Port of Gladstone
Gatcombe and Golding Cutting
Channel Duplication Project

Environmental Impact Statement

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10

Water resources

Contents

10 Water resources

10.1 Chapter purpose

The purpose of this chapter is to define and describe the existing water resources that may be impacted by the Project and to assess the potential impacts of the Project on water resource values.

Water resources are defined in this EIS as including surface water (freshwater with no tidal influence) and groundwater. As there are no fresh water areas (e.g. watercourses, dams, lakes, springs) within the Project direct and potential indirect impact areas, a freshwater assessment is not considered necessary for this Project EIS.

The watercourses within proximity to Project activities and within the potential indirect impact areas are all tidally influenced. The Project is wholly located within the marine coastal area, no works are proposed within any defined terrestrial watercourse, lake or spring and the Project does not propose to take any underground water or take overland flow. As a result, the water quality values and potential Project impacts are assessed in Chapter 8 (water quality) and Chapter 9 (nature conservation).

This chapter will focus on groundwater resources in proximity to the Project activities associated with the WB and WBE reclamation areas as this is the only component of the Project that has potential to impact on water resources being the groundwater resource of the local area.

Elements of the groundwater assessment include:

- Describing the existing groundwater environment within and adjacent to the Project impact areas associated with the WB and WBE reclamation areas (refer Section 10.4)
- Assessment of potential impacts on the groundwater resource (refer Section 10.5)
- Identification of mitigation measures to be implemented to minimise the potential groundwater impacts from the Project (refer Section 10.6)
- Assessment of the potential groundwater resource risks (refer Section 10.7).

10.2 Methodology

A desktop study using the following reports, maps and data was undertaken to identify the groundwater resources located in close proximity to the existing WB and WBE reclamation areas:

- Queensland Government 2018, *Queensland Globe,* viewed 27 March 2018
- Australian Government Bureau of Meteorology, *Australian Groundwater Explorer*, viewed 27 March 2018
- *Report for Western Basin Dredging and Disposal Project: Groundwater Resources*, prepared for GPC (GHD 2009)
- *Port of Gladstone Western Project Environmental Impact Statement: Chapter 8 – Water Resources*, prepared for GPC (GHD 2009).

The potential impacts and risks associated with groundwater resources were assessed for the relevant Project activities (i.e. WBE reclamation area and BUF construction, dredged material placement within the WB and WBE reclamation areas and maintenance).

Management and mitigation measures were identified to minimise impacts on groundwater resources and a risk assessment was conducted.

10.3 Legislative and policy context

10.3.1 State legislation

10.3.1.1 Environmental Protection (Water) Policy 2009

The EPP (Water*)* seeks to achieve the objective of the EP Act which is to protect Queensland's waters while allowing for development that is environmentally sustainable. Queensland waters include water in rivers, streams, wetlands, lakes, aquifers, estuaries and coastal areas. This purpose is achieved by:

- Identifying environmental values for aquatic ecosystems and human uses (e.g. farm supply, agriculture, industry and recreational use)
- Determining water quality guidelines and WQOs to enhance or protect the environmental values
- Making consistent and equitable decisions about Queensland waters that promote efficient use of resources and best practice environmental management
- Involving the community through consultation and education, and promoting community responsibility.

10.3.1.2 State code 10: Taking or interfering with water

The purpose of SDAP State Code 10 – Taking or interfering with water is to provide for the sustainable management of water by ensuring that development that involves the taking or interfering with water resources maintains natural systems, minimises impacts on these systems and does not impact on the water security and access to water by other users.

The code is only triggered where a project proposes Operational Works that are:

- Taking or interfering with water in a defined watercourse, lake or spring
- Taking or interfering with underground water
- Taking overland flow where the works are:
  - Prescribed by regulation under the *Water Act 2000*
  - Proposed within a limited catchment area identified in a water plan
  - Taking contaminated agricultural runoff water
  - Part of an ERA or under an EA.

The Project is wholly located within the marine coastal area and does not propose works within any defined watercourses, lakes or springs. As the Project does not propose to take or interfere with underground water or take overland flow, SDAP State Code 10 does not apply to the Project.

10.3.1.3 Relevant guidelines

The relevant guidelines for assessing the quality of water resources include:

- Australia and New Zealand Guidelines for Fresh and Marine Water Quality (ANZECC and ARMCANZ 2000)
- Water Quality Guidelines for the Great Barrier Reef Marine Park (GBRMPA 2010)
- Using monitoring data to assess groundwater quality and potential environmental impacts (Department of Science, Information Technology and Innovation 2017).

10.4 Existing environment

10.4.1 Project overview

The WBE reclamation area comprises northern and southern areas, and is situated to the north and west of the existing WB reclamation area. The outer bund walls for both areas and the BUF will be constructed over a three year period at a rate of approximately 24,900m^3/month (southern area) and 37,850m^3/month (northern area). Construction of the WBE reclamation area and the BUF will commence prior to Stage 1 dredging and will involve the following construction sequence:

- Placement of core material
- Placement of armour material (primary and secondary)
- Topping off
- Construction of the BUF using core and armour material, sheet piles (or similar earth retaining structure) and fill sourced from the WB reclamation area
- Completion of geotextile placement
- Drainage control structures to manage water flow
- Dredged material placement within the WB and WBE reclamation areas and decant water management
- Stabilisation and maintenance works.

Further details on the construction of the WBE reclamation area and BUF are provided in Chapter 2 (Project description).

For the purposes of the EIS, the potential general quarry location is within the Targinnie/Yarwun area and rock material will be transported to the WBE reclamation area and BUF via the public road network. The environmental assessment and approvals for the extraction and transport activities associated with the construction of the reclamation bund walls will be the responsibility of the quarry operator(s) and the construction contractor (refer Section 2.5.4). The impacts of the quarry on surface and groundwater resources will be addressed through the ERA licence and operational management plan for the quarry.

10.4.2 Groundwater

10.4.2.1 Overview

A desktop study was undertaken using Queensland Globe (viewed 11 December 2018) to determine the location of registered groundwater boreholes within the vicinity of the WB and WBE reclamation areas (refer Figure 10.1). The assessment revealed that there are 14 registered boreholes (standpipe piezometers) located on the perimeter of the southern settlement pond of the existing WB reclamation area. These boreholes were installed between 29 May and 4 June 2013 as part of the WBDDP groundwater monitoring program. A further 16 groundwater monitoring boreholes were installed during 2013. Figure 10.2 shows the location of the WBDDP groundwater monitoring sites. There are also three registered groundwater boreholes located on the mainland adjacent to the proposed channel between the mainland and the WBE reclamation area.

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Western Basin Expansion Reclamation Area

Northern Reclamation Area

Southern Reclamation Area

Legend

- Western Basin Expansion reclamation area
- Great Barrier Reef Marine Park boundary
- Initial dredging works for barge access channel
- Barge unloading facility
- Yarwun/Targinnie general quarry
- Proposed Channel Duplication Project extent
- Existing shipping channels
- Port of Gladstone Port limits
- East Banks dredged material placement area (DMPA)
- Registered groundwater boreholes

151774, 97444, 151772, 151773, 151674, 151763, 151762, 151764, 151765, 151710, 88456, 91788, 88459, 84982, 111120, 151759, 151760, 97989, 97960, 111423, 91789, 88464, 151814, 151807, 151811, 151805, 151806, 151812, 151813, 151801, 151802, 151810, 151775, 151776, 151803, 151808, 151809, 151804, 151777, 151778, 1662, 161761, 161759, 161760, 111929, 111930, 111931, 111928, 97440, 111932, 151848, 151849, 151837, 151850, 151845, 151844, 151847, 151843, 151841, 161250, 161248, 161247, 161249, 161246, 161251, 161252, 161103, 161102, 151393, 151083, 161105, 161104, 151084, 161106, 161107, 151394, 151082

Source:
Aerial: GPC (2015) and DigitalGlobe Web Map Service (2013)
Registered groundwater bores: DNRME (2018)

Metres
0 385 770

Date: 11/12/2018 Version: 4 Job No: 237374

Coordinate system: GDA_1994_MGA_Zone_56

Map by: RB

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Gatcombe and Golding Cutting Channel Duplication Project

Figure 10.1: Registered Groundwater bores in proximity to Western Basin Expansion reclamation area

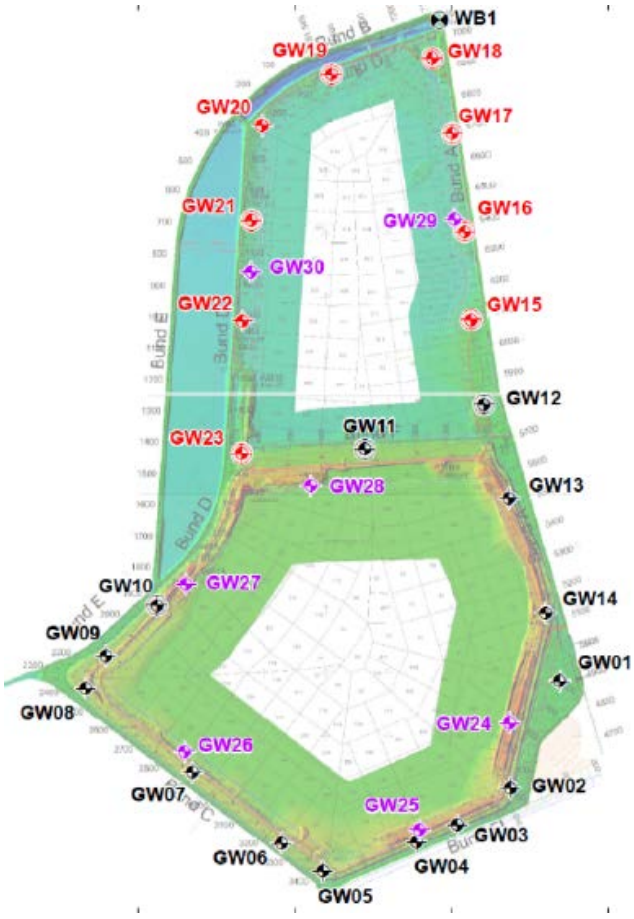

Figure 10.2 Western Basin Dredging and Disposal Project groundwater monitoring sites

The groundwater monitoring program for the WBDDP was developed as a portion of the dredged material was found to contain PASS. The objectives of the monitoring program were to monitor:

- Fluctuation in groundwater levels. Levels which drop below the SPRL could expose untreated material which could lead to oxidation of PASS (EnvironMine 2017).
- Changes in groundwater quality that could be attributed to PASS materials.

Reports of the monitoring program are prepared both monthly and annually with the most recent annual report prepared for the January to December 2017 period (EnvironMine 2017). Between 2013 and 2017 the groundwater level within the existing WB reclamation area has been found to be above the SPRL with groundwater quality above the low pH sampling threshold of pH 6.5 for the majority of the sampling events with the trend predominately stable. Monthly monitoring results to September 2018 confirm these trends in groundwater levels with the pH data indicating similar trends through January to September 2018 (EnviroMine 2018).

10.4.2.2 Topography, geology and groundwater flow-

The mainland adjacent to the WB and WBE reclamation areas is low lying, sloping towards the coastline. The existing WB reclamation area is situated to the south and east of the proposed WBE reclamation area, with alluvial plains and forested land to the west and tidally inundated mudflats to the north.

In summary, the geology of the local area includes:

- Fill
- Coastal/estuarine sediments
- Alluvium and colluvium
- Bed rock of varying ages.

The existing WB reclamation area has been constructed from quarry and dredged material from the WBDDP. The lithology of the material is expected to be a relatively heterogeneous mix of dredged coastal and estuarine sediment, which would now be classified as anthropogenic material/fill. It is assumed that the permeability will range from low to high dependent on the material encountered.

According to Queensland Globe (viewed 27 March 2018), the coastline adjacent to the WB and WBE reclamation areas consists of coastal/estuarine sediments. Previous studies undertaken indicate that these sediments are of Holocene-age and include mud, sandy mud and minor gravel. Organic and shell material was also found to occur in certain areas. These areas have a low permeability (GHD 2009).

The areas with alluvium and colluvium are likely to be dominated by clay and sandy clay deposits with minor clayey gravel and gravelly clay layers. The level of permeability will be dependent on the presence and absence of sand and gravel horizons. Previous studies determined that groundwater in these areas will flow towards the coastline moving through high sand or gravel components before discharging either directly into the marine intertidal waters and/or low-lying discharge channels (GHD 2009).

The bed rock for the onshore areas generally comprises Late Devonian-Early Carboniferous rocks of the Curtis Island Group; specifically, the Wandilla Formation and the Shoalwater Formation. According to Geoscience Australia (2015), the Wandilla Formation comprises mudstone, lithic sandstone, siltstone, jasper, chert, slate and local schist. Geology of Queensland (Jell 2013) describes the Wandilla Formation as being dominated by rhythmically interbedded mudstone and graded sandstone derived from intermediate to felsic volcanics.

The regional deformation and fault lines indicate that the permeability of the bed rock is high as groundwater moves via the fractures and joints towards the coastline. The groundwater from bedrock found below coastal/estuarine sediments is likely to discharge directly into the marine intertidal waters into the zone between the coastline and the existing WB and WBE reclamation areas.

In relation to the groundwater within the existing WB reclamation area, advice provided to GPC by Gilbert + Sutherland in November 2017 noted that:

- Both the northern and southern ponds of the existing WB reclamation area are permanently saturated with pooled water visible across all or part of the surface at all times
- The groundwater levels in the existing WB reclamation area material are observed to be at the surface of the placed material over much of the area and are well above LAT and remain at relatively consistent levels over time, with some fluctuation based on the level of rainfall received
- Groundwater levels in both the northern and southern ponds remain well above the SPRLs
- The groundwater behaviour is generally consistent with the modelling conducted as part of the WB Acid Sulphate Soil Management Plan 2010.

10.4.2.3 Groundwater quality and use

Groundwater quality data for the existing WB reclamation area has been collected and analysed since 2013 with the objective of assessing and changes in groundwater quality that could be attributed to PASS materials (EnviroMine 2017 and 2018). The results of the monitoring program through to September 2018 show the groundwater quality to be above the low pH sampling threshold of pH 6.5 for the majority of the sampling events with the trend predominately stable.

For the areas outside the existing WB reclamation area, groundwater quality data is available from sampling conducted at nine nearby boreholes, including:

- Three boreholes located close to Fisherman's Landing
- Three boreholes located in close proximity to the currently registered boreholes RN151674, RN151762 and RN151763
- Two boreholes located on the coastline adjacent to the WBE reclamation area (southern area)

- One borehole located further inland adjacent to the WBE reclamation area (southern area) (GHD 2009).

The results of the sampling conducted in the alluvium and colluvium deposits indicated that the groundwater is brackish to saline with a neutral to slightly acidic pH. The groundwater therefore found in the coastal strip of land adjacent to the WBE reclamation area was found to be unsuitable for drinking, stock watering and irrigation. The results further indicated concentrations of dissolved metals and nutrients exceeding the guideline values for marine aquatic ecosystems.

The majority of the registered groundwater boreholes investigated have been recorded as other exploration/investigation boreholes. RN151674 located 770m from the west of the WBE reclamation area, is registered for mining monitoring.

The available water quality data indicates that the groundwater in the vicinity of the WB and WBE reclamation areas is of moderate to low quality and not suitable for drinking, stock watering and irrigation. The nearby boreholes are used for groundwater monitoring, industrial and mining purposes.

10.5 Potential impacts

10.5.1 Groundwater

No significant impact on groundwater resources and/or quality are anticipated by Project activities based on the location, design and construction method for the WBE reclamation area and BUF, and the dredged material placement methodology. No groundwater will be taken during the construction or operation of the WBE reclamation area therefore resulting in no depletion of the local groundwater resource nor any impact on the recharge of the local groundwater regime. The flow of existing groundwater into intertidal areas will not be impacted by the WBE reclamation area due to the intertidal channel which will remain between the mainland and the WBE reclamation area.

Once the WBE reclamation area (southern area) has sufficient dredged material (i.e. above the existing WB reclamation area groundwater level) there is the potential for Project activities to impact on the groundwater of the combined reclamation areas.

Possible Project sources of impacts on groundwater are identified below.

10.5.1.1 Construction phase impacts

Potential construction impacts that have the potential to affect the quality of the groundwater resource within and adjacent to the WB and WBE reclamation areas may include:

- Degradation of groundwater quality as a result of leaks and spills from storage and use of oils, fuels, chemicals and hazardous materials used for the operation of machinery, vehicles and other equipment within and external to the WB and WBE reclamation areas, including the barge unloading and dredged material transport activities
- Contamination due to ASS disturbance during the dredging process. This is unlikely to occur as Project geochemical investigations (refer Chapter 5 (topography, geology and soils)) have indicated that there is sufficient available acid neutralising capacity in the material to be dredged to neutralise any acid that may be generated. Also, the majority of ASS material will be dredged early in the dredging program and placed in the WBE reclamation area under water which will limit the ability of the sediment to oxidise. Any ASS which is encountered will be handled in accordance with the requirements of the ASS Management Plan (refer Section 5.6.1 and the Dredging EMP in Appendix Q1). Groundwater level and quality monitoring as currently conducted for the WBDDP would also be implemented for the Project.

10.5.1.2 Stabilisation and maintenance phase impacts

During stabilisation and maintenance of the WB and WBE reclamation areas, potential impacts on the groundwater within the WB and WBE reclamation areas and potentially to the adjacent groundwater resource may include:

- Degradation of groundwater quality within the WB and WBE reclamation areas as a result of leaks and spills from storage and use of oils, fuels, chemicals and hazardous materials for the operation of machinery, vehicles and other equipment involved in stabilisation and maintenance activities
- Contamination of WB and WBE reclamation areas groundwater and potentially of groundwater external to the reclamation areas as a result of ASS exposure within the WB and WBE reclamation areas following the completion of dredged material placement. This is unlikely to occur as Project geochemical investigations (refer Chapter 5 (topography, geology and soils)) have indicated that there is sufficient available acid neutralising capacity in the material to be dredged to neutralise any acid that may be generated. Also the majority of ASS material will be dredged early in the dredging program and placed in the WBE reclamation area under water which will limit the ability of the sediment to oxidise. Any ASS which is encountered during operational activities will be handled in accordance with the requirements of the ASS Management Plan (refer Section 5.6.1 and the Project EMP in Appendix Q2). Groundwater level and quality monitoring as currently conducted for the WBDDP would also be implemented for the Project.

10.6 Mitigation measures

10.6.1 Construction phase

The following mitigation measures will be implemented to minimise potential groundwater impacts:

- Implementation of an ASS Management Plan (refer Section 5.6.1 and the Dredging EMP in Appendix Q1)
- Provide spill control materials at the WB and WBE reclamation areas and BUF, including spill kits, booms and absorbent materials, to control any event of chemical spill
- Educate relevant site personnel in appropriate chemical handling and response techniques
- Installation of piezometers on the perimeter of the WBE reclamation area once earthworks are completed. Ensure the piezometers are installed in the dredged material and not the bund wall to ensure the accuracy of results.
- Development of a WB and WBE reclamation areas groundwater monitoring program to be implemented once dredging and earthworks have been completed and the WB and WBE reclamation areas are stable. Monitoring to include sites within the coastal strip of land adjacent to the WBE reclamation area to be installed prior to construction commencing. Groundwater monitoring piezometer installation will not be undertaken during the construction of the WBE reclamation area as piezometers are likely to be broken/demolished prior to finalisation of earthworks.

10.6.2 Stabilisation and maintenance phase

As part of the stabilisation and maintenance phases of the WB and WBE reclamation areas (post dredging) an ongoing groundwater monitoring program (i.e. groundwater levels and water quality, specifically pH) will be implemented until the risk of PASS contamination is minimised. If potential effects are observed, as part of the operational groundwater monitoring, corrective actions would include:

- Further investigation to qualify, quantity and delineate impacts
- Identify and implement appropriate management and/or remediation measures.

10.7 Risk assessment

To assess and appropriately manage the potential impact on groundwater as a result of Project activities, a risk assessment process has been implemented (herein referred to as 'risk assessment'). The risk assessment methodology adopted is based on principles outlined in the:

- AS/NZS ISO 31000:2009 Risk management – Principles and guidelines
- HB 203:2012 Handbook: Managing environment-related risk
- The risk assessment identifies and assesses the risks to groundwater impacts for both the establishment and operational management of the WB and WBE reclamation areas.

The purpose of this risk assessment is to identify potential impacts to environmental values/receptors, prioritise environmental management actions and mitigation measures, and to inform the Project decision making process.

The risk management framework incorporates the Australian/New Zealand Standard for Risk Management (AS/NZS 4360:2004) and contains quantitative scales to define the **likelihood** of the potential impact occurrence and the **consequence** of the potential impact should it occur.

An overview of the interaction between Project activities (drivers/stressors), sensitive values/receptors and the risk impact assessment process is provided in Figure 10.3.

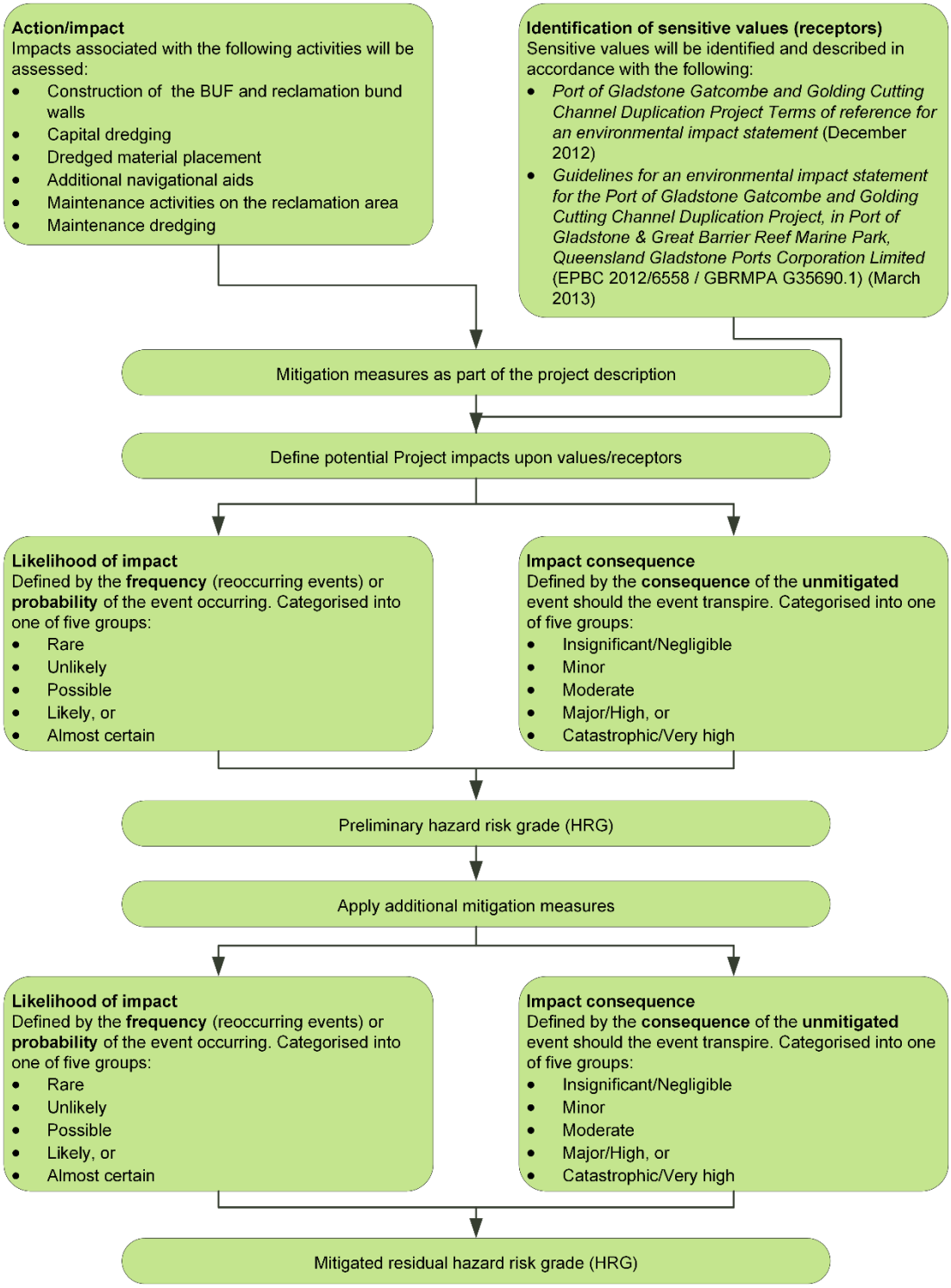

Figure 10.3 Risk assessment framework

Criteria used to rank the **likelihood** and **consequence** of potential impacts are provided in Table 10.1 and Table 10.2, respectively.

Table 10.1 Environmental (ecosystem), public perception and financial consequence category definitions (adapted from GBRMPA 2009)

Description	Definition/quantification[1]		
	Environmental*	**Public perception**	**Financial**
Negligible (Insignificant)	No impact or, if impact is present, then not to an extent that would draw concern from a reasonable person No impact on the overall condition of the ecosystem	No media attention	Financial losses up to $500,000
Low (Minor)	Impact is present but not to the extent that it would impair the overall condition of the ecosystem, sensitive population or community in the long term	Individual complaints	Financial loss from $500,001 to $5 million
Moderate	Impact is present at either a local or wider level Recovery periods of 5 to 10 years likely	Negative regional media attention and region group campaign	Financial loss from $6 million to $50 million
High (Major)	Impact is significant at either a local or wider level or to a sensitive population or community Recovery periods of 11 to 20 years are likely	Negative national media attention and national campaign	Financial loss from $51 million to $100 million
Very high (Catastrophic)	Impact is clearly affecting the nature of the ecosystem over a wide area **or** impact is catastrophic and possibly irreversible over a small area or to a sensitive population or community Recovery periods of greater than 21 years likely **or** condition of an affected part of the ecosystem irretrievably compromised	Negative and extensive national media attention and national campaigns	Financial loss in excess of $100 million

Table notes:

1 Quantification of impacts should use the impact with the greatest magnitude in order to determine the consequence category

* For Matters of National Environmental Significance (MNES) protected under the provisions of the EPBC Act the *Matters of National Environmental Significance – Significant Impact Guidelines 1.1 – Environmental Protection and Biodiversity Conservation Act 1999* (DoE 2013b) are to be used to determine the consequence category

Table 10.2 Likelihood category definitions (adapted from GBRMPA 2009)

Description	Frequency	Probability
Rare	Expected to occur once or more over a timeframe greater than 101 years	0-5% chance of occurring
Unlikely	Expected to occur once or more in the period of 11 to 100 years	6-30% chance of occurring
Possible	Expected to occur once or more in the period of 1 to 10 years	31-70% chance of occurring
Likely	Expected to occur once or many times in a year (e.g. 1 to 250 days per year)	71-95% chance of occurring
Almost certain	Expected to occur more or less continuously throughout a year (e.g. more than 250 days per year)	96-100% chance of occurring

Once the likelihood and the consequence has been defined, determination of the HRG of the potential hazard will be determined through the use of a five by five matrix (refer Table 10.3).

Table 10.3 Hazard risk assessment matrix (adapted from GBRMPA 2009)

Likelihood	Consequence rating				
	Negligible (insignificant)	Low (minor)	Moderate	High (major)	Very high (catastrophic)
Rare	Low	Low	Medium	Medium	Medium
Unlikely	Low	Low	Medium	Medium	High
Possible	Low	Medium	High	High	Extreme
Likely	Medium	Medium	High	High	Extreme
Almost certain	Medium	Medium	High	Extreme	Extreme

Table note:

Hazard risk categories identified in Table 10.3 are defined in Table 10.4

Table 10.4 Risk definitions and actions associated with hazard risk categories (adapted from GBRMPA 2009)

Hazard risk category	Hazard Risk Grade (HRG) definition
Low	These risks should be recorded, monitored and controlled. Activities with unmitigated environmental risks that are graded above this level should be avoided.
Medium	Mitigation actions to reduce the likelihood and consequences to be identified and appropriate actions (if possible) to be identified and implemented.
High	If uncontrolled, a risk event at this level may have a significant residual adverse impact on MNES, MSES, GBRWHA and/or social/cultural heritage values. Mitigating actions need to be very reliable and should be approved and monitored in an ongoing manner.
Extreme	Activities with unmitigated risks at this level should be avoided. Nature and scale of the significant residual adverse impact is wide spread across a number of MNES and GBRWHA values.

10.7.1 Summary of risk assessment

The potential groundwater impact risk assessment is summarised in Table 10.5. The implementation of the mitigation measures (refer Section 10.6), will result in the residual groundwater risks from the Project activities being assessed as low.

Table 10.5 Potential water resource impacts and risk assessment ratings

Potential impact	Project phase					Preliminary HRG			Post mitigation HRG		
	Reclamation area and BUF establishment	Dredging	Navigational aids	Demobilisation	Maintenance	Likelihood	Consequence	HRG	Likelihood	Consequence	HRG
Degradation of groundwater quality in the combined existing WB and WBE reclamation areas, and potentially in groundwater external to the WBE reclamation area as a result of leaks and spills from the use and storage of oils and hazardous materials	✓	✓		✓	✓	Possible	Negligible	Low	Unlikely	Negligible	Low
Contamination of groundwater quality of the combined existing WB and WBE reclamation areas as a result of ASS disturbance	✓	✓			✓	Possible	Low	Medium	Unlikely	Low	Low

10.8 Summary

The Project dredging activities and the changes to navigational aids will all occur in tidal waters and therefore the likelihood of impacts on water resources from these Project activities is predicted to be remote.

There is potential for the Project activities associated with the WB and WBE reclamation areas and BUF to impact on surface water resources. However existing watercourses within the vicinity of the WB and WBE reclamation areas are subject to intertidal influence and will not be subject to direct or indirect impacts from Project activities. There will therefore be no direct impact on the freshwater surface water resources identified upstream of the WB and WBE reclamation areas.

There is potential for the Project activities associated with the WB and WBE reclamation areas and BUF to impact on groundwater resources. Groundwater boreholes in close proximity to the WBE reclamation area are registered as explorative/investigative boreholes and are situated on the perimeter of the existing WB reclamation area for groundwater monitoring purposes. Other nearby boreholes are used for industrial activities and mining monitoring.

Permeability is anticipated to be low along the coastline adjacent to the WB and WBE reclamation areas due to the presence of coastal/estuarine sediments and it is anticipated that groundwater will discharge into intertidal marine waters through the alluvium and colluvium layers. The quality of the groundwater along the existing shoreline is brackish to saline and unsuitable for drinking, stock watering and irrigation.

The potential impacts related to the groundwater resources during the construction and operational phases include potential spillage associated with the storage and use of oils, fuels, chemicals and hazardous materials for the operation of machinery, vehicles and other equipment as well as potential contamination from ASS disturbance.

Due to the location of the Project activities within the marine coastal area as well as the effective implementation of the identified mitigation measures the residual impact risk on groundwater resources is assessed as being low.