



Report


Revised Wastewater Discharge Assessment

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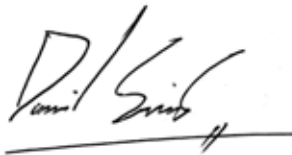
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Introduction

This report has been prepared to provide additional information on the potential impacts of wastewater discharges from the LNG facility in response to conditions imposed by the Coordinator General (CG) on the quality of proposed sewage effluent and brine discharges.

1.1 Background

The EIS and Supplement assessed the impacts of proposed discharges from the LNG facility on water quality in Port Curtis based on a discharge point within China Bay. The CG's report on the EIS requires more assessment of the discharge to be undertaken prior to setting EA conditions for the discharges. The CG report also placed proposed conditions on the quality of the discharges from the wastewater treatment plant (WWTP) and the reverse osmosis (RO) plant to be attached to the environmental authority for activities in the Petroleum Facility Licence.

The CG's proposed conditions for sewage effluent are inconsistent with the tertiary treatment standards specified in section 135(3) of the Great Barrier Reef Marine Park (GBRMP) Regulations 1983 and GBRMP Sewage Discharge Policy March 2005. The CG Report deferred the establishment of Reverse Osmosis Plant discharge quality limits for most parameters, pending the outcomes of further assessment of the combined discharges from the facility.

Accordingly further assessment has been undertaken of the proposed discharges from the LNG facility during construction and operation. Sewage effluent discharges have been assessed by applying the GBRMP discharge criteria to sewage effluent discharges from the LNG facility. The reverse osmosis discharge has been assessed by applying the expected discharge quality arising from the facility following treatment of raw seawater from the proposed intake to the plant based on actual water quality data.

1.2 Objectives

The primary objective of the study is to reassess the impacts of the proposed wastewater and reverse osmosis concentrate discharges from the facility in response to the CG's requirement for further assessment of the proposed discharges.

1.3 Scope of Works

The scope of this assessment is to:

- Review and interpret outfall modelling (near and far field) of the proposed WWTP and ROC discharges, undertaken by WBM
- Assess the impacts of wastewater discharge and present mitigation measures to avoid, mitigate or manage impacts within Port Curtis.

Wastewater Discharges

The proposed LNG facility will generate distinct wastewater streams during the construction and operation of the facility. The wastewater streams generated and proposed treatment processes are discussed below for both the construction and operational phases of the facility.

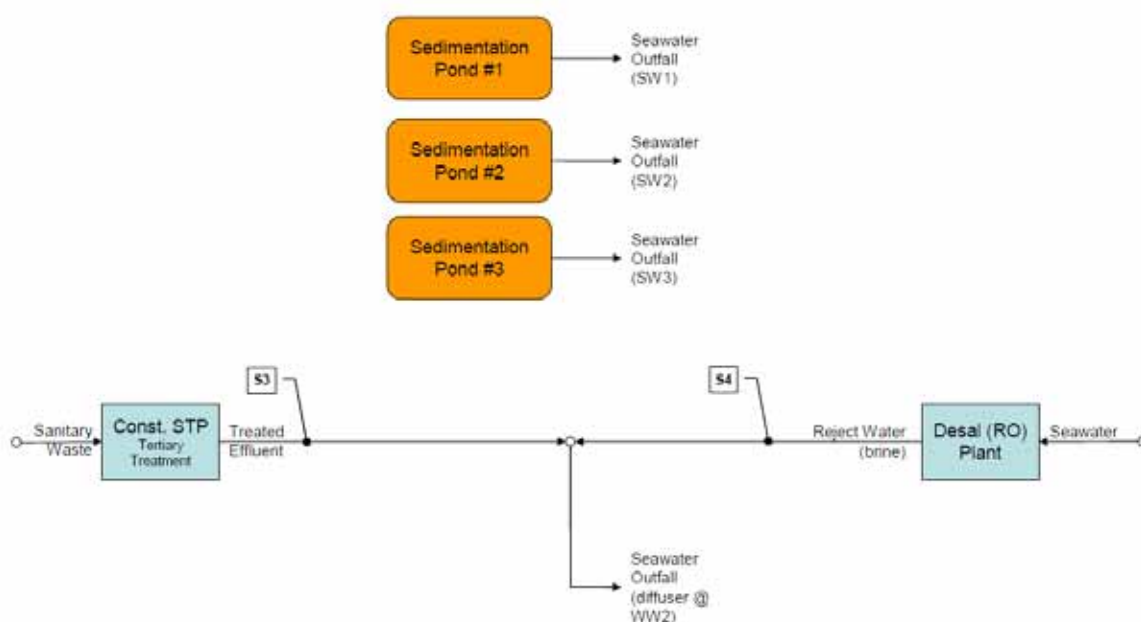
2.1 Construction

During the construction phase two primary wastewater streams will be generated. These being:

- sewage/sanitary waste; and,
- reverse osmosis/desalination plant waste/brine.

A schematic of the waste water streams is provided in Figure 2-1.

Figure 2-1 Construction Phase Waste Water Schematic



The two wastewater streams will be discharged as a combined wastewater stream into Port Curtis via a dedicated diffuser structure (denoted WW2 in Figure 2-1) which will be located near the Marine Offloading Facility (MOF). Further details on the location of the construction phase diffuser are provided in Appendix B. The characteristics of each waste stream and proposed discharge volumes are discussed in detail below.

2.1.1 Sewage/Sanitary Waste

An onsite sewage treatment plant will be constructed to treat sewage from the construction camp population including commuting personnel from the mainland.

The sewage treatment plant will utilise a suspended growth activated sludge process modified to accomplish biological nutrient removal (BNR). Nitrogen removal will be achieved through anoxic and aerobic zones for nitrification and denitrification respectively. Clarified effluent will be polished in denitrification filters which, in addition to providing supplementary nitrogen removal, will act as effluent filters. Supplemental Carbon in the form of sugar solution will be added to propagate growth of

2 Wastewater Discharges

denitrification microorganisms for nitrogen removal. Phosphorus will be removed in the main part through biological processes with residual phosphorus concentrations lowered to the required limits through chemical polishing using alum.

Sodium hydroxide will be added for pH control during the treatment process. Sodium hypochlorite will be added to the treated effluent to provide adequate disinfection.

Treated sewage will be discharged via a diffuser into Port Curtis for the operational life of the construction camp.

2.1.2 Reverse osmosis/desalination plant waste/brine

A construction water treatment plant will be provided to meet the water supply requirements for the construction period including water for soil compaction, potable water, concrete batch plant, service water for wash down, and hydrotest water.

The Construction site Water Treatment Plant (WTP) will utilise Seawater Reverse Osmosis (SWRO) technology with seawater for the plant being sourced from China Bay via seawater intake pumps. A schematic of the proposed treatment process is provided below in Figure 2-2.

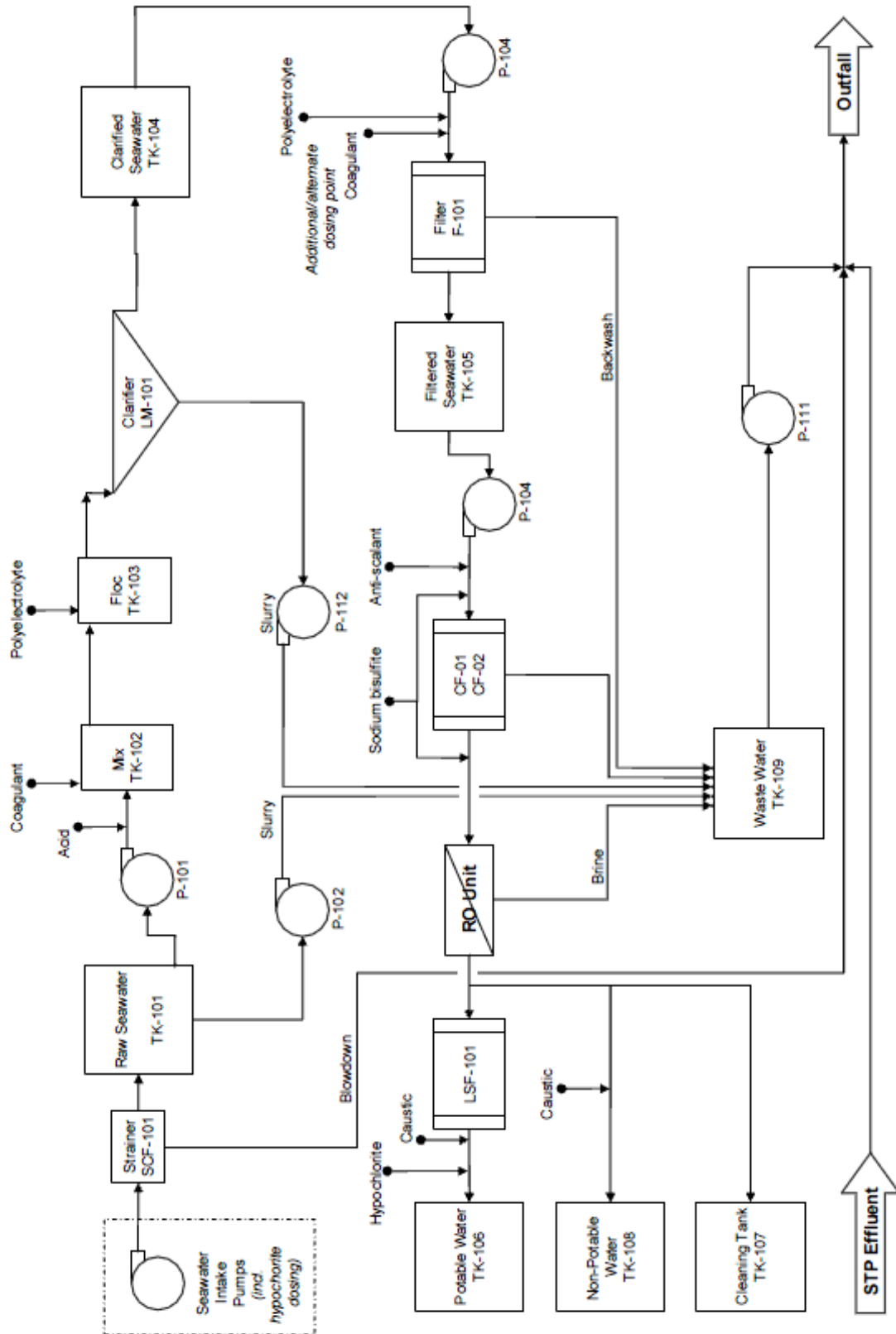
As can be seen in Figure 2-2 the treatment process requires pre-treatment prior to the reverse osmosis filters. The pre-treatment process involves the addition of sodium hypochlorite to disinfect the seawater and prevent biological fouling of equipment. A strainer is provided to remove gross materials from seawater such as leaves; seaweed, and other material debris that can clog downstream equipment. Periodically the screen is backwashed to remove accumulated sea debris that is discharged back to sea. Ferric Chloride and polyelectrolyte are then added to aid in the removal of suspended sediments in the raw seawater. The ferric chloride causes the fine colloidal particles to clump together to form 'micro-flocs', whilst the polyelectrolyte neutralises the negative charge of particles which would otherwise cause them to repel each other and stay in suspension. The seawater then flows to a clarifier where the bulk of the solids are removed. Overflow from the clarifier is directed to a clarified seawater tank and from there is directed via multimedia (sand) filters to the filtered sea water tank. This filtration process also uses coagulant and polyelectrolyte to improve efficiency of removal of residual colloidal solids that are not removed in the clarifier. The filter removes a residual precipitate as ferric hydroxide. The filters are backwashed automatically when the differential pressure reaches a preset limit, with backwash water directed to the waste water tank.

Sodium bisulfite is added to the filtered seawater to neutralize any residual chlorine prior to the RO filters. Anti-scalant is also added to inhibit scale formation within the RO filters. The treated water then passes through cartridge filters to the reverse osmosis units. Permeate from the RO units is directed to a potable water treatment system and either into the potable water tank, or into the non-potable water tank. Permeate is also directed to a cleaning tank as required.

Brine from the RO units is directed to the waste water tank. It is proposed that a combined waste water (slurry from raw seawater tank and clarifier, backwash from the filters, and brine) will be discharged via a subsea diffuser.

2 Wastewater Discharges

Figure 2-2 Reverse Osmosis Plant Process Diagram



2 Wastewater Discharges

It is anticipated that the RO membranes will need to be chemically cleaned 4 times a year using chemicals such as citric acid. The choice of chemical used will be dependent on the type of fouling observed. The cleaning process is anticipated to generate up to about 3 m³ of spent chemical that will be disposed offsite by a waste contractor. One RO unit will be cleaned at a time while the other units remain online.

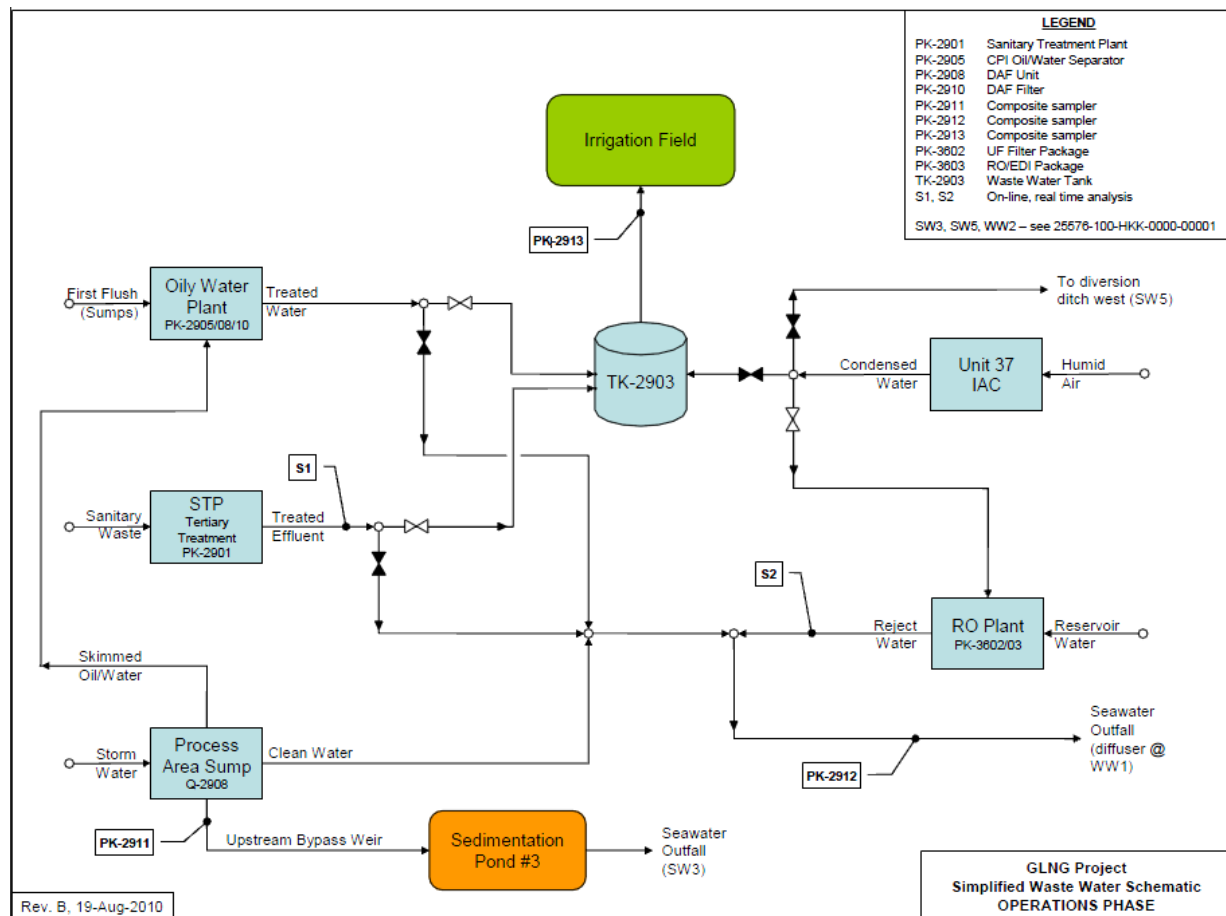
2.2 Operation

During the operation of the LNG facility three primary wastewater streams will be generated. The proposed wastewater streams are as follows:

- sewage/sanitary waste;
- reverse osmosis/desalination plant waste/brine; and
- treated process water.

A waste water schematic for the operational phase is provided in Figure 2-3.

Figure 2-3 Operational Phase Waste Water Schematic



During normal operation the sewage and process water waste streams will be irrigated on site with only the brine waste stream being discharged into Port Curtis. However, when conditions are not suitable for irrigation, it is proposed that the three waste streams will be discharged as a combined wastewater stream into Port Curtis via a dedicated diffuser structure (WW1 in Figure 2-3). The

2 Wastewater Discharges

operational phase diffuser will be located off the LNG Loading Jetty. Further detail on the location of the proposed diffuser is provided in Appendix B. Each of these streams is discussed in more detail below.

2.2.1 Sewage/Sanitary Waste

During operation of the LNG facility sewage generated from operational personnel will be treated through a dedicated treatment plant, which will be sized based on a 2-train operation. This treatment plant will be constructed during the construction phase of the LNG Facility and will be separate to the construction sewage treatment plant. Treated sewage will be irrigated on-site under most conditions. However, when conditions are not suitable for irrigation, treated sewage will be discharged to Port Curtis via a seawater outfall.

2.2.2 Reverse osmosis/desalination plant waste/brine

During the operation of the LNG facility, utility water, including demineralised water for the LNG Plant, will be provided through a dedicated reverse osmosis plant. This facility will be built during the construction phase of the project and will be separate to the construction phase reverse osmosis plant. The plant will use ultrafilters as a pre-treatment process rather than multi-media filters used in the Construction WTP. The plant will be supplied with raw water sourced from Gladstone Area Water Board and transferred to Curtis Island by barge or tankers.

The plant will produce a reject stream (labelled S2 in Figure 2-3) that will be pumped to the seawater outfall for discharge into Port Curtis.

2.2.3 Treated Process Water

During the operational period of the LNG facility treated process water and potentially contaminated site water will be used for irrigation purposes. However during prolonged wet weather this waste stream will be combined with the brine and sewage effluent streams and discharged through the seawater outfall

Outfall Modelling

Water quality modelling of the proposed discharges was undertaken by WBM. The full report is provided in Appendix A. The following section outlines the modelling assumptions, describes the modelling scenarios and summarises the modelling results.

3.1 Modelling Assumptions

Four discharge scenarios have been modelled each representing worst case and typical discharge conditions during the construction and operational phases of the LNG facility. Separate diffuser structures will be used for the construction and operational phases.

During the construction phase discharges will occur via a diffuser which will be located at E 318191.77 N 7367192.28 (As shown in Appendix B). Two scenarios have been modelled as follows:

- Scenario 1 – A combined sewage and reverse osmosis waste (Sewage 45 m³/hr and Brine 500 m³/hr); and,
- Scenario 2 – A combined sewage and reverse osmosis waste (Sewage 22.5 m³/hr and Brine 233 m³/hr).

During the operational phase the diffuser will be located at E 316794.358 N 7368573.212 (As shown in Appendix B). Two scenarios have been modelled as follows

- Scenario 1 – A combined sewage, reverse osmosis waste and treated process and contaminated stormwater; and,
- Scenario 2 – Reverse osmosis waste only.

The flow rates for the proposed discharges from the LNG facility during the construction and operational period are as shown in Table 3-1 below.

Table 3-1 Wastewater stream flow data

Waste Stream	Construction Stage		Operational Stage	
	Scenario 1	Scenario 2	Scenario 1	Scenario 2
Sewage/Sanitary Waste	45 m ³ /hr	22.5 m ³ /hr	30 m ³ /day	-
Reverse Osmosis Waste	500 m ³ /hr	233 m ³ /hr	10 m ³ /hr	10 m ³ /hr
Treated Process and Contaminated Stormwater	-	-	160 m ³ /hr	-
TOTAL	545 m³/hr	255.5 m³/hr	171.25 m³/hr	10 m³/hr

The behaviour of the combined discharge after release via the proposed diffuser structure will be different for the construction and operational stages due to the varying proportions of (dense) reverse osmosis waste and (fresh/buoyant) sewage and process waste present in the discharge.

The construction stage plumes will be negatively buoyant, and will 'fall' through the water column potentially impacting the sea bed. The operational stage plume will be a buoyant plume and will rise through the water column before impacting on the water surface. For these reasons, the height of the construction diffuser above the sea bed will be critical whereas the depth of the diffuser below the water surface will be critical during the operational stage.

3 Outfall Modelling

The following assumptions were made for the discharge modelling:

- The background salinity in Port Curtis is 38 g/L.
- The reverse osmosis process will produce a concentrate which has a salinity 1.7 times higher than background salinities, calculated to be 64.6 g/L during the construction phase (based on sourcing water from within Port Curtis).
- Background temperatures in Port Curtis of 24 °C.
- Background TSS in Port Curtis ranges from 2 to 116 mg/L. According the reverse osmosis concentrate will produce a TSS concentration 1.7 times higher than background, plus 50 mg/L (Ferric Hydroxide).
- Operational stage desalination waste will have a salinity of 20.0 g/L (based on sourcing water from Gladstone and with desalination using ion exchange);
- The other waste streams will effectively be 'fresh' water in nature, though they may contain other pollutants.
- All wastewaters will discharge at the provided rates via dedicated outfall/diffuser structures located as advised by Santos.

3.2 Discharge Constituents

3.2.1 Construction Phase

Scenario 1

The scenario 1 discharge represents the high flow discharge during the construction of the LNG facility and will comprise a mix of sewage and brine. The effective combined salinity of the discharge will be 59.3 g/L and, as such, will be a negatively buoyant plume which will more readily fall through the water column and impact the sea bed.

The quality of the effluents contributing to the discharge is as follows:

- Sewage/Sanitary Waste

The quality standard applied to sewage for modelling purposes is based on the Sewage Policy 2005 of the GBRMP Regulations 183, as defined in Regulation 135 (c) for tertiary treatment. The quality of sewage effluent is as follows:

- BOD < 20 mg/L
 - TSS < 30 mg/L
 - DO > 2 mg/L
 - TN < 5 mg/L
 - TP < 1 mg/L
- Desalination Brine
 - Salinity = 64.6 g/L
 - TSS = 250 mg/L (maximum, range 50 to 250 mg/L)

3 Outfall Modelling

Scenario 2

The scenario 2 discharge represents the typical expected discharge from the LNG facility during construction and will also comprise a mix of sewage and brine albeit at reduced volumes compared with the Scenario 1 discharge. The quality of the effluents contributing to the Scenario 2 discharge will be as for the Scenario 1 discharge described previously. The effective combined salinity of the discharge will be 58.9 g/L which will therefore be a negatively buoyant plume which will more readily fall through the water column and impact the sea bed.

3.2.2 Operational Phase

Scenario 1

The scenario 1 discharge represents the high flow discharge during the operation of the LNG facility and will comprise a mix of sewage, brine and process water. The combined salinity of the discharge will be 1.0 g/L. The operational stage plume will therefore be buoyant and will take far longer to impact on the seabed. For this case, the depth of the diffuser below the water surface is critical.

The quality of the effluents contributing to the discharge is as follows:

- Sewage/Sanitary Waste

The quality standard applied to sewage for modelling purposes is based on the Sewage Policy 2005 of the GBRMP Regulations 183, as defined in Regulation 135 (c) for tertiary treatment. The quality of sewage effluent is as follows:

- BOD < 20 mg/L
- TSS < 30 mg/L
- DO > 2 mg/L
- TN < 5 mg/L
- TP < 1 mg/L

- Desalination Brine

- Salinity = 20 g/L
- TSS = Negligible

- Treated Process Water and Contaminated Stormwater

- BOD = 20 mg/L (median)
- TSS = 30 mg/L (median)
- Oil and Grease = 10 mg/L
- TDS = 1000 mg/L (median)

Scenario 2

The scenario 2 discharge represents the typical expected discharge from the LNG facility during operation and comprises brine only. The salinity of the brine stream may be as high as 20 g/L depending on the desalination technology used and hence this has been modelled as the worst case scenario for the typical discharge. The TSS concentration of the discharge is expected to be negligible.

3 Outfall Modelling

3.3 Hydrodynamic Modelling

Hydrodynamic modelling was undertaken using the hydrodynamic models which have been developed for the Gladstone Ports Corporation. These models are the recognised benchmark assessment tools for the region and it should be noted that for this assessment, the model has been configured to include planned dredging works in the vicinity of the LNG facility thereby ensuring accurate data for modelling assessments.

The receiving water hydrodynamic models were run for a representative 28 day complete spring-neap tidal period of velocity data at the proposed outfall site. The velocity data are illustrated below in Figure 3-1 for the construction phase discharge location, and in Figure 3-2 for the operational phase discharge location. The velocity statistics for each outfall location are presented in Table 3-2.

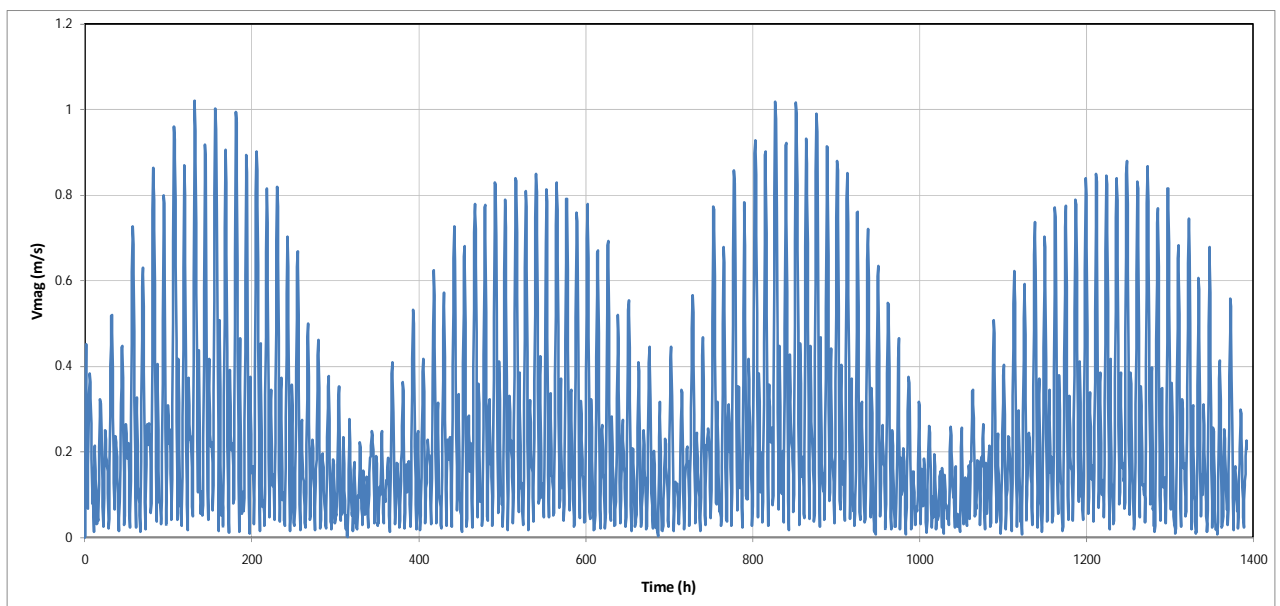
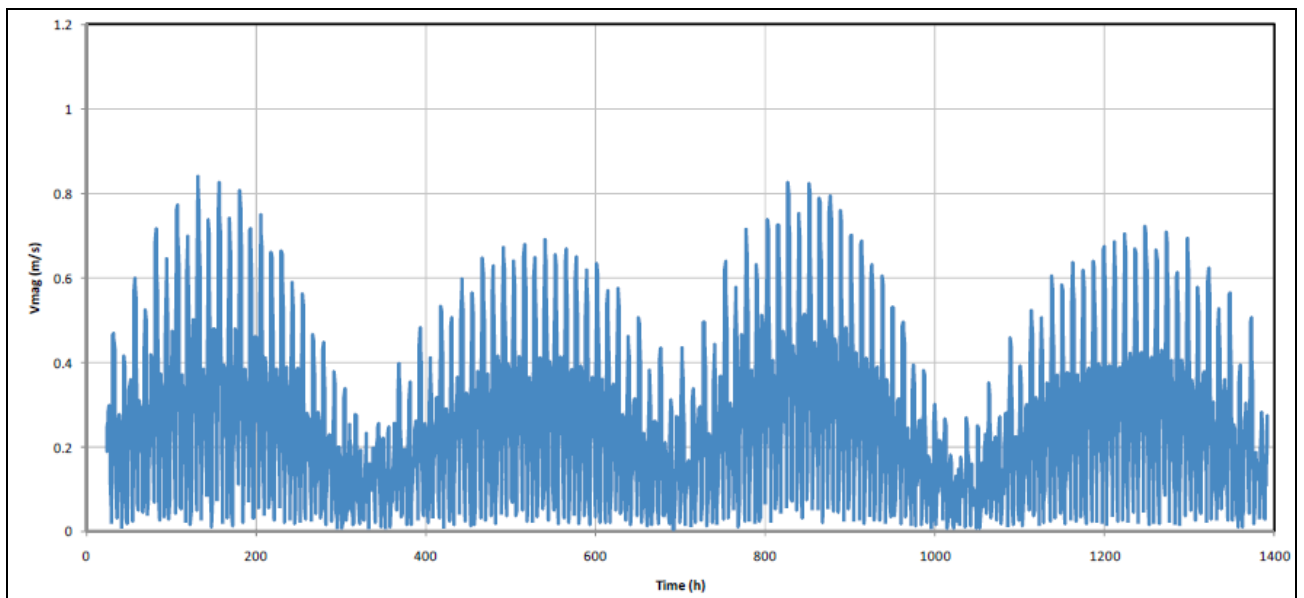


Figure 3-1 Velocity Pattern at the Construction Outfall Location



3 Outfall Modelling

Figure 3-2 Velocity Pattern at the Operational Phase Outfall Location

Table 3-2 Relevant Outfall Location Velocity Statistics

Velocity Percentile	Construction Stage Outfall Velocity (m/s)	Operational Stage Outfall Velocity (m/s)
10%	0.06 m/s	0.05 m/s
25%	0.14 m/s	0.12 m/s
50%	0.25 m/s	0.24 m/s
75%	0.43 m/s	0.37 m/s
90%	0.77 m/s	0.53 m/s

Conceptual diffuser designs were developed for each of the four discharge scenarios to enable the discharges to be modelled. The diffuser designs were refined through an iterative process to optimise the effective dilution achieved within close proximity of the discharge. This assessment showed that during construction it was possible to utilise one diffuser for both discharge scenarios. However, during the operational phase, the characteristics of the two discharge scenarios are sufficiently different to require two different discharge diffusers. The diffuser details are as follows:

- Construction Stage – Scenarios 1 and 2
 - 0.1 m diameter outlet ports (10 of) spaced at 1 m centres, with the outfall pipeline oriented perpendicular to the prevailing ebb/flood tidal flow direction (basically at right angles to the ‘long’ axis of Port Curtis). The ports should be oriented at 45 degrees upwards from the horizontal and the outfall pipe needs to be at least 6 m above the sea bed.
- Operational Stage – Scenario 1
 - 0.1 m diameter outlet ports (5 of) spaced at 1 m centres, with the outfall pipeline oriented perpendicular to the prevailing ebb/flood tidal flow direction (basically at right angles to the ‘long’ axis of Port Curtis). The ports should be oriented at 45 degrees downwards from the horizontal and the outfall pipe needs to be at least 10 m below the water surface.
- Operational Stage – Scenario 2
 - Due to the very small flow rate associated with this scenario, this flow will not work for the Operational Stage Scenario 1 diffuser mentioned above for likely operational (marine fouling) reasons. In fact, there is no real need for a ‘diffuser’ at all. A single outlet port with a diameter of 0.075 m (7.5 cm) at a depth of 10 m will achieve surface dilutions of in excess of 180:1.

Each discharge scenario and diffuser design was modelled with a CORMIX model using the 10 %ile velocity as key background/forcing data. Plume behaviour was also assessed for the 25 %ile velocity case. The critical dilution was modelled for the construction phase based on plume contact with the sea bed, and for the operation phase when the plume contacts the water surface. The critical dilutions achieved for each discharge scenario are presented in Table 3-3 below.

Table 3-3 Critical dilution achieved for each discharge scenario

Velocity Case	Critical Dilution Construction Stage 1	Critical Dilution Operational Stage 2

¹ Dilution at bottom contact (negatively buoyant plume)

² Dilution at surface contact (positively buoyant plume)

3 Outfall Modelling

	Scenario 1	Scenario 2	Scenario 1	Scenario 2
10 %ile	58:1	74:1	70:1	182:1
25 %ile	167:1	233:1	226:1	671:1

The critical dilutions presented above are the dilutions achieved at the bottom or surface contact. In reality, especially for the 10 %ile velocity, this is a very conservative assumption as the zone of influence is extremely close to the outfall. To demonstrate this, the table below summarises the distances to bottom/surface contact of the plume for each of the velocity cases modelled.

Table 3-4 Distance from the outfall to bottom/surface contact

Velocity Case	Distance to Bottom Contact Construction Stage		Distance to Surface Contact Operational Stage	
	Scenario 1	Scenario 2	Scenario 1	Scenario 2
10 %ile	5 m	5 m	3 m	5 m
25 %ile	16 m	17 m	13 m	20 m

The data presented in Table 3-4 confirms that the points at which predictions from the model have been extracted are very close to the outfall. A more common approach is to define an initial 'mixing zone' located a certain distance either side of the diffuser. It is proposed that a suitable initial mixing zone for this site would be 50 m. Hydrodynamic modelling was undertaken to define dilutions of the discharge plumes at this distance from the outfall. The results of this modelling are presented in Table 3-5 below.

Table 3-5 Plume Dilution at 50m from the Outfall

Velocity Case	Construction Stage		Operational Stage	
	Scenario 1	Scenario 2	Scenario 1	Scenario 2
10 %ile	91:1	164:1	146:1	496:1
25 %ile	230:1	317:1	506:1	1370:1

The data presented in Table 3-5 shows that significant dilutions of the plume constituents are expected to occur within 50 m of the outfall.

Impacts and Mitigation Measures

4.1 Impacts

4.1.1 Water Quality

In order to assess the impacts of the proposed discharges on water quality in Port Curtis the dilution factors presented in Table 3-3 and Table 3-5 were applied to the constituents of each discharge to estimate the potential changes in water quality. The predicted changes in water quality both at surface/bottom contact and 50 m downstream of the outfall are presented in Table 4-1. The results are presented for the worst case 10 %ile velocity.

Table 4-1 Predicted changes in water quality at surface/bottom contact and 50 m from the outfall (10 %ile velocity)

Water Quality Parameter	Unit	Construction Stage				Operational Stage			
		Scenario 1		Scenario 2		Scenario 1		Scenario 2	
		Bottom Contact	50 m	Bottom Contact	50 m	Surface Contact	50 m	Surface Contact	50 m
BOD	mg/L	0.03	0.02	0.02	0.01	0.29	0.13	0.00	0.00
TSS	mg/L	4.00	2.55	3.12	1.41	0.4	0.19	0.00	0.00
DO	mg/L	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
TN	mg/L	0.01	0.00	0.01	0.00	0.00	0.00	0.00	0.00
TP	mg/L	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Salinity	g/L	1.03	0.66	0.80	0.36	0.02	0.01	0.11	0.04

A comparison of the results presented in Table 4-1 with available data on ambient water quality levels in Port Curtis indicates that the only scenarios which may result in potentially detectable changes in water quality occur at bottom contact during the construction stage for TSS. Whilst this impact may be discernable for the 10 %ile case, it is anticipated to be short lived and will occur in an environment of naturally variable TSS concentrations. As such, this is considered unlikely to be of any real consequence.

No other discernable impacts on water quality are predicted to arise from the discharge of wastewaters from the LNG facility.

4.1.2 Eco-Toxicity

The Coordinator General's report has specified two main requirements with regard to the presence of toxic substances in the LNG facility discharge which are as follows:

4 Impacts and Mitigation Measures

- *Notwithstanding any other condition of this environmental authority, there must be no discharge of any contaminants to any waters where the no observed effect concentration (NOEC) for acute toxicity tests to any test organisms in a direct toxicity assessment (DTA) is observed at a 100 per cent concentration i.e. the lowest observed effect concentration (LOEC) must only be observed at a dilution greater than 1:1*
- *There must be no discharge of any contaminants to any waters where the NOEC for chronic toxicity tests to any test organisms in DTA is observed at a 6.25 per cent concentration i.e. the LOEC must only be observed at a dilution greater than 1:15.*

The impact assessment has considered two main aspects with regard to toxicant presence in the discharge. Firstly the potential for toxicants present in the influent streams to be concentrated during the treatment process and discharged into Port Curtis, and secondly the potential for chemicals added during the treatment process to exert a toxic effect in Port Curtis.

Toxicity of Influent Streams

As discussed previously two main wastewater streams will be generated during the construction and operation of the LNG facility, these being sewage effluent and reverse osmosis waste. A third wastewater stream will be generated during operation which will comprise treated process and contaminated stormwater.

Best practice treatment processes will be employed for sewage and process water treatment to ensure that high quality effluents are produced prior to discharge. This combined with controls regarding the inputs of toxicants into the influent streams will minimise the potential for toxicants present in influent sewage and process water streams to be discharged into Port Curtis. Any residual toxicants present will be substantially diluted on contact with the waters in Port Curtis with the predicted dilution at 50 m from the outfall being 230:1 and 506:1 during the construction and operational phases respectively.

The treatment process and discharge regime proposed for the reverse osmosis plant does have the potential for toxicants present in raw water drawn from Port Curtis to be concentrated by a factor of 1.7. However the potential for toxicants to be present in the raw water is low given the good water quality present in Port Curtis. This is supported by specific water quality monitoring that was undertaken to characterise expected influent water quality. The results of this sampling are provided in Appendix D.

Toxicity of Chemicals Added During the Treatment Process

As discussed in section 2 the treatment processes employed for the waste streams from the LNG facility require the addition of certain chemicals to maximise the efficiency of the treatment process. A discussion of each of the chemicals added and the potential concentrations of these chemicals in discharges from the facility is presented below.

1. Sewage Effluent

The sewage treatment process requires the addition of three main chemicals as follows:

- Sodium Hydroxide is added to control pH during the treatment process and is an accepted chemical used in water and wastewater treatment. Sodium Hydroxide is added to increase pH and reduce the potential for corrosion and ensure that effluent pH is within receiving water limits.

4 Impacts and Mitigation Measures

- Sugar solution to provide carbon for denitrification process.
- Alum is added to remove residual phosphate from the effluent and is commonly used for water and wastewater treatment. Alum is not classified as a Dangerous Good. It is classed as a Hazardous Substance with an Irritant (Xi) rating. A Material Safety Data Sheet (MSDS) for alum is provided in Appendix C. The active ingredient is the Aluminium Ion which reacts with hydroxy groups to form positively charged floc particles which absorb phosphate from the solution. The floc is then removed through the filtration process and captured with the sludge.
- Sodium Hypochlorite is added to disinfect the effluent prior to discharge and in so doing ensure that faecal coliform concentrations meet discharge requirements. An MSDS for sodium hypochlorite is provided in Appendix C. This chemical is known to be toxic to fish at concentrations between 0.07 and 5.9 mg/L and has the potential to form disinfection by-products which can also be toxic. Consequently the addition of sodium hypochlorite will be carefully controlled to ensure that the chlorine residual in the effluent is kept below 0.07 mg/L. In addition the diffuser design is predicted to achieve dilutions of 230:1 and 506:1 during the construction and operational phases respectively, which will minimise the potential for toxic effects to occur.

2. Reverse Osmosis

Several chemicals are used during the reverse osmosis process, which are described below.

- Chlorine & Sodium Bisulfite. - Chlorine, usually in the form of hypochlorite, is injected at a very low dose at the start of the process as a disinfectant and prevent biological fouling of equipment. As free chlorine can damage the RO membranes and cartridge filters, it is removed by the addition and sodium bisulfite immediately upstream of these units. Chlorine reacts with the bisulfite to form sodium chloride (salt), which is rejected by the RO units.
- Sulphuric acid is added to control pH of seawater to improve efficiency of pre-treatment process.
- Coagulant/Flocculant - Fine suspended (colloidal) particulates in the seawater are treated with chemicals that cause the particles to “clump” together to produce “micro-flocs”, which are then removed by filtration. A polyelectrolyte is added to neutralise the negative charge on the particles, which otherwise causes the particles to repel each other and remain suspended. Ferric chloride is then added to aid coagulation. Both chemicals are precipitated with the solids and removed in the filtration process. Ferric chloride precipitates as ferric hydroxide and is rejected in the filter backwash water to the waste water tank. Ferric hydroxide is benign in the environment, having no established ecotoxicity levels. An MSDS for Ferric Hydroxide is provided in Appendix C.
- Anti-scalant - To inhibit scale formation on the RO membranes, an anti-scalant is added. The likely product to be used is Nalco PC191 or Metito’s M51 and is widely used in the desalination process. It is added at a rate of approximately 3 mg/L and is rejected with the brine. As the brine flow is approximately 65 % of the inlet water, the anti-scalant concentration in the brine is anticipated to be around 5 mg/L. In contrast, the LC50 for cuttlefish (96 hr) is > 2400 mg/L. In addition the brine discharge is expected to be diluted by a factor of 250 at 50 m from the outfall and hence have an effective concentration of 0.02 mg/L which is well below the concentration at which a toxic effect is likely.

The impact assessment has therefore found that any toxicants used in the treatment process will not be present in discharges from the facility at levels above the lowest observed effect concentration.

4 Impacts and Mitigation Measures

4.2 Mitigation Measures

The diffuser designs and configurations presented in this report should be adopted for the proposed discharges from the LNG facility.

A Construction Environmental Management Plan (CEMP) should be prepared and best practice operating procedures implemented to minimise the potential for adverse impacts from wastewater discharges.

An Environmental Management Plan (EMP) for the operational phase should be prepared including catchment/stormwater treatment measures and a monitoring program to minimise the potential for adverse impacts arising from wastewater discharges from the LNG facility.

Conclusions and Recommendations

This assessment has shown that during the construction phase the discharge of a combined wastewater stream of sewage and brine may give rise to potentially detectable changes in water quality associated with TSS at bottom contact. This impact, however, is expected to be short lived and will occur in an environment of naturally variable TSS concentrations. During the operation of the facility the discharge of wastewaters from the facility is not predicted to cause any discernable impacts on water quality.

The assessment has also shown that any toxicants used in the treatment process will not be present in discharges from the facility at levels which exceed the lowest observed effect concentration.

References

- Anderson, L.E., Melville, F., Steinberg, A. N., Teasdale, A. W., and Fabbro, L.D. (2008) PCIMP Biomonitoring 2007: Port Curtis Integrated Monitoring Program, Centre for Environmental Management, Central Queensland University.
- Environmental Protection Agency (2003) Queensland Government, Queensland Parks and Wildlife Service) *Curtis Coast Regional Coastal Management Plan*, September 2003. Available online:<http://www.epa.qld.gov.au/register/p00528bm.pdf>
- Queensland EPA (2006) Queensland Water Quality Guidelines (Minor Updates March 2007).
- WBM (2008) Proposed Santos LNG Facility- Marine Water Quality Assessments. Prepared for URS.
- WBM (2009) Plume Dispersion Modelling and Data Review Port Curtis GLNG Supplementary EIS. Prepared for URS.

Limitations

URS Australia Pty Ltd (URS) has prepared this report in accordance with the usual care and thoroughness of the consulting profession for the use of Santos and only those third parties who have been authorised in writing by URS to rely on the report. It is based on generally accepted practices and standards at the time it was prepared. No other warranty, expressed or implied, is made as to the professional advice included in this report. It is prepared in accordance with the scope of work and for the purpose outlined in the Proposal dated 24 September 2010.

The methodology adopted and sources of information used by URS are outlined in this report. URS has made no independent verification of this information beyond the agreed scope of works and URS assumes no responsibility for any inaccuracies or omissions. No indications were found during our investigations that information contained in this report as provided to URS was false.

This report was prepared between 24 September and 05 November 2010 and is based on the conditions encountered and information reviewed at the time of preparation. URS disclaims responsibility for any changes that may have occurred after this time.

This report should be read in full. No responsibility is accepted for use of any part of this report in any other context or for any other purpose or by third parties. This report does not purport to give legal advice. Legal advice can only be given by qualified legal practitioners.

Appendix A Hydrodynamic Modelling Results

Memorandum

From: Tony McAlister To: Julian Long
URS

Date: 19 October 2010 CC:

Subject: GLNG: Additional Wastewater
Discharge Assessments

Dear Julian

Following from your recent request and provision of relevant information in regard to modifications to the quantities and qualities of wastewater likely to be discharged to Port Curtis from the proposed GLNG operations, I am pleased to provide this brief report outlining the findings of our investigations.

1. Project Background

- BMT WBM has previously undertaken modelling assessments of the potential impacts on local and regional water quality of discharges from the proposed GLNG facility on Curtis Island. In this work, regional impacts were shown to be inconsequential. There were however some potential localised impacts.
- There have recently been changes to the locations, rates and qualities of the proposed discharges and re-assessments of our earlier work are required, specifically the near field or localised impacts.
- This report outlines the approach, assumptions and findings of these investigations.

2. Project Assumptions

Wastewater will be discharged from the project via separate dedicated diffuser structures for the construction and operational phases. Locations of these discharges have been provided to BMT WBM. Wastewaters for these outfalls will be sourced from the following potential 'streams' of operation on the site:

- Construction (diffuser location E 318191.77 N 7367192.28)
 - sewage/sanitary waste; and
 - reverse osmosis/desalination plant waste/brine.

We have been asked to assess two discharge options, one for combined sewage (@ 45 m³/hr) and reverse osmosis waste (@ 500 m³/hr) and the second for combined sewage (@ 22.5 m³/hr) and reverse osmosis waste (@ 233 m³/hr).

- Operation (diffuser location E 316794.358 N 7368573.212)
 - sewage/sanitary waste;
 - reverse osmosis/desalination plant waste/brine; and
 - treated process and contaminated stormwater.

We have been asked to assess two discharge options, one for combined sewage (@ 30m³/day), reverse osmosis waste (@ 10 m³/hr) and treated process and contaminated stormwater (@ 160m³/hr) and the second for the reverse osmosis waste only (@ 10 m³/hr).

We can hence summarise the maximum (i.e. worst case) combined discharges for each of these potential scenarios in Table 1.

Table 1 Relevant Wastewater Stream Flow Data

Waste Stream	Construction Stage		Operational Stage	
	Option 1	Option 2	Option 1	Option 2
Sewage/Sanitary Waste	45 m ³ /hr	22.5 m ³ /hr	30 m ³ /day	-
Reverse Osmosis Waste	500 m ³ /hr	233 m ³ /hr	10 m ³ /hr	10 m ³ /hr
Treated Process and Contaminated Stormwater	-	-	160 m ³ /hr	-
TOTAL	545 m ³ /hr	255.5 m ³ /hr	171.25 m ³ /hr	10 m ³ /hr

The fundamental 'nature' of how these combined discharges will behave after release via the proposed diffuser structures will be different due to the varying proportions of (dense) reverse osmosis waste and (fresh/buoyant, in a discharge to the saline waters of Port Curtis) sewage and process waste. In this regard, we have assumed or been advised as follows:

- background salinities in Port Curtis of 38 g/L.
- background temperatures in Port Curtis of 24 deg C.
- construction stage desalination waste will have a salinity of 64.6 g/L (based on sourcing water from within Port Curtis at 38 g/L and with desalination using reverse osmosis).
- operational stage desalination waste will have a salinity of 20.0 g/L (based on sourcing water from Gladstone and with desalination using ion exchange).
- the other waste streams will effectively be 'fresh' water in nature, though they may contain other pollutants (discussed later in this report).
- all wastewaters will discharge at the provided rates via dedicated outfall/diffuser structures located as advised by Santos.

We have re-run and interrogated previously developed hydrodynamic models of Port Curtis to support these assessments of outfall design. In regard to these models, which are the established and recognised benchmark assessment tools for the region, we note as follows:

- the models are regularly updated, calibrated and validated for GPC and many other local project proponents; and
- in this case, the model has been configured with relevant local (and regional) dredging works which are planned having been assumed to occur, thereby ensuring accurate data for modelling assessments.

The receiving water hydrodynamic models were run for a several week period and a representative 28 day complete spring-neap tidal period of velocity data extracted at the proposed outfall sites. These data are illustrated in Figure 1 and Figure 2 below. Relevant velocity percentiles are also presented in Table 2.

Table 2 Relevant Outfall Location Velocity Statistics

Velocity Percentile	Construction Stage Velocity (m/s)	Operational Stage Velocity (m/s)
10%	0.06 m/s	0.05 m/s
25%	0.14 m/s	0.12 m/s
50%	0.25 m/s	0.24 m/s
75%	0.43 m/s	0.37 m/s
90%	0.77 m/s	0.53 m/s

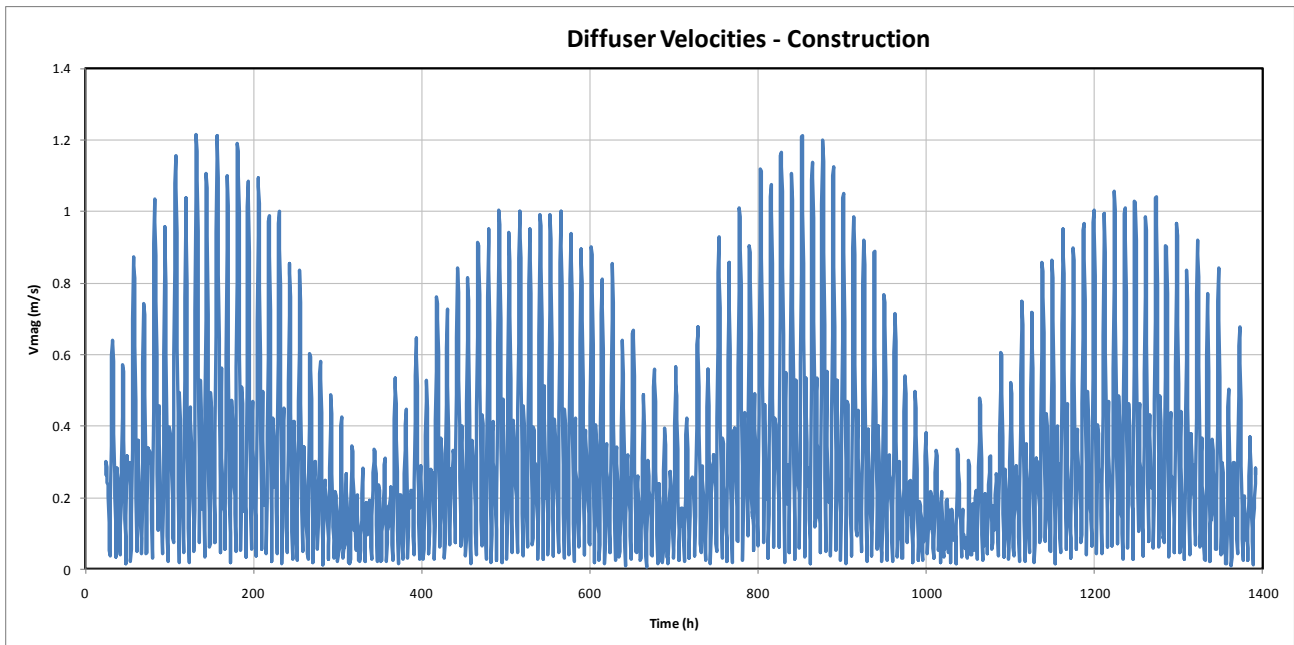


Figure 1 Velocity Pattern at Port Curtis Construction Stage Outfall Location

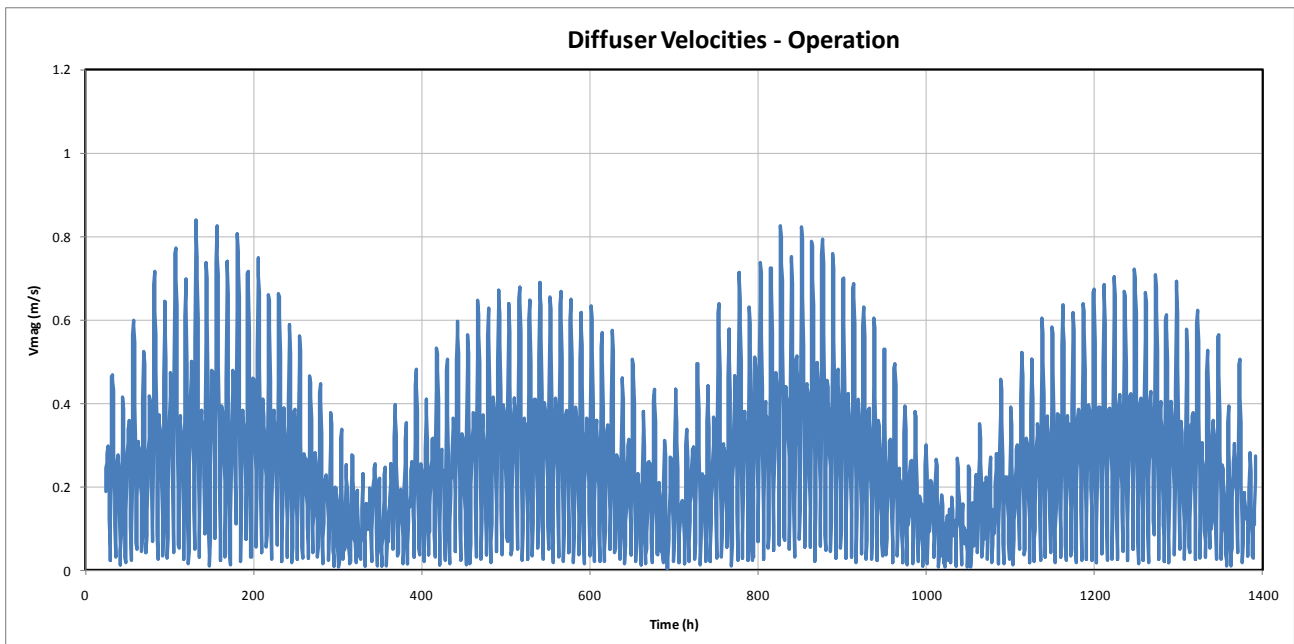


Figure 2 Velocity Pattern at Port Curtis Operation Stage Outfall Location

Given all of the above, we have defined four separate 'worst' case outfall assessments, as follows:

- Construction Stage
 - 45 m³/hr sewage and 500 m³/hr reverse osmosis brine with an effective combined salinity of 59.3 g/L; and
 - 22.5 m³/hr sewage and 233 m³/hr reverse osmosis brine with an effective combined salinity of 58.9 g/L
- Operational Stage
 - 30 m³/day sewage, 10 m³/hr reverse osmosis brine and 160 m³/hr treated process water with an effective combined salinity of 1.2 g/L; and
 - 10 m³/hr reverse osmosis brine with a salinity of 20.0 g/L

Of these cases, from a design/impact perspective it is important to note that the construction stage case will be a negatively buoyant plume, which will 'fall' through the water column and potentially impact the sea bed. The operational stage plume will be a buoyant plume and will rise through the water column before impacting on the water surface. For these reasons, the height of the construction diffuser *above the sea bed* will be critical whereas for the operational stage outfall the depth of the diffuser *below the water surface* will be critical. Hence, in our modelling we have assumed the critical dilution to be respectively that when the plume contacts the sea bed and the water surface for the construction and operational stages.

For each of these outfall scenarios, we have run CORMIX assessments, conservatively using the 10%ile velocity as key background/forcing data. We have designed the diffuser to achieve the acceptable dilutions shown in Table 3 for the construction and operational stage cases to ensure no water quality impacts. We have also assessed plume behaviour for the 25%ile velocity case.

Table 3 Critical Dilutions at Sea Bed and Surface Contact

Velocity Case	Critical Dilution Construction Stage ¹		Operational Stage ²	
	Option 1	Option 2	Option 1	Option 2
10%ile	58:1	74:1	70:1	182:1
25%ile	167:1	233:1	226:1	671:1

The outfalls selected for the above are as follows:

- Construction Stage (Options 1 and 2)
 - 0.1m diameter outlet ports (10 of) spaced at 1m centres, with the outfall pipeline oriented perpendicular to the prevailing ebb/flood tidal flow direction (basically at right angles to the 'long' axis of Port Curtis). The ports should be oriented at 45 degrees upwards from the horizontal and the outfall pipe needs to be at least 6m above the sea bed. This configuration will accommodate both scenarios and provides dilutions in excess of 58:1, achieving water quality requirements (see below).
- Operational Stage (Option 1)
 - 0.1m diameter outlet ports (5 of) spaced at 1m centres, with the outfall pipeline oriented perpendicular to the prevailing ebb/flood tidal flow direction (basically at right angles to the 'long' axis of Port Curtis). The ports should be oriented at 45 degrees downwards from the horizontal and the outfall pipe needs to be at least 10m below the water surface. This configuration will provide a dilution in excess of 70:1, achieving water quality requirements (see below).
- Operational Stage (Option 2)
 - Due to the very small flow rate associated with this case, this flow will not work for the Operational Stage Option 1 diffuser mentioned above for likely operational (marine fouling) reasons. In fact, there is no real need for a 'diffuser' at all. A single outlet port with a diameter of 0.075m (7.5cm) at a depth of 10m will achieve surface dilutions of in excess of 180:1, which also will be more than adequate.

One further relevant consideration in regard to the above is the behaviour of the diffused plume from the outfall with progressively increasing distance downcurrent from the discharge. To date, we have defined critical dilutions as being the dilution at bottom or surface contact. The reality is that, especially for the 10%ile velocity, this is a very conservative assumption as the zone of influence is essentially extremely close to the outfall. By way of example, the following values summarise the distances to bottom/surface contact of the plume.

¹ Dilution at bottom contact (negatively buoyant plume)

² Dilution at surface contact (positively buoyant plume)

Table 4 Distance to Bottom/Surface Contact

Velocity Case	Construction Stage ³		Operational Stage ⁴	
	Option 1	Option 2	Option 1	Option 2
10%ile	5m	5m	3m	5m
25%ile	16m	17m	13m	20m

It can be seen that the points at which we have extracted predictions from the model are very close to the outfall. A commonly used approach in this regard is to define an initial 'mixing zone' located a certain distance either side of the diffuser. We propose that a suitable initial mixing zone for this site would be 50m. Modelling has also been undertaken to define dilutions of the discharge plumes at this distance from the outfall, and the following results have been obtained.

Table 5 Dilution in Plume Centreline 50m from Outfall

Velocity Case	Construction Stage ⁵		Operational Stage ⁶	
	Option 1	Option 2	Option 1	Option 2
10%ile	91:1	164:1	146:1	496:1
25%ile	230:1	317:1	506:1	1370:1

We have also reviewed the likely qualities of the proposed discharge streams to quantify potential changes in receiving water quality associated with the proposed operations. In this regard, likely effluent qualities for key water quality parameters are summarised below:

- Sewage/Sanitary Waste
 - BOD < 20 mg/L
 - TSS < 30 mg/L
 - DO > 2 mg/L
 - TN < 5 mg/L
 - TP < 1 mg/L
- Construction Stage Desalination Brine
 - Salinity = 65 g/L
 - TSS = 250 mg/L
- Operational Stage Desalination Brine
 - Salinity = 20 g/L
 - TSS = negligible
- Treated Process Water and Contaminated Stormwater
 - Clean water.

Based on the above, and the respective flows presented earlier in this report, we can estimate the likely changes in ambient water quality levels at bottom (construction stage) and surface (operation stage) contact and 50m downstream of the outfall. Relevant results are summarised in Table 6 for the 10th percentile velocity and in Table 7 for the 25th percentile velocity. Of these results, the only potentially significant detectable case is for TSS levels at bottom contact for the construction stage. All other water quality parameters show negligible change, as could be expected. For the one potential case of note, even though this impact may be able to be discerned at the 10th percentile case, such observations are likely to be short lived and occur in an environment with regularly naturally elevated TSS levels. As such, this is unlikely to be of any real consequence.

³ Bottom contact

⁴ Surface contact

⁵ Bottom contact

⁶ Surface contact

Table 6 Predicted Localised Changes in Water Quality (10%ile velocity)

Water Quality Parameter	Unit	Construction Stage				Operational Stage			
		Option 1		Option 2		Option 1		Option 2	
		Bottom Contact	50m	Bottom Contact	50m	Surface Contact	50m	Surface Contact	50m
BOD	mg/L	0.03	0.02	0.02	0.01	0.00	0.00	0.00	0.00
TSS	mg/L	4.00	2.55	3.12	1.41	0.00	0.00	0.00	0.00
DO	mg/L	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
TN	mg/L	0.01	0.00	0.01	0.00	0.00	0.00	0.00	0.00
TP	mg/L	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Salinity	g/L	1.03	0.66	0.80	0.36	0.02	0.01	0.11	0.04

Table 7 Predicted Localised Changes in Water Quality (25%ile velocity)

Water Quality Parameter	Unit	Construction Stage				Operational Stage			
		Option 1		Option 2		Option 1		Option 2	
		Bottom Contact	50m	Bottom Contact	50m	Surface Contact	50m	Surface Contact	50m
BOD	mg/L	0.01	0.01	0.01	0.01	0.00	0.00	0.00	0.00
TSS	mg/L	1.39	1.01	0.99	0.73	0.00	0.00	0.00	0.00
DO	mg/L	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
TN	mg/L	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
TP	mg/L	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Salinity	g/L	0.36	0.26	0.25	0.19	0.01	0.00	0.03	0.01

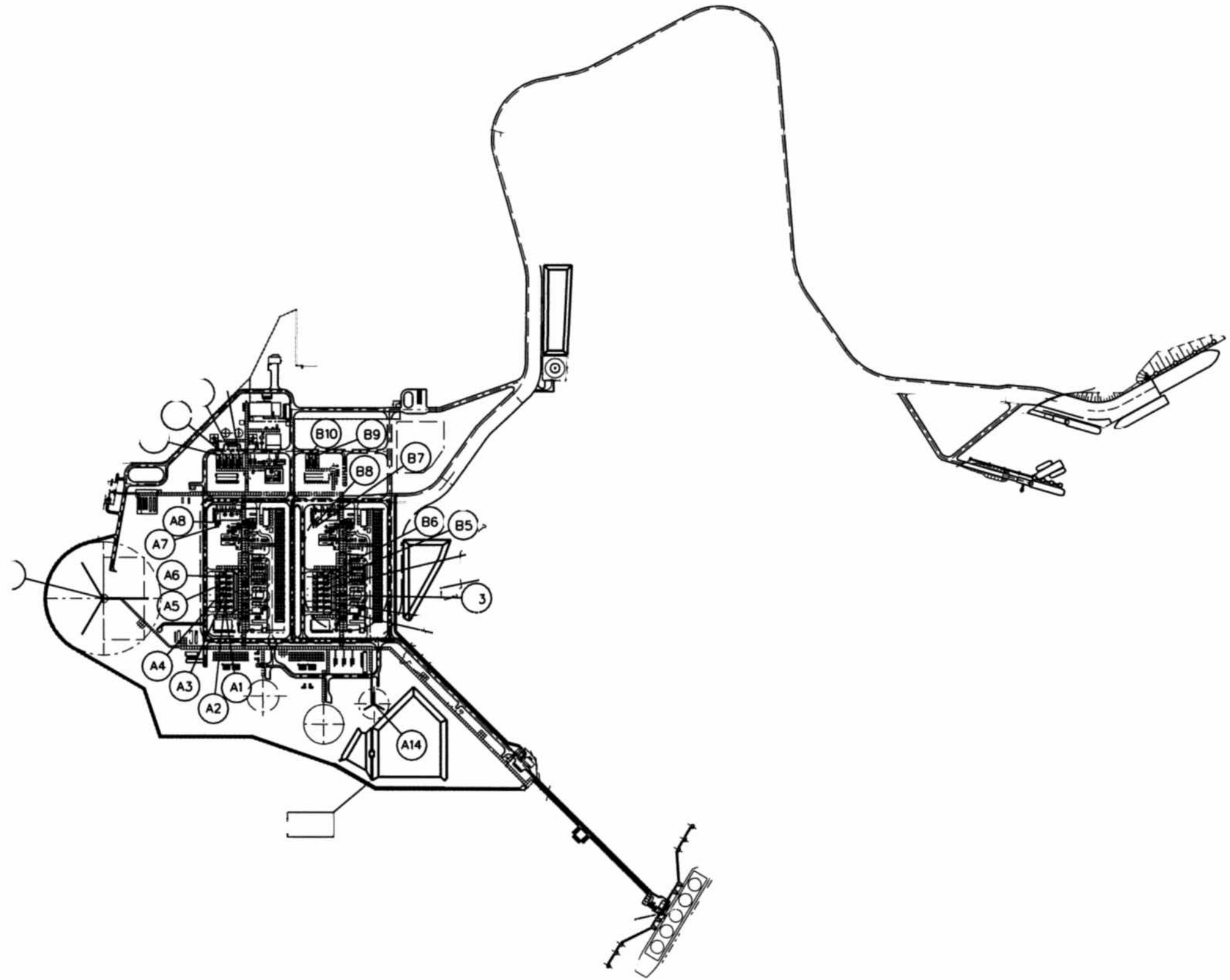
By inspection of the above, and comparison with available data on ambient water quality levels in Port Curtis, and when focussing on the critically defined mixing zone of 50m either side of the outfall, it is concluded that no discernible or significant water quality impact will result from the proposed discharge.

Yours Faithfully
BMT WBM Pty Ltd



Tony McAlister
 (Managing Director)

Appendix B Diffuser Outfall Location



Appendix C Material Safety Data Sheets for Treatment Chemicals

C



Material Safety Data Sheet

Catalog Number: **204237**

Revision date: 10-Mar-2005

Australia Hazardous Statement: **Not classified as hazardous according to criteria of NOHSC**

1. COMPANY DETAILS

Supplier: MP Biomedicals Australasia Pty Limited
Unit 12, 167 Prospect Hwy.
Seven Hills, NSW 2147 Aust.

Telephone Number: (02) 9838 7422
Fax Number: (02) 9838 7390

Emergency telephone number: (02) 9838 7422: hours: 8.30 AM to 5.00 PM

Australian Business Number (ABN): 31 106 467 109

2. IDENTIFICATION

Product name: FERRIC HYDROXIDE
Catalog Number: 204237
Synonyms: Ferric Hydroxide Oxide; Iron (III) Oxide Hydrate

UN/Id No: No UN Number allocated
Proper shipping name: No Dangerous goods class allocated
IATA Hazard Label(s): No Dangerous goods class allocated
Hazard Class: No Dangerous goods class allocated
Subsidiary risk: No Subsidiary Risk allocated

Emergency Action Code (Hazchem code): No Hazchem Code allocated
Poisons schedule No. (Aust)/Toxic Substance (NZ): No Poisons Schedule Number allocated
Recommended use: Research product for non-human use

Component	Australia (AICS):
FERRIC HYDROXIDE N/A (100)	Not Present

3. PHYSICAL DESCRIPTION/PROPERTIES

Physical state: Powder
Formula: Fe₂O₃.xH₂O
Boiling point/range: Not determined
Melting point/range: Not determined
Density: 3.4-3.9 g/ml
Vapor pressure: Not determined
Solubility (in water): Insoluble
Flash point: Not determined
Autoignition temperature: Not determined
Flammable limits in air - lower (%): Not determined

Flammable limits in air - upper Not determined
(%):

4. INGREDIENTS

Components	CAS Number	Weight %	EC No.	Classification
FERRIC HYDROXIDE	N/A	100	--	--

5. HAZARDS IDENTIFICATION

Australia Hazardous Statement: Not classified as hazardous according to criteria of NOHSC

Indication of Danger:
None.

Safety Phrases:
S36 - Wear suitable protective clothing.

Poisons schedule No. (Aust)/Toxic Substance (NZ): No Poisons Schedule Number allocated

6. HEALTH HAZARD INFORMATION

HEALTH EFFECTS

EMERGENCY OVERVIEW: May cause skin irritation and/or dermatitis
Principle routes of exposure: Skin
Inhalation: May cause irritation of respiratory tract
Ingestion: May be harmful if swallowed.
Skin contact: May cause allergic skin reaction
Eye contact: Avoid contact with eyes
Statements of hazard MAY CAUSE ALLERGIC SKIN REACTION.

Components	Australian Exposure Standards - Carcinogens	Australia - Exposure Standards - Short
FERRIC HYDROXIDE	Not Listed	Not Listed

Components	Australia - Exposure Standards - Skin E	Australia - Exposure Standards - Time W
FERRIC HYDROXIDE	Not Listed	Not Listed

FIRST AID

General advice: In the case of accident or if you feel unwell, seek medical advice immediately (show the label where possible).
Inhalation: Move to fresh air. Call a physician immediately.
Skin contact: Rinse immediately with plenty of water and seek medical advice
Ingestion: Do not induce vomiting without medical advice.
Eye contact: In the case of contact with eyes, rinse immediately with plenty of water and seek medical advice.
Protection of first-aiders: No information available
Notes to physician: None

Medical conditions aggravated by exposure: None known

7. PRECAUTIONS FOR USE

Section 8 Notes: TWA - The time-weighted average airborne concentration over an eight-hour working day, for a five-day working week over an entire working life. According to current knowledge this concentration should neither impair the health or, not cause undue discomfort to, nearly all workers.

Engineering measures: Ensure adequate ventilation.

PERSONAL PROTECTIVE EQUIPMENT

Respiratory protection: Self-contained breathing apparatus

Hand protection: Pvc disposable gloves

Skin and body protection: Usual safety precautions while handling the product will provide adequate protection against this potential effect.

Eye protection: Safety glasses

Hygiene measures: Avoid contact with skin, eyes and clothing.



8. SAFE HANDLING INFORMATION

Storage:

ROOM TEMPERATURE

Handling:

Use only in area provided with appropriate exhaust ventilation.

Safe handling advice:

Wear personal protective equipment.

Stability:

Stable under recommended storage conditions.

Polymerization:

None under normal processing.

Hazardous decomposition products:

Thermal decomposition can lead to release of irritating gases and vapours such as carbon oxides.

Materials to avoid:

Strong oxidising agents

Conditions to avoid:

Exposure to air or moisture over prolonged periods.

Spills and Disposal:

Personal precautions:

Use personal protective equipment.

Environmental precautions:

Prevent product from entering drains.

Methods for cleaning up:

Sweep up and shovel into suitable containers for disposal.

Waste from residues / unused products:

Waste disposal must be in accordance with appropriate Federal, State, and local regulations. This product, if unaltered by use, may be disposed of by treatment at a permitted facility or as advised by your local hazardous waste regulatory authority. Residue from fires extinguished with this material may be hazardous.

Contaminated packaging:

Do not re-use empty containers

Fire/Explosion Hazards:

Suitable extinguishing media:

Use dry chemical, CO₂, water spray or "alcohol" foam

Specific hazards:	Burning produces irritant fumes.
Unusual hazards:	None known
Special protective equipment for firefighters:	As in any fire, wear self-contained breathing apparatus pressure-demand, MSHA/NIOSH (approved or equivalent) and full protective gear
Specific methods:	Water mist may be used to cool closed containers.

9. TOXICOLOGICAL INFORMATION

Product Information

Acute toxicity

Components	RTECS Number:	Selected LD50s and LC50s
FERRIC HYDROXIDE	Not Available	Not Determined

Chronic toxicity:	Chronic exposure may cause nausea and vomiting, higher exposure causes unconsciousness.
Local effects:	Symptoms of overexposure may be headache, dizziness, tiredness, nausea and vomiting.
Specific effects:	May include moderate to severe erythema (redness) and moderate edema (raised skin), nausea, vomiting, headache.
Carcinogenic effects:	No data is available on the product itself.
Mutagenic effects:	No data is available on the product itself.
Reproductive toxicity:	No data is available on the product itself.

10. ECOLOGICAL INFORMATION

Mobility:	No data available
Bioaccumulation:	No data available
Ecotoxicity effects:	No data available
Aquatic toxicity:	May cause long-term adverse effects in the aquatic environment.

Components	U.S. DOT - Appendix B - Marine Pollutan	U.S. DOT - Appendix B - Severe Marine Pollutants	United Kingdom - The Red List:
FERRIC HYDROXIDE	Not Listed	Not Listed	Not Listed

Components	Germany VCI (WGK)	World Health Organization (WHO) - Drinking Water	Ecotoxicity - Fish Species Data
FERRIC HYDROXIDE	Not Listed	Not Listed	Not Listed

Components	Ecotoxicity - Freshwater Algae Data	Ecotoxicity - Microtox Data	Ecotoxicity - Water Flea Data
FERRIC HYDROXIDE	Not Listed	Not Listed	Not Listed

Components	EPA - ATSDR Priority List	EPA - HPV Challenge Program Chemical List	California - Priority Toxic Pollutants
FERRIC HYDROXIDE	Not Listed	Not Listed	Not Listed

Components	California - Priority Toxic Pollutants	California - Priority Toxic Pollutants
FERRIC HYDROXIDE	Not Listed	Not Listed

11. TRANSPORT INFORMATION

IMDG/IMO

IMDG - Hazard Classifications	Not Applicable
IMDG - Marine Pollutants	Not Applicable
IMDG - Marine Pollutants	Not Applicable
IMDG - Regulated Substances	Not Applicable
IMDG - Severe Marine Pollutants	Not Applicable

IMO-labels:

Packing group:	None
Proper shipping name:	Not Regulated
UN/Id No:	Not regulated

ADR/RID

Australia Hazardous Statement:	Not classified as hazardous according to criteria of NOHSC
Hazard Class	No Dangerous goods class allocated
Item:	FERRIC HYDROXIDE
ADR/RID-labels:	No Dangerous goods class allocated
UN/Id No:	Not regulated
Emergency Action Code (Hazchem code):	Not required
Proper shipping name:	Not Regulated

ICAO:

Hazard Class	No Dangerous goods class allocated
Packing group:	None
Proper shipping name:	Not Regulated

12. REGULATORY INFORMATION**International inventories:**

FERRIC HYDROXIDE

Australia (AICS): Not Present**EU EINECS List -** Not Present**Indication of Danger:**

None.

Safety Phrases: S36 - Wear suitable protective clothing.**Poisons schedule No. (Aust)/Toxic Substance (NZ):** Not required**13. OTHER INFORMATION****Prepared by:** Health & Safety

Disclaimer: The information and recommendations contained herein are based upon tests believed to be reliable. However, MP Biomedicals does not guarantee the accuracy or completeness NOR SHALL ANY OF THIS INFORMATION CONSTITUTE A WARRANTY, WHETHER EXPRESSED OR IMPLIED, AS TO THE SAFETY OF THE GOODS, THE MERCHANTABILITY OF THE GOODS, OR THE FITNESS OF THE GOODS FOR A PARTICULAR PURPOSE. Adjustment to conform to actual conditions of usage maybe required. MP Biomedicals assumes no responsibility for results obtained or for incidental or consequential damages, including lost profits arising from the use of these data. No warranty against infringement of any patent, copyright or trademark is made or implied.

End of Safety Data Sheet



Material Safety Data Sheet

1. IDENTIFICATION OF THE MATERIAL AND SUPPLIER

Product Name: ALUMINIUM POTASSIUM SULFATE

Other name(s): Aluminium Potassium Sulphate; Aluminium Potassium Sulphate BP

Recommended Use: Pharmaceutical applications.

Supplier: Bronson & Jacobs Pty Ltd
ABN: 81 000 063 249
Street Address: 70 Marple Avenue
Villawood NSW 2163
Australia

Telephone Number: +61 2 8717 2929
Facsimile: +61 2 9755 9611

Emergency Telephone: 1 800 033 111 (ALL HOURS)

2. HAZARDS IDENTIFICATION

Based on available information, not classified as hazardous according to criteria of ASCC; NON-HAZARDOUS SUBSTANCE.

Not classified as Dangerous Goods by the criteria of the Australian Dangerous Goods Code (ADG Code) for transport by Road and Rail; NON-DANGEROUS GOODS.

Poisons Schedule: None allocated.

3. COMPOSITION/INFORMATION ON INGREDIENTS

Components / CAS Number	Proportion	Risk Phrases
Sulfuric acid, aluminium potassium salt (2:1:1), dodecahydrate 7784-24-9	100%	-

4. FIRST AID MEASURES

Inhalation: Remove victim from area of exposure - avoid becoming a casualty. Remove contaminated clothing and loosen remaining clothing. Allow patient to assume most comfortable position and keep warm. Keep at rest until fully recovered. Seek medical advice if effects persist.

Product Name: ALUMINIUM POTASSIUM SULFATE
Substance No: 00000035991

Issued: 19/11/2007

Version: 1



Material Safety Data Sheet

- Skin Contact:** If skin contact occurs, remove contaminated clothing and wash skin with running water. If irritation occurs seek medical advice.
- Eye Contact:** If in eyes, wash out immediately with water. In all cases of eye contamination it is a sensible precaution to seek medical advice.
- Ingestion:** Rinse mouth with water. If swallowed, give a glass of water to drink. If vomiting occurs give further water. Seek medical advice.
- Medical attention and special treatment:** Treat symptomatically.

5. FIRE FIGHTING MEASURES

Hazards from combustion products: Non-combustible material.

Precautions for fire fighters and special protective equipment: Decomposes on heating emitting toxic fumes, including those of oxides of sulfur and oxides of aluminium. Fire fighters to wear self-contained breathing apparatus and suitable protective clothing if risk of exposure to products of decomposition.

Suitable Extinguishing Media: Extinguishing media appropriate to surrounding fire conditions.

6. ACCIDENTAL RELEASE MEASURES

Emergency procedures: If contamination of sewers or waterways has occurred advise local emergency services.

Methods and materials for containment and clean up: Wear protective equipment to prevent skin and eye contact and breathing in dust. Work up wind or increase ventilation. Cover with damp absorbent (inert material, sand or soil). Sweep or vacuum up, but avoid generating dust. Collect and seal in properly labelled containers or drums for disposal.

7. HANDLING AND STORAGE

Conditions for safe storage: Store in a cool, dry, well ventilated place and out of direct sunlight. Store away from incompatible materials described in Section 10. Keep containers closed when not in use - check regularly for spills.

Precautions for safe handling: Avoid skin and eye contact and breathing in dust.

Product Name: ALUMINIUM POTASSIUM SULFATE
Substance No: 000000035991

Issued: 19/11/2007

Version: 1



Material Safety Data Sheet

8. EXPOSURE CONTROLS/PERSONAL PROTECTION

Occupational Exposure Limits:

No value assigned for this specific material by the National Occupational Health and Safety Commission. However, Exposure Standard(s) for constituent(s):

Aluminium, soluble salts (as Al): 8hr TWA = 2 mg/m³

Nuisance dust: 8hr TWA = 10 mg/m³

As published by the National Occupational Health and Safety Commission.

TWA - The time-weighted average airborne concentration over an eight-hour working day, for a five-day working week over an entire working life.

These Exposure Standards are guides to be used in the control of occupational health hazards. All atmospheric contamination should be kept to as low a level as is workable. These exposure standards should not be used as fine dividing lines between safe and dangerous concentrations of chemicals. They are not a measure of relative toxicity.

Engineering controls:

Ensure ventilation is adequate to maintain air concentrations below Exposure Standards. Avoid generating and breathing in dusts. Use with local exhaust ventilation or while wearing dust mask. Keep containers closed when not in use.

Personal Protective Equipment:

The selection of PPE is dependant on a detailed risk assessment. The risk assessment should consider the work situation, the physical form of the chemical, the handling methods, and environmental factors.

OVERALLS, SAFETY SHOES, SAFETY GLASSES, GLOVES, DUST MASK.

Wear overalls, safety glasses and impervious gloves. Avoid generating and inhaling dusts. If excessive dust exists, wear dust mask/respirator meeting the requirements of AS/NZS 1715 and AS/NZS 1716. Always wash hands before smoking, eating, drinking or using the toilet. Wash contaminated clothing and other protective equipment before storage or re-use.

9. PHYSICAL AND CHEMICAL PROPERTIES

Physical state:	Crystals
Colour:	White
Odour:	Odourless
Solubility:	Soluble in water. Insoluble in alcohol.
Specific Gravity:	1.75

Product Name: ALUMINIUM POTASSIUM SULFATE
Substance No: 00000035991

Issued: 19/11/2007

Version: 1



Material Safety Data Sheet

Relative Vapour Density (air=1):	Not applicable
Vapour Pressure (20 °C):	Not applicable
Flash Point (°C):	Not applicable
Flammability Limits (%):	Not available
Autoignition Temperature (°C):	Not available
Melting Point/Range (°C):	92
Boiling Point/Range (°C):	64.5 (loses water)
Decomposition Point (°C):	Not available
pH:	3.3 (9.4%)

10. STABILITY AND REACTIVITY

Chemical stability:	Stable under normal ambient and anticipated storage and handling conditions of temperature and pressure.
Conditions to avoid:	Avoid dust generation.
Incompatible materials:	Incompatible with strong oxidising agents.
Hazardous decomposition products:	Oxides of sulfur. Oxides of aluminium.
Hazardous reactions:	Hazardous polymerisation will not occur. In the presence of moisture, the material is corrosive to aluminium, zinc and tin producing highly flammable hydrogen gas.

11. TOXICOLOGICAL INFORMATION

No adverse health effects expected if the product is handled in accordance with this Safety Data Sheet and the product label. Symptoms or effects that may arise if the product is mishandled and overexposure occurs are:

Ingestion:	No adverse effects expected, however, large amounts may cause nausea and vomiting. Sulphates are not well absorbed orally, but can cause diarrhoea.
Eye contact:	May be an eye irritant. Exposure to the dust may cause discomfort due to particulate nature. May cause physical irritation to the eyes.
Skin contact:	Repeated or prolonged skin contact may lead to irritation.
Inhalation:	Breathing in dust may result in respiratory irritation.

Long Term Effects:

Prolonged or repeated skin contact may cause dryness with cracking, irritation and possible dermatitis following. (1)

Product Name: ALUMINIUM POTASSIUM SULFATE
Substance No: 000000035991

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Material Safety Data Sheet

Toxicological Data:

Reproductive effector in rats. (1)

Exposure to large doses of aluminium has been connected with the degenerative brain disease Alzheimer's Disease. (1)

12. ECOLOGICAL INFORMATION

Ecotoxicity Avoid contaminating waterways.

13. DISPOSAL CONSIDERATIONS

Disposal methods: Refer to Waste Management Authority. Dispose of material through a licensed waste contractor.

14. TRANSPORT INFORMATION

Road and Rail Transport

Not classified as Dangerous Goods by the criteria of the Australian Dangerous Goods Code (ADG Code) for transport by Road and Rail; NON-DANGEROUS GOODS.

Marine Transport

Not classified as Dangerous Goods by the criteria of the International Maritime Dangerous Goods Code (IMDG Code) for transport by sea; NON-DANGEROUS GOODS.

Air Transport

Not classified as Dangerous Goods by the criteria of the International Air Transport Association (IATA) Dangerous Goods Regulations for transport by air; NON-DANGEROUS GOODS.

15. REGULATORY INFORMATION

Classification: Based on available information, not classified as hazardous according to criteria of ASCC; NON-HAZARDOUS SUBSTANCE.

Poisons Schedule: None allocated.

This material is listed on the Australian Inventory of Chemical Substances (AICS).

16. OTHER INFORMATION

(1) Supplier Material Safety Data Sheet; 08/ 2006.

Product Name: ALUMINIUM POTASSIUM SULFATE
Substance No: 00000035991

Issued: 19/11/2007

Version: 1



Material Safety Data Sheet

This material safety data sheet has been prepared by SH&E Shared Services, Orica.

Reason(s) for Issue:

First Issue Primary MSDS

This MSDS summarises to our best knowledge at the date of issue, the chemical health and safety hazards of the material and general guidance on how to safely handle the material in the workplace. Since Bronson & Jacobs Pty Ltd cannot anticipate or control the conditions under which the product may be used, each user must, prior to usage, assess and control the risks arising from its use of the material.

If clarification or further information is needed, the user should contact their Bronson & Jacobs representative or Bronson & Jacobs Pty Ltd at the contact details on page 1.

Bronson & Jacobs Pty Ltd's responsibility for the material as sold is subject to the terms and conditions of sale, a copy of which is available upon request.

Bronson and Jacobs incorporating the businesses of Woods and Woods and Keith Harris.

Product Name: ALUMINIUM POTASSIUM SULFATE
Substance No: 00000035991

Issued: 19/11/2007

Version: 1

Material Safety Data Sheet



1. IDENTIFICATION OF THE MATERIAL AND SUPPLIER

Product Name: **SODIUM HYPOCHLORITE SOLUTION (10-15% AVAILABLE CHLORINE)**

Recommended Use: Dairy, food and beverage industries: Sanitising processing equipment.
Textile industry: Bleaching agent.
Water treatment: Sanitising agent.
Available chlorine = 10 - 15%.

Supplier: Orica Australia Pty Ltd
ABN: 99 004 117 828
Street Address: 1 Nicholson Street,
Melbourne 3000
Australia
Telephone Number: +61 3 9665 7111
Facsimile: +61 3 9665 7937
Emergency Telephone: **1 800 033 111 (ALL HOURS)**

2. HAZARDS IDENTIFICATION

This material is hazardous according to criteria of Safe Work Australia; HAZARDOUS SUBSTANCE.

Classified as Dangerous Goods by the criteria of the Australian Dangerous Goods Code (ADG Code) for Transport by Road and Rail; DANGEROUS GOODS.

Risk Phrases: Contact with acids liberates toxic gas. Causes burns. Risk of serious damage to eyes. Very toxic to aquatic organisms.

Safety Phrases: Avoid contact with skin and eyes. In case of contact with eyes, rinse immediately with plenty of water and seek medical advice. Wear suitable protective clothing, gloves and eye/face protection. In case of accident or if you feel unwell, seek medical advice immediately (show the label whenever possible). Do not mix with acids. Avoid release to the environment. Refer to special instructions safety data sheets.

Poisons Schedule: S5 Caution.

3. COMPOSITION/INFORMATION ON INGREDIENTS

Components	CAS Number	Proportion	Risk Phrases
Water	7732-18-5	>60%	-
Sodium hydroxide	1310-73-2	<1%	R35, R41
Sodium hypochlorite	7681-52-9	10-<30%	R31, R34, R41

4. FIRST AID MEASURES

For advice, contact a Poisons Information Centre (e.g. phone Australia 131 126; New Zealand 0800 764 766) or a doctor.

Product Name: SODIUM HYPOCHLORITE SOLUTION (10-15% AVAILABLE CHLORINE)
Substance No: 000034421401

Issued: 11/11/2009

Version: 7

Material Safety Data Sheet



Inhalation:

Remove victim from area of exposure - avoid becoming a casualty. Remove contaminated clothing and loosen remaining clothing. Allow patient to assume most comfortable position and keep warm. Keep at rest until fully recovered. If patient finds breathing difficult and develops a bluish discolouration of the skin (which suggests a lack of oxygen in the blood - cyanosis), ensure airways are clear of any obstruction and have a qualified person give oxygen through a face mask. Apply artificial respiration if patient is not breathing. Seek immediate medical advice.

Skin Contact:

If spilt on large areas of skin or hair, immediately drench with running water and remove clothing. Continue to wash skin and hair with plenty of water (and soap if material is insoluble) until advised to stop by the Poisons Information Centre or a doctor.

Eye Contact:

If in eyes, hold eyelids apart and flush the eye continuously with running water. Continue flushing until advised to stop by a Poisons Information Centre or a doctor, or for at least 15 minutes.

Ingestion:

Immediately rinse mouth with water. If swallowed, do NOT induce vomiting. Give a glass of water. Seek immediate medical assistance.

Medical attention and special treatment:

Treat symptomatically. Can cause corneal burns. Delayed pulmonary oedema may result.

5. FIRE FIGHTING MEASURES

Hazards from combustion products:

Non-combustible material.

Precautions for fire fighters and special protective equipment:

Decomposes on heating emitting toxic fumes, including those of chlorine. Fire fighters to wear self-contained breathing apparatus and suitable protective clothing if risk of exposure to products of decomposition.

Suitable Extinguishing Media:

Not combustible, however, if material is involved in a fire use: Fine water spray, normal foam, dry agent (carbon dioxide, dry chemical powder).

Hazchem Code: 2X

6. ACCIDENTAL RELEASE MEASURES

Emergency procedures:

Clear area of all unprotected personnel. If contamination of sewers or waterways has occurred advise local emergency services.

Methods and materials for containment and clean up:

Slippery when spilt. Avoid accidents, clean up immediately. Wear protective equipment to prevent skin and eye contact and breathing in vapours. Work up wind or increase ventilation. Contain - prevent run off into drains and waterways. Use absorbent (soil, sand or other inert material). Collect and seal in properly labelled containers or drums for disposal.

7. HANDLING AND STORAGE

This material is a Scheduled Poison S5 and must be stored, maintained and used in accordance with the relevant regulations.

Product Name: SODIUM HYPOCHLORITE SOLUTION (10-15% AVAILABLE CHLORINE)
Substance No: 000034421401

Issued: 11/11/2009

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Conditions for safe storage:

Store in cool place and out of direct sunlight. Store away from foodstuffs. Store away from incompatible materials described in Section 10. Keep containers closed when not in use - check regularly for leaks.

Precautions for safe handling:

Avoid skin and eye contact and breathing in vapour, mists and aerosols. Keep out of reach of children.

8. EXPOSURE CONTROLS/PERSONAL PROTECTION

Occupational Exposure Limits: No value assigned for this specific material by the National Occupational Health and Safety Commission. However, Exposure Standard(s) for constituent(s):

Chlorine: Peak Limitation = 3 mg/m³ (1 ppm)

Sodium hydroxide: Peak Limitation = 2 mg/m³

As published by the National Occupational Health and Safety Commission.

Peak Limitation - a ceiling concentration which should not be exceeded over a measurement period which should be as short as possible but not exceeding 15 minutes.

These Exposure Standards are guides to be used in the control of occupational health hazards. All atmospheric contamination should be kept to as low a level as is workable. These exposure standards should not be used as fine dividing lines between safe and dangerous concentrations of chemicals. They are not a measure of relative toxicity.

Engineering controls:

Ensure ventilation is adequate and that air concentrations of components are controlled below quoted Exposure Standards. If inhalation risk exists: Use with local exhaust ventilation or while wearing air supplied mask. Keep containers closed when not in use.

Personal Protective Equipment:

The selection of PPE is dependant on a detailed risk assessment. The risk assessment should consider the work situation, the physical form of the chemical, the handling methods, and environmental factors.

Orica Personal Protection Guide No. 1, 1998: D - OVERALLS, RUBBER BOOTS, CHEMICAL GOGGLES, FACE SHIELD, SAFETY SHOES, GLOVES (Long), APRON.



Wear overalls, chemical goggles, face shield, elbow-length impervious gloves, splash apron and rubber boots. Always wash hands before smoking, eating, drinking or using the toilet. Wash contaminated clothing and other protective equipment before storage or re-use.

If risk of inhalation exists, wear air supplied respirator meeting the requirements of AS/NZS 1715 and AS/NZS 1716.

9. PHYSICAL AND CHEMICAL PROPERTIES

Physical state: Liquid

Product Name: SODIUM HYPOCHLORITE SOLUTION (10-15% AVAILABLE CHLORINE)

Substance No: 000034421401

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Colour:	Pale Yellow - Green
Odour:	Slight Chlorine
Solubility:	Miscible in water.
Specific Gravity:	1.2 @20°C
Flash Point (°C):	Not applicable
Flammability Limits (%):	Not applicable
Solubility in water (g/L):	Complete
pH:	12.5 (1% w/w)

10. STABILITY AND REACTIVITY

Chemical stability:	Stable under normal ambient and anticipated storage and handling conditions of temperature and pressure. The amount of available chlorine diminishes over time.
Conditions to avoid:	Avoid contact with foodstuffs. Avoid exposure to heat, sources of ignition, and open flame. Avoid contact with other chemicals.
Incompatible materials:	Incompatible with acids, metals, metal salts, peroxides, reducing agents, and ethylene diamine tetraacetic acid. Incompatible with ammonia and ammonium compounds such as amines and ammonium salts.
Hazardous decomposition products:	Chlorine.
Hazardous reactions:	Hazardous polymerisation will not occur. Reacts exothermically with acids. Reacts with acids liberating toxic gas. (Chlorine) Reacts with ammonia, amines and ammonium salts to produce chloramines. Decomposes on heating to produce chlorine gas.

11. TOXICOLOGICAL INFORMATION

No adverse health effects expected if the product is handled in accordance with this Safety Data Sheet and the product label. Symptoms or effects that may arise if the product is mishandled and overexposure occurs are:

Ingestion:	Swallowing can result in nausea, vomiting, diarrhoea, abdominal pain and chemical burns to the gastrointestinal tract.
Eye contact:	A severe eye irritant. Corrosive to eyes; contact can cause corneal burns. Contamination of eyes can result in permanent injury.
Skin contact:	Contact with skin will result in severe irritation. Corrosive to skin - may cause skin burns.
Inhalation:	Breathing in mists or aerosols may produce respiratory irritation. Delayed (up to 48 hours) fluid build up in the lungs may occur.

Long Term Effects:

No information available for the product.

Toxicological Data: No LD50 data available for the product. For the constituent

SODIUM HYPOCHLORITE:

Oral LD50 (mice): 5800 mg/kg

EYES: Moderate irritant (rabbit).

12. ECOLOGICAL INFORMATION

Ecotoxicity	Avoid contaminating waterways. For SODIUM HYPOCHLORITE:
Persistence/degradability and mobility	This material is biodegradable.
Aquatic toxicity:	Toxic to aquatic organisms.
48hr LC50 (fish):	0.07 - 5.9 mg/L.
Terrestrial toxicity:	Expected to be harmful to terrestrial species.

13. DISPOSAL CONSIDERATIONS

Disposal methods:

Refer to Waste Management Authority. Dispose of material through a licensed waste contractor. Decontamination and destruction of containers should be considered.

14. TRANSPORT INFORMATION

Road and Rail Transport

Classified as Dangerous Goods by the criteria of the Australian Dangerous Goods Code (ADG Code) for Transport by Road and Rail; DANGEROUS GOODS.



UN No:	1791
Class-primary	8 Corrosive
Packing Group:	III
Proper Shipping Name:	HYPOCHLORITE SOLUTION
Hazchem Code:	2X

Marine Transport

Classified as Dangerous Goods by the criteria of the International Maritime Dangerous Goods Code (IMDG Code) for transport by sea; DANGEROUS GOODS.

UN No:	1791
Class-primary:	8 Corrosive
Packing Group:	III
Proper Shipping Name:	HYPOCHLORITE SOLUTION

Air Transport

Classified as Dangerous Goods by the criteria of the International Air Transport Association (IATA) Dangerous Goods Regulations for transport by air; DANGEROUS GOODS.

UN No:	1791
Class-primary:	8 Corrosive
Packing Group:	III
Proper Shipping Name:	HYPOCHLORITE SOLUTION

Product Name: SODIUM HYPOCHLORITE SOLUTION (10-15% AVAILABLE CHLORINE)
Substance No: 000034421401

Issued: 11/11/2009

Version: 7

15. REGULATORY INFORMATION

Classification:	This material is hazardous according to criteria of Safe Work Australia; HAZARDOUS SUBSTANCE.
Hazard Category:	C: Corrosive N: Dangerous for the Environment
Risk Phrase(s):	R31: Contact with acids liberates toxic gas. R34: Causes burns. R41: Risk of serious damage to eyes. R50: Very toxic to aquatic organisms.
Safety Phrase(s):	S24/25: Avoid contact with skin and eyes. S26: In case of contact with eyes, rinse immediately with plenty of water and seek medical advice. S36/37/39: Wear suitable protective clothing, gloves and eye/face protection. S45: In case of accident or if you feel unwell, seek medical advice immediately (show the label whenever possible). S50: Do not mix with acids. S61: Avoid release to the environment. Refer to special instructions Safety Data Sheets.
Poisons Schedule:	S5 Caution.

All the constituents of this material are listed on the Australian Inventory of Chemical Substances (AICS).

16. OTHER INFORMATION

'Registry of Toxic Effects of Chemical Substances'. Ed. D. Sweet, US Dept. of Health & Human Services: Cincinnati, 2009.

This material safety data sheet has been prepared by SH&E Shared Services, Orica.

Reason(s) for Issue:

Revised Primary MSDS
Alignment to HSNO requirements

This MSDS summarises to our best knowledge at the date of issue, the chemical health and safety hazards of the material and general guidance on how to safely handle the material in the workplace. Since Orica Limited cannot anticipate or control the conditions under which the product may be used, each user must, prior to usage, assess and control the risks arising from its use of the material.

If clarification or further information is needed, the user should contact their Orica representative or Orica Limited at the contact details on page 1.

Orica Limited's responsibility for the material as sold is subject to the terms and conditions of sale, a copy of which is available upon request.

Material Safety Data Sheet



Product Name: SODIUM HYPOCHLORITE SOLUTION (10-15%
AVAILABLE CHLORINE)
Substance No: 000034421401

Issued: 11/11/2009

Version: 7

Appendix D Desalination Intake Water Quality



Draft Report

GLNG Proposed Desalination Plant Intake - Water Quality

9 APRIL 2010

Prepared for
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URS

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Environmental Engineer

Reviewer:



Julian Long
Principal Water Quality
Scientist

Date: **9 April 2010**
Reference: 42626488/1/1
Status: Draft

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Introduction

A reverse osmosis desalination plant is proposed to supply water for the LNG facility which is to be located on Curtis Island, as part of the GLNG project. The desalination plant intake is to be located within China Bay at a depth of approximately 2 metres. The quality of water available at the intake location is a key consideration in the design of the reverse osmosis plant. However very limited data is available on water quality within China Bay and virtually no information is available for many of the parameters that are of concern for the performance of the plant. The available information suggests that water quality is likely to vary considerably between the wet season and the dry season and between low and high tides. Accordingly two rounds of water quality sampling have been undertaken to characterise water quality at the location of proposed desalination plant intake. The first round of sampling was undertaken during October 2009 following a period of prolonged dry weather, in the dry season. The most recent sampling was undertaken during March 2010 following a period of heavy rainfall at the end of the wet season. The result from the first round of sampling were presented in a separate report but have been combined with the results from the second round of sampling to provide a more complete picture of the anticipated water quality variability in the vicinity of the proposed intake.

1.1 Aims and Objectives

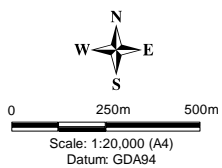
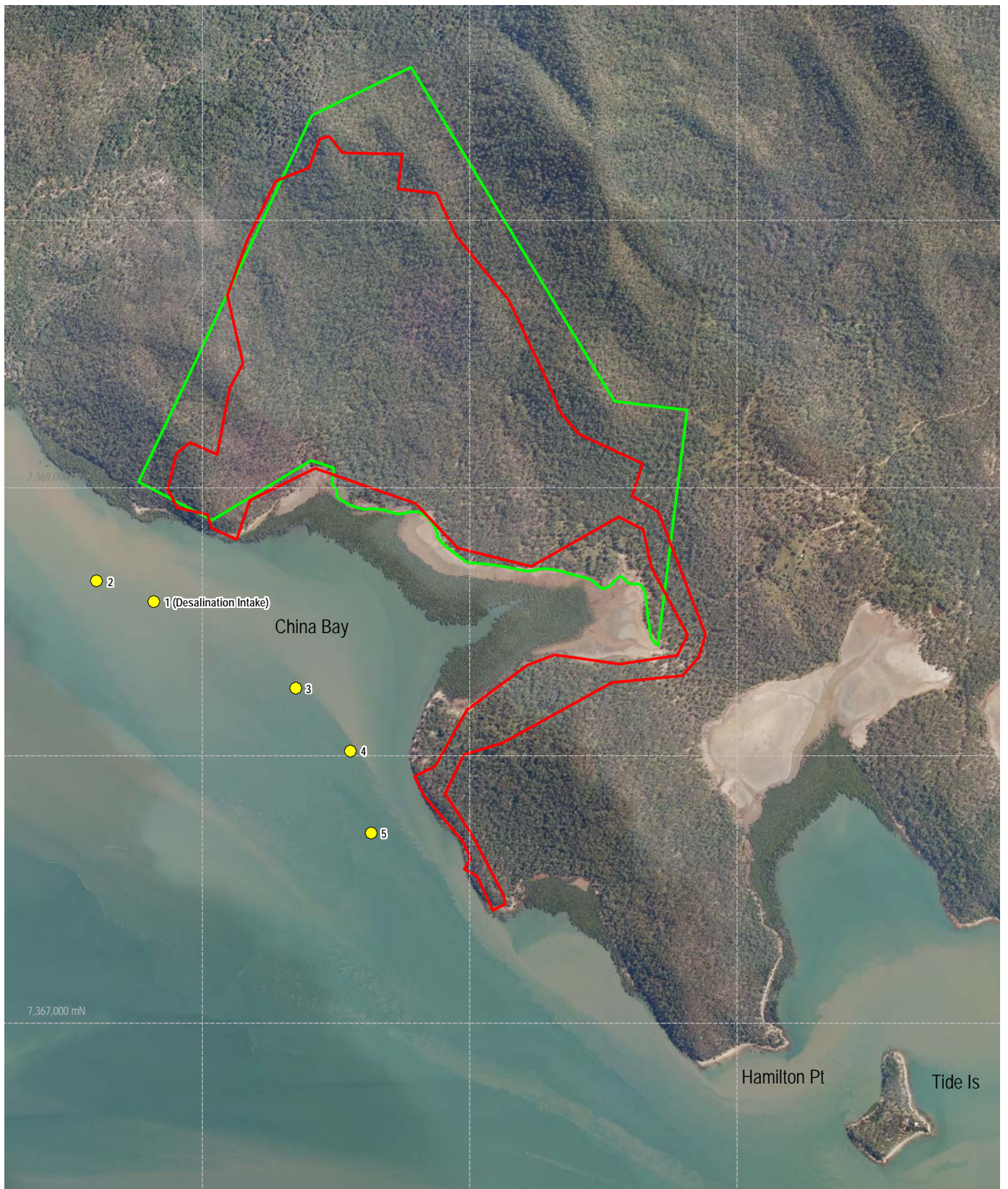
The primary objective of this study was to undertake an assessment of water quality, in the vicinity of the proposed intake to the desalination plant, for the full suite of parameters that are important for water treatment processes. The results would provide valuable input into the reverse osmosis plant design.

Methodology

2.1 Study Sites

Water quality samples were collected from a depth of 2 metres at both high and low tides from five locations including the site of the proposed desalination plant intake and also sites upstream and downstream to provide an indication of the potential water quality variability within China Bay. However the location of two of the water quality sampling sites was altered for the wet season sampling due to a change to the location of the proposed desalination plant intake following the dry season sampling.

The location of the water quality sampling sites sampled during the wet season sampling is shown in Figure 2-1, whilst the location of the site sampled during the dry season sampling is presented in shown in Figure 2-2. Three (3) sites were maintained for both the dry and wet season sampling to enable inferences to be made about the likely water quality which would be encountered at the revised location of the proposed desalination plant intake during dry season conditions.



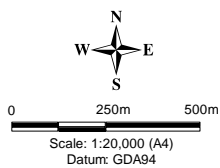
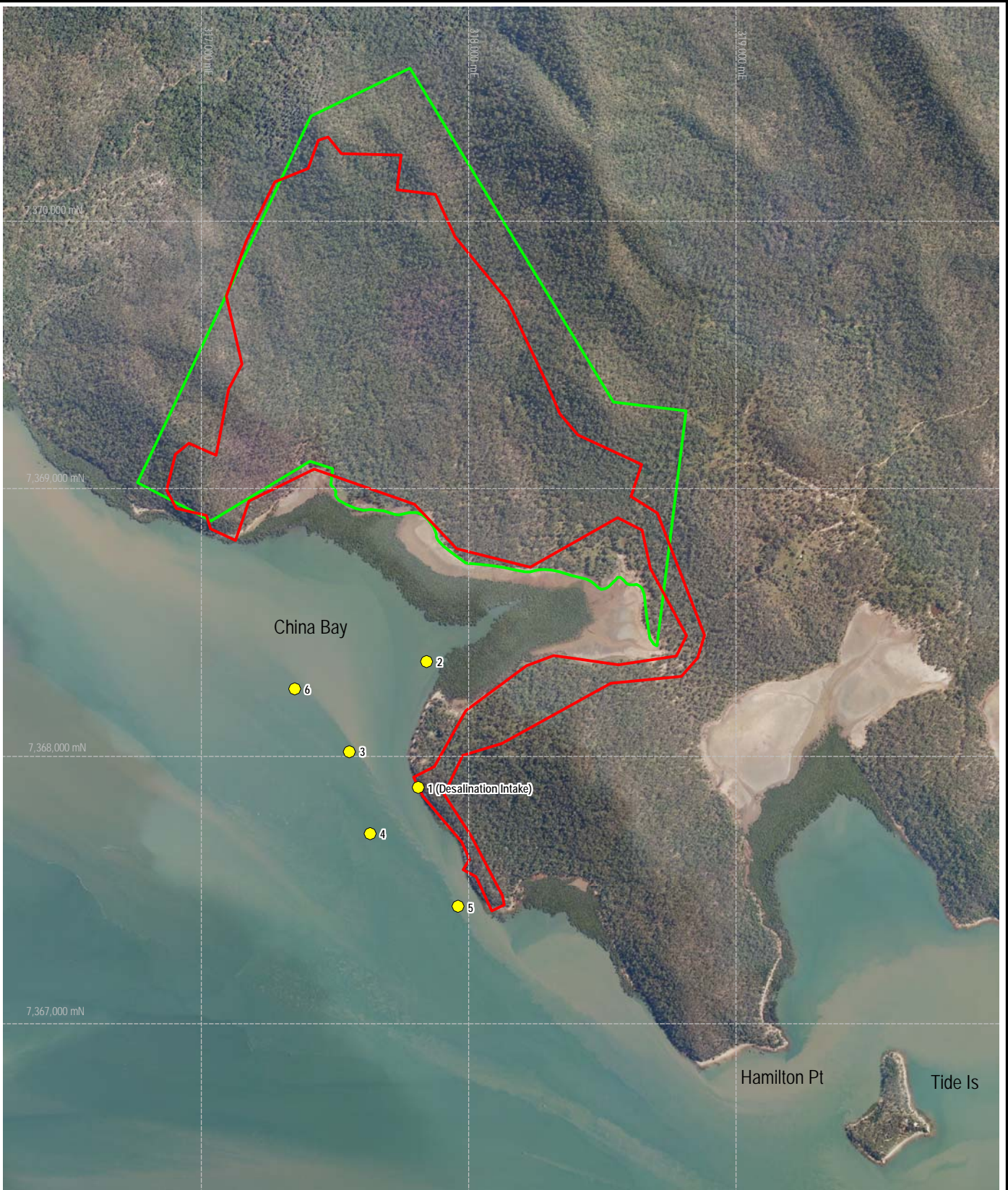
- LNG Facility Footprint
- LNG Facility Indicative Site Boundary

● Water Quality Sampling Location (March 2010)

Source: This map may contain data which is sourced and Copyright. Refer to Section 18.2 of the EIS for Ownership and Copyright.

<p>Client</p> 	<p>Project</p> <p style="text-align: center;">GLADSTONE LNG PROJECT GLNG PROPOSED DESALINATION PLANT INTAKE WATER QUALITY SAMPLING (ROUND 2)</p>	<p>Title</p> <p style="text-align: center;">WATER QUALITY SAMPLING LOCATIONS - DESALINATION PLANT INTAKE</p>						
	<table border="1" style="width: 100%; border-collapse: collapse;"> <tr> <td style="width: 33%;">Drawn: RG</td> <td style="width: 33%;">Approved: JL</td> <td style="width: 33%;">Date: 12-04-2010</td> </tr> <tr> <td colspan="2">Job No: 4262 6440 /6452</td> <td>File No: 42626440-g-1922.wor</td> </tr> </table>	Drawn: RG	Approved: JL	Date: 12-04-2010	Job No: 4262 6440 /6452		File No: 42626440-g-1922.wor	<p>Figure: 2-1</p>
Drawn: RG	Approved: JL	Date: 12-04-2010						
Job No: 4262 6440 /6452		File No: 42626440-g-1922.wor						

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- LNG Facility Footprint
- LNG Facility Indicative Site Boundary

● Water Quality Sampling Location

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<p>Client</p> 	<p>Project</p> <p style="text-align: center;">GLADSTONE LNG PROJECT GLNG PROPOSED DESALINATION PLANT INTAKE WATER QUALITY SAMPLING (ROUND 1)</p>	<p>Title</p> <p style="text-align: center;">WATER QUALITY SAMPLING LOCATIONS - DESALINATION PLANT INTAKE</p>						
	<table border="1" style="width: 100%; border-collapse: collapse;"> <tr> <td style="width: 33%;">Drawn: RG</td> <td style="width: 33%;">Approved: JL</td> <td style="width: 33%;">Date: 12-04-2010</td> </tr> <tr> <td colspan="2">Job No: 4262 6440 /6452</td> <td>File No: 42626440-g-1921.wor</td> </tr> </table>	Drawn: RG	Approved: JL	Date: 12-04-2010	Job No: 4262 6440 /6452		File No: 42626440-g-1921.wor	<p>Figure: 2-2</p>
Drawn: RG	Approved: JL	Date: 12-04-2010						
Job No: 4262 6440 /6452		File No: 42626440-g-1921.wor						

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2 Methodology

2.2 Sampling and Analytical Techniques

2.2.1 Sampling Techniques

Samples were collected from a depth of two meters below the surface at each sampling location using a Niskin sampler. Samples were collected on five consecutive days on a high tide and again on low tide.

In-situ measurements of pH, dissolved oxygen, temperature, conductivity and turbidity were taken for each location using a DKK-TOA Electronics Ltd multi parameter water quality meter model number WQC-24 fitted with a turbidity sensor.

Water (grab) samples were also collected at the same time and sent to Australian Laboratory Services (ALS) laboratory within 24 hours of sampling for analysis of the following parameters: Physical Tests, Dissolved Anions, Nutrients, Total Metals and Organic Parameters.

2.2.2 Weather Conditions

Dry Season Sampling

The weather conditions encountered during the dry season sampling were fine. No rainfall had occurred during the previous week

Wet Season Sampling

The weather conditions encountered during the wet weather sampling varied over the five days with a mixture of overcast days and some rainfall. A significant amount of rainfall had occurred in the previous week with a total of 88 mm.

2.2.3 Analytical Techniques

The analytical procedures used by the laboratory for water quality analysis are in accordance with established internationally recognized procedures such as those published by the United States Environmental Protection Agency (USEPA), American Public Health Association (APHA), Australian Standards (AS) and NEPM.

During round one sampling analysis the Limits of Reporting (LOR) for metal analysis were increased due to the saline matrix of the samples submitted. The high salt content of the samples caused matrix interferences for the determination of many of the trace metals and, as such, required dilution prior to analysis to reduce the extent of the interference. Due to the required dilution prior to analysis, the limit of reporting was adjusted accordingly. During round two sampling trace metal analysis was undertaken to overcome the salt interferences and allow the LOR to be reduced, giving more accurate results. The effective LOR for each parameter is presented in Appendix A.

Water Quality Results

The water quality results for the wet season sampling are summarised in Figure 3-1 whilst the results for the dry season sampling are presented in Figure 3-2. These tables provide the minimum, maximum and average values at the location of the proposed desalination intake, and also the combined range for the upstream and downstream locations from the proposed intake. The detailed results (including variations between tides) from the water quality sampling are provided in Appendix A.

Table 3-1 Water Quality Results – Wet Season

Parameters	Proposed Desalination Intake			Upstream and Downstream Locations		
	Minimum	Maximum	Average	Minimum	Maximum	Average
Physical Tests						
Colour (PCU)	15	15	15	15	15	15
Conductivity (In-Situ) (mS/cm)	3.85	4.32	4.07	2.98	4.33	4.02
Total Suspended Solids, mg/L	2	47	17	1	32	13
Total Dissolved Solids (In Situ) (mg/L)	23,200	26,300	24,610	22,800	26,400	24,500
pH	7.5	7.7	7.6	7.5	7.7	7.6
Turbidity (In-situ) (NTU)	3.8	13.6	8.2	1.8	16.7	6.9
UV Absorbance @ 254 nm/cm	0.08	0.12	0.10	0.06	0.12	0.10
Temperature °C	27.0	28.5	27.7	26.7	28.8	27.6
Dissolved Oxygen, mg/L	7.5	8.2	7.8	7.1	8.7	7.9
Specific Gravity	1.01	1.02	1.02	1.01	1.02	1.02
Dissolved Anions						
Alkalinity-Total as CaCO ₃ , mg/L	97	107	101	92	108	101
Alkalinity-Carbonate as CaCO ₃ , mg/L	<1	<1	<1	<1	<1	<1
Alkalinity-Hydroxide as CaCO ₃ , mg/L	<1	<1	<1	<1	<1	<1
Chloride, Cl, mg/L	13,300	15,600	14,170	13,100	15,700	14,051
Fluoride, F, mg/L	0.7	0.9	0.8	0.8	0.9	0.8

3 Water Quality Results

	Proposed Desalination Intake			Upstream and Downstream Locations		
Silicate, Total SiO ₂ , mg/L	2.9	4.4	3.8	2.9	4.5	3.8
Silicate, Reactive, SiO ₂ , mg/L	2.1	3.3	2.7	2.0	3.4	2.8
Sulfides S, mg/L	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Sulphate, SO ₄ , mg/L	2,120	2,420	2,258	2,070	2,470	2,265
Nutrients						
Ammonia Nitrogen, as N, mg/L	0.06	0.12	0.09	0.05	0.16	0.10
Nitrate Nitrogen, as N, mg/L	0.02	0.08	0.03	0.01	0.08	0.03
Total Metals						
Aluminium, Al, mg/L	0.03	0.5	0.2	0.02	0.6	0.1
Antimony, Sb, mg/L	0.0005	0.0006	0.0005	0.0005	0.0005	0.0005
Arsenic, As, mg/L	0.0013	0.0018	0.0016	0.0010	0.0019	0.0015
Barium, Ba, mg/L	0.012	0.017	0.014	0.011	0.018	0.014
Beryllium, Bi, mg/L	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001
Bismuth, Bi, mg/L	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001
Boron, B, mg/L	2.6	4.2	3.34	2.5	4.5	3.3
Cadmium, Cd, mg/L	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002
Calcium, Ca, mg/L	303	343	324	296	352	323
Chromium, Cr, mg/L	<0.0005	0.0028	0.001	<0.0005	0.0082	0.0011
Cobalt, Co, mg/L	0.0002	0.0005	0.0003	0.0002	0.0005	0.0002
Copper, Cu, mg/L	0.002	0.005	0.003	0.001	0.009	0.003
Iron, Fe, mg/L	0.05	0.468	0.193	0.023	0.598	0.126
Lead, Pb, mg/L	0.0002	0.0012	0.0007	0.0002	0.0044	0.0009
Lithium, Li, mg/L	0.116	0.157	0.133	0.104	0.153	0.129
Magnesium, Mg, mg/L	8	1,070	902	922	1,090	1,007

3 Water Quality Results

	Proposed Desalination Intake			Upstream and Downstream Locations		
Manganese, Mn, µg/L	0.0075	0.021	0.014	0.0027	0.028	0.011
Mercury, Hg, mg/L	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001
Molybdenum, Mo, mg/L	0.0085	0.0102	0.0091	0.0083	0.0103	0.0091
Nickel, Ni, mg/L	0.0005	0.0019	0.0009	0.0005	0.0066	0.0012
Potassium, K, mg/L	359	418	387	352	423	387
Selenium, Se, mg/L	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002
Silver, Ag, mg/L	<0.0001	0.0006	0.0002	<0.0001	<0.0001	<0.0001
Sodium, Na, mg/L	7,880	9,240	8,422	7,800	9,400	8,353
Strontium, Sr, mg/L	4.8	6.2	5.4	4.5	6.5	5.3
Thallium, Tl, mg/L	<0.0001	0.001	0.0004	<0.0001	0.0005	0.0002
Tin, Sn, mg/L	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005
Vanadium, V, mg/L	0.0024	0.0042	0.0032	0.0023	0.0039	0.0031
Zinc, Zn, mg/L	0.005	0.039	0.009	0.005	0.018	0.006
Organic Parameters						
Total Organic Carbon, TOC, mg/L	2	4	3	2	6	3.7
Oil and Grease, mg/L	5	5	5	5	5	5

3 Water Quality Results

Table 3-2 Water Quality Results – Dry Season

Parameters	Proposed Desalination Intake			Upstream, Downstream and Offshore Locations		
	Minimum	Maximum	Average	Minimum	Maximum	Average
Physical Tests						
Colour (PCU)	1	1	1	1	1	1
Conductivity (µS/cm)	5.66	5.67	5.67	5.51	5.75	5.65
Total Suspended Solids, mg/L	12	27	20	10	48	29
Total Dissolved Solids, mg/L	35,500	35,900	35,750	34,600	36,300	35,590
pH	8.08	8.12	8.10	5.3	8.2	7.7
Turbidity (NTU)	2.0	9.8	6.9	2.2	17.2	11.7
UV Absorbance @ 254 nm/cm	0.03	0.04	0.033	0.01	0.05	0.035
Temperature °C	24.4	25.2	24.8	24.0	27.0	24.9
Dissolved Oxygen, mg/L	8.7	9.7	9.2	8.0	9.9	9.1
Dissolved Anions						
Alkalinity- Total as CaCO ₃ , mg/L	114	118	116	112	136	116
Alkalinity- Carbonate as CaCO ₃ , mg/L	<1	<1	<1	<1	<1	<1
Alkalinity- Hydroxide as CaCO ₃ , mg/L	<1	<1	<1	<1	<1	<1
Chloride, Cl, mg/L	22,700	25,000	23,850	22,000	25,600	23,944
Fluoride, F, mg/L	0.9	0.9	0.9	0.9	0.9	0.9
Silicate, Total SiO ₂ , mg/L	0.7	0.7	0.7	0.4	1.8	0.7
Silicate, Reactive, SiO ₂ , mg/L	0.54	1.5	1.02	0.38	2.19	1.26
Sulfides S, mg/L	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Sulphate, SO ₄ , mg/L	2,960	3,340	3,150	2,920	3,380	3,138
Nutrients						

3 Water Quality Results

	Proposed Desalination Intake			Upstream, Downstream and Offshore Locations		
Ammonia Nitrogen, as N, mg/L	0.4	0.5	0.45	0.03	0.10	0.05
Nitrate Nitrogen, as N, mg/L	0.06	0.07	0.065	0.01	0.09	0.04
Total Metals						
Aluminium, Al, mg/L	<0.5	<0.5	<0.5	<0.5	0.69	0.54
Antimony, Sb, mg/L	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005
Arsenic, As, mg/L	<0.05	<0.05	<0.05	<0.05	0.06	<0.05
Barium, Ba, mg/L	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05
Beryllium, Bi, mg/L	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005
Bismuth, Bi, mg/L	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005
Boron, B, mg/L	5.64	6.28	5.96	0.25	6.20	4.38
Cadmium, Cd, mg/L	<0.0005	<0.0005	<0.0005	<0.0005	0.0025	0.0006
Calcium, Ca, mg/L	454	465	460	451	478	462
Chromium, Cr, mg/L	0.019	0.023	0.022	0.005	0.028	0.017
Cobalt, Co, mg/L	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005
Copper, Cu, mg/L	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05
Iron, Fe, mg/L	1.41	1.87	1.64	0.26	2.31	1.41
Lead, Pb, mg/L	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005
Lithium, Li, mg/L	0.166	0.182	0.174	0.005	0.248	0.174
Magnesium, Mg, mg/L	1340	1380	1360	1320	1430	1388
Manganese, Mn, mg/L	<0.01	<0.01	<0.01	0.101	0.022	0.014
Mercury, Hg, mg/L	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001
Molybdenum, Mo, mg	0.014	0.015	0.0145	0.005	0.016	0.013
Nickel, Ni, mg/L	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05
Potassium, K, mg/L	574	603	589	570	612	590

3 Water Quality Results

	Proposed Desalination Intake			Upstream, Downstream and Offshore Locations		
Selenium, Se, mg/L	0.10	0.13	0.12	0.10	0.26	0.14
Silver, Ag, mg/L	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Sodium, Na, mg/L	11400	12800	12100	10800	13100	11968
Strontium, Sr, mg/L	10.5	10.9	10.7	0.01	11.40	9.26
Thallium, Tl, mg/L	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005
Tin, Sn, mg/L	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005
Vanadium, V, mg/L	<0.05	<0.05	<0.05	<0.05	0.07	0.05
Zinc, Zn, mg/L	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05
Organic Parameters						
Total Organic Carbon, TOC, mg/L	1	2	1.5	1	3	2
Oil and Grease, mg/L	<5	<5	<5	<5	11	6

3.1 Site comparison

As discussed earlier the location of the proposed desalination intake was changed in response to design changes between the dry and wet season sampling. Three (3) sites were maintained for both the dry and wet season sampling to enable inferences to be made about the likely water quality which would be encountered at the revised location of the proposed desalination plant intake during dry season conditions.

These sites were upstream and downstream of the original intake location and downstream of the revised location. Table 3-3 dry and wet season water quality comparison compares these sites, during both seasons, showing minimum, maximum and average water quality values for a suite of parameters. As discussed in Section 2.2.3 the LOR varies between each sampling event. Therefore the LOR for each parameter is also shown in Table 3-3 dry and wet season water quality comparison.

It can be seen from Table 3-3 dry and wet season water quality comparison that there is minimal variation between sites with a high degree of consistency between minimum to maximum. This is further highlighted in Table 3-4 comparison of upstream and downstream sites water quality, which shows a comparison of the averages of the water quality results for each parameter at each location. This infers that the sampling undertaken during the dry season is likely to be representative of the water quality variability at the revised desalination plant intake site at the time of sampling during the dry season.

3 Water Quality Results

Table 3-3 Dry and Wet Season Water Quality Comparison

Parameters	Dry Season (Round 1)				Wet Season (Round 2)			
	Minimum	Maximum	Average	LOR	Minimum	Maximum	Average	LOR
Physical Tests								
Colour (PCU)	<1	<1	<1	1	15	15	15	1
Conductivity (In-Situ) (mS/cm)	5.5	5.7	5.6	-	3.0	4.3	4.0	-
Total Suspended Solids, mg/L	14	48	32	1	1	32	13	1
Total Dissolved Solids (mg/L)	34,600	36,000	35,480	-	26,800	26,200	24,500	-
pH (In-situ)	5.3	8.2	7.7	-	7.5	7.7	7.6	-
Turbidity (In-situ) (NTU)	8	17	12.8	-	2.0	16.7	7.0	-
UV Absorbance @ 254 nm/cm	0.03	0.05	0.038	0.01	0.07	0.12	0.098	0.001
Temperature °C	24	25.4	24.7	-	27.0	28.8	27.6	-
Dissolved Oxygen, mg/L	8.02	9.42	8.94	-	7.1	8.7	7.9	-
Specific Gravity	-	-	-	-	1.01	1.02	1.02	0.01
Dissolved Anions								
Alkalinity- Total as CaCO ₃ , mg/L	113	136	117	1	92	108	101	1
Alkalinity- Carbonate as CaCO ₃ , mg/L	<1	<1	<1	1	<1	<1	<1	1
Alkalinity- Hydroxide as CaCO ₃ , mg/L	<1	<1	<1	1	<1	<1	<1	1
Chloride, Cl, mg/L	22,000	25,600	23,887	1	13,200	15,700	14,047	1
Fluoride, F, mg/L	0.9	0.9	0.9	0.1	0.8	0.9	0.8	0.1
Silicate, Total SiO ₂ , mg/L	0.7	0.7	0.7	0.1	0.4	0.8	0.6	0.1
Silicate, Reactive, SiO ₂ , mg/L	0.4	1.9	1.3	0.1	2.0	3.4	2.8	0.1
Sulfides S, mg/L	<0.1	<0.1	<0.1	0.1	<0.1	<0.1	<0.1	0.1

3 Water Quality Results

	Dry Season (Round 1)				Wet Season (Round 2)			
Sulphate, SO ₄ , mg/L	2,970	3,654	3,147	1	2,070	2,440	2,267	1
Nutrients								
Ammonia Nitrogen, as N, mg/L	0.03	0.06	0.04	0.01	0.06	0.16	0.09	0.01
Nitrate Nitrogen, as N, mg/L	<0.01	<0.01	<0.01	0.01	<0.01	0.08	0.03	0.01
Total Metals								
Aluminium, Al, mg/L	<0.5	0.7	0.54	0.5	0.02	0.55	0.10	0.01
Antimony, Sb, mg/L	<0.005	<0.005	<0.005	0.005	<0.0005	<0.0005	<0.0005	0.0005
Arsenic, As, mg/L	<0.05	<0.05	<0.05	0.05	0.001	0.002	0.001	0.0005
Barium, Ba, mg/L	<0.05	<0.05	<0.05	0.05	0.011	0.018	0.015	0.001
Beryllium, Bi, mg/L	<0.005	<0.005	<0.005	0.005	<0.0001	<0.0001	<0.0001	0.0001
Bismuth, Bi, mg/L	<0.005	<0.005	<0.005	0.005	<0.0001	<0.0001	<0.0001	0.0001
Boron, B, mg/L	3.1	6.2	4.7	0.05	11	18	14.5	0.1
Cadmium, Cd, mg/L	<0.0005	0.0008	0.0006	0.0005	<0.0002	<0.0002	<0.0002	0.0002
Calcium, Ca, mg/L	451	478	463	1	296	347	322	1
Chromium, Cr, mg/L	0.012	0.025	0.018	0.001	0.0005	0.0082	0.0014	0.0005
Cobalt, Co, mg/L	<0.005	<0.005	<0.005	0.005	<0.0002	0.0005	0.00022	0.0002
Copper, Cu, mg/L	<0.05	<0.05	<0.05	0.05	<0.001	0.009	0.003	0.001
Iron, Fe, mg/L	0.7	2.3	1.4	5	0.02	0.6	0.11	0.05
Lead, Pb, mg/L	<0.005	<0.005	<0.005	0.005	<0.0002	0.0044	0.0009	0.0002
Lithium, Li, mg/L	0.1	1.5	0.3	0.001	0.104	0.153	0.129	0.001
Magnesium, Mg, mg/L	1,340	1,430	1,392	1	922	1,090	1,006	1
Manganese, Mn, µg/L	<0.01	0.02	0.016	0.01	<0.5	<0.5	<0.5	0.5
Mercury, Hg, mg/L	0.02	0.02	0.015	0.0001	<0.0001	<0.0001	<0.0001	0.0001
Molybdenum, Mo, mg/L	0.012	0.016	0.013	0.001	0.008	0.010	0.009	0.0001
Nickel, Ni, mg/L	<0.05	<0.05	<0.05	0.05	<0.0005	0.0066	0.0013	0.0005

3 Water Quality Results

	Dry Season (Round 1)				Wet Season (Round 2)			
Potassium, K, mg/L	570	612	590	1	352	423	387	1
Selenium, Se, mg/L	0.11	0.26	0.15	0.01	0.002	0.005	0.0022	0.002
Silver, Ag, mg/L	<0.01	<0.01	<0.01	0.01	<0.0001	<0.0001	<0.0001	0.0001
Sodium, Na, mg/L	10,900	13,100	12,067	1	7,800	9,400	8,361	1
Strontium, Sr, mg/L	8.2	10.6	9.8	0.001	4.5	6.5	5.3	0.01
Thallium, Tl, mg/L	<0.005	<0.005	<0.005	0.005	<0.0001	0.0005	0.00017	0.0001
Tin, Sn, mg/L	<0.005	<0.005	<0.005	0.005	0.1	0.5	0.17	0.005
Vanadium, V, mg/L	<0.05	0.07	0.05	0.05	0.002	0.004	0.003	0.0005
Zinc, Zn, mg/L	<0.05	<0.05	<0.05	0.05	<0.005	0.018	0.006	0.005
Organic Parameters								
Total Organic Carbon, TOC, mg/L	1	3	1.6	1	2	5	3.8	1
Oil and Grease, mg/L	5	10	5.3	5	5	5	5	5

3 Water Quality Results

Table 3-4 Comparison of Upstream and Downstream Sites Water Quality

Parameters	Dry Season (Round 1)			Wet Season (Round 2)		
	Site 3	Site 4	Site 6	Site 3	Site 4	Site 6
Physical Tests						
Colour (PCU)	1	1	1	15	15	15
Conductivity (In-Situ) (mS/cm)	5.7	5.6	5.6	4.1	3.9	4.1
Total Suspended Solids, mg/L	32	31	34	14	11	13
Total Dissolved Solids (In-situ) (mg/L)	35,800	35,400	35,700	24,500	24,300	24,700
pH	7.9	7.7	7.2	7.5	7.6	7.5
Turbidity (Lab) (NTU) ¹	-	-	-	1.4	0.9	1.4
Turbidity (In-situ) (NTU) ¹	10	12	11	8.2	5.6	6.8
UV Absorbance @ 254 nm/cm	0.03	0.04	0.02	0.1	0.1	0.1
Temperature °C	25.0	24.7	25.5	27.6	27.7	27.6
Dissolved Oxygen, mg/L	9.2	9.1	8.6	7.8	7.9	7.9
Specific Gravity	-	-	-	1.02	1.02	1.02
Dissolved Anions						
Alkalinity-Total as CaCO ₃ , mg/L	114	116	123	100	102	102
Alkalinity-Carbonate as CaCO ₃ , mg/L	<1	<1	<1	<1	<1	<1
Alkalinity-Hydroxide as CaCO ₃ , mg/L	<1	<1	<1	<1	<1	<1
Chloride, Cl, mg/L	24,183	23,883	23,300	13,991	14,000	14,150
Fluoride, F, mg/L	0.9	0.9	0.9	0.8	0.8	0.8
Silicate, Total SiO ₂ , mg/L	0.6	0.6	0.8	3.9	3.8	3.8
Silicate, Reactive, SiO ₂ , mg/L	1.2	1.4	1.5	2.8	2.8	2.7
Sulfides S, mg/L	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1

3 Water Quality Results

	Dry Season (Round 1)			Wet Season (Round 2)		
Sulphate, SO ₄ , mg/L	3,141	3,108	3,235	2,247	2,279	2,278
Nutrients						
Ammonia Nitrogen, as N, mg/L	0.04	0.04	0.04	0.08	0.09	0.09
Nitrate Nitrogen, as N, mg/L	<0.01	<0.01	<0.01	0.03	0.03	0.03
Total Metals						
Aluminium, Al, mg/L	0.6	0.5	0.5	0.1	0.09	0.08
Antimony, Sb, mg/L	<0.005	<0.005	<0.005	<0.0005	<0.0005	<0.0005
Arsenic, As, mg/L	<0.05	<0.05	<0.05	0.0014	0.0014	0.0015
Barium, Ba, mg/L	<0.05	<0.05	<0.05	0.015	0.015	0.014
Beryllium, Bi, mg/L	<0.005	<0.005	<0.005	<0.0001	<0.0001	<0.0001
Bismuth, Bi, mg/L	<0.005	<0.005	<0.005	<0.0001	<0.0001	<0.0001
Boron, B, mg/L	4.1	5.3	4.6	3.2	3.3	3.4
Cadmium, Cd, mg/L	0.0006	<0.0005	<0.0005	<0.0002	<0.0002	<0.0002
Calcium, Ca, mg/L	465	462	461	321	322	325
Chromium, Cr, mg/L	0.017	0.018	0.017	0.002	0.001	0.0008
Cobalt, Co, mg/L	<0.005	<0.005	<0.005	<0.0002	<0.0002	<0.0002
Copper, Cu, mg/L	<0.05	<0.05	<0.05	0.003	0.002	0.003
Iron, Fe, mg/L	1.46	1.35	1.58	0.14	0.10	0.09
Lead, Pb, mg/L	<0.005	<0.005	<0.005	0.0009	0.001	0.0007
Lithium, Li, mg/L	0.21	0.42	0.20	0.13		0.14
Magnesium, Mg, mg/L	1,400	1,387	1,387	999	1,000	1,018
Manganese, Mn, µg/L	<0.01	<0.01	<0.01	0.011	0.010	0.010
Mercury, Hg, mg/L	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001
Molybdenum, Mo, mg/L	0.01	0.01	0.01	0.009	0.009	0.009
Nickel, Ni, mg/L	<0.05	<0.05	<0.05	0.002	0.001	0.0008

3 Water Quality Results

	Dry Season (Round 1)			Wet Season (Round 2)		
Potassium, K, mg/L	592	589	587	385	386	389
Selenium, Se, mg/L	<0.158	<0.128	<0.187	<0.002	<0.002	<0.002
Silver, Ag, mg/L	<0.01	<0.01	<0.01	<0.0001	<0.0001	<0.0001
Sodium, Na, mg/L	12,000	12,000	12,333	8,305	8,359	8,423
Strontium, Sr, mg/L	9.6	10.2	9.7	5.2	5.2	5.3
Thallium, Tl, mg/L	<0.005	<0.005	<0.005	0.0002	0.0002	0.0002
Tin, Sn, mg/L	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005
Vanadium, V, mg/L	<0.05	<0.05	<0.05	0.003	0.002	0.003
Zinc, Zn, mg/L	<0.05	<0.05	<0.05	0.007	<0.005	<0.005
Organic Parameters						
Total Organic Carbon, TOC, mg/L	1.2	1.8	2	3.6	3.8	3.9
Oil and Grease, mg/L	5	5	5	5	5	5

Limitations

URS Australia Pty Ltd (URS) has prepared this report in accordance with the usual care and thoroughness of the consulting profession for the use of Santos Ltd and only those third parties who have been authorised in writing by URS to rely on the report. It is based on generally accepted practices and standards at the time it was prepared. No other warranty, expressed or implied, is made as to the professional advice included in this report. It is prepared in accordance with the scope of work and for the purpose outlined in the Proposal dated 13 January 2010.

The methodology adopted and sources of information used by URS are outlined in this report. URS has made no independent verification of this information beyond the agreed scope of works and URS assumes no responsibility for any inaccuracies or omissions. No indications were found during our investigations that information contained in this report as provided to URS was false.

This report was prepared between 15 March 2010 and 9 April 2010 and is based on the conditions encountered and information reviewed at the time of preparation. URS disclaims responsibility for any changes that may have occurred after this time.

This report should be read in full. No responsibility is accepted for use of any part of this report in any other context or for any other purpose or by third parties. This report does not purport to give legal advice. Legal advice can only be given by qualified legal practitioners.

Appendix A Water Quality Data – March 2010 ‘Wet Season’

Appendix A

Table A-1 Water quality data (In-situ measurements)

Sample ID	Sample Date	Tides	Depth	In-situ parameters						
				pH	DO mg/L	Cond μ S/cm	Temp $^{\circ}$ C	Turbidity NTU	TDS mg/L	
1	8/3/2010	High	8.0	7.5	8.0	3.9	27.5	6.0	23,200	
		Low	8.0	7.6	8.0	4.0	27.6	8.4	24,400	
	9/3/2010	High	9.0	7.5	8.2	4.1	27.0	3.8	24,700	
		Low	8.0	7.5	7.8	3.9	28.5	13.6	23,400	
	10/3/2010	High	8.2	7.6	7.8	4.3	27.4	7.5	26,100	
		Low	8.0	7.5	7.5	4.0	28.4	7.5	24,000	
	11/3/2010	High	8.2	7.7	7.7	4.3	27.6	7.3	25,900	
		Low	6.0	7.5	7.6	4.0	27.9	7.3	23,900	
	12/3/2010	High	9.3	7.6	7.9	4.3	27.2	8.6	26,300	
		Low	8.6	7.5	7.7	4.0	27.4	11.8	24,200	
	3	8/3/2010	High	15.0	7.5	8.1	3.8	27.3	3.5	23,000
			Low	11.0	7.6	8.0	4.0	27.6	3.5	24,500
9/3/2010		High	17.0	7.6	7.1	4.1	27.0	2.9	24,700	
		Low	14.0	7.5	7.4	3.9	28.4	6.0	23,400	
10/3/2010		High	10.0	7.5	7.8	4.2	27.4	14.6	25,900	
		Low	7.5	7.5	7.5	4.0	28.5	7.9	23,900	
11/3/2010		High	10.0	7.6	7.8	4.1	27.4	7.2	25,000	
		Low	6.0	7.5	7.7	4.0	28.1	16.7	24,300	
12/3/2010		High	5.5	7.6	8.7	4.3	27.0	6.8	26,200	
		Low	7.0	7.5	7.8	4.1	27.3	13.1	24,300	
4		8/3/2010	High	20.0	7.5	7.8	3.8	27.6	2.0	23,000
			Low	15.5	7.6	8.2	4.1	27.6	4.2	24,200
	9/3/2010	High	9.0	7.6	8.1	4.1	27.0	3.7	22,800	
		Low	7.0	7.7	7.9	3.9	28.1	6.0	23,600	
	10/3/2010	High	16.0	7.6	7.9	4.2	27.5	6.3	25,100	
		Low	7.5	7.5	7.5	4.0	28.8	9.5	23,800	
	11/3/2010	High	15.0	7.6	7.9	3.0	27.4	5.4	25,900	
		Low	14.0	7.5	7.7	4.0	28.1	6.5	24,100	
	12/3/2010	High	14.0	7.6	8.1	4.3	27.0	6.9	25,900	
		Low	Na	na	na	na	na	na	na	
	5	8/3/2010	High	8.0	7.6	8.1	3.9	27.5	1.8	23,100
			Low	10.0	7.6	8.1	4.0	27.7	4.0	23,900
9/3/2010		High	10.5	7.6	8.4	4.0	26.7	8.5	24,000	
		Low	8.5	7.6	7.5	3.9	28.2	13.5	23,600	
10/3/2010		High	10.0	7.6	7.7	4.2	27.4	7.5	25,500	
		Low	7.0	7.5	7.4	4.0	28.2	6.4	23,900	
11/3/2010		High	10.0	7.6	7.8	4.3	27.6	5.0	25,800	
		Low	7.0	7.5	7.9	4.0	28.1	7.8	24,100	

Appendix A

Sample ID	Sample Date	Tides	Depth	In-situ parameters					
				pH	DO mg/L	Cond μ S/cm	Temp $^{\circ}$ C	Turbidity NTU	TDS mg/L
	12/3/2010	High	10.0	7.7	8.0	4.3	27.0	6.0	26,400
		Low	5.5	7.5	7.8	4.0	27.5	9.3	24,100
6	8/3/2010	High	6.0	7.5	8.2	3.8	27.4	4.3	23,100
		Low	7.0	7.6	8.1	4.0	27.7	5.3	24,000
	9/3/2010	High	8.0	7.6	8.2	4.2	27.0	5.4	25,600
		Low	6.5	7.5	7.8	3.9	28.5	3.6	23,400
	10/3/2010	High	7.0	7.5	7.8	4.3	27.3	10.2	26,100
		Low	7.0	7.5	7.6	4.0	28.3	6.5	23,900
	11/3/2010	High	8.5	7.6	7.8	4.3	27.6	5.4	26,000
		Low	5.0	7.5	7.9	4.0	27.9	9.6	24,000
	12/3/2010	High	7.6	7.6	7.9	4.3	27.1	8.3	26,100
		Low	5.5	7.5	7.8	4.0	27.5	9.8	24,400

Table A-2 Water quality data (Analysed – Dissolved Anions)

Location	Sample Date	Tide State	Water Depth (m)	Units LOR	Dissolved Anions									
					Alkalinity-Total as CaCO3 mg/L 1	Alkalinity-Carbonate as CaCO3 mg/L 1	Alkalinity Hydroxide as CaCO3 mg/L 1	Chloride mg/L 1	Fluoride mg/L 0.1	Silica mg/L 0.1	Reactive Silica mg/L 0.1	Sulfide as S ²⁻ mg/L 0.1	Sulfate as SO ₄ ²⁻ mg/L 1	
1	8/3/2010	High	8.0		97	<1	<1	13500	0.8	4.3	3.18	<0.1	2120	
		Low	8.0		98	<1	<1	14000	0.8	3.9	2.85	<0.1	2260	
	9/3/2010	High	9.0		99	<1	<1	14300	0.8	4	2.81	<0.1	2330	
		Low	8.0		99	<1	<1	13500	0.8	4.4	3.33	<0.1	2180	
	10/3/2010	High	8.2		106	<1	<1	14900	0.7	3.1	2.34	<0.1	2410	
		Low	8.0		103	<1	<1	13800	0.8	4	2.94	<0.1	2200	
	11/3/2010	High	8.2		107	<1	<1	14300	0.9	2.9	2.12	<0.1	2340	
		Low	6.0		105	<1	<1	13300	0.8	3.9	2.89	<0.1	2160	
	12/3/2010	High	9.3		102	<1	<1	15600	0.8	2.9	2.1	<0.1	2420	
		Low	8.6		97	<1	<1	14500	0.8	4.1	2.82	<0.1	2160	
	3	8/3/2010	High	15.0		94	<1	<1	13300	0.8	4.5	3.36	<0.1	2080
			Low	11.0		99	<1	<1	13900	0.8	4.1	2.98	<0.1	2230
9/3/2010		High	17.0		101	<1	<1	14200	0.8	3.9	2.75	<0.1	2320	
		Low	14.0		100	<1	<1	13400	0.9	4.3	3.11	<0.1	2160	
10/3/2010		High	10.0		105	<1	<1	14900	0.8	3.1	2.23	<0.1	2370	
		Low	7.5		103	<1	<1	13800	0.8	4.1	3	<0.1	2190	
11/3/2010		High	10.0		105	<1	<1	13900	0.9	3.4	2.35	<0.1	2250	
		Low	6.0		104	<1	<1	13300	0.8	3.7	2.82	<0.1	2420	
12/3/2010		High	5.5		99	<1	<1	15400	0.8	3	2.17	<0.1	2430	
		Low	7.0		101	<1	<1	14500	0.8	4.1	2.82	<0.1	2190	
4		8/3/2010	High	20.0		92	<1	<1	13400	0.8	4.5	3.38	<0.1	2070
			Low	15.5		99	<1	<1	14200	0.8	3.8	2.72	<0.1	2310

Appendix A

Location	Sample Date	Tide State	Water Depth (m)	Units LOR	Dissolved Anions									
					Alkalinity-Total as CaCO3 mg/L 1	Alkalinity-Carbonate as CaCO3 mg/L 1	Alkalinity Hydroxide as CaCO3 mg/L 1	Chloride mg/L 1	Fluoride mg/L 0.1	Silica mg/L 0.1	Reactive Silica mg/L 0.1	Sulfide as S2- mg/L 0.1	Sulfate as SO4 2- mg/L 1	
	9/3/2010	High	9.0		102	<1	<1	13800	0.8	4.4	3.18	<0.1	2220	
		Low	7.0		100	<1	<1	13800	0.8	4.3	2.9	<0.1	2220	
	10/3/2010	High	16.0		103	<1	<1	14600	0.8	3.2	2.59	<0.1	2380	
		Low	7.5		103	<1	<1	13700	0.8	4	3.03	<0.1	2200	
	11/3/2010	High	15.0		108	<1	<1	14100	0.9	3	2.18	<0.1	2320	
		Low	14.0		103	<1	<1	13200	0.8	3.8	2.7	<0.1	2390	
	12/3/2010	High	14.0		106	<1	<1	15200	0.8	3.1	2.07	<0.1	2400	
	5	8/3/2010	High	8.0		95	<1	<1	13500	0.8	4.4	3.08	<0.1	2160
			Low	10.0		98	<1	<1	13700	0.8	4.2	3.05	<0.1	2260
		9/3/2010	High	10.5		100	<1	<1	13800	0.8	4.4	3.13	<0.1	2240
Low			8.5		100	<1	<1	13800	0.9	4.3	3.08	<0.1	2150	
10/3/2010		High	10.0		101	<1	<1	14200	0.8	3.7	2.35	<0.1	2270	
		Low	7.0		103	<1	<1	13800	0.8	4	2.91	<0.1	2200	
11/3/2010		High	10.0		107	<1	<1	14100	0.9	3.1	2.22	<0.1	2300	
		Low	7.0		103	<1	<1	13100	0.8	3.8	2.88	<0.1	2150	
12/3/2010		High	10.0		103	<1	<1	15700	0.8	2.9	2.03	<0.1	2470	
		Low	5.5		97	<1	<1	14200	0.8	4.3	2.93	<0.1	2190	
6	8/3/2010	High	6.0		94	<1	<1	13500	0.8	4.5	3.29	<0.1	2120	
		Low	7.0		99	<1	<1	13700	0.8	4.2	2.95	<0.1	2220	

Appendix A

Location	Sample Date	Tide State	Water Depth (m)	Units LOR	Dissolved Anions								
					Alkalinity- Total as CaCO3 mg/L 1	Alkalinity- Carbonate as CaCO3 mg/L 1	Alkalinity Hydroxide as CaCO3 mg/L 1	Chloride mg/L 1	Fluoride mg/L 0.1	Silica mg/L 0.1	Reactive Silica mg/L 0.1	Sulfide as S2- mg/L 0.1	Sulfate as SO4 2- mg/L 1
	9/3/2010	High	8.0		104	<1	<1	14200	0.8	3.8	2.74	<0.1	2330
		Low	6.5		97	<1	<1	13400	0.9	4.3	3.22	<0.1	2160
	10/3/2010	High	7.0		105	<1	<1	15300	0.8	2.9	2.19	<0.1	2420
		Low	7.0		102	<1	<1	13700	0.8	4	2.97	<0.1	2200
	11/3/2010	High	8.5		107	<1	<1	14300	0.9	3	2.42	<0.1	2330
		Low	5.0		105	<1	<1	13200	0.8	3.8	2.72	<0.1	2380
	12/3/2010	High	7.6		103	<1	<1	15700	0.8	2.9	1.98	<0.1	2440
		Low	5.5		99	<1	<1	14500	0.8	4.2	2.83	<0.1	2180

Appendix A

Table A-3 Water Quality Data (Analysed - Nutrients, Physical Tests, Organic Parameters)

Location	Sample Date	Tide State	Water Depth (m)	Units LOR	Nutrients		Organic Parameters			Physical Tests			
					Ammonia as N mg/L 0.01	Nitrate as N mg/L 0.01	Total Organic Carbon mg/L 1	Oil & Grease mg/L 5	Suspended Solids mg/L 1	UV Absorbance @ 254nm 0.001	Turbidity NTU 0.1	Colour (True) PCU 1	
1	8/3/2010	High	8.0		0.07	0.02	2	<5	2	0.103	0.9	15	
		Low	8.0		0.11	0.03	3	<5	4	0.09	0.6	15	
	9/3/2010	High	9.0		0.09	0.03	4	<5	10	0.09	0.5	15	
		Low	8.0		0.06	0.02	4	<5	4	0.112	1.4	15	
	10/3/2010	High	8.2		0.11	0.03	4	<5	4	0.083	0.6	15	
		Low	8.0		0.08	0.02	3	<5	12	0.104	1	15	
	11/3/2010	High	8.2		0.09	0.02	3	<5	16	0.079	0.8	15	
		Low	6.0		0.09	0.02	4	<5	40	0.108	1.3	15	
	12/3/2010	High	9.3		0.12	0.08	3	<5	47	0.085	2.2	15	
		Low	8.6		0.08	0.04	2	<5	34	0.121	6.2	15	
	3	8/3/2010	High	15.0		0.07	0.03	4	<5	2	0.104	0.5	15
			Low	11.0		0.07	0.02	4	<5	12	0.097	1	15
		9/3/2010	High	17.0		0.16	0.03	3	<5	12	0.095	0.9	15
			Low	14.0		0.06	0.03	5	<5	1	0.117	0.6	15
10/3/2010		High	10.0		0.09	0.06	2	<5	11	0.083	0.6	15	
		Low	7.5		0.09	0.02	4	<5	12	0.108	0.9	15	
11/3/2010		High	10.0		0.08	0.01	4	<5	16	0.088	0.8	15	
		Low	6.0		0.07	0.02	5	<5	32	0.108	2.3	15	

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Location	Sample Date	Tide State	Water Depth (m)	Units LOR	Nutrients		Organic Parameters			Physical Tests			
					Ammonia as N mg/L 0.01	Nitrate as N mg/L 0.01	Total Organic Carbon mg/L 1	Oil & Grease mg/L 5	Suspended Solids mg/L 1	UV Absorbance @ 254nm 0.001	Turbidity NTU 0.1	Colour (True) PCU 1	
	12/3/2010	High	5.5		0.06	0.03	3	<5	28	0.07	1.5	15	
		Low	7.0		0.08	0.03	2	<5	28	0.121	5.7	15	
4	8/3/2010	High	20.0		0.1	0.03	4	<5	1	0.111	0.7	15	
		Low	15.5		0.11	0.03	4	<5	8	0.093	1.1	15	
	9/3/2010	High	9.0		0.09	0.02	4	<5	6	0.106	0.6	15	
		Low	7.0		0.07	0.03	4	<5	2	0.105	1	15	
	10/3/2010	High	16.0		0.1	0.07	3	<5	10	0.084	0.7	15	
		Low	7.5		0.1	0.01	4	<5	10	0.105	0.7	15	
	11/3/2010	High	15.0		0.1	0.02	4	<5	20	0.079	0.9	15	
		Low	14.0		0.09	0.01	4	<5	18	0.105	1.1	15	
	12/3/2010	High	14.0		0.06	0.03	3	<5	23	0.084	1.7	15	
	5	8/3/2010	High	8.0		0.11	0.02	6	<5	8	0.105	0.5	15
			Low	10.0		0.1	0.02	4	<5	3	0.104	0.6	15
		9/3/2010	High	10.5		0.06	0.03	4	<5	1	0.1	0.5	15
			Low	8.5		0.05	0.02	4	<5	15	0.119	1.9	15
		10/3/2010	High	10.0		0.08	0.05	3	<5	9	0.102	1.1	15
Low			7.0		0.09	0.02	4	<5	8	0.108	1.5	15	
11/3/2010		High	10.0		0.07	0.01	3	<5	20	0.083	0.8	15	
		Low	7.0		0.09	0.02	4	<5	24	0.109	1.7	15	
12/3/2010		High	10.0		0.08	0.02	3	<5	24	0.063	4.3	15	

Appendix A

Location	Sample Date	Tide State	Water Depth (m)	Units LOR	Nutrients		Organic Parameters			Physical Tests		
					Ammonia as N mg/L 0.01	Nitrate as N mg/L 0.01	Total Organic Carbon mg/L 1	Oil & Grease mg/L 5	Suspended Solids mg/L 1	UV Absorbance @ 254nm 0.001	Turbidity NTU 0.1	Colour (True) PCU 1
		Low	5.5		0.09	0.04	2	<5	30	0.122	6	15
6	8/3/2010	High	6.0		0.09	0.03	5	<5	4	0.108	0.5	15
		Low	7.0		0.08	0.02	4	<5	4	0.095	0.6	15
	9/3/2010	High	8.0		0.08	0.03	3	<5	3	0.09	0.6	15
		Low	6.5		0.13	0.02	4	<5	4	0.108	1.1	15
	10/3/2010	High	7.0		0.14	0.08	4	<5	10	0.077	0.5	15
		Low	7.0		0.1	0.03	4	<5	12	0.106	1.2	15
	11/3/2010	High	8.5		0.09	0.01	4	<5	18	0.078	0.7	15
		Low	5.0		0.08	0.02	4	<5	23	0.107	1.5	15
	12/3/2010	High	7.6		0.08	0.02	3	<5	32	0.076	2.3	15
Low		5.5		0.09	0.04	4	<5	19	0.12	5.3	15	

Appendix A

Table A-4 Water quality data (Analysed - Total Metals)

Location	Sample Date	Tide State	Water Depth (m)	Units LOR	Total Metals									
					Aluminium µg/L 10	Antimony µg/L 0.5	Arsenic µg/L 0.5	Barium µg/L 0.1	Bismuth µg/L 0.1	Boron µg/L 100	Cadmium µg/L 0.2	Calcium mg/L 1	Chromium µg/L 0.5	
1	8/3/2010	High	8.0		40	0.6	1.6	17	<0.1	2600	<0.2	303	0.7	
		Low	8.0		90	0.5	1.5	16	<0.1	2800	<0.2	322	2.5	
	9/3/2010	High	9.0		30	0.5	1.8	14	<0.1	3800	<0.2	332	<0.5	
		Low	8.0		300	0.5	1.6	16	<0.1	3200	<0.2	309	0.8	
	10/3/2010	High	8.2		90	0.5	1.6	12	<0.1	3100	<0.2	343	2.8	
		Low	8.0		210	0.5	1.5	15	<0.1	2800	<0.2	312	0.8	
	11/3/2010	High	8.2		60	0.5	1.6	12	<0.1	4200	<0.2	339	<0.5	
		Low	6.0		290	0.5	1.4	16	<0.1	3900	<0.2	316	<0.5	
	12/3/2010	High	9.3		220	0.5	1.3	12	<0.1	3800	<0.2	340	0.6	
		Low	8.6		460	0.5	1.6	14	<0.1	3300	<0.2	324	0.7	
	3	8/3/2010	High	15.0		40	0.5	1.3	18	<0.1	2700	<0.2	298	8.2
			Low	11.0		70	0.5	1.4	16	<0.1	2600	<0.2	317	<0.5
9/3/2010		High	17.0		120	0.5	1.7	14	<0.1	3300	<0.2	332	1.2	
		Low	14.0		60	0.5	1.4	17	<0.1	3500	<0.2	308	<0.5	
10/3/2010		High	10.0		70	0.5	1.5	13	<0.1	3100	<0.2	337	0.8	
		Low	7.5		170	0.5	1.6	16	<0.1	3000	<0.2	313	1.1	
11/3/2010		High	10.0		120	0.5	1.3	12	<0.1	4000	<0.2	329	1	
		Low	6.0		550	0.5	1.5	14	<0.1	3300	<0.2	322	0.9	
12/3/2010		High	5.5		20	0.5	1.3	11	<0.1	3700	<0.2	345	<0.5	

Appendix A

Location	Sample Date	Tide State	Water Depth (m)	Units LOR	Total Metals								
					Aluminium µg/L 10	Antimony µg/L 0.5	Arsenic µg/L 0.5	Barium µg/L 0.1	Bismuth µg/L 0.1	Boron µg/L 100	Cadmium µg/L 0.2	Calcium mg/L 1	Chromium µg/L 0.5
		Low	7.0		150	0.5	1.4	14	<0.1	3300	<0.2	327	<0.5
4	8/3/2010	High	20.0		50	0.5	1.5	18	<0.1	2500	<0.2	296	4.9
		Low	15.5		200	0.5	1.7	16	<0.1	2700	<0.2	328	0.8
	9/3/2010	High	9.0		70	0.5	1.3	14	<0.1	3400	<0.2	315	<0.5
		Low	7.0		120	0.5	1.6	18	<0.1	3400	<0.2	315	1.3
	10/3/2010	High	16.0		80	0.5	1.4	13	<0.1	3400	<0.2	337	0.8
		Low	7.5		60	0.5	1.6	14	<0.1	2800	<0.2	312	1.4
	11/3/2010	High	15.0		40	0.5	1.2	11	<0.1	4000	<0.2	339	<0.5
		Low	14.0		110	0.5	1	15	<0.1	3300	<0.2	319	<0.5
12/3/2010	High	14.0		40	0.5	1.3	12	<0.1	3800	<0.2	339	<0.5	
5	8/3/2010	High	8.0		60	0.5	1.6	18	<0.1	2500	<0.2	306	1
		Low	10.0		60	0.5	1.6	18	<0.1	2900	<0.2	320	2.1
	9/3/2010	High	10.5		30	0.5	1.5	14	<0.1	3400	<0.2	321	<0.5
		Low	8.5		290	0.5	1.9	16	<0.1	3400	<0.2	307	0.7
	10/3/2010	High	10.0		100	0.5	1.7	14	<0.1	3200	<0.2	322	1
		Low	7.0		210	0.5	1.5	16	<0.1	2700	<0.2	314	1.8
	11/3/2010	High	10.0		150	0.5	1.4	12	<0.1	3800	<0.2	336	<0.5
		Low	7.0		220	0.5	1.2	14	<0.1	3200	<0.2	314	<0.5
12/3/2010	High	10.0		20	0.5	1.8	11	<0.1	3700	<0.2	352	<0.5	
	Low	5.5		310	0.5	1.5	14	<0.1	3300	<0.2	329	0.7	
6	8/3/2010	High	6.0		40	0.5	1.4	18	<0.1	2800	<0.2	302	2.2

Appendix A

Location	Sample Date	Tide State	Water Depth (m)	Units LOR	Total Metals								
					Aluminium µg/L 10	Antimony µg/L 0.5	Arsenic µg/L 0.5	Barium µg/L 0.1	Bismuth µg/L 0.1	Boron µg/L 100	Cadmium µg/L 0.2	Calcium mg/L 1	Chromium µg/L 0.5
		Low	7.0		70	0.5	1.8	16	<0.1	2800	<0.2	318	<0.5
	9/3/2010	High	8.0		80	0.5	1.6	13	<0.1	3400	<0.2	332	<0.5
		Low	6.5		60	0.5	1.6	16	<0.1	3600	<0.2	308	<0.5
	10/3/2010	High	7.0		40	0.5	1.8	12	<0.1	3000	<0.2	346	0.7
		Low	7.0		170	0.5	1.6	15	<0.1	2800	<0.2	313	1.7
	11/3/2010	High	8.5		70	0.5	1.8	13	<0.1	4500	<0.2	340	<0.5
		Low	5.0		90	0.5	1	14	<0.1	3300	<0.2	316	1
	12/3/2010	High	7.6		40	0.5	1.4	11	<0.1	4400	<0.2	347	<0.5
		Low	5.5		160	0.5	1.4	14	<0.1	3400	<0.2	325	<0.5

Appendix A

Location	Sample Date	Tide State	Water Depth (m)	Units LOR	Total Metals											
					Beryllium µg/L 0.1	Cobalt µg/L 0.2	Copper µg/L 1	Iron µg/L 5	Lead µg/L 5	Lithium µg/L 1	Magnesium mg/L 1	Manganese mg/L 1	Mercury mg/L 0.0001	Tin µg/L 5	Zinc µg/L 5	
1	8/3/2010	High	8.0		<0.1	<0.2	2	50	1.2	116	951	9	<0.0001	<5	<5	
		Low	8.0		<0.1	<0.2	3	98	1.2	124	1010	7.5	<0.0001	<5	<5	
	9/3/2010	High	9.0		<0.1	<0.2	5	66	1.1	157	7.8	7.8	<0.0001	<5	<5	
		Low	8.0		<0.1	<0.2	2	340	0.7	131	973	20.7	<0.0001	<5	<5	
	10/3/2010	High	8.2		<0.1	<0.5	5	98	0.6	129	1070	9.6	<0.0001	<5	13	
		Low	8.0		<0.1	<0.2	2	272	0.5	121	970	21.2	<0.0001	<5	<5	
	11/3/2010	High	8.2		<0.1	<0.2	2	56	0.4	138	1040	8.5	<0.0001	<5	<5	
		Low	6.0		<0.1	<0.2	2	267	0.2	137	966	16.8	<0.0001	<5	<5	
	12/3/2010	High	9.3		<0.1	<0.3	3	212	0.5	144	1040	15.8	<0.0001	<5	<5	
		Low	8.6		<0.1	<0.3	3	468	0.4	128	997	21	<0.0001	<5	39	
	3	8/3/2010	High	15.0		<0.1	<0.2	3	83	2.5	117	926	9.9	<0.0001	<5	6
			Low	11.0		<0.1	<0.2	3	90	0.7	113	999	7.6	<0.0001	<5	<5
		9/3/2010	High	17.0		<0.1	<0.4	2	149	0.8	120	1080	11.4	<0.0001	<5	10
			Low	14.0		<0.1	<0.2	2	52	0.5	143	967	11	<0.0001	<5	<5
10/3/2010		High	10.0		<0.1	<0.2	2	86	0.6	121	1060	8	<0.0001	<5	7	
		Low	7.5		<0.1	<0.2	3	193	0.5	133	982	15.8	<0.0001	<5	<5	
11/3/2010		High	10.0		<0.1	<0.2	2	110	1.6	133	1010	9.6	<0.0001	<5	<5	
		Low	6.0		<0.1	<0.4	2	598	0.4	127	984	28.4	<0.0001	<5	<5	
12/3/2010		High	5.5		<0.1	<0.2	3	24	0.3	140	1050	2.7	<0.0001	<5	<5	
		Low	7.0		<0.1	<0.2	9	142	0.2	127	1010	8	<0.0001	<5	18	

Appendix A

Location	Sample Date	Tide State	Water Depth (m)	Units LOR	Total Metals										
					Beryllium µg/L 0.1	Cobalt µg/L 0.2	Copper µg/L 1	Iron µg/L 5	Lead µg/L 5	Lithium µg/L 1	Magnesium mg/L 1	Manganese mg/L 1	Mercury mg/L 0.0001	Tin µg/L 5	Zinc µg/L 5
4	8/3/2010	High	20.0		<0.1	<0.2	4	84	4.4	104	922	10.2	<0.0001	<5	12
		Low	15.5		<0.1	<0.2	3	278	0.5	118	1030	11.2	<0.0001	<5	<5
	9/3/2010	High	9.0		<0.1	<0.2	1	69	0.4	132	980	9.1	<0.0001	<5	<5
		Low	7.0		<0.1	<0.2	2	126	1.2	137	979	12.5	<0.0001	<5	<5
	10/3/2010	High	16.0		<0.1	<0.2	5	79	1.3	153	1060	8	<0.0001	<5	<5
		Low	7.5		<0.1	<0.3	2	78	0.5	121	980	12.9	<0.0001	<5	<5
	11/3/2010	High	15.0		<0.1	<0.2	1	40	0.8	134	1040	7.7	<0.0001	<5	<5
		Low	14.0		<0.1	<0.2	3	99	0.6	129	978	11.4	<0.0001	<5	<5
12/3/2010	High	14.0		<0.1	<0.2	3	37	0.6	142	1030	4.2	<0.0001	<5	<5	
5	8/3/2010	High	8.0		<0.1	<0.2	2	70	1.1	107	961	9.2	<0.0001	<5	<5
		Low	10.0		<0.1	<0.2	4	95	1.6	118	1040	8.9	<0.0001	<5	6
	9/3/2010	High	10.5		<0.1	<0.2	4	34	1.6	143	1010	9.4	<0.0001	<5	7
		Low	8.5		<0.1	<0.3	2	332	0.8	139	959	26.6	<0.0001	<5	<5
	10/3/2010	High	10.0		<0.1	<0.2	2	112	0.5	134	1010	9.9	<0.0001	<5	<5
		Low	7.0		<0.1	<0.2	3	261	0.8	112	982	19.7	<0.0001	<5	6
	11/3/2010	High	10.0		<0.1	<0.2	5	137	0.6	134	1030	9.4	<0.0001	<5	<5
		Low	7.0		<0.1	<0.2	2	233	0.6	126	980	20.2	<0.0001	<5	<5
12/3/2010	High	10.0		<0.1	<0.3	2	23	0.5	137	1060	2.9	<0.0001	<5	<5	
	Low	5.5		<0.1	<0.2	5	310	0.5	129	1000	15.8	<0.0001	<5	<5	
6	8/3/2010	High	6.0		<0.1	<0.2	2	64	1.4	121	953	9.7	<0.0001	<5	<5
		Low	7.0		<0.1	<0.2	2	86	0.6	124	996	8.2	<0.0001	<5	<5

Appendix A

Location	Sample Date	Tide State	Water Depth (m)	Units LOR	Total Metals										
					Beryllium µg/L 0.1	Cobalt µg/L 0.2	Copper µg/L 1	Iron µg/L 5	Lead µg/L 5	Lithium µg/L 1	Magnesium mg/L 1	Manganese mg/L 1	Mercury mg/L 0.0001	Tin µg/L 5	Zinc µg/L 5
	9/3/2010	High	8.0		<0.1	<0.2	1	78	0.9	134	1090	7.3	<0.0001	<5	<5
		Low	6.5		<0.1	<0.2	2	57	1.1	145	967	10.9	<0.0001	<5	<5
	10/3/2010	High	7.0		<0.1	<0.2	2	52	0.4	122	1070	8	<0.0001	<5	<5
		Low	7.0		<0.1	<0.5	4	217	0.4	120	976	16.5	<0.0001	<5	8
	11/3/2010	High	8.5		<0.1	<0.2	1	50	1	150	1040	8.4	<0.0001	<5	<5
		Low	5.0		<0.1	<0.3	4	89	0.6	127	1020	14.8	<0.0001	<5	6
	12/3/2010	High	7.6		<0.1	<0.2	4	41	0.4	143	1070	5.7	<0.0001	<5	<5
		Low	5.5		<0.1	<0.2	4	140	0.2	129	1000	7.6	<0.0001	<5	<5

Appendix A

Location	Sample Date	Tide State	Water Depth (m)	Units LOR	Total Metals								
					Molybdenum µg/L 0.1	Potassium mg/L 1	Selenium µg/L 2	Silver µg/L 0.1	Sodium mg/L 1	Strontium µg/L 10	Thallium µg/L 0.1	Nickel µg/L 0.5	Vanadium µg/L 0.5
1	8/3/2010	High	8.0		8.5	359	<2	<0.1	7880	4750	0.6	1.2	3
		Low	8.0		8.8	387	<2	<0.1	8440	4900	0.3	1.9	3.4
	9/3/2010	High	9.0		8.9	400	<2	<0.1	8520	5110	0.1	0.8	3.2
		Low	8.0		8.7	371	<2	<0.1	8010	4780	0.1	1.1	3.9
	10/3/2010	High	8.2		10.2	418	<2	<0.1	8800	5570	0.5	0.7	2.7
		Low	8.0		9.3	373	<2	<0.1	8230	4750	0.1	0.8	3.3
	11/3/2010	High	8.2		9.4	411	<2	<0.1	8780	6150	0.6	0.5	2.4
		Low	6.0		9	376	<2	<0.1	8120	5880	1	0.5	3
12/3/2010	High	9.3		9.2	396	<2	0.6	9240	6200	0.3	0.6	2.6	
	Low	8.6		9	378	<2	<0.1	8200	5640	0.1	0.7	4.2	
3	8/3/2010	High	15.0		9.3	357	<2	<0.1	7820	4500	0.3	6.6	3.4
		Low	11.0		8.8	386	<2	<0.1	8220	4790	0.2	1.1	3.4
	9/3/2010	High	17.0		9.8	402	<2	<0.1	8520	5110	0.1	1.2	3.4
		Low	14.0		8.6	371	<2	<0.1	7980	5110	0.1	0.7	3.2
	10/3/2010	High	10.0		10.2	413	<2	<0.1	8700	5330	0.1	0.7	2.9
		Low	7.5		9.6	375	<2	<0.1	8130	4980	0.1	0.9	3.2
	11/3/2010	High	10.0		9.1	399	<2	<0.1	8400	5720	0.1	1	3
		Low	6.0		8.8	386	<2	<0.1	8190	5470	0.2	0.7	3.8
12/3/2010	High	5.5		9.3	400	<2	<0.1	9220	6260	0.1	0.5	2.4	
	Low	7.0		9.2	385	<2	<0.1	8360	5780	0.1	0.5	3.6	

Appendix A

Location	Sample Date	Tide State	Water Depth (m)	Units LOR	Total Metals								
					Molybdenum µg/L 0.1	Potassium mg/L 1	Selenium µg/L 2	Silver µg/L 0.1	Sodium mg/L 1	Strontium µg/L 10	Thallium µg/L 0.1	Nickel µg/L 0.5	Vanadium µg/L 0.5
4	8/3/2010	High	20.0		8.8	352	<2	<0.1	7800	4500	0.5	4.7	3.1
		Low	15.5		8.9	394	<2	<0.1	8560	4890	0.3	0.8	3.5
	9/3/2010	High	9.0		8.9	378	<2	<0.1	8220	5020	0.1	0.5	3.1
		Low	7.0		8.5	376	<2	<0.1	8110	4890	0.1	1.9	3.1
	10/3/2010	High	16.0		9.7	409	<2	<0.1	8740	5180	0.1	1.4	2.6
		Low	7.5		9.4	374	<2	<0.1	8210	4790	0.1	0.8	3
	11/3/2010	High	15.0		9.2	415	<2	<0.1	8440	5920	0.2	0.6	2.6
		Low	14.0		8.6	384	<2	<0.1	7940	5500	0.3	0.5	2.9
12/3/2010	High	14.0		9.3	395	<2	<0.1	9210	6280	0.1	0.5	2.3	
5	8/3/2010	High	8.0		8.3	365	<2	<0.1	7890	4630	0.2	1.5	3
		Low	10.0		8.9	385	<2	<0.1	8250	4770	0.2	2.3	3.2
	9/3/2010	High	10.5		9.1	385	<2	<0.1	8030	5020	0.1	1.4	2.7
		Low	8.5		8.8	370	<2	<0.1	8030	5200	0.1	0.8	3.6
	10/3/2010	High	10.0		9.9	391	<2	<0.1	8380	5310	0.1	0.8	2.9
		Low	7.0		9.1	376	<2	<0.1	8050	4940	0.1	1.9	3.1
	11/3/2010	High	10.0		9.3	409	<2	<0.1	8650	6060	0.1	0.5	3.2
		Low	7.0		8.7	377	<2	<0.1	7900	5440	0.1	0.8	3.4
12/3/2010	High	10.0		9.3	402	<2	<0.1	9240	6360	0.1	0.7	2.8	
	Low	5.5		8.8	380	<2	<0.1	8340	5470	0.1	1.4	3.9	
6	8/3/2010	High	6.0		8.4	357	<2	<0.1	7920	4670	0.4	2.2	3
		Low	7.0		8.7	380	<2	<0.1	8170	4800	0.3	0.8	3.2

Appendix A

Location	Sample Date	Tide State	Water Depth (m)	Units LOR	Total Metals								
					Molybdenum µg/L 0.1	Potassium mg/L 1	Selenium µg/L 2	Silver µg/L 0.1	Sodium mg/L 1	Strontium µg/L 10	Thallium µg/L 0.1	Nickel µg/L 0.5	Vanadium µg/L 0.5
	9/3/2010	High	8.0		9.1	406	<2	<0.1	8500	5230	0.1	0.6	3.2
		Low	6.5		8.7	367	<2	<0.1	8090	4800	0.1	0.6	3.1
	10/3/2010	High	7.0		10.3	423	<2	<0.1	9020	5430	0.1	0.8	2.6
		Low	7.0		9.3	378	<2	<0.1	8170	4900	0.1	0.9	3.6
	11/3/2010	High	8.5		10	412	<2	<0.1	8600	6450	0.1	0.5	3.1
		Low	5.0		8.5	383	<2	<0.1	8040	5390	0.1	0.6	3
	12/3/2010	High	7.6		9.3	402	<2	<0.1	9400	6200	0.1	0.5	2.6
		Low	5.5		9	386	<2	<0.1	8320	5700	0.1	0.7	3.6

Appendix B Water Quality Data October 2009 - Dry Season

Appendix B

Table B-1 Water Quality Data (In-situ measurements)

Sample ID	Sample Date	Tides	Depth	In-situ parameters					
				pH	DO mg/L	Cond µS/cm	Temp °C	Turbidity (NTU)	TDS
1	5/10/2009	High	3.5	8.12	9.7	5.67	24.4	9	36,300
	6/10/2009		2.5	8.08	8.7	5.67	25.2	2	36,300
	7/10/2009		3.8	8.1	9.08	5.66	24.9	9.8	36,200
2	5/10/2009	High	3	8.1	9.54	5.74	25.6	6.2	35,800
	6/10/2009		3	8.08	9.18	5.73	27.1	2.2	35,700
	7/10/2009		3	8.13	9.17	5.75	24.9	5.2	35,800
3	5/10/2009	High	12.5	8.15	9.88	5.62	24	15.5	35,300
	5/10/2009	Low	9	5.43	9.31	5.68	25.2	14.9	35,700
	6/10/2009	High	10.5	8.13	9.02	5.61	24.2	10.2	35,300
	6/10/2009	Low	8.5	8.04	9.09	5.68	24.9	17.2	36,000
	7/10/2009	High	7.3	8.16	9.21	5.61	24.5	10.3	35,400
	7/10/2009	Low	8	8.08	9	5.68	25	14.3	35,700
4	5/10/2009	High	12	8.1	9.42	5.51	24.1	9.9	34,600
	5/10/2009	Low	11.5	5.36	9.04	5.66	25.3	14.9	35,600
	6/10/2009	High	14.5	8.14	9.2	5.6	24.2	9.6	35,200
	6/10/2009	Low	11.5	8.05	9.42	5.67	25	15.4	35,700
	7/10/2009	High	14.5	8.17	9.05	5.61	24.6	9	35,300
	7/10/2009	Low	12.5	8.09	8.26	5.68	24.7	14.8	35,900
5	5/10/2009	High	14.5	8.12	8.95	5.57	24.1	16.2	35,000
	5/10/2009	Low	8	5.32	9.14	5.66	25.2	10.9	35,500
	6/10/2009	High	15.5	8.14	9.19	5.62	24.4	8.9	35,400
	6/10/2009	Low	14.5	8.08	9.4	5.68	25.2	16.2	35,900

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			In-situ parameters						
	7/10/2009	High	17.5	8.16	9.16	5.61	24.7	10.2	35,400
	7/10/2009	Low	16.5	8.12	9.26	5.66	25.4	15.2	35,700
6	5/10/2009	Low	3.5	5.31	8.93	5.63	26.1	8	35,500
	6/10/2009		6.5	8.07	8.36	5.66	25.4	11.5	35,800
	7/10/2009		7.3	8.07	8.47	5.67	24.9	14.5	35,900

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Table B-2 Water quality data (Analysed – Dissolved Anions)

Location	Sample Date	Tide State	Water Depth (m)	Units LOR	Dissolved Anions								
					Alkalinity- Total as CaCO3 mg/L 1	Alkalinity- Carbonate as CaCO3 mg/L 1	Alkalinity Hydroxide as CaCO3 mg/L 1	Chloride mg/L 1	Fluoride mg/L 0.1	Silica mg/L 0.01	Reactive Silica mg/L 0.1	Sulfide as S ²⁻ mg/L 0.1	Sulfate as SO ₄ ²⁻ mg/L 1
1	5/10/2009	High	3.5		116	<1	<1	24400	0.9	0.6	1.22	<0.1	3024
	6/10/2009		2.5		118	<1	<1	25000	0.9	0.7	0.9	<0.1	3340
	7/10/2009		3.8		114	<1	<1	22700	0.9	0.5	0.54	<0.1	2960
2	5/10/2009	High	3.0		114	<1	<1	24700	0.9	0.6	1.23	<0.1	3354
	6/10/2009		3.0		118	<1	<1	24600	0.9	0.7	0.51	<0.1	3320
	7/10/2009		3.0		116	<1	<1	22100	0.9	0.5	1.1	<0.1	2920
3	5/10/2009	High	12.5		115	<1	<1	25000	0.9	0.5	0.96	<0.1	3100
		Low	9.0		113	<1	<1	25600	0.9	0.7	1.45	<0.1	2987
	6/10/2009	High	10.5		114	<1	<1	24600	0.9	0.5	0.38	<0.1	3380
		Low	8.5		113	<1	<1	25000	0.9	0.8	1.17	<0.1	3160
	7/10/2009	High	7.3		114	<1	<1	22200	0.9	0.6	1.37	<0.1	3100
		Low	8.0		116	<1	<1	22700	0.9	0.5	1.59	<0.1	3120
4	5/10/2009	High	12		114	<1	<1	24500	0.9	0.4	1.09	<0.1	3060
		Low	11.5		115	<1	<1	24600	0.9	0.7	1.28	<0.1	3190
	6/10/2009	High	14.5		123	<1	<1	24500	0.9	0.5	0.9	<0.1	3248
		Low	11.5		114	<1	<1	24900	0.9	0.8	1.82	<0.1	3100
	7/10/2009	High	14.5		114	<1	<1	22300	0.9	0.8	1.5	<0.1	2980

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Location	Sample Date	Tide State	Water Depth (m)	Units LOR	Dissolved Anions								
					Alkalinity- Total as CaCO3 mg/L 1	Alkalinity- Carbonate as CaCO3 mg/L 1	Alkalinity Hydroxide as CaCO3 mg/L 1	Chloride mg/L 1	Fluoride mg/L 0.1	Silica mg/L 0.01	Reactive Silica mg/L 0.1	Sulfide as S2- mg/L 0.1	Sulfate as SO4 2- mg/L 1
		Low	12.5		116	<1	<1	22500	0.9	0.5	1.64	<0.1	3070
5	5/10/2009	High	14.5		115	<1	<1	24600	0.9	0.5	1.17	<0.1	3140
		Low	8.0		116	<1	<1	24900	0.9	0.7	1.39	<0.1	3210
	6/10/2009	High	15.5		112	<1	<1	24700	0.9	0.5	0.9	<0.1	3102
		Low	14.5		113	<1	<1	25200	0.9	0.8	1.58	<0.1	3030
	7/10/2009	High	17.5		116	<1	<1	22700	0.9	0.7	1.47	<0.1	3080
		Low	16.5		116	<1	<1	22400	0.9	0.7	0.71	<0.1	3130
6	5/10/2009	Low	3.5		119	<1	<1	22000	0.9	0.8	1.41	<0.1	3654
	6/10/2009		6.5		136	<1	<1	25100	0.9	0.8	1.9	<0.1	3080
	7/10/2009		7.3		114	<1	<1	22800	0.9	0.7	1.33	<0.1	2970

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Table B-3 Water Quality Data (Analysed – Nutrients, Physical Tests, Organic Parameters)

Location	Sample Date	Tide State	Water Depth (m)	Units LOR	Nutrients		Organic Parameters			Physical Tests	
					Ammonia as N mg/L 0.01	Nitrate as N mg/L 0.01	Total Organic Carbon mg/L 1	Oil & Grease mg/L 5	Suspended Solids mg/L 1	UV Absorbance @ 254nm 0.01	Colour (True) PCU 1
1	5/10/2009	High	3.5		0.04	<0.01	2	<5	18	0.03	<1
	6/10/2009		2.5		0.04	<0.01	<1	5	12	0.03	<1
	7/10/2009		3.8		0.05	<0.01	2	<5	12	0.03	<1
2	5/10/2009	High	3.0		0.04	<0.01	2	<5	20	0.04	<1
	6/10/2009		3.0		0.05	<0.01	2	<5	10	0.03	<1
	7/10/2009		3.0		0.05	<0.01	2	<10	22	0.03	<1
3	5/10/2009	High	12.5		0.03		<1		30	0.04	<1
		Low	9.0		0.05	<0.01	<1	<5	46	0.03	<1
	6/10/2009	High	10.5		0.04	<0.01	<1	<5	14	0.03	<1
		Low	8.5		0.04	<0.01	<1	<5	25	0.04	<1
	7/10/2009	High	7.3		0.04	<0.01	2	<5	43	0.03	<1
		Low	8.0		0.04	<0.01	<1	<5	36	0.03	<1
4	5/10/2009	High	12		0.04	<0.01	2	<10	23	0.04	<1
		Low	11.5		0.04		3	<5	48	0.03	<1
	6/10/2009	High	14.5		0.06	<0.01	2	<5	20	0.03	<1
		Low	11.5		0.04	<0.01	2	<5	22	0.05	<1
	7/10/2009	High	14.5		0.04	<0.01	<1	<5	30	0.03	<1
		Low	12.5		0.04	<0.01	<1	<5	42	0.05	<1

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Location	Sample Date	Tide State	Water Depth (m)	Units LOR	Nutrients		Organic Parameters			Physical Tests	
					Ammonia as N mg/L 0.01	Nitrate as N mg/L 0.01	Total Organic Carbon mg/L 1	Oil & Grease mg/L 5	Suspended Solids mg/L 1	UV Absorbance @ 254nm 0.01	Colour (True) PCU 1
5	5/10/2009	High	14.5		0.04		2		28	0.04	<1
		Low	8.0		0.04	<0.01	<1	<10	40	0.03	<1
	6/10/2009	High	15.5		0.04	<0.01	2	<10	14	0.03	<1
		Low	14.5		0.04	<0.01	2	<5	15	0.04	<1
	7/10/2009	High	17.5		0.06	<0.01	<1	<5	33	0.03	<1
		Low	16.5		0.06	<0.01	2	<5	36	0.04	<1
6	5/10/2009	Low	3.5		0.03	<0.01	2	<5	47	0.04	<1
	6/10/2009		6.5		0.04	<0.01	2	<5	26	0.05	<1
	7/10/2009		7.3		0.05	<0.01	2	<5	28	0.05	<1

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Table B-4 Water Quality Data (Analysed - Total Metals)

Location	Sample Date	Tide State	Water Depth (m)	Units LOR	Total Metals								
					Aluminium mg/L 0.05	Antimony mg/L 0.005	Arsenic mg/L 0.05	Barium mg/L 0.05	Bismuth mg/L 0.005	Boron mg/L 0.05	Cadmium mg/L 0.0005	Calcium mg/L 1	Chromium mg/L 0.001
1	5/10/2009	High	3.5		<0.5	<0.005	<0.05	<0.05	<0.005	3.24	<0.0005	461	0.019
	6/10/2009		2.5		<0.5	<0.005	<0.05	<0.05	<0.005	5.64	<0.0005	465	0.023
	7/10/2009		3.8		<0.5	<0.005	<0.05	<0.05	<0.005	6.28	<0.0005	454	0.021
2	5/10/2009	High	3.0		<0.5	<0.005	<0.05	<0.05	<0.005	4.64	<0.0005	456	0.025
	6/10/2009	High	3.0		<0.5	<0.005	<0.05	<0.05	<0.005	3.92	<0.0005	464	0.019
	7/10/2009	High	3.0		<0.5	<0.005	<0.05	<0.05	<0.005	2.80	<0.0005	452	0.024
3	5/10/2009	High	12.5									456	
		Low	9.0		<0.6	<0.005	<0.05	<0.05	<0.005	5.67	<0.0008	469	0.014
	6/10/2009	High	10.5		<0.5	<0.005	<0.05	<0.05	<0.005	3.80	<0.0005	463	0.019
		Low	8.5		0.69	<0.005	0.06	<0.05	<0.005	3.72	<0.0005	466	0.015
	7/10/2009	High	7.3		<0.5	<0.005	<0.05	<0.05	<0.005	3.54	0.0007	464	0.014
		Low	8.0		<0.5	<0.005	<0.05	<0.05	<0.005	3.61	<0.0005	469	0.025
4	5/10/2009	High	12		<0.5	<0.005	<0.05	<0.05	<0.005	5.11	<0.0005	453	0.015
		Low	11.5									464	
	6/10/2009	High	14.5		<0.5	<0.005	<0.05	<0.05	<0.005	5.14	<0.0005	478	0.024
		Low	11.5		0.69	<0.005	<0.05	<0.05	<0.005	5.64	<0.0005	464	0.013
	7/10/2009	High	14.5		<0.5	<0.005	<0.05	<0.05	<0.005	5.32	<0.0005	451	0.016
		Low	12.5		<0.5	<0.005	<0.05	<0.05	<0.005	5.28	<0.0005	462	0.024
5	5/10/2009	High	14.5									454	

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Location	Sample Date	Tide State	Water Depth (m)	Units LOR	Total Metals								
					Aluminium mg/L 0.05	Antimony mg/L 0.005	Arsenic mg/L 0.05	Barium mg/L 0.05	Bismuth mg/L 0.005	Boron mg/L 0.05	Cadmium mg/L 0.0005	Calcium mg/L 1	Chromium mg/L 0.001
	6/10/2009	Low	8.0		<0.5	<0.005	<0.05	<0.05	<0.005	6.09	<0.0005	467	0.024
		High	15.5		<0.5	<0.005	<0.05	<0.05	<0.005	6.01	<0.0006	460	0.021
		Low	14.5		0.67	<0.005	<0.05	<0.05	<0.005	4.94	<0.0005	459	0.011
	7/10/2009	High	17.5		<0.5	<0.005	<0.05	<0.05	<0.005	1.95	<0.0005	460	0.015
		Low	16.5		<0.5	<0.005	<0.05	<0.05	<0.005	3.28	<0.0005	464	0.028
	6	5/10/2009	Low	3.5		<0.5	<0.005	<0.05	<0.05	<0.005	3.08	0.0007	466
6/10/2009		6.5			0.64	<0.005	<0.05	<0.05	<0.005	4.53	<0.0005	455	0.012
7/10/2009		7.3			<0.5	<0.005	<0.05	<0.05	<0.005	6.20	<0.0005	462	0.021

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Location	Sample Date	Tide State	Water Depth (m)	Units LOR	Total Metals										
					Beryllium µg/L 0.005	Cobalt mg/L 0.005	Copper mg/L 0.05	Iron mg/L 0.05	Lead mg/L 0.005	Lithium mg/L 1	Magnesium mg/L 1	Manganese mg/L 0.01	Mercury mg/L 0.0001	Tin mg/L 0.005	Zinc mg/L 0.05
1	5/10/2009	High	3.5		<0.005	<0.005	<0.05	0.26	<0.005	0.181	1400	<0.01	<0.0001	<0.005	<0.05
	6/10/2009	High	2.5		<0.005	<0.005	<0.05	1.41	<0.005	0.166	1380	<0.01	<0.0001	<0.005	<0.05
	7/10/2009	High	3.8		<0.005	<0.005	<0.05	1.87	<0.005	0.182	1340	<0.01	<0.0001	<0.005	<0.05
2	5/10/2009	High	3.0		<0.005	<0.005	<0.05	1.09	<0.005	0.136	1390	0.011	<0.0001	<0.005	<0.05
	6/10/2009	High	3.0		<0.005	<0.005	<0.05	0.86	<0.005	0.162	1380	<0.01	<0.0001	<0.005	<0.05
	7/10/2009	High	3.0		<0.005	<0.005	<0.05	1.49	<0.005	0.146	1320	<0.01	<0.0001	<0.005	<0.05
3	5/10/2009	High	12.5								1380				
		Low	9.0		<0.005	<0.005	<0.05	2.31	<0.005	0.203	1420	0.022	<0.0001	<0.005	<0.05
	6/10/2009	High	10.5		<0.005	<0.005	<0.05	0.72	<0.005	0.236	1390	<0.01	<0.0001	<0.005	<0.05
		Low	8.5		<0.005	<0.005	<0.05	1.22	<0.005	0.248	1420	0.021	<0.0001	<0.005	<0.05
	7/10/2009	High	7.3		<0.005	<0.005	<0.05	1.63	<0.005	0.243	1380	0.01	<0.0001	<0.005	<0.05
		Low	8.0		<0.005	<0.005	<0.05	1.44	<0.005	0.125	1410	0.011	<0.0001	<0.005	<0.05
4	5/10/2009	High	12		<0.005	<0.005	<0.05	1.45	<0.005	0.201	1370	0.015	<0.0001	<0.005	<0.05
		Low	11.5								1410				
	6/10/2009	High	14.5		<0.005	<0.005	<0.05	0.72	<0.005	1.45	1420	0.017	<0.0001	<0.005	<0.05
		Low	11.5		<0.005	<0.005	<0.05	1	<0.005	0.202	1400	0.018	<0.0001	<0.005	<0.05
	7/10/2009	High	14.5		<0.005	<0.005	<0.05	2	<0.005	0.142	1340	0.011	<0.0001	<0.005	<0.05
		Low	12.5		<0.005	<0.005	<0.05	1.59	<0.005	0.141	1380	0.015	<0.0001	<0.005	<0.05
5	5/10/2009	High	14.5								1380				
		Low	8.0		<0.005	<0.005	<0.05	1.68	<0.005	0.185	1420	0.014	<0.0001	<0.005	<0.05

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Location	Sample Date	Tide State	Water Depth (m)	Units LOR	Total Metals										
					Beryllium µg/L 0.005	Cobalt mg/L 0.005	Copper mg/L 0.05	Iron mg/L 0.05	Lead mg/L 0.005	Lithium mg/L 1	Magnesium mg/L 1	Manganese mg/L 0.01	Mercury mg/L 0.0001	Tin mg/L 0.005	Zinc mg/L 0.05
	6/10/2009	High	15.5		<0.005	<0.005	<0.05	1.51	<0.005	0.182	1380	<0.01	<0.0001	<0.005	<0.05
		Low	14.5		<0.005	<0.005	<0.05	1.19	<0.005	0.208	1370	0.022	<0.0001	<0.005	<0.05
	7/10/2009	High	17.5		<0.005	<0.005	<0.05	1.48	<0.005	0.201	1380	<0.01	<0.0001	<0.005	<0.05
		Low	16.5		<0.005	<0.005	<0.05	1.89	<0.005	0.136	1400	0.013	<0.0001	<0.005	<0.05
6	5/10/2009	Low	3.5		<0.005	<0.005	<0.05	1.67	<0.005	0.134	1430	0.015	<0.0001	<0.005	<0.05
	6/10/2009		6.5		<0.005	<0.005	<0.05	1.06	<0.005	0.229	1380	0.018	<0.0001	<0.005	<0.05
	7/10/2009		7.3		<0.005	<0.005	<0.05	2.01	<0.005	0.224	1350	0.017	<0.0001	<0.005	<0.05

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Location	Sample Date	Tide State	Water Depth (m)	Units LOR	Total Metals								
					Molybdenum mg/L 0.001	Potassium mg/L 1	Selenium mg/L 0.01	Silver mg/L 0.01	Sodium mg/L 1	Strontium mg/L 0.001	Thallium µg/L 0.005	Nickel mg/L 0.05	Vanadium µg/L 0.05
1	5/10/2009	High	3.5		0.014	600	0.14	<0.01	11300	9.4	<0.005	<0.05	<0.05
	6/10/2009		3.8		0.015	603	0.13	<0.01	11400	10.5	<0.005	<0.05	<0.05
	7/10/2009		2.5		0.014	574	0.23	<0.01	11400	10.9	<0.005	<0.05	<0.05
2	5/10/2009	High	3		0.014	591	0.21	<0.01	11100	9.5	<0.005	<0.05	<0.07
	6/10/2009		3		0.014	598	0.12	<0.01	11500	8.9	<0.005	<0.05	<0.05
	7/10/2009		3		0.014	573	0.12	<0.01	12100	9.2	<0.005	<0.05	<0.05
3	5/10/2009	High	12.5			585			11100				
		Low	9		0.014	605	0.13	<0.01	11300	10.0	<0.005	<0.05	<0.05
	6/10/2009	High	10.5		0.013	602	0.12	<0.01	10900	9.1	<0.005	<0.05	<0.05
		Low	8.5		0.016	588	0.26	<0.01	13100	10.5	<0.005	<0.05	<0.05
	7/10/2009	High	7.3		0.012	582	0.14	<0.01	12800	9.2	<0.005	<0.05	<0.05
Low		8		0.013	593	0.14	<0.01	12800	9.1	<0.005	<0.05	<0.05	
4	5/10/2009	High	12		0.012	590	0.13	<0.01	11200	9.4	<0.005	<0.05	<0.05
		Low	11.5			595			11300				
	6/10/2009	High	14.5		0.012	610	0.14	<0.01	10900	10.6	<0.005	<0.05	<0.05
		Low	11.5		0.015	581	0.15	<0.01	13100	10.4	<0.005	<0.05	<0.05
	7/10/2009	High	14.5		0.014	570	0.11	<0.01	12500	10.4	<0.005	<0.05	<0.05
Low		12.5		0.014	587	0.11	<0.01	13000	10.2	<0.005	<0.05	<0.07	
5	5/10/2009	High	14.5			586			11300				
		Low	8		0.014	608	0.11	<0.01	11300	10.4	<0.005	<0.05	<0.05

Appendix B

Location	Sample Date	Tide State	Water Depth (m)	Units LOR	Total Metals								
					Molybdenum mg/L 0.001	Potassium mg/L 1	Selenium mg/L 0.01	Silver mg/L 0.01	Sodium mg/L 1	Strontium mg/L 0.001	Thallium µg/L 0.005	Nickel mg/L 0.05	Vanadium µg/L 0.05
	6/10/2009	High	15.5		0.013	598	0.24	<0.01	10800	10.5	<0.005	<0.05	<0.05
		High	14.5		0.014	573	0.25	<0.01	13000	9.8	<0.005	<0.05	<0.05
	7/10/2009	Low	17.5		0.012	578	0.13	<0.01	12800	9.9	<0.005	<0.05	<0.05
		High	16.5		0.014	590	0.15	<0.01	12900	9.9	<0.005	<0.05	<0.05
6	5/10/2009	Low	3.5		0.012	612	0.12	<0.01	11400	8.2	<0.005	<0.05	<0.05
	6/10/2009		6.5		0.014	570	0.25	<0.01	12800	10.4	<0.005	<0.05	<0.05
	7/10/2009		7.3		0.014	580	0.19	<0.01	12800	10.5	<0.005	<0.05	<0.05



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