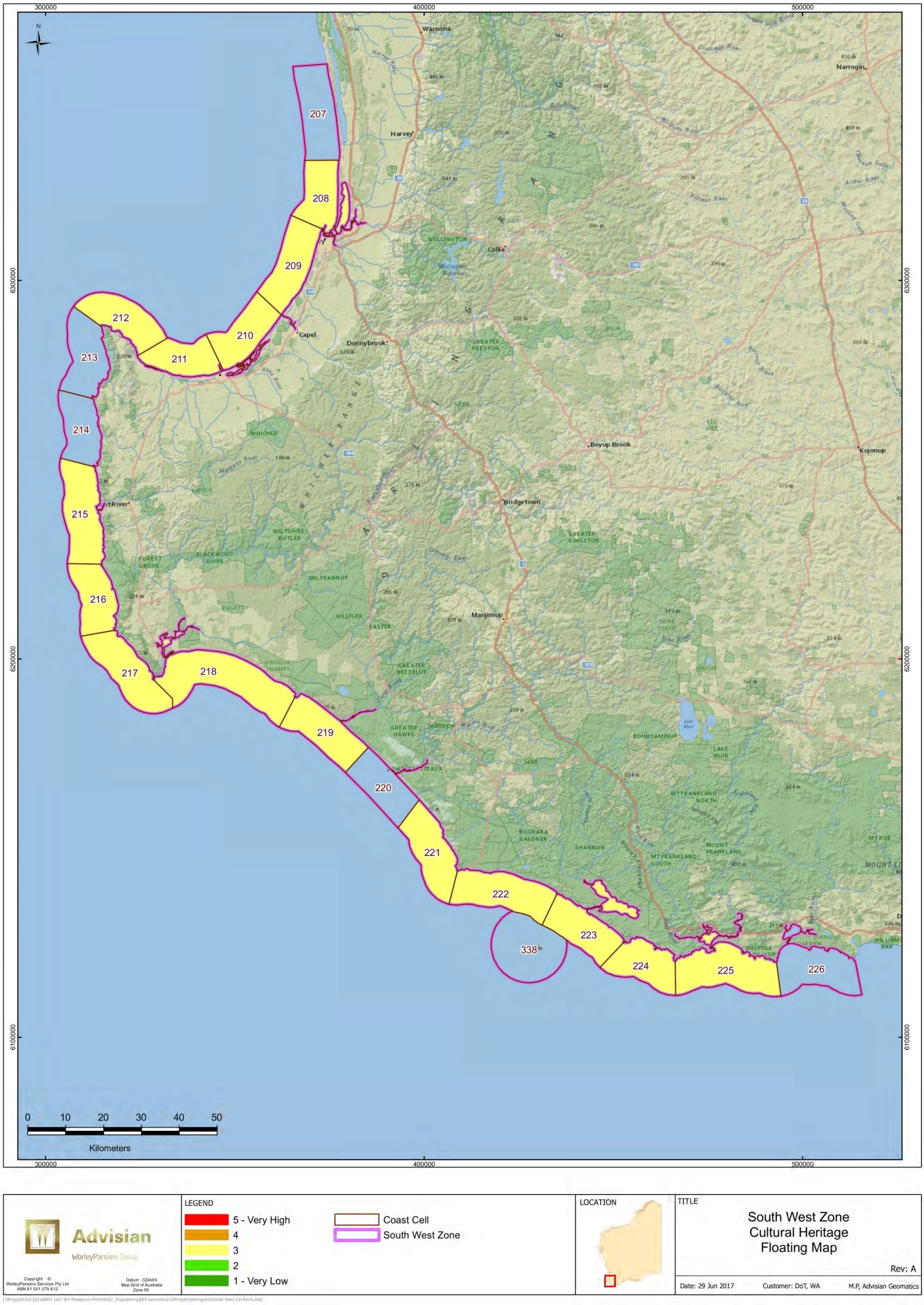

Figure A5: Cultural heritage shoreline cell protection priority ranking for floating hydrocarbons effects

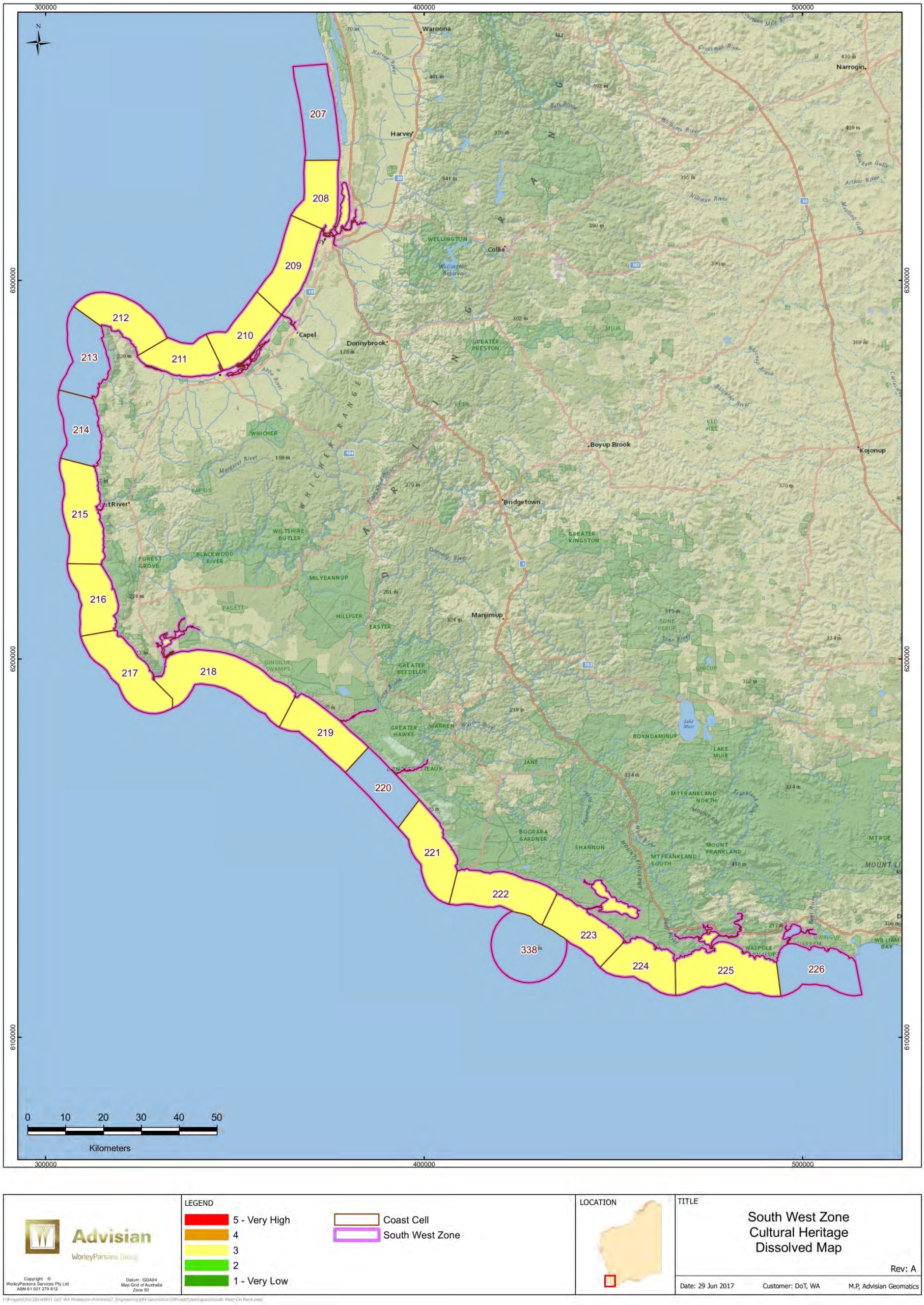

Figure A6: Cultural heritage shoreline cell protection priority ranking for dissolved hydrocarbons effects

Economic

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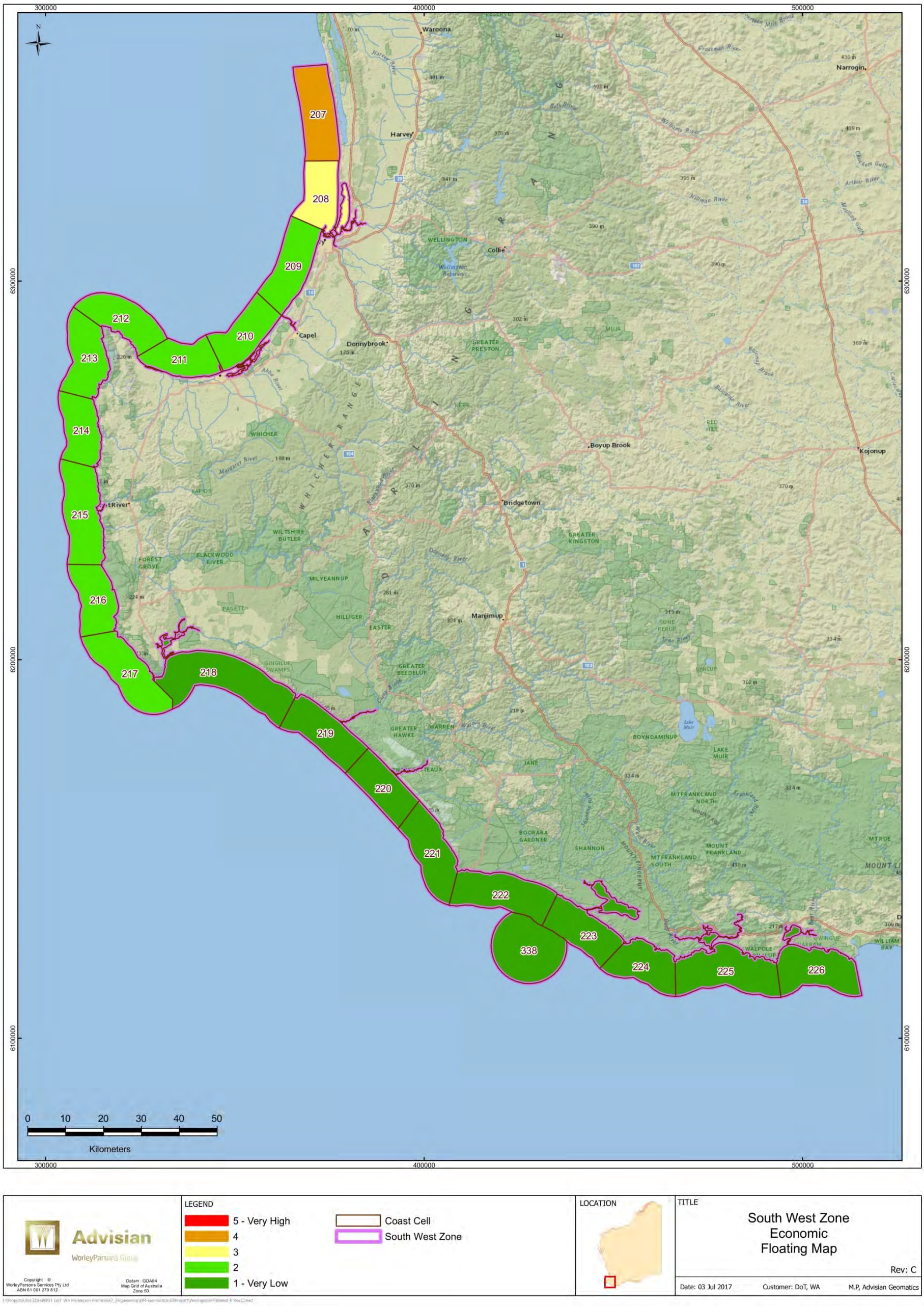

Figure A7: Economic shoreline cell protection priority ranking for floating hydrocarbons effects

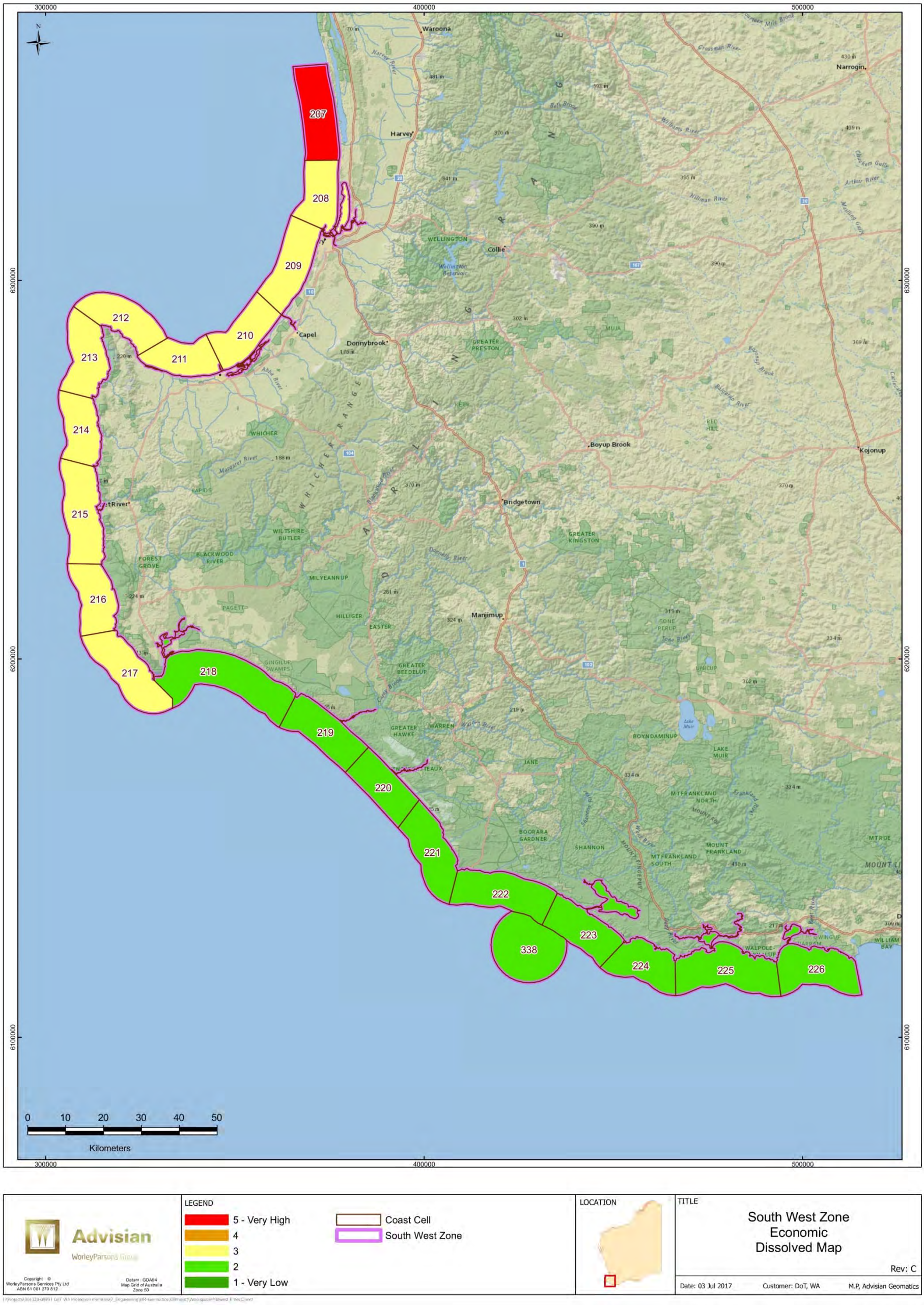

Figure A8: Economic shoreline cell protection priority ranking for dissolved hydrocarbons effect

Social, Amenity and Recreation

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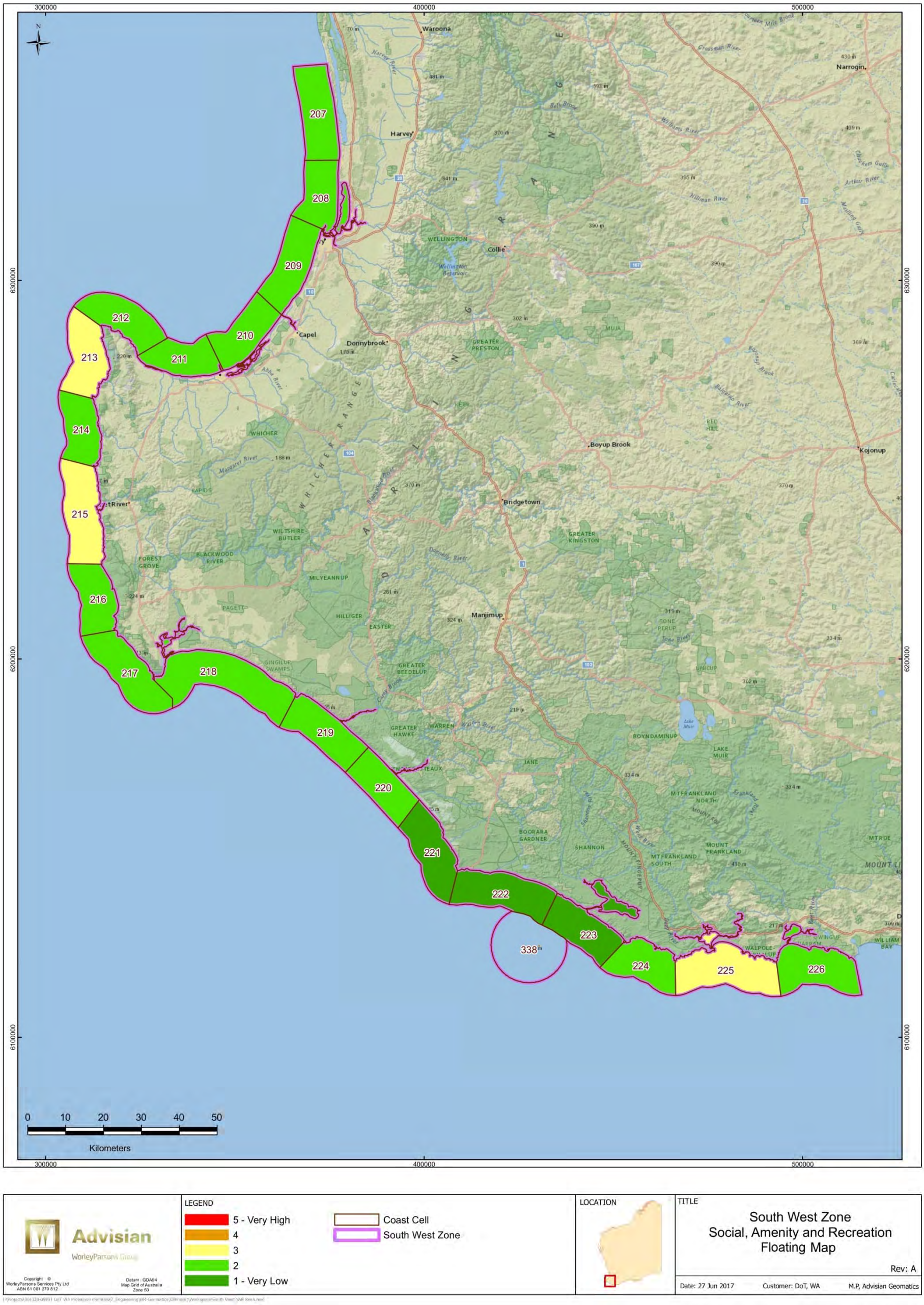

Figure A9: Social, amenity and recreation shoreline cell protection priority ranking for floating hydrocarbons effects

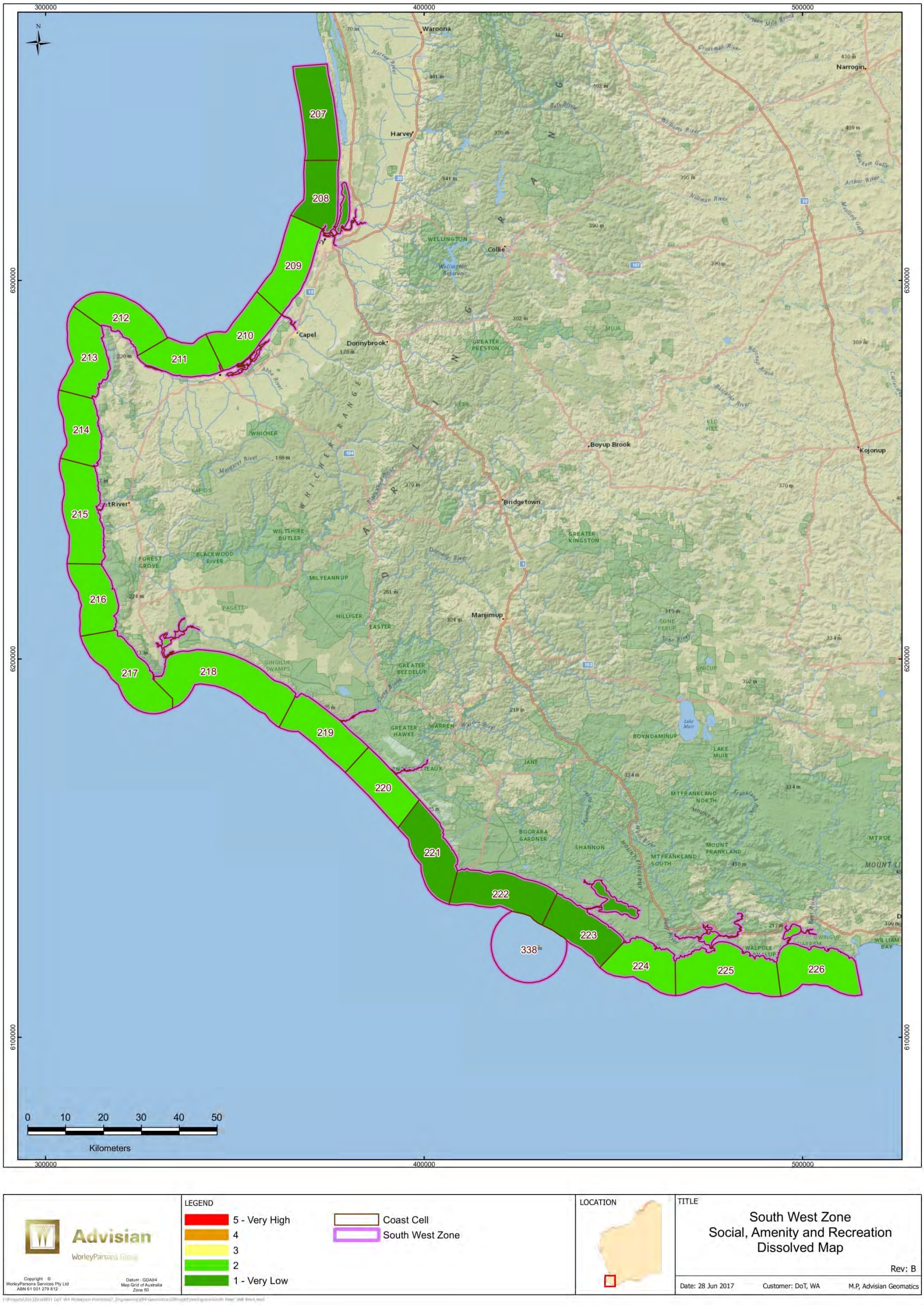

Figure A10: Social, amenity and recreation shoreline cell protection priority ranking for dissolved hydrocarbons effects

Appendix B South Coast Zone Shoreline Cell Maps

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Protected Fauna

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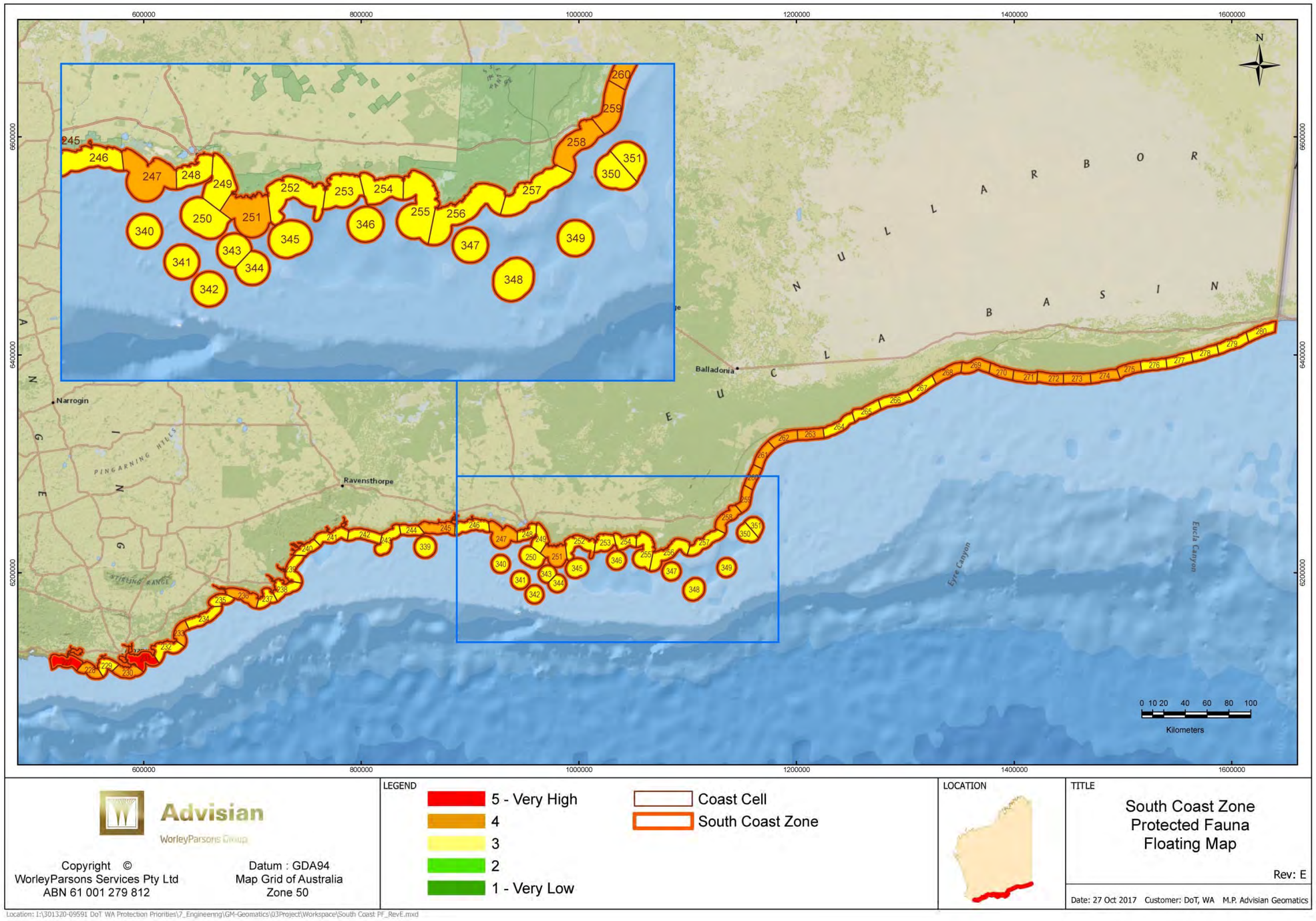

Figure B1: Protected fauna shoreline cell protection priority ranking for floating hydrocarbons effects

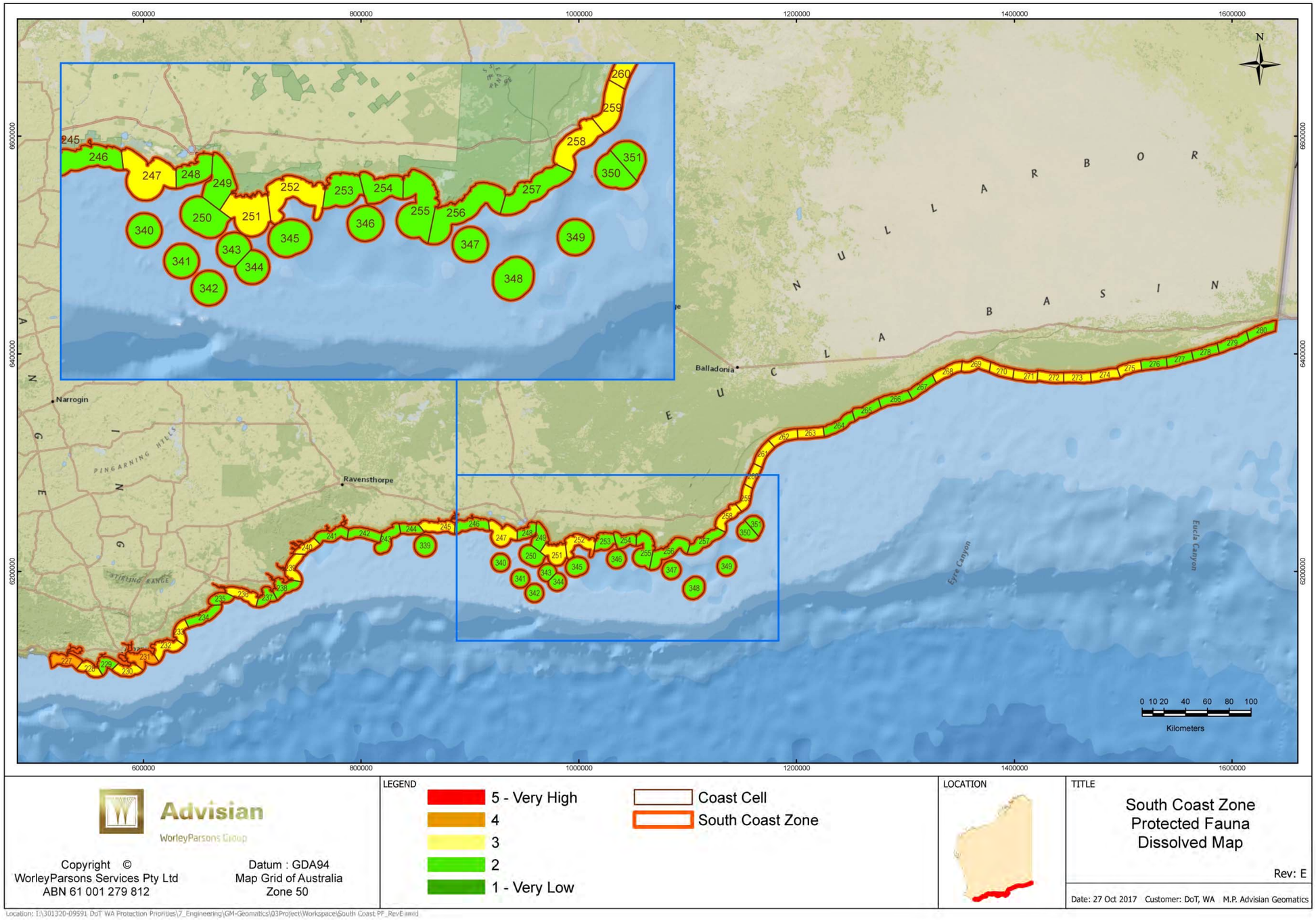

Figure B2: Protected fauna shoreline cell protection priority ranking for dissolved hydrocarbons effects

Protection Areas

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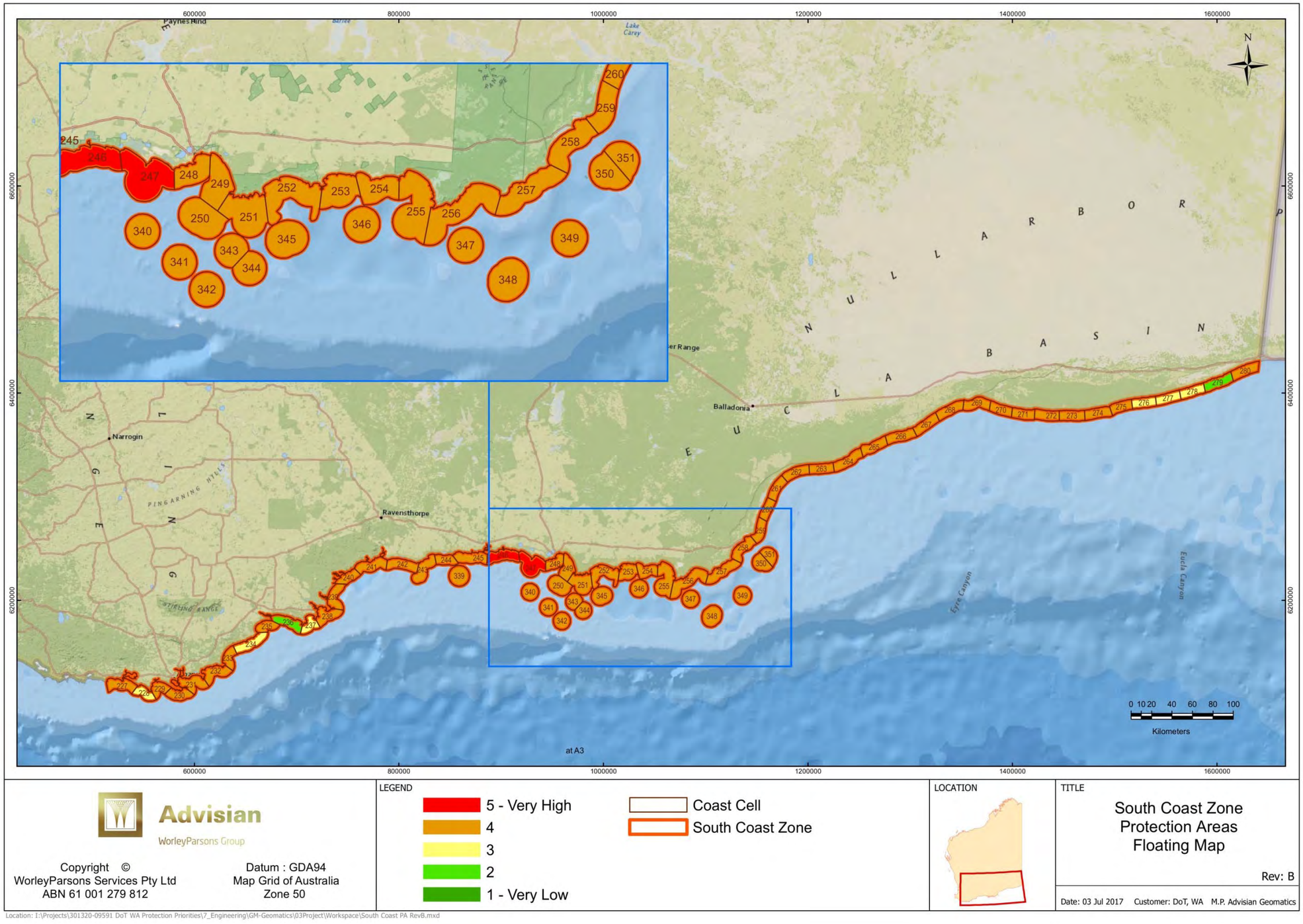

Figure B3: Protection areas shoreline cell protection priority ranking for floating hydrocarbons effects

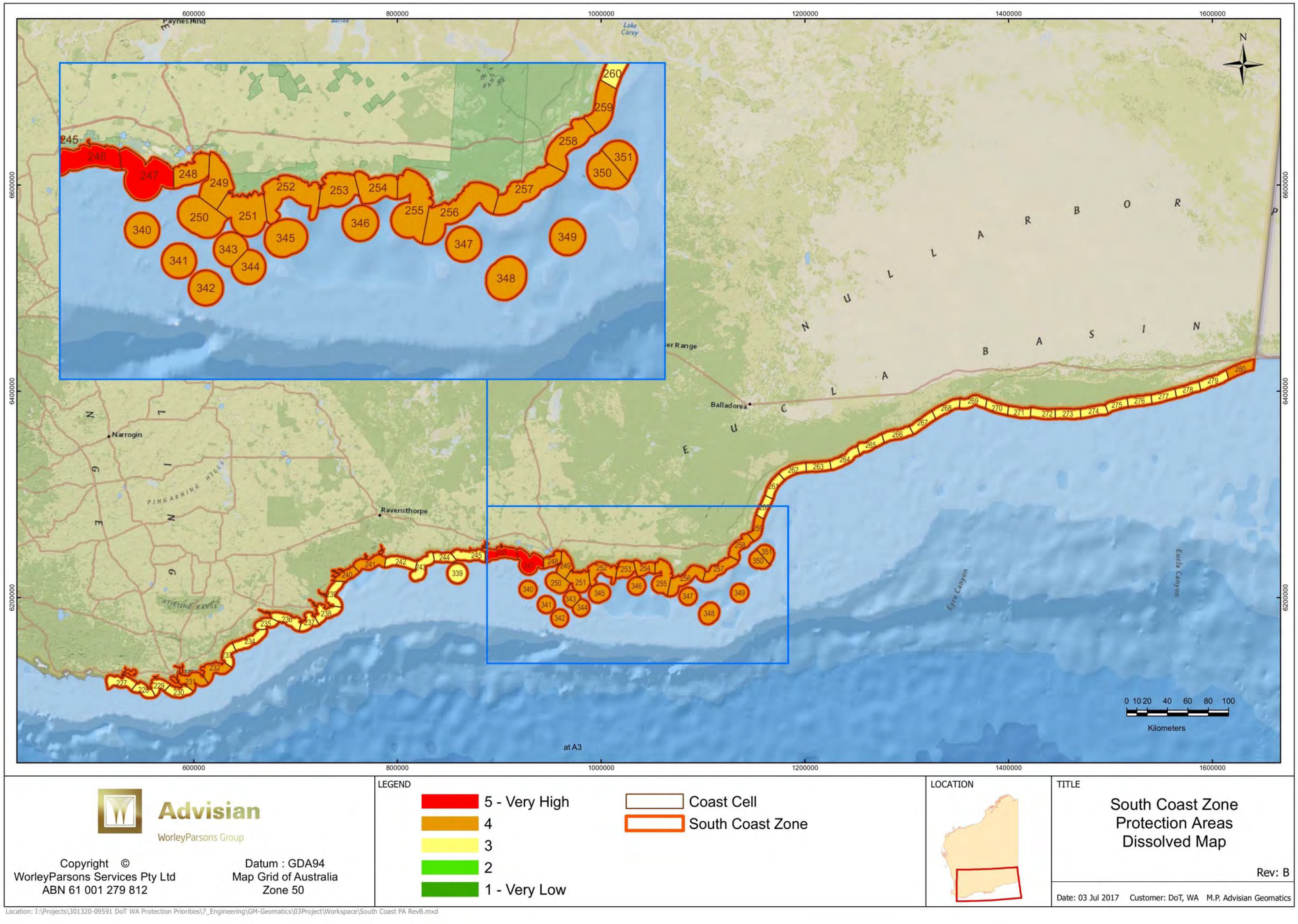

Figure B4: Protection areas shoreline cell protection priority ranking for dissolved hydrocarbons effect

Cultural Heritage

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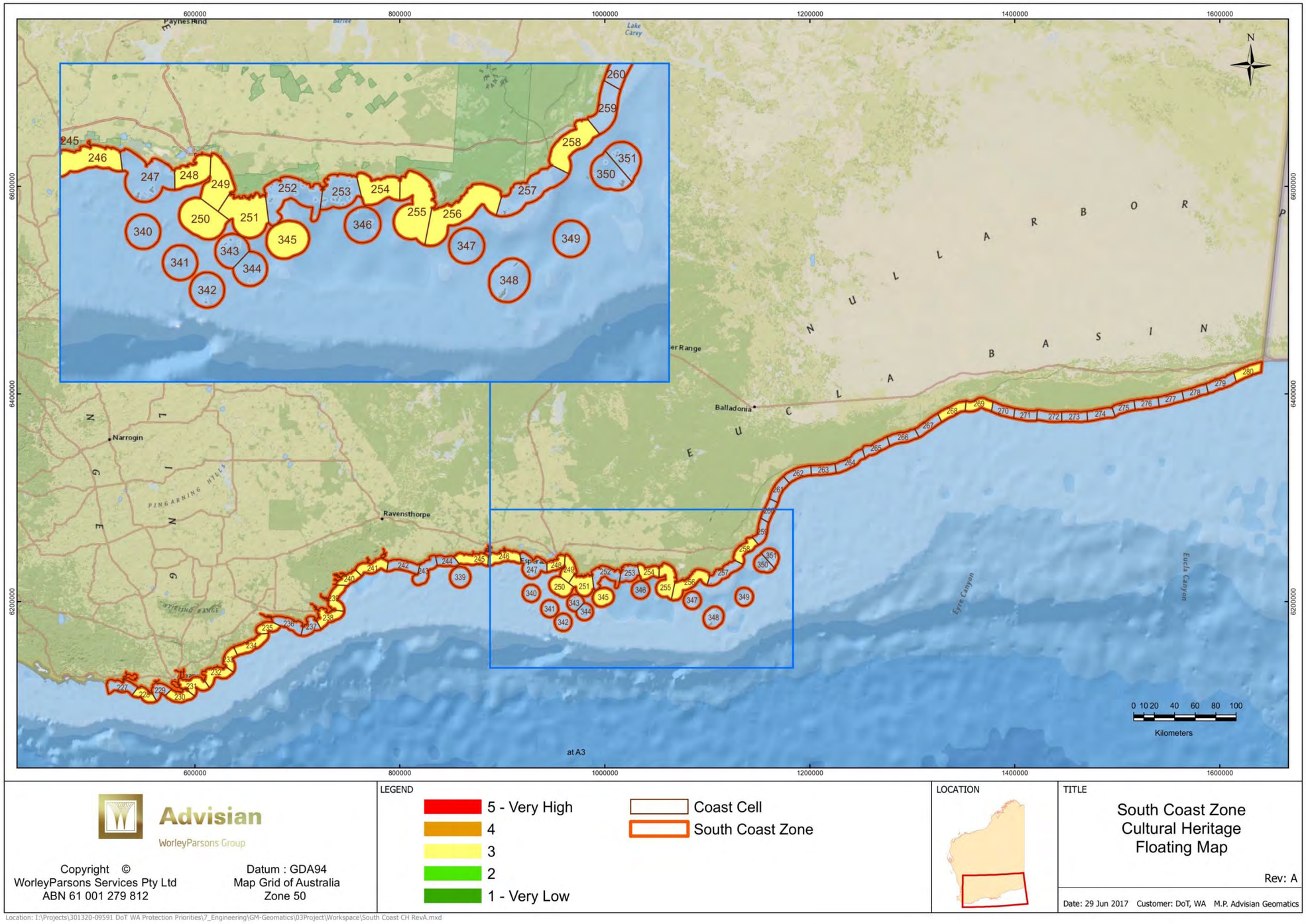

Figure B5: Cultural heritage shoreline cell protection priority ranking for floating hydrocarbons effects

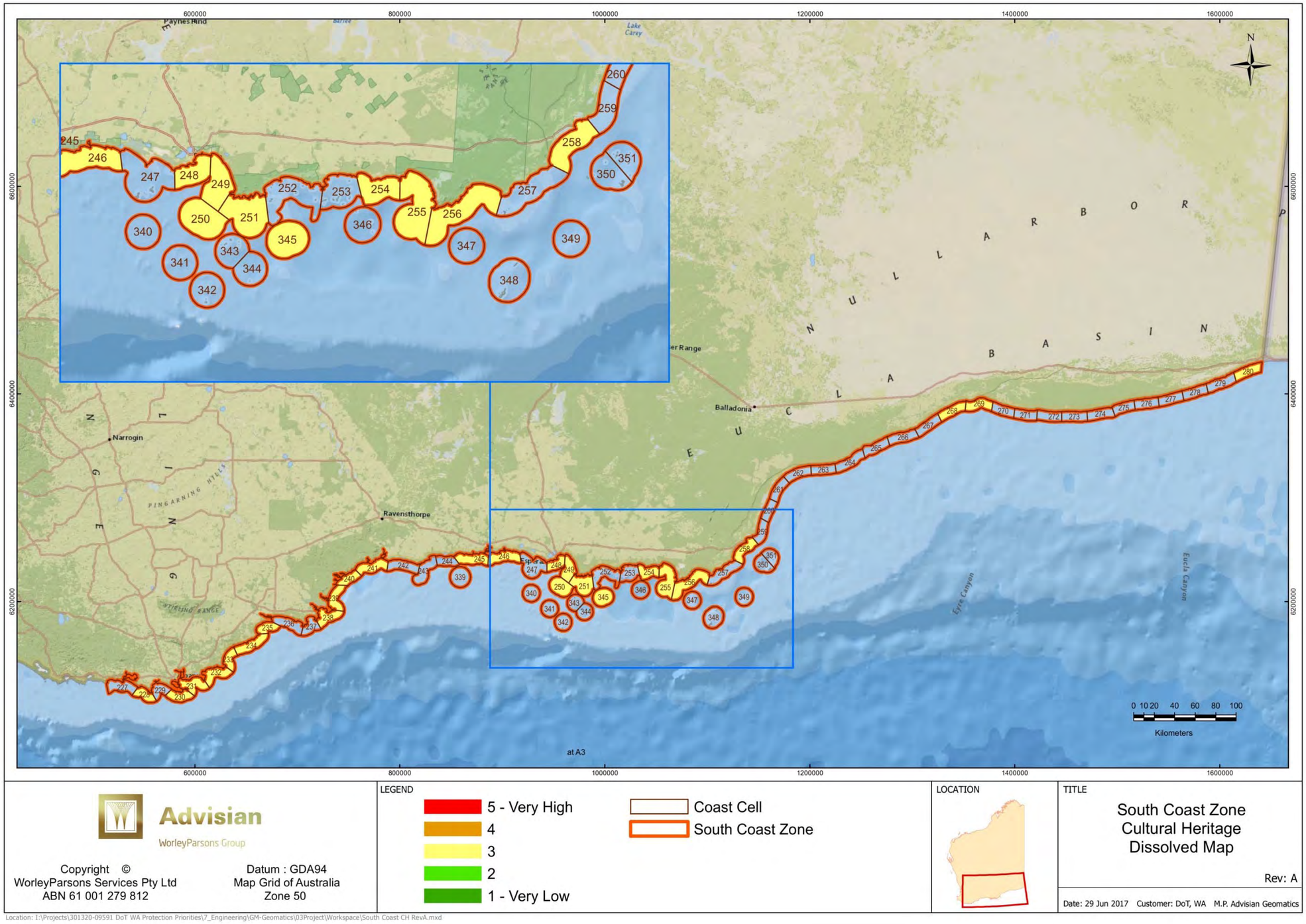

Figure B6: Cultural heritage shoreline cell protection priority ranking for dissolved hydrocarbons effects

Economic

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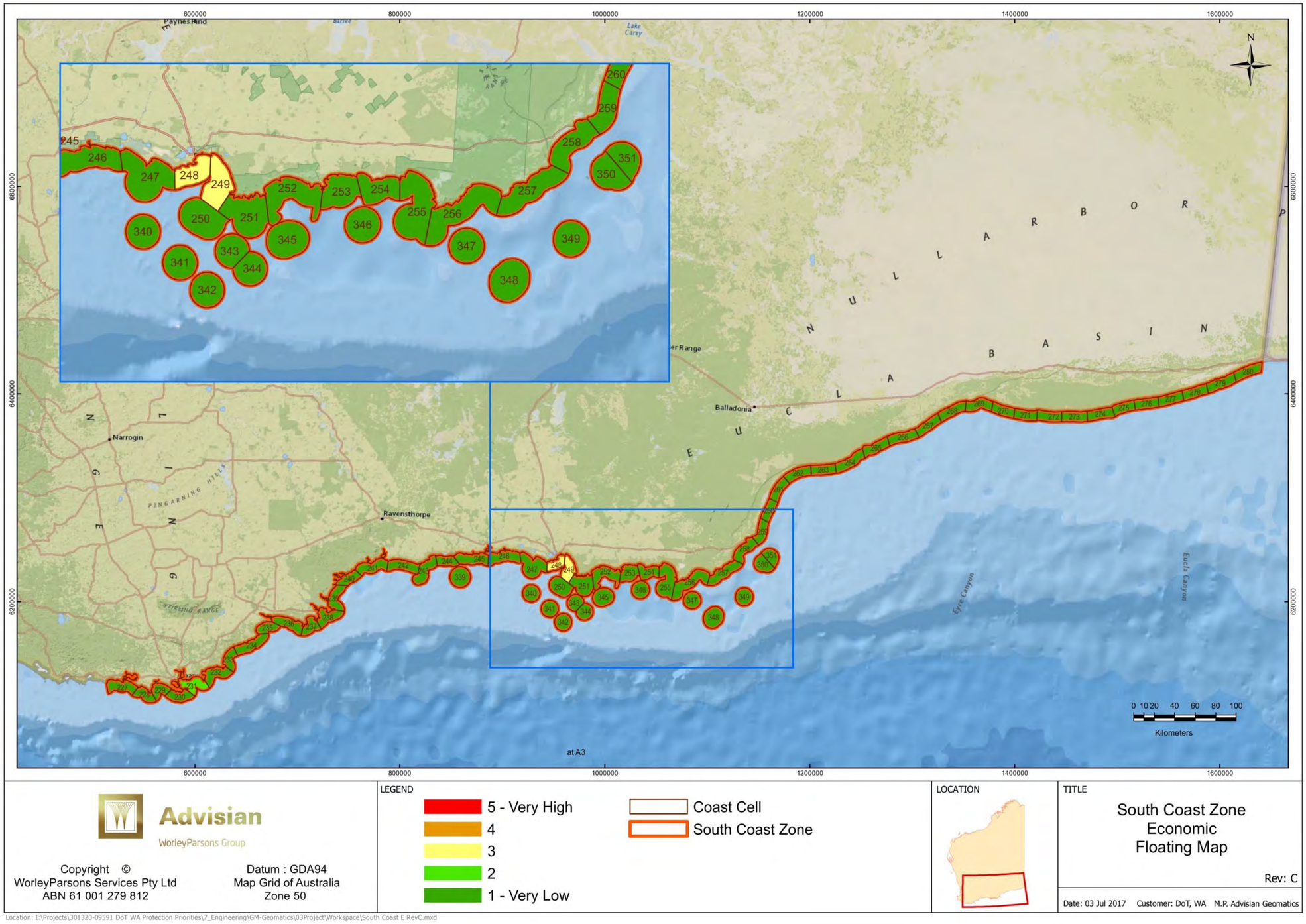

Figure B7: Economic shoreline cell protection priority ranking for floating hydrocarbons effects

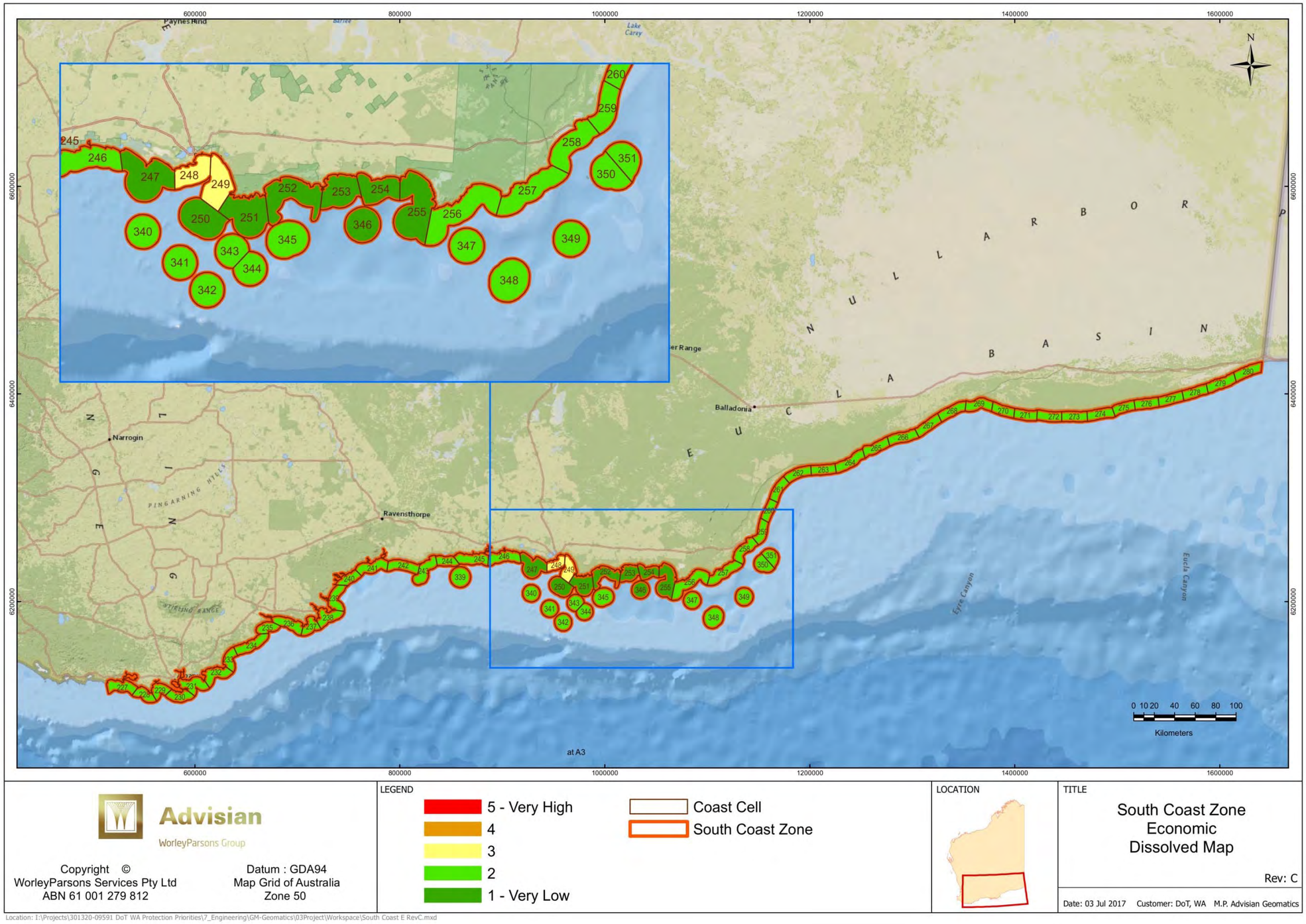

Figure B8: Economic shoreline cell protection priority ranking for dissolved hydrocarbons effect

Social, Amenity and Recreation

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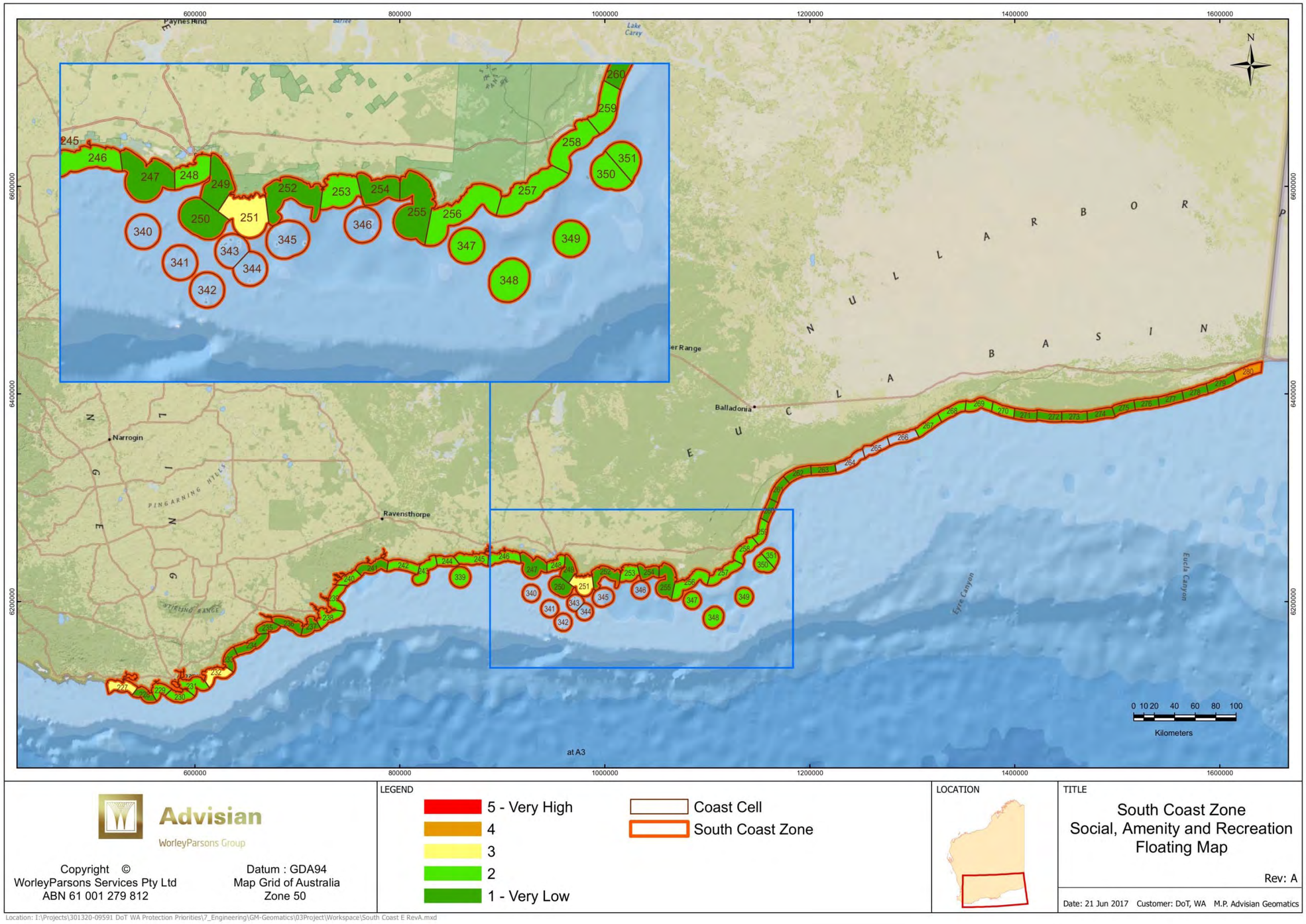

Figure B9: Social, amenity and recreation shoreline cell protection priority ranking for floating hydrocarbons effects

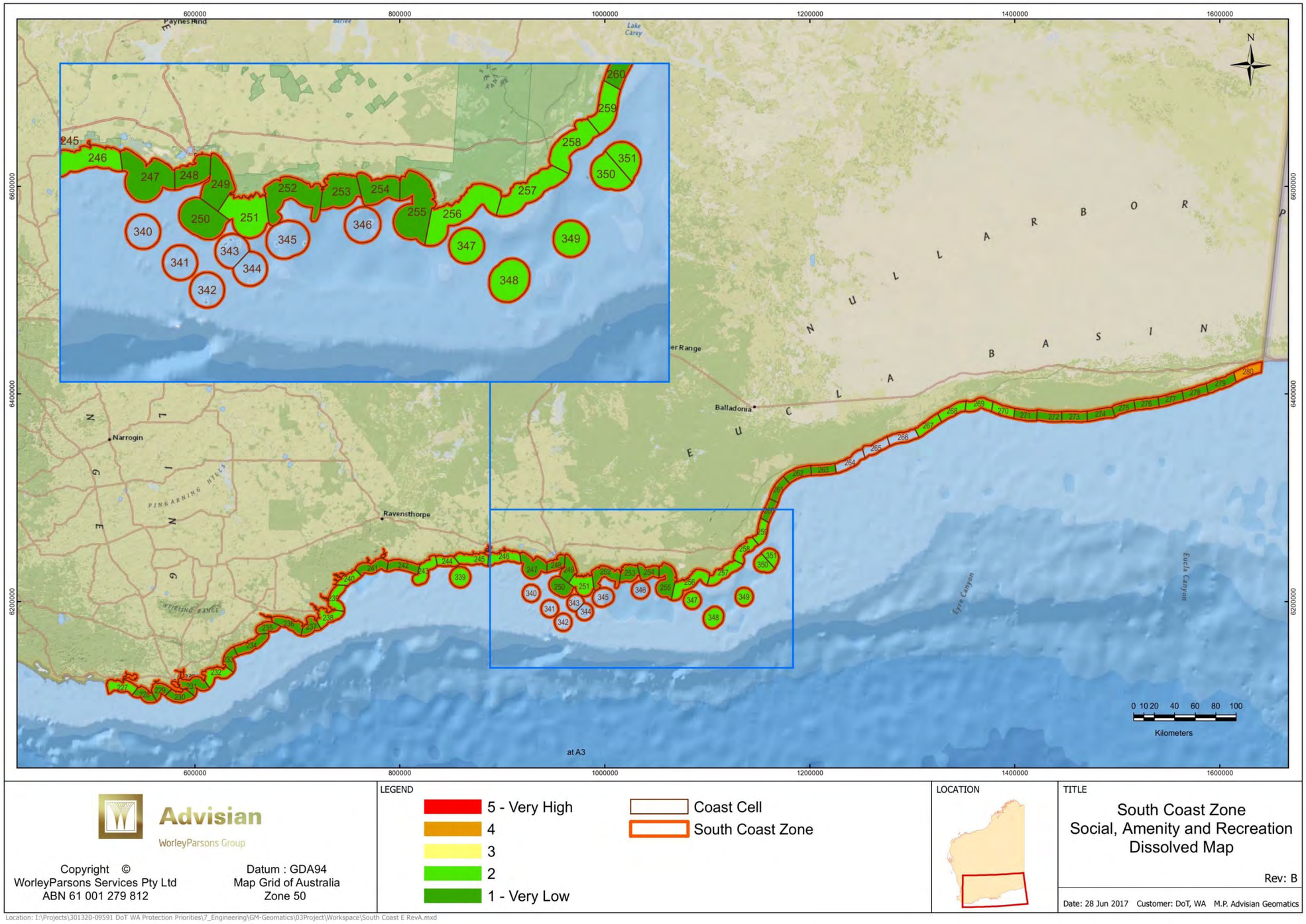

Figure B10: Social, amenity and recreation shoreline cell protection priority ranking for dissolved hydrocarbons effects