10 REFERENCES

Abdul-Azis PK, Al-Tisan IA, Daili MA, Green TN, Dalvi AGI and Javeed MA 2003. Chlorophyll and plankton of the Gulf coastal waters of Saudi Arabia bordering a desalination plant. *Desalination* 154: 291-302.

American Chemistry Council 2006. A Comparison of the Environmental Performance of Olefin and Paraffin Synthetic Base Fluids (SBF).

AMSA 2015. NP-GUI-012: National Plan technical guidelines for preparing contingency plans for marine and coastal facilities. Accessed at: < https://www.amsa.gov.au/marine-environment/national-plan-maritime-environmental-emergencies/np-gui-012-national-plan>

Australian Bureau of Agricultural and Resource Economics and Sciences (ABARES) 2019. Fishery Status Reports. Australian Bureau of Agricultural and Resource Economics and Sciences. Accessed at: <https://www.agriculture.gov.au/abares/research-topics/fisheries/fishery-status>

Baker C, Potter A, Tran M and Heap A 2008. Sedimentology and Geomorphology of the Northwest Marine Region – A spatial analysis. Geoscience Australia, Australian Government.

Bakke T, Klungsøyr J, and Sanni S 2013. Environmental impacts of produced water and drilling waste discharges from the Norwegian offshore petroleum industry. *Marine Environmental Research* 92:154-169.

Bannister JL, Kemper, CM and Warneke, RM 1996. The action plan for Australian cetaceans, Australian Nature Conservation Agency, Canberra. Accessed at:<https://www.environment.gov.au/resource/action-plan-australian-cetaceans>

Bejder M, Johnston D, Smith J, Friedlaender A and Bejder L 2016. Embracing conservation success of recovering humpback whale populations: Evaluating the case for downlisting their conservation status in Australia. *Marine Policy* 66:137–141.

Black KP, Brand GW, Gwyther D, Hammond LS, Mourtikes S, Moyes-Fitzsimmons RL, Smith JM and Richardson BJ 1994. Coastal facilities. In *Environmental implications of offshore oil and gas development in Australia: The findings of an independent review*, eds JM Seans, JM Neff & PC Young, Australian Petroleum Exploration Association, Sydney, 209-407.

BP 2013. Shah Deniz 2 Project. In *Environmental and Socio-Economic Impact Assessment*. BP Development Pty Ltd.

Brewer D, Lyne V, Skewes T and Rothlisberg P 2007. Trophic Systems of the North-West Marine Region. Report to the Department of the Environment, Water, Heritage and the Arts, CSIRO, Cleveland.

Bruce BD and Bradford RW 2008. Spatial dynamics and habitat preferences of juvenile white sharks—identifying critical habitat and options for monitoring recruitment. Final report to Department of Environment, Water, Heritage and the Arts, 71.

Bruce BD, Stevens JD and Malcolm H 2006. Movements and swimming behaviour of white sharks (*Carcharodon carcharias*) in Australian waters. *Marine Biology* 150:161-172.

Carroll AG, Przeslawskia R, Duncanb A, Gunningc M and Bruced B 2017. A critical review of the potential impacts of marine seismic surveys on fish and invertebrates. *Marine Pollution Bulletin* 114(1):9-24.

Chatto R 2001. The distribution and status of colonial breeding seabirds in the Northern Territory, technical report 70, Parks and Wildlife Commission of the Northern Territory, Palmerston.

Commonwealth of Australia (CoA) 2019. National Light Pollution Guidelines for Wildlife Including Marine Turtles, Seabirds and Migratory Shorebirds, Canberra, Australia.

CoA 2017. Conservation Management Plan for the Blue Whale. Accessed at: < https://www.environment.gov.au/system/files/resources/9c058c02-afd1 -4e5d-abff-11cac2ebc486/files/blue-whale-conservation-management-plan.pdf>

Conservation and Land Management (CALM) 2005. Management Plan for the Ningaloo Marine Park and Muiron Islands Marine Management Area 2005 – 2015. Management Plan Number 52. Department of Conservation and Land Management, Perth, WA.

Crawford, R.J.M., Davis, S.A., Harding, R.T., Jackson, L.F., Leshoro, T.M., Myer, M.A., Randall, R.M., Underhill, L.G., Upfold, L., Van Dalsen, A.P., Van Der Merwe, E., Whittington, P.A., Williams, A.J. and Wolfaardt, A.C. 2000. Initial Impact of the Treasure Oil Spill on Seabirds off Western South Africa. South African Journal of Marine Science 22:157-176.

CSIRO 2011. Regional Climate Vulnerability Assessment: The Pilbara. CSIRO Report EP114812, CSIRO, Western Australia.

Currie DR and Isaacs LR 2005. Impact of exploratory offshore drilling on benthic communities in the Minerva gas field, Port Campbell, Australia. *Marine Environmental Research* 59:217-233.

Daan R and M Mulder 1996. Long-term effects of OBM cuttings discharges at 12 locations on the Dutch continental shelf. NIOZ-report 1996-6.

DBCA 2017. Pilbara Inshore Islands Nature Reserves. Parks and Wildlife Service, Department of Biodiversity, Conservation and Attractions. Government of Western Australia. Accessed at: https://parks.dpaw.wa.gov.au/park/pilbara-inshore-islands

del Hoyo J., Elliott A. and Sargatal J. (eds) 1996. Handbook of the birds of the world, volume 2: New World vultures to guineafowl, Lynx Edicions, Barcelona.

Department of Environment (DOE) 2004. Pilbara Air Quality Study – Summary Report. Department of Environment, Technical Series No. 120. Accessed at: <https://www.der.wa.gov.au/images/documents/your-environment/air/publications/pilbara-air-quality-report-2004.pdf>

Department of the Environment (DotE) 2015a. Conservation Management Plan for the Blue Whale — A Recovery Plan under the Environment Protection and Biodiversity Conservation Act 1999.

DotE 2015b. Wildlife Conservation Plan for Migratory Shorebirds. Commonwealth of Australia 2015. Accessed on J Jan 2020 at: <http://www.environment.gov.au/system/files/resources/9995c620-45c9-4574-af8e-a7cfb9571deb/files/widlife-conservation-plan-migratory-shorebirds.pdf>

Department of the Environment, 2020. Dugong dugon in Species Profile and Threats Database, Department of the Environment, Canberra. Available from: http://www.environment.gov.au/sprat. Accessed Tue, 21 Jan 2020 14:17:54 +1100.

Department of Environment and Conservation (DEC) 2006. Background quality for coastal marine waters of the North West Shelf, Western Australia Technical Report. Wenziker K, McAlpine K, Apte S, Masini R. Available at:

<http://epa.wa.gov.au/sites/default/files/Policies_and_Guidance/NWSJEMS%20Technical%20Report-NWS%20BG%20WaterQual.pdf>

Department of the Environment and Energy (DEE) 2019a. Species Profile and Threats Database. *Ardenna pacifica* — Wedge-tailed Shearwater. Department of the Environment and Energy, Canberra. Accessed on 26 Nov 2019 at: < http://www.environment.gov.au/cgi-bin/sprat/public/publicspecies.pl?taxon_id=84292>

DEE 2019b. Species Profile and Threats Database – Exmouth Plateau. Department of the Environment and Energy, Australian Government. Accessed at: <https://www.environment.gov.au/sprat-public/action/kef/view/12;jsessionid=ACF4D013818E181DD36A2CF029BE5656>

DEE 2019c. Species Profile and Threats Database – *Dugong dugon* — Dugong. Department of the Environment and Energy, Australian Government. Accessed at: < http://www.environment.gov.au/cgi-bin/sprat/public/publicspecies.pl?taxon_id=28>

DEE 2019d. World Heritage Places - The Ningaloo Coast. Department of Environment and Energy Accessed at: <https://www.environment.gov.au/heritage/places/world/ningaloo>

DEE 2019e. Underwater heritage protected zones. Accessed at: https://www.environment.gov.au/heritage/underwater-heritage/protected-zones

DEE 2018. Threat Abatement Plan for the impacts of marine debris on the vertebrate wildlife of Australia's coasts and oceans (2018). Commonwealth of Australia 2018. Accessed at: <https://www.environment.gov.au/system/files/resources/e3318495-2389-4ffc-b734-164cdd67fe19/files/tap-marine-debris-2018.pdf>

DEE 2017. Recovery Plan for Marine Turtles in Australia 2017-2027. Commonwealth of Australia 2017. Accessed on 7 Jan 2020 at: <https://www.environment.gov.au/system/files/resources/46eedcfc-204b-43de-99c5-4d6f6e72704f/files/recovery-plan-marine-turtles-2017.pdf>

DEE 2015. National Conservation Values Atlas. Department of Environment and Energy, Australian Government. Accessed at: <http://www.environment.gov.au/webgis-framework/apps/ncva/ncva.jsf>

DEE 2000. Directory of Important Wetlands in Australia - Information sheet: Cape Range Subterranean Waterways - WA006. Compiled originally Roger P. Jaensch in 1992. Minor revision by Romeny J. Lynch and WADCALM staff in 1995 and Sue Elscot in 2000. Accessed at: <http://www.environment.gov.au/cgi-bin/wetlands/report.pl?smode=DOIW;doiw_refcodelist=WA006>

Department of the Environment, Water, Heritage and the Arts (DEWHA) 2010. Australian sea lion (*Neophoca cinerea*) recovery plan—technical issues paper Australian Government Department of the Environment, Heritage, Water and the Arts, Canberra. Accessed on 21 March 2011 at: <https://www.environment.gov.au/system/files/resources/1eb9233c-8474-40bb-8566-0ea02bbaa5b3/files/neophoca-cinerea-recovery-plan.pdf>

DEWHA 2008. The North-west Marine Bioregional Plan, Bioregional Profile. A Description of the Ecosystems, Conservation Values and Uses of the North-west Marine Region. Department of Environment, Water, Heritage and the Arts. Commonwealth of Australia, Canberra, Australia.

Department of Fisheries and Oceans (DFO) 2004. Review of Scientific Information on Impacts of Seismic Sound on Fish, Invertebrates, Marine Turtles and Marine Mammals. Canadian Science Advisory Secretariat (CSAS), Habitat Status Report 2004/002, Department of Fisheries and Oceans (DFO), Canada. 15. Accessed at: <http://www.dfompo.gc.ca/csas/Csas/status/2004/HSR2004_002_e.pdf>

Department of Mines, Industry, Regulation and Safety (DMIRS) 2019. Northern Carnarvon Basin. Department of Mines, Industry Regulation and Safety, Western Australia. Accessed at: <https://www.dmp.wa.gov.au/Petroleum/Northern-Carnarvon-Basin-10990.aspx.>

Det Nortske Vertitas (DNV) 2011. Final Report– Assessment of the Risk of Pollution for Marine Oil Spills in Australian Ports and Waters. Det Norske Veritas report for Australian Maritime Safety Authority. London, UK. Accessed at: <https://www.amsa.gov.au/marine-environment/national-plan-maritime-environmental-emergencies/assessment-risk-pollution-marine>

Department of Parks and Wildlife (DPAW). 2013. Whale shark management with particular reference to Ningaloo Marine Park, Wildlife management program no.57, Department of Parks and Wildlife, Perth, Western Australia.

Department of Parks and Wildlife (DPAW) 2016. Management Plan for the Ningaloo Marine Park and Muiron Islands Marine Management Area. 2005 - 2015 Management Plan Number 52. Accessed at: https://www.dpaw.wa.gov.au/images/documents/parks/management-plans/decarchive/ningaloo_mp_01_2005_withmaps.pdf DPIRD 2019a. Aquatic Resources Management Act. Department of Primary Industries and Regional Development, Western Australia. https://www.fish.wa.gov.au/Fishing-and-Aquaculture/Aquatic-resources-management-act/Pages/default.aspx

Department of Primary Industries and Regional Development (DPIRD) 2019a. Aquatic Resources Management Act. Department of Primary Industries and Regional Development, Western Australia. Accessed at: <https://www.fish.wa.gov.au/Fishing-and-Aquaculture/Aquatic-resources-management-act/Pages/default.aspx>

DPIRD 2019b. The catch and effort data used in this study was obtained on 5 May 2019 from the Department of Primary Industries and Regional Development, Western Australia.

Department of Sustainability, Environment, Water, Population and Communities (DSEWPaC) 2013. Recovery Plan for the White Shark (*Carcharodon carcharias*). Commonwealth of Australia, Canberra. Accessed on 7 Jan 2020 at: <https://www.environment.gov.au/system/files/resources/ce979f1b-dcaf-4f16-9e13-010d1f62a4a3/files/white-shark.pdf>

DSEWPC 2012a. The North-West Marine Bioregional Plan. The Department of Sustainability, Environment, Water, Population and Communities, Canberra. Accessed at: < https://www.environment.gov.au/system/files/pages/1670366b-988b-4201-94a1-1f29175a4d65/files/north-west-marine-plan.pdf>

DSEWPC 2012b. Species group report card – seabirds and migratory shorebirds. The Department of Sustainability, Environment, Water, Population and Communities, Canberra. Accessed at: <https://www.environment.gov.au/system/files/pages/1670366b-988b-4201-94a1-1f29175a4d65/files/north-west-report-card-seabirds.pdf>

DSEWPC 2012c. Species group report card —cetaceans. Department of Sustainability, Environment, Water, Population and Communities, Canberra. Accessed at:

<http://www.environment.gov.au/system/files/pages/a73fb726-8572-4d64-9e33-1d320dd6109c/files/south-west-report-card-cetaceans.pdf>

DSEWPC 2011. National recovery plan for threatened albatrosses and giant petrels 2011-2016, Commonwealth of Australia, Hobart. Accessed on 7 Jan 2020 at: < https://www.environment.gov.au/system/files/resources/bb2cf120-0945-420e-bdfa-d370cf90085e/files/albatrosses-and-giant-petrels-recovery-plan.pdf>

Director of National Parks (DNP) 2018a. North-west Marine Parks Network Management Plan 2018, Director of National Parks, Canberra.

DNP 2018b. South-west Marine Parks Network Management Plan 2018, Director of National Parks, Canberra.

DNP 2013. North-West Commonwealth Marine Reserves Network Management Plan 2014-24. Director of National Parks, Canberra. Accessed at: <https://www.legislation.gov.au/Details/F2013L00428/Html/Volume_2>

Dunlop R, Noad M, McCauley R, Kniest E, Slade R, Paton D and Cato D 2017. The behavioural response of migrating humpback whales to a full seismic airgun array. Published by the Royal Society. Accessed at: https://doi.org/10.1098/rspb.2017.1901

DWER 2006. The South-west Marine Region: Ecosystems and Key Species Groups. Part 2 Species Group. Available at:< https://www.environment.gov.au/system/files/resources/5d5ddf48-0f87-4e76-9613-2291e29c42f6/files/sw-ecosystems-part2.pdf >

EA (Environment Australia) 2003. Recovery plan for marine turtles in Australia, Environment Australia, Canberra.

Edyvane K 1999. Coastal and marine wetlands in Gulf St Vincent, South Australia: understanding their loss and degradation. *Wetlands Ecology and Management* 7: 83-104.

ERM 2013. Scarborough Marine Studies – Environmental Characterisation Report. Report prepared for Esso Australia Pty Ltd, by Environmental Resources Management Australia. Report Reference: 0177357.

Esler D, Ballachey B, Matkin C, Cushin D, Kaler R, Bodkin J, Monson D, Esslinger G, Kloecker. 2018. Timelines and mechanisms of wildlife population recovery following the Exxon Valdez oil spill. Deep Sea Research Part II: Topical Studies in Oceanography Volume 147, January 2018, Pages 36-42

Fields DM, Handegard NO, Dalen J, Eichner C, Malde K, Karlsen Ø, Skiftesvik AB, Durif CMF and Browman HI 2019. Airgun blasts used in marine seismic surveys have limited effects on mortality, and no sublethal effects on behaviour or gene expression, in the copepod *Calanus finmarchicus*. *ICES Journal of Marine Science* 76:7, 2033–2044. Accessed on 20 Dec 2019: < https://academic.oup.com/icesjms/article/76/7/2033/5543877>

Forrest BM, Gardner JP and Taylor MD 2009. Internal borders for managing invasive marine species. *Journal of Applied Ecology*, 46(1):46-54.

Fox NJ and Beckley LE 2005. Priority Areas for Conservation of Western Australian Coastal Fishes: A Comparison of Hotspot, Biogeographical and Complimentary Approaches. *Biological Conservation* 125:399–410.

Fraker MA 2013. Killer Whale (*Orcinus orca*) Deaths in Prince William Sound, Alaska, 1985-1990. *Human and Ecological Risk Assessment: An International Journal* 19(1): 28-52.

French McCay D, Crowley D, Rowe JJ, Bock M, Robinson H, Wenning R, Hayward WA, Joeckeld J, Nedwede JT and Parkerton TF 2018. Comparative Risk Assessment of spill response options for a deepwater oil well blowout: Part 1. Oil spill modelling, *Marine Pollution Bulletin* 133:1001-1015.

French McCay D 2016. Potential Effects Thresholds for Oil Spill Risk Assessments. Proceedings of the *39th AMOP Technical Seminar*, Environment and Climate Change Canada, Ottawa, ON, 285-303.

French McCay, D.P. 2004. Oil spill impact modelling: Development and validation. Environmental Toxicology and Chemistry 23(10):2441–2456.

Frick, W.E., Roberts, P.J.W., Davis, L.R., Keyes, J., Baumgartner, D.J., George, K.P., 2001. Dilution Models for Effluent Discharges. 4th Edition (Visual Plumes). U.S. EPA Environmental Standards Division.

Fulton E, McDonald D, Hayes D, Lyne V, Little LR, Fuller M, Condie S, Gray R, Scott R, Webb H, Hatfield B, Martin M, Sainsbury K 2006. Management Strategy Evaluation Specification for Australia's North West Shelf. NWSJEMS Technical Report No. 15., CSIRO, Hobart, Tasmania.

Gardline 2009. Hess exploration Australia Pty Limited Auraria-B – Carnarvon Basin Australia Block WA390-P May 2009 Interpretation report. Gardline Geosurvey Ltd, Norfolk.

Garnett ST. and Crowley GM. 2000. The action plan for Australian birds, Environment Australia, Canberra.

Garnett ST, Szabo J and Dutson, G 2011. The 2011 Action Plan for Australian Birds, CSIRO Publishing, Canberra.

Geraci JR and St. Aubin DJ 1988. Synthesis of Effects of Oil on Marine Mammals. Report to US Department of the Interior, Minerals Management Service, Atlantic OCS Region, OCS Study. Ventura, California.

Greenlight Environmental (GLE) 2019. Western Gas Equus Project – Development Concept and Site Selection Rev01. Fremantle Western Australia.

Hamilton LJ 1997. Methods to obtain representative surface wave spectra, illustrated for two ports of north-western Australia. Marine Freshwater Research 48: 43-57.

Hamilton-Smith E, Kiernan K and Spate A 1998. Karst Management Considerations for the Cape Range Karst Province, Western Australia. Department of Environmental Protection, Perth.

Hannay D, A MacGillivray, Laurinolli M and Racca R 2004. Sakhalin Energy: Source Level Measurements from 2004 Acoustics Program. Version 1.5. Technical report prepared for Sakhalin Energy by JASCO Applied Sciences.

Hanson C, Waite A, Thompson PA, and Pattiaratchi C 2007. Phytoplankton community structure and nitrogen nutrition in Leeuwin Current and coastal waters off the Gascoyne region of Western Australia. *Deep Sea Research Part II: Topical Studies in Oceanography*, 54(8-10):902-924. Accessed at: <https://doi.org/10.1016/j.dsr2.2006.10.002>

Hedley SL, Bannister JL, Dunlop RA. 2011. Abundance estimates of Southern Hemisphere Breeding Stock 'D' Humpback Whales from aerial and land-based surveys off Shark Bay, Western Australia, 2008. *Journal of Cetacean Research and Management (Special Issue)* 2011(3):209–21.

Helm RC, Costa DP, O'Shea TJ, Wells RS and Williams TM 2015. Overview of Effects of Oil Spills on Marine Mammals. Handbook of Oil Spill Science and Technology.

Higgins PJ and Davies SJJF (eds) 1996. Handbook of Australian, New Zealand and Antarctic birds, volume 3: snipe to pigeons, Oxford University Press, Melbourne

Hinwood JB, Poots AE, Dennis LR, Carey JM, Houridis H, Bell RJ, Thomson JR, Boudreau P, Ayling AM. 1994. Drilling activities. In: Swan JM, Neff JM, Young PC (eds) *Environmental Implications of offshore oil and gas development in Australia: findings of an independent scientific review*. Australian Petroleum Production and Exploration Association, Canberra, 123–207.

Hook S, Batley G, Holoway M, Irving P and Ross A 2016. Oil Spill Monitoring Handbook. CSIRO Publishing.

Huisman, J.M. 2000. Marine Plants of Australia. UWA Publishing, Perth, Western Australia.

Hyland J, Hardin D, Steinhauer M, Coats D, Green DR and Neff J 1994. Environmental impact of offshore oil development on the outer continental shelf and slope off Point Arguello, California. *Marine Environmental Research* 37:195-229.

INPEX 2009. Ichthys Gas Filed Development Project: Appendix 15, Review of Literature on Sound in the Ocean and Effects of Noise on Marine Fauna. INPEX Browse Ltd. Perth. Accessed at: <https://www.inpex.com.au/media/1738/draft-eis-technical-appendices-appendix-15-review-of-literature-on-sound-in-the-ocean-and-on-the-effects-of-noise-on-marine-fauna.pdf>

ITOPF, 2014. Fate of Marine Oil Spills. Technical Information Paper. Number 2. Accessed on 29 Mar 2019 at: <https://www.itopf.org >

ITOPF, 2011. Effects of Oil Pollution on the Marine Environment. Technical Information Paper. Number 13. Accessed on 29 Mar 2019 at: <https://www.itopf.org >

IUCN (International Union for Conservation of Nature) 2010. The IUCN red list of threatened species.

Jaensch RA and Watkins DG 1999. Nomination of additional Ramsar Wetlands in Western Australia: Final Report. Department of Conservation and Land Management, Perth.

Jenkins GP and McKinnon L 2006. Channel Deepening Supplementary Environmental Effects Statement - Aquaculture and Fisheries. Department of Primary Industries, Queenscliff.

Jenner KCS, Jenner MNM and McCabe KA 2001, Geographical and temporal movements of humpback whales in Western Australia. Australian Petroleum Production and Exploration Association Journal 41:749–765.

Jones DOB, Hudson IR, Bett BJ 2006. Effects of physical disturbance on the cold-water megafaunal communities of the Faroe-Shetland Channel. Marine Ecology Progress Series 319: 43–54.

Jones DOB, Gates AR and Lausen B 2012. Recovery of deep-water megafaunal assemblages from hydrocarbon drilling disturbance in the Faroe-Shetland Channel. *Marine Ecology Progress Series* 461: 71–82.

Jones D and Morgan G 1994. A Field Guide to Crustaceans of Australian Waters. Reed Books, Australia.

Kirkman H 1997. Seagrasses of Australia: State of the Environmental Technical Paper Series (Estuaries and the Sea). 366pp.

Klimley AP and Myrberg AA 1979. Acoustic stimuli underlying withdrawal from a sound source by adult lemon sharks, Negaprion brevirostris (Poey). Bull. Mar. Sci. 29, 447–458.

Langford TEL 1990. Ecological effects of thermal discharges. *Elsevier* xi:468.

Lee RF 1980. Processes affecting the fate of oil in the sea. In Marine Environmental Pollution. 1: Hydrocarbons, ed. R. A. Geyer. *Elsevier* 337-351.

Limpus CJ 2008a. A biological review of Australian marine turtle species: 1. Loggerhead turtle, *Caretta caretta Linneaus*), Environmental Protection Agency, Queensland.

Limpus CJ 2008b. A biological review of Australian marine turtle species: 2. Green turtle, *Chelonia mydas (Linneaus*), Environmental Protection Agency, Queensland.

Marchant S and Higgins PJ (eds) 1990. Handbook of Australian, New Zealand and Antarctic birds, volume 1: ratites to ducks, part A: ratites to petrels, Oxford University Press, Melbourne.

Marsh H, Eros C, Penrose H and Hugues J 2002. Dugong status report and action plans for countries and territories. UNEP Early Warning and Assessment Report Series 1. Cambridge: UNEP.

Marsh H, O'Shea TJ and Reynolds JR 2011. The ecology and conservation of sirenia; dugongs and manatees. Cambridge University Press, London, United Kingdom.

McClatchie S, Middleton J, Pattiaratchi C, Currie, D and Kendrick G 2006. The South-west Marine Region: Ecosystems and Key Species Groups. Department of the Environment and Water Resources. Australian Government.

McCauley RD. 2004. Underwater sea noise in the Otway Basin – drilling, seismic and blue whales. Report prepared by Centre for Marine Science and Technology, Curtin University, for Santos Ltd McIntyre, A.D. and Johnson, R. 1975. Effects of nutrient enrichment from sewage in the sea. In: ALH Gameson, ed. Discharge of sewage from sea outfalls. New York, Pergamon Press. pp.131–141.

McCauley 1998. Radiated underwater noise measured from the drilling rig 'Ocean General', rig tenders 'Pacific Ariki' and 'Pacific Frontier', fishing vessel 'Reef Venture' and natural sources in the Timor Sea, Northern Australia. Report prepared for Shell Australia, 54.

McLeay LJ, Sorokin SJ, Rogers PJ and Ward TM 2003. Benthic Protection Zone of the Great Australian Bight Marine Park: Literature Review. Prepared by the South Australia Marine Research and Development Institute (Aquatic Sciences) for the Commonwealth Department of Environment and Heritage.

Meekan MG, Wilson SG, Halford A and Retzel A 2001. A comparison of catches of fishes and invertebrates by two light trap designs, in tropical NW Australia. Marine Biology 139: 373-381.

Milicich MJ 1992. Light traps: a novel technique for monitoring larval supply and replenishment of coral reef fish populations. PhD thesis, Griffith University.

Milton S and Lutz P 2010. Oil and Sea Turtles. Biology, Planning and Response. US Department of Commerce.

Montevecchi WA 2006. Influences of artificial light on marine birds. Chapter 5 in C. Rich and T. Longcore, eds. *Ecological consequences of artificial night lighting*. Washington, D.C., Island Press.

Mustoe S and Edmunds M 2008. Coastal and marine natural values of the Kimberley, report by AES Applied Ecology Solutions for WWF-Australia.

Myberg 2001. The Acoustical Biology of Elasmobranchs. Environmental Biology of Fishes 60(1):31-46.

National Marine Fisheries Service (NMFS) 2016. Technical Guidance for Assessing the Effects of Anthropogenic Sound on Marine Mammal Hearing Underwater Acoustic Thresholds for Onset of Permanent and Temporary Threshold Shifts. U.S. Dept. of Commer., NOAA. NOAA Technical Memorandum NMFS-OPR-55, p178. Accessed at: <https://www.sprep.org/attachments/VirLib/Global/technical-guidance-assessing-effects-anthropogenic-sound-marine-mammal-hearing-noaa.pdf>

NMFS 2014. Marine Mammals: Interim Sound Threshold Guidance (webpage). National Marine Fisheries Service, National Oceanic and Atmospheric Administration, U.S. Department of Commerce. Accessed at: <http://www.westcoast.fisheries.noaa.gov/protected_species/marine_mammals/threshold_guidance.html >

Neff JM 2010. Fate and effects of water based drilling muds and cuttings in cold water environments. Houston (TX): Report to Shell Exploration and Production Company. p309. Available at: <www-static.shell.com/static/usa/downloads/2010/alaska/neff_final_draft_gs-072010>

Neff JM 2005. Composition, environmental fates, and biological effects of water based drilling muds and cuttings discharged to the marine environment: a synthesis and annotated bibliography. Report prepared for the Petroleum Environmental Research Forum (PERF). Washington DC: American Petroleum Institute.

Neuparth T, Costa F and Costa MH 2002. Effects of Temperature and Salinity on Life History of the Marine Amphipod Gammarus locusta. Implications for Ecotoxicological Testing. *Ecotoxicology* 11(1):61-73.

NOAA 2018. Marine Mammal Acoustic Technical Guidance 2018 Revision to: Technical Guidance for Assessing the Effects of Anthropogenic Sound on Marine Mammal Hearing. Available at: < https://www.fisheries.noaa.gov/national/marine-mammal-protection/marine-mammal-acoustic-technical-guidance>

NOPSEMA 2019. Environmental bulletin April 2019: Oil spill modelling. NOPSEMA. Accessed at: < https://www.nopsema.gov.au/assets/Bulletins/A652993.pdf >

NOPSEMA 2015. ALARP Guidance Note (N-04300-GN0166). Accessed at: <https://www.nopsema.gov.au/assets/Guidance-notes/A138249.pdf>

NRDA 2012. April 2012 Status Update for the Deepwater Horizon Oil Spill. Accessed at: < http://www.gulfspillrestoration.noaa.gov. Natural Resource Damage Assessment>

OGUK 2014. The UK offshore oil and gas industry guidance on risk-related decision making. Oil and Gas UK.

OSPAR Commission 2009. Overview of the impacts of anthropogenic underwater sound in the marine environment. Accessed at: < https://qsr2010.ospar.org/media/assessments/p00441_Noise_background_document.pdf>

Parnell PE 2003. The effects of sewage discharge on water quality and phytoplankton of Hawai'ian Coastal Waters. Marine Environmental Research 44:293-311.

Parr W, Clarke SJ, Van Dijk P, Morgan N 1998. Turbidity in English and Welsh Tidal Waters. WRC Report No. CO 4301, Report for English Nature, WRC.

Pearce AF, Buchan S, Chiffings T, D'Adamo N, Fandry C, Fearns P, Mills D, Phillips R and Simpson C 2003. A review of the oceanography of the Dampier Archipelago, Western Australia, Museum of Western Australia, Perth, Western Australia.

Peel D, Smith JN and Childerhouse S 2016. Historical Data on Australian Whale Vessel Strikes. International Whaling Commission. SC/66b/HIM/05 Rev1.

Popper AN, Hawkins AD, Fay RR, Mann D, Bartol S, Carlson T, Coombs S, Ellison WT, Gentry R and Halvorsen MB 2014. Sound Exposure Guidelines for Fishes and Sea Turtles: A Technical Report prepared by ANSI-Accredited Standards Committee S3/SC1 and registered with ANSI.

Ramboll Danmark, 2008. Offshore pipeline through the Baltic Sea. Release of sediments from anchor operations. Memo 4.3A-9.

Richardson AJ, Matear RJ and Lenton A 2017. Potential impacts on zooplankton of seismic surveys. CSIRO, Australia. 34 pp.

Richardson WJ, Greene CR, Malme CI and Thomson DH 1995. Marine Mammals and Noise. Academic Press, San Diego, CA, 576 pp.

Rodriguez A, Arcos JM, Bretagnolle V, Dias MP, Holmes ND, Louzao M, Provencher J, Raine AF, Ramírez F and Rodríguez B 2019. Future Directions in Conservation Research on Petrels and Shearwaters. *Frontiers in Marine Science* 6:94.

Rogers PJ, Ward TM, van Ruth PD, Williams A, Bruce BD, Connell SD, Currie DR, Davies CR, Evans K, Gillanders BM, Goldsworthy SD, Griffin DA, Hardman-Mountford NJ, Ivey AR, Kloser RJ, Middleton, JK, Richardson AE, Ross A, Tanner JE and Young J 2013. Physical processes, biodiversity and ecology of the Great Australian Bight Region: a literature review. CSIRO, Australia.

Rowe GT, Polloni PT and Haedrich RL 1982. The Deepsea Macrobenthos on the Continental Margin of the Northwest Atlantic Ocean. Deep-Sea Research 29:257-278.

RPS. 2019. Equus WA-390-P Oil Spill Modelling Rev0. 17 December 2019. RPS Report No: MAQ0899J, RPS Perth.

RPS 2012a. Baseline Water Quality Study – Field Survey Report. Hess Equus Gas Fields Development Project Environmental Impact Assessment. RPS Report No: M11112/15:3, RPS, Perth.

RPS 2012b. Sediment and Infauna – Field Survey Report, Hess Equus Project Environmental Impact Assessment. Report by RPS, Perth Report Number M11112/12:2.

RPS 2005. Gorgon Development on Barrow Island Technical Report Marine Bentic Habitatas. Report prepared for Chevron Texaco Pty Ltd. RPS Bowman Bishaw Gorham Pty Ltd, Perth.

Salgado Kent C, McCauley RD, Duncan A, Erber C, Gavrilov A, Lucke K and Parnum I 2016. Underwater Sound and Vibration from Offshore Petroleum Activities and their Potential Effects on Marine Fauna: An Australian Perspective. Curtin University, Perth, Western Australia. Accessed on 20 Dec 2019 at: <https://www.appea.com.au/wp-content/uploads/2017/08/CMST-Underwater-Sound-and-Vibration-from-Offshore-Activities.pdf>

Semeniuk V, Charmer PN and Le Provost I 1982. The marine environments of the Dampier Archipelago. *Journal of the Royal Society of Western Australia* 65:97-114.

Shaughnessy, PD. 1999. The action plan for Australian seals, Environment Australia, Canberra, Accessed on 20 December 2012 at: <http://www.environment.gov.au/resource/action-plan-australian-seals>

Shell. 2010. Prelude Floating LNG Project EIS Supplement-Response to Submissions.

SKM 2006. Northwest Shelf Cumulative Environmental Impact Study – Offshore Marine Cumulative Assessment. Report prepared for Woodside Energy Pty Ltd by Sinclair Knight Merz, Perth, WA.

Southall, B. L., Bowles, A. E., Ellison, W. T., Finneran, J. J., Gentry, R. L., Greene, C. R. Jr. 2007. Marine mammal noise exposure criteria: initial scientific recommendations. Aqua. Mammals 33, 411–521. doi: 10.1578/AM.33.4.2007.411.

SSE 1993. Review of oceanography of North West Shelf and Timor Sea regions pertaining to the environmental impact of the offshore oil and gas industry. Vol I prepared for Woodside Offshore Petroleum and the APPEA Review Project of Environmental Consequences of Development Related to the Petroleum Production in the Marine Environment: Review of Scientific Research, Report E1379, October 1993.

Sudmeyer R 2016. Climate in the Pilbara, Bulletin 4873, Department of Agriculture and Food, Western Australia, Perth.

Surman C and Nicholson L 2006. Seabirds, in S McClatchie, J Middleton, C Pattiaratchi, D Currie & G Hendrick (eds), *The south-west marine region: ecosystems and key species groups*, Australian Government Department of the Environment and Heritage, Canberra.

Terrens G, Gwyther D and Keough M 1998. Environmental assessment of synthetic-based drilling mud discharges to bass strait, Australia. *APPEA Journal* 38(1):610-625.

Threatened Species Scientific Committee (TSSC) 2015a. Conservation Advice *Megaptera novaeangliae* humpback whale. Canberra: Department of the Environment. Accessed at: <http://www.environment.gov.au/biodiversity/threatened/species/pubs/38-conservation-advice-10102015.pdf. In effect under the EPBC Act from 01-Oct-2015>

TSSC 2015b. Conservation Advice *Balaenoptera borealis* sei whale. Canberra: Department of the Environment. Accessed at: <http://www.environment.gov.au/biodiversity/threatened/species/pubs/34-conservation-advice-01102015.pdf. >

TSSC 2015c. Conservation Advice *Balaenoptera physalus* fin whale. Canberra: Department of the Environment. Accessed at: <http://www.environment.gov.au/biodiversity/threatened/species/pubs/37-conservation-advice-01102015.pdf >

Tourism Western Australia 2017. Western Australia cruising Sanpshot. Government of Western Australia. Accessed at: <https://www.tourism.wa.gov.au/About%20Us/Documents/DESTINATION%20DEVELOPMENT%20247_CRUISE%20SNAPSHOT%20V2%20FINAL.pdf >

United Nations Environment Programme (UNEP) 1985. GESAMP: Thermal discharges in the marine environment. UNEP Regional Seas Reports and Studies No. 45.

UNESCO 2019. Ningaloo Coast. United Nations Educational, Scientific and Cultural Organisation. Accessed at: <https://whc.unesco.org/en/list/1369>

Veron J EN and Marsh LM 1988. Hermatypic corals of Western Australia. Records and annotated species list. Records of the Western Australian Museum 29: 1–136.

Volkman, J.K., Miller, G.J., Revill, A.T. and Connell, D.W. 1994. 'Oil spills.' In Environmental Implications of offshore oil and gas development in Australia - the findings of an independent scientific review. Edited by Swan, J.M., Neff, J.M. and Young, P.C. Australian Petroleum Exploration Association. Sydney.

Walker DI and McComb AJ 1990. Salinity responses of the seagrass Amphibolis antarctica (Labill.) Sonder et Aschers.: Experimental validation of field results. Aquatic Botany 36: 359-366.

WDCS 2006. Vessel Collisions and Cetaceans: What happens when they don't miss the boat. Whale and Dolphin Society. United Kingdom.

DHI Water & Environment Pty Ltd, 2014. Browse FLNG Development Wastewater Dispersion Modelling in Support of EIS. Prepared for Woodside Energy Ltd.

Wiese F, Montevecchi W, Davoren G, Huettman F, Diamond A and Linke J 2001. Seabirds at risk around oil platforms. *Marine Pollution* Bulletin 42.

Wilson S, Polovina J, Stewart B, Meekan M 2006. Movements of whale sharks (*Rhincodon typus*) tagged at Ningaloo Reef, Western Australia. *Marine Biology* 148: 1157– 1166.

Woodside Energy Ltd 2019. Scarborough Offshore Project Proposal. Development Division Revision 2, submission June 2019. Woodside Energy, Perth.

Woodside Energy Ltd 2014. Browse FLNG Development Draft EIS

Woodside 2008. Torosa South - 1 (TS-1) Pilot Appraisal well, Environmental Monitoring Program - Development of Methodologies Part 1 (p51). Report produced by Environmental Resources Management and SKM.

Woodside Energy Ltd 2006. The Pluto LNG Development. Draft Public Environment Report/Public Environmental Review. December 2006.

Woodside Energy Ltd 2005. The Vincent Development – Draft Environmental Impact Statement (EPBC Referral 2005/2110). Perth, Western Australia: Woodside Energy Ltd. Cited in Hydra, 2015. Corowa Development Offshore Project Proposal. Hydra Energy, West Perth.

APPENDIX A: WESTERN GAS HEALTH, SAFETY AND ENVIRONMENT POLICY

WESTERN GAS

Health, Safety & Environment Policy

Western Gas are a proud Western Australian company and one that's focused on providing customers with secure, reliable and clean energy.

Western Gas recognise that excellence in Environmental, Health and Safety performance is an essential part of our mission to provide sustainable growth.

To accomplish this, we will:

- *Identify, assess and manage the Environmental, Health and Safety risks and impacts of our existing and planned operations*
- *Set our objectives and targets that result in continuous improvement of our Environmental, Health and Safety performance*
- *Provide the leadership and resources that will enable our workforce to meet improvement objectives and targets*
- *Require every employee, contractor and other service providers to take personal responsibility towards meeting Environmental, Health and Safety objectives*
- *Comply with applicable Environmental, Health and Safety laws and regulations*
- *Eliminate or minimise all workplace hazards and risks as far as is reasonably practicable*
- *Communicate regularly with the communities where we operate to develop and maintain a mutual understanding of goals and expectations*
- *Promote the conservation of energy and natural resources and reduce waste*
- *Routinely monitor, assess and report on the company's Environmental Health and Safety performance and on our conformity with this policy.*

Andrew Leibovitch, Executive Director
Date: November 2017

Will Barker, Executive Director
Date: November 2017

APPENDIX B: EPBC PROTECTED MATTERS SEARCH TOOL RESULTS

Bird species or species habitat that may occur within the Project EMBA

Scientific Name	Common Name	EPBC Status			Project Areas		
		Threatened Species	Migratory Species	Marine Species	Operational Area	Hydrocarbon Exposure	EMBA
Actitis hypoleucos	Common Sandpiper		(W)	yes	(MO)	(KO)	(KO)
Anous stolidus	Common Noddy		(M)	yes	(MO)	(LO)	(FLO)
Anous tenuirostris melanops	Australian Lesser Noddy	V		yes			(BKO)
Apus pacificus	Fork-tailed Swift		(M)	yes		(LO)	(LO)
Ardea alba	Great Egret			yes		(LO)	(KO)
Ardea ibis	Cattle Egret			yes		(MO)	(MO)
Ardenna carneipes	Flesh-footed Shearwater		(M)			(FLO)	(FLO)
Ardenna pacifica *	Wedge-tailed Shearwater		(M)				(KO)
Calidris acuminate	Sharp-tailed Sandpiper		(W)	yes	(MO)		(KO)
Calidris canutus	Red knot	E	(W)	yes	(MO)	(LO)	(KO)
Calidris ferruginea	Curlew Sandpiper	CE	(W)	yes		(KO)	(KO)
Calidris melanotos	Pectoral Sandpiper		(W)	yes	(MO)	(MO)	(MO)
Calonectris leucomelas	Streaked Shearwater		(M)	yes		(LO)	(KO)
Calyptorhynchus latirostris	Carnaby's Cockatoo	E					(LO)
Catharacta skua	Great Skua			yes			(MO)
Charadrius veredus	Oriental Plover		(W)	yes		(MO)	(MO)

Scientific Name	Common Name	EPBC Status			Project Areas		
		Threatened Species	Migratory Species	Marine Species	Operational Area	Hydrocarbon Exposure	EMBA
Chrysococcyx osculans	Black-eared Cuckoo			yes		(LO)	(KO)
Diomedea amsterdamensis	Amsterdam Albatross	E	(M)	yes			(LO)
Diomedea epomophora	Southern Royal Albatross	V	(M)	yes			(FLO)
Diomedea exulans	Wandering Albatross	V	(M)	yes			(FLO)
Diomedea sanfordi	Northern Royal Albatross	E	(M)	yes			(FLO)
Fregata andrewsi	Christmas Island Frigatebird	E	(M)	yes			(FKO)
Fregata ariel	Lesser Frigatebird		(M)	yes	(MO)	(LO)	(KO)
Fregata minor	Great Frigatebird		(M)	yes		(MO)	(MO)
Glareola maldivarum	Oriental Pratincole		(W)	yes		(MO)	(MO)
Haliaeetus leucogaster	White-bellied Sea-Eagle			yes		(MO)	(KO)
Halobaena caerulea	Blue Petrel	V		yes			(MO)
Hirundo rustica	Barn Swallow		(T)	yes		(MO)	(MO)
Hydroprogne caspia *	Caspian Tern		(M)			(BKO)	(BKO)
Larus novaehollandiae	Silver Gull			yes			(BKO)
Larus pacificus	Pacific Gull			yes			(BKO)
Leipoa ocellata	Malleefow	V					(LO)

Scientific Name	Common Name	EPBC Status			Project Areas		
		Threatened Species	Migratory Species	Marine Species	Operational Area	Hydrocarbon Exposure	EMBA
Limosa lapponica	Bar-tailed Godwit		(W)	yes		(KO)	(KO)
Limosa lapponica bauera	Bar-tailed Godwit (baueri)	V					(MO)
Limosa lapponica menzbieri	Northern Siberian Bar-tailed Godwit	CE				(MO)	(MO)
Macronectes giganteus	Southern Giant-Petrel	E	(M)	yes		(MO)	(MO)
Malurus leucopterus edouardi	White-winged Fairy-wren	V					(LO)
Macronectes giganteus	Southern Giant-Petrel	E	(M)	yes	(MO)	(MO)	(MO)
Macronectes halli	Northern Giant Petrel	V	(M)	yes		(MO)	(MO)
Merops ornatus	Rainbow Bee-eater			yes		(MO)	(MO)
Motacilla cinerea	Grey Wagtail		(T)	yes		(MO)	(MO)
Motacilla flava	Yellow Wagtail		(T)	yes		(MO)	(MO)
Numenius madagascariensis	Eastern Curlew	CE	(W)	yes		(KO)	(KO)
Onychoprion anaethetus	Bridled Tern		(M)			(FLO)	(BKO)
Pachyptila turtur	Fairy Prion			yes			(MO)
Pachyptila turtur (subantarctica)	Fairy Prion (southern)	V					(MO)
Pandion haliaetus	Osprey		(W)	yes		(BKO)	(KO)
Papasula abbotti	Abbott's Booby	E		yes		(MO)	(LO)

Scientific Name	Common Name	EPBC Status			Project Areas		
		Threatened Species	Migratory Species	Marine Species	Operational Area	Hydrocarbon Exposure	EMBA
Pelagodroma marina	White-faced Storm-Petrel			yes			(BKO)
Pezoporus occidentalis	Night Parrot	E					(MO)
Phaethon lepturus	White-tailed Tropicbird		(M)	yes			(FLO)
Phaethon rubricauda	Red-tailed Tropicbird		(M)	yes			(BKO)
Phalacrocorax fuscescens	Black-faced Cormorant			yes			(BLO)
Phoebetria fusca	Sooty Albatross	V	(M)	yes			(MO)
Pterodroma arminjoniana	Round Island Petrel	CE					(MO)
Pterodroma macroptera	Great-winged Petrel			yes			(FKO)
Pterodroma mollis	Soft-plumaged Petrel	V		yes		(FLO)	(FKO)
Puffinus assimilis	Little Shearwater			yes			(BKO)
Puffinus carneipes	Flesh-footed Shearwater			yes		(FLO)	(FLO)
Puffinus huttoni	Hutton's Shearwater			yes			(FKO)
Puffinus pacificus *	Wedge-tailed Shearwater		(M)	yes			(BKO)
Rostratula australis	Australian Painted-snipe	E		yes		(MO)	(LO)
Rostratula benghalensis (sensu lato) *	Painted Snipe	E		yes		(MO)	(LO)

Scientific Name	Common Name	EPBC Status			Project Areas		
		Threatened Species	Migratory Species	Marine Species	Operational Area	Hydrocarbon Exposure	EMBA
Sterna albifrons	Little Tern		(M)	yes			(CKO)
Sterna anaethetus	Bridled Tern			yes		(FLO)	(BKO)
Sterna bengalensis	Lesser Crested Tern			yes			(BKO)
Sterna bergii	Crested Tern		(M)	yes		(BKO)	(BKO)
*Sterna caspia**	Caspian Tern			yes		(BKO)	(BKO)
Sterna dougallii	Roseate Tern		(M)			(BKO)	(BKO)
Sterna fuscata *	Sooty Tern			yes		(FLO)	(BKO)
Sterna nereis	Fairy Tern			yes			(BKO)
*Sternula albifrons**	Little Tern		(M)	yes			(CKO)
Sternula nereis nereis	Australian Fairy Tern	V				(BKO)	(BKO)
*Thalasseus bergii**	Crested Tern		(W)	yes		(BKO)	(BKO)
Thalassarche carteri	Indian Yellow-nosed Albatross	V	(M)	yes		(FMO)	(FMO)
*Thalassarche cauta**	Shy Albatross	V	(M)	yes		(MO)	(MO)
Thalassarche cauta cauta	Shy Albatross	V	(M)	yes		(MO)	(MO)
*Thalassarche cauta steadi**	White-capped Albatross	V	(M)	yes		(FLO)	(FLO)
Thalassarche impavida	Campbell Albatross	V	(M)	yes		(MO)	(MO)
Thalassarche melanophris	Black-browed Albatross	V	(M)	yes		(MO)	(MO)

Scientific Name	Common Name	EPBC Status			Project Areas		
		Threatened Species	Migratory Species	Marine Species	Operational Area	Hydrocarbon Exposure	EMBA
*Thalassarche steadi**	White-capped Albatross	V	(M)	yes		(FLO)	(FLO)
Thinornis rubricollis	Hooded Plover			yes			(KO)
Tringa nebularia	Common Greenshank		(W)	yes			(LO)
Turnix varius scintillans	Painted Button-quail	V					(LO)

Threatened Species:
V Vulnerable
E Endangered
CE Critically Endangered
Migratory Species:
M Marine
W Wetland
T Terrestrial

Type of Presence:
MO Species of species habitat may occur within area
LO Species or species habitat likely to occur within area
KO Species or species habitat known to occur within area
FMO Foraging, feeding or related behaviour may occur within area
FLO Foraging, feeding or related behaviour likely to occur within area
FKO Foraging, feeding or related behaviour known to occur within area
BLO Breeding likely to occur within area
BKO Breeding known to occur within area
RLO Roosting likely to occur within area
RKO Roosting known to occur within area
CKO Congregation known to occur within area

* Species name provided in PMST search however species has multiple different scientific name

Sharks and ray species or species habitat that may occur within the Project Areas

Scientific Name	Common Name	EPBC Status			Project Areas		
		Threatened Species	Migratory Species	Marine Species	Operational Area	Hydrocarbon Exposure Area	EMBA
Sharks							
Carcharias taurus (west coast population)	Grey Nurse Shark (west coast population)	V				(KO)	(KO)
Carcharodon Carcharias	Great White Shark	V	M		(MO)	(KO)	(FKO)

Scientific Name	Common Name	EPBC Status			Project Areas		
		Threatened Species	Migratory Species	Marine Species	Operational Area	Hydrocarbon Exposure Area	EMBA
Isurus oxyrinchus	Shortfin Mako		M		(LO)	(LO)	(LO)
Isurus paucus	Longfin Mako		M		(LO)	(LO)	(LO)
Lamna nasus	Mackerel Shark		M			(MO)	(MO)
Rhincodon typus	Whale Shark	V	M			(FKO)	(MO)
Sawfish							
Anoxypristis cuspidata	Narrow Sawfish		M			(KO)	(KO)
Pristis clavata	Dwarf Sawfish	V	M			(KO)	(KO)
Pristis pristis	Freshwater Sawfish	V	M				(KO)
Pristis zijsron	Green Sawfish	V	M			(KO)	(KO)
Ray							
Manta alfredi	Reef Manta Ray		M			(KO)	(KO)
Manta birostris	Giant Manta Ray		M		(MO)	(KO)	(KO)

Other fish species or species habitat that may occur within the Project Areas

Scientific Name	Common Name	EPBC Status			Project Areas		
		Threatened Species	Migratory Species	Marine Species	Operational Area	Hydrocarbon Exposure Area	EMBA
Pipehores, Seahorse, seadragon							
Acentronura australe	Southern Pygmy Pipehorse			Yes			(MO)
Acentronura larsonae	Helen's Pygmy Pipehorse			Yes		(MO)	(MO)

Scientific Name	Common Name	EPBC Status			Project Areas		
		Threatened Species	Migratory Species	Marine Species	Operational Area	Hydrocarbon Exposure Area	EMBA
Bhanotia fasciolata	Corrugated Pipefish			Yes			(MO)
Bulbonaricus brauni	Braun's Pughead Pipefish			Yes		(MO)	(MO)
Campichthys galei	Gale's Pipefish			Yes			(MO)
Campichthys tricarinatus	Three-keel Pipefish			Yes		(MO)	(MO)
Choeroichthys brachysoma	Pacific Short-bodied Pipefish			Yes		(MO)	(MO)
Choeroichthys latispinosus	Muiron Island Pipefish			Yes		(MO)	(MO)
Choeroichthys suillus	Pig-snouted Pipefish			Yes		(MO)	(MO)
Corythoichthys amplexus	Fijian Banded Pipefish			Yes			(MO)
Corythoichthys flavofasciatus	Reticulate Pipefish			Yes		(MO)	(MO)
Corythoichthys intestinalis	Australian Messmate Pipefish			Yes			(MO)
Corythoichthys schultzi	Schultz's Pipefish			Yes			(MO)
Cosmocampus banneri	Roughridge Pipefish			Yes		(MO)	(MO)
Doryrhamphus dactyliophorus	Banded Pipefish			Yes		(MO)	(MO)
Doryrhamphus excisus	Bluestripe Pipefish			Yes		(MO)	(MO)

Scientific Name	Common Name	EPBC Status			Project Areas		
		Threatened Species	Migratory Species	Marine Species	Operational Area	Hydrocarbon Exposure Area	EMBA
Doryrhamphus janssi	Cleaner Pipefish			Yes		(MO)	(MO)
Doryrhamphus multiannulatus	Many-banded Pipefish			Yes		(MO)	(MO)
Doryrhamphus negrosensis	Flagtail Pipefish			Yes		(MO)	(MO)
Festucalex scalaris	Ladder Pipefish			Yes		(MO)	(MO)
Filicampus tigris	Tiger Pipefish			Yes		(MO)	(MO)
Halicampus brocki	Brock's Pipefish			Yes		(MO)	(MO)
Halicampus dunckeri	Red-hair Pipefish			Yes			(MO)
Halicampus grayi	Mud Pipefish			Yes		(MO)	(MO)
Halicampus nitidus	Glittering Pipefish			Yes		(MO)	(MO)
Halicampus spinirostris	Spiny-snout Pipefish			Yes		(MO)	(MO)
Haliichthys taeniophorus	Ribboned Pipehorse			Yes		(MO)	(MO)
Hippichthys penicillus	Beady Pipefish			Yes		(MO)	(MO)
Hippocampus angustus	Western Spiny Seahorse			Yes		(MO)	(MO)
Hippocampus breviceps	Short-head Seahorse			Yes			(MO)
Hippocampus histrix	Spiny Seahorse			Yes		(MO)	(MO)

Scientific Name	Common Name	EPBC Status			Project Areas		
		Threatened Species	Migratory Species	Marine Species	Operational Area	Hydrocarbon Exposure Area	EMBA
Hippocampus kuda	Spotted Seahorse			Yes		(MO)	(MO)
Hippocampus planifrons	Flat-face Seahorse			Yes		(MO)	(MO)
Hippocampus spinosissimus	Hedgehog Seahorse			Yes		(MO)	(MO)
Hippocampus subelongatus	West Australian Seahorse			Yes			(MO)
Hippocampus trimaculatus	Three-spot Seahorse			Yes		(MO)	(MO)
Lissocampus fatiloquus	Prophet's Pipefish			Yes			(MO)
Maroubra perserrata	Sawtooth Pipefish			Yes			(MO)
Micrognathus micronotopterus	Tidepool Pipefish			Yes		(MO)	(MO)
Mitotichthys meraculus	Western Crested Pipefish			Yes			(MO)
Nannocampus subosseus	Bonyhead Pipefish			Yes			(MO)
Phoxocampus belcheri	Black Rock Pipefish			Yes		(MO)	(MO)
Phycodurus eques	Leafy Seadragon			Yes			(MO)
Phyllopteryx taeniolatus	Common Seadragon			Yes			(MO)
Pugnaso curtirostris	Pugnose Pipefish			Yes			(MO)
Solegnathus hardwickii	Pallid Pipehorse			Yes		(MO)	(MO)

Scientific Name	Common Name	EPBC Status			Project Areas		
		Threatened Species	Migratory Species	Marine Species	Operational Area	Hydrocarbon Exposure Area	EMBA
Solegnathus lettiensis	Gunther's Pipehorse			Yes		(MO)	(MO)
Solenostomus cyanopterus	Robust Ghostpipefish			Yes		(MO)	(MO)
Stigmatopora argus	Spotted Pipefish			Yes			(MO)
Stigmatopora nigra	Widebody Pipefish			Yes			(MO)
Syngnathoides biaculeatus	Double-end Pipehorse			Yes		(MO)	(MO)
Trachyrhamphus bicoarctatus	Bentstick Pipefish			Yes		(MO)	(MO)
Trachyrhamphus longirostris	Straightstick Pipefish			Yes		(MO)	(MO)
Urocampus carinirostris	Hairy Pipefish			Yes			(MO)
Vanacampus margaritifer	Mother-of-pearl Pipefish			Yes			(MO)
Eel							
Milyeringa veritas	Blind Gudgeon	V				(MO)	(KO)
Ophisternon candidum	Blind Cave Eel	V					(KO)

Scientific Name	Common Name	EPBC Status			Project Areas		
		Threatened Species	Migratory Species	Marine Species	Operational Area	Hydrocarbon Exposure Area	EMBA
Threatened Species: *V Vulnerable* *E Endangered* *CE Critically Endangered* *Migratory Species:* *M Marine* *W Wetland* *T Terrestrial*					*Type of Presence:* *MO Species of species habitat may occur within area* *LO Species or species habitat likely to occur within area* *KO Species or species habitat known to occur within area* *FMO Foraging, feeding or related behaviour may occur within area* *FLO Foraging, feeding or related behaviour likely to occur within area* *FKO Foraging, feeding or related behaviour known to occur within area* *BLO Breeding likely to occur within area* *BKO Breeding known to occur within area* *CKO Congregation known to occur within area*		

Marine Mammal species or species habitat that may occur within the Project Areas

Scientific Name	Common Name	EPBC Status			Project Areas		
		Threatened Species	Migratory Species	Marine Species	Operational Area	Hydrocarbon Exposure Area	EMBA
Whales							
Balaenoptera acutorostrata	Minke Whale			Yes	(MO)	(MO)	(MO)
Balaenoptera bonaerensis	Antarctic Minke Whale		Marine	Yes	(LO)	(LO)	(LO)
Balaenoptera borealis	Sei Whale	V	Marine	Yes	(LO)	(FLO)	(FLO)
Balaenoptera edeni	Bryde's Whale		Marine	Yes	(LO)	(LO)	(LO)
Balaenoptera musculus	Blue Whale	E	Marine	Yes	(LO)	(MKO)	(MKO)
Balaenoptera physalus	Fin Whale	V	Marine	Yes	(LO)	(FLO)	(FLO)

Scientific Name	Common Name	EPBC Status			Project Areas		
		Threatened Species	Migratory Species	Marine Species	Operational Area	Hydrocarbon Exposure Area	EMBA
Caperea marginata	Pygmy Right Whale		Marine	Yes			(MO)
Eubalaena australis	Southern Right Whale	E	Marine	Yes		(LO)	(LO)
Feresa attenuata	Pygmy Killer Whale			Yes	(MO)	(MO)	(MO)
Globicephala macrorhynchus	Short-finned Pilot Whale			Yes	(MO)	(MO)	(MO)
Globicephala melas	Long-finned Pilot Whale			Yes			(MO)
Hyperoodon planifrons	Southern Bottlenose Whale			Yes			(MO)
Indopacetus pacificus	Longman's Beaked Whale			Yes		(MO)	(MO)
Kogia breviceps	Pygmy Sperm Whale			Yes	(MO)	(MO)	(MO)
Kogia simus	Dwarf Sperm Whale			Yes	(MO)	(MO)	(MO)
Megaptera novaeangliae	Humpback Whale	V	Marine	Yes	(MO)	(KO)	(CKO)
Mesoplodon bowdoini	Andrew's Beaked Whale			Yes			(MO)
Mesoplodon densirostris	Blainville's Beaked Whale			Yes	(MO)	(MO)	(MO)
Mesoplodon ginkgodens	Gingko-toothed Beaked Whale			Yes		(MO)	(MO)
Mesoplodon grayi	Gray's Beaked Whale			Yes		(MO)	(MO)
Mesoplodon layardii	Strap-toothed Beaked Whale			Yes			(MO)

Scientific Name	Common Name	EPBC Status			Project Areas		
		Threatened Species	Migratory Species	Marine Species	Operational Area	Hydrocarbon Exposure Area	EMBA
Mesoplodon mirus	True's Beaked Whale			Yes			(MO)
Peponocephala electra	Melon-headed Whale			Yes	(MO)	(MO)	(MO)
Physeter macrocephalus	Sperm Whale		Marine	Yes	(MO)	(MO)	(FKO)
Ziphius cavirostris	Cuvier's Beaked Whale			Yes	(MO)	(MO)	(MO)
Dolphins							
Delphinus delphis	Common Dophin			Yes	(MO)	(MO)	(MO)
Grampus griseus	Risso's Dolphin			Yes	(MO)	(MO)	(MO)
Lagenodelphis hosei	Fraser's Dolphin			Yes	(MO)	(MO)	(MO)
Lagenorhynchus obscurus	Dusky Dolphin		Marine	Yes			(LO)
Lissodelphis peronii	Southern Right Whale Dolphin			Yes			(MO)
Orcinus orca	Killer Whale		Marine	Yes	(MO)	(MO)	(MO)
Pseudorca crassidens	False Killer Whale			Yes	(LO)	(LO)	(LO)
Sousa chinensis	Indo-Pacific Humpback Dolphin		Marine	Yes		(MO)	(KO)
Stenella attenuate	Spotted Dolphin			Yes			(MO)
Stenella coeruleoalba	Striped Dolphin			Yes	(MO)	(MO)	(MO)
Stenella longirostris	Long-snouted Spinner Dolphin			Yes	(MO)	(MO)	(MO)

Scientific Name	Common Name	EPBC Status			Project Areas		
		Threatened Species	Migratory Species	Marine Species	Operational Area	Hydrocarbon Exposure Area	EMBA
Steno bredanensis	Rough-toothed Dolphin			Yes	(MO)	(MO)	(MO)
Tursiops aduncus	Indian Ocean Bottlenose Dolphin			Yes		(LO)	(LO)
Tursiops aduncus (Arafura/Timor Sea populations)	Spotted Bottlenose Dolphin (Arafura/Timor Sea populations)		Marine	Yes		(KO)	(KO)
Tursiops truncatus s. str.	Bottlenose Dolphin			Yes	(MO)	(MO)	(MO)
Pinnipeds							
Arctocephalus forsteri	Long-nosed Fur-seal			Yes			(MO)
Neophoca cinerea	Australian Sea-lion	V		Yes			(CKO)
Dugong							
Dugong dugon	Dugong		Marine	Yes		(BKO)	(BKO)
Threatened Species: *V Vulnerable* *E Endangered* *CE Critically Endangered* *Migratory Species:* *M Marine* *W Wetland* *T Terrestrial*		*Type of Presence:* *MO Species of species habitat may occur within area* *LO Species or species habitat likely to occur within area* *KO Species or species habitat known to occur within area* *FMO Foraging, feeding or related behaviour may occur within area* *FLO Foraging, feeding or related behaviour likely to occur within area* *FKO Foraging, feeding or related behaviour known to occur within area* *BLO Breeding likely to occur within area* *BKO Breeding known to occur within area* *CKO Congregation known to occur within area*					

Marine reptile species or species habitat that may occur within the Project EMBA

Scientific Name	Common Name	EPBC Status			Project Areas		
		Threatened Species	Migratory Species	Marine Species	Operational Area	Hydrocarbon Exposure Area	EMBA
Turtles							
Caretta caretta	Loggerhead Turtle	E	Marine	Yes	(LO)	(BKO)	(BKO)
Chelonia mydas	Green Turtle	V	Marine	Yes	(LO)	(BKO)	(BKO)
Dermochelys coriacea	Leatherback Turtle	E	Marine	Yes	(LO)	(KO)	(FKO)
Eretmochelys imbricata	Hawksbill Turtle	V	Marine	Yes	(LO)	(BKO)	(BKO)
Lepidochelys olivacea	Olive Ridley Turtle	E	Marine	Yes			(LO)
Natator depressus	Flatback Turtle	V	Marine	Yes	(LO)	(BKO)	(BKO)
Seasnakes							
Acalyptophis peronii	Horned Seasnake			Yes		(MO)	(MO)
Aipysurus apraefrontalis	Short-nosed Seasnake	CE		Yes		(LO)	(KO)
Aipysurus duboisii	Dubois' Seasnake			Yes		(MO)	(MO)
Aipysurus eydouxii	Spine-tailed Seasnake			Yes		(MO)	(MO)
Aipysurus laevis	Olive Seasnake			Yes	(MO)	(MO)	(MO)
Aipysurus pooleorum	Shark Bay Seasnake			Yes		(MO)	(MO)
Aipysurus tenuis	Brown-lined Seasnake			Yes			(MO)
Astrotia stokesii	Stokes' Seasnake			Yes		(MO)	(MO)
Disteira kingii	Spectacled Seasnake			Yes	(MO)	(MO)	(MO)

Scientific Name	Common Name	EPBC Status			Project Areas		
		Threatened Species	Migratory Species	Marine Species	Operational Area	Hydrocarbon Exposure Area	EMBA
Disteira major	Olive-headed Seasnake			Yes		(MO)	(MO)
Emydocephalus annulatus	Turtle-headed Seasnake			Yes		(MO)	(MO)
Ephalophis greyi	North-western Mangrove Seasnake			Yes		(MO)	(MO)
Hydrelaps darwiniensis	Black-ringed Seasnake			Yes			(MO)
Hydrophis czeblukovi	Fine-spined Seasnake			Yes		(MO)	(MO)
Hydrophis elegans	Elegant Seasnake			Yes			(MO)
Hydrophis mcdowelli	*Hydrophis mcdowelli*			Yes		(MO)	(MO)
Hydrophis ornatus	Spotted Seasnake			Yes		(MO)	(MO)
Lapemis hardwickii	Spine-bellied Seasnake			Yes			(MO)
Pelamis platurus	Yellow-bellied Seasnake			Yes	(MO)	(MO)	(MO)

Australian Government

Department of Agriculture, Water and the Environment

EPBC Act Protected Matters Report

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Information on the coverage of this report and qualifications on data supporting this report are contained in the caveat at the end of the report.

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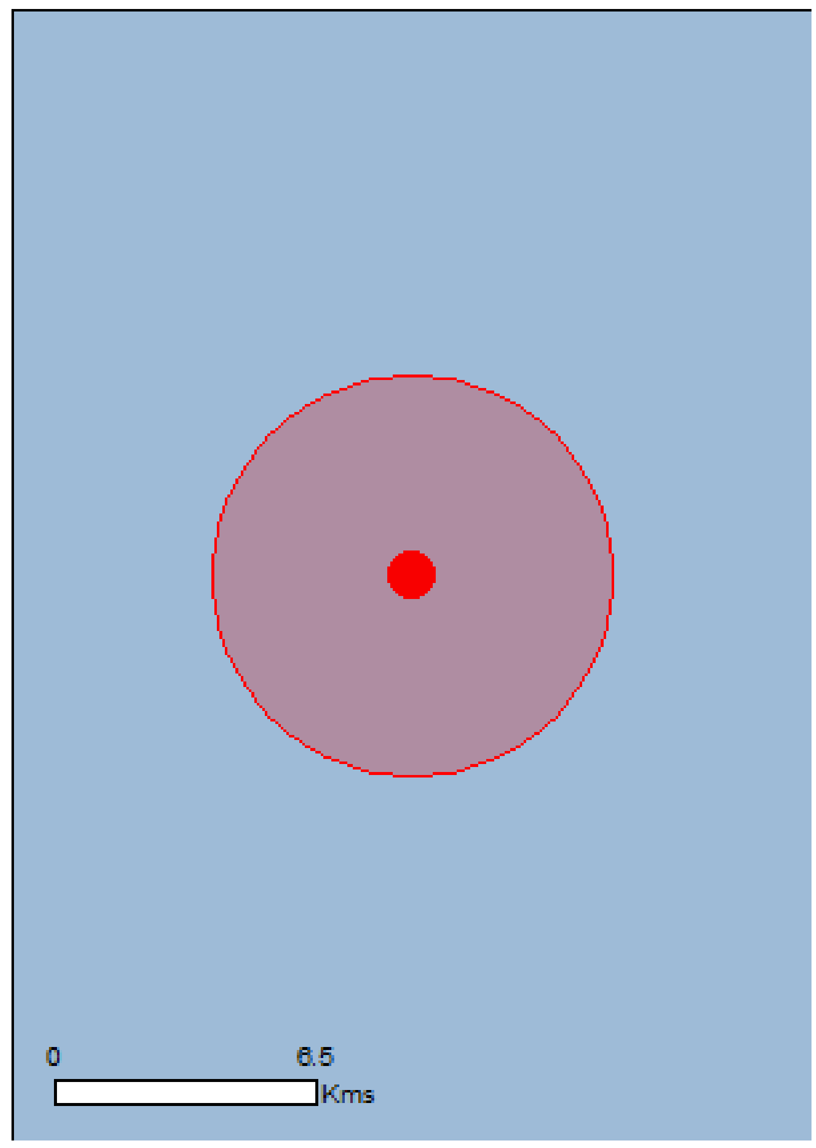

Coordinates

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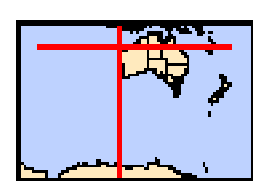

Summary

Matters of National Environmental Significance

This part of the report summarises the matters of national environmental significance that may occur in, or may relate to, the area you nominated. Further information is available in the detail part of the report, which can be accessed by scrolling or following the links below. If you are proposing to undertake an activity that may have a significant impact on one or more matters of national environmental significance then you should consider the Administrative Guidelines on Significance.

World Heritage Properties:	None
National Heritage Places:	None
Wetlands of International Importance:	None
Great Barrier Reef Marine Park:	None
Commonwealth Marine Area:	1
Listed Threatened Ecological Communities:	None
Listed Threatened Species:	12
Listed Migratory Species:	25

Other Matters Protected by the EPBC Act

This part of the report summarises other matters protected under the Act that may relate to the area you nominated. Approval may be required for a proposed activity that significantly affects the environment on Commonwealth land, when the action is outside the Commonwealth land, or the environment anywhere when the action is taken on Commonwealth land. Approval may also be required for the Commonwealth or Commonwealth agencies proposing to take an action that is likely to have a significant impact on the environment anywhere.

The EPBC Act protects the environment on Commonwealth land, the environment from the actions taken on Commonwealth land, and the environment from actions taken by Commonwealth agencies. As heritage values of a place are part of the 'environment', these aspects of the EPBC Act protect the Commonwealth Heritage values of a Commonwealth Heritage place. Information on the new heritage laws can be found at http://www.environment.gov.au/heritage

A permit may be required for activities in or on a Commonwealth area that may affect a member of a listed threatened species or ecological community, a member of a listed migratory species, whales and other cetaceans, or a member of a listed marine species.

Commonwealth Land:	None
Commonwealth Heritage Places:	None
Listed Marine Species:	15
Whales and Other Cetaceans:	25
Critical Habitats:	None
Commonwealth Reserves Terrestrial:	None
Australian Marine Parks:	None

Extra Information

This part of the report provides information that may also be relevant to the area you have nominated.

State and Territory Reserves:	None
Regional Forest Agreements:	None
Invasive Species:	None
Nationally Important Wetlands:	None
Key Ecological Features (Marine)	1

Details

Matters of National Environmental Significance

Commonwealth Marine Area [Resource Information]

Approval is required for a proposed activity that is located within the Commonwealth Marine Area which has, will have, or is likely to have a significant impact on the environment. Approval may be required for a proposed action taken outside the Commonwealth Marine Area but which has, may have or is likely to have a significant impact on the environment in the Commonwealth Marine Area. Generally the Commonwealth Marine Area stretches from three nautical miles to two hundred nautical miles from the coast.

Name
EEZ and Territorial Sea

Marine Regions [Resource Information]

If you are planning to undertake action in an area in or close to the Commonwealth Marine Area, and a marine bioregional plan has been prepared for the Commonwealth Marine Area in that area, the marine bioregional plan may inform your decision as to whether to refer your proposed action under the EPBC Act.

Name
North-west

Listed Threatened Species [Resource Information]

Name	Status	Type of Presence
Birds		
Calidris canutus		
Red Knot, Knot [855]	Endangered	Species or species habitat may occur within area
Macronectes giganteus		
Southern Giant-Petrel, Southern Giant Petrel [1060]	Endangered	Species or species habitat may occur within area
Mammals		
Balaenoptera borealis		
Sei Whale [34]	Vulnerable	Species or species habitat likely to occur within area
Balaenoptera musculus		
Blue Whale [36]	Endangered	Migration route known to occur within area
Balaenoptera physalus		
Fin Whale [37]	Vulnerable	Species or species habitat likely to occur within area
Megaptera novaeangliae		
Humpback Whale [38]	Vulnerable	Species or species habitat may occur within area
Reptiles		
Caretta caretta		
Loggerhead Turtle [1763]	Endangered	Species or species habitat likely to occur within area
Chelonia mydas		
Green Turtle [1765]	Vulnerable	Species or species habitat likely to occur within area
Dermochelys coriacea		
Leatherback Turtle, Leathery Turtle, Luth [1768]	Endangered	Species or species

Name	Status	Type of Presence
		habitat likely to occur within area
Eretmochelys imbricata Hawksbill Turtle [1766]	Vulnerable	Species or species habitat likely to occur within area
Natator depressus Flatback Turtle [59257]	Vulnerable	Species or species habitat likely to occur within area
Sharks		
Carcharodon carcharias White Shark, Great White Shark [64470]	Vulnerable	Species or species habitat may occur within area

Listed Migratory Species

[Resource Information]

* Species is listed under a different scientific name on the EPBC Act - Threatened Species list.

Name	Threatened	Type of Presence
Migratory Marine Birds		
Anous stolidus Common Noddy [825]		Species or species habitat may occur within area
Fregata ariel Lesser Frigatebird, Least Frigatebird [1012]		Species or species habitat may occur within area
Macronectes giganteus Southern Giant-Petrel, Southern Giant Petrel [1060]	Endangered	Species or species habitat may occur within area
Migratory Marine Species		
Balaenoptera bonaerensis Antarctic Minke Whale, Dark-shoulder Minke Whale [67812]		Species or species habitat likely to occur within area
Balaenoptera borealis Sei Whale [34]	Vulnerable	Species or species habitat likely to occur within area
Balaenoptera edeni Bryde's Whale [35]		Species or species habitat likely to occur within area
Balaenoptera musculus Blue Whale [36]	Endangered	Migration route known to occur within area
Balaenoptera physalus Fin Whale [37]	Vulnerable	Species or species habitat likely to occur within area
Carcharhinus longimanus Oceanic Whitetip Shark [84108]		Species or species habitat may occur within area
Carcharodon carcharias White Shark, Great White Shark [64470]	Vulnerable	Species or species habitat may occur within area
Caretta caretta Loggerhead Turtle [1763]	Endangered	Species or species habitat likely to occur within area
Chelonia mydas Green Turtle [1765]	Vulnerable	Species or species habitat likely to occur within area
Dermochelys coriacea Leatherback Turtle, Leathery Turtle, Luth [1768]	Endangered	Species or species habitat likely to occur within area

Name	Threatened	Type of Presence
Eretmochelys imbricata Hawksbill Turtle [1766]	Vulnerable	Species or species habitat likely to occur within area
Isurus oxyrinchus Shortfin Mako, Mako Shark [79073]		Species or species habitat likely to occur within area
Isurus paucus Longfin Mako [82947]		Species or species habitat likely to occur within area
Manta birostris Giant Manta Ray, Chevron Manta Ray, Pacific Manta Ray, Pelagic Manta Ray, Oceanic Manta Ray [84995]		Species or species habitat may occur within area
Megaptera novaeangliae Humpback Whale [38]	Vulnerable	Species or species habitat may occur within area
Natator depressus Flatback Turtle [59257]	Vulnerable	Species or species habitat likely to occur within area
Orcinus orca Killer Whale, Orca [46]		Species or species habitat may occur within area
Physeter macrocephalus Sperm Whale [59]		Species or species habitat may occur within area
Migratory Wetlands Species		
Actitis hypoleucos Common Sandpiper [59309]		Species or species habitat may occur within area
Calidris acuminata Sharp-tailed Sandpiper [874]		Species or species habitat may occur within area
Calidris canutus Red Knot, Knot [855]	Endangered	Species or species habitat may occur within area
Calidris melanotos Pectoral Sandpiper [858]		Species or species habitat may occur within area

Other Matters Protected by the EPBC Act

Listed Marine Species [Resource Information]

* Species is listed under a different scientific name on the EPBC Act - Threatened Species list.

Name	Threatened	Type of Presence
Birds		
Actitis hypoleucos Common Sandpiper [59309]		Species or species habitat may occur within area
Anous stolidus Common Noddy [825]		Species or species habitat may occur within area
Calidris acuminata Sharp-tailed Sandpiper [874]		Species or species habitat may occur within area

Name	Threatened	Type of Presence
Calidris canutus Red Knot, Knot [855]	Endangered	Species or species habitat may occur within area
Calidris melanotos Pectoral Sandpiper [858]		Species or species habitat may occur within area
Fregata ariel Lesser Frigatebird, Least Frigatebird [1012]		Species or species habitat may occur within area
Macronectes giganteus Southern Giant-Petrel, Southern Giant Petrel [1060]	Endangered	Species or species habitat may occur within area
Reptiles		
Aipysurus laevis Olive Seasnake [1120]		Species or species habitat may occur within area
Caretta caretta Loggerhead Turtle [1763]	Endangered	Species or species habitat likely to occur within area
Chelonia mydas Green Turtle [1765]	Vulnerable	Species or species habitat likely to occur within area
Dermochelys coriacea Leatherback Turtle, Leathery Turtle, Luth [1768]	Endangered	Species or species habitat likely to occur within area
Disteira kingii Spectacled Seasnake [1123]		Species or species habitat may occur within area
Eretmochelys imbricata Hawksbill Turtle [1766]	Vulnerable	Species or species habitat likely to occur within area
Natator depressus Flatback Turtle [59257]	Vulnerable	Species or species habitat likely to occur within area
Pelamis platurus Yellow-bellied Seasnake [1091]		Species or species habitat may occur within area

Whales and other Cetaceans

[Resource Information]

Name	Status	Type of Presence
Mammals		
Balaenoptera acutorostrata Minke Whale [33]		Species or species habitat may occur within area
Balaenoptera bonaerensis Antarctic Minke Whale, Dark-shoulder Minke Whale [67812]		Species or species habitat likely to occur within area
Balaenoptera borealis Sei Whale [34]	Vulnerable	Species or species habitat likely to occur within area
Balaenoptera edeni Bryde's Whale [35]		Species or species habitat likely to occur within area
Balaenoptera musculus Blue Whale [36]	Endangered	Migration route known to occur within area

Name	Status	Type of Presence
Balaenoptera physalus Fin Whale [37]	Vulnerable	Species or species habitat likely to occur within area
Delphinus delphis Common Dolphin, Short-beaked Common Dolphin [60]		Species or species habitat may occur within area
Feresa attenuata Pygmy Killer Whale [61]		Species or species habitat may occur within area
Globicephala macrorhynchus Short-finned Pilot Whale [62]		Species or species habitat may occur within area
Grampus griseus Risso's Dolphin, Grampus [64]		Species or species habitat may occur within area
Kogia breviceps Pygmy Sperm Whale [57]		Species or species habitat may occur within area
Kogia simus Dwarf Sperm Whale [58]		Species or species habitat may occur within area
Lagenodelphis hosei Fraser's Dolphin, Sarawak Dolphin [41]		Species or species habitat may occur within area
Megaptera novaeangliae Humpback Whale [38]	Vulnerable	Species or species habitat may occur within area
Mesoplodon densirostris Blainville's Beaked Whale, Dense-beaked Whale [74]		Species or species habitat may occur within area
Orcinus orca Killer Whale, Orca [46]		Species or species habitat may occur within area
Peponocephala electra Melon-headed Whale [47]		Species or species habitat may occur within area
Physeter macrocephalus Sperm Whale [59]		Species or species habitat may occur within area
Pseudorca crassidens False Killer Whale [48]		Species or species habitat likely to occur within area
Stenella attenuata Spotted Dolphin, Pantropical Spotted Dolphin [51]		Species or species habitat may occur within area
Stenella coeruleoalba Striped Dolphin, Euphrosyne Dolphin [52]		Species or species habitat may occur within area
Stenella longirostris Long-snouted Spinner Dolphin [29]		Species or species habitat may occur within area
Steno bredanensis Rough-toothed Dolphin [30]		Species or species habitat may occur within area

Name	Status	Type of Presence
Tursiops truncatus s. str. Bottlenose Dolphin [68417]		Species or species habitat may occur within area
Ziphius cavirostris Cuvier's Beaked Whale, Goose-beaked Whale [56]		Species or species habitat may occur within area

Extra Information

Key Ecological Features (Marine) [Resource Information]

Key Ecological Features are the parts of the marine ecosystem that are considered to be important for the biodiversity or ecosystem functioning and integrity of the Commonwealth Marine Area.

Name	Region
Exmouth Plateau	North-west

Caveat

The information presented in this report has been provided by a range of data sources as acknowledged at the end of the report.

This report is designed to assist in identifying the locations of places which may be relevant in determining obligations under the Environment Protection and Biodiversity Conservation Act 1999. It holds mapped locations of World and National Heritage properties, Wetlands of International and National Importance, Commonwealth and State/Territory reserves, listed threatened, migratory and marine species and listed threatened ecological communities. Mapping of Commonwealth land is not complete at this stage. Maps have been collated from a range of sources at various resolutions.

Not all species listed under the EPBC Act have been mapped (see below) and therefore a report is a general guide only. Where available data supports mapping, the type of presence that can be determined from the data is indicated in general terms. People using this information in making a referral may need to consider the qualifications below and may need to seek and consider other information sources.

For threatened ecological communities where the distribution is well known, maps are derived from recovery plans, State vegetation maps, remote sensing imagery and other sources. Where threatened ecological community distributions are less well known, existing vegetation maps and point location data are used to produce indicative distribution maps.

Threatened, migratory and marine species distributions have been derived through a variety of methods. Where distributions are well known and if time permits, maps are derived using either thematic spatial data (i.e. vegetation, soils, geology, elevation, aspect, terrain, etc) together with point locations and described habitat; or environmental modelling (MAXENT or BIOCLIM habitat modelling) using point locations and environmental data layers.

Where very little information is available for species or large number of maps are required in a short time-frame, maps are derived either from 0.04 or 0.02 decimal degree cells; by an automated process using polygon capture techniques (static two kilometre grid cells, alpha-hull and convex hull); or captured manually or by using topographic features (national park boundaries, islands, etc). In the early stages of the distribution mapping process (1999-early 2000s) distributions were defined by degree blocks, 100K or 250K map sheets to rapidly create distribution maps. More reliable distribution mapping methods are used to update these distributions as time permits.

Only selected species covered by the following provisions of the EPBC Act have been mapped:

- migratory and
- marine

The following species and ecological communities have not been mapped and do not appear in reports produced from this database:

- threatened species listed as extinct or considered as vagrants
- some species and ecological communities that have only recently been listed
- some terrestrial species that overfly the Commonwealth marine area
- migratory species that are very widespread, vagrant, or only occur in small numbers

The following groups have been mapped, but may not cover the complete distribution of the species:

- non-threatened seabirds which have only been mapped for recorded breeding sites
- seals which have only been mapped for breeding sites near the Australian continent

Such breeding sites may be important for the protection of the Commonwealth Marine environment.

Coordinates

-20.4871 113.544

Acknowledgements

This database has been compiled from a range of data sources. The department acknowledges the following custodians who have contributed valuable data and advice:

-Office of Environment and Heritage, New South Wales
-Department of Environment and Primary Industries, Victoria
-Department of Primary Industries, Parks, Water and Environment, Tasmania
-Department of Environment, Water and Natural Resources, South Australia
-Department of Land and Resource Management, Northern Territory
-Department of Environmental and Heritage Protection, Queensland
-Department of Parks and Wildlife, Western Australia
-Environment and Planning Directorate, ACT
-Birdlife Australia
-Australian Bird and Bat Banding Scheme
-Australian National Wildlife Collection
-Natural history museums of Australia
-Museum Victoria
-Australian Museum
-South Australian Museum
-Queensland Museum
-Online Zoological Collections of Australian Museums
-Queensland Herbarium
-National Herbarium of NSW
-Royal Botanic Gardens and National Herbarium of Victoria
-Tasmanian Herbarium
-State Herbarium of South Australia
-Northern Territory Herbarium
-Western Australian Herbarium
-Australian National Herbarium, Canberra
-University of New England
-Ocean Biogeographic Information System
-Australian Government, Department of Defence
Forestry Corporation, NSW
-Geoscience Australia
-CSIRO
-Australian Tropical Herbarium, Cairns
-eBird Australia
-Australian Government – Australian Antarctic Data Centre
-Museum and Art Gallery of the Northern Territory
-Australian Government National Environmental Science Program
-Australian Institute of Marine Science
-Reef Life Survey Australia
-American Museum of Natural History
-Queen Victoria Museum and Art Gallery, Inveresk, Tasmania
-Tasmanian Museum and Art Gallery, Hobart, Tasmania
-Other groups and individuals

The Department is extremely grateful to the many organisations and individuals who provided expert advice and information on numerous draft distributions.

Please feel free to provide feedback via the Contact Us page.

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Department of Agriculture, Water and the Environment

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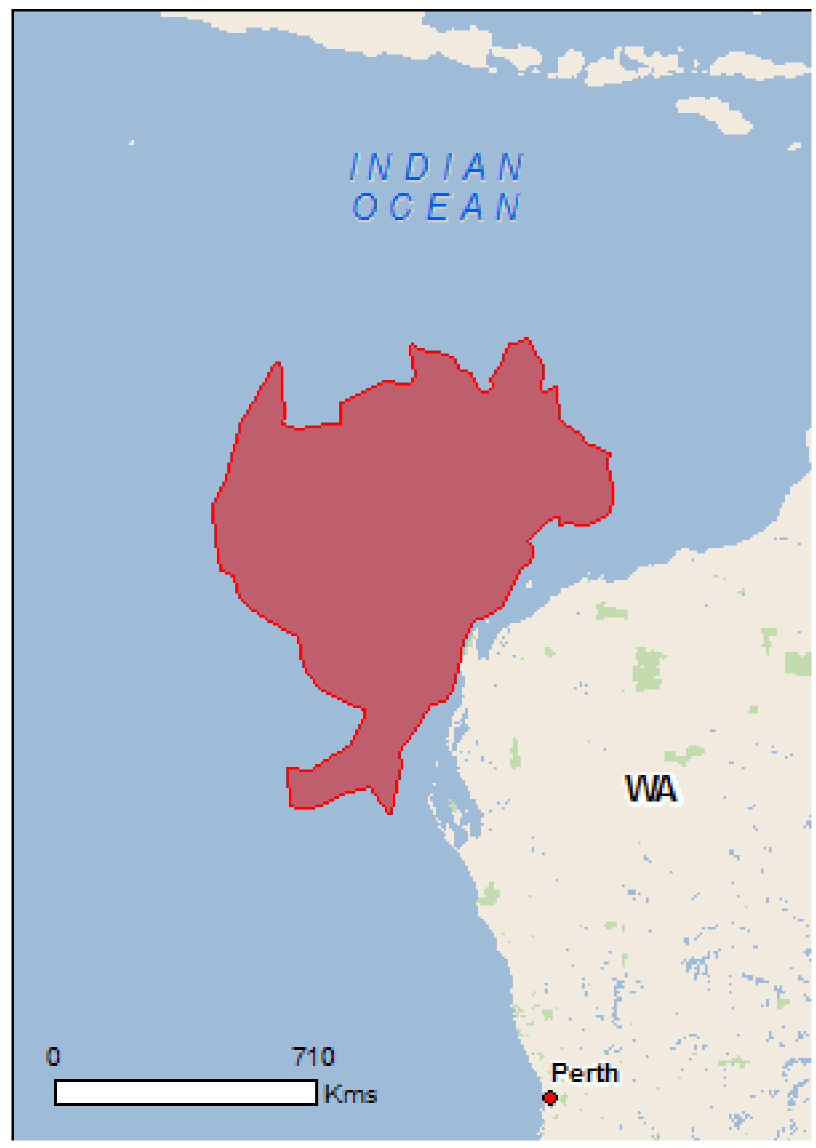
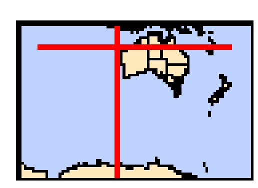


Coordinates
Buffer: 0.0Km



Summary

Matters of National Environmental Significance

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World Heritage Properties:	1
National Heritage Places:	1
Wetlands of International Importance:	None
Great Barrier Reef Marine Park:	None
Commonwealth Marine Area:	2
Listed Threatened Ecological Communities:	None
Listed Threatened Species:	33
Listed Migratory Species:	53

Other Matters Protected by the EPBC Act

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The EPBC Act protects the environment on Commonwealth land, the environment from the actions taken on Commonwealth land, and the environment from actions taken by Commonwealth agencies. As heritage values of a place are part of the 'environment', these aspects of the EPBC Act protect the Commonwealth Heritage values of a Commonwealth Heritage place. Information on the new heritage laws can be found at http://www.environment.gov.au/heritage

A permit may be required for activities in or on a Commonwealth area that may affect a member of a listed threatened species or ecological community, a member of a listed migratory species, whales and other cetaceans, or a member of a listed marine species.

Commonwealth Land:	None
Commonwealth Heritage Places:	1
Listed Marine Species:	88
Whales and Other Cetaceans:	32
Critical Habitats:	None
Commonwealth Reserves Terrestrial:	None
Australian Marine Parks:	9

Extra Information

This part of the report provides information that may also be relevant to the area you have nominated.

State and Territory Reserves:	None
Regional Forest Agreements:	None
Invasive Species:	None
Nationally Important Wetlands:	None
Key Ecological Features (Marine)	7

Details

Matters of National Environmental Significance

World Heritage Properties [Resource Information]

Name	State	Status
The Ningaloo Coast	WA	Declared property

National Heritage Properties [Resource Information]

Name	State	Status
Natural		
The Ningaloo Coast	WA	Listed place

Commonwealth Marine Area [Resource Information]

Approval is required for a proposed activity that is located within the Commonwealth Marine Area which has, will have, or is likely to have a significant impact on the environment. Approval may be required for a proposed action taken outside the Commonwealth Marine Area but which has, may have or is likely to have a significant impact on the environment in the Commonwealth Marine Area. Generally the Commonwealth Marine Area stretches from three nautical miles to two hundred nautical miles from the coast.

Name
EEZ and Territorial Sea
Extended Continental Shelf

Marine Regions [Resource Information]

If you are planning to undertake action in an area in or close to the Commonwealth Marine Area, and a marine bioregional plan has been prepared for the Commonwealth Marine Area in that area, the marine bioregional plan may inform your decision as to whether to refer your proposed action under the EPBC Act.

Name
North-west
South-west

Listed Threatened Species [Resource Information]

Name	Status	Type of Presence
Birds		
Anous tenuirostris melanops Australian Lesser Noddy [26000]	Vulnerable	Species or species habitat may occur within area
Calidris canutus Red Knot, Knot [855]	Endangered	Species or species habitat may occur within area
Calidris ferruginea Curlew Sandpiper [856]	Critically Endangered	Species or species habitat may occur within area
Limosa lapponica menzbieri Northern Siberian Bar-tailed Godwit, Russkoye Bar-tailed Godwit [86432]	Critically Endangered	Species or species habitat known to occur within area
Macronectes giganteus Southern Giant-Petrel, Southern Giant Petrel [1060]	Endangered	Species or species habitat may occur within area
Macronectes halli Northern Giant Petrel [1061]	Vulnerable	Species or species habitat may occur within area
Numenius madagascariensis Eastern Curlew, Far Eastern Curlew [847]	Critically Endangered	Species or species habitat may occur within

Name	Status	Type of Presence
		area
Papasula abbotti Abbott's Booby [59297]	Endangered	Species or species habitat may occur within area
Pterodroma mollis Soft-plumaged Petrel [1036]	Vulnerable	Foraging, feeding or related behaviour likely to occur within area
Rostratula australis Australian Painted Snipe [77037]	Endangered	Species or species habitat may occur within area
Sternula nereis nereis Australian Fairy Tern [82950]	Vulnerable	Breeding known to occur within area
Thalassarche carteri Indian Yellow-nosed Albatross [64464]	Vulnerable	Foraging, feeding or related behaviour may occur within area
Thalassarche cauta Shy Albatross [89224]	Endangered	Species or species habitat may occur within area
Thalassarche impavida Campbell Albatross, Campbell Black-browed Albatross [64459]	Vulnerable	Species or species habitat may occur within area
Thalassarche melanophris Black-browed Albatross [66472]	Vulnerable	Species or species habitat may occur within area
Thalassarche steadi White-capped Albatross [64462]	Vulnerable	Foraging, feeding or related behaviour likely to occur within area
Mammals		
Balaenoptera borealis Sei Whale [34]	Vulnerable	Foraging, feeding or related behaviour likely to occur within area
Balaenoptera musculus Blue Whale [36]	Endangered	Migration route known to occur within area
Balaenoptera physalus Fin Whale [37]	Vulnerable	Foraging, feeding or related behaviour likely to occur within area
Eubalaena australis Southern Right Whale [40]	Endangered	Species or species habitat likely to occur within area
Megaptera novaeangliae Humpback Whale [38]	Vulnerable	Breeding known to occur within area
Reptiles		
Aipysurus apraefrontalis Short-nosed Seasnake [1115]	Critically Endangered	Species or species habitat likely to occur within area
Aipysurus foliosquama Leaf-scaled Seasnake [1118]	Critically Endangered	Species or species habitat likely to occur within area
Caretta caretta Loggerhead Turtle [1763]	Endangered	Foraging, feeding or related behaviour known to occur within area
Chelonia mydas Green Turtle [1765]	Vulnerable	Foraging, feeding or related behaviour known to occur within area

Name	Status	Type of Presence
Dermochelys coriacea Leatherback Turtle, Leathery Turtle, Luth [1768]	Endangered	Species or species habitat known to occur within area
Eretmochelys imbricata Hawksbill Turtle [1766]	Vulnerable	Foraging, feeding or related behaviour known to occur within area
Natator depressus Flatback Turtle [59257]	Vulnerable	Foraging, feeding or related behaviour known to occur within area
Sharks		
Carcharias taurus (west coast population) Grey Nurse Shark (west coast population) [68752]	Vulnerable	Species or species habitat known to occur within area
Carcharodon carcharias White Shark, Great White Shark [64470]	Vulnerable	Species or species habitat known to occur within area
Pristis clavata Dwarf Sawfish, Queensland Sawfish [68447]	Vulnerable	Species or species habitat known to occur within area
Pristis zijsron Green Sawfish, Dindagubba, Narrowsnout Sawfish [68442]	Vulnerable	Species or species habitat known to occur within area
Rhincodon typus Whale Shark [66680]	Vulnerable	Foraging, feeding or related behaviour known to occur within area

Listed Migratory Species [Resource Information]

* Species is listed under a different scientific name on the EPBC Act - Threatened Species list.

Name	Threatened	Type of Presence
Migratory Marine Birds		
Anous stolidus Common Noddy [825]		Species or species habitat may occur within area
Apus pacificus Fork-tailed Swift [678]		Species or species habitat likely to occur within area
Ardenna carneipes Flesh-footed Shearwater, Fleshy-footed Shearwater [82404]		Foraging, feeding or related behaviour likely to occur within area
Calonectris leucomelas Streaked Shearwater [1077]		Species or species habitat likely to occur within area
Fregata ariel Lesser Frigatebird, Least Frigatebird [1012]		Species or species habitat likely to occur within area
Fregata minor Great Frigatebird, Greater Frigatebird [1013]		Species or species habitat may occur within area
Hydroprogne caspia Caspian Tern [808]		Breeding known to occur within area
Macronectes giganteus Southern Giant-Petrel, Southern Giant Petrel [1060]	Endangered	Species or species habitat may occur within area
Macronectes halli Northern Giant Petrel [1061]	Vulnerable	Species or species habitat may occur within area

Name	Threatened	Type of Presence
Onychoprion anaethetus Bridled Tern [82845]		Foraging, feeding or related behaviour likely to occur within area
Sterna dougallii Roseate Tern [817]		Breeding known to occur within area
Thalassarche carteri Indian Yellow-nosed Albatross [64464]	Vulnerable	Foraging, feeding or related behaviour may occur within area
Thalassarche cauta Shy Albatross [89224]	Endangered	Species or species habitat may occur within area
Thalassarche impavida Campbell Albatross, Campbell Black-browed Albatross [64459]	Vulnerable	Species or species habitat may occur within area
Thalassarche melanophris Black-browed Albatross [66472]	Vulnerable	Species or species habitat may occur within area
Thalassarche steadi White-capped Albatross [64462]	Vulnerable	Foraging, feeding or related behaviour likely to occur within area
Migratory Marine Species		
Anoxypristis cuspidata Narrow Sawfish, Knifetooth Sawfish [68448]		Species or species habitat known to occur within area
Balaena glacialis australis Southern Right Whale [75529]	Endangered*	Species or species habitat likely to occur within area
Balaenoptera bonaerensis Antarctic Minke Whale, Dark-shoulder Minke Whale [67812]		Species or species habitat likely to occur within area
Balaenoptera borealis Sei Whale [34]	Vulnerable	Foraging, feeding or related behaviour likely to occur within area
Balaenoptera edeni Bryde's Whale [35]		Species or species habitat likely to occur within area
Balaenoptera musculus Blue Whale [36]	Endangered	Migration route known to occur within area
Balaenoptera physalus Fin Whale [37]	Vulnerable	Foraging, feeding or related behaviour likely to occur within area
Carcharhinus longimanus Oceanic Whitetip Shark [84108]		Species or species habitat likely to occur within area
Carcharodon carcharias White Shark, Great White Shark [64470]	Vulnerable	Species or species habitat known to occur within area
Caretta caretta Loggerhead Turtle [1763]	Endangered	Foraging, feeding or related behaviour known to occur within area
Chelonia mydas Green Turtle [1765]	Vulnerable	Foraging, feeding or related behaviour known to occur within area
Dermochelys coriacea Leatherback Turtle, Leathery Turtle, Luth [1768]	Endangered	Species or species

Name	Threatened	Type of Presence
		habitat known to occur within area
Dugong dugon Dugong [28]		Breeding known to occur within area
Eretmochelys imbricata Hawksbill Turtle [1766]	Vulnerable	Foraging, feeding or related behaviour known to occur within area
Isurus oxyrinchus Shortfin Mako, Mako Shark [79073]		Species or species habitat likely to occur within area
Isurus paucus Longfin Mako [82947]		Species or species habitat likely to occur within area
Lamna nasus Porbeagle, Mackerel Shark [83288]		Species or species habitat may occur within area
Manta alfredi Reef Manta Ray, Coastal Manta Ray, Inshore Manta Ray, Prince Alfred's Ray, Resident Manta Ray [84994]		Species or species habitat known to occur within area
Manta birostris Giant Manta Ray, Chevron Manta Ray, Pacific Manta Ray, Pelagic Manta Ray, Oceanic Manta Ray [84995]		Species or species habitat known to occur within area
Megaptera novaeangliae Humpback Whale [38]	Vulnerable	Breeding known to occur within area
Natator depressus Flatback Turtle [59257]	Vulnerable	Foraging, feeding or related behaviour known to occur within area
Orcinus orca Killer Whale, Orca [46]		Species or species habitat may occur within area
Physeter macrocephalus Sperm Whale [59]		Species or species habitat may occur within area
Pristis clavata Dwarf Sawfish, Queensland Sawfish [68447]	Vulnerable	Species or species habitat known to occur within area
Pristis zijsron Green Sawfish, Dindagubba, Narrowsnout Sawfish [68442]	Vulnerable	Species or species habitat known to occur within area
Rhincodon typus Whale Shark [66680]	Vulnerable	Foraging, feeding or related behaviour known to occur within area
Sousa chinensis Indo-Pacific Humpback Dolphin [50]		Species or species habitat may occur within area
Tursiops aduncus (Arafura/Timor Sea populations) Spotted Bottlenose Dolphin (Arafura/Timor Sea populations) [78900]		Species or species habitat known to occur within area
Migratory Wetlands Species		
Actitis hypoleucos Common Sandpiper [59309]		Species or species habitat known to occur within area
Calidris acuminata Sharp-tailed Sandpiper [874]		Species or species habitat known to occur within area

Name	Threatened	Type of Presence
Calidris canutus Red Knot, Knot [855]	Endangered	Species or species habitat may occur within area
Calidris ferruginea Curlew Sandpiper [856]	Critically Endangered	Species or species habitat may occur within area
Calidris melanotos Pectoral Sandpiper [858]		Species or species habitat may occur within area
Limosa lapponica Bar-tailed Godwit [844]		Species or species habitat known to occur within area
Numenius madagascariensis Eastern Curlew, Far Eastern Curlew [847]	Critically Endangered	Species or species habitat may occur within area
Pandion haliaetus Osprey [952]		Breeding known to occur within area
Thalasseus bergii Greater Crested Tern [83000]		Breeding known to occur within area

Other Matters Protected by the EPBC Act

Commonwealth Heritage Places [Resource Information]

Name	State	Status
Natural		
Ningaloo Marine Area - Commonwealth Waters	WA	Listed place

Listed Marine Species [Resource Information]

* Species is listed under a different scientific name on the EPBC Act - Threatened Species list.

Name	Threatened	Type of Presence
Birds		
Actitis hypoleucos Common Sandpiper [59309]		Species or species habitat known to occur within area
Anous stolidus Common Noddy [825]		Species or species habitat may occur within area
Anous tenuirostris melanops Australian Lesser Noddy [26000]	Vulnerable	Species or species habitat may occur within area
Apus pacificus Fork-tailed Swift [678]		Species or species habitat likely to occur within area
Calidris acuminata Sharp-tailed Sandpiper [874]		Species or species habitat known to occur within area
Calidris canutus Red Knot, Knot [855]	Endangered	Species or species habitat may occur within area
Calidris ferruginea Curlew Sandpiper [856]	Critically Endangered	Species or species habitat may occur within area
Calidris melanotos Pectoral Sandpiper [858]		Species or species habitat may occur within area

Name	Threatened	Type of Presence
Calonectris leucomelas Streaked Shearwater [1077]		Species or species habitat likely to occur within area
Fregata ariel Lesser Frigatebird, Least Frigatebird [1012]		Species or species habitat likely to occur within area
Fregata minor Great Frigatebird, Greater Frigatebird [1013]		Species or species habitat may occur within area
Limosa lapponica Bar-tailed Godwit [844]		Species or species habitat known to occur within area
Macronectes giganteus Southern Giant-Petrel, Southern Giant Petrel [1060]	Endangered	Species or species habitat may occur within area
Macronectes halli Northern Giant Petrel [1061]	Vulnerable	Species or species habitat may occur within area
Numenius madagascariensis Eastern Curlew, Far Eastern Curlew [847]	Critically Endangered	Species or species habitat may occur within area
Pandion haliaetus Osprey [952]		Breeding known to occur within area
Papasula abbotti Abbott's Booby [59297]	Endangered	Species or species habitat may occur within area
Pterodroma mollis Soft-plumaged Petrel [1036]	Vulnerable	Foraging, feeding or related behaviour likely to occur within area
Puffinus carneipes Flesh-footed Shearwater, Fleshy-footed Shearwater [1043]		Foraging, feeding or related behaviour likely to occur within area
Rostratula benghalensis (sensu lato) Painted Snipe [889]	Endangered*	Species or species habitat may occur within area
Sterna anaethetus Bridled Tern [814]		Foraging, feeding or related behaviour likely to occur within area
Sterna bergii Crested Tern [816]		Breeding known to occur within area
Sterna caspia Caspian Tern [59467]		Breeding known to occur within area
Sterna dougallii Roseate Tern [817]		Breeding known to occur within area
Sterna fuscata Sooty Tern [794]		Foraging, feeding or related behaviour likely to occur within area
Thalassarche carteri Indian Yellow-nosed Albatross [64464]	Vulnerable	Foraging, feeding or related behaviour may occur within area
Thalassarche cauta Shy Albatross [89224]	Endangered	Species or species habitat may occur within area

Name	Threatened	Type of Presence
Thalassarche impavida Campbell Albatross, Campbell Black-browed Albatross [64459]	Vulnerable	Species or species habitat may occur within area
Thalassarche melanophris Black-browed Albatross [66472]	Vulnerable	Species or species habitat may occur within area
Thalassarche steadi White-capped Albatross [64462]	Vulnerable	Foraging, feeding or related behaviour likely to occur within area
Fish		
Acentronura larsonae Helen's Pygmy Pipehorse [66186]		Species or species habitat may occur within area
Bulbonaricus brauni Braun's Pughead Pipefish, Pug-headed Pipefish [66189]		Species or species habitat may occur within area
Campichthys tricarinatus Three-keel Pipefish [66192]		Species or species habitat may occur within area
Choeroichthys brachysoma Pacific Short-bodied Pipefish, Short-bodied Pipefish [66194]		Species or species habitat may occur within area
Choeroichthys latispinosus Muiron Island Pipefish [66196]		Species or species habitat may occur within area
Choeroichthys suillus Pig-snouted Pipefish [66198]		Species or species habitat may occur within area
Corythoichthys flavofasciatus Reticulate Pipefish, Yellow-banded Pipefish, Network Pipefish [66200]		Species or species habitat may occur within area
Cosmocampus banneri Roughridge Pipefish [66206]		Species or species habitat may occur within area
Doryrhamphus dactyliophorus Banded Pipefish, Ringed Pipefish [66210]		Species or species habitat may occur within area
Doryrhamphus excisus Bluestripe Pipefish, Indian Blue-stripe Pipefish, Pacific Blue-stripe Pipefish [66211]		Species or species habitat may occur within area
Doryrhamphus janssi Cleaner Pipefish, Janss' Pipefish [66212]		Species or species habitat may occur within area
Doryrhamphus multiannulatus Many-banded Pipefish [66717]		Species or species habitat may occur within area
Doryrhamphus negrosensis Flagtail Pipefish, Masthead Island Pipefish [66213]		Species or species habitat may occur within area
Festucalex scalaris Ladder Pipefish [66216]		Species or species habitat may occur within area
Filicampus tigris Tiger Pipefish [66217]		Species or species habitat may occur within area

Name	Threatened	Type of Presence
Halicampus brocki Brock's Pipefish [66219]		Species or species habitat may occur within area
Halicampus grayi Mud Pipefish, Gray's Pipefish [66221]		Species or species habitat may occur within area
Halicampus nitidus Glittering Pipefish [66224]		Species or species habitat may occur within area
Halicampus spinirostris Spiny-snout Pipefish [66225]		Species or species habitat may occur within area
Haliichthys taeniophorus Ribboned Pipehorse, Ribboned Seadragon [66226]		Species or species habitat may occur within area
Hippichthys penicillus Beady Pipefish, Steep-nosed Pipefish [66231]		Species or species habitat may occur within area
Hippocampus angustus Western Spiny Seahorse, Narrow-bellied Seahorse [66234]		Species or species habitat may occur within area
Hippocampus histrix Spiny Seahorse, Thorny Seahorse [66236]		Species or species habitat may occur within area
Hippocampus kuda Spotted Seahorse, Yellow Seahorse [66237]		Species or species habitat may occur within area
Hippocampus planifrons Flat-face Seahorse [66238]		Species or species habitat may occur within area
Hippocampus spinosissimus Hedgehog Seahorse [66239]		Species or species habitat may occur within area
Hippocampus trimaculatus Three-spot Seahorse, Low-crowned Seahorse, Flat-faced Seahorse [66720]		Species or species habitat may occur within area
Micrognathus micronotopterus Tidepool Pipefish [66255]		Species or species habitat may occur within area
Phoxocampus belcheri Black Rock Pipefish [66719]		Species or species habitat may occur within area
Solegnathus hardwickii Pallid Pipehorse, Hardwick's Pipehorse [66272]		Species or species habitat may occur within area
Solegnathus lettiensis Gunther's Pipehorse, Indonesian Pipefish [66273]		Species or species habitat may occur within area
Solenostomus cyanopterus Robust Ghostpipefish, Blue-finned Ghost Pipefish, [66183]		Species or species habitat may occur within area
Syngnathoides biaculeatus Double-end Pipehorse, Double-ended Pipehorse, Alligator Pipefish [66279]		Species or species habitat may occur within area

Name	Threatened	Type of Presence
Trachyrhamphus bicoarctatus Bentstick Pipefish, Bend Stick Pipefish, Short-tailed Pipefish [66280]		Species or species habitat may occur within area
Trachyrhamphus longirostris Straightstick Pipefish, Long-nosed Pipefish, Straight Stick Pipefish [66281]		Species or species habitat may occur within area
Mammals		
Dugong dugon Dugong [28]		Breeding known to occur within area
Reptiles		
Acalyptophis peronii Horned Seasnake [1114]		Species or species habitat may occur within area
Aipysurus apraefrontalis Short-nosed Seasnake [1115]	Critically Endangered	Species or species habitat likely to occur within area
Aipysurus duboisii Dubois' Seasnake [1116]		Species or species habitat may occur within area
Aipysurus eydouxii Spine-tailed Seasnake [1117]		Species or species habitat may occur within area
Aipysurus foliosquama Leaf-scaled Seasnake [1118]	Critically Endangered	Species or species habitat likely to occur within area
Aipysurus laevis Olive Seasnake [1120]		Species or species habitat may occur within area
Aipysurus pooleorum Shark Bay Seasnake [66061]		Species or species habitat may occur within area
Astrotia stokesii Stokes' Seasnake [1122]		Species or species habitat may occur within area
Caretta caretta Loggerhead Turtle [1763]	Endangered	Foraging, feeding or related behaviour known to occur within area
Chelonia mydas Green Turtle [1765]	Vulnerable	Foraging, feeding or related behaviour known to occur within area
Dermochelys coriacea Leatherback Turtle, Leathery Turtle, Luth [1768]	Endangered	Species or species habitat known to occur within area
Disteira kingii Spectacled Seasnake [1123]		Species or species habitat may occur within area
Disteira major Olive-headed Seasnake [1124]		Species or species habitat may occur within area
Emydocephalus annulatus Turtle-headed Seasnake [1125]		Species or species habitat may occur within area
Ephalophis greyi North-western Mangrove Seasnake [1127]		Species or species habitat may occur within area

Name	Threatened	Type of Presence
Eretmochelys imbricata Hawksbill Turtle [1766]	Vulnerable	Foraging, feeding or related behaviour known to occur within area
Hydrophis czeblukovi Fine-spined Seasnake [59233]		Species or species habitat may occur within area
Hydrophis elegans Elegant Seasnake [1104]		Species or species habitat may occur within area
Hydrophis mcdowelli null [25926]		Species or species habitat may occur within area
Hydrophis ornatus Spotted Seasnake, Ornate Reef Seasnake [1111]		Species or species habitat may occur within area
Natator depressus Flatback Turtle [59257]	Vulnerable	Foraging, feeding or related behaviour known to occur within area
Pelamis platurus Yellow-bellied Seasnake [1091]		Species or species habitat may occur within area

Whales and other Cetaceans [Resource Information]

Name	Status	Type of Presence
Mammals		
Balaenoptera acutorostrata Minke Whale [33]		Species or species habitat may occur within area
Balaenoptera bonaerensis Antarctic Minke Whale, Dark-shoulder Minke Whale [67812]		Species or species habitat likely to occur within area
Balaenoptera borealis Sei Whale [34]	Vulnerable	Foraging, feeding or related behaviour likely to occur within area
Balaenoptera edeni Bryde's Whale [35]		Species or species habitat likely to occur within area
Balaenoptera musculus Blue Whale [36]	Endangered	Migration route known to occur within area
Balaenoptera physalus Fin Whale [37]	Vulnerable	Foraging, feeding or related behaviour likely to occur within area
Delphinus delphis Common Dolphin, Short-beaked Common Dolphin [60]		Species or species habitat may occur within area
Eubalaena australis Southern Right Whale [40]	Endangered	Species or species habitat likely to occur within area
Feresa attenuata Pygmy Killer Whale [61]		Species or species habitat may occur within area
Globicephala macrorhynchus Short-finned Pilot Whale [62]		Species or species habitat may occur within area
Grampus griseus Risso's Dolphin, Grampus [64]		Species or species

Name	Status	Type of Presence
		habitat may occur within area
Indopacetus pacificus Longman's Beaked Whale [72]		Species or species habitat may occur within area
Kogia breviceps Pygmy Sperm Whale [57]		Species or species habitat may occur within area
Kogia simus Dwarf Sperm Whale [58]		Species or species habitat may occur within area
Lagenodelphis hosei Fraser's Dolphin, Sarawak Dolphin [41]		Species or species habitat may occur within area
Megaptera novaeangliae Humpback Whale [38]	Vulnerable	Breeding known to occur within area
Mesoplodon densirostris Blainville's Beaked Whale, Dense-beaked Whale [74]		Species or species habitat may occur within area
Mesoplodon ginkgodens Gingko-toothed Beaked Whale, Gingko-toothed Whale, Gingko Beaked Whale [59564]		Species or species habitat may occur within area
Mesoplodon grayi Gray's Beaked Whale, Scamperdown Whale [75]		Species or species habitat may occur within area
Orcinus orca Killer Whale, Orca [46]		Species or species habitat may occur within area
Peponocephala electra Melon-headed Whale [47]		Species or species habitat may occur within area
Physeter macrocephalus Sperm Whale [59]		Species or species habitat may occur within area
Pseudorca crassidens False Killer Whale [48]		Species or species habitat likely to occur within area
Sousa chinensis Indo-Pacific Humpback Dolphin [50]		Species or species habitat may occur within area
Stenella attenuata Spotted Dolphin, Pantropical Spotted Dolphin [51]		Species or species habitat may occur within area
Stenella coeruleoalba Striped Dolphin, Euphrosyne Dolphin [52]		Species or species habitat may occur within area
Stenella longirostris Long-snouted Spinner Dolphin [29]		Species or species habitat may occur within area
Steno bredanensis Rough-toothed Dolphin [30]		Species or species habitat may occur within area
Tursiops aduncus Indian Ocean Bottlenose Dolphin, Spotted Bottlenose Dolphin [68418]		Species or species habitat likely to occur within area

Name	Status	Type of Presence
Tursiops aduncus (Arafura/Timor Sea populations) Spotted Bottlenose Dolphin (Arafura/Timor Sea populations) [78900]		Species or species habitat known to occur within area
Tursiops truncatus s. str. Bottlenose Dolphin [68417]		Species or species habitat may occur within area
Ziphius cavirostris Cuvier's Beaked Whale, Goose-beaked Whale [56]		Species or species habitat may occur within area

Australian Marine Parks [Resource Information]

Name	Label
Abrolhos	Habitat Protection Zone (IUCN IV)
Argo-Rowley Terrace	Multiple Use Zone (IUCN VI)
Carnarvon Canyon	Habitat Protection Zone (IUCN IV)
Gascoyne	Habitat Protection Zone (IUCN IV)
Gascoyne	Multiple Use Zone (IUCN VI)
Gascoyne	National Park Zone (IUCN II)
Montebello	Multiple Use Zone (IUCN VI)
Ningaloo	National Park Zone (IUCN II)
Ningaloo	Recreational Use Zone (IUCN IV)

Extra Information

Key Ecological Features (Marine) [Resource Information]

Key Ecological Features are the parts of the marine ecosystem that are considered to be important for the biodiversity or ecosystem functioning and integrity of the Commonwealth Marine Area.

Name	Region
Ancient coastline at 125 m depth contour	North-west
Canyons linking the Cuvier Abyssal Plain and the	North-west
Commonwealth waters adjacent to Ningaloo Reef	North-west
Continental Slope Demersal Fish Communities	North-west
Exmouth Plateau	North-west
Wallaby Saddle	North-west
Western demersal slope and associated fish	South-west

Caveat

The information presented in this report has been provided by a range of data sources as acknowledged at the end of the report.

This report is designed to assist in identifying the locations of places which may be relevant in determining obligations under the Environment Protection and Biodiversity Conservation Act 1999. It holds mapped locations of World and National Heritage properties, Wetlands of International and National Importance, Commonwealth and State/Territory reserves, listed threatened, migratory and marine species and listed threatened ecological communities. Mapping of Commonwealth land is not complete at this stage. Maps have been collated from a range of sources at various resolutions.

Not all species listed under the EPBC Act have been mapped (see below) and therefore a report is a general guide only. Where available data supports mapping, the type of presence that can be determined from the data is indicated in general terms. People using this information in making a referral may need to consider the qualifications below and may need to seek and consider other information sources.

For threatened ecological communities where the distribution is well known, maps are derived from recovery plans, State vegetation maps, remote sensing imagery and other sources. Where threatened ecological community distributions are less well known, existing vegetation maps and point location data are used to produce indicative distribution maps.

Threatened, migratory and marine species distributions have been derived through a variety of methods. Where distributions are well known and if time permits, maps are derived using either thematic spatial data (i.e. vegetation, soils, geology, elevation, aspect, terrain, etc) together with point locations and described habitat; or environmental modelling (MAXENT or BIOCLIM habitat modelling) using point locations and environmental data layers.

Where very little information is available for species or large number of maps are required in a short time-frame, maps are derived either from 0.04 or 0.02 decimal degree cells; by an automated process using polygon capture techniques (static two kilometre grid cells, alpha-hull and convex hull); or captured manually or by using topographic features (national park boundaries, islands, etc). In the early stages of the distribution mapping process (1999-early 2000s) distributions were defined by degree blocks, 100K or 250K map sheets to rapidly create distribution maps. More reliable distribution mapping methods are used to update these distributions as time permits.

Only selected species covered by the following provisions of the EPBC Act have been mapped:

- migratory and
- marine

The following species and ecological communities have not been mapped and do not appear in reports produced from this database:

- threatened species listed as extinct or considered as vagrants
- some species and ecological communities that have only recently been listed
- some terrestrial species that overfly the Commonwealth marine area
- migratory species that are very widespread, vagrant, or only occur in small numbers

The following groups have been mapped, but may not cover the complete distribution of the species:

- non-threatened seabirds which have only been mapped for recorded breeding sites
- seals which have only been mapped for breeding sites near the Australian continent

Such breeding sites may be important for the protection of the Commonwealth Marine environment.

Coordinates

-15.635 109.259,-15.813 109.315,-16.151 109.322,-16.881 109.391,-17.075 109.319,-17.187 109.72,-17.104 110.147,-17.068 110.449,-17.062 110.745,-16.562 110.791,-16.148 111.764,-16.095 111.82,-16.109 112.441,-16.043 112.507,-15.928 112.571,-15.318 112.441,-15.205 112.498,-15.198 112.518,-15.305 112.633,-15.461 113.346,-15.57 113.542,-15.79 113.706,-15.819 113.759,-15.903 113.93,-15.985 113.999,-16.224 114.125,-16.339 114.209,-16.289 114.36,-16.22 114.444,-15.997 114.439,-15.699 114.679,-15.21 114.87,-15.172 114.964,-15.073 115.3,-15.137 115.355,-15.422 115.522,-15.594 115.631,-15.77 115.692,-15.91 115.698,-16.148 115.654,-16.321 115.695,-16.219 116.043,-16.943 116.114,-17.075 116.213,-17.305 116.62,-17.55 116.799,-17.55 116.939,-17.75 117.33,-17.773 117.333,-17.964 117.266,-18.072 117.302,-18.483 117.401,-18.802 117.379,-19.085 117.338,-19.213 117.233,-19.358 116.931,-19.392 116.753,-19.389 116.656,-19.328 116.285,-19.425 116.093,-19.4 116.084,-19.252 116.112,-19.195 116.027,-19.265 115.931,-19.338 115.8,-19.473 115.614,-19.568 115.542,-19.643 115.46,-19.685 115.368,-19.795 115.333,-19.893 115.465,-20.081 115.44,-20.248 115.374,-20.316 115.296,-20.371 115.169,-20.579 115.084,-20.902 114.957,-21.206 114.758,-21.43 114.502,-21.548 114.134,-21.597 114.019,-21.722 113.982,-21.811 113.897,-22.041 113.743,-22.353 113.697,-22.666 113.624,-23.165 113.493,-23.402 113.305,-23.461 112.957,-24.112 112.523,-24.533 112.201,-24.822 112.247,-25.302 112.168,-25.854 111.997,-25.873 111.912,-25.305 111.504,-25.443 110.765,-25.699 110.285,-25.768 110.032,-25.788 109.716,-25.683 109.552,-24.901 109.486,-24.914 110.084,-24.759 110.344,-24.348 111.028,-23.783 111.36,-23.599 111.356,-23.435 110.992,-23.303 110.63,-23.122 110.255,-22.6 109.867,-21.982 109.723,-21.555 108.967,-21.272 108.579,-21.042 108.329,-20.588 108.145,-20.431 107.836,-19.734 107.698,-18.991 107.652,-18.288 107.955,-16.911 108.346,-16.871 108.431,-15.823 109.085,-15.681 109.128,-15.635 109.259

Acknowledgements

This database has been compiled from a range of data sources. The department acknowledges the following custodians who have contributed valuable data and advice:

- -Office of Environment and Heritage, New South Wales
- -Department of Environment and Primary Industries, Victoria
- -Department of Primary Industries, Parks, Water and Environment, Tasmania
- -Department of Environment, Water and Natural Resources, South Australia
- -Department of Land and Resource Management, Northern Territory
- -Department of Environmental and Heritage Protection, Queensland
- -Department of Parks and Wildlife, Western Australia
- -Environment and Planning Directorate, ACT
- -Birdlife Australia
- -Australian Bird and Bat Banding Scheme
- -Australian National Wildlife Collection
- -Natural history museums of Australia
- -Museum Victoria
- -Australian Museum
- -South Australian Museum
- -Queensland Museum
- -Online Zoological Collections of Australian Museums
- -Queensland Herbarium
- -National Herbarium of NSW
- -Royal Botanic Gardens and National Herbarium of Victoria
- -Tasmanian Herbarium
- -State Herbarium of South Australia
- -Northern Territory Herbarium
- -Western Australian Herbarium
- -Australian National Herbarium, Canberra
- -University of New England
- -Ocean Biogeographic Information System
- -Australian Government, Department of Defence
- Forestry Corporation, NSW
- -Geoscience Australia
- -CSIRO
- -Australian Tropical Herbarium, Cairns
- -eBird Australia
- -Australian Government – Australian Antarctic Data Centre
- -Museum and Art Gallery of the Northern Territory
- -Australian Government National Environmental Science Program
- -Australian Institute of Marine Science
- -Reef Life Survey Australia
- -American Museum of Natural History
- -Queen Victoria Museum and Art Gallery, Inveresk, Tasmania
- -Tasmanian Museum and Art Gallery, Hobart, Tasmania
- -Other groups and individuals

The Department is extremely grateful to the many organisations and individuals who provided expert advice and information on numerous draft distributions.

Please feel free to provide feedback via the Contact Us page.

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Australian Government

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EPBC Act Protected Matters Report

This report provides general guidance on matters of national environmental significance and other matters protected by the EPBC Act in the area you have selected.

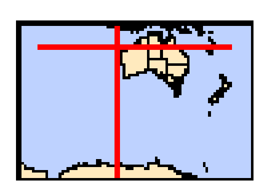
Information on the coverage of this report and qualifications on data supporting this report are contained in the caveat at the end of the report.

Information is available about Environment Assessments and the EPBC Act including significance guidelines, forms and application process details.

Report created: 10/06/21 16:41:22

Coordinates

Buffer: 0.0Km



Summary

Matters of National Environmental Significance

This part of the report summarises the matters of national environmental significance that may occur in, or may relate to, the area you nominated. Further information is available in the detail part of the report, which can be accessed by scrolling or following the links below. If you are proposing to undertake an activity that may have a significant impact on one or more matters of national environmental significance then you should consider the Administrative Guidelines on Significance.

World Heritage Properties:	1
National Heritage Places:	3
Wetlands of International Importance:	None
Great Barrier Reef Marine Park:	None
Commonwealth Marine Area:	2
Listed Threatened Ecological Communities:	6
Listed Threatened Species:	71
Listed Migratory Species:	73

Other Matters Protected by the EPBC Act

This part of the report summarises other matters protected under the Act that may relate to the area you nominated. Approval may be required for a proposed activity that significantly affects the environment on Commonwealth land, when the action is outside the Commonwealth land, or the environment anywhere when the action is taken on Commonwealth land. Approval may also be required for the Commonwealth or Commonwealth agencies proposing to take an action that is likely to have a significant impact on the environment anywhere.

The EPBC Act protects the environment on Commonwealth land, the environment from the actions taken on Commonwealth land, and the environment from actions taken by Commonwealth agencies. As heritage values of a place are part of the 'environment', these aspects of the EPBC Act protect the Commonwealth Heritage values of a Commonwealth Heritage place. Information on the new heritage laws can be found at http://www.environment.gov.au/heritage

A permit may be required for activities in or on a Commonwealth area that may affect a member of a listed threatened species or ecological community, a member of a listed migratory species, whales and other cetaceans, or a member of a listed marine species.

Commonwealth Land:	1
Commonwealth Heritage Places:	2
Listed Marine Species:	147
Whales and Other Cetaceans:	40
Critical Habitats:	None
Commonwealth Reserves Terrestrial:	None
Australian Marine Parks:	21

Extra Information

This part of the report provides information that may also be relevant to the area you have nominated.

State and Territory Reserves:	18
Regional Forest Agreements:	None
Invasive Species:	23
Nationally Important Wetlands:	None
Key Ecological Features (Marine)	15

Details

Matters of National Environmental Significance

World Heritage Properties [Resource Information]

Name	State	Status
The Ningaloo Coast	WA	Declared property

National Heritage Properties [Resource Information]

Name	State	Status
Natural		
The Ningaloo Coast	WA	Listed place
Historic		
Batavia Shipwreck Site and Survivor Camps Area 1629 - Houtman Abrolhos	WA	Listed place
HMAS Sydney II and HSK Kormoran Shipwreck Sites	EXT	Listed place

Commonwealth Marine Area [Resource Information]

Approval is required for a proposed activity that is located within the Commonwealth Marine Area which has, will have, or is likely to have a significant impact on the environment. Approval may be required for a proposed action taken outside the Commonwealth Marine Area but which has, may have or is likely to have a significant impact on the environment in the Commonwealth Marine Area. Generally the Commonwealth Marine Area stretches from three nautical miles to two hundred nautical miles from the coast.

Name
EEZ and Territorial Sea
Extended Continental Shelf

Marine Regions [Resource Information]

If you are planning to undertake action in an area in or close to the Commonwealth Marine Area, and a marine bioregional plan has been prepared for the Commonwealth Marine Area in that area, the marine bioregional plan may inform your decision as to whether to refer your proposed action under the EPBC Act.

Name
North-west
South-west

Listed Threatened Ecological Communities [Resource Information]

For threatened ecological communities where the distribution is well known, maps are derived from recovery plans, State vegetation maps, remote sensing imagery and other sources. Where threatened ecological community distributions are less well known, existing vegetation maps and point location data are used to produce indicative distribution maps.

Name	Status	Type of Presence
Banksia Woodlands of the Swan Coastal Plain ecological community	Endangered	Community may occur within area
Banksia Woodlands of the Swan Coastal Plain ecological community	Endangered	Community may occur within area
Banksia Woodlands of the Swan Coastal Plain ecological community	Endangered	Community may occur within area
Tuart (Eucalyptus gomphocephala) Woodlands and Forests of the Swan Coastal Plain ecological community	Critically Endangered	Community may occur within area
Tuart (Eucalyptus gomphocephala) Woodlands and Forests of the Swan Coastal Plain ecological community	Critically Endangered	Community may occur within area
Tuart (Eucalyptus gomphocephala) Woodlands and Forests of the Swan Coastal Plain ecological community	Critically Endangered	Community may occur within area

Listed Threatened Species [Resource Information]

Name	Status	Type of Presence
Birds		
Anous tenuirostris melanops		
Australian Lesser Noddy [26000]	Vulnerable	Breeding known to occur within area

Name	Status	Type of Presence
Calidris canutus Red Knot, Knot [855]	Endangered	Species or species habitat known to occur within area
Calidris ferruginea Curlew Sandpiper [856]	Critically Endangered	Species or species habitat known to occur within area
Calyptorhynchus latirostris Carnaby's Cockatoo, Short-billed Black-Cockatoo [59523]	Endangered	Species or species habitat likely to occur within area
Diomedea amsterdamensis Amsterdam Albatross [64405]	Endangered	Species or species habitat likely to occur within area
Diomedea epomophora Southern Royal Albatross [89221]	Vulnerable	Foraging, feeding or related behaviour likely to occur within area
Diomedea exulans Wandering Albatross [89223]	Vulnerable	Foraging, feeding or related behaviour likely to occur within area
Diomedea sanfordi Northern Royal Albatross [64456]	Endangered	Foraging, feeding or related behaviour likely to occur within area
Falco hypoleucos Grey Falcon [929]	Vulnerable	Species or species habitat known to occur within area
Fregata andrewsi Christmas Island Frigatebird, Andrew's Frigatebird [1011]	Endangered	Foraging, feeding or related behaviour known to occur within area
Halobaena caerulea Blue Petrel [1059]	Vulnerable	Species or species habitat may occur within area
Leipoa ocellata Malleefowl [934]	Vulnerable	Species or species habitat likely to occur within area
Limosa lapponica menzbieri Northern Siberian Bar-tailed Godwit, Russkoye Bar-tailed Godwit [86432]	Critically Endangered	Species or species habitat known to occur within area
Macronectes giganteus Southern Giant-Petrel, Southern Giant Petrel [1060]	Endangered	Species or species habitat may occur within area
Macronectes halli Northern Giant Petrel [1061]	Vulnerable	Species or species habitat may occur within area
Malurus leucopterus edouardi White-winged Fairy-wren (Barrow Island), Barrow Island Black-and-white Fairy-wren [26194]	Vulnerable	Species or species habitat likely to occur within area
Numenius madagascariensis Eastern Curlew, Far Eastern Curlew [847]	Critically Endangered	Species or species habitat known to occur within area
Pachyptila turtur subantarctica Fairy Prion (southern) [64445]	Vulnerable	Species or species habitat may occur within area
Papasula abbotti Abbott's Booby [59297]	Endangered	Species or species habitat may occur within area

Name	Status	Type of Presence
Pezoporus occidentalis		
Night Parrot [59350]	Endangered	Species or species habitat may occur within area
Phoebetria fusca		
Sooty Albatross [1075]	Vulnerable	Species or species habitat may occur within area
Pterodroma arminjoniana		
Round Island Petrel, Trinidade Petrel [89284]	Critically Endangered	Species or species habitat may occur within area
Pterodroma mollis		
Soft-plumaged Petrel [1036]	Vulnerable	Foraging, feeding or related behaviour known to occur within area
Rostratula australis		
Australian Painted Snipe [77037]	Endangered	Species or species habitat likely to occur within area
Sternula nereis nereis		
Australian Fairy Tern [82950]	Vulnerable	Breeding known to occur within area
Thalassarche carteri		
Indian Yellow-nosed Albatross [64464]	Vulnerable	Foraging, feeding or related behaviour may occur within area
Thalassarche cauta		
Shy Albatross [89224]	Endangered	Species or species habitat may occur within area
Thalassarche impavida		
Campbell Albatross, Campbell Black-browed Albatross [64459]	Vulnerable	Species or species habitat may occur within area
Thalassarche melanophris		
Black-browed Albatross [66472]	Vulnerable	Species or species habitat may occur within area
Thalassarche steadi		
White-capped Albatross [64462]	Vulnerable	Foraging, feeding or related behaviour likely to occur within area
Turnix varius scintillans		
Painted Button-quail (Houtman Abrolhos) [82451]	Vulnerable	Species or species habitat likely to occur within area
Fish		
Milyeringa veritas		
Blind Gudgeon [66676]	Vulnerable	Species or species habitat likely to occur within area
Mammals		
Balaenoptera borealis		
Sei Whale [34]	Vulnerable	Foraging, feeding or related behaviour likely to occur within area
Balaenoptera musculus		
Blue Whale [36]	Endangered	Foraging, feeding or related behaviour known to occur within area
Balaenoptera physalus		
Fin Whale [37]	Vulnerable	Foraging, feeding or related behaviour likely to occur within area
Bettongia lesueur Barrow and Boodie Islands subspecies		
Boodie, Burrowing Bettong (Barrow and Boodie Islands) [88021]	Vulnerable	Species or species habitat known to occur within area
Dasyurus geoffroii		
Chuditch, Western Quoll [330]	Vulnerable	Species or species habitat likely to occur within area

Name	Status	Type of Presence
Dasyurus hallucatus Northern Quoll, Digul [Gogo-Yimidir], Wijingadda [Dambimangari], Wiminji [Martu] [331]	Endangered	Species or species habitat may occur within area
Eubalaena australis Southern Right Whale [40]	Endangered	Species or species habitat likely to occur within area
Isoodon auratus barrowensis Golden Bandicoot (Barrow Island) [66666]	Vulnerable	Species or species habitat known to occur within area
Lagorchestes conspicillatus conspicillatus Spectacled Hare-wallaby (Barrow Island) [66661]	Vulnerable	Species or species habitat known to occur within area
Lagorchestes hirsutus Central Australian subspecies Mala, Rufous Hare-Wallaby (Central Australia) [88019]	Endangered	Translocated population known to occur within area
Megaptera novaeangliae Humpback Whale [38]	Vulnerable	Breeding known to occur within area
Neophoca cinerea Australian Sea-lion, Australian Sea Lion [22]	Endangered	Breeding known to occur within area
Osphranter robustus isabellinus Barrow Island Wallaroo, Barrow Island Euro [89262]	Vulnerable	Species or species habitat likely to occur within area
Parantechinus apicalis Dibbler [313]	Endangered	Species or species habitat known to occur within area
Petrogale lateralis lateralis Black-flanked Rock-wallaby, Moororong, Black-footed Rock Wallaby [66647]	Endangered	Species or species habitat known to occur within area
Rhinonicteris aurantia (Pilbara form) Pilbara Leaf-nosed Bat [82790]	Vulnerable	Species or species habitat known to occur within area
Plants		
Andersonia gracilis Slender Andersonia [14470]	Endangered	Species or species habitat may occur within area
Eucalyptus argutifolia Yanchep Mallee, Wabling Hill Mallee [24263]	Vulnerable	Species or species habitat may occur within area
Hemiandra gardneri Red Snakebush [7945]	Endangered	Species or species habitat likely to occur within area
Leucopogon obtectus Hidden Beard-heath [19614]	Endangered	Species or species habitat may occur within area
Thelymitra stellata Star Sun-orchid [7060]	Endangered	Species or species habitat may occur within area
Reptiles		
Aipysurus apraefrontalis Short-nosed Seasnake [1115]	Critically Endangered	Species or species habitat known to occur within area
Aipysurus foliosquama Leaf-scaled Seasnake [1118]	Critically Endangered	Species or species habitat known to occur within area

Name	Status	Type of Presence
Caretta caretta		
Loggerhead Turtle [1763]	Endangered	Breeding known to occur within area
Chelonia mydas		
Green Turtle [1765]	Vulnerable	Breeding known to occur within area
Ctenotus lancelini		
Lancelin Island Skink [1482]	Vulnerable	Translocated population known to occur within area
Ctenotus zastictus		
Hamelin Ctenotus [25570]	Vulnerable	Species or species habitat known to occur within area
Dermochelys coriacea		
Leatherback Turtle, Leathery Turtle, Luth [1768]	Endangered	Foraging, feeding or related behaviour known to occur within area
Egernia stokesii badia		
Western Spiny-tailed Skink, Baudin Island Spiny-tailed Skink [64483]	Endangered	Species or species habitat may occur within area
Eretmochelys imbricata		
Hawksbill Turtle [1766]	Vulnerable	Breeding known to occur within area
Lepidochelys olivacea		
Olive Ridley Turtle, Pacific Ridley Turtle [1767]	Endangered	Species or species habitat likely to occur within area
Liopholis pulchra longicauda		
Jurien Bay Skink, Jurien Bay Rock-skink [83162]	Vulnerable	Species or species habitat known to occur within area
Natator depressus		
Flatback Turtle [59257]	Vulnerable	Breeding known to occur within area
Sharks		
Carcharias taurus (west coast population)		
Grey Nurse Shark (west coast population) [68752]	Vulnerable	Species or species habitat known to occur within area
Carcharodon carcharias		
White Shark, Great White Shark [64470]	Vulnerable	Foraging, feeding or related behaviour known to occur within area
Pristis clavata		
Dwarf Sawfish, Queensland Sawfish [68447]	Vulnerable	Species or species habitat known to occur within area
Pristis pristis		
Freshwater Sawfish, Largetooth Sawfish, River Sawfish, Leichhardt's Sawfish, Northern Sawfish [60756]	Vulnerable	Species or species habitat known to occur within area
Pristis zijsron		
Green Sawfish, Dindagubba, Narrowsnout Sawfish [68442]	Vulnerable	Species or species habitat known to occur within area
Rhincodon typus		
Whale Shark [66680]	Vulnerable	Foraging, feeding or related behaviour known to occur within area

Listed Migratory Species [Resource Information]

* Species is listed under a different scientific name on the EPBC Act - Threatened Species list.

Name	Threatened	Type of Presence
Migratory Marine Birds		
Anous stolidus		
Common Noddy [825]		Species or species habitat likely to occur within area
Apus pacificus		
Fork-tailed Swift [678]		Species or species

Name	Threatened	Type of Presence
		habitat likely to occur within area
Ardenna carneipes Flesh-footed Shearwater, Fleshy-footed Shearwater [82404]		Foraging, feeding or related behaviour likely to occur within area
Ardenna pacifica Wedge-tailed Shearwater [84292]		Breeding known to occur within area
Calonectris leucomelas Streaked Shearwater [1077]		Species or species habitat known to occur within area
Diomedea amsterdamensis Amsterdam Albatross [64405]	Endangered	Species or species habitat likely to occur within area
Diomedea epomophora Southern Royal Albatross [89221]	Vulnerable	Foraging, feeding or related behaviour likely to occur within area
Diomedea exulans Wandering Albatross [89223]	Vulnerable	Foraging, feeding or related behaviour likely to occur within area
Diomedea sanfordi Northern Royal Albatross [64456]	Endangered	Foraging, feeding or related behaviour likely to occur within area
Fregata andrewsi Christmas Island Frigatebird, Andrew's Frigatebird [1011]	Endangered	Foraging, feeding or related behaviour known to occur within area
Fregata ariel Lesser Frigatebird, Least Frigatebird [1012]		Species or species habitat known to occur within area
Fregata minor Great Frigatebird, Greater Frigatebird [1013]		Species or species habitat may occur within area
Hydroprogne caspia Caspian Tern [808]		Breeding known to occur within area
Macronectes giganteus Southern Giant-Petrel, Southern Giant Petrel [1060]	Endangered	Species or species habitat may occur within area
Macronectes halli Northern Giant Petrel [1061]	Vulnerable	Species or species habitat may occur within area
Onychoprion anaethetus Bridled Tern [82845]		Breeding known to occur within area
Phaethon lepturus White-tailed Tropicbird [1014]		Breeding likely to occur within area
Phaethon rubricauda Red-tailed Tropicbird [994]		Breeding known to occur within area
Phoebetria fusca Sooty Albatross [1075]	Vulnerable	Species or species habitat may occur within area
Sterna dougallii Roseate Tern [817]		Breeding known to occur within area
Sternula albifrons Little Tern [82849]		Congregation or aggregation known to occur within area

Name	Threatened	Type of Presence
Thalassarche carteri Indian Yellow-nosed Albatross [64464]	Vulnerable	Foraging, feeding or related behaviour may occur within area
Thalassarche cauta Shy Albatross [89224]	Endangered	Species or species habitat may occur within area
Thalassarche impavida Campbell Albatross, Campbell Black-browed Albatross [64459]	Vulnerable	Species or species habitat may occur within area
Thalassarche melanophris Black-browed Albatross [66472]	Vulnerable	Species or species habitat may occur within area
Thalassarche steadi White-capped Albatross [64462]	Vulnerable	Foraging, feeding or related behaviour likely to occur within area
Migratory Marine Species		
Anoxypristis cuspidata Narrow Sawfish, Knifetooth Sawfish [68448]		Species or species habitat known to occur within area
Balaena glacialis australis Southern Right Whale [75529]	Endangered*	Species or species habitat likely to occur within area
Balaenoptera bonaerensis Antarctic Minke Whale, Dark-shoulder Minke Whale [67812]		Species or species habitat likely to occur within area
Balaenoptera borealis Sei Whale [34]	Vulnerable	Foraging, feeding or related behaviour likely to occur within area
Balaenoptera edeni Bryde's Whale [35]		Species or species habitat likely to occur within area
Balaenoptera musculus Blue Whale [36]	Endangered	Foraging, feeding or related behaviour known to occur within area
Balaenoptera physalus Fin Whale [37]	Vulnerable	Foraging, feeding or related behaviour likely to occur within area
Caperea marginata Pygmy Right Whale [39]		Species or species habitat may occur within area
Carcharhinus longimanus Oceanic Whitetip Shark [84108]		Species or species habitat likely to occur within area
Carcharodon carcharias White Shark, Great White Shark [64470]	Vulnerable	Foraging, feeding or related behaviour known to occur within area
Caretta caretta Loggerhead Turtle [1763]	Endangered	Breeding known to occur within area
Chelonia mydas Green Turtle [1765]	Vulnerable	Breeding known to occur within area
Dermochelys coriacea Leatherback Turtle, Leathery Turtle, Luth [1768]	Endangered	Foraging, feeding or related behaviour known to occur within area
Dugong dugon Dugong [28]		Breeding known to occur

Name	Threatened	Type of Presence
		within area
Eretmochelys imbricata Hawksbill Turtle [1766]	Vulnerable	Breeding known to occur within area
Isurus oxyrinchus Shortfin Mako, Mako Shark [79073]		Species or species habitat likely to occur within area
Isurus paucus Longfin Mako [82947]		Species or species habitat likely to occur within area
Lagenorhynchus obscurus Dusky Dolphin [43]		Species or species habitat likely to occur within area
Lamna nasus Porbeagle, Mackerel Shark [83288]		Species or species habitat may occur within area
Lepidochelys olivacea Olive Ridley Turtle, Pacific Ridley Turtle [1767]	Endangered	Species or species habitat likely to occur within area
Manta alfredi Reef Manta Ray, Coastal Manta Ray, Inshore Manta Ray, Prince Alfred's Ray, Resident Manta Ray [84994]		Species or species habitat known to occur within area
Manta birostris Giant Manta Ray, Chevron Manta Ray, Pacific Manta Ray, Pelagic Manta Ray, Oceanic Manta Ray [84995]		Species or species habitat known to occur within area
Megaptera novaeangliae Humpback Whale [38]	Vulnerable	Breeding known to occur within area
Natator depressus Flatback Turtle [59257]	Vulnerable	Breeding known to occur within area
Orcinus orca Killer Whale, Orca [46]		Species or species habitat may occur within area
Physeter macrocephalus Sperm Whale [59]		Foraging, feeding or related behaviour known to occur within area
Pristis clavata Dwarf Sawfish, Queensland Sawfish [68447]	Vulnerable	Species or species habitat known to occur within area
Pristis pristis Freshwater Sawfish, Largetooth Sawfish, River Sawfish, Leichhardt's Sawfish, Northern Sawfish [60756]	Vulnerable	Species or species habitat known to occur within area
Pristis zijsron Green Sawfish, Dindagubba, Narrowsnout Sawfish [68442]	Vulnerable	Species or species habitat known to occur within area
Rhincodon typus Whale Shark [66680]	Vulnerable	Foraging, feeding or related behaviour known to occur within area
Sousa chinensis Indo-Pacific Humpback Dolphin [50]		Species or species habitat known to occur within area
Tursiops aduncus (Arafura/Timor Sea populations) Spotted Bottlenose Dolphin (Arafura/Timor Sea populations) [78900]		Species or species habitat known to occur within area
Migratory Terrestrial Species		
Hirundo rustica Barn Swallow [662]		Species or species

Name	Threatened	Type of Presence
		habitat may occur within area
Motacilla cinerea Grey Wagtail [642]		Species or species habitat may occur within area
Motacilla flava Yellow Wagtail [644]		Species or species habitat may occur within area
Migratory Wetlands Species		
Actitis hypoleucos Common Sandpiper [59309]		Species or species habitat known to occur within area
Calidris acuminata Sharp-tailed Sandpiper [874]		Species or species habitat known to occur within area
Calidris canutus Red Knot, Knot [855]	Endangered	Species or species habitat known to occur within area
Calidris ferruginea Curlew Sandpiper [856]	Critically Endangered	Species or species habitat known to occur within area
Calidris melanotos Pectoral Sandpiper [858]		Species or species habitat may occur within area
Charadrius veredus Oriental Plover, Oriental Dotterel [882]		Species or species habitat may occur within area
Glareola maldivarum Oriental Pratincole [840]		Species or species habitat may occur within area
Limosa lapponica Bar-tailed Godwit [844]		Species or species habitat known to occur within area
Numenius madagascariensis Eastern Curlew, Far Eastern Curlew [847]	Critically Endangered	Species or species habitat known to occur within area
Pandion haliaetus Osprey [952]		Breeding known to occur within area
Thalasseus bergii Greater Crested Tern [83000]		Breeding known to occur within area
Tringa nebularia Common Greenshank, Greenshank [832]		Species or species habitat likely to occur within area

Other Matters Protected by the EPBC Act

Commonwealth Land [Resource Information]

The Commonwealth area listed below may indicate the presence of Commonwealth land in this vicinity. Due to the unreliability of the data source, all proposals should be checked as to whether it impacts on a Commonwealth area, before making a definitive decision. Contact the State or Territory government land department for further information.

Name
Commonwealth Land -

Commonwealth Heritage Places [Resource Information]

Name	State	Status
Natural		
Ningaloo Marine Area - Commonwealth Waters	WA	Listed place
Historic		
HMAS Sydney II and HSK Kormoran Shipwreck Sites	EXT	Listed place

Listed Marine Species [Resource Information]

* Species is listed under a different scientific name on the EPBC Act - Threatened Species list.

Name	Threatened	Type of Presence
Birds		
Actitis hypoleucos Common Sandpiper [59309]		Species or species habitat known to occur within area
Anous stolidus Common Noddy [825]		Species or species habitat likely to occur within area
Anous tenuirostris melanops Australian Lesser Noddy [26000]	Vulnerable	Breeding known to occur within area
Apus pacificus Fork-tailed Swift [678]		Species or species habitat likely to occur within area
Ardea ibis Cattle Egret [59542]		Species or species habitat may occur within area
Calidris acuminata Sharp-tailed Sandpiper [874]		Species or species habitat known to occur within area
Calidris canutus Red Knot, Knot [855]	Endangered	Species or species habitat known to occur within area
Calidris ferruginea Curlew Sandpiper [856]	Critically Endangered	Species or species habitat known to occur within area
Calidris melanotos Pectoral Sandpiper [858]		Species or species habitat may occur within area
Calonectris leucomelas Streaked Shearwater [1077]		Species or species habitat known to occur within area
Catharacta skua Great Skua [59472]		Species or species habitat may occur within area
Charadrius veredus Oriental Plover, Oriental Dotterel [882]		Species or species habitat may occur within area
Chrysococcyx osculans Black-eared Cuckoo [705]		Species or species habitat likely to occur within area

Name	Threatened	Type of Presence
Diomedea amsterdamensis Amsterdam Albatross [64405]	Endangered	Species or species habitat likely to occur within area
Diomedea epomophora Southern Royal Albatross [89221]	Vulnerable	Foraging, feeding or related behaviour likely to occur within area
Diomedea exulans Wandering Albatross [89223]	Vulnerable	Foraging, feeding or related behaviour likely to occur within area
Diomedea sanfordi Northern Royal Albatross [64456]	Endangered	Foraging, feeding or related behaviour likely to occur within area
Fregata andrewsi Christmas Island Frigatebird, Andrew's Frigatebird [1011]	Endangered	Foraging, feeding or related behaviour known to occur within area
Fregata ariel Lesser Frigatebird, Least Frigatebird [1012]		Species or species habitat known to occur within area
Fregata minor Great Frigatebird, Greater Frigatebird [1013]		Species or species habitat may occur within area
Glareola maldivarum Oriental Pratincole [840]		Species or species habitat may occur within area
Haliaeetus leucogaster White-bellied Sea-Eagle [943]		Species or species habitat known to occur within area
Halobaena caerulea Blue Petrel [1059]	Vulnerable	Species or species habitat may occur within area
Hirundo rustica Barn Swallow [662]		Species or species habitat may occur within area
Larus novaehollandiae Silver Gull [810]		Breeding known to occur within area
Larus pacificus Pacific Gull [811]		Breeding known to occur within area
Limosa lapponica Bar-tailed Godwit [844]		Species or species habitat known to occur within area
Macronectes giganteus Southern Giant-Petrel, Southern Giant Petrel [1060]	Endangered	Species or species habitat may occur within area
Macronectes halli Northern Giant Petrel [1061]	Vulnerable	Species or species habitat may occur within area
Merops ornatus Rainbow Bee-eater [670]		Species or species habitat may occur within area
Motacilla cinerea Grey Wagtail [642]		Species or species habitat may occur within area
Motacilla flava Yellow Wagtail [644]		Species or species habitat may occur within

Name	Threatened	Type of Presence
		area
Numenius madagascariensis Eastern Curlew, Far Eastern Curlew [847]	Critically Endangered	Species or species habitat known to occur within area
Pachyptila turtur Fairy Prion [1066]		Species or species habitat may occur within area
Pandion haliaetus Osprey [952]		Breeding known to occur within area
Papasula abbotti Abbott's Booby [59297]	Endangered	Species or species habitat may occur within area
Pelagodroma marina White-faced Storm-Petrel [1016]		Breeding known to occur within area
Phaethon lepturus White-tailed Tropicbird [1014]		Breeding likely to occur within area
Phaethon rubricauda Red-tailed Tropicbird [994]		Breeding known to occur within area
Phalacrocorax fuscescens Black-faced Cormorant [59660]		Breeding likely to occur within area
Phoebetria fusca Sooty Albatross [1075]	Vulnerable	Species or species habitat may occur within area
Pterodroma macroptera Great-winged Petrel [1035]		Foraging, feeding or related behaviour known to occur within area
Pterodroma mollis Soft-plumaged Petrel [1036]	Vulnerable	Foraging, feeding or related behaviour known to occur within area
Puffinus assimilis Little Shearwater [59363]		Breeding known to occur within area
Puffinus carneipes Flesh-footed Shearwater, Fleshy-footed Shearwater [1043]		Foraging, feeding or related behaviour likely to occur within area
Puffinus huttoni Hutton's Shearwater [1025]		Foraging, feeding or related behaviour known to occur within area
Puffinus pacificus Wedge-tailed Shearwater [1027]		Breeding known to occur within area
Rostratula benghalensis (sensu lato) Painted Snipe [889]	Endangered*	Species or species habitat likely to occur within area
Sterna albifrons Little Tern [813]		Congregation or aggregation known to occur within area
Sterna anaethetus Bridled Tern [814]		Breeding known to occur within area
Sterna bengalensis Lesser Crested Tern [815]		Breeding known to occur within area
Sterna bergii Crested Tern [816]		Breeding known to occur within area

Name	Threatened	Type of Presence
Sterna caspia Caspian Tern [59467]		Breeding known to occur within area
Sterna dougallii Roseate Tern [817]		Breeding known to occur within area
Sterna fuscata Sooty Tern [794]		Breeding known to occur within area
Sterna nereis Fairy Tern [796]		Breeding known to occur within area
Thalassarche carteri Indian Yellow-nosed Albatross [64464]	Vulnerable	Foraging, feeding or related behaviour may occur within area
Thalassarche cauta Shy Albatross [89224]	Endangered	Species or species habitat may occur within area
Thalassarche impavida Campbell Albatross, Campbell Black-browed Albatross [64459]	Vulnerable	Species or species habitat may occur within area
Thalassarche melanophris Black-browed Albatross [66472]	Vulnerable	Species or species habitat may occur within area
Thalassarche steadi White-capped Albatross [64462]	Vulnerable	Foraging, feeding or related behaviour likely to occur within area
Thinornis rubricollis Hooded Plover [59510]		Species or species habitat likely to occur within area
Tringa nebularia Common Greenshank, Greenshank [832]		Species or species habitat likely to occur within area
Fish		
Acentronura australe Southern Pygmy Pipehorse [66185]		Species or species habitat may occur within area
Acentronura larsonae Helen's Pygmy Pipehorse [66186]		Species or species habitat may occur within area
Bhanotia fasciolata Corrugated Pipefish, Barbed Pipefish [66188]		Species or species habitat may occur within area
Bulbonaricus brauni Braun's Pughead Pipefish, Pug-headed Pipefish [66189]		Species or species habitat may occur within area
Campichthys galei Gale's Pipefish [66191]		Species or species habitat may occur within area
Campichthys tricarinatus Three-keel Pipefish [66192]		Species or species habitat may occur within area
Choeroichthys brachysoma Pacific Short-bodied Pipefish, Short-bodied Pipefish [66194]		Species or species habitat may occur within area
Choeroichthys latispinosus Muiron Island Pipefish [66196]		Species or species habitat may occur within area

Name	Threatened	Type of Presence
Choeroichthys suillus Pig-snouted Pipefish [66198]		Species or species habitat may occur within area
Corythoichthys amplexus Fijian Banded Pipefish, Brown-banded Pipefish [66199]		Species or species habitat may occur within area
Corythoichthys flavofasciatus Reticulate Pipefish, Yellow-banded Pipefish, Network Pipefish [66200]		Species or species habitat may occur within area
Corythoichthys intestinalis Australian Messmate Pipefish, Banded Pipefish [66202]		Species or species habitat may occur within area
Corythoichthys schultzi Schultz's Pipefish [66205]		Species or species habitat may occur within area
Cosmocampus banneri Roughridge Pipefish [66206]		Species or species habitat may occur within area
Doryrhamphus dactyliophorus Banded Pipefish, Ringed Pipefish [66210]		Species or species habitat may occur within area
Doryrhamphus excisus Bluestripe Pipefish, Indian Blue-stripe Pipefish, Pacific Blue-stripe Pipefish [66211]		Species or species habitat may occur within area
Doryrhamphus janssi Cleaner Pipefish, Janss' Pipefish [66212]		Species or species habitat may occur within area
Doryrhamphus multiannulatus Many-banded Pipefish [66717]		Species or species habitat may occur within area
Doryrhamphus negrosensis Flagtail Pipefish, Masthead Island Pipefish [66213]		Species or species habitat may occur within area
Festucalex scalaris Ladder Pipefish [66216]		Species or species habitat may occur within area
Filicampus tigris Tiger Pipefish [66217]		Species or species habitat may occur within area
Halicampus brocki Brock's Pipefish [66219]		Species or species habitat may occur within area
Halicampus dunckeri Red-hair Pipefish, Duncker's Pipefish [66220]		Species or species habitat may occur within area
Halicampus grayi Mud Pipefish, Gray's Pipefish [66221]		Species or species habitat may occur within area
Halicampus nitidus Glittering Pipefish [66224]		Species or species habitat may occur within area
Halicampus spinirostris Spiny-snout Pipefish [66225]		Species or species habitat may occur within area

Name	Threatened	Type of Presence
Haliichthys taeniophorus Ribboned Pipehorse, Ribboned Seadragon [66226]		Species or species habitat may occur within area
Hippichthys penicillus Beady Pipefish, Steep-nosed Pipefish [66231]		Species or species habitat may occur within area
Hippocampus angustus Western Spiny Seahorse, Narrow-bellied Seahorse [66234]		Species or species habitat may occur within area
Hippocampus breviceps Short-head Seahorse, Short-snouted Seahorse [66235]		Species or species habitat may occur within area
Hippocampus histrix Spiny Seahorse, Thorny Seahorse [66236]		Species or species habitat may occur within area
Hippocampus kuda Spotted Seahorse, Yellow Seahorse [66237]		Species or species habitat may occur within area
Hippocampus planifrons Flat-face Seahorse [66238]		Species or species habitat may occur within area
Hippocampus spinosissimus Hedgehog Seahorse [66239]		Species or species habitat may occur within area
Hippocampus subelongatus West Australian Seahorse [66722]		Species or species habitat may occur within area
Hippocampus trimaculatus Three-spot Seahorse, Low-crowned Seahorse, Flat-faced Seahorse [66720]		Species or species habitat may occur within area
Lissocampus fatiloquus Prophet's Pipefish [66250]		Species or species habitat may occur within area
Maroubra perserrata Sawtooth Pipefish [66252]		Species or species habitat may occur within area
Micrognathus micronotopterus Tidepool Pipefish [66255]		Species or species habitat may occur within area
Mitotichthys meraculus Western Crested Pipefish [66259]		Species or species habitat may occur within area
Nannocampus subosseus Bonyhead Pipefish, Bony-headed Pipefish [66264]		Species or species habitat may occur within area
Phoxocampus belcheri Black Rock Pipefish [66719]		Species or species habitat may occur within area
Phycodurus eques Leafy Seadragon [66267]		Species or species habitat may occur within area
Phyllopteryx taeniolatus Common Seadragon, Weedy Seadragon [66268]		Species or species habitat may occur within area

Name	Threatened	Type of Presence
Pugnaso curtirostris Pugnose Pipefish, Pug-nosed Pipefish [66269]		Species or species habitat may occur within area
Solegnathus hardwickii Pallid Pipehorse, Hardwick's Pipehorse [66272]		Species or species habitat may occur within area
Solegnathus lettiensis Gunther's Pipehorse, Indonesian Pipefish [66273]		Species or species habitat may occur within area
Solenostomus cyanopterus Robust Ghostpipefish, Blue-finned Ghost Pipefish, [66183]		Species or species habitat may occur within area
Stigmatopora argus Spotted Pipefish, Gulf Pipefish, Peacock Pipefish [66276]		Species or species habitat may occur within area
Stigmatopora nigra Widebody Pipefish, Wide-bodied Pipefish, Black Pipefish [66277]		Species or species habitat may occur within area
Syngnathoides biaculeatus Double-end Pipehorse, Double-ended Pipehorse, Alligator Pipefish [66279]		Species or species habitat may occur within area
Trachyrhamphus bicoarctatus Bentstick Pipefish, Bend Stick Pipefish, Short-tailed Pipefish [66280]		Species or species habitat may occur within area
Trachyrhamphus longirostris Straightstick Pipefish, Long-nosed Pipefish, Straight Stick Pipefish [66281]		Species or species habitat may occur within area
Urocampus carinirostris Hairy Pipefish [66282]		Species or species habitat may occur within area
Vanacampus margaritifer Mother-of-pearl Pipefish [66283]		Species or species habitat may occur within area
Mammals		
Arctocephalus forsteri Long-nosed Fur-seal, New Zealand Fur-seal [20]		Species or species habitat may occur within area
Dugong dugon Dugong [28]		Breeding known to occur within area
Neophoca cinerea Australian Sea-lion, Australian Sea Lion [22]	Endangered	Breeding known to occur within area
Reptiles		
Acalyptophis peronii Horned Seasnake [1114]		Species or species habitat may occur within area
Aipysurus apraefrontalis Short-nosed Seasnake [1115]	Critically Endangered	Species or species habitat known to occur within area
Aipysurus duboisii Dubois' Seasnake [1116]		Species or species habitat may occur within area
Aipysurus eydouxii Spine-tailed Seasnake [1117]		Species or species habitat may occur within area

Name	Threatened	Type of Presence
Aipysurus foliosquama Leaf-scaled Seasnake [1118]	Critically Endangered	Species or species habitat known to occur within area
Aipysurus laevis Olive Seasnake [1120]		Species or species habitat may occur within area
Aipysurus pooleorum Shark Bay Seasnake [66061]		Species or species habitat may occur within area
Aipysurus tenuis Brown-lined Seasnake [1121]		Species or species habitat may occur within area
Astrotia stokesii Stokes' Seasnake [1122]		Species or species habitat may occur within area
Caretta caretta Loggerhead Turtle [1763]	Endangered	Breeding known to occur within area
Chelonia mydas Green Turtle [1765]	Vulnerable	Breeding known to occur within area
Dermochelys coriacea Leatherback Turtle, Leathery Turtle, Luth [1768]	Endangered	Foraging, feeding or related behaviour known to occur within area
Disteira kingii Spectacled Seasnake [1123]		Species or species habitat may occur within area
Disteira major Olive-headed Seasnake [1124]		Species or species habitat may occur within area
Emydocephalus annulatus Turtle-headed Seasnake [1125]		Species or species habitat may occur within area
Ephalophis greyi North-western Mangrove Seasnake [1127]		Species or species habitat may occur within area
Eretmochelys imbricata Hawksbill Turtle [1766]	Vulnerable	Breeding known to occur within area
Hydrelaps darwiniensis Black-ringed Seasnake [1100]		Species or species habitat may occur within area
Hydrophis czeblukovi Fine-spined Seasnake [59233]		Species or species habitat may occur within area
Hydrophis elegans Elegant Seasnake [1104]		Species or species habitat may occur within area
Hydrophis mcdowelli null [25926]		Species or species habitat may occur within area
Hydrophis ornatus Spotted Seasnake, Ornate Reef Seasnake [1111]		Species or species habitat may occur within area
Lapemis hardwickii Spine-bellied Seasnake [1113]		Species or species habitat may occur within area

Name	Threatened	Type of Presence
Lepidochelys olivacea Olive Ridley Turtle, Pacific Ridley Turtle [1767]	Endangered	Species or species habitat likely to occur within area
Natator depressus Flatback Turtle [59257]	Vulnerable	Breeding known to occur within area
Pelamis platurus Yellow-bellied Seasnake [1091]		Species or species habitat may occur within area

Whales and other Cetaceans

[Resource Information]

Name	Status	Type of Presence
Mammals		
Balaenoptera acutorostrata Minke Whale [33]		Species or species habitat may occur within area
Balaenoptera bonaerensis Antarctic Minke Whale, Dark-shoulder Minke Whale [67812]		Species or species habitat likely to occur within area
Balaenoptera borealis Sei Whale [34]	Vulnerable	Foraging, feeding or related behaviour likely to occur within area
Balaenoptera edeni Bryde's Whale [35]		Species or species habitat likely to occur within area
Balaenoptera musculus Blue Whale [36]	Endangered	Foraging, feeding or related behaviour known to occur within area
Balaenoptera physalus Fin Whale [37]	Vulnerable	Foraging, feeding or related behaviour likely to occur within area
Caperea marginata Pygmy Right Whale [39]		Species or species habitat may occur within area
Delphinus delphis Common Dolphin, Short-beaked Common Dolphin [60]		Species or species habitat may occur within area
Eubalaena australis Southern Right Whale [40]	Endangered	Species or species habitat likely to occur within area
Feresa attenuata Pygmy Killer Whale [61]		Species or species habitat may occur within area
Globicephala macrorhynchus Short-finned Pilot Whale [62]		Species or species habitat may occur within area
Globicephala melas Long-finned Pilot Whale [59282]		Species or species habitat may occur within area
Grampus griseus Risso's Dolphin, Grampus [64]		Species or species habitat may occur within area
Hyperoodon planifrons Southern Bottlenose Whale [71]		Species or species habitat may occur within area
Indopacetus pacificus Longman's Beaked Whale [72]		Species or species

Name	Status	Type of Presence
		habitat may occur within area
Kogia breviceps Pygmy Sperm Whale [57]		Species or species habitat may occur within area
Kogia simus Dwarf Sperm Whale [58]		Species or species habitat may occur within area
Lagenodelphis hosei Fraser's Dolphin, Sarawak Dolphin [41]		Species or species habitat may occur within area
Lagenorhynchus obscurus Dusky Dolphin [43]		Species or species habitat likely to occur within area
Lissodelphis peronii Southern Right Whale Dolphin [44]		Species or species habitat may occur within area
Megaptera novaeangliae Humpback Whale [38]	Vulnerable	Breeding known to occur within area
Mesoplodon bowdoini Andrew's Beaked Whale [73]		Species or species habitat may occur within area
Mesoplodon densirostris Blainville's Beaked Whale, Dense-beaked Whale [74]		Species or species habitat may occur within area
Mesoplodon ginkgodens Gingko-toothed Beaked Whale, Gingko-toothed Whale, Gingko Beaked Whale [59564]		Species or species habitat may occur within area
Mesoplodon grayi Gray's Beaked Whale, Scamperdown Whale [75]		Species or species habitat may occur within area
Mesoplodon layardii Strap-toothed Beaked Whale, Strap-toothed Whale, Layard's Beaked Whale [25556]		Species or species habitat may occur within area
Mesoplodon mirus True's Beaked Whale [54]		Species or species habitat may occur within area
Orcinus orca Killer Whale, Orca [46]		Species or species habitat may occur within area
Peponocephala electra Melon-headed Whale [47]		Species or species habitat may occur within area
Physeter macrocephalus Sperm Whale [59]		Foraging, feeding or related behaviour known to occur within area
Pseudorca crassidens False Killer Whale [48]		Species or species habitat likely to occur within area
Sousa chinensis Indo-Pacific Humpback Dolphin [50]		Species or species habitat known to occur within area
Stenella attenuata Spotted Dolphin, Pantropical Spotted Dolphin [51]		Species or species habitat may occur within area

Name	Status	Type of Presence
Stenella coeruleoalba Striped Dolphin, Euphrosyne Dolphin [52]		Species or species habitat may occur within area
Stenella longirostris Long-snouted Spinner Dolphin [29]		Species or species habitat may occur within area
Steno bredanensis Rough-toothed Dolphin [30]		Species or species habitat may occur within area
Tursiops aduncus Indian Ocean Bottlenose Dolphin, Spotted Bottlenose Dolphin [68418]		Species or species habitat likely to occur within area
Tursiops aduncus (Arafura/Timor Sea populations) Spotted Bottlenose Dolphin (Arafura/Timor Sea populations) [78900]		Species or species habitat known to occur within area
Tursiops truncatus s. str. Bottlenose Dolphin [68417]		Species or species habitat may occur within area
Ziphius cavirostris Cuvier's Beaked Whale, Goose-beaked Whale [56]		Species or species habitat may occur within area

Australian Marine Parks [Resource Information]

Name	Label
Abrolhos	Habitat Protection Zone (IUCN IV)
Abrolhos	Multiple Use Zone (IUCN VI)
Abrolhos	National Park Zone (IUCN II)
Abrolhos	Special Purpose Zone (IUCN VI)
Argo-Rowley Terrace	Multiple Use Zone (IUCN VI)
Argo-Rowley Terrace	National Park Zone (IUCN II)
Argo-Rowley Terrace	Special Purpose Zone (Trawl) (IUCN VI)
Carnarvon Canyon	Habitat Protection Zone (IUCN IV)
Gascoyne	Habitat Protection Zone (IUCN IV)
Gascoyne	Multiple Use Zone (IUCN VI)
Gascoyne	National Park Zone (IUCN II)
Jurien	National Park Zone (IUCN II)
Jurien	Special Purpose Zone (IUCN VI)
Kimberley	Multiple Use Zone (IUCN VI)
Mermaid Reef	National Park Zone (IUCN II)
Montebello	Multiple Use Zone (IUCN VI)
Ningaloo	National Park Zone (IUCN II)
Ningaloo	Recreational Use Zone (IUCN IV)
Perth Canyon	Habitat Protection Zone (IUCN IV)
Perth Canyon	National Park Zone (IUCN II)
Shark Bay	Multiple Use Zone (IUCN VI)

Extra Information

State and Territory Reserves [Resource Information]

Name	State
Airlie Island	WA
Barrow Island	WA
Bessieres Island	WA
Boodie, Double Middle Islands	WA
Boullanger, Whitlock, Favourite, Tern And Osprey Islands	WA
Cape Range	WA
Escape Island	WA
Houtman Abrolhos Islands	WA

Name	State
Lowendal Islands	WA
Montebello Islands	WA
Muiron Islands	WA
Round Island	WA
Serrurier Island	WA
Unnamed WA40322	WA
Unnamed WA40828	WA
Unnamed WA41080	WA
Unnamed WA44665	WA
Unnamed WA44682	WA

Invasive Species

[Resource Information]

Weeds reported here are the 20 species of national significance (WoNS), along with other introduced plants that are considered by the States and Territories to pose a particularly significant threat to biodiversity. The following feral animals are reported: Goat, Red Fox, Cat, Rabbit, Pig, Water Buffalo and Cane Toad. Maps from Landscape Health Project, National Land and Water Resouces Audit, 2001.

Name	Status	Type of Presence
Birds		
Columba livia Rock Pigeon, Rock Dove, Domestic Pigeon [803]		Species or species habitat likely to occur within area
Streptopelia senegalensis Laughing Turtle-dove, Laughing Dove [781]		Species or species habitat likely to occur within area
Mammals		
Canis lupus familiaris Domestic Dog [82654]		Species or species habitat likely to occur within area
Capra hircus Goat [2]		Species or species habitat likely to occur within area
Equus caballus Horse [5]		Species or species habitat likely to occur within area
Felis catus Cat, House Cat, Domestic Cat [19]		Species or species habitat likely to occur within area
Feral deer Feral deer species in Australia [85733]		Species or species habitat likely to occur within area
Mus musculus House Mouse [120]		Species or species habitat likely to occur within area
Oryctolagus cuniculus Rabbit, European Rabbit [128]		Species or species habitat likely to occur within area
Rattus rattus Black Rat, Ship Rat [84]		Species or species habitat likely to occur within area
Sus scrofa Pig [6]		Species or species habitat likely to occur within area
Vulpes vulpes Red Fox, Fox [18]		Species or species habitat likely to occur within area
Plants		

Name	Status	Type of Presence
Asparagus asparagoides Bridal Creeper, Bridal Veil Creeper, Smilax, Florist's Smilax, Smilax Asparagus [22473]		Species or species habitat likely to occur within area
Brachiaria mutica Para Grass [5879]		Species or species habitat may occur within area
Cenchrus ciliaris Buffel-grass, Black Buffel-grass [20213]		Species or species habitat likely to occur within area
Chrysanthemoides monilifera Bitou Bush, Boneseed [18983]		Species or species habitat may occur within area
Genista sp. X Genista monspessulana Broom [67538]		Species or species habitat may occur within area
Lycium ferocissimum African Boxthorn, Boxthorn [19235]		Species or species habitat likely to occur within area
Olea europaea Olive, Common Olive [9160]		Species or species habitat may occur within area
Opuntia spp. Prickly Pears [82753]		Species or species habitat likely to occur within area
Pinus radiata Radiata Pine Monterey Pine, Insignis Pine, Wilding Pine [20780]		Species or species habitat may occur within area
Tamarix aphylla Athel Pine, Athel Tree, Tamarisk, Athel Tamarisk, Athel Tamarix, Desert Tamarisk, Flowering Cypress, Salt Cedar [16018]		Species or species habitat likely to occur within area
Reptiles		
Hemidactylus frenatus Asian House Gecko [1708]		Species or species habitat likely to occur within area

Key Ecological Features (Marine) [Resource Information]

Key Ecological Features are the parts of the marine ecosystem that are considered to be important for the biodiversity or ecosystem functioning and integrity of the Commonwealth Marine Area.

Name	Region
Ancient coastline at 125 m depth contour	North-west
Canyons linking the Argo Abyssal Plain with the	North-west
Canyons linking the Cuvier Abyssal Plain and the	North-west
Commonwealth waters adjacent to Ningaloo Reef	North-west
Continental Slope Demersal Fish Communities	North-west
Exmouth Plateau	North-west
Glomar Shoals	North-west
Mermaid Reef and Commonwealth waters	North-west
Wallaby Saddle	North-west
Ancient coastline at 90-120m depth	South-west
Commonwealth marine environment surrounding	South-west
Commonwealth marine environment within and	South-west
Perth Canyon and adjacent shelf break, and other	South-west
Western demersal slope and associated fish	South-west
Western rock lobster	South-west

Caveat

The information presented in this report has been provided by a range of data sources as acknowledged at the end of the report.

This report is designed to assist in identifying the locations of places which may be relevant in determining obligations under the Environment Protection and Biodiversity Conservation Act 1999. It holds mapped locations of World and National Heritage properties, Wetlands of International and National Importance, Commonwealth and State/Territory reserves, listed threatened, migratory and marine species and listed threatened ecological communities. Mapping of Commonwealth land is not complete at this stage. Maps have been collated from a range of sources at various resolutions.

Not all species listed under the EPBC Act have been mapped (see below) and therefore a report is a general guide only. Where available data supports mapping, the type of presence that can be determined from the data is indicated in general terms. People using this information in making a referral may need to consider the qualifications below and may need to seek and consider other information sources.

For threatened ecological communities where the distribution is well known, maps are derived from recovery plans, State vegetation maps, remote sensing imagery and other sources. Where threatened ecological community distributions are less well known, existing vegetation maps and point location data are used to produce indicative distribution maps.

Threatened, migratory and marine species distributions have been derived through a variety of methods. Where distributions are well known and if time permits, maps are derived using either thematic spatial data (i.e. vegetation, soils, geology, elevation, aspect, terrain, etc) together with point locations and described habitat; or environmental modelling (MAXENT or BIOCLIM habitat modelling) using point locations and environmental data layers.

Where very little information is available for species or large number of maps are required in a short time-frame, maps are derived either from 0.04 or 0.02 decimal degree cells; by an automated process using polygon capture techniques (static two kilometre grid cells, alpha-hull and convex hull); or captured manually or by using topographic features (national park boundaries, islands, etc). In the early stages of the distribution mapping process (1999-early 2000s) distributions were defined by degree blocks, 100K or 250K map sheets to rapidly create distribution maps. More reliable distribution mapping methods are used to update these distributions as time permits.

Only selected species covered by the following provisions of the EPBC Act have been mapped:

- migratory and
- marine

The following species and ecological communities have not been mapped and do not appear in reports produced from this database:

- threatened species listed as extinct or considered as vagrants
- some species and ecological communities that have only recently been listed
- some terrestrial species that overfly the Commonwealth marine area
- migratory species that are very widespread, vagrant, or only occur in small numbers

The following groups have been mapped, but may not cover the complete distribution of the species:

- non-threatened seabirds which have only been mapped for recorded breeding sites
- seals which have only been mapped for breeding sites near the Australian continent

Such breeding sites may be important for the protection of the Commonwealth Marine environment.

Coordinates

-20.896093 115.702567,-21.155433 115.450776,-21.261924 115.480073,-21.411167 115.393947,-21.52672 115.200726,-21.576411 114.855378,-21.691937 114.602933,-21.719749 114.433923,-21.882341 114.292725,-21.913162 114.156955,-21.901796 114.147483,-21.86391 114.15506,-21.816552 114.194841,-21.776771 114.160743,-21.797609 114.098231,-21.860121 113.997832,-21.945366 113.942896,-22.256034 113.827343,-22.403792 113.743992,-22.559126 113.653065,-22.725826 113.672008,-22.746664 113.749675,-23.129317 113.723155,-23.593834 113.569619,-24.539434 112.902136,-25.48017 112.724847,-27.230524 113.300721,-28.511086 113.725049,-28.852064 114.3085,-29.011187 114.710097,-29.70072 114.960147,-30.06443 114.944992,-30.392741 115.047921,-31.731984 114.827566,-31.834674 112.970596,-31.338341 110.146632,-30.516824 109.282328,-28.069389 106.834893,-27.521711 106.235871,-25.433689 105.080613,-24.073052 104.892348,-23.645179 104.139291,-24.68919 101.435132,-23.974641 100.412515,-23.38505 100.188224,-22.437889 100.157915,-22.198967 100.245644,-21.452842 100.184436,-21.339183 100.324615,-21.028514 101.775666,-20.316249 101.711259,-19.760089 101.845891,-18.324574 100.110864,-18.025063 99.995339,-17.190617 99.9268083,-15.470573 100.108663,-14.61434 100.055622,-15.220523 101.548347,-15.713046 103.851843,-15.152327 103.897307,-14.796194 104.071584,-13.399753 102.836417,-12.381414 101.937883,-11.795588 99.9950038,-10.848427 99.9495401,-10.833273 101.078556,-10.984819 102.442467,-12.083525 105.064209,-12.720018 105.821938,-12.750327 106.481162,-12.030484 106.708481,-11.136364 107.049458,-10.714848 107.433916,-9.988405 107.382859,-9.548923 107.4359,-8.491891 108.193629,-8.722998 108.424736,-8.977682 109.233123,-8.253206 109.186254,-7.805309 109.429232,-7.776784 109.563299,-7.805309 109.690947,-7.865212 109.725177,-8.806533 109.669554,-8.357266 111.368211,-9.636061 112.974898,-8.654803 113.596235,-8.556298 113.72126,-8.787405 114.554762,-8.738153 114.607803,-8.442639 114.585071,-8.594184 115.047286,-8.859389 115.096538,-8.821503 115.827747,-8.916219 115.971715,-8.94274 116.392254,-9.105651 117.009803,-8.901064 118.457065,-8.806348 119.33982,-8.91243 120.271826,-8.965471 121.006823,-8.920008 121.631949,-8.730575 122.503337,-8.597973 123.33305,-8.563875 124.079413,-8.336557 125.155388,-8.032082 125.389619,-8.288806 125.500866,-8.476736 125.409227,-8.596875 125.175682,-8.926337 124.929655,-9.020469 124.668652,-9.003354 123.725192,-9.127438 122.638393,-9.426949 122.124945,-9.546754 121.684236,-9.512524 121.234969,-9.302866 120.404895,-9.272915 119.484967,-9.548923 118.616189,-10.333172 119.313299,-10.753711 119.968734,-11.48502 120.036924,-12.60257 119.885384,-13.693699 120.029353,-14.405255 120.103244,-15.053822 120.143012,-15.406166 119.817189,-16.023715 121.056075,-16.756419 121.145116,-16.914732 119.773782,-17.111056 119.137127,-17.573271 119.165542,-17.900988 119.023468,-18.31395 119.265941,-18.465772 119.116996,-18.833743 118.577876,-19.188878 117.916812,-19.477693 117.339183,-19.822131 116.4706,-19.950493 116.526223,-20.202938 116.500551,-20.335579 116.365771,-20.508867 116.106907,-20.587137 115.812592,-20.896093 115.702567

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-Office of Environment and Heritage, New South Wales
-Department of Environment and Primary Industries, Victoria
-Department of Primary Industries, Parks, Water and Environment, Tasmania
-Department of Environment, Water and Natural Resources, South Australia
-Department of Land and Resource Management, Northern Territory
-Department of Environmental and Heritage Protection, Queensland
-Department of Parks and Wildlife, Western Australia
-Environment and Planning Directorate, ACT
-Birdlife Australia
-Australian Bird and Bat Banding Scheme
-Australian National Wildlife Collection
-Natural history museums of Australia
-Museum Victoria
-Australian Museum
-South Australian Museum
-Queensland Museum
-Online Zoological Collections of Australian Museums
-Queensland Herbarium
-National Herbarium of NSW
-Royal Botanic Gardens and National Herbarium of Victoria
-Tasmanian Herbarium
-State Herbarium of South Australia
-Northern Territory Herbarium
-Western Australian Herbarium
-Australian National Herbarium, Canberra
-University of New England
-Ocean Biogeographic Information System
-Australian Government, Department of Defence
Forestry Corporation, NSW
-Geoscience Australia
-CSIRO
-Australian Tropical Herbarium, Cairns
-eBird Australia
-Australian Government – Australian Antarctic Data Centre
-Museum and Art Gallery of the Northern Territory
-Australian Government National Environmental Science Program
-Australian Institute of Marine Science
-Reef Life Survey Australia
-American Museum of Natural History
-Queen Victoria Museum and Art Gallery, Inveresk, Tasmania
-Tasmanian Museum and Art Gallery, Hobart, Tasmania
-Other groups and individuals

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Please feel free to provide feedback via the Contact Us page.

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APPENDIX C: SPILL MODELLING REPORT

EQUUS WA-390-P GAS PROJECT

Oil Spill Modelling

MAQ0899J
Equus WA-390-P Oil Spill
Modelling
Rev1
15 January 2020

rpsgroup.com/mst

Document status

Version	Purpose of document	Authored by	Reviewed by	Approved by	Review date
RevA	Daft issued for internal review	Jordan Glen Jeremie Bernard	Jeremie Bernard		16 December 2019
Rev0	Draft issued for client review		Dr Sasha Zigic	Dr Sasha Zigic	17 December 2019
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Dr. Sasha Zigic	S. Zigic	15 January 2021

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Contents

Tables

Figures

TERMS AND ABBREVIATIONS

°	Degrees
‘	Minutes
“	Seconds
Actionable oil	Oil which is thick enough for the effective use of mitigation strategies
ARMCANZ	Agriculture and Resource Management Council of Australia and New Zealand
AMSA	Australian Maritime Safety Authority
ANZECC	Australian and New Zealand Environment and Conservation Council
API	American Petroleum Institute gravity. A measure of how heavy or light a petroleum liquid is compared to water.
ASTM	American Society for Testing and Materials
Bonn Agreement	An agreement for cooperation in dealing with pollution of the North Sea by oil and other harmful substances, 1983, includes: Governments of the Kingdom of Belgium, the Kingdom of Denmark, the French Republic, the Federal Republic of Germany, the Republic of Ireland, the Kingdom of the Netherlands, the Kingdom of Norway, the Kingdom of Sweden, the United Kingdom of Great Britain and Northern Ireland and the European Union.
Biodegradation	Decomposition of organic material by microorganism
BTEX	Benzene, toluene, ethylbenzene, and xylenes
ºC	degree Celsius (unit of temperature)
CFSR	Climate Forecast System Reanalysis
CNES	The National Centre for Space Studies (France)
cP	Centipoise (unit of dynamic viscosity)
Decay	The process where oil components are changed either chemically or biologically (biodegradation) to another compound. It includes breakdown to simpler organic carbon compounds by bacteria and other organisms, photo-oxidation by solar energy, and other chemical reactions.
DEWHA	Department of the Environment, Water, Heritage and the Arts
Dissolved hydrocarbons	Hydrocarbon droplets which are dissolved in water.
Dynamic viscosity	The dynamic viscosity of a fluid expresses its resistance to shearing flows, where adjacent layers move parallel to each other with different speeds.
Entrained hydrocarbons	Hydrocarbon droplets that are suspended into the water column, though not dissolved.
EP	Environmental plan
Evaporation	The process whereby components of the oil mixture are transferred from the sea-surface to the atmosphere as vapours.
g/m^2	Grams per square meter (unit of surface area density)
GODAE	Global Ocean Data Assimilation Experiment
HYCOM	Hybrid Coordinate Ocean Model. A data-assimilative, three-dimensional ocean model.
HYDROMAP	Advanced ocean/coastal tidal model used to predict tidal water levels, current speed and current direction.
Isopycnal layer	Water layer characterised by the same density
ITOPF	International Tankers Owners Pollution Federation

km	Kilometer (unit of length)
km^2	Square Kilometers (unit of area)
Knots	unit of speed (1 knot = 0.514 m/s)
KP0	Kilometer point 380
LC_{50}	Median lethal dose required for mortality of 50% of a tested population after a specified exposure duration.
m	Meter (unit of length)
MAHs	Monoaromatic hydrocarbons
MGO	Marine gas oil
mm	Millimeter (unit of length)
µm	Micrometer (unit of length; 1 µm = 0.001 mm)
m/s	Meter per Second (unit of speed)
m^3	Cubic meter (unit of volume)
NASA	National Aeronautics and Space Administration
NCEP	National Centres for Environmental Prediction
NOAA	National Oceanic and Atmospheric Administration
NOPSEMA	National Offshore Petroleum Safety and Environmental Management Authority
NRC	National Research Council
PAHs	Polynuclear aromatic hydrocarbons
ppb	parts per billion (concentration)
Pour Point	The pour point of a liquid is the temperature below which the liquid loses its flow characteristics.
PSU	Practical salinity units
Sea surface exposure	Contact by floating oil on the sea surface at concentrations equal to or exceeding defined threshold concentrations. The consequence will vary depending on the threshold and the receptors.
SIMAP	Spill Impact Mapping Analysis Program
Shoreline contact	Arrival of oil at or near shorelines at on-water concentrations equal to or exceeding defined threshold concentrations. Shoreline contact is judged for floating oil arriving within a 1 km buffer zone from any shoreline as a conservative measure
Single Oil spill modelling	Oil spill modelling involving a computer simulation of a single hypothetical oil spill event subject to a single sequence of wind, current and other sea conditions over time. Single oil spill modelling, also referred to as “deterministic modelling” provides a simulation of one possible outcome of a given spill scenario, subject to the metocean conditions that are imposed. Single oil spill modelling is commonly used to consider the fate and effects of ‘worst-case’ oil spill scenarios that are carefully selected in consideration of the nature and scale of the offshore petroleum activity and the local environment (NOPSEMA, 2018). Because the outcomes of a single oil spill simulation can only represent the outcome of that scenario under one sequence of metocean conditions, worst-case conditions are often identified from stochastic modelling. It is impossible to calculate the likelihood of any outcome from a single oil spill simulation. Single oil spill modelling is generally used for response planning, preparedness planning and for supporting oil spill response operations in the event of an actual spill.
Stochastic Oil spill modelling	Stochastic oil spill modelling is created by overlaying and statistically analysing the outcomes of many single oil-spill simulations of a defined spill scenario, where each simulation was subject to a different sequence of metocean conditions, selected objectively (typically by random selection) from a long sequence of historic conditions for the study area. Analysis of this larger set of simulations provides a more accurate indication of the area that maybe affected (EMBA) and also indicates which particular locations are more likely to be affected (as well as other statistics).

	Stochastic oil spill modelling avoids biases that affect single oil spill modelling (due to the reliance on only one possible sequence of conditions). However, when interpreting stochastic modelling, which is based on a wide range of potential conditions that might happen to occur, it is essential to understand that calculations for the Risk EMBA will enclose a much larger area than could be affected in any single spill event, where a more limited set of conditions will occur. Consequently, it is misleading to imply that the Risk EMBA contours derived from stochastic modelling indicate the outcomes expected from a single spill event (NOPSEMA, 2018). Stochastic modelling is generally used for risk assessment and preparedness planning by indicating locations that could be exposed and may require response or subsequent impact assessment.
TOPEX/Poseidon	A joint satellite mission between NASA and CNES to map ocean surface topography using an array of satellites equipped with detailed altimeters
Weathered oil	Oil that no longer contains volatile or soluble components

EXECUTIVE SUMMARY

Background

Western Gas Corporation Pty Ltd (Western Gas) is currently developing the Equus Gas Project located offshore about 200 km north west of Onslow, Western Australia. The planned development consists of a floating production storage and offloading (FPSO) facility in the offshore permit to process condensate for export, a gas pipeline to a nearshore floating liquefied natural gas facility (FLNG), to process gas for export; and the option for a DomGas pipeline from the FLNG to the shore for connection into the Dampier to Bunbury pipeline.

To support the development of the environmental plan (EP) and oil pollution emergency plan (OPEP), RPS was commissioned to undertake a comprehensive oil spill modelling study, which considered the following two hypothetical spill scenarios:

- **Scenario 1:** A 2,727,570 bbl (22,542 bbl/day) <u>subsea release of Mentorc condensate over 121 days</u> resulting from a loss of well control at Mentorc-1;
- **Scenario 2:** A 1,000 m^3 <u>surface</u> release of marine gas oil (MGO) over 6 hours resulting from a vessel collision along the pipeline route straddling the State/Commonwealth boundary. The potential risk of exposure was assessed at two locations:
  - Point 1 was selected as it is closest to several islands and closest to North West Cape and Exmouth Gulf; and
  - Point 4 was selected as it is the most northerly location closest to Thevenard Island.

The potential risk of exposure to the surrounding waters and contact to shorelines was assessed for three distinct seasons; (i) summer (September to the following March), (ii) the transitional periods (April and August) and (iii) winter (May to July). This approach assists with identifying the environmental values and sensitivities that would be at risk of exposure on a seasonal basis.

The purpose of the modelling is to further improve understanding of a conservative 'outer envelope' of the potential area that may be affected in the unlikely event of hydrocarbon release. The modelling does not take into consideration any of the spill prevention, mitigation and response capabilities that would be implemented in response to the spill. Therefore, the modelling results represent the maximum extent that the released hydrocarbons may influence.

Methodology

The modelling study was carried out in several stages. Firstly, a ten-year current dataset (2009–2018) that includes the combined influence of large-scale ocean and nearshore tidal currents was developed. Secondly, the currents, local winds and detailed hydrocarbon characteristics were used as inputs in the three-dimensional oil spill model (SIMAP) to simulate the drift, spread, weathering and fate of the spilled oil.

As spills can occur during any set of wind and current conditions, modelling was conducted using a stochastic (or probabilistic) approach, which involved running 100 randomly selected single trajectory simulations per season (3 seasons per scenario), with each simulation having the same spill information (spill volume, duration and composition of hydrocarbons) but varying start time. This ensured that each spill trajectory was subjected to varying wind and current conditions.

Oil Properties

Mentorc condensate has a density of 728 kg/m^3 (API of 62.8), dynamic viscosity of 0.5 cP at 15°C and a low pour point (-100°C). This condensate is comprised of 95.9% components which will evaporate and 4.1% of residuals, which are unlikely to evaporate. These properties classify the condensate as a group I oil (or non-persistent oil), according to the International Tanker Owners Pollution Federation (ITOPF, 2014),

Marine gas oil is characterised by a density of 830 kg/m^3 (API gravity of 36.4), a pour point of -36°C and a dynamic viscosity of 4 cP at 25°C. These properties classify it as a group II oil (light persistence) according to ITOPF (2014). This oil is likely to spread quickly when spilt at sea and thin out to low thickness levels; which increases the rate of evaporation. Due to its chemical composition, up to 65% will generally evaporate over the first two days depending upon the prevailing conditions and spill volume. Approximately 2.7% of the oil is considered “persistent hydrocarbons”, which are unlikely to evaporate.

Key Findings

Scenario 1: 2,727,570 bbl Subsea Release of Condensate at Mentorc-1

- The maximum distance from the release location to the low (≥ 1 g/m^2), moderate (≥ 10 g/m^2) and high (≥ 50 g/m^2) exposure thresholds was 134.7 km north-northwest (transitional), 62.9 km south-southwest (summer) and 5.2 km south-southwest (transitional), respectively.

- No shoreline contact was predicted above the low threshold for this scenario.

- No dissolved hydrocarbon exposure was predicted above the low threshold in the top 30 m of the water column for this scenario.

- For the 0 – 10 m depth layer, the Gascoyne AMP was predicted to record 100% probability of entrained hydrocarbon exposure at the low threshold during every season. Additionally, the Argo-Rowley Terrace, the Carnarvon Canyon and the Ningaloo AMPs, the Ningaloo, Northwest Shelf, and the Pilbarra (offshore) IMCRAs and the Canyons and the Commonwealth waters adjacent to Ningaloo Reef KEFs all recorded probabilities of low entrained hydrocarbon exposure at or above 30% for each season. At the high entrained hydrocarbon exposure threshold, the Gascoyne AMP recorded the greatest probabilities of exposure ranging from 91% in summer to 100% during transitional and winter conditions. The Canyons KEF was also predicted to be exposed at the high entrained hydrocarbon threshold with predicted probabilities of 60% in summer, 72% during transitional conditions and 61% during winter.

Scenario 2: 1,000 m^3 Surface Release of Marine Gas Oil at Point 1

- The maximum distance from the release location to the low (≥ 1 g/m^2), moderate (≥ 10 g/m^2) and high (≥ 50 g/m^2) exposure thresholds was 69.5 km west-southwest (transitional), 35.3 km west (transitional) and 7.6 km west-southwest (summer and transitional), respectively.

- The probability of contact to any shoreline at, or above, the low threshold (≥ 10 g/m^2) was 3% in summer and winter, and 9% during transitional conditions. The minimum time before shoreline contact was approximately 0.4 days (~9 hours) during winter and the maximum volume of oil ashore was 147.8 m^3, recorded during transitional conditions.

- The probability of shoreline contact (at the low threshold) for nearby islands ranged from 1%, recorded by Peak Island in summer, Bessieres Island, Exmouth and Table Island in transitional conditions, to 6% at Flat Island during transitional conditions.

- In the surface (0-10 m) depth layer, the Ningaloo IMCRA, Ancient coastline at 125 m depth contour and the Canyons linking the Cuvier Abyssal Plain and the Cape Range Peninsula (Canyons) Key Ecological Features (KEF) were all predicted to be exposed at the low dissolved hydrocarbon threshold during every season with probabilities of exposure ranging from 3% to 9% in summer, 4% to 13% during transitional conditions and 3% to 8% in winter. No receptors were predicted to be exposed at or above the moderate threshold.

- At the surface layer (0-10 m), the Ningaloo IMCRA, Ancient coastline at 125 m depth contour KEF and the Canyons KEF were predicted to be exposed at the low threshold with probabilities ranging from 53% to 58% in summer, 46% to 48% in transitional conditions and 51% to 52% in winter. At the high entrained hydrocarbon threshold, the maximum probability of exposure was 42% at the Ancient coastline at 125 m depth contour KEF during summer while it also recorded 38% and 42% probabilities of high entrained hydrocarbon exposure during transitional and winter conditions.

Scenario 2: 1,000 m^3 Surface Release of Marine Gas Oil at Point 4

- The maximum distance from the release location to the low (≥ 1 g/m^2), moderate (≥ 10 g/m^2) and high (≥ 50 g/m^2) exposure thresholds was 97.5 km west-southwest, 26.8 km west and 8.8 km west, all during transitional conditions, respectively.

- The probability of contact to any shoreline at, or above, the low threshold was 5% during both transitional and winter conditions, and there was no contact predicted in summer months. The minimum time before shoreline contact was approximately 1.1 days (26 hours) in transitional conditions and 0.8 days (20 hours) during winter and the maximum volume of oil ashore was predicted during winter with 6.5 m^3.

- Oil contact was predicted to impact Bessieres Island and Flat Island shorelines at the low threshold during transitional and winter conditions with probabilities of exposure ranging from 1% to 3%. Additionally, Peak Island was predicted to be contacted during winter conditions at the low and moderate thresholds with probabilities of 2% and 1%, respectively. No receptors were predicted to be contacted during summer conditions.

- The Ancient coastline at 125 m depth contour KEF recorded the greatest probability of dissolved hydrocarbon exposure at the low threshold in the 0- 10 m layer during all seasons with 6%, 5% and 4% in summer, transitional and winter conditions, respectively. The Ningaloo IMCRA and the Canyons KEF were also predicted to be exposed at the low threshold during summer, transitional and winter conditions with probabilities ranging between 1% to 3%.

- Ningaloo IMCRA, Ancient coastline at 125 m depth contour KEF and the Canyons KEFs were predicted to be exposed at the low entrained hydrocarbon threshold (0-10 m depth) with probabilities ranging from 37% to 54% in summer, 36% to 49% in transitional conditions and 45% to 49% during winter. At the high entrained hydrocarbon threshold, the maximum probability of exposure was 31% at the Ancient coastline at 125 m depth contour KEF during transitional conditions, while it also recorded 26% and 28% probabilities of high entrained hydrocarbon exposure during summer and winter conditions.

1 INTRODUCTION

Western Gas Corporation Pty Ltd (Western Gas) is currently developing the Equus Gas Project located offshore about 200 km north west of Onslow, Western Australia. The Equus Gas Project is a greenfield development, targeting the Equus resource in WA-390-P, in water depths of approximately 1,000 m – 1,200 m below sea surface. The planned development consists of a floating production storage and offloading (FPSO) facility in the offshore permit to process condensate for export, a gas pipeline to a nearshore floating liquefied natural gas facility (FLNG), to process gas for export; and the option for a DomGas pipeline from the FLNG to the shore for connection into the Dampier to Bunbury pipeline.

To support the development of the environmental plan (EP) and oil pollution emergency plan (OPEP), RPS was commissioned to undertake a comprehensive oil spill modelling study, which considered the following two hypothetical spill scenarios:

- **Scenario 1:** A 2,727,570 bbl (22,542 bbl/day) <u>subsea release of Mentorc condensate over 121 days</u> resulting from a loss of well control at Mentorc-1;
- **Scenario 2:** A 1,000 m^3 <u>surface</u> release of marine gas oil (MGO) over 6 hours resulting from a vessel collision along the pipeline route straddling the State/Commonwealth boundary. The potential risk of exposure was assessed at two locations:
  - Point 1 was selected as it is closest to several islands and closest to North West Cape and Exmouth Gulf; and
  - Point 4 was selected as it is the most northerly location closest to Thevenard Island.

The release locations used for the oil spill assessment are presented in Table 1.1 and illustrated in Figure 1.1.

The potential risk of exposure to the surrounding waters and contact to shorelines was assessed for three distinct seasons; (i) summer (September to the following March), (ii) the transitional periods (April and August) and (iii) winter (May to July). This approach assists with identifying the environmental values and sensitivities that would be at risk of exposure on a seasonal basis.

The purpose of the modelling is to further improve understanding of a conservative ‘outer envelope’ of the potential area that may be affected in the unlikely event of hydrocarbon release. The modelling does not take into consideration any of the spill prevention, mitigation and response capabilities that would be implemented in response to the spill. Therefore, the modelling results represent the maximum extent that the released hydrocarbons may influence.

The spill modelling was performed using the advanced three-dimensional trajectory and fates model; Spill Impact Mapping Analysis Program (SIMAP). The SIMAP model calculates the transport, spreading, entrainment and evaporation of spilled hydrocarbons over time, based on the prevailing wind and current conditions and the physical and chemical properties.

Table 1.1 Coordinates of the oil spill modelling release locations for the Equus Gas Project.

Scenario	Location	Latitude	Longitude	Depth (mLAT)
1	Mentorc-1	20° 29’ 21.9”S	113° 32’ 13.2”E	1,000
2	Point 1	21° 31’ 22.59” S	114° 35’ 4.69” E	65
	Point 4	21° 23’ 44.29’ S	114° 48’ 53.70” E	55

The hydrocarbon spill model, the method and analysis applied herein uses modelling algorithms which have been peer reviewed and published in international journals. Further, RPS warrants that this work meets and exceeds the American Society for Testing and Materials (ASTM) Standard F2067-13 “*Standard Practice for Development and Use of Oil Spill Models*”.

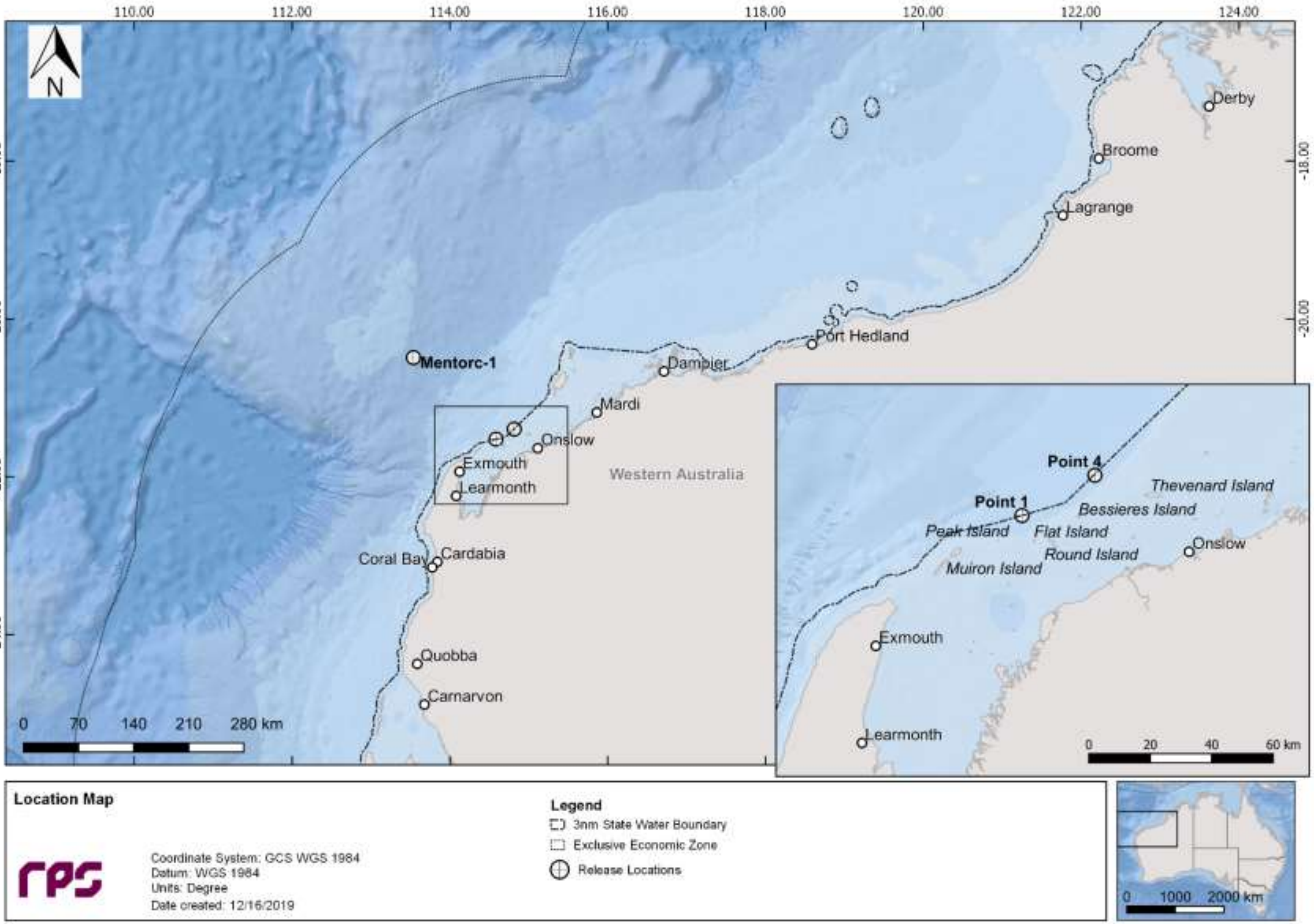

Figure 1.1 Map of the release locations used as part of the Equus Gas Project oil spill modelling study.

2 SCOPE OF WORK

The scope of work included the following components:

1. Generate ten years (2009 to 2018 (inclusive)) wind and current data. The three-dimensional current data includes the combined influence of ocean and tidal currents;

2. Use 10 years of high-resolution wind, aggregated current data and hydrocarbon characteristics as input into the 3-dimensional oil spill model to represent the movement, spreading, entrainment and weathering of the oil over time;

3. Use SIMAP's stochastic model to calculate exposure to surrounding waters (sea surface and water column) and contact to shorelines. This involved running 100 randomly selected single trajectory simulations for each season (i.e. 300 simulations per scenario), with each simulation having the same spill information (spill volume, duration and composition of hydrocarbons) but varying start times. This will ensure that each spill trajectory is subjected to unique wind and current conditions.

4. Combine the 100 spill trajectories per season to determine the probability of exposure to the sea surface and water column, in addition to contact to shorelines (for a defined low, moderate and high threshold); and

5. Identify the "worst case" deterministic run for each scenario based on the largest volume of oil ashore (if shoreline contact is predicted) or the largest area of oil on the sea surface above 10 g/m^2 (actionable sea surface oil).

3 REGIONAL CURRENTS

The proposed release locations are located within the Carnarvon Basin, on the North West Shelf, a waterbody bordered by the Indian Ocean and Timor Sea. The North West Shelf is characterised by complex geomorphological features such as shoals, valleys and terraces and is dominated by high-amplitude tides and seasonally-dependant wind driven currents (DEWHA, 2007).

The Western Australian coastline is also influenced by the Indonesian Throughflow current. This system is a warm, low salinity current which travels predominantly from the northern Pacific Ocean, through the Indonesian Archipelago and into the eastern Indian Ocean (Schott and McCreary, 20016). Along the Western Australian coastline, the Throughflow eventually feeds into the Leeuwin Current, a warm south flowing current which separates the Western Australian coast from the Western Australian Current. The Operational Area lies in an area influenced by the Leeuwin Current.

A comprehensive description of the circulation patterns of the Northwest Shelf is provided in a review by Condie and Andrewartha (2008) and a schematic of the ocean currents along the Northwest Australian continental shelf is shown in Figure 3.1.

While, tidal currents are generally weaker in the deeper waters, its influence is greatest along the near shore and around islands. Therefore, to accurately account for the movement of an oil spill, which can move between the offshore and near shore region, ocean and tidal currents were combined as part of the study.

Figure 3.2 and Figure 3.3 present summer and winter current trends within the Carnarvon Basin and the North West Shelf.

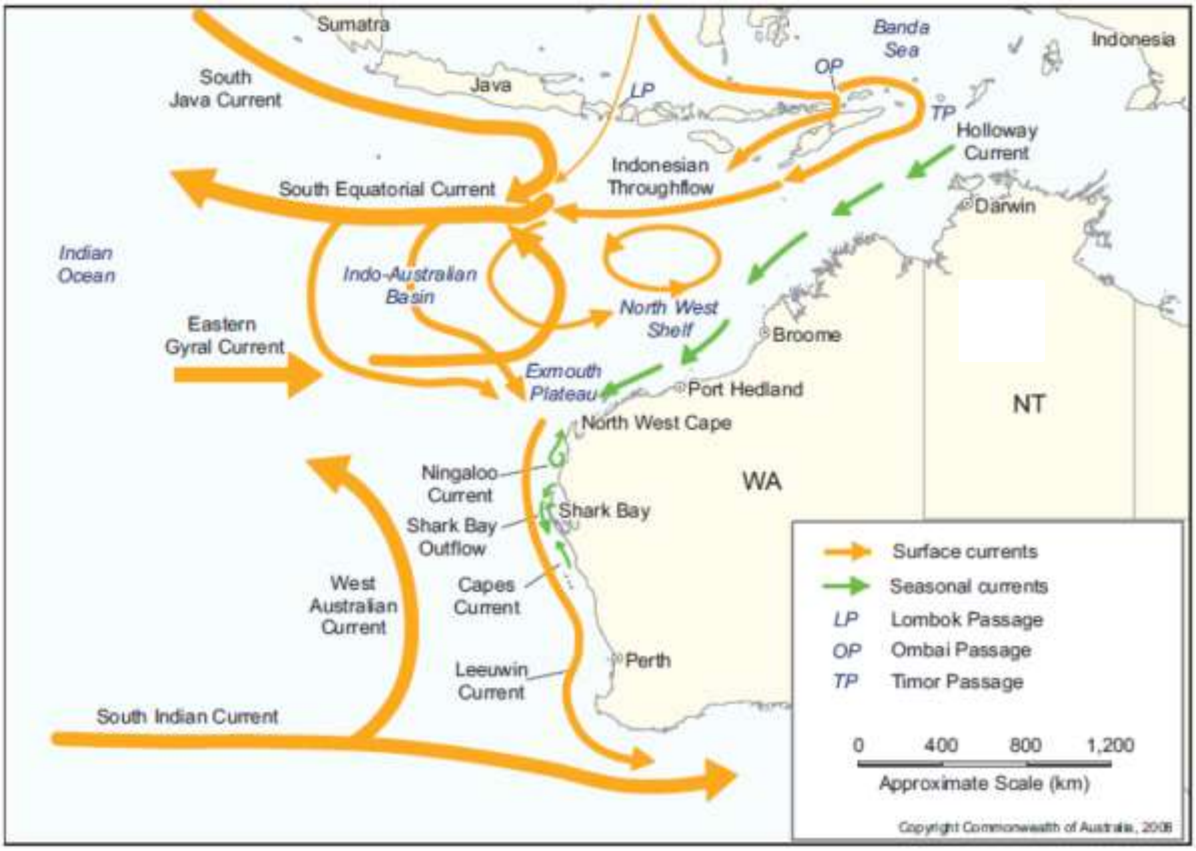

Figure 3.1 Schematic of ocean currents along the northwest Australian continental shelf. Image adapted from DEWHA (2008).

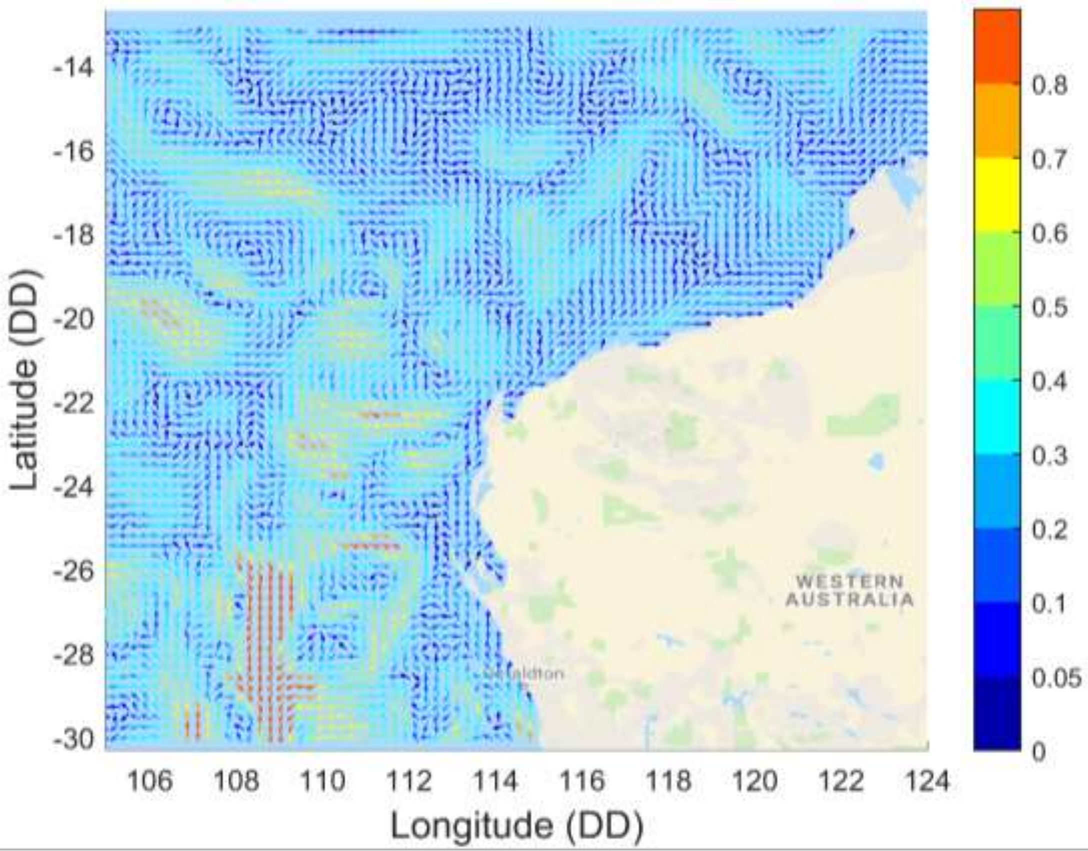

Figure 3.2 Typical ocean current circulation pattern during the summer months.

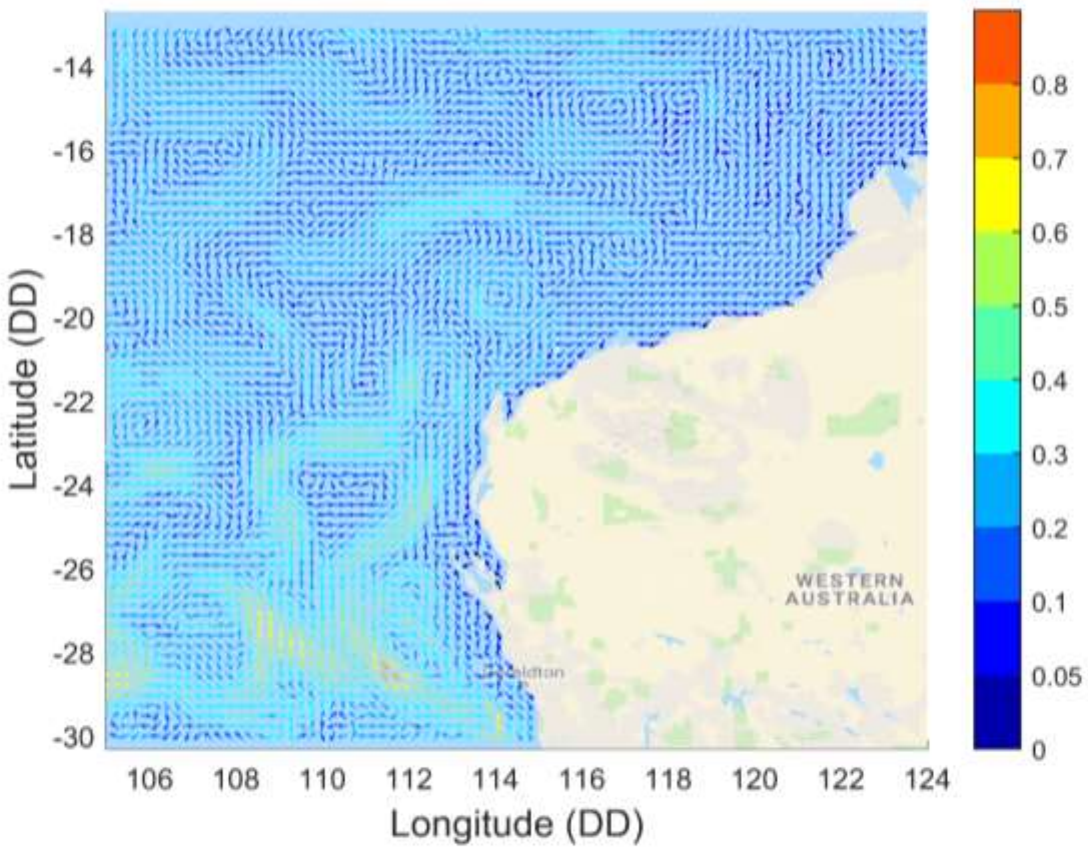

Figure 3.3 Typical ocean current circulation pattern during the winter months.

3.1 Tidal Currents

Tidal current data was generated using RPS's advanced ocean/coastal model, HYDROMAP. The HYDROMAP model has been thoroughly tested and verified through field measurements throughout the world for more than 30 years (Isaji & Spaulding, 1984; Isaji, et al., 2001; Zigic, et al., 2003). HYDROMAP tidal current data has been used as input to forecast (in the future) and hindcast (in the past) pollutant spills in Australian waters and forms part of the Australian National Oil Spill Emergency Response System operated by AMSA (Australian Maritime Safety Authority).

HYDROMAP employs a sophisticated sub-gridding strategy, which supports up to six levels of spatial resolution, halving the grid cell size as each level of resolution is employed. The sub-gridding allows for higher resolution of currents within areas of greater bathymetric and coastline complexity, and/or of particular interest to a study.

The numerical solution methodology follows that of Davies (1977a and 1977b) with further developments for model efficiency by Owen (1980) and Gordon (1982). A more detailed presentation of the model can be found in Isaji and Spaulding (1984) and Isaji et al. (2001).

3.1.1 Grid Setup

The tidal model domain has been sub-gridded to a resolution of 500 m for shallow and coastal regions, starting from an offshore (or deep water) resolution of 8 km. The finer grids were allocated in a step-wise fashion to more accurately resolve flows along the coastline, around islands and over regions with more complex bathymetry. Figure 3.4 shows the tidal model grid covering the study domain.

A combination of datasets was used and merged to describe the shape of the seabed within the grid domain (Figure 3.5). These included spot depths and contours which were digitised from nautical charts released by the hydrographic offices as well as Geoscience Australia database and depths extracted from the Shuttle Radar Topography Mission (SRTM30_PLUS) Plus dataset (see Becker et al., 2009).

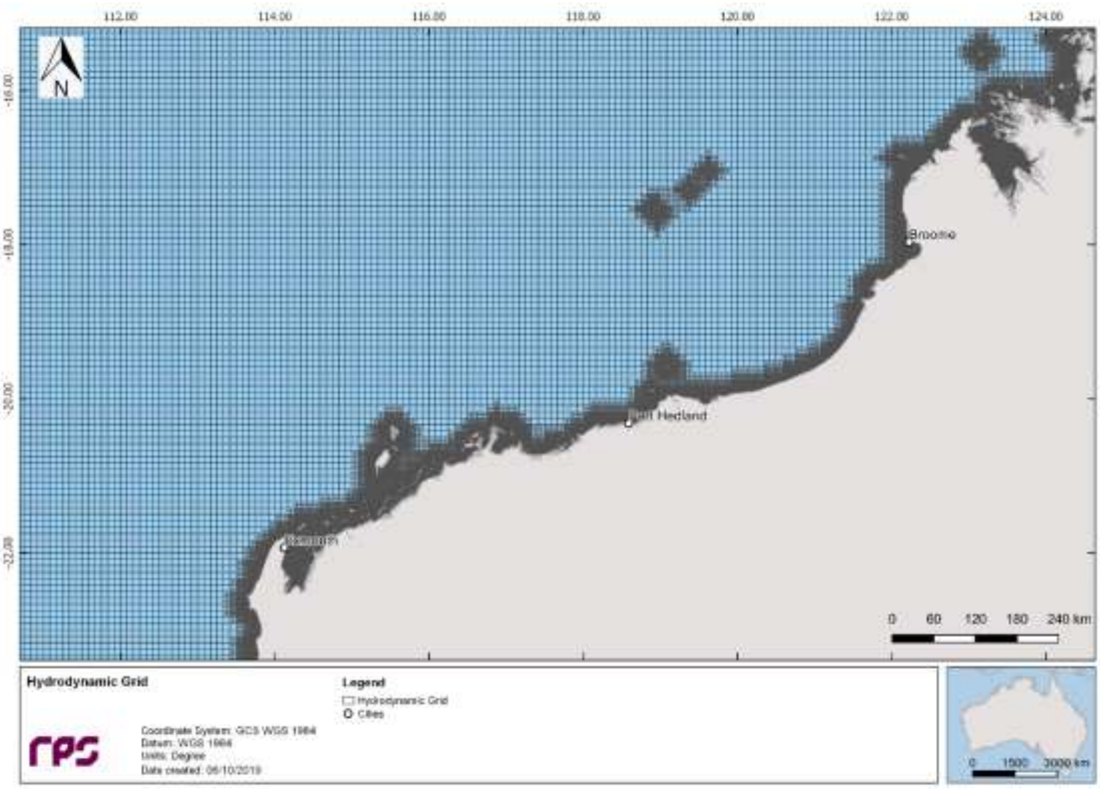

Figure 3.4 Hydrodynamic grid for the tidal model.

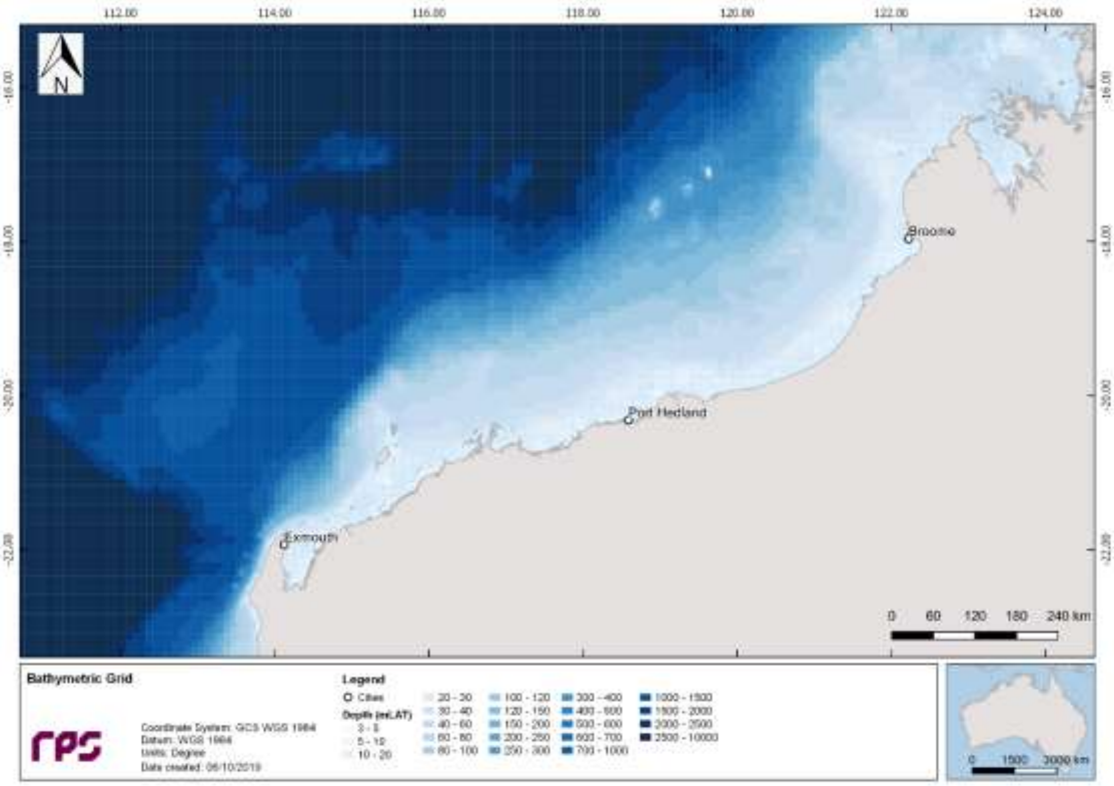

Figure 3.5 Bathymetry defined throughout the tidal model domain.

3.1.2 Tidal Conditions

The ocean boundary data for the regional model was obtained from satellite measured altimetry data (TOPEX/Poseidon 7.2) which provided estimates of the eight dominant tidal constituents at a horizontal scale of approximately 0.25 degrees. The eight major tidal constituents used were K_2, S_2, M_2, N_2, K_1, P_1, O_1 and Q_1. Using the tidal data, surface heights were firstly calculated along the open boundaries, at each time step in the model.

The TOPEX/Poseidon satellite data has a global resolution of 0.25 degrees and is produced and quality controlled by NASA (National Aeronautics and Space Administration). The satellites equipped with two highly accurate altimeters and capable of taking sea level measurements with an accuracy of ± 5 cm measured oceanic surface elevations (and the resultant tides) for over 13 years (1992–2005). In total, these satellites carried out 62,000 orbits of the planet.

The TOPEX/Poseidon tidal data has been widely used amongst the oceanographic community, being included in more than 2,100 research publications (e.g. Andersen, 1995; Ludicone et al., 1998; Matsumoto et al., 2000; Kostianoy et al., 2003; Yaremchuk and Tangdong, 2004; Qiu and Chen 2010). As such the TOPEX/Poseidon tidal data is considered suitably accurate for this study.

3.1.3 Surface Elevation Validation

To ensure that tidal predictions were accurate, predicted surface elevations were compared to data observed at several locations (see Table 3.2).

To provide a statistical measure of the model performance, the Index of Agreement (IOA - Willmott (1981)) and the Mean Absolute Error (MAE - Willmott (1982) and Willmott and Matsuura (2005)) were used.

The MAE (Eq.1) is simply the average of the absolute values of the difference between the model-predicted (P) and observed (O) variables. It is a more natural measure of the average error (Willmott and Matsuura, 2005) and more readily understood. The MAE is determined by:

$$MAE = N^{-1} \sum_{i=1}^{N} |P_i - O_i| \qquad \text{Eq.1}$$

Where: N = Number of observations
P_i = Model predicted surface elevation
O_i = Observed surface elevation

The Index of Agreement (IOA; Eq 2) in contrast, gives a non-dimensional measure of model accuracy or performance. A perfect agreement between the model predicted and observed surface elevations exists if the index gives an agreement value of 1, and complete disagreement between model and observed surface elevations will produce an index measure of 0 (Willmott, 1981). Willmott et al (1985) also suggests that values larger than 0.5 may represent good model performance. The IOA is determined by:

$$IOA = 1 - \frac{\sum |X_{model} - X_{obs}|^2}{\sum (|X_{model} - \overline{X_{obs}}| + |X_{obs} - \overline{X_{obs}}|)^2} \qquad \text{Eq.2}$$

Where: X_{model} = Model predicted surface elevation
X_{obs} = Obsrved surface elevation

Clearly, a greater IOA and lower MAE represent a better model performance.

Figure 3.7 to Figure 3.9 illustrate a comparison of the predicted and observed surface elevations for each location for January 2014. As shown on the graph, the model accurately reproduced the phase and amplitudes throughout the spring and neap tidal cycles.

Table 3.1 Statistical comparison between the observed and predicted surface elevations.

Tide Station	IOA	MAE (m)
Learmonth	0.96	0.14
Onslow	0.96	0.17
Barrow Island - Tkr Mrg	0.98	0.21
Cape Legendre	0.98	0.27
Port Walcott	0.98	0.30
Port Hedland	0.98	0.34
Red Bluff	0.99	0.30

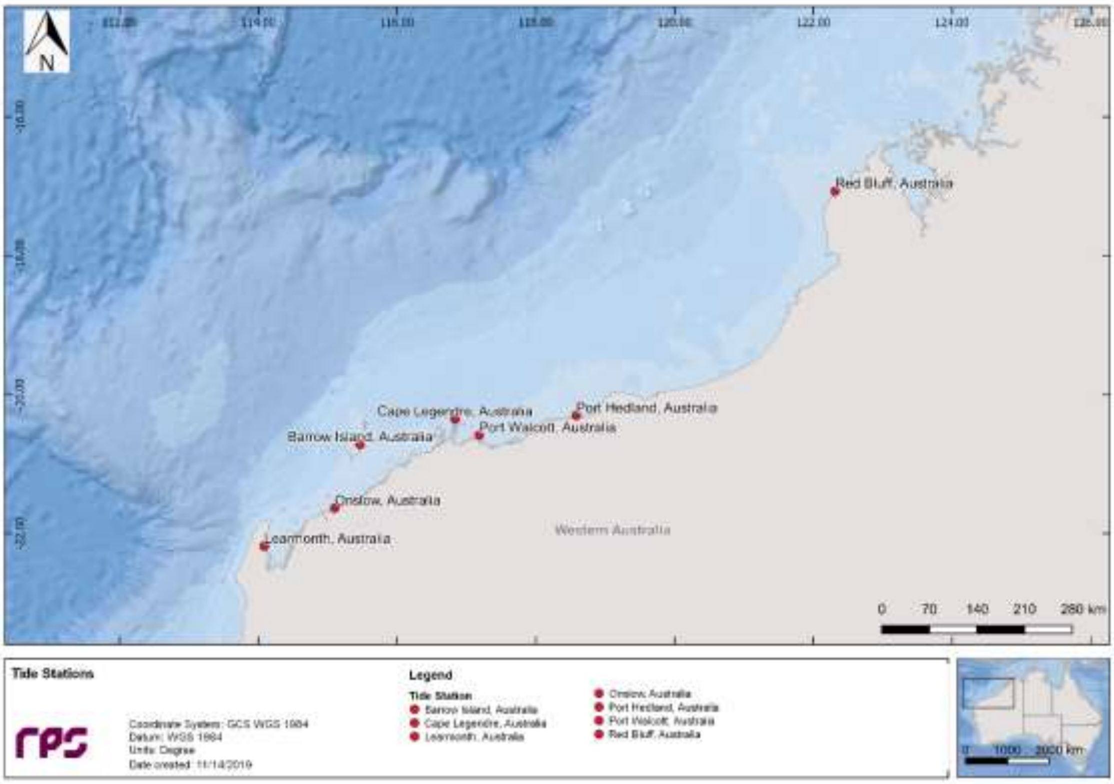

Figure 3.6 Tide stations used to calibrate surface elevation within the model.

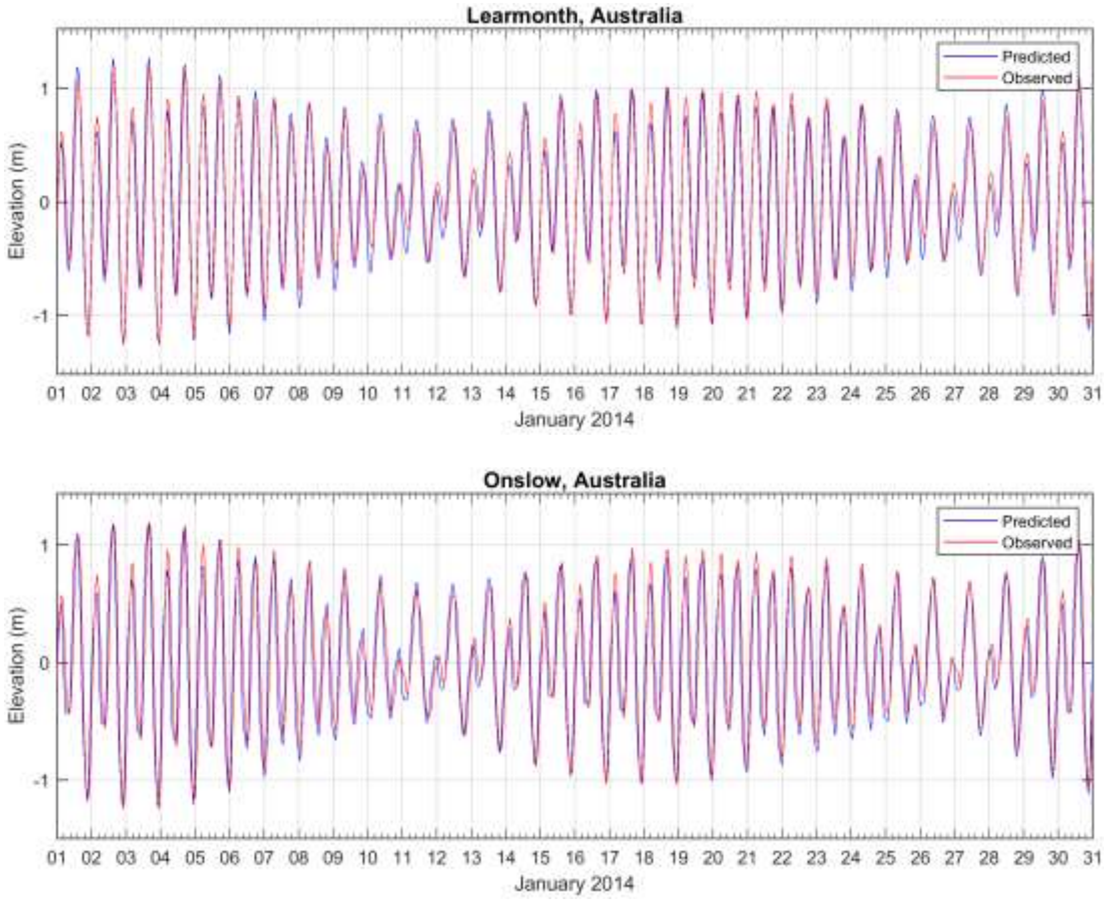

Figure 3.7 Comparison between HYDROMAP predicted (blue line) and observed (red line) surface elevation.

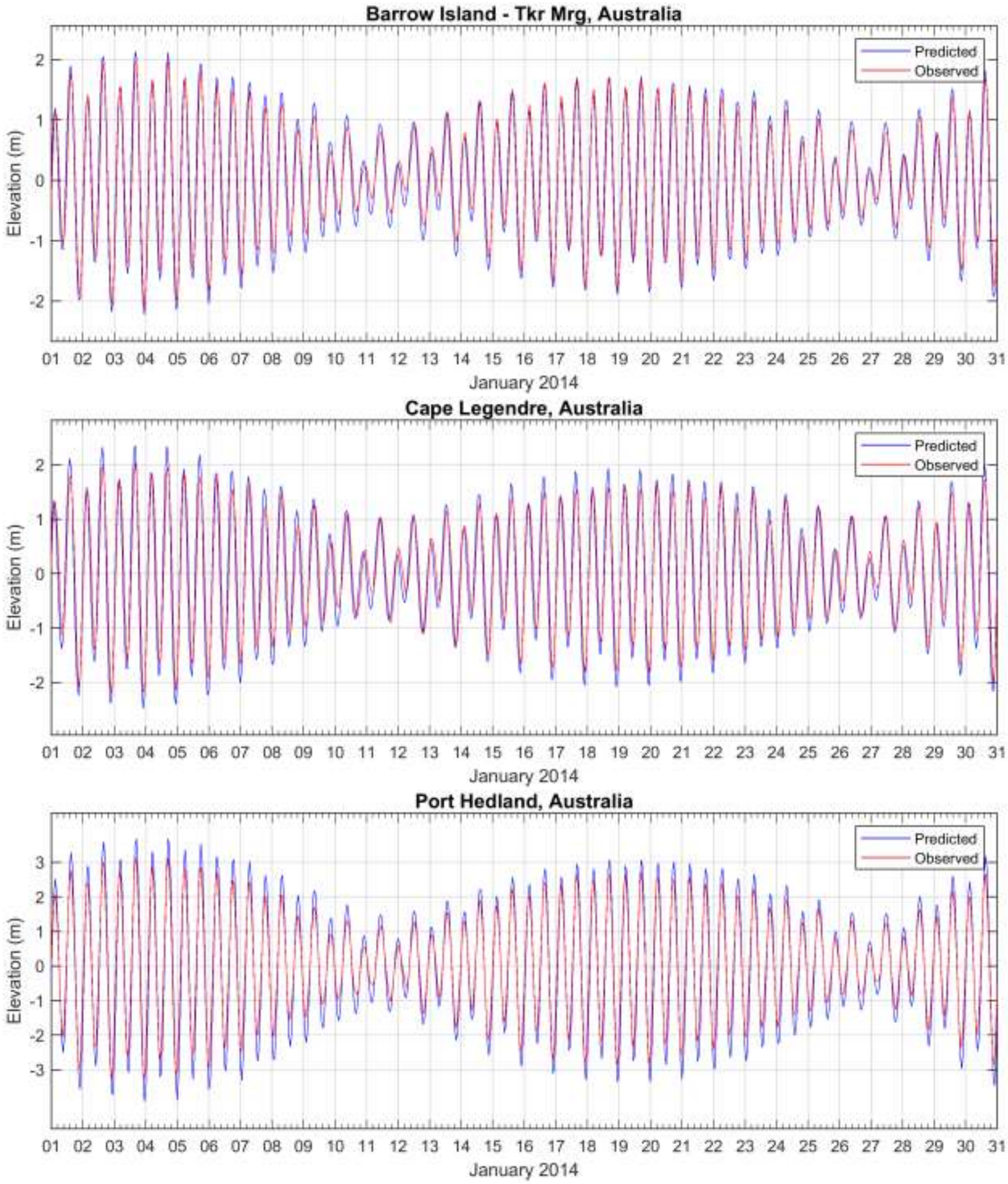

Figure 3.8 Comparison between HYDROMAP predicted (blue line) and observed (red line) surface elevation.

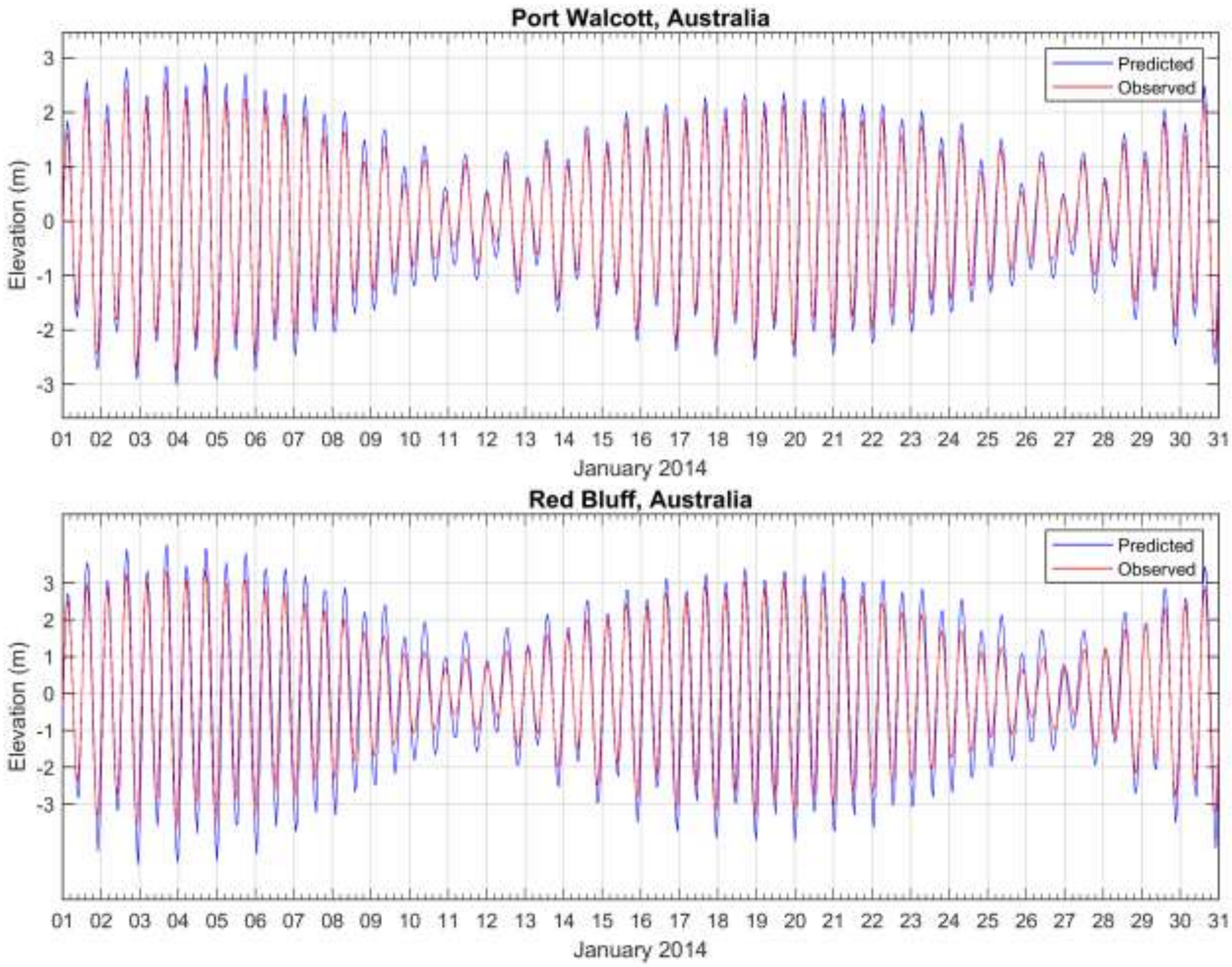

Figure 3.9 Comparison between HYDROMAP predicted (blue line) and observed (red line) surface elevation.

3.2 Ocean Currents

Data describing the flow of ocean currents was obtained from HYCOM (Hybrid Coordinate Ocean Model, (Chassignet et al., 2007), operated by the HYCOM Consortium and sponsored by the Global Ocean Data Assimilation Experiment (GODAE). HYCOM is a data-assimilative, three-dimensional ocean model that is run as a hindcast (for a past period), assimilating time-varying observations of sea surface height, sea surface temperature and in-situ temperature and salinity measurements (Chassignet et al., 2009). The HYCOM predictions for drift currents are produced at a horizontal spatial resolution of approximately 8.25 km (1/12th of a degree) over the region, at a frequency of once per day. HYCOM uses isopycnal layers in the open, stratified ocean, but uses the layered continuity equation to make a dynamically smooth transition to a terrain following coordinate in shallow coastal regions, and to z-level coordinates in the mixed layer and/or unstratified seas.

For this study, the HYCOM hindcast currents were obtained for the years 2009 to 2018 (inclusive).

3.2.1 Surface Currents

Table 3.2, Table 3.3 and Table 3.4 display the predicted average and maximum surface current speed near the Mentorc-1, Point 1 and Point 4 release locations, respectively. Figure 3.10, Figure 3.12 and Figure 3.14 illustrate the monthly current rose distributions (2009-2018 inclusive) while Figure 3.11, Figure 3.13 and Figure 3.15 illustrate the seasoal current rose distributions, derived from combining HYCOM ocean current data and HYDROMAP tidal data near the Mentorc-1, Point 1 and Point 4 release locations, respectively.

Note the convention for defining current direction throughout this report is the direction the current flows towards. Each branch of the current rose distribution represents the currents flowing to that direction, with north to the top of the diagram. The branches are divided into segments of different colour, which represent the current speed ranges for each direction. Speed intervals of 0.1 m/s are predominantly used in these current roses. The length of each coloured segment within a branch is proportional to the frequency of currents flowing within the corresponding speed and direction.

The analysis of the combined surface current data (oceans plus tides) demonstrated slightly stronger currents at the offshore location (Mentorc-1), with waters generally flowing at 0.2-0.3 m/s on average throughout the year versus 0.1-0.2 m/s for the locations closer to the pipeline route at Point 1 and Point 4. The general current direction near the Mentorc-1 release location was predominately north during summer, west during winter and north and southwest during the transitional period with maximum current speeds ranging between 0.6 m/s (June) to 1.3 m/s (April and May).

Table 3.2 Predicted monthly average and maximum surface current speeds close to the Mentorc-1 release location. Data derived by combining the HYCOM ocean data and HYDROMAP high resolution tidal data from 2009-2018 (inclusive).

Season	Month	Average current speed (m/s)	Maximum current speed (m/s)	General direction (towards)
Summer	January	0.3	0.9	North
	February	0.2	0.9	North
	March	0.2	0.6	Variable
Transitional	April	0.2	1.3	Variable
Winter	May	0.2	1.3	Variable
	June	0.2	0.6	Variable
	July	0.2	0.7	Variable
Transitional	August	0.2	0.8	North
Summer	September	0.3	0.9	North
	October	0.3	0.8	North and West
	November	0.3	1.1	North
	December	0.3	0.8	Northeast
	Minimum	**0.2**	**0.6**	
	Maximum	**0.3**	**1.3**	

Table 3.3 Predicted monthly average and maximum surface current speeds close to the Point 1 location. Data derived by combining the HYCOM ocean data and HYDROMAP high resolution tidal data from 2009-2018 (inclusive).

Season	Month	Average current speed (m/s)	Maximum current speed (m/s)	General direction (towards)
Summer	January	0.2	1.0	Variable
	February	0.2	0.7	Variable
	March	0.2	0.8	Variable
Transitional	April	0.2	0.7	West
Winter	May	0.2	0.7	West
	June	0.2	0.6	West-southwest
	July	0.2	0.6	West-southwest
Transitional	August	0.1	0.6	West
Summer	September	0.1	0.6	Variable
	October	0.2	0.5	Variable
	November	0.2	0.4	Variable
	December	0.2	0.5	Variable
	Minimum	**0.1**	**0.4**	
	Maximum	**0.2**	**1.0**	

Table 3.4 Predicted monthly average and maximum surface current speeds close to the Point 4 release location. Data derived by combining the HYCOM ocean data and HYDROMAP high resolution tidal data from 2009-2018 (inclusive).

Season	Month	Average current speed (m/s)	Maximum current speed (m/s)	General direction (towards)
Summer	January	0.2	0.9	West and East-northeast
	February	0.2	0.6	West and East
	March	0.2	0.7	West and East-northeast
Transitional	April	0.2	0.8	West and East-northeast
Winter	May	0.2	0.8	West
	June	0.2	0.8	West-southwest
	July	0.2	0.7	West-southwest
Transitional	August	0.2	0.7	West
Summer	September	0.2	0.6	West and East
	October	0.1	0.5	West-northwest and East-northeast
	November	0.1	0.5	West and East-northeast
	December	0.1	0.6	West and East-northeast
	Minimum	**0.1**	**0.5**	
	Maximum	**0.2**	**0.9**	

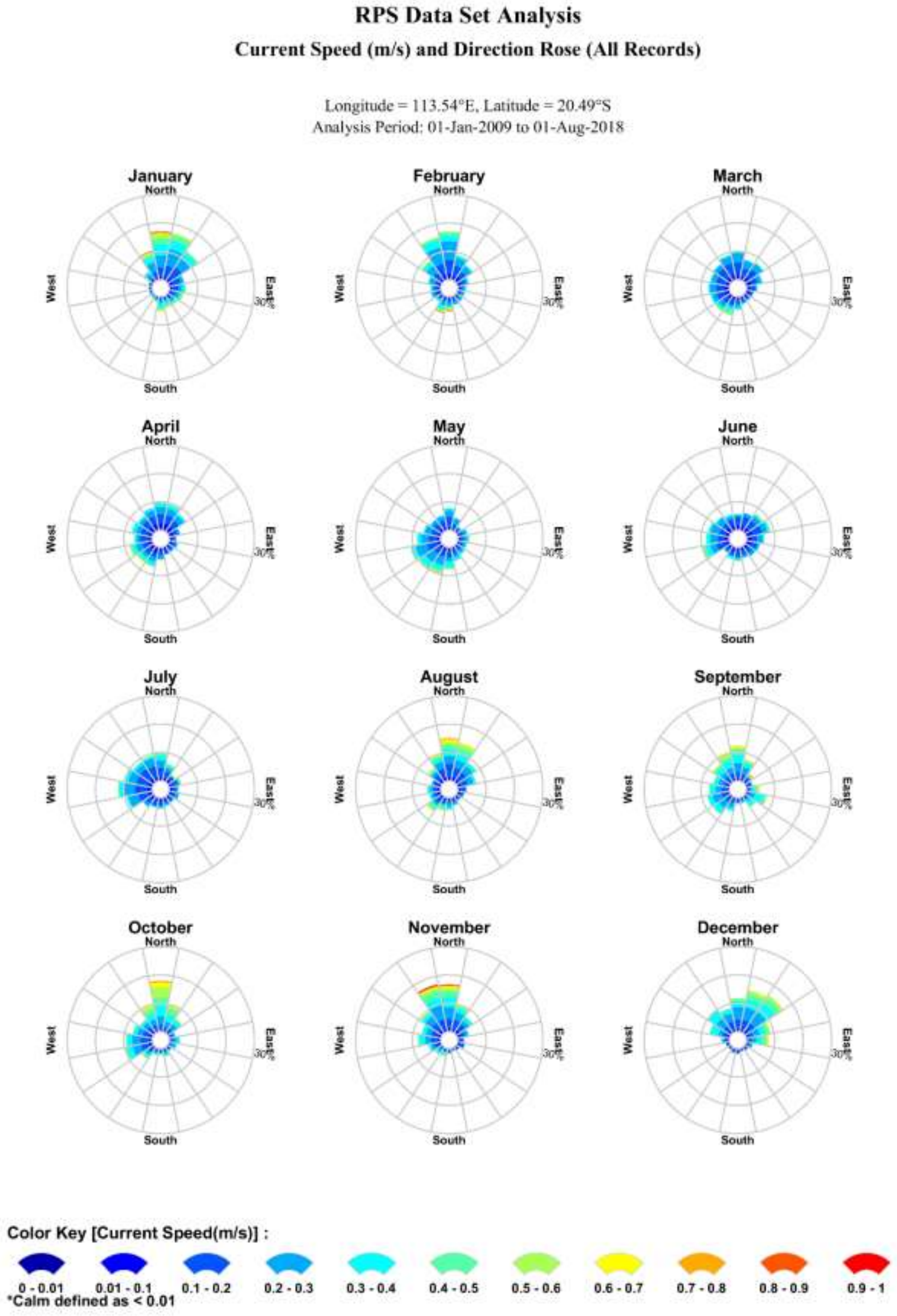

Figure 3.10 Monthly surface current rose plots near the Mentorc-1 release location (derived by combining the HYDROMAP and HYCOM ocean currents for 2009-2018; inclusive).

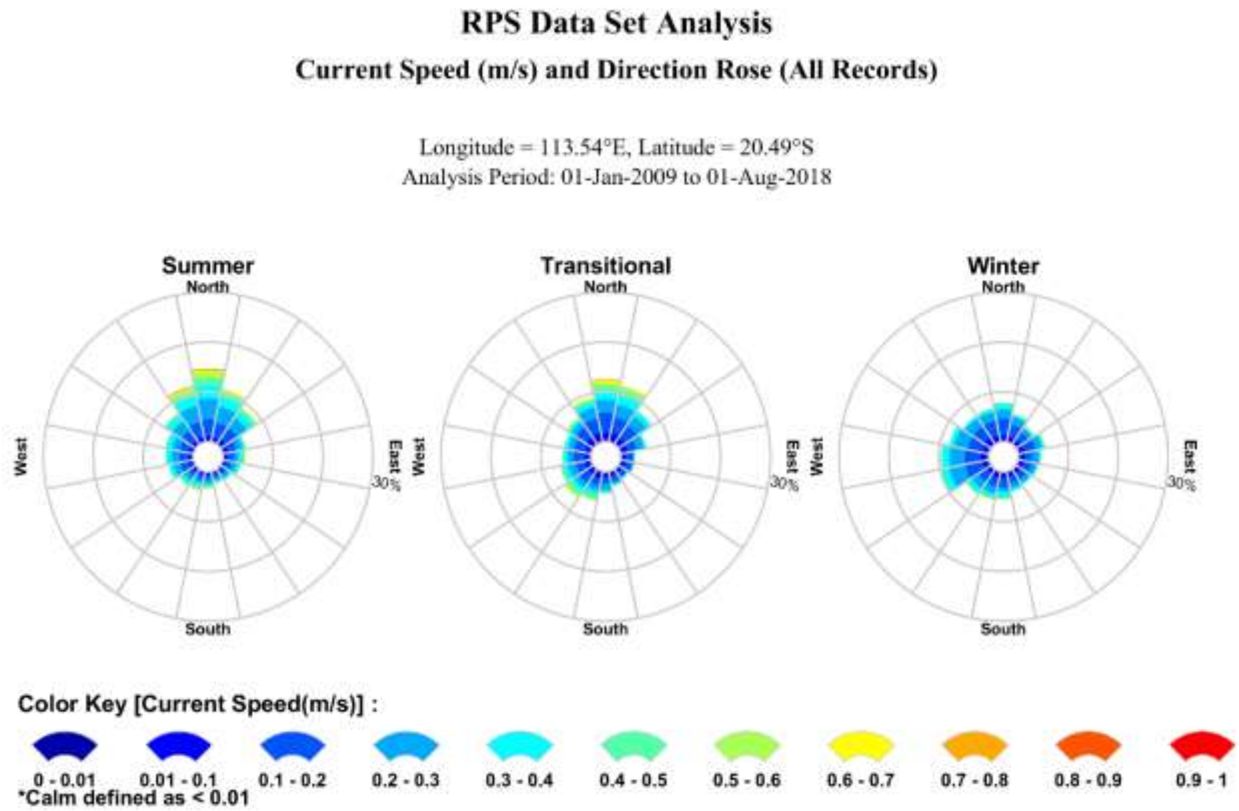

Figure 3.11 Seasonal surface current rose plot near the Mentorc-1 release location (derived by combining the HYDROMAP and HYCOM ocean currents for 2009-2018; inclusive).

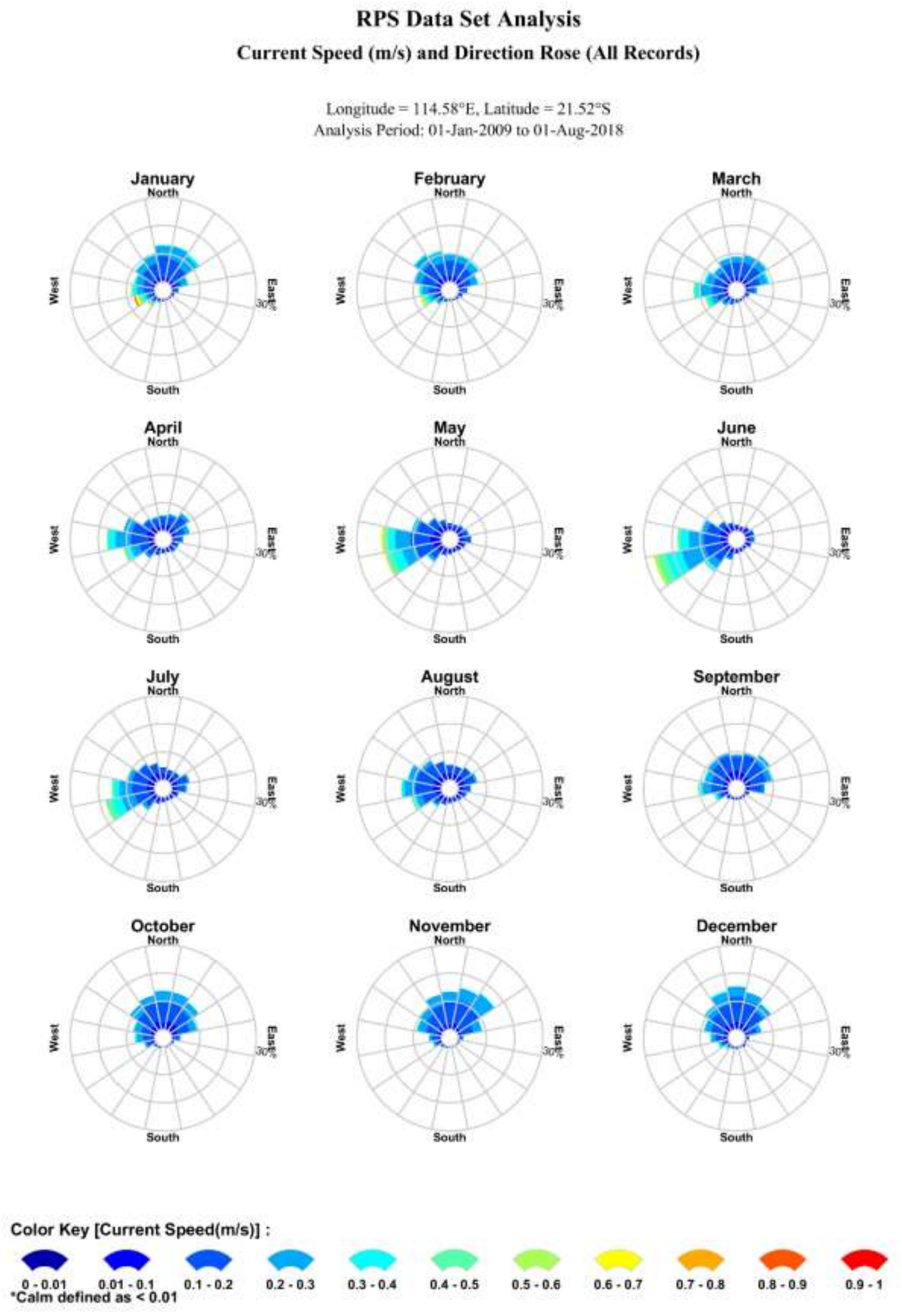

Figure 3.12 Monthly surface current rose plots near the Point 1 release location (derived by combining the HYDROMAP and HYCOM ocean currents for 2009-2018; inclusive).

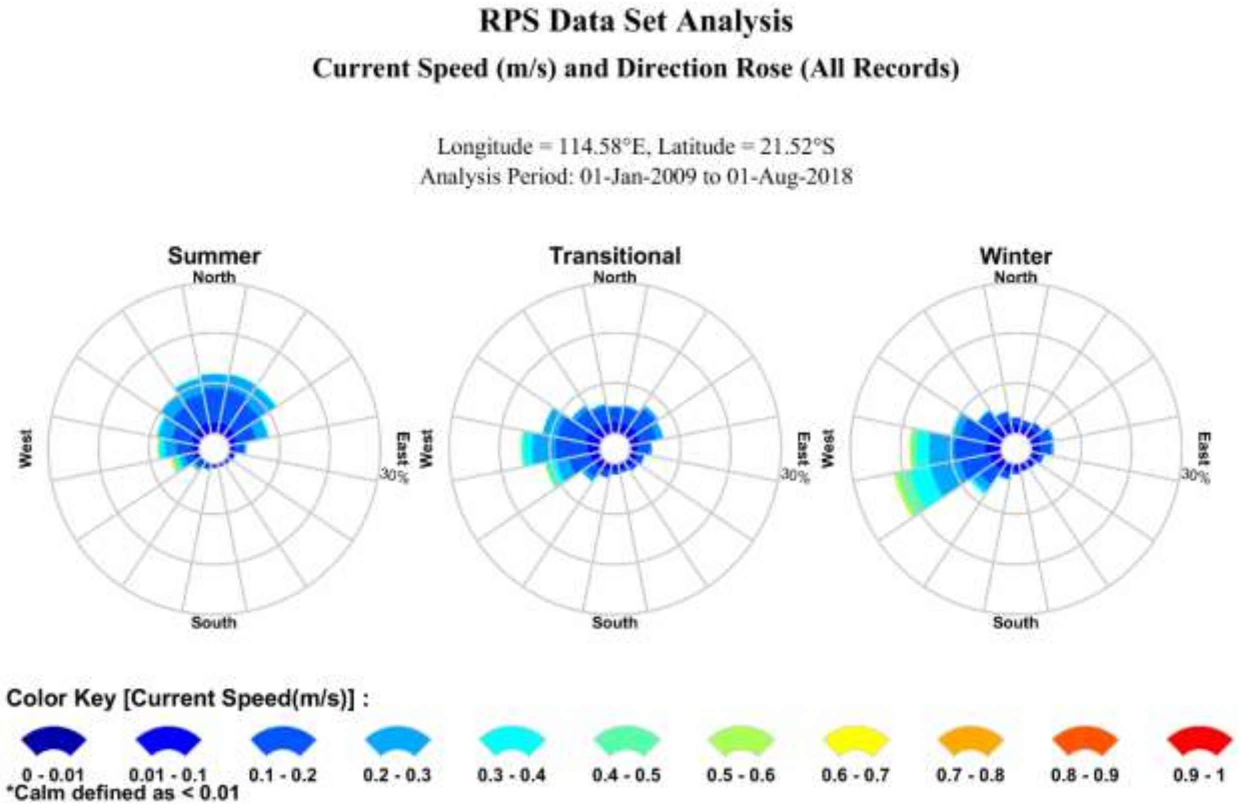

Figure 3.13 Seasonal surface current rose plot near the Point 1 release location (derived by combining the HYDROMAP and HYCOM ocean currents for 2009-2018; inclusive).

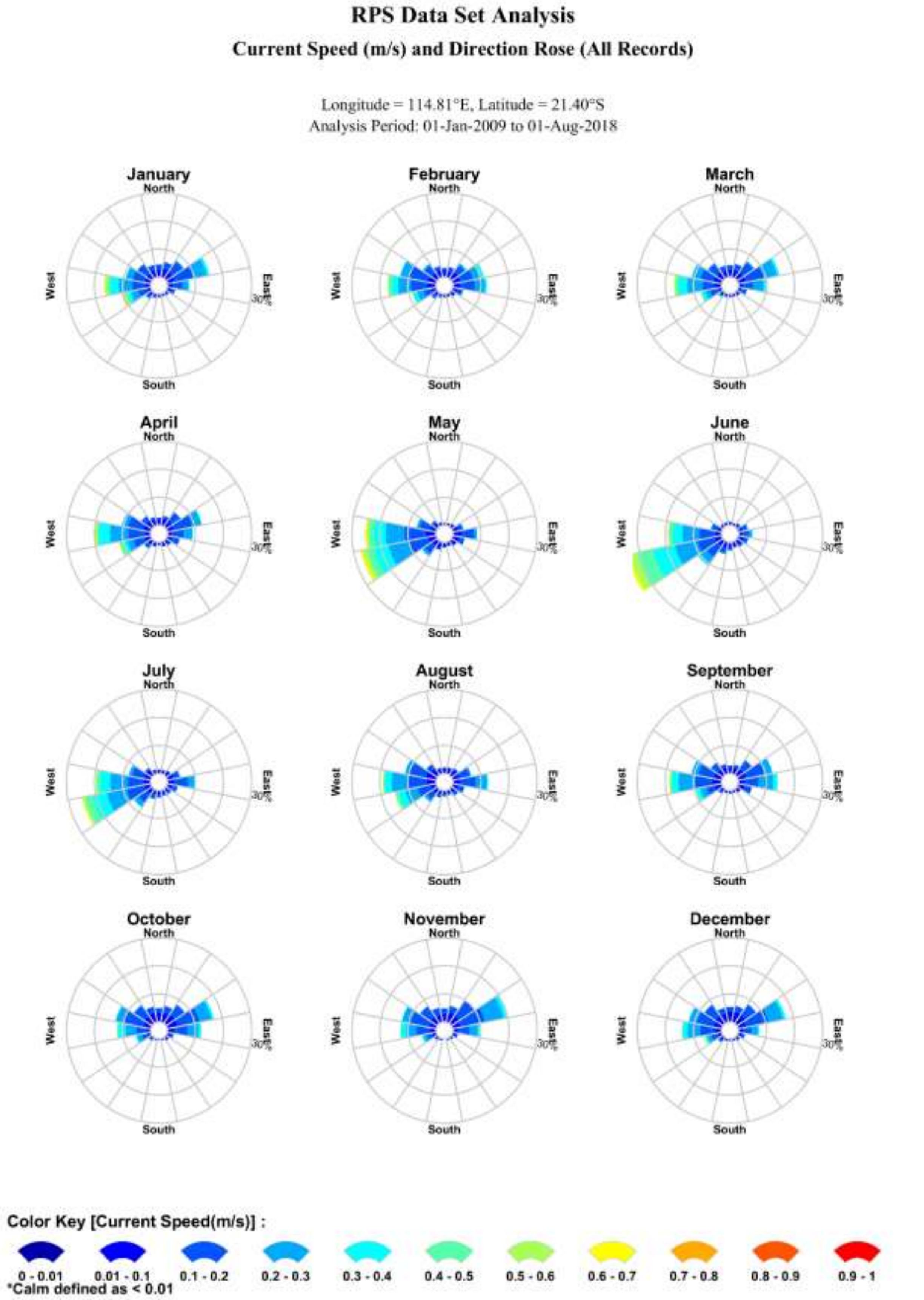

Figure 3.14 Monthly surface current rose plots near the Point 4 release location (derived by combining the HYDROMAP and HYCOM ocean currents for 2009-2018; inclusive).

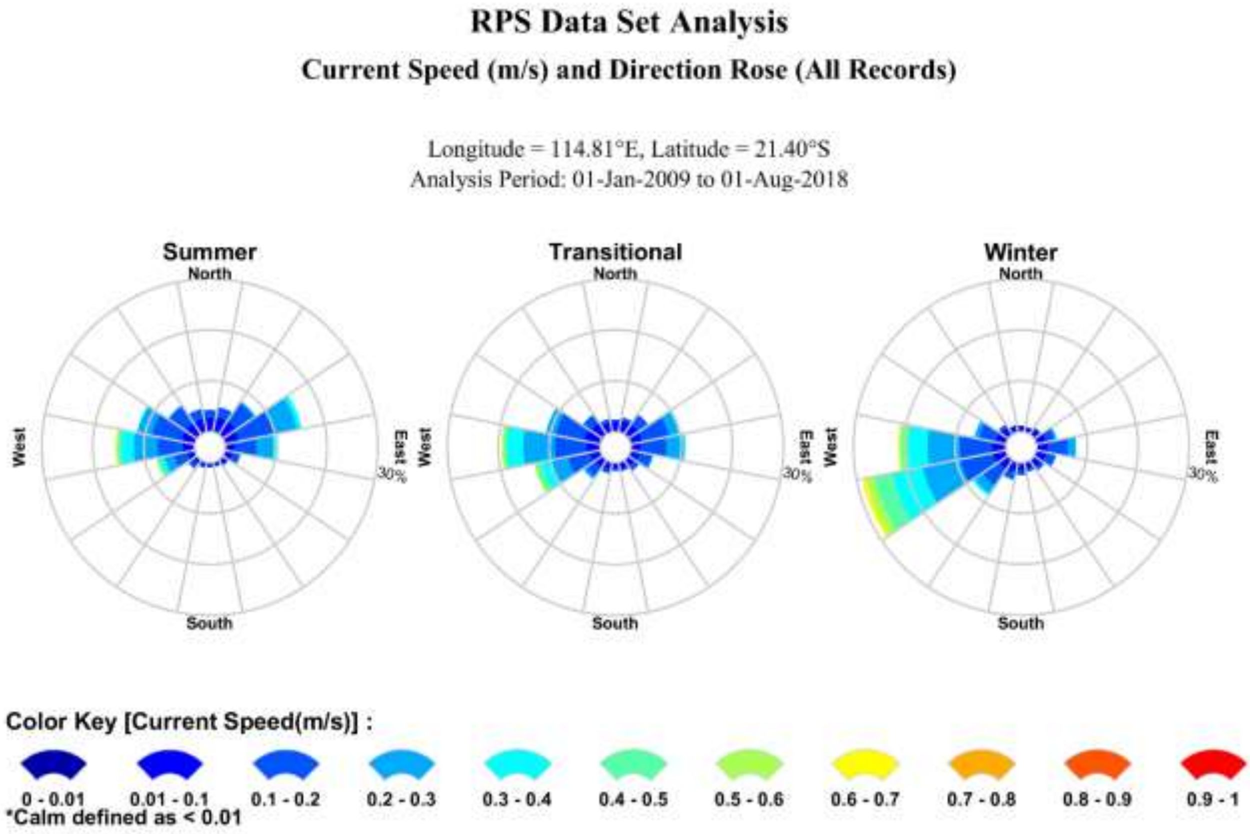

Figure 3.15 Seasonal surface current rose plot near the Point 4 release location (derived by combining the HYDROMAP and HYCOM ocean currents for 2009-2018; inclusive).

4 WIND DATA

High resolution wind data from 2009 to 2018 (inclusive) was sourced from the National Centre for Environmental Prediction (NCEP) Climate Forecast System Reanalysis (CFSR; see Saha et al., 2010). The CFSR wind model includes observations from many data sources; surface observations, upper-atmosphere air balloon observations, aircraft observations and satellite observations. The model is capable of accurately representing the interaction between the earth's oceans, land and atmosphere. The gridded wind data output is available at ¼ of a degree resolution (~33 km) and 1-hourly time intervals. Figure 4.1 shows the spatial resolution of the wind field used as input into the oil spill model and the wind point used to create the wind roses.

Table 4.1, Table 4.2 and Table 4.3 show the monthly average and maximum winds derived from the CFSR points located near the Mentorc-1, Point 1 and Point 4 release locations, respectively. Figure 4.2, Figure 4.4 and Figure 4.6 illustrate the monthly wind rose distributions while Figure 4.3, Figure 4.5 and Figure 4.7 illustrate the seasonal wind rose distributions at the Mentorc-1, Point 1 and Point 4 release locations, respectively.

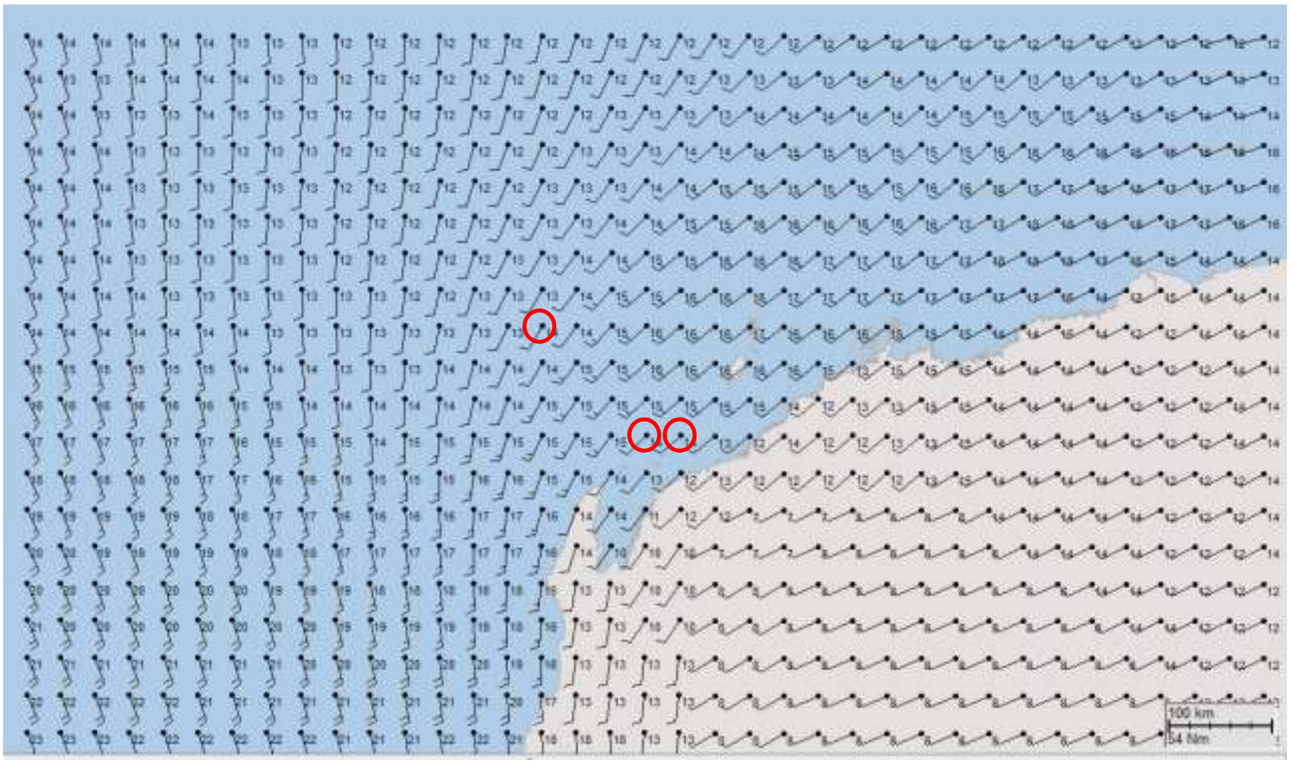

Figure 4.1 Spatial resolution of the CFSR modelled wind data used as input into the oil spill model. The red circles indicate the wind points used to generate the wind roses, for each release location.

Note that the atmospheric convention for defining wind direction, that is, the direction the wind blows from, is used to reference wind direction throughout this report. Each branch of the rose represents wind coming from that direction, with north to the top of the diagram. Sixteen directions are used. The branches are divided into segments of different colour, which represent wind speed ranges from that direction. Speed ranges of 2 knot intervals, are used in these wind roses. The length of each segment within a branch is proportional to the frequency of winds blowing within the corresponding range of speeds from that direction.

The model wind data demonstrated that this region typically experiences moderate winds all year round and although the monthly average wind speeds remain under 7 knots, winds can at times blow over 31 knots at the offshore location (Mentorc-1). Winds in the region typically blow from the southwest during summer, east-southeast during winter and south during the transitional period.

Table 4.1 Predicted average and maximum winds for the wind station closest to the Mentorc-1 release location. Data derived from CFSR hindcast model 2009 to 2018 (inclusive).

Season	Month	Average wind (knots)	Maximum wind (knots)	General direction (from)
Summer	January	7	28	Southwest
	February	6	27	Southwest
	March	6	18	South-southwest
Transitional	April	6	31	South-southeast
Winter	May	6	28	East-southeast
	June	7	18	East-southeast
	July	7	16	Southeast
Transitional	August	6	15	South
Summer	September	7	14	South
	October	7	14	South-Southwest
	November	7	14	Southwest
	December	7	17	Southwest
	Minimum	**6**	**14**	
	Maximum	**7**	**31**	

Table 4.2 Predicted average and maximum winds for the wind station closest to the Point 1 release location. Data derived from CFSR hindcast model 2009 to 2018 (inclusive).

Season	Month	Average wind (knots)	Maximum wind (knots)	General direction (from)
Summer	January	7	26	Southwest
	February	6	30	Southwest
	March	6	18	Southwest
Transitional	April	6	22	Variable
Winter	May	6	25	East-southeast
	June	6	18	Southeast
	July	7	18	South-southwest
Transitional	August	6	15	South-southeast
Summer	September	7	15	Southwest
	October	7	15	Southwest
	November	7	14	Southwest
	December	7	16	Southwest
	Minimum	**6**	**14**	
	Maximum	**7**	**30**	

Table 4.3 Predicted average and maximum winds for the wind station closest to the Point 4 release location. Data derived from CFSR hindcast model 2009 to 2018 (inclusive).

Season	Month	Average wind (knots)	Maximum wind (knots)	General direction (from)
Summer	January	7	25	Southwest
	February	6	28	Southwest
	March	6	17	Southwest
Transitional	April	6	21	Variable
Winter	May	6	25	East-southeast
	June	6	17	East-southeast
	July	6	17	Southeast
Transitional	August	6	14	South-southeast
Summer	September	7	14	Southwest
	October	7	14	Southwest
	November	7	14	Southwest
	December	7	15	Southwest
	Minimum	**6**	**14**	
	Maximum	**7**	**28**	

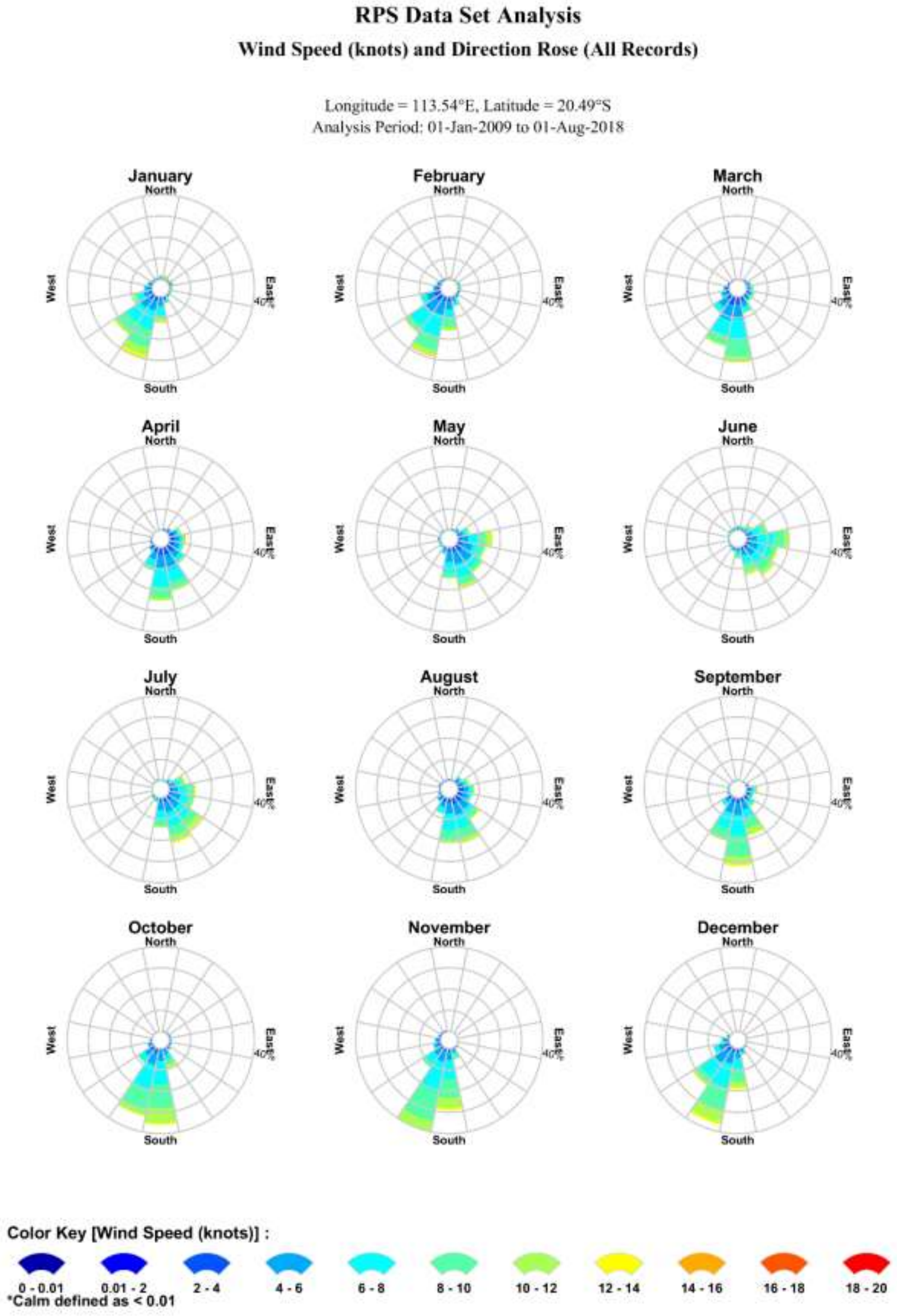

Figure 4.2 Monthly wind rose distributions derived from CFSR model from 2009 to 2018 (inclusive), for the wind point closest to the Mentorc-1 release location.

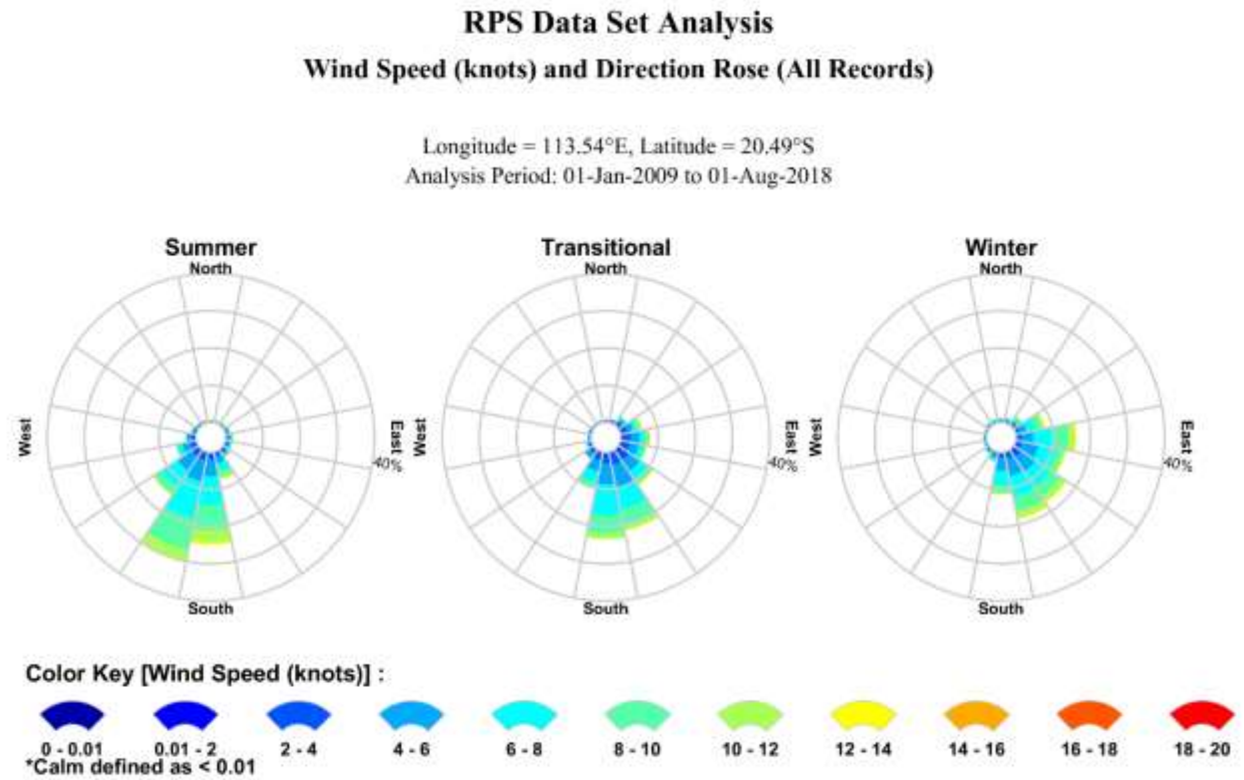

Figure 4.3 Seasonal wind rose distribution derived from the CFSR model from 2009 to 2018 (inclusive), for the wind point closest to the Mentorc-1 release location.

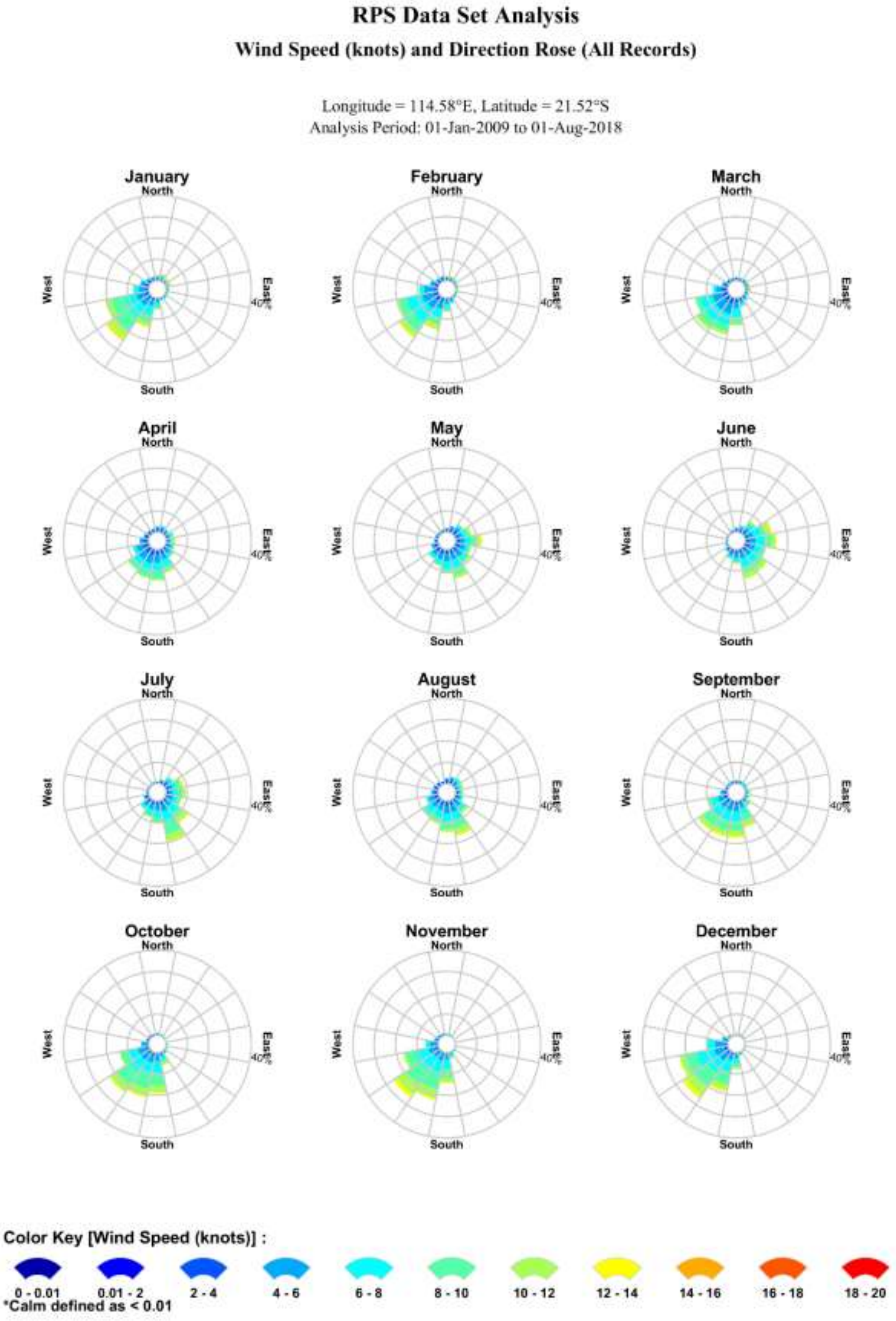

Figure 4.4 Monthly wind rose distributions derived from CFSR model from 2009 to 2018 (inclusive), for the wind point closest to the Point 1 release location.

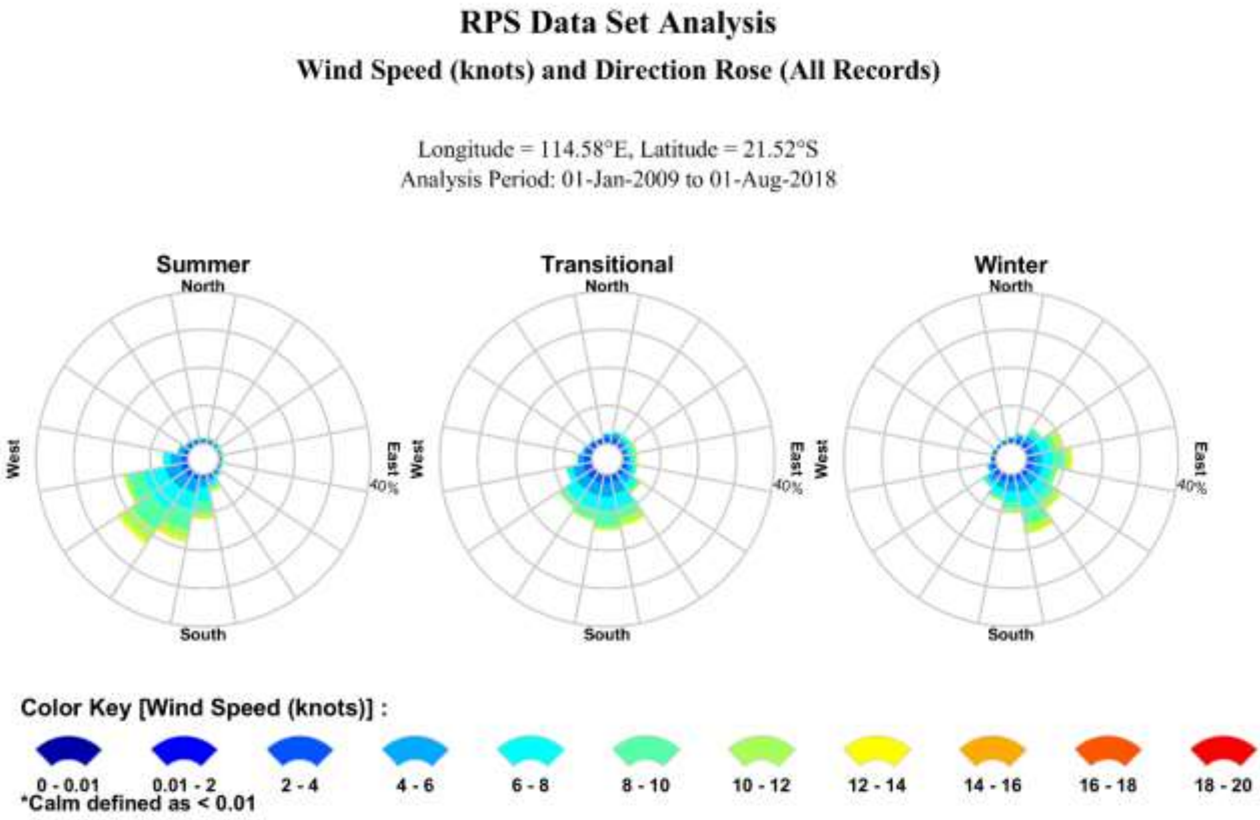

Figure 4.5 Seasonal wind rose distribution derived from the CFSR model from 2009 to 2018 (inclusive), for the wind point closest to the Point 1 release location.

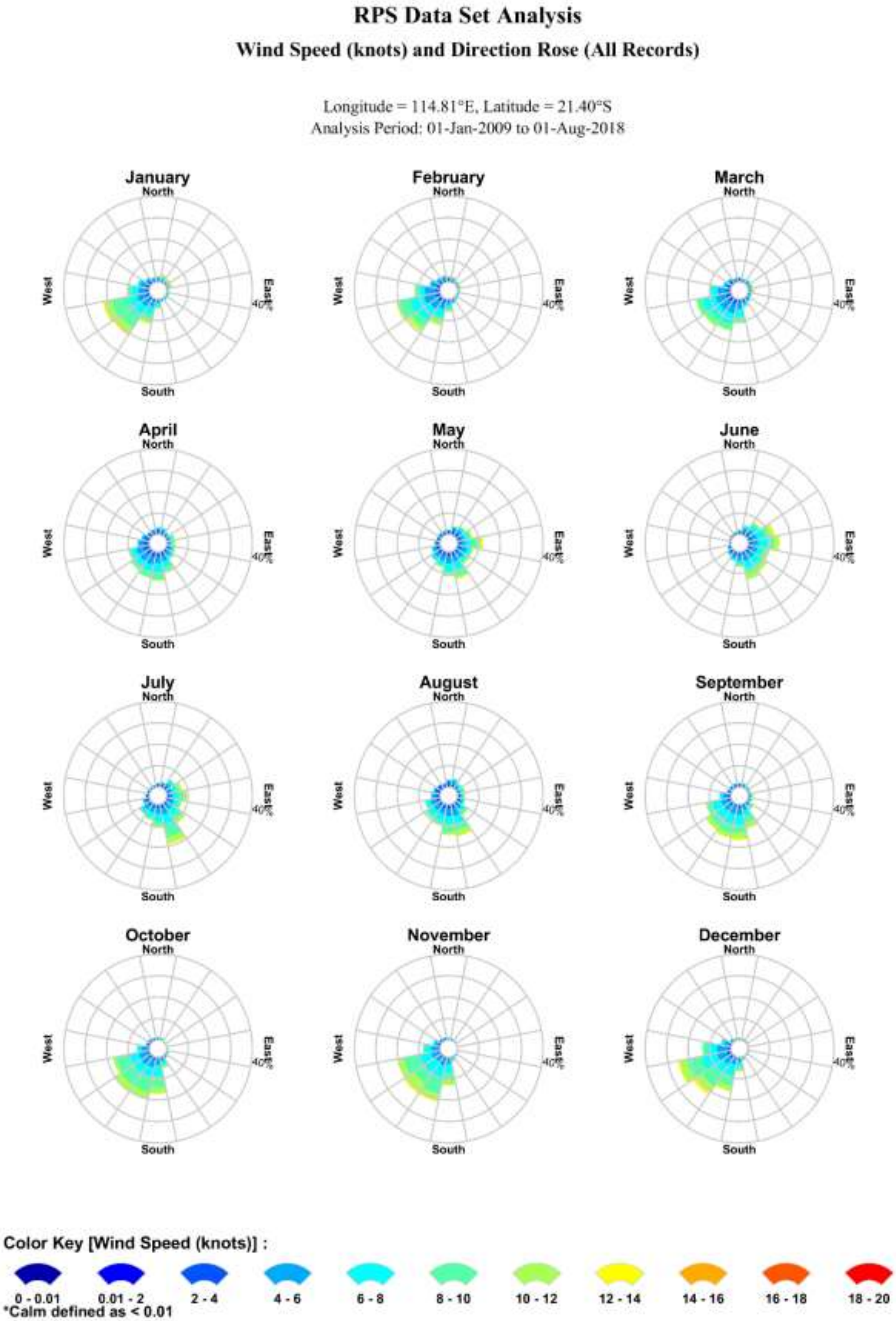

Figure 4.6 Monthly wind rose distributions derived from CFSR model from 2009 to 2018 (inclusive), for the wind point closest to the Point 4 release location.

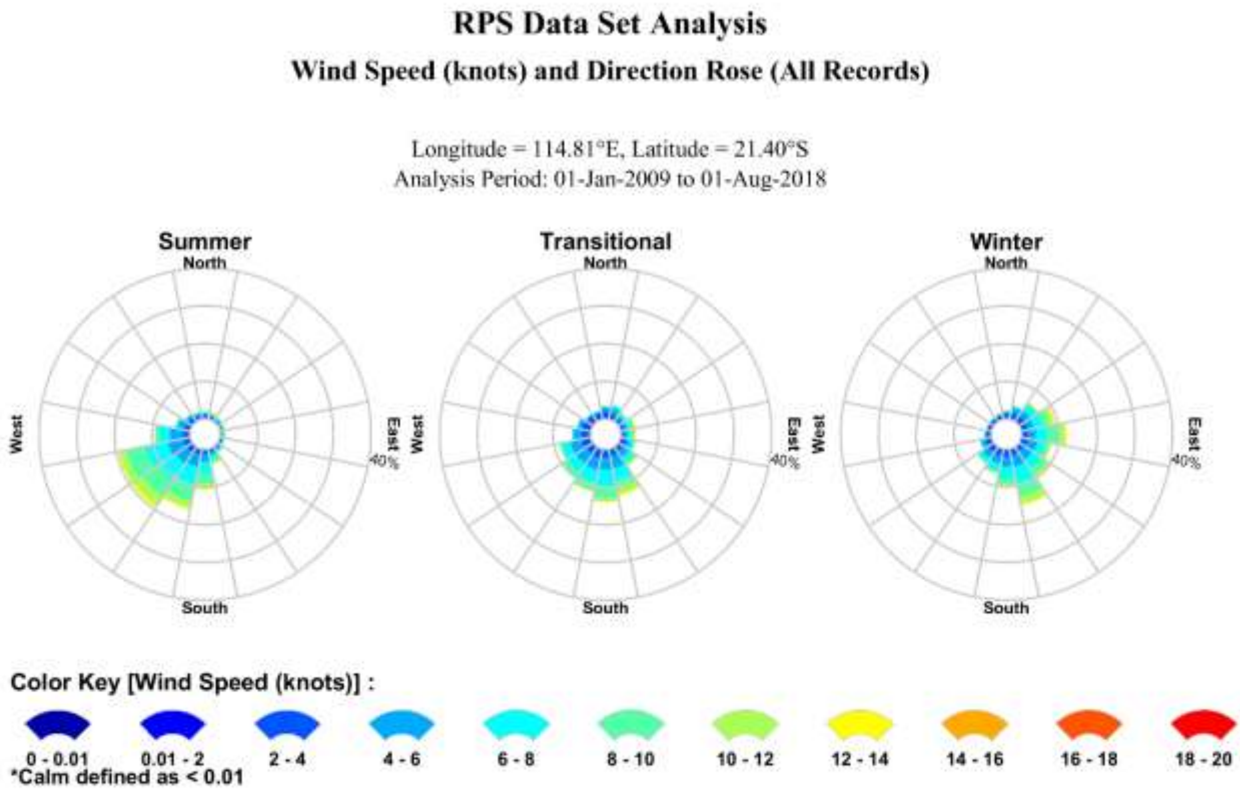

Figure 4.7 Seasonal wind rose distribution derived from the CFSR model from 2009 to 2018 (inclusive), for the wind point closest to the Point 4 release location.

5 WATER TEMPERATURE AND SALINITY

To accurately represent the water column temperature and salinity, monthly data was obtained from the World Ocean Atlas 2013 database produced by the National Oceanographic Data Centre (National Oceanic and Atmospheric Administration) and its co-located World Data Center for Oceanography (Levitus et al. 2013). The data is used to inform the weathering, movement and evaporative loss of hydrocarbon spills in the surface and subsurface layers.

The World Ocean Atlas 2013 is a set of objectively analysed (1° grid) fields of in situ parameters (e.g. temperature, salinity and dissolved oxygen) at standard depth levels for annual, seasonal, and monthly periods for the global oceans. The dataset represents the largest collection of restriction-free ocean profile data available internationally. Locarnini et al. (2013) and Zweng et al. (2013) provide discussion regarding the temperature and salinity data as part of the World Ocean Atlas 2013 database.

Table 5.1 details the monthly average sea surface temperatures and salinity (from the 0-5 m depth layer) nearest to the Mentorc-1 release location. Monthly temperature and salinity profiles throughout the water column are presented in Figure 5.1. Monthly average sea surface temperatures were shown to range from 23.7°C (September) to 29.1°C (March). Salinity remained consistent throughout the year at 34-35 psu.

Table 5.1 Monthly average sea surface temperature and salinity near the Mentorc-1 release location in the 0-5 m depth layer.

Month	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sept	Oct	Nov	Dec
Temperature (°C)	27.9	28.6	29.1	28.6	27.3	26.1	24.9	23.8	23.7	24.8	26.2	26.7
Salinity (psu)	34.9	34.8	34.8	34.5	34.5	34.6	34.6	34.8	34.9	34.8	34.8	34.8

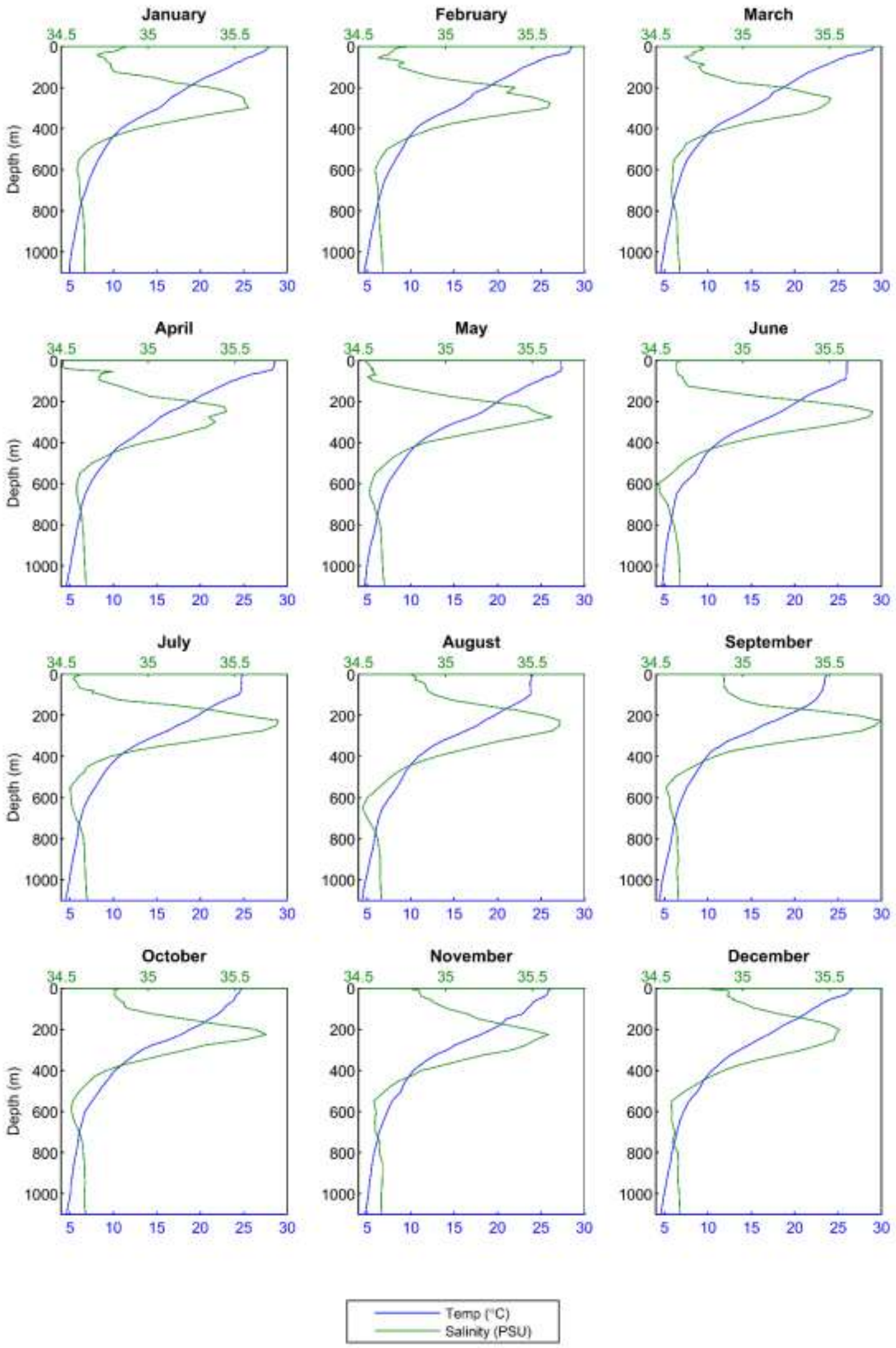

Figure 5.1 Monthly temperature and salinity profiles throughout the water column near the Mentorc-1 release location.

6 NEAR-FIELD MODEL – OILMAP DEEP

The plume dynamics due to the amalgamation of the condensate, gas and fluids during the loss of well control at the seabed was modelled using the advanced OILMAP-DEEP blowout model. The model simulates the plume rise dynamics in two phases, the initial jet phase and the buoyant plume phase. The initial jet phase governs the plume dynamics directly above the subsea release location and is predominantly driven by the exit velocity. During this phase, the condensate droplet size and distribution are calculated. Next, the rise dynamics are dominated by the buoyant nature of the plume until the termination of the plume phase (known as the trapping depth). At this point, the results from OILMAP-DEEP (including plume trapping depth, plume diameter and droplet size distribution) are integrated into the far-field model SIMAP to simulate the rise and dispersion of the condensate droplets. Figure 6.1 illustrates the various stages of an example blowout plume.

More details on the OILMAP-DEEP model, can be found in Spaulding et al. (2015). The model has been validated against observations from Deepwater Horizon as well as small and large-scale laboratory studies on subsurface oil releases (Brandvik et al 2013, 2014; Belore 2014; Spaulding et al. 2015; Li et al. 2017).

Table 6.1 presents the near-field model input parameters and key results used in the SIMAP far-field model. The modelling showed that in the event of a blowout from the Mentorc-1 well, the gas/liquid will propel the condensate upward from the seabed (i.e. 1,000 m depth) to approximately 600 m below the sea surface corresponding to the plume trapping depth. From this point onward, the condensate droplets will be subject to their own buoyancy and the varying oceanographic conditions. The model predicted condensate droplet sizes to range from 134 µm to 578 µm. The larger droplets in this study (above 200 µm) would rise to the surface, spread and evaporate over time. The smaller droplets (less than 200 µm) were predicted to rise toward the surface though re-entrain more readily due to the prevailing conditions back in the water column and decay overtime.

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Table 6.1 Input characteristics and key results from the subsea modelling.

Input Variable	Value
Scenario	Scenario 1
Location name	Mentorc-1
Water depth (m)	1,000
Tubing diameter (inch) [m]	12.25 [0.31]
Condensate rate (stb/day)	22,542
Water rate (stb/day)	233
Gas rate (MMscf/day)	670
Condensate to gas ratio (bbl/MMscf)	34.5
Gas to total liquids ration (scf/bbl)	29,418
Reservoir temperature (°C)	70
Release pressure (psia)	3,553
Key Results	
Plume execution depth (m BMSL)	600
Droplet sizes (µm)	134-578

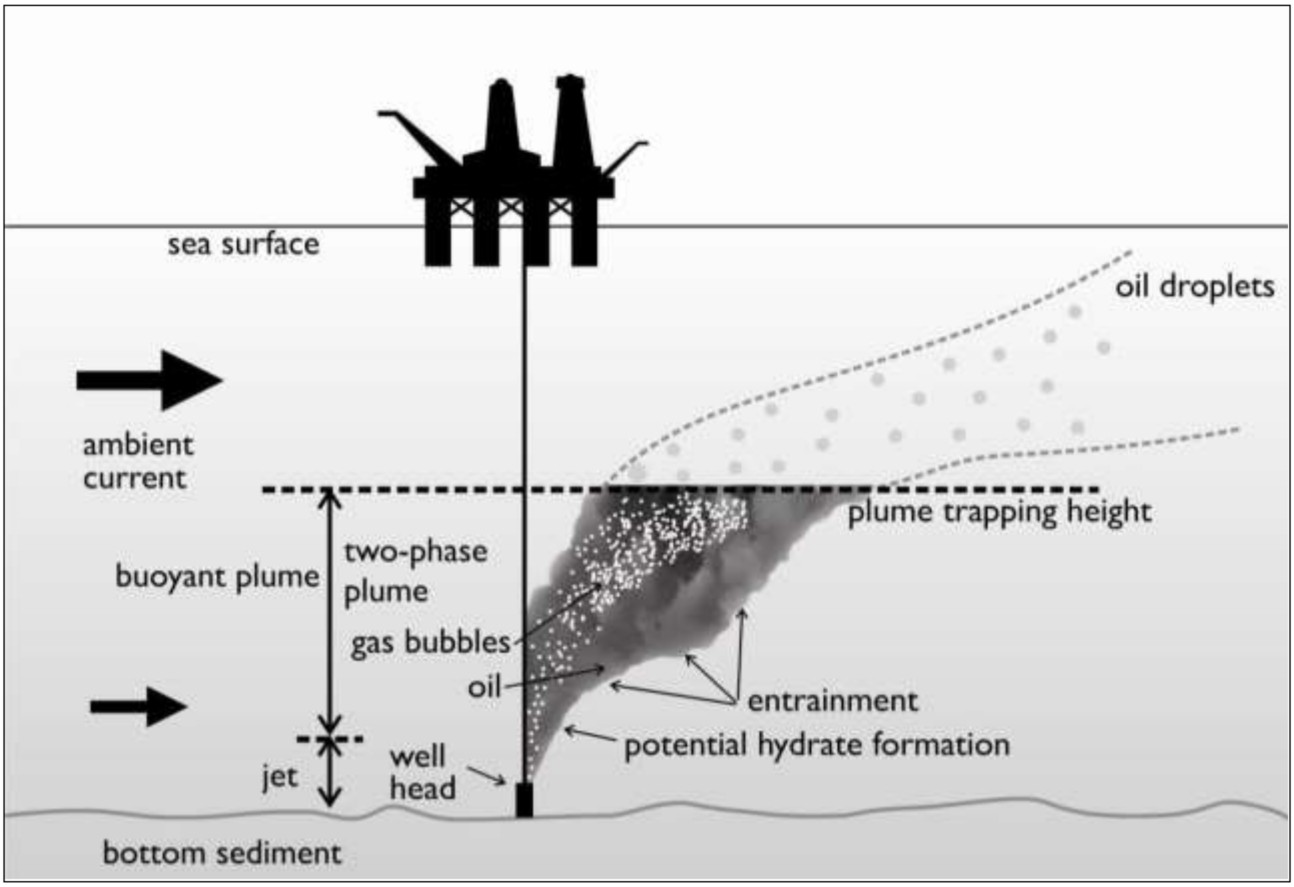

Figure 6.1 Example of a blowout plume illustrating the various stages of the plume in the water column (Source: Applied Science Associates, 2011).

7 OIL SPILL MODEL – SIMAP

Modelling of the fate of oil was performed using the Spill Impact Mapping Analysis Program (SIMAP). SIMAP is designed to simulate the fate and effects of spilled hydrocarbons for both the surface and subsurface releases (Spaulding et al. 1994; French et al. 1999; French-McCay, 2003, 2004; French-McCay et al. 2004).

SIMAP has been used to predict the weathering and fate of oil spills during and after major incidents including: Montara (Australia) well blowout August 2009 in the Timor Sea (Asia-Pacific ASA, 2010); Macondo (USA) well blowout April 2010 in the Gulf of Mexico; Bohai Bay (China) oil spill August 2011; and the pipeline oil spill July 2013 in the Gulf of Thailand

The SIMAP model calculates the transport, spreading, entrainment, evaporation and decay of surface hydrocarbon slicks as well as the entrained and dissolved oil components in the water column, either from surface slicks or from oil discharged subsea. The movement and weathering of the spilled oil is calculated for specific oil types. Input specifications for oil mixtures include the density, viscosity, pour point, distillation curve (volume lost versus temperature) and the aromatic/aliphatic component ratios within given boiling point ranges.

SIMAP is a three-dimensional model that allows for various response actions to be modelled including oil removal from skimming, burning, or collection booms, and surface and subsurface dispersant application.

The SIMAP model includes advanced weathering algorithms, specifically focussed on unique oils that tend to form emulsions and/or tar balls. The weathering algorithms are based on 5 years of extensive research conducted in response to the Deepwater Horizon oil spill in the Gulf of Mexico (French et al., 2015).

Biodegradation is included in the oil spill model. In the model, SIMAP, degradation is calculated for the surface slick, deposited oil on the shore, the entrained oil and dissolved constituents in the water column, and oil in the sediments. For surface oil, water column oil, and sedimented oil a first order degradation rate is specified. Biodegradation rates are relatively high for hydrocarbons in dissolved state or in dispersed small droplets.

7.1 Stochastic Modelling

Stochastic modelling involves running numerous individual oil spill simulations using a range of prevailing wind and current conditions that are historically representative of the season and location of where the spill event may occur. Stochastic oil spill modelling is created by overlaying a great number (often 100 hundred) simulated hypothetical oil spills. As part of this study, 300 oil spills were simulated for each season using the same spill information (release location, spill volume, duration and oil type) but with varied start dates and times corresponding to the period represented by the available wind and current data. Once the simulations were complete, the results were overlaid (NOPSEMA, 2018, Figure 7.1) to determine the following on seasonal basis:

- Exposure load (concentrations and volumes);
- Minimum time before exposure;
- Probability of contact above defined concentrations;
- Volume of oil that may strand on shorelines from any single simulation;
- Concentration that might occur on sections of individual shorelines;
- Instantaneous exposure to dissolved hydrocarbons in the water column; and
- Instantaneous exposure to entrained hydrocarbons in the water column.

Figure 7.1 Predicted movement of four single oil spill simulations by SIMAP for the same scenario (left image). All model runs are overlain (shown as the stacked runs on the right) and the number of times that trajectories contact a given location at a concentration is used to calculate the probability (Source: NOPSEMA, 2018).

7.2 Sea-Surface, Shoreline and In-Water Thresholds

The thresholds and their relationship to exposure for the sea surface, shoreline and water column (entrained and dissolved hydrocarbons) are presented in Sections 7.2.1 to 7.2.3. Supporting justifications of the adopted thresholds applied during the study and additional context relating to the area of influence are also provided. It is important to note that the thresholds herein are based on NOPSEMA (2019).

7.2.1 Sea-surface Exposure Thresholds

The modelling results can be presented to any levels; therefore, thresholds have been specified (based on scientific literature) to record oil exposure to the sea-surface at meaningful levels only, described in the following paragraphs.

The lowest threshold to better assess the potential for sea surface exposure, was 1 g/m^2, which equates approximately to an average thickness of 1 µm, referred to as visible oil. Oil of this thickness is described as rainbow sheen in appearance, according to the Bonn Agreement Oil Appearance Code (Bonn Agreement 2009) (see Table 7.1). Figure 7.2 shows photographs highlighting the difference in appearance between a silvery sheen, rainbow sheen and metallic sheen. This threshold is considered below levels which would cause environmental harm and it is more indicative of the areas perceived to be affected due to its visibility on the sea surface and potential to trigger temporary closures of areas (i.e. fishing grounds) as a precautionary measure. Table 7.1 provides a description of the appearance in relation to exposure zone thresholds used to classify the zones of sea surface exposure.

Ecological impact has been estimated to occur at 10 g/m^2 (a film thickness of approximately 10 µm or 0.01 mm) according to French et al. (1996) and French-McCay (2009) as this level of fresh oiling has been observed to mortally impact some birds through adhesion of oil to their feathers, exposing them to secondary effects such as hypothermia. The appearance of oil at this average thickness has been described as a metallic sheen (Bonn Agreement, 2009). Concentrations above 10 g/m^2 is also considered the lower actionable threshold, where oil may be thick enough for containment and recovery as well as dispersant treatment (AMSA, 2015).

Scholten et al. (1996) and Koops et al. (2004) indicated that at oil concentrations on the sea surface of 25 g/m^2 (or greater), would be harmful for all birds that have landed in an oil film due to potential contamination of their feathers, with secondary effects such as loss of temperature regulation and ingestion of oil through preening. The appearance of oil at this thickness is also described as metallic sheen (Bonn Agreement, 2009). For this study the high exposure threshold was set to 50 g/m^2 and above based on NOPSEMA (2019). This threshold can also be used to inform response planning.

Table 7.1 defines the thresholds used to classify the zones of sea surface exposure reported herein.

Table 7.1 The Bonn Agreement Oil Appearance Code.

Code	Description Appearance	Layer Thickness Interval (g/m^2 or µm)	Litres per km^2
1	Sheen (silvery/grey)	0.04 - 0.30	40 - 300
2	Rainbow	0.30 – 5.0	300 – 5,000
3	Metallic	5.0 – 50	5,000 – 50,000
4	Discontinuous True Oil Colour	50 – 200	50,000 – 200,000
5	Continuous True Oil Colour	≥ 200	≥ 200,000

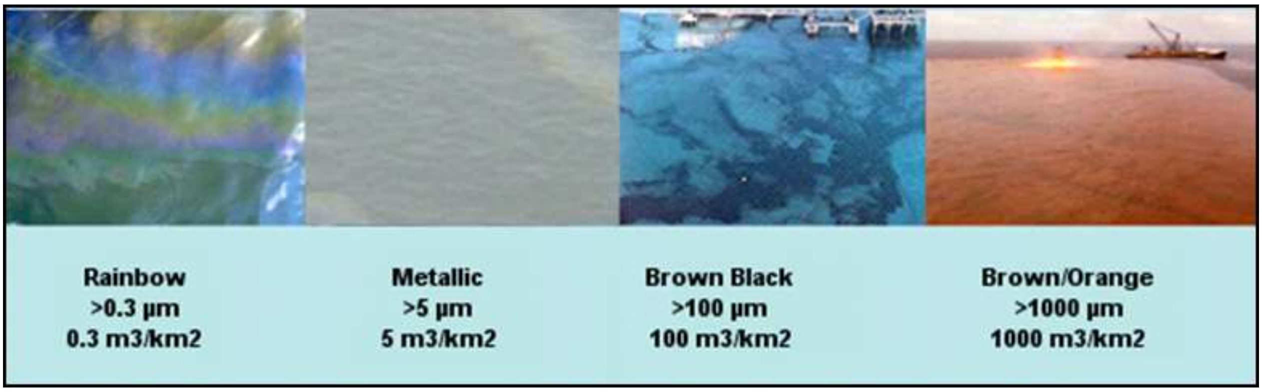

Figure 7.2 Photographs showing the difference between oil colour and thickness on the sea surface (source: adapted from OilSpillSolutions.org, 2015).

Table 7.2 Oil exposure thresholds on the sea surface as per NOPSEMA (2019).

Threshold level	Floating oil (g/m^2)	Appearance	Oil presence
Low	1	Rainbow to metallic sheen	¼ teaspoon to 2 teaspoons of oil every 1 m^2
Moderate	10	Metallic sheen	2 teaspoons to under 4 tablespoons of oil every 1 m^2
High	50	Metallic sheen to continuous true oil colour	> 4 tablespoon of oil every 1 m^2

7.2.2 Shoreline Contact Thresholds

There are many different types of shorelines, ranging from cliffs, rocky beaches, sandy beaches, mud flats and mangroves, and each of these influence the volume of oil that can remain stranded ashore and its thickness before the shoreline saturation point occurs. For instance, a sandy beach may allow oil to percolate through the sand, thus increasing its ability to hold more oil ashore over tidal cycles and various wave actions than an equivalent area of water; hence oil can increase in thickness onshore over time. A sandy beach shoreline was assumed as the default shoreline type for the modelling herein, as it allows for the highest carrying capacity of oil (of the available open/exposed shoreline types). Hence the results contained herein would be indicative of a worst-case scenario, where the highest volume of oil may be stranded on the shoreline (when compared to other shoreline types, such as exposed rocky shores).

In previous risk assessment studies, French-McCay et al. (2005a; 2005b) used a threshold of 10 g/m^2 to assess the potential for shoreline contact. This is a conservative threshold used to define regions of socio-economic impact, such as triggering temporary closures of adjoining fisheries or the need for shore clean-up on beaches or man-made features/amenities (breakwaters, jetties, marinas, etc.). It would equate to approximately two teaspoons of hydrocarbon per square meter of shoreline contacted. The appearance is described as a stain/film. On that basis, the 10 g/m^2 shoreline contact threshold has been selected to define the zone of potential “low shoreline contact”.

French et al. (1996) and French-McCay (2009) have defined a hydrocarbon exposure threshold for shorebirds and wildlife (furbearing aquatic mammals and marine reptiles) on or along the shore at 100 g/m^2, which is based on studies for sub-lethal and lethal impacts. This threshold has been used in previous environmental risk assessment studies (see French-McCay 2003; French-McCay et al. 2004, French-McCay et al. 2011; 2012; NOAA 2013). The 100 g/m^2 shoreline contact threshold is also recommended in the Australian Maritime Safety Authority’s (AMSA) foreshore assessment guide[1] as the acceptable minimum thickness that does not inhibit the potential for recovery and is best remediated by natural coastal processes alone (AMSA 2007). It equates to approximately ½ a cup of hydrocarbon per square meter of shoreline contacted. The appearance is described as a hydrocarbon coat. Therefore, 100 g/m^2 has been selected to define the zone of potential “moderate shoreline contact”.

Observations by Lin & Mendelssohn (1996), demonstrated that loadings of more than 1,000 g/m^2 of hydrocarbon during the growing season would be required to impact marsh plants significantly. Similar thresholds have been found in studies assessing hydrocarbon impacts on mangroves (Grant, Clarke & Allaway 1993; Suprayogi & Murray 1999). Hence, 1,000 g/m^2 has been selected to define the zone of potential “high shoreline contact”. It equates to approximately 1 litre of hydrocarbon per square meter of shoreline contacted. The appearance is described as a hydrocarbon cover.

It is worth noting that the shoreline contact thresholds derived from extensive literature review (outlined in Table 7.2) agree with the commonly used threshold values for oil spill modelling specified in NOPSEMA (2019).

Table 7.3 Thresholds used to assess shoreline contact.

Threshold level	Shoreline concentration (g/m^2)	Appearance	Oil presence
Low (socioeconomic/sublethal)	10 – 100	Stain/Film	2 tsp to ½ cup of oil every 1 m^2
Moderate	100* 1,000	Coat	~ ½ cup to >4 ¼ cups of oil every 1 m^2
High	> 1,000	Cover	>4 ¼ cups of oil every 1 m^2

* 100 g/m^2 also used to define the threshold for actionable shoreline oil.

7.2.3 In-water Exposure Thresholds

Oil is a mixture of thousands of hydrocarbons of varying physical, chemical, and toxicological characteristics, and therefore, demonstrate varying fates and impacts on organisms. As such, for in-water exposure, the SIMAP model provides separate outputs for dissolved and entrained hydrocarbons from oil droplets. The

[1] Recommended for shoreline typles including sandy beach, boulder shorelines, pebble shorelines, rock platforms and industry facility structures.

consequences of exposure to dissolved and entrained components will differ because they have different modes and magnitudes of effect.

Entrained hydrocarbon concentrations were calculated based on oil droplets that are suspended in the water column, though not dissolved. The composition of this oil would vary with the state of weathering (oil age) and may contain soluble hydrocarbons when the oil is fresh. Calculations for dissolved hydrocarbons specifically calculates oil components which are dissolved in water, which are known to be the primary source of toxicity exerted by oil.

7.2.3.1 Dissolved Hydrocarbons

Laboratory studies have shown that dissolved hydrocarbons exert most of the toxic effects of oil on aquatic biota (Carls et al., 2008; Nordtug et al., 2011; Redman, 2015). The mode of action is a narcotic effect, which is positively related to the concentration of soluble hydrocarbons in the body tissues of organisms (French-McCay, 2002). Dissolved hydrocarbons are taken up by organisms directly from the water column by absorption through external surfaces and gills, as well as through the digestive tract. Thus, soluble hydrocarbons are termed “bioavailable”.

Hydrocarbon compounds vary in water-solubility and the toxicity exerted by individual compounds is inversely related to solubility, however bioavailability will be modified by the volatility of individual compounds (Nirmalakhandan & Speece, 1988; Blum & Speece, 1990; McCarty, 1986; McCarty et al., 1992a, 1992b; Mackay et al., 1992; McCarty & Mackay, 1993; Verhaar et al., 1992, 1999; Swartz et al., 1995; French-McCay, 2002; McGrath et al., 2009). Of the soluble compounds, the greatest contributor to toxicity for water-column and benthic organisms are the lower-molecular-weight aromatic compounds, which are both volatile and soluble in water. Although they are not the most water-soluble hydrocarbons within most oil types, the polynuclear aromatic hydrocarbons (PAHs) containing 2-3 aromatic ring structures typically exert the largest narcotic effects because they are semi-soluble and not highly volatile, so they persist in the environment long enough for significant accumulation to occur (Anderson et al., 1974, 1987; Neff & Anderson, 1981; Malins & Hodgins, 1981; McAuliffe, 1987; NRC, 2003). The monoaromatic hydrocarbons (MAHs), including the BTEX compounds (benzene, toluene, ethylbenzene, and xylenes), and the soluble alkanes (straight chain hydrocarbons) also contribute to toxicity, but these compounds are highly volatile, so that their contribution will be low when oil is exposed to evaporation and higher when oil is discharged at depth where volatilisation does not occur (French-McCay, 2002).

French-McCay (2002) reviewed available toxicity data, where marine biota was exposed to dissolved hydrocarbons prepared from oil mixtures, finding that 95% of species and life stages exhibited 50% population mortality (LC_{50}) between 6 and 400 ppb total PAH concentration after 96 hrs exposure, with an average of 50 ppb. Hence, concentrations lower than 6 ppb total PAH value should be protective of 97.5% of species and life stages even with exposure periods of days (at least 96 hours). Early life-history stages of fish appear to be more sensitive than older fish stages and invertebrates.

Exceedances of 10, 50 or 400 ppb over a 1-hour timestep (see Table 7.4) was applied to indicate increasing potential for sub-lethal to lethal toxic effects (or low to high), based on NOPSEMA (2019).

7.2.3.2 Entrained Hydrocarbons

Entrained hydrocarbons consist of oil droplets that are suspended in the water column and insoluble. As such, insoluble compounds in oil cannot be absorbed from the water column by aquatic organisms, hence are not bioavailable through absorption of compounds from the water. Exposure to these compounds would require routes of uptake other than absorption of soluble compounds. The route of exposure of organisms to whole oil alone include direct contact with tissues of organisms and uptake of oil by direct consumption, with potential for biomagnification through the food chain (NRC, 2005).

The 10-ppb threshold represents the very lowest concentration and corresponds generally with the lowest trigger levels for chronic exposure for entrained hydrocarbons in the ANZECC (2000) water quality guidelines. Due to the requirement for relatively long exposure times (> 24 hours) for these concentrations to be significant, they are likely to be more meaningful for juvenile fish, larvae and planktonic organisms that might be entrained (or otherwise moving) within the entrained plumes, or when entrained hydrocarbons adhere to organisms or trapped against a shoreline for periods of several days or more.

This exposure zone is not considered to be of significant biological impact and is therefore outside the adverse exposure zone. This exposure zone represents the area contacted by the spill. This area does not define the area of influence as it is considered that the environment will not be affected by the entrained hydrocarbon at this level.

Thresholds of 10 ppb and 100 ppb were applied over a 1-hour time exposure (Table 7.4), to cover the range of thresholds outlined in the ANZECC/ARMCANZ (2000) water quality guidelines, the incremental change for greater potential effect and is per NOPSEMA (2019).

A complicating factor that should be considered when assessing the consequence of dissolved and entrained oil distributions is that there will be some areas where both physically entrained oil droplets and dissolved hydrocarbons co-exist. Higher concentrations of each will tend to occur close to the source where sea conditions can force mixing of relatively unweathered oil into the water column, resulting in more rapid dissolution of soluble compounds.

Table 7.4 Dissolved and entrained hydrocarbon exposure values assessed over a 1-hour time step, as per NOPSEMA (2019).

Threshold level	Dissolved hydrocarbon concentration (ppb)	Entrained hydrocarbon concentrations (ppb)
Low	10	10
Moderate	50	NA
High	400	100

8 OIL PROPERTIES

Table 8.1 and Table 8.2 present the physical properties and boiling point ranges of Mentorc condensate used for the loss of well control scenario (Scenario 1) and Marine Gas Oil (MGO) used for the vessel collision scenario.

Table 8.1 Physical properties of oil types used in this study.

Characteristic	Mentorc Condensate	Marine Gas Oil (MGO)
Density (kg/m^3)	728 (at 15 °C)	830 (at 15 °C)
API	62.8	36.4
Dynamic viscosity (cP)	0.5	4
Pour point (°C)	-100	-36
Hydrocarbon property category	Group I	Group II
Hydrocarbon property classification	Non - Persistent	Light – Persistent

Table 8.2 Boiling point ranges of the oil types used in this study.

Characteristics	Non-Persistent			Persistent
	Volatile (%)	*Semi-volatile (%)*	*Low-volatility (%)*	*Residual (%)*
Boiling point (°C)	*<180*	*180-265*	*265-380*	*>380*
Mentorc Condensate	51.7	32.1	12.1	4.1
MGO	16.4	49	31.9	2.7

8.1 Mentorc Condensate

Mentorc condensate has a density of 728 kg/m^3 (API of 62.8), dynamic viscosity of 0.5 cP at 15°C and a low pour point (-100°C). Up to 69% of the hydrocarbon would evaporate over the first few hours or day, with up to 83% evaporated after a few days when on the sea surface. Only 4% of the condensate is considered persistent, which would eventually breakdown due to the decay. These properties classify the condensate as a group I oil (or non-persistent oil), according to the International Tanker Owners Pollution Federation (ITOPF, 2014), and it is expected to readily evaporate once on the sea surface. The classification is based on the specific gravity of hydrocarbons in combination with relevant boiling point ranges.

Figure 8.1 shows weathering for Mentorc-1 condensate. At the conclusion of the simulation (day-141), approximately 1,976,743 bbl (72%) spilled oil was lost to the atmosphere through evaporation. Approximately 645,504 bbl (24%) of the condensate was predicted to have decayed, while approximately 104,561 bbl (4%) was predicted to remain within the water column and no condensate was predicted to accumulate on the shorelines.

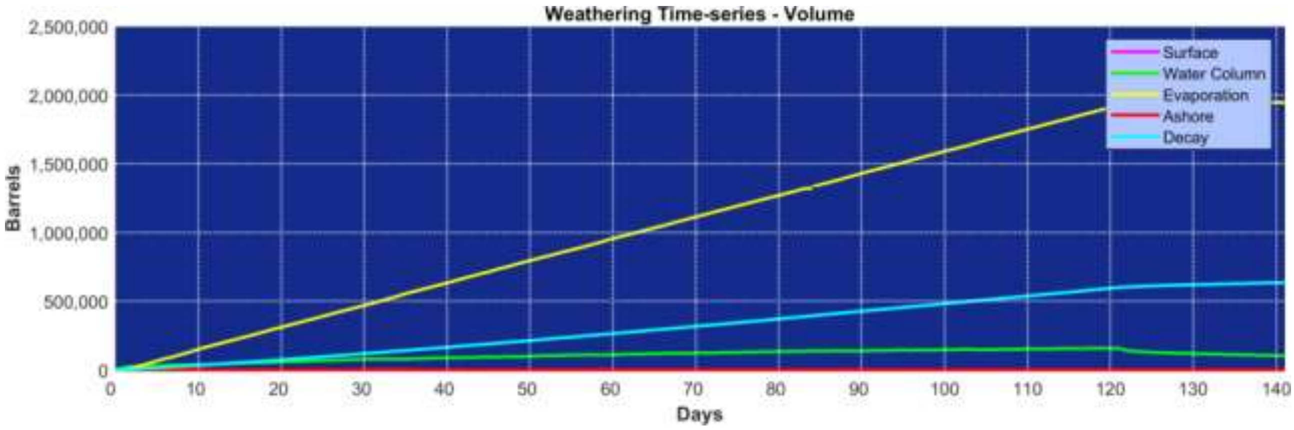

Figure 8.1 Weathering of Mentorc condensate for the trajectory resulting in the largest swept area above 10 g/m^2 on the sea surface. The results are based on a 2,727,570 bbl (22,542 bbl/day) subsea release of Mentorc condensate over 121 days, tracked for 141 days.

8.2 Marine Gas Oil

Marine gas oil (MGO) has a density of 830 kg/m^3 (API gravity of 36.4), a pour point of -36°C and a dynamic viscosity of 4 cP at 25°C. This oil is likely to spread quickly when spilt at sea and thin out to low thickness levels; which increases the rate of evaporation. Due to its chemical composition, up to 65% will generally evaporate over the first two days depending upon the prevailing conditions and spill volume. Approximately 2.7% of the oil is considered “persistent hydrocarbons”, which are unlikely to evaporate. These properties classify it as a group II oil (light persistence) according to ITOPF (2014).

Figure 8.2 shows weathering graphs for a 1,000 m^3 release of MGO over 6 hours (tracked for 40 days) during three static wind conditions. The prevailing weather conditions will influence the weathering and fate of the MGO. Under low (5 knots) wind-speeds, the MGO will remain on the surface longer, forming a moderately thick film on the sea surface while sustained stronger winds (>10 knots) will generate breaking waves at the surface, causing a higher volume to be entrained into the water column, hence increasing the amount available to degradation and reducing the amount available to evaporation.

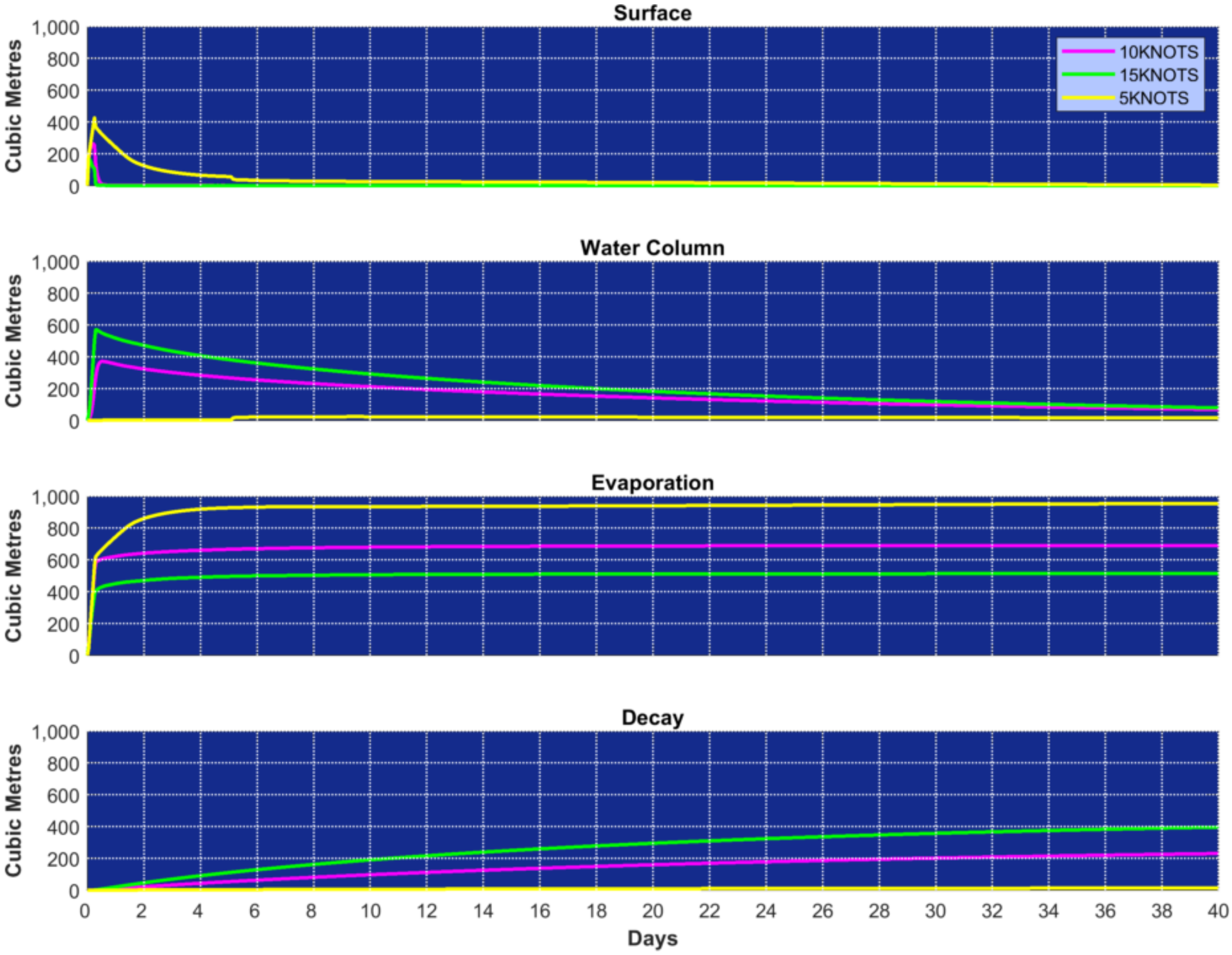

Figure 8.2 Weathering of MGO under three static wind conditions (5, 10 and 15 knots). The results are based on a 1,000 m^3 surface release of MGO over 6 hours and tracked for 40 days.

9 MODEL SETTINGS

Table 9.1 provides a summary of the oil spill model settings.

Table 9.1 Summary of the oil spill model settings used in this assessment.

Input Parameters	Scenario 1	Scenario 2	
Scenario Description	Blowout at Mentorc-1 Well	Vessel collision along the pipeline route straddling the State/Commonwealth boundary	Vessel collision along the pipeline route straddling the State/Commonwealth boundary
Location Name	Mentorc-1	Point 1	Point 4
Geographic location (WGS 84)	20º 29' 21.9" S, 113º 32' 13.2" E	21º 31' 22.59" S, 114º 35' 4.69" E	21º 23' 44.29' S, 114º 48' 53.70" E
Number of randomly selected spill start times per season	100 (300 total)	100 (300 total)	100 (300 total)
Oil type	Mentorc condensate	Marine Gas Oil	
Daily flow rate	~22,542 bbl/day	-	
Total volume released	2,727,570 bbl	1,000 m^3	
Release duration	121 days	6 hours	
Release depth	1,000 m	surface	
Simulation length	141 days	40 days	
Seasons assessed	Summer (September to the following March) Transitional period (April and August) Winter (May to July)		
Surface thresholds (g/m^2)	1 (low exposure) 10 (moderate exposure) 50 (high exposure)		
Shoreline accumulation thresholds (g/m^2)	10 (low potential exposure) 100 (moderate potential exposure) 1,000 (high potential exposure)		
Dissolved hydrocarbon exposure thresholds (ppb)	10 (10 ppb x 1 hr, potential low exposure) 50 (50 ppb x 1 hrs, potential moderate exposure) 400 (400 ppb x 1 hrs, potential high exposure)		
Entrained hydrocarbon exposure thresholds (ppb)	10 (10 ppb x 1 hr, potential low exposure) 100 (100 ppb x 1 hr, potential high exposure)		

10 PRESENTATION AND INTERPRETATION OF MODEL RESULTS

The results from the modelling study are presented in a number of tables and figures, which aim to provide an understanding of the predicted sea-surface and water column (subsurface) exposure and shoreline contact (if predicted).

10.1 Annual Analysis

10.1.1 Figures

The figures are based on the following principles:

- The ***potential zones of exposure (surface oil, entrained and dissolved hydrocarbons)*** – is determined by identifying the maximum loading (surface) or exposure (in-water) within a grid cell and is then classified according to identified surface or subsea thresholds.
- The ***probability of exposure/contact (surface oil, shoreline oil, entrained and dissolved hydrocarbons)*** – is calculated by dividing the number of spill trajectories passing over that given cell (surface, shoreline or subsea) by the total number of spill trajectories, above the specified threshold value.
- The ***maximum potential shoreline loading*** – is determined by identifying the maximum loading within a shoreline cell and is then classified according to the identified thresholds (i.e. 10 g/m^2, 100 g/m^2 and 1,000 g/m^2).
- The ***dissolved and entrained hydrocarbon concentration*** – is determined by recording the maximum instantaneous concentrations (i.e. exposure over the model 1-hour timestep) at each grid cell.

10.1.2 Statistics

The statistics are based on the following principles:

- The ***greatest distance travelled by a spill trajectory*** – is determined by a) recording the maximum and b) second greatest distance travelled (or 99th percentile) by a single trajectory, within a scenario, from the release location to the identified exposure thresholds.
- The ***probability of oil exposure to a receptor*** – is determined by recording the number of spill trajectories to reach a specified sea surface or subsea threshold within a receptor polygon, divided by the total number of spill trajectories within that scenario.
- The ***minimum time before oil exposure to a receptor*** – is determined by ranking the elapsed time before sea surface exposure, at a specified threshold, to grid cells within a receptor polygon and recording the minimum value.
- The ***probability of oil contact to a receptor*** – is determined by recording the number of spill trajectories to reach a specified shoreline contact threshold within a receptor polygon, divided by the total number of spill trajectories within that scenario.
- The ***maximum potential oil loading within a receptor*** – is determined by identifying the maximum loading to any grid cell within a receptor polygon, for a scenario.

10.2 Deterministic Trajectories

The modelling results were assessed for each scenario (and release point) and the "worst case" deterministic runs were identified based on the largest volume of oil ashore (if shoreline contact was predicted for the given scenario) or the area of oil exposure on the sea surface above 10 g/m^2 (actionable sea surface oil).

10.3 Sensitive Receptors Assessed

A range of environmental receptors and shorelines were assessed for sea surface exposure, shoreline contact and water column exposure as part of the study (see Table 10.1). The receptors are geographically represented in Figure 10.1 to Figure 10.9.

The Pilbarra (Offshore) Integrated Marine and Coastal Regionalisation of Australia (IMCRA) is not presented in tabulated results as the release locations for Scenario 2 reside within the receptors boundary and therefore will always record a 100% probability of exposure.

Additionally, the Exmouth Plateau Key Ecological Feature (KEF) was excluded from tabulated results for Scenario 1.

Table 10.1 Summary of receptors used to assess surface, shoreline and in-water exposure to hydrocarbons.

Receptor category	Acronym	Hydrocarbon exposure assessment		
		Water column	Sea surface	Shoreline
Australian Marine Park	AMP	✓	✓	✗
National/Marine Park also includes: Indigenous Protected Area & Marine Management Area	NP & MP IPA & MMA	✓	✓	✗
Nature Reserves	NR	✓	✓	✗
RAMSAR	RAMSAR	✓	✓	✗
Integrated Marine and Coastal Regionalisation of Australia	IMCRA	✓	✓	✗
Interim Biogeographic Regionalisation of Australia	IBRA	✓	✓	✓
Key Ecological Feature	KEF	✓	✓	✗
Reefs, Shoals and Banks	RSB	✓	✓	✗
Shoreline	Shore	✗	✓ (reported as nearshore waters)	✓

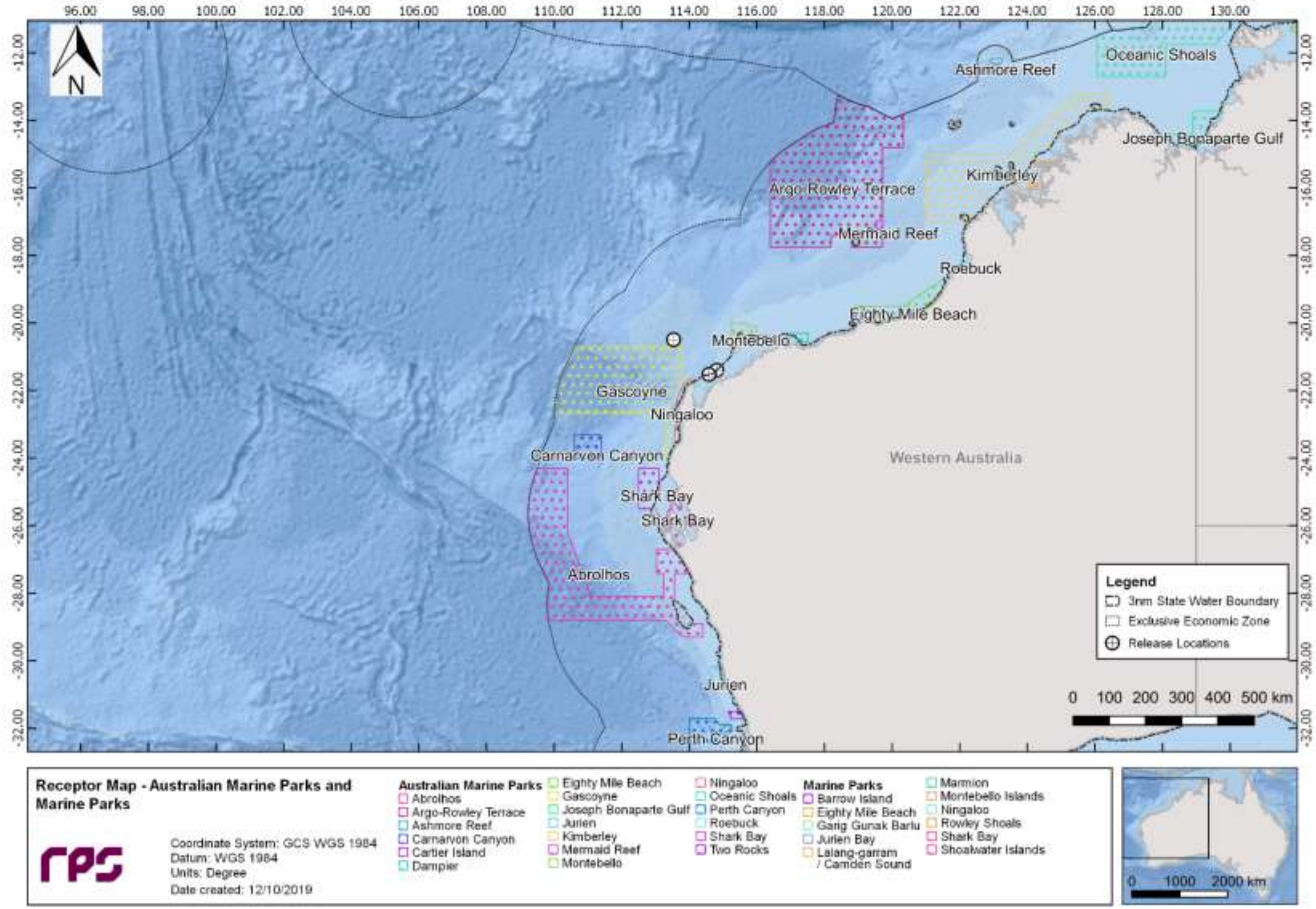

Figure 10.1 Receptor map for Australian Marine Parks (AMP) and Marine Parks (MP).

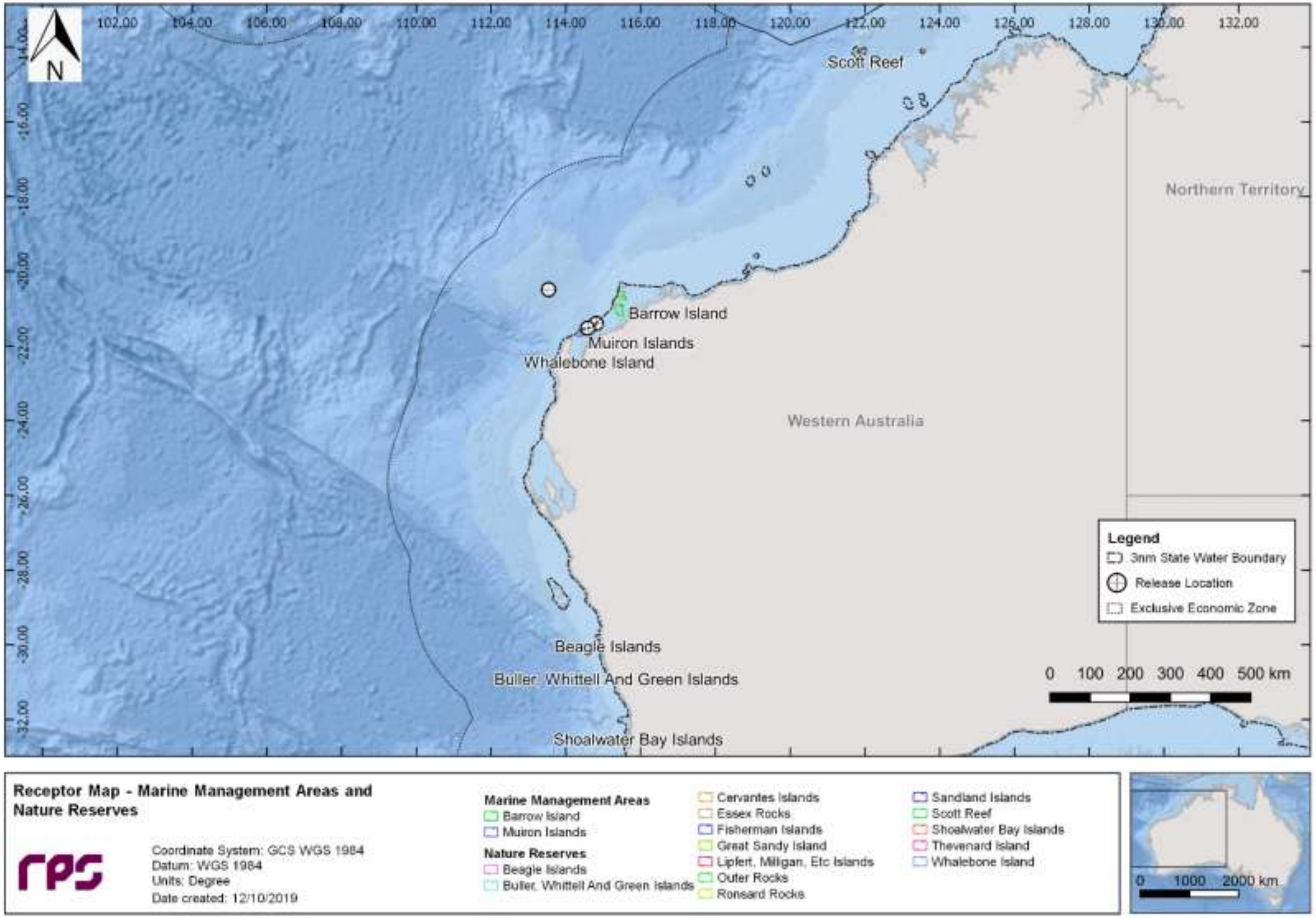

Figure 10.2 Receptor map for Marine Management Areas (MMA) and Nature Reserves (NR).

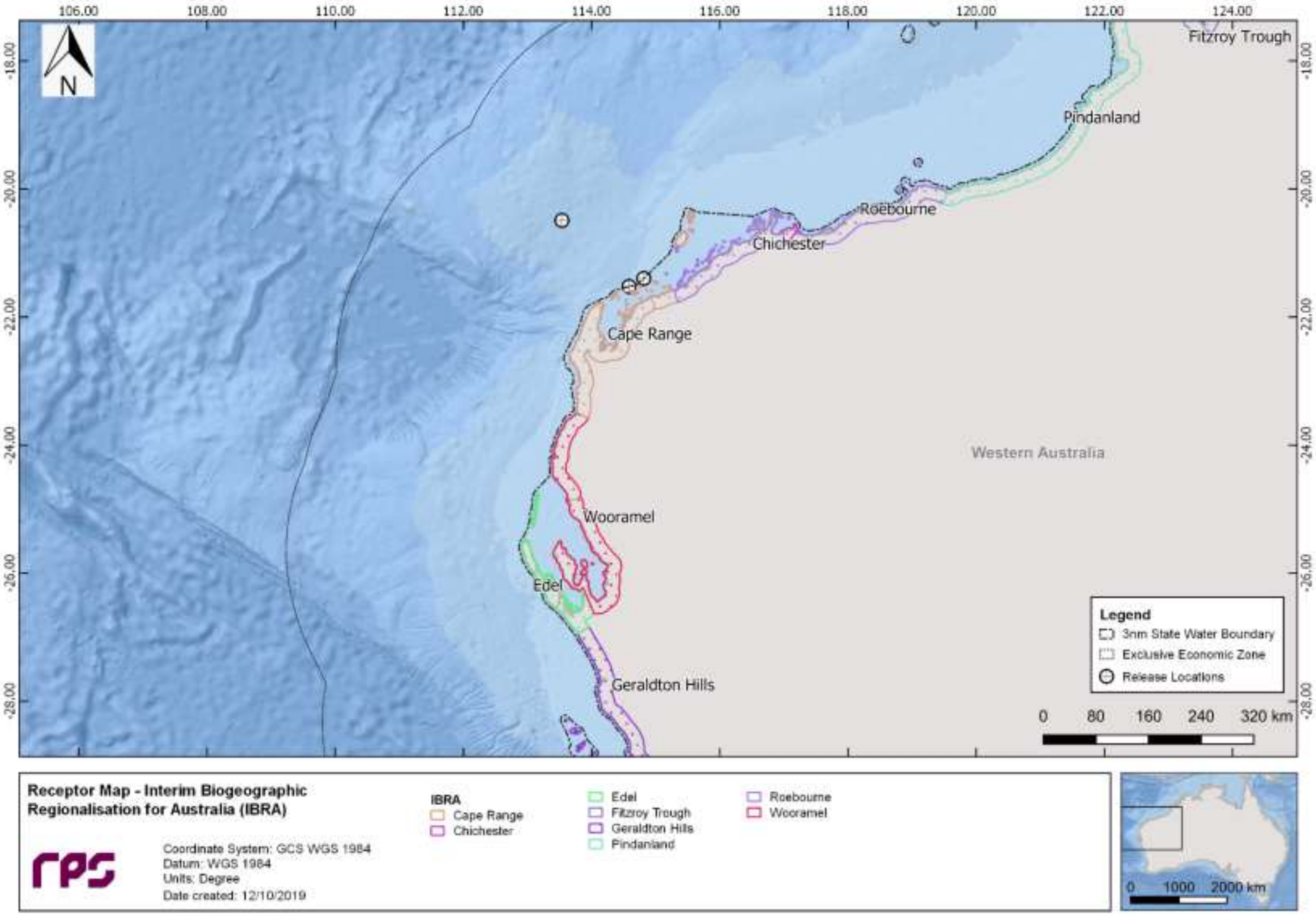

Figure 10.3 Receptor map for Interim Biogeographic Regionalisation for Australia (IBRA).

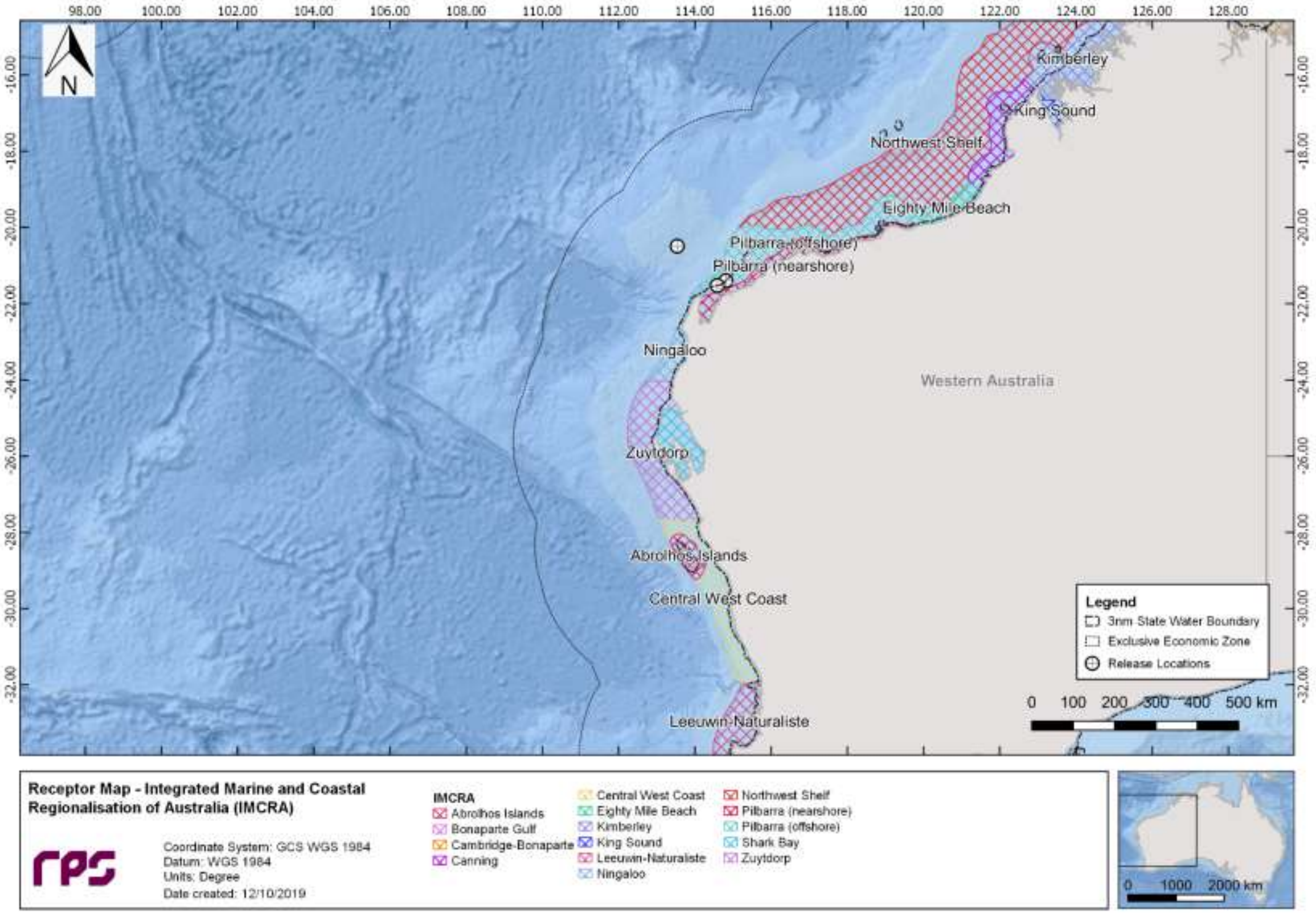

Figure 10.4 Receptor map for Integrated Marine and Coastal Regionalisation of Australia (IMCRA).

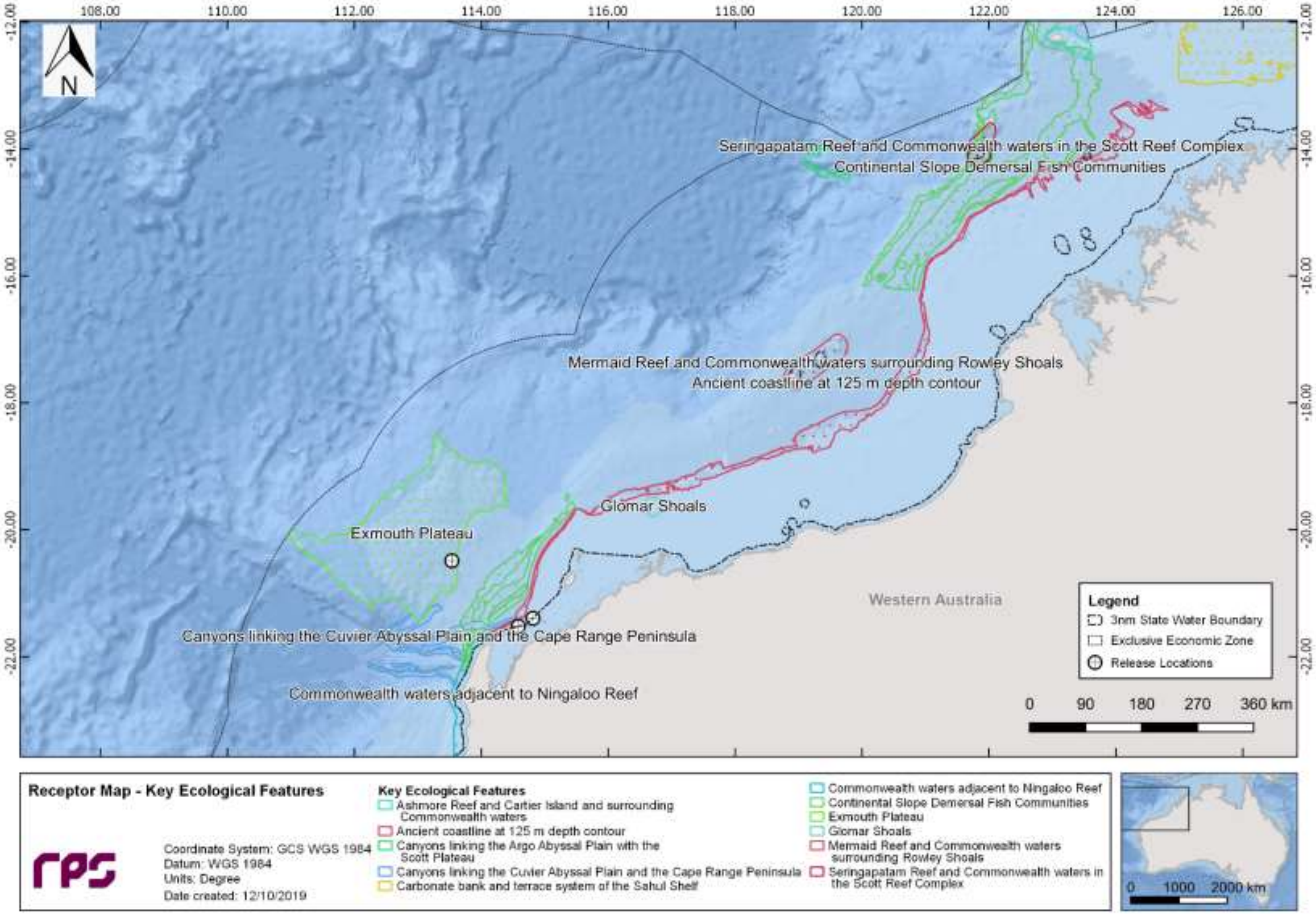

Figure 10.5 Receptor map for Key Ecological Features (KEF) (1 of 2).

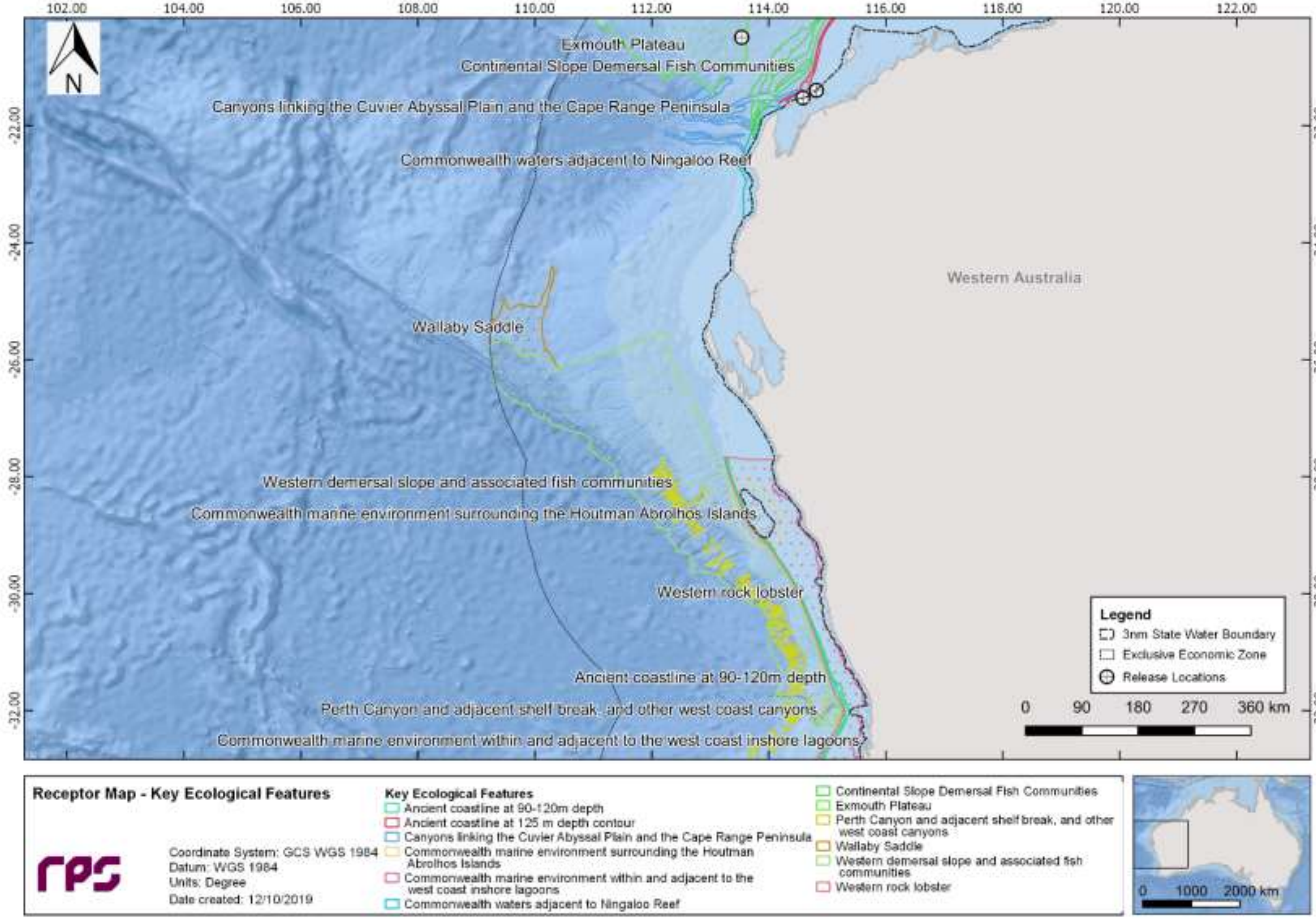

Figure 10.6 Receptor map for Key Ecological Features (KEF) (2 of 2).

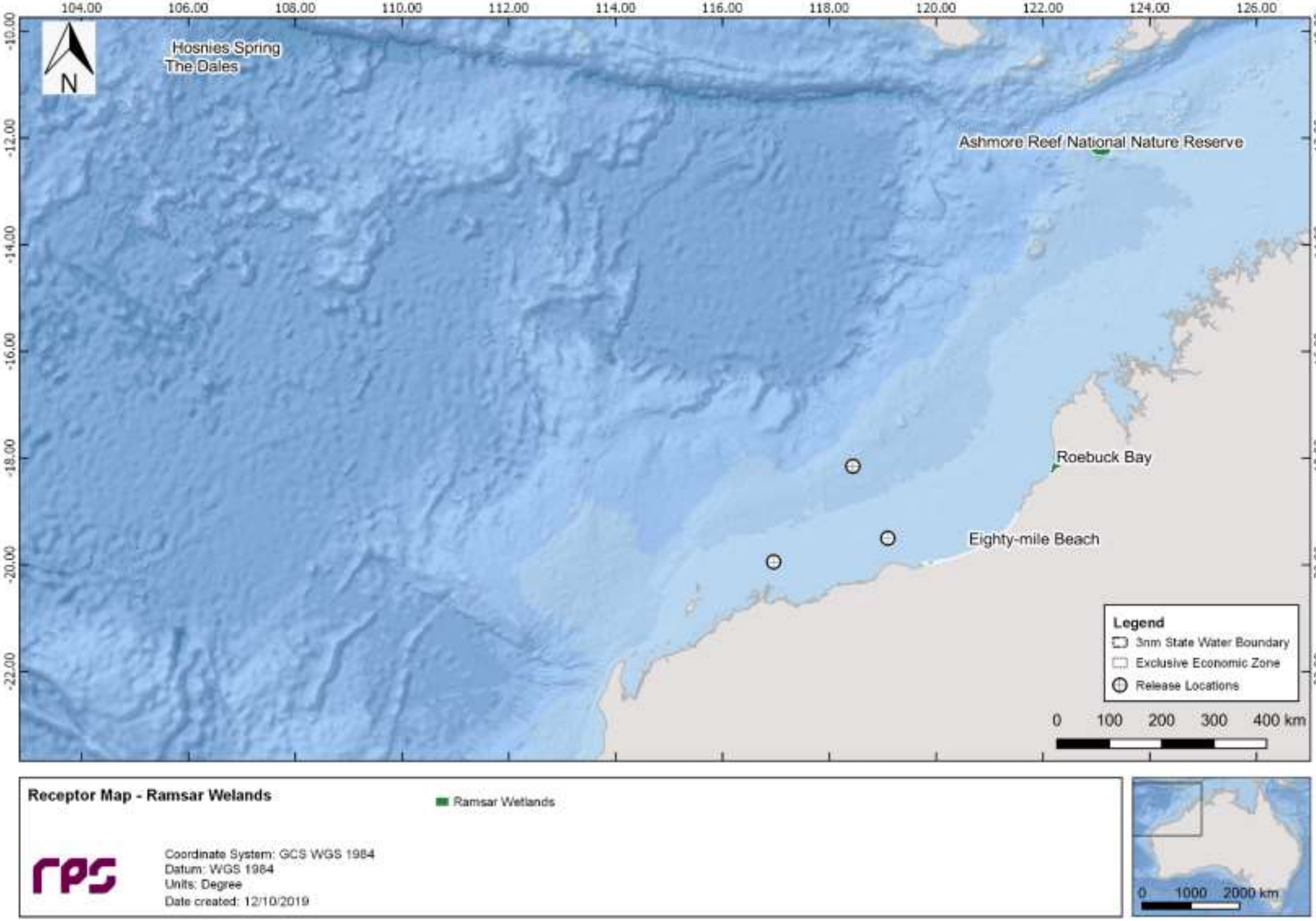

Figure 10.7 Receptor map for RAMSAR sites.

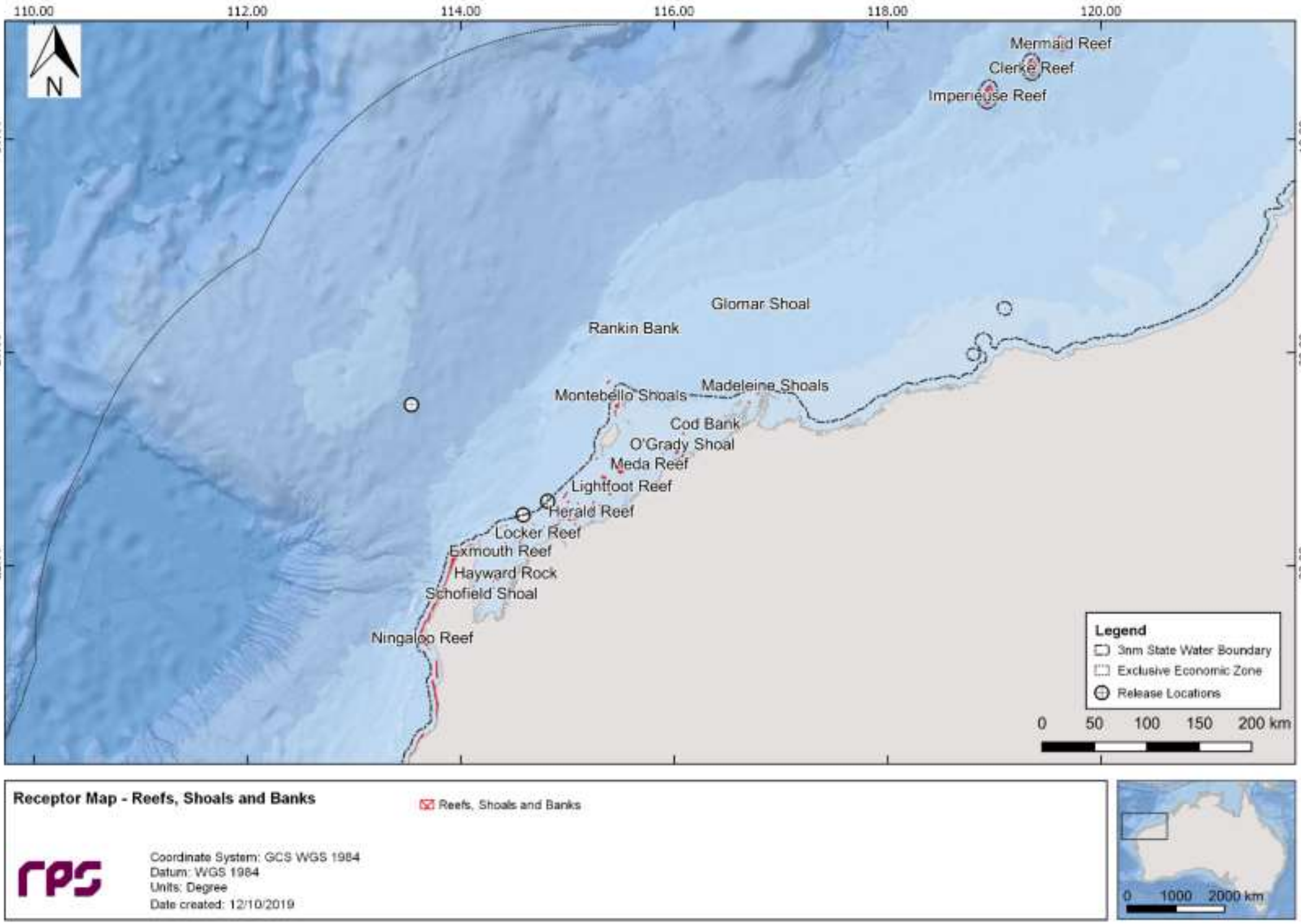

Figure 10.8 Receptor map for Reefs, Shoals and Banks (RSB).

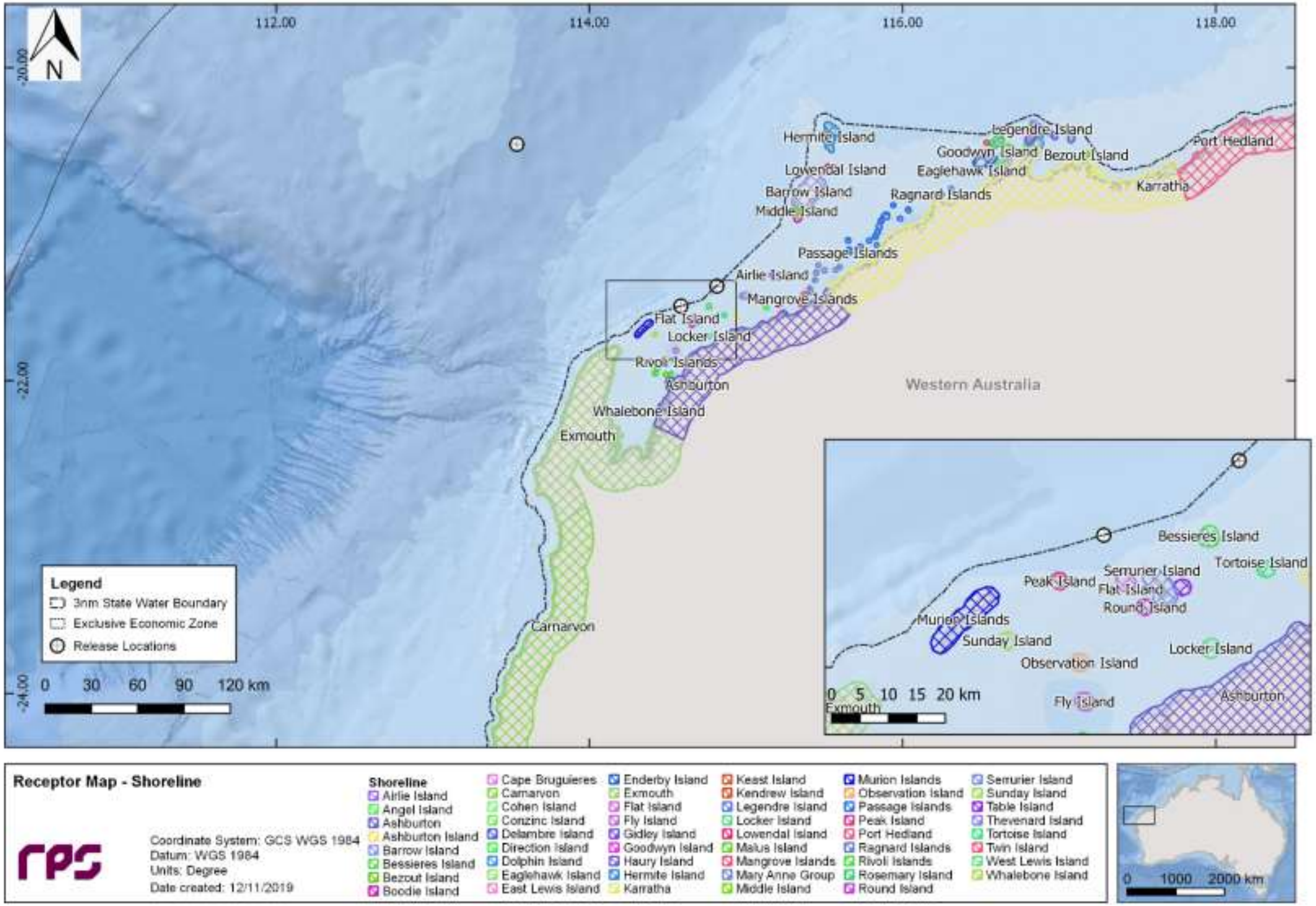

Figure 10.9 Receptor map for Shorelines.

11 RESULTS: SCENARIO 1: 2,727,570 BBL SUBSEA RELEASE OF CONDENSATE AT MENTORC-1

This scenario examined a 2,727,570 bbl (22,542 bbl/day) subsea release of Mentorc condensate over 121 days, tracked for 141 days. A total of 300 spill trajectories were simulated across three seasons; summer, transitional and winter (i.e. 100 spills per season).

Section 11.1 presents the seasonal stochastic analysis and Section 11.2 presents the deterministic results.

11.1 Seasonal analysis

11.1.1 Sea Surface Exposure

Table 11.1 summarises the maximum distances from the release location to oil exposure zones on the sea surface for each season.

The maximum distance from the release location to the low (≥ 1 g/m^2), moderate (≥ 10 g/m^2) and high (≥ 50 g/m^2) exposure thresholds was 134.7 km north-northwest (transitional), 62.9 km south-southwest (summer) and 5.2 km south-southwest (transitional), respectively.

Table 11.2 presents the potential sea surface exposure to the two receptors during summer, transitional and winter conditions. Low sea surface exposure was predicted at the Gascoyne Australian Marine Park (AMP) and the Canyons linking the Cuvier Abyssal Plain and the Cape Range Peninsula Key Ecological Feature (Canyons KEF) during summer, transitional and winter conditions. At the Gascoyne AMP, predicted probabilities of low sea surface exposure ranged from 84% in summer to 93% in winter while the Canyons KEF recorded probabilities of low sea surface exposure ranging from 2% during transitional and winter conditions to 11% in summer.

Additionally, the Gascoyne AMP recorded probabilities of sea surface exposure at or above the moderate threshold with probabilities of 25% in summer, 33% during transitional conditions and 32% during winter.

Figure 11.1 to Figure 11.3 present the zones of sea surface exposure at the low, moderate and high thresholds in summer, transitional and winter conditions.

Note, the release location resides within the Exmouth Plateau KEF, hence it is not presented in the tabulated results.

Table 11.1 Maximum distance and direction from Mentorc-1 to oil exposure thresholds on the sea surface. Results are based on a 2,727,570 bbl (22,542 bbl/day) subsea release of Mentorc condensate over 121 days, tracked for 141 days during all seasonal conditions. The results were calculated from 100 spill trajectories per season.

Season	Distance and direction	Zones of potential sea surface exposure		
		Low	Moderate	High
Summer	Max. distance from release site (km)	129.2	62.9	4.8
	Max distance from release site (km) (99th percentile)	79.5	40.1	4.8
	Direction	SSW	SSW	NE
Transitional	Max. distance from release site (km)	134.7	47.9	5.2
	Max distance from release site (km) (99th percentile)	75.6	39.7	5.2
	Direction	NNW	SE	SSW
Winter	Max. distance from release site (km)	125.1	52.6	5.0
	Max distance from release site (km) (99th percentile)	73.1	40.5	5.0
	Direction	NNW	S	SW

Table 11.2 Summary of the potential sea surface exposure to individual receptors. Results are based on a 2,727,570 bbl (22,542 bbl/day) subsea release of Mentorc condensate over 121 days, tracked for 141 days during all seasonal conditions. The results were calculated from 100 spill trajectories per season.

Season	Receptor		Probability of oil exposure on the sea surface (%)			Minimum time before oil exposure on the sea surface (days)		
			Low	Moderate	High	Low	Moderate	High
Summer	AMP	Gascoyne	84	25	-	1.25	3.96	-
	KEF	Canyons linking the Cuvier Abyssal Plain and the Cape Range Peninsula (Canyons)	11	-	-	21.71	-	-
Transitional	AMP	Gascoyne	91	33	-	1.08	2.58	-
	KEF	Canyons linking the Cuvier Abyssal Plain and the Cape Range Peninsula (Canyons)	2	-	-	4.25	-	-
Winter	AMP	Gascoyne	93	32	-	2.83	8.67	-
	KEF	Canyons linking the Cuvier Abyssal Plain and the Cape Range Peninsula (Canyons)	2	-	-	48.83	-	-

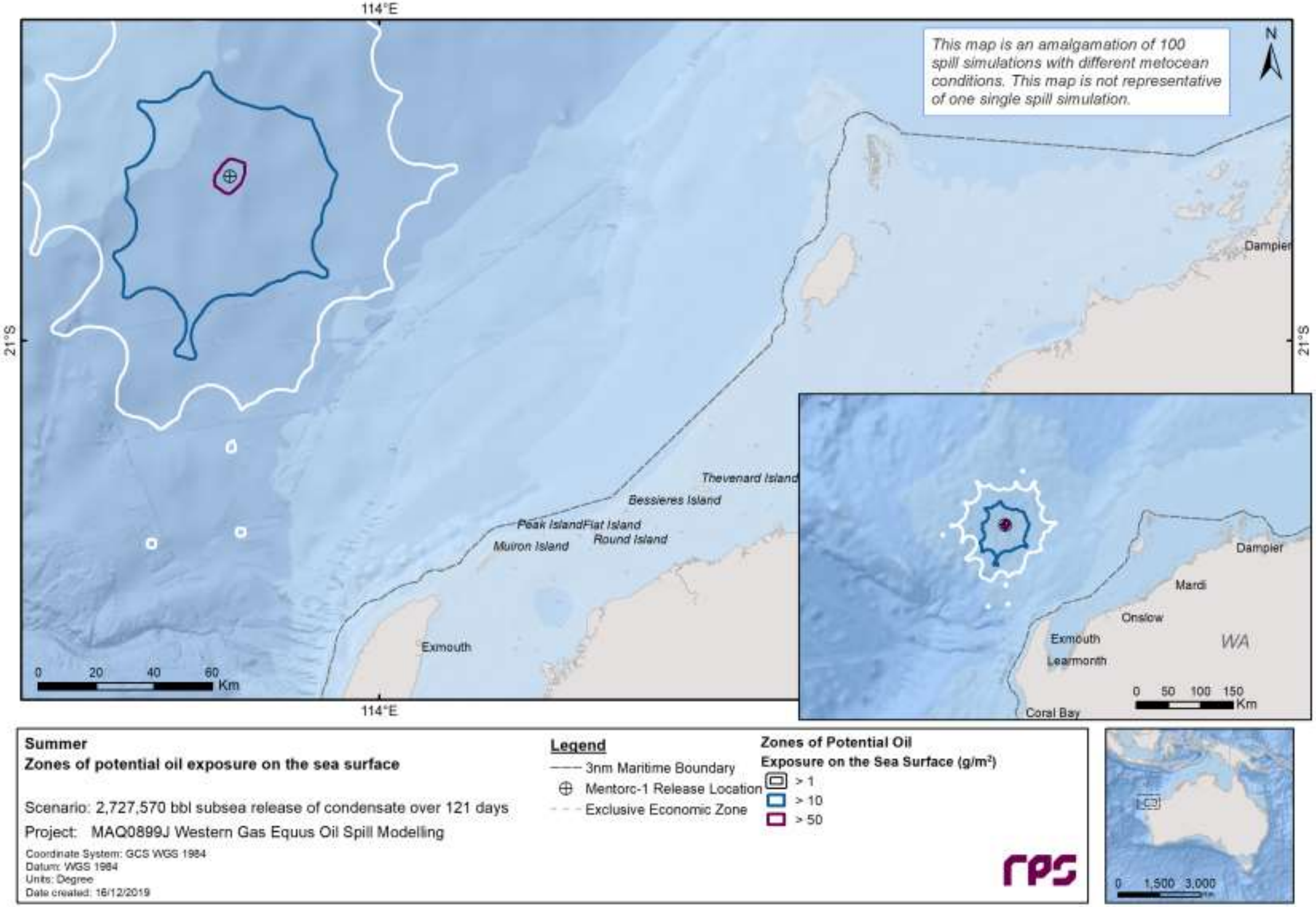

Figure 11.1 Zones of potential oil exposure on the sea surface for each threshold, in the event of a 2,727,570 bbl (22,542 bbl/day) subsea release of Mentorc condensate over 121 days, tracked for 141 days. The results were calculated from 100 spill trajectories commencing during summer (September to March) conditions.

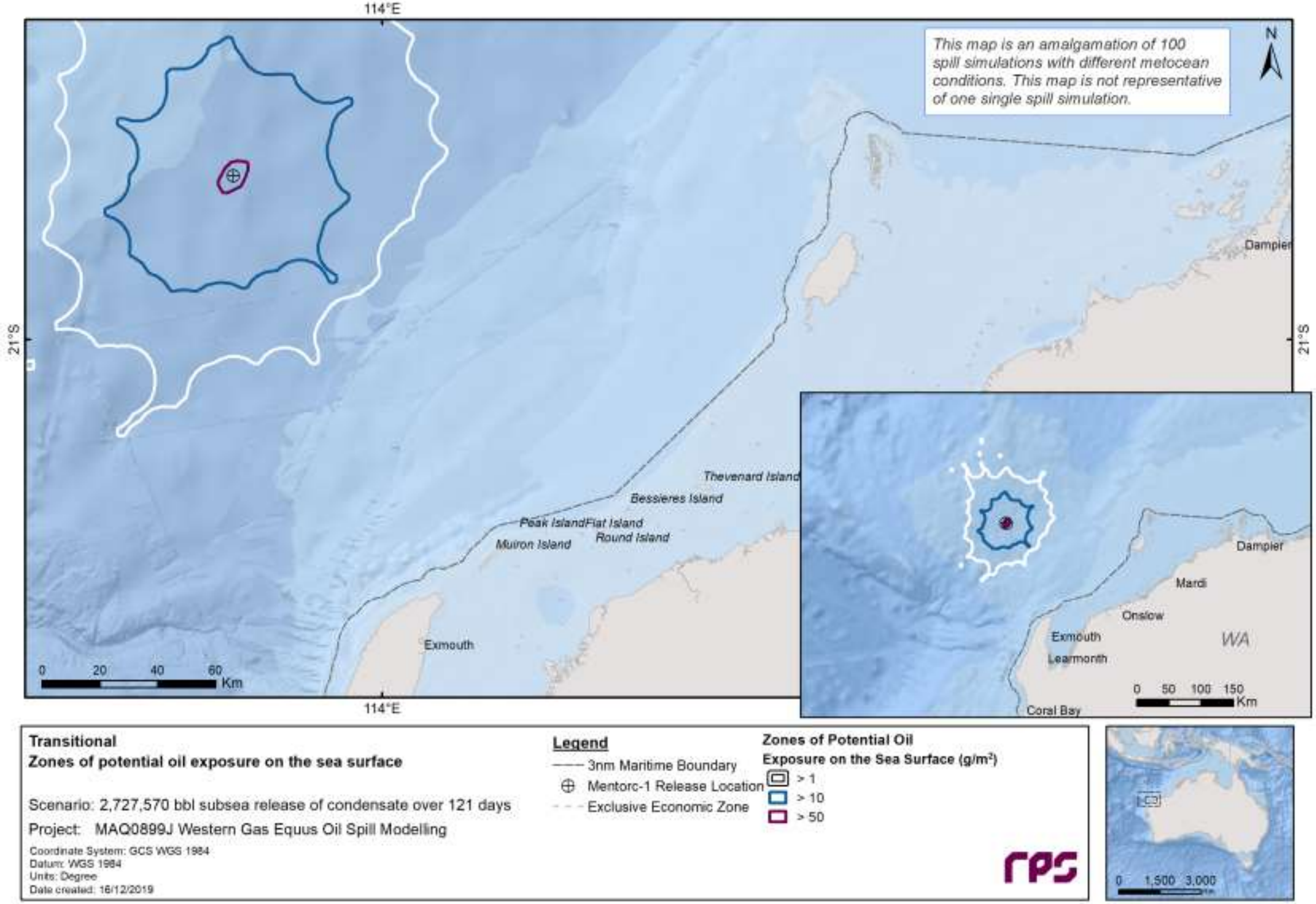

Figure 11.2 Zones of potential oil exposure on the sea surface for each threshold, in the event of a 2,727,570 bbl (22,542 bbl/day) subsea release of Mentorc condensate over 121 days, tracked for 141 days. The results were calculated from 100 spill trajectories commencing during transitional (April and August) conditions.

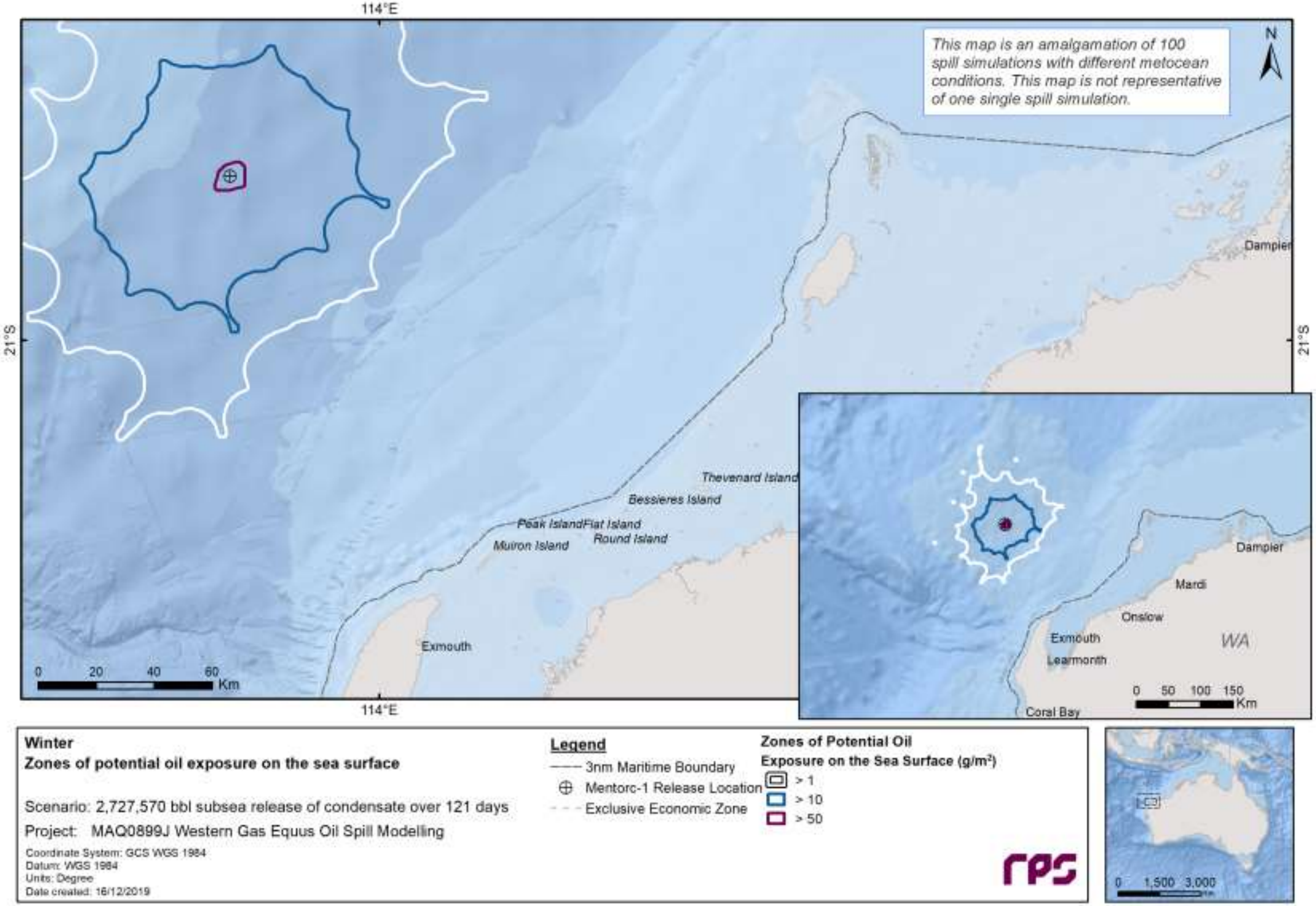

Figure 11.3 Zones of potential oil exposure on the sea surface for each threshold, in the event of a 2,727,570 bbl (22,542 bbl/day) subsea release of Mentorc condensate over 121 days, tracked for 141 days. The results were calculated from 100 spill trajectories commencing during winter (May to July) conditions.

11.1.2 Shoreline Contact

No shoreline contact was predicted above the low threshold for this scenario, consequently no shoreline contact results are presented.

11.1.3 Water Column Exposure

11.1.3.1 Dissolved Hydrocarbons

No dissolved hydrocarbon exposure was predicted above the low threshold in the top 30 m of the water column for this scenario, consequently no dissolved hydrocarbon results are presented.

11.1.3.2 Entrained Hydrocarbons

Table 11.3 summarises the maximum distance and direction from the release location to entrained hydrocarbon exposure zones at the low (≥ 10 ppb) and high (≥ 100 ppb) thresholds, in the 0-10 m depth layer. The maximum distance of low and high entrained hydrocarbon exposure was 1881.6 km (northeast) and 704.8 km (southwest), recorded during summer and transitional conditions, respectively.

Table 11.4 to Table 11.6 summarise the probability of exposure to receptors from entrained hydrocarbons in the 0-10 m depth layer for each of the three seasons, at the low (≥ 10 ppb) and high (≥ 100 ppb) thresholds (NOPSEMA, 2019).

The Gascoyne AMP was predicted to record 100% probability of entrained hydrocarbon exposure at the low threshold during every season. Additionally, the Argo-Rowley Terrace, the Carnarvon Canyon and the Ningaloo AMPs, the Ningaloo, Northwest Shelf, and the Pilbarra (offshore) IMCRAs and the Canyons and the Commonwealth waters adjacent to Ningaloo Reef KEFs all recorded probabilities of low entrained hydrocarbon exposure at or above 30% for each season. At the high entrained hydrocarbon exposure threshold, the Gascoyne AMP recorded the greatest probabilities of exposure ranging from 91% in summer to 100% during transitional and winter conditions. The Canyons KEF was also predicted to be exposed at the high entrained hydrocarbon threshold with predicted probabilities of 60% in summer, 72% during transitional conditions and 61% during winter.

Table 11.7 summarises the probability of exposure to receptors from entrained hydrocarbons in the 10-20 m depth layer, during all seasonal conditions and at the low and high entrained hydrocarbon exposure thresholds.

In the 10-20 m layer, the Gascoyne AMP recorded the highest predicted low entrained hydrocarbon exposure, with probabilities of 77% during summer, 86% during transitional conditions and 98% during winter. Additionally, the Canyons KEF recorded probabilities of low entrained hydrocarbon exposure of 9% during summer, 11% during transitional conditions and 14% in winter. Only the Gascoyne AMP was predicted to be exposed at or above the high entrained hydrocarbon ci with predicted probabilities of 6% during summer and 4% during transitional and winter conditions.

Table 11.8 summarises the probability of exposure to receptors from entrained hydrocarbons in the 20-30 m depth layer, during all seasonal conditions and at the low and high entrained hydrocarbon exposure thresholds.

In the 20-30 m layer, only the Gascoyne AMP was predicted to be exposed to entrained hydrocarbons at or above the low threshold during summer, transitional and winter conditions with predicted probabilities ranging from 60% during transitional conditions to 75% during winter. At the high entrained hydrocarbon threshold, the Gascoyne AMP recorded probabilities of exposure ranging from 4% during transitional and winter conditions and 5% during summer.

Figure 11.4 to Figure 11.12 illustrate the zones of potential entrained hydrocarbon exposure for the low (≥ 10 ppb) and high (≥ 100 ppb) thresholds in the 0-10 m, 10-20 m and 20-30 m depth layers during summer, transitional and winter conditions.

Table 11.3 Maximum distance and direction from the release location to entrained hydrocarbon exposure (0 – 10m). Results are based on a 2,727,570 bbl (22,542 bbl/day) subsea release of Mentorc condensate over 121 days, tracked for 141 days for all seasons. The results were calculated from 100 spill simulations per season.

Season	Distance and direction travelled	Zones of potential entrained hydrocarbon exposure	
		Low 10 ppb	High 100 ppb
Summer	Maximum distance (km) from the release location	1881.6	640.5
	Direction	NE	NW
Transitional	Maximum distance (km) from the release location	1814.9	704.8
	Direction	NE	SW
Winter	Maximum distance (km) from the release location	1497.2	642.6
	Direction	NW	SSW

Table 11.4 Predicted probability and maximum entrained hydrocarbon exposure to individual receptors in the 0-10 m depth layer. Results are based on a 2,727,570 bbl (22,542 bbl/day) subsea release of Mentorc condensate over 121 days, tracked for 141 days, during summer (September to March) conditions.

Receptor		Maximum exposure to entrained hydrocarbons (ppb)	Probability of exposure to entrained hydrocarbons	
			Low	High
AMP	Abrolhos	81	28	-
	Argo-Rowley Terrace	95	36	-
	Carnarvon Canyon	154	68	4
	Gascoyne	1,825	100	91
	Montebello	235	49	10
	Ningaloo	179	42	8
	Perth Canyon	26	3	-
	Shark Bay	40	33	-
EEZ	Christmas Island Exclusive Economic Zone	31	8	-
	Cocos Islands Exclusive Economic Zone	13	2	-
	East Timorian Exclusive Economic Zone	15	5	-
	Indonesian Exclusive Economic Zone	37	5	-
	Oecussi Ambeno Exclusive Economic Zone	10	1	-
IBRA	Cape Range	89	25	-
	Roebourne	35	13	-
IMCRA	Central West Coast	16	5	-
	Leeuwin-Naturaliste	12	2	-
	Ningaloo	159	52	8
	Northwest Shelf	258	54	11
	Pilbarra (nearshore)	16	5	-
	Pilbarra (offshore)	275	68	12
	Zuytdorp	62	35	-
KEF	Ancient coastline at 125 m depth contour	236	52	11
	Ancient coastline at 90-120m depth	10	1	-
	Canyons linking the Argo Abyssal Plain with the Scott Plateau	19	3	-
	Canyons linking the Cuvier Abyssal Plain and the Cape Range Peninsula (Canyons)	527	91	60
	Commonwealth marine environment surrounding the Houtman Abrolhos Islands	11	1	-
	Commonwealth waters adjacent to Ningaloo Reef	179	42	8
	Glomar Shoals	80	14	-
	Perth Canyon and adjacent shelf break, and other west coast canyons	32	8	-
	Wallaby Saddle	81	22	-
	Western demersal slope and associated fish communities	124	24	3
	Western rock lobster	13	2	-
MMA	Barrow Island	53	27	-
	Muiron Islands	30	15	-
MP	Barrow Island	50	20	-

Receptor		Maximum exposure to entrained hydrocarbons (ppb)	Probability of exposure to entrained hydrocarbons	
			Low	High
NR	Montebello Islands	49	29	-
	Ningaloo	141	26	8
	Thevenard Island	51	6	-
RSB	Barrow Island Reefs and Shoals	11	1	-
	Brewis Reef	28	6	-
	Dailey Shoal	10	1	-
	Glomar Shoal	40	14	-
	Herald Reef	12	1	-
	Montebello Shoals	45	24	-
	Moresby Shoals	10	1	-
	Ningaloo Reef	95	18	-
	Penguin Bank	24	19	-
	Poivre Reef	18	12	-
	Rankin Bank	45	28	-
	Ripple Shoals	17	6	-
	Rosily Shoals	57	17	-
	Tryal Rocks	49	37	-
State Waters	Western Australia State Waters	141	29	8

Table 11.5 Predicted probability and maximum entrained hydrocarbon exposure to individual receptors in the 0-10 m depth layer. Results are based on a 2,727,570 bbl (22,542 bbl/day) subsea release of Mentorc condensate over 121 days, tracked for 141 days, during transitional (April and August) conditions.

Receptor		Maximum exposure to entrained hydrocarbons (ppb)	Probability of exposure to entrained hydrocarbons	
			Low	High
AMP	Abrolhos	122	19	1
	Argo-Rowley Terrace	89	47	-
	Carnarvon Canyon	146	51	3
	Gascoyne	1,635	100	100
	Montebello	119	36	2
	Ningaloo	145	32	8
	Perth Canyon	25	4	-
	Shark Bay	30	29	-
EEZ	Christmas Island Exclusive Economic Zone	19	7	-
	Cocos Islands Exclusive Economic Zone	14	2	-
	East Timorian Exclusive Economic Zone	13	2	-
	Indonesian Exclusive Economic Zone	36	12	-
	Oecussi Ambeno Exclusive Economic Zone	12	1	-
IBRA	Cape Range	64	11	-
	Roebourne	32	10	-
IMCRA	Central West Coast	17	6	-
	Leeuwin-Naturaliste	12	2	-
	Ningaloo	191	40	6
	Northwest Shelf	150	55	5
	Pilbarra (nearshore)	14	6	-
	Pilbarra (offshore)	269	71	10
	Zuytdorp	62	28	-
KEF	Ancient coastline at 125 m depth contour	244	57	9
	Canyons linking the Argo Abyssal Plain with the Scott Plateau	23	6	-
	Canyons linking the Cuvier Abyssal Plain and the Cape Range Peninsula (Canyons)	565	89	72
	Commonwealth marine environment surrounding the Houtman Abrolhos Islands	11	1	-
	Commonwealth waters adjacent to Ningaloo Reef	145	32	8
	Glomar Shoals	17	2	-
	Perth Canyon and adjacent shelf break, and other west coast canyons	33	9	-
	Wallaby Saddle	122	19	1
	Western demersal slope and associated fish communities	115	18	2
	Western rock lobster	12	1	-
MMA	Barrow Island	42	13	-
	Muiron Islands	28	5	-
MP	Barrow Island	35	12	-
	Montebello Islands	32	13	-

Receptor		Maximum exposure to entrained hydrocarbons (ppb)	Probability of exposure to entrained hydrocarbons	
			Low	High
	Ningaloo	120	17	1
NR	Thevenard Island	52	10	-
RSB	Barrow Island Reefs and Shoals	11	1	-
	Brewis Reef	30	10	-
	Dailey Shoal	11	2	-
	Glomar Shoal	11	1	-
	Herald Reef	11	1	-
	Montebello Shoals	24	12	-
	Ningaloo Reef	74	5	-
	Penguin Bank	27	10	-
	Poivre Reef	21	8	-
	Rankin Bank	34	16	-
	Ripple Shoals	19	8	-
	Rosily Shoals	52	10	-
	Tryal Rocks	50	12	-
State Waters	Western Australia State Waters	120	17	1

Table 11.6 Predicted probability and maximum entrained hydrocarbon exposure to individual receptors in the 0-10 m depth layer. Results are based on a 2,727,570 bbl (22,542 bbl/day) subsea release of Mentorc condensate over 121 days, tracked for 141 days, during winter (May to July) conditions.

Receptor		Maximum exposure to entrained hydrocarbons (ppb)	Probability of exposure to entrained hydrocarbons	
			Low	High
AMP	Abrolhos	94	34	-
	Argo-Rowley Terrace	68	36	-
	Carnarvon Canyon	150	54	6
	Gascoyne	1,878	100	100
	Montebello	99	28	-
	Ningaloo	137	31	5
	Perth Canyon	14	1	-
	Shark Bay	49	30	-
EEZ	Christmas Island Exclusive Economic Zone	15	2	-
	Indonesian Exclusive Economic Zone	34	13	-
IBRA	Cape Range	23	8	-
IMCRA	Central West Coast	16	1	-
	Ningaloo	187	30	6
	Northwest Shelf	142	55	9
	Pilbarra (offshore)	287	60	7
	Zuytdorp	57	31	-
KEF	Ancient coastline at 125 m depth contour	235	49	6
	Canyons linking the Argo Abyssal Plain with the Scott Plateau	21	5	-
	Canyons linking the Cuvier Abyssal Plain and the Cape Range Peninsula (Canyons)	588	100	61
	Commonwealth marine environment surrounding the Houtman Abrolhos Islands	10	1	-
	Commonwealth waters adjacent to Ningaloo Reef	137	31	5
	Perth Canyon and adjacent shelf break, and other west coast canyons	19	2	-
	Wallaby Saddle	93	27	-
	Western demersal slope and associated fish communities	98	27	-
MMA	Barrow Island	25	3	-
MP	Barrow Island	21	3	-
	Montebello Islands	22	2	-
	Ningaloo	47	13	-
RSB	Montebello Shoals	14	1	-
	Ningaloo Reef	45	9	-
	Penguin Bank	21	3	-
	Rankin Bank	20	17	-
	Rosily Shoals	15	3	-
	Tryal Rocks	41	2	-
State Waters	Western Australia State Waters	47	13	-

Table 11.7 Predicted probability and maximum entrained hydrocarbon exposure to individual receptors in the 10-20 m depth layer. Results are based on a 2,727,570 bbl (22,542 bbl/day) subsea release of Mentorc condensate over 121 days, tracked for 141 days, during all seasonal conditions. The results were calculated from 100 spill trajectories per season.

Season	Receptor		Maximum exposure to entrained hydrocarbons (ppb)	Probability of exposure to entrained hydrocarbons	
				Low	High
Summer	AMP	Gascoyne	183	77	6
		Ningaloo	12	1	-
	IMCRA	Ningaloo	12	1	-
		Pilbarra (offshore)	14	1	-
	KEF	Ancient coastline at 125 m depth contour	12	1	-
		Canyons linking the Cuvier Abyssal Plain and the Cape Range Peninsula (Canyons)	21	9	-
		Commonwealth waters adjacent to Ningaloo Reef	12	1	-
	MP	Ningaloo	12	1	-
	State Waters	Western Australia State Waters	12	1	-
Transitional	AMP	Gascoyne	218	86	4
		Ningaloo	11	1	-
	IMCRA	Ningaloo	11	1	-
		Pilbarra (offshore)	15	1	-
	KEF	Ancient coastline at 125 m depth contour	11	1	-
		Canyons linking the Cuvier Abyssal Plain and the Cape Range Peninsula (Canyons)	25	11	-
		Commonwealth waters adjacent to Ningaloo Reef	11	1	-
Winter	AMP	Gascoyne	187	98	4
	IMCRA	Ningaloo	10	1	-
		Pilbarra (offshore)	13	1	-
	KEF	Canyons linking the Cuvier Abyssal Plain and the Cape Range Peninsula (Canyons)	25	14	-

Table 11.8 Predicted probability and maximum entrained hydrocarbon exposure to individual receptors in the 20-30 m depth layer. Results are based on a 2,727,570 bbl (22,542 bbl/day) subsea release of Mentorc condensate over 121 days, tracked for 141 days, during all seasonal conditions. The results were calculated from 100 spill trajectories per season.

Season	Receptor		Maximum exposure to entrained hydrocarbons (ppb)	Probability of exposure to entrained hydrocarbons	
				Low	High
Summer	AMP	Gascoyne	176	63	5
Transitional	AMP	Gascoyne	161	60	4
Winter	AMP	Gascoyne	154	75	4

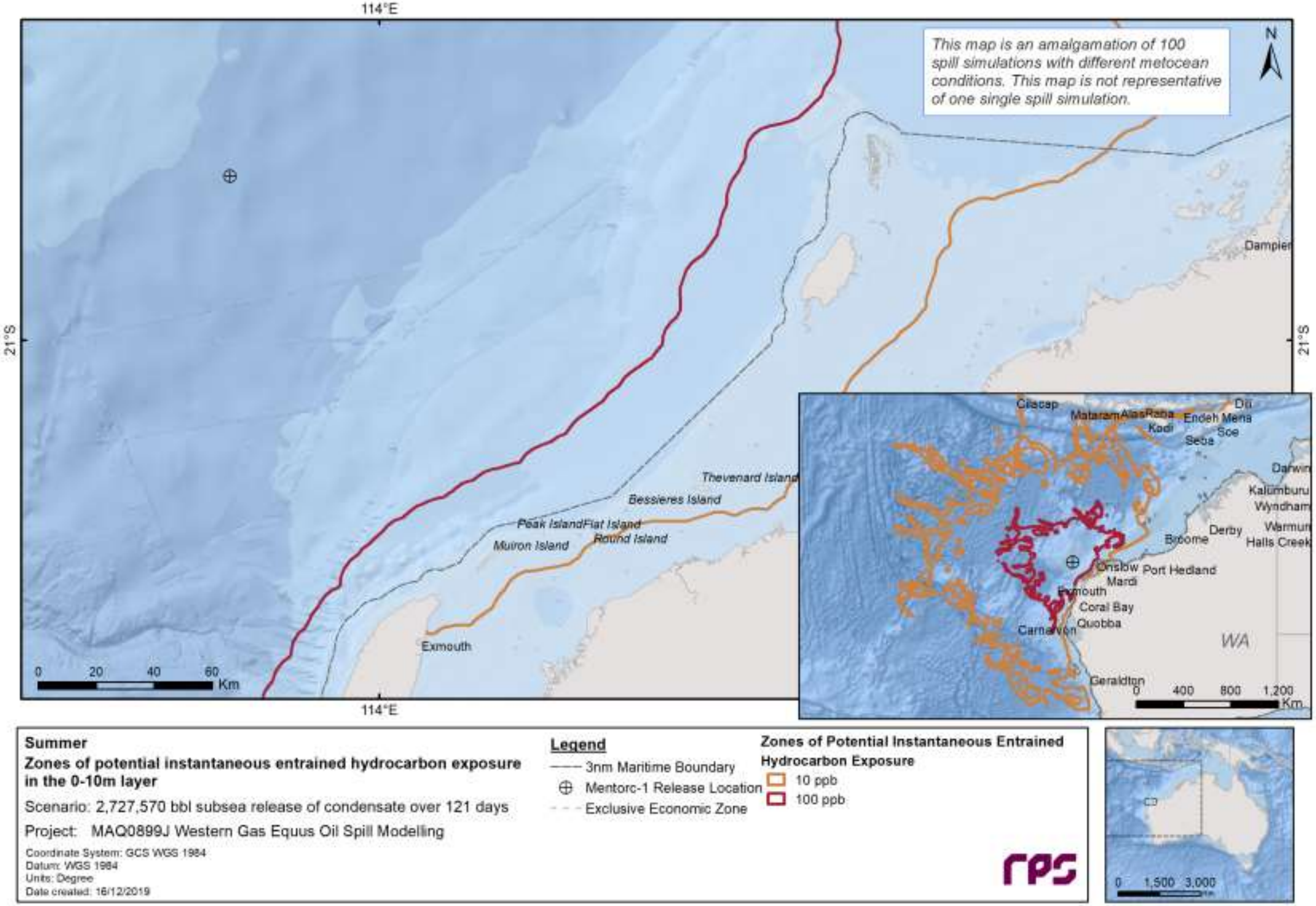

Figure 11.4 Zones of potential entrained hydrocarbon exposure over 1-hour duration at 0-10 m below the sea surface in the event of a 2,727,570 bbl (22,542 bbl/day) subsea release of Mentorc condensate over 121 days, tracked for 141 days. The results were calculated from 100 spill trajectories commencing during summer (September to March) conditions.

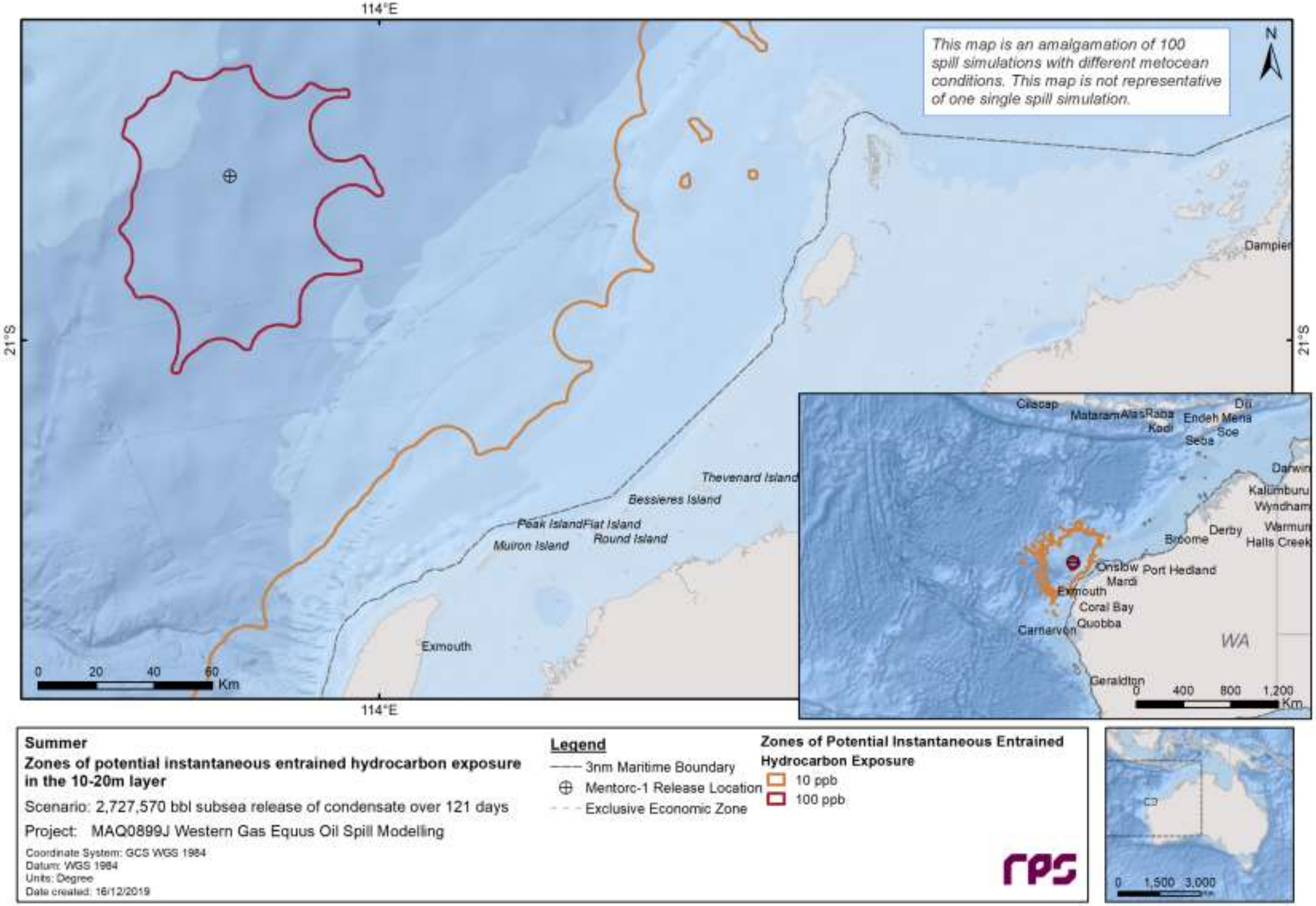

Figure 11.5 Zones of potential entrained hydrocarbon exposure over 1-hour duration at 10-20 m below the sea surface in the event of a 2,727,570 bbl (22,542 bbl/day) subsea release of Mentorc condensate over 121 days, tracked for 141 days. The results were calculated from 100 spill trajectories commencing during summer (September to March) conditions.

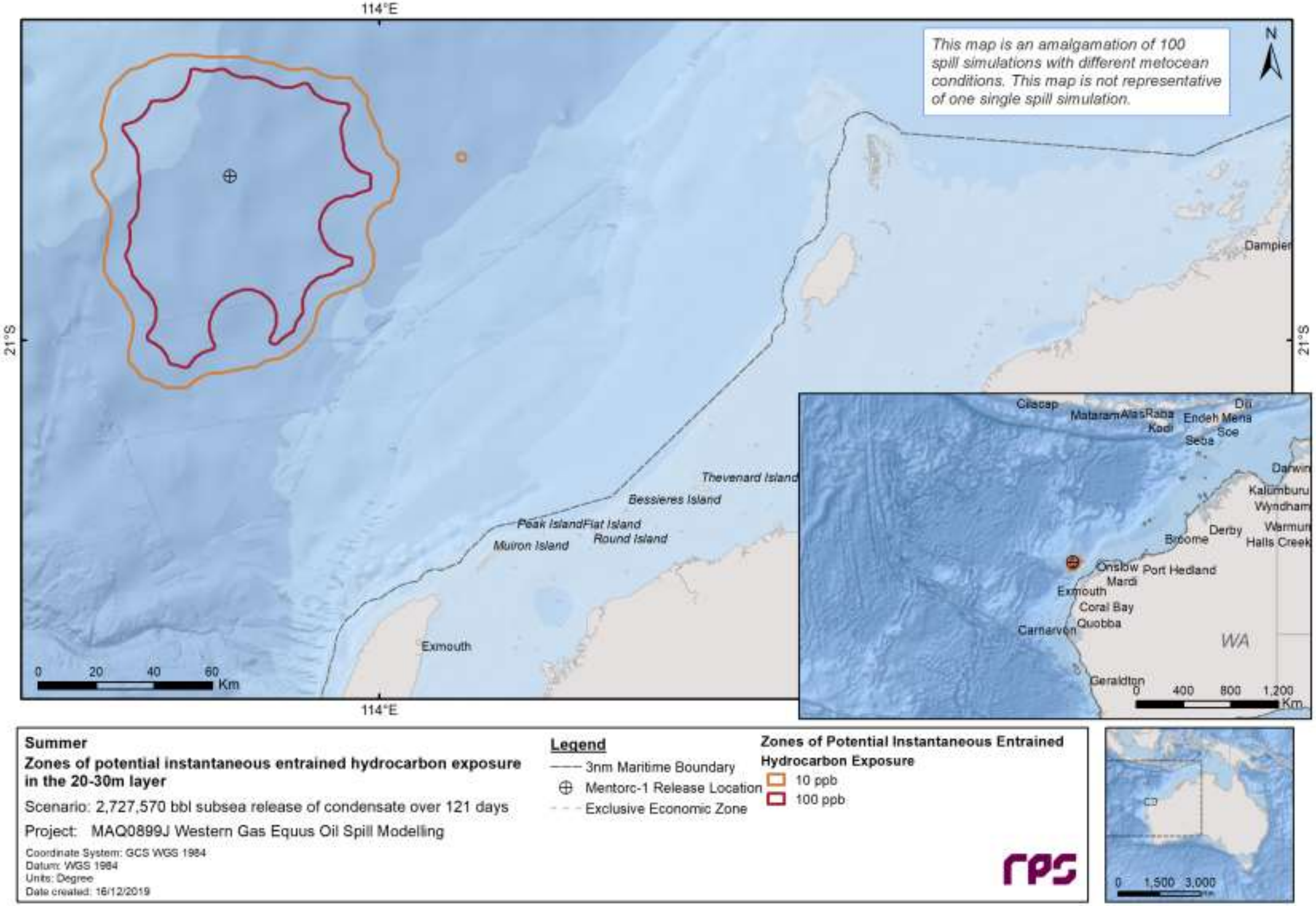

Figure 11.6 Zones of potential entrained hydrocarbon exposure over 1-hour duration at 20-30 m below the sea surface in the event of a 2,727,570 bbl (22,542 bbl/day) subsea release of Mentorc condensate over 121 days, tracked for 141 days. The results were calculated from 100 spill trajectories commencing during summer (September to March) conditions.

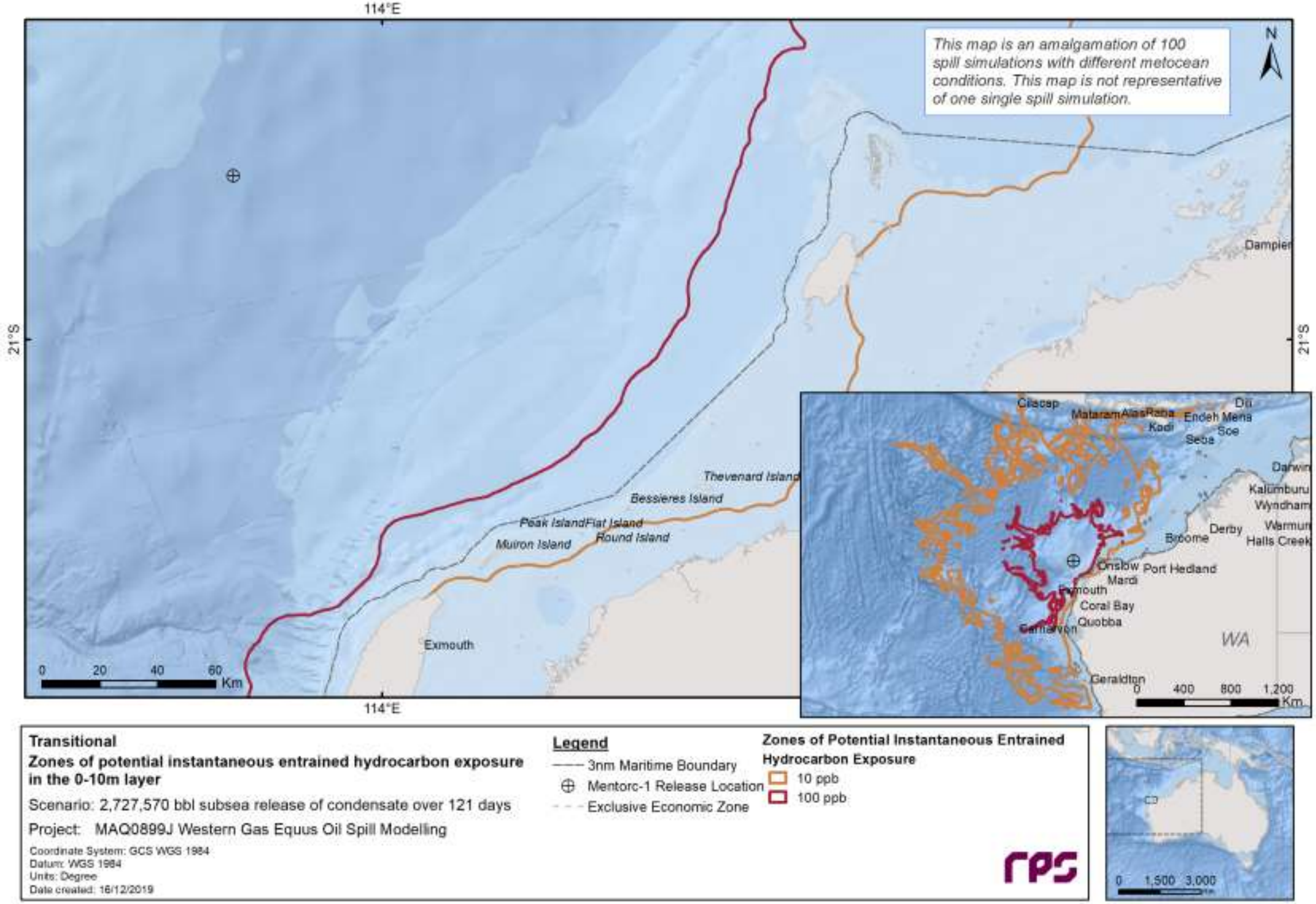

Figure 11.7 Zones of potential entrained hydrocarbon exposure over 1-hour duration at 0-10 m below the sea surface in the event of a 2,727,570 bbl (22,542 bbl/day) subsea release of Mentorc condensate over 121 days, tracked for 141 days. The results were calculated from 100 spill trajectories commencing during transitional (April and August) conditions.

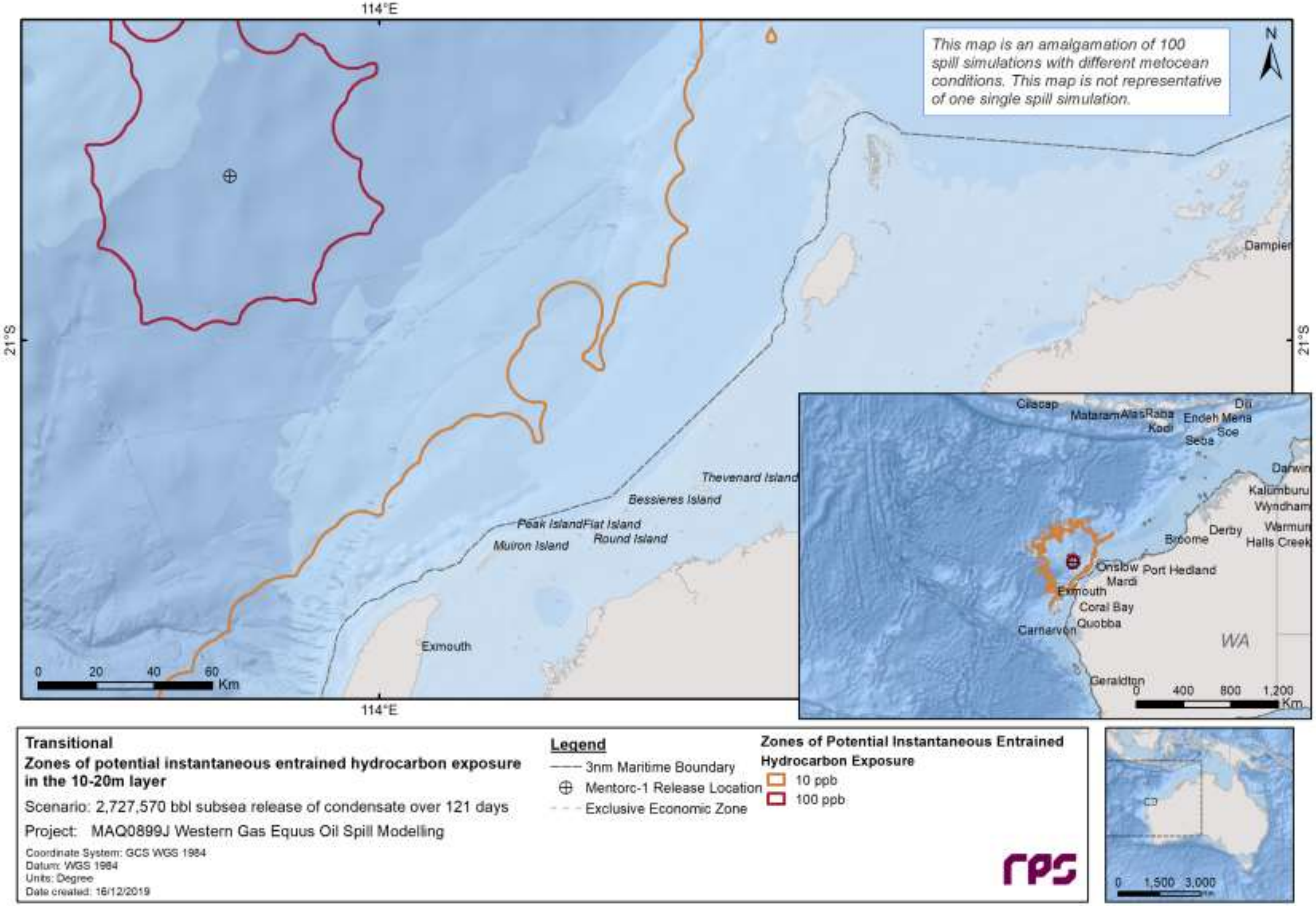

Figure 11.8 Zones of potential entrained hydrocarbon exposure over 1-hour duration at 10-20 m below the sea surface in the event of a 2,727,570 bbl (22,542 bbl/day) subsea release of Mentorc condensate over 121 days, tracked for 141 days. The results were calculated from 100 spill trajectories commencing during transitional (April and August) conditions.

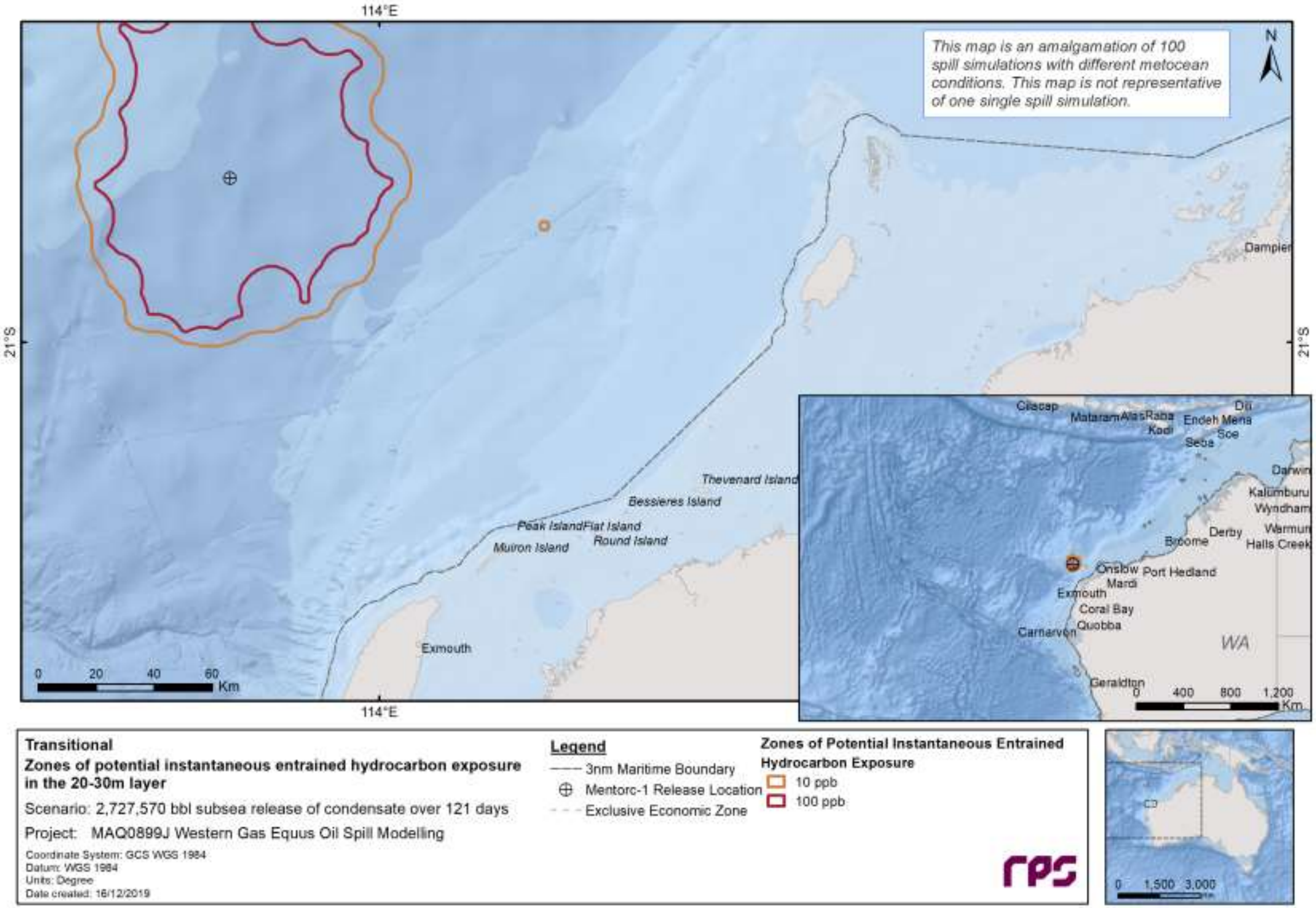

Figure 11.9 Zones of potential entrained hydrocarbon exposure over 1-hour duration at 20-30 m below the sea surface in the event of a 2,727,570 bbl (22,542 bbl/day) subsea release of Mentorc condensate over 121 days, tracked for 141 days. The results were calculated from 100 spill trajectories commencing during transitional (April and August) conditions.

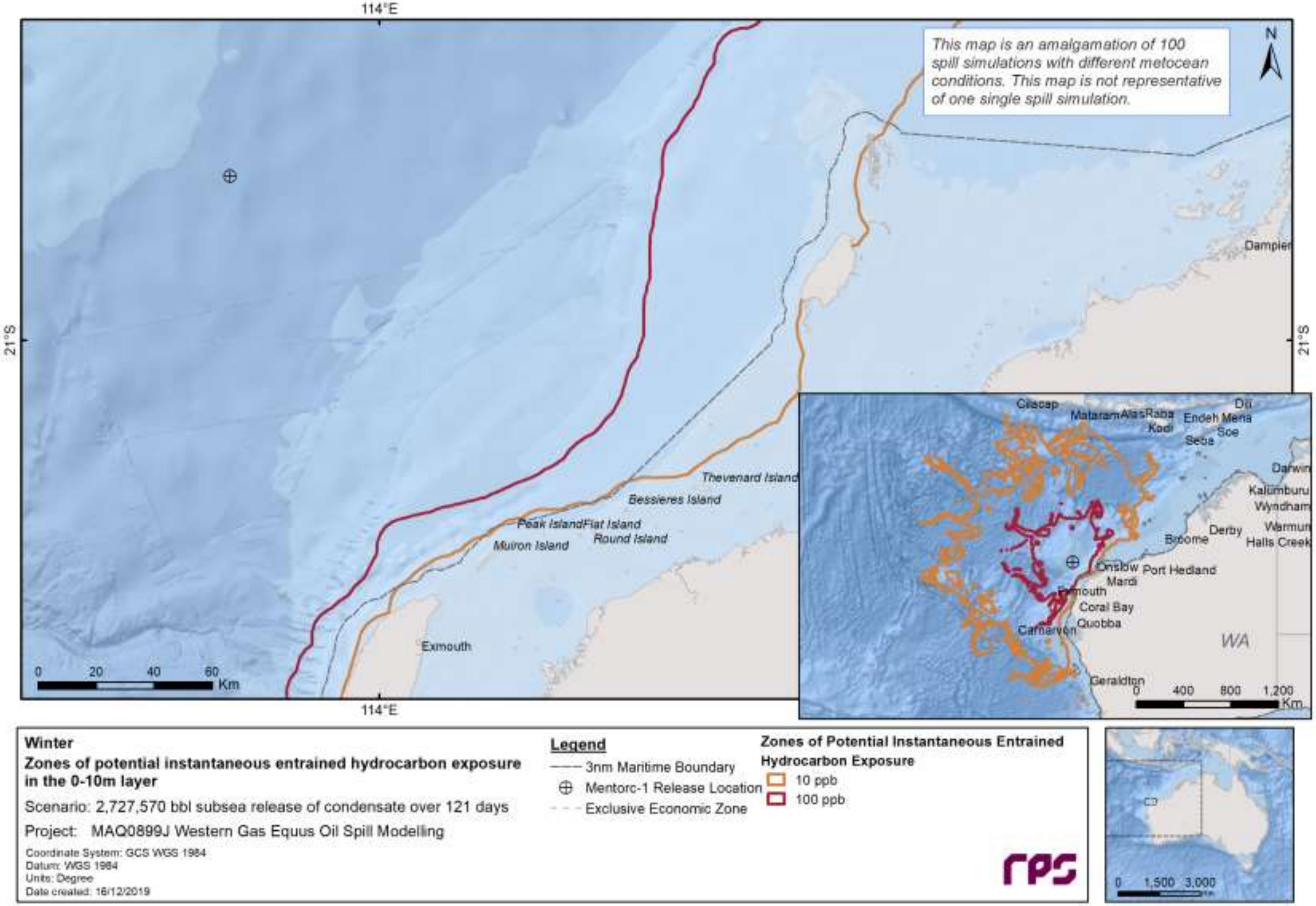

Figure 11.10 Zones of potential entrained hydrocarbon exposure over 1-hour duration at 0-10 m below the sea surface in the event of a 2,727,570 bbl (22,542 bbl/day) subsea release of Mentorc condensate over 121 days, tracked for 141 days. The results were calculated from 100 spill trajectories commencing during winter (May to July) conditions.

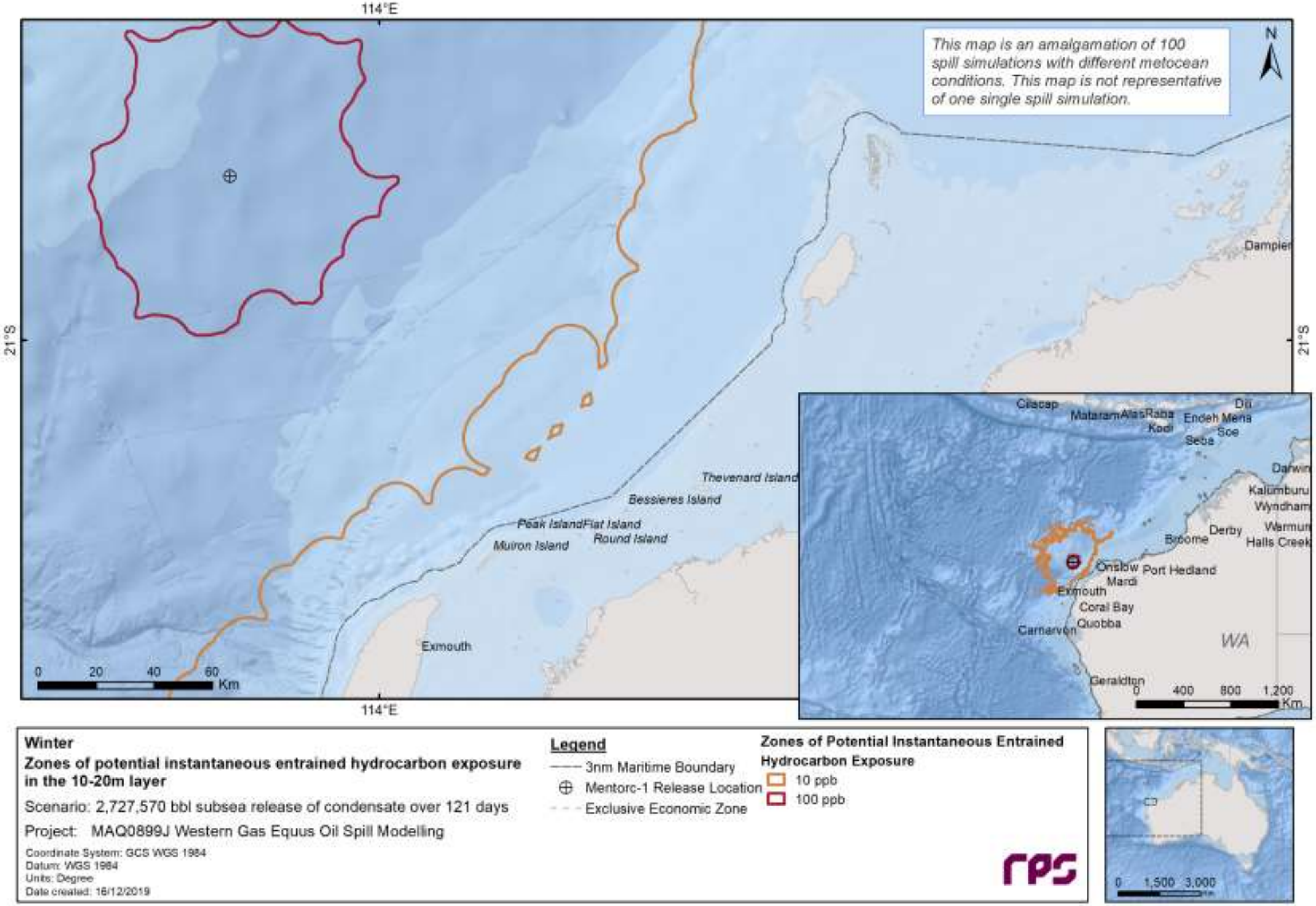

Figure 11.11 Zones of potential entrained hydrocarbon exposure over 1-hour duration at 10-20 m below the sea surface in the event of a 2,727,570 bbl (22,542 bbl/day) subsea release of Mentorc condensate over 121 days, tracked for 141 days. The results were calculated from 100 spill trajectories commencing during winter (May to July) conditions.

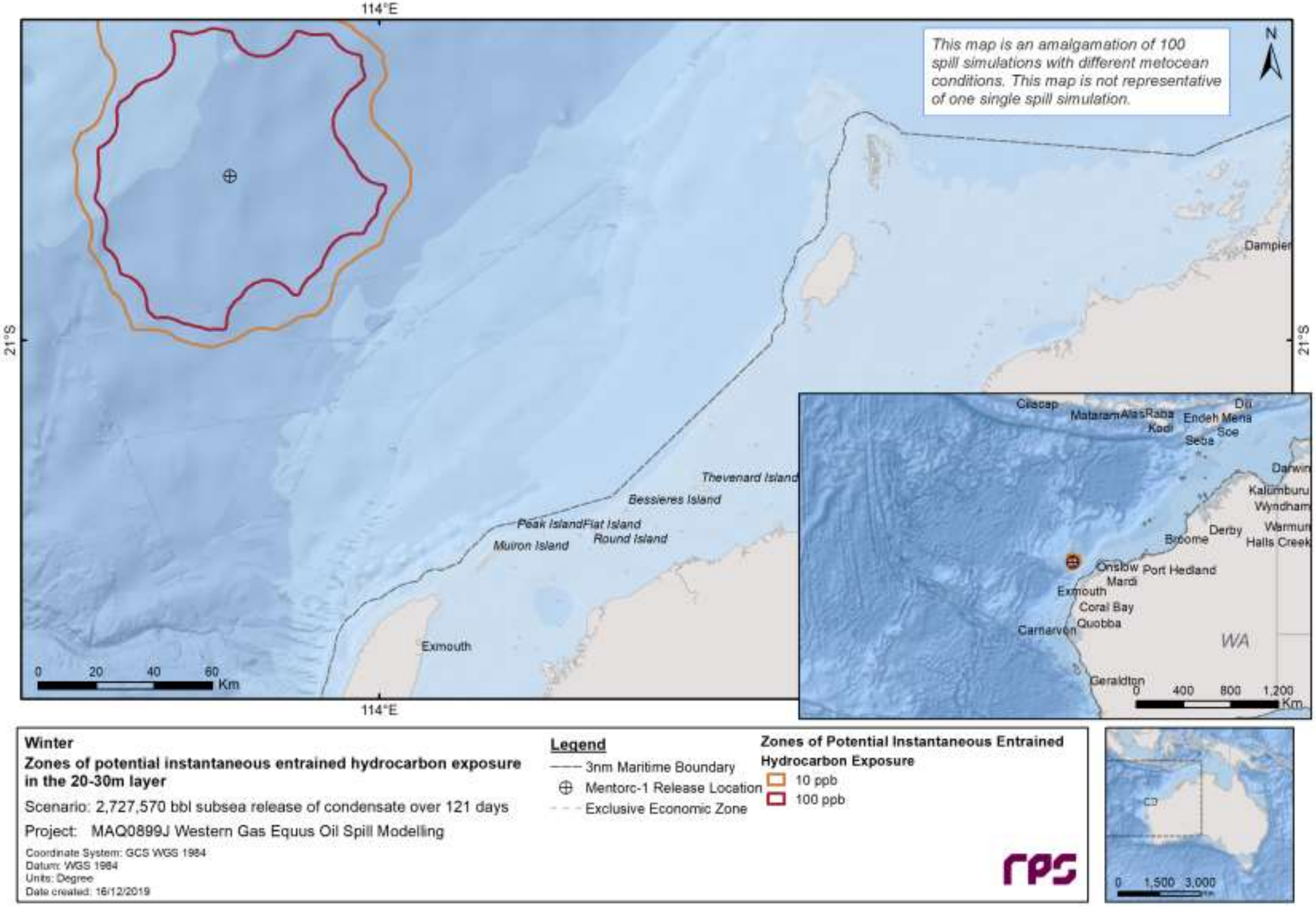

Figure 11.12 Zones of potential entrained hydrocarbon exposure over 1-hour duration at 20-30 m below the sea surface in the event of a 2,727,570 bbl (22,542 bbl/day) subsea release of Mentorc condensate over 121 days, tracked for 141 days. The results were calculated from 100 spill trajectories commencing during winter (May to July) conditions.

11.2 Deterministic Trajectory

11.2.1 Deterministic Case: Largest area of exposure on the sea surface

The simulation that resulted in the largest area of exposure on the sea surface above 10 g/m^2 (moderate threshold and actionable surface oil) was identified as run number 85, to commence during transitional conditions, 6 pm on the 3rd of August 2017.

Zones of oil exposure on the sea surface (swept area) over the entire simulation (141 days) is presented in Figure 11.13.

Figure 11.14 is a graph of area of exposure on the sea surface at the visible oil (≥1 g/m^2) and actionable oil (10 g/m^2) exposure levels over the 141-day simulation. The largest area of exposure at the visible oil threshold was predicted to occur 8 days after the spill started and covered approximately 91 km^2. The maximum area at actionable surface oil threshold was 6 km^2, approximately 2 days into the simulation.

Figure 11.15 presents the fates and weathering graph for the identified simulation. At the conclusion of the simulation (day-141), approximately 1,976,743 bbl (72%) spilled oil was lost to the atmosphere through evaporation. Approximately 645,504 bbl (24%) of the condensate was predicted to have decayed, while approximately 104,561 bbl (4%) was predicted to remain within the water column and no condensate was predicted to accumulate on the shorelines.

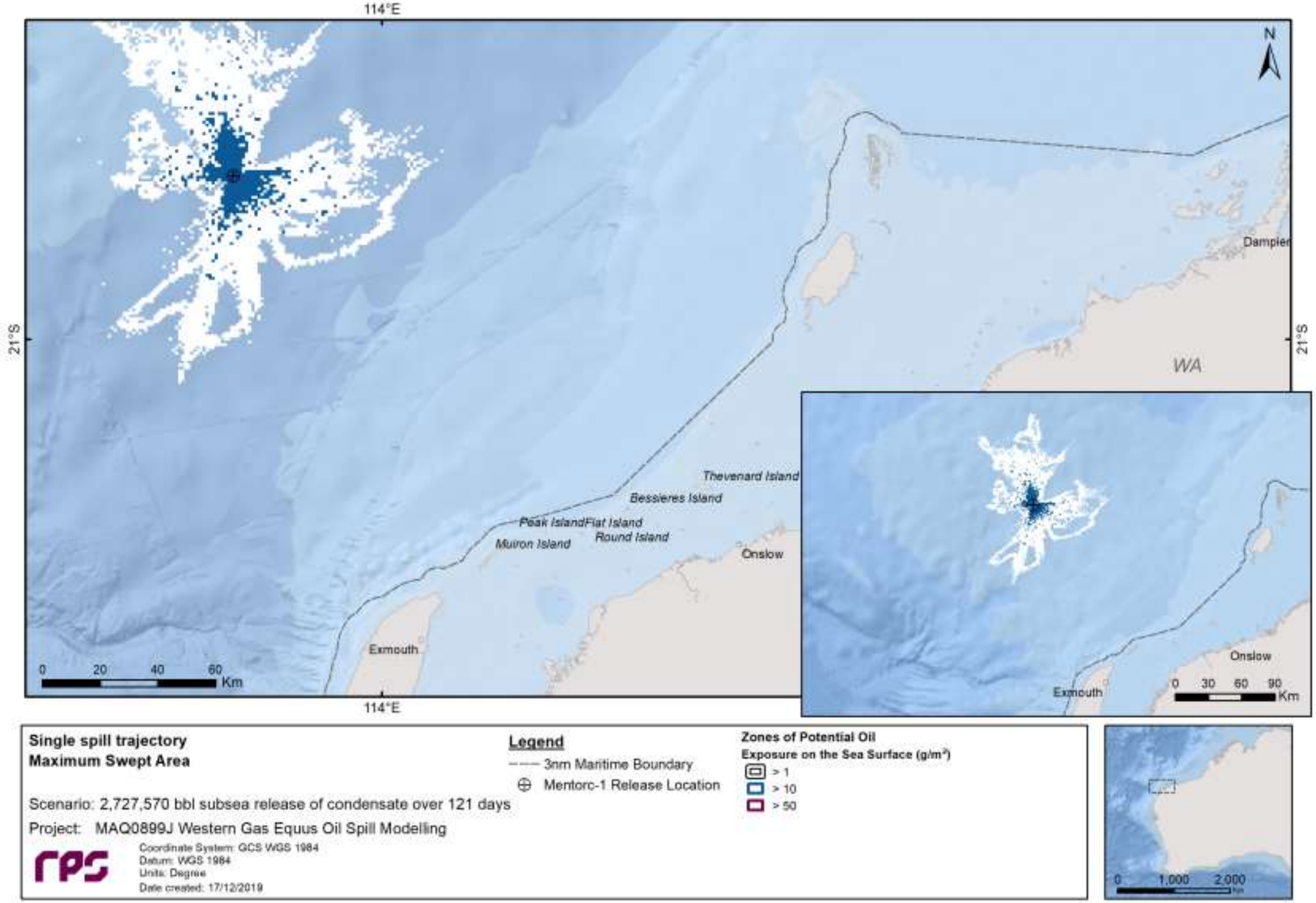

Figure 11.13 Zones of potential oil exposure on the sea surface (over 141 days) for the trajectory with the largest area of oil exposure on the sea surface above 10 g/m^2 (moderate threshold and actionable surface oil). Results are based on a 2,727,570 bbl (22,542 bbl/day) subsea release of Mentorc condensate over 121 days, tracked for 141 days, commencing at 6 pm on the 3rd of August 2017.

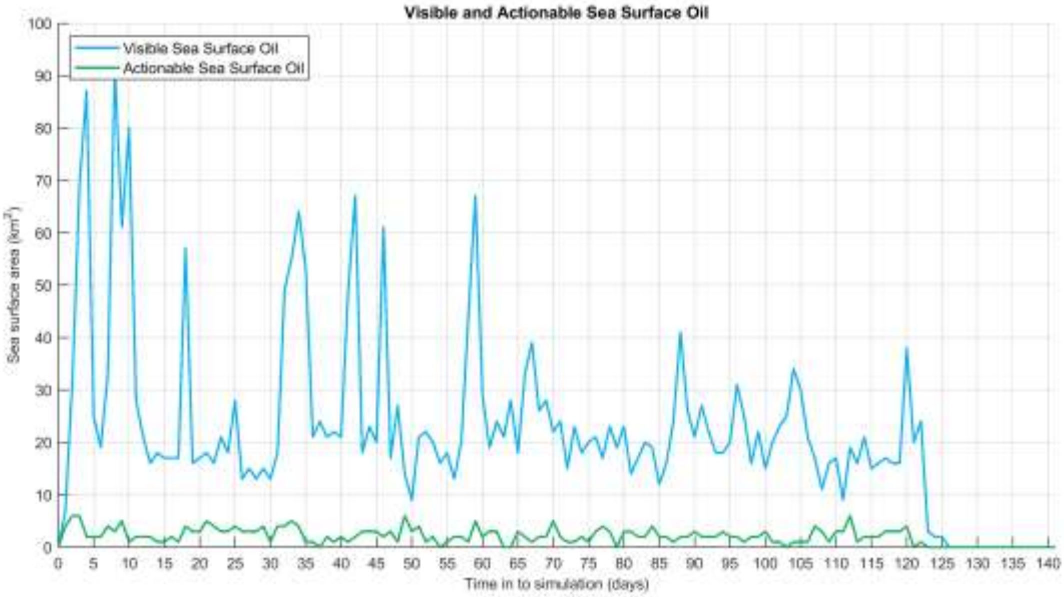

Figure 11.14 Area of exposure at low (1 g/m²) and actionable (10 g/m²) surface oil thresholds for the trajectory with the largest area of oil on the sea surface above 10 g/m². Results are based on a 2,727,570 bbl (22,542 bbl/day) subsea release of Mentorc condensate over 121 days, tracked for 141 days, commcencing at 6 pm on the 3rd of August 2017.

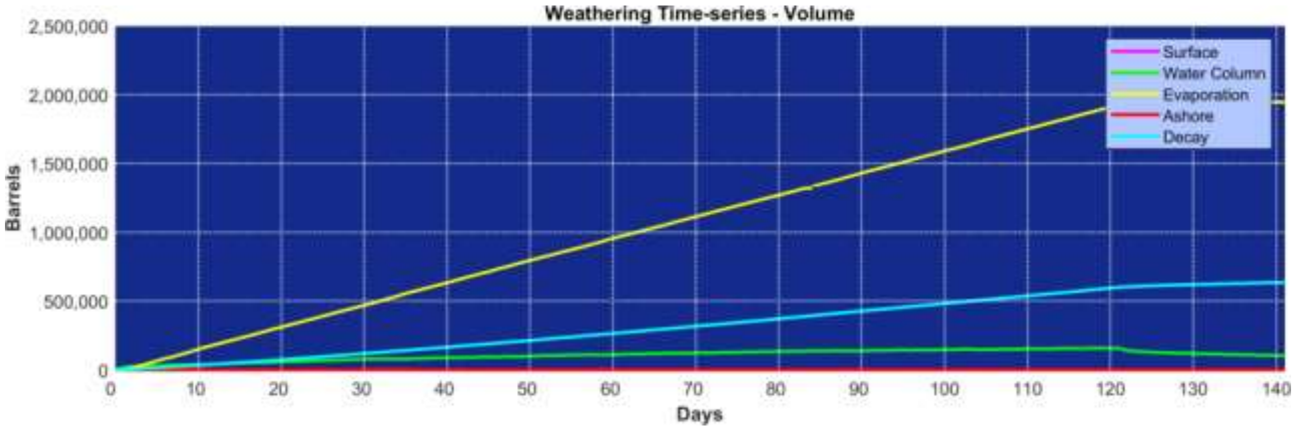

Figure 11.15 Predicted weathering and fates graph for the trajectory with the largest swept area of oil on the sea surface above 10 g/m². Results are based on a 2,727,570 bbl (22,542 bbl/day) subsea release of Mentorc condensate over 121 days, tracked for 141 days, commencing at 6 pm on the 3rd of August 2017.

12 RESULTS: SCENARIO 2: 1,000 M^3 SURFACE RELEASE OF MARINE GAS OIL

This scenario examined a 1,000 m^3 surface release of MGO from Point 1 and Point 4 over 6 hours, tracked for 40 days. A total of 300 spill trajectories were simulated across three seasons; summer, transitional and winter (i.e. 100 spills per season).

Section 12.1.1 presents the seasonal analysis and Section 12.1.2 presents the deterministic results for Point 1.

12.1 Point 1

12.1.1 Seasonal Analysis

12.1.1.1 Sea Surface Exposure

Table 12.1 summarises the maximum distances from the release location to oil exposure zones on the sea surface for each season.

The maximum distance from the release location to the low (≥ 1 g/m^2), moderate (≥ 10 g/m^2) and high (≥ 50 g/m^2) exposure thresholds was 69.5 km west-southwest (transitional), 35.3 km west (transitional) and 7.6 km west-southwest (summer and transitional), respectively.

Table 12.2 presents potential sea surface exposure to individual receptors during summer, transitional and winter conditions. Low sea surface exposure was predicted at the Ningaloo IMCRA, Ancient coastline at 125 m depth contour KEF and the Canyons KEF during all three seasons with probabilities ranging from 1% (Ningaloo IMCRA, summer) to 32% (Ancient coastline at 125 m depth contour KEF, transitional conditions). Additionally, exposure was predicted at the moderate threshold during all seasons with probabilities ranging from 1% (multiple receptors) to 8% (Ancient coastline at 125 m depth contour KEF, transitional conditions). Minimum times before sea surface exposure (at the low threshold) ranged from 0.38 days (9 hours) at Cape Range IMCRA and nearshore waters adjacent to Peak Island during winter conditions to 2.29 days (55 hours) for nearshore waters along Table Island during transitional conditions.

Figure 12.1 to Figure 12.3 present the zones of sea surface exposure at the low (≥ 1 g/m^2), moderate (≥ 10 g/m^2) and high (≥ 50 g/m^2) thresholds in summer, transitional and winter conditions.

Note, the release location resides within the Pilbarra (Offshore) IMCRA, hence it is not presented in the tabulated results.

Table 12.1 Maximum distance and direction from Point 1 to oil exposure thresholds on the sea surface. Results are based on a 1,000 m^3 surface release of MGO over 6 hours, tracked for 40 days during all seasonal conditions. The results were calculated from 100 spill trajectories per season.

Season	Distance and direction	Zones of potential sea surface exposure		
		Low	Moderate	High
Summer	Max. distance from release site (km)	55.9	33.9	7.6
	Max distance from release site (km) (99th percentile)	43.5	30.1	7.6
	Direction	W	W	WSW
Transitional	Max. distance from release site (km)	69.5	35.3	7.6
	Max distance from release site (km) (99th percentile)	61.4	32.4	7.5
	Direction	WSW	W	WSW
Winter	Max. distance from release site (km)	42.7	23.4	4.9
	Max distance from release site (km) (99th percentile)	37.8	21.8	4.9
	Direction	WSW	WSW	NNE

Table 12.2 Summary of the potential sea surface exposure to receptors. Results are based on a 1,000 m^3 surface release of MGO from Point 1 over 6 hours, tracked for 40 days during all seasonal conditions. The results were calculated from 100 spill trajectories per season.

Season	Receptor		Probability of oil exposure on the sea surface (%)			Minimum time before oil exposure on the sea surface (days)		
			Low	Moderate	High	Low	Moderate	High
Summer	IMCRA	Ningaloo	1	-	-	0.92	-	-
Summer	KEF	Ancient coastline at 125 m depth contour	18	2	-	0.50	0.67	-
Summer	KEF	Canyons linking the Cuvier Abyssal Plain and the Cape Range Peninsula (Canyons)	4	-	-	0.63	-	-
Summer	MMA	Muiron Islands	2	-	-	1.29	-	-
Transitional	AMP	Ningaloo	3	-	-	1.96	-	-
Transitional	IBRA	Cape Range	8	3	-	0.58	0.67	-
Transitional	IMCRA	Ningaloo	6	-	-	1.50	-	-
Transitional	KEF	Ancient coastline at 125 m depth contour	32	8	-	0.58	0.79	-
Transitional	KEF	Canyons linking the Cuvier Abyssal Plain and the Cape Range Peninsula (Canyons)	16	1	-	0.83	1.46	-
Transitional	KEF	Commonwealth waters adjacent to Ningaloo Reef	3	-	-	2.04	-	-
Transitional	MMA	Muiron Islands	3	1	-	0.88	0.96	-
Transitional	Nearshore Waters	Flat Island	5	4	-	0.58	0.63	-
Transitional	Nearshore Waters	Peak Island	2	-	-	0.54	-	-
Transitional	Nearshore Waters	Round Island	2	-	-	1.00	-	-
Transitional	Nearshore Waters	Serrurier Island	2	-	-	1.04	-	-
Transitional	Nearshore Waters	Table Island	1	-	-	2.29	-	-
Winter	IBRA	Cape Range	2	1	-	0.38	0.50	-
Winter	IMCRA	Ningaloo	2	-	-	1.38	-	-
Winter	KEF	Ancient coastline at 125 m depth contour	22	1	-	0.67	1.33	-
Winter	KEF	Canyons linking the Cuvier Abyssal Plain and the Cape Range Peninsula (Canyons)	12	1	-	0.92	1.46	-
Winter	MMA	Muiron Islands	6	1	-	0.58	0.83	-
Winter	Nearshore Waters	Murion Islands	1	-	-	0.75	-	-
Winter	Nearshore Waters	Peak Island	2	1	-	0.38	0.50	-

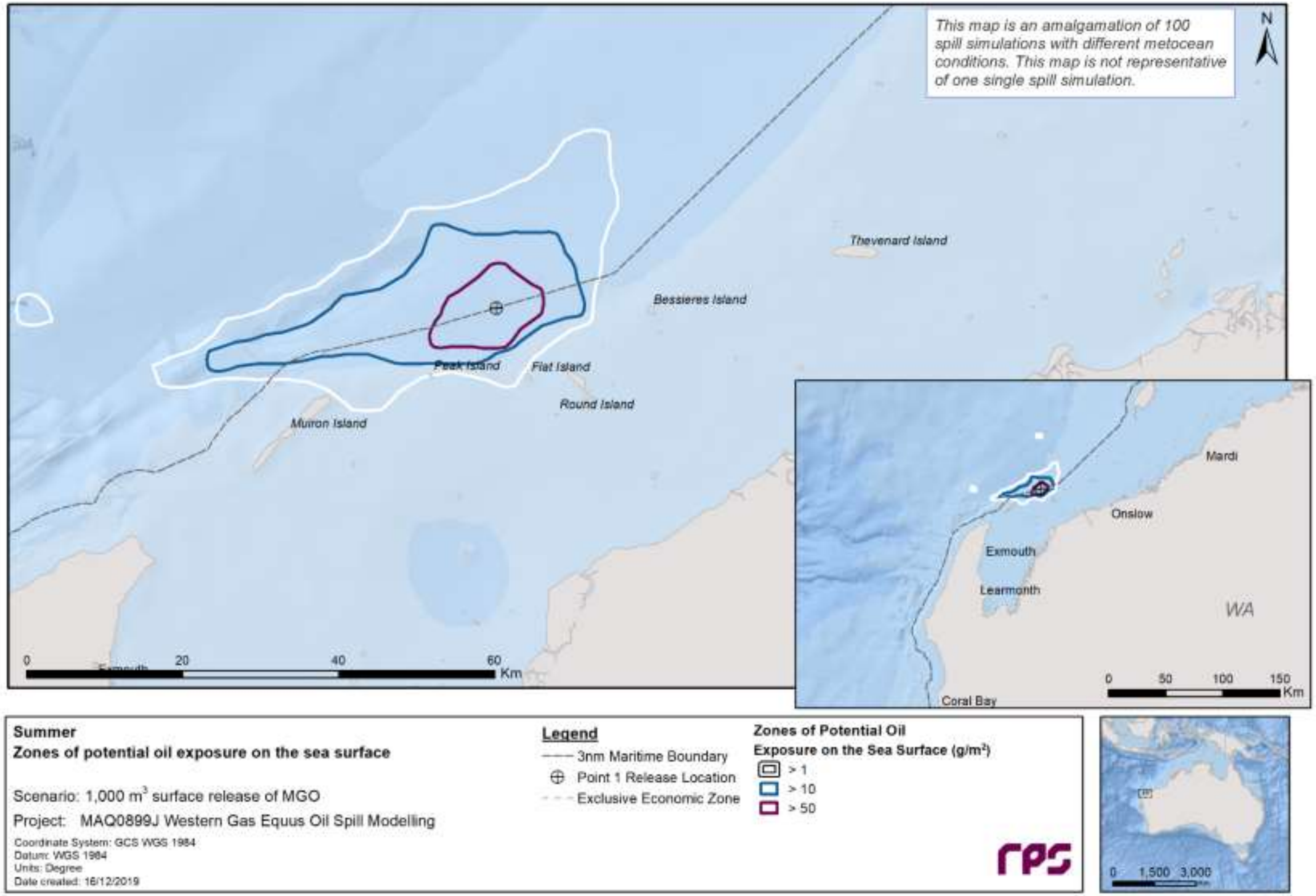

Figure 12.1 Zones of potential oil exposure on the sea surface for each threshold, in the event of a 1,000 m^3 surface release of MGO from Point 1 over 6 hours, tracked for 40 days. The results were calculated from 100 spill trajectories commencing during summer (September to March) conditions.

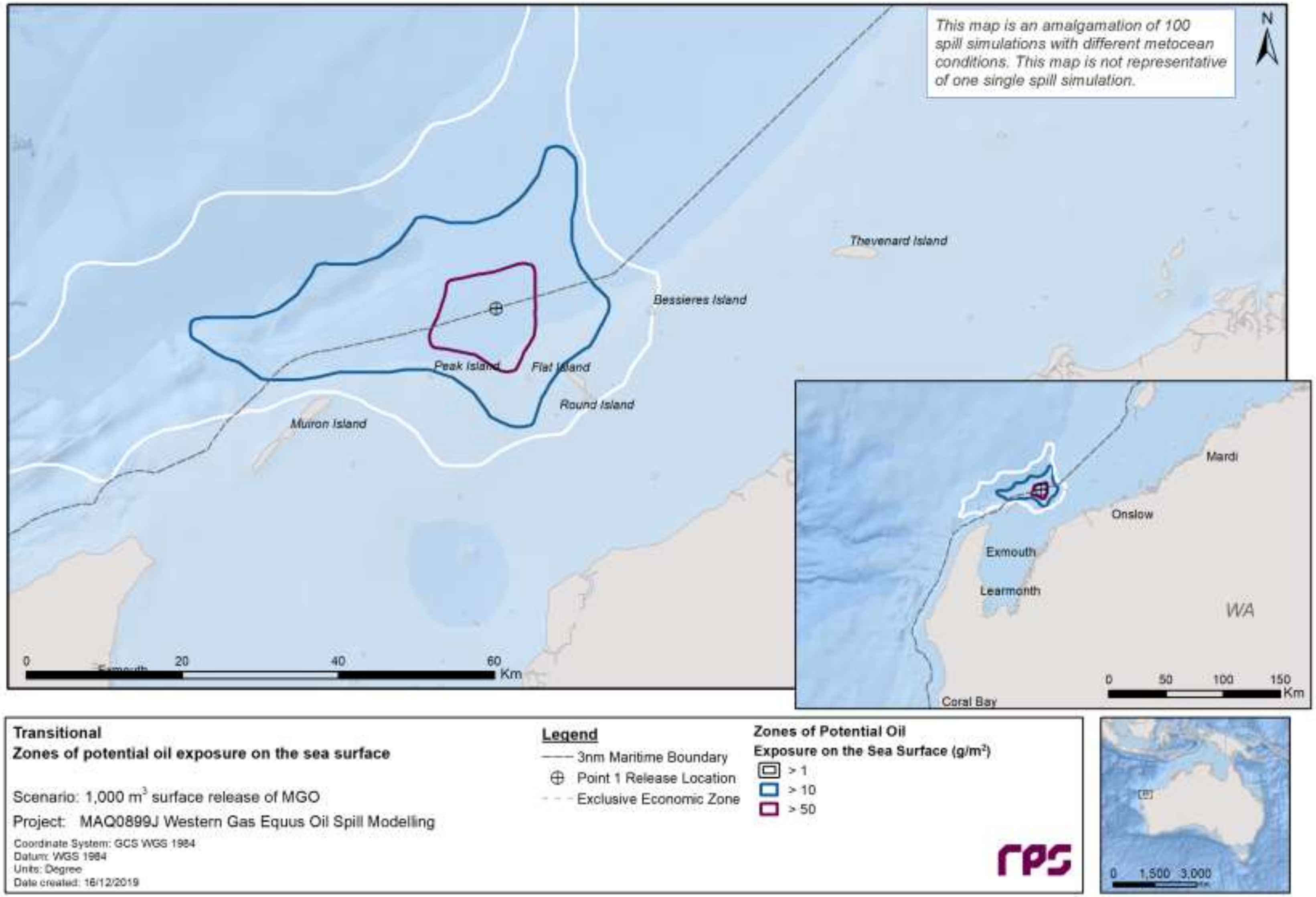

Figure 12.2 Zones of potential oil exposure on the sea surface for each threshold, in the event of a 1,000 m^3 surface release of MGO from Point 1 over 6 hours, tracked for 40 days. The results were calculated from 100 spill trajectories commencing during transitional (April and August) conditions.

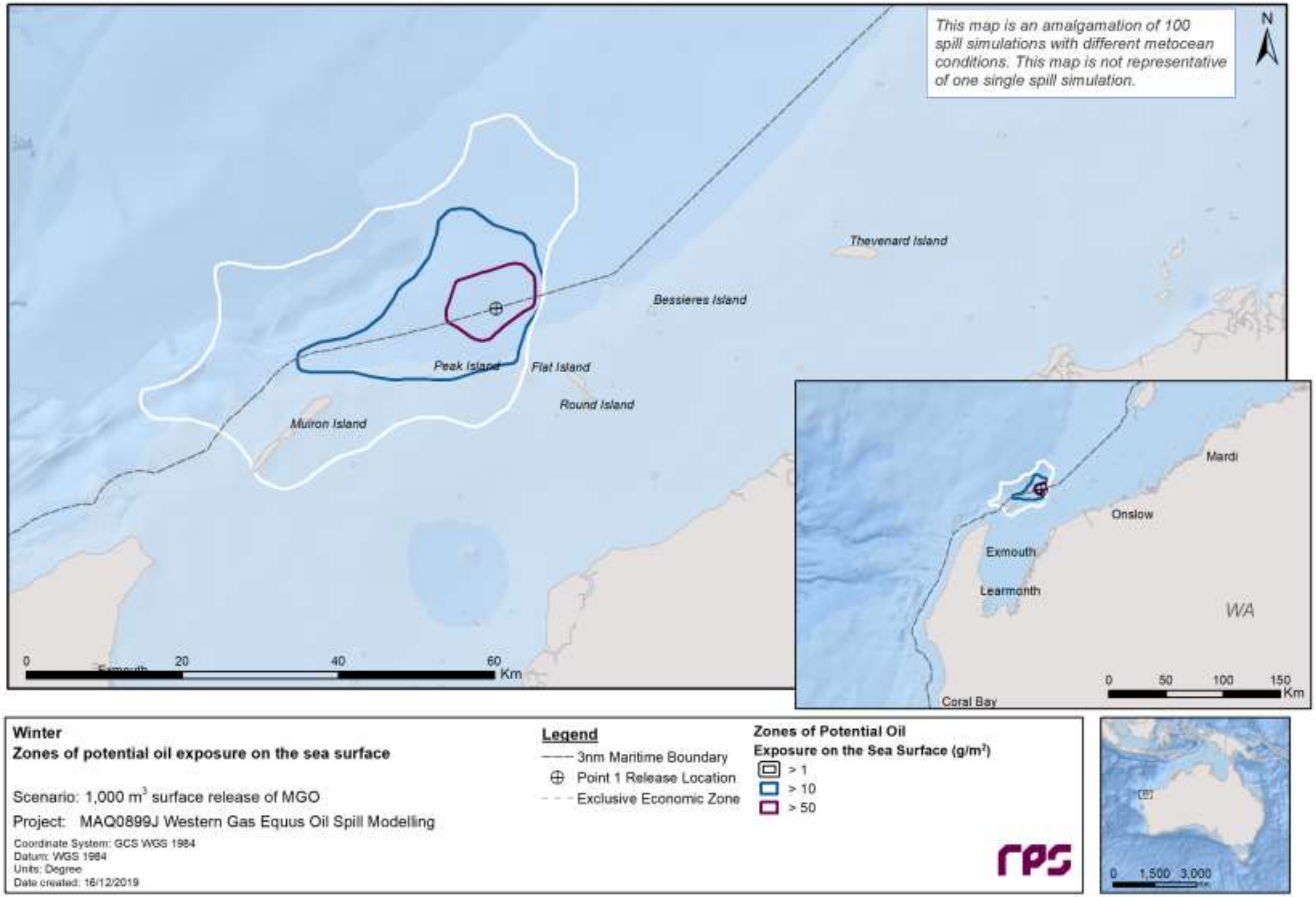

Figure 12.3 Zones of potential oil exposure on the sea surface for each threshold, in the event of a 1,000 m^3 surface release of MGO from Point 1 over 6 hours, tracked for 40 days. The results were calculated from 100 spill trajectories commencing during winter (May to July) conditions.

12.1.1.2 Shoreline Contact

Table 12.3 presents a summary of the predicted shoreline contact during summer, transitional and winter conditions. The probability of contact to any shoreline at, or above, the low threshold (≥ 10 g/m^2) was 3% in summer and winter, and 9% during transitional conditions. The minimum time before shoreline contact was approximately 0.4 days (~9 hours) during winter and the maximum volume of oil ashore was 147.8 m^3, recorded during transitional conditions.

Table 12.4 summarises the contact to nearby islands during summer, transitional and winter conditions. The probability of shoreline contact (at the low threshold) ranged from 1%, recorded by Peak Island in summer, Bessieres Island, Exmouth and Table Island in transitional conditions, to 6% at Flat Island during transitional conditions. The predicted minimum time before shoreline accumulation above the low threshold ranged from 0.38 days (~9 hours), recorded at Peak Island during winter, to 2.58 days (~62 hours) at Exmouth during transitional conditions.

The maximum potential shoreline loading above the low, moderate and high shoreline thresholds are presented for summer, winter and transitional conditions in Figure 12.4 to Figure 12.6.

Table 12.3 Summary of oil contact across all shorelines. Results are based on a 1,000 m^3 surface release of MGO from Point 1 over 6 hours, tracked for 40 days during all seasonal conditions. The results were calculated from 100 spill trajectories per season.

Shoreline Statistics	Summer	Transitional	Winter
Probability of contact to any shoreline (%)	3	9	3
Absolute minimum time for oil to accumulate on the shoreline at **10 g/m^2** (days)	0.88	0.50	0.38
Maximum volume of hydrocarbons ashore (m^3)	10.4	147.8	59.2
Average volume of hydrocarbons ashore (m^3)	3.8	45.0	22.4
Maximum length of the shoreline at **10 g/m^2** (km)	5.0	5.0	9.0
Average shoreline length (km) at **10 g/m^2** (km)	2.7	3.3	4.7
Maximum length of the shoreline at **100 g/m^2** (km)	4.0	5.0	7.0
Average shoreline length (km) at **100 g/m^2** (km)	4.0	2.4	3.3
Maximum length of the shoreline at **1,000 g/m^2** (km)	-	2.0	1.0
Average shoreline length (km) at **1,000 g/m^2** (km)	-	1.7	1.0

Table 12.4 Summary of oil contact to nearby islands. Results are based on a 1,000 m^3 surface release of MGO from Point 1 over 6 hours, tracked for 40 days during all seasonal conditions. The results were calculated from 100 spill trajectories.

Season	Shoreline receptor	Maximum probability of shoreline loading (%)			Minimum time before shoreline accumulation (days)			Load on shoreline (g/m^2)		Volume on shoreline (m^3)		Mean length of shoreline contacted (km)			Maximum length of shoreline contacted (km)		
		Low	Moderate	High	Low	Moderate	High	Mean	Peak	Mean	Peak	Low	Moderate	High	Low	Moderate	High
Summer	Exmouth	2	1	-	2.29	2.46	-	104.9	326.7	3.6	10.4	3.5	4.0	-	5.0	4.0	-
	Peak Island	1	-	-	0.88	-	-	41.9	41.9	<1	<1	1.0	-	-	1.0	-	-
Transitional	Bessieres Island	1	1	-	1.54	1.63	-	242.5	287.5	0.9	8.2	3.0	3.0	-	3.0	3.0	-
	Exmouth	1	1	-	2.58	2.92	-	45.9	117.2	0.2	1.6	2.0	1.0	-	2.0	1.0	-
	Flat Island	6	6	4	0.54	0.63	0.67	1,807.2	9,756.2	40.5	147.8	2.5	2.2	1.5	3.0	3.0	2.0
	Peak Island	2	2	-	0.50	0.54	-	170.9	391.3	0.6	4.5	1.0	1.0	-	1.0	1.0	-
	Round Island	2	1	1	1.04	1.71	1.79	780.5	1,514.1	2.0	17.2	1.0	1.0	1.0	1.0	1.0	1.0
	Serrurier Island	2	1	-	2.29	2.38	-	94.5	273.1	0.8	6.4	2.5	2.0	-	4.0	2.0	-
	Table Island	1	-	-	2.29	-	-	97.6	97.6	0.1	1.1	1.0	-	-	1.0	-	-
Winter	Murion Islands	2	2	-	0.79	0.79	-	215.5	954.2	12.0	31.0	6.0	4.0	-	8.0	6.0	-
	Peak Island	2	2	1	0.38	0.38	0.42	1,367.6	2,479.0	10.4	28.3	1.0	1.0	1.0	1.0	1.0	1.0

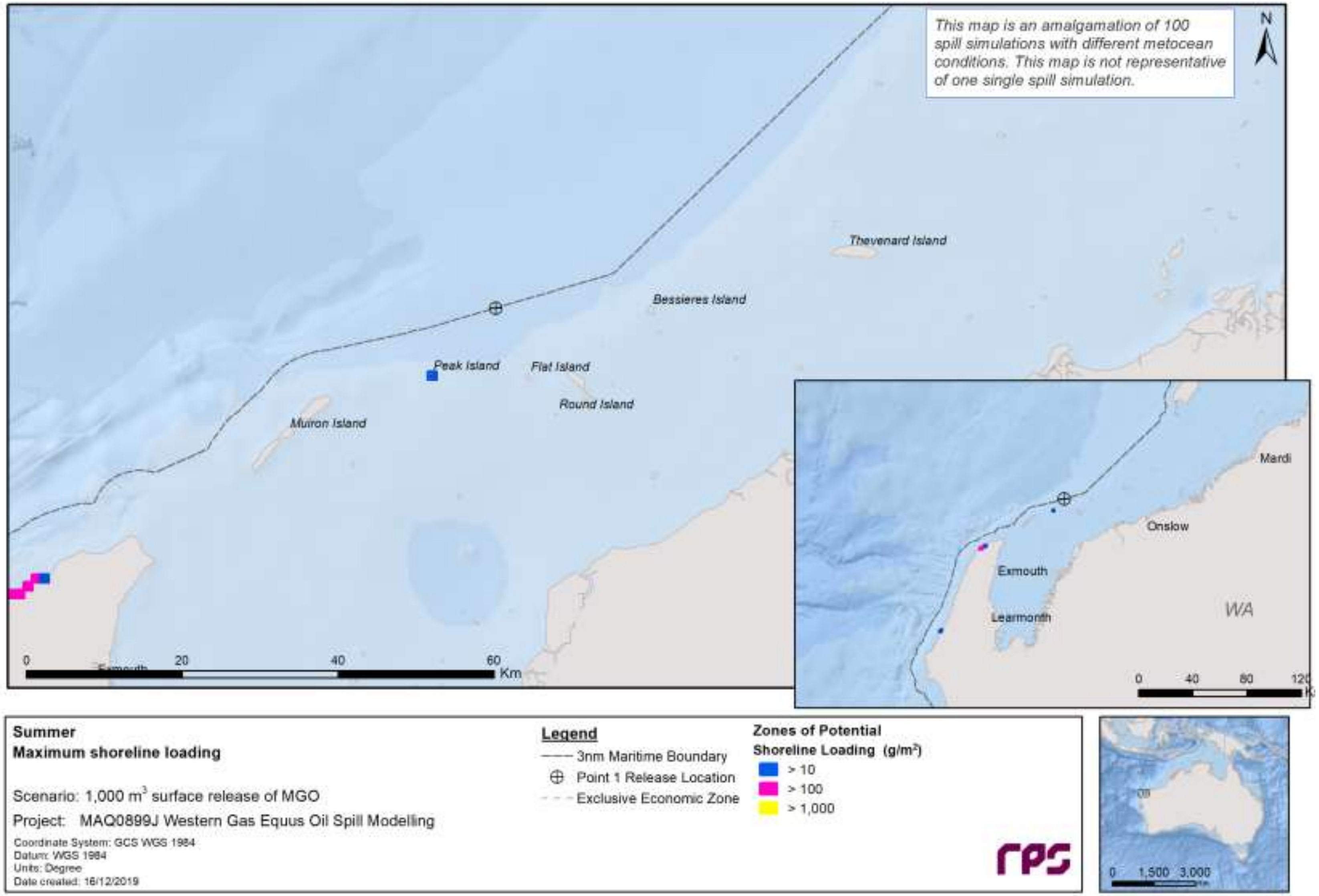

Figure 12.4 Maximum potential shoreline loading in the event of a 1,000 m^3 surface release of MGO from Point 1 over 6 hours, tracked for 40 days during summer (September to March) conditions. The results were calculated from 100 spill trajectories.

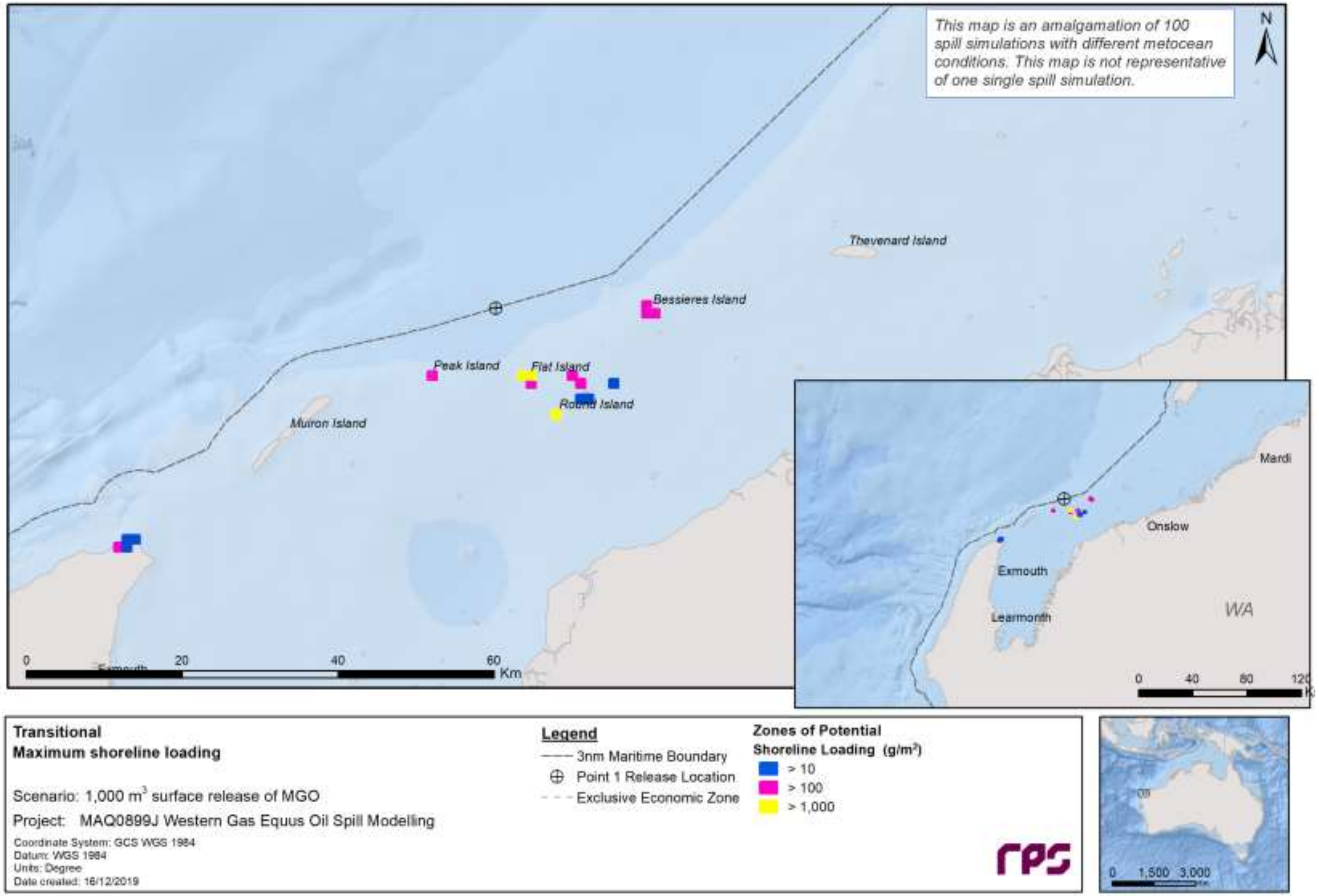

Figure 12.5 Maximum potential shoreline loading in the event of a 1,000 m^3 surface release of MGO from Point 1 over 6 hours, tracked for 40 days during transitional (April and August) conditions. The results were calculated from 100 spill trajectories.

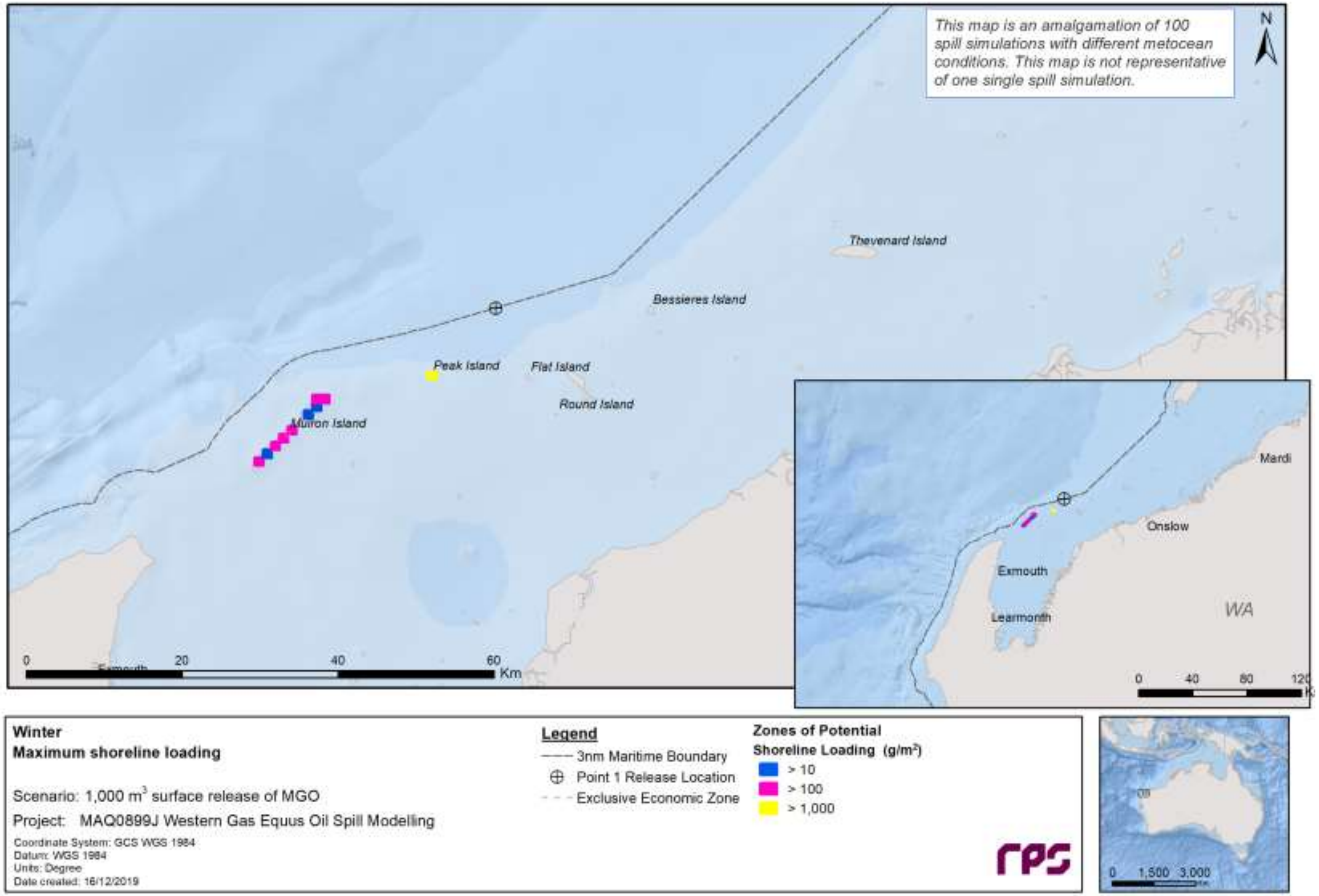

Figure 12.6 Maximum potential shoreline loading in the event of a 1,000 m^3 surface release of MGO from Point 1 over 6 hours, tracked for 40 days during winter (May to July) conditions. The results were calculated from 100 spill trajectories.

12.1.1.3 Water Column Exposure

12.1.1.3.1 Dissolved Hydrocarbons

Table 12.5 summarises the maximum distance and direction from the release location to dissolved hydrocarbon exposure zones at the low (≥ 10 ppb), moderate (≥ 50 ppb) and high (≥ 400 ppb) thresholds, in the 0-10 m depth layer. The maximum distance of low and moderate dissolved hydrocarbon exposure was 402.4 km (southwest) and 1.7 km (southwest), recorded during winter conditions, respectively. No dissolved hydrocarbon exposure was predicted at the high threshold.

Table 12.6 to Table 12.7 summarise the seasonal probability of exposure to receptors from dissolved hydrocarbons in the 0-10 m, 10-20 m and 20-30 m depth layers, respectively, at the low (≥ 10 ppb), moderate (≥ 50 ppb) and high (≥ 400 ppb) exposure thresholds (NOPSEMA, 2019).

In the surface (0-10 m) depth layer, the Ningaloo IMCRA, Ancient coastline at 125 m depth contour KEF and the Canyons KEF were all predicted to be exposed at the low threshold during every season with probabilities of exposure ranging from 3% to 9% in summer, 4% to 13% during transitional conditions and 3% to 8% in winter. No receptors were predicted to be exposed at or above the moderate threshold.

The greatest probability of dissolved hydrocarbon exposure for the 10-20 m layer above the low threshold was predicted as 3%, recorded by the Ningaloo IMCRA during winter, the Ancient coastline at 125 m depth contour KEF during transitional conditions and the Canyons linking the Cuvier Abyssal Plain and the Cape Range Peninsula KEF during transitional and winter conditions. No receptors were predicted to be exposed at or above the moderate dissolved hydrocarbon threshold within this depth layer.

In the 20-30 m layer, the Ningaloo AMP, Ningaloo IMCRA and the Commonwealth waters adjacent to Ningaloo Reef KEF were the only receptors predicted to be exposed at the low dissolved hydrocarbon threshold, each recording a 1% probability of exposure during transitional conditions. No receptors were predicted to be exposed to dissolved hydrocarbons during summer and winter conditions.

Figure 12.7 to Figure 12.12 presents the zones of potential instantaneous dissolved hydrocarbon exposure for the 0-10 m and 10-20 m depth layers for the summer, transitional and winter periods, respectively.

Table 12.5 Maximum distance and direction from the release location to dissolved hydrocarbon exposure (0 – 10m). Results are based on a 1,000 m^3 surface release of MGO from Point 1 over 6 hours, tracked for 40 days for all seasons. The results were calculated from 100 spill simulations per season.

Season	Distance and direction travelled	Zones of potential dissolved hydrocarbon exposure		
		Low 6 ppb	Moderate 50 ppb	High 400 ppb
Summer	Maximum distance (km) from the release location	161.9	1.5	-
	Direction	NW	NNW	-
Transitional	Maximum distance (km) from the release location	175.2	0.8	-
	Direction	WSW	WNW	-
Winter	Maximum distance (km) from the release location	402.4	1.7	-
	Direction	SW	W	-

Table 12.6 Predicted probability and maximum dissolved hydrocarbon exposure to individual receptors in the 0-10 m depth layer. Results are based on a 1,000 m^3 surface release of MGO from Point 1 over 6 hours, tracked for 40 days during all seasonal conditions. The results were calculated from 100 spill trajectories per season.

Season	Receptor		Maximum exposure to dissolved hydrocarbons (ppb)	Probability of exposure to dissolved hydrocarbons (%)		
				Low	Moderate	High
Summer	AMP	Gascoyne	16	1	-	-
	AMP	Ningaloo	22	2	-	-
	IBRA	Cape Range	21	3	-	-
	IMCRA	Ningaloo	25	3	-	-
	KEF	Ancient coastline at 125 m depth contour	44	9	-	-
		Canyons linking the Cuvier Abyssal Plain and the Cape Range Peninsula (Canyons)	46	7	-	-
		Commonwealth waters adjacent to Ningaloo Reef	22	2	-	-
		Exmouth Plateau	11	1	-	-
	MMA	Muiron Islands	31	5	-	-
	MP	Ningaloo	25	3	-	-
	RSB	Ningaloo Reef	22	2	-	-
	Nearshore Waters	Exmouth	21	3	-	-
		Murion Islands	14	1	-	-
		Peak Island	18	2	-	-
Transitional	AMP	Gascoyne	18	2	-	-
		Ningaloo	28	4	-	-
	IBRA	Cape Range	27	2	-	-
	IMCRA	Ningaloo	28	4	-	-
		Pilbarra (nearshore)	13	1	-	-
	KEF	Ancient coastline at 125 m depth contour	32	13	-	-
		Canyons linking the Cuvier Abyssal Plain and the Cape Range Peninsula (Canyons)	35	7	-	-
		Commonwealth waters adjacent to Ningaloo Reef	28	4	-	-
	MMA	Muiron Islands	19	4	-	-
	MP	Ningaloo	20	2	-	-
	RSB	Ningaloo Reef	20	1	-	-
	Nearshore Waters	Exmouth	27	2	-	-
		Murion Islands	10	1	-	-
		Peak Island	12	1	-	-
Winter	AMP	Gascoyne	19	3	-	-
		Ningaloo	25	2	-	-
	IBRA	Cape Range	15	3	-	-
	IMCRA	Ningaloo	25	3	-	-
	KEF	Ancient coastline at 125 m depth contour	36	8	-	-
		Canyons linking the Cuvier Abyssal Plain and the Cape Range Peninsula (Canyons)	34	6	-	-
		Commonwealth waters adjacent to Ningaloo Reef	25	2	-	-

Season	Receptor		Maximum exposure to dissolved hydrocarbons (ppb)	Probability of exposure to dissolved hydrocarbons (%)		
				Low	Moderate	High
	MMA	Muiron Islands	25	2	-	-
	MP	Ningaloo	25	2	-	-
	RSB	Ningaloo Reef	11	1	-	-
	Nearshore Waters	Exmouth	15	1	-	-
		Murion Islands	11	1	-	-
		Peak Island	13	3	-	-

Table 12.7 Predicted probability and maximum dissolved hydrocarbon exposure to individual receptors in the 10-20 m depth layer. Results are based on a 1,000 m^3 surface release of MGO from Point 1 over 6 hours, tracked for 40 days during all seasonal conditions. The results were calculated from 100 spill trajectories per season.

Season	Receptor		Maximum exposure to dissolved hydrocarbons (ppb)	Probability of exposure to dissolved hydrocarbons (%)		
				Low	Moderate	High
Summer	AMP	Gascoyne	14	1	-	-
	AMP	Ningaloo	12	1	-	-
	IBRA	Cape Range	12	1	-	-
	IMCRA	Ningaloo	16	2	-	-
	KEF	Ancient coastline at 125 m depth contour	21	2	-	-
		Canyons linking the Cuvier Abyssal Plain and the Cape Range Peninsula (Canyons)	24	2	-	-
		Commonwealth waters adjacent to Ningaloo Reef	12	1	-	-
	MMA	Muiron Islands	16	1	-	-
	MP	Ningaloo	16	1	-	-
	RSB	Ningaloo Reef	12	1	-	-
	Nearshore Waters	Exmouth	12	1	-	-
Transitional	AMP	Gascoyne	14	1	-	-
		Ningaloo	17	2	-	-
	IBRA	Cape Range	15	1	-	-
	IMCRA	Ningaloo	22	2	-	-
	KEF	Ancient coastline at 125 m depth contour	25	3	-	-
		Canyons linking the Cuvier Abyssal Plain and the Cape Range Peninsula (Canyons)	22	3	-	-
		Commonwealth waters adjacent to Ningaloo Reef	17	2	-	-
	MMA	Muiron Islands	11	1	-	-
	MP	Ningaloo	18	1	-	-
	RSB	Ningaloo Reef	13	1	-	-
	Nearshore Waters	Exmouth	15	1	-	-
		Murion Islands	11	1	-	-
Winter	AMP	Gascoyne	16	1	-	-
		Ningaloo	15	2	-	-
	IMCRA	Ningaloo	25	3	-	-
	KEF	Ancient coastline at 125 m depth contour	22	2	-	-
		Canyons linking the Cuvier Abyssal Plain and the Cape Range Peninsula (Canyons)	28	3	-	-
		Commonwealth waters adjacent to Ningaloo Reef	15	2	-	-
	MMA	Muiron Islands	23	1	-	-
	MP	Ningaloo	18	1	-	-

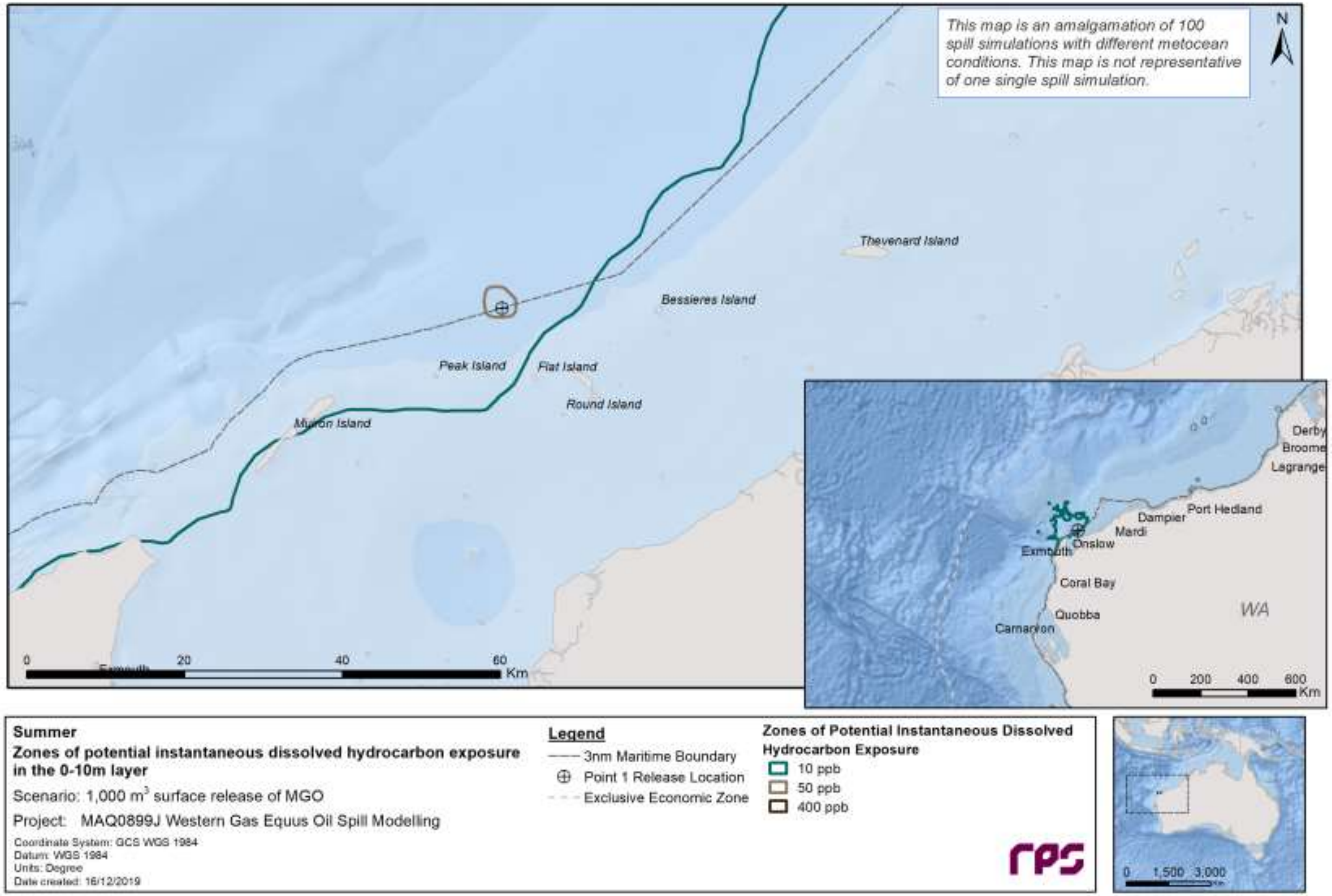

Figure 12.7 Zones of potential instantaneous dissolved hydrocarbon exposure at 0-10 m below the sea surface in the event of a 1,000 m^3 surface release of MGO from Point 1 over 6 hours, tracked for 40 days. The results were calculated from 100 spill trajectories commencing during summer (September to March) conditions.

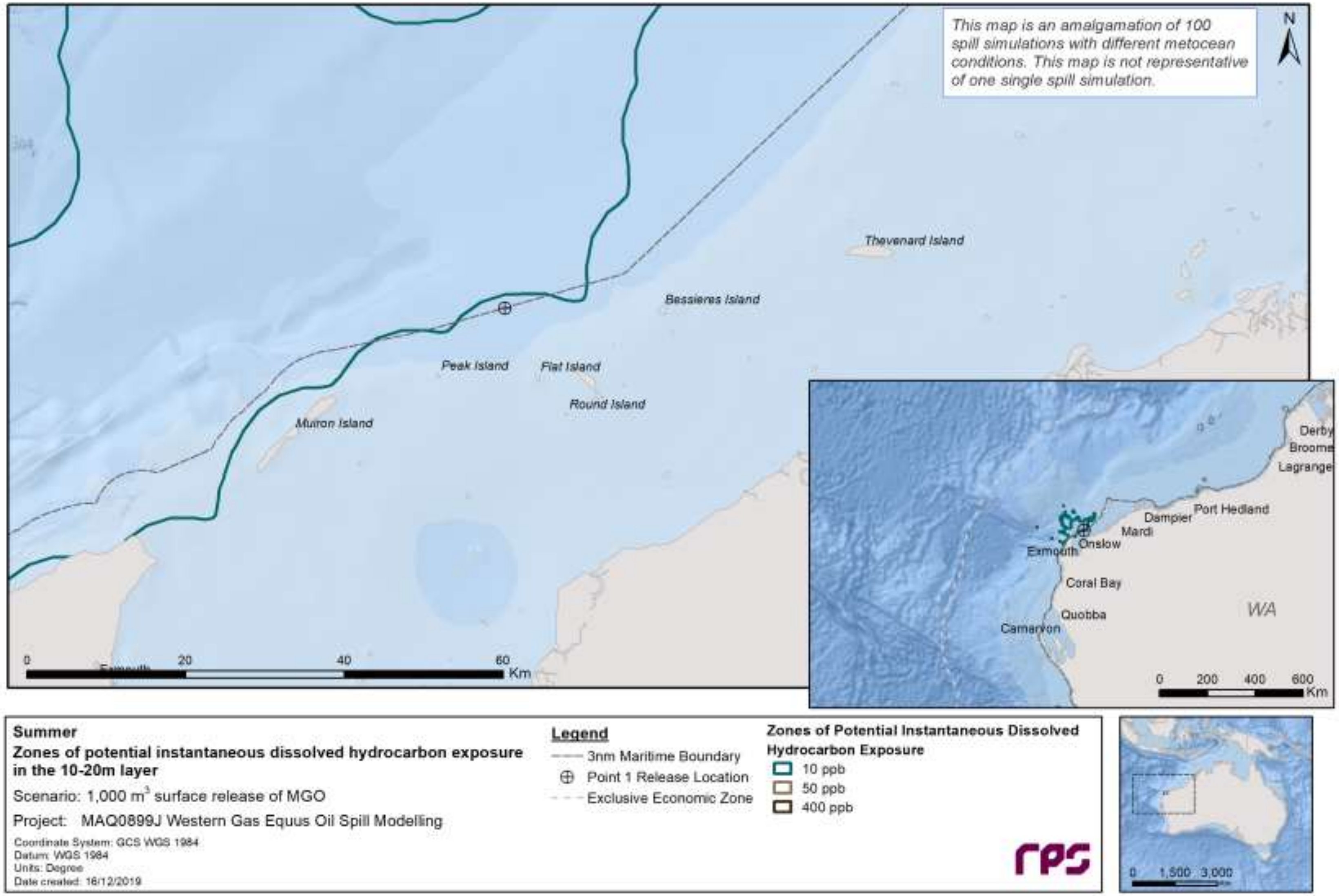

Figure 12.8 Zones of potential instantaneous dissolved hydrocarbon exposure at 10-20 m below the sea surface in the event of a 1,000 m^3 surface release of MGO from Point 1 over 6 hours, tracked for 40 days. The results were calculated from 100 spill trajectories commencing during summer (September to March) conditions.

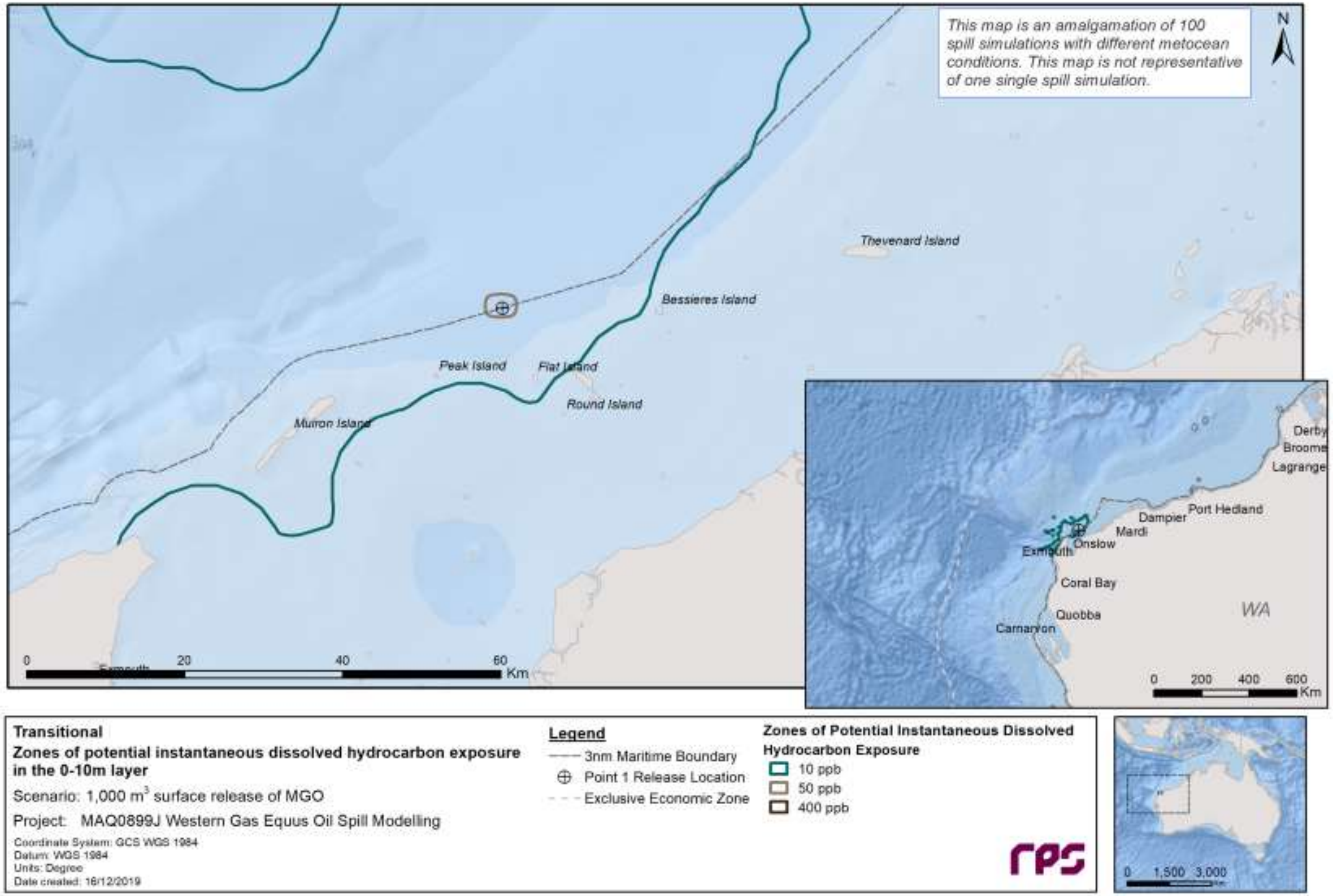

Figure 12.9 Zones of potential instantaneous dissolved hydrocarbon exposure at 0-10 m below the sea surface in the event of a 1,000 m^3 surface release of MGO from Point 1 over 6 hours, tracked for 40 days. The results were calculated from 100 spill trajectories commencing during transitional (April and August) conditions.

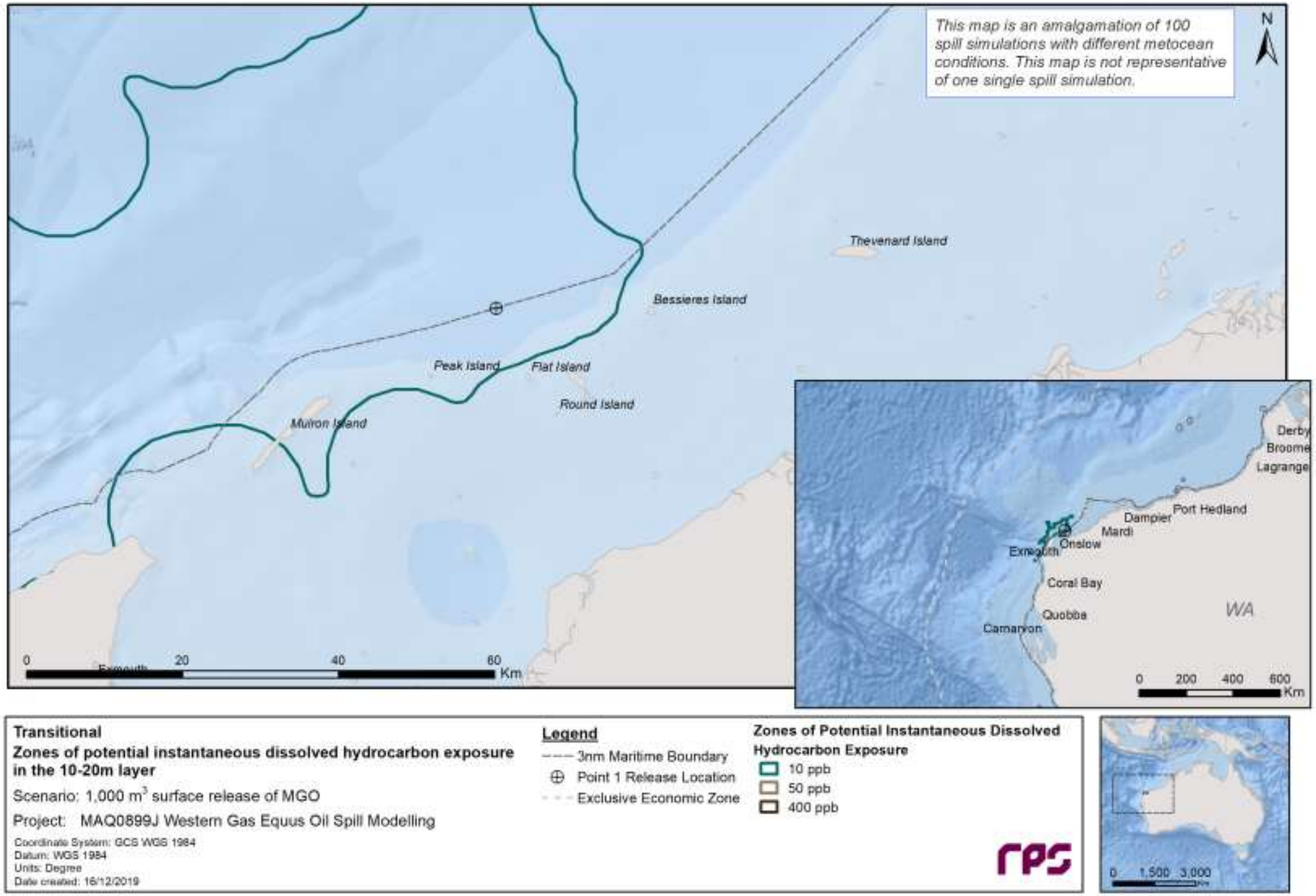

Figure 12.10 Zones of potential instantaneous dissolved hydrocarbon exposure at 10-20 m below the sea surface in the event of a 1,000 m^3 surface release of MGO from Point 1 over 6 hours, tracked for 40 days. The results were calculated from 100 spill trajectories commencing during transitional (April and August) conditions.

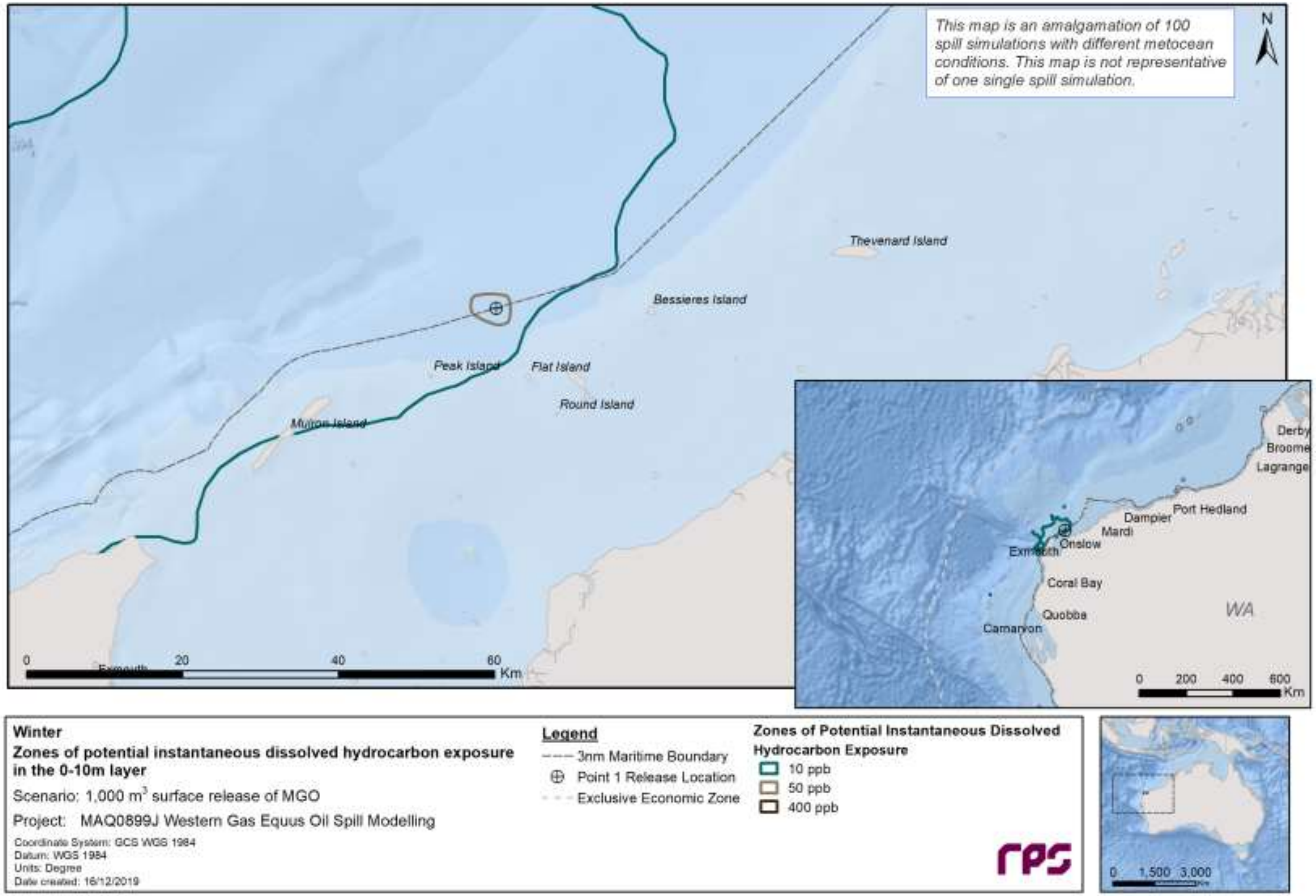

Figure 12.11 Zones of potential instantaneous dissolved hydrocarbon exposure at 0-10 m below the sea surface in the event of a 1,000 m^3 surface release of MGO from Point 1 over 6 hours, tracked for 40 days. The results were calculated from 100 spill trajectories commencing during winter (May to July) conditions.

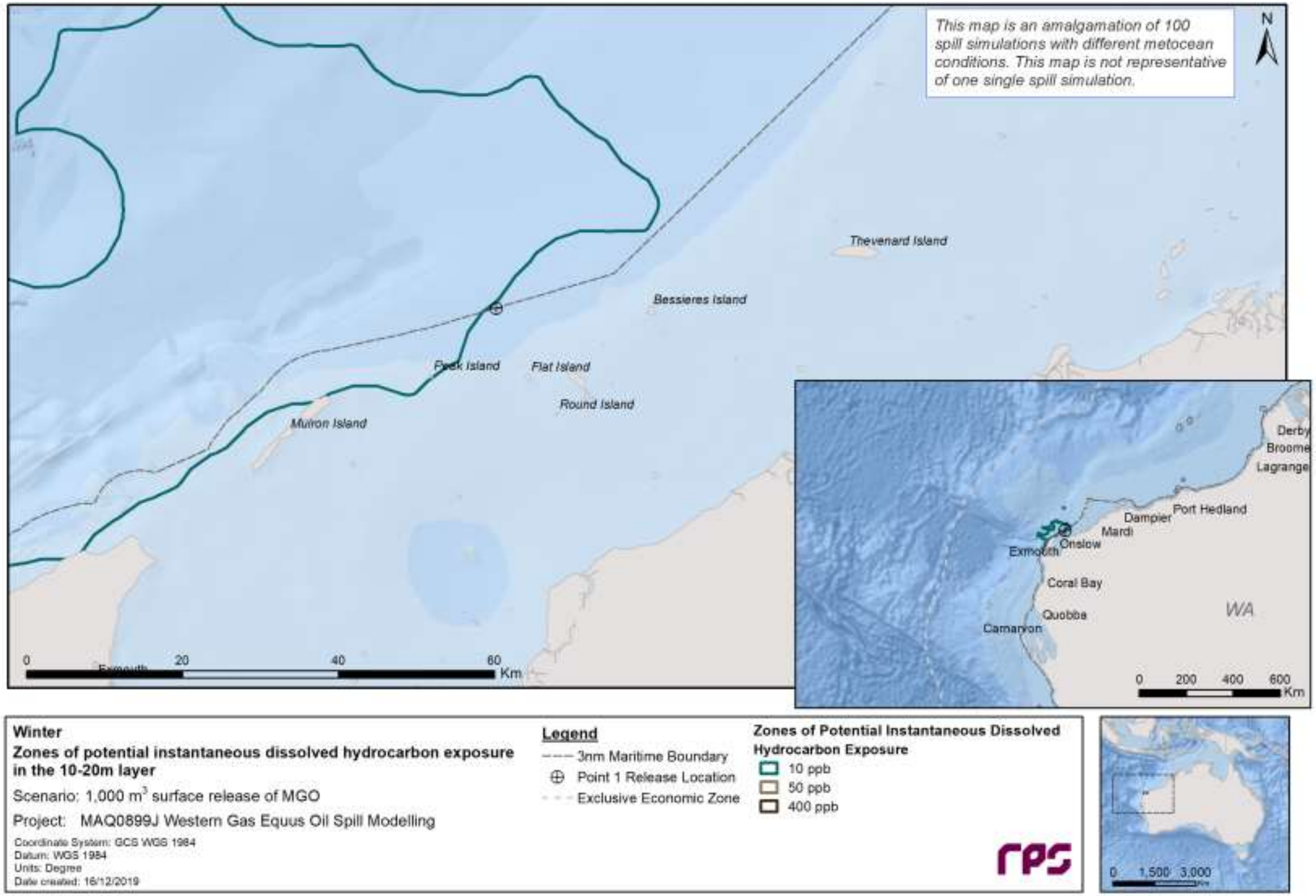

Figure 12.12 Zones of potential instantaneous dissolved hydrocarbon exposure at 10-20 m below the sea surface in the event of a 1,000 m^3 surface release of MGO from Point 1 over 6 hours, tracked for 40 days. The results were calculated from 100 spill trajectories commencing during winter (May to July) conditions.

12.1.1.3.2 Entrained Hydrocarbons

Table 12.8 summarises the maximum distance and direction from the release location to entrained hydrocarbon exposure zones at the low (≥ 10 ppb) and high (≥ 100 ppb) thresholds, in the 0-10 m depth layer. The maximum distance of low and high entrained hydrocarbon exposure was 824.3 km (south-southwest) and 367.3 km (west-southwest), recorded during winter conditions, respectively.

Table 12.9 to Table 12.11 summarise the probability of exposure to receptors from entrained hydrocarbons in the 0-10 m depth layer, in summer, transitional and winter conditions, at the low (≥ 10 ppb) and high (≥ 100 ppb) entrained hydrocarbon exposure thresholds (NOPSEMA, 2019).

At the surface layer (0-10 m), the Ningaloo IMCRA, Ancient coastline at 125 m depth contour KEF and the Canyons KEF were predicted to be exposed at the low threshold with probabilities ranging from 53% to 58% in summer, 46% to 48% in transitional conditions and 51% to 52% in winter. At the high entrained hydrocarbon threshold, the maximum probability of exposure was 42% at the Ancient coastline at 125 m depth contour KEF during summer while it also recorded 38% and 42% probabilities of high entrained hydrocarbon exposure during transitional and winter conditions.

Table 12.12 summarises the probability of exposure to receptors from entrained hydrocarbons in the 10-20 m depth layer, during all seasonal conditions and at the low (≥ 10 ppb) and high (≥ 100 ppb) entrained hydrocarbon exposure thresholds.

The greatest probabilities of low exposure in the 10-20 m layer were recorded at the Ancient coastline at 125 m depth contour KEF during all seasons with predicted probabilities of 11%, 13% and 10% during summer, transitional and winter conditions, respectively. The Ningaloo IMCRA and the Canyons KEF were also predicted to be exposed at the low entrained hydrocarbon threshold, with probabilities of 3% and 8% during summer and transitional conditions, respectively, and 5% and 7% during winter. No receptors were predicted to be exposed at, or above the low entrained hydrocarbon threshold in the 20-30 m depth layer.

Figure 12.13 to Figure 12.18 illustrates the zones of potential entrained hydrocarbon exposure for the low (≥ 10 ppb) and high (≥ 100 ppb) entrained hydrocarbon thresholds in the 0-10 m and 10-20 m depth layers in summer, transitional and winter conditions.

Table 12.8 Maximum distance and direction from the release location to entrained hydrocarbon exposure (0 – 10m). Results are based on a 1,000 m^3 surface release of MGO from Point 1 over 6 hours, tracked for 40 days for all seasons. The results were calculated from 100 spill simulations per season.

Season	Distance and direction travelled	Zones of potential entrained hydrocarbon exposure	
		Low 10 ppb	High 100 ppb
Summer	Maximum distance (km) from the release location	727.5	288.2
	Direction	WSW	NNW
Transitional	Maximum distance (km) from the release location	625.5	337.0
	Direction	NNE	SW
Winter	Maximum distance (km) from the release location	824.3	367.3
	Direction	SSW	WSW

Table 12.9 Predicted probability and maximum entrained hydrocarbon exposure to individual receptors in the 0-10 m depth layer. Results are based on a 1,000 m^3 surface release of MGO from Point 1 over 6 hours, tracked for 40 days, during summer (September to March) conditions.

Receptor		Maximum exposure to entrained hydrocarbons (ppb)	Probability of exposure to entrained hydrocarbons	
			Low	High
AMP	Abrolhos	16	2	-
	Carnarvon Canyon	39	2	-
	Gascoyne	659	32	11
	Montebello	85	4	-
	Ningaloo	1,308	34	15
	Shark Bay	50	6	-
IBRA	Cape Range	1,729	20	11
IMCRA	Ningaloo	1,326	53	29
	Northwest Shelf	43	4	-
	Pilbarra (nearshore)	573	8	5
	Zuytdorp	50	6	-
KEF	Ancient coastline at 125 m depth contour	3,338	58	42
	Canyons linking the Cuvier Abyssal Plain and the Cape Range Peninsula (Canyons)	2,738	57	35
	Commonwealth waters adjacent to Ningaloo Reef	1,308	34	15
	Exmouth Plateau	297	16	5
	Glomar Shoals	32	2	-
	Wallaby Saddle	15	2	-
	Western demersal slope and associated fish communities	28	1	-
MMA	Barrow Island	36	2	-
	Muiron Islands	1,960	35	24
MP	Montebello Islands	61	2	-
	Ningaloo	1,223	23	13
RSB	Baylis Patches	23	1	-
	Beryl Reef	26	2	-
	Locker Reef	27	1	-
	Montebello Shoals	28	2	-
	Ningaloo Reef	1,118	13	7
	Pearl Reef	11	1	-
	Penguin Bank	20	1	-
	Rankin Bank	17	1	-
	Tryal Rocks	31	3	-
Nearshore Waters	Bessieres Island	11	1	-
	Exmouth	1,077	13	7
	Flat Island	261	6	1
	Fly Island	52	1	-
	Hermite Island	22	2	-
	Locker Island	19	1	-
	Murion Islands	768	20	8
	Observation Island	98	4	-

Receptor		Maximum exposure to entrained hydrocarbons (ppb)	Probability of exposure to entrained hydrocarbons	
			Low	High
	Peak Island	1,734	17	11
	Round Island	42	2	-
	Serrurier Island	68	4	-
	Sunday Island	122	6	1
	Table Island	22	3	-

Table 12.10 Predicted probability and maximum entrained hydrocarbon exposure to individual receptors in the 0-10 m depth layer. Results are based on a 1,000 m^3 surface release of MGO from Point 1 over 6 hours, tracked for 40 days, during transitional (April and August) conditions.

Receptor		Maximum exposure to entrained hydrocarbons (ppb)	Probability of exposure to entrained hydrocarbons	
			Low	High
AMP	Abrolhos	13	1	-
	Argo-Rowley Terrace	12	2	-
	Carnarvon Canyon	19	2	-
	Gascoyne	646	31	9
	Montebello	11	1	-
	Ningaloo	1,563	41	24
	Shark Bay	25	3	-
IBRA	Cape Range	1,119	21	12
IMCRA	Ningaloo	1,549	46	27
	Northwest Shelf	32	2	-
	Pilbarra (nearshore)	527	7	4
	Zuytdorp	25	5	-
KEF	Ancient coastline at 125 m depth contour	3,825	48	38
	Canyons linking the Cuvier Abyssal Plain and the Cape Range Peninsula (Canyons)	2,575	48	31
	Commonwealth waters adjacent to Ningaloo Reef	1,563	41	24
	Exmouth Plateau	143	16	2
	Wallaby Saddle	11	1	-
	Western demersal slope and associated fish communities	12	1	-
MMA	Muiron Islands	2,686	36	28
MP	Ningaloo	1,502	28	13
RSB	Brewis Reef	12	1	-
	Ningaloo Reef	860	18	10
Nearshore Waters	Bessieres Island	274	5	1
	Exmouth	897	15	8
	Flat Island	931	8	5
	Murion Islands	957	20	10
	Observation Island	39	2	-
	Peak Island	1,119	21	12

Receptor		Maximum exposure to entrained hydrocarbons (ppb)	Probability of exposure to entrained hydrocarbons	
			Low	High
	Round Island	180	5	2
	Serrurier Island	201	7	2
	Sunday Island	324	2	2
	Table Island	99	5	-
	Tortoise Island	19	3	-

Table 12.11 Predicted probability and maximum entrained hydrocarbon exposure to individual receptors in the 0-10 m depth layer. Results are based on a 1,000 m^3 surface release of MGO from Point 1 over 6 hours, tracked for 40 days, during winter (May to July) conditions.

Receptor		Maximum exposure to entrained hydrocarbons (ppb)	Probability of exposure to entrained hydrocarbons	
			Low	High
AMP	Abrolhos	15	3	-
	Carnarvon Canyon	61	7	-
	Gascoyne	987	47	22
	Montebello	20	1	-
	Ningaloo	1,233	43	23
	Shark Bay	23	5	-
IBRA	Cape Range	1,505	25	15
IMCRA	Ningaloo	1,632	52	30
	Northwest Shelf	25	1	-
	Pilbarra (nearshore)	361	9	5
	Zuytdorp	26	5	-
KEF	Ancient coastline at 125 m depth contour	3,641	51	40
	Canyons linking the Cuvier Abyssal Plain and the Cape Range Peninsula (Canyons)	2,504	51	32
	Commonwealth waters adjacent to Ningaloo Reef	1,233	44	23
	Exmouth Plateau	175	15	3
	Perth Canyon and adjacent shelf break, and other west coast canyons	30	1	-
	Perth Canyon and adjacent shelf break, and other west coast canyons	30	1	-
	Western demersal slope and associated fish communities	36	3	-
MMA	Muiron Islands	1,632	52	41
MP	Ningaloo	860	28	18
RSB	Ningaloo Reef	599	17	5
Nearshore Waters	Exmouth	607	16	5
	Flat Island	32	1	-
	Murion Islands	902	25	14
	Peak Island	1,505	20	15
	Sunday Island	136	4	1

Table 12.12 Predicted probability and maximum entrained hydrocarbon exposure to individual receptors in the 10-20 m depth layer for each season. Results are based on a 1,000 m^3 surface release of MGO from Point 1 over 6 hours, tracked for 40 days.

Season	Receptor		Maximum exposure to entrained hydrocarbons (ppb)	Probability of exposure to entrained hydrocarbons	
				Low	High
Summer	AMP	Ningaloo	17	3	-
	IBRA	Cape Range	13	1	-
	IMCRA	Ningaloo	21	3	-
	KEF	Ancient coastline at 125 m depth contour	31	11	-
		Canyons linking the Cuvier Abyssal Plain and the Cape Range Peninsula (Canyons)	31	8	-
		Commonwealth waters adjacent to Ningaloo Reef	17	2	-
	MMA	Muiron Islands	21	5	-
	MP	Ningaloo	18	2	-
	RSB	Ningaloo Reef	13	1	-
	Nearshore Waters	Exmouth	15	1	-
		Murion Islands	10	1	-
		Peak Island	13	1	-
Transitional	AMP	Gascoyne	15	1	-
		Ningaloo	15	2	-
	IBRA	Cape Range	14	1	-
	IMCRA	Ningaloo	18	3	-
	KEF	Ancient coastline at 125 m depth contour	28	13	-
		Canyons linking the Cuvier Abyssal Plain and the Cape Range Peninsula (Canyons)	21	8	-
		Commonwealth waters adjacent to Ningaloo Reef	15	2	-
	MMA	Muiron Islands	20	5	-
	MP	Ningaloo	15	1	-
	RSB	Ningaloo Reef	10	1	-
	Nearshore Waters	Exmouth	14	1	-
Winter	AMP	Gascoyne	16	1	-
		Ningaloo	17	3	-
	IBRA	Cape Range	17	2	-
	IMCRA	Ningaloo	22	5	-
	KEF	Ancient coastline at 125 m depth contour	26	10	-
		Canyons linking the Cuvier Abyssal Plain and the Cape Range Peninsula (Canyons)	23	7	-
		Commonwealth waters adjacent to Ningaloo Reef	17	3	-
	MMA	Muiron Islands	18	10	-
	MP	Ningaloo	14	2	-
	RSB	Ningaloo Reef	10	1	-
	Nearshore Waters	Exmouth	11	1	-
		Murion Islands	12	1	-
		Peak Island	17	2	-

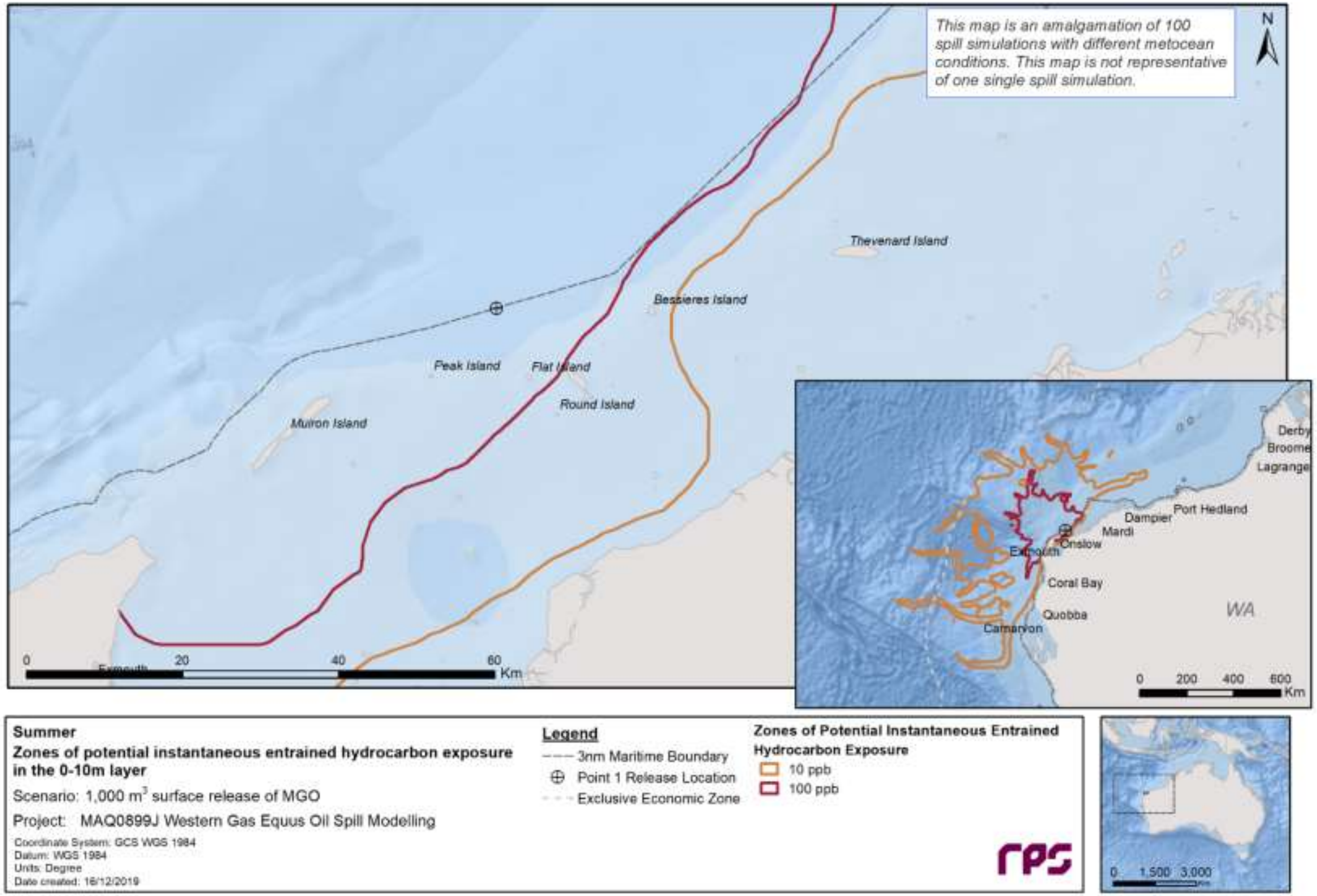

Figure 12.13 Zones of potential instantaneous entrained hydrocarbon exposure at 0-10 m below the sea surface in the event of a 1,000 m^3 surface release of MGO from Point 1 over 6 hours, tracked for 40 days. The results were calculated from 100 spill trajectories commencing during summer (September to March) conditions.

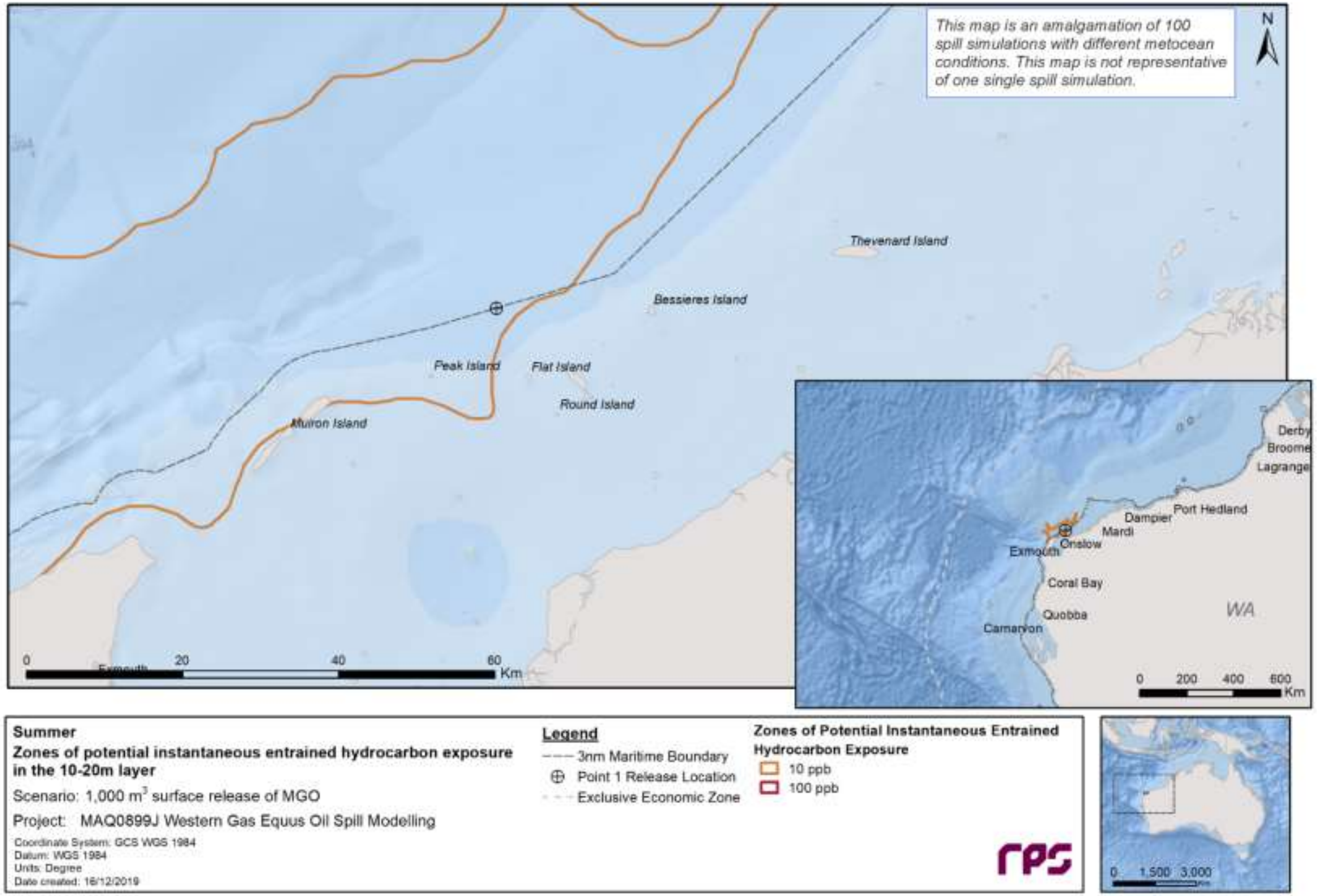

Figure 12.14 Zones of potential instantaneous entrained hydrocarbon exposure at 10-20 m below the sea surface in the event of a 1,000 m^3 surface release of MGO from Point 1 over 6 hours, tracked for 40 days. The results were calculated from 100 spill trajectories commencing during summer (September to March) conditions.

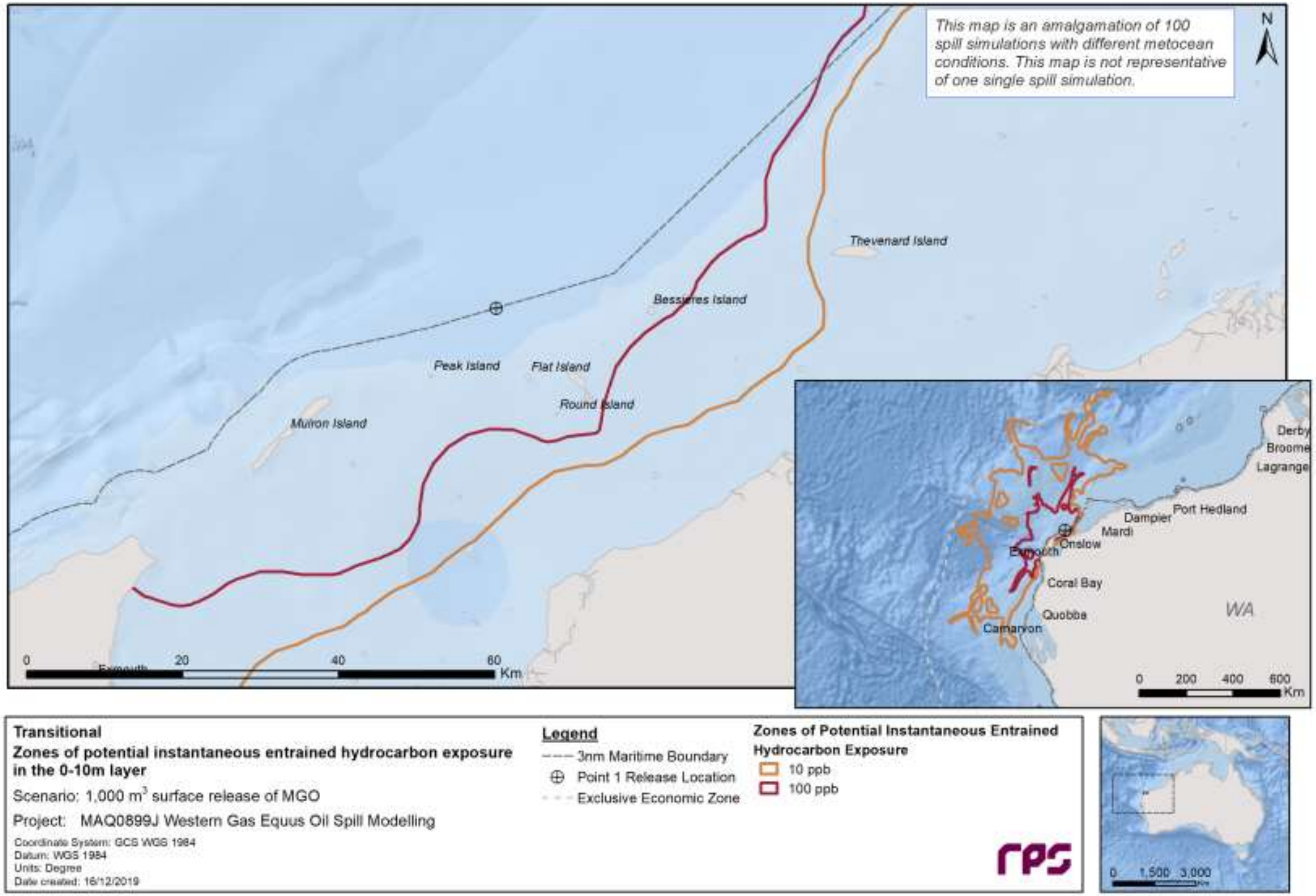

Figure 12.15 Zones of potential instantaneous entrained hydrocarbon exposure at 0-10 m below the sea surface in the event of a 1,000 m^3 surface release of MGO from Point 1 over 6 hours, tracked for 40 days. The results were calculated from 100 spill trajectories commencing during transitional (April and August) conditions.

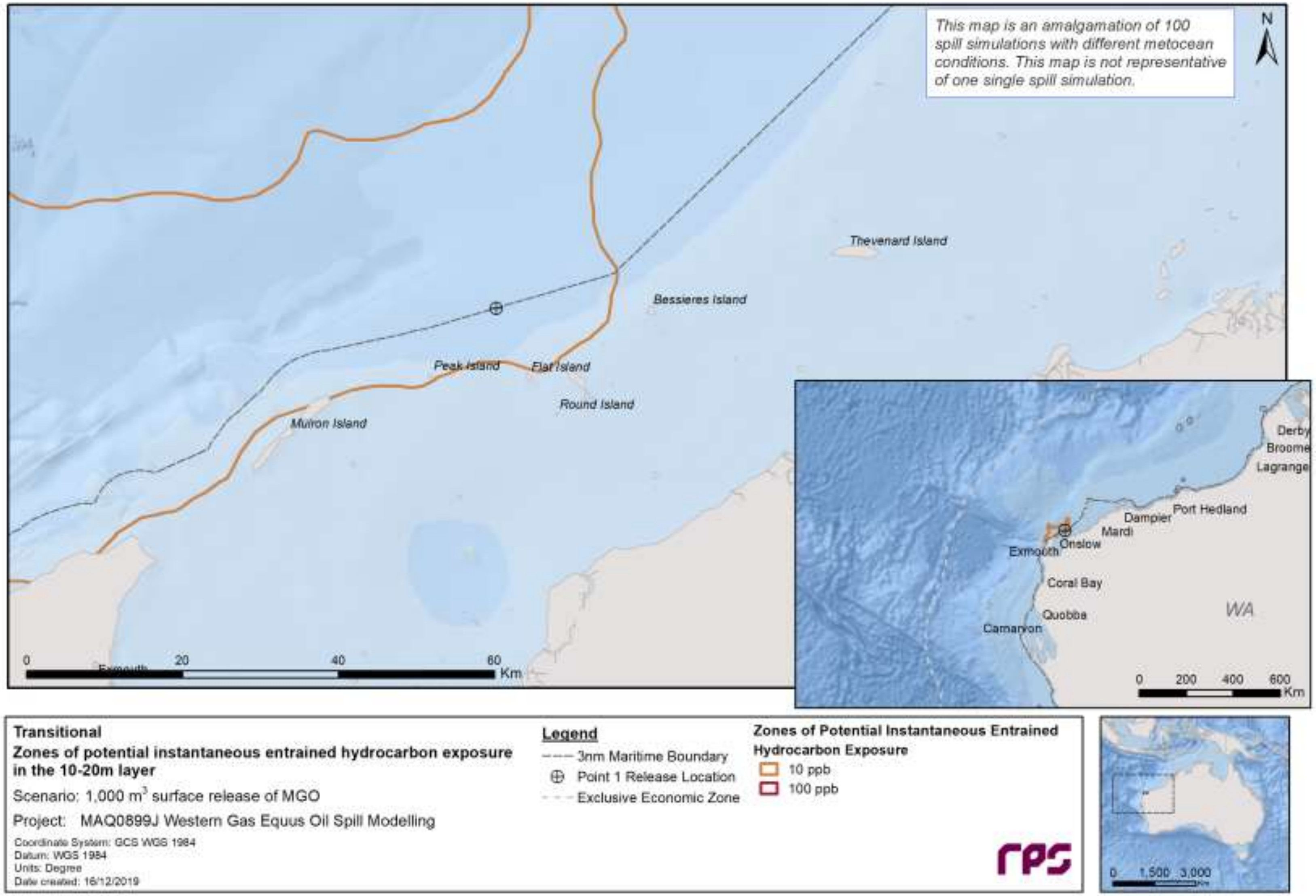

Figure 12.16 Zones of potential instantaneous entrained hydrocarbon exposure at 10-20 m below the sea surface in the event of a 1,000 m^3 surface release of MGO from Point 1 over 6 hours, tracked for 40 days. The results were calculated from 100 spill trajectories commencing during transitional (April and August) conditions.

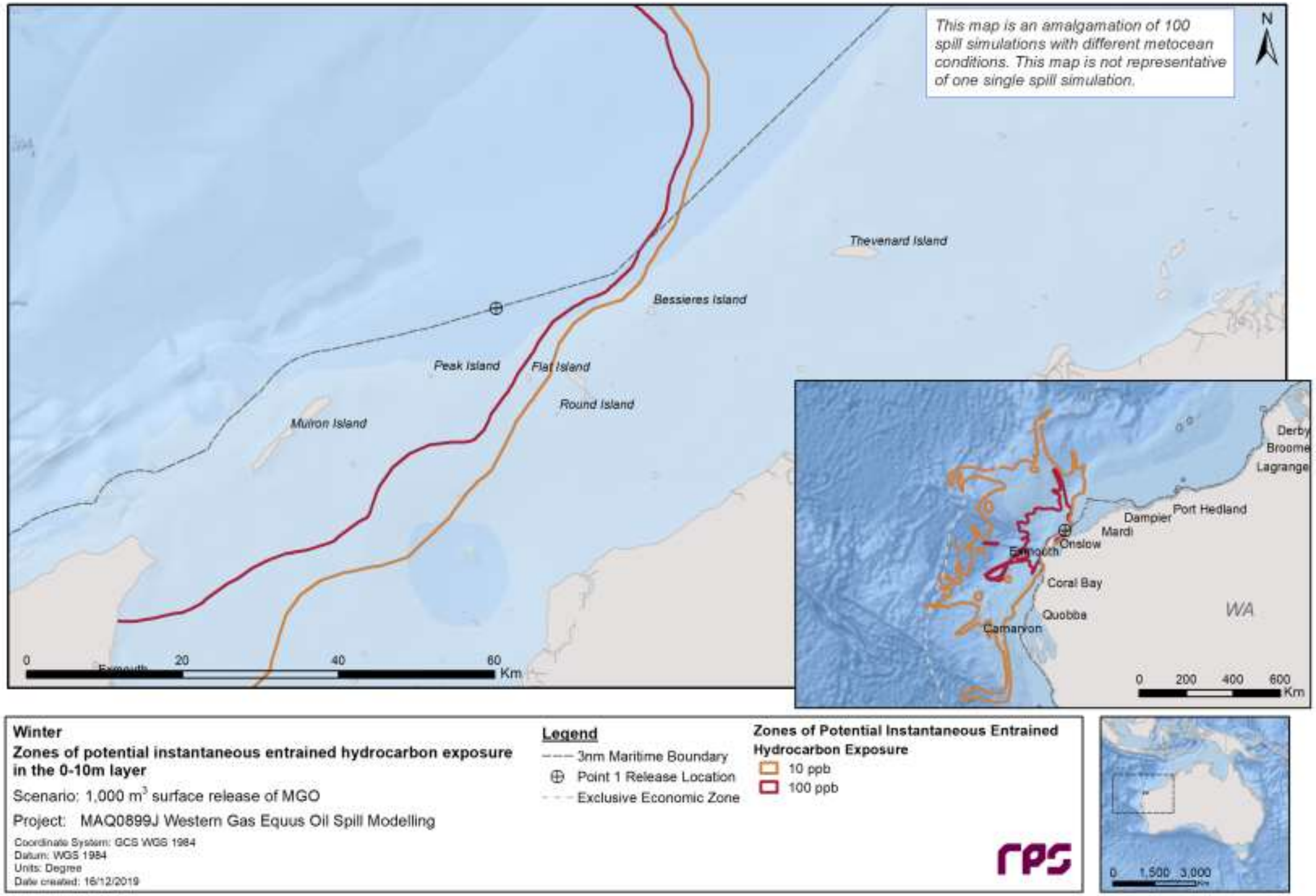

Figure 12.17 Zones of potential instantaneous entrained hydrocarbon exposure at 0-10 m below the sea surface in the event of a 1,000 m^3 surface release of MGO from Point 1 over 6 hours, tracked for 40 days. The results were calculated from 100 spill trajectories commencing during winter (May to July) conditions.

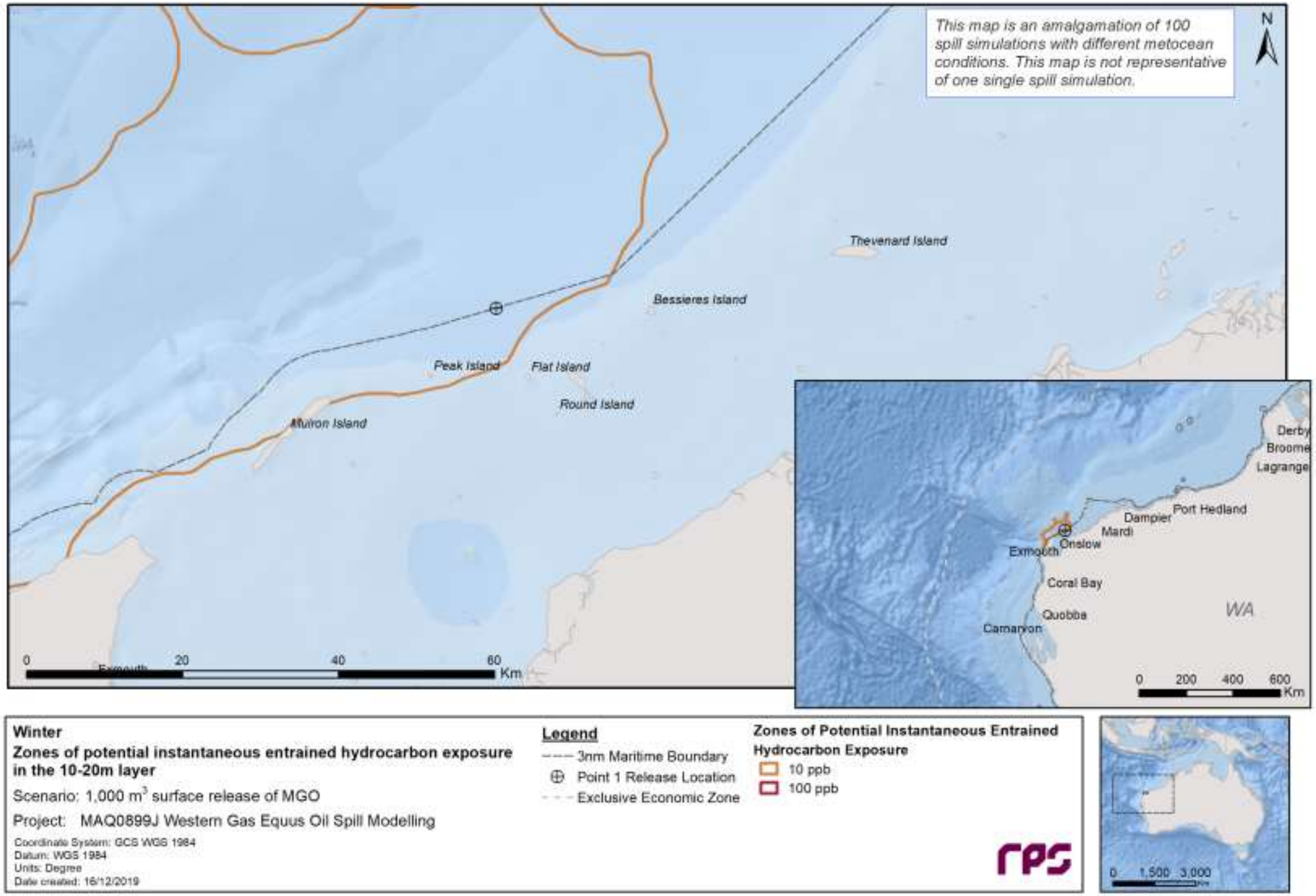

Figure 12.18 Zones of potential entrained hydrocarbon exposure over 1-hour duration at 10-20 m below the sea surface in the event of a 1,000 m^3 surface release of MGO from Point 1 over 6 hours, tracked for 40 days. The results were calculated from 100 spill trajectories commencing during winter (May to July) conditions.

12.1.2 Deterministic Trajectory

12.1.2.1 Deterministic Cases: Largest volume of oil ashore

The simulation that resulted in the largest volume of oil ashore was identified in transitional conditions, as run number 86, which commenced at 6 pm on the 24th of April 2014.

Zones of oil exposure on the sea surface (swept area) and shoreline loading over the entire simulation (40 days) is presented in Figure 12.19. The spill was predicted to travel south from the release location towards Flat Island where shoreline contact was predicted 18 hours after the spill started.

Figure 12.20 displays the area of exposure at low (1 g/m^2) and actionable (10 g/m^2) surface oil thresholds, and length of oil contact to shorelines at the actionable threshold (100 g/m^2). The maximum area of coverage of visible oil on the sea surface was predicted to occur 12 hours after the spill commenced and covered approximately 14 km^2. The maximum area of actionable sea surface oil above 10 g/m^2 at any given time was predicted as 6 km^2.The maximum length of shoreline above the actionable oil threshold was predicted as 3 km on day 1 of the simulation. Figure 12.21 is a time series of the mass on shore at the low (10 g/m^2), moderate (100 g/m^2) and high (1,000 g/m^2) thresholds.

Figure 12.22 presents the fates and weathering graph for the corresponding single spill trajectory. At the conclusion of the simulation period (day-40), approximately 755 m^3 (76%) spilled oil was lost to the atmosphere through evaporation. Approximately 81 m^3 (8%) of the oil was predicted to have decayed, while approximately 23 m^3 (2%) was predicted to remain within the water column and 141 m^3 (13%) was predicted to arrive ashore.

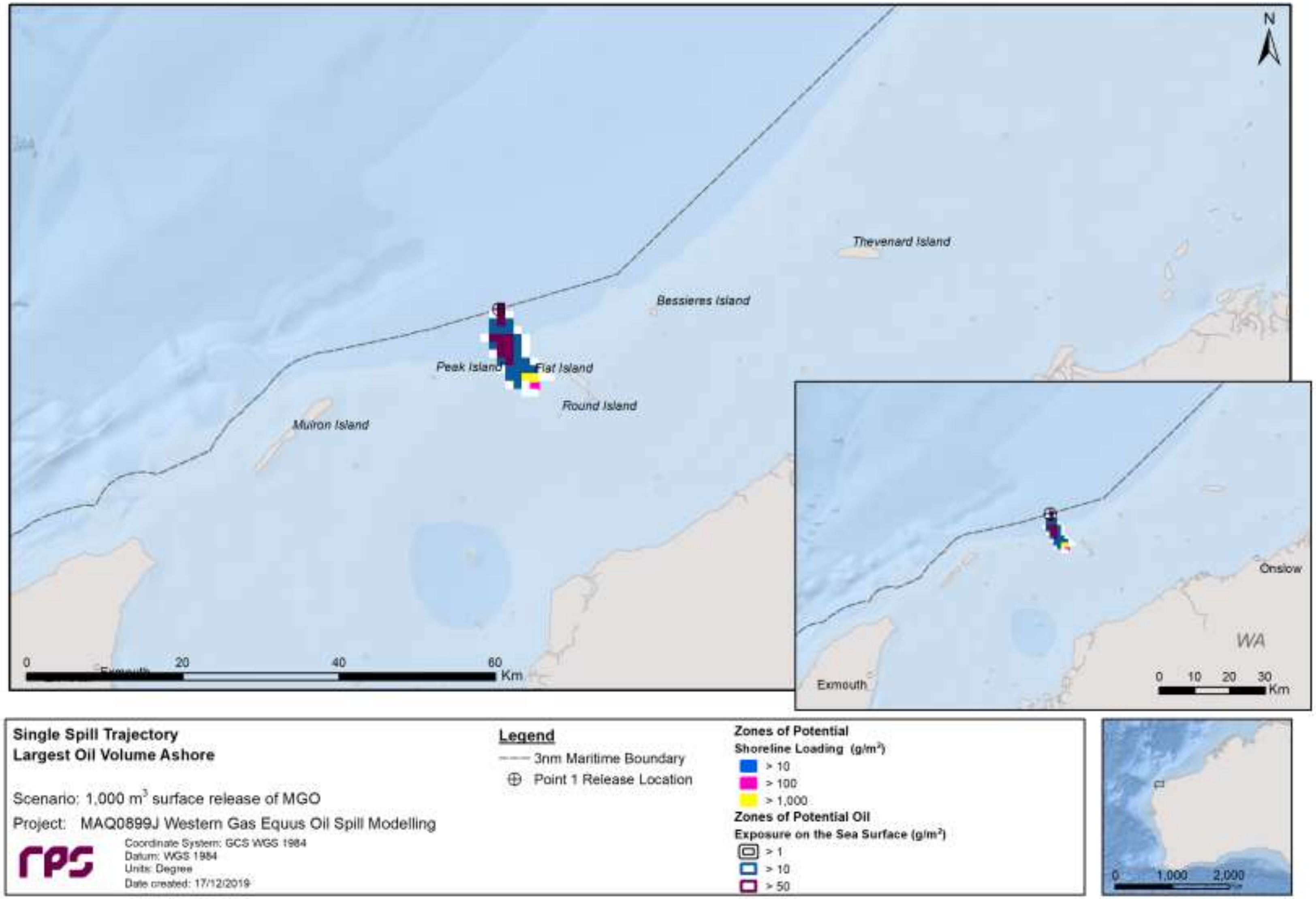

Figure 12.19 Zones of oil exposure on the sea surface (swept area) and shoreline loading over the entire simulation (40 days), for the trajectory with the largest volume of oil ashore. Results are based on a 1,000 m^3 surface release of MGO from Point 1 over 6 hours, tracked for 40 days, commencing at 6 pm on the 24th of April 2014.

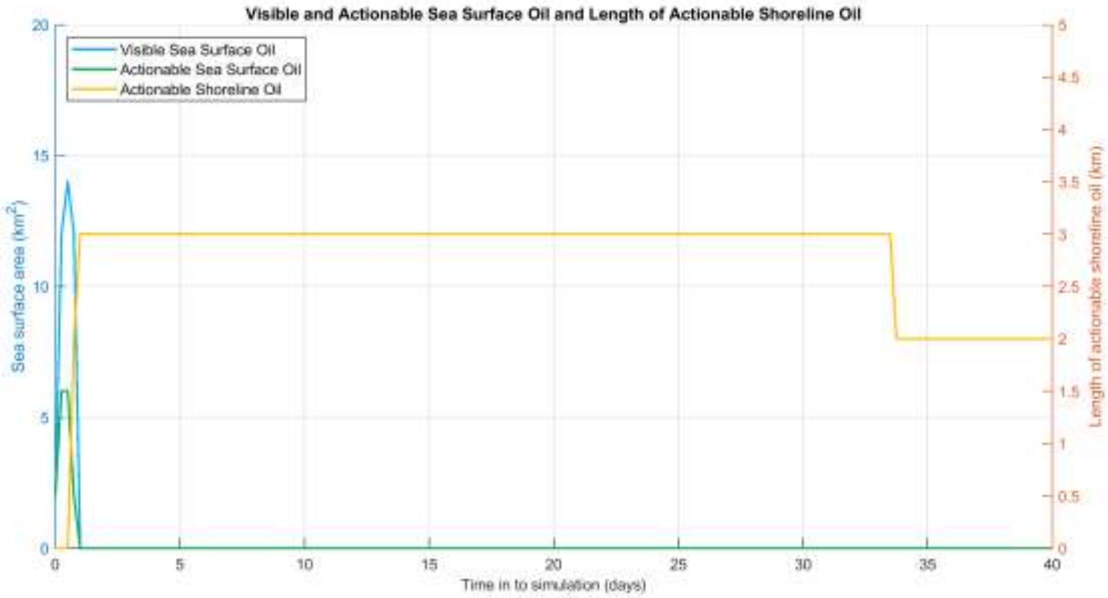

Figure 12.20 Area of exposure at low (1 g/m^2) and actionable (10 g/m^2) surface oil thresholds and length of oil contact to shorelines at the actionable threshold (100 g/m^2); for the simulation identified to result in the largest volume of oil ashore from Point 1. Results are based on 1,000 m^3 surface release of MGO from Point 1 over 6 hours, tracked for 40 days, 6 pm on the 24th of April 2014.

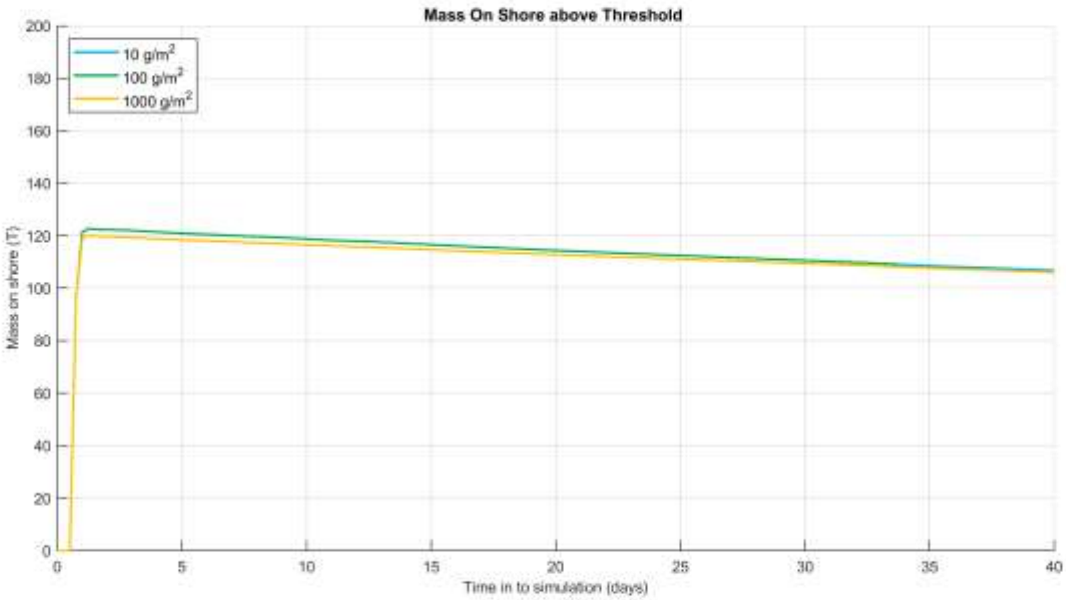

Figure 12.21 Time series of the mass ashore at each threshold for the trajectory with the largest volume of oil ashore. Results are based on a 1,000 m^3 surface release of MGO from Point 1 over 6 hours, tracked for 40 days, commencing at 6 pm on the 24th of April 2014.

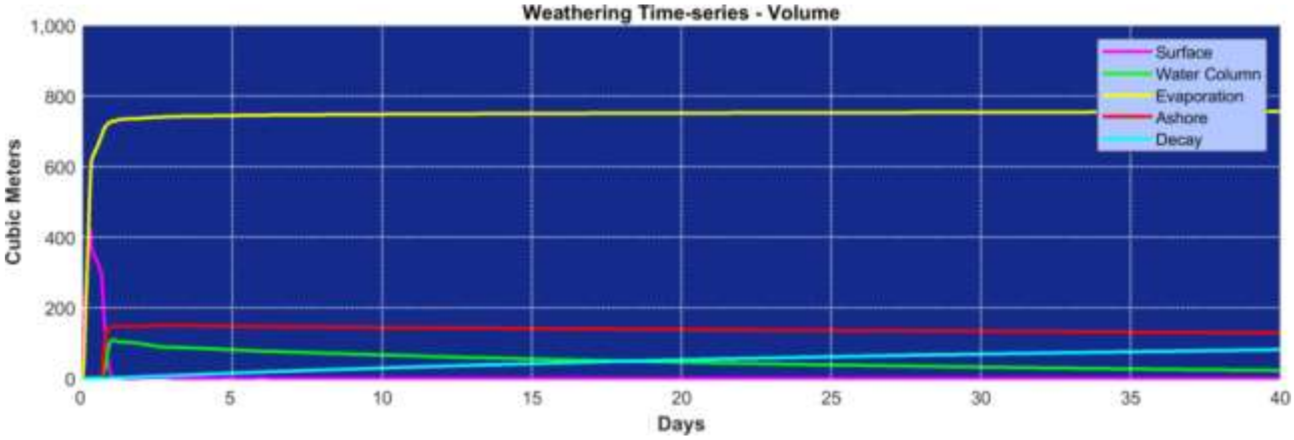

Figure 12.22 Predicted weathering and fates graph for the trajectory with the largest volume of oil ashore. Results are based on a 1,000 m^3 surface release of MGO from Point 1 over 6 hours, tracked for 40 days, commencing at 6 pm on the 24th of April 2014.

12.2 Point 4

12.2.1 Seasonal analysis

12.2.1.1 Sea Surface Exposure

Table 12.13 summarises the maximum distances from the release location to oil exposure zones on the sea surface for each season.

The maximum distance from the release location to the low (≥ 1 g/m^2), moderate (≥ 10 g/m^2) and high (≥ 50 g/m^2) exposure thresholds was 97.5 km west-southwest, 26.8 km west and 8.8 km west, all during transitional conditions, respectively.

Table 12.14 presents potential sea surface exposure to individual receptors during summer, transitional and winter conditions. Low sea surface exposure was predicted at the Ancient coastline at 125 m depth contour KEF during summer, transitional and winter conditions with probabilities of 3%, 17% and 9%, respectively. Additionally, the Ningaloo IMCRA and the Canyons KEF recorded probabilities of low sea surface exposure during transitional conditions of 3% and 9%, respectively. The Ancient coastline at 125 m depth contour KEF was the only receptor predicted to be exposed at the moderate threshold with a probability of 1% during transitional conditions. Minimum times before sea surface exposure (at the low threshold) ranged from 0.63 days (15 hours) at the Ancient coastline at 125 m depth contour KEF to 2.17 days (52 hours) at Commonwealth waters adjacent to Ningaloo Reef KEF, both during transitional conditions.

Figure 12.23 to Figure 12.25 present the zones of sea surface exposure for low moderate and high thresholds during summer, transitional and winter conditions.

Note, the release location resides within the Pilbarra (Offshore) IMCRA, hence it is not presented in the tabulated results.

Table 12.13 Maximum distance and direction from Point 4 to oil exposure thresholds on the sea surface. Results are based on a 1,000 m^3 surface release of MGO over 6 hours, tracked for 40 days during all seasonal conditions. The results were calculated from 100 spill trajectories per season.

Season	Distance and direction	Zones of potential sea surface exposure		
		Low	Moderate	High
Summer	Max. distance from release site (km)	57.3	19.4	7.4
	Max. distance from release site (km) (99th percentile)	35.9	17.9	7.4
	Direction	N	WSW	WSW
Transitional	Max. distance from release site (km)	97.5	26.8	8.8
	Max. distance from release site (km) (99th percentile)	92.0	25.2	8.8
	Direction	WSW	W	W
Winter	Max. distance from release site (km)	46.3	21.1	5.2
	Max. distance from release site (km) (99th percentile)	40.2	20.0	5.2
	Direction	WSW	WSW	WSW

Table 12.14 Summary of the potential sea surface exposure to receptors. Results are based on a 1,000 m^3 surface release of MGO from Point 4 over 6 hours, tracked for 40 days during all seasonal conditions. The results were calculated from 100 spill trajectories per season.

Season	Receptor		Probability of oil exposure on the sea surface (%)			Minimum time before oil exposure on the sea surface (days)		
			Low	Moderate	High	Low	Moderate	High
Summer	KEF	Ancient coastline at 125 m depth contour	3	-	-	0.71	-	-
Transitional	AMP	Ningaloo	2	-	-	2.13	-	-
	IMCRA	Ningaloo	3	-	-	2.04	-	-
	KEF	Ancient coastline at 125 m depth contour	17	1	-	0.63	2.08	-
		Canyons linking the Cuvier Abyssal Plain and the Cape Range Peninsula (Canyons)	9	-	-	1.33	-	-
		Commonwealth waters adjacent to Ningaloo Reef	2	-	-	2.17	-	-
	MMA	Muiron Islands	2	-	-	1.71	-	-
	Nearshore Waters	Bessieres Island	1	-	-	1.50	-	-
Winter	KEF	Ancient coastline at 125 m depth contour	9	-	-	0.79	-	-
	Nearshore Waters	Bessieres Island	1	-	-	1.29	-	-

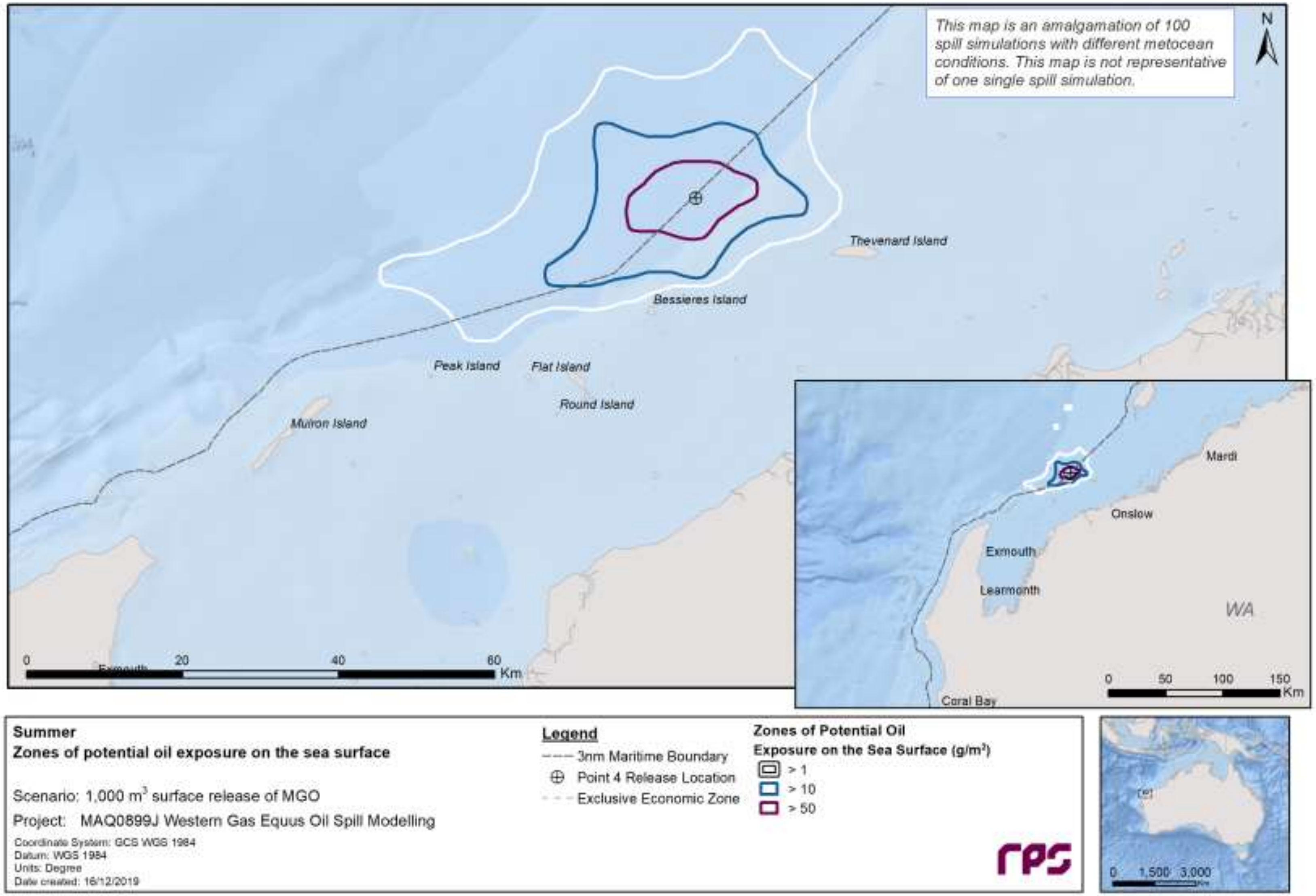

Figure 12.23 Zones of potential oil exposure on the sea surface for each threshold, in the event of a 1,000 m^3 surface release of MGO from Point 4 over 6 hours, tracked for 40 days. The results were calculated from 100 spill trajectories commencing during summer (September to March) conditions.

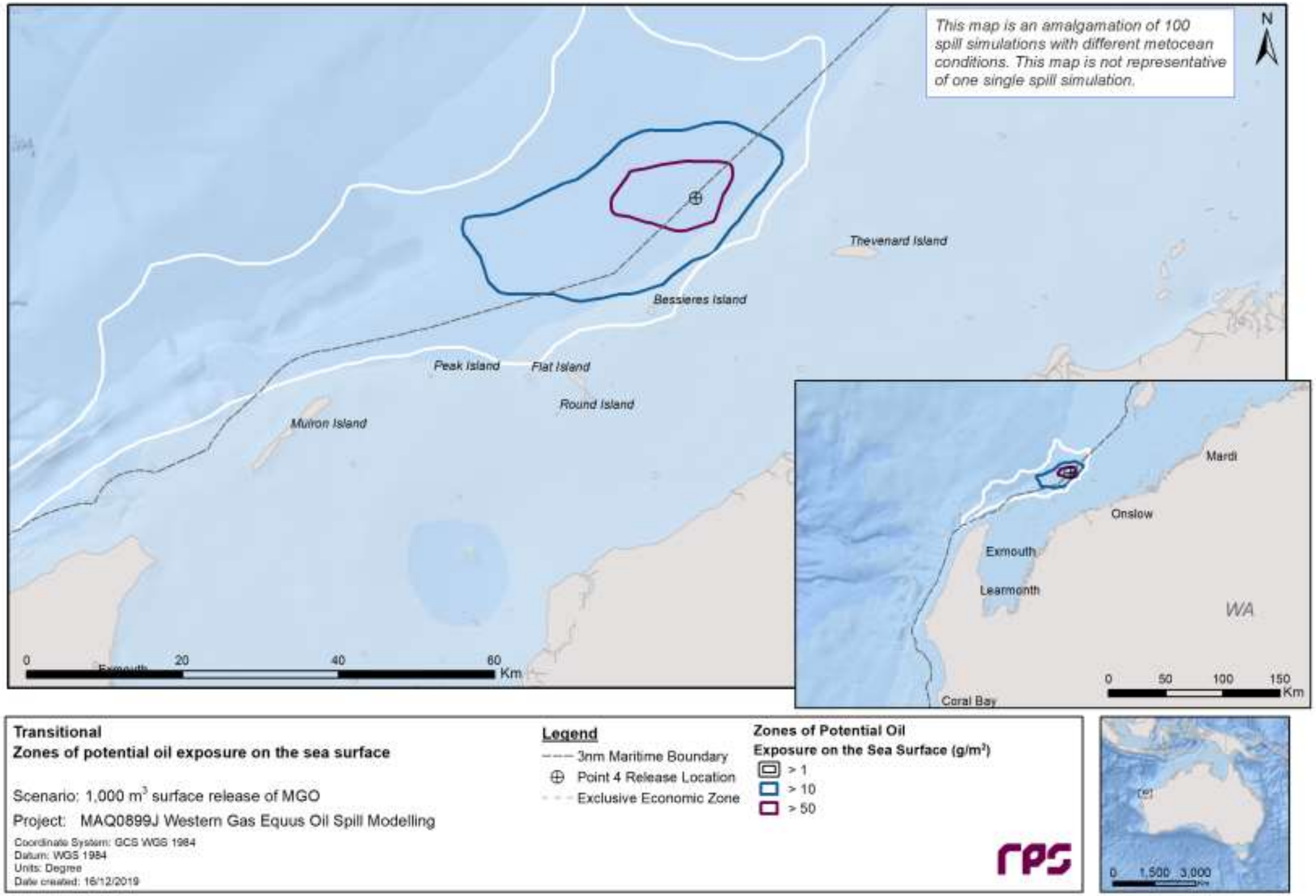

Figure 12.24 Zones of potential oil exposure on the sea surface for each threshold, in the event of a 1,000 m^3 surface release of MGO from Point 4 over 6 hours, tracked for 40 days. The results were calculated from 100 spill trajectories commencing during transitional (April and August) conditions.

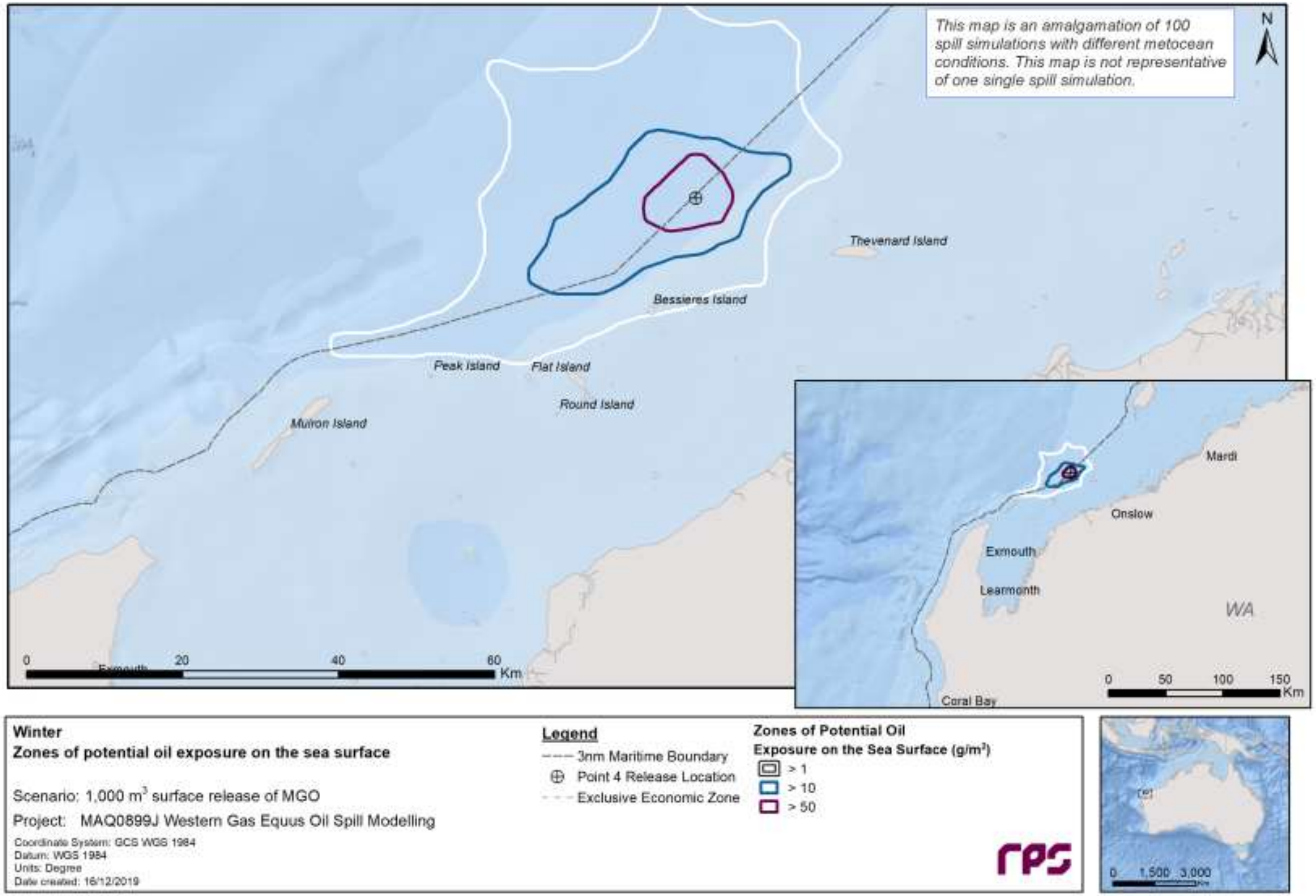

Figure 12.25 Zones of potential oil exposure on the sea surface for each threshold, in the event of a 1,000 m³ surface release of MGO from Point 4 over 6 hours, tracked for 40 days. The results were calculated from 100 spill trajectories commencing during winter (May to July) conditions.

12.2.1.2 Shoreline Contact

Table 12.15 presents a summary of the predicted shoreline contact during summer, transitional and winter conditions. The probability of contact to any shoreline at, or above, the low threshold (≥ 10 g/m^2) was 5% during both transitional and winter conditions, with no contact predicted in summer months. The minimum time before shoreline contact was approximately 1.1 days (26 hours) in transitional conditions and 0.8 days (20 hours) during winter and the maximum volume of oil ashore was predicted during winter with 6.5 m^3.

Table 12.16 summarises the shoreline contact to nearby islands during summer, transitional and winter conditions. Bessieres Island and Flat Island were both predicted to be contacted by oil at the low threshold during transitional and winter conditions with probabilities of exposure ranging from 1% to 3%. Additionally, Peak Island was predicted to be contacted during winter conditions at the low and moderate thresholds with probabilities of 2% and 1%, respectively. No receptors were predicted to be contacted during summer conditions.

The maximum potential shoreline loading above the low, moderate and high shoreline thresholds are presented for transitional and winter conditions in Figure 12.26 and Figure 12.27.

Table 12.15 Summary of oil contact across all shorelines. Results are based on a 1,000 m^3 surface release of MGO from Point 4 over 6 hours, tracked for 40 days during all seasonal conditions. The results were calculated from 100 spill trajectories per season.

Shoreline Statistics	Summer	Transitional	Winter
Probability of contact to any shoreline (%)	-	5	5
Absolute minimum time for oil to accumulate on the shoreline at **10 g/m^2** (days)	-	1.1	0.8
Maximum volume of hydrocarbons ashore (m^3)	-	5.0	6.5
Average volume of hydrocarbons ashore (m^3)	-	1.6	2.4
Maximum length of the shoreline at **10 g/m^2** (km)	-	4.0	3.0
Average shoreline length (km) at **10 g/m^2** (km)	-	2.0	1.6
Maximum length of the shoreline at **100 g/m^2** (km)	-	2.0	2.0
Average shoreline length (km) at **100 g/m^2** (km)	-	1.5	1.7
Maximum length of the shoreline at **1,000 g/m^2** (km)	-	-	-
Average shoreline length (km) at **1,000 g/m^2** (km)	-	-	-

Table 12.16 Summary of oil contact to nearby islands. Results are based on a 1,000 m^3 surface release of MGO from Point 4 over 6 hours, tracked for 40 days during all seasonal conditions. The results were calculated from 100 spill trajectories.

Season	Shoreline receptor	Maximum probability of shoreline loading (%)			Minimum time before shoreline accumulation (days)			Load on shoreline (g/m^2)		Volume on shoreline (m^3)		Mean length of shoreline contacted (km)			Maximum length of shoreline contacted (km)		
		Low	Moderate	High	Low	Moderate	High	Mean	Peak	Mean	Peak	Low	Moderate	High	Low	Moderate	High
Summer	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Transitional	Bessieres Island	3	2	-	1.08	1.54	-	79.3	301.4	1.3	5.0	2.3	1.5	-	4.0	2.0	-
	Flat Island	2	-	-	1.79	-	-	43.3	76.7	<1	1.3	1.5	-	-	2.0	-	-
Winter	Bessieres Island	2	1	-	0.83	1.29	-	91.7	339.3	1.2	6.5	2.0	2.0	-	3.0	2.0	-
	Flat Island	1	1	-	1.17	1.75	-	162.2	184.5	<1	3.7	2.0	2.0	-	2.0	2.0	-
	Peak Island	2	1	-	1.33	1.96	-	143.5	207.8	<1	2.4	1.0	1.0	-	1.0	1.0	-

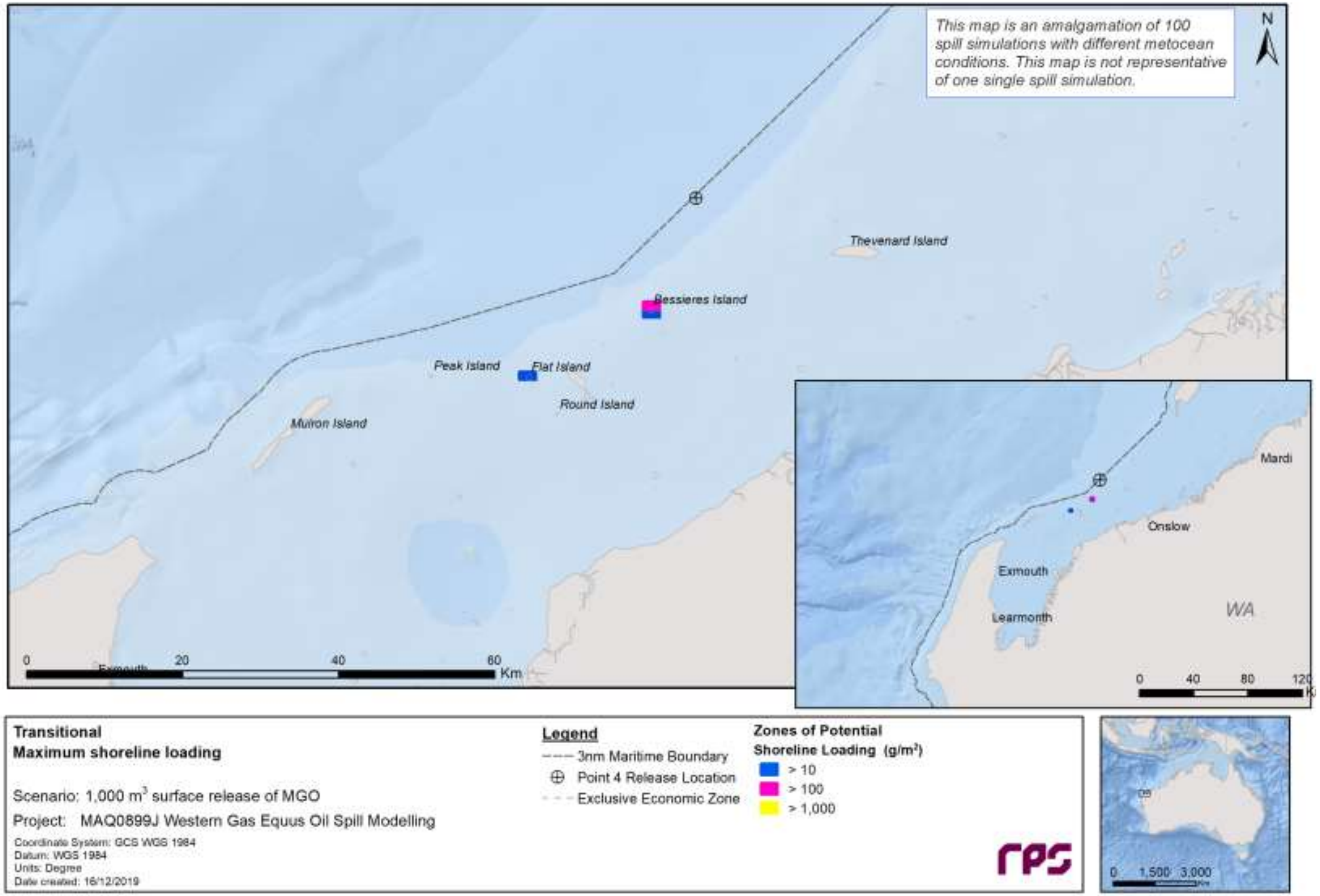

Figure 12.26 Maximum potential shoreline loading in the event of a 1,000 m^3 surface release of MGO from Point 4 over 6 hours, tracked for 40 days during transitional (April and August) conditions. The results were calculated from 100 spill trajectories.

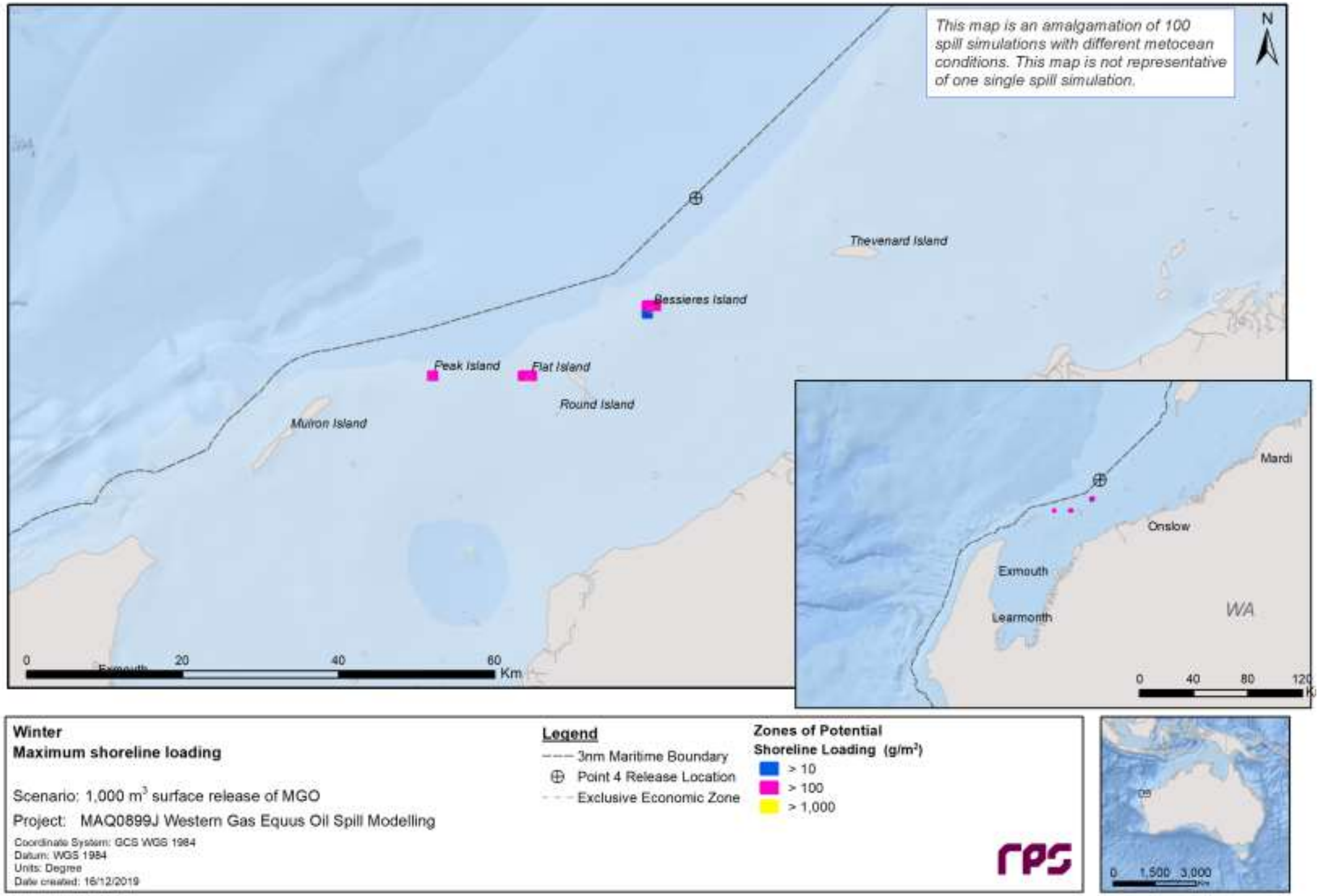

Figure 12.27 Maximum potential shoreline loading in the event of a 1,000 m^3 surface release of MGO from Point 4 over 6 hours, tracked for 40 days during winter (May to July) conditions. The results were calculated from 100 spill trajectories.

12.2.1.3 Water Column Exposure

12.2.1.3.1 Dissolved Hydrocarbons

Table 12.17 summarises the maximum distance and direction from the release location to dissolved hydrocarbon exposure zones at the low (≥ 10 ppb), moderate (≥ 50 ppb) and high (≥ 400 ppb) thresholds, in the 0-10 m depth layer. The maximum distance of low and moderate dissolved hydrocarbon exposure was 199.9 km (southwest) and 8.6 km (northeast), recorded during winter conditions, respectively. No dissolved hydrocarbon exposure was predicted at the high threshold.

Table 12.18 and Table 12.19 summarise the seasonal probability of exposure to receptors from dissolved hydrocarbons in the 0-10 m and 10-20 m depth layers, respectively, at the low (≥ 10 ppb), moderate (≥ 50 ppb) and high (≥ 400 ppb) exposure thresholds (NOPSEMA, 2019).

In the surface (0-10 m) the Ancient coastline at 125 m depth contour KEF recorded the greatest probability of exposure at the low threshold during all seasons with 6%, 5% and 4% in summer, transitional and winter conditions, respectively. The Ningaloo IMCRA and the Canyons KEF were also predicted to be exposed at the low threshold during summer, transitional and winter conditions with probabilities ranging between 1% to 3%.

In the 10-20 m layer, the greatest probabilities of low exposure was predicted at the Ancient coastline at 125 m depth contour KEF with 3%, during summer and transitional conditions. Additionally, a 2% probability of low dissolved hydrocarbon exposure was predicted at the Canyons linking the Cuvier Abyssal Plain and the Cape Range Peninsula KEF during summer and transitional conditions, the Murion Islands MMA during winter and the Ancient coastline at 125 m depth contour KEF during winter.

Figure 12.28 to Figure 12.33 presents the zones of potential instantaneous dissolved hydrocarbon exposure for the 0-10 m and 10-20 m depth layers for the summer, transitional and winter periods, respectively.

Table 12.17 Maximum distance and direction from the release location to dissolved hydrocarbon exposure (0 – 10m). Results are based on a 1,000 m^3 surface release of MGO from Point 4 over 6 hours, tracked for 40 days for all seasons. The results were calculated from 100 spill simulations per season.

Season	Distance and direction travelled	Zones of potential dissolved hydrocarbon exposure		
		Low 6 ppb	Moderate 50 ppb	High 400 ppb
Summer	Maximum distance (km) from the release location	192.4	0.8	-
	Direction	SW	S	-
Transitional	Maximum distance (km) from the release location	152.3	1.5	-
	Direction	SW	NW	-
Winter	Maximum distance (km) from the release location	199.9	8.6	-
	Direction	SW	NE	-

Table 12.18 Predicted probability and maximum dissolved hydrocarbon exposure to individual receptors in the 0-10 m depth layer. Results are based on a 1,000 m^3 surface release of MGO from Point 4 over 6 hours, tracked for 40 days during all seasonal conditions. The results were calculated from 100 spill trajectories per season.

Season	Receptor		Maximum exposure to dissolved hydrocarbons (ppb)	Probability of exposure to dissolved hydrocarbons (%)		
				Low	Moderate	High
Summer	AMP	Gascoyne	15	1	-	-
		Montebello	12	1	-	-
		Ningaloo	14	1	-	-
	IBRA	Cape Range	25	1	-	-
	IMCRA	Ningaloo	19	1	-	-
	KEF	Ancient coastline at 125 m depth contour	29	6	-	-
		Canyons linking the Cuvier Abyssal Plain and the Cape Range Peninsula (Canyons)	19	2	-	-
		Commonwealth waters adjacent to Ningaloo Reef	16	1	-	-
		Exmouth Plateau	11	1	-	-
	MMA	Muiron Islands	17	1	-	-
	MP	Ningaloo	12	1	-	-
	RSB	Ningaloo Reef	11	1	-	-
	Nearshore Waters	Exmouth	10	1	-	-
		Flat Island	12	1	-	-
		Serrurier Island	18	2	-	-
Transitional	AMP	Gascoyne	18	1	-	-
		Ningaloo	22	2	-	-
	IBRA	Cape Range	15	1	-	-
	IMCRA	Ningaloo	22	2	-	-

Season	Receptor		Maximum exposure to dissolved hydrocarbons (ppb)	Probability of exposure to dissolved hydrocarbons (%)		
				Low	Moderate	High
	KEF	Ancient coastline at 125 m depth contour	32	5	-	-
		Canyons linking the Cuvier Abyssal Plain and the Cape Range Peninsula (Canyons)	18	3	-	-
		Commonwealth waters adjacent to Ningaloo Reef	22	2	-	-
	MMA	Muiron Islands	16	2	-	-
	MP	Ningaloo	17	1	-	-
	RSB	Penguin Bank	15	1	-	-
	Nearshore Waters	Bessieres Island	12	1	-	-
		Exmouth	15	1	-	-
		Murion Islands	12	1	-	-
Winter	AMP	Gascoyne	13	1	-	-
		Ningaloo	20	2	-	-
	IBRA	Cape Range	19	1	-	-
	IMCRA	Ningaloo	20	2	-	-
		Pilbarra (nearshore)	12	1	-	-
	KEF	Ancient coastline at 125 m depth contour	24	4	-	-
		Canyons linking the Cuvier Abyssal Plain and the Cape Range Peninsula (Canyons)	21	2	-	-
		Commonwealth waters adjacent to Ningaloo Reef	20	2	-	-
	MMA	Muiron Islands	17	2	-	-
	MP	Ningaloo	16	2	-	-
	RSB	Ningaloo Reef	11	1	-	-
	Nearshore Waters	Bessieres Island	11	1	-	-
		Exmouth	11	1	-	-
		Murion Islands	15	1	-	-
		Peak Island	17	1	-	-

Table 12.19 Predicted probability and maximum dissolved hydrocarbon exposure to individual receptors in the 10-20 m depth layer. Results are based on a 1,000 m^3 surface release of MGO from Point 4 over 6 hours, tracked for 40 days during all seasonal conditions. The results were calculated from 100 spill trajectories per season.

Season	Receptor		Maximum exposure to dissolved hydrocarbons (ppb)	Probability of exposure to dissolved hydrocarbons (%)		
				Low	Moderate	High
Summer	AMP	Gascoyne	15	1	-	-
		Montebello	11	1	-	-
		Ningaloo	14	1	-	-
	IMCRA	Ningaloo	16	1	-	-
	KEF	Ancient coastline at 125 m depth contour	22	3	-	-
		Canyons linking the Cuvier Abyssal Plain and the Cape Range Peninsula (Canyons)	16	2	-	-
		Commonwealth waters adjacent to Ningaloo Reef	14	1	-	-
Transitional	AMP	Gascoyne	14	1	-	-
		Ningaloo	21	1	-	-
	IBRA	Cape Range	11	1	-	-
	IMCRA	Ningaloo	14	1	-	-
		Pilbarra (nearshore)	10	1	-	-
	KEF	Ancient coastline at 125 m depth contour	18	3	-	-
		Canyons linking the Cuvier Abyssal Plain and the Cape Range Peninsula (Canyons)	14	2	-	-
		Commonwealth waters adjacent to Ningaloo Reef	21	1	-	-
	MMA	Muiron Islands	12	1	-	-
	MP	Ningaloo	12	1	-	-
	RSB	Penguin Bank	11	1	-	-
	Nearshore Waters	Exmouth	12	1	-	-
Winter	AMP	Gascoyne	13	1	-	-
		Ningaloo	17	1	-	-
	IBRA	Cape Range	16	1	-	-
	IMCRA	Ningaloo	17	1	-	-
	KEF	Ancient coastline at 125 m depth contour	19	2	-	-
		Canyons linking the Cuvier Abyssal Plain and the Cape Range Peninsula (Canyons)	17	1	-	-
		Commonwealth waters adjacent to Ningaloo Reef	17	1	-	-
	MMA	Muiron Islands	21	2	-	-
	MP	Ningaloo	15	1	-	-
	Nearshore Waters	Exmouth	12	1	-	-
		Murion Islands	14	1	-	-
		Peak Island	16	1	-	-

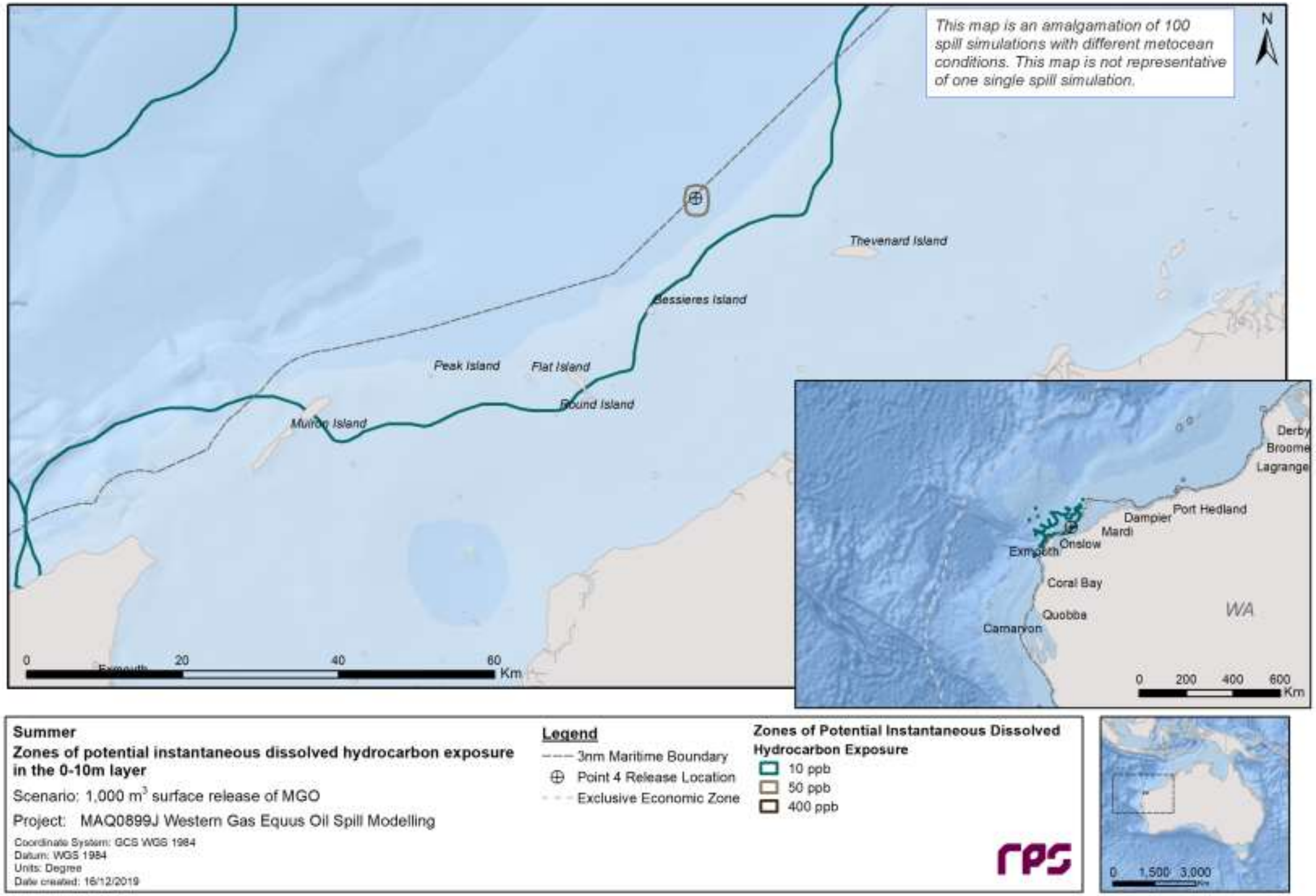

Figure 12.28 Zones of potential instantaneous dissolved hydrocarbon exposure at 0-10 m below the sea surface in the event of a 1,000 m^3 surface release of MGO from Point 4 over 6 hours, tracked for 40 days. The results were calculated from 100 spill trajectories commencing during summer (September to March) conditions.

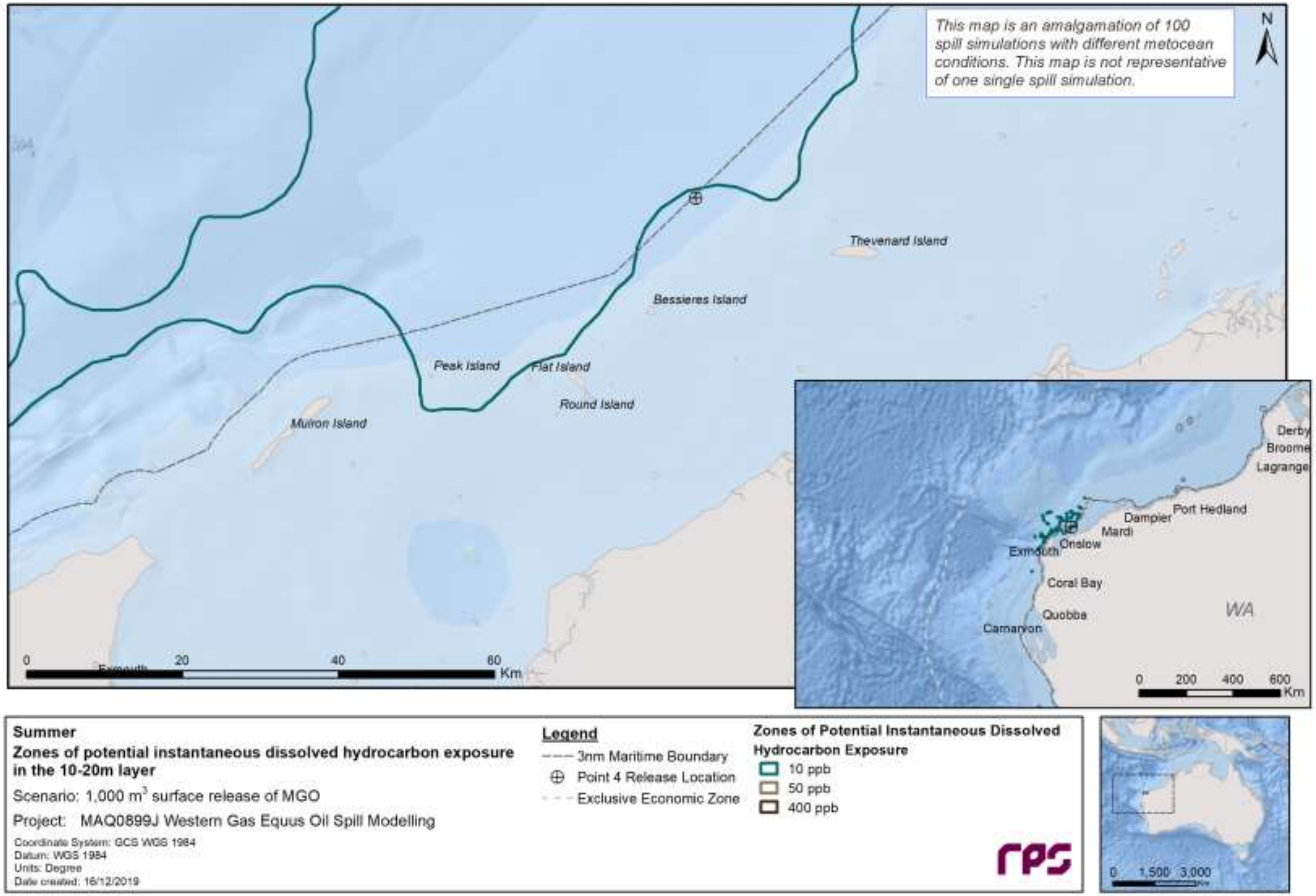

Figure 12.29 Zones of potential instantaneous dissolved hydrocarbon exposure at 10-20 m below the sea surface in the event of a 1,000 m^3 surface release of MGO from Point 4 over 6 hours, tracked for 40 days. The results were calculated from 100 spill trajectories commencing during summer (September to March) conditions.

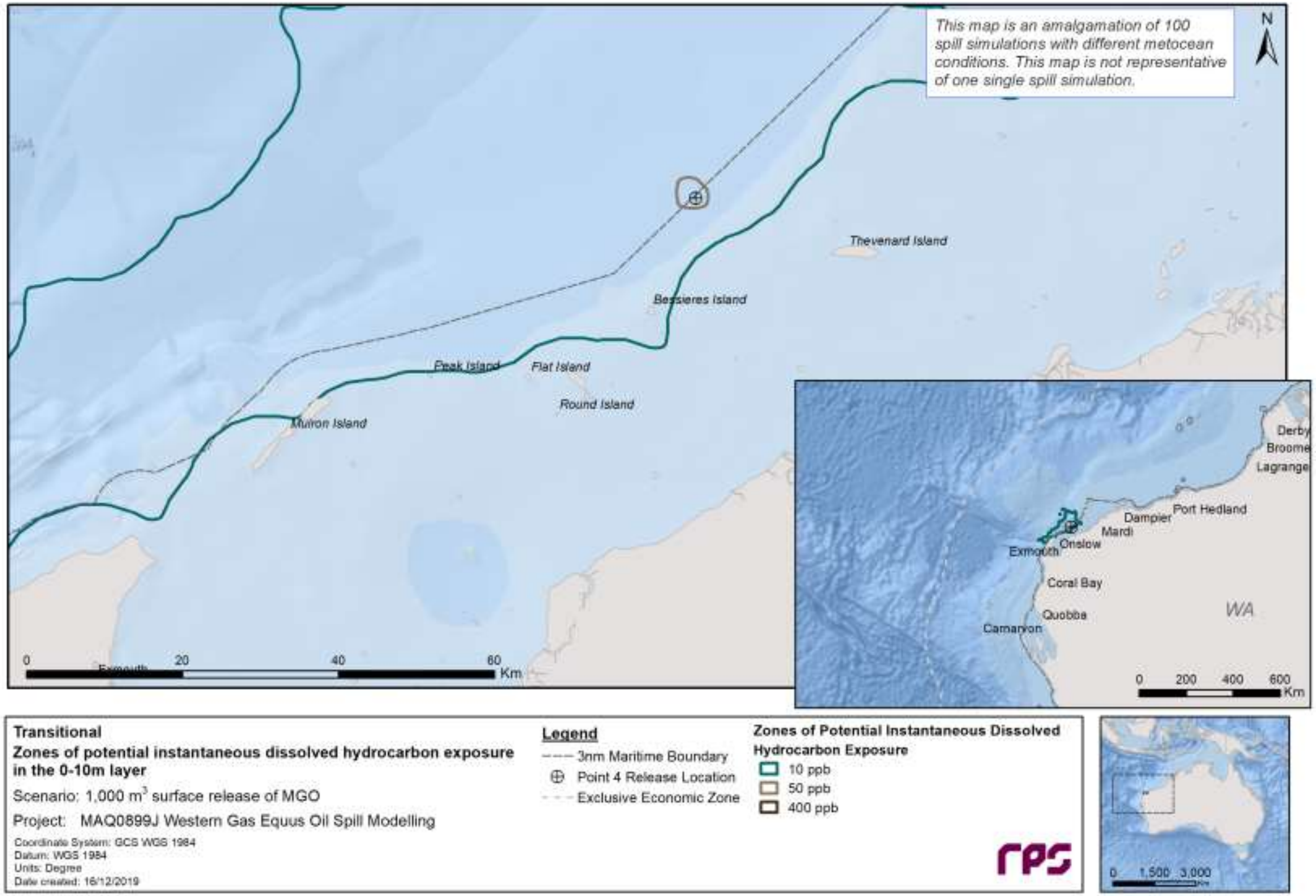

Figure 12.30 Zones of potential instantaneous dissolved hydrocarbon exposure at 0-10 m below the sea surface in the event of a 1,000 m^3 surface release of MGO from Point 4 over 6 hours, tracked for 40 days. The results were calculated from 100 spill trajectories commencing during transitional (April and August) conditions.

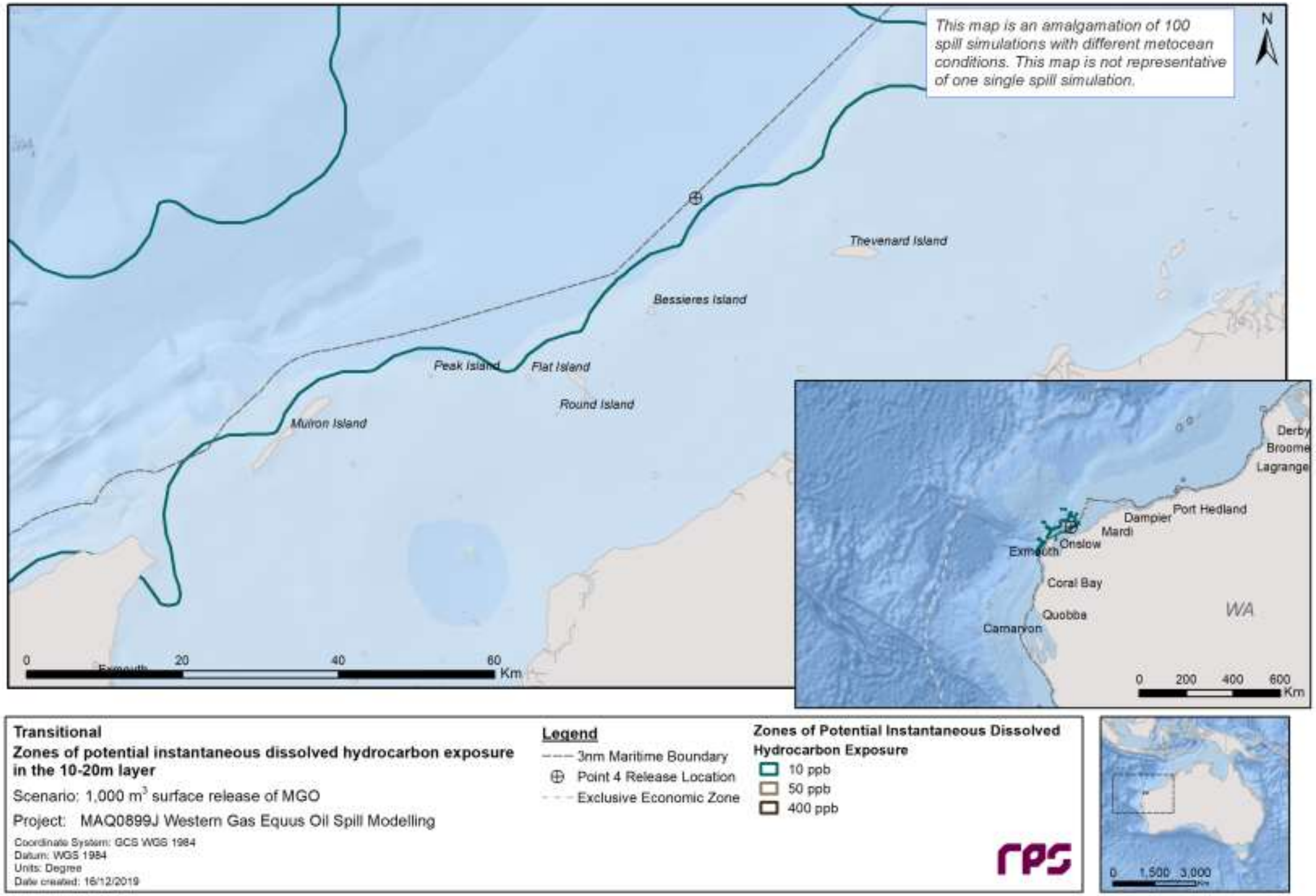

Figure 12.31 Zones of potential instantaneous dissolved hydrocarbon exposure at 10-20 m below the sea surface in the event of a 1,000 m^3 surface release of MGO from Point 4 over 6 hours, tracked for 40 days. The results were calculated from 100 spill trajectories commencing during transitional (April and August) conditions.

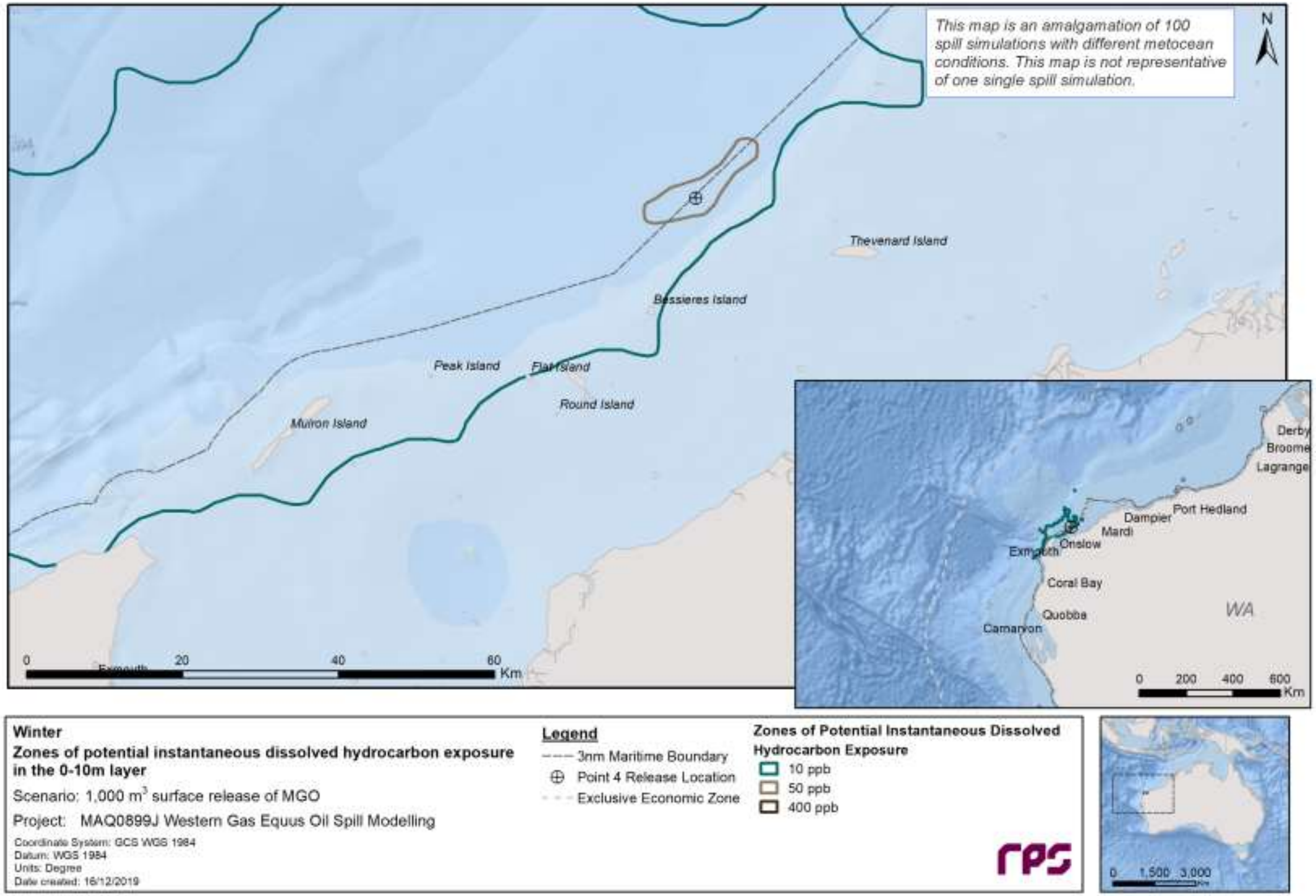

Figure 12.32 Zones of potential instantaneous dissolved hydrocarbon exposure at 0-10 m below the sea surface in the event of a 1,000 m^3 surface release of MGO from Point 4 over 6 hours, tracked for 40 days. The results were calculated from 100 spill trajectories commencing during winter (May to July) conditions.

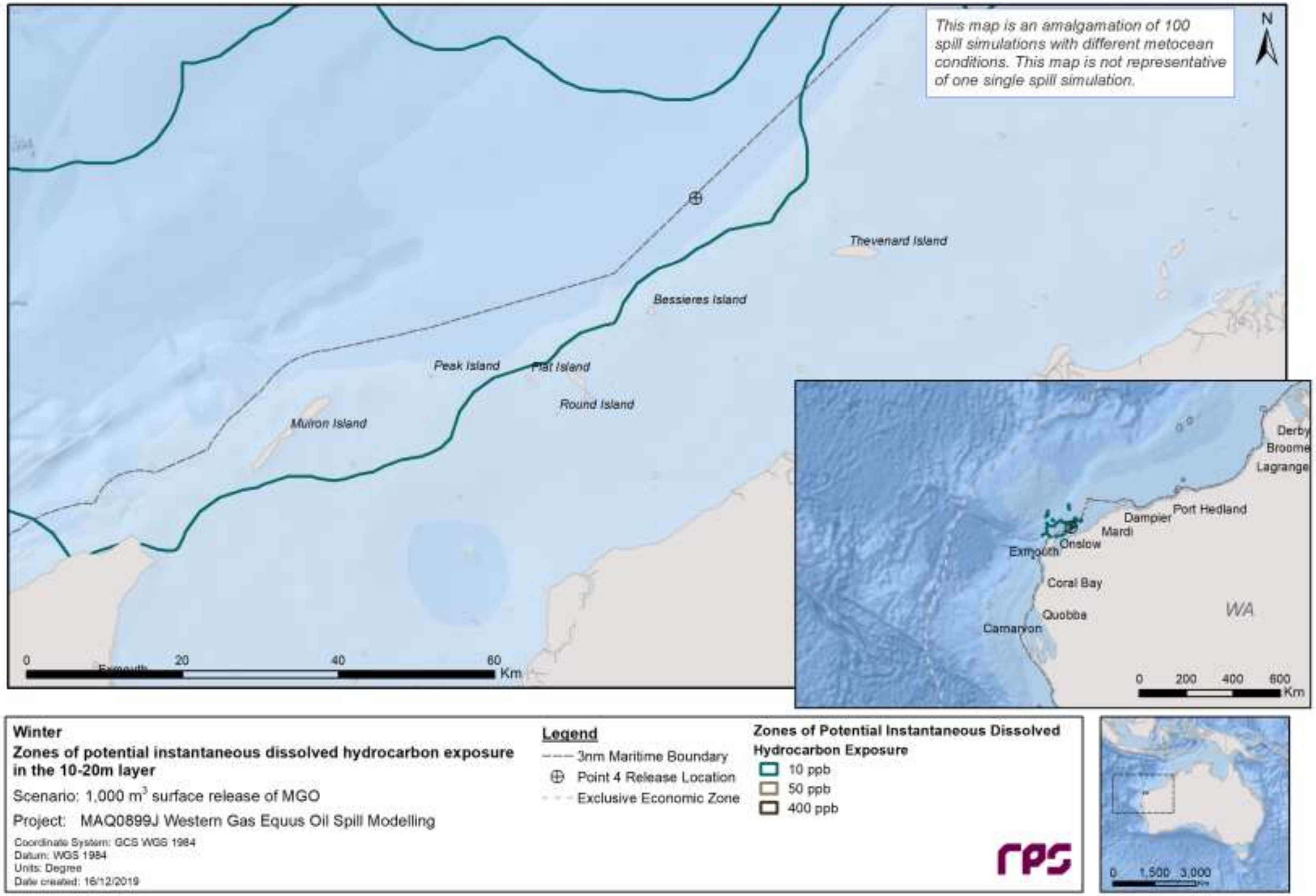

Figure 12.33 Zones of potential instantaneous dissolved hydrocarbon exposure at 10-20 m below the sea surface in the event of a 1,000 m^3 surface release of MGO from Point 4 over 6 hours, tracked for 40 days. The results were calculated from 100 spill trajectories commencing during winter (May to July) conditions.

12.2.1.3.2 Entrained Hydrocarbons

Table 12.20 summarises the maximum distance and direction from the release location to entrained hydrocarbon exposure zones at the low (≥ 10 ppb) and high (≥ 100 ppb) thresholds, in the 0-10 m depth layer. The maximum distance of low and high entrained hydrocarbon exposure was 849.5 km (southwest) and 337.7 km (southwest), recorded during transitional conditions, respectively.

Table 12.21 to Table 12.23 summarise the probability of exposure to receptors from entrained hydrocarbons in the 0-10 m depth layer, in summer, transitional and winter conditions, at the low (≥ 10 ppb) and high (≥ 100 ppb) entrained hydrocarbon exposure thresholds (NOPSEMA, 2019).

At the surface layer (0-10 m), the Ningaloo IMCRA, Ancient coastline at 125 m depth contour and the Canyons KEFs were predicted to be exposed at the low entrained hydrocarbon threshold with probabilities ranging from 37% to 54% in summer, 36% to 49% in transitional conditions and 45% to 49% during winter. At the high entrained hydrocarbon threshold, the maximum probability of exposure was 31% at the Ancient coastline at 125 m depth contour KEF during transitional conditions, while it also recorded 26% and 28% probabilities of high entrained hydrocarbon exposure during summer and winter conditions.

Table 12.24 summarises the probability of exposure to receptors from entrained hydrocarbons in the 10-20 m depth layer, during all seasonal conditions at the low (≥ 10 ppb) and high (≥ 100 ppb) entrained hydrocarbon exposure thresholds.

The greatest probabilities of low entrained hydrocarbon exposure in the 10-20 m layer were recorded at the Ancient coastline at 125 m depth contour KEF during all seasons with predicted probabilities of 5% during summer and transitional conditions and 6% in winter. The Ningaloo IMCRA and the Canyons linking the Cuvier Abyssal Plain and the Cape Range Peninsula KEF were also predicted to be exposed to low entrained hydrocarbons during summer, transitional and winter conditions with probabilities of 1% and 2% in summer, 1% for both receptors during transitional conditions and 3% during winter. No receptors were predicted to be exposed at the high entrained hydrocarbon threshold.

Figure 12.34 to Figure 12.39 illustrates the zones of potential entrained hydrocarbon exposure for the low (≥ 10 ppb) and high (≥ 100 ppb) entrained hydrocarbon thresholds in the 0-10 m and 10-20 m depth layers in summer, transitional and winter conditions.

Table 12.20 Maximum distance and direction from the release location to entrained hydrocarbon exposure (0 – 10m). Results are based on a 1,000 m^3 surface release of MGO from Point 4 over 6 hours, tracked for 40 days for all seasons. The results were calculated from 100 spill simulations per season.

Season	Distance and direction travelled	Zones of potential entrained hydrocarbon exposure	
		Low 10 ppb	High 100 ppb
Summer	Maximum distance (km) from the release location	614.6	317.7
	Direction	SSW	SW
Transitional	Maximum distance (km) from the release location	849.5	337.7
	Direction	SW	SW
Winter	Maximum distance (km) from the release location	684.7	336.5
	Direction	SSW	WSW

Table 12.21 Predicted probability and maximum entrained hydrocarbon exposure to individual receptors in the 0-10 m depth layer. Results are based on a 1,000 m^3 surface release of MGO from Point 4 over 6 hours, tracked for 40 days, during summer (September to March) conditions.

Receptor		Maximum exposure to entrained hydrocarbons (ppb)	Probability of exposure to entrained hydrocarbons	
			Low	High
AMP	Abrolhos	21	1	-
	Carnarvon Canyon	19	3	-
	Gascoyne	368	33	7
	Montebello	380	15	5
	Ningaloo	721	28	9
	Shark Bay	68	3	-
IBRA	Cape Range	1,669	18	8
IMCRA	Ningaloo	721	37	11
	Northwest Shelf	83	5	-
	Pilbarra (nearshore)	100	5	1
	Zuytdorp	93	3	-
KEF	Ancient coastline at 125 m depth contour	2,713	54	26
	Canyons linking the Cuvier Abyssal Plain and the Cape Range Peninsula (Canyons)	1,074	47	19
	Commonwealth waters adjacent to Ningaloo Reef	721	28	9
	Exmouth Plateau	204	15	2
	Glomar Shoals	17	1	-
	Wallaby Saddle	17	1	-
	Western demersal slope and associated fish communities	22	2	-
MMA	Barrow Island	71	5	-
	Muiron Islands	758	23	16
MP	Barrow Island	37	5	-

Receptor		Maximum exposure to entrained hydrocarbons (ppb)	Probability of exposure to entrained hydrocarbons	
			Low	High
	Montebello Islands	57	5	-
	Ningaloo	472	18	6
NR	Thevenard Island	65	6	-
RSB	Baylis Patches	11	1	-
	Brewis Reef	120	5	1
	Glomar Shoal	14	1	-
	Locker Reef	26	2	-
	Montebello Shoals	28	4	-
	Ningaloo Reef	443	11	1
	Penguin Bank	81	7	-
	Rankin Bank	75	4	-
	Rosily Shoals	459	10	5
	Tryal Rocks	116	8	2
Nearshore Waters	Ashburton Island	31	3	-
	Barrow Island	24	3	-
	Bessieres Island	475	12	6
	Exmouth	297	11	1
	Flat Island	678	10	7
	Hermite Island	25	3	-
	Locker Island	11	1	-
	Lowendal Island	12	2	-
	Middle Island	14	1	-
	Murion Islands	291	17	5
	Peak Island	373	18	8
	Round Island	349	7	3
	Serrurier Island	1,480	11	7
	Sunday Island	31	3	-
	Table Island	489	6	3
	Thevenard Island	42	7	-
	Tortoise Island	60	4	-

Table 12.22 Predicted probability and maximum entrained hydrocarbon exposure to individual receptors in the 0-10 m depth layer. Results are based on a 1,000 m^3 surface release of MGO from Point 4 over 6 hours, tracked for 40 days, during transitional (April and August) conditions.

Receptor		Maximum exposure to entrained hydrocarbons (ppb)	Probability of exposure to entrained hydrocarbons	
			Low	High
AMP	Abrolhos	18	2	-
	Argo-Rowley Terrace	21	2	-
	Gascoyne	584	28	10
	Montebello	119	5	1
	Ningaloo	855	29	16
	Shark Bay	52	4	-
IBRA	Cape Range	650	15	9
IMCRA	Ningaloo	855	36	16
	Northwest Shelf	38	2	-
	Pilbarra (nearshore)	255	7	2
	Zuytdorp	70	5	-
KEF	Ancient coastline at 125 m depth contour	2,593	49	31
	Canyons linking the Cuvier Abyssal Plain and the Cape Range Peninsula (Canyons)	1,236	42	25
	Commonwealth waters adjacent to Ningaloo Reef	809	29	15
	Exmouth Plateau	195	17	1
	Wallaby Saddle	11	1	-
	Western demersal slope and associated fish communities	19	2	-
MMA	Barrow Island	26	3	-
	Muiron Islands	1,090	24	14
MP	Barrow Island	26	3	-
	Montebello Islands	16	2	-
	Ningaloo	504	16	7
RSB	Montebello Shoals	15	2	-
	Ningaloo Reef	329	9	4
	Penguin Bank	279	4	2
	Ripple Shoals	26	2	-
	Rosily Shoals	505	6	3
	Tryal Rocks	12	2	-
Nearshore Waters	Airlie Island	28	2	-
	Barrow Island	19	2	-
	Bessieres Island	559	10	4
	Boodie Island	16	2	-
	Exmouth	304	9	4
	Flat Island	618	10	6
	Middle Island	17	2	-
	Murion Islands	448	14	8

Receptor		Maximum exposure to entrained hydrocarbons (ppb)	Probability of exposure to entrained hydrocarbons	
			Low	High
	Observation Island	24	2	-
	Peak Island	650	15	9
	Round Island	29	4	-
	Serrurier Island	409	9	4
	Sunday Island	49	5	-
	Table Island	141	2	2
	Thevenard Island	10	1	-

Table 12.23 Predicted probability and maximum entrained hydrocarbon exposure to individual receptors in the 0-10 m depth layer. Results are based on a 1,000 m^3 surface release of MGO from Point 4 over 6 hours, tracked for 40 days, during winter (May to July) conditions.

Receptor		Maximum exposure to entrained hydrocarbons (ppb)	Probability of exposure to entrained hydrocarbons	
			Low	High
AMP	Abrolhos	13	1	-
	Carnarvon Canyon	23	2	-
	Gascoyne	655	41	13
	Montebello	55	2	-
	Ningaloo	791	43	20
	Shark Bay	51	2	-
IBRA	Cape Range	1,346	30	19
IMCRA	Ningaloo	937	49	23
	Northwest Shelf	80	2	-
	Pilbarra (nearshore)	576	10	3
	Zuytdorp	68	3	-
KEF	Ancient coastline at 125 m depth contour	2,436	49	28
	Canyons linking the Cuvier Abyssal Plain and the Cape Range Peninsula (Canyons)	1,325	45	22
	Commonwealth waters adjacent to Ningaloo Reef	832	43	22
	Exmouth Plateau	166	12	2
	Wallaby Saddle	11	1	-
	Western demersal slope and associated fish communities	20	1	-
MMA	Muiron Islands	1,193	39	26
MP	Ningaloo	604	27	10
NR	Thevenard Island	102	2	1
RSB	Brewis Reef	40	2	-
	Locker Reef	15	1	-
	Ningaloo Reef	510	19	4

Receptor		Maximum exposure to entrained hydrocarbons (ppb)	Probability of exposure to entrained hydrocarbons	
			Low	High
	Penguin Bank	517	5	3
	Rosily Shoals	944	9	4
Nearshore Waters	Airlie Island	41	1	-
	Ashburton Island	11	1	-
	Bessieres Island	529	8	5
	Exmouth	527	19	4
	Flat Island	688	19	14
	Murion Islands	637	28	9
	Observation Island	11	1	-
	Peak Island	1,361	30	19
	Round Island	73	5	-
	Serrurier Island	538	11	7
	Sunday Island	139	11	1
	Table Island	199	4	1
	Thevenard Island	132	2	1
	Tortoise Island	12	1	-

Table 12.24 Predicted probability and maximum entrained hydrocarbon exposure to individual receptors in the 10-20 m depth layer for each season. Results are based on a 1,000 m^3 surface release of MGO from Point 4 over 6 hours, tracked for 40 days.

Season	Receptor		Maximum exposure to entrained hydrocarbons (ppb)	Probability of exposure to entrained hydrocarbons	
				Low	High
Summer	AMP	Ningaloo	11	1	-
	IMCRA	Ningaloo	12	1	-
	KEF	Ancient coastline at 125 m depth contour	20	5	-
		Canyons linking the Cuvier Abyssal Plain and the Cape Range Peninsula (Canyons)	19	2	-
		Commonwealth waters adjacent to Ningaloo Reef	11	1	-
	MMA	Muiron Islands	14	1	-
Transitional	AMP	Ningaloo	11	1	-
	IMCRA	Ningaloo	11	1	-
	KEF	Ancient coastline at 125 m depth contour	24	5	-
		Canyons linking the Cuvier Abyssal Plain and the Cape Range Peninsula (Canyons)	12	1	-
		Commonwealth waters adjacent to Ningaloo Reef	11	1	-
	MMA	Muiron Islands	12	1	-
Winter	AMP	Gascoyne	12	1	-
		Ningaloo	13	2	-
	IBRA	Cape Range	16	3	-
	IMCRA	Ningaloo	15	3	-
	KEF	Ancient coastline at 125 m depth contour	26	6	-
		Canyons linking the Cuvier Abyssal Plain and the Cape Range Peninsula (Canyons)	20	3	-
		Commonwealth waters adjacent to Ningaloo Reef	12	1	-
	MMA	Muiron Islands	14	3	-
	MP	Ningaloo	11	1	-
	Nearshore Waters	Murion Islands	10	1	-
		Peak Island	16	3	-

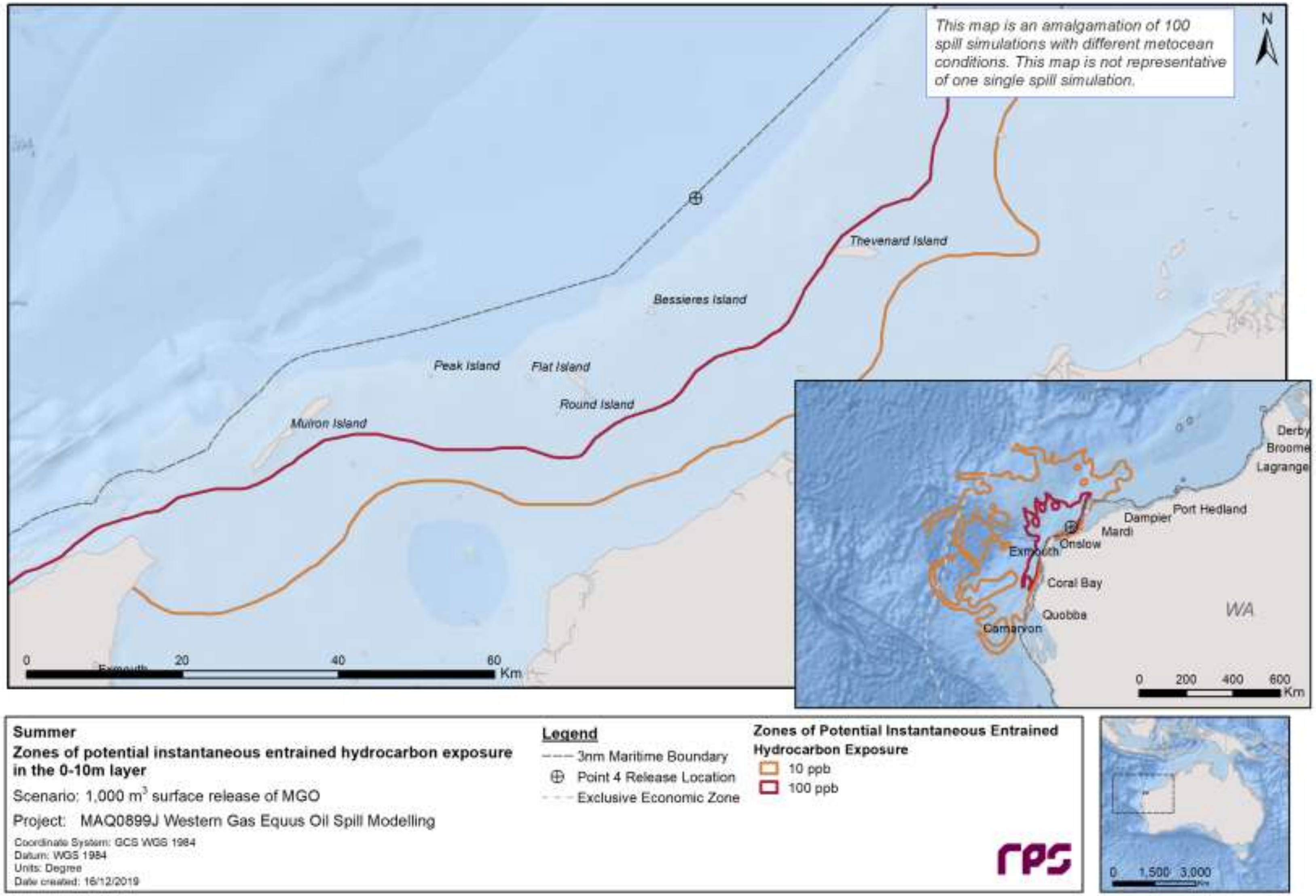

Figure 12.34 Zones of potential instantaneous entrained hydrocarbon exposure at 0-10 m below the sea surface in the event of a 1,000 m^3 surface release of MGO from Point 4 over 6 hours, tracked for 40 days. The results were calculated from 100 spill trajectories commencing during summer (September to March) conditions.

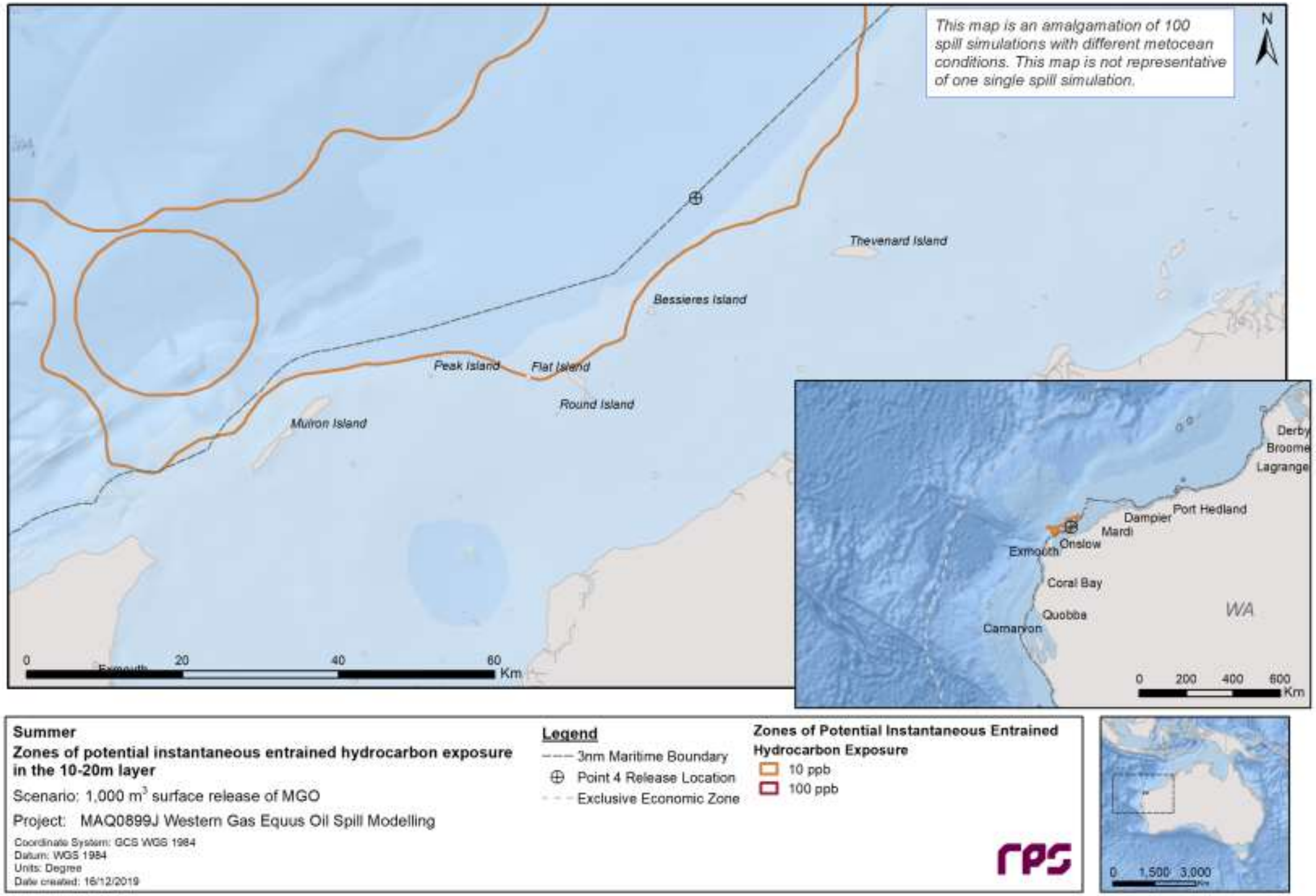

Figure 12.35 Zones of potential instantaneous entrained hydrocarbon exposure at 10-20 m below the sea surface in the event of a 1,000 m^3 surface release of MGO from Point 4 over 6 hours, tracked for 40 days. The results were calculated from 100 spill trajectories commencing during summer (September to March) conditions.

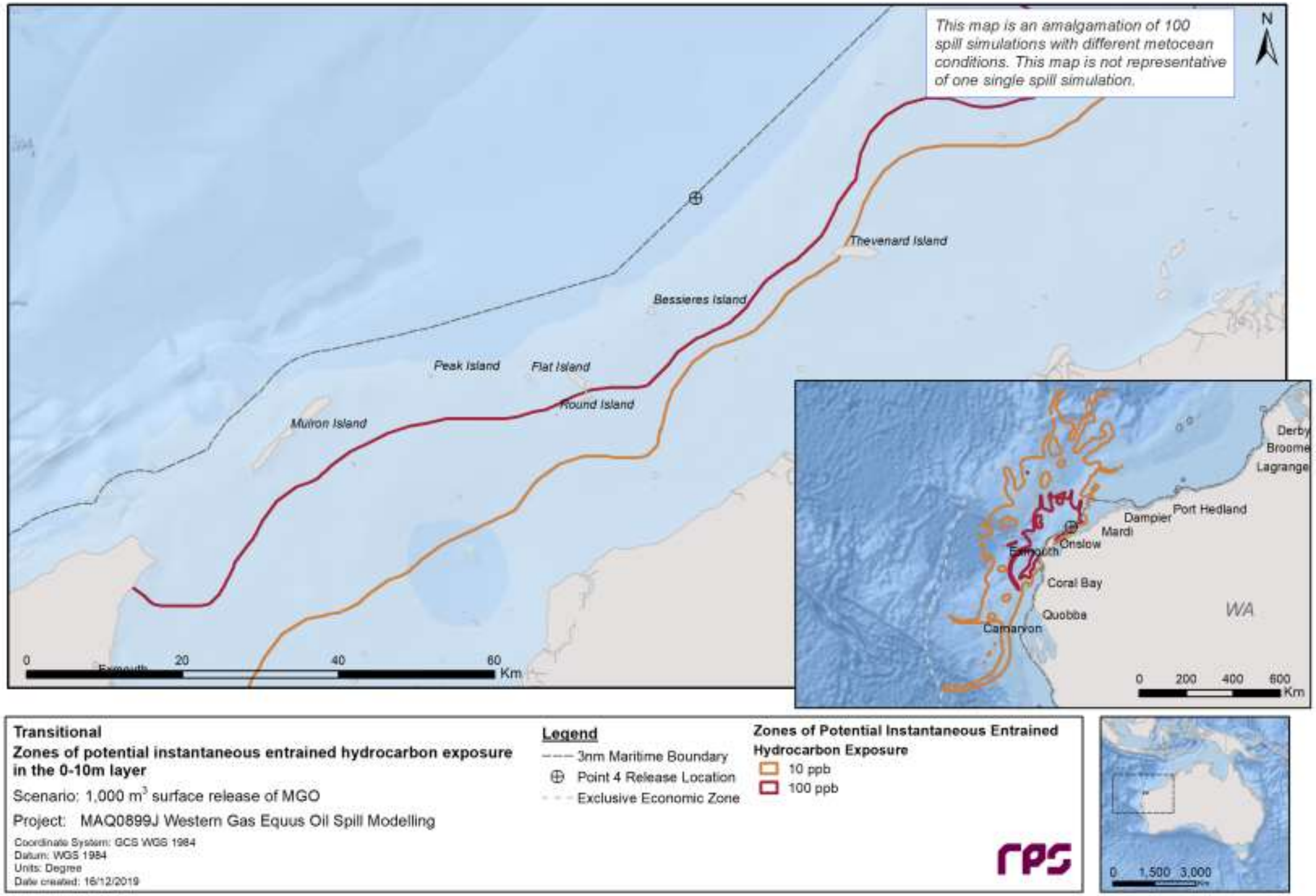

Figure 12.36 Zones of potential instantaneous entrained hydrocarbon exposure at 0-10 m below the sea surface in the event of a 1,000 m^3 surface release of MGO from Point 4 over 6 hours, tracked for 40 days. The results were calculated from 100 spill trajectories commencing during transitional (April and August) conditions.

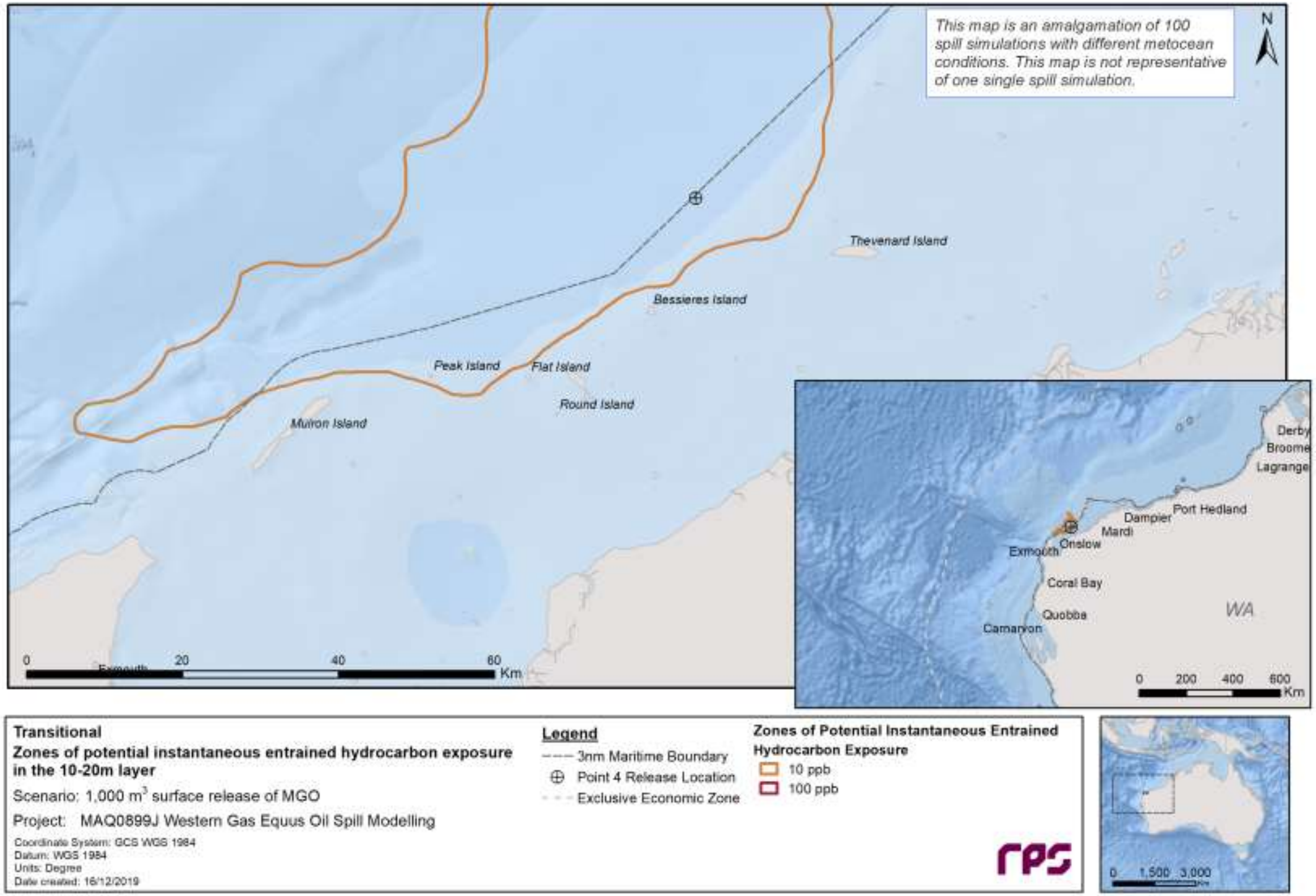

Figure 12.37 Zones of potential instantaneous entrained hydrocarbon exposure at 10-20 m below the sea surface in the event of a 1,000 m^3 surface release of MGO from Point 4 over 6 hours, tracked for 40 days. The results were calculated from 100 spill trajectories commencing during transitional (April and August) conditions.

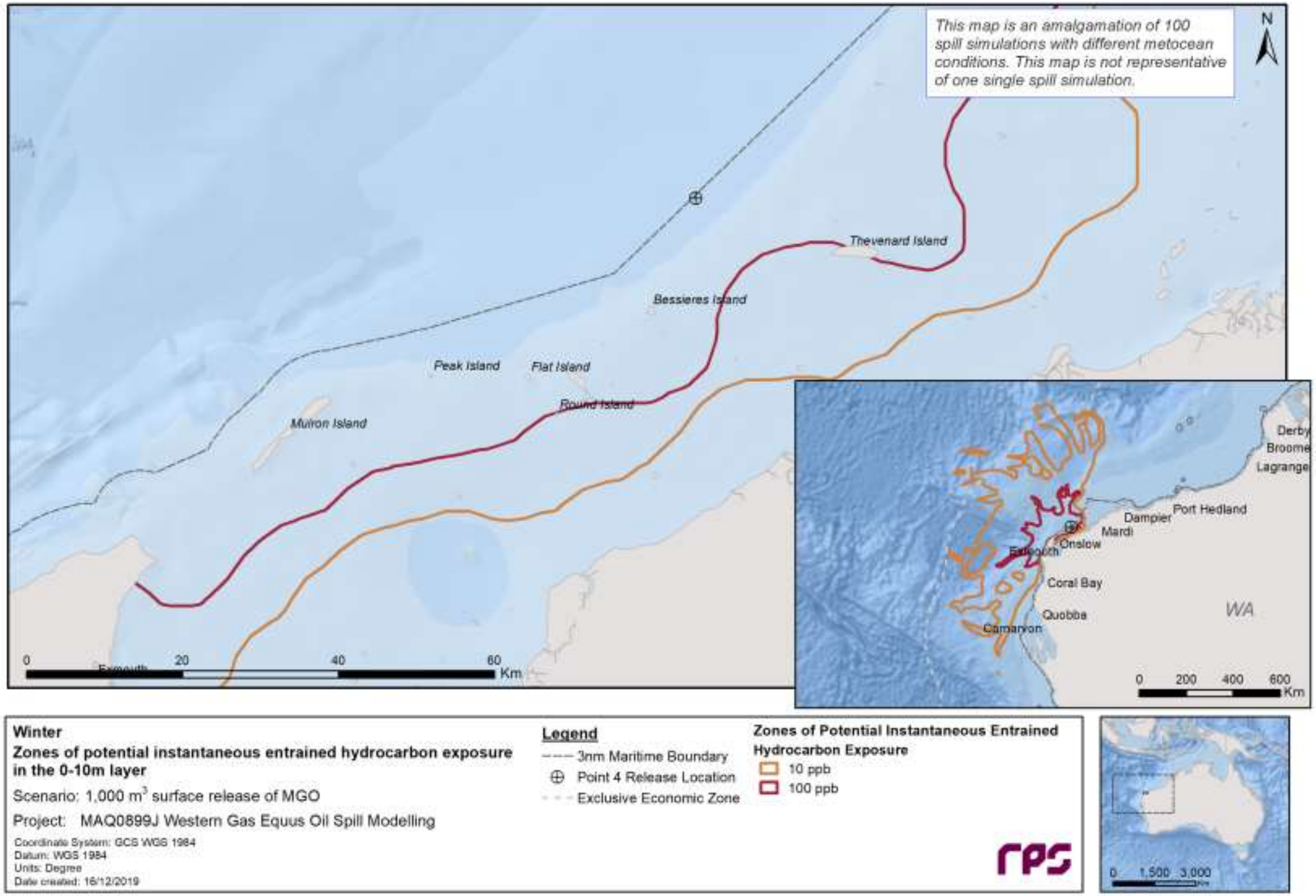

Figure 12.38 Zones of potential instantaneous entrained hydrocarbon exposure at 0-10 m below the sea surface in the event of a 1,000 m^3 surface release of MGO from Point 4 over 6 hours, tracked for 40 days. The results were calculated from 100 spill trajectories commencing during winter (May to July) conditions.

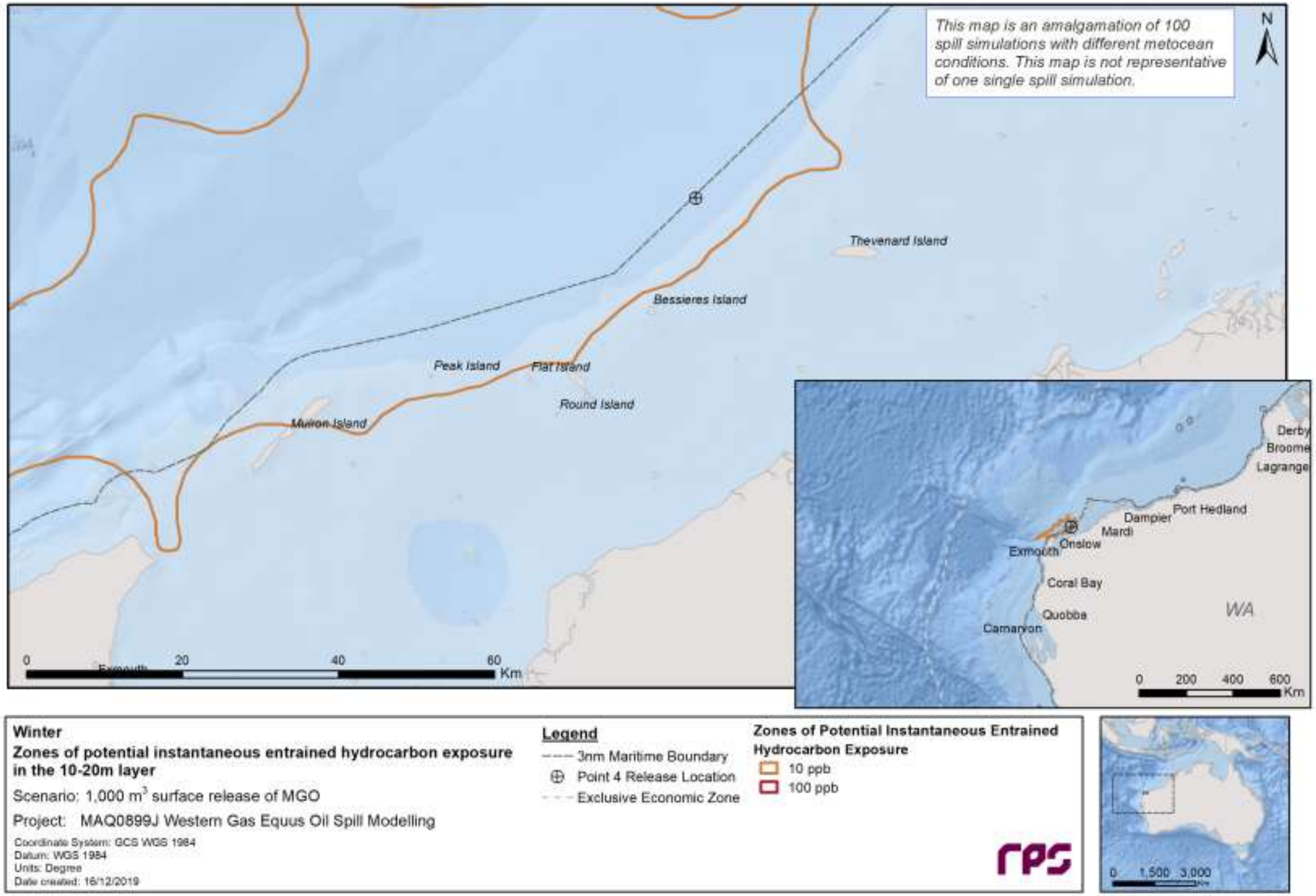

Figure 12.39 Zones of potential entrained hydrocarbon exposure over 1-hour duration at 10-20 m below the sea surface in the event of a 1,000 m^3 surface release of MGO from Point 4 over 6 hours, tracked for 40 days. The results were calculated from 100 spill trajectories commencing during winter (May to July) conditions.

12.2.2 Deterministic Trajectory

12.2.2.1 Deterministic Cases: Largest volume of oil ashore

The simulation that resulted in the largest volume of oil ashore was identified in winter, as run number 24, which commenced at 4 am on the 4th of May 2012.

Zones of oil exposure from sea surface oil (swept area) and shoreline loading over the entire simulation (40-days) is presented in Figure 12.40. The spill was predicted to travel southwest from the release location towards Bessieres Island.

Figure 12.41 displays the area of exposure at low (1 g/m^2) and actionable (10 g/m^2) surface oil thresholds, and length of oil contact to shorelines at the actionable threshold (100 g/m^2). The maximum area of coverage of visible oil on the sea surface was predicted to occur 6 hours after the spill commenced and covered approximately 16 km^2. The maximum length of shoreline above the actionable threshold (>100 g/m^2) was 2 km and had occurred 1.5 days (36 hours) after the spill commenced. Figure 12.42 is a time series of the mass on shore at the low (10 g/m^2), moderate (100 g/m^2) and high (1,000 g/m^2) thresholds.

Figure 12.43 presents the fates and weathering graph for the corresponding single spill trajectory. At the conclusion of the simulation period (day-40), approximately 677 m^3 (67%) spilled oil was lost to the atmosphere through evaporation. Approximately, 235 m^3 (24%) of the oil was predicted to have decayed, while approximately 86 m^3 (8%) was predicted to remain within the water column and 2 m^3 (0.2%) was predicted to arrive ashore.

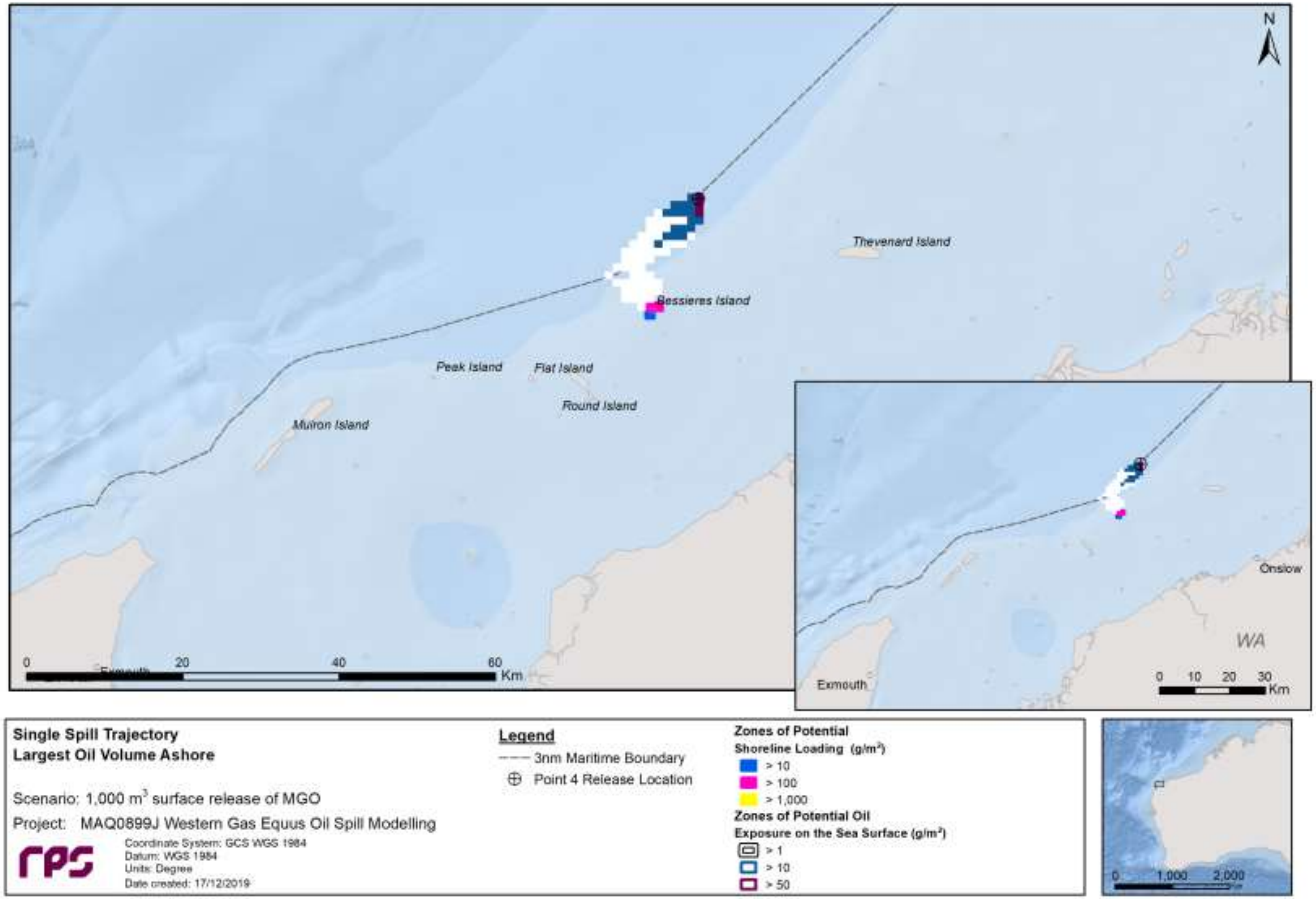

Figure 12.40 Zones of oil exposure on the sea surface (swept area) and shoreline loading over the entire simulation (40 days), for the trajectory with the largest volume of oil ashore. Results are based on a 1,000 m^3 surface release of MGO from Point 4 over 6 hours, tracked for 40 days, commencing at 4 am on the 4th of May 2012.

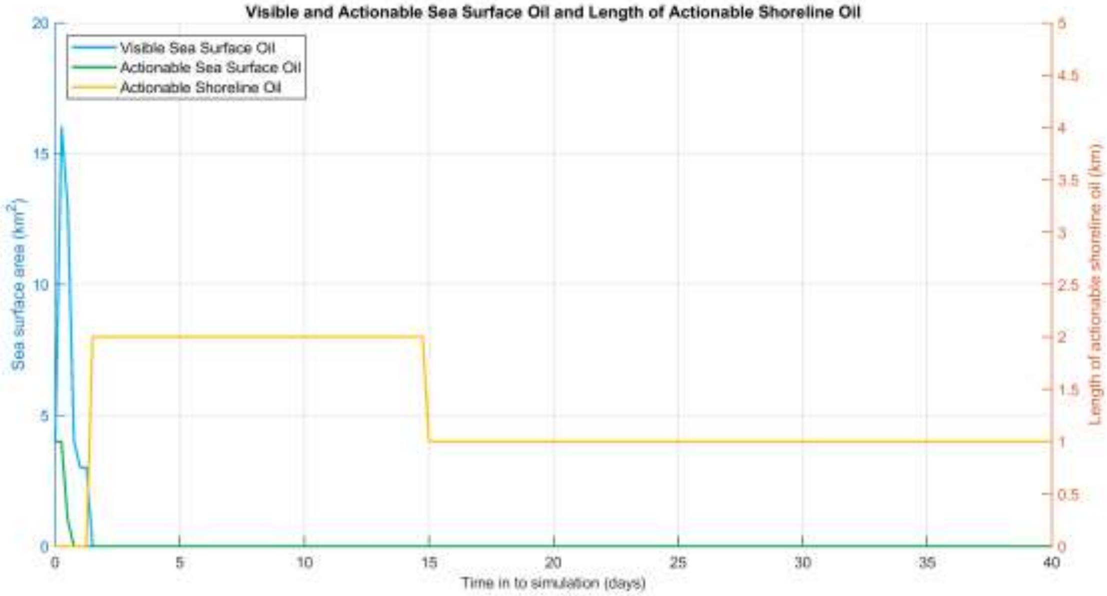

Figure 12.41 Area of exposure at low (1 g/m^2) and actionable (10 g/m^2) surface oil thresholds and length of oil contact to shorelines at the actionable threshold (100 g/m^2); for the simulation identified to result in the largest volume of oil ashore from Point 4. Results are based on 1,000 m^3 surface release of MGO from Point 1 over 6 hours, tracked for 40 days, 4 am on the 4th of May 2012.

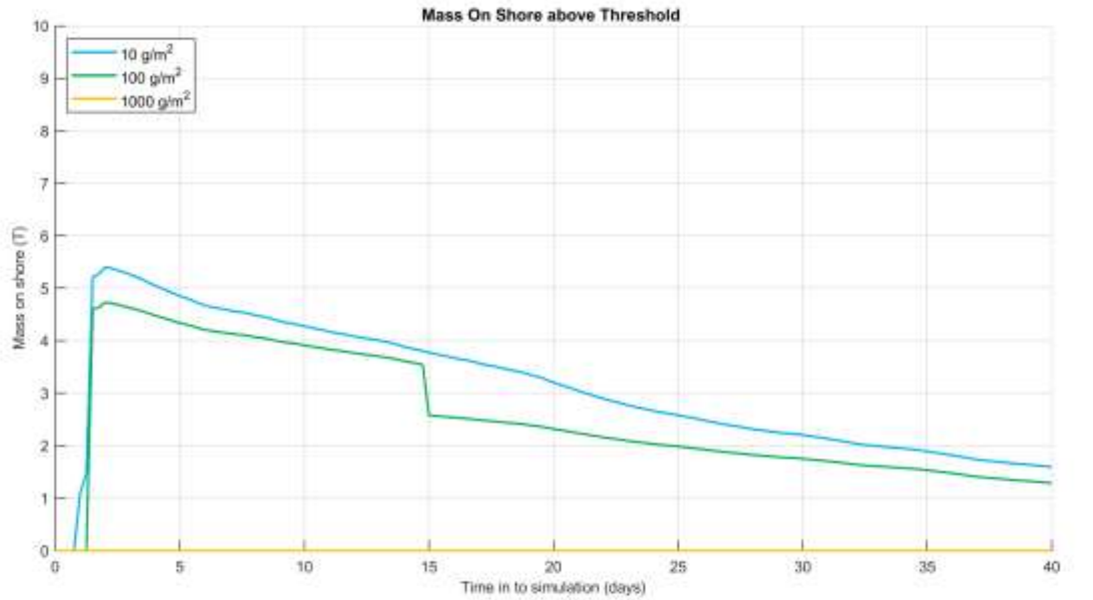

Figure 12.42 Time series of the mass ashore at each threshold for the trajectory with the largest volume of oil ashore. Results are based on a 1,000 m^3 surface release of MGO from Point 4 over 6 hours, tracked for 40 days, 4 am on the 4th of May 2012.

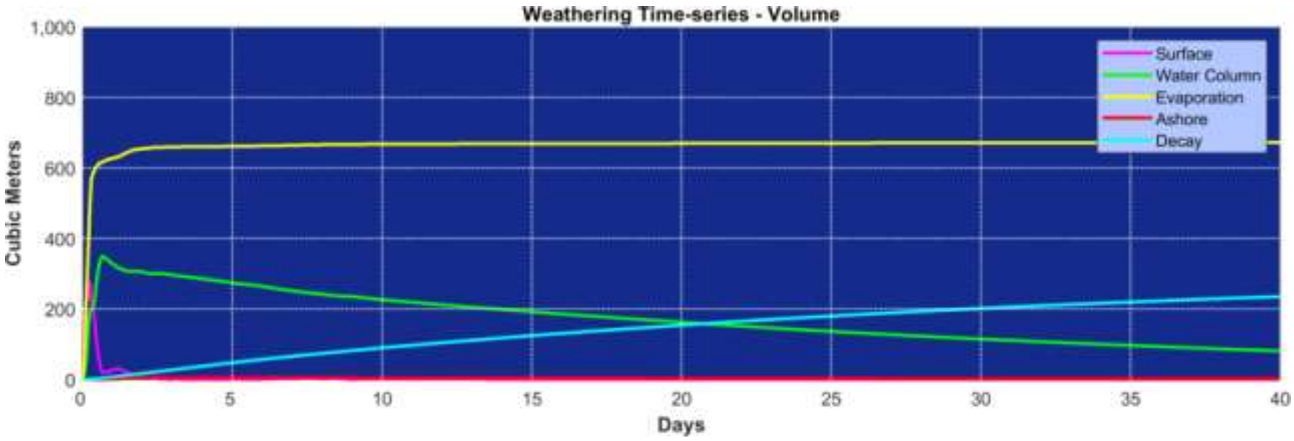

Figure 12.43 Predicted weathering and fates graph for the trajectory with the largest volume of oil ashore. Results are based on a 1,000 m^3 surface release of MGO from Point 4 over 6 hours, tracked for 40 days, 4 am on the 4th of May 2012.

13 REFERENCES

Andersen, OB 1995, 'Global ocean tides from ERS 1 and TOPEX/POSEIDON altimetry', Journal of Geophysical Research: Oceans, vol. 100, no. C12, pp. 25249–25259.

Anderson JW, Neff JM, Cox BA, Tatem HE & Hightower GM 1974, 'Characteristics of dispersions and water-soluble extracts of crude and refined oils and their toxicity to estuarine crustaceans and fish', Marine Biology, vol. 27, no. 1, pp. 75–88.

Anderson JW, Riley R, Kiesser S & Gurtisen J 1987, 'Toxicity of dispersed and undispersed Prudhoe Bay crude oil fractions to shrimp and fish', Proceedings of the 1987 International Oil Spill Conference, American Petroleum Institute, pp. 235–240.

Asia-Pacific ASA, 2010. Montara well release monitoring study S7.2. Oil fate and effects assessment: modelling of chemical dispersant operation. Prepared for PTTEP Australasia.

Australian Maritime Safety Authority (AMSA) 2015a, Technical Guidelines for Preparing Contingency Plans for Marine and Coastal Facilities.

Australian Maritime Safety Authority (AMSA) 2015b, National Plan - Response, Assessment and Termination of Cleaning for Oil Contaminated Foreshores (NP-GUI-025)

Australian and New Zealand Environment and Conservation Council (ANZECC) and Agriculture and Resource Management Council of Australia and New Zealand (ARMCANZ) 2000, Australian and New Zealand Guidelines for Fresh and Marine Water, Australian and New Zealand Environment and Conservation Council, Agriculture and Resource Management Council of Australia and New Zealand, Canberra.

Becker, JJ, Sandwell, DT, Smith, WHF, Braud, J, Binder, B, Depner, J, Fabre, D, Factor, J, Ingalls, S, Kim, S-H, Ladner, R, Marks, K, Nelson, S, Pharaoh, A, Trimmer, R, Von Rosenberg, J, Wallace, G & Weatherall, P 2009, 'Global bathymetry and evaluation data at 30 arc seconds resolution: SRTm^{3}0_PLUS', Marine Geodesy, vol. 32, no. 4, pp. 355–371.

Belore, UC 2014, Subsea chemical dispersant research. Proceedings of the 37th AMOP Technical Seminar on Environmental Contamination and Response, Environmental Canada, Canmore, Alberta, Canada pp 618-650.

Blum DJ & Speece RE 1990, "Determining chemical toxicity to aquatic species', Environmental Science & Technology, vol. 24, no. 3, pp. 284–293.

Bonn Agreement 2009, 'Bonn Agreement aerial operations handbook, 2009 - Publication of the Bonn Agreement', London, viewed 13 January 2015, http://www.bonnagreement.org/site/assets/files/3947/ba-aoh_revision_2_april_2012.pdf.

Brandvik, PJ, Johansen, O, Leirvik, F, Farooq, U & Daling PS 2013, 'Droplet Breakup in subsurface oil releases – Part 1: Experimental study of droplet breakup and effectiveness of dispersant injection', Marine Pollution Bulletin, vol. 73, no. 1, pp 319–326.

Brandvik, PJ, Johansen, O, Farooq, U, Angell, G & Leirvik F 2014, Sub-surface oil releases – Experimental study of droplet distributions and different dispersant injection techniques- version 2. A scaled experimental approach using the SINTEF Tower basin. SINTEF report no: A25122. Trondheim Norway 2014. ISBN: 9788214057393

Carls, M.G., Holland, L., Larsen, M., Collier, T.K., Scholz, N.L. and Incardona, J.P., 2008. Fish embryos are damaged by dissolved PAHs, not oil particles. Aquatic toxicology, 88(2), pp.121-127.

Chassignet, EP, Hurlburt, HE, Smedstad, OM, Halliwell, GR, Hogan, PJ, Wallcraft, AJ, Baraille, R & Bleck, R 2007, 'The HYCOM (hybrid coordinate ocean model) data assimilative system', Journal of Marine Systems, vol. 65, no. 1, pp. 60–83.

Chassignet, E, Hurlburt, H, Metzger, E, Smedstad, O, Cummings, J & Halliwell, G 2009, 'U.S. GODAE: Global Ocean Prediction with the HYbrid Coordinate Ocean Model (HYCOM)', Oceanography, vol. 22, no. 2, pp. 64–75.

Condie, SA., & Andrewartha, JR (2008). Circulation and connectivity on the Australian Northwest Shelf. Continental Shelf Research, 28, 1724-1739.

Davies, AM 1977a, 'The numerical solutions of the three-dimensional hydrodynamic equations using a B-spline representation of the vertical current profile', in JC Nihoul (ed), Bottom Turbulence: Proceedings of the 8th Liège Colloquium on Ocean Hydrodynamics, Elsevier Scientific, Amsterdam, pp. 1–25.

Davies, AM 1977b, 'Three-dimensional model with depth-varying eddy viscosity', in JC Nihoul (ed), Bottom Turbulence: Proceedings of the 8th Liège Colloquium on Ocean Hydrodynamics, Elsevier Scientific, Amsterdam, pp. 27–48.

DEWHA, 2007. Characterisation of the marine environment in the north marine region. Marine Division, Department of the environment, water heritage and the arts.

DEWHA. 2008. The North-West Marine Bioregional Plan - Bioregional Profile. Retrieved February 12, 2013, from Australian Government Department of Environment, Water, Heritage and the Arts: http://www.environment.gov.au/coasts/mbp/publications/north-west/pubs/bioregional-profile.pdf

French, D., Reed, M., Jayko, K., Feng, S., Rines, H., Pavignano, S.1996. The CERCLA Type A Natural Resource Damage Assessment Model for Coastal and Marine Environments (NRDAM/CME), Technical Documentation, Vol. I - Model Description, Final Report. Office of Environmental Policy and Compliance, U.S. Department of the Interior. Washington, D.C.: Contract No. 14-0001-91-C-11.

French, D, Schuttenberg, H & Isaji, T 1999, 'Probabilities of oil exceeding thresholds of concern: examples from an evaluation for Florida Power and Light', Proceedings of the 22nd Arctic and Marine Oil Spill Program (AMOP) Technical Seminar, Environment Canada, Alberta, pp. 243–270.

French-McCay, DP 2002, 'Development and application of an oil toxicity and exposure model, OilToxEx', Environmental Toxicology and Chemistry, vol. 21, no. 10, pp. 2080-2094.

French-McCay, DP 2003, 'Development and application of damage assessment modelling: example assessment for the North Cape oil spill', Marine Pollution Bulletin, vol. 47, no. 9, pp. 9–12.

French-McCay, DP 2004, 'Spill impact modelling: development and validation', Environmental Toxicology and Chemistry, vol. 23, no.10, pp. 2441–2456.

French-McCay, D, Rowe, JJ, Whittier, N, Sankaranarayanan, S, & Etkin, DS 2004, 'Estimate of potential impacts and natural resource damages of oil', Journal of Hazardous Materials, vol. 107, no. 1, pp. 11–25.

French-McCay, DP 2009, 'State-of-the-art and research needs for oil spill impact assessment modelling', Proceedings of the 32nd Arctic and Marine Oil Spill Program (AMOP) Technical Seminar, Environment Canada, Ottawa, pp. 601–653.

French-McCay, D, Whittier, N, Dalton, C, Rowe, J, Sankaranarayanan, S & Aurand, D 2005a, 'Modeling the fates of hypothetical oil spills in Delaware, Florida, Texas, California, and Alaska waters, varying response options including use of dispersants', Proeceedings of the International Oil Spill Conference 2005, American Petroleum Institute, Washington DC, paper 399.

French-McCay, D, Whittier, N, Rowe, J, Sankaranarayanan, S, Kim, H-S & Aurand, D 2005b, 'Use of probabilistic trajectory and impact modeling to assess consequences of oil spills with various response strategies,' Proceedings of the 28th Arctic and Marine Oil Spill Program (AMOP) Technical Seminar, Environment Canada, Ottawa, pp. 253–271.

French-McCay, D, Reich, D, Rowe, J, Schroeder, M & Graham, E 2011, 'Oil spill modeling input to the offshore environmental cost model (OECM) for US-BOEMRE's spill risk and costs evaluations', Proceedings of the 34th Arctic and Marine Oil Spill Program (AMOP) Technical Seminar, Environment Canada, Ottawa.

French-McCay, D, Reich, D, Michel, J, Etkin, DS, Symons, L, Helton, D, & Wagner J 2012, 'Oil spill consequence analysis of potentially-polluting shipwrecks', Proceedings of the 35th Arctic and Marine Oil Spill Program (AMOP) Technical Seminar, Environment Canada, Ottawa.

Grant, DL, Clarke, PJ & Allaway, WG 1993, 'The response of grey mangrove (Avicennia marina (Forsk.) Vierh) seedlings to spills of crude oil,' The Journal of Experimental Marine Biological Ecology, vol. 171, no. 2, pp. 273–295.

Gordon, R 1982, 'Wind driven circulation in Narragansett Bay' PhD thesis, Department of Ocean Engineering, University of Rhode Island.

Isaji, T & Spaulding, M 1984, 'A model of the tidally induced residual circulation in the Gulf of Maine and Georges Bank', Journal of Physical Oceanography, vol. 14, no. 6, pp. 1119–1126.

Isaji, T, Howlett, E, Dalton C, & Anderson, E 2001, 'Stepwise-continuous-variable-rectangular grid hydrodynamics model', Proceedings of the 24th Arctic and Marine Oil spill Program (AMOP) Technical Seminar (including 18th TSOCS and 3rd PHYTO), Environment Canada, Edmonton, pp. 597–610.

International Tankers Owners Pollution Federation (ITOPF) 2014. Technical Information Paper 2 -Fate of Marine Oil Spills, International Tankers Owners Pollution Federation td, UK.

Koops, W, Jak, RG & van der Veen, DPC 2004, 'Use of dispersants in oil spill response to minimise environmental damage to birds and aquatic organisms', Proceedings of the Interspill 2004: Conference and Exhibition on Oil Spill Technology, Trondheim, presentation 429.

Kostianoy, AG, Ginzburg, AI, Lebedev, SA, Frankignoulle, M & Delille, B 2003, 'Fronts and mesoscale variability in the southern Indian Ocean as inferred from the TOPEX/POSEIDON and ERS-2 Altimetry data', Oceanology, vol. 43, no. 5, pp. 632–642.

Levitus, S, Antonov, JI, Baranova, OK, Boyer, TP, Coleman, CL, Garcia, HE, Grodsky, AI, Johnson, DR, Locarnini, RA, Mishonov, AV, Reagan, JR, Sazama, CL, Seidov, D, Smolyar, I, Yarosh, ES & Zweng, MM 2013, 'The World Ocean Database', Data Science Journal, vol.12, no. <1, pp. WDS229–WDS234.

Lin, Q & Mendelssohn, IA 1996, 'A comparative investigation of the effects of south Louisiana crude oil on the vegetation of fresh, brackish and Salt Marshes', Marine Pollution Bulletin, vol. 32, no. 2, pp. 202–209.

Locarnini, R.A., Mishonov A.V., Antonov, J.I., Boyer, T.P., Garcia, H.E., Baranova, O.K., Zweng, M.M., Paver, C.R., Reagan, J.R., Johnson, D.R., Hamilton, M., Seidov, D. 2013. World Ocean Atlas 2013, Volume 1: Temperature. S. Levitus, Ed.; A. Mishonov, Technical Ed.; NOAA Atlas NESDIS 73, 40 pp

Ludicone, D, Santoleri, R, Marullo, S & Gerosa, P 1998, 'Sea level variability and surface eddy statistics in the Mediterranean Sea from TOPEX/POSEIDON data', Journal of Geophysical Research I, vol. 103, no. C2, pp. 2995–3011.

McAuliffe CD 1987, 'Organism exposure to volatile/soluble hydrocarbons from crude oil spills – a field and laboratory comparison', Proceedings of the 1987 International Oil Spill Conference, American Petroleum Institute, pp. 275–288.

Mackay D, Puig H & McCarty LS 1992, 'An equation describing the time course and variability in uptake and toxicity of narcotic chemicals to fish', Environmental Toxicology and Chemistry: An International Journal, vol. 11, no. 7, p.941–951.

Malins DC & Hodgins HO 1981, 'Petroleum and marine fishes: a review of uptake, disposition, and effects', Environmental Science & Technology, vol. 15, no. 11, pp.1272–1280.

McCarty LS 1986, 'The relationship between aquatic toxicity QSARs and bioconcentration for some organic chemicals', Environmental Toxicology and Chemistry, vol. 5, no. 12, pp. 1071–1080.

McCarty LS & Mackay D 1993, 'Enhancing ecotoxicological modelling and assessment. Body residues and modes of toxic action', Environmental Science & Technology, vol. 27, no. 9, pp. 1718–1728.

McCarty LS, Dixon DG, MacKay D, Smith AD & Ozburn GW 1992a, 'Residue-based interpretation of toxicity and bioconcentration QSARs from aquatic bioassays: Neutral narcotic organics', Environmental Toxicology and Chemistry: An International Journal, vol. 11, no. 7, pp.917–930.

McCarty LP, Flannagan DC, Randall SA & Johnson KA 1992b, 'Acute toxicity in rats of chlorinated hydrocarbons given via the intratracheal route', Human & Experimental Toxicology, vol. 11, no. 3, pp.173–117.

McGrath JA, & Di Toro DM 2009, 'Validation of the target lipid model for toxicity assessment of residual petroleum constituents: monocyclic and polycyclic aromatic hydrocarbons, 'Environmental Toxicology and Chemistry, vol. 28, no. 6, pp. 1130–1148.

Matsumoto, K, Takanezawa, T & Ooe, M 2000, 'Ocean tide models developed by assimilating TOPEX/POSEIDON altimeter data into hydrodynamical model: A global model and a regional model around Japan', Journal of Oceanography, vol. 56, no.5, pp. 567–581.

National Oceanic and Atmospheric Administration (NOAA) 2013, 'Screening level risk assessment package Gulf state', Office of National Marine Sanctuaries & Office of Response and Restoration, Washington DC.

National Offshore Petroleum Safety and Environmental Management Authority (NOPSEMA) 2018, 'At a glance: Oil spill modelling', viewed 15 November 2018, https://www.nopsema.gov.au/assets/Publications/A626200.pdf

National Offshore Petroleum Safety and Environmental Management Authority (NOPSEMA) 2019, 'NOPSEMA Bulletin #1: Oil spill modelling', viewed April 2019, https://www.nopsema.gov.au/assets/Bulletins/A652993.pdf

National Research Council (NRC) 2003, 'Oil in the sea III: Inputs, fates and effects', The National Academic Press, Washington D.C.

Neff JM, Anderson JW 1981, 'Response of marine animals to petroleum and specific petroleum hydrocarbons' United States Department of Energy, United States.

Nirmalakhandan N & Speece RE 1998, 'ES&T Critical Review: Structure-activity relationships. Quantitative techniques for predicting the behaviour of chemicals in the ecosystem', Environmental Science & Technology, vol. 22, no. 6, pp. 606–615.

Nordtug, T., Olsen, A.J., Altin, D., Overrein, I., Storøy, W., Hansen, B.H. and De Laender, F., 2011. Oil droplets do not affect assimilation and survival probability of first feeding larvae of North-East Arctic cod. Science of the Total Environment, 412, pp.148-153.

Oil Spill Solutions 2015, Evaluation - The Theory of Oil Slick Appearances, viewed 6 January 2015, http://www.oilspillsolutions.org/evaluation.htm

Owen, A 1980, 'A three-dimensional model of the Bristol Channel', Journal of Physical Oceanography, vol. 10, no. 8, pp. 1290–1302.

Qiu, B & Chen, S 2010, 'Eddy-mean flow interaction in the decadally modulating Kuroshio Extension system', Deep-Sea Research II, vol. 57, no. 13, pp. 1098–1110.

Redman AD 2015, 'Role of entrained droplet oil on the bioavailability of petroleum substances in aqueous exposures', Marine Pollution Bulletin, vol. 97, no. (1-2), pp. 342–348.

Saha, S, Moorthi, S, Pan, H-L, Wu, X, Wang, J & Nadiga, S 2010, 'The NCEP Climate Forecast System Reanalysis', Bulletin of the American Meteorological Society, vol. 91, no. 8, pp. 1015–1057.

Scholten, MCTh, Kaag, NHBM, Dokkum, HP van, Jak, R.G., Schobben, HPM & Slob, W 1996, Toxische effecten van olie in het aquatische milieu, TNO report TNO-MEP – R96/230, Den Helder.

Smit, MG, Bechmann, RK, Hendriks, AJ, Skadsheim, A, Larsen, BK, Baussant, T, Shaw, B & Sanni, S 2009, 'Relating biomarkers to whole-organism effects using species sensitivity distributions: A pilot study for marine species exposed to oil', Environmental Toxicology and Chemistry, vol. 28, no. 5, pp. 1104-1109.

Spaulding, ML., Kolluru, VS, Anderson, E & Howlett, E 1994, 'Application of three-dimensional oil spill model (WOSM/OILMAP) to hindcast the Braer Spill', Spill Science and Technology Bulletin, vol. 1, no. 1, pp. 23–35.

Spaulding, MS, Mendelsohn, D, Crowley, D, Li, Z, and Bird A, 2015. Technical Reports for Deepwater Horizon Water Column Injury Assessment- WC_TR.13: Application of OILMAP DEEP to the Deepwater Horizon Blowout. RPS APASA, 55 Village Square Drive, South Kingstown, RE 02879.

Suprayogi, B & Murray, F 1999, 'A field experiment of the physical and chemical effects of two oils on mangroves', Environmental and Experimental Botany, vol. 42, no. 3, pp. 221–229.

Swartz RC, Schults DW, Ozretich RJ, Lamberson JO, Cole FA, Ferraro SP, Dewitt TH & Redmond MS 1995, 'ΣPAH: A Model to predict the toxicity of polynuclear aromatic hydrocarbon mixtures in field-collected sediments', Environmental Toxicology and Chemistry, vol. 14, no. 11, pp. 1977–1187.

Verhaar HJM, Van Leeuwen CJ & Hermens JLM 1992, 'Classifying environmental pollutants', Chemosphere, vol. 24, no. 4, pp. 471–491.

Verhaar HJM, de Jongh J & Hermens JLM 1999, 'Modelling the bioconcentration of organic compounds by fish: A novel approach', Environmental Science & Technology, vol. 33, no. 22, pp. 4069–4072.

Willmott, CJ 1981, 'On the validation of models', Physical Geography, vol. 2, no. 2, pp.184–194.

Willmott, CJ 1982, 'Some comments on the evaluation of model performance', Bulletin of the American Meteorological Society, vol. 63, no. 11, pp.1309–1313.

Willmott CJ, Ackleson SG, Davis RE, Feddema JJ, Klink, KM, Legates, DR, O'Donnell, J & Rowe, CM 1985, 'Statistics for the evaluation of model performance', Journal of Geophysical Research, vol. I 90, no. C5, pp. 8995–9005.

Willmott, CJ & Matsuura, K 2005, 'Advantages of the mean absolute error (MAE) over the root mean square error (RMSE) in assessing average model performance', Journal of Climate Research, vol. 30, no. 1, pp. 79–82.

Yaremchuk, M & Tangdong, Q 2004, 'Seasonal variability of the large-scale currents near the coast of the Philippines', Journal of Physical Oceanography, vol. 34, no., 4, pp. 844–855.

Zigic, S, Zapata, M, Isaji, T, King, B, & Lemckert, C 2003, 'Modelling of Moreton Bay using an ocean/coastal circulation model', Proceedings of the 16th Australasian Coastal and Ocean Engineering Conference, the 9th Australasian Port and Harbour Conference and the Annual New Zealand Coastal Society Conference, Institution of Engineers Australia, Auckland, paper 170.

Zweng, M.M., Reagan, J.R., Antonov, J.I., Locarnini, R.A., Mishonov, A.V., Boyer, T.P., Garcia, H.E., Baranova, O.K., Johnson, D.R., Seidov, D., Biddle, M.M. 2013. World Ocean Atlas 2013, Volume 2: Salinity. S. Levitus, Ed.; A. Mishonov, Technical Ed.; NOAA Atlas NESDIS 74, 39 pp.

WESTERN GAS

APPENDIX D: STAKEHOLDER CONSULTATION RECORD

Consultation Information Sheet sent to all stakeholders

STAKEHOLDER CONSULTATION INFORMATION SHEET

WESTERN GAS

SASANOF-1 EXPLORATION WELL ENVIRONMENT PLAN

MAY 2021

Western Gas is planning to drill the Sasanof-1 exploration well in Exploration Permit WA-519-P, located in Commonwealth Waters in the Carnarvon Basin offshore Western Australia, starting at the earliest in Q1 2022 subject to approvals, vessel availability and weather constraints.

An Environment Plan for the proposed activities will be submitted to the National Offshore Petroleum Safety and Environmental Management Authority (NOPSEMA) and will be made available for public comment following a completeness check by NOPSEMA. NOPSEMA acceptance of this plan is required before any petroleum activity can commence.

The Environment Plan will cover well design and drilling operations, installation and testing of well safety equipment, well evaluation and plugging activities prior to the abandonment of the well.

Western Gas is Operator and 100% owner of WA-519-P and the adjacent Equus Gas Project.

Figure 1: Sasanof-1 well location

ACTIVITY OVERVIEW

Earliest start date:
Q1 2022, subject to approvals, vessel availability and weather constraints

Approximate Location:
- ~207 km northwest of Onslow
- Latitude: 20.4871°S
- Longitude: 113.544°E

Approximate estimated duration:
- ~25 days, excluding weather and operational delays

Water depth:
- ~1071 m

Project vessels:
- Semi-submersible mobile offshore drilling unit (MODU)
- Activity support vessels, including general supply/support vessels and anchor handling vessel(s)

Distance to nearest marine park:
- ~23.6 km north of the Gascoyne Marine Park (Multiple Use Zone)

Exclusion zones:
- A temporary Petroleum Safety Zone with a radius of 500 m around the MODU during the activity. Unauthorised vessels are not permitted to enter this zone.
- A temporary Cautionary Area with a radius of 5 km around the MODU during the activity. Marine users will be permitted to enter this area but should take care for safety reasons.

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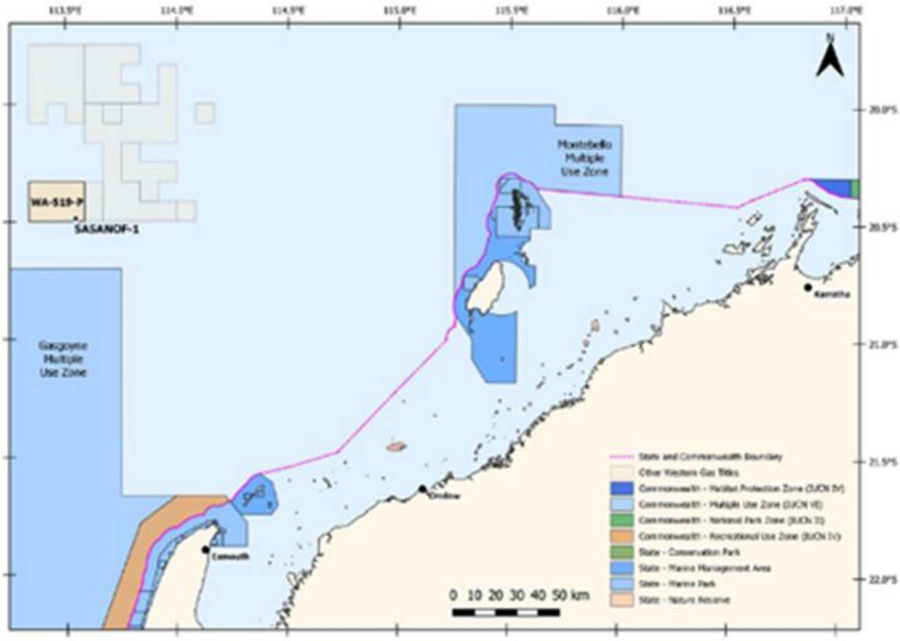

Figure 2: Sasanof well location

PROPOSED ACTIVITY

Western Gas is planning to drill the Sasanof-1 exploration well in WA-519-P. Results from drilling activities will be used to confirm the presence of undiscovered oil and gas reservoirs, as well as to help inform Western Gas' understanding of its known discoveries in the area.

The Environment Plan for the activity will cover well design and drilling operations, installation and testing of well safety equipment, and well evaluation activities.

Best endeavours will be made to remove the wellhead. If the structure cannot be retrieved, it will be left in situ and the well location will be marked on nautical charts.

Drilling and support activities will typically be conducted on a 24-hour basis. The duration of these activities is subject to change due to project schedule requirements, drill rig and vessel availability, weather, and unforeseen circumstances.

Listed below is a summary of key activities for the drilling of the well.

- Pre-drilling survey
- MODU positioning and anchoring
- Installation and testing of the blow out preventers
- Drilling of the well
- Cementing of the well
- Well evaluation
- Well plugging and abandonment
- Post-drilling survey
- Support operations, including vessel and helicopter movements

PROJECT VESSELS

Western Gas is currently considering vessel options, with the drilling rig likely to be a moored semi-submersible mobile offshore drilling unit (MODU). Typically, two or three vessels will support drilling activities, with at least one vessel in the vicinity to complete standby duties, if required. Supply vessels from either Onslow or Dampier will visit the selected MODU at regular intervals.

STAKEHOLDER NOTIFICATIONS

Notifications will be issued prior to the start of the activity to alert other marine users who may be operating in nearby waters. A temporary Petroleum Safety Zone and Cautionary Area will be in place during the drilling of the well. Drilling activities will be deemed complete following the MODU moving off station.

ASSESSMENT OF IMPACTS AND RISKS

Western Gas has assessed potential risks and impacts to the marine environment and relevant stakeholders, considering the timing, duration, location and the nature and scale of the proposed activity. Table 1 summarises key potential impacts resulting from planned and unplanned activities. Western Gas is consulting relevant stakeholders to help inform its management of these impacts and risks, and planning for the Environment Plan.

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Table 1. Risk and impact assessment, and associated management measures

POTENTIAL RISKS/ IMPACTS	MANAGEMENT MEASURES
PLANNED ACTIVITIES	
Interactions with other marine users	▪ Establishment of a temporary Petroleum Safety Zone with a radius of 500 m around the MODU during the activity. Unauthorised vessels are not permitted to enter this zone. ▪ Establishment of a temporary Cautionary Area with a radius of up to number km around the MODU during the activity. Marine users will be permitted to enter this area but should take care for safety reasons. ▪ Consultation with relevant stakeholders, including adjacent petroleum titleholders, commercial fishers and their representative organisations, and government departments and agencies to inform decision making for the proposed activity and the development of the Environment Plan. ▪ Western Gas will notify maritime safety agencies and other identified stakeholders of the MODU location and start and end dates for the activity.
Light emissions	▪ Lighting is minimised to that required for safety and navigational purposes.
Seabed disturbance	▪ Well location and site appraisal to identify and address well-specific hazards and drilling constraints. ▪ MODU mooring analysis and anchor deployment in accordance with drilling contractor standards. ▪ No anchoring of support vessels during drilling.
Planned discharges to the marine environment	▪ All routine marine discharges will be managed according to legislative and regulatory requirements and Western Gas' HSE Corporate Management System where applicable. ▪ Chemical use will be managed in accordance with contractor chemical selection and approval procedures.
Underwater noise	▪ Measures will be in place for interacting with protected marine fauna as per Part 8 of the Environment Protection and Biodiversity Conservation Regulations 2000 should vertical seismic profiling be undertaken.
Waste generation	▪ Waste generated on the MODU and support vessels will be managed in accordance with legislative requirements and a Waste Management Plan. ▪ Wastes will be managed and disposed of in a safe and environmental responsible manner that prevents accidental loss to the marine environment. ▪ Wastes transported onshore will be sent to appropriate recycling or disposal facilities by a licenced waste contractor.
UNPLANNED ACTIVITIES	
Hydrocarbon release	▪ Oil Pollution Emergency Plan and Operational and Scientific Monitoring Plan will be in place. ▪ Appropriate vessel spill response plans, equipment and materials will be in place and maintained.
Invasive marine species	▪ Contracted vessels will comply with Australian biosecurity requirements and guidance, and Australian ballast water requirements. ▪ Vessels will be assessed and managed as appropriate to prevent the introduction of invasive marine species.
Marine fauna interaction	▪ Compliance with Part 8 of the Environment Protection and Biodiversity Conservation Regulations 2000.

PROVIDING FEEDBACK

Please contact Western Gas before **25 June 2021** if you would like to comment on the proposed activities outlined in this information sheet or would like additional information.

Your feedback will be included in the Environment Plan for the proposed activity, which will be submitted to the National Offshore Petroleum Safety and Environmental Management Authority (NOPSEMA) for acceptance in accordance with the *Offshore Petroleum and Greenhouse Gas Storage (Environment) Regulations 2009 (Cth).*

Please let us know if wish your personal/organisation details or any part of your feedback to remain confidential as a summary of your feedback and our response in the Environment Plan for this activity will be published on NOPSEMA's web site.

This Environment Plan for this activity will also be open to public review and comment and will be published **here** following submission by Western Gas and a completeness check by NOPSEMA.

Please contact Western Gas at: **feedback@westerngas.com.au**

WESTERN GAS Accelerating development of Western Australia's gas resources

Ref. 1.1 - Email to Australian Border Force (ABF) – 26 May 2021

Dear Australian Border Force

Western Gas is seeking your feedback on its plan to drill the Sasanof-1 exploration well in Exploration Permit WA-519-P, located in Commonwealth waters in the Carnarvon Basin offshore Western Australia.
Drilling will commence at the earliest in Q1 2022 subject to approvals, vessel availability and weather constraints.
Consultation for this activity builds on Western Gas' ongoing stakeholder consultation program for its activities in the region, including engagements in late 2019 for a proposed exploration program, including proposed drilling activities in WA-519-P, which was subsequently deferred due to operational impacts related to COVID-19.
An activity overview for the Sasanof-1 exploration well is outlined below, and a Stakeholder Consultation Information Sheet is attached providing more information about the proposed activity. The Information Sheet is also available on our **website**.

Activity	Details
Approximate location*	~207 km northwest of Onslow Latitude: 20.4871ºS Longitude: 113.544ºE
Earliest possible start date	Q1 2022
Approximate duration	~25 days, excluding weather and operational delays
Approximate water depth	~1071 m
Approximate distance to nearest marine park	~23.6 km north of the Gascoyne Marine Park (Multiple Use Zone)
Vessels	Semi-submersible mobile offshore drilling unit (MODU) Activity support vessels, including general supply/support vessels and anchor handling vessel(s)
Exclusion zones	A temporary Petroleum Safety Zone with a radius of 500 m around the MODU during the activity. Unauthorised vessels are not permitted to enter this zone. A temporary Cautionary Area with a radius of up to 5 km around the MODU during the activity. Marine users will be permitted to enter this area but should take care for safety reasons.

* The exact location the well is subject to change. Marine users, adjacent titleholders and other relevant stakeholders will be advised should there be a material change to the location or activity timing once planning is finalised.

Providing feedback

Please contact Western Gas before close of business on 25 June 2022 if you would like to comment on the proposed activity or would like additional information. We are also open to receiving any information you think may be relevant to our consideration of managing environmental impacts and risks of the activity, including contact details for relevant others who may be affected.
A summary of your feedback and our response will be included in the Environment Plan for the proposed activity. The Environment Plan will be submitted to the National Offshore Petroleum Safety and Environmental Management Authority (NOPSEMA) for acceptance in accordance with the Offshore Petroleum and Greenhouse Gas Storage (Environment) Regulations 2009 (Cth).
The Environment Plan for this activity will also be open to public review and comment and will be published here following submission by Western Gas and a completeness check by NOPSEMA.
Please let us know if you wish your personal/organisation details or any part of your feedback to remain confidential to NOPSEMA.

Regards

Ref. 1.2 - Email to the Australian Fisheries Management Authority (AFMA) – 26 May 2021

Dear AFMA

Western Gas is seeking your feedback on its plan to drill the Sasanof-1 exploration well in Exploration Permit WA-519-P, located in Commonwealth waters in the Carnarvon Basin offshore Western Australia.

Drilling will commence at the earliest in Q1 2022 subject to approvals, vessel availability and weather constraints.

Consultation for this activity builds on Western Gas' ongoing stakeholder consultation program for its activities in the region, including engagements in late 2019 for a proposed exploration program, including proposed drilling activities in WA-519-P, which was subsequently deferred due to operational impacts related to COVID-19.

Our assessment indicates that licence holders in the Western Deepwater Trawl Fishery may be relevant to the proposed activities in WA-519-P, based on fishing licence overlap with the proposed Sasanof-1 well location and consideration of government fishing effort data from recent years, fishing methods and water depth. Licence holders in this fishery, as well as their representative fishing organisations are being consulted for the proposed Activity. A map is attached showing the proposed Sasanof-1 well location relative to the Western Deepwater Trawl Fishery.

Whilst not being identified as relevant to the proposed activity, Western Gas is engaging the Australian Southern Bluefin Tuna Industry Association given stakeholder advice from previous consultation activities for the organisation to be kept informed about proposed oil and gas activities.

An activity overview for the Sasanof-1 exploration well is outlined below, and a Stakeholder Consultation Information Sheet is attached providing more information about the proposed activity. The Information Sheet is also available on our website.

Activity	Details
Approximate location*	~207 km northwest of Onslow Latitude: 20.4871ºS Longitude: 113.544ºE
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* The exact location the well is subject to change. Marine users, adjacent titleholders and other relevant stakeholders will be advised should there be a material change to the location or activity timing once planning is finalised.

Providing feedback

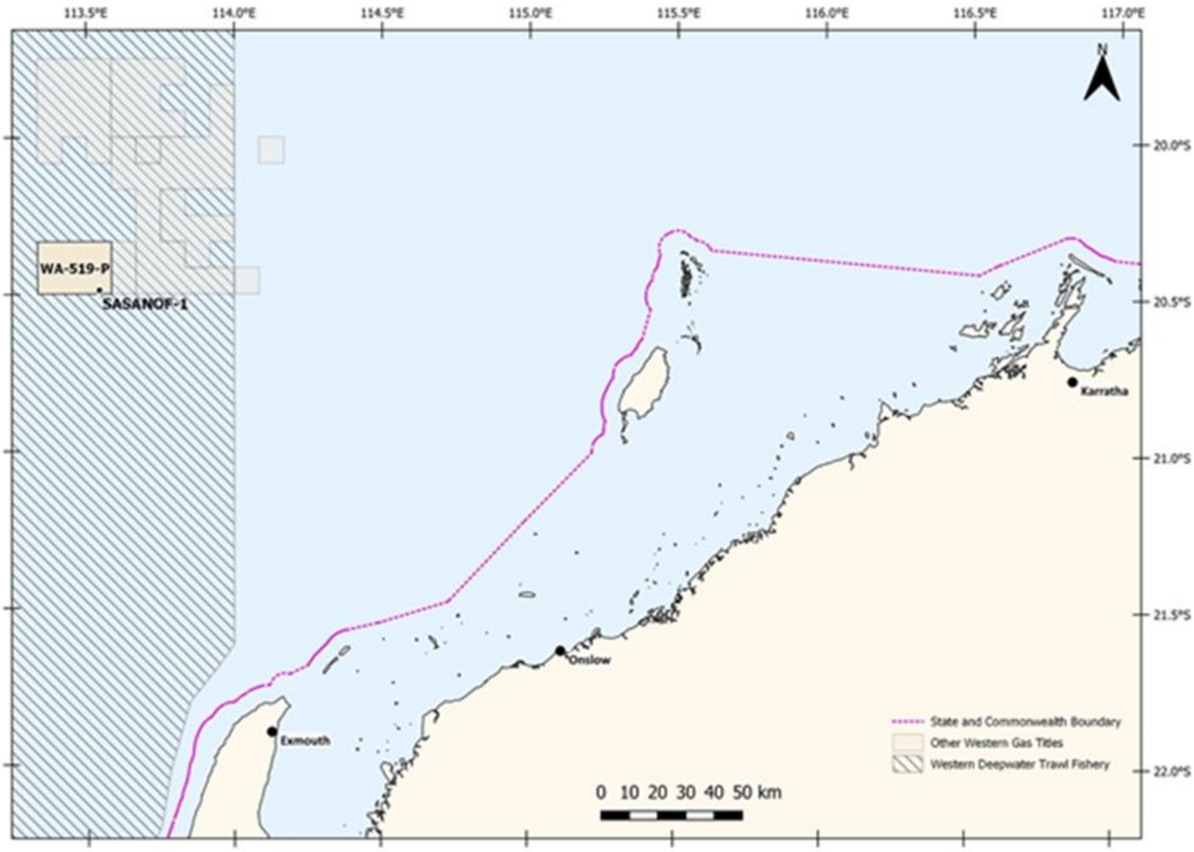
Please contact Western Gas before close of business on 25 June 2022 if you would like to comment on the proposed activity or would like additional information.

A summary of your feedback and our response will be included in the Environment Plan for the proposed activity. The Environment Plan will be submitted to the National Offshore Petroleum Safety and Environmental Management Authority (NOPSEMA) for acceptance in accordance with the Offshore Petroleum and Greenhouse Gas Storage (Environment) Regulations 2009 (Cth).

The Environment Plan for this activity will also be open to public review and comment and will be published here following submission by Western Gas and a completeness check by NOPSEMA.

Please let us know if you wish your personal/organisation details or any part of your feedback to remain confidential to NOPSEMA.

Regards



Ref. 1.3 - Email to Australian Hydrographic Office (AHO) and Australian Maritime Safety Authority (AMSA) (maritime safety) – 26 May 2021

Dear AHO and AMSA

Western Gas is seeking your feedback on its plan to drill the Sasanof-1 exploration well in Exploration Permit WA-519-P, located in Commonwealth waters in the Carnarvon Basin offshore Western Australia.

Drilling will commence at the earliest in Q1 2022 subject to approvals, vessel availability and weather constraints.

Consultation for this activity builds on Western Gas' ongoing stakeholder consultation program for its activities in the region, including engagements in late 2019 for a proposed exploration program, including proposed drilling activities in WA-519-P, which was subsequently deferred due to operational impacts related to COVID-19.

An activity overview for the Sasanof-1 exploration well is outlined below, and a Stakeholder Consultation Information Sheet is attached providing more information about the proposed activity. The Information Sheet is also available on our website.

A map is also attached showing the proposed Sasanof-1 well location relative to AMSA shipping fairways.

Activity	Details
Approximate location*	~207 km northwest of Onslow Latitude: 20.4871ºS Longitude: 113.544ºE
Earliest possible start date	Q1 2022
Approximate duration	~25 days, excluding weather and operational delays
Approximate water depth	~1071 m
Approximate distance to nearest marine park	~23.6 km north of the Gascoyne Marine Park (Multiple Use Zone)
Vessels	Semi-submersible mobile offshore drilling unit (MODU) Activity support vessels, including general supply/support vessels and anchor handling vessel(s)

Exclusion zones	A temporary Petroleum Safety Zone with a radius of 500 m around the MODU during the activity. Unauthorised vessels are not permitted to enter this zone. A temporary Cautionary Area with a radius of up to 5 km around the MODU during the activity. Marine users will be permitted to enter this area but should take care for safety reasons.

* The exact location the well is subject to change. Marine users, adjacent titleholders and other relevant stakeholders will be advised should there be a material change to the location or activity timing once planning is finalised.

Providing feedback

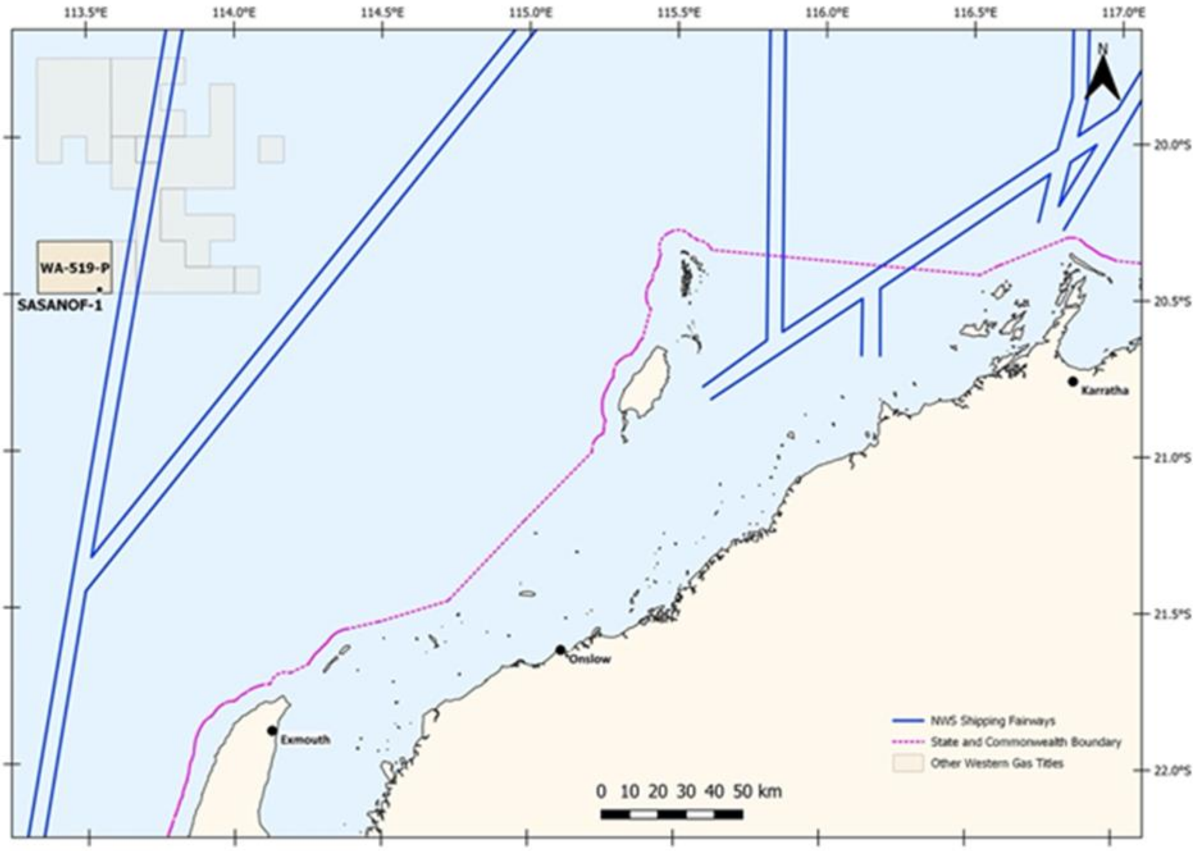
Please contact Western Gas before close of business on 25 June 2022 if you would like to comment on the proposed activity or would like additional information.

A summary of your feedback and our response will be included in the Environment Plan for the proposed activity. The Environment Plan will be submitted to the National Offshore Petroleum Safety and Environmental Management Authority (NOPSEMA) for acceptance in accordance with the Offshore Petroleum and Greenhouse Gas Storage (Environment) Regulations 2009 (Cth).

The Environment Plan for this activity will also be open to public review and comment and will be published here following submission by Western Gas and a completeness check by NOPSEMA.

Please let us know if you wish your personal/organisation details or any part of your feedback to remain confidential to NOPSEMA.

Regards



Ref. 1.4 - Email to Australian Maritime Safety Authority (AMSA) (marine pollution) – 26 May 2021

Dear AMSA

Western Gas advises that it plans to drill the Sasanof-1 exploration well in Exploration Permit WA-519-P, located in Commonwealth waters in the Carnarvon Basin offshore Western Australia.

Drilling will commence at the earliest in Q1 2022 subject to approvals, vessel availability and weather constraints.

An activity overview is outlined below, and a Stakeholder Consultation Information Sheet is attached providing more information about the proposed activity. The Information Sheet is also available on our **website**.

A First Strike Response Plan is currently being developed and will be provided to AMSA once finalised and for comment if requested.

Activity	Details
Approximate location*	~207 km northwest of Onslow Latitude: 20.4871ºS Longitude: 113.544ºE
Earliest possible start date	Q1 2022
Approximate duration	~25 days, excluding weather and operational delays
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* The exact location the well is subject to change. Marine users, adjacent titleholders and other relevant stakeholders will be advised should there be a material change to the location or activity timing once planning is finalised.

Providing feedback

Please contact Western Gas before close of business on 25 June 2022 if you would like to comment on the proposed activity or would like additional information.

A summary of your feedback and our response will be included in the Environment Plan for the proposed activity. The Environment Plan will be submitted to the National Offshore Petroleum Safety and Environmental Management Authority (NOPSEMA) for acceptance in accordance with the Offshore Petroleum and Greenhouse Gas Storage (Environment) Regulations 2009 (Cth).

The Environment Plan for this activity will also be open to public review and comment and will be published here following submission by Western Gas and a completeness check by NOPSEMA.

Please let us know if you wish your personal/organisation details or any part of your feedback to remain confidential to NOPSEMA.

Regards

Ref. 1.5 - Email to Department of Agriculture, Water and the Environment (DAWE) (fisheries and biosecurity) – 26 May 2021

Dear Stakeholder

Western Gas is seeking your feedback on its plan to drill the Sasanof-1 exploration well in Exploration Permit WA-519-P, located in Commonwealth waters in the Carnarvon Basin offshore Western Australia.

Drilling will commence at the earliest in Q1 2022 subject to approvals, vessel availability and weather constraints.

Consultation for this activity builds on Western Gas' ongoing stakeholder consultation program for its activities in the region, including engagements in late 2019 for a proposed exploration program, including proposed drilling activities in WA-519-P, which was subsequently deferred due to operational impacts related to COVID-19.

An activity overview for the Sasanof-1 exploration well is outlined below, and a Stakeholder Consultation Information Sheet is attached providing more information about the proposed activity. The Information Sheet is also available on our **website**.

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* The exact location the well is subject to change. Marine users, adjacent titleholders and other relevant stakeholders will be advised should there be a material change to the location or activity timing once planning is finalised.

Implications for DAWE's interests

We have identified and assessed potential risks and impacts to active Commonwealth commercial fishers, biosecurity matters and the marine environment that overlap in proposed activity in the Environment Plan for this activity. Western Gas has endeavoured to reduce these risks and impacts to an as low as reasonably practicable (ALARP) level.

Commercial fishing implications:

Our assessment indicates that licence holders in the Western Deepwater Trawl Fishery may be relevant to the proposed activities in WA-519-P, based on fishing licence overlap with the proposed Sasanof-1 well location and consideration of government fishing effort data from recent years, fishing methods and water depth. Licence holders in this fishery, as well as their representative fishing organisations are being consulted for the proposed Activity. A map is attached showing the proposed Sasanof-1 well location relative to the Western Deepwater Trawl Fishery.

Whilst not being identified as relevant to the proposed activity, Western Gas is engaging the Australian Southern Bluefin Tuna Industry Association given stakeholder advice from previous consultation activities for the organisation to be kept informed about proposed oil and gas activities.

Biosecurity implications:

Western Gas provides the following information with respect to the surround environment at the well location and management measures to prevent the introduction and establishment of Invasive Marine Species (IMS).

Aspect	Details
Environment description	The seabed in WA-519-P is a relatively flat and featureless sandy habitat.
Legislation and other requirements that apply	Biosecurity Act (2015) (Cth) Biosecurity (Ballast Water and Sediment) Determination 2017 and the Ballast Water Management Requirements Version 8 National biofouling management guidelines for the petroleum production and exploration industry (DAFF 2009) Marine Order 98
IMS mitigation measures	Submersible equipment will be cleaned prior to initial use in the activity area Support vessels will fulfil requirements of the Australian Ballast Water Management Requirements DAWE will be advised immediately in the event of non-compliant discharges of domestic ballast water

Providing feedback

Please contact Western Gas before close of business on 25 June 2022 if you would like to comment on the proposed activity or would like additional information.
A summary of your feedback and our response will be included in the Environment Plan for the proposed activity. The Environment Plan will be submitted to the National Offshore Petroleum Safety and Environmental Management Authority (NOPSEMA) for acceptance in accordance with the Offshore Petroleum and Greenhouse Gas Storage (Environment) Regulations 2009 (Cth).
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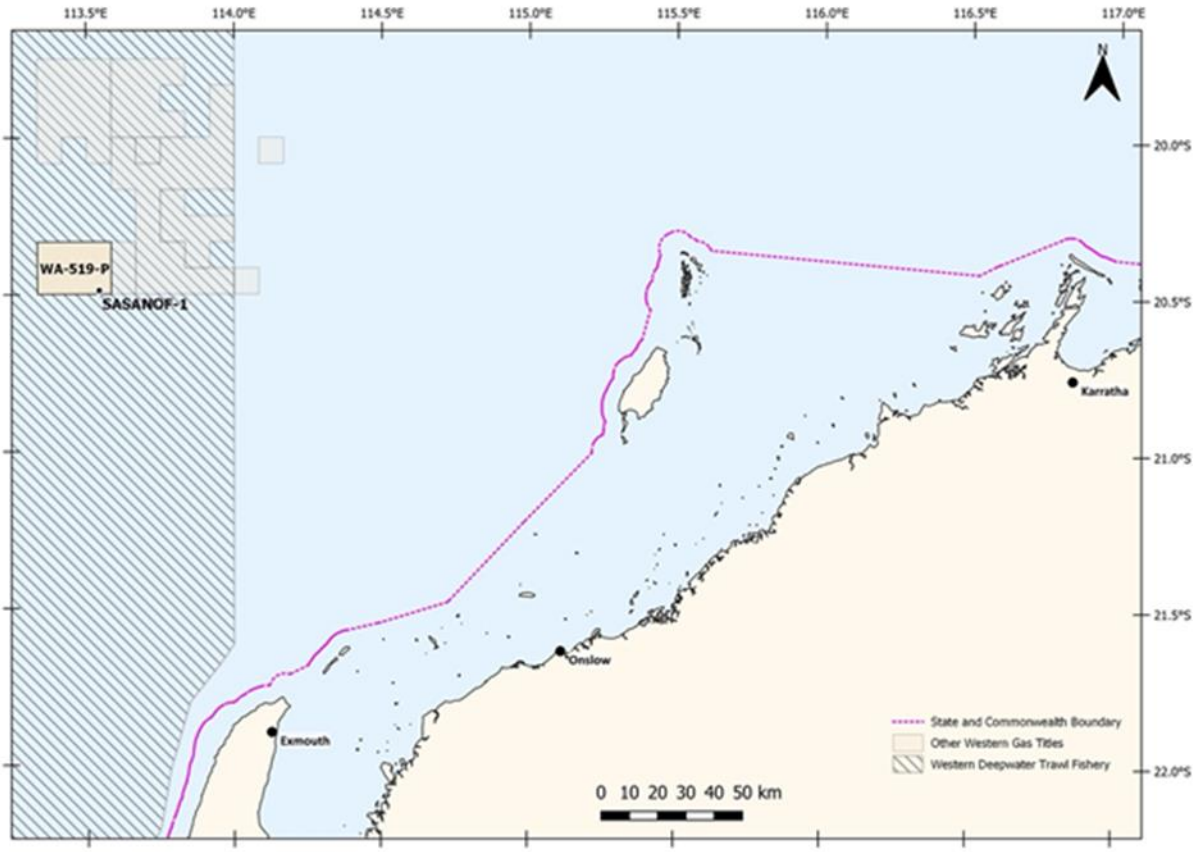

Ref. 1.6 - Email to Department of Defence (DoD) – 26 May 2021

Dear Stakeholder

Western Gas is seeking your feedback on our plan to drill the Sasanof-1 exploration well in Exploration Permit WA-519-P, located in Commonwealth waters in the Carnarvon Basin offshore Western Australia.

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An activity overview for the Sasanof-1 exploration well is outlined below, and a Stakeholder Consultation Information Sheet is attached providing more information about the proposed activity. The Information Sheet is also available on our website.

A map is also attached showing the proposed Sasanof-1 well location relative to Defence interests.

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Approximate location*	~207 km northwest of Onslow Latitude: 20.4871ºS Longitude: 113.544ºE
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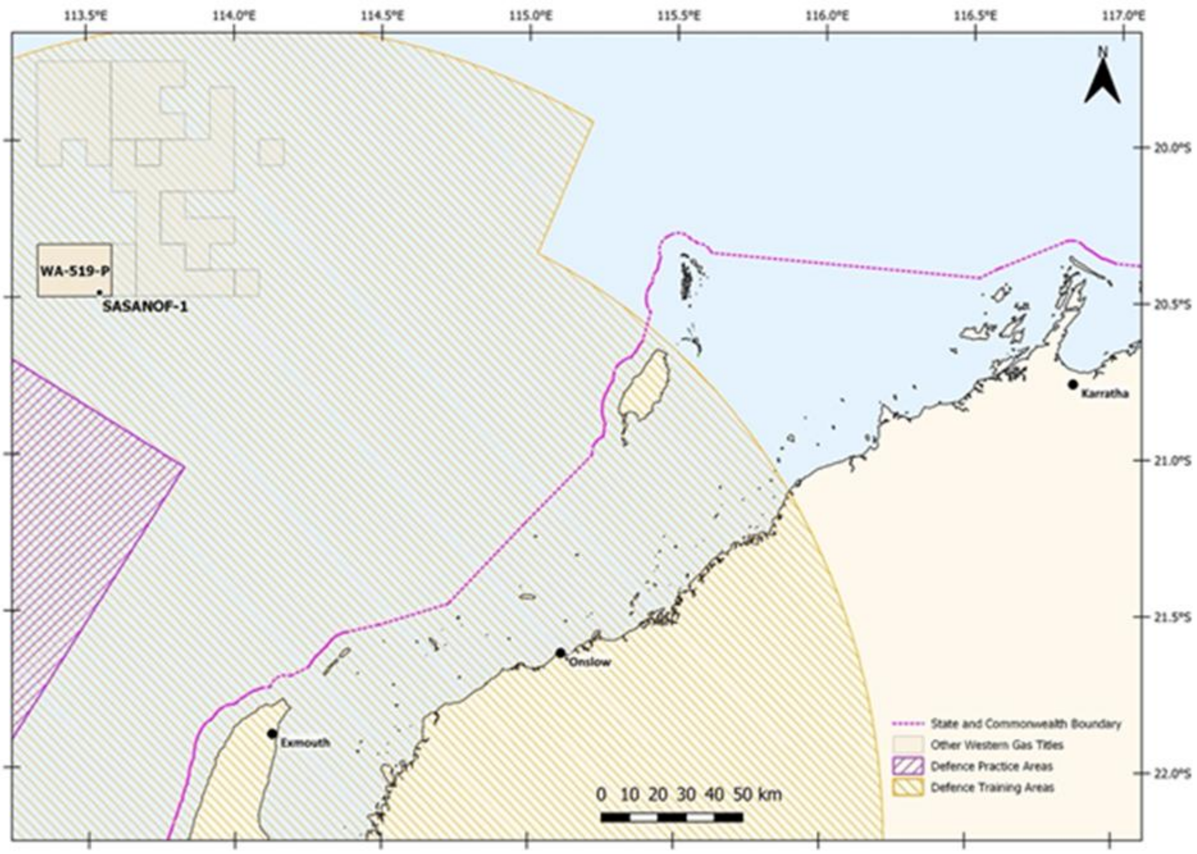

Ref. 1.7 - Email to Department of Industry, Science, Energy and Resources (DISER) – 26 May 2021

Dear DISER

Western Gas is seeking your feedback on our plan to drill the Sasanof-1 exploration well in Exploration Permit WA-519-P, located in Commonwealth waters in the Carnarvon Basin offshore Western Australia.

Drilling will commence at the earliest in Q1 2022 subject to approvals, vessel availability and weather constraints.

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Providing feedback

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The Environment Plan for this activity will also be open to public review and comment and will be published here following submission by Western Gas and a completeness check by NOPSEMA.

Please let us know if you wish your personal/organisation details or any part of your feedback to remain confidential to NOPSEMA.

Regards

Ref. 1.8 - Email to Director of National Parks (DNP) – 26 May 2021

Dear Director National Parks

Western Gas is seeking your feedback on our plan to drill the Sasanof-1 exploration well in Exploration Permit WA-519-P, located in Commonwealth waters in the Carnarvon Basin offshore Western Australia.

Drilling will commence at the earliest in Q1 2022 subject to approvals, vessel availability and weather constraints.

Consultation for this activity builds on Western Gas' ongoing stakeholder consultation program for its activities in the region, including engagements in late 2019 for a proposed exploration program, including proposed drilling activities in WA-519-P, which was subsequently deferred due to operational impacts related to COVID-19.

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* The exact location the well is subject to change. Marine users, adjacent titleholders and other relevant stakeholders will be advised should there be a material change to the location or activity timing once planning is finalised.

Implications for the interests of Parks Australia

We note Australian Government Guidance on consultation activities with respect to the proposed activities and confirm that:

- We have assessed potential risks and impacts to Australian Marine Parks (AMPs) in the development of the Environment Plan for this activity, with the nearest AMP being the Gascoyne Marine Park (Multiple Use Zone) approximately 23.6 km to the south of the proposed Sasanof-1 well location.
- We have not identified impacts associated with planned activities that have potential to impact the values of this AMP.
- In the unlikely event of a hydrocarbon release from the Sasanof-1 exploration well there is a risk of hydrocarbons contacting the Gascoyne Marine Park.
- A NOPSEMA approved oil spill response plan will be in place for the duration of the activities. A stakeholder notification matrix is included in the plan. The Director of National Parks will be advised as part of this communications escalation if an environmental incident occurs that may impact the values of an AMP.

Providing feedback

Please contact Western Gas before close of business on 25 June 2022 if you would like to comment on the proposed activity or would like additional information.

A summary of your feedback and our response will be included in the Environment Plan for the proposed activity. The Environment Plan will be submitted to the National Offshore Petroleum Safety and Environmental Management Authority (NOPSEMA) for acceptance in accordance with the Offshore Petroleum and Greenhouse Gas Storage (Environment) Regulations 2009 (Cth).

The Environment Plan for this activity will also be open to public review and comment and will be published here following submission by Western Gas and a completeness check by NOPSEMA.

Please let us know if you wish your personal/organisation details or any part of your feedback to remain confidential to NOPSEMA.

Regards

Ref. 1.9 - Email to Department of Biodiversity, Conservation and Attractions (DBCA) – 26 May 2021

Dear DBCA

Western Gas is seeking your feedback on our plan to drill the Sasanof-1 exploration well in Exploration Permit WA-519-P, located in Commonwealth waters in the Carnarvon Basin offshore Western Australia.

Drilling will commence at the earliest in Q1 2022 subject to approvals, vessel availability and weather constraints.

Consultation for this activity builds on Western Gas' ongoing stakeholder consultation program for its activities in the region, including engagements in late 2019 for a proposed exploration program, including proposed drilling activities in WA-519-P, which was subsequently deferred due to operational impacts related to COVID-19.

An activity overview for the Sasanof-1 exploration well is outlined below, and a Stakeholder Consultation Information Sheet is attached providing more information about the proposed activity. The Information Sheet is also available on our [website].

Activity	Details
Approximate location*	~207 km northwest of Onslow Latitude: 20.4871°S Longitude: 113.544°E
Earliest possible start date	Q1 2022
Approximate duration	~25 days, excluding weather and operational delays
Approximate water depth	~1071 m
Approximate distance to nearest marine park	~23.6 km north of the Gascoyne Marine Park (Multiple Use Zone)
Vessels	Semi-submersible mobile offshore drilling unit (MODU) Activity support vessels, including general supply/support vessels and anchor handling vessel(s)
Exclusion zones	A temporary Petroleum Safety Zone with a radius of 500 m around the MODU during the activity. Unauthorised vessels are not permitted to enter this zone.

	A temporary Cautionary Area with a radius of up to 5 km around the MODU during the activity. Marine users will be permitted to enter this area but should take care for safety reasons.

* The exact location the well is subject to change. Marine users, adjacent titleholders and other relevant stakeholders will be advised should there be a material change to the location or activity timing once planning is finalised.

Implications for the DBCA interests

We provide the following information with respect to DBCA's interests:

- We have assessed potential risks and impacts to DBCA managed assets in the development of the Environment Plan for this activity, with the nearest Marine Park being the Ningaloo Marine Park approximately 150 km (State Boundary) to the south of the proposed Sasanof-1 exploration well location.
- We have not identified impacts associated with planned activities that have potential to impact the values of this marine park.
- Oil spill modelling for this activity does not show any surface contact with DBCA managed assets in the unlikely event of a hydrocarbon release from the Sasanof-1 exploration well location.
- A NOPSEMA approved oil spill response plan will be in place for the duration of the activities. A stakeholder notification matrix is included in the plan. DBCA will be advised if an environmental incident occurs that may impact the values of a DBCA managed asset.

Providing feedback

Please contact Western Gas before close of business on 25 June 2022 if you would like to comment on the proposed activity or would like additional information.

A summary of your feedback and our response will be included in the Environment Plan for the proposed activity. The Environment Plan will be submitted to the National Offshore Petroleum Safety and Environmental Management Authority (NOPSEMA) for acceptance in accordance with the Offshore Petroleum and Greenhouse Gas Storage (Environment) Regulations 2009 (Cth).

The Environment Plan for this activity will also be open to public review and comment and will be published here following submission by Western Gas and a completeness check by NOPSEMA.

Please let us know if you wish your personal/organisation details or any part of your feedback to remain confidential to NOPSEMA.

Regards

Ref. 1.10 - Email to Department of Mines, Industry Regulation and Safety (DMIRS) – 26 May 2021

Dear DMIRS

Western Gas is seeking your feedback on our plan to drill the Sasanof-1 exploration well in Exploration Permit WA-519-P, located in Commonwealth waters in the Carnarvon Basin offshore Western Australia.

Drilling will commence at the earliest in Q1 2022 subject to approvals, vessel availability and weather constraints.

Consultation for this activity builds on Western Gas' ongoing stakeholder consultation program for its activities in the region, including engagements in late 2019 for a proposed exploration program, including proposed drilling activities in WA-519-P, which was subsequently deferred due to operational impacts related to COVID-19.

An activity overview for the Sasanof-1 exploration well is outlined below, and a Stakeholder Consultation Information Sheet is attached providing more information about the proposed activity. The Information Sheet is also available on our website.

Activity	Details
Approximate location*	~207 km northwest of Onslow Latitude: 20.4871ºS Longitude: 113.544ºE

Earliest possible start date	Q1 2022
Approximate duration	~25 days, excluding weather and operational delays
Approximate water depth	~1071 m
Approximate distance to nearest marine park	~23.6 km north of the Gascoyne Marine Park (Multiple Use Zone)
Vessels	Semi-submersible mobile offshore drilling unit (MODU) Activity support vessels, including general supply/support vessels and anchor handling vessel(s)
Exclusion zones	A temporary Petroleum Safety Zone with a radius of 500 m around the MODU during the activity. Unauthorised vessels are not permitted to enter this zone. A temporary Cautionary Area with a radius of up to 5 km around the MODU during the activity. Marine users will be permitted to enter this area but should take care for safety reasons.

* The exact location the well is subject to change. Marine users, adjacent titleholders and other relevant stakeholders will be advised should there be a material change to the location or activity timing once planning is finalised.

Providing feedback

Please contact Western Gas before close of business on 25 June 2022 if you would like to comment on the proposed activity or would like additional information.

A summary of your feedback and our response will be included in the Environment Plan for the proposed activity. The Environment Plan will be submitted to the National Offshore Petroleum Safety and Environmental Management Authority (NOPSEMA) for acceptance in accordance with the Offshore Petroleum and Greenhouse Gas Storage (Environment) Regulations 2009 (Cth).

The Environment Plan for this activity will also be open to public review and comment and will be published here following submission by Western Gas and a completeness check by NOPSEMA.

Please let us know if you wish your personal/organisation details or any part of your feedback to remain confidential to NOPSEMA.

Regards

Ref 1.11 - Email to Department of Primary Industries and Regional Development (DPIRD) – 26 May 2021

Dear Stakeholder

Western Gas advises that it plans to drill the Sasanof-1 exploration well in Exploration Permit WA-519-P, located in Commonwealth waters in the Carnarvon Basin offshore Western Australia.

Drilling will commence at the earliest in Q1 2022 subject to approvals, vessel availability and weather constraints.

Consultation for this activity builds on Western Gas' ongoing stakeholder consultation program for its activities in the region, including engagements in late 2019 for a proposed exploration program, including proposed drilling activities in WA-519-P, which was subsequently deferred due to operational impacts related to COVID-19.

This previous consultation included engagement with WAFIC, which at the time indicated that no State-managed commercial fishing activities occur at water depths greater than 1000 m. Western Gas will reconfirm with WAFIC this previous advice remains current. Similarly, we seek confirmation from DPIRD on this previously provided advice.

We have provided details below on the proposed activity should you wish to provide feedback.

Activity	Details
Approximate location*	~207 km northwest of Onslow Latitude: 20.4871°S Longitude: 113.544°E
Earliest possible start date	Q1 2022
Approximate duration	~25 days, excluding weather and operational delays
Approximate water depth	~1071 m
Approximate distance to nearest marine park	~23.6 km north of the Gascoyne Marine Park (Multiple Use Zone)
Vessels	Semi-submersible mobile offshore drilling unit (MODU)

	Activity support vessels, including general supply/support vessels and anchor handling vessel(s)
Exclusion zones	A temporary Petroleum Safety Zone with a radius of 500 m around the MODU during the activity. Unauthorised vessels are not permitted to enter this zone. A temporary Cautionary Area with a radius of up to 5 km around the MODU during the activity. Marine users will be permitted to enter this area but should take care for safety reasons.

* The exact location the well is subject to change. Marine users, adjacent titleholders and other relevant stakeholders will be advised should there be a material change to the location or activity timing once planning is finalised.

Providing feedback

Please contact Western Gas before close of business on 25 June 2022 if you would like to comment on the proposed activity or would like additional information.

A summary of your feedback and our response will be included in the Environment Plan for the proposed activity. The Environment Plan will be submitted to the National Offshore Petroleum Safety and Environmental Management Authority (NOPSEMA) for acceptance in accordance with the Offshore Petroleum and Greenhouse Gas Storage (Environment) Regulations 2009 (Cth).

The Environment Plan for this activity will also be open to public review and comment and will be published here following submission by Western Gas and a completeness check by NOPSEMA.

Please let us know if you wish your personal/organisation details or any part of your feedback to remain confidential to NOPSEMA.

Regards

Ref. 1.12 - Email to Department of Transport (DoT) – 26 May 2021

Dear Stakeholder

Western Gas advises that it plans to drill the Sasanof-1 exploration well in Exploration Permit WA-519-P, located in Commonwealth waters in the Carnarvon Basin offshore Western Australia.

Drilling will commence at the earliest in Q1 2022 subject to approvals, vessel availability and weather constraints.

Please note that oil spill modelling for this activity does not show any surface contact with State waters in the unlikely event of a hydrocarbon release.

Western Gas recognises DoT's guidance on consultation for the development of appropriate oil spill response plans and seeks advice from DoT and its expectation to be involved in reviewing the First Strike Response Plan being developed for this activity.

An activity overview for the Sasanof-1 exploration well is outlined below, and a Stakeholder Consultation Information Sheet is attached providing more information about the proposed activity. The Information Sheet is also available on our website.

Activity	Details
Approximate location*	~207 km northwest of Onslow Latitude: 20.4871ºS Longitude: 113.544ºE
Earliest possible start date	Q1 2022
Approximate duration	~25 days, excluding weather and operational delays
Approximate water depth	~1071 m
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APPENDIX E: SASANOF-1 OIL POLLUTION EMERGENCY PLAN

WESTERN GAS

SASANOF-1 EXPLORATION DRILLING PROGRAM

OIL POLLUTION EMERGENCY PLAN

Document No.:	**WG-EHS-PLN-003**	**Revision:**	**1**
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DOCUMENT INFORMATION

Document No:	WG-EHS-PLN-003	Revision:	1
Document Owner:	Western Gas Sasanof-1 Project Director		

REVISION HISTORY

Rev.	Description	Prepared by	Reviewed by	Approved by	Date
0	For public comment submission to NOPSEMA	PH	MS	PR	7/7/21
1	Incorporating consultation and feedback from public comments	PH	CM	RB	18/8/21

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ACRONYMS

Abbreviation	Description
AHS	Australian Hydrographic Service
AIIMS	Australasian Inter-Service Incident Management System
AMOSC	Australian Marine Oil Spill Centre
AMSA	Australian Maritime Safety Authority
BOP	Blowout Preventer
CAA	Company Approved Authority
CMT	Crisis Management Team
CMP	Crisis Management Plan
DAWE	Department of Agriculture, Water and the Environment
DBCA	Department of Biodiversity, Conservation and Attractions
DEE	Department of Environment and Energy
DIMT	Drilling Incident Management Team
DISER	Department of Industry, Science, Energy and Resources
DMIRS	Department of Mines, Industry, Regulation and Safety
DoT	Department of Transport
DWER	Department of Water and Environment Regulation
EMBA	Environment that May Be Affected
EP	Environmental Plan
EPBC	Environment Protection and Biodiversity Conservation
ERP	Emergency Response Plan
HMA	Hazard Management Agency
IAP	Incident Action Plan

Abbreviation	Description
IC	Incident Commander
ICR	Incident Command Room
JRCC	Joint Rescue Coordination Centre
JSCC	Joint Strategic Coordination Committee
LOWC	Loss of Well Control
MARPOL	International Convention for the Prevention of Pollution from Ships
MDO	Marine Diesel Oil
MEE	Maritime Environmental Emergencies
MEECC	Maritime Environmental Emergency Coordination Centre
MEER	Maritime Environmental Emergency Response
MES	Monitoring, Evaluation and Surveillance
NES	Matters of National Environmental Significance
MODU	Mobile offshore Drilling Unit
MoU	Memorandum of Understanding
NEBA	Net Environmental Benefit Analysis
NOPSEMA	National Offshore Petroleum Safety and Environmental Management Authority
NOPTA	National Offshore Petroleum Titles Authority
OIM	Offshore Installation Manager
OPEP	Oil Pollution Emergency Plan
OPGGS	Offshore Petroleum and Greenhouse Gas Storage

Abbreviation	Description
OPGGS(E)R	Offshore Petroleum and Greenhouse Gas Storage (Environment) Regulations
ORT	On-site Response Teams
OSMP	Operational and Scientific Monitoring Plan
OSRL	Oil Spill Response Ltd
OSTM	Oil Spill Trajectory Modelling
OSWMP	Oil Spill Waste Management Plan
OWR	Oiled Wildlife Response
ROV	Remotely Operated Vehicle
SCERP	Source Control Emergency Response Plan
SFRT	Subsea First Response Toolkit
SMPC	State Marine Pollution Coordinator
SOPEP	Ship Oil Pollution Emergency Plan
WA	Western Australia
WAOWRP	Western Australian Oiled Wildlife Response Plan
WOMP	Well Operations Management Plans

1 INTRODUCTION

1.1 ACTIVITY DESCRIPTION

Western Gas (519P) Pty Ltd (Western Gas) proposes to undertake a single-well exploration drilling program (Sasanof-1) in permit area WA-519-P, targeting a gas condensate reservoir in the Carnarvon Basin in the North West Shelf (Figure 1-1).

The permit area is wholly within offshore Commonwealth waters, approximately 335 km west of Karratha, Western Australia (WA), in water depths of approximately 1070 m. The Operational Area is defined as a 3 km x 3 km area centered on the planned Sasanof-1 well location with a duration of 25 days after which the well will be plugged and abandoned (P&A).

The drilling activity will be carried out using a semi-submersible mobile offshore drilling unit (MODU) with support vessels and helicopters. The EP covers the drilling activities and all MODU, vessel and helicopter operations within the Operational Area (the activity). A 500 m Petroleum Safety Zone will be established around the Sasanof-1 well location. Refer to Section 3 of the Sasanof-1 Exploration Drilling EP (WG-EHS-PLN-002) for detail on the activity.

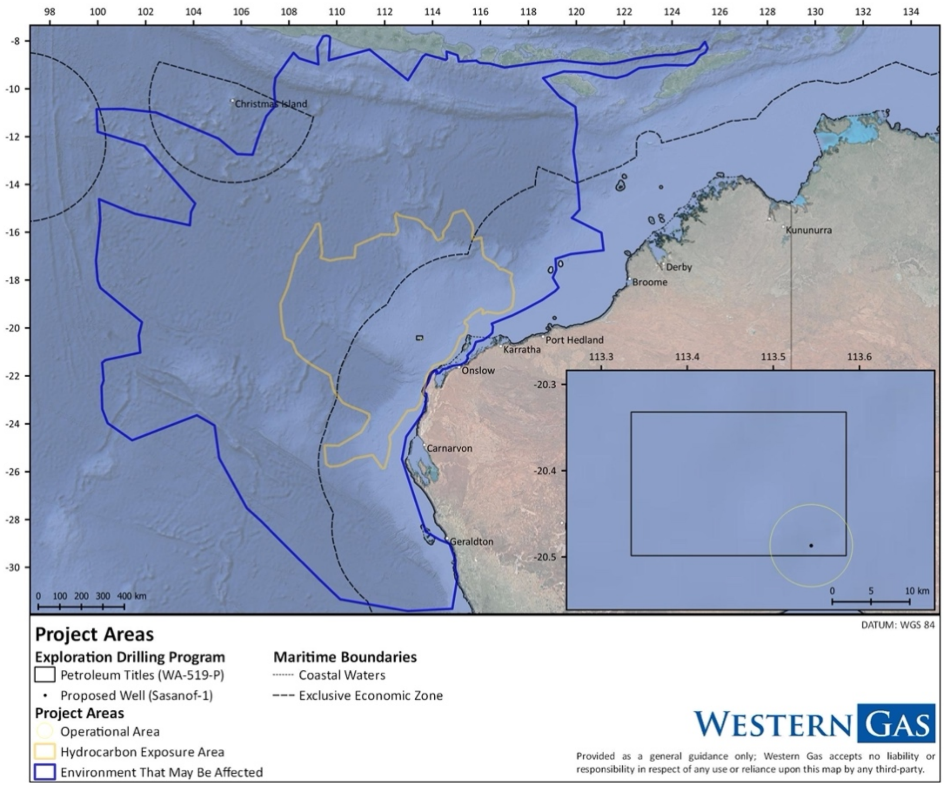


Figure 1-1 Location of Exploration Permit WA-519-P and Sasanof-1 well

1.2 PURPOSE

This Oil Pollution Emergency Plan (OPEP) has been prepared in accordance with Regulation 14(8) and Regulation 14(8AA) of the *Commonwealth Offshore Petroleum and Greenhouse Gas Storage (Environment) Regulations 2009* (OPGGS(E)R). The OPEP has been prepared to integrate with the National Plan for Maritime Environmental Emergencies (National Plan) and the Western Australian (WA) State Hazard Plan: Maritime Environmental Emergencies (MEE).

This OPEP is designed to be an operational response document used in the event of a hydrocarbon spill event associated with Western Gas' exploration drilling activities in WA-519-P, as described in the Sasanof-1 Exploration Drilling Program Environment Plan (WG-EHS-PLN-002) (the EP).

The objectives of this OPEP are to:

- Support the timely implementation of pre-determined response strategies as outlined in this OPEP.
- Ensure that the management of the response is consistent with the Commonwealth National Plan for Maritime Environmental Emergencies (National Plan), the Western Australian (WA) State Hazard Plan: Maritime Environmental Emergencies (MEE) and the Australian Industry Cooperative Oil Spill Response Arrangements (AMOSPlan).
- Ensure effective integration and use of industry/government response efforts and resources.
- Ensure Western Gas has timely access to appropriately trained people and resources in order to effectively respond to and manage an oil spill response.

1.3 SCOPE

Western Gas identified two potential hydrocarbon spill scenarios that have the potential to require a coordinated spill response, as outlined in this OPEP:

- A vessel loss of containment resulting in a release of Marine Diesel Oil (MDO) to the sea surface.
- A spill from the Mobile Offshore Drilling Unit (MODU), the worst-case scenario being a total loss of well control (LOWC) resulting in a subsea release of gas and condensate.

Excluded from the scope of this OPEP are vessels transiting to or from the Operational Area (as described in the EP). These vessels are deemed to be operating under the Commonwealth *Navigation Act 2012* and not engaged in petroleum-related activity.

1.4 SPILL RESPONSE AND OPEP STRUCTURE

The structure of this OPEP is organised to follow the sequence of response activities (Figure 1-2).

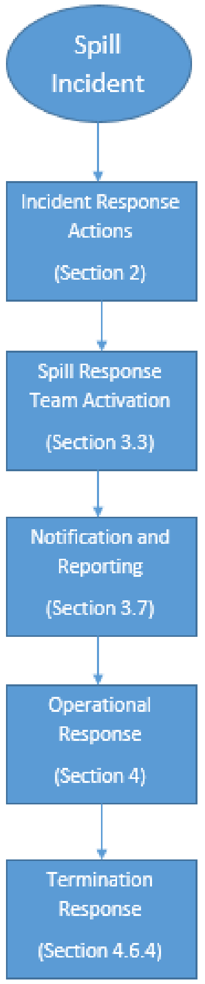


Figure 1-2 Spill Response Actions and Requirements

2 INITIAL RESPONSE GUIDES

The following initial response guides include immediate actions to be undertaken following the detection of a spill from a vessel (Table 2-1) or associated with a loss of containment from the MODU, the worst-case scenario being a total LOWC incident (Table 2-2).

Table 2-3 also includes actions in the initial phase of spill response to guide the Incident Commander (IC) and AGR Drilling Incident Management Team (DIMT) following activation.

These initial response guides are intended as guides only and are not considered an exhaustive list of actions that will be undertaken – they are subject to change based on the specific parameters and conditions at the time of the incident.

The initial response guides are consistent with the strategic response priorities detailed in the National Plan and WA State Hazard Plan – Maritime Environmental Emergencies (refer also to Section 4.6.1 of this OPEP). In the initial phase of a spill, the primary protection priority is human health and safety.

2.1 INITIAL RESPONSE GUIDE – SPILL FROM VESSEL

Table 2-1: Initial Response Guide – MDO Spill from Vessel

Step	Action	Responsibility	Indicative Timing	Additional Information
1	On discovery of a spill from the vessel - notify the Vessel Master	Spill Observer	Immediate	SOPEP
2	Manage the safety of all personnel Secure sources of ignition and alert all personnel (appropriate to the level of the spill)	Vessel Master	Immediate	SOPEP
3	If safe, stop the spill through source control actions Assess incident and prevent further spillage if possible / safe	Vessel Master	Immediate	SOPEP
4	Determine spill parameters: • What is it - oil type/group/properties? • Where is it - lat/long, leading edge (if known) • How big is it - area/volume? • What is happening to it - status of release i.e. continuing or under control? • Weather conditions at site (wind/currents)	Vessel Master	As soon as practible	SOPEP
5	Determine Spill Response Level required: Level 1 or 2: • If Level 1: Vessel Master to act as Incident Commander and refer to SOPEP • If Level 2: Contact AGR Drilling Supervisor who will contact AGR Drilling Superintendent to request DIMT Leader assume role of Incident Commander, with Vessel Master becoming On-scene Commander	Vessel Master	As soon as practible	SOPEP / OPEP
6	In the event of a significant (Level 2) spill, deploy the oil spill tracking Buoy(s), following the deployment instructions	Vessel Master	As soon as practicable	
7	Complete tasks outlined in Table 2-3 – Initial Response Guide – IC and DIMT	Vessel Master / AGR Drilling Superintendent	Refer to Table 2-3	Section 2.3
8	Continue to assess spill parameters - provide regular reports to the IC regarding appearance and behaviour of surface spill, weather (surface wind speed, direction, sea state, current speed and direction), tidal conditions and any changes to release status	Vessel Master	Ongoing until terminated	SOPEP

2.2 INITIAL RESPONSE GUIDE – SPILL FROM MODU (LOWC)

Table 2-2: Initial Response Guide – Gas Condensate Spill from MODU

Step	Action	Responsibility	Indicative Timing	Additional Information
1	On discovery of a hydrocarbon release - immediately notify the Offshore Installation Manager (OIM).	Spill Observer	Immediate	MODU ERP
2	Activate MODU Emergency Response Plan (ERP) and this OPEP. Notify AGR Drilling Supervisor.	OIM	As soon as practicable	MODU ERP
3	Manage the safety of all personnel. Secure sources of ignition and alert all personnel (appropriate to the level of the spill).	OIM	Immediate	MODU ERP
4	If safe, stop the spill through source control actions. Assess incident and prevent further spillage if possible / safe.	OIM	Immediate	MODU ERP Section 4.2
5	Determine spill parameters and issue POLREP: • What is it - oil type/group/properties? • Where is it - lat/long, leading edge (if known)? • How big is it - area/volume? • What is happening to it - status of release i.e. continuing or under control? • Weather conditions at site (wind/current)?	OIM or delegate	As soon as practible	Section 4.3
6	Determine Spill Response Level required: Level 2 or 3: Contact AGR Drilling Superintendent and confirm he will assume role of Incident Commander Rig OIM assuming role of On-scene Commander in consultation with the with AGR Drilling Supervisor.	AGR Drilling Supervisor / OIM	ASAP but within 30 minutes of notification	Section 3.1
7	Issue alerts and initiate spill tracking: • Deploy the Oil Spill Tracking Buoy following the deployment instructions; • Alert support vessels; • Alert supply base; and • Alert helicopters provider.	AGR Drilling Supervisor / OIM or delegate	As soon as practible	Section 4.3
8	Complete tasks outlined in Table 2-3 – Initial Response Guide – IC and DIMT.	AGR Drilling Superintendent	Refer Table 2-3	Section 2.3
9	Initiate Source Control – activate Source Control Emergency Response Plan (SCERP).	AGR Drilling Supervisor / OIM / IC	As soon as practicable	Section 4.2
10	Provide regular SITREPs to the DIMT IC (as agreed) regarding the appearance and behaviour of surface spill.	AGR Drilling Supervisor / OIM or delegate	Ongoing as agreed with IC	Section 4.6

Step	Action	Responsibility	Indicative Timing	Additional Information
	and weather (surface wind speed, direction, sea state, current speed and direction) and tidal conditions			

2.3 INITIAL RESPONSE GUIDE – INCIDENT COMMANDER AND DIMT

Table 2-3: Initial Response Guide – IC and DIMT

Step	Action	Responsibility	Indicative Timing	Additional Information
1	Upon notification from site, determine if Incident Commander role being assumed by shoreside (AGR Drilling Superintendent. If yes, Vessel Master / AGR Drilling Supervisor assuming role of On-scene Commander in consultation with the Rig OIM. If no, AGR Drilling Superintendent to monitor situation pending change in status of response.	Incident Commander.	On notification	Section 3.5
2	Notify DIMT members to standby or mobilise to Incident Command Room (ICR) and set up Incident Control Room and advise Western Gas Duty CMT Manager.	Incident Commander.	90 minutes from notification	Section 3.3
3	Establish a reliable communications line with the incident site / On-scene Commander.	Incident Commander.	Following notification	Sasanof-1 Bridging ERP

4	Confirm with On-scene Commander:
	• Muster numbers and status of personnel;
	• POLREP showing current situation with release:
	  ○ Shutdown and isolation;
	  ○ Continuing or under control;
	  ○ Material and quantity released;
	  ○ Agreed SITREP frequency.
		Incident Commander.	90 minutes from notification	Sasanof-1 Bridging ERP

5	Set up regular briefing of Western Gas Duty CMT Manager	Incident Commander.	ASAP following notification from OSC.	Sasanof-1 Bridging ERP
6	Undertake regulatory notifications and other stakeholder notifications (as required).	Incident Commander or delegate.	Refer Table 3-4	Table 3-4
7	Implement the Sasanof-1 Exploration Drilling Program Bridging ERP. Establish Incident Command Post	Incident Commander.	90 minutes from notification	Sasanof-1 Bridging ERP
8	Determine spill trajectory – weather conditions and perform initial vector analysis	Incident Commander or	Within 90 minutes from	4.3.2

Step	Action	Responsibility	Indicative Timing	Additional Information
	• Where is it going - Weather conditions/currents/tides? • What is in the way - Resources at risk? • When will it get there - Weather conditions/currents/tides? Activate Monitoring, Evaluation and Surveillance tactics.	DIMT Planning Section.	DIMT activation.	
9	Based on the preliminary spill assessment provided by OIM/Vessel Master and operational monitoring data: • Assess response required; and • Implement spill response commensurate to the size and level of risk.	Incident Commander.	90 minutes from notification	Section 4.6
10	Activate Source Control ERP: • Engage well control specialists and prepare for mobilisation; and • Initiate APPEA MoU: Mutual Assistance to facilitate relief rig.	Incident Commander or delegate.	Refer to 4.2	Section 4.2
11	If DoT to assume control as Control Agency, assist in completion of DoT Incident Control Handover Checklist.	IC	As required	Section 3.5.3
12	Notify oil spill response contractor(s) and determine level of support required based on the escalation potential of the incident: • Activate AMOSC Member Agreement to support the response, if appropriate; and • Engage Clarksons Vessel Broker to identify additional support / surveillance vessels.	Incident Commander or delegate. AMOSC: Pre-approved Company Approved Authority (CAA)	As soon as practicable	Table 3-4: Hydrocarbon Spill Notification Requirements
13	Prepare for potential evacuation of personnel from the incident site.	Incident Commander.	Refer to Bridging ERP	Sasanof-1 Bridging ERP
14	Establish spatial context of the spill: • Obtain all necessary maps/modelling from GIS software and establish sensitivity mapping; and • Identify protection priorities and confirm response options via NEBA.	Planning Section Chief (or delegate).	90 minutes from notification	Section 4.1 Section 4.6
15	Support incident action plan (IAP) (as required) in consultation with AMOSC and Control Agency (DoT, if applicable)	Incident Commander.	Ongoing	Section 4.6
16	Review OSMP to determine which rapid assessments initiation criteria are triggered, and direct personnel to undertake required assessments.	Planning Section Chief (or delegate).	Refer to OSMP	Section 4.7

3 SPILL RESPONSE FRAMEWORK

3.1 SPILL CLASSIFICATION

The National Plan classifies incidents to provide direction on the potential consequence and impact of an incident. This assists in guiding agency readiness levels, incident notifications, response actions and potential response escalations. The classification consists of three levels, which are based on the size and/or complexity of the incident (Table 3-1).

Table 3-1: Spill Level Classification (Adapted from the National Plan)

Characteristic	Level 1	Level 2	Level 3
MANAGEMENT			
Jurisdiction	Single jurisdiction	Multiple jurisdiction	Multiple jurisdictions including international
No. of agencies	First Response Agency	Routine multi-agency response	Agencies from across government and industry
Incident Action Plan	Simple/Outline	Outline	Detailed
Resources	Onsite resources required only	Requires intra-state resources	Requires national or international resources
TYPE OF INCIDENT			
Type of response	First Strike	Escalated	Campaign
Duration	Single shift	Multiple shifts - days to weeks	Extended response - weeks to months
Hazards	Single Hazard	Single Hazard	Multiple Hazards
RESOURCES AT RISK			
Human	Potential for serious injuries	Potential for loss of life	Potential for multiple loss of life
Environment	Isolated impacts with natural recovery in a few weeks	Significant impacts, recovery may take months. Remediation required.	Significant area, recovery may take months. Remediation required.
Wildlife	Individual fauna	Groups of fauna or threatened fauna	Large numbers of fauna
Economy	Business level disruption	Business failure	Disruption to a sector
Social	Reduced services	Ongoing reduced services	Reduced quality of life
Infrastructure	Short term failure	Medium term failure	Severe impairment
Public Affairs	Local and regional media coverage	National media coverage	International media coverage

3.2 JURISDICTIONAL AUTHORITY AND CONTROL AGENCIES

Western Gas will be the Control Agency for spills from the MODU or support vessels within the Operational Area. In accordance with the State Hazard Plan – MEE, there are certain circumstances where the Department of Transport (DoT) (WA) will assume control of the incident as Control Agency in State waters:

- The incident occurred in Commonwealth waters, but has impacted (or is likely to impact) State waters (i.e. a Level 2/3 spill);
- The Control Agency has requested State assistance; and
- The State believes that Western Gas is not implementing an appropriate response to the incident

If the DoT assumes the role of Control Agency, it is responsible for that portion of the response activities that occur within State waters and will form a separate Incident Management Team (IMT). Western Gas will support the Control Agency by providing equipment, trained personnel, technical specialists etc. in accordance with this OPEP. If the DoT assumes control as Control Agency, Western Gas will provide the 10 required DIMT personnel to support the DoT IMT, as outlined in the State Hazard Plan – MEE. Further personnel will be provided as requested by DoT.

Western Gas will also appoint a Liaison Officer for the DoT IMT to facilitate efficient and rapid exchange of information. Western Gas will remain the Control Agency for the response activities in Commonwealth waters and undertake a coordinated response effort.

Note that the worst case credible spill trajectory modelling does not predict sea surface or dissolved hydrocarbon exposure or any shoreline contact above the low threshold to reach WA State Waters. There is a 29% and 8 % probability respectively, that entrained low and high hydrocarbon threshholds will be reached in the September to March summer season.

Table 3-2 outlines the Statutory and Control Agencies relevant to Western Gas' activities and potential oil spill scenarios.

Table 3-2: Statutory and Control Agencies

Location	Source	Statutory Authority	Control Agency
Commonwealth Waters	Shipping (vessel)	AMSA	AMSA
	Offshore petroleum activities	NOPSEMA	Western Gas
State Waters	Shipping (vessel)	DoT	DoT

3.2.1 Cross-Jurisdictional Response

The management and coordination of cross-border incidents will follow the National Plan Coordination of Cross-border Incidents Guideline (NP-GUI-023) (AMSA 2017). To facilitate effective coordination in the event of a Level 2/3 spill, a Joint Strategic Coordination Committee (JRCC) will be established. The JSCC will be jointly chaired by the State Maritime Environmental Emergency Coordinator (SMEEC) and a senior representative from the Western Gas Crisis Management Team.

3.3 SPILL RESPONSE TEAM ACTIVATION

All those that may be required to assist in an emergency are to be notified as early as possible. The following notification process is to be followed:

1. The incident is reported to the AGR Drilling Superintendent via the duty phone number (Sasanof-1 Exploration Drilling Bridging Emergency Response Plan Contacts directory). Should the Drilling Superintendent not be immediately available, a Duty Manager can be contacted via on-call phone number (refer to Contacts Directory). At this point, if the incident has escalated beyond a Level 1, the person contacted will confirm they are assuming the role of Incident Commander and, as such, becomes accountable for managing the Western Gas response to the incident. The lead in the field (e.g. Vessel Master or OIM in consultation with AGR Drilling Supervisor) will become the On-Scene Commander.
2. After consulting with the On-scene Commander, the Incident Commander will notify the Drilling Incident Management Team (DIMT) members to either standby or mobilise to Incident Command Room (ICR).
3. The DIMT will conduct all relevant notifications, action any appropriate response plans and mobilise the required resources for the incident.

The Sasanof-1 Exploration Drilling Program DIMT is on 24-hour call and can be stood up within 1 hour. Additional support can be drawn from the AMOSC Core Group, which can supply up to 30 additional staff to support the DIMT, and other service providers under Contract Service Agreements with Western Gas (see Section 5.1). Upon notification of a Level 2 or 3 incident, the DIMT will scale appropriately in size and scope (operational and tactical levels, as applicable) to manage the impending response of the incident.

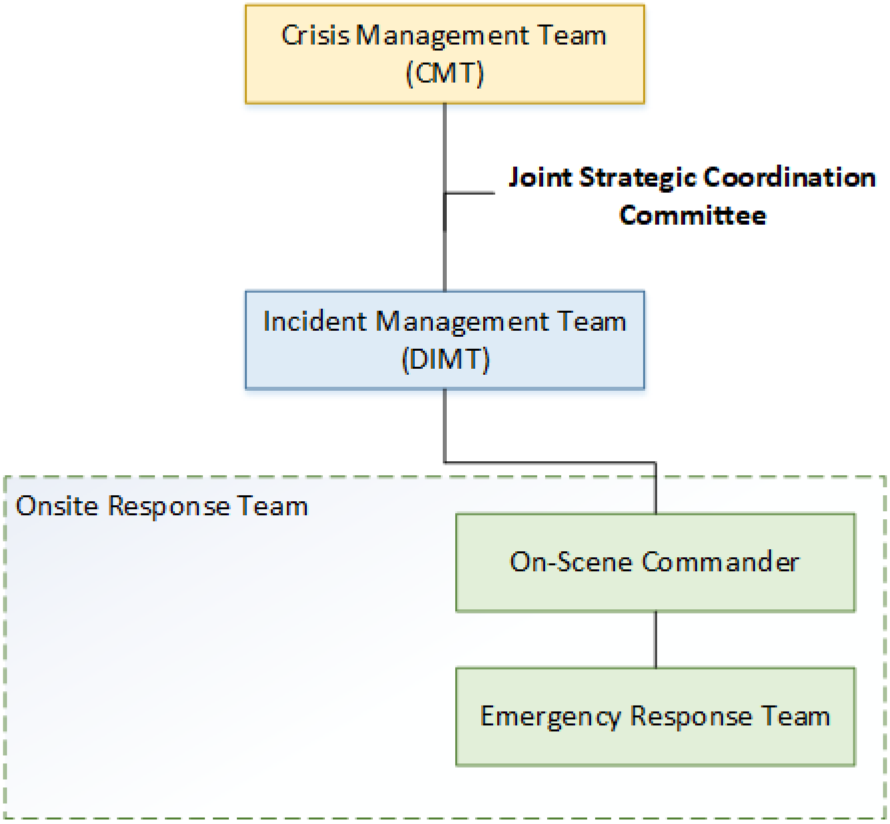


Figure 3-1 Sasanof-1 Exploration Drilling Program Incident Management Teams

The oil spill response management arrangements and Incident Management System outlined in this OPEP reflect the Australasian Inter-Service Incident Management System (AIIMS). This allows for a standardised and consistent approach to emergency response across Western Gas, AGR, contractors and relevant State and Commonwealth government agencies.

Figure 3-1 and Figure 3-2 outline Western Gas' Incident Management System, however it should be noted that the structure shown is intended to be adaptable, scalable and flexible. The size and structure of the Incident Management Team reflects the complexity of the incident and is expected to vary throughout the various stages of response and recovery.

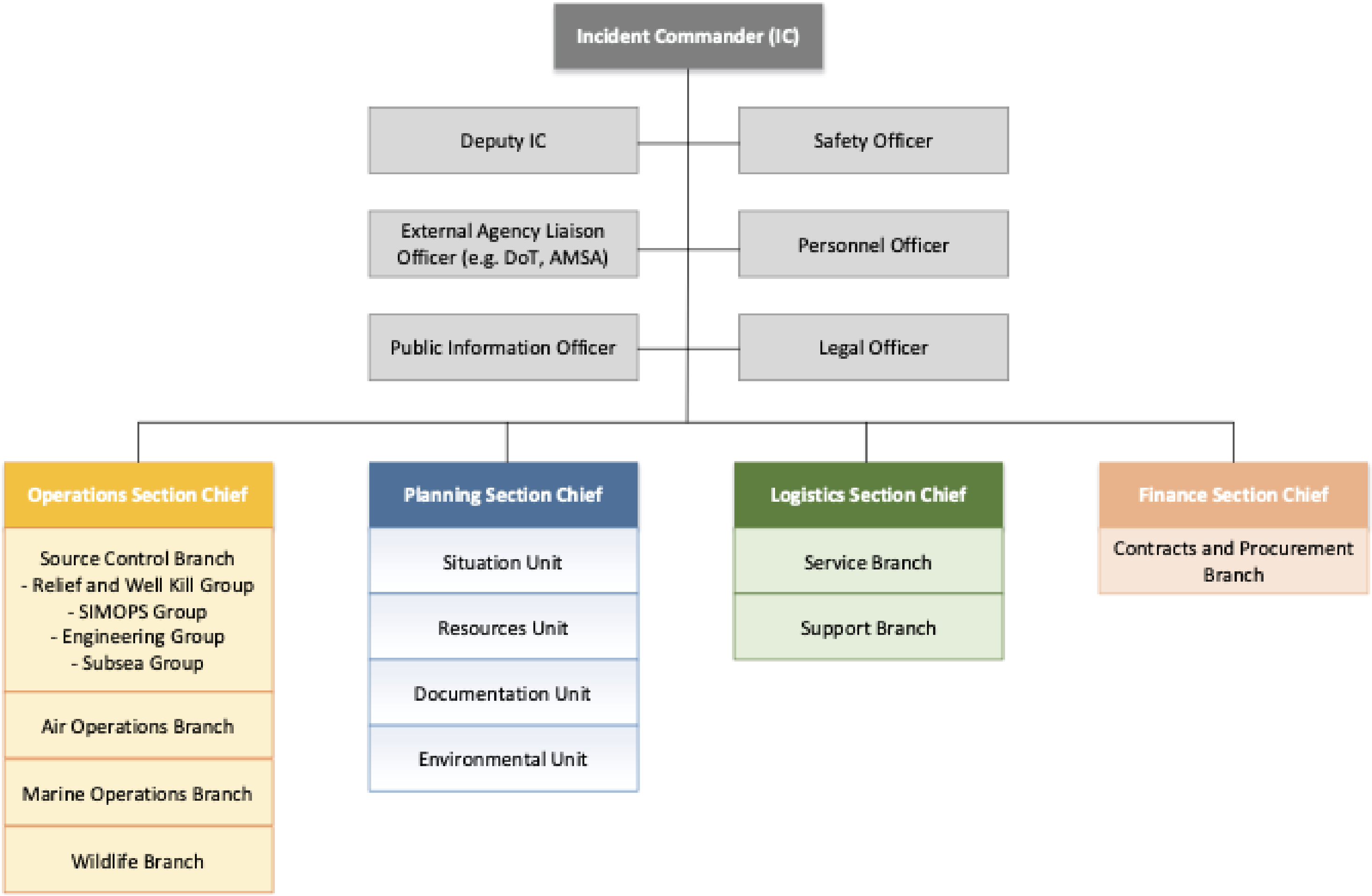


Figure 3-2 Western Gas Sasanof-1 Incident Command Structure

3.4 WESTERN GAS INCIDENT MANAGEMENT DOCUMENTATION

Western Gas will manage any incident resulting from its offshore petroleum activities in accordance with the Sasanof-1 Exploration Drilling Program Bridging Emergency Response Plan (ERP) will be prepared prior to the commencement of the drilling activities. This plan will refer to this OPEP as the operational document for use in the event of an oil spill.

The interfaces of relevant documentation within Western Gas, AGR and external oil spill response plans is shown in Figure 3-3, and described in Table 3-3.

Table 3-3 Western Gas Sasanof-1 Exploration Drilling Program Document Interfaces

Document	Description
National Plan for Maritime Environmental Emergencies (National Plan)	The umbrella contingency planning and response arrangement for Australia and is administered by the Australian Maritime Safety Authority (AMSA). The National Plan defines national arrangements, principles and policies for responding to maritime emergencies.
Australian Industry Cooperative Oil Spill Response Arrangements (AMOSPlan)	Describes mutual aid arrangements of the petroleum industry coordinated by AMOSC. It outlines membership arrangements, activation procedures and interfaces with other plans.
State Hazard Plan – Maritime Environmental Emergencies (MEE)	Describes management arrangements for the prevention of, preparation for, response to and recovery from a marine oil pollution emergency in order to minimise the impacts of marine oil pollution from vessels, offshore petroleum activities and other sources in WA State waters.
Sasanof-1 Exploration Drilling Program Environment Plan (EP)	Describes the petroleum activity, existing environment, risk assessment and environmental performance outcomes. Prepared to meet the *Offshore Petroleum and Greenhouse Gas Storage (Environment) Regulations 2009*.
Sasanof-1 Exploration Drilling Program Well Operations Management Plan (WOMP)	Details well integrity aspects for Sasanof-1 and includes Western Gas' emergency management systems and well intervention strategies. As accepted by NOPSEMA under the *Offshore Petroleum and Greenhouse Gas Storage (Resource Management and Administration) Regulations 2011*.
Sasanof-1 Exploration Drilling Program Safety Case Revision (SCR)	Details the Major Accident Event (MAE) and Safety Critical Control details for the safety aspects for the Sasanof-1 Exploration Drilling Program. The document is prepared by AGR and the MODU Drilling Contractor and submitted by the MODU Drilling Contractor as the registered facility operator to NOPSEMA in accordance with the *Offshore Petroleum and Greenhouse Gas Storage (Safety) Regulations 2009*.

Document	Description
Source Control Emergency Response Plan (SCERP) for Sasanof-1 Exploration Drilling Program	The SCERP includes an initial investigation stage with provision for escalation including the mobilisation of a rig to undertake relief well activities. The SCERP provides the Source Control Branch within the DIMT with guidance and checklists in the event of a LOWC to implement source control strategies including well capping, hydrostatic well kills and wellhead fluid containment.
Operational and Scientific Monitoring Plan (OSMP) for Sasanof-1 Exploration Drilling Program	The OSMP describes a program of monitoring oil pollution that will be enacted in the event of an emergency condition. The OSMP is the principal tool for determining the extent, severity, and persistence of environmental impacts from a marine hydrocarbon spill and inform remediation activities. The OSMP addresses the requirements of Regulation 14 (8D) of the *Offshore Petroleum and Greenhouse Gas (Environment) Regulations 2009.*
MODU Contractor Emergency Response Plan (ERP)	The ERP outlines the organizational responsibilities, actions, reporting requirements and resources required should an emergency situation unfold during routine and source control operations.
Sasanof-1 Exploration Drilling Program Bridging Emergency Response Plan (ERP)	The purpose of the Bridging ERP is to provide the DIMT with the necessary information to respond to any emergency associated with the Sasanof-1 Exploration Drilling Program, including, but not limited to, hydrocarbon spills. The Bridging ERP provides details on the interfaces between the activity emergency response teams as well as the specific AGR DIMT roles and responsibilities. It describes the emergency notification and management process, the response management process, lists the roles and responsibilities for the DIMT members, and provides useful resources (e.g. forms, templates) that can be used to store and organise information during an emergency situation.
Western Gas Crisis Management and Emergency Respone Plan (CMERP)	The CMERP defines the organizational responsibilities, actions, reporting requirements and resources required to manage a crisis.
Vessel and MODU SOPEP	A Ship Oil Pollution Emergency Plan (SOPEP) is required under the International Convention for the Prevention of Pollution from Ships (MARPOL), for vessels >400t. The SOPEP includes vessel specifications, procedures to follow for notification and spill response, and a list of spill equipment and locations.

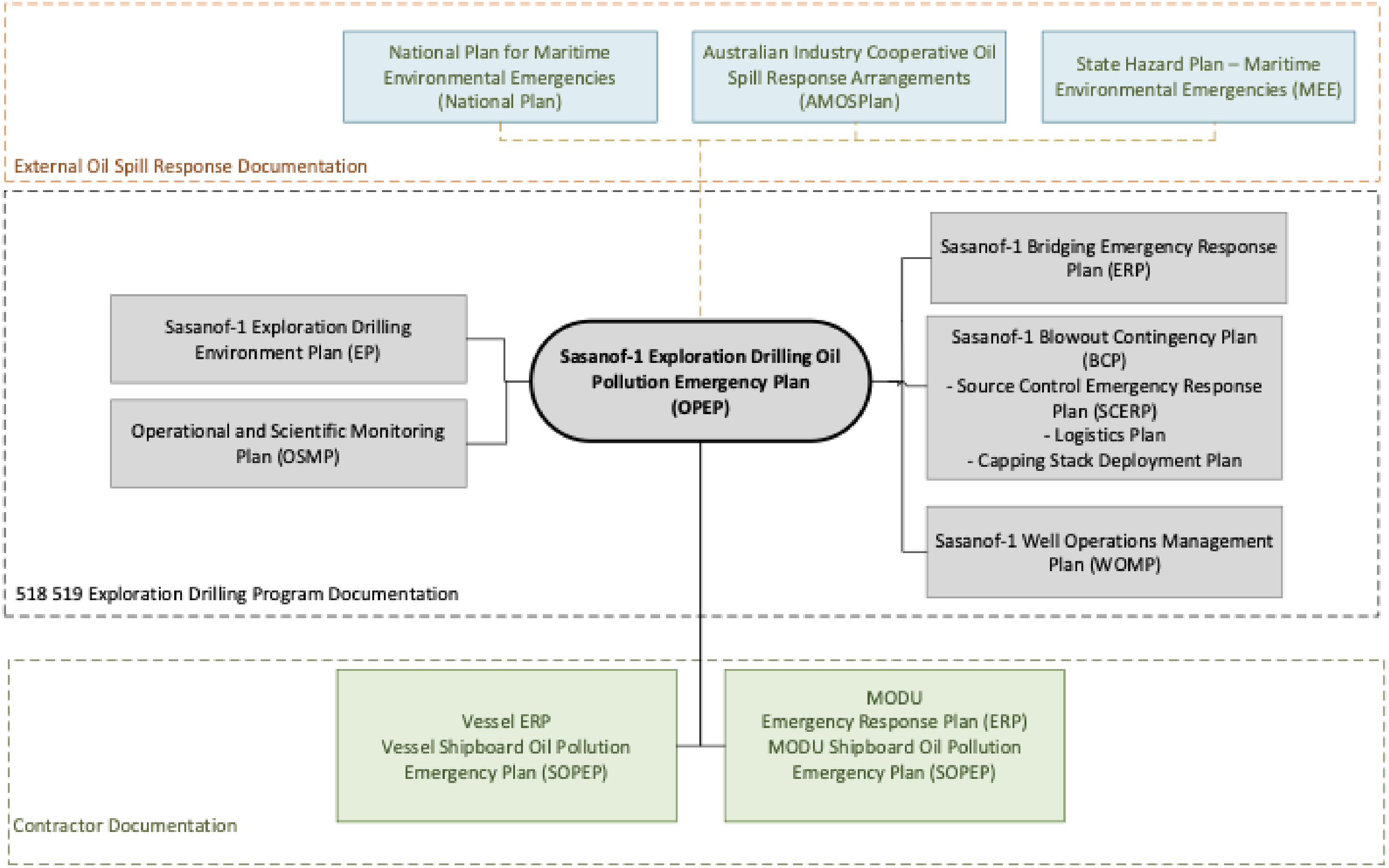


Figure 3-3 Western Gas Sasanof-1 Exploration Drilling Program Emergency Management Framework

3.5 COMMUNICATION AND INTEGRATION WITH OTHER ORGANISATIONS AND PLANS

The AGR DIMT is responsible for both internal (i.e. CMT, ERT/SCT) and external communications related to the spill response (e.g. AMOSC, DoT etc). The Western Gas CMT is responsible for external communcations related to government regulatory bodies, media liaison and related stakeholders. Dependent on the size of the spill and jurisdiction, Western Gas has support from a range of mutual support agencies and organisations, of which some of the key agencies and organisations are outlined in the following sub-sections.

3.5.1 Australian Maritime Safety Authority (AMSA) and NatPlan

NatPlan sets out the national arrangements, policies, and roles and responsibilities of states, territories and industry in managing maritime environmental emergencies. NatPlan integrates Commonwealth and State government oil spill response framework to facilitate effective response to marine pollution incidents. AMSA manages the National Plan and works with State governments (who manage the equivalent State plans that integrate into the NatPlan), shipping, petroleum, chemical industry and emergency services to optimise Australia's marine pollution response capability. This plan applies to all hydrocarbon spills in Commonwealth waters seaward of the State water limit while the WA State Hazard Plan – MEE applies in State waters within 3 nautical miles (nm) of the territorial sea baseline. The National Plan is Australia's key maritime emergency contingency and response plan.

3.5.2 Australian Marine Oil Spill Centre (AMOSC) and AMOSPlan

Western Gas will have access to AMOSC oil spill recovery and response equipment, dispersant and technical (human) capabilities along with those resources held by member companies as outlined in the AMOSPlan on a 24-hour, 7-days a week basis before and throughout drilling operations. The AMOSPlan details the Australian industry cooperative arrangements in a series of international agreements and relationships designed to support the petroleum industry during a Level 3 response. Western Gas' primary interface with the AMOSPlan during an oil spill response is via AMOSC's 24/7 Duty Officer, who will provide the initial point of contact for oil spill responses that require AMOSC assistance.

AMOSC is a member of the Global Response Network.

3.5.3 WA Department of Transport (DoT) and WA State Hazard Plan

The WA State Hazard Plan – Maritime Environmental Emergencies (MEE) sets out arrangements for managing marine oil pollution and marine transport emergencies in WA. The WA State Hazard

Plan – MEE prescribes management arrangements for the prevention of, preparation for, response to and recovery from a marine oil pollution incident in order to minimise the impacts of oil spill incidents from vessels, offshore petroleum activities and other sources in State waters.

Where a spill enters or is predicted to enter from Commonwealth to State waters, the Hazard Management Agency (HMA)(DoT Chief Executive Officer, or their designated proxy) will assume the role as the State Maritime Pollution Coordinator (SMPC), and the DoT will take on the role of Controlling Agency for response actions in State waters. The HMA has overall responsibility for ensuring there is an adequate response to spill incidents in State waters, including those resulting from a petroleum activity and from a vessel originating in Commonwealth waters. The SMPC provides overall strategic management response and executive level support and guidance to the Incident Control.

For a spill that crosses from Commonwealth to State waters, it is an expectation that Western Gas will conduct initial response actions in State waters as necessary in accordance with this OPEP and continue to manage those operations until formal incident control can be established by WA DoT. Western Gas will notify the WA DoT Maritime Environmental Emergency Response (MEER) unit as soon as practicable as per Section 3.7. On notification, the HMA will establish and operate the Maritime Environmental Emergency Coordination Centre (MEECC) and activate the WA DoT IMT.

Western Gas and DoT will establish separate IMTs to manage response activities in Commonwealth and State waters, respectively, with one of the IMTs adopting the role of 'Lead IMT' for some response functions. Unless otherwise agreed through the Joint Strategic Coordination Committee (JSCC), the allocation of IMT function and designation of 'Lead IMT' will be as detailed in Appendix 2 of the Offshore Petroleum Industry Guidance Note: Marine Oil Pollution - Response and Consultation Arrangements (DoT, 2020).

To facilitate effective coordination between DoT and Western Gas and their respective IMTs in the event of a cross-jurisdictional response (e.g. if Western Gas remains Controlling Agency for those responses in Commonwealth marine waters with the WA DoT the Controlling Agency in State waters), the JSCC will be established. The JSCC is a committee, not a team operating from a specified location. The JSCC will be jointly chaired by the SMPC and a nominated senior Western Gas representative, and will comprise individuals deemed necessary by the chairs to ensure an effective coordinated response across both jurisdictions and to provide a mechanism for de-conflicting competing priorities and requests for resources. The key functions of the JSCC are set out within Section 6.5.1 of DoT's Offshore Petroleum Industry Guidance Note: Marine Oil Pollution Response and Consultation Arrangements (DoT, 2020).

In the event that WA DoT is required to establish an IMT, at the request of the SMPC, Western Gas will comply with WA DoT's Offshore Petroleum Industry Guidance Note: Marine Oil Pollution - Response and Consultation Arrangements (DoT, 2020) and provide the necessary resourcing including equipment and personnel, to assist the WA DoT's IMT in performing duties as a Controlling Agency. Western Gas will initially make available 11 appropriately qualified persons to work within the DoT IMT (as described in Appendix 3 and 4 of the Offshore Petroleum Industry Guidance Note: Marine Oil Pollution - Response and Consultation Arrangements (DoT, 2020).

In addition to the IMT roles, Western Gas will also provide appropriately qualified personnel (e.g. AMOSC core group and specialist consultants) to assist with field operational activities, such as oiled wildlife response. DoT may also opt to deploy field response personnel through the State Response Team and request National Response Team support.

3.5.4 WA Department of Biodiversity, Conservation and Attractions (DBCA) and WAOWRP

The DBCA has responsibility and statutory authority to protect wildlife as outlined in the WA Biodiversity Conservation Act 2016. It also has legislative requirement to ensure the humane treatment, housing and release or euthanising of fauna under the Animal Welfare Act 2002.

For spills in State waters, WA DoT is the Controlling Agency and DBCA is the Jurisdictional Authority for OWR and lead agency for OWR. The role of DBCA (formerly DPaW) in an OWR is outlined in the WA Oiled Wildlife Response Plan (WAOWRP) and regional sub-plans. The WAOWRP (DPaW, 2014a) sets out the minimum standard required for an OWR in WA in both State and Commonwealth waters. The Pilbara Region Oiled Wildlife Response Plan (PROWRP) (DPaW, 2014b) outlines specific 'on ground' information required to carry out OWR specific to this region (e.g. environmental values, high risk environmental areas, designated oiled wildlife facilities, equipment lists and resource lists, contact lists).

For a spill originating from petroleum activities in Commonwealth waters that moves into State waters, Western Gas retains command until formal incident control is established by WA DoT. In the event that wildlife has been impacted or there is imminent threat of impact requiring OWR, the WAOWRP and PROWRP will be activated. A Wildlife Division Coordinator (WDC) will be established and will liaise with the WA DoT to identify and coordinate the necessary OWR functional units of the Oiled Wildlife Division (OWD), as per the WAOWRP. In the event of oiled wildlife, DBCA will provide an Oiled Wildlife Advisor (OWA) to advise. The OWA and WDC will provide advice to the WA DoT on the level of OWR required and will ensure provision of resources to support OWR operations.

Once WA DoT becomes the Controlling Agency, they will be responsible for overall command of an OWR. Western Gas will provide necessary resources (equipment and personnel, primarily through Western Gas' AMOSC membership), as directed by WA DoT to support their functions.

During a Level 3 spill from petroleum activities and that impacts only Commonwealth waters, DBCA will similarly provide advice on OWR to the Western Gas DIMT through a nominated OWA.

3.5.5 Australian Petroleum Production and Exploration Association (APPEA)

APPEA is the peak national body representing Australia's oil and gas exploration and production industry. It has about 60 full member companies, and about 140 associate member companies of which Western Gas is an Associate Member. Western Gas will engage with other APPEA members via a signed Mutual Aid Memorandum of Understanding (MoU) and source assistance from nearby operators.

3.6 ADDITIONAL SUPPORT FOR DIMT (SURGE CAPACITY)

In the event of a large spill requiring resources exceeding those of the Western Gas organisation, additional personnel and resources will be obtained from:

- Third party contract services and agency hire.
- Industry organisations (e.g. AMOSC).
- APPEA Mutual Aid MoU.

Additional resources will be under the control of the relevant DIMT Section Chiefs. An indication of the potential positions and delegation of responsibilities that may occur in a large spill scenario are described in Appendix B.

3.7 EXTERNAL NOTIFICATION AND REPORTING

A spill which may result from the Western Gas Sasanof-1 Exploration Drilling Program activities is required to be reported to a range of stakeholders. Table 3-4 provides information relevant to external notification and reporting requirements, including the responsible party and any additional information required, including contact details and links to the required notification and reporting forms.

Notifications and reporting should be undertaken by the Incident Commander or CMT delegate.

Table 3-4: Hydrocarbon Spill Notification Requirements

Spill type	From	To	Reporting Trigger	Type	Timing	Supporting Information
Level 1 spill	Vessel Master or OIM	AGR Drilling Supervisor	All spills (or probable spills) to the marine environment	Verbal	Immediately	-
		AMSA – Commonwealth Waters (> 3nm)	All spills (or probable spills) to the marine environment	Verbal	Immediately	Report verbally or by email if phone contact is not possible to AMSA immediately: Ph: +61 2 62306811 or 1800 641 792 Email: mdo@amsa.gov.au
				Written notification	ASAP	POLREP available at: https://amsa-forms.nogginoca.com/public/
				Written updates	As requested, or every 24 hours	SITREP / POLREP available at https://amsa-forms.nogginoca.com/public/ and IAP
Level 2 MDO spill from vessel within 500m PSZ	Vessel Master	AGR Drilling Supervisor	All spills	Verbal	Immediately	-
	AGR Drilling Supervisor (or delegate)	AMSA – Commonwealth Waters (> 3nm)	Level 2 vessel spills in Commonwealth waters	Verbal	Immediately	Report verbally or by email if phone contact is not possible to AMSA immediately: Ph: +61 2 62306811 Email: mdo@amsa.gov.au
				Written notification	ASAP	POLREP form available at: https://amsa-forms.nogginoca.com/public/
				Written updates	As requested, or every 24 hours	SITREP / POLREP form available at https://amsa-forms.nogginoca.com/public/ and IAP
		NOPSEMA Commonwealth Waters (> 3 nm)	Spill has caused, or has the potential to cause, moderate to more serious	Verbal	As soon as practicable and no later than 2 hours	Ph: 08 6461 7090

Spill type	From	To	Reporting Trigger	Type	Timing	Supporting Information
			than moderate environmental damage (refer to activity-specific spill risk assessment in EP)	Written notification	As soon as practicable after oral notification	Form available at: https://www.nopsema.gov.au/assets/Forms/N-03000-FM0831-Report-of-an-Accident-Dangerous-Occurrence-or-Environmental-Incident-Rev-8-Jan-2015-MS-Word-2010.docx Email: submissions@nopsema.gov.au Copy also to NOPTA Email: info@nopta.gov.au
				Written report	As soon as practicable, but within 3 days of incident	NOPSEMA Form N-03000-FM0831 Email: submissions@nopsema.gov.au Copy also to NOPTA Email: info@nopta.gov.au
		Port Authorities	Level 2 vessel spills (threatening State waters)	Verbal	ASAP	Port authorities details available at: https://www.transport.wa.gov.au/Freight-Ports/port-authorities.asp
		DoT Maritime Environmental Emergency Response (MEER) Unit – State Waters (< 3nm)	Level 2 vessel spills (threatening State waters)	Verbal and Written	As soon as practicable and no later than 2 hours	DoT MEER Unit: Ph: (08) 9480 9924 (24 hours) POLREP Incident form available at: www.transport.wa.gov.au/imarine/report-marine-oil-pollution.asp Email: marine.pollution@transport.wa.gov.au
		Department of Agriculture, Water and the Environment (DAWE)	Spill has potential to cause significant impact to a matter of national environmental significance (NES) Death or injury of individual(s) from a Listed Species	Verbal and Written	Verbal within 24hrs of detection for death or injury of Listed Fauna / within 48hrs of detection of impact on matters of NES Written within 3 days	Ph: +61 2 6274 1372 or 1800 110 395 Email: compliance@environment.gov.au

Spill type	From	To	Reporting Trigger	Type	Timing	Supporting Information
Level 2/3 spill from MODU	Offshore Installation Manager (OIM)	Incident Commander	All spills	Verbal	Immediately	DIMT Duty Roster
	IC or delegate	NOPSEMA Commonwealth Waters (> 3 nm)	Level 2/3 spill or Spill has caused, or has the potential to cause, moderate to more serious than moderate environmental damage (refer to activity-specific spill risk assessment in EP)	Verbal	As soon as practicable and no later than 2 hours	Ph: 08 6461 7090
				Written notification	As soon as practicable after oral notification	Form available at: https://www.nopsema.gov.au/assets/Forms/N-03000-FM0831-Report-of-an-Accident-Dangerous-Occurrence-or-Environmental-Incident-Rev-8-Jan-2015-MS-Word-2010.docx Email: submissions@nopsema.gov.au Copy also to NOPTA Email: info@nopta.gov.au
				Written report	As soon as practicable, but within 3 days of incident	NOPSEMA Form N-03000-FM0831 Email: submissions@nopsema.gov.au Copy also to NOPTA Email: info@nopta.gov.au
		DoT Maritime Environmental Emergency Response (MEER) Unit – State Waters (< 3nm)	Level 2/3 spill or Spill has caused, or has the potential to cause, moderate to more serious than moderate environmental damage (refer to activity-specific EP spill risk assessment)	Verbal and Written	As soon as practicable and no later than 2 hours	DoT MEER Unit: Ph: (08) 9480 9924 (24 hours) POLREP Incident form available at: www.transport.wa.gov.au/imarine/report-marine-oil-pollution.asp Email: marine.pollution@transport.wa.gov.au
		AMOSC - Mutual Aid	Level 2/3 spill requiring additional support / resources	Verbal	As soon as practicable	Ph: 0438 379 328 Email: amosc@amosc.com.au

Spill type	From	To	Reporting Trigger	Type	Timing	Supporting Information
		OSRL (assistance as a support agency)	Level 2/3 spill requiring additional support / resources	Verbal and Written	As soon as practicable	24/7 Emergency Ph: +65 6266 1566 Mobilisation Authorisation and Notification Forms: https://www.oilspillresponse.com/activate-us/activation-procedure/
		Oil Spill Modelling Service Provider	Level 2/3 spill	Verbal and Written	As soon as practicable	Provide all relevant and available spill information, spill modelling request form. Sasanof-1 Exploration Drilling Program Contacts directory
		AMSA	Level 2/3 spill requiring additional support and resources under MoU	Verbal	Immediately	Report verbally or by email if phone contact is not possible to AMSA immediately: Ph: +61 2 62306811 Email: mdo@amsa.gov.au
		Other Resources/Contractors	Level 2/3 spill	Verbal	As directed	Sasanof-1 Exploration Drilling Program Contacts directory
		Marine Stakeholders (Fisherpersons, AHS, adjacent titleholders)	Level 2/3 spill	Verbal	As directed	Sasanof-1 Exploration Drilling Program Contacts directory
		Port Authorities	Level 2 vessel spills (threatening State waters)	Verbal	ASAP	Port authorities details available at: https://www.transport.wa.gov.au/Freight-Ports/port-authorities.asp
		Department of Agriculture, Water and the Environment (DAWE)	Spill has potential to cause significant impact to a matter of national environmental significance (NES) Death or injury of individual(s) from a Listed Species	Verbal and Written	Verbal within 24hrs of detection for death or injury of Listed Fauna / within 48hrs of detection of impact on matters of NES Written within 3 days	Ph: +61 2 6274 1372 or 1800 110 395 Email: compliance@environment.gov.au
		Director of National Parks, DAWE	An oil spill that may impact upon Marine Parks; and/or	Verbal and Written	ASAP	Notification should include:

Spill type	From	To	Reporting Trigger	Type	Timing	Supporting Information
			an oil spill response action (including monitoring and remediation) occurring within a Marine Park.			• Titleholder details • Time and location of the incident (including name of marine park likely to be effected) • Proposed response arrangements as per the Oil Pollution Emergency Plan (e.g. dispersant, containment, etc.) • Confirmation of providing access to relevant monitoring and evaluation reports when available; and • Contact details for the response coordinator. Note that the DNP may request daily or weekly Situation Reports, depending on the scale and severity of the pollution incident. Marine Park Duty Compliance Officer: 0419 293 465 E: marineparks@awe.gov.au
		Department of Industry, Science, Energy and Resources (DISER)	If spill is predicted to enter Indonesian or Timor Leste waters	Verbal	ASAP	+61 2 6213 6000
		WA DWER Pollution Response Unit	If temporary waste storage areas are required	Verbal	ASAP	24/7 Ph: 1300 784 782
		WA DBCA	If spill has affected, or has the potential to affect wildlife and require oiled wildlife response Spill may enter State marine parks	Verbal	ASAP	Marine Emergencies: +61 8 9474 9055

4 OPERATIONAL RESPONSE

4.1 SPILL RESPONSE STRATEGY SELECTION

A preliminary Net Environmental Benefit Analysis (NEBA) was conducted using hydrocarbon spill modelling of the worst-case spill scenarios identified for the Sasanof-1 Exploration Drilling program (refer to Section 4.2 of the EP). The preliminary NEBA considered the effectiveness of response strategies for the potential spill parameters, the benefit(s), potential environmental impacts and risks and the operational/functional constraints of the response option. The following key considerations, operational limitations and assumptions led the decision-making process during the preliminary NEBA:

- No shoreline contact above modelled thresholds is predicted. Due to the low waxy content expected for the condensate (less than 5%, compared to 11% for Montara hydrocarbons), waxy residues are not expected to form. Therefore, containment and recovery, shoreline protection and clean up are not expected for this type of spill event.
- Gas condensate and marine diesel oil have limited persistence and upon release the surface expression are expected to rapidly evaporate and disperse.
- Dispersant application (both surface and subsurface) is not considered suitable for hydrocarbons which are non-persistent and highly evaporative.
- Given the location and water depth of the drilling program and no shoreline contact above modelled thresholds predicted, any spill is expected to have limited impacts to wildlife. Oiled Wildlife Response is included as a secondary response option, should monitoring and evaluation of the spill parameters suggest it is required.

Table 4-1 outlines the response strategies assessed as applicable for the Sasanof-1 Exploration Drilling Program, and whether they will be applied as a primary or secondary response option.

Table 4-1 Western Gas Sasanof-1 Exploration Drilling Program – Hydrocarbon Response Strategies

Worst-case Spill Scenario	Primary Response Strategies	Secondary Response Strategies
Diesel spill from vessel: *Credible worst-case scenario: Ruptured fuel tank of 250 m^3 instantaneous release.*	1. Monitoring, Evaluation and Surveillance (MES). 2. Waste Management.	1. Oiled Wildlife Response
Loss of well control: *Credible worst-case scenario: Flow of condensate from well of estimated 22,542 bbl / day for 121 days*	1. Source Control – ROV Intervention. 2. Debris clearance. 3. Source Control – Capping and Containment.	1. Oiled Wildlife Response

Worst-case Spill Scenario	Primary Response Strategies	Secondary Response Strategies
	4. Source Control – Relief Well. 5. MES. 6. Waste Management.	

In the event of a spill, the assessment of response options will be reviewed and verified prior to implementation to ensure that the assumptions made in the planning process are valid. This process is described in Section 4.6.

4.2 SOURCE CONTROL

4.2.1 Overview

The initial and highest priority response to a spill incident is to prevent or limit further loss of hydrocarbons into the marine environment. This will only be attempted if the safety of personnel is not compromised and the source control activity does not cause any further risk or impact to the environment. In most circumstances, the net benefit of source control outweighs the risks and impacts from further hydrocarbons being released.

This section provides an overview of the Source Control Emergency Response Plan (SCERP) for a Level 3 spill (Table 4-2) and Figure 4-2 provides the timeline for its implementation. The Blowout Contingency Plan will be supported by a Source Control Emergency Response Plan (SCERP), Logistics Plan and Capping Stack Deployment Plan and contains additional high level IMT guidance. For a Level 3 spill due to a loss of well containment, Western Gas will be the controlling agency for the source control response.

4.2.2 Source Control Methods

In the event of a spill from a vessel, the Vessel Master will enact the SOPEP.

In the event of a loss of well control, the immediate response is dependent on the level of damage to the wellhead infrastructure and the rate of flow of hydrocarbons. The source control activities that may be undertaken in the event of a loss of well control during the Sasanof-1 Exploration Drilling Program include:

- ROV emergency BOP intervention;
- Site survey and debris clearance;
- Well capping and containment; and
- Relief well installation.

The following tables provide information regarding the activation of source control tactics, the relevant documentation for implementation, and outlines the applicability and capability to implement those tactics for the drilling program. Further information regarding response capability is provided in Section 5.1.

Table 4-2 Sasanof-1 Exploration Drilling Program – Source Control – BOP Emergency Intervention

	BOP Emergency Intervention
Relevant Implementation / Activation Documentation	Sasanof-1 Exploration Drilling Program ROV Emergency BOP Intervention Plan. Drilling Contractor Well Control Bridging Document. Source Control Emergency Response Plan (SCERP). Clarksons Support Vessel Database.
Applicability	Involves the use of response vessels and work-class ROVs with BOP intervention tooling to attempt to close the shear rams of the BOP and cease flow of hydrocarbons from the well.
Dependencies	BOP Emergency Intervention activities depend on the state of the wellhead and may require debris clearance to be undertaken prior (which would be determined by observation of the condition of the wellhead / site survey techniques).
Activation Procedure	DIMT to activate WWC and prepare for mobilisation of equipment and personnel (as per Table 2-3: Initial Response Guide – IC and DIMT).
Capability Provider	The location and availability of support vessels with ROV and BOP tooling capability will be tracked on the Clarksons Vessel Database which is updated continuously. BOP Intervention tooling is readily available and will be mobilised with the vessel with ROV capability.
Availability / Timeframe	Western Gas will preferentially mobilise work-class ROV for any response activities so the vessel / ROV spread would be capable of undertaking BOP intervention, reducing potential further mobilisation requirements.

Table 4-3 Sasanof-1 Exploration Drilling Program – Source Control – Site Survey and Debris Clearance

	Site Survey and Debris Clearance
Relevant Implementation / Activation Documentation	Support Vessel Register.
Applicability	A site survey may be required to undertake visual observations of the well location and surrounds. Debris clearance may be required, depending on the state of the wellhead, and involves the use of equipment to clean around the wellhead to enable intervention, prepare for relief well drilling and if appropriate, installation of a capping device.
Dependencies	A site survey would require a support vessel with ROV spread and crew, to undertake visual and/or sonar observations.

	Site Survey and Debris Clearance	
	Debris clearance would require a construction support vessel with lifting equipment rated to approximately 150 T with a work-class ROV.	
Activation Procedure	DIMT to activate Clarksons Vessel Broker to support in contracting / mobilisation of vessels to site (as per Table 2-3: Initial Response Guide – IC and DIMT).	
Capability Provider	The location and availability of support vessels with ROVs and Construction Support Vessels will be tracked on a register which is updated on a monthly basis. Register to include vessel Safety Case status / information. Wild Well Control maintains a debris removal package, located in Singapore which will be activated.	
Availability / Timeframe	Typically, several support vessels with ROV capability are located in the North West region and would be preferentially contracted to reduce mobilisation time. Construction Support Vessels would be preferentially contracted from within Australia, or the Asia-Pacific region. The Wild Well Control Debris Removal Package is located in Singapore and could be mobilised within 15 days to site.	
Item	**Maximum Duration (days)**	**Comments**
Mobilize crews and equipment to Port	0-1	Based on previous simulations. Concurrently source capping stack construction vessel with Australian safety case. Commence Safety Case Revision.
Continue to source and mobilise vessel to Singapore	0-7	Typical response time based on market knowledge of suitable vessels in SE Asia. A suitable vessel register will be updated on a monthly basis prior to spud.
Loadout debris clearance equipment on construction vessel	7-8	
Transit capping stack directly to well location	8-14	Estimated transit time from Port to location
Deployment of Debris clearing equipment	15	
Total	15	
Safety Case Revision Timelines (assumes Debris Clearance Tool deployed separately from Capping Stack Deployment Vessel)		
Item	**Duration (days)**	**Comments**
Identify vessel	1	
Safety Case Revision Kick off	1	Commence SCR plan. Engage with NOPSEMA to prioritise

	Site Survey and Debris Clearance	
Develop SCR	7	Perform HAZID. Complete SCR
Submit SCR	0	NOPSEMA review SCR
SCR review process	7	Ongoing dialogue with NOPSEMA to optimise RFFWI response
SCR Accepted	0	
Total	**16**	

Table 4-4 Sasanof-1 Exploration Drilling Program – Source Control – Capping and Containment

	Capping and Containment	
Relevant Implementation / Activation Documentation	Sasanof-1 Exploration Drilling Program Capping and Containment Plan.	
Applicability	Involves the use of a heavy lift vessel with work-class ROV capability to lower and latch the capping stack onto the damaged well to stem flow of hydrocarbons. The effectiveness of capping and containment is largely dependent on the conditions at the time of a well control incident.	
Dependencies	The safe and effective deployment of capping and containment equipment is subject to sea state operating limits.	
Activation Procedure	DIMT to activate Well Control well control specialists and prepare for mobilisation of equipment and personnel (as per Table 2-3: Initial Response Guide – IC and DIMT).	
Capability Provider	WG maintains a contractual agreement with Well Control/Capping stack provider, which provides capping and containment capability with the ability to escalate the scale of equipment needed based on the incident.	
Availability / Timeframe	16 days from activation	
Item	**Maximum Duration (days)**	**Comments**
Mobilize crews and equipment to Port	0-3.5	Based on previous simulations. Concurrently source capping stack construction vessel with Australian safety case. Commence Safety Case Revision.
Stack up and test Capping Stack	3.5-7.5	Most recent exercise reduced this time to 2.8 days.
Continue to source and mobilise vessel to Singapore	0-7.5	Typical response time based on market knowledge of suitable vessels in SE Asia. A suitable vessel register will be updated on a monthly basis prior to spud.
Loadout capping stack to construction vessel	7.5-9.5	Conservative estimate with 1 day achievable

	Capping and Containment	
Transit capping stack directly to well location	9.5-15.5	Estimated transit time from Port to location
Awaiting SCR	0-16	
Conduct Debris Clearance activities	16	Assumes debris clearance has not been conducted prior to Capping Stack arrival.
Deployment of capping stack	16-21	Assumes vertical access is possible. Additional time to allow for adverse weather.
Total	**21**	
Safety Case Revision Timelines		
Item	**Duration (days)**	**Comments**
Identify vessel	1	
Safety Case Revision Kick off	1	Commence SCR plan. Engage with NOPSEMA to prioritise
Develop SCR	7	Perform HAZID. Complete SCR
Submit SCR	0	NOPSEMA review SCR
SCR review process	7	Ongoing dialogue with NOPSEMA to optimise RFFWI response
SCR Accepted	0	
Total	**16**	

Table 4-5 Sasanof-1 Exploration Drilling Program – Source Control – Relief Well

	Relief Well
Relevant Implementation / Activation Documentation	Sasanof-1 Exploration Drilling Program Relief Well Plan. Relief Well Drilling Unit Register. Source Control Emergency Response Plan (SCERP).
Applicability	In the event that a loss of well control cannot be contained by BOP emergency intervention, the drilling of a relief well is the primary source of well control, to be achieved by intersecting the well bore below the release location, circulating kill weight drilling fluid to stem the flow of hydrocarbons.
Dependencies	The drilling of a relief well requires availability of a suitable MODU and a NOPSEMA accepted Safety Case. A Safety Case Revision will be prepared following identification of an appropriate MODU during the demobilisation / mobilisation process.

	Relief Well
Activation Procedure	DIMT will contact operators of suitable drilling units identified through the Relief Well Drilling Unit Register under the APPEA MoU: Mutual Assistance (as per Table 2-3: Initial Response Guide – IC and DIMT).
Capability Provider	Western Gas is a member of the APPEA MOU for Mutual Assistance to share drilling units during an emergency. Suitable relief well drilling units will be tracked by AGR on a register which is updated on a monthly basis. Register to include Safety Case status / information.
Availability / Timeframe	80 days.

Item	Duration (days)	Comments
Identify suitable MODU	0-1	Suitable MODU's are identified 2 months prior to spud and updated monthly. Signatory to APPEA MOU.
SCR Schedule developed	1-2	Meet NOPSEMA to discuss imminent SCR and its urgency
SCR submitted	2-16	SCR Submitted to NOPSEMA.
SCR Review process	16-23	Ongoing dialogue with NOPSEMA to optimise RFFWI response
MODU mobilised	20-23	Spud equipment loaded to MODU. Specialised equipment mobilised.
SCR Accepted	24	
MODU Drills relief well	24-80	Well Killed
Total	**80**	

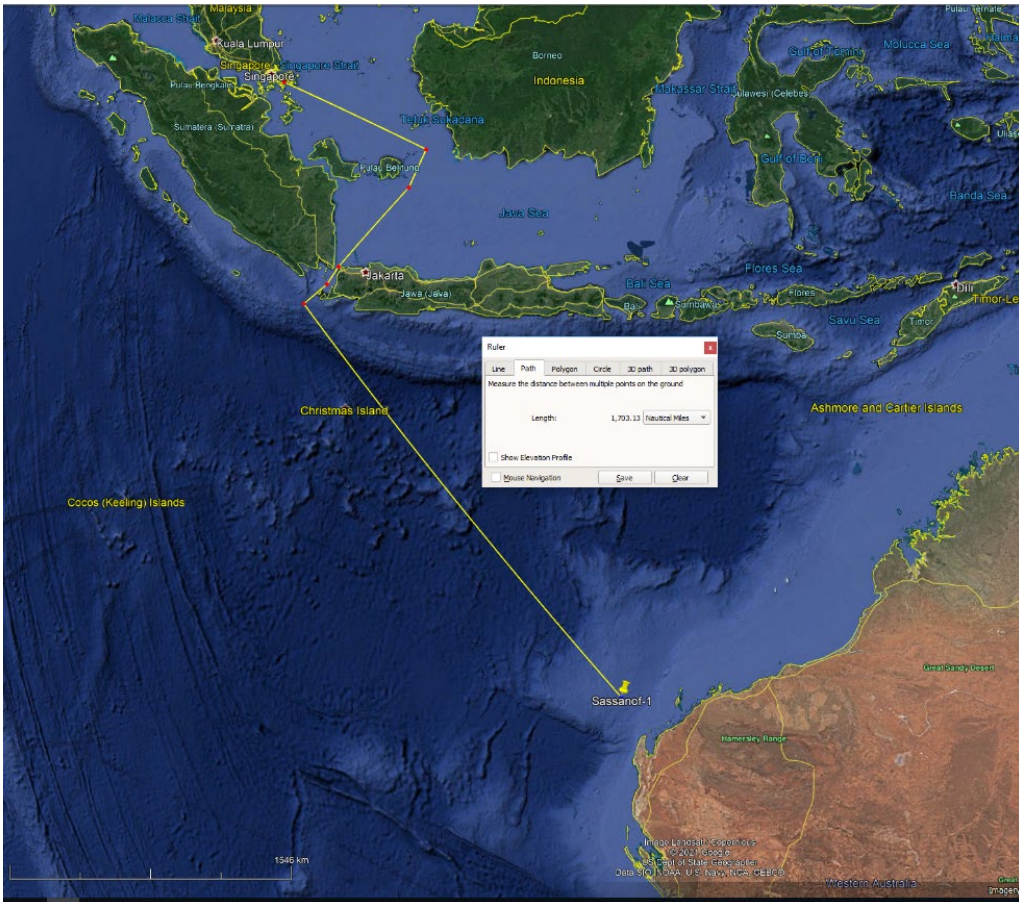


Figure 4-1 Capping Stack and Debris Clearance Journey Passage

4.2.3 Source Control Performance Standards and Measurement Criteria

The Environmental Performance Outcome for Source Controls is to contain the unplanned release of hydrocarbons from a Level 3 spill. The required Control Measures (CM), Environmental Performance Standards (EPS) and Measurement Criteria are detailed in Table 4-6.

Table 4-6 Source Control Performance Standards and Measurement Criteria

Control Measure	Performance Standard	Measurement Criteria
Source Control Planning - General	The AGR Project Drilling Manager will ensure that the SCERP is developed consistent with IOGP 594 (2019) and endorsed by Well Control Provider at least 3 months prior to commencement of the Activity.	SCREP endorsed by Well Control Provider at least 3 months prior to commencement of the Activity.
	Source Control Personnel Resourcing Plan included within SCERP: • Identifies required position/roles for Source Control Team; and	SCERP demonstrates resourcing capability to meet source control personnel requirements for well containment activities.

Control Measure	Performance Standard	Measurement Criteria
	• Describes personnel sourcing arrangements to assure resourcing capability.	
	The AGR Project Drilling Manager will ensure that regular vessel / MODU availability forecasting is in place at least three months prior to the commencement of the Activity.	Monthly vessel/MODU availability forecasts for Activity period commence at least three months prior to commencement of the Activity.
	SC Logistics Plan addresses: • Availability of vessel / MODU for the Activity period based on forecasting and live vessel surveillance (via tracking/brokerage) during the Activity • IMS risk for primary "likely" response vessels. • Source control personnel mobilisation (including quarantine) arrangements to assure resourcing capability within required timeframes in the event of an incident.	1. SC Logistics Plan that incorporates: • Vessel/MODU availability for Activity period; • Completed IMS risk assessments; • Mobilisation arrangements / constraints and associated timelines; and • Capping Stack deployment feasibility. Live vessel tracking / brokerage software in place.
	The AGR Project Drilling Manager will ensure that an exercise is conducted to test the SCERP prior to the commencement of the Activity and that any learnings are fed back into the SCERP and any associated sub-plans.	1. Exercise Report issued. 2. Learnings captured in the AGR Project Action Tracker Register.
	The AGR Project Drilling Manager will ensure that Executed contract with Well Control Provider remains active throughout the Activity for provision of well intervention services.	AGR Executed contract with Well Control Provider.
Emergency BOP Intervention	Initiation of emergency BOP intervention by ROV within 9 days of LOWC	SCERP demonstrates capability to meet required timelines per Figure 4-2 for well containment activities.
	The AGR Project Drilling Manager will ensure that Emergency ROV BOP Intervention (if Rig cannot deploy and separate vessel is required) Safety Case Revision preparatory works if the deployment vessel is defined as a Facility.	AGR maintains in-house experienced / qualified Safety Case expertise for completion of vessel-based Emergency ROV BOP Intervention.

Control Measure	Performance Standard	Measurement Criteria
Debris Clearance	Mobilisation of debris clearance equipment to site within 21 days	SCERP demonstrates capability to meet required timelines per Figure 4-2 for well containment activities.
	The AGR Project Drilling Manager will ensure that debris removal equipment is available during the Activity on a call-off basis within the required timeframe.	Executed call-off contract for debris removal equipment with Well Control Provider.
Capping Stack Deployment	Deployable capping stack (with suitable vessel) available on site within 28 days	Incident Action Plan records.
	The AGR Project Drilling Manager will ensure that capping stack is available during the Activity.	SCERP demonstrates capability to meet required timelines per Figure 4-2 for well containment activities.
	The AGR Project Drilling Manager will ensure that capping stack Safety Case preparatory works, addressing any relevant learnings from the DISC and industry knowledge on comparable activities, are completed prior to entering the reservoir.	AGR maintains in-house experienced / qualified Safety Case expertise for completion of Capping Stack Safety Case Revision preparatory works.
Relief Well Drilling	Relief well drilled and dynamic kill, within 80 days	Mutual Aid agreement MoU in place with other operators to allow use of their MODU, where available, for drilling relief well.
	Relief well casing and wellhead pre-arranged prior to the Activity.	Agreement(s) in place.
	Geophysical site survey, mooring analysis and conductor fatigue analysis conducted for relief well location/MODU prior to entering the reservoir that address: • Most onerous MODU mooring; and • Heaviest feasible BOP.	1. Site survey report incorporating primary and relief well locations. 2. Mooring analysis report. 3. Conductor analysis report.
	Mutual Aid agreement MoU in place with other operators to allow use of their MODU, where available, for drilling relief well.	Signed APPEA Mutual Aid MoU.
	IC initiates WCP within 3 hours of loss of well control notification.	Incident response logs.
	The AGR Project Drilling Manager will ensure that Relief Well Safety Case Revision preparatory works, addressing	AGR maintains in-house experienced / qualified Safety Case expertise for completion of Safety Case Revision

Control Measure	Performance Standard	Measurement Criteria
	any relevant learnings from the DISC and industry knowledge on comparable activities, are completed prior to entering the reservoir.	preparatory works after primary MODU safety case is issued and prior to entering the reservoir.

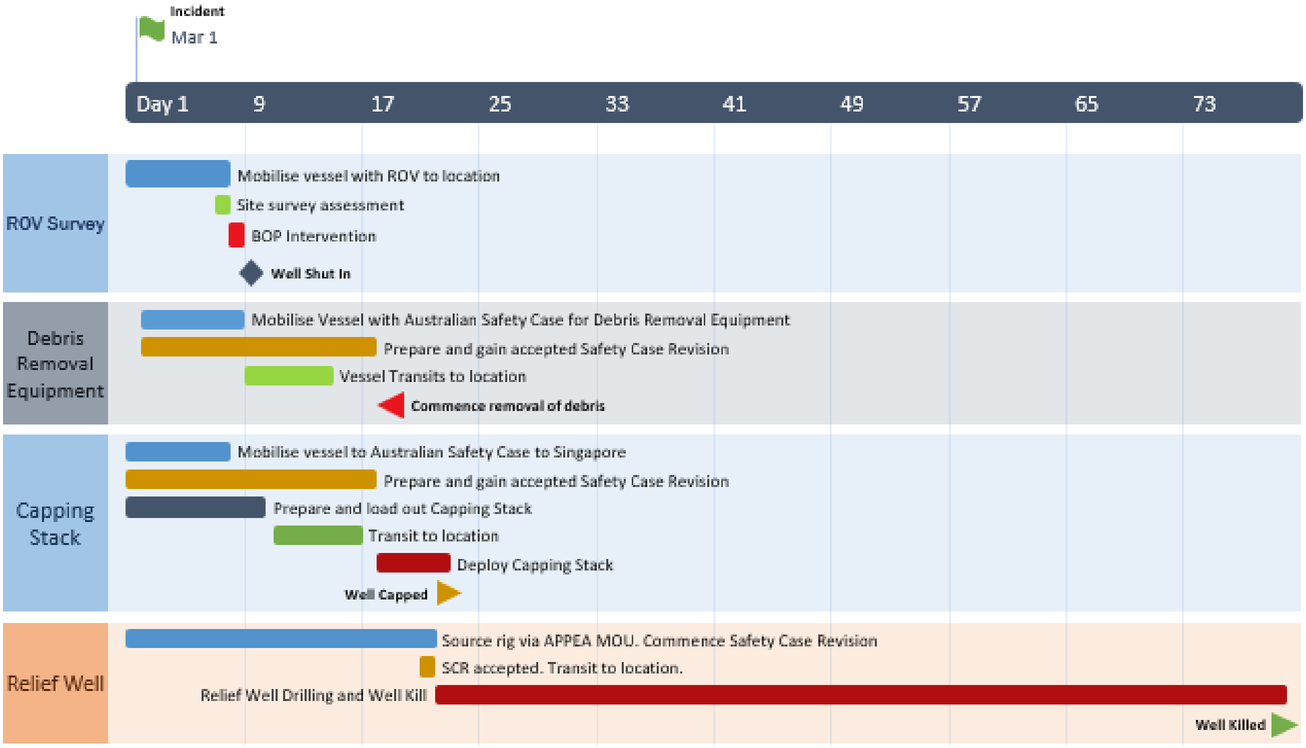


Figure 4-2 Sasanof-1 Source Control Plan Timeline

4.3 MONITORING, EVALUATION AND SURVEILLANCE

4.3.1 Overview

Monitoring, Evaluation and Surveillance (MES) activities are undertaken to assist in anticipating resources at risk of exposure, directing response resources and evaluating the effectiveness of response techniques. MES activities are conducted throughout the incident response. This OPEP includes MES tactics that may be used to evaluate the parameters and potential trajectory of the spill and may include one or more of the following:

- Fate and weathering modelling – computer modelling and computational techniques to estimate the weathering of an oil spill;
- Trajectory modelling – computer models and computational techniques to estimate the speed and direction of movement, weathering and dispersal patterns;

- Visual observation (from aircraft and/or vessels) – observers on aircraft or vessels use standard references to characterise oil slicks; and
- Remote sensing – uses remote sensing technologies, including tracking buoys and satellite imagery, to identify and track surface oil.

Table 4-7 provides guidance for implementing MES for the Sasanof-1 Exploration Drilling Program (this is guidance only and the IC may vary tasks as appropriate). MES tactics will be terminated in accordance with the process detailed in Section 4.6.4.

Table 4-7 Monitoring, Evaluation, and Surveillance Implementation Guide

MES Tactic	Action	Complete
Information gathering	Obtain weather data via of the Bureau of Meteorology (http://www.bom.gov.au/) for the spill location.	

Hydrocarbon, distribution, fate and weathering assessment	Conduct hydrocarbon distribution, fate and weathering assessment to further develop response strategies:
	• Spill fates, weathering and trajectory (for marine spills) modelling – conduct internally, through AMOSC; or conduct through AMSA National Plan arrangements.
	    o If using AMSA, complete then email the AMSA Oil Spill Trajectory Modelling (OSTM) request form, available from: http://www.amsa.gov.au/environment/maritime-environmental-emergencies/national-plan/General-Information/SPILLREQUEST/index.asp
	    o If using AMOSC – Initiate via AMOSC Duty Manager.
	• Undertake ADIOS modelling using hydrocarbon characteristics detailed in the EP https://response.restoration.noaa.gov/adios
	• Conduct satellite/optical imagery (through AMSA, AMOSC and OSRL)	

Vectoring	Use vectoring to identify predicted spill trajectory. https://response.restoration.noaa.gov/sites/default/files/Trajectory_Analysis_Handbook.pdf	
Tracking Buoy Monitoring	Confirm deployment of satellite tracking buoys (if Level 2/3 incident). Access oil spill tracking buoy live feed data if a buoy has been deployed from the vessel / MODU: • Buoy service will be activated prior to spudding well and vessel and rig operators will be trained on their deployment. • Western Gas – through Metocean Services - can log into the tracking buoy account and monitor location.	
Aerial Observation	Mobilise Aerial Observation aircraft (if Level 2/3 incident) to commence operations in daylight hours (through AMOSC). Initial aerial observation to be conducted from crew change helicopter supplier followed by contractors identified through AMOSC.	
Marine Observation	Obtain vessel observations from any vessels on location / spill source vessel (if appropriate)	
Satellite Imagery Observation	Access satellite imagery through AMOSC.	

4.3.2 Oil Spill Trajectory Calculation

Spill Size Estimation

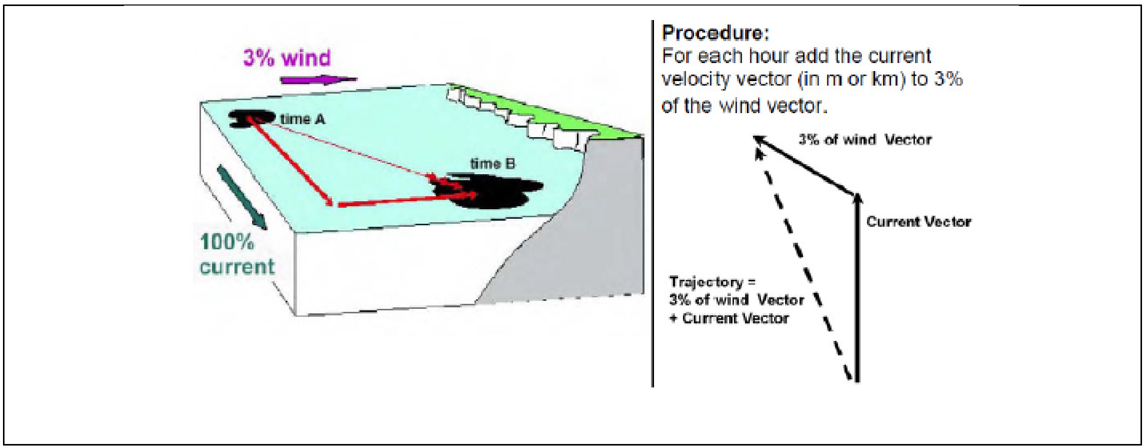
The spill size may be determined based upon the estimated amount of hydrocarbon released from a 'known' hydrocarbon inventory; an estimate of release rates from time of the commencement of the incident; or an estimate of the appearance of oil on the sea surface based upon the likely thickness and type of oil (Table 4-8 and Figure 4-4).

Spill Movement

The movement and behaviour of an oil slick may be manually estimated by undertaking vector calculations. Manual calculations can commence as soon as the preliminary information on the spill is known and proposed within 3 hours of the spill. For spills in close proximity to shore, this method may provide the best option for predicting the likely spill trajectory and timeframes before protection priorities are impacted. Manual estimation of oil trajectory movement applies only to floating oil on the sea surface.

Prior to commencing the calculation, the wind and current data is required. This can be accessed via the Bureau of Meteorology observation station (winds) (http://www.bom.gov.au/wa/observations/waall.shtml).

The calculation is based on the spill moving 100% of the current vector and 3% of the wind vector, as shown in Figure 4-3.



Source: AMSA (2003).

Figure 4-3 Spill vectoring overview

Hydrocarbon Weathering

The Automated Data Inquiry for Oil Spills (ADIOS) can be used to provide weathering predictions of hydrocarbon types for spill volumes at different wind speeds and water temperatures. This computer-based oil spill response tool is available to download from: http://response.restoration.noaa.gov/oil-and-chemical-spills/oil-spills/response- tools/downloading-installing-and-running-adios.html.

4.3.3 Visual Observation - Aerial Surveillance

In the event of a Level 2 or 3 Gas Condensate or MDO release, surveillance will be carried out via aerial means to gain situational awareness and inform the spill response. Aerial surveillance will be commissioned by the IC.

AMOSC has access to the fixed wing service providers and provide accredited marine pollution aerial observers as part of the AMOSC Core Group.

Requests for aircraft to conduct aerial observations should be made by the IC to the AMOSC.

Trained aerial observers are also available through AMSA (NRT Members). The observers will undertake observations over the spill location and any predicted areas of shoreline contact.

From aerial observations, coarse estimates of spill volume can be made on the basis of its appearance at sea, using the area covered and colour of spill (Table 4-8). Examples of appearance are provided in Figure 4-4. Bonn Agreement Oil Appearance Code.

AMSA provides guidance called 'Identification of Oil on Water – Aerial Observation and Identification Guide' which can be found at: https://www.amsa.gov.au/forms-and-publications/Publications/AMSA22.pdf.

Aerial observations should be documented in the format shown in the Aerial Observer log forms in Appendix A.

Table 4-8 Guidelines for estimating spill volume

Code	Description of appearance	Approximate thickness (μm)	Approximate litres per km^2
1	Silvery	<0.05 to 0.1	
2	Grey	0.1 to 0.30	40-300
3	Rainbow	0.3 to 5.0	300-5,000
4	Metallic	5.0 to 50	5,000-50,000
5	Discontinuous true oil colour (heavy oil)	50 to 200	50,000 – 200,000
6	Continuous true colour (heavy oil)	>200	>200,000
Other	Mousse or emulsion		

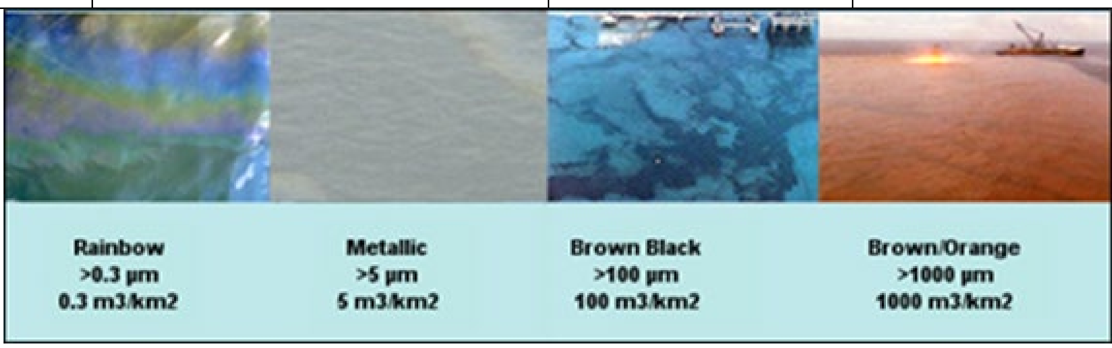


Figure 4-4. Bonn Agreement Oil Appearance Code

Aerial Observer logs that must be completed by the aerial observer and emailed to the DIMT after each flight are available in Appendix A.

Table 4-9 Aerial surveillance resources

Resource	Requirements	Provider
Trained Oil Spill Response personnel	1 x Aerial Observer (trained)	AMOSC AMSA NRT
Air Support	1 x Aircraft & Pilot	AMOSC Contracts

4.3.4 Visual Surveillance – Vessels

For a Level 2 or 3 spill, monitoring and evaluation will be undertaken to assess the natural weathering process and identify the location of the slick. In all cases this will involve visual monitoring from vessels of opportunity (as available) following a spill incident. Contracted vessels could be onsite within 20 hours.

Spill observers may include project team members, vessel crew and in the event of a Level 2 or 3 spill, AMOSC Core Group Resources and / or AMSA NRT members.

Depending on the scale of the spill, additional vessels may need to be chartered for various tasks such as monitoring, deployment of spill deflection and protection equipment and recovery of personnel and equipment.

Any vessel that is chartered must be commercially registered and suitable for its intended purpose. Once a suitable vessel has been identified, the Logistics Officer must organise an official contract for supply.

4.3.5 Oil Spill Tracking Buoys

Both vessels involved in the activity will carry an oil spill tracking buoy for deployment in the event of a Level 2 or 3 spill. Instructions will be provided to Vessel Master for the deployment of the buoy.

At the time of a spill, the monitoring buoy will be activated and deployed overboard to allow for real-time satellite tracking of the spill (Level 2 or 3 only). The buoys' location will be monitored through regular data downloads (every 30 minutes).

4.3.6 Oil Spill Trajectory Modelling

The DIMT is able to assess the movement of a hydrocarbon slick using computerised OSTM using RPS via its arrangements with AMOSC to undertake real-time modelling of an actual spill event to available from AMSA.

OSTM is available through AMOSC, who have a standing contract with RPS APASA or through AMSA upon request (submit an electronic request via the NEMO system, phone AMSA Rescue Coordination Centre 02 6230 6811 (24 hrs) or by request form via the AMSA Contractor Portal/Modelling Access Portal on the National Environmental Maritime Operations (NEMO) (https://amsa-forms.nogginoca.com/). NEMO is AMSA's cloud-based customisable incident management system, designed to manage and monitor all national pollution and maritime casualty incidents. Information is captured from multiple sources and in a variety of formats to provide a real-time common operating picture during maritime environmental emergencies. It delivers information management and decision support tools that assist AMSA and the States / Northern Territory during NatPan activations.

To predict the early movement of larger spills, real-time OSTM will be conducted. Preliminary modelling results are generally available within 2-3 hours of an initial request following a spill event.

For Level 1 spills, Western Gas will not undertake OSTM due to the limitations of using the model near shore with small volumes. Aerial observations will be used to ground-truth the spill location.

Table 4-10 Summary of the MES strategy

Requirement	Spill Level			Outcome	Minimum resources	Provider	Minimum standard
	1	2	3				
Visual observation – vessels of opportunity (VoO)	-	Y	Y	Identify extent and trajectory of spill. Record visual characteristics.	1 x vessel & crew 1 x Observer	Sasanof-1 Project Contracted Support Vessel Sasanof-1 Project Team Contract Personnel	VoO onsite within 48 hours
Visual observation – aircraft	-	Y	Y	Identify the extent and trajectory of the spill, record visual characteristics	1 x Aircraft 1 x Observer	AMOSC AMSA NRT	Onsite within 12 hours of request
Satellite tracking buoys	-	Y	Y	Imagery to identify the trajectory of the spill and	1 x satellite tracking buoy on	Advisian and/or AMOSC	Deployed immediately after a spill

Requirement	Spill Level			Outcome	Minimum resources	Provider	Minimum standard
	1	2	3				
				ground truth computer modelling	Survey Support Vessel		support vessel/s
Oil spill vectoring	-	Y	Y	Identify the likely trajectory and fate of spill using real time parameters. Predict timeframes to contact environmental sensitivities.	1 x person with spill assessment training	DIMT Planning Unit or DIMT Intelligence Unit	Undertaken within 3 hours from oil spill notification
OSTM	-	Y	Y	Model the likely trajectory and fate of pill using available data. Predict timeframes to contact environmental sensitivities	Contract with RPS via AMOSC or AMSA.	RPS	Results within 4 hours of spill notification
Satellite Monitoring (note remote sensing only effective if layer is >60 ppm in water)	-	Y	Y	Identify extent and trajectory of spill. Record visual characteristics of surface exposure coverage (>25 micron).	Remote Sensing via AMSA NatPan	AMSA	Will depend which satellite used and varies between 6 – 12 hours

4.3.7 MES Summary & Performance Standards

Table 4-11 provides a summary of the performance standards for the MES strategy.

Table 4-11 MES Performance Standards and Measurement Criteria

Control Measure	Performance Standard	Measurement Criteria
Satellite Tracking Buoys	Satellite tracking buoy deployed from MODU / support vessel within 1 hour of spill.	• MODU / vessels storage logs confirm tracking buoys on-board; • Emails between Vessel Master and DIMT confirm commencement of tracking; • Incident log indicates tracking buoys deployed; • Operational web-based buoy tracking portal; and • Archive of satellite tracking buoy data.
Vessel Surveillance	Surveillance with contracted support vessel(s) undertaken within 30 minutes (if it is available for surveillance activities) of spill notification. Vessel surveillance with untrained observers within 24 hours of IMT activation. Ongoing vessel surveillance information regularly available until termination criteria met.	• DIMT logs; • Vessel logs; • Completed OS1 vessel; and • Completed Observation sheets.
Aerial Surveillance	Aerial surveillance requested by AGR DIMT within 3 hours and initial survey within 24 hours (daylight permitting) with untrained observers and 48 hours with trained observers.	• AGR DIMT logs; • Flight logs; and • Associate Membership with AMOSC for core • group access.
	Aerial surveillance observations made available to DIMT within 1 hour of completion of flight.	• AGR DIMT logs; • Completed OMS-1 aerial observation data sheets or similar reporting; and • Flight logs.
	Provision of aerial surveillance observations to RPS APASA within 4 hours of receipt.	• Emails between AGR DIMT and OSTM service provider; and • Incident log indicates date and time of aerial surveillance observations sent to RPS APASA.
Satellite Imagery	Satellite imagery provided ad hoc (as required) to AGR DIMT at frequency requested to track spill trajectory.	• Emails between AGR DIMT and AMOSC;

Control Measure	Performance Standard	Measurement Criteria
		• DIMT Incident log; and • Archive of satellite imagery.
	Provision of satellite imagery to RPS APASA within 4 hours of receipt.	• Emails between AGR DIMT and RPS APASA; and • Incident log indicates date and time of satellite imagery sent to RPS APASA.
OSTM	OSTM commissioned within 2 hours of OMS-1 initiation.	• Emails between AGR DIMT, and RPS APASA show date and time of OSTM request; and • Completed SAP OMS-1 initiation checklist.
	OSTM continues until spill source is controlled and no further regions affected by the spill.	• AGR DIMT access-enabled web portal with quasi-real-time modelling results; and • OSTM forecast report(s) to AGR DIMT

4.4 OILED WILDLIFE RESPONSE

4.4.1 Overview

A marine oil pollution incident has the potential to immediately impact wildlife. As such, rapid establishment of the Wildlife Branch, activation of an oiled wildlife response contractor, and the immediate implementation of wildlife response actions are critical for the prevention and mitigation of impact to wildlife and responding to oiled animals through capture and rehabilitation.

The level of escalation of the OWR is determined by the DIMT, informed by advice from Western Gas and Parks and Wildlife Oiled Wildlife Advisors and data collected via initial MES tactics. The OWR will be conducted in accordance with the WA Oiled Wildlife Response Plan (WAOWRP) (Parks and Wildlife & AMOSC 2014). This overarching document provides the framework for OWR, with the regional context and detail required to carry out an OWR provided in seven regional response plans. The relevant Regional Oiled Wildlife Response Plan(s) will be enacted following initial MES information.

Table 4-12 provides the steps to be undertaken by the DIMT and is consistent with the OWR framework outlined in the WAOWRP.

Table 4-12 Oiled Wildlife Response Implementation Guide

Tactic	Implementation / Activation Guide	Complete
OWR Activation	Notification of Department of Parks and Wildlife State Duty Officer as per Table 3-4. The State Duty Officer will contact the Parks and Wildlife Oiled Wildlife Advisor (OWA) to provide advice to the Control Agency.	
OWR Plan Activation and Escalation	Activate the relevant Regional Oiled Wildlife Response Plan(s) in accordance with the Western Australian – Oiled Wildlife Response Plan (Parks and Wildlife & AMOSC 2014). https://www.dpaw.wa.gov.au/images/documents/conservation-management/marine/wildlife/West_Australian_Oiled_Wildlife_Response_Plan_V1.1.pdf Notify key stakeholders as outlined in the relevant regional OWR plan, based on preliminary reports and trajectory information.	
Wildlife First Strike Response	Activate the relevant Regional Oiled Wildlife Response Plan in accordance with the Western Australian – Oiled Wildlife Response Plan. Undertake the Wildlife First Strike Response steps outlined in the Western Australian – Oiled Wildlife Response Plan.	
Mobilisation of Resources	Mobilise personnel, equipment and facilities in coordination with AMOSC and Parks and Wildlife.	
Wildlife Reconnaissance	Determine potential wildlife resources at risk based on initial MES data (aerial and marine observation). If shoreline contact is predicted, mobilise personnel to conduct shoreline observations. Focus resources on potential populations at risk, based on trajectory analysis (MES tactics). Information gained from these surveys is key to mounting effective deterrence, search and capture, and response efforts and will be used to determine the scope and scale of wildlife response.	
Incident Action Plan Wildlife Sub-Plan	Develop the Incident Action Plan Wildlife Sub-plan in coordination with regulatory agencies (DAWE, DBCA, WA DoT) and AMOSC based on known conditions and information gathered from wildlife reconnaissance and MES. The sub-plan is to be modified or amended throughout the incident as needed when conditions change. The sub-plan is to include the appropriate response options: • Wildlife priorities for protection from contact with oil; • Deterrence measures; and • Recovery and treatment of oiled wildlife; resourcing of equipment and personnel.	
Wildlife Rescue and Staging	Based on daily wildlife monitoring observations and assessment of oil-impacted wildlife, determine location of wildlife rescue effort locations (where there are known concentrations of impacted animals) and appropriate rescue methods based on individual animal health condition or potential for rapidly declining health secondary to oiling. Mobilise OWR kit(s) and containers managed by AMSA, AMOSC to site.	
Wildlife Rehabilitation	Rehabilitate oiled wildlife immediately after an incident in accordance with the practices outlined in the Western Australian – Oiled Wildlife Response Plan and the Incident Action Plan Wildlife Sub-plan.	
Oiled wildlife carcass collection	Recover dead oiled wildlife at sea as part of ongoing oil recovery operations. Oiled wildlife carcasses will be bagged and labelled and transported in accordance with approved wildlife response plan.	

Marine mammal and turtle sampling/necropsy	Investigate marine mammal and turtle strandings, collect samples and conduct carcass necropsy as determined on a case-by-case basis. WG to request AMOSC assistance whenever needed.	
Waste Management	Refrigerate carcasses to preserve for pathology studies and reduce potential for further contamination. Oil contaminated wastes and carcasses to be managed in accordance with local council and waste contractor requirements.	

4.4.2 Oiled Wildlife Performance Standards

Table 4-13 provides a summary of the performance standards for Oiled Wildlife Response.

Table 4-13 Oiled Wildlife Response Performance Standards

Control Measure	Performance Standard	Measurement Criteria
OWR Planning	Maintain AMOSC Associate membership to ensure that equipment and personnel can be provided.	• AMOSC Associate Membership contract.
	DBCA notified as soon as possible after sighting of oiled wildlife.	AGR DIMT records verify that verbal and/or written notification was provided to DBCA as soon as possible after sighting.

4.5 WASTE MANAGEMENT

Oil spills to the marine environment can generate significant amounts of oily waste that need to be collected and disposed of properly, in accordance with MARPOL 73/78 Annex V – Garbage, relevant Commonwealth and State/Territory laws and regulations.

Immediately upon knowledge of an oil spill, Western Gas will develop an Oil Spill Waste Management Plan (OSWMP) in consultation with AMOSC and the relevant control agency. The OSWMP will ensure the ongoing supply and backload of appropriate waste management equipment.

Based on the hydrocarbon characteristics of diesel and condensate, and the predicted outcomes of the modelling of credible worst-case spill scenarios, large volumes of waste are not expected to be generated. Waste generated from the spill is anticipated to be managed and contained within small transportable waste receptables, suitable for the storage capacity on support vessels and port waste reception facilities.

All waste stored or transferred will be fully documented, including details of exact volume and nature of the waste, date and time, receiver of the waste and destination of the waste, in accordance with vessel Garbage Management Plans and the onshore licenced waste contractor’s waste tracking process.

4.6 INCIDENT ACTION PLANNING

The Incident Action Planning process governs the ongoing response following the initial response phase (first 24 hours). During the initial response phase, initial response (or 'first-strike') actions and notifications are undertaken and the required spill response teams are activated.

An Incident Action Plan (IAP) is developed for each Operational Period (as defined by the IC) following the initial response. The IAP informs incident personnel of the objectives for that operational period, the specific resources that will be applied, actions taken during the operational period to achieve the objectives, and other specific operational information (e.g. weather, constraints, limitations, etc). The Initial IAP facilitates the transition from the Initial Response phase to an ongoing incident response (Figure 4-5). IAP Templates are shown in Appendix A.

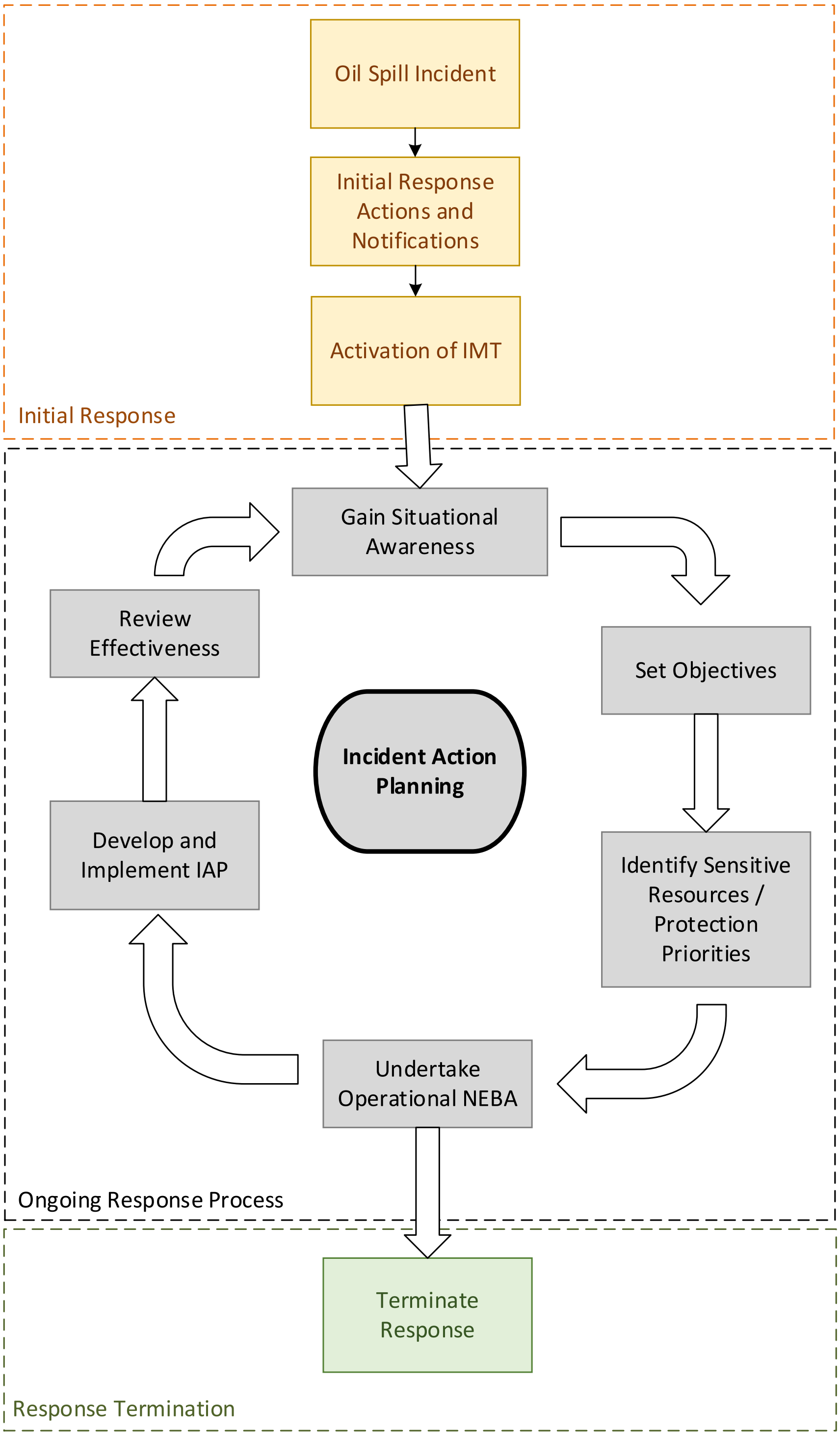


Figure 4-5 Incident Action Planning and Response Phases

4.6.1 Identify Sensitive Resources and Protection Priorities

The following strategic response priorities have been adopted for this OPEP and are consistent with the overall protection priorities detailed in the National Plan and State Hazard Plan – Maritime Environmental Emergencies:

- Priority 1 – Human health and safety;
- Priority 2 – Protected habitats and cultural artefacts;
- Priority 3 – Threatened flora and fauna;
- Priority 4 – Commercial resources; and
- Priority 5 – Recreational and amenity areas.

These priorities provide context to decision-making when evaluating spill response options and selecting the overall response strategy and are continuously reviewed and assessed when reviewing feasibility and effectiveness of response options throughout a spill event.

Western Gas has further adopted the WA Department of Transport protection priority ranking process (DoT 2018) for socio-environmental receptors, to ensure a standardised and consist approach in the event of cross-jurisdictional response management. Each sensitive receptor has been given a classification from Very Low to Very High in order to rank their priority for protection in an oil spill (Table 4-14), taking into consideration the receptor's vulnerability and/or sensitivity to a marine oil spill (DoT 2018).

Table 4-14 Department of Transport Protection Priority Ranking

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

The environment that may be affected (EMBA) by an unplanned oil spill event associated with the Sasanof-1 Exploration Drilling Program is detailed in Section 5.0 of the EP. In the event of an oil spill, information from MES tactics will be used to identify potential ecological and socio-economic receptors at risk as detailed in the EP, and their protection priority ranked based on Table 4-14 (DoT 2018). This will be used to inform the IAP process.

4.6.2 Operational Net Environmental Benefit Analysis (NEBA)

A Preliminary NEBA has been conducted for the Sasanof-1 Exploration Drilling Program and is outlined in Section 7.0 of the EP, and the spill response strategies selected detailed in Section 4.1 of this OPEP.

In the event of an oil spill, the DIMT will undertake an Operational NEBA, intended to validate the assumptions made in the Preliminary NEBA, and identify any new parameters which have not been considered. The actual spill event parameters, such as the spill rate and volume, location and current metocean conditions and forecasted metocean and weather conditions, the seasonality of environmental sensitivities, will provide input into the Operational NEBA to assess the applicability and likely effectiveness of spill response tactics, along with the potential impacts and challenges of implementation given the parameters of the spill. An Operational NEBA will be undertaken / reviewed during the development of IAPs.

Any changes to the identified response options included in this OPEP will be assessed in accordance with the Management of Change process described in the EP.

4.6.3 Review Effectiveness

The effectiveness of the response is assessed every Operational Period, based on updated situational awareness (i.e. updates in predictive modelling and MES data, current environmental conditions, hydrocarbon release status and weathering). Where a change to operational conditions has occurred, the effectiveness review process may be conducted using the Operational NEBA. The outcomes of the review of response effectiveness informs the IAP process.

The 'Review Effectiveness' process is conducted until the termination criteria have been met (Section 4.6.4). An Operational NEBA will be used to inform the decision to terminate the response.

4.6.4 Terminate Response

The Control Agency is responsible for the decision to terminate response operations. In order to terminate response to a marine oil spill, the following requirements must be met:

- The source of the spill has been stopped;
- The objectives of the IAP have been met; and
- There are no further practicable steps that can be taken to respond to the spill.

This may include a gradual downsizing of response teams, resources and termination of certain response tactics, or complete termination of the response. An Operational NEBA will be conducted with the relevant DIMT members, liaison officers and stakeholders to inform the decision to terminate a particular response strategy. Termination of response in WA State waters will be agreed with DoT.

Key considerations include:

- The efficacy and benefit of the response options implemented against natural attenuation and weathering;
- The significance of the environmental receptor impacted; and
- Potential for environmental damage caused by further response efforts and other detrimental factors such as health and safety risks associated with the activity.

Table 4-15 provides termination criteria for the spill response options included in this OPEP. These termination criteria are intended as guidance and are not considered an exhaustive list. Termination criteria may change due to the actual parameters in the event of a spill, response team / liaison officer advice, or stakeholder engagement during a spill.

Table 4-15 Spill Response Termination Criteria

Response Option	Termination Criteria
Source Control	• Vessel spill - source has been eliminated (e.g. fuel tank is secure) or the leak has been contained and controlled onboard. • LOWC - hydrocarbon release has been contained and well control re-established.
Monitoring, Evaluation and Surveillance	• Source control has terminated (spill source eliminated/contained). • The spill is no longer visible to human observers (silver/grey sheen as defined by the Bonn Agreement (BAOAC 2007) is not observable and 24 hrs has elapsed since the last confirmed observation of surface hydrocarbons). • Modelling results do not predict surface exposures at visible levels.
Oiled wildlife response	• Response is discontinued when all affected/recovered animals are cleaned and rehabilitated as advised by relevant expert bodies. *To be determined in consultation with DAWE, DBCA, WA DoT) and AMOSC.*
Waste management	• All waste generated from spill response activities has been appropriately disposed of.

4.7 OPERATIONAL AND SCIENTIFIC MONITORING PLAN

The Operational and Scientific Monitoring Plan (OSMP) has primarily been developed to achieve operational monitoring 'readiness' in the event of an unplanned Level 2 or Level 3 spill from the activity.

In the unlikely event of a Level 2 or Level 3 incident, Western Gas will immediately initiate OMSs and SMSs according to the relevant monitoring strategy initiation criteria and sensitivities affected or with potential to be affected by an actual spill event.

Responsibilities for managing implementation of the OSMP and delivery of the information required within the context of a coordinated spill response required for a Level 2 or Level 3 spill incident will probably lie within the Environmental Unit (EU) of the DIMT.

The OSMP is triggered when initiation criteria for the various assessment components are met. Those MES tactics that are associated with protecting environmental receptors are addressed in the OSMP, with initiation and termination triggers provided in the OSMP. A summary of the OSMP is provided here

4.7.1 Scope

The Sasanof-1 Exploration Drilling OSMP has been prepared as a separate document in support of this OPEP. The OSMP provides a comprehensive description of the response phase and recovery phase monitoring programs that may be implemented in the event of a Level 2 or Level 3 hydrocarbon spill from the proposed activity. Monitoring methodologies are defined in individual sampling and analysis plans (SAPs) prepared for each response phase and recovery phase monitoring study, which underpin the OSMP in the event of a Level 2 or 3 Gas Condensate or MDO release.

The objectives of the OSMP are to:

- Identify high priority protection areas within the EMBA in real time;
- Specify response phase (operational) and recovery phase (scientific) monitoring methodologies;
- Detail the process that Western Gas and the DIMT will follow to determine the monitoring studies that will be implemented in order to:
- Provide situational awareness and assist in planning and execution of spill response to minimise environmental harm; and
- Provide for short-term and long-term environmental damage and recovery assessments.

In the event of a worst-case scenario where recovery phase monitoring is required for a Level 2 or 3 MDO release, Western Gas will utilise the scientific resources of a qualified marine science contractor to provide the required Principal Investigator (PI) and Monitoring Personnel (MP) outlined in the OSMP. Response phase monitoring would be implemented as part of the DIMT.

4.7.2 OSMP Framework

In the event of a Level 2 or Level 3 hydrocarbon spill during drilling activities, operational monitoring studies (OMSs) will be implemented to inform spill response and quantify the extent of the spill impact. In addition, scientific monitoring studies (SMSs) will be implemented to evaluate the potential environmental impacts to the marine environment. OMSs and SMSs are developed based on:

- The values and sensitivities of receptors within the EMBA and hydrocarbon exposure area;
- The potential impacts and risks of MDO and gas/condensate spills;
- The assessment of spill response options and selection of an overall spill response strategy.

The OSMP includes:

- Monitoring strategies for OMSs and SMSs that have been deem relevant for this activity. The strategies provide details on the monitoring performance outcomes, monitoring standards, measurement criteria, initiation triggers, and termination criteria.
- Study Implementation Plans (SIPs) content list to define the operational document to execute activated OMSs and SMSs in the event of a spill incident.
- Sampling and Analysis Plans (SAPs) to detail the technical aspects of each of the monitoring studies such as field methodology, data analysis and reporting.

4.7.3 Monitoring Studies

OMSs and SMSs to be implemented in the event of a Level 2 or Level 3 spill during drilling activities are summarised in Table 4-16.

Table 4-16 - List of OSMP Studies

Study ID	Study Name	Monitoring Outcome	Study Initiated
Operational Monitoring Studies			
OMS1	Operational Forecast Modelling	Carry out daily real-time predictions (forecasts) of the temporal / spatial distribution and concentrations of hydrocarbons on the surface and within the water column via numerical modelling.	
OMS2	Hydrocarbon Spill Surveillance and Tracking	Conduct surveillance and tracking of surface hydrocarbon spill distribution	
OMS3	Hydrocarbon Weathering Assessment	To determine the physical and chemical properties of hydrocarbon as it weathers to characterize temporal decrease in toxicity	
OMS4	Dispersant Efficacy Assessment	To provide information on the efficacy of a chemical dispersant applied to the spilled hydrocarbon.	
OMS5	Water Quality Assessment	Conduct intertidal and subtidal water quality monitoring to provide a rapid assessment of the presence, type and concentrations of oil (and dispersant chemicals where relevant) in offshore and	

Study ID	Study Name	Monitoring Outcome	Study Initiated
		intertidal waters and provide data to validate forecast / hindcast modelling.	
OMS6	Sediment Quality Assessment	Conduct intertidal and subtidal sediment quality monitoring to provide a rapid assessment of the presence, type and concentrations of oil (and dispersant chemicals where relevant) in subtidal and intertidal sediments.	
OMS7	Marine Fauna Surveillance	Conduct fauna surveillance to provide a rapid assessment of the presence, type and location of oiled marine fauna.	
OMS8	Fish Taint Assessment	Conduct surveillance and sampling to provide an assessment of the potential of fish tainting in areas of recreational and/or commercial fisheries.	
OMS9	Air Quality (Responder Health and Safety) Assessment	Conduct fauna surveillance to provide a rapid assessment of the presence, type and concentration of hazardous volatile organic compounds (VOCs).	
Scientific Monitoring Studies			
SMS1	Ecotoxicology Assessment of Hydrocarbons	Undertake eco-toxicological studies to establish hydrocarbon exposure thresholds for sensitive biotic receptors to assist with the assessment of impacts to environmental sensitivities affected by the spill.	
SMS2	Water Quality Monitoring	Monitor hydrocarbons in marine waters at subtidal and offshore intertidal impact sites (which may include where relevant: priority/sensitive locations, State or Commonwealth marine protected areas, pelagic sites, commercial fishery areas) and reference sites to support the assessment of environmental impacts and recovery.	
SMS3	Sediment Quality Monitoring	Monitor hydrocarbons in marine sediments at subtidal (rocky reef), pelagic sites, commercial fishery areas and reference sites to support assessment of environmental impacts and recovery.	
SMS4	Benthic Habitat Monitoring	Monitor subtidal and intertidal habitats (e.g. sponge gardens) including demersal fish and priority sensitive locations and one reference site to support the assessment of environmental impacts and recovery.	
SMS5	Seabird Population Monitoring	Monitor seabird populations to assess potential impacts to, and subsequent recovery following a hydrocarbon release.	
SMS6	Marine Megafauna Surveys	Undertake marine megafauna monitoring to assess potential impacts to, and subsequent recovery following a hydrocarbon release.	
SMS7	Hydrocarbon Monitoring of Representative Commercial and Recreational Fish Species	Monitor for hydrocarbons in representative commercial and recreational fish species (including shellfish) to assess the physiological impacts to fisheries; seafood quality/safety and the fisheries recovery following a hydrocarbon release.	
SMS8	Hindcast Modelling for Impact Assessment	Undertake hind-cast simulations of a hydrocarbon release, validated with information / data from other OSMP studies to refine post-incident impact assessment and to inform long-term scientific monitoring specifications to support assessments of	

Study ID	Study Name	Monitoring Outcome	Study Initiated
		the impacts and recovery of environmental sensitivities affected by the hydrocarbon spill.	
SMS9	Socio-Economic Surveys	The monitoring performance outcomes for this study is to carry out socio-economic monitoring studies to assess socio-economic, including cultural impacts and subsequent recovery pathways following a Level 2/3 hydrocarbon spill.	

5 SPILL RESPONSE RESOURCES

5.1 CAPABILITY AND COMPETENCIES

A response to a Level 2 or Level 3 spill will require specialist skills for an extended period of time. As per Table 5-1, the initial response DIMT manning will be fulfilled by personnel from AGR and other contracted organisations along with provision of additional support to provide complete coverage of all DIMT positions.

Western Gas has conducted an analysis of peak DIMT resourcing requirements and competencies to manage the response in the event of an extended duration 'worst case discharge' scenario, and the capacity to meet those requirements, which is detailed in the tables in Appendix B.

The DIMT can activate several internal and external support agencies if additional support is required. Table 5-1 describes internal and external support agencies, the capability they provide, and the relevant activation procedures.

Table 5-1 Oil Spill Response Support Services and Activation

Support Resource	Support Services Capability	Activation Procedure
Internal Support Resources		
Sasanof-1 Drilling Incident Management Team (DIMT)	Personnel trained in emergency response and crisis management.	DIMT Activation (as described in Section 3.3)
Sasanof-1 Source Control Operations Team	Established for a LOWC Level 2 and above response.	Source Control Emergency Response Plan.
External Support Agencies		
Wild Well Control Well Control Specialist.	Third-party well control first responders: • Mobilising Well Control Specialists and Engineers to the well site and to the AGR Perth office; • Provide logistics support for well control equipment; • Planning and implementation of intervention procedures; • Planning and drilling of relief wells; • Design and implementation of dynamic kills or other special kill procedures. **Equipment:** • Debris Removal Package; • Subsea Dispersant Application Package; and • Subsea Capping Stack System.	Source Control Emergency Response Plan.

Support Resource	Support Services Capability	Activation Procedure

Australian Marine Oil Spill Centre Pty Ltd (AMOSC)	Western Gas is an associate member company in AMOSC and can call on AMOSC personnel and equipment to support oil spill response. Under the AMOSPlan, Western Gas can access mutual aid from other industry company resources (equipment and personnel).
	
	Equipment:
	AMOSC's stockpiles of equipment include dispersant, containment, recovery, cleaning, absorbent, and communications equipment (located in Geelong, Fremantle, and Exmouth).
	• OSTM Tracking buoys; and
	• Australian Subsea First Response Toolkit (SFRT) – Perth.
	Oiled Wildlife Equipment (WA):
	• 2 × Oiled Wildlife Response Kits (Broome, Exmouth);
	• 1 × Oiled Wildlife Container (Fremantle); and
	• Additional equipment based in Geelong, if required.
	Personnel:
	• AMOSC Core Group personnel (approx. 120 persons);
	• Oiled Wildlife personnel (10 personnel trained to Level 2-4 [WA Department of Parks and Wildlife]);
	• Trained OWR personnel (AMOSC developed relationship with):
	  ◦ Blue Planet Marine (Capacity 10-20 OWR responders);
	  ◦ Massey University (Capacity 4-6 OWR responders);
	  ◦ International Bird Rescue (Capacity 4 OWR responders);
	  ◦ Oiled Wildlife Response Kits (Fremantle, Geelong) – 50 units per day; and
	  ◦ Oiled Wildlife Response Containers (Fremantle, Geelong) – 100 units per day;
	• Trained aerial/vessel observers.
	
	Services
	• Spill fates, weathering and trajectory modelling;
	• Hindcast modelling;
	• ADIOS Modelling;
	• Aerial Surveillance; and
	• Satellite imagery.
		First call as early as possible to 24-hour AMOSC Duty Manager emergency number:
		+61 (0) 438 379 328

Australian Maritime Safety Authority (AMSA)	Request for assistance can be made through activation of the National Plan. **Equipment:**	A request should be made initially through the Environment Protection Duty Officer via the Emergency Response Centre on **1800 641 792 or (02) 6230 6811.**

Support Resource	Support Services Capability	Activation Procedure
	AMSA maintains nine strategic equipment stockpiles (WA locations include Fremantle, Exmouth, Dampier, and Broome), including the following resources: • Aerial surveillance support; • Dispersants; • 2 × Oiled Wildlife Response Kits (Fremantle, Karratha); • Oiled Wildlife Response Containers (Dampier, Darwin, Townsville, Karratha, Tasmania) – 100 units per day; and • OSTM Tracking buoys. **Personnel and Services:** • Advisory services and response personnel; • Spill fates, weathering and trajectory modelling; • Satellite/optical imagery.	This request must be followed by written confirmation within three hours of the verbal request.
Department of Transport (WA) (DoT)	There is a State Response Team, Regional Response Team, and a National Response Team that can rapidly deploy. Each Port Authority and Maritime Export Facility holds a quantity of DoT-owned Level 1 containment and recovery equipment.	DoT Maritime Environmental Emergency Response Unit (MEER) 24-hour number: (08) 9480 9924
Department of Biodiversity, Conservation and Attractions (DBCA)	DBCA are the WA State control agency for oiled wildlife response and have equipment and trained personnel capability.	P +61 8 9219 9108
Department of Parks and Wildlife	• Oiled Wildlife Advisor (OWA) - advisory role to IMP • Personnel to assist in coordination of wildlife response (advisors, licencing)	Notify State Duty Officer +61 (0) 8 9219 9108
Aircraft providers	Western Gas is capable of contracting on an as needs basis with aviation. Contracts will not be entered into prior as this does not guarantee supply or impact the mobilisation times.	First call as early as possible to 24-hour AMOSC Duty Manager emergency number: +61 (0) 438 379 328
Vessel providers	Western Gas is capable of contracting on an as needs basis with a range of marine providers including Mermaid Marine, Bhagwan Marine, Australian Marine Services, Offshore Unlimited, Broadsword Marine, Fugro TSM, DOF Subsea, Go Marine Group. Companies able to provide dive support vessels and divers include Neptune Marine, Hallin Marine and CalDive. Western Gas has engaged Clarksons vessel brokers to assist in contracting vessels during a response.	Source Control Emergency Response Plan
ROV providers	Western Gas will have a contract in place with to provide ROV's and ROV project Management Services. Other specialist companies that can provide ROVs include Subsea 7, Deeplink, Intervention Engineering,	Source Control Emergency Response Plan

Support Resource	Support Services Capability	Activation Procedure
	Neptune Marine Services, Tamboritha and Total Marine Technology.	
Licensed Waste Management Contractor (to be contracted)	A licensed Waste Management Contractor will be contracted prior to commencement of the drilling program, and the scope will include management of waste in the event of an oil spill, in accordance with MARPOL 73/78 Annex V – Garbage, relevant Commonwealth and State/Territory laws and regulations.	Sasanof-1 Exploration Drilling Project HSE Plan
Mutual Aid Resources	APPEA MoU: Mutual Assistance for transfer of drilling units for emergency situations.	Source Control Emergency Response Plan
Operational and Scientific Monitoring Services Provider	Principal Investigators (PI) and Monitoring Personnel (MP) as outlined in the Sasanof-1 OSMP.	Astron / BMT M + 61 (0) XXXXXXXX
Xodus Group	Western Gas has a contract in place with Xodus for environmental support (including response and OSMP implementation). Xodus has access to additional resources if required.	M +61 (0) 458 887 791

The availability of key spill response plant, equipment and personnel from external organisations (e.g. WWC, AMOSC, Astron / BMT) and mobilisation timeframes referred to this OPEP will be confirmed and related contractual arrangements and / or agreements will be in place prior to mobilisation activities commence for the Sasanof-1 Exploration Drilling Program. The peak DIMT sesourcing requirements will be independently analysed and validated by AMOSC and will be subject to testing in an OSR exercise.

6 DEMOBILISATION

6.1 DEMOBILISATION/STAND-DOWN PROCEDURES

6.1.1 Incident Control

Upon conclusion of the spill response operations, the following tasks will be undertaken by the DIMT IC (and/or delegate):

- Advise all relevant contractors and Sasanof-1 project management personnel;
- Advise all relevant government authorities;
- Prepare detailed reports on the response activities and outcomes and collate all documents for secure storage and/or submission to regulators;
- Undertake an inventory of consumables and prepare accounts;
- Arrange for the return and/or refurbishment of equipment;
- Conduct an investigation into the cause of the incident and report to relevant authorities; and
- Assess environmental monitoring requirements.

6.1.2 Return of Equipment

Upon completion of the spill response operation, the DIMT IC (or delegate) will:

- Arrange recovery of all equipment and unused materials;
- Ensure that all equipment is cleaned, to the extent that available facilities allow; and
- Ensure that all equipment is returned to the owner by the quickest possible means (having regard to costs).

6.1.3 Servicing of Equipment

Upon its return to the owner, equipment shall be thoroughly serviced or replaced in accordance with equipment maintenance schedules prior to being stored.

6.1.4 Marine Support Activities

Upon receipt of response termination, the DIMT will ensure that:

- All personnel are accounted for;
- All equipment is recovered and cleaned;
- All vessels return to their respective berths;
- Equipment is safely offloaded and transported to a site for cleaning or repair;
- All equipment returned is logged; and

- All equipment is returned to the correct owner/ location.

6.2 RESPONSE DEBRIEF/CRITIQUE

6.2.1 Analysis

The NatPan Guidelines for the Conduct of Post-Incident Analysis (https://www.amsa.gov.au/marine-environment/national-plan-maritime-environmental-emergencies/np-gui-004-national-plan-conduct) and Lessons Management Handbook 8 (AEMI) (https://knowledge.aidr.org.au/resources/lessons-management-handbook/) provide the framework for the debrief and analysis process.

6.2.2 Hot debriefs with key personnel

Prior to deactivation, the DIMT should conduct separate hot debriefs with key personnel with the aim of recording lessons learned from the response.

6.2.3 Incident debrief and post incident reporting

The DIMT IC will lead a comprehensive debrief following termination of the incident response. All agencies involved in the response should be represented in the debrief process.

Outcomes of the debrief will be documented and disseminated to relevant stakeholders. The debrief should include discussion of:

- Details of the incident (initial notification/oil type/volume/location);
- Timeliness of response activation;
- Effectiveness of tactics and strategies;
- Equipment suitability and availability;
- Health and safety issues;
- Communications;
- Integration of plans and procedures with other response agencies;
- Suggested improvements to contingency plans and procedures;
- Strategic considerations;
- Environmental impacts; and
- Cultural heritage impacts.

6.2.4 Post-incident report

The DIMT IC will prepare a formal post-incident report following the debrief. The report will include a description of:

- Response operations;
- Challenges;
- A lessons management process; and
- Feedback from debriefs to improve future responses.

7 PLAN DISTRIBUTION, REVIEW AND UPDATE

7.1 REVIEW PROCEDURES

Given the short duration of the proposed activity, this document shall be revised only in the event of regulator feedback, a project delay (which may result in the need for a legislative review) or a spill event.

Any revisions to this OPEP will be undertaken utilising Western Gas Management of Change Procedure, recognising the EP revision triggers in the OPGGS(E). Trigger thresholds for an EP revision include:

- Inclusion of a new activity;
- If there is a significant modification or new stage to an activity;
- If a significant new environmental impact or risk, or significant increase in existing environmental impact or risk is identified for the proposed activity;
- If there is a series of new environmental impacts or risks or a series of increases in existing environmental impacts or risks, which when taken together, results in a significant new environmental impact or risk; or a significant increase in existing environmental impact or risk not provided for in the EP; or
- If there is a change in titleholder, which results in a change in the manner in which environmental impacts and risks are managed.

7.2 ELECTRONIC ACCESS

This document is maintained on the Western Gas SharePoint system.

7.3 TRAINING AND EXERCISES

Oil spill response training and exercises for the Sasanof-1 Exploration Drilling Program are included in Section 9.10.2 of the EP.

8 REFERENCES

AMOSPlan Australian Industry Cooperative Oil Spill Response Arrangements (2017). Accessed at https://amosc.com.au/wp-content/uploads/2018/01/AMOSPlan-2017.pdf

Australian Maritime Safety Authority (AMSA) 2019. National Plan for Maritime Environmental Emergencies. Accessed at: https://www.amsa.gov.au/marine-environment/national-plan-maritime-environmental-emergencies/national-plan-maritime

AMSA 2017. NP-GUI-023. National Plan Coordination of Cross Border Incidents. Accessed at: https://www.amsa.gov.au/files/gui023-coordination-cross-border-incidentspdf

Department of Parks and Wildlife and AMOSC 2014. Western Australian Oiled Wildlife Response Plan. Department of Parks and Wildlife, Perth, WA.

Department of Transport 2018. DOT307215 Provision of Western Australian Marine Oil Pollution Risk Assessment – Protection Priorities. Protection Priority Assessment for Zone 1: Kimberley – Draft Report. Department of Transport, Perth, WA.

BAOAC 2007 Bonn Agreement Oil Appearance Code. Bonn Agreement Aerial Operations Handbook.

Appendix A Forms

The following forms are available on AGR's Network Drive:

- **POLREP & SITREP**
- **Status Board Form 1 - Incident Details**
- **Status Board Form 2 - Initial Assessment**
- **Status Board Form 3 – Notifications and Contacts**
- **Status Board Form 4 - Initial Actions**
- **Status Board Form 5 - Resources at Risk / Protection Priorities / Strategies**
- **Status Board Form 6 - Incident Action Plan**
- **Status Board Form 7 – Tactics**
- **Status Board Form 8 – Resources**
- **Status Board Guidance**
- **Sampling Guideline Form**

Appendix B Expanded DMIT Roles & Responsibilities

Expanded DIMT Role Descriptions

DIMT Role	Job Description	Outputs
Incident Commander	Overall management of incident response operations.	Response operations tailored to the scenario and conditions presented at the time, consistent with the OPEP, EP, company policies and requirements of the National Plan.
Deputy Incident Commander	Deputises for the IC as required, directly supervises work of section chiefs, and oversees the smooth implementation of the IMS. Oversees a particular portion of the response organisation.	As directed by the IC at the time.
Safety Officer	Provides support to the site safety officers; oversights the preparation, distribution, and execution of the response safety plan; undertakes investigations of near misses/incidents; ensures technical expertise such as industrial hygienists, air monitoring specialists, etc – are deployed as needed.	Site risk assessments are in place and safety plan is in force across all of the response.
Public Information Officer	Working with Liaison Officers, manage all external affairs for the response. Strong link with Crisis Management teams and external reach out to State and Commonwealth media/public affairs teams.	Key stakeholder groups identified and regularly updated – specific and holding statements are prepared and disseminated to relevant company spokespeople.
Federal Liaison Officer	Responsible for the management of company liaison into Commonwealth Government structures – OPICC, DIIS, relevant Minister's offices (Primary portfolio focus is Resources, secondary focus on Environment & Transport).	Facilitate the two way exchange of critical situational and crisis management information b/w the title holder and commonwealth government. Daily one-on-one briefings & meetings as determined by the commonwealth.
State Liaison Officer	Responsible for the management of company liaison into State Government structures – State Control Agency and the Premier's office.	Facilitate the two way exchange of critical situational, crisis and incident management information b/w the title holder and state government. Daily one-on-one briefings & meetings as determined by the state.
HR	Provide HR advice to the logistics section and the IC.	HR factors are considered and managed consistent with Western Gas systems. HR risks are minimised through the response.
Legal	Provide legal advice to the planning, operational, and logistic sections (as needed) and the IC.	Legal consideration is used to guide the activities of the response and minimise risks.
Planning Section Chief	Lead the planning section	Ensure that the planning process is adhered to, an IAP comprising all relevant sections including relevant ICS is produced.
Documentation	Implement a record keeping and archival system to capture all documents, consistent with organisational and legal requirements.	Establish and maintain record keeping system including decision making logs (minutes of meeting, personal notes) and provide forms/formats of records as required by the organisation.
Environment Unit Lead	Ensures that environmental consequences are mitigated (managed in accordance with the EP/OPEP) and the operational & scientific monitoring plan is executed.	OSMP is enacted; NEBA completed/up-to- date, response is undertaken in accordance with the OPEP.
Trajectory Forecasting	Monitors and predicts the fate and weathering of the oil.	Regular (twice/three times daily) mapping data that displays predictions of future oil locations, and how the oil may change in chemical make-up (weathering).

DIMT Role	Job Description	Outputs
Response Technical Specialist	Works with the enviro team to provide data on oil spill response strategy impacts on sensitivities; and that new/emerging technology is considered as part of the response.	Quality assures tactical strategy execution.
Operations Section Chief	Lead the operations function.	Execute operations in line with the daily IAP. Draft the IAP for the following operational period.
Air Operations Branch Manager	Lead aviation operations (primarily aerial observations)	Draft and execute plans from the previous day (204s/Operational Briefing). Draft and execute Air operations Plan (ICS220) Coordinate aerial assets in the field. Work with SitPlan Doc to provide current information.
Marine Operations Branch Manager	Lead marine activities.	Draft and execute plans from the previous day (204s/Operational Briefings/Operational Risk management plans). Draft and execute marine operations plan (s) as they relate to the operations at the time. Coordinate marine assets in the field. Input to the safety documentation. Production of maps and displays for operations. Work with SitPlan Doc to provide current information.
Oiled Wildlife Response Commander	In conjunction with the relevant state authorities, lead the implementation of industry equipment, materials and personnel for a OWR response. Work with planning to identify fauna that may be impacted by oiling (or response operations) and reduce / prevent the consequences on fauna.	Field activities, resourcing and facility support provided in aid of the OWR response.
SC Branch Director	As per Source Control planning and guidance.	Source Control Execution Plan
SC Deputy Director		
SCER Advisor		
Logistics Section Chief	Ensures development of logistics section of IAPs and provision of all facilities, services, support, persons and materials required for the response. Particular focus on the provision of vessels and aircraft for spill response activities, spill response equipment and specially trained personnel for these tasks.	Equipment, materials and other resources are appropriately sourced, deployed, maintained and serviced as required by the response.
Support Branch Director	The support branch is in charge of the logistics plans for the daily incident action plan. These plans cover the operations of Supply, Facilities, Ground and Vessel Support units.	Daily logistics planning completed.
Supply Unit Lead	Procurement of resources for the response (personnel, equipment & supplies).	Procurement matches the need identified by operations for daily taskings.
Service Branch Director	Manages and runs the service aspects of the response - Communications, Medical and Food Units.	Service units operate effectively and efficiently as per the need at the time.

DIMT Role	Job Description	Outputs
Communications Unit (IT) Manager	Run the communication networks and IT infrastructure critical for the response.	Effective communications from the DIMT to the field, and intra-field communications. Ensure that all computer devices, networks, printers, etc work as they should.
Medical Unit Lead (includes infection control – COVID-19)	Provide expertise on medical issues as a result of the response; drafts and advises on operational issues from the execution of the Covid19 response plan.	Medical staff and expertise to assist develop and execute the safety risk management plan.
Finance Section Chief	All financial, administrative and cost aspects of the incident, and management of the team.	Accurate financial records keeping and daily cash 'burn rate' is tracked. Appropriate financial DOA is working amongst the DIMT. Financial software/tracking system is in place with line items and cost centres established.
Procurement Unit (marine & aviation asset contracting)	Provides contractual support, leases and agreements with external parties.	Contractually enables the control agency to bring together all of the necessary third-party contractors to support the response.
Compensation Unit	Responsible for the administration of the claims process (collation of data and logging of claim) from third parties who may be affected by the response.	System in place to engage with affected parties so that they may log their claims (compensation).
Administration & Records	Provide administrative services (systems and facilities) to the DIMT.	IMS software/paper-based system is used by all sections. Access to other software – databases, spreadsheet, internal SharePoint systems, etc, are in place.

Expanded DIMT Role Competency Requirements

DIMT Role	Project Specific OPEP Induction	Oil Spill Response Command and Control (IMO Level III / PMAOIR 418 / ICS 300 Equivalent)	Oil Spill Response Management (IMO Level II / PMAOIR 320/322 / ICS 200 Equivalent)	Emergency Response Exercise Training / Workshop
Incident Commander	✓	✓		✓
Deputy Incident Commander	✓	✓		✓
Safety Officer	✓			
Public Information Officer	✓		✓	✓
Federal Liaison Officer	✓		✓	✓
State Liaison Officer	✓		✓	✓
HR	✓			✓
Legal	✓			✓
Planning Section Chief	✓		✓	✓
Documentation	✓			✓
Environment Unit Lead	✓		✓	✓
Trajectory Forecasting	✓			✓
Response Technical Specialist	✓		✓	✓
Operations Section Chief	✓		✓	✓
Air Operations Branch Manager	✓		✓	✓
Marine Operations Branch Manager	✓		✓	✓

DIMT Role	Project Specific OPEP Induction	Oil Spill Response Command and Control (IMO Level III / PMAOIR 418 / ICS 300 Equivalent)	Oil Spill Response Management (IMO Level II / PMAOIR 320/322 / ICS 200 Equivalent)	Emergency Response Exercise Training / Workshop
Oiled Wildlife Response Commander	✓		✓	✓
SC Branch Director				
SC Deputy Director	✓		✓	✓
SCER Advisor				
Logistics Section Chief	✓		✓	✓
Support Branch Director	✓		✓	
Supply Unit Lead				
Service Branch Director	✓			
Communications Unit (IT) Manager	✓			
Medical Unit Lead (includes infection control – COVID-19)	✓			
Finance Section Chief	✓		✓	✓
Procurement Unit (marine & aviation asset contracting)				
Compensation Unit				
Administration & Records				

Expanded DIMT Availability Matrix

Section No.	DIMT Position	Total Persons Required	Available Resources						
			AGR DIMT	Western Gas	Xodus	AMOSC	Contracted Specialist Resource	Agency Personnel	Total Competent Personnel Available
1	Incident Commander	2	2					2	2
	Deputy IC	2				2			12
2	Safety Officer	2						2	6
3	Public Information Officer	2					1		2
4	Federal LO	2		1		1			12
	State LO	2		1		1			12
5	HR	2						2	5
6	Legal	2					2		5
7	Planning Section Chief	2	2						2
	Trajectory Modelling	2					1		2
	Documentation Lead	2						2	4
	Response Technical Specialist	2				2			12
	Environment Lead	2			2				4
	Situation Lead	2				2			12
8	Operations Section Chief	2	2						2
	Air Operations Branch Manager	2				2			12
	Marine Operations Branch Manager	2					2		4
	Oiled Wildlife Division Lead	2				2			12
	Source Control Branch Director	2					2		4
	Source Control ER Advisor	2					2		4
9	Logistics Section Chief	2	2						2
	Support Branch Director	2						2	12
	Supply Unit Lead	2						2	12
	Services Branch Director	2						2	12
	Communications IT Manager	2					2		12
	Medical Unit Lead (including COVID-19 Contro	2						2	4
10	Finance Section Chief	2	2						2
	Procurement Unit	2						2	5
	Compensation Unit	2						2	5
	Administration & Record Keeping.	2						2	6

Total	60	10	2	2	12	12	22

<u>Sasanof-1 Oil Spill Response Readiness Check List</u>

Oil Spill Response Arrangement	Readiness Check	Schedule	Performance Standard	Measurement Criteria
Source Control				
Relief Well Drilling - Access to MODU	MODU Register review	One month prior to spud.	Suitable rigs that can be deployed in the event of a Source Control incident requiring a relief well.	Document the identified suitable rig by: • Name • Rig Type • Location • Contract Status • NOPSEMA-accepted MODU Safety Case • Technical specification to meet requirements of relief well.
<u>Source Control Equipment & Services</u> Capping stack BOP intervention. Debris clearance equipment. Associated well control personnel and technical services.	Contract / Plan Review	Up to 30 days prior to well spud.	WWC availability of well control specialist to fill the roles of Source Control Branch Director and ER Specialist within 72 hours of notification. Source Control Equipment Availability	Confirmation (email) from WWC with names of personnel and status of equipment as detailed in SCERP.

Oil Spill Response Arrangement	Readiness Check	Schedule	Performance Standard	Measurement Criteria
Capping Stack Installation	Vessel Register Review	One month prior to spud.	Suitable ISV that can be deployed in the event of a Source Control incident requiring a capping stack deployment.	Document the identified suitable ISV by: • Name • Rig Type • Location • Contract Status • NOPSEMA-accepted MODU Safety Case Technical specification to meet requirements of capping stack deployment.
Vessel MDO Spill Response	Contract / Plan Review	Prior to mobilisation or vessel arrival in field.	Approved SOPEP in place	Copy of SOPEP for each vessel on file.
Vessel Emergency communication link between shore base, rig, and support vessels	Notification / Comms Check	Prior to activity commencement.	Notifications / comms can be established between vessels and shore base or rig in the event of an emergency	Documented comms check showing date , time and elapsed response time.
Monitoring, Evaluation, Surveillance (MES)				
Vessel Surveillance	Contract / Plan Review	Prior to activity commencement.	Access to vessels for surveillance	Copy of Master Services Agreement (MSA) with multiple vessel providers to gain access to vessels
Aerial Surveillance	Contract / Plan Review	Prior to activity commencement.	Access to aircrafts for surveillance	Copy of Master Services Agreement (MSA) with helicopter provider for duration of Sasanof-1 Drilling Program.
Aerial Surveillance	Contract / Plan Review	Prior to activity commencement.	Access to trained aerial observers	AMOSC Member Contract in place. AMOSC Readiness Report prior to activity commencement
Tracking Buoys availability	Contract / Plan Review	Prior to activity commencement.	1 tracking buoy on each support vessel and on rig.	Vessel Master / On-board AGR HSE Coordinator confirmation that buoy is on board

Oil Spill Response Arrangement	Readiness Check	Schedule	Performance Standard	Measurement Criteria
Tracking Buoys functionality	Comms / Tracking software Test	Prior to activity commencement and weekly thereafter.	Signal confirmation from tracking software.	Tracking buoys pass functional test as per Operation Work Instruction.
Trajectory Modelling	Contract / Plan Review	Prior to activity commencement.	Access to oil spill trajectory modelling services	Contract with RPS APASA in place.
Satellite Imagery	Contract / Plan Review	Prior to activity commencement.	Access to satellite imagery services	AMOSC Member Contract in place. AMOSC Readiness Report prior to activity commencement Review to confirm access to satellite imagery services
CMT / DIMT Readiness	Desktop Exercise	Prior to activity commencement.	CMT / DIMT meets the performance standards in OPEP and to ensure situational awareness for DIMT	Documented OPEP Response Exercise Report.
Oiled Wildlife Response				
OWR equipment	Contract / Plan Review	Prior to activity commencement.	Access to OWR equipment for duration of drilling program.	AMOSC Member Contract.
OWR personnel	Contract / Plan Review	Prior to activity commencement.	Access to OWR personnel for duration of drilling program.	AMOSC Member Contract.
Waste Management				
Waste management	Contract / Plan Review	Prior to activity commencement.	Access to waste management service provider for duration of drilling program.	Waste Management Contract in place.
Operational and Scientific Monitoring				

Oil Spill Response Arrangement	Readiness Check	Schedule	Performance Standard	Measurement Criteria
Monitoring equipment	Contract / Plan Review	Prior to activity commencement.	Access to OSM equipment for duration of drilling program.	Equipment confirmation report from Astron / BMT.
Monitoring personnel	Contract / Plan Review	Prior to activity commencement.	Access to OSM specialist personnel equipment for duration of drilling program.	Duty Roster Report from Astron / BMT
Monitoring readiness	Desktop Exercise	Prior to activity commencement.	OSM personnel respond in accordance with OSMP Performance Standards	Documented OPEP Response Exercise Report.

Service	Service Provider	Contracting arrangement / Timing	General Contract Specifications
Source Control Services - Capping stack - Debris clearance equipment and BOP intervention - Associated well control personnel and technical services	WWC	Contact between Western Gas and WWC prior to spud.	Provision of Source control expertise and capping services
Operational Monitoring - Initial hydrocarbon surveillance	Vessels on Contract to Rig	Contact between Western Gas and Program Vessel Provider prior to spud.	Initial (immediate) operational hydrocarbon surveillance and ongoing scientific monitoring
	Clarksons Vessel Broker	Call off as required	
Source Control Well control / installation vessels (Vessel Safety Case (VSC) may be required)	Vessel contractors via Clarkson's and/or APPEA MoU.	Contracted as required. Triggered by Source Control ERP.	**Vessels to support following source activities:** - Relief well - Emergency BOP activation - Debris clearance - Capping stack installation Vessel specifications will be as per SCERP with Capping stack installation requiring 250 tonne crane capacity
Oil spill response vessels (small, no VSC)	Vessel contractors via Clarksons.	Contracted as required. Additional vessel call off option in place with primary vessel supplier prior to drilling or contracted when required direct from local suppliers.	Vessels to support spill response efforts and transport personnel and monitoring equipment to / from Sasanof-1 and other areas as dictated by OSTM.
Relief Well Drilling - Secondary MODU.	As available.	Contracted as required. Triggered by Source Control ERP. Contracted when required via APPEA Mutual Aid MoU or direct.	**Relief Well Drilling** - NOPSEMA-accepted MODU Safety Case - Technical specification to meet requirements of relief well. - List of suitable rigs in the area to be updated one month prior to spud

Service	Service Provider	Contracting arrangement / Timing	General Contract Specifications
	Long Lead Equipment Wellhead / Conductor Joints / Casing	Spare Wellhead and Conductor in place prior to spud. Casing quantities and location identified.	Technical specifications as per Sasanof-1 Drilling Program and Relief Well Plan.
Capping Stack and BOP Intervention - ROVs	ROV Service Provider on contract to Western Gas	Contact between Western Gas and ROV provider prior to spud. Primary ROV supplier in-place prior to start of Activity.	Technical specification to meet requirements of response role. ROV will be capable of performing BOP and capping stack interventions.
		Additional suppliers contracted as necessary.	
Satellite tracking buoys to leave on MODU during Activity.	AMOSC service agreement	Membership in place prior to spud.	Refer to OPEP Section 4.3.5.
Oil Spill Observers	AMOSC service agreement	Membership in place prior to spud.	Trained observers and sampling of spilled oil and water column. Refer to OPEP Section 4.3.3, 4.3.4.
Helicopter services for spill monitoring	Helicopter provider(s)	Contact between Western Gas and Helicopter provider prior to program mobilisation.	Dedicated helicopter will be available if not otherwise required, for safety reasons.
Fixed-wing aircraft services for spill monitoring	Aircraft from AMOSC qualified contractors.	Call off / MoU arrangement via primary aerial services provider under AMOSC. In-place prior to start of Activity.	Provision of fixed wing aircraft for aerial observation.

Service	Service Provider	Contracting arrangement / Timing	General Contract Specifications
Satellite imagery	AMOSC service agreement	Membership in place prior to spud.	Satellite imagery will be used to identify surface oil distributions and to track surface oil movements. Satellite imagery service will be accessed by the DIMT via AMOSC's Konsberg Satellite Service (KSAT) contract
Oil Spill Trajectory Modelling	RPS APASA via AMOSC		Provision of OSTM services during spill.
Scientific Monitoring personnel and equipment	Environmental consultancy	Contract between Western Gas and Consultancy prior to spud.	Demonstrated capability and capacity to implement Scientific Monitoring Plan including: - Nominated personnel with expertise in relevant disciplines that meet the minimum qualifications and experience requirements for key OSMP roles. - Confirmed local (i.e. WA) resourcing (personnel and equipment) capacity sufficient to meet immediate OSMP implementation requirements. - Experience coordinating and implementing scientific monitoring studies for oil and gas operators in WA.
Oiled Wildlife Response (OWR) - Personnel - OWR kits - OWR container - OWR Centres	AMOSC service agreement WA DBCA (via WA State Hazard Plan) AMSA (via National Plan)	AMOSC Membership in place prior to spud.	Trained in the implementation of oiled wildlife response plan including long-term care, relocation and remediation of marine fauna.
Waste Management equipment and services.	Licensed waste management contractor	Contract between Western Gas and Waste Management Services Provider prior to spud.	Set up secure temporary waste storage/laydown areas in proximity to clean-up operations, manage collection, transport and delivery of wastes to licensed facilities, and maintain all relevant waste documentation. Waste will include hazardous and non-hazardous solid and liquid wastes.

Service	Service Provider	Contracting arrangement / Timing	General Contract Specifications
DIMT support services	AMOSC service agreement	Membership in place prior to spud.	Support services from specialist third party providers to support the DIMT resourcing for Deputy IC, Federal and State Liaison Officers, Air Operations Branch Manager and Oiled Wildlife Division Lead.
	WWC	Contract between Western Gas and WWC prior to spud.	General well control expertise services.
	WG Legal consultancy	Contract in place with Thomson Geer	Support to CMT
	WG Media consultancy	Contract in place with Platfrom Communications	Support to CMT
	WG Environmental consultancy	Contract in place with Xodus	Environment Lead position in Planning Section
	Agency hire	Contract in place with AGR	Additional IC, Safety Officers, HR Document Control, Logistics personnel and accounting staff support
Mainland Transport Contractor.	Logistics and transport contractor	Contract between Western Gas and Transport Services Provider prior to spud.	Vehicles and drivers (with controlled waste licences), hotshot services, transport of personnel mobilised during response.
Marine Operations Base.	Onslow / Karratha	Contract between Western Gas and Marine Base Services Supplier prior to spud.	Likely established at primary supply port (Onslow / Karratha).
			Storage, laydown and biosecurity areas, forklifts, office space warehouses, lifting equipment, cleaning and servicing facilities.