PORT OF BRISBANE CORPORATION

FUTURE PORT EXPANSION – BUND CONSTRUCTION

ENVIRONMENTAL MANAGEMENT PLAN

AUGUST 2002

Prepared by: Port of Brisbane Corporation
Sandpiper Avenue
FISHERMAN ISLANDS QLD 4178

Telephone: (07) 3258 4888
Fax: (07) 3258 4703

FOREWORD

This document provides the Environmental Management Plan (EMP) for the Future Port Expansion project being undertaken by the Port of Brisbane Corporation at Fisherman Islands. The EMP specifically addresses those issues associated with the construction phase of the project, in particular the bund wall. It addresses the range of topics identified through the Impact Assessment Study process as requiring specific management to avoid unacceptable environmental impacts.

This document provides a basis for discussion with the various government agencies involved in the regulation of the project. As such, it contains supplementary material and explanatory notes which will not appear in the 'working' version of the document, except where required to assist understanding of operators.

The intent of the 'working' version of this document is to provide a concise account of the objectives and responsibilities of the staff involved in the day-to-day operation of the Future Port Expansion project.

CONTENTS

1 INTRODUCTION

The Port of Brisbane Corporation (PBC) is about to undertake a major expansion of the Port facilities located at Fisherman Islands, at the mouth of the Brisbane River (Figure 1.1). This will entail the reclamation of 230ha of subtidal land immediately north of the existing facilities through a process of external and internal bund development and subsequent infilling of the area with dredge material resulting from the Corporation's maintenance dredging program (Figure 1.2).

The project is located adjacent to a number of environmental resources, such as the Moreton Bay Marine Park, internationally recognised RAMSAR wetlands, extensive seagrass meadows and mangrove communities. Further, the area is utilised by a wide variety of marine and marine dependent fauna, including a number of species protected under international conventions to which Australia is a co-signatory (such as the Bonn Convention).

The successful environmental management of the Future Port Expansion (FPE) will be paramount in ensuring the overall success of the project, and ensuring the minimal regional environmental impact predicted by the Impact Assessment Statement (WBM 2000).

This document provides the Environmental Management Plans (EMP's) for the items identified through the Impact Assessment Statement as requiring specific attention to minimise the potential for unacceptable environmental impact.

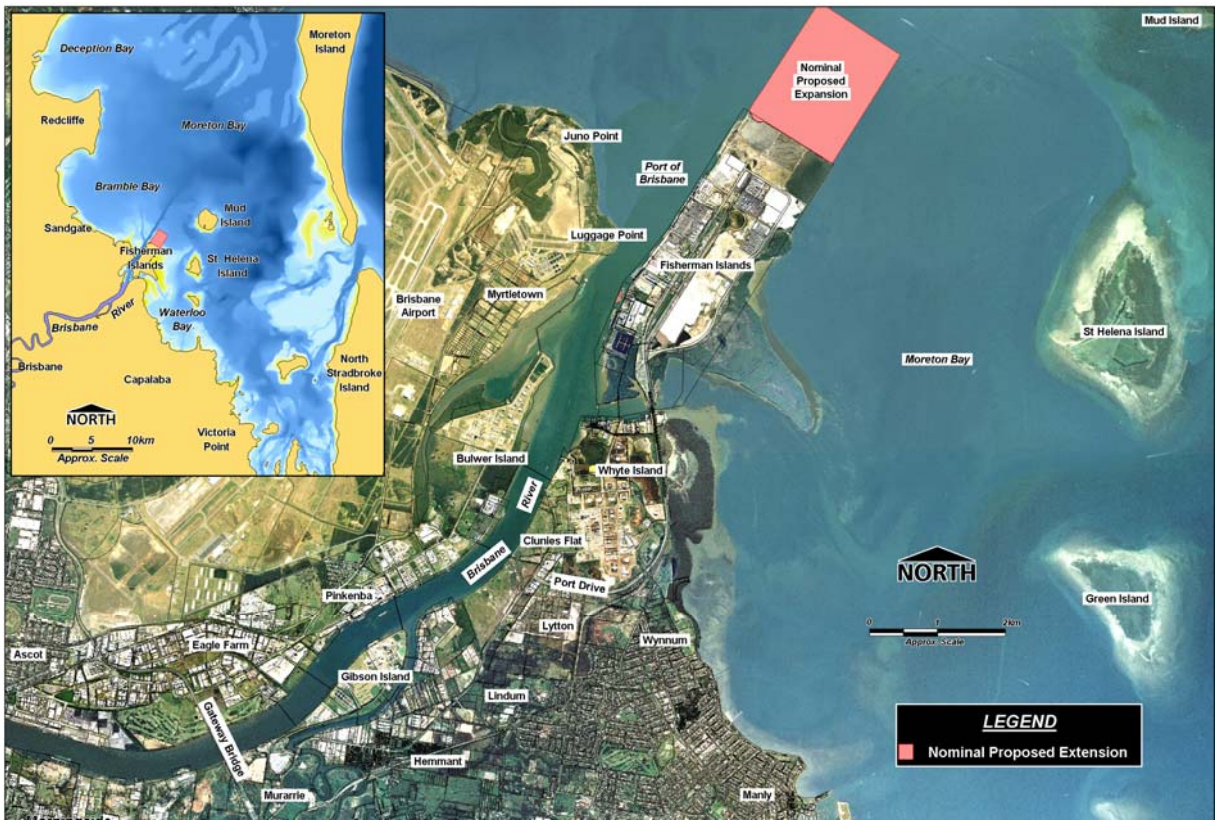


Figure 1.1: Locality Plan

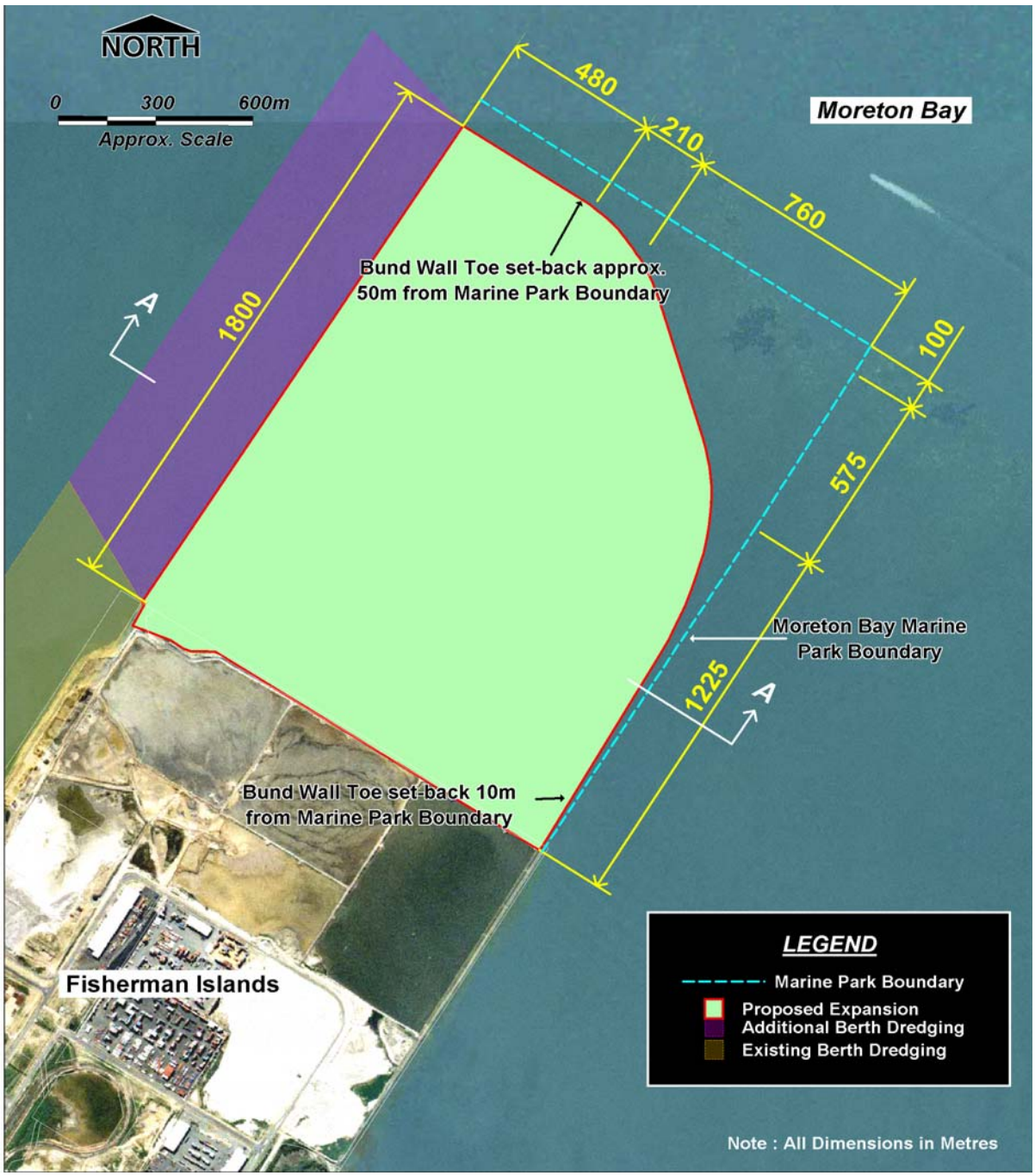


Figure 1.2 : Conceptual Future Port Expansion Layout

2 PROPOSED WORKS

The principal focus of this Environmental Management Plan, as was that of the Impact Assessment Statement (WBM 2000), is the development of the surrounding bund for the Future Port Expansion project. This bund will extend up to 1.8km seawards from the existing reclamation area, enclosing an area of some 230Ha (Figure 1.2).

2.1 Construction Material

The rock rubble used for the bund construction will be imported via road from existing quarries in South East Queensland. The source rocks have been specifically selected to maintain desirable physical characteristics during prolonged exposure in a marine environment, thus reducing the potential for material loss following construction. One such source rock is greywacke. Other material may be used for the core of the bund wall or for the final stages of construction (see below).

2.2 Construction Method

Generally, the construction methodology is the placement of the bund material at the end of the construction area such that the bund extends seaward as construction progresses. Where the condition of the bed sediments is unstable, improvement of the load bearing characteristics may be required. This will be achieved through the placement of supporting material or a layer of geo-fabric material (or combination of these), increasing the shear strength of the supporting sediments.

The bund will be constructed in two stages. The first will be the initial development of the bund to a final level approximately 1.3 – 1.5m above high tide (R.L. 4.0m). The second stage will see the capping of this bund with a further 2.0 – 2.5m of material. Both stages will include the placement of large rock on the outer face of the bund to act as an armouring surface.

Plate 2.1: Construction of Berth 8 facility, Fisherman Islands 2001.

During the construction of the Berth 8 facility at Fisherman Islands (January-March 2001, see Plate 2.1), a similar construction methodology was employed. The length of the bund extends as construction continues. Depending upon a number of factors such as rock delivery rate, water depth and site conditions, advancement of the bund will be in the order of 5-20m per day.

The alignment of the wall will be surveyed and marked with buoys by Corporation surveyors. Further, the final level of the bund surface will be monitored by the surveyors using dGPS and RTK technology to ensure design criteria are met.

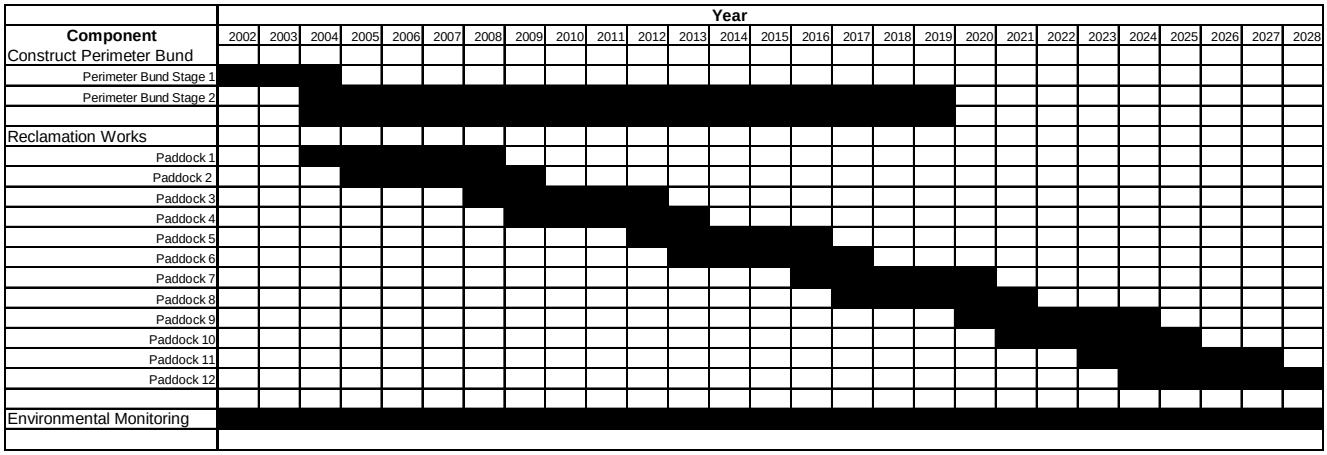
3 PROJECT TIMELINE

The development of the outer bund wall is anticipated to take two years, with construction beginning mid/late 2002, and continuing until approximately June 2004. Works will be from 6am to 6pm and may be undertaken seven days per week.

At this stage, it is proposed to progress the development of the initial stages of the eastern wall ahead of the western wall. This will then act to contain the work site and provide physical separation from the more sensitive seagrass areas to the south east of the FPE area.

As discussed above, the bund is constructed in two stages. Stage 1 to R.L. 4.0m is to be constructed initially in a two-year period, with stage 2 to R.L. 6.0m to R.L. 6.5m constructed as required over the following 13 – 15 years to meet internal bunds and paddock filling requirements. The Gantt Chart presented below provides an outline of the proposed construction for both the outer bund (the focus of this EMP) and the subsequent internal filling works.

Table 3.1: Construction Timeline



4 SUMMARY OF ENVIRONMENTAL ISSUES

The following is a summary of key environmental issues identified through the IAS prepared for the FPE project (WBM 2000). These items were identified as requiring specific management procedures to be developed and implemented in order to mitigate any potential development impacts.

4.1 Turbidity

The generation of plumes of turbid waters from the works area has potential to impact on the environmental values of the receiving environment by either direct impacts (such as smothering benthic organisms) or indirect impacts, such as limiting plant growth by reducing light penetration to the water column. As such, the minimisation, and subsequent control if required, of turbid plumes is one of the principal aims of this document

4.2 Marine Ecology

The most significant potential for the FPE construction to impact adjacent areas is to reduce the viability or health of adjacent extensive seagrass areas, which in turn may impact a range of associated fauna and food webs. As such, this EMP focuses on preventing impacts to adjacent seagrasses and providing a structured monitoring program to detect changes.

4.3 Noise

The FPE is not located adjacent to sensitive receptors such as residential dwellings. Further, the construction site is located some distance from adjacent relatively high noise environment (industrial) land users. As such, it is not anticipated that noise generated by the FPE construction will be a major management issue. The EMP criteria and actions are complaint based.

4.4 Dust

As with the issue of noise generation, dust is not anticipated to generate a significant management issue. As such, this EMP criteria and actions are also complaint based.

4.5 Terrestrial Ecology

The FPE construction area is subtidal lands and largely devoid of native terrestrial fauna with the exception of shorebirds. The current reclamation area is utilised by an abundant and diverse range of shorebirds, including international migratory waders. This use is a beneficial outcome of the construction phase and this EMP is intended to maximise shorebird use, whilst minimising disturbance within the practical limitations of an active worksite.

4.6 Cultural Heritage

In recognition of the importance of this issue, the Port of Brisbane Corporation's has developed specific stand-alone documents to address the management of indigenous and non-indigenous cultural heritage issues during the construction of the FPE.

5 MANAGEMENT PLANS

5.1 Management Plan Components

The Management Plans (MP) presented in this document are provided in the following format:

- *Policy* – provides a short description of the objective of the MP;
- *Performance Criteria* - provides the critical measure of the MP;
- *Monitoring Specifications* – provides an outline of the monitoring to be undertaken for comparison to performance criteria;
- *Reporting* – provides an outline of the reporting requirements under the MP, and the destination of those reports;
- *Corrective Action* – describes the actions to be taken in the event that the Performance Criteria are exceeded;

- *Responsibility* – defines the lines of responsibility for overseeing the implementation, monitoring and reporting of the MP; and
- *Timing* – provides and outline of the timing and/or duration of the MP.

5.2 EMP Continual Improvement Process

The Future Port Expansion is a large project spanning a considerable time period. It is likely that there will be a requirement to change work practices during construction due to factors such as improved techniques, changes in technologies or factors that cannot be envisaged at this stage.

As such, there may be a requirement to amend the following Management Plans to ensure they remain applicable throughout the life of the project. The following outlines a protocol for this revision to be managed if required.

1. Need for change to management plan identified;
2. Practicalities of changes explored and working draft of revised management plan developed;
3. Provision of required components of EMP, and supporting information, provided to regulatory authorities (e.g. Environment Australia (EA), EPA) for comment and approval;
4. Revised component inserted into EMP under new document revision number.
5. All onsite copies updated and staff informed of relevant changes.

As a change in a management plan will be a reaction to a perceived need, it will be essential that the changes can be made rapidly. As such, it is envisaged that the majority of the above stages will be communicated verbally or electronically to the responsible regulatory officer.

To ensure a Corporate history is maintained within EPA and EA familiar with the project, it is requested that EPA/EA provide a designated contact for the project. This position will be the first point of contact for the FPE project. Reporting to the EPA/EA designated contact will be presented as a brief report on a monthly basis.

5.3 Daily Assessments and Complaints Register

The Environmental Site Supervisor (or delegate) will undertake daily assessments of the FPE construction area. During these inspections, a log will be kept of pertinent observations and follow-up actions as required (Appendix A).

Any complaints which are received will be recorded and addressed under the existing Corporation guidelines. A register of complaints will be maintained by the Environmental Site

Supervisor, with details of the complaints and follow-up actions detailed on individual issued based forms (Appendix A).

5.4 Roles and Responsibilities

The following table provides an outline of the roles and responsibilities of the staff involved in the Future Port Expansion project.

Table 5.1: Roles and Responsibilities of Key Staff for Future Port Expansion Project

Name and Position	Responsibility	Reporting to	Contact Numbers
Wayne Young ***Environmental Site Supervisor***	Day-to-Day monitoring and management of environmental issues. Ensuring compliance with aspects of Environmental Management Plan.	Manager Environment	Ph. 3258 4848 mob. 0408 458 160 Fax 3258 4703
Brad Kitchen ***Manager Environment***	Overall environmental management and ensuring reporting responsibilities are met.	General Manager Planning and Environment	Ph. 3258 4658 mob. 0419 711 770 Fax 3258 4703
Bill Tranberg ***Project Manager***	Ensure engineering aspects of project are met.	General Manager Operations	Ph. 3258 4850 mob. 0418 771 896 fax 3258 4703
TBA ***Site Supervisor***	Day-to-Day management of construction works. Ensuring compliance with design specifications.	Project Supervisor	TBA

5.5 Turbidity Management Plan

Element:	Turbidity Monitoring
Policy:	To ensure turbidity[1] generated by the development of the FPE does not exceed acceptable criteria.
Performance Criteria:	No plumes of turbid waters exceeding acceptable criteria to be generated outside the FPE as defined in Figure 1.2. ***Criteria*** [2] The running 2hr average of turbidity at the impact site is not to exceed : • 10 NTU above background where background levels are <25NTU; or • 25% above background where background levels are >25NTU for a continuous period of more than 1 hour within a tidal phase (flood/ebb). If the above criteria are exceeded, an additional criteria[3] relative to the adjacent Ramsar Wetland area will also be applied to ensure that impacts are within • the 12 hour moving average of turbidity within the Ramsar Site does not exceed 6% (3 times the modelled scenarios in Section 8.4.2 of the IAS) of the initial concentration immediately adjacent the construction area. The **impact site** is defined as a point 100m directly down-current of the boundary of the FPE area *where the plume is likely to be transported*, recognising factors such as wind direction, local current variations and tidal phase.[4] **Background** is defined as measurements of turbidity representative of local ambient conditions, recognising factors such as sediment type, exposure, water depth and current direction at the impact site. To be representative of the impact site without the influence of the construction activities, the background site will generally be within 100m directly up-current of the active works area, but may be varied based on the experience and observations of Environmental Site Supervisor. **Measurements** are to be taken approximately mid depth within the water column. Continuos measurements are to be compared on the basis of a 2hr running average. Spot measurements are an average of a minimum of 20 measurements taken over at least a 1 min period. **Calibration** of turbidity monitoring buoys will be assessed by reference to the data record for datum drift, but will be undertaken at no more than 3 week intervals. Hand held equipment will be calibrated at least fortnightly or before use, whichever is less. Calibration will be to standard solutions (such as Formazine). Records of calibration will be kept and provided to Manager Environment.
Monitoring Specifications:	During construction works, a number (likely 3) automated turbidity monitoring stations will be located at critical sites relative to the active works area. These will provide a measurement of impact and background turbidity values, forming the basis of turbidity monitoring. The stations will be linked via RF modems to a computer in the Environmental Site Supervisor's Site Office. Two phases of monitoring will be implemented [5]. ***Phase 1*** If the data from the automated turbidity monitoring stations located in positions representative of impact and background as define above indicate that criteria

	are exceeded for more than a continuous period of 1hour, or in the judgement of the Environmental Site Supervisor, current work activities are likely to result in this level being exceeded, phase two investigations shall be implemented. ***Phase 2*** Investigation of the works area to determine if the work activities are, were or will be likely to generate turbid plumes sufficient to exceed action criteria defined above. This may include site-based measurements, drogue releases, dye releases, vessel based investigations or a combination of these. If in the experience and observation of the Environmental Site Supervisor, the work activities are likely to be responsible for exceeding the action criteria, implement Corrective Action.
Reporting:	All data recorded by the automated stations will be retained as digital files by the Environmental Site Supervisor for inspection as required. Daily during works - reporting to PBC Manager Environment and Project Manager of occurrences of Phases 1 and/or 2 investigations. These reports will also detail the rational for the advancement, or otherwise, to successive stages of investigation and corrective measures implemented. Monthly during works – Reporting to PBC Manager Environment a summary of data recorded and activities undertaken. Exceedences of the criteria within the Ramsar site will be reported within 2 working days to Environment Australia, along with remedial actions, as a brief report. **Performance Review** A review of the Turbidity Management Plan, including Performance Criteria, Monitoring Specifications and Corrective Actions will be undertaken on a six monthly basis. The performance review team shall be include but not be limited to representatives from the Port of Brisbane Corporation , the Environmental Protection Agency and Environment Australia.
Corrective Action:	If Phases 1 and 2 of the monitoring indicate that the works are exceeding acceptable criteria, undertake discussions with relevant Site Supervisor and Project Manager and PBC Manager Environment to determine the most effective techniques for ameliorating generation of turbid plumes. This will involve the hierarchy of controls as follows: 1. change work activities at the same site, such as reducing placement velocities, placement technique and/or frequency; 2. change the works such that generated plumes are not transported from the site (e.g. placement within bund area); 3. change work area (e.g. placement at alternate location) 4. implement control devices; 5. cease works. The implementation of these strategies will include consideration of: • tidal phase (e.g. time until tide change); • weather conditions (e.g. wind increasing, direction shifting); • works location and daily work plan (time remaining on current activity); and • likely effectiveness of above controls given site conditions.
Responsibility:	Environmental Site Supervisor

Timing:	Throughout the construction of the Future Port Expansion Bund.

5.4.1 Note 1 – Turbidity based

The focus of this EMP is the control of plumes of resuspended material emanating from the construction site. The sediment, once resuspended from the bed by the works, becomes suspended particulate material (SPM). The principal effect of increasing SPM within the water column is the optical impact, whereby the SMP alters light penetration into the water column and potentially primary production.

Traditionally, SPM has been measured and regulated as a mass calculation such as total suspended solids (TSS). The relationship between TSS and the optical impact is not constant (WBM 2001). The character of the SPM, such as size distribution, particle shapes, fall velocity, optical character, specific surface area and organic content, affects the light attenuation of the material (CCREM 1991, ANZECC 1992). In an area such as the FPE with both river and bay influences, the supply of sediment and grain sizing results in a highly variable correlation between TSS and light attenuation.

The Corporation proposes to adopt turbidity as the principal monitoring measurement. This is consistent with comments made in Australian and New Zealand Environment and Conservation Council (ANZECC, 1992), Section 2.3.6 pp2-27.

The sole use of turbidity provides the following advantages as a reactive monitoring tool:

- Turbidity can be measured and reported real time, a crucial requirement for a reactive management tool.
- The principal impact of SPM is a reduction in light penetration into the water column by either absorption or reflection of incident light by suspended particles. Turbidity provides a direct measure of the optical impact of SPM. The relationship between this and TSS is not constant.
- The measure of nephelometric turbidity is reliable, robust and repeatable.
- Turbidity is measured *in-situ* using optical backscatter sensors (OBS). These emit an infrared light source and measure the amount backscattered to a receiving source at a known angle to the emission. Pure water returns no backscatter, where increasing SPM concentration results in increased backscatter and hence increased readings in a generally linear relationship for the range anticipated at the FPE (Longstaff and Dennison 1999). These results are generally expressed as nephelometric turbidity units. Results are instantaneous and will be monitored at multiple locations in all weather conditions by remote stations, avoiding the need to have staff collect samples and inherent risk exposure.
- Multiple turbidity measurements can rapidly be made at a location to provide an average and standard deviation statistic. This is not possible with a TSS “grab” sample.

- TSS requires laboratory analysis, with results taking a minimum of twelve hours to obtain. In a reactive monitoring situation such as the FPE project, this is not a useful measure.

- The nature of the bund material is unlikely to directly impact other physical water quality parameters such as pH, dissolved oxygen content or salinity. Whilst these may be indirectly impacted through the generation of significant and persistent turbidity plumes, monitoring of these impacts is more effectively achieved through the principal process, which is turbidity.

5.4.2 Note 2 – Criteria

In the regulation of Environmentally Relevant Activities (ERA's) within Moreton Bay, the EPA has often used the following criteria:

Suspended Solids

Where background TSS is less than 100mg/L, development related change not to exceed 10mg/L, and where background exceeds 100mg/L, permitted impact not to exceed 10% of background.

Turbidity

Where background turbidity is less than 20NTU, development related change not to exceed 2NTU, and where background exceeds 20NTU, permitted impact not to exceed 10% of background.

For the reasons outlined above, the Corporation intends to use turbidity as the principal measure of development conformance. The simultaneous conditions for TSS and turbidity may be contradictory as the relationship between TSS and turbidity is not constant (WBM 2001). A 10mg/L TSS reduction corresponds with approximately 10NTU below 100mg/L based on the TSS/turbidity correlation for the FPE developed in WBM 2001. Thus the turbidity criteria above could be exceeded while the TSS condition is not.

The basis for the 10% change in turbidity criteria applied by the EPA is unknown. The Corporation has purposed a 10 NTU change when background is below 25NTU, and a 25% criteria when turbidity is above 25NTU.

This measurement is based on impact relative to background conditions rather than changes in seasonal mean nephelometric turbidity as suggested by ANZECC (1992) Section 2.3.6. The variation in a seasonal mean is not suitable as a day-to-day reactive monitoring tool. This is particularly relevant in a setting such as the mouth of the Brisbane River which is subject to greater diurnal than seasonal variation in turbidity levels. Further, no data collection undertaken in the FPE site to date provides sufficient data to confidently predicted seasonal average values.

The rational of the purposed criteria is:

- The field measurement of, and management reaction to, a change in turbidity of less than 10 NTU is not reliable, especially given the highly variable nature of the receiving environment (Figure 5.1).

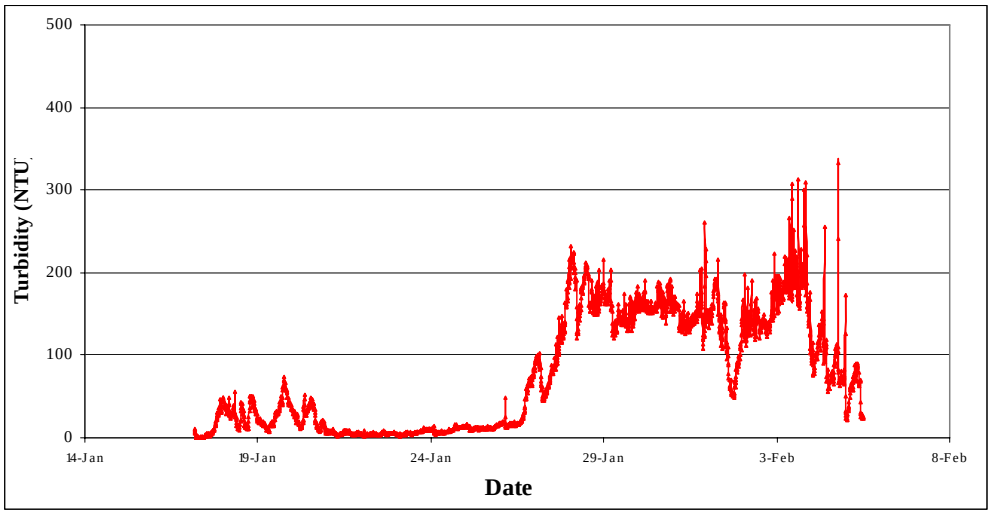


Figure 5.1: Turbidity record from FPE area 16th Jan – 6th Feb 2001.

- Monitoring of the FPE area indicates that generally turbidities are low (<20NTU), but change rapidly under the influence of wind (see WBM 2001 and BRMBWMS 1999 for a full investigation and explanation of the process). Values greater than 100 NTU were often recorded during windy conditions. The occurrence of extensive seagrass beds in these areas, with deeper sections dominated by *Holophila ovalis* and *H.spinulsoa* indicates that these species are adapted to a highly variable light environment. Works by Longstaff *et al* (1999) found that *H.ovalis* increased leaf chlorophyll concentrations once light reached 0.5% surface irradiation. Further, plant biomass started to decrease only after 3-6 days complete light deprivation, with plant death occurring after 30 days complete light deprivation. Hence the proposed criteria provide a very conservation approach to avoid impacts to seagrasses.

- ANZECC (1992) indicate that the natural eutrophic depth (z_{eu})[1] should not be permitted to change by more than 10% in waters deeper than 0.5 z_{eu}, [2]. A 10% reduction in the eutrophic depth corresponds to a 40% reduction in PAR at this depth (ANZECC 1992). Whilst the correlation between PAR and turbidity developed for the FPE area (WBM 2001) is not robust, it

[1] Eutrophic depth is defined as the depth at which photosynthetically available radiation (PAR) is reduced to 1% of the level at the water's surface. Generally, aquatic plants cannot grow at depths greater than the eutrophic depth as the energy consumed during respiration phases (photosynthetic dark reaction) is greater than that produced during photosynthesis (ANZECC 1992).

[2] Curruthers *et al* (in press) indicate that the mean annual attenuation coefficient (K_z) can be calculated utilising the minimum light requirements for the local species and the measured maximum depth limit. For the FPE area, this provides a K_z value of 0.921. Using the equations provided in by Kirk (1983, cited ANZECC 1992), the z_{eu} is 4.99m, thus the FPE area is deeper then the guideline value, 0.5 z_{eu} or 2.5m. This corresponds well with the observed lower depth limit of seagrasses at the site.

generally shows a 2:1 relationship. As such, the 25% increase in turbidity provides a useful criteria corresponding to the ANZECC (1992) guidelines. Further, it should be noted that the application of this criteria is as an immediate action level, whereas the ANZECC guidelines are for an overall change in the eutrophic depth. As such the purposed FPE EMP criteria are very conservative.

- Whilst the relationship between turbidity and light attenuation (and hence eutrophic depth), is yet to be definitively determined, data from WBM 2001 and Dennison *et. al.* (1994) indicates that turbidities below 10-20 NTU have a minimal impact on light reduction (Figure 5.2) in the water depths within the FPE area (i.e 2.5m LAT). As such, even if the background turbidities were elevated within the purposed 25% criteria, seagrass species are likely to reach light saturation during lower tides.

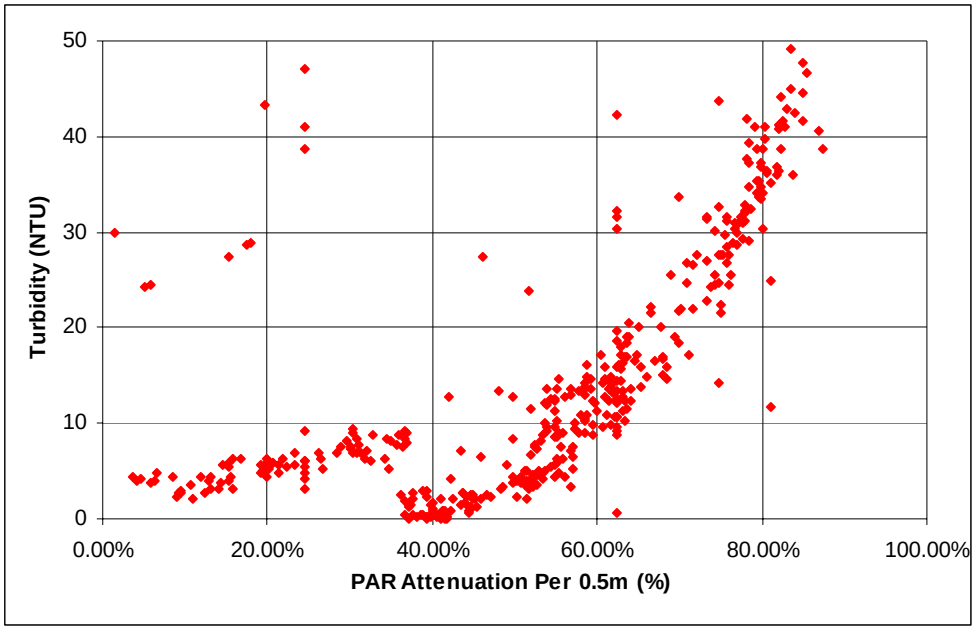


Figure 5.2: Correlation of Turbidity and PAR Attenuation for the FPE Area. Data collected in Jan- March 2001 (WBM 2001)

5.4.3 Note 3 – Environment Australia Criteria

The approval of the Future Port Expansion by Environment Australia under the Environment Protection and Biodiversity Conservation Act 1999 required that the hydrological modelling presented in Section 8.4.2 of the IAS (WBM 2000) not be exceeded by more than a factor of three. The minimum modelled impact to reach the Ramsar site was approximately 2% of the initial concentration at the construction face. As such a criteria of 6% has been adopted.

The nearest point of the Ramsar site is more than 1,000m from the start of the construction, with works extending away from this point. As such, the degradation of any plume from the works site is likely to be significant before entering the Ramsar area. Further, the Ramsar area is largely intertidal and located

south of the works area. As such, plumes from the site can only be carried to the Ramsar area on a flooding tide, 2-3 hrs after low water.

The performance criteria outlined above will trigger well in advance of the EA criteria, and as such provide a considerable safety margin. Therefore, discussions with Environment Australia have concluded that the proposed criteria will address the concerns for the protection of the Ramsar site. However, if the near field performance criteria are exceeded, sampling within the Ramsar site will be undertaken where possible (e.g. not possible at low tide) or required (e.g. not required on ebbing tide).

5.4.4 Note 4 – Impact and Background sites

Generally environmental licence conditions are prescriptive, specifying the location of the background site as an area not more than 100m directly up-current, and the impact site similarly not more than 100m directly down-current.

In previous monitoring works undertaking of dredges operating in Moreton Bay, the strict application of these criteria has proven unworkable. In many cases, natural variations in turbidities exceeded environmental licence criteria, or where up-current levels are elevated by local conditions such that impacts of the operating dredge would be unlikely to be detected.

The intent of the purposed conditions is to allow the Environmental Site Supervisor the flexibility to use additional judgement and experience in locating the impact site, and measurement of background values, possibly at a number of sites, to determine if development related turbidity is exceeding criteria.

This would take into account factors such as water depth, wind exposure, sediment type and water velocities. The location of the sites (impact and background) would be recorded in relation to the works area and the rational for their selection detailed in any subsequent reports.

5.4.5 Note 5 – Investigation and Management Options

During the construction of the FPE, the Corporation will maintain a number of automated OBS stations. These will be linked to the Environmental Site Supervisor's Site office via radio frequency modem to display a real-time measurement on a monitor. At the sites, measurements will be taken every 15mins. Each measurement will consist of 120 readings taken over a 1min period, and relayed as an average and standard deviation.

The stations will be relocated in response to site activities and conditions. This may involve drogue releases at the works area to determine the appropriate impact and background monitoring locations. Details of station location and rational will be recorded.

Plate 5.1: Automated OBS Station – FPE Area July 2000

If the data received from the stations indicates that the impact values exceed the background values by greater than the action criteria, or in the judgement of the Environmental Site Supervisor they may in the immediate future based on site conditions, investigations will be undertaken to determine if this exceedance is related to the construction activities.

Investigations will be enacted promptly and changes made to the construction activity (following the purposed hierarchy) within an hour to effect turbidity control. Where action criteria are exceeded within the Ramsar area as a result of work site activities for a period of 1 hour, the Environmental Site Supervisor will issue instructions to cease work at the site immediately. This instruction shall remain in place until site conditions change or work practices are introduced to reduce such impacts.

5.5 Marine Ecology Management Plan

Element:	Seagrass Monitoring
Policy:	To monitor potential impacts of port expansion works on seagrass[1] condition.
Performance Criteria:	No construction related impact on seagrass condition[2] external to FPE development area.
Monitoring Specifications:	Pilot study will be undertaken in Feb and May 2002. This will refine sampling strategy and monitoring design (ie. number and location of sites, number of replicate samples etc.) and provide pre-development data. Monitoring program will be undertaken at a number of control and putatively impacted locations (and sites within locations), and at regular intervals (as determined by pilot study). Indicators measured will include seagrass biomass, leaf length and shoot density. Recorded visual (eg. video or photographic) monitoring will also be undertaken at all sites.
Reporting:	Reports will be provided approximately quarterly dependant upon sampling frequency. Interim and final reports containing the results of the monitoring program are to be forwarded to the PBC Manager Environment.
Corrective Action:	PBC Manager Environment to review port expansion construction program and determine any necessary improvements in conjunction with the Site Supervisor and Project Manager.
Responsibility:	Environmental Site Supervisor
Timing:	Throughout the construction of the Future Port Expansion Bund.

5.5.1 Note 1 –Seagrass Based Monitoring

The principal focus of the marine ecology EMP will be seagrasses. Whilst it is possible that the construction of the FPE may result in impacts to other flora/fauna, (e.g. fish populations), the mobility, natural variability, sampling difficulties and long reaction time of these environmental resources do not lend themselves as effective monitoring tools. Further, the seagrass meadows adjacent the FPE area provide the source of primary production for many of the reliant systems. Thus, monitoring the seagrass will provide an early warning of potential impacts to other systems.

5.5.2 Note 2 –Monitoring Methodology

An external consortium of WBM Oceanics Australia and the University of Queensland will undertake the monitoring of the seagrasses. This will be a major project lasting for the construction period. The methodology to be employed is provided for comment as required in Appendix B.

5.6 Noise Management Plan

Element:	Noise Management
Policy:	To minimise noise impact on noise sensitive places as a result of the bund construction and reclamation works [1].
Performance Criteria:	The Performance Criteria is no complaints regarding excessive noise from construction site.
Monitoring:	On receipt of a formal complaint regarding the noise generated from the construction site, an investigation by a suitably qualified acoustic consultant will be undertaken in order to determine the source of the offending noise, assess whether performance criteria have been exceeded and to advise appropriate noise control measures. Assessment criteria are likely to include : • No exceedance of the background + 5 dB(A) criteria for noise sensitive residential receivers and no exceedance of the background + 10 dB(A) criteria for commercial premises in the period between 6:00 AM to 10:00 PM Monday to Friday and 7:00 AM to 12:00 noon Saturday. • No exceedance of the background + 3 dB(A) criteria for noise sensitive residential receivers and no exceedance of the background + 8 dB(A) criteria for commercial premises in any other time and on public holidays.
Reporting:	The Environmental Site Supervisor will keep a register of noise complaints (if any), including the complaint's details and the immediate action undertaken to reduce the noise emitted. These records will be available for audit by the Manager Environment or by relevant Administrative Authority on request. Should there be any need for noise measurement to be carried out by specialised acoustic consultant (i.e due to noise complaint to an Administrative Authority) the Acoustic Report will be retained by the Environmental Site Supervisor and made available to the Administrative Authority on request.
Corrective Action:	The Environmental Site Supervisor will be responsible for immediate rectification of any identified non-conformance with the objectives of this EMP. In the event that the non-conformance has occurred as a result of poor practices, personnel on site will be made aware of the problem immediately and informed of acceptable work practices.
Responsibility:	Environmental Site Supervisor
Timing:	Throughout the construction of the Future Port Expansion Bund.

5.6.1 Note 1 –Complaint Based Monitoring

The construction of the FPE bund is in an area remote from commercial premises (>1km) and very remote from residential areas (>5km). The works are to be undertaken in an industrial workplace, with the noise likely to be generated of a similar nature to the existing noise environment.

As such, the works are unlikely to provide an issue for management in this regard. Hence the principal management response will be investigation of specific noise complaints. If in the term of the project a number of complaints are received, overall project monitoring will be instigated.

5.7 Air Quality Management Plan

Element:	Air Quality Management
Policy:	To minimise impact on air quality, particularly in regards to airborne dust, as a result of bund construction and reclamation works.
Performance Criteria:	The Performance Criteria is no complaints regarding excessive dust from construction site[1].
Monitoring:	If a complaint to excessive dust is received, investigation by the Environmental Site Supervisor will be undertaken into the source of the dust and possible remediation options. If required, dust monitoring by a suitably qualified consultant will be undertaken in accordance with the requirements of Australian Standard AS2922 - 1987 *(Ambient Air - Guide to the siting of sampling units)* and Australian Standard AS3580.9.6 - 1990 (*Determination of suspended particulate matter PM_{10} high volume sampler with size selective inlet - Gravimetric method).*
Reporting:	The Environmental Site Supervisor will keep a register of dust complaints (if any), including the complaint's details and the immediate action undertaken to reduce the dust emitted. These records will be available for audit by the Manager Environment or by relevant Administrative Authority on request. Should there be any need for dust measurement to be carried out by specialised consultant, the report will be retained by the Environmental Site Supervisor and made available to the Administrative Authority on request
Corrective Action:	The Environmental Site Supervisor will be responsible for immediate rectification of any identified non-conformance with the objectives of this EMP. In the event that the non-conformance has occurred as a result of poor practices, personnel on site will be made aware of the problem immediately and informed of acceptable work practices.
Responsibility	Environmental Site Supervisor
Timing	Throughout the construction of the Future Port Expansion Bund.

5.7.1 Note 1 –Complaint Based Monitoring

As discussed in the explanatory notes for the Noise EMP above (Section 4.4), the construction site is relatively distant from sensitive receptors such as residential places. Further, the construction of the FPE bund will not include the rehandling of large stockpiles of material other than at the working face of the bund construction. The nature of this material is unlikely to generate significant amounts of dust.

The principal source of dust will be that disturbed by trucks on haul routes. This has effectively been managed to date via traditional techniques such as water trucks and surface treatments. This will also be undertaken during the FPE construction.

5.8 Shorebird Management Plan

Element:	Management of Potential Disturbance to Avifauna and their Habitat
Policy:	To ensure the development of the FPE bund does not negatively impact avifauna, especially migratory waders[1].
Performance Criteria:	No undue construction related impact on avifauna utilisation of Port area[2].
Monitoring:	A monitoring program is to be undertaken throughout the development of the FPE in order to assess the potential influences of port expansion related activities on avifauna. This will include monitoring of: • avifauna occurrence on roost and intertidal feeding habitats of Fisherman Islands. • assemblage characteristics including species richness and abundance. This monitoring will be in addition, and complementary to the monitoring undertaken of the current reclamation area.
Reporting:	Interim and final reports containing the results of the monitoring are to be retained by the Environmental Site Supervisor. These records will be available for audit by the Manager Environment or by relevant Administrative Authority on request.
Corrective Action:	Manager Environment to review port expansion construction and determine any necessary improvements in conjunction with the Environmental Site Supervisor and Project Manager.
Responsibility:	Environmental Site Supervisor
Timing:	Throughout the construction of the Future Port Expansion Bund.

5.8.1 Note 1 –Shorebird Based Monitoring

The FPE area is subtidal. As such it is largely devoid of terrestrial fauna, with the exception of shorebirds. As such, this group will form the basis of monitoring works.

5.8.2 Note 2 –Monitoring Methodology

The use of both the current reclamation area and the FPE by shorebirds, especially international migratory waders, is a beneficial outcome of the development which will be pursued by the Corporation within the practical limitations of an active worksite. To this ends, the Corporation has engaged a consultant with considerable experience in shorebird management to prepare an overall shorebird management plan. The details of the monitoring and management protocols are contained in this document (Appendix C).

6 REFERENCES

BRMBWMS (1999) Task RD-Resuspension Dynamics. Prepared by Brisbane River and Moreton Bay Wastewater Management Study.

Carruthers, T.J.B., Longstaff, B.J., Dennison, W.C., Abal, E.G., and Aioi, K. (in press) *Measurement of Light Penetration in relation to seagrass*. Chapter 19 of text in press.

Longstaff, B.J., Loneragan, N.R., O'Donohue, M.J. and Dennison, W.C. (1999) Effects of light deprivation on the survival and recovery of the seagrass *Halophila ovalis*. *J.Exp.Mar. Bot. Ecol.* **234**, 1-27.

Longstaff, B.L. and Dennison, W.C. (1999) Seagrass survival during pulsed turbidity events: the effects of light deprivation on the seagrasses *Halodule pinifolia* and *Halophila ovalis*. Aquatic Botany **65**, 105-121.

WBM (2000) *Proposed Port Expansion at Fisherman islands. Impact Assessment Study* Volume 1 August 2000. Prepared for the Port of Brisbane Corporation.

WBM (2001). *Water Quality Monitoring – Fisherman Islands Expansion*. Prepared for the Port of Brisbane Corporation.

Appendix A - DAILY ENVIRONMENTAL RECORDS AND COMPLAINTS RECORDS

PORT OF BRISBANE CORPORATION

Controlled Document
Information contained in photocopied material may be superseded

Issue: A
Revision: 1
Date: 20 February 2002

COMPLAINT / ISSUES FORM

Date:	
Time:	
Taken By:	

Name of Complainant:	
Organisation:	
Address:	
Telephone Number:	
Fax Number:	
Email Address:	
Complaint:	

Forwarded To:	
Date Forwarded:	

Summary of Action Taken:	
Date Action Taken:	

Is an A / I Report Required?	

Follow-up (if any):	

Sign-off by Manager Environment / Manager Quality Systems

Date:

File on M-4-70

Reference
S:\IMS Standard Forms\Complaint Issues Form.xls

Issued by the Loss Control Unit for Public Relations

PORT OF BRISBANE CORPORATION

PORT OF BRISBANE CORPORATION

Future Port Expansion – Daily Environmental Assessment Report DRAFT

Date: …… ……**Auditor** ……
Time: ……**Weather** ……..
Tides……**Comments**……
……
Site Activity (e.g. working east wall)…….

Land Based Observations

Dust……
……
……..
Noise……
……
……
Dirt onto adjacent road system……
……
Shorebirds – Species and location within ponds……
……
……
Other……
……
……
Follow-up Actions Required? YES/NO. By Who?…….**By When?**…….

Marine Observations

Location of Buoys……..
……
……
Visible Plume from Construction? YES/NO

Data indicates advancement to Phase 2 Investigations? YES/NO. File Reference……

Site Based Observations……
……
……
……
……
……
Follow-up Actions Required? YES/NO. By Who?…….**By When?**…….

Follow-up Actions
……
……
……
……
……
……..**Date**…… ……..**Attachments YES/NO**

Appendix B SEAGRASS MONITORING METHODOLOGY

Text from successful WBM Pty Ltd Proposal to Port of Brisbane Corporation, *Seagrass Monitoring – Future Port Expansion. Proposal of Services.* November 2001.

Field sampling of seagrass assemblages

We propose a combination of intrusive (physical) and non-intrusive (visual) field sampling of seagrasses at putative impact and two control sites. The proposed sampling approaches will include reference to the following variables:

- seagrass extent and coverage;
- seagrass species abundance and distribution;
- above and below ground biomass;
- shoot length and density;
- epiphytic algae coverage;
- macro algae cover (e.g. *Caulerpa taxifolia*)

Five (5) sampling episodes are proposed - two (2) sampling episodes in the initial pilot study and then a further three (3) in the first year of monitoring.

Intrusive Sampling Approach

An intrusive sampling approach involving the removal of seagrass is proposed to obtain direct measures of below ground biomass, shoot length, and species composition (particularly the differentiation of morphologically similar species), and epiphytic and macro algal cover. The intrusive sampling approach is also critical for validation of the non-intrusive sampling component.

The Impact Assessment Study for the Port expansion (WBM, 2000) identifies five different seagrass assemblages (outlined in Figure 7.2.2 of the Call for Tenders). Four of these assemblage types (continuous *Halophila spinulosa*, continuous *Halophila* spp. and *Zostera capricorni*, continuous *Zostera capricorni*, and patchy *Halophila spinulosa*) will be assessed in this study. Patchy *Zostera capricorni* is the assemblage type to be omitted which constitutes only 1.2% of the overall area seagrass adjacent to the Port.

Field sampling will consist of a number of replicated 0.09 m^2 quadrats (within each site in each zone). All material to a depth of 5-10 cm, will be removed, washed and placed in plastic bags for storage. Each sample will be sorted into taxonomic groups and the above and below ground components separated, dried and weighed. Sediment samples will also be taken along side the quadrats for analysis of particle size distribution.

The most appropriate sampling design is a nested hierarchical approach incorporating several spatial scales and appropriate temporal replication. For this approach, reference locations (at

least 2) need to be included to identify effects limited to the area of the Port and those occurring at the bay wide scale. Based on seagrass species composition recorded by Hyland (1987) appropriate reference locations containing a similar range of assemblage types to that of Fisherman Islands are likely to be Manly and Cleveland. This approach will be able to detect effects at scales of kilometres (comparing putative impact sites with reference sites), hundreds of metres (between sites within zones) and tens of metres (replicates within sites). The lower levels of spatial scales are necessary to separate other potential impacts (e.g. commercial worm digging), which operate at a spatial scale different than those resulting from Port expansion. The design will be analysed using an appropriate asymmetrical Analysis of Variance (ANOVA) approach (see Underwood, 1993; Glasby, 1997).

In order to detect a statistical significant difference from an ANOVA, the statistical test must have sufficient statistical power. Although some relevant information on seagrass parameters of interest exist (e.g. Long 1994; WBM, 2000), it is not sufficient for a rigorous analysis of statistical power under different levels of replication. WBM propose to use the first sampling period as a pilot study to identify effect size necessary for the calculation of power. Based on the results of the pilot study, different experimental options with their corresponding level of statistical power will be provided to the Port. Possible options then include: continuing as is with the approach used in the first sampling period; modifying the number of replicates within a site or the number of sites within a zone; or, only focussing on the zone or zones with the least variance and potentially the greatest sensitivity to any impacts (e.g. continuous *H. spinulosa*).

Overall the spatial pattern of sampling consists of three (3) locations (one (1) putative impact and two (2) controls), four (4) zones corresponding to the different seagrass assemblages within each location, three (3) sites within each zone and (4) replicates within each site. This equates to 144 samples per sampling episode. Five sampling episodes are proposed in the first phase of monitoring- two in the pilot phase and a further three in the first year.

Non-intrusive (Visual) Sampling Approach

We also propose to use a non-intrusive visual (video based) method for assessing above ground seagrass cover, biomass and species composition over a wide spatial scale. WBM Oceanics Australia has developed in-house, a highly mobile underwater video system, consisting of low light, high-resolution digital video cameras mounted on a variable depth probe. The probe depth can be adjusted to provide optimal resolution of bed features (such as bed form) whilst providing maximum visual coverage. The unit provides a live feed to the tow vessel, which can then be recorded on common format material, such as VHS tape. The system also allows direct audio annotation of the tape with salient features, such as site, water depth, GPS location, tide, state and/or visual observations.

The benefits of conducting video assessments are twofold. First, they provide a permanent record of the state of the seabed at the survey locations. Second, the video assessments can be viewed by a variety of individuals from various perspectives, many not anticipated at the conception of the works. For example, underwater video footage taken by WBM Oceanics for the purpose of deepwater seagrass assessments (to depths of 25m off Bundaberg) have subsequently been reviewed by coastal engineers to interpret wave and current climate. Additionally, portions of the tape were used by the client to provide stakeholders with a first hand image of the existing sea floor, providing more relevant information to a variety of parties than would be demonstrated by a written report.

We propose video sampling for two reasons. The first is for ground truthing of remote sensing information (Section 3.5). The second is as a rapid assessment approach at selected sites within a zone for estimating: seagrass cover, species composition, presence of epiphytes and macroalgae and above ground seagrass biomass. The video would be attached to a standard-sized reference quadrat for area-based assessments.

Overall (as for intrusive sampling) the spatial pattern of sampling consists of three (3) locations (one (1) putative impact and two (2) controls), four (4) zones corresponding to the different seagrass assemblages within each location, three (3) sites within each zone and (4) replicates within each site. This equates to 144 samples per sampling episode. Five sampling episodes are proposed in the first phase of monitoring- two in the pilot phase and a further three in the first year.

Broadscale Assessment of Seagrass Extent and Ground Truthing

We propose to use visual methods for monitoring and ground truthing of the extent and species composition of seagrass beds at a large spatial scale. Replicate transects will be established running perpendicular to the shoreline and extending from the inshore margin of the bed to beyond the deepwater margin. At predetermined intervals along each transect the level of the bed will be determined using either a Real-Time Kinematic Global Positioning System (RTK GPS) or a surveying staff and level. The use of the RTK GPS equipment will allow the levels of the seagrass beds to be referenced to AHD and this will provide a much more accurate and useful data record that will enable comparisons to be made between locations and time periods.

To allow for comparisons between seagrass beds it is necessary to reference the heights of the beds to a known datum level. WBM Oceanics Australia proposes, where possible, to use RTK GPS equipment to establish the absolute vertical levels of the seagrass beds referenced to AHD. This equipment is accurate to within ± 30 mm vertically and ± 10 mm horizontally. The location of the start and end point of each transect will also be recorded enabling future monitoring episodes to return to the same point each time. The limiting factor with the use of this equipment is the availability of a Permanent Survey Mark (PSM) close to the area being surveyed. For RTK GPS equipment to be accurate a Base Station has to be established over a PSM of known height. The accuracy of the equipment decreases with increasing distance between the PSM and the area to be levelled.

Upon commissioning, one of the first tasks will be in conjunction with the Port of Brisbane, to determine the location of suitable PSM's with respect to the seagrass beds to be monitored.

Data from the seagrass depth assessment will be presented in graphical format. The depth profile for each transect will be presented along with any changes in species composition or percentage cover (Figure 3.1) presents an example of the expected output. Maps of the broad scale distribution of seagrass will also be produced based on this data and with reference to aerial photography (see section 3.7).

Video Assessment at Selected Sites

We propose to use rapid assessment approach for assessing: seagrass cover, species composition, presence of epiphytes and macroalgae and above ground seagrass biomass, at selected sites within each seagrass assemblage. At selected sites, video quadrats will be taken and species composition and seagrass cover will be assessed by a point intersect method. The presence of epiphytes in this quadrats will be recorded and epiphyte cover will be categorised as "high", "medium" and "low".

The Queensland Department of Primary Industries (e.g. McKenzie *et al*., 2000) modified the method used by Mellors (1991) for visual assessment of above ground biomass using video. The method has the advantage over intrusive methods is that it allows a large number of samples to be taken. However, some intrusive sampling is still necessary to validate observations from this method. We propose to use a similar method and conduct the appropriate validations.

We propose to establish a number of sites in each of the species assemblage zones identified by WBM (2000). The video camera mounted on a frame will be lowered over the side 10 times (a video quadrat of fixed area) at each site and the image is recorded. An observer then ranks the seagrass biomass in each video quadrat on an ordinal scale from 0 referring to "no seagrass" up to 5 referring to "most seagrass". The proposed steps in this method are:

1. Identification of sites.
    - identification of a number (nominally 3) of suitable sites (approximately 50 m^2) within each zone.
2. Standardisation and calibration.
    - select reference quadrats that represent the range of seagrass biomasses likely to be encountered in each zone;
    - 10 video images over a fixed area (0.25 m^2) in each zone are taken and seagrass is removed from this area for weighing and calibration; and
    - observers rank these quadrats from 0 to 5 (without knowing biomass) and a calibration curve is fitted to the relationship between rank and biomass.
3. Surveying.
    - during each sampling episode, four (4) video images are taken over a fixed area (0.25 m^2) in each site within each zone; and
    - observers rank these quadrats from 0 to 5 and biomass is estimated from the calibration curve.

Environmental Measurements

We propose to monitor several environmental parameters relevant to the Port expansion and its potential impacts on seagrass habitats.

In-situ water quality

At each replicate transect, secchi depth and the following physical water quality parameters will be recorded using a pre-calibrated Yeokal water quality instrument:

pH;

Salinity;

Turbidity;

Depth;

Dissolved oxygen; and

Conductivity.

The Secchi depth provides a measure of the ambient light conditions and has been identified as a well-known correlate for the deep-water distributional level of several species (ANZECC/ARMCANZ

2001). Univariate statistical analysis will be used to identify any correlations between the water quality parameters and seagrass depth.

Light

Light availability is frequently the primary environmental factor controlling the depth penetration of seagrass (Dennison and Alberte, 1985). Therefore an essential component of assessing potential impacts upon seagrass communities should involve accurate assessment of the light climate (Longstaff *et al*., 1999). One potential impact of the port expansion is an increase in turbidity in the waters of Fisherman's Island, documenting the light climate of this region as well as the control sites is therefore essential.

While the use of a Secchi disc is a standard method for obtaining an instantaneous estimate of ambient light conditions, it is becoming increasingly recognised that small-scale temporal and spatial variations in light are significant to seagrass. It is therefore recommended that long term logged PAR in addition to instantaneous measures are taken wherever possible (Carruthers *et al*, 2001).

During the pilot study, variation in light climate across the study site will be assessed with instantaneous measurements under different tidal flow conditions. At two appropriate sites within the study area and at each control site, light loggers will be deployed for continuous measurement of attenuation coefficient (K_d). Two light loggers will be deployed, with cleaning units to minimise accumulation of sediment and overgrowth of algae onto the sensor surface. Loggers will be downloaded monthly, over the 12 months of the monitoring period.

Long term monitored light data will be related to maximum depth limit of the different seagrass species, and will provide a baseline for assessing potential changes in light climate in future monitoring.

Remote Sensing

Traditional aerial photography has been shown to be an effective monitoring tool for mapping the area of seagrass south of Fisherman Island. Digital remote sensing technology combined with field data is capable of improving this methodology by using a combination of different bandwidths over the visible light spectrum. The Marine Botany Group and the Biophysical Remote Sensing Group are working together with CSIRO Land & Water in developing these techniques for the marine environment.

Remote sensing will have two components:

1. In the pilot phase, three different remotely sensed data types and processing approaches would be compared to identify the most accurate and cost-effective data/processing approach to use in the Fisherman Island region. For this purpose airborne and satellite image data sets collected over the past three years by UQ will be used in combination with standard image processing techniques.

2. In the second component, image data will be collected for the project area with a multi-spectral airborne digital camera (owned and operated by UQ) from a small plane. The image collection will occur during an extreme low tide to capture exposed areas of seagrass. This will reduce the challenge of extracting substrate information in nearshore environments caused by water depths and its optical properties. The resulting image data will be classified according to collected field data and satellite imagery. The final product will be a map of seagrass distribution for the project area.

Conceptual Models of Seagrass Communities

It is intended to synthesise known information about static communities and habitat processes into a series of conceptual models of the seagrass communities of Fisherman Islands. This method has been successfully employed by Marine Botany to effectively communicate at both a management (Abal *et al*., 2001) and scientific (Carruthers *et al*., in press) level.

The initial stage of the project will include a desktop study using current generic models of seagrass habitats in Queensland coastal environments (Figure 3.2), these will be modified to include site specific data (eg Long *et al*., 1994, WBM Oceanics Australia 2000). Production of conceptual models will provide a framework for identifying current gaps in knowledge of the area, assessing important processes in terms of potential impacts and eventually for communication of findings.

Predictive (Numerical) Models of Seagrass Communities

The Numerical Ecology and Spatial Modelling (NESM) group of the Cleveland based CSIRO Marine Research division is in the process of developing a seagrass prediction model for the Moreton Bay. This work is (partly) undertaken within the Ecosystem Health Monitoring Program (EHMP) framework, in close collaboration with Marine Botany at the University of Queensland and the Queensland EPA. We are able to offer access to this modelling technology through our links with CSIRO, Marine Botany and The Ecology Centre (UQ), where the key modeller is a PhD student.

The model is based on what are thought to be the major environmental drivers for seagrass growth i.e. available light, inter- and intra-species competition, temperature and available nutrients and possibly water current induced bottom stress. Estimations of available light are calculated using water turbidity, bathymetry and diurnal and seasonal daylight regimes.

Spatio-temporal prediction methods have been developed and applied (using core water quality data as collected through the EHMP program) providing the model with high-resolution environmental descriptors of the Bay.

Physiological responses of seagrass to these external drivers are currently estimated based on literature values, with the expectation to replace these with local measurements if and when they come available. Information from the Port of Brisbane seagrass monitoring program may also contribute to the improvement of the model through environmental and ecosystem measurements.

Two main applications of the model for the Port of Brisbane seagrass monitoring project are to supply critical environmental values impacting on seagrass growth to be used as triggers for the monitoring program and to systematically model environmental management options to estimate impacts on the seagrasses.

Geographical Outputs

Both WBM Oceanics and UQ have significant expertise and equipment for the production of high quality geographical outputs. We propose to prepare seagrass maps, similar to those provided as Figure 7.7.2. in the Call for Tenders. These maps will illustrate the broad scale distribution of seagrass adjacent to the Port of Brisbane.

Importantly, these maps can be compared with previous mapping exercises to aid visualisation of broad scale trends over time. Specifically, we will compare and interpret map outputs from the proposed sampling with those obtained in 1992, 1998 and 2000. We propose to use methods that are directly comparable, thus, allowing for assessment of trends through time.

Appendix C - SHOREBIRD MANAGEMENT PLAN – PORT OF BRISBANE FUTURE PORT EXPANSION

PORT OF BRISBANE

SHOREBIRD MANAGEMENT PLAN

Port of Brisbane Corporation

BRETT LANE & ASSOCIATES PTY LTD
Ecological Research and Management
P O Box 597
Mansfield, Vic. 3722
Ph. (03) 5779 1217
Mob. 0418 110 324
Email: Brett.Lane@bigpond.com

February 2002

Report No. 2001.42C(1.3)

CONTENTS

1.0 INTRODUCTION

The Port of Brisbane Corporation is constructing a 230 ha reclamation seaward of its current operations on Fisherman Islands, on the southern side of the mouth of the Brisbane River in Moreton Bay. This development is occurring in response to projected demand for additional shipping berths, container storage and commercial warehouse development.

The 25 year construction period will require ongoing management of potential environmental impacts. Construction and Operational Environmental Management Plans will be developed for each stage of the development that sit within the wider Port of Brisbane Environmental Management System (EMS).

Migratory and resident shorebird populations of international significance feed and roost in and near the port. These shorebirds are one of a number of significant environmental values in and near the Port of Brisbane for which conditions were place on the development approval issued by the relevant regulatory agencies. This plan provides a framework for managing the potential impacts of the Corporation's activities on shorebirds across all land that it controls, including the new reclamation area. This plan is also a significant component in the implementation of the Corporation's Environmental Policy and EMS.

Brett Lane & Associates Pty Ltd has developed this Plan in consultation with the Environment Protection Agency, Queensland Parks and Wildlife Service and the Queensland Wader Study Group. Port Corporation Environmental personnel (Wayne Young and Brad Kitchen) provided significant assistance. We are very grateful to these groups for their worthwhile input.

1.1 Purpose of the Plan

A number of activities and decisions in recent years have provided impetus to the development of this plan. These are described briefly below.

- The Port of Brisbane Corporation has committed to an Environmental Policy and has implemented an EMS to bring greater control over the environmental impact of its activities.

- The activities and developments at the Port of Brisbane have the potential to affect the populations of shorebirds. This has been recognised by the Corporation and by the regulatory agencies that reviewed and approved the new development.

- The Port of Brisbane Corporation has recognised the importance of shorebirds on its land and has provided for the development of a 12 ha roosting wetland as part of current and proposed port development. Other opportunities, such as the eastern edge of the Future Port Expansion, will be investigated as they become available.

- The environmental significance of Moreton Bay has been recognised through:

    - Its designation as a Wetland of International Importance under the Convention on Wetlands (the "Ramsar" Convention);
    - Its listing as a site on the East Asia – Australasia Shorebird Reserve Network;

- Its designation as a Marine Park under the Queensland *Marine Parks Act 1982* and its management consistent with the *Marine Park (Moreton Bay) Zoning Plan 1997*; and
- The forthcoming preparation of a Regional Coastal Management Plan for south-east Queensland under the *Coastal Protection and Management Act 1995.*

These developments affect how the Corporation manages the Port, in particular how it manages its potential impacts on Moreton Bay and on shorebirds, one of the Bay's most significant values.

The purpose of the plan is to provide a coordinated framework for the protection of shorebirds and the management and enhancement of their habitat in the Port while allowing demand for port services to be met through future port expansion.

The Corporation is committed to expansion of its Port services to the South-east Queensland and wider Australian community. It is also committed to doing so in a way that protects the environment, including maximising shorebird habitat opportunities during and after port expansion works.

The Shorebird Management Plan enables the Corporation to fulfil these commitments and to meet the conditions of its development approval while meeting its boarder state, Commonwealth and international obligations related to shorebirds.

1.2 Organisation of the plan

This plan is divided into the sections described below.

Section 2 describes the regulatory and policy context of the plan and provides information on the relevant legislation, regulations, policies and plans that influence how the Corporation approaches the management of shorebirds.

Section 3 summarises information on the shorebirds of the Port, including the species involved, their numbers and significance, and their usage of habitats. In particular, a description is provided of the way that shorebirds change their usage of areas as reclamation proceeds , as a basis for guiding management.

Section 4 provides a goal and objectives for shorebirds management at the Port. The objectives address key issues and set both directions and management outcomes.

Section 5 sets out strategies and actions to be taken by the Corporation to achieve the management goal and objectives set out in section 4. Activities and outcomes are described for each management objective.

Section 6 provides a framework for implementation of the activities in this plan. It addresses roles and responsibilities and implementation timing.

2.0 CONTEXT OF PLAN

This section describes the regulatory and policy context of the plan and provides information on the relevant legislation, regulations, policies and plans that influence how the Corporation approaches the management of shorebirds.

The following levels are considered under separate headings:

- International;
- National (Commonwealth);
- State (Queensland);
- Regional (Moreton Bay); and
- Local (Fisherman Islands).

2.1 International

The Port of Brisbane is located within Moreton Bay, which is listed as a wetland of international importance on the **Convention on Wetlands** (Ramsar, 1971), also known as the Ramsar Convention. The convention obligates signatory countries to protect listed sites by managing them consistent with the principles of wise use. This involves protecting and using wetland resources but at the same time maintaining the ecological character and attributes of the site. This approach is consistent with the principles of ecologically sustainable development.

Many of the shorebirds that use the Port of Brisbane are listed on international migratory birds agreements, in particular:

- The Japan – Australia Migratory Birds Agreement (JAMBA); and
- The China – Australia Migratory Birds Agreement (CAMBA).

These agreements provide for the protection of migratory shorebirds and their habitats. Some 20 species of birds listed on these agreements occur on Fisherman Islands.

2.2 National

The Commonwealth government has agreed with the states on activities for the implementation of the international agreements described in Section 2.1 at a state level. This agreement is called the Inter-governmental Agreement on the Environment (IGAE).

Consistent with this agreement, the Commonwealth has developed policies and programs, including the **Wetlands Policy for the Commonwealth of Australia**. This policy requires the Commonwealth to promote the conservation, repair and wise management of wetlands.

The Commonwealth government has also enacted the ***Environment Protection and Biodiversity Conservation Act 1999*** (EPBC Act), which clearly defines the Commonwealth's role in environmental matters, as agreed in the IGAE. Specifically, it requires Commonwealth approval for any actions that are likely to have a significant impact on matters of national environmental significance. Among these matters are Ramsar Wetlands and Listed Migratory Species (including those listed on the agreements mentioned in Section 2.1).

The Port of Brisbane Corporation obtained approval under the EPBC Act on 8th July 2001 for the development of the future port expansion area. The approval has effect for Sections 16 and 17B (wetlands of international importance) and Sections 20 and 20A (listed migratory species) of the Act. As a condition of approval, construction could not commence before Commonwealth approval of

> "a plan for managing the impacts of construction of the bund wall and reclamation works on listed migratory species…".

This plan responds to this requirement and is a draft for consideration by the Commonwealth.

2.3 State

The migratory shorebirds feed at low tide in the Moreton Bay Marine Park, which is subject to the provisions of the Queensland *Marine Park Act 1982* and the *Marine Parks (Moreton Bay) Zoning Plan 1997*. The marine park boundary follows the edge of the Port and the FPE area. The areas of shorebird feeding habitat adjacent to the Port lie in a "habitat zone", the aim of which is to protect habitat from shipping activities and mining.

Section 66 of the *Marine Parks (Moreton Bay) Zoning Plan 1997* provides specific provisions for managing disturbance to shorebirds within the Marine Park. These acknowledge the sensitivity of shorebirds to disturbance and recommend measures for reducing human disturbance.

The Queensland Government recently issued a Coastal Policy under the *Coastal Protection and Management Act 1995* (the Coastal Act). This calls for a range of measures, the most relevant of which are the protection of coastal wetlands and coastal biodiversity, and the development of regional coastal management plans.

The FPE area development project was subject to an exhaustive environmental assessment process under the *State Development and Public Works Organisation Act 1971.* This required the preparation of an Impact Assessment Study (IAS) and associated Environmental Management Plan (EMP). The IAS (WBM Pty Ltd 2000), including the associated environmental management plan was approved in 2001. The EMP contained in the IAS has specific directions for birds in the area, including the following requirements:

- Construction schedules and plans that minimise disturbance during periods of peak shorebird usage of the reclamation area (Sept-Oct and Mar-Apr);
- Rehabilitation of injured birds;
- Temporary fencing and visual separation of birds and areas of construction activity; and

- Establishment of a permanent, secure high tide shorebird roost.

In addition, other shorebird habitat enhancement activities were flagged in the IAS.

This shorebird management plan provides a detailed framework for implementing these requirements.

2.4 Regional

A **Coastal Management Plan for South-east Queensland** is currently being prepared under the Coastal Act. The content of this plan is not finalised but it is expected to set management directions that include protection of coastal wetlands and shorebirds in the region. The district office of the Queensland Parks and Wildlife Service is preparing a **Shorebird Management Plan for Moreton Bay Marine Park**, which will be a component of the regional coastal management plan.

The Moreton Bay Marine Park Shorebird Management Plan will contain strategies and site-specific actions aimed at:

- Preventing human disturbance to shorebirds;
- Protecting shorebird habitats;
- Promoting shorebird conservation; and
- Protection measures at critical sites.

Discussions with personnel from the service indicate that Fisherman Islands is considered to be one of a small number of the critical shorebird sites in Moreton Bay requiring urgent management. This Shorebird Management Plan for the Port of Brisbane is considered to be an important component of the plan for the whole Bay.

2.5 Local

For the purposes of this plan, 'local' refers to Fisherman Islands and the area under the control of the Port of Brisbane Corporation.

A range of policies and plans of the Corporation apply to the management of Port activities that may have an impact on shorebirds. These are described briefly below.

The Port of Brisbane Corporation has an **Environment Policy** that includes commitments to eliminate or control risks to the environment through performance targets and monitoring. Specific environmental management objectives, targets and actions are indentified in an **Environmental Management (EM) Program**.

The Port of Brisbane Corporation manages its Environmentally Relevant Activities (ERAs) through an **Environmental Management System**, which sits within the Integrated Management System (IMS) for all its operations. All activities on Port land, including those of the Corporation, its tenants and contractors. The system provides guidance to Corporation personnel, tenants and contractors on:

- Key Environmental Issues at the Port;
- Management Responsibilities for those issues and actions to address them;
- Monitoring and Reporting requirements;
- The development of activity- or project-specific environmental management plans.

All construction works and operating activities of the Corporation, its tenants and their contractors must be undertaken consistent with the requirements of this system, supervised by the Corporation's Environment Department.

The **Environmental Monitoring and Measurement Section** of the Environmental Management System includes a schedule of monthly bird monitoring counts. These counts have been incorporated into the current shorebird management plan, together with investigations aimed at informing optimal management of shorebird habitats.

The potential environmental risks associated with the development of the FPE area will be managed through a **Construction Environmental Management Plan**. Implementation of this plan will be an important commitment of the construction contractor, supervised by the Corporation's Environment Department. This Shorebird Management Plan is an important component of the Construction Environmental Management Plan for the FPE area development project.

The proposed permanent shorebird roost area will be subject to an **Operational Environmental Management Plan** within the Corporation's Environmental Management System. This shorebird management plan forms an important component of this plan.

All these Corporation procedures will be implemented as part of environmental conditions of approval for the FPE area development.

3.0 THE SHOREBIRDS OF THE PORT OF BRISBANE

This section provides information on the shorebirds of the Port of Brisbane as background to the development and implementation of this plan. Information is presented under the following headings:

- Shorebird behaviour;
- Use by shorebirds of Fisherman Islands and surrounding areas; and
- Significance of Fisherman Islands and the FPE area.

3.1 Shorebird behaviour

The shorebirds are a group of wetland birds that forage on wet mudflats on a range of invertebrate and plant food. They belong to the families Scolopacidae, Burhiniidae, Haematopodidae, Recurvirostridae, Charadriidae and Glareolidae. Many species breed in the Northern Hemisphere and migrate thousands of kilometres southwards to spend the southern spring, summer and early autumn in Australia.

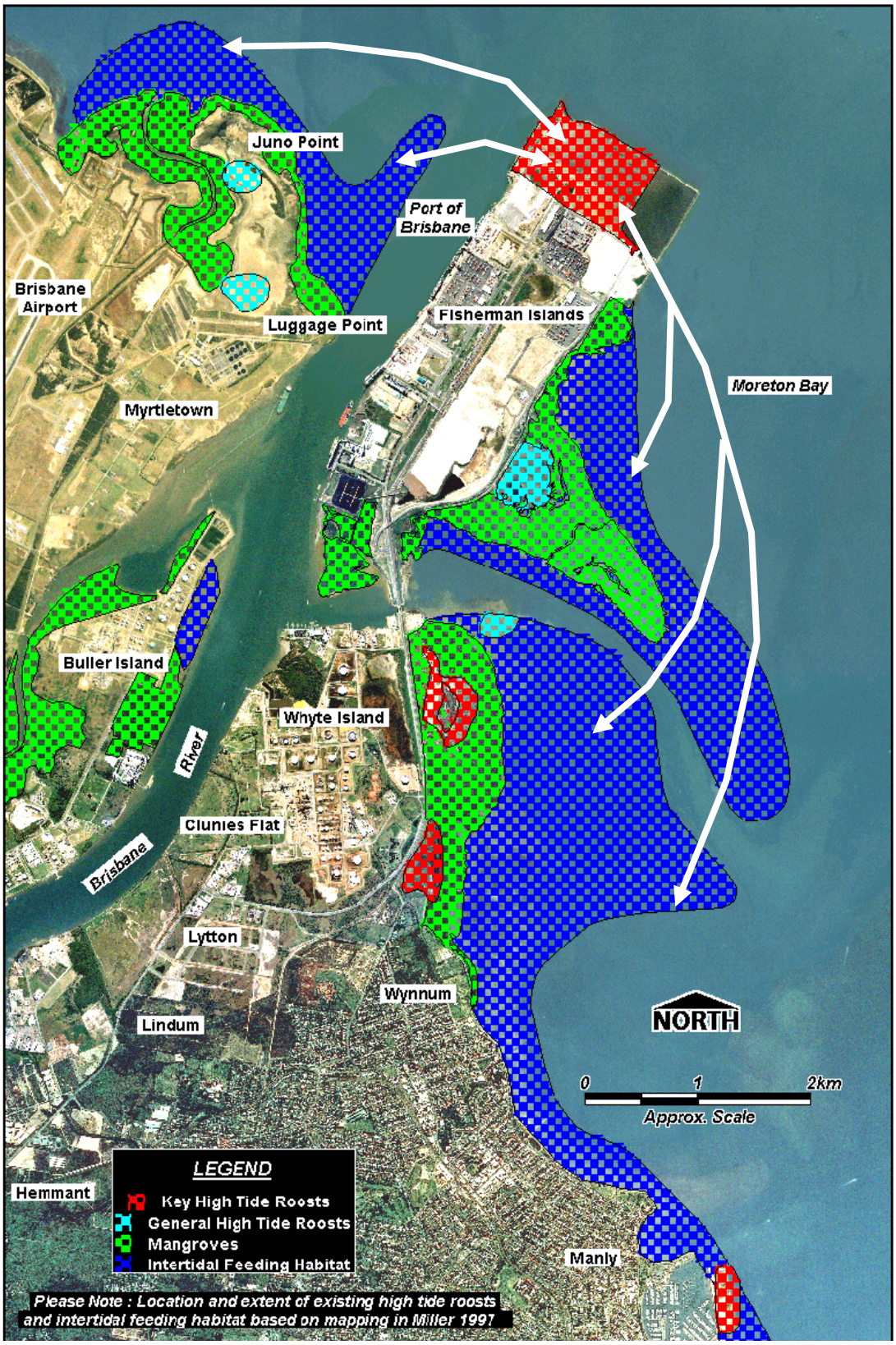
During spring (Sept – Oct) and autumn (Feb – Apr) migration periods, numbers of shorebirds in Moreton Bay reach peak numbers, indicating passage of birds southwards then northwards again from habitats along the Australian south-east coast (Driscoll et al. 1993). At this time, they are using Moreton Bay as a rich source of food that enables them to deposit fat, used as fuel during subsequent migratory flight. As shorebird energetics is finely balanced at these times of year, reduced disturbance-induced energy consumption is important for the deposition of sufficient fat reserves for migration and breeding.

Shorebirds tend to occur in their largest numbers in coastal wetlands. At low tide they forage across the extensive mudflats exposed in Moreton Bay. At high tide they are forced to fly to high ground to roost on beaches, saltmarshes and artificial ponds.

This group of birds can be very sensitive to human disturbance for two reasons, described below.

Many migratory shorebird species are hunted in Asia when migrating between their high latitude breeding areas and their southern non-breeding habitats. This has made many species, particularly the larger species, such as Eastern Curlew, Bar-tailed Godwit, Great Knot and Greenshank, very wary and easily flushed from roosting sites.

Figure 1: Map showing the location of shorebird feeding and roosting areas in and near the Port of Brisbane. (Notional flight zones arrowed).



Disturbance can interrupt feeding or increase the amount of time shorebirds spend flying. Regular disturbance can reduce total food intake and increase energy consumption. This can limit weight gains prior to migration, potentially reducing the chances of successful migration. Disturbance can ultimately reduce the breeding success of both migratory and resident shorebird species. Chronic disturbance can lead to the complete desertion by shorebirds of the most disturbed areas of otherwise suitable habitat (Davidson & Rothwell 1993), at least during daylight hours when human activity is at its highest.

3.2 Shorebird usage of Fisherman Islands

The locations of low tide feeding habitats and high tide roosting areas on and near the port of Brisbane are shown on Figure 1.

Low tide feeding areas include most intertidal mudflats to the north-west and south-east of the Port. High tide roosts include open areas at the back of mangroves on the eastern shores of Whyte Island and Fisherman Islands and behind Juno and Luggage Points, a shallow water roost at Manly Boat Harbour, and the paddocks of the current reclamation area.

In the current reclamation area, birds roost in 'paddocks' that have filled to above the water with dredge spoil and have a mix of shallow water, wet mud and dry mud habitats. Once the "paddocks" are filled with sand, they are dry and no longer used by shorebirds.

Figure 2 provides a recent aerial view of the current reclamation area indicating areas used by roosting shorebirds.

Figure 2 demonstrates that at any time in the reclamation process, a number of roosting options are available to shorebirds. This is considered again in Section 5.0.

In addition to the wet dredged material in the "paddocks" of the reclamation area, some species of shorebirds roost at high tide on sheltered artificial rock walls, either within the "paddocks" or on the lee shore of the existing reclamation area. This behaviour is likely to continue during and after the completion of the future port expansion area.

Shorebirds move between high tide roosts and low tide feeding areas in either direction depending on the state of the tide. These zones of movement are currently unobstructed by port infrastructure or development, enabling the free movement of shorebirds from their feeding areas northwest and southeast of the reclamation area roosts. P. Driscoll (Queensland Wader Study Group, pers. comm.)

Figure 2: Oblique aerial view (looking southwest) of the current port reclamation area indicating areas used by shorebirds for roosting at high tide (outlined). (Source of Photo: Port of Brisbane Corporation 2000).

has not observed shorebirds moving over developed parts of the port. Based on this consistent observation, and the final layout of the FPE area, concern has been expressed that distances between the final roosting and feeding sites in and near the port may become too great (WBM Pty Ltd 2000). As potential flight zones will eventually become occupied by built development, this may lead to significant impacts on shorebird numbers in the port area. This issue is dealt with in Section 5.0.

3.3 Significance of Fisherman Islands for Shorebirds

The shorebirds that use Fisherman Islands and the numbers in which they occur are presented in Table 1, together with an estimate of the numbers in south-east Queensland (mostly Moreton Bay).

The numbers of birds in southeast Queensland are based on summer averages for regularly counted areas and, in part, maximum counts for resident species or for areas not counted as regularly. For this reason, the numbers given for southeast Queensland in Table 1 are not directly comparable with the maximum counts presented for the Port area. However, the information presented provides some indication of the role of the Port area as a shorebird habitat in Moreton Bay. For many shorebird species, the area supports a high proportion of the regional population. The region supports a significant proportion of the Queensland

population of shorebirds, including 17 species represented by more than four percent of the state population (Driscoll 1997).

Table 2: Shorebird species and number using Fisherman Islands.

SPECIES	CAMBA JAMBA LISTED?	MAX. NUMBER AT PORT*	NUMBER IN S.E.QLD**
Black-tailed Godwit **Limosa limosa**	Y	350#	368
Bar-tailed Godwit **L. lapponica**	Y	1,604	16,638
Whimbrel **Numenius phaeopus**	Y	251	2,149
Eastern Curlew **N. madagascariensis**	Y	473	4,726
Marsh Sandpiper **Tringa stagnatilis**	Y	40	94
Common Greenshank **T. nebularia**	Y	33	498
Terek Sandpiper **Xenus cinereus**	Y	30	949
Grey-tailed Tattler **Heterosceles brevipes**	Y	471	4,393
Ruddy Turnstone **Arenaria interpres**	Y	26	221
Great Knot **Calidris tenuirostris**	Y	2,600	1,476
Red Knot **C. canutus**	Y	410	69
Red-necked Stint **C. ruficollis**	Y	1,389	1,382
Sharp-tailed Sandpiper **C. acuminata**	Y	906	299
Curlew Sandpiper **C. ferruginea**	Y	2,434	2,237
Broad-billed Sandpiper **Limicola falcinellus**	Y	6	0
Pied Oystercatcher **Haematopus longirostris**	N	333	1,047
Black-winged Stilt **Himantopus himantopus**	N	344	357
Red-necked Avocet **Recurvirostra novaehollandiae**	N	731	726
Pacific Golden Plover **Pluvialus fulva**	Y	300	277
Grey Plover **P. squatarola**	Y	98	217

SPECIES	CAMBA JAMBA LISTED?	MAX. NUMBER AT PORT*	NUMBER IN S.E.QLD**
Red-capped Plover **Charadrius reficapillus**	N	40	287
Double-banded Plover **Charadrius bicinctus**	N	45	148
Lesser Sand Plover **C. mongolus**	Y	690	1,887
Greater Sand Plover **C. leschenaultii**	Y	669	461
Oriental Plover **C. veredus**	Y	6	6
Black-fronted Plover **Elsyornis melanops**	N	5	9
Red-kneed Dotterel **Erythrogonys cinctus**	N	3	–
Masked Lapwwing **Vanellus miles**	N	2	80

* Driscoll (1998) Maxima for period 1991 – 1998. ** Driscoll (1997).
# Numbers have declined in recent years.

The foregoing indicates that the Fisherman Islands roosts make an important contribution to the regional shorebird population which has been shown to meet the Ramsar criteria for international importance, namely, it supports more than 1% of the flyway population of one or more waterbird species.

4.0 GOAL AND OBJECTIVES FOR SHOREBIRD MANAGEMENT

This section provides a goal for shorebird management at the port, and documents issues and sets objectives for the shorebird management activities at the Port.

4.1 Goal

The goal of shorebird management at the Port is:

"To maintain and protect shorebird populations at the Port through the active management and enhancement of their habitats while meeting demand for port services through ecologically sustainable development."

Ecologically sustainable development in this case allows for current and future port development and uses, while protecting the ecological processes on which shorebirds at the port depend, notably their needs for secure roosting habitat.

4.2 Risks to shorebirds

This section documents potential risks to shorebirds from activities at the port and identifies the mechanisms by which risks could be managed. Risks arise from the following activities that occur at the Port.

- The movement of people, vehicles and freight about the Port;
- Routine maintenance of port infrastructure;
- Construction of new port infrastructure, including reclamation;
- Port landscaping and open space maintenance;
- Design, construction and operation of tenant facilities (including stormwater);
- Materials handling (including spills); and
- Emergency response.

The priority given to managing these risks will change depending on the area of the shorebird habitat involved and the stage of development of the future port expansion area. As indicated in Section 2, the key shorebird habitat areas covered by this plan are the existing and future port expansion (FPE) area and the permanent bird roost (PBR). The potential risks to shorebirds in these areas are documented in Table 2.

Table 3: Risk assessment for shorebirds at the Port of Brisbane and management responses.

PORT ACTIVITY	POTENTIAL RISK TO SHOREBIRDS
EXISTING AND FUTURE PORT EXPANSION AREA	
STAGING CONSTRUCTION WORK	▪ Staging without regard of shorebird habitat needs, leading to periods without secure roosting habitat available.
THE MOVEMENT OF CONSTRUCTION VEHICLES, EQUIPMENT AND PERSONNEL	▪ Disturbance to shorebirds from noise and activity ▪ Exclusion of shorebirds from potentially suitable temporary habitat.
DREDGED MATERIAL DISPOSAL	▪ Degradation or loss of temporary shorebird habitat, through filling of temporary habitat and/or inappropriate water level management in "paddocks".
PERMANENT BIRD ROOST	
PORT LANDSCAPING AND OPEN SPACE MAINTENANCE	▪ Deterrence of shorebirds from roosts by tall and close planting of trees (incl. mangroves) near roosting habitat. ▪ Disturbance to shorebirds from noise and activity of landscape and open space maintenance activities
PORT LAND USE	▪ Interference with bird flight paths to feeding areas
DESIGN, CONSTRUCTION AND OPERATION OF TENANT FACILITIES, INCL. STORMWATER RUNOFF	▪ Disturbance of shorebirds by personnel, vehicles and equipment at tenant facilities. ▪ Location of noisy or very active facilities near shorebird habitat leading to disturbance. ▪ Contaminated stormwater runoff
MATERIALS HANDLING	▪ Spills of fuels and oils from construction sites. ▪ Windblown materials (e.g. bulk cargoes) degrading shorebird habitats
EMERGENCY RESPONSE	▪ Oil Spills on Moreton Bay near or from the Port. ▪ Fire

4.3 Shorebird Management Objectives

Objectives for the management of shorebirds at the Port of Brisbane are presented below. They are based on the requirement to manage shorebirds in two separate areas: the future port expansion area and the permanent bird roost.

Objectives for each area are presented below.

4.3.1 EXISTING AND FUTURE PORT EXPANSION AREA (FPE AREA)

Objective One: Plan and execute development of the existing and future port expansion area in a manner that maintains suitable shorebird roosting habitat until near the completion of the project, wherever practical by:

- Staging dredge spoil disposal to ensure temporary habitat is available;
- Maintenance of appropriate water and sediment levels in temporary habitat areas;
- Undertaking active works in areas mostly separated from habitats being used by significant numbers of shorebirds;
- Monitoring shorebird usage of areas and adapting works plans to optimise shorebird habitat opportunities.

4.3.2 PERMANENT BIRD ROOST AREA (PBR)

Objective Two: Provide a permanent, secure shorebird roosting habitat on Fisherman Islands by:

- Providing a 12 hectare area of dredge spoil (and other areas where possible) managed solely for this purpose;
- Maintaining water and sediment levels in this area at optimum levels;
- Protecting water quality in the habitat through prevention of pollution;
- Preventing human disturbance through appropriate planning and control of adjacent land use and sensitive on-site land management; and
- Monitoring shorebird usage of the area and adapting management to maximise shorebird usage and the availability of suitable habitat.

4.3.3 ADAPTIVE MANAGEMENT AND MONITORING

Adaptive management refers to a way of managing natural resources where management actions are regularly reviewed and, if necessary, modified based on monitored changes in environmental condition. Implicit in this approach is the need for benchmarks or targets for management. Adaptive management therefore allows the performance of management actions to be monitored, thereby bringing greater accountability and, potentially, increasing the cost-effectiveness of management activities. A corollary of

adaptive management is a commitment to monitoring and to a mechanism for regularly reviewing the results of management activities. This is dealt with in more detail in Section 6.

The adaptive management approach has been adopted for the reasons outlined below.

Not all the effects of future port development are accurately predictable.

The future port expansion project presents opportunities for continuing to provide shorebird habitat on Fisherman Islands concurrent with progressive, staged development of the project.

The methods for ensuring that the permanent habitat area remains optimal for shorebirds are not fully understood.

In the light of these uncertainties, an approach to management that includes flexible management responses guided by monitoring is considered necessary. This will ensure that shorebirds continue to use the port in significant numbers, notwithstanding the ongoing changes occurring to their habitats.

5.0 STRATEGIES AND ACTIONS

Based on the two management objectives for this plan in section 4.3, two strategies with associated activities have been formulated. These are presented in this section. For each strategy, information is presented under the headings described below.

Objective reiterates the broad objective of the strategy.

Management targets lists the measurable outcomes of management that demonstrate that the objective is being met.

Management activities lists a series of actions designed to meet the targets, in tabular form.

Monitoring requirements and adaptive management describes the scope of monitoring activities necessary to monitor progress against targets.

Lines of accountability and reporting will be the same as those established within the Corporation's Environmental Management System for the Environmental Management Plans established for each strategy.

5.1 Future Port Expansion (FPE) Area Strategy

Objective

Plan and execute development of the future port expansion area, including bund wall construction and reclamation paddock filling, in a manner that maintains suitable shorebird roosting habitat until near the completion of the project, wherever practicable.

Management and monitoring targets

Achieving this objective will involve meeting the targets below.

- Temporary roosting habitat will be available whenever practicable for use by shorebirds roosting at high tide in *at least* two reclamation paddocks simultaneously for as long as possible for the life of the project. Particular priority will be given to maximising the numbers of alternative "paddocks" available during the migration periods (Sept-Oct and Feb-Apr).

- Water and sediment levels in temporary habitat areas ("paddocks") will be maintained in a suitable condition for shorebird roosting, including a diversity of wet and dry substrates on shores of very low slope.

- Temporary habitats will be separated from bund wall construction works areas and related truck access routes by a distance of at least 150 metres, the distance at which the most sensitive species is disturbed (Eastern Curlew, P. Driscoll, Queensland Wader Study Group, pers. comm.). A precautionary distance of 200 metres should be used wherever practicable. (This will negate the requirement for any fencing or artificial screening.)

- At construction works sites, areas with the highest activity levels will be located on the far side of the construction works site from the nearest temporary shorebird roosting habitat to reduce the chances of disturbance and maximise opportunities for using temporary buildings to screen such activities from habitats.

- Shorebird use of the FPE area, including pond-specific occurrence, and surrounding habitats (see Driscoll 1998 for areas) will be monitored on a routine basis at least once per month, in combination with QWSG counts.

- Activities undertaken to manage the impacts of development and construction on shorebirds will be thoroughly and accurately documented, in order to build up a database of shorebird responses to management intervention and to enable management responses to be refined and improved.

6.0 Management Activities

Management activities to meet targets are tabulated below. (Note that FPE area refers to the existing and future port expansion areas.)

Management Target	Management Activities
Maintain *at least* two alternative habitat areas for roosting shorebirds	▪ *Develop dredging and "paddock" filling plans to ensure two or more alternative roosting habitats are available in the FPE area whenever practicable.* ▪ *Annually review these plans in the light of construction requirements and shorebird monitoring results* ▪ *Monitor habitat conditions for shorebirds in each available "paddock" monthly to ensure availability.* ▪ *Significant changes to "paddocks" to be filled (e.g. after a "paddock" has filled) should occur in May, and dredging timed accordingly, so new habitat can be created by September.*
Maintain suitable water and sediment levels in reclamation "paddocks"	▪ *Investigate and document the relationship between "paddock" water levels, sediment levels, habitat types and shorebird usage over the life of a "paddock" (starting in the existing reclamation area).* ▪ *Based on this investigation, develop a "paddock" filling method that maximises the extent and duration of suitable shorebird habitat in each pond.* ▪ *Implement this method of "paddock" filling wherever and whenever practicable.*
Separation from construction areas	▪ *Identify areas where construction activities will be required to be undertaken, including truck and vehicle access routes.* ▪ *Plan construction activities and "paddock" filling in a coordinated way to achieve target separation distances between habitats and works areas whenever practicable.* ▪ *Examine the practicality of construction access routes that avoid actively filling "paddocks by at least 150m and ideally 200m or more, and implement where possible.* ▪ *Where it is not possible to achieve adequate separation then construction works closer to habitat areas should be planned to occur between May and August, wherever possible.*
Construction site layout	▪ *Wherever practicable, areas where regular works activities will occur should be located at least 150 m from temporary shorebird habitats and, ideally, 200 m.* ▪ *Where possible, construction sites should be arranged to place the areas of greatest activity as far as possible form the side of the site closest to the temporary shorebird habitat.* ▪ *If temporary buildings are involved, these should be situated on the side of the site closest to the habitat with access on the opposite site in order to screen activities at the site to the maximum extent possible.*

6.2 Monitoring requirements and adaptive management

The table below summarises monitoring activities and indicates possible management responses in the event of detrimental impacts occurring. The monitoring activities should be undertaken simultaneous with monitoring by the QWSG at nearby habitats (i.e. Lytton, Juno Point and Manly Boat Harbour). In this way, wider changes in shorebird abundance can be tracked and compared with changes at Fisherman Islands. This enables shorebird responses to port-related activities to be distinguished from more widespread changes in abundance (e.g. changes in annual breeding success).

Monitoring requirement	Monitoring activities and management responses
Monitoring impacts of changes	• The timing of significant management changes (e.g. completion of "paddock" filling, filling of new areas) should be estimated in advance and high tide shorebird counts of the FPE area planned to ensure adequate information on shorebird responses is gathered as soon as practicable after the proposed change. • Counts should be undertaken at high tide when maximum numbers of shorebirds area likely to be present.
Routine monitoring	• Shorebird numbers and locations should be counted and mapped in a manner consistent with past monitoring studies of the area and flight zones between roosts and feeding grounds should be documented consistently. • A monitoring plan should be developed that ensures monitoring is undertaken in a way that provides adequate information on trends and changes, as well as meets the requirement of informing construction and habitat management planning and activities. • The results of monitoring should be reviewed after each count to determine if significant changes in shorebird usage have occurred (numbers, locations, flight paths, choice of substrate) and whether this is natural variability (eg. wind-induced) or due to habitat changes resulting from works or port development. • Where works-related changes can be demonstrated and these are detrimental, appropriate management responses should be developed, including but not limited to: o Changing works areas, if possible; o Changing location/volume of dredge spoil delivery to affected area; o Altering water levels; and/or o Changing timing of potentially detrimental activities to avoid high tide periods when birds are present.
Documentation of management	• A shorebird management log will be established based on a pro-forma that ensures consistent and complete information is recorded on the timing, location, extent and type of management activity. • A monthly review of monitoring results and management activities will be undertaken to inform management activities in the following month. • Management and monitoring information will be stored in a manner that makes it accessible and simple to analyse.

Monitoring requirement	Monitoring activities and management responses
	• Back-up copies will be maintained of all monitoring results and management documentation.

5.2 Permanent Bird Roost (PBR) Strategy

Objective

Provide a permanent, secure shorebird roosting habitat on Fisherman Islands.

Management and monitoring targets

- Achieving this objective will involve meeting the targets below.
- Land uses adjacent to the permanent bird roost will be of a type and design that does not affect the suitability of the PBR for roosting shorebirds.
- Management of land on and adjacent to the PBR will not conflict with its primary purpose to provide secure roosting habitat for shorebirds.
- Initiate monitoring of shorebird use of the area immediately.
- By 2005 a management plan for the permanent bird roost area will be developed.
- Any necessary modifications to sediment and water control structures to enable water levels to be managed should be in place by 2010.
- Experimental management of water levels to maximise suitable habitat and shorebird usage should be implemented from 2010, based on the techniques developed through adaptive management in the FPE area.
- Adapt both physical characteristics and water level management at the site to create optimum conditions by the time locations for shorebird roosting in the FPE become limited to only two.
- Monitor shorebird usage of the PBR in a manner consistent with FPE area.

7 IMPLEMENTATION

This section of the plan provides information on the roles and responsibilities of various agencies in the implementation of this plan and suggested timing for implementation of the activities.

Reporting and review will be undertaken consistent with the relevant EMPs developed for both areas.

7.1 Roles and Responsibilities

Table 3 summarises the roles and responsibilities of various agencies and personnel for the implementation of this plan.
It is proposed to continue meetings of a working group to provide advice to Port of Brisbane Corporation on shorebird management activities in the area. This group, established about 12 months ago, will continue to operate in an advisory capacity to ensure the Corporation benefits from the considerable expertise of the members involved. Group members include:

Port of Brisbane Corporation;
Environment Protection Agency; and
Queensland Wader Study Group.

Table 3: Responsibility for and role in implementing actions in this plan of agencies and personnel.

ACTIVITY	RESPONSIBILITY	ROLE
EXISTING AND FUTURE PORT EXPANSION AREA		
CONSTRUCTION AND DREDGE-SPOIL DISPOSAL PLANNING	PBC	▪ PBC TO DEVELOP CONSTRUCTION PLAN IN MANNER THAT PROVIDES SHOREBIRD HABITAT
	CONSTRUCTION CONTRACTOR	▪ CONTRACTOR TO IMPLEMENT PLAN
WATER LEVEL MANAGEMENT IN "PADDOCKS"	CONTRACTOR AND PBC PROJECT SUPERVISOR	▪ OPERATION OF WATER CONTROL STRUCTURES
	PBC ENVIRONMENT SUPERVISOR AND SHOREBIRD MONITORING CONTRACTOR	▪ INVESTIGATING CURRENT SHOREBIRD HABITAT USAGE ▪ DEVELOPING GUIDELINES FOR SEDIMENT AND WATER LEVEL MANAGEMENT ▪ MONITORING OF WATER LEVELS AND SHOREBIRD USAGE ▪ PROVIDING DIRECTIONS ON WATER LEVELS
MAINTAINING SEPARATION BETWEEN CONSTRUCTION AREAS AND HABITAT	PBC ENVIRONMENT SUPERVISOR	▪ ENSURE CONSTRUCTION PLAN HAS CORRECT SEPARATIONS WHEREVER PRACTICABLE ▪ ADVISING ON TIMING OF SHOREBIRD HABITAT USAGE TO GUIDE CONSTRUCTION IN AREAS WHERE SEPARATIONS NOT POSSIBLE
	CONTRACT SUPERVISOR AND SITE MANAGER	▪ ENSURE CONSTRUCTION CONTRACTORS COMPLY WITH PLAN
CONSTRUCTION SITE LAYOUT	PBC ENVIRONMENT SUPERVISOR AND CONSTRUCTION CONTRACTOR	▪ WORK WITH CONTRACTOR TO PLAN LAYOUT OF CONSTRUCTION SITES BASED ON PLANNED HABITAT MAINTENANCE
	CONSTRUCTION	▪ ENSURE COMPLIANCE OF PERSONNEL WITH

ACTIVITY	RESPONSIBILITY	ROLE
	CONTRACTOR	ACTIVITY AREA PROVISIONS
MONITORING IMPACTS OF CHANGES	PBC ENVIRONMENT SUPERVISOR	▪ REVIEW PLANS TO DETERMINE TIMING OF CHANGES ▪ RECOMMEND MITIGATION MEASURES, WHERE REQUIRED
	PBC ENVIRONMENT SUPERVISOR AND SHOREBIRD MONITORING CONTRACTOR	▪ MONITOR SHOREBIRD USAGE AFTER CHANGES
ROUTINE MONITORING	PBC ENVIRONMENT SUPERVISOR AND SHOREBIRD MONITORING CONTRACTOR	▪ DEVELOP A MONITORING PLAN THAT MEETS THE REQUIREMENTS OF THIS MANAGEMENT PLAN. ▪ UNDERTAKE TWICE-MONTHLY, HIGH TIDE SHOREBIRD MONITORING ▪ PREPARE ANNUAL REPORTS ON MONITORING
DOCUMENTATION OF MANAGEMENT	PBC ENVIRONMENT SUPERVISOR	▪ CREATE MANAGEMENT LOG AND DATA CURATION SYSTEM ▪ MAINTAIN LOG RECORDS AND DATA CURATION SYSTEM ▪ INTEGRATE MANAGEMENT LOG WITH SHOREBIRD MONITORING RESULTS

7.2 Timing

The implementation of this plan should be timed in the manner outlined below.

PERIOD	ACTIVITY
FUTURE PORT EXPANSION AREA	
2002 (VERY URGENT)	▪ DEVELOP AND COMMENCE IMPLEMENTATION (FROM JULY 2002) OF MONITORING PLAN. ▪ ENSURE ALL NECESSARY AND RELEVANT CONTRACTUAL REQUIREMENTS TO ENSURE CONSISTENCY WITH THIS PLAN ARE IDENTIFIED AND DOCUMENTED IN DRAFT CONSTRUCTION CONTRACTS ▪ DEVELOP CONSTRUCTION PLAN FOR FIRST STAGE OF WORKS (PERIMETER BUND STAGE ONE AND FIRST THREE "PADDOCKS") TAKING INTO ACCOUNT REQUIREMENTS OF THIS PLAN ▪ ESTABLISH MANAGEMENT LOG AND DOCUMENTATION PROTOCOLS
2002 - 2006	▪ IMPLEMENT CONSTRUCTION PLAN AND HABITAT MANAGEMENT PROVISIONS OF THIS PLAN ▪ UNDERTAKE ROUTINE MONITORING AND ADAPTIVE MANAGEMENT ▪ CONTINUE INVESTIGATIONS OF SHOREBIRD USAGE OF HABITAT IN RELATION TO "PADDOCK" FILLING APPROACHES. ▪ UNDERTAKE ANNUAL REVIEWS OF RESULTS OF HABITAT MANAGEMENT ACTIVITIES AND ADJUST PLANS ACCORDINGLY. ▪ AT END OF PERIOD, REVIEW AND REFINE SHOREBIRD MANAGEMENT PLAN.
2006 ONWARDS	▪ IMPLEMENT REVISED SHOREBIRD MANAGEMENT PLAN
PERMANENT BIRD ROOST	
2002 ONWARDS	▪ DEVELOP AND IMPLEMENT LAND USE PLANNING GUIDELINES ▪ DEVELOP LAND MANAGEMENT PLAN FOR NON-HABITAT AREAS OF PBR AREA ▪ INCORPORATE PBR AREA INTO ROUTINE SHOREBIRD MONITORING PROGRAM.
2006	▪ COMPLETE PBR MANAGEMENT PLAN

	▪ COMPLETE IMPLEMENTATION OF MAIN NON-HABITAT AREA WORKS (E.G. STABILISATION OF PERIMETER, FENCING, LANDSCAPE AND SCREENING PLANTINGS
2006 - 2009	▪ DESIGN AND INSTALL ALL NECESSARY STRUCTURES TO ENABLE ADAPTIVE MANAGEMENT OF THE SITE, CONSISTENT WITH THE PLAN
2010 ONWARDS	▪ IMPLEMENT ADAPTIVE MANAGEMENT OF SHOREBIRD USAGE OF AREA.
2015	▪ REVIEW PBR MANAGEMENT PLAN ▪ IMPLEMENT ENHANCEMENTS WHERE NECESSARY

7.0 REFERENCES

DAVIDSON, N C & ROTHWELL, P (EDS.) (1993) 'DISTURBANCE TO WATERFOWL ON ESTUARIES.' WADER STUDY GROUP BULL. 68, SPECIAL ISSUE.

DRISCOLL, P V (1997) 'THE DISTRIBUTION OF WADERS ALONG THE QUEENSLAND COASTLINE.' PP. 80-122. IN. STRAW, P (ED.) 'SHOREBIRD CONSERVATION IN THE ASIA – PACIFIC REGION.'. AUSTRALASIAN WADER STUDIES GROUP.

DRISCOLL, P V (1998) 'FURTHER ASSESSMENT OF BIRD NUMBERS, MOVEMENTS AND HABITAT CONDITIONS IN THE ENVIRONS OF FISHERMAN ISLANDS.' UNPUBL. REPORT TO PORT OF BRISBANE CORPORATION.

DRISCOLL, PV; GEERING, A; GYNTHER, I; HARDING, S; AND STEWART, D (1993) 'MONITORING OF MIGRATORY WADERS IN THE MORETON BAY REGION.' UNPUBL. REPORT TO DEPARTMENT OF ENVIRONMENT & HERITAGE, COASTAL MANAGEMENT BRANCH, BY THE QUEENSLAND WADER STUDY GROUP.

PORT OF BRISBANE CORPORATION (2000) 'ENVIRONMENT PERFORMANCE REPORT 2000.' PORT OF BRISBANE CORPORATION, BRISBANE.

WBM PTY LTD (2000) 'PORT OF BRISBANE CORPORATION PROPOSED PORT EXPANSION AT FISHERMAN ISLANDS DRAFT IMPACT ASSESSMENT STUDY. VOLUME 1.' CONSULTANT'S REPORT TO PORT OF BRISBANE CORPORATION BY WBM OCEANICS AUSTRALIA.