Northern Land Expansion Project: Monitoring Program for seagrass and macroalgae

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List of acronyms

ANOVA	Analysis of variance
BACI	Before After Control Impact
BPAR	Benthic Photo synthetically Active Radiation
DCCEEW	Department of Climate Change, Energy, Environment and Water
DESI	Department of Environment, Science and Innovation
EPBC	Environmental Protection and Biodiversity Act 1999
GIS	Geographic Information System
NLEP	Northern Land Expansion Project
PAR	Photosynthetically Active Radiation
RA	Rolling Average
REMP	Receiving Environment Management Plan
GHHP	Gladstone Healthy Harbour Partnership
SRA	Southern Reclamation Area
WBDDP	Western Basin Dredging and Disposal Project
ZoI	Zone of Influence

Version Control

Date	Version	Author	Status
15/05/2024	1	MR/TS	Draft
24/07/2024	2	MR/TS	Final and verified by GPC

Declaration of Accuracy

In making this declaration, I am aware that the sections 490 and 491 of the Environment Protection and Biodiversity Conservation Act 1999 (Cth) (EPBC Act) make it an offence in certain circumstances to knowingly provide false or misleading information or documents. The offence is punishable on conviction by imprisonment or a fine, or both. I declare that all the information and documentation supporting this compliance report is truce and correct in every particular.
I am authorised to bind the approval holder to this declaration, and I have no knowledge of the authorisation being revoked at the time of making this declaration.

Signed: 

Full name (please print) Richard Haward

Position (please print) Executive General Manager - Safety & Environmental Social & Governance

Organisation (please print including ABN/ACN if applicable)

- **Gladstone Ports Corporation Limited**
- **131 965 896**

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1.0 Legislative Requirements

The seagrass monitoring program addresses conditions 14e and 17 (a-f) of the EPBC Approval (2012/6558) as it applies to Stage 1 of the project:

*"A program capable of accurately **monitoring** and quantifying any **sub-lethal or lethal impacts to seagrass and macroalgae** identified in the surveys required under condition 11(b) during **Project Stage 1** and Project Stage 3 and for a period of **2 years following completion** of the construction of the **southern reclamation** area and northern reclamation area."*

Requirements for monitoring programs

17. All monitoring plans and programs required under conditions 14, 15 and 16 must:
a. be designed and undertaken by a person suitably qualified to design and/or implement the specific plan or program and who is a suitably qualified person, such as a suitably qualified field ecologist, or a marine sediment expert.
b. be submitted for the Minister's approval prior to the commencement of the relevant Project Stage;
c. include commitments for reporting to the Department the relevant findings and outcomes of monitoring, including performance against specified monitoring objectives, and procedures for undertaking periodic reviews of the effectiveness and appropriateness of the monitoring plan/program;
d. commit to submit completion reports to the Department within 6 months following the completion of each monitoring program (i.e. the completion of the monitoring in respect of the particular Project Stage which is the subject of the monitoring plan or program);
e. inform relevant management plans required by this approval to adaptively manage and mitigate impacts to protected matters; and
f. be used to inform the development and delivery of environmental offsets for protected matters.

This monitoring Plan has been designed for Stage 1 of the Gatcombe Golding Cutting Channel Duplication Project. Project Stage 1 as defined in the EPBC 2012/6558 means any aspect of the construction of the barge unloading facility and the southern reclamation area, however the construction of the barge unloading facility is not being envisaged at this stage. The monitoring program will be amended if needed when GPC decides to construct the barge unloading facility.

2.0 Approach to monitoring design

Key Considerations

1. This monitoring design covers construction activities for the Northern Land Expansion Project (NLEP). It does not include consideration of dredge material placement and water discharge associated with later stages of the project (although an extension of this monitoring design is likely to be appropriate for those activities as well).

2. Some seagrass habitat lies directly in the footprint of the Southern Reclamation Area (see Map 1) and will be permanently lost. This area is not included in the monitoring program and is dealt with separately under offset plans and conditions.

3. Modelling provided (BMT 2020) suggests fairly minor impacts to water quality are expected during stage 1 construction phase for the NLEP. However, given parts of the wall will be placed directly on or adjacent to seagrass, an appropriate seagrass monitoring program and assessment of Benthic Photosynthetically Active Radiation (PAR) is warranted to ensure compliance with condition 14e above. While the PAR monitoring component is addressed as part of a separate GPC scope coupling PAR data and seagrass conditions is critical to understanding seagrass change and the inferences to the causes of any observed changes and will be integrated in seagrass monitoring reports.

4. GPC has a well-established long term monitoring program for seagrasses that covers the area of interest providing an excellent basis for a robust assessment and monitoring of compliance with the conditions, by building on the extensive baseline and established monitoring program.

5. Locally relevant light thresholds to maintain the key (highest light requiring) seagrass species in the meadow of interest, *Zostera muelleri,* have been established and developed (Section 8), providing a high level of confidence in PAR thresholds that can be used to assess the maintenance of seagrass growing requirements (see Chartrand et al. 2012; 2016; Collier et al. 2016).

6. The light thresholds have been integrated as compliance monitoring triggers in the Receiving Environment Management Plan (REMP) with adaptive management framework designed to ensure light thresholds are being sustained during the construction activities.

Key elements of the monitoring strategy include:

1. Building on a strong baseline history – Seagrass monitoring locations for the NLEP occur in areas where there is a long (>20 year) history of monitoring data to more effectively ascertain the condition of seagrasses relative to historical variability and between impact and reference meadows. This adds an important element to assessing compliance with the EPBC conditions and greater certainty around the expected condition of seagrasses, placing any changes occurring into a historical perspective and providing strong statistical support for determining if impacts have occurred.

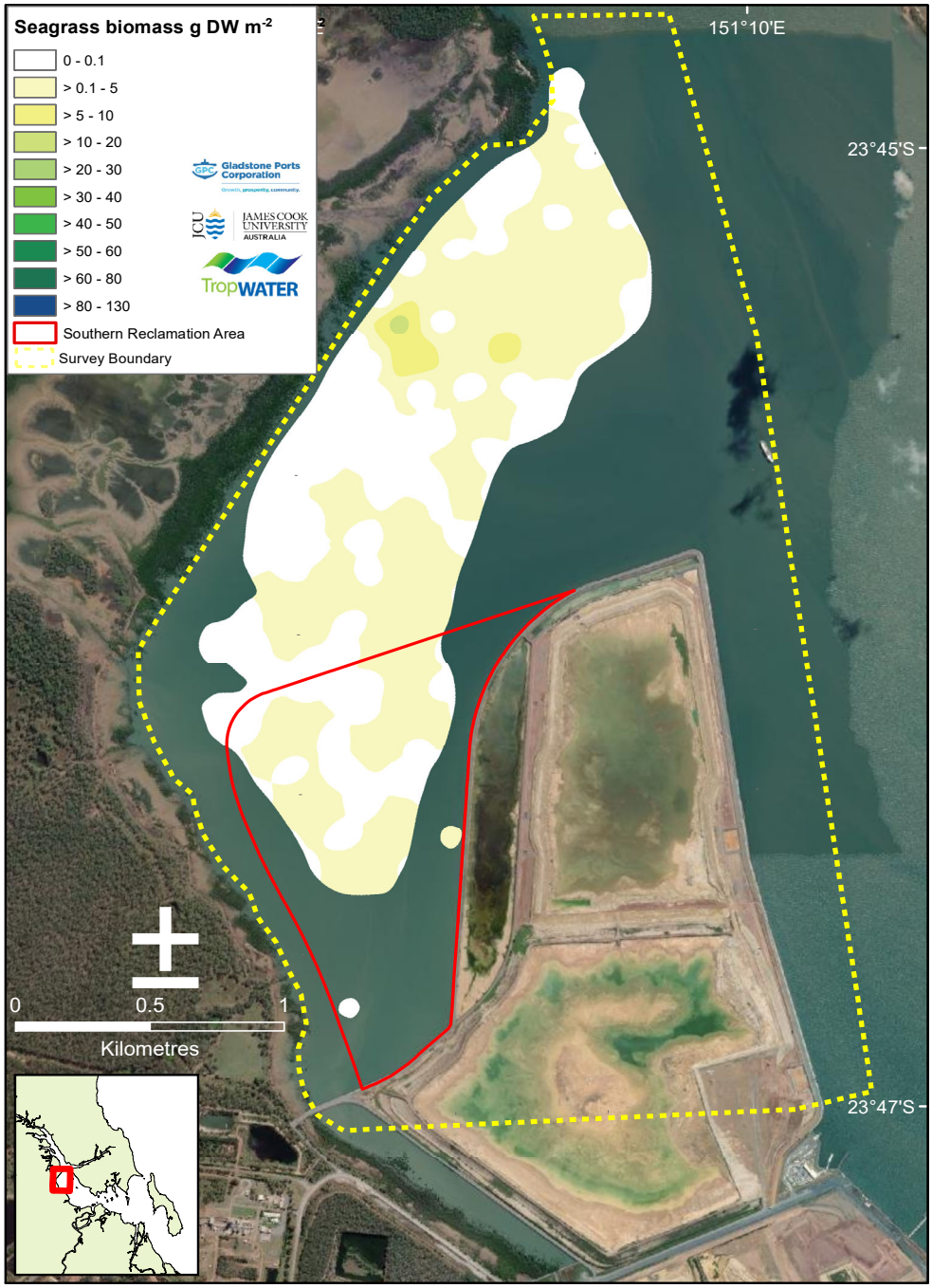
2. Conduct monitoring at an appropriate spatial scale – The monitoring program examines seagrasses at a spatial scale that is sufficient to incorporate the known variability that occurs within seagrass meadows in the area. This is critical as results from >20 years of monitoring in Gladstone show substantial shifts of where biomass hotspots occur within meadow boundaries as well as spatial change in the footprint of where seagrass meadows occur from year to year. Larger “meadow-scale” monitoring assures that an accurate picture of seagrass condition is obtained rather than the danger of simply measuring within the “noise” of variability that can occur with smaller fixed site monitoring. Seagrass meadows adjacent to the NLEP have been surveyed intensely over the previous 4 years to build a detailed baseline of seagrass conditions to complement the previous >20 years of monitoring. Seagrass biomass in meadows adjacent to the NELP have low biomass that shows inter and intra annual variation. Seagrass area has remained relatively consistent over this period covering between 180 and 235 ha.

3. Using standard and established measures and indicators – The proposed seagrass monitoring program for the project will use a set of standard, proven and peer reviewed metrics for measuring seagrass change. This will allow results to be compared with historical data from the project area and also to be compared for context with other seagrass monitoring conducted in

the region and Queensland wide as well as regional reporting as part of the Gladstone Healthy Harbour Partnership (GHHP).

4. Using a network of impact and reference meadows- suitable “impact” and “un-impacted” meadows and monitoring locations have been identified from within and outside the Zone of influence (ZoI) to resolve any project related changes from non-project related natural change to seagrasses and light (PAR).

***Map 1**. Seagrass meadow area and biomass distribution across meadows in the NLEP monitoring footprint in 2023.*



2.1 Seagrass and macroalgae Monitoring Design

Given the above considerations a two-part monitoring approach will be used:

Monitoring seagrass condition in the meadow within the Zone of Influence (ZoI) and two nearby reference meadows with similar seagrass species composition and history of seagrass change and trends – *Assessing any potential lethal impacts*

A. Quarterly assessment of the seagrass meadow that lies within the ZoI of construction and two nearby reference meadows with similar characteristics and historical trends from 3 months prior to start of works to 6 months post completion.

B. Continued assessment of the NLEP ZoI and reference monitoring meadows as part of the annual seagrass monitoring program each November for two years post completion of the works.

C. Light conditions within the ZoI and at reference meadows will be compared to observed seagrass condition to identify potential light related stress and changes in seagrass condition. *Light monitoring is outside of the scope of this proposal and will be conducted under the REMP.*

While we have not specifically highlighted macroalgae in the approach, macroalgae was a relatively minor feature of the NLEP stage 1 area of interest (Smith et al. 2020, 2021, 2022 and 2023) and maintenance of light for seagrass, by default would likely provide suitable conditions for local macroalgae. Macroalgae type and percent cover will also be collected as part of this seagrass monitoring program.

Location of primary impact and reference monitoring meadows

The only seagrass predicted to be within the ZoI lies entirely within the meadow on the intertidal bank adjacent to the NLEP to the north of the Fisherman's Landing reclamation (Map 1; Smith et al. 2023). The monitoring design examines this ZoI meadow and two reference meadows outside of the ZoI that have similar species compositions; South Fisherman's (Meadow 6) and Wiggins Island (Meadow 5) (Table 1; Figure 1; Map 2).

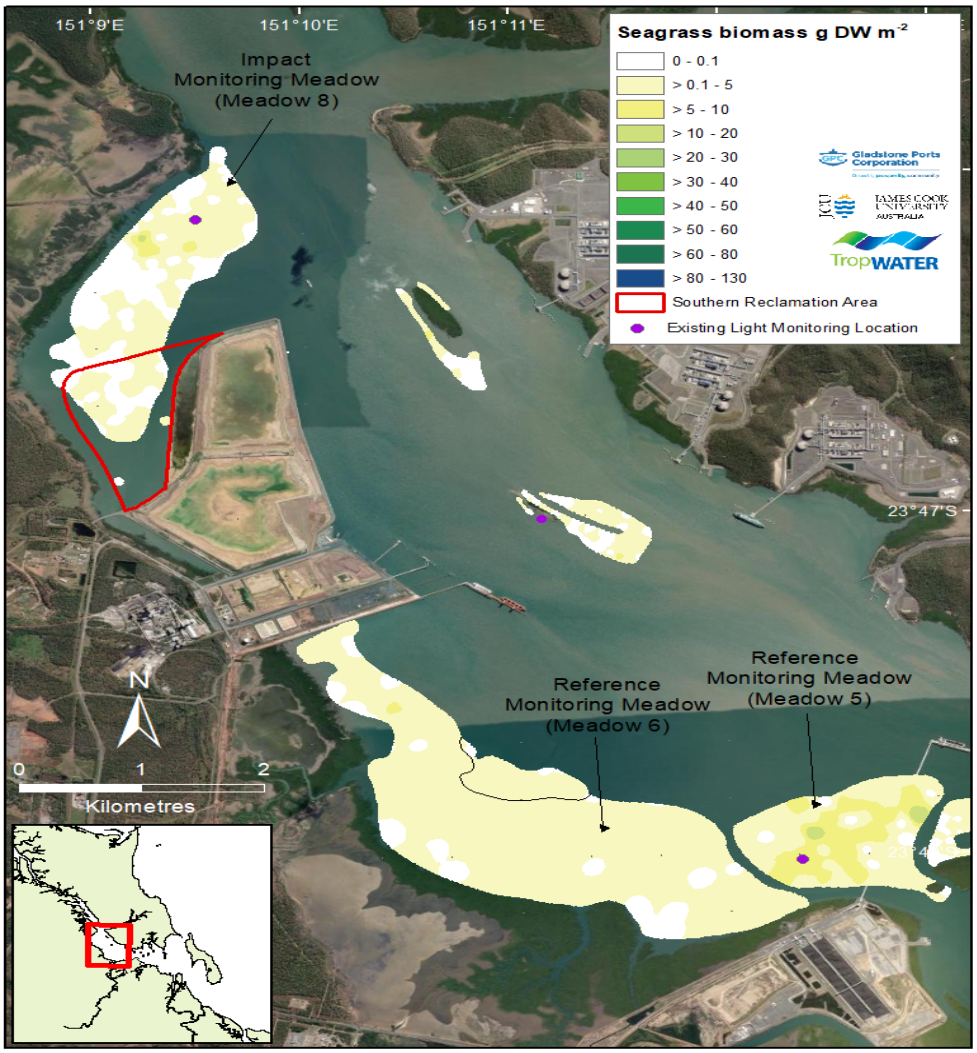
All of the meadows selected have a long history of monitoring, with at least annual monitoring conducted for the last 18 years. This enables an excellent ability to place changes within a historical context. All three meadows are intertidal and have very similar species mixes and a similar low mean biomass (Table 1; Figure 1). Importantly, all three meadows show similar trends in change of biomass, species composition and area over time (Figure 1) which means they are ideal reference sites to one another.

***Table 1**. Seagrass meadow monitoring characteristics.*

Monitoring Location (meadow ID)	Monitoring Location Type	Seagrass Meadow Depth	Seagrass Meadow Type (dominant species)	Species Present	Average Biomass October 2023	Monitoring History
North Fishermans (Meadow 8)	Zone of Influence	Intertidal	*Zostera muelleri with mixed species*	ZM, HO, HD, HS	0.82 g DW m^{-2}	Detailed Annual >20 years + 4 years project specific baseline studies
South Fishermans (Meadow 6)	Reference	Intertidal	*Zostera muelleri / Halophila ovalis*	ZM, HO, HD, HS	1.72 g DW m^{-2}	Detailed Annual >20 years ++ 4 years project specific baseline studies
Wiggins Island (Meadow 5)	Reference	Intertidal	*Zostera muelleri with mixed species*	ZM, HO, HD, HU	3.76 g DW m2	Detailed Annual >20 years ++ 4 years project specific baseline studies

Species abbreviations: ZM, *Zostera muelleri*; HO, *Halophila ovalis*; HD, *Halophila decipiens*; HS, *Halophila spinulosa*; HU, *Halodule uninervis*.

***Map 2.** Location of suggested impact and reference meadows for the NLEP seagrass monitoring.*



ZoI / Impact monitoring meadow	Reference monitoring meadows

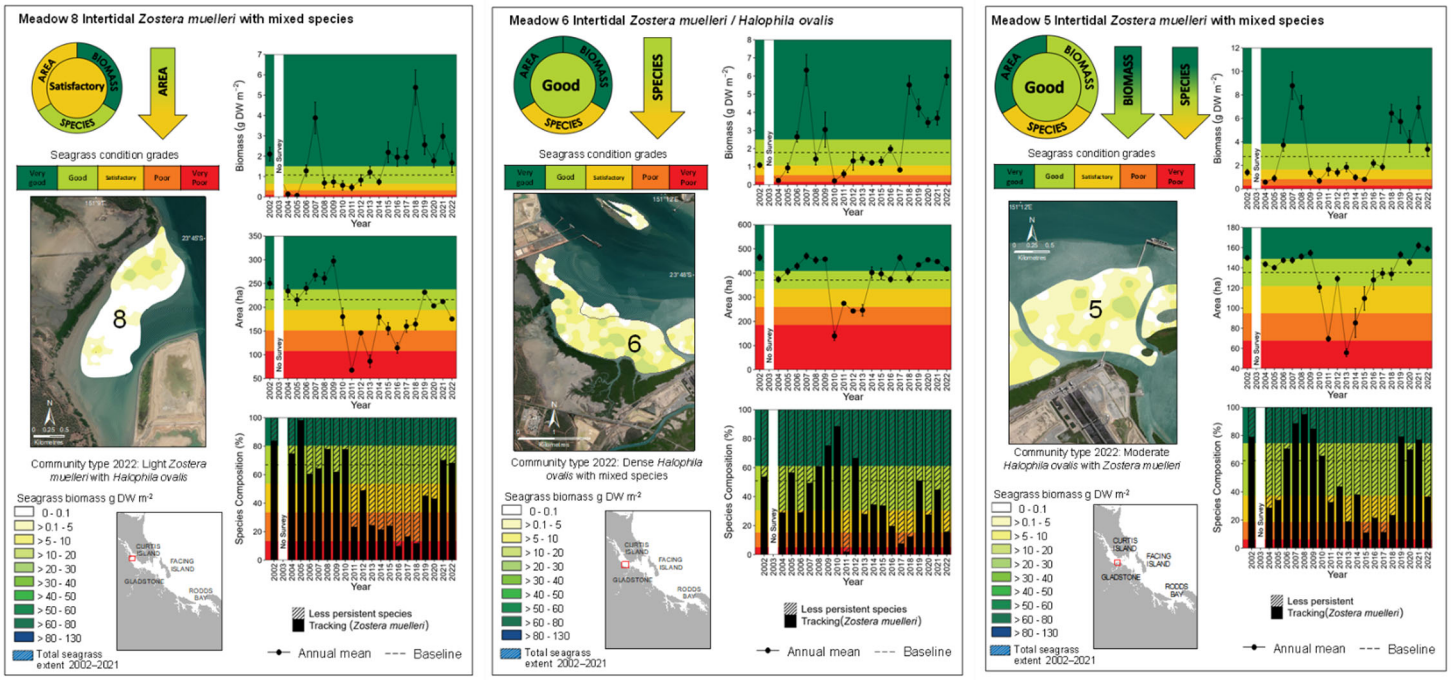


Figure 1. *Characteristics of the ZoI and Reference meadows showing similar trends in biomass, area and species composition between 2002 and 2023 (from Smith et al. 2023).*

Broader annual monitoring assessment context

In addition to the proposed specific NLEP monitoring and frequency of sampling (see below) all three of the selected monitoring meadows form part of the Port Curtis long-term annual seagrass monitoring program, which examines seagrass meadows more broadly throughout the port limits and in Rodds Bay in November each year (Smith et al. 2020). These annual surveys provide additional scope for reference to examine changes in the SRA meadows against all 17 seagrass meadows that form part of the annual program. This will provide two sampling occasions during construction (assuming an 18 month construction phase) where the changes could be placed in a broader regional perspective as well as a broader network for comparison during the two years of post-construction monitoring.

Monitoring frequency

The timing and frequency of sampling is presented in Table 2. For the monitoring program we are assuming that stage 1 construction will take approximately 18 months and begin in January 2025. Higher quarterly frequency of sampling begins at 3 months prior to the commencement of works and continues throughout construction and for 6 months post construction to ensure adequate frequency to detect potential impacts associated with the works, as well as immediate pre and post works sampling. Following that, sampling reverts to the annual sampling each November as part of the annual long-term monitoring program (at the peak of seasonal seagrass abundance) to capture the requirement for 2 years of post-works monitoring under the EPBC conditions. Previous experience monitoring these meadows as part of the Western Basin Dredging and Disposal Project (WBDDP) indicates a 3 month frequency to be ideally suited to measure changes associated with potential impacts (Chartrand et al. 2017)

Table 2. *Schedule and timing of monitoring for the NLEP seagrass monitoring.*

Note: dates are indicative only and are subject to change	2024												2025												2026												2027												2028											
	Year 1												Year 2												Year 3												Year 4												Year 5											
	J	F	M	A	M	J	J	A	S	O	N	D	J	F	M	A	M	J	J	A	S	O	N	D	J	F	M	A	M	J	J	A	S	O	N	D	J	F	M	A	M	J	J	A	S	O	N	D	J	F	M	A	M	J	J	A	S	O	N	D
NELP Project Stage 1 works (indicative)																																																												
Seagrass Monitoring Program																																																											
Before works monitoring survey																																																											
During works monitoring survey																																																											
Post works monitoring surveys																																																											
Monitoring as part of Annual Seagrass Program																																																										

Note *monitoring will be conducted at the above frequency though dates may vary based on tides and prevailing weather conditions.*

PAR (light) monitoring to assess sub-lethal impacts

A PAR monitoring program will be implemented by GPC as part of the environmental monitoring and compliance package for the NLEP stage 1 construction. Established locally relevant ecological light threshold requirements and relevant triggers will be used to protect seagrass from sub-lethal light stress providing an effective dredge mitigation strategy to protect seagrasses in the area (Chartand et al. 2016). There is an extensive history of research and PAR assessment for maintenance of growing conditions for seagrasses in the Gladstone area (see Chartrand et al 2012; 2016). This work has established a benthic PAR requirement of 6 mol m^{-2} day^{-1} over a 14-day rolling average to maintain growth and function of intertidal *Z. muelleri*. As *Z. muelleri* is the key foundation species of the ZoI and two reference meadows in the NLEP monitoring design it is appropriate to use that benthic PAR threshold to demonstrate that growth requirements for seagrasses are being met, and not impacted by NLEP construction activities.

2.2 Monitoring methods

The success of the NLEP seagrass monitoring program in meeting EPBC approval conditions relies on maintaining consistent methodology with the historical and ongoing long-term seagrass monitoring program to allow direct assessments of change relative to background and within the nested broader program. This also allows use of the established framework for assessing seagrass condition and health (Smith et al. 2023). The detailed methods for the established monitoring, health scoring and analysis are available from reports and publications from those programs (e.g. see Smith et al. 2023) and we have only included a general summary below.

Three principal indicators of seagrass condition are assessed– seagrass biomass, species composition, and meadow area. These are fundamental indicators used to answer questions surrounding seagrass condition. The importance of these indicators in seagrass habitat and health assessments was highlighted by the Seagrass Expert Group's recommendations for monitoring seagrass within the Reef 2050 Integrated Monitoring and Reporting Program (Udy et al. 2018) and form the key indicators of seagrass condition in the GHHP regional report card (Carter et al. 2023). The monitoring methods, analysis and assessments used in previous surveys (e.g. Smith et al. 2023, Carter et al. 2023) will be followed as part of this monitoring program.

Sampling techniques

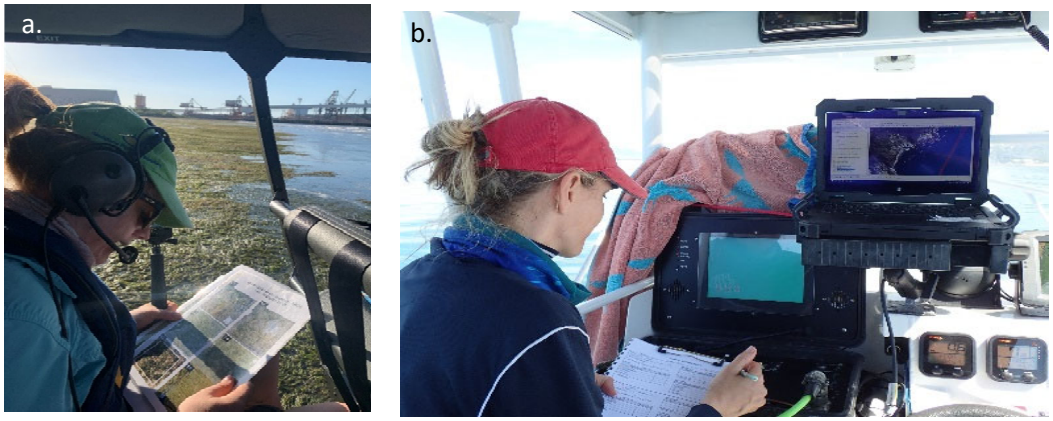
Sampling techniques used in the long-term Port Curtis annual seagrass surveys and throughout the Queensland Ports Seagrass Monitoring Program as applicable to the NLEP will be implemented in this plan:

1. *Intertidal seagrass*: helicopter survey of exposed banks during low tide (Figure 2a) – assessment sites are scattered throughout the seagrass meadow and sampled when the helicopter comes

into a low hover <1m from the substrate. Boundary of meadows is mapped from the helicopter at low tide

2. *Shallow subtidal seagrass (limited or no requirement for SRA)*: boat-based camera drop surveys (Figure 2b).

Figure 2. *Seagrass monitoring techniques using (a) helicopter; (b) boat-based camera survey*



Number of sampling sites within meadows

All of the meadows in the NLEP program are part of the existing monitoring program and power analysis techniques have already determined the appropriate number of sampling sites for each meadow in order to detect seagrass meadow change (Quinn and Keough, 2002).

Site details

Spatial data for each survey collected is incorporated into a Geographic Information System (GIS) in ArcGIS®. The site GIS layer includes:

1. Site number
2. Sampling date
3. Sediment type
4. Latitude and longitude
5. Seagrass total above-ground biomass in grams dry weight per square metre (g DW m^{-2}). This is determined using the "visual estimate of biomass" technique (see Kirkman 1978; Mellors 1991).
6. Species above-ground biomass for each species. This is calculated using the percent contribution of each species to a site's total biomass.
7. Macroalgae % cover and functional groups
8. Comments

Meadow details

Seagrass meadow boundaries are defined using meadow edge mapping waypoints entered during helicopter surveys. Meadows are mapped as polygons in ArcGIS®. The meadow GIS layer includes:

Seagrass meadow characteristics – Meadow ID number, area $\pm$ R (hectares) where R is a measurement of error, mean biomass $\pm$ standard error, mean biomass of each species, community type based on to species composition from nomenclature developed for Queensland seagrass meadows, density categories (light, moderate, dense) based on above-ground biomass of the dominant species.

3.0 Statistical Design and Analysis

A statistical design and analysis will incorporate an assessment against existing meadow baseline conditions that have already been established for the three meadows identified for the NLEP as part of the annual long term monitoring program for Port Curtis (see Smith et al 2020; Carter et al. 2023; Bryant et al. 2014). A typical BACI design analysis commonly used in impact assessment (before-during-after and control-impact) focused on the three targeted meadows over the time period of the NLEP program will also be applied. Seagrass data in tropical Queensland rarely meets the assumptions required to conduct standard statistical analysis used in BACI impact assessments, such as ANOVA. The existing seagrass monitoring program incorporates advanced statistical techniques used to deal with difficult data, including generalised linear mixed models, logistic regression, zero-inflated models and zero-altered gamma models and will likely need to be applied in the analysis of the NLEP monitoring. The number of days PAR is under the threshold for *Z. muelleri* growth and function (6 mol m^{-2} day^{-1} over a 14-day rolling average) will be reported on and compared to seagrass biomass and area using models suggested above.

4.0 Concluding Remarks

The risk to seagrasses from the NLEP Project stage 1 (apart from the area directly lost to reclamation) appears to be quite low from the anticipated water quality impacts in the modelling provided. Despite this, the proposed monitoring would be fit for purpose to detect any unexpected impacts and also meet the EPBC condition requirements as outlined. Due to the extensive baseline history of monitoring and the presence of suitable reference meadows with similar characteristics, there is a high level of confidence in being able to measure change in the context of expected seagrass condition and in comparison to meadows outside the ZoI. Combined with the excellent local knowledge of seagrass light requirements and a matching light monitoring program this presents a robust monitoring program to satisfy EPBC condition requirements.

Finally, seagrasses can be impacted by large scale events (storms and cyclones; Chartrand et al. 2017) as well as large herbivore feeding behaviour (Scott et al. 2020). The large meadow scale design of monitoring combined with this program being nested within the larger Port Curtis monitoring ensures that such events can be taken into account as part of inference assessments of change in seagrasses in the NLEP area of interest.

5.0 Deliverables and Reporting

The NLEP seagrass monitoring program will deliver the project according to the table below in line with that in the detailed scope of works.

***Table 3**. Reports from Field work*

Deliverable	Description	Deadline
Before, during and post SRA bund wall construction surveys	Implement surveys at the frequency detailed in Table 2 of the seagrass monitoring plan following the exact same methods	As per Table 2 of the seagrass monitoring plan
	Following analyses detailed in the monitoring plan after each survey produce a brief (technical report summarizing findings and trends)	Within two (2) calendar months following field work completion
	Review of, methods, results, conclusion and monitoring objectives and actions to improve monitoring and reporting.	Annual Report
Final compliance report	Produce a comprehensive report on the findings of the monitoring program	Within three (3) calendar months (~February 2028) following field works completion

Reporting to DCCEEW

The results of the seagrass and macroalgae monitoring program will be reported to DCCEEW as below:

***Table 4**. Reports to DCCEEW*

Deliverable	Details	Timeline
Annual Compliance Report	Findings from the seagrass and macroalgae surveys will be reported in the Annual Compliance Report required under Condition 65 of the EPBC Approval	Annual for the duration of the monitoring program
Project completion Report	A seagrass monitoring completion report will be submitted	Six months after completion of all field works
Significant Residual Impact Report	A significant Residual Impact Report will be submitted. If a Significant Residual Impact is identified, the Seagrass and macroalgae offset plan will be amended to address the SRI	Six months after completion of all field works

6.0 Adaptive Management Framework

BPAR elevation adaptive management

Continuous monitoring of Benthic Photosyntheticaly Active Radiation (BPAR) will be conducted at meadow FL8. The BPAR levels will be compared against established trigger developed for *Z. muelleri,* which is 6 moles/m^2/day (Table 5).

Level 1- Internal Investigation

The BPAR Internal Alert Level 1 is reached when the rolling average BPAR at the designated Concern benthic light monitoring site falls below the 6 mol/m^2/day threshold for one (1) day (one (1) 14 day RA value). This will in turn initiate Response 1 where GPC will initiate an investigation to determine the causes of the reduced BPAR conditions at the site. The investigation will commence within 24 hours of becoming aware of the reduced BPAR levels, and it will remain open until BPAR values return above threshold.

Table 5: *BPAR management light threshold for Z. muelleri (6 mol/m^2/d over a 14 day RA) adapted from Collier et al. (2016) with related investigation and management actions at different consecutive days of BPAR 14 day RA below threshold.*

Site	Level 1 Internal investigation	Level 2 External notification (DESI and DCCEEW	Level 3 Time to potential impact
FL8	1 (equivalent to 14 days of low light)	7 (equivalent to 21 days low light)	14 (equivalent to 28 days low light)

Adaptive Management 1

Whenever the investigation shows that likely causes of BPAR values below threshold are due to environmental conditions (eg, clouds, tides, floods, natural turbidity, etc.) no actions will be taken, monitoring will continue with the investigation remaining open until the BPAR 14 day RA returns above threshold. The investigation will be closed once the BPAR levels returns above threshold.

If internal investigations reveal that the reduced light levels conditions and 14 day RA below threshold to be predominantly attributable to the construction of the NLEP and not environmental conditions, appropriate adaptive management actions will be implemented in order to reduce turbidity levels and in turn help BPAR values to return above threshold. Adaptive management measures will include:

- Work only in mud –water interface at low tides when water level is below mud level and work in areas above the tidal level as tide rises and falls.
- Only day time works instead of 24 hours operation, thus limiting continuous disturbance of seabed
- Reduce the level of construction activity in the area of mud –water interface.

Level 2- External Notification

The BPAR External Alert Level 2 is reached when the rolling average value remains below the 6 mol/m2/day threshold for seven (7) consecutive days of 14 days RA. At this stage, notification will be sent to both Department of Environment, Science and Innovation (DESI) and DCCEEW.

Adaptive Management 2

If the investigation shows that the likely causes of continued low BPAR are driven by environmental conditions, no actions will be taken, the investigation will remain open and held at Level 2 until it either progresses to the next Alert phase) or BPAR 14 day RA returns above threshold.

However if the low light is attributed to the construction activities, the adaptive management measures will be reviewed.

Level 3 – Time of impact

The BPAR External Alert Level 3 is reached when the rolling average value remains below the 6 mol/m^2/day threshold for seven (14) consecutive days of 14 days RA. At this stage, notification will be sent to both DESI and DCCEEW.

Adaptive Management -3

If the investigation shows that the likely causes of continued low BPAR are driven by environmental conditions, no actions will be taken, the investigation will remain open and held at Level 3 until BPAR 14 day RA returns above threshold.

However if the low light is attributed to the construction activities, work at the mud –water interface will be suspended until light condition returns above threshold.

7.0 References

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Final Audit Report 2024-07-24

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