7. Water Quality

7.1 Existing Conditions

7.1.1 Water Quality Studies

Water quality conditions for Boathaven Bay were characterised in Section 4.1 of the 1998 IAS (Burchill 1998). At that time there were only two main sources of reliable water quality data, the Department of Environment and Heritage (DEH; now Environmental Protection Agency, (EPA) and a report by the Marine Botany Section of the University of Queensland (UQ) for Sinclair Knight Merz (SKM) and the Whitsunday Shire Council (UQ 1995). This was supplemented by further sampling by WBM, specifically investigating the project site (Burchill 1998). A standard suite of physical and chemical parameters were analysed in these studies. More recent monitoring in the area has been undertaken by FRC Environmental for the Whitsunday Shire Council (FRC 1998a, 1998b, 1999a, 1999b, 2000a, 2000b, 2001a, 2001b etc).

Water quality monitoring has typically included Boathaven Bay, Pioneer Bay and Charlies Bay. Boathaven Bay has been referred to as Muddy Bay in some instances. **Table 7-1** summarises available water quality data.

■ **Table 7-1 Available Water Quality Data – Pioneer and Boathaven Bay**

Source	Period	Total sampling events	No. sites and locations
DEH	1989-90	6	8 - Pioneer Bay 3 - Shute Harbour 2 -Boathaven Bay
UQ	1995	3	3 – Boathaven Bay 3 – Pioneers Bay 3 – Charlies Bay
WBM	1998	1 (July)	9 – Boathaven Bay 2 – Pioneer Bay 1 – Campbell Creek
FRC	1998-2001	8	3 – Boathaven Bay 3 – Pioneer Bay 3 – Charlies Bay 1 – Funnel Bay

The DEH, UQ and WBM datasets are presented in detail in Section 4.1 of the 1998 IAS. These data sets and recent FRC Environmental data are presented in **Appendix F**.

The FRC dataset presents the most recent and comprehensive data available. The results of this three-year, seasonal data set are generally similar to the results obtained in previous studies, although some changes in nutrient levels may be due to the partial diversion of Jubilee Pocket WWTP to Cannonvale WWTP in 1999.

7.1.2 Existing Water Quality

The water quality of Boathaven Bay is generally good and shows seasonal variations in water ambient water quality. Across the bay, there is little significant difference, except for some inshore sites. Results from water quality testing conducted by FRC Environmental data for the period 1998 to present are presented in **Appendix F**.

The water quality of Boathaven Bay is similar to that of Pioneer Bay although turbidity may be higher in Boathaven, with higher average suspended solids concentrations. Levels of nutrients in offshore areas of Pioneer Bay commonly exceed those in Boathaven, and this has become even more marked following the diversion of half of the flows from Jubilee Pocket WWTP to Cannonvale WWTP in 1999. It is likely that catchment runoff significantly contributes to the nutrient and suspended solids loads to Boathaven, Pioneer and Charlies Bays (FRC, 2002).

Salinity levels are typical of marine inshore areas. During the dry season, levels are essentially oceanic (up to 38 g/L) while freshwater inflows can slightly reduce the salinity during the wet season (down to 30 g/L). ANZECC (2000) Guideline does not recommend a salinity level for salinity.

Dissolved oxygen levels remain above 6 mg/L and have been recorded up to 9.6 mg/L based on monitoring data of WBM, DEH and UQ. ANZECC (2000) Guidelines provide a recommended level in terms of percentage saturation, rather than concentration. However, ANZECC (1992) recommend a level of DO above 6mg/L. WBM (in Burchill, 1998) monitored DO concentrations over spring and neap tides. They found that there is minimal difference between the tidal states and that there is only a minor oxygen sag overnight. Monitoring of dissolved oxygen (mg/L and % saturation) over one week (14 July 1998 – 25 July 1998) showed that it ranged between about 6.1 to 7.0 mg/L and 89 to 104 % saturation. Only once did the % saturation level drop below the ANZECC (2000) Guideline level of 90%, with it remaining above 91% for the remainder of the survey, making it well within acceptable levels.

pH levels typically range from approximately 7.9 to 8.7 for Boathaven, Pioneer and Charles Bays. ANZECC (2000) Guidelines recommend a range of 8.0 to 8.4 for marine waters

Turbidity levels in Boathaven Bay are low although typically higher than Pioneer Bay due to its more inshore position and hence likely to experience higher tidal resuspension and catchment loads. The existing water quality regime includes periods of high turbidity, particularly during windy conditions and flood events (WBM in Burchill, 1998). Average turbidity was 5.1 NTU (sd=5.2) in the DEH monitoring undertaken over two years and 3.7 NTU (sd=2.4) in the UQ monitoring undertaken over 1 year, with levels decreasing from inshore to offshore locations. Monitoring undertaken in July by WBM for the IAS (WBM in Burchill, 1998) recorded a maximum level of 13 NTU. ANZECC (2000) Guidelines recommend a level of up to 20. Investigations found that the most inshore location experienced significantly higher turbidity and suspended solids levels during spring tide conditions, attributed to higher resuspension activity. It is presumed that turbidity shows some seasonal trend as this occurs with total suspended solids.

Total suspended solids levels in Boathaven Bay have an average level of 10.4 mg/L (sd=11.8) based on data taken in 1989-90 (DEH data reported in Burchill, 1998). Suspended solids levels tend to be higher in the wet season presumably from catchment inflows. This trend was also shown in the FRC data.

Total nitrogen (TN) levels in Boathaven Bay have been extensively monitored by FRC Environmental and commonly exceed ANZECC (2000) Guideline levels, both before and after the diversion of half the discharge volume from Jubilee Pocket WWTP to Cannonvale WWTP in 1999. Pioneer Bay and Charlies Bay also commonly exceed the guideline level, but given that there is no WWTP outfall in Charlies Bay, it seems that factors other than the WWTP (e.g. catchment runoff) may contribute to the exceedences.

WBM (reported in Burchill 1998) observed that nitrogen concentrations tended to be higher during spring tide over neap tide.

Nitrate levels are temporally (not necessarily seasonally) variable in both Boathaven Bay and the general region. ANZECC (2000) provides a guideline for nitrous oxides (NOx: NO_3 and NO_2), rather than nitrate. Assuming that the nitrous oxides are all nitrate, then the levels are typically higher than the guideline levels, often by several factors. Nitrate levels in Boathaven Bay are typically well in exceedance of the guideline level even following the partial diversion of the Jubilee Pocket WWTP flows. Concentrations in Boathaven Bay, Pioneer Bay and Charlies Bay are often similar, indicating that catchment influences dominate discharges from the WWTPs. The primary nutrient contributors to Charlies Bay catchment are not known.

Ammonia (NH4) levels are similarly variable in Boathaven, Pioneers and Charlies Bays, but exceed the ANZECC (2000) Guidelines less frequently as for nitrate or total nitrogen. Any exceedences are typically within twice the guideline level.

Total phosphorus (TP) levels in Boathaven Bay, Pioneer Bay and Charlies Bay have been extensively monitored by FRC Environmental since 1998. They were found to be temporally variable (not necessarily seasonally) and commonly exceed ANZECC (2000) guideline levels. They generally follow similar patterns to the total nitrogen concentrations. Exceedences remain common in Boathaven Bay following the partial diversion of Jubilee Pocket WWTP effluent, so catchment contributions are the likely contributor.

In the 1998 IAS, it was observed that phosphorus concentrations tended to be higher during neap tide over spring tide (WBM in Burchill 1998).

Phosphate (PO_4) levels in Boathaven, Pioneer and Charlies Bays and are similarly temporally variable and occasionally exceed the guideline levels. These exceedences can be numerous times the limit in all bays.

Chlorophyll-a (Chl a) levels have been extensively surveyed by FRC Environmental since 1998. Levels are typically low in all the bays, with levels below the ANZECC (2000) Guideline level and limits of detection. Exceedences of ANZECC Guidelines occurred in November 1999 and June and November 2001, often in more than one of the three bays.

In the original IAS (WBM in Burchill, 1998), it was found that within Boathaven Bay there were higher levels inshore than at other sites. This was attributed to their proximity to stormwater runoff or nutrient release from nutrient laden mangrove muds. Still, the levels of Chlorophyll a were not high.

Heavy metals and **pesticides** levels were analysed from Boathaven and Pioneer Bays in the original IAS (WBM in Burchill, 1998). No significant levels were detected in their study.

Bacteria in Boathaven have not been assessed since 1998 for the original IAS. At that stage, sewage discharges from the Jubilee Pocket WWTP and boats in the bay were having some impact on the water quality. High levels of bacteria contamination in water are believed to be more likely to have viral or fungal contamination than low levels of contamination water. The current levels are unknown and it would be difficult to determine any probable trend since although half the sewage effluent is diverted to Cannonvale WWTP there is an increase in boat visits to the bay. It is possible that Pioneer Bay may have experienced marginally higher bacterial counts since it now has increased boat traffic and receives the diverted effluent from Jubilee Pocket WWTP via Cannonvale WWTP.

Sediment chemistry was analysed by Earthtech in the Draft IAS in Section 6.1.4.2 (WBM in Burchill, 1998) and also by Earthtech for this Supplementary EIS. The sediments contained high levels of fines (<75µm), ranging from 55% to 99%. Total and fines corrected concentrations of metals were below the *National Ocean Disposal Guidelines for Dredged Material* (Environment Australia, 2002) Effects Range-low or screening level. Levels of contamination below the Effects Range-low trigger level are deemed to be benign to biota. Molybdenum has no guideline level but was comparatively higher in Campbell Creek, which drains to Boathaven Bay, than other sites in Boathaven Bay. This is discussed in more detail in **Section 6**.

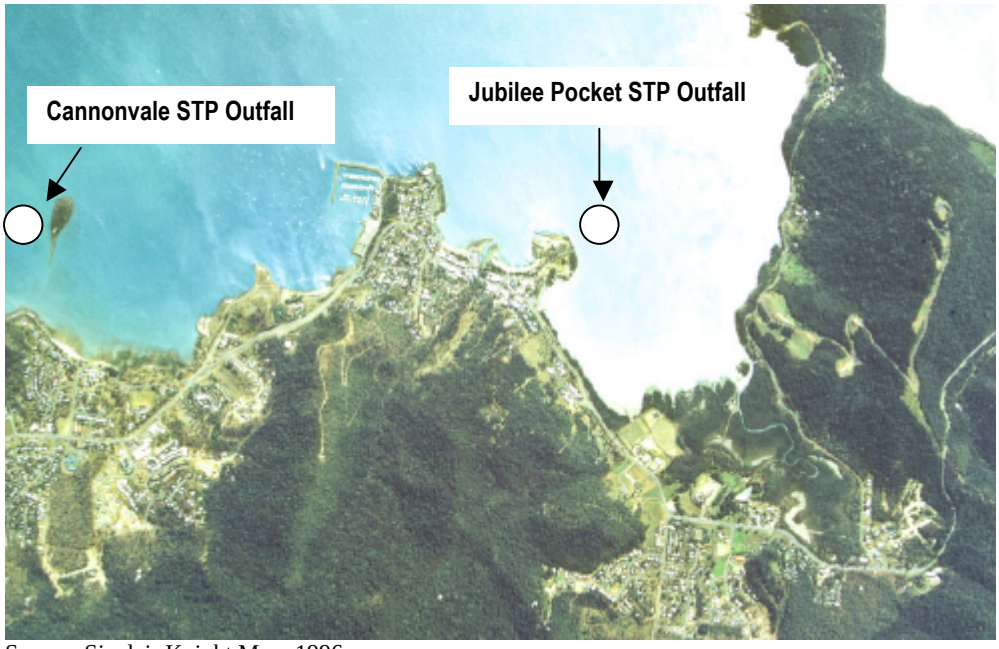
Nutrient concentrations in the sediments have not been assessed from Boathaven Bay previously. High concentrations may be present in the sediments resulting from high nutrient discharges into the Bay over an extended period. Nutrient concentrations in the sediment will be determined prior to dredging activities to ascertain the potential availability of nutrients and consequent algae growth.

Seasonal changes in water quality are not readily determined, particularly in most recent monitoring. From three monitoring events over one year, UQ (1996) determined that there were higher nutrient and suspended solids levels occurring during the wet season, with many parameter averages in the wet season being twice the dry season averages. Seasonal differences were attributed not only to catchment runoff but also to the increases in visitor levels over the year causing commensurately higher sewage loads to the bays. Catchment contribution were considered high though because Charlies Bay (a control site without sewage input) also experienced similar changes in water quality.

7.1.3 Catchment Influences

Existing impacts were discussed in the original IAS (WBM in Burchill, 1998) and may come from the Jubilee Pocket Sewage Treatment Plant, the outfall of which is located at just offshore of the Whitsunday Sailing Club and a former landfill area opposite Hermitage Drive which is now being used as a sports park. Impacts from treated sewage have been addressed above in relation to nutrients and bacteria. Based on their inshore monitoring results for the IAS (WBM in Burchill, 1998), WBM determined that there were no significant impacts from the former landfill. Approximate locations of the two sewage treatment plants discharging into Pioneer Bay is shown in **Figure 7-1**.

A boat maintenance and repair facility is being operated at the mouth of Campbells Creek. This site has no stormwater control and contaminants such as tributyl tin and possibly hydrocarbons are likely to be draining to Boathaven Bay. Residential development in the Campbell's Creek/Boathaven Bay catchment has also been significant and additional development is planned here and also along Mandalay Point. There is also some commercial and light industrial activity in the Jubilee Pocket area.



Source: Sinclair Knight Merz 1996

■ **Figure 7-1 Location of Sewage Treatment Plant Outfalls (approximate)**

7.2 Potential Impacts

7.2.1 Construction

Potential water quality impacts during the construction phase of Port of Airlie relate primarily to sediment and erosion processes which can generate high suspended sediment and turbidity levels as well as the potential for spills and leaks of hydrocarbons and other hazardous materials. The following construction activities may impact on water quality:

- construction of the dredge spoil disposal area
- construction of the marina and waterway;
- dredging of the navigation channel;
- generation of stormwater runoff from disturbed areas; and
- accidental spills and leaks of hydrocarbons and other hazardous materials.

High suspended sediment and turbidity levels can reduce light penetration into the water column, thus affecting primary productivity, infill interstitial spaces in the sediments, block gills of fish and invertebrates and smother benthic organisms. The potential for these impacts to occur in the Port of Airlie development will be limited via the use of appropriate construction techniques.

Construction of Dredge Spoil Disposal Area

Construction of the dredge spoil disposal area will involve construction of an earth and rock bund around the disposal area (see **Figures 2-6** and **2-9**). The construction method will be similar to that currently being used for construction of the Abel Point Marina expansion, with dumping of fill material, spreading of this material using a bulldozer and lining of the external wall with protective rock. Some sediment will be released to the marine environment during this construction. However the construction sequence will be planned so that initial filling over the seabed will only be undertaken during the bottom half of the tide to minimise the dispersal of sediments. Observations of the Abel Point Marina expansion show that the sediment plume is minimal and silt curtains have not been required at Abel Point. Bund construction is expected to take 1 month.

A more detailed description of the dredge spoil disposal area is provided in **Section 2.7.1**.

Marina Construction

The marina construction will have the potential to significantly impact on water quality, primarily from elevated suspended solids and turbidity levels, if not managed appropriately. Elevated suspended solids and turbidity levels in tailwaters may result from erosion in the dry marina basin and cleared vegetation areas during rain events and from water discharge from the dredge disposal and land reclamation areas. However, the use of sheet piles to surround the earthworks area will prevent any direct discharge to the marine environment.

The potential for high suspended sediment and turbidity to occur in the receiving waters will be minimised during marina construction through the implementation of dry basin construction techniques, best practice dredging activities, a bunded spoil area and sedimentation basins and low flow channels to allow settlement of sediments out of water (see also **Section 2.7**). It is proposed to implement a reactive monitoring program to allow rapid response to high discharge turbidity levels if they were to occur. The monitoring program will be linked with corrective actions to avoid any significant impact on water quality. These strategies are described in more detail in **Section 7.3.1**.

Discharge from the spoil disposal area will be via dissipators to the mangrove fringe which is to be retained between Shute Harbour Road the development. This will allow additional filtering and enhance mixing of the discharge waters (which will be largely saline).

The initial installation of the sheet pile walls around the marina is likely to generate some suspended sediments as the mudflats will be slightly disturbed, however any impact is likely to be limited to immediate area of installation and time of installation. The short-term and limited extent of this potential impact renders it highly unlikely to create any significant change to the water quality in Boathaven Bay or in the surrounding waters.

The removal of the sheet pile across the entry to the Marina has the potential to generate increased suspended sediment and turbidity levels as the sheet pile is removed. Rapid inflow of water into the marina basin will be controlled by pumping water into the basis prior to removing sheet piles or gradual removal of the enclosure.

It is anticipated that this will result in minor sediment plume into the harbour which will quickly dissipate due to tidal flows.

It is expected that through the implementation of the proposed construction mitigation measures and the reactive monitoring program, no significant impact will occur on the water quality of Boathaven Bay or adjacent Pioneer Bay during construction.

Dredging of the Navigation Channel

The navigation channel will be dredged approximately 1km in length, 100m wide and to –5.25 AHD (3.5m below lowest astronomical tide). Dredging activities can impact on water quality through changes to turbidity and suspended sediment loading, dissolved oxygen concentrations, pH, metals and salinity.

Initial dredging of the navigation channel is expected to take 2 months and may cause some increase in turbidity during this time. The extent of sediment generated will be minimised by the use of best management practices, including discharge of dredge spoil and tail water into an enclosed area (spoil disposal area) monitoring of water quality adjacent to dredging activities. Dredging will be conducted using a cutter suction dredge and dredge spoil and tailwater will be pumped to the secure bunded area adjacent to Shute Harbour Road, east of the marina. Dredge spoil and tailwater from the channel dredging will be managed in the same way as that from the marina basin excavation described above.

Predictions on the likely transport and dispersion of turbidity plumes that may be generated during dredging and reclamation activities for the larger marina originally proposed were made in the IAS (WBM in Burchill, 1998) using the RMA hydraulic computer model. Detail of the model and its configuration can be found in the original IAS. The model simulated the extent of turbidity plumes under three wind scenarios for spring tides: no wind; with a 10 knot north-easterly wind; and with a 15 knot south-easterly wind.

Graphical outcomes from the modelling can be seen in Figures 4.8 to 4.10 of the original IAS. All scenarios showed that the dredge plumes are limited in extent (around the immediate dredging activities), with only minor quantities of sediment being transported to adjacent areas. The plumes tended to travel northwards and westwards, with only limited amounts of material being transported into Boathaven Bay (during the no wind scenario only) and Pioneer Bay. The plumes did not extend to Mandalay Point or the eastern areas of Boathaven Bay. No significant turbidity plumes are expected to remain within a few days of dredge completion.

It should be noted that this modelling was based on the dredging required for the 1998 proposal which was much larger than the current proposal. The area of the current proposal is entirely within that of the 1998 proposal. Hence, it can be expected that impacts associated with dredging of the current proposal will be no greater than and probably less than those predicted for the 1998 proposal.

Short term increases in turbidity should not significantly affect the ecology of the area, as the existing water quality regime includes periods of high turbidity, particularly during certain wind conditions and flood events. Sediment transport during floods commonly leads to low water quality.

All sediments from the areas potentially affected by the marina development are low in metal concentrations and so are not expected to cause any significant adverse water quality impacts from dredging disturbance during marina construction or operation.

Dredging operations can potentially liberate nutrients and metals that have accumulated in sediments over extended periods. Liberation of nutrients can cause nuisance algae growth on seagrasses in the Bay, potentially smothering them. Release of heavy metals may have toxic effects on flora and fauna or may bioaccumulate in their tissues. Nutrient concentrations in the sediments have not been determined, so their potential impact through mobilisation from dredging cannot be determined.

Metal concentrations are below the *National Ocean Disposal Guidelines for Dredged Material* (Environment Australia, 2002) Effects Range-low or screening level. Consequently, dredging of this material then is unlikely to impact on the marine biota.

Stormwater Runoff from the Construction Site

The construction site and dredge spoil disposal area will be fully enclosed. Any stormwater will be contained within the construction site or dredge disposal area and then pumped to the dredge disposal area for treatment and disposal.

Upstream catchments will be temporarily diverted around the construction area. The quality of stormwater from these catchments is independent of the construction activities.

Stormwater runoff from construction sites is typically high in suspended sediment levels. As already discussed, this high suspended sediment loads entering the marine environment can impact on the inshore and nearshore marine habitat in a variety of ways.

Other sediment and erosion control techniques that will be used during construction are discussed in **Section 7.3.1**.

During very heavy rainfall events, it is possible that the dredge disposal area may overflow, releasing waters with elevated suspended solids and turbidity loads. The impact of this is likely to be negligible though, because the rainfall is likely to increase sediment loads through catchment inflows and disturbance of the intertidal sediments. Detailed hydrological studies will be undertaken during detailed design to provide input into the sizing of the dredge disposal area and water management features.

Acid Generation from Potential Acid Sulfate Soils

Discussion of acid sulphate soils is discussed in **Section 6**. Preliminary testing of sediments indicates that small quantities of ASS are present. A detailed ASS Management Plan has been prepared for the project and is included in **Appendix E**. Any potential impacts from ASS can be avoided through appropriate management and mitigation strategies of acid sulfate soils/sediments. With proper management, no significant impacts on water quality is expected due to acid generation from ASS.

Spills

The potential impact on the receiving marine environmental from chemical spills during construction depends on the toxicity, quantities, contamination pathways and persistence of the chemical in the marine environment. Potential for spills at the construction site may come from fuel/oil spills from construction machinery.

The likelihood of spills will be reduced through the appropriate handling and containment of fuels/oils and chemicals. The management of hazardous materials is discussed in **Section 2.7.8**. In any case, construction activities take place entirely within an area enclosed by sheet piles and hence, spills will not enter the marine environment.

7.2.2 Operation

Potential water quality related impacts during the operation of the development may result from the following:

- generation of poor quality stormwater from the developed marina, maintenance and residential areas;
- salinity changes in Boathaven Bay due to increased urban runoff
- potential for chemical spillage in the marina;
- vessel and exhaust discharges;
- poor quality water in the marina if tidal mixing does not extend to the whole basin;
- turbidity plume during maintenance dredging of channel and marina basin;
- discharges from the vessel maintenance facilities;
- sewage;
- increase in sewage outfall from Cannonvale WWTP; and
- disposal of sullage from boats.

Stormwater

Existing stormwater drains from the town of Airlie Beach that currently discharge into Boathaven Bay will be extended through the Port of Airlie development and stormwater from the development will mix with existing stormwater flows.

Stormwater from the land areas of Port of Airlie will be typical of stormwater generated in urban areas and may contain slightly increased pollutant loads of suspended solids, nitrogen, phosphorus and petroleum hydrocarbons compared to stormwater from non-urban areas.

The stormwater drainage design has not yet been developed, so the exact percentage of areas contributing stormwater to the marina is not known. The stormwater drainage system will be designed on the basis of catchment analysis following the final earthworks plan. Overall, the volume of stormwater generated from the site is expected to be minor, due to the small area of the site.

The impact from increased stormwater runoff will be minimised through the implementation of various mitigation measures as detailed in **Section 7.3.2**. All drains that outfall into the marina basin will be constructed with catch pits and trash racks to collect sediments and debris. The catch pits and trash racks will be cleaned out regularly and after heavy rainfall. These structures and maintenance procedures are

not present in the current stormwater systems flowing into Boathaven Bay. The high degree of flushing within the marina area and adjacent waters will ensure that pollutants in stormwater are quickly diluted and dispersed.

Impacts from stormwater generated from vessel maintenance and repair facilities will be addressed separately by respective businesses when applying for their Environmental Authority. It is expected that these areas will be required to have a self-contained drainage system as described in **Section 2.6.1**.

Salinity Changes in Boathaven Bay

Freshwater runoff from large catchments can reduce salinity of the receiving waters if the volumes are discharged from few discharge points. The impact would be most acute if discharge was to occur in intertidal areas, potentially resulting in significant salinity changes over the tidal cycle.

The potential for significant impact from salinity changes to occur is minimal in the marina. This is due to the small catchment area and the discharge being directed to the well-flushed marina, which is not intertidal in nature. In fact, the diversion of existing stormwater flows from Airlie Beach into the marina may reduce existing impacts on Boathaven Bay in this regard.

Fuel and Chemical Contamination

There is potential for fuel and chemical contamination of the marina waters from accidental spills during marina operations. Contaminants such as cleaning agents, fuels, oils, antifouling coatings and litter may enter the waterway. Some of these contaminants have the potential to cause significant impact on the receiving water quality and aquatic organisms, depending on the quantity. Preventative and emergency mitigation measures, however, will minimise their potential occurrence and extent of contamination. These measures are more fully discussed in **Section 7.3.2**.

Management and operation of the marina and marine facilities is subject to the conditions of an Environmental Authority as described in more detail in **Section 2.5.1** and **4.2.2**.

Vessel and Exhaust Discharges

The discharge of bilge waters and sewage from boats can significantly contribute to the pollutants in marinas and inshore areas, in particular hydrocarbons, nutrients and bacteria.

There are numerous vessels on moorings at the mouth of Boathaven Bay as well as 10-15 “squatter” boats beached on the west side of the Bay which are used as residences. There is currently no sewage or bilge water pumpout facilities available in Airlie Beach. Consequently, there is direct discharge into the bay by many of these moored vessels and the “squatter vessels”. The current water quality in the western part of the bay shows elevated bacteria levels, and is likely the result of both moored boats and beached “squatter” boats and possibly the discharge from the Jubilee Pocket wastewater treatment plant.

These raw sewage and bilge discharges will essentially be eliminated in the marina waters and it is anticipated that there should be a resulting improvement in water quality. Discharges will be reduced through the provision of sewage and bilge-water pumpout facilities. Bilge water will first enter an oil-water separator. Oily residues from the oil-water separator will be removed periodically by a licensed contractor, while the wastewater will be directed to the marina holding tank and pumping station.

It should be noted that GBRMPA will introduce regulations within the next 2 years prohibiting discharge of sewage from vessels within 1 km of any land (whether within the park boundaries of not). Boats will be required to install holding tanks and make use of facilities such as the sewage pump out to be installed at Port of Airlie.

Further detail of mitigation measures is provided in **Section 7.3.2**.

Exhausts from outboard motors are a potential pollution source of petroleum hydrocarbon pollution to the marina waters. Previously, lead contained in the fuel was also a potential contaminant, however, lead is no longer a petrol additive. Due to the high flushing nature of the marina and waterway, dispersion and dilution of hydrocarbons will be rapid, resulting in negligible impact on water quality. In terms of cumulative impacts, the marina is not expected to dramatically increase the number of boats in the Whitsunday area, but rather provide a more controlled environment for boats to be berthed, compared to current high usage of moorings in the area.

Sewage

Sewage from the marina will be derived from the vessel pumpout facility and from the sewage amenities of the residential and commercial developments. The sewage will enter the marina complex holding tank and pump station, where it will mix with the non-oily bilge water and be pumped to the Cannonvale WWTP. The high salinity of the bilge water will be greatly reduced through mixing with the sewage from the marina, followed by further mixing at Cannonvale WWTP.

The impact of increased sewage discharges from the Cannonvale WWTP will depend on the staging of development and the state of upgrade of the Cannonvale plant. The plant is required to be upgraded to meet EPA and GBRMPA requirements by 2008, so works will be required prior to this and may coincide with the latter stages of the marina development. The Proponent will make a contribution towards the provision of sewage facilities which will make the upgrade of the Cannonvale WWTP more viable. This is more fully described in the **Section 2.6.2**.

Prior to the upgrade of the Cannonvale WWTP, there may be an increase in the nutrients entering the western part of Pioneer Bay via the Cannonvale WWTP outfall. This may result in an incremental increase in nutrients and epiphytic algae, resulting in a cumulative decrease in water quality in the bay and potential impacts on seagrass distribution. Persistent dense algal epiphytes on the seagrasses in Pioneer Bay are a continuing cause for concern (FRC, 2001b). Following the upgrade of the WWTP, however, there should be a significant decrease in nutrient loads entering Pioneer Bay, although other catchment nutrient sources will continue to contribute.

Limited Tidal Exchange and Stratification

The water quality in the marina will be influenced by the extent of flushing by tidal action. In order to maintain good water quality, waterbodies should have a flushing time of five days or less. A high flushing rate ensures that the water in the marina will be similar to that of the adjacent waterbody (i.e. Boathaven Bay/Pioneer Bay) and no accumulation of pollutants will occur (WBM in Burchill, 1998).

Tidal exchange was modelled for the much larger Port of Airlie Marina Development proposed in 1998. Modelling of the waterway tidal exchange was undertaken using the MIKE 11 model, while marina flushing was assessed using the RMA hydraulic model. Modelling results showed that the range of flushing times in the waterway ranged between 0.91 and 1.18 days during a spring tide and 1.35 to 1.73 days during a neap tide. Flushing times for the marina varied between 3.5 and 7.5 days during a neap tide and between 1.9 and 4.0 days during a spring tide. Water quality of slightly poorer quality than that of Boathaven Bay was expected in the area furthest from the marina entrance, but the difference was expected to be minor.

Given the more open configuration of the marina and its much reduced size, flushing times are expected to be much shorter than for the previous development proposal, probably in the order of 1 to 2 days. This will mean that the waters in the marina should be well flushed by the tides and significant levels of contaminants are unlikely to build up within the marina.

The high, tidal flushing rate will also minimise the potential for stratification of the water column in the marina and channel. Stratification typically occurs in deep relatively still, turbid and deep waterbodies (>5m). It can significantly alter the dissolved oxygen and temperature profile of the water column, potentially asphyxiating benthic fauna. Such conditions are unlikely to occur in the shallow (1-3 m), well-mixed marina and channel.

Dredging

The marina and access channels have been designed such that maintenance dredging is required every should be 5 to 10 years. The potential impacts from maintenance dredging will be similar to those for dredging of the navigation channel in the construction phase, however the duration of maintenance dredging is likely to be about one month, compared to two months for the capital dredging and the volumes of material to be removed will be significantly less (approx 25,000m3 for each maintenance dredging operation). Dredging activities can impact on water quality through changes to turbidity and suspended sediment loading, dissolved oxygen concentrations, pH, metals and salinity.

Maintenance dredging will require an Environmental Authority from EPA and all dredging activities will have to be conducted in accordance with the conditions of the Authority. A dredging and spoil management plan will be developed for the dredging process.

Vessel Maintenance Facilities

Vessel maintenance facilities may undertake a range of activities including hull cleaning and maintenance, repairs to vessels, servicing of engines and equipment and painting. Spills and washdown contamination from the chemicals used in these

activities have the potential to adversely impact on the receiving water quality and are toxic to aquatic organisms. The extent of impact will be limited by spill and contaminant containment management. This is discussed in more detail in **Section 2.5.2**.

Antifouling Compound Contamination

Antifouling coatings in Australia typically contain toxic chemicals such as tributyl tin (TBT) or copper. These coatings inhibit settlement of hull-fouling organisms through leaching of these chemicals. The leaching of TBT from marine paints has been associated with extensive impacts on aquatic organisms, particularly intertidal organisms (ANZECC 2000). The use of TBT on small boats (<25m length) is banned under the *Chemical Usage and Control Act 1998* and requires State government agency approval for large boats (>25m length). It is expected that few, if any, boats in the marina would be treated with TBT antifouling agents. Therefore, potential quantities of TBT in the water or sediments of the proposed development should be minor. In addition dredging of the marina and channel will remove some sediments that currently have low levels of TBT contamination.

Since the vessel maintenance and repair to be carried out at the marina will involve small vessels, no TBT paints will be applied and hence none will be stored on site in any vessel repair or maintenance areas.

7.3 Impact Mitigation

7.3.1 Construction Phase

The major impacts during the construction phase which may require mitigation are related to sediment.

Sediment Loads

It is proposed to construct the marina basin and land reclamation in a dry state, which will limit any potential for any impacts from elevated suspended sediments in the basin area. This will be achieved through a steel sheet pile wall which will be constructed around the entire marina basin and reclaimed land area leading to the navigation channel (see also **Section 2.7.1**). The area within the sheet pile wall will be pumped dry and maintained in a dry condition. These sheet pile walls will ultimately form the internal marina wall and also part of the external breakwater design and will remain in place after construction. The sheet pile wall across the marina entrance will be removed.

The water that is pumped from the marina basin during construction is likely to contain high suspended sediment levels. These waters will be pumped to a sedimentation pond and then into a bunded dredge spoil disposal area. The ability of the sediment pond to remove sediments depends on the capacity and residence time, which will be determined at the detailed design stage. This water will then flow through a series of low velocity channels and be discharged to the mangroves behind the dredge spoil disposal area via dissipaters. From there, it will drain into Boathaven Bay via drainage channels at either end of the dredge disposal area, with the mangrove being flushed at high tide. Regular checks will be used to ensure that turbidity levels in discharge waters do not exceed acceptable levels for the receiving marine environment.

The environmental management of dredge spoil will be more comprehensively detailed in a Dredging and Spoil Environmental Management Plan which will be developed toward obtaining a dredging licence. It is proposed to have trigger levels for dredge spoil settling area water discharges based on multiples of observed turbidities. Observed turbidity levels in Boathaven Bay during spring and neap tides have been monitored by WBM (in Burchill 1998) in the area of the proposed marina (WBM Site 3). Levels were highest during spring tides (13 NTU) and lowest during neap tides (4 NTU). The trigger levels are to be determined within permits/approvals and/or by negotiation with EPA and GBRMPA. Turbidity is selected as the parameter to monitor, rather than suspended sediments, because turbidity can be measured *in-situ* and in real-time using a water quality probe while suspended solids/sediments must be analysed off-site in a laboratory. The time saving will allow for more rapid response in the event of identifying unacceptable levels.

In the event that unacceptable turbidity levels occur, the drainage outlets will be closed to increase settlement time or alternative treatment such as filtering or flocculation will be used to reduce turbidity and suspended solids.

Any dewatering effluent from the marina basin and land reclamation areas will pass through the sedimentation pond, bunded spoil disposal area and low velocity channels to reduce sedimentation levels prior to discharge to Boathaven Bay.

The pH (measure of acidity) of water discharged from the dredge spoil disposal area will be monitored. Where pH varies from levels in the receiving waters by more than one pH unit, corrective action may be required. This would be through reducing the pH of the water through the addition of lime.

Dredging

Dredging works will require approval under Section 86 of the *Harbours Act 1955*, with referral plans to the Beach Protection Authority for comment. Dredging is also a Level 1 Environmentally Relevant Activity requiring approval under Section 47 of the *Environmental Protection Act 1994*. A Dredging and Spoil Management Plan will be submitted to the relevant State authorities as part of the process for obtaining a dredging licence. This will include the following mitigation measures:

- monitoring of turbidity levels and appropriate triggers for corrective measures;
- appropriate corrective actions for situations when elevated turbidity levels are identified (these may include introduction of silt curtains, and, possibly, cessation of dredging for short periods of time);
- appropriate actions in the event of adverse weather conditions; and
- management of acid sulphate soils/sediments.

Sediments dredged from the navigation channel will be pumped to a secure bunded area to the east of Shute Harbour Road. Tailwater from any dredged area will be pumped through a series of low velocity channels to enable sediments to be removed. Regular checks of turbidity will be conducted on all runoff from dredge disposal and fill areas.

The use of silt curtains may be inappropriate for most of the channel dredging as the channel is being dredged through areas that are exposed or quite shallow at low tide. In this instance, silt curtains are likely to be ineffective in containing sediment.

However, the potential to use silt curtains will not be discounted in the event that actual turbidity levels from the dredging activities are excessive. Excessive turbidity levels that will require the use of silt curtains during dredging will be determined through developing the Dredging and Spoil Management Plan and through discussion and negotiation with EPA and GBRMPA.

Note that it is not intended to conduct dredging during the wet season. In the event that maintenance dredging during the wet season cannot be avoided, the impacts of dredging during wet weather will be addressed in the Dredging and Spoil Management Plan.

Acid Sulphate Soils

An assessment of the ASS potential of sediment for the Vision Airlie Project did not indicate any ASS potential at this location (Whitsunday Tourism Strategy, 1998) (See **Section 6.1.5**). Given that this hazard is not present in the marina development area, the risk of impact on water quality is considered minimal.

7.3.2 Operation Phase

Stormwater

The detailed design of the stormwater drainage system will be based on catchment analysis of the final earthworks plan. Overall, the contribution of stormwater to the overall volumes of stormwater currently discharging into Boathaven Bay is small.

Trash racks on stormwater drains will collect gross pollutants and litter will be regularly collected from the site as well.

The collection and treatment of stormwater from the marina facilities area will need to be addressed by the individual businesses when applying for an Environmental Authority for operation of this area. The nature of this will depend on the activities undertaken, the products used, the wastes generated and the potential for stormwater to contact these materials.

Fuel and Chemical Spills

Refuelling of boats will occur at the fuel dock facilities which are to be located away from the marina berths. Fuel transfer will be supervised by trained marina staff. Drip trays will be provided beneath each of the fuel bowsers to catch incidental fuel drips and spillage. Waste from these trays will be directed to a holding tank. The contents of the holding tank will be disposed of by a licensed contractor. Emergency spill containment equipment, including fuel absorbent mats and floating boom will be located near the refuelling berth. Other spill containment devices will be stored near other possible spill sources.

Vessel Maintenance Facilities

The management of potential spills and contamination from boat maintenance of repair facilities will need to be addressed by each boat maintenance/repair business when they apply for an environmental licence. An environmental licence is required from the Environmental Protection Agency since the operation of a boat maintaining or repairing facility is a level 1 environmentally relevant activity (ERA 69).

To minimise the potential for contamination from antifouling and in-water hull cleaning and maintenance activities, boat repair and maintenance business operators will be required to conform with the practices set out in the ANZECC *Code of Practice for Antifouling and In-water Hull Cleaning and Maintenance* (2000).

Sewage and Sullage

The provision of vessel sewage and sullage pumpout facilities should improve water quality in Boathaven Bay. The operation of the marina, however, will generate more sewage and sullage that will be pumped to Cannonvale WWTP for treatment and disposal.

As described in the **Section 2**, Cannonvale WWTP is required to be upgraded by 2008 to meet more strict EPA and GBRMPA licence requirements. As part of the upgrade, the capacity of the plant will also be increased to accommodate sewage from the marina complex and other development in the area. This upgrade will largely coincide with the staged construction of the marina complex.

Reclamation and major earthworks for the marina development are scheduled to occur in 2003-2004. The first stage of occupied development will occur in 2005, with subsequent stages being built in subsequent years. In order to achieve the 2008 timeframe for the Cannonvale WWTP upgrade, works will similarly need to be undertaken in the years prior, at about the same time as the marina development is becoming more developed and occupied. Overall then, the increase in sewage will be largely offset by the increase in capacity and treatment of the upgraded Cannonvale WWTP.

7.4 Conclusions and Recommendations

The following recommendations apply to the construction and operation of the marina.

7.4.1 Construction

The potential for adverse impacts on water quality to occur during construction is considered to be very low. Sediment disturbed during channel dredging will cause a sediment plume, however this expected to be rapidly dispersed and is not expected to have significant impact on any marine or intertidal ecosystems. All other construction activities are taking place within an enclosed and controlled environment and the potential for releases to the marine environment is very low.

The following requirements are relevant to construction of the marina facilities:

- Waters with high sediment loads should be directed to the settlement pond, bunded dredge spoil area and low velocity drainage channels to provide for settlement of sediment loads.
- A Dredging and Spoil Management Plan should be developed and accepted by EPA and GBRMPA prior to any dredging activity being undertaken.
- A reactive water quality monitoring program should be developed and implemented (see also **Section 21.5.1**)
- An Erosion and Sediment Control Plan should be developed and implemented to minimise sediment loads going to the receiving waters.

- Effluent from dewatering of reclaimed lands should be passed through the sedimentation pond, bunded dredge spoil area and low velocity channels to reduce sediment load.

Preliminary acid sulphate soils investigations have been undertaken in the marina development area. Results indicate that ASS are not present. Consequently, no impacts from pH decrease are expected to occur as a result of excavation, however, monitoring of pH in the spoil area discharge water will occur to ensure that any significant decrease is noted.

- The potential impact from acid sulfate soils will be minimised through the development and implementation of an appropriate site specific Acid Sulfate soils Management Plan (see also **Section 6** and **Appendix E**).

7.4.2 Operation

During operation, the following matters should be addressed to minimise air and odour emissions:

- Fuel storage and refuelling facilities should be designed and operated in accordance with AS 1940 and other relevant standards and codes of practice. Emergency spill control and containment equipment should be available at vessel refuelling berths. Vessel refuelling should be supervised by marina staff. Drip trays from bowsers will be emptied daily, or sooner if they become full.
- Stormwater design should maximise the infiltration of non-contaminated stormwater where practicable. Potentially hydrocarbon contaminated stormwater should be directed to an oil-water separator.
- Ongoing water quality monitoring should be carried out (see **Section 21.5.1**)
- Litter should be removed from the marina area regularly to prevent it being washed into the water.
- Vessel maintenance and repair facilities should be designed and operated in accordance with EPA requirements and in accordance with the Environmental Authority.

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