Central Queensland Coal Project

Appendix 10i – Estuarine Benthic Study

Central Queensland Coal

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YEATS PLANNING AND ENVIRONMENT

STYX COAL PROJECT BASELINE MONITORING PROGRAM

PRE-WET SEASON 2011 ESTUARINE BENTHIC STUDY

May 2012

The ALS Water Sciences Group is part of the Environmental Division of ALS, one of the largest and most geographically diverse environmental testing businesses in the world.

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TABLE OF CONTENTS

1 Background 3

1.1 Background to this Report 3

1.2 Study Objectives 3

1.3 Scope 3

2 Sampling Method Summary 5

2.1 Study Design and Sampling Site Locations 5

2.2 Sampling Method Overview 7

2.2.1 Macroinvertebrates 7
2.2.2 Aquatic Habitat Assessment 9
2.2.3 Water Quality 9

3 Results 12

3.1 Sampling Achieved 12

3.2 General Habitat Observations 12

3.3 CHRISWEB Search Results 17

3.4 Site-Specific Observations 19

3.5 Estuarine Benthic Community 19

3.5.1 Abundance and Diversity 19
3.5.2 Composition 24

3.6 Water Quality 32

3.6.1 *In Situ* Water Quality Measurements 32
3.6.2 Analytical Water Quality Testing Results 34

3.7 Sediment Quality 38

3.7.1 Physical Properties 38
3.7.2 Analytical Sediment Quality Results 38

3.8 Implications of Findings 44

4 Potential Impacts & Mitigation Measures 46

4.1 Construction Phase 46

4.1.1 Sediment Mobilisation during Construction 46
4.1.2 Chemical Spills 47

4.2 Operation Phase 47

4.3 Considerations for Future Estuarine Sampling 48

5 References 51

APPENDIX A – HABITAT ASSESSMENT FIELD SHEET 53
APPENDIX B – RAW WATER QUALITY AND SEDIMENT QUALITY LABORATORY RESULTS 57

1 Background

1.1 Background to this Report

Waratah Coal is seeking to develop a coal deposit in their exploration permit for coal 1029 (EPC1029) in the Styx River catchment, Central Queensland. Waratah Coal appointed YEATS Planning and Environment (YEATS), to project manage the environmental planning and approvals works required for this Project. As part of the assessment process, YEATS commissioned ALS to undertake a characterisation of the surface water aquatic environment. ALS undertook the first round of surface water aquatic ecology sampling in May / June 2011, corresponding with the 2010/11 post wet season. That sampling event covered nine stream habitat sites within the southern and central region of the EPC over a five day period.

Since that survey, YEATS has requested that YEATS complete the sampling necessary to fulfil the likely general requirements for an EIS for the Styx Coal Project. To that end, ALS advised YEATS that this should involve a description of estuarine benthos, benthic habitat and water quality, given that the Styx Coal Project EPC lies close to the coastline and that the estuarine reaches of the Styx River and adjacent Broad Sound would ultimately be part of the receiving water environment with respect to this proposed mine.

In September 2011, YEATS commissioned ALS to undertake a pre-wet season survey of the estuarine environment. Initially, the findings of this study will be used to inform the development of an Environmental Management Plan (EM Plan), which will be compiled by YEATS and submitted to the Department of Environment and Resource Management (DERM). DERM will use the EM Plan as a basis for setting objectives for environment management and license conditions for the mine. Ultimately, this survey will form one of possibly several estuarine environment surveys underpinning the development of the Styx Coal Project EIS (assuming Waratah Coal pursue this).

This report outlines the sampling methods and findings with respect to estuarine environment sampling downstream of the Styx Coal Project EPC in the 2011 pre-wet season period.

1.2 Study Objectives

The main objective of this baseline monitoring component was to characterise the estuarine receiving waters in terms of habitat, resident benthic fauna, water quality and sediment texture and chemistry in order to assess the potential ecological impacts of runoff and / or releases associated with the Styx River Coal Project.

1.3 Scope

The need to progress to a full EIS to support the development of the Styx Coal Project has yet to be determined by DERM. As such, there was no specific Terms of Reference (TOR) to inform the development of the scope for the baseline monitoring program for this study. Rather than use the DERM Generic EIS TOR as a default set of guidelines, YEATS requested that the ALS baseline estuarine survey be designed to provide data that would indicate the need or otherwise to undertake an EIS.

The scope of works put forward by ALS and agreed to by YEATS involved the following:

- Collecting benthic grab, water quality and sediment samples at sites within the Styx River estuary receiving waters and from two adjacent estuaries to the north that will not be impacted by the Project;
- Collecting information on estuarine habitat at each of the sites;
- Assessing variation in the diversity, abundance and composition of benthic fauna along the estuarine gradient in each estuary and comparing benthic diversity, abundance and composition between the Styx River estuary and the two 'reference' estuaries under baseline conditions;
- Comparing water and sediment quality results against relevant guidelines to assess current condition; and
- Assess spatial variation in water and sediment quality within and between estuaries.

While the Styx River Coal Project may well potentially impact on seagrass communities in the estuarine and coastal reaches, which in turn could affect dugong and marine turtles, the assessment of the status of seagrasses in these reaches was not included as part of the scope of works as such assessments require specialist skills that are not available within ALS. The ALS staff member who led this study has PhD level qualifications in regards to estuarine benthic ecology. Benthic taxa were also chosen as a focus for assessment because they occur widely and are easy to collect. Benthic communities also generally contain a range of functional guilds and taxa with different sensitivities to pollution, which makes them ideally suited as a means of detecting anthropogenic impacts. Further, benthic organisms are likely to be most exposed to the main potential impacts associated with mine site runoff, which are: increased turbidity; the smothering of benthic fauna and habitat associated with the deposition of sediment slugs mobilised in the upper catchment by mining activity and the release of contaminants associated with mine-worked water or chemical spills.

2 Sampling Method Summary

2.1 Study Design and Sampling Site Locations

Unlike freshwater systems, for which there are predictive models and expected ranges available to assess condition, there is no equivalent assessment tools available for assessing condition based on estuarine benthos. The status of benthic communities is best assessed either by carrying out Before After Control versus Impact (BACI)-style surveys or assessing variation in community structure along a pollution / disturbance gradient (ANZECC & ARMCANZ, 2000). The study design used for this study is a combination of both techniques.

The baseline survey carried out by ALS included five sites located within the Styx River estuary downstream of EPC1029 and two each in reference estuaries to the north, Waverley Creek and St Lawrence Creek. The latter are smaller systems than the Styx River, so may not be true 'reference' systems, but they were among the closest estuaries within the study area and, given that benthic organisms generally have a larval dispersal phase, were expected to have a similar suite of benthic fauna. Sampling as part of the baseline study has provided the 'Before' and 'Control versus Impact' data components of a BACI-style monitoring approach. The full BACI design would be implemented as and when post-construction and / or post-operation phase monitoring is carried out.

Sampling in the Styx River covered sites in the upper, mid and lower estuary. Given their smaller size, sampling in the two other estuaries only involved one upper and one lower estuary site. Benthic diversity and abundance generally decreases with distance from the river mouth so this sampling design aimed to determine whether or not this was also true for the estuaries sampled. Further, the effects of runoff and sediment mobilisation associated with mining activity is likely to dissipate with increased distance from the source due to the settling out of suspended particles near the upstream extent of the salt wedge, so it was important for the spatial design of sampling to characterise spatial variation along both the estuarine gradient and according to the distance from the EPC.

Sampling in the Styx River catchment also included a site in Wellington Creek. This creek lies in the upper estuary and will not be impacted by the Project. It therefore serves as an additional 'reference' site for this study and is particularly useful as a basis for comparison with the upper Styx River estuary impact site.

Location details of the sites sampled are given in Table 2-1 and Figure 2-1.

Table 2-1: Site location details for the estuarine monitoring sites

Site Code	Site Name	Latitude	Longitude
WELL	Wellington Creek downstream	-22.515794°	149.681854°
Styx US	Styx River Upper	-22.495319°	149.657414°
Styx Mid	Styx River Mid Estuary	-22.478513°	149.678743°
Styx DS1	Styx River Lower Left Branch	-22.442742°	149.695649°
Styx DS2	Styx River Lower Right Branch	-22.460139°	149.721296°
WAV US	Waverley Creek Upper	-22.374336°	149.573557°
WAV DS	Waverley Creek Lower	-22.356136°	149.634410°
STL US	St Lawrence Creek Upper	-22.295233°	149.554176°
STL DS	St Lawrence Creek Lower	-22.279961°	149.592409°

Figure 2-1: Map showing 2011 pre-wet season estuarine survey sampling locations

Each site was accessed via a small boat launched from a larger vessel moored off shore. Due to the size of the vessel (which had a draw of >3m) and the large tidal range of >8m experienced at the time of sampling (26/11/11 to 28/11/11), the mother ship needed to moor some 12kms offshore. Fast currents, choppy conditions associated with tidal changes and the fact that sediments in the main estuarine channels had been scoured to the point where little soft sediment was available for benthic grab collection meant that no sampling could be carried out in the main estuarine channels (as was originally planned). Instead, samples were taken in small inlets connected to the main channel. While not optimal, this was considered a valid approach, not just in terms of safety and sampling logistics, but because these areas were the main depositional zones within the estuaries, so would perhaps be the most vulnerable to increased turbidity and sediment mobilisation impacts associated with the Styx Coal Project (notwithstanding that the major depositional areas associated with the Styx River appear to be offshore rather than within the estuary itself). The inlets would also receive exposure to any contaminants or turbid water in the main estuarine channel resulting from the Styx Coal Project through tidal mixing, albeit to a reduced extent of exposure compared to the main estuarine channel.

2.2 Sampling Method Overview

2.2.1 Macroinvertebrates

At each site, five replicate estuarine bed samples were collected using a lead weighted Birge-Ekman grab sampler (dimensions 15cm x 15cm x 20cm and sampling a bed area of 0.0225m^2) which was lowered to the bottom by a rope (Figure 2-2). The aim was to obtain samples which were unbiased and quantitative so that they accurately reflected the communities from which they were collected. Samples collected in this manner allow the comparison of abundances for macrofauna and community structure. A grab sampler was used for this project because of its suitability to sample soft sediment at depths up to 5m. It is acknowledged that a grab is biased towards slow moving epibenthic animals and other animals buried in the upper layers of the sediment. Motile epifauna are poorly sampled by grab sampling because there is the possibility that they can avoid the grab. The depth to which the grab penetrates the sediment depends on the sediment type sampled. Some sediments are more easily sampled by the grab than others, meaning that different sample volumes can be yielded depending on the habitat type sampled. To cater for this and reduce sampling bias, every attempt was made to sample similar volumes of sediment per grab sample at each site, even if that meant taking multiple grabs and combining the contents. In some cases, samples with very low volumes were rejected entirely and new samples taken.

Each benthic fauna sample was washed through a 600µm sieve once returned to the mother ship (Figure 2-3), labelled, and preserved in 100% Methylated Spirits for transport to the laboratory. Samples were processed by a qualified estuarine benthic taxonomist with many years of experience (Shona Hucknall, Benthic Australia). The fauna from each sample were identified to a minimum of family level using published and unpublished taxonomic keys. Where the taxonomy of certain taxa related to common, widely distributed benthic fauna, certain taxa were identified to genera or species level.

The nature of the sediments sampled as part of this study meant that, once the bulk sample had been sieved, the volume of the residual material was minimal and relatively free of extraneous organic matter (Figure 2-4). As a result, estuarine grab samples did not require sub-sampling to obtain measures of abundance and were 100% sorted with all animals removed. Once identified, all fauna captured were retained and stored at ALS's Yeerongpilly Laboratory for future reference.

Figure 2-2: Birge-Eckman grab sampler being lowered from the boat (Photo: ALS Water Sciences)

Figure 2-3: Benthic fauna samples being washed through a 600µm sieve aboard the mother ship (Photo; ALS Water Sciences)

Figure 2-4: Residual material in the 600µm sieve (Photo: ALS Water Sciences)

2.2.2 Aquatic Habitat Assessment

Information on habitat condition was recorded at each site by completing fields in a habitat assessment proforma designed by ALS specifically for estuarine habitat assessment. The fields covered in the habitat assessment proforma were chosen specifically to capture aspects of the estuarine habitat that could potentially be impacted by the Styx Coal Project –specifically the degree of fine sediment and organics within the sediment profiles, the oxidisation of the sediment profile and the presence and extent of bars in the channel and associated degree of mangrove colonisation. The habitat assessment proforma also contained fields to describe the broader habitat features and condition (with respect to 'naturalness'), the nature and extent of existing disturbances and physico-chemical water quality conditions and notes on what samples were collected at each site. A proforma was completed for each site and details of site location, sampling time, tidal conditions and any other comments (e.g. weather conditions, alternative site access) were made. A copy of the proforma is provided in Appendix A.

2.2.3 Water Quality

The following physico-chemical parameters were measured *in situ* at each site in conjunction with biological sampling:

- Water temperature (˚C)
- Electrical Conductivity (µS/cm)
- DO (% sat)
- DO (mg/L)
- pH
- Turbidity (NTU)

Chemical parameters were measured using a YSI multi-parameter water quality meter coupled with a YSI 556 WPS digital display. Turbidity was measured using a Hach 2100P turbidimeter. Both meters were fully calibrated in the field in accordance with ALS Quality Systems requirements and the manufacturers' specifications.

In addition to collecting *in situ* water quality readings to describe physico-chemical conditions, a water quality and a sediment quality grab sample was taken at each site to determine the chemical characteristics of the water and sediment, particularly with regards to metalliferous and petroleum hydrocarbon contaminants. All water quality and sediment quality testing was carried out according to procedures outlined in the DERM Monitoring and Sampling 2009 Protocols(DERM, 2009a). Sediment samples were collected using the Birge-Eckman grab sampler, which is constructed of high grade stainless steel and therefore, unlikely to contaminate the samples and bias the metal concentration results. Sediment samples were removed from the grab and placed directly into large plastic bags in order to further reduce the potential for sample contamination.

Water quality and sediment samples were taken to the mother ship and stored in the freezer on board until fieldwork was completed. They were subsequently placed in chilled eskies and transported directly to the laboratory for analysis. Samples were analysed for a range of analytes as outlined in 2.2.3.1 at ALS's NATA accredited laboratory in Brisbane..

2.2.3.1 Water Quality Testing

Metals (Total and Dissolved)

- Aluminium
- Arsenic
- Boron
- Cobalt
- Iron
- Lead
- Manganese
- Molybdenum
- Nickel
- Selenium
- Vanadium
- Cadmium
- Chromium
- Copper
- Silver
- Uranium
- Zinc
- Mercury

PAH/ BTEX

- C6-C36 TPH
- PAH
- BTEX

Nutrients

- TN
- TP
- Nitrate;
- Ammonia
- Nitrite
- NOx
- Soluble Reactive Phosphate

Major Ions

- Chloride
- Fluoride
- Sulphate
- Calcium
- Sodium
- Potassium

Physical

- TSS

2.2.3.2 Sediment Quality Testing

Metals

- Aluminium
- Arsenic
- Boron
- Cobalt
- Iron
- Lead
- Manganese
- Molybdenum
- Nickel
- Selenium
- Vanadium
- Cadmium
- Chromium
- Copper
- Silver
- Uranium
- Zinc
- Mercury

Nutrients

- TN
- TP
- Nitrate
- Ammonia
- Nitrite
- NOx
- Total Organic Carbon
- Sulphide

Physical

- Redox Potential

It is acknowledged that the holding times for soluble phosphorus, TSS and redox potential were compromised due to the fact that samples could not be couriered to the laboratory until the mother ship returned to port in Mackay following the completion of the fieldwork (three days in total). However, the results obtained for these parameters will provide an indicative measure of habitat conditions and will allow between-site / between estuary comparisons.

Water quality and sediment quality results were compared against relevant guidelines (e.g. ANZECC & ARMCANZ (2000) and the Queensland Water Quality Guidelines for Central Queensland (DERM, 2009b), as appropriate. Water quality was also interpreted in relation to the stage of the tidal cycle during which sampling occurred. Note that time constraints meant that each site was only sampled at one point of the tidal cycle.

3 Results

Note that the 2011 pre-wet sampling was carried out after an extreme wet season in 2011 so the results are potentially biased by the associated disturbance from flooding and/or the benefits of a prolonged flow period.

3.1 Sampling Achieved

Sampling for estuarine baseline study covered:

- 9 sites, five of which were within the Styx River – the system potentially at risk of impacts associated with the Project;
- 45 benthic fauna samples;
- 9 water and sediment quality samples, tested for a range of contaminants; and
- Habitat assessment and benthic sampling along the estuarine gradients of three estuaries.

3.2 General Habitat Observations

- The tidal range in the study area is very large (8-10m during king tides – as observed in this study);
- The benthic habitat in the main estuarine channels is quite consolidated as a result of scouring associated with strong tidal movement. This makes them very difficult to sample for benthic fauna effectively. However, due to the constant scouring effects associated with strong tidal movement, the benthic fauna in these habitats is likely to be much reduced, with the possible exception of those larger, motile species that construct deep burrows;
- The strong tidal movement and / or heavy discharge associated with the flooding in early 2011, has resulted in the collapse of banks and dieback of mangroves in the lower Styx River (Figure 3-1). Where banks were made of consolidated clay, scouring has resulted in near vertical drop offs. The tidal movement was so large at the time of sampling that water was observed cascading down from such drop offs (Figure 3-2).
- The Styx River estuary in particular is very turbid. The outgoing plume was observed in excess of 12km offshore (Figure 3-3). On another occasion, the plume extended north along the coast past the Waverley Estuary due to long-shore drift;
- In contrast to the main channel habitat, the small tributary habitats sampled had a shallower gradient, spoon-shaped channel bathymetry and unconsolidated muddy substrata. Those systems were not immune from rapid tidal movement with a change in water level of the order of 3-4m observed within 20 minutes on one occasion (Figure 3-4 and Figure 3-5);
- No seagrasses were observed within the estuaries sampled or in the adjacent coastal zone. They may have been present, but the water was too turbid to determine whether or not this was the case. A dugong was sighted in the coastal waters, indicating the potential presence of seagrasses, though dugongs have extended their normal distribution ranges in 2011 following a decline in seagrasses after the floods of early 2011 in order to find alternative seagrass patches;

- Mangroves present included the Grey Mangrove (*Avicennia marina*) and the Red Mangrove (*Rhizophora stylosa*) (see Figure 3-6 and Figure 3-7). The latter dominated the river mouth banks in the coastal reaches of the Styx River estuary, but were also found throughout the estuarine reach. The former occurred mainly in the smaller tributaries as a mixed canopy with the red mangrove. Apart from parts of the upper Styx River estuary and in the smaller estuaries where boat access points had been created, mangrove habitat was continuous and extended back from the bank tens of metres. Mangroves form part of the Directory of Important Wetland (DIWA) listed wetland habitat within the study area;
- A salt marsh is present in the Waverley Creek Estuary adjacent the mangrove zone (Figure 3-8). This salt marsh forms part of the Newport Conservation Area (Flora observed in the saltmarsh included Samphire (also known as Beaded Greenwort), Marine Couch (*Sporobolus virginicus*) (Figure 3-9). Similar saltmarsh habitats were observed within the Styx River estuary system;
- Orange-clawed Fiddler Crabs (were observed in the estuarine mangrove intertidal zone (Figure 3-10).

Based on the above, the following observations can be made:

- The study area features high integrity estuarine and riparian habitat with relatively few anthropogenic influences affecting habitat quality or the ecology of these systems. Apart from natural bank erosion associated with tidal movement and recent flooding, the only other existing disturbances relate to some minor clearing of mangroves for boat access, vehicle access to parts of the saltmarsh and minor road and walkway construction associated with the Newport Conservation Area. Upstream agricultural landuse may also contribute to nutrient runoff and increased turbidity through erosion;
- The large tidal movement means that the Styx River estuary is well flushed. This should result in a short residence time of any eroded sediment and / or contaminants associated with the Styx River Coal Project within this estuary, but might mean that these have a greater potential to affect adjacent coastal areas, of Princess Charlotte Bay, which form part of the Great Barrier Reef Marine Park; and
- Receiving waters in the Styx River estuary are already turbid, but runoff from the Styx River Coal Project has the potential to further increase turbidity, which could result in the loss of seagrasses, if present. While seagrasses are not historically known to the study area based on Queensland Government Survey data collected between 1984 and 1988 (see section 3.3), given that a dugong was sighted in the study area, under the precautionary principal it should possibly be assumed that they could still be present.

Figure 3-1: Example of bank collapse in the lower Styx River estuary (Photo: ALS Water Science Group)

Figure 3-2: Example of near vertical drop off caused by severe bank scouring (Photo: ALS Water Science Group)

Figure 3-3: Turbid water in the coastal waters adjacent the Styx River (Photo: ALS Water Science Group)

Figure 3-4: Small tributary habitat at low tide (Photo: ALS Water Science Group)

Figure 3-5: Small-tributary habitat on the rising tide (20 minutes later) (Photo: ALS Water Science Group)

Figure 3-6: Grey Mangrove (Photo: ALS Water Science Group)

Figure 3-7: Red mangrove leaves (Photo: ALS Water Science Group)

Figure 3-8: Newport Conservation Area covering the saltmarsh adjacent the Waverley Creek estuary (Photo: ALS Water Science Group)

Figure 3-9: Samphire and Marine Couch in the Saltmarsh (Photo: ALS Water Science Group)

Figure 3-10: Orange-Clawed Fiddler Crabs

3.3 CHRISWEB Search Results

A review of the online DEEDI mapping database (CHRISWEB - http://chrisweb.dpi.qld.gov.au/website/ArcIMS_CHRIS/ -accessed 19/02/12) revealed that the historical seagrass mapping (1984-1988) showed no seagrass meadows or reefal areas within or immediately adjacent to the estuaries surveyed as part of this study. The nearest seagrass meadow / reefal area lies in coastal waters directly north of the estuary to the north of St Lawrence Creek (Figure 3-11). These habitats could potentially be exposed to mine runoff through northward long-shore drift of discharges from the Styx River, although this would need to be confirmed based on hydrological modelling and water quality monitoring. That sort of assessment was beyond the scope of this study.

The Styx River, Waverley Creek and St Lawrence Creek estuaries fall within a declared Fisheries Habitat Area (Figure 3-11), so there is potential for fisheries habitat values to be exposed to mine runoff / sediment mobilisation impacts associated with the Styx River Coal Project.

Beyond the mouth of the Styx River lies a GBRMPA 'green' zone (high conservation) protected area (Figure 3-11). Other protected areas include the Newport Conservation area on Waverley Creek, the Tooloombah Creek Conservation Park and several small protected areas on the coastline immediately south the Styx River (note: more up to date GBRMPA mapping shows that the boundary of the grean zone does not extend into the estuary south of the Styx River as shown in Figure 3-11, which based on CHRISWEB data). Of these, the Toolombah Creek Conservation Park and the GBRMPA 'green' zone adjacent the Styx River estuary are potentially exposed to mine runoff / sediment mobilisation impacts associated with the Styx Coal Project.

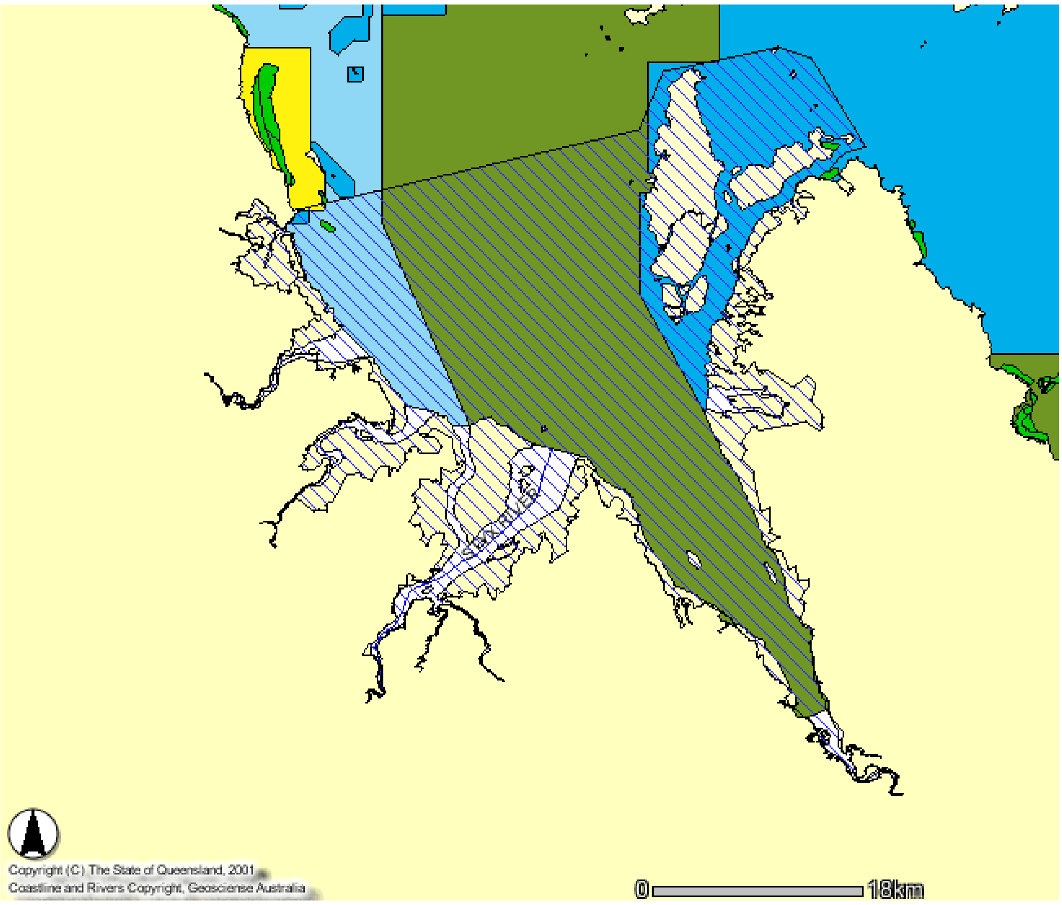


Figure 3-11: CHRISWEB interactive map download (www.chrisweb.qld.gov.au). Hashed areas represent a declared Fish Habitat Area, Olive Green area represents GBRMPA 'green zone' area, bright green areas indicate historically mapped seagrass beds and yellow area indicates reefal area.

3.4 Site-Specific Observations

Most sites sampled were adjacent to a mature mangrove canopy and there was evidence of mangrove recruitment in the understory (Table 3-1). At the STYX U/S site, juvenile mangroves actually dominated the mangrove stand, suggesting that mangroves were expanding into the depositional area of the intertidal zone at this site, STYX DS2 was atypical of the sites sampled in that it was adjacent to a mud island that was dominated by Tea Tree scrub rather than mangroves and both mature and juvenile mangroves each made up less than 20% of the adjacent habitat (Table 3-1).

Seagrass and saltmarsh habitat was not recorded directly adjacent to the sites sampled. As alluded to above, the water was very turbid at the time, so the detection of seagrass was difficult. If turbid conditions are routine, then seagrasses are unlikely to be abundant in the areas sampled. As mentioned in Section 3.3, seagrasses have not been recorded historically from the estuaries sampled. Salt marsh habitat is present in the upper reaches of the Styx River and Waverley Creek, but further inland from the estuarine sites sampled.

Other site-specific habitat observations in relation to substratum type, water quality and tidal regime / flows are presented in Section 3.6 and Section 3.7.

Table 3–1: Habitat features adjacent each site sampled during the 2011 pre-wet season estuarine survey.

Data	WELL	STYX_ US	STYX_ MID	STYX_ DS1	STYX_ DS2	WAV_ US	WAV_ DS	STL_ US	STL_ DS
Mature Mangroves	50-75%	10-50%	50-75%	50-75%	1-10%	50-75%	50-75%	50-75%	50-75%
Mangrove seedlings / recruits	10-50%	50-75%	10-50%	10-50%	1-10%	10-50%	10-50%	10-50%	10-50%
Salt Marsh	0	0	0	0	0	0	0	0	0
Seagrass	0	0	0	0	0	0	0	0	0
Other Vegetation	0	0	0	0	Mud Island with Tea Tree scrub - 50-75%	0	0	0	0

3.5 Estuarine Benthic Community

3.5.1 Abundance and Diversity

Benthic fauna abundance and diversity were low for the broader study area. Only 190 individuals belonging to 16 Order / Family level taxonomic units were recorded from 45 grab samples. Ten grab samples contained no benthic fauna at all. The highest mean number of taxa recorded for any reach was < 4.5, while the highest mean abundance recorded for any site was < 8 individuals. By comparison, Corfield (1999) collected 55 species from 280 samples from a sub-tropical NSW estuary over a two year period, with the highest number of species recorded from any one sampling occasion being 35. Mean number of species recorded over that study did not exceed 7 for any site, so are broadly in keeping with those recorded in this study (see Figure 3-12). However, the mean number of individuals recorded by Corfield (1999) for a given site exceeded 10, even for upper estuary sites and was as high as around 30 for lower estuary sites. That is well in excess of the abundances recorded from this study (see Figure 3-13). Results from the study by Saenger (1988) for the Calliope River, closer to the Styx River, showed that diversity and abundance was even higher than that recorded for the Richmond River by Corfield, while Sheaves et al (unpublished) collected 109, 048 individuals from three north Queensland estuaries and five sampling occasions. Note that a higher diversity is somewhat expected for larger systems such as the Richmond River and Calliope River, but results from this study still provide a preliminary indication of a depauperate benthic fauna community.

One possible explanation is that this was due to the floods associated with the 2010 / 11 wet season. The study by Corfield (1999) showed that summer floods resulted in reduced diversity and abundance, as did a study by Sheaves et al (unpublished) for three north Queensland estuaries. Corfield (1999) found that, in the absence of further freshwater flushes, recovery from such disturbances would take around 3 -6 months, while a similar time-scale for recovery was observed by Sheaves et al. (unpublished). As reported in ALS (2012), November and December 2010 and March 2011 recorded rainfall well above long –term averages for those months leading up to the post-wet season round of sampling, but apart from August 2011, rainfall levels in the few months leading up to the pre-wet season sampling were below the long-term average for those months. It is possible that the freshwater flush event in August 2011 set back the recovery process in relation to the 2010/11 wet season floods.

Another explanation is that all three estuaries are affected by large tidal ranges and strong water velocities associated with this. Even though the sites sampled were in more sheltered, depositional areas, tidal currents and water level changes were rapid. This level of temporal variability in habitat condition could make it difficult for many species to adapt in terms of their physiological tolerances and burrowing / feeding activity, leading to a reduced diversity and abundance. Further sampling in a period less affected by flooding may resolve this issue.

A third explanation for the low diversity observed is the lack of habitat heterogeneity. Diversity is said to increase with increased habitat heterogeneity (Deeley and Paling, 1999). The estuarine habitats sampled as part of this study were fairly consistent across sites in terms of sediment type (Table 3–8), fairly consistent within sites and lacked three dimensional structure such as seagrass, cobbles / boulders and shell beds. The contours of the substratum were also relatively smooth. Thus reduced habitat variability may well partly explain the low diversity of benthic fauna observed in this study.

One final explanation is that the sieve mesh size used for this study was not adequate for characterising the diversity and abundance of benthic fauna in the study area. A study by (Schlacher and Wooldridge 1996) found that recovery of macrobenthos was influenced by sieve size. 0.25mm mesh retained all benthic macrobenhic fauna adequately, but only 55% of numbers present were retained by a 0.5mm mesh sieve (the same used for this study). A mere 8% of numbers present were retained by a 1mm mesh sieve (the same used by Corfield, 1999). This too requires further investigation. The mesh size chosen for this study was slightly larger than the small of the two mesh sizes commonly used (0.5mm and 1mm). Smaller mesh sizes tend to capture a mix of juvenile and adult benthos, while larger mesh sizes capture predominantly adult benthos (Bachelet, 1990). Consequently, smaller mesh sizes are favoured over larger mesh sizes for population studies. Larger mesh sizes are considered better for community level assessment based on taxa present because adults are easier to identify than juveniles and. hence, misidentifications are less likely to compromise the data. In this case, the mesh size chosen provided a compromise in terms of assessing abundance (based on juvenile and adult benhos) and what taxa occur in the study area.

Abundance and diversity was lowest on average in the Styx River (Figure 3-12 and Figure 3-13). All estuaries recorded high abundance and diversity in the downstream reaches, which was expected based on information on other estuaries (though see Attrill, Ramsay et al. 1996). When estuaries were compared on a reach by reach basis, abundance and diversity were still higher in the Waverley and St Lawrence estuaries compared to the Styx River estuary (Figure 3-12 and Figure 3-13).

Shannon-Weiner diversity is a more reliable measure of diversity than number of taxa as it takes in the spread of abundance across the number of species recorded. Higher Shannon-Weiner diversity indicates that there was both a range of taxa recorded and that the number of individuals recorded was relatively evenly spread across those taxa. Assemblages affected to disturbance or pollution typically have a low Shannon-Weiner diversity even if high abundances are recorded, because that abundance is usually apportioned to opportunistic, generalist taxa able to tolerate such conditions. Mean Shannon-Weiner diversity results were broadly similar to the patterns observed for mean number of taxa and mean abundance (Figure 3-12to Figure 3-14), but note for example, that although STYX DS and WAV US recorded the same mean number of taxa, Shannon-Weiner diversity for the latter was higher because the spread of abundance across the number of taxa present was more even.

'Species' accumulation plots for the Styx River and for the two reference estuaries shows that there was a plateauing out of new 'species' with additional sampling effort (Figure 3-15 and Figure 3-16), suggesting that the sampling effort applied captured most of the benthic taxa likely to be present at those sites at the time (at least with respect to the less mobile infauna). This is not to say that additional taxa might be recorded with further temporal sampling effort.

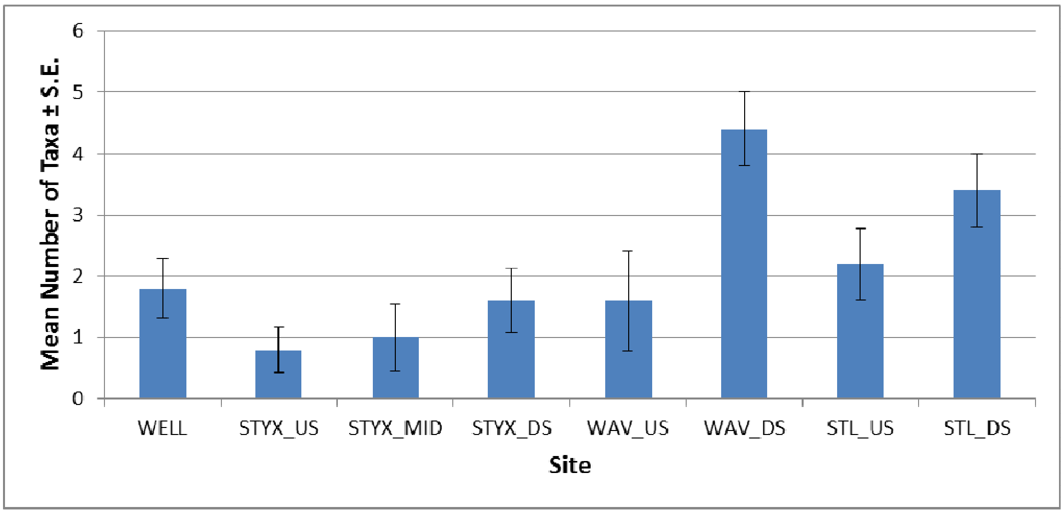


Figure 3-12: Variation in mean number of taxa between sites

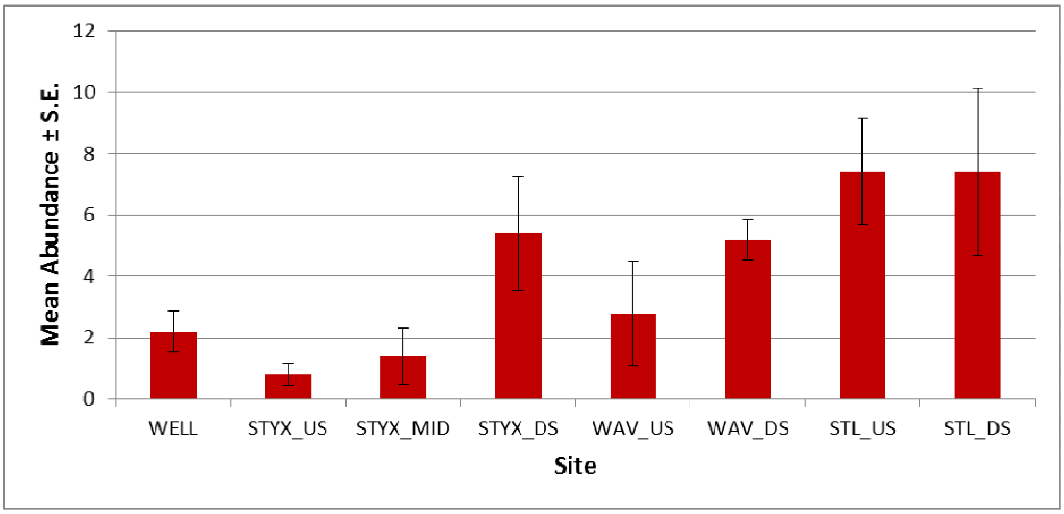


Figure 3-13: Variation in mean abundance between sites

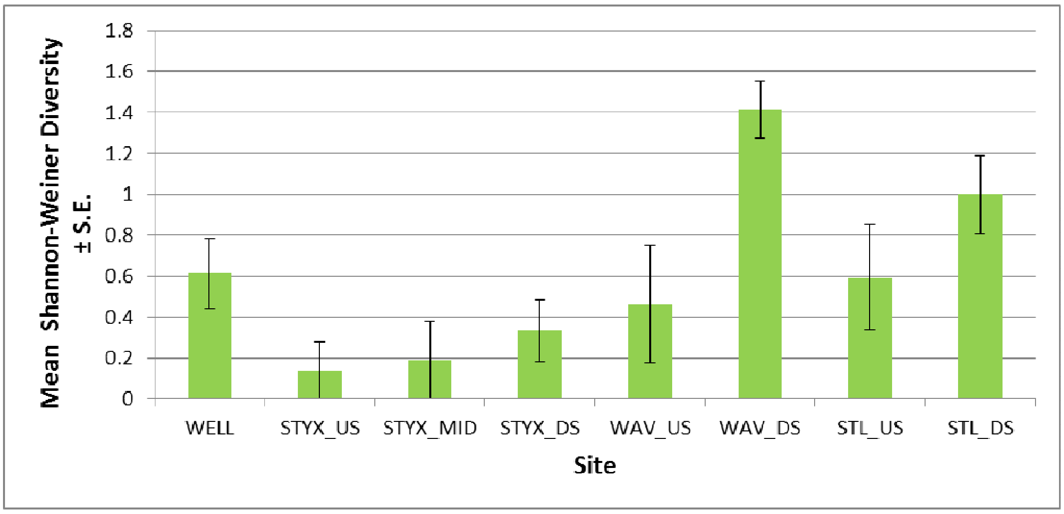


Figure 3-14: Variation in Shannon-Weiner diversity between sites

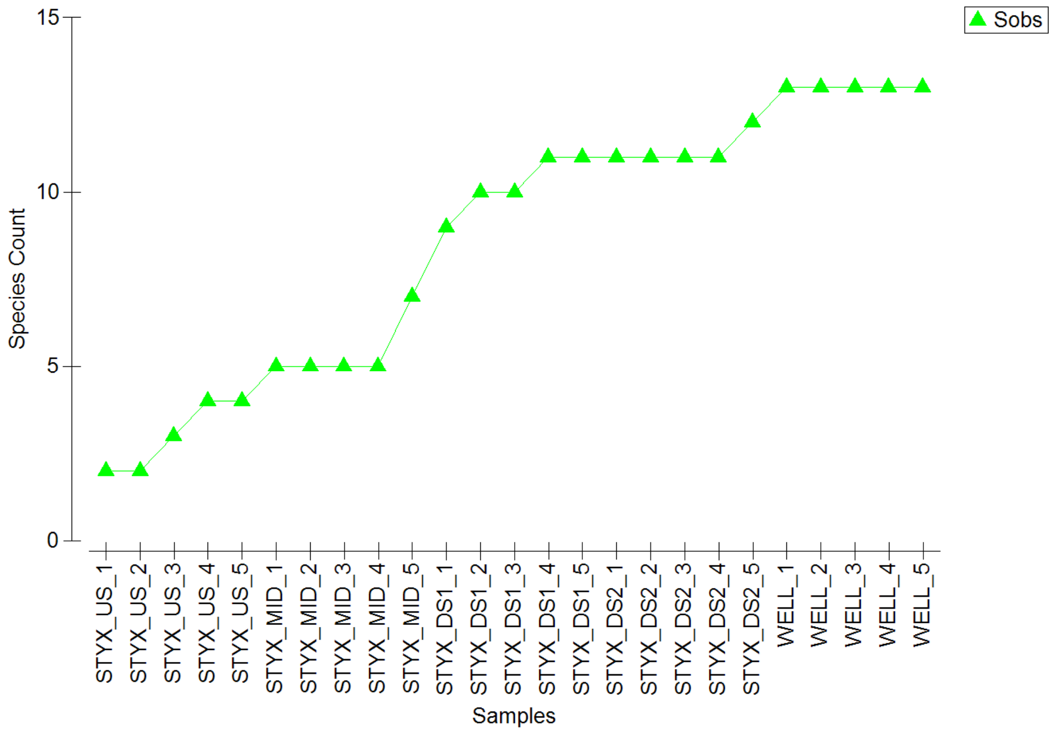


Figure 3-15: Species accumulation plot for Styx River catchment sites

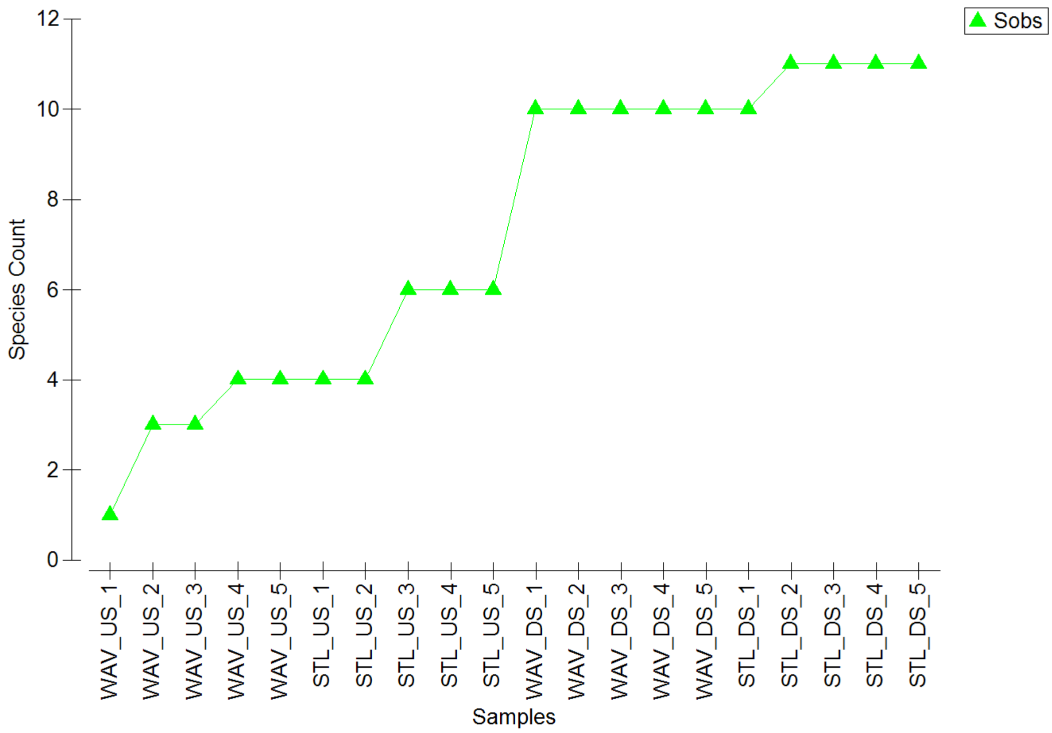


Figure 3-16: Species-accumulation curve for Waverley Creek and St Lawrence Creek sites

3.5.2 Composition

A total of 16 Order / Family level taxa were recorded during the 2011 pre-wet season estuarine survey. This included six polychaete worms, two species of amphipod shrimp, two other types of shrimp (one Seed Shrimp (Ostacroda) and one Green Shrimp (Carida)), two crabs, two bivalve molluscs (Pipis) and a Peanut Worm (Sipucula) (Table 3-2). These faunal groups are relatively widespread and common in estuarine environments, so much so that several taxa were readily identifiable to genus or species level (see Table 3-2and Figure 3-17).). Note that the sampling methods used would not have effectively sampled larger benthic species such as mud crabs or mobile epibenthic (surface- dwelling benthos) fauna. Moreover, these results are based on one round of sampling, so it is more than likely that a greater number of benthic taxa than this occur in the study area. With respect to the Styx Coal Project, however, infauna are most vulnerable to potential impacts of water pollution and sediment overburden, so the fact that data presented in this report concentrates on infauna is not of concern.

It is difficult to determine whether or not the benthic fauna captured in this study are truly representative of the Styx River main estuary. While most estuarine benthic fauna have a mobile larval stage, and tidal exchange in the study area would make it likely that the species present have a similar chance of colonising the main estuary as the tributary habitats, it is well established that differences in sediment type and current velocity have a strong bearing on benthic fauna composition (Gray 1974; De Wilde 1991; Connor, Hiscock et al. 1993). The main estuary was less of a depositional environment than the adjacent tributary habitat and featured stronger tidal currents and more consolidated sediment as a result of scouring. As such, it would likely be favoured by deep burrowing species (e.g. crabs and yabbies) in reaches lined with consolidated clay or sand and large, errant (mobile) benthic taxa (e.g. large polychaete worms and amphipod shrimp) in reaches with cobbles.

Apart from taxonomic classification, from which diversity information is derived, another relevant means of classifying these fauna is by functional feeding guild (FFG). This is of relevance to the Styx Coal Project as some FFGs are more sensitive to sediment overburden and increased turbidity than others. Suspension feeding taxa are most vulnerable to increased turbidity as suspended sediment particles can clog their gills or feeding apparatuses. Surface deposit feeders and gatherers are somewhat less affected by increased turbidity, but could still be affected through a reduction in benthic algal production as a food source. Any FFG that requires close association with the sediment-water interface will be more vulnerable to sediment overburden impacts than FFGs that involve no such association (e.g. sub-surface deposit feeding) or major burrow construction and irrigation (e.g. crab and yabby burrows). Generalist taxa with more than one FFG mode will also be less vulnerable to increased turbidity as they are capable of switching feeding modes based on the conditions. Predatory species would be potentially affected by any change in the abundance of other benthic fauna species.

For this study, FFG information for the taxa recorded was obtained by information listed in Beesley et al (1998), Beesley et al (2000) and from various sources on the internet. Information presented in Table 3-2 shows that only the bivalve, *Siliqua tenerior,* has an exclusively suspension feeding mode. Taxa with this feeding mode are potentially vulnerable to increased suspended sediment levels as this can lead to the clogging of their feeding apparatuses. Other taxa listed with a suspension feeding mode are either known to have alternating feeding modes (e.g. Tellinidae) or represent families for which various FFGs have been recorded among the constituent species (e.g. Nereididae, Aoridae). It is possible that the species from those families represented in the study area are exclusive suspension feeders, but this cannot be assumed. Based on the high turbidity levels present in the estuaries sampled, it would be unlikely. Of the taxa recorded, apart from the sub-surface deposit feeding worms (capitellids) and amphipods (Urohaustoriidae) and the two crab taxa (Grapsidae and Ocypodidae), most have a FFG that requires a close association with the sediment-water interface, which makes them potentially vulnerable to sediment overburden impacts. Capitellids are a known opportunistic group that can proliferate after disturbance and pollution events (Grassle and Grassle 1974; Heip 1995). As they feed indiscriminately on organic matter and bacteria buried in the sediment profile and can withstand anoxic conditions (Fauchald and Jumars 1979, Grassle, 1974 #237; Heip 1995), they would be expected to flourish or remain unimpacted by increased turbidity or sediment overburden (so long as the overburden was not heavily contaminated by toxicants). Urohaustoriid amphipods tend to undertake sub-surface deposit feeding in the interstitial spaces between sand grains. While they are unlikely to be impacted by increased turbidity, they may still be vulnerable to sediment overburden impacts, particularly if the overburden sediment is made of fine particles and those particles clog interstitial spaces. The two crab taxa recorded are both burrowing species. These crabs feed on leaf litter and are regarded as 'keystone' taxa within estuarine ecosystems for their role in recycling nutrients through that process and also for the oxidising of the sediment by virtue of the links between the sediment-water interface created by their burrows (Frusher et al 1994; Queensland Museum, 2007). The greater water exchange in the burrows of these species would also make them less vulnerable to other water pollution impacts as the burrow water would be regularly flushed with each tide cycle.

Table 3-2: Taxa recorded during the 2011 pre-wet season survey and information on the feeding modes of those taxa

Phylum	Class/order	Family	OTU	FFG
Annelida	Polychaeta	Capitellidae	Capitellidae	SSD
Annelida	Polychaeta	Glyceridae	*Glycera* sp.	P
Annelida	Polychaeta	Magelonidae	*Magelona dakini*	SD
Annelida	Polychaeta	Nephtyidae	Nephtyidae	P
Annelida	Polychaeta	Nereididae	Nereididae	SD/G/SF
Annelida	Polychaeta	Orbiniidae	Orbiniidae	SD
Arthropoda/ Crustacea	Amphipoda	Aoridae	Aoridae	SD/G/SF
Arthropoda/ Crustacea	Amphipoda	Urohaustoriidae	Urohaustoriidae	SSD
Arthropoda/ Crustacea	Brachyura	Grapsidae	Grapsidae	LF
Arthropoda/ Crustacea	Brachyura	Ocypodidae	Ocypodidae	LF
Arthropoda/ Crustacea	Carida	Pasiphaeoidae	Pasiphaeoidae	G
Arthropoda/ Crustacea	Ostracoda	Ostracoda	Ostracoda	G
Mollusca	Bivalvia	Pharidae	*Siliqua tenerior*	SF
Mollusca	Bivalvia	Tellinidae	Tellinidae	SD/SF
Nemertea	Nemertea	Nemertea	Nemertea	P
Sipuncula	Sipuncula	Sipuncula	Sipuncula	SD/SSD/SF

SD –Surface Deposit Feeder

SSD –Sub-surface Deposit Feeder

P – Predator

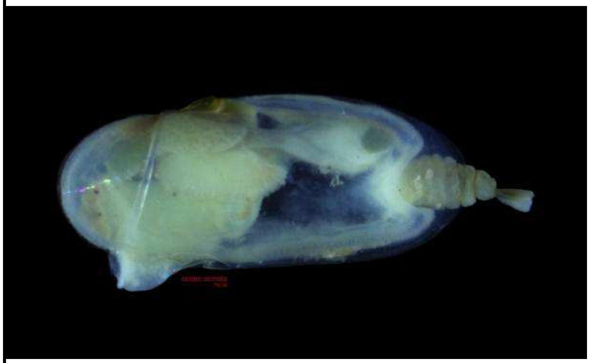
G –Gatherer/Grazer

SF-Suspension Feeder

LF –Leaf litter Feeder

a)

b)



c)

Figure 3-17: **Images of estuarine benthic fauna collected during the 2011 pre-wet season estuarine survey: a) *Magelona dakini*, b) Nephtyidae and c) *Siliqua tenerior*. (Photos: Benthic Australia)**

The benthic fauna collected were compared between estuaries and between reaches not affected by and potentially affected by the Styx Coal Project based on multivariate data analyses. Figure 3-18 shows that, while there were no distinct groupings according to estuary, samples from the Styx River tended to concentrate towards the middle and right hand side of the NMDS plot, whereas those from Waverley Creek and St Lawrence Creek tended to concentrate towards the middle and left hand side of the plot. The results of ANOSIM showed that there was significant variation in benthic fauna composition between estuaries ($R = 0.144$, $p = 0.008$) and when broken down, this was due to differences between fauna from the Styx River catchment (including Wellington Creek) and fauna from Waverley Creek and St Lawrence Creek (which shared similar benthic fauna) (Table 3-3). Not surprisingly, Wellington Creek and Styx River sites were not significantly different in terms of benthic fauna composition (Table 3-3). This indicates that the two 'reference' estuaries may not be adequate surrogates for the Styx River estuary, though this remains to be determined based on further sampling. It should be noted that between-estuary comparisons obscure the fact that benthic fauna composition can vary between estuarine reaches. Comparisons between 'potentially impacted' reaches and equivalent 'non-impacted' reaches provide a more meaningful way of assessing this. Such comparisons were attempted as part of this study and results are outlined below.

When comparisons between 'potentially impacted' reaches and equivalent 'non-impacted' reaches were done using data from this study, the NMDS plot shows that all Styx – impacted reaches were concentrated towards the right hand side of the plot and all Styx-reference sites were concentrated towards the left hand side of the plot (Figure 3-19). ANOSIM results confirm that there were significant differences in benthic fauna composition among the defined reaches and that differences between reference and impact site benthic fauna for equivalent reaches were a contributor to this (Table 3-4).

Based on the combination of the above data, the ongoing use of Waverley Creek and St Lawrence Creek as reference systems for the Styx River estuary is potentially questionable. However, a more thorough assessment of this through additional sampling is required to determine whether or not this is the case. Should this indeed prove to be the case, the large un-named estuary / embayment to the south of the Styx River could be explored as an alternate reference system for the Styx River. Results from this study do, however, indicate that Wellington Creek would be a suitable reference system for the Styx River.

It should also be noted that due to the low abundance and diversity of benthic fauna captured in this study, differences between estuaries or key reaches are likely to have been magnified by small differences in the relative abundance and presence/absence of certain taxa. At other times, benthic fauna abundance and diversity in the study area may be greater, which may in turn, result in the benthic fauna being more statistically comparable between these estuaries / key reaches.

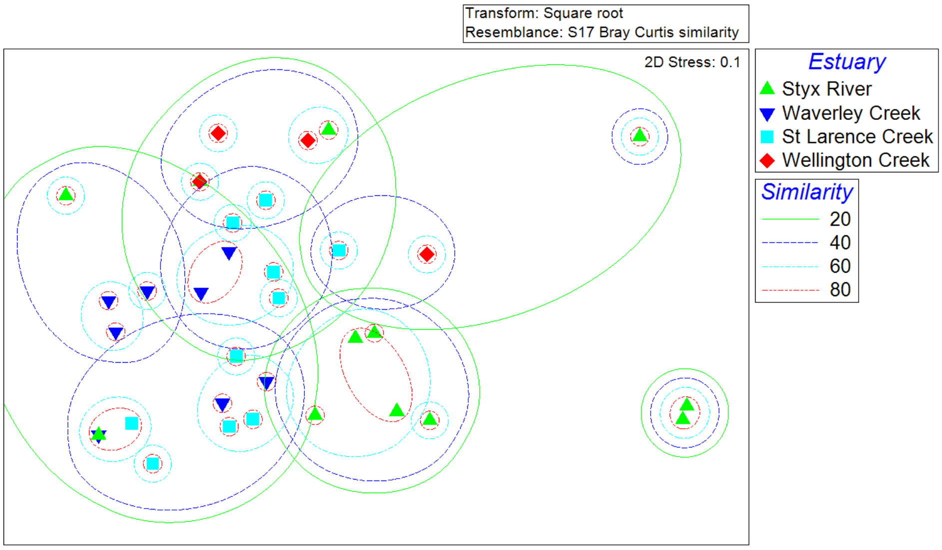


Figure 3-18: NMDS plot showing variation in the benthic fauna composition among samples according to estuary sampled

Table 3-3: ANOSIM Pair-wise test results comparing benthic fauna composition between estuaries. Significant differences are highlighted in red text.

Groups	R value	P	Possible Permutations	Actual Permutations	Number ≥ Observed
Styx River, Waverley Creek	0.167	0. 035	125970	999	34
Styx River, St Lawrence Creek	0.118	0.059	646646	999	58
Styx River, Wellington Creek	-0.005	0.493	1820	999	492
Waverley Creek, St Lawrence Creek	0.049	0.248	43758	999	247
Waverley Creek, Wellington Creek	0.59	0.002	495	495	1
St Lawrence Creek, Wellington Creek	0.279	0.022	1001	999	21

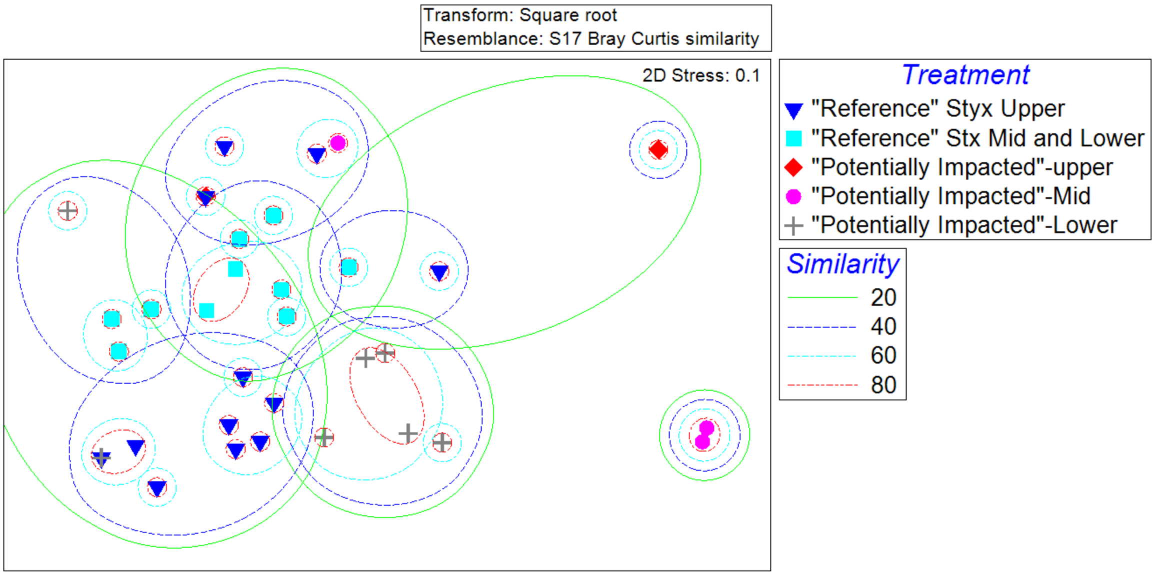


Figure 3-19: NMDS plot showing variation in the benthic fauna composition among samples according to estuary sampled

Groups	R value	P	Possible Permutations	Actual Permutations	Number ≥ Observed
Potentially Impacted-upper, "Reference" Styx Upper	0.373	0.044	91	91	4
Potentially Impacted-Mid, "Reference" Styx Mid and Lower	0.69	0.003	286	286	1
Potentially Impacted-Lower, "Reference" Styx Mid and Lower	0.463	0.002	19448	999	1

Results of SIMPER analysis show that average similarity was low for all estuaries sampled and, not surprisingly, lowest for the Styx River estuary, for which sampling covered a greater extent of the estuarine gradient. Low average similarity among estuarine samples is not surprising as estuarine benthos are notoriously patchily distributed (Morrisey, Howitt et al. 1992), but again, the low abundance and diversity of the benthic community sampled in this case just exaggerates the low within-estuary or within-reach similarity.

SIMPER results show that differences between the Styx River estuary and the two 'reference' estuaries, were due to the presence of Ostracoda in the Styx River samples but not in the Waverley Creek and St Lawrence Creek samples and the presence of *Magelona dakini*, Ocypodidae, Aoridae, Sipuncula and Nemertea in Waverley Creek and St Lawrence Creek samples and not Styx River samples. Wellington Creek featured Tellinidae which were not recorded from other estuaries (Table 3-4). Between-estuary differences are unlikely to have been due to differences in sediment particle size as most sites sampled were a mix of sand and silt-clay (predominantly the latter) (Table 3-8), but Waverley Creek and St Lawrence Creek had slightly higher levels of organic carbon in the sediment than Styx River (Table 3-10), which may account for such differences. Whitlatch (1980) and Gaston (1987) found positive correlations between benthic species richness and organic carbon, although too much organic carbon through eutrophication can lead to a decrease in diversity (Heip 1995).

Table 3-4: Results of SIMPER analysis showing the level of similarity among samples collected from the same estuary and the taxa that are most representative of the estuaries sampled

Group	**SIMPER RESULTS**				
Styx River	**Average similarity: 14.79**				
Species	**Av. Abundance**	**Av. Similarity**	**Sim/SD**	**Contribution%**	**Cumulative.%**
Nephtyidae	1.12	7.82	0.41	52.9	52.9
Ostracoda	0.25	2.35	0.18	15.91	68.81
Glycera sp.	0.33	2.2	0.3	14.88	83.69
Siliqua tenerior	0.51	1.99	0.31	13.48	97.17
Waverley Creek	**Average similarity: 38.95**				
Species	**Av. Abundance**	**Av. Similarity**	**Sim/SD**	**Contribution%**	**Cumulative.%**
Magelona dakini	1.03	21.15	1.44	54.31	54.31
Ocypodidae	0.5	4.19	0.51	10.77	65.08
Aoridae	0.55	4.13	0.51	10.61	75.68
Sipuncula	0.43	2.75	0.34	7.06	82.74
Glycera sp.	0.43	2.21	0.34	5.68	88.42
Nemertea	0.38	1.92	0.34	4.92	93.34
St Lawrence Creek	**Average similarity: 28.46**				
Species	**Av. Abundance**	**Av. Similarity**	**Sim/SD**	**Contribution%**	**Cumulative.%**
Magelona dakini	1.04	10.49	0.51	36.87	36.87
Siliqua tenerior	1.08	8.6	0.68	30.22	67.09
Glycera sp.	0.85	6.55	0.49	23.02	90.12
Wellington Creek	**Average similarity: 29.16**				
Species	**Av. Abundance**	**Av. Similarity**	**Sim/SD**	**Contribution%**	**Cumulative.%**
Glycera sp.	0.75	23.44	0.91	80.38	80.38
Tellinidae	0.6	5.72	0.41	19.62	100

3.6 Water Quality

3.6.1 *In Situ* Water Quality Measurements

Instantaneous water quality readings taken during the 2011 pre-wet season estuarine survey reinforce how turbid the water in the estuaries was. Turbidity levels were routinely above 150 NTU, well above the Queensland Water Quality Guidelines for Central Queensland estuaries (of ≤ 40km in length). EC levels at all sites were characteristic of brackish-marine water. pH levels recorded were all within guideline ranges. Dissolved oxygen levels in the Styx River, Wellington Creek and St Lawrence Creek were lower than the guideline range, but given that readings were only representative of a single point in the diel photosynthesis-respiration cycle and tidal cycle, it is not to say that those systems are potentially impacted through organic enrichment. Indeed, given the remote status of the study area and the general lack of extensive urban and agricultural surrounding landuse, this seems unlikely.

In terms of observations recorded at the time, surface foam was observed at some sites during the incoming tide. This is probably due to the mixing of biofilm.

Table 3-5: *In situ* water quality measurements and comparison with the relevant QWQG (2009) recommended ranges. Values in red indicate readings outside the recommended range.

Data	GUIDELINE LEVEL		WELL	STYX_US	STYX_MID	STYX_DS1	STYX_DS2	WAV_US	WAV_DS	STL_US	STL_DS
	Upper Estuary	Mid-Lower Estuary									
Sample Depth			1	1	0.2	0.2	0.1	3	3	2	3
Water Temperature (°C)	N/A	N/A	29.35	29.6	29.17	28.07	28.1	30.87	30.56	29.55	31.8
Conductivity (µS/cm)	N/A	N/A	61,222	58,522	60,330	56,778	46,755	61,681	59,910	58,548	61,226
pH	7.0-8.4	7.0-8.4	8.09	8.15	7.94	8.11	7.15	8.14	8.22	8.01	8.23
DO (mg/L)	N/A	N/A	3.99	5.16	4.17	5.04	4.15	4.55	5.55	4.15	3.55
DO (% Sat.)	70-100	85-100	65.8	82.5	67	78.5	66.1	75.2	90.5	66.3	79.1
Turbidity (NTU)	25	8	309	321	252	178	125	258	151	369	91
Date Collected			26/11/11	26/11/11	26/11/11	26/11/11	26/11/11	27/11/11	27/11/11	27/11/11	27/11/11
Time Collected (24h)			1200	1345	1100	1415	1000	1305	1400	10.15	1115
Waves			Small (<0.3m)	Small (<0.3m)	Small (<0.3m)	Small (<0.3m)	Small (<0.3m)	Small (<0.3m)	Small (<0.3m)	Small (<0.3m)	Small (<0.3m)
Tide Level			High	High	Mid	High	Low	High	High	Low	Mid
Tidal Direction			Slack Tide	Going Out	Coming in	Going Out	Coming In	Slack Tide	Going Out	Coming in	Coming in
Other Comments / Surface Condition			Some foaming observed	Normal	Some foaming observed	Some foaming observed	Incoming flow very fast	Normal	Only slow current movemen t	Tidal Currents strong. Foaming observed	Still coming in, but near slack tide

3.6.2 Analytical Water Quality Testing Results

Water quality analysis results showed that most metals measured were at concentrations below the limit of reporting (LOR) (Table 3-6). Exceptions to this included Aluminium, Chromium, Manganese, Molybdenum, Boron and Iron. Of these, guideline ranges only exist for Aluminium, Manganese and Boron. Total Aluminium and Boron concentrations were above the guideline ranges for these parameters at all sites, however dissolved Aluminium concentrations were below LOR level at all sites, indicating that the Aluminium present was all in non-bioavailable form. The same was not true of Boron, which recorded dissolved concentrations roughly equal to total concentrations. Manganese concentrations were within guideline limits. It should be noted that the LORs used for Cadmium, Copper, Nickel, Lead, Selenium and Silver were all above the respective guideline levels and, hence, it was not possible to assess compliance with regards to those guideline levels. The relatively high LORs achieved were due to interference in the salt water matrix, which is a common issue with analysing metals from marine waters. At this stage, however, results suggest that there are no major contamination issues relating to these metals in the estuaries studied.

By contrast, nutrient results suggest that most sites were slightly enriched in terms of ammonia and nitrogenous compounds (total N) and moderately enriched in terms of phosphorous (Table 3-7). While soluble reactive phosphorus results need to be regarded with caution given the holding time breaches for the samples, it appears that soluble reactive phosphorous levels for the Styx River catchment in particular are quite high, implying that this catchment has high concentrations of phosphorous in bioavailable form, even prior to any development associated with the Styx Coal Project. While the sources of phosphorous in this catchment are unknown, they possibly relate to agricultural runoff or sediment erosion. Meltzer et al (2008) noted extensive erosion in the upper Styx River catchment associated with grazing and vegetation clearing activities. Uncontrolled runoff from excavations near waterways and the release of mine-worked water from the mine site during the operations phase could potentially exacerbate phosphorus levels in the Styx River potentially resulting in detrimental effects to the estuarine benthic community. It should be noted, however, that nitrogen is the main limiting nutrient in estuarine and marine systems (Harris, 1994 *In* Deeley and Paling, 1999). Hence, the potential release of nitrogenous compounds associated with the Styx Coal Project would be more of a concern from a eutrophication perspective. It should also be noted that nitrogen and phosphorus are essential nutrients for seagrass and benthic algal growth, but light level sets the upper limit for the productivity of these flora and in the turbid estuarine systems studied, light would be expected to limit their growth for much of the time, regardless of nutrient availability.

While not shown in the main report, analytical results showed that petroleum hydrocarbons (TPH, PAH and BTEX) were all below LOR (see Appendix B).

Table 3-6: Analytical Water Quality Results with respect to metals for the 2011 pre-wet season estuarine survey. Measurements outside the ANZECC &ARMCANZ (2000) recommended range based on 95% ecosystem-level protection for slightly to moderately disturbed systems. Values in red indicate readings outside the recommended range.

Analyte grouping/Analyte	Units	LOR	Sample date:	29/11/11	29/11/11	29/11/11	29/11/11	29/11/11	29/11/11	29/11/11	29/11/11	29/11/11
			Site	WELL	Styx_US	Styx_ Mid	Styx_DS1	Styx_DS2	WAV_US	WAV_DS	STL_US	STL_DS
			Guideline Range									
Total Metals												
Aluminium	mg/L	0.01	0.055	5.88	2.26	10.7	1.2	2.11	2.46	3.53	2.93	0.89
Arsenic	mg/L	0.001		<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050
Cadmium	mg/L	0.0001	0.0002	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050
Chromium	mg/L	0.001		0.019	0.012	0.027	0.012	0.013	0.014	0.014	0.015	<0.010
Copper	mg/L	0.001	0.0014	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050
Cobalt	mg/L	0.001		<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010
Nickel	mg/L	0.001	0.011	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050
Lead	mg/L	0.001	0.0034	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010
Zinc	mg/L	0.005	0.008	<0.250	<0.250	<0.250	<0.250	<0.250	<0.250	<0.250	<0.250	<0.250
Manganese	mg/L	0.001	1.9	0.152	0.172	0.302	0.1	0.175	0.164	0.085	0.203	0.059
Molybdenum	mg/L	0.001		0.012	0.01	0.012	0.011	0.014	0.014	0.013	0.01	0.01
Selenium	mg/L	0.01	0.011	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10
Silver	mg/L	0.001	0.00005	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010
Uranium	mg/L	0.001		<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010
Vanadium	mg/L	0.01		<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10
Boron	mg/L	0.05	0.37	3.96	4.18	4.22	4.23	4.16	4.11	4.02	4.18	3.97
Iron	mg/L	0.05		8.67	4.25	15.4	2.87	4.28	4.86	5.54	5.44	2.4
Mercury	mg/L	0.0001		<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001
Dissolved Metals												

			Sample date:	29/11/11	29/11/11	29/11/11	29/11/11	29/11/11	29/11/11	29/11/11	29/11/11	29/11/11
			Site	WELL	Styx_US	Styx_ Mid	Styx_DS1	Styx_DS2	WAV_US	WAV_DS	STL_US	STL_DS
Analyte grouping/Analyte	Units	LOR	Guideline Range									
Aluminium	mg/L	0.01	0.055	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50
Arsenic	mg/L	0.001		<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050
Cadmium	mg/L	0.0001	0.0002	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050
Chromium	mg/L	0.001		<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010
Copper	mg/L	0.001	0.0014	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050
Cobalt	mg/L	0.001		<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010
Nickel	mg/L	0.001	0.011	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050
Lead	mg/L	0.001	0.0034	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010
Zinc	mg/L	0.005	0.008	<0.250	<0.250	<0.250	<0.250	<0.250	<0.250	<0.250	<0.250	<0.250
Manganese	mg/L	0.001	1.9	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010
Molybdenum	mg/L	0.001		0.012	0.012	0.012	0.014	<0.010	<0.010	0.013	<0.010	0.012
Selenium	mg/L	0.01	0.011	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10
Silver	mg/L	0.001		<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010
Uranium	mg/L	0.001		<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010
Vanadium	mg/L	0.01	0.00005	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10
Boron	mg/L	0.05	0.37	4.18	4.53	4.41	4.32	4.36	4.19	4.2	4.08	4.14
Iron	mg/L	0.05		0.89	<0.50	0.58	0.66	0.72	0.73	0.8	0.82	0.83
Mercury	mg/L	0.0001		<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001

Table 3-7: Analytical Water Quality Results with respect to nutrients and suspended solids for the 2011 pre-wet season estuarine survey. Measurements outside the QWQG (2009) recommended range for Central Queensland estuarine waters. Values in red indicate readings outside the recommended range.

			Sample date:		**29/11/11**	**29/11/11**	**29/11/11**	**29/11/11**	**29/11/11**	**29/11/11**	**29/11/11**	**29/11/11**	**29/11/11**
			Site		**WELL**	**Styx_US**	**Styx_ Mid**	**Styx_DS1**	**Styx_DS2**	**WAV_US**	**WAV_DS**	**STL_US**	**STL_DS**
			Guideline Range										
Analyte grouping/Analyte	**Units**	**LOR**	Upper	Mid-Lower									
Nutrients													
Ammonia as N	mg/L	0.01	0.03	0.01	0.05	0.06	0.06	0.07	0.05	0.05	0.05	0.06	0.03
Nitrite as N	mg/L	0.01			<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Nitrate as N	mg/L	0.01			0.01	0.01	0.01	0.02	0.01	0.01	0.01	<0.01	<0.01
Nitrite + Nitrate as N	mg/L	0.01	0.015	0.1	0.01	0.01	0.01	0.02	0.01	0.01	0.01	<0.01	<0.01
Total Kjeldahl Nitrogen as N	mg/L	0.1			<0.5	0.7	0.9	0.6	0.7	0.8	0.5	0.8	<0.5
Total Nitrogen as N	mg/L	0.1	0.45	0.3	<0.5	0.7	0.9	0.6	0.7	0.8	0.5	0.8	<0.5
Total Phosphorus as P	mg/L	0.01	0.04	0.025	0.17	0.27	<0.05	0.11	0.08	<0.05	<0.05	0.25	<0.05
Reactive Phosphorus as P	mg/L	0.01	0.01	0.008	0.02	0.02	0.02	0.03	0.01	0.01	<0.01	<0.01	<0.01
Physical													
Suspended Solids (SS)	mg/L	5	25	20	256	316	621	231	349	359	204	380	175

3.7 Sediment Quality

3.7.1 Physical Properties

The benthic habitat at all sites sampled was a mix of sand, silt and clay (Table 3–8) and apart from the STYX US and STYX DS2 site, the relative contributions of these sediment size particle categories was similar across the study area (Figure 3-20). Sediment colour was also broadly similar, with most sites having grey coloured sediment, interspersed with oxidised brown sediment, anoxic (reducing) black sediment, or a combination of these. In terms of texture, sediment of the Styx River catchment was slightly gritty sand / silt, whereas sediments of Waverley Creek and St Lawrence Creek were predominantly soft, fine-medium malleable clay, except for STL DS, which had harder clay. No distinct redocline (black anoxic layer) was visible in the sediment profile, but this was possibly due to the mixing of the sediment sample when placed in the tray. Some anoxic black patches were visible at certain sites, indicating patches of anoxic sediment that probably reflect small areas of the sediment profile not worked on by burrowing infauna in which organic matter was being decomposed by bacteria. Further, no odours were recorded for any of the sediment samples suggesting that they were not organically enriched.

3.7.2 Analytical Sediment Quality Results

Metal concentrations in estuarine waters may not reliably indicate the magnitude of inputs, as they are readily lost from the water column through biological uptake and adsorption to suspended particles, which settle onto the estuarine benthic habitat (Deeley and Paling, 1999). For that reason, and because benthic organisms reside within the sediment where metals settle, sediment samples were taken at each site in addition to water quality samples and tested for various metal concentrations.

Results from the 2011 pre-wet season estuarine survey indicated that the dominant metal constituents of the sediment profile were aluminium, iron and to a lesser extent, Manganese. Aluminium and Iron were present at concentrations of tens of thousands of mg/kg (Table 3–9). For metals with specified guideline ranges, none were recorded at concentrations exceeding Interim Sediment Quality Guideline low range (ISQG-low) concentrations (Table 3–9), indicating that those metals were present in low concentrations and that the associated risk of ecological effects for those metals was <10%. There were no major differences in metal concentrations between sites, except for STYX US, which had the lowest concentrations of metals of all sites (Table 3–9). This was not surprising given that this site had a much higher ratio of sand to silt / clay (Figure 3-20) compared to other sites and metals bind preferentially to smaller sediment particles.

It should be noted that concentrations of metals in the sediment partly reflects the source and magnitude of supply and partly the degree to which resident benthic biota rework and bio-irrigate the sediment profile through their burrowing activities. Benthic biota are well known for maintaining metals at low concentrations in sediments through this process (Atkinson et al, 2007), particularly larger burrowing taxa. In this case, apart from crabs, most of the benthic biota captured were small, non–burrow-constructing taxa. Moreover, the density of benthic fauna recorded was low. Therefore, the contribution of sediment bioturbation to the low metal concentrations recorded was probably minimal.

In terms of nutrients and major ions results, sulphate was present in relatively high concentrations (Table 3–10). This is not surprising given that many of the metals present in the sediment would be in the form of non-bioavailable precipitate as metal sulphates. There was a tendency for slightly higher levels of total organic carbon, total nitrogen and total phosphorous on average in Waverley Creek and St Lawrence Creek compared to the Styx River catchment (Table 3–10). This too can be explained partly by differences in sediment particle size distribution. Waverley Creek and St Lawrence Creek sites had among the highest ratio of silt/clay to sand of the sites monitored and, as with metals, nutrients bind preferentially to smaller sediment particles. The higher ratio of silt/clay to sand at the Waverley Creek and St Lawrence Creek sites is also a sign of those sites being depositional areas, where organic carbon is more likely to accumulate, hence the higher organic carbon content in the sediment samples from these estuaries.

Sediment particle size distribution data presented in Figure 3-20 also show that cobbles and gravel fractions were not present at any of the sites monitored, which is not uncommon in estuarine environments.

Table 3-8: Physical characteristics of sediment sampled as part of the 2011 pre-wet season estuarine survey.

Data	WELL	STYX_US	STYX_MID	STYX_DS1	STYX_DS2	WAV_US	WAV_DS	STL_US	STL_DS
Dominant PSD Fraction	Silt / Clay- Sand	Sand - Silt/Clay	Sand - Silt/Clay	Sand - Silt/Clay	Sand - Silt/Clay	Silt /Clay - Sand	Silt /Clay - Sand	Silt /Clay - Sand	Silt /Clay - Sand
Redocline Visible	No	No	No	No	No	No	No	No	No
Colour	Light grey/ black	Light grey	Light grey / brown	Light grey/ black	Grey / brown	Light grey /brown/black	Light grey /brown/black	Light grey /brown/black	Grey / brown
Texture	Silt / Sand	Sand /Silt	Sand/ Silt	Sand /Silt	Sand / Silt	Soft fine clay	Soft fine clay	Fine to medium clay-soft and malleable	Clay, but not soft
Odour	None	None	None	None	None	None	None	None	None

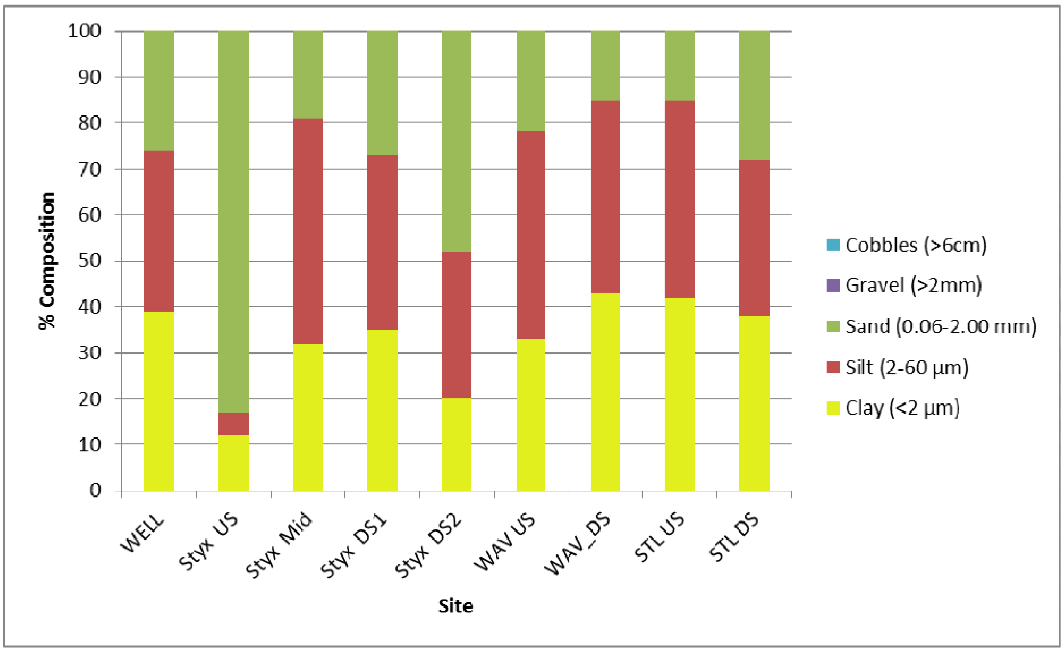


Figure 3-20: Analytical Particle Size Distribution (PSD) results for the 2011 pre-wet season estuarine survey

Table 3-9: Analytical Sediment Quality Metal Results and Comparisons with ISQG high and low levels as per ANZECC & ARMCANZ (2000).

Analyte	Units	LOR	ISQG -low	ISQG -high	WELL	Styx US	Styx Mid	Styx DS1	Styx DS2	WAV US	WAV_DS	STL US	STL DS
Aluminium	mg/kg	50			16000	4590	13800	15300	10000	15600	19900	18700	15000
Iron	mg/kg	50			18500	6630	15500	17000	11100	17400	20500	20000	16300
Arsenic	mg/kg	0.1			4.2	2.2	4.9	4.3	3	5.9	6.6	5.6	4.6
Selenium	mg/kg	1			<1	<1	<1	<1	<1	<1	<1	<1	<1
Silver	mg/kg	0.1	1	3.7	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Cadmium	mg/kg	0.1	1.5	10	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Cobalt	mg/kg	0.1			7.3	3.6	5.9	6.5	4.5	6.8	8	7.5	5.8
Chromium	mg/kg	0.1	80	370	24.4	8.2	21.4	24.5	15.2	25.3	32.2	28.4	23.5
Copper	mg/kg	0.1	65	270	8.6	3	6.4	6.7	4.1	6.2	7.5	8.2	5.9
Boron	mg/kg	0.1			36.6	33.8	33.8	37.8	24	35.1	35.9	41.5	35.2
Manganese	mg/kg	0.1			380	479	379	335	322	421	353	342	261
Molybdenum	mg/kg	0.1			0.3	0.2	0.3	0.3	0.3	0.4	0.4	0.4	0.4
Nickel	mg/kg	0.1	21	52	12.7	3.6	10.5	11.8	7.4	12	15.8	14.1	11
Lead	mg/kg	0.1	50	220	7.8	3.6	6.7	7.2	5	7.2	8	8.4	6.7
Uranium	mg/kg	0.1			0.7	0.6	0.7	0.7	0.6	0.8	0.8	0.9	0.8
Zinc	mg/kg	0.1	200	410	24.2	7.1	19.8	21.9	13.1	22.2	28.8	26.5	20.2
Vanadium	mg/kg	1			29	9	22	24	16	25	29	28	23
Mercury	mg/kg	0.1	0.15	1	<0.1	<0.1	0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1

Table 3-10: Analytical Sediment Quality Nutrient and Major Ion Results

Analyte	Unit	LOR	WELL	Styx US	Styx Mid	Styx DS1	Styx DS2	WAV US	WAV_DS	STL US	STL DS
Sulphate as SO_4	mg/kg	100	3870	5900	5400	4450	3650	3190	5080	4230	4820
Sulphur - Total as S (LECO)	%	0.01	0.22	0.15	0.19	0.21	0.1	0.24	0.21	0.22	0.18
Sulphide as S	%	0.01	0.09	<0.01	0.01	0.06	<0.01	0.13	0.04	0.08	0.02
Total Organic Carbon	%	0.02	0.52	0.09	0.35	0.42	0.22	0.52	0.47	0.44	0.58
Ammonia as N	mg/kg	20	<20	<20	<20	<20	<20	20	<20	<20	<20
Nitrite as N (Sol.)	mg/kg	0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Nitrate as N (Sol.)	mg/kg	0.1	0.9	0.3	<0.1	0.2	0.1	<0.1	<0.1	0.1	0.2
Nitrite + Nitrate as N (Sol.)	mg/kg	0.1	0.9	0.3	<0.1	0.2	0.1	<0.1	<0.1	0.1	0.2
Total Kjeldahl Nitrogen as N	mg/kg	20	340	260	530	500	240	540	670	580	520
Total Nitrogen as N	mg/kg	20	340	260	530	500	240	540	670	580	520
Total Phosphorus as P	mg/kg	2	268	269	304	278	241	360	366	319	293

3.8 Implications of Findings

The estuarine ecosystems of the study area are within a declared fisheries habitat area and the Styx River estuary is directly adjacent to a GBRMPA 'green'zone offshore beyond the estuary mouth. Also, a seagrass / reefal habitat area exists to the north of the St Lawrence estuary that could be exposed to discharges from the Styx River estuary based on the extent of the turbid plume observed in this study. Accordingly, conservation and fisheries values are at potential risk from activities associated with the Styx River Coal Project. This study focussed mainly on estuarine benthos, sediment quality and water quality within the Styx River estuary and adjacent estuaries, with only a qualitative assessment of mangrove and seagrass communities provided. Further study covering fisheries values associated with the fish habitat area and the ecology of the adjacent coastline are recommended.

The estuaries of the study area are relatively physically intact, although bank scouring and mangrove slumping in the lower Styx River estuary indicates the effects of recent flooding. Most sites had actively recruiting mangroves. Seagrasses weren't recorded, but that was consistent with historical seagrass mapping for the area and is likely a response to light limitation in these estuaries through high turbidity. Strong tidal currents associated with a large tidal range might also limit the colonisation of seagrass in the estuaries sampled.

The abundance and diversity of the Styx River estuary and neighbouring 'reference' estuaries was low. There are a number of potential reasons for this, ranging from the impacts of the 2010/11 wet season flooding, the physical and physiological stresses placed on benthic organisms systems associated with large tidal movement in the study area, a lack of habitat heterogeneity and the potential reduced effectiveness of the 0.5mm mesh sieve in capturing the resident benthic fauna. On the one hand, it could be said that, given the low abundance and diversity of benthic fauna, few benthic organisms will be exposed to impacts associated with the Styx Coal Project. However, another school of thought is that potential impacts associated with the Styx Coal Project could further reduce an already low abundance and diversity of benthic fauna. One of the consequences of having a low diversity community is a lack of redundancy in terms of ecosystem roles and functioning (Deeley and Paling, 1999). Therefore, a further loss of diversity could undermine local ecosystem processes and functioning and, therefore, ecosystem health. The two main issues that require further investigation based on the above are:

- Whether benthic fauna diversity and abundance will increase markedly as part of a recovery phase following the 2010/11 floods (and hence, establish what the real diversity and composition of benthic fauna is for the study area); and
- Whether or not the use of a 0.25mm mesh size would greatly improve abundance and diversity measures for the study area.

Those issues will need to be addressed as part of follow-up studies, ideally commencing in the post-wet season of 2012. Note that to truly understand the diversity of a benthic community it has been recommended that studies are carried out over the full turnover cycle of a benthic community, which coincides with the expected lifespan of the longest lived species. While this is often difficult to determine, some Nereididae, which were recorded in this study, can live for up to 5 years (Beesley et al, 2000). The expected timeline for the delivery of the Styx Coal Project is likely to prevent a baseline study of that extent, but this issue should be considered when outlining the monitoring programs associated with the Project.

The estuarine benthic fauna sampled as part of this study contained very few obligate suspension feeders, but did contain a number of taxa that may undertake this feeding mode at times. Most taxa present had feeding modes that require a close association with the sediment-water interface. Accordingly, most taxa present are either vulnerable to increased turbidity or sediment overburden, both of which could potentially arise if activities associated with the Styx River Coal Project are not properly mitigated. Burrowing crabs were also recorded and while those species would not be as vulnerable to the potential impacts described above, they are regarded as keystone species in estuarine ecosystems for their role in leaf litter recycling and sediment bioturbation. They may still be vulnerable to potential impacts of other changes in water quality including elevated nutrients and / or elevated metal and other contaminant levels, so the careful management of mine worked water discharge will need to be considered as part of the Project.

Benthic fauna results showed significant variation in faunal composition between estuaries and, even between relevant 'potentially impacted' and 'non-impacted' estuarine reaches. This potentially indicates that Waverley Creek and St Lawrence Creek are not effective surrogates for the Styx River estuary. However, the low abundance and diversity of fauna sampled probably exacerbated the statistical significance of such differences. Hence, if the observed low abundance and diversity of benthic fauna was atypical for the study area, further monitoring may potentially indicate that they are suitable surrogates. If, on the other hand, that turns out not to be the case, the estuary / embayment immediately south of the Styx River estuary could potentially serve as alternative reference system.

Currently, the water quality and sediment quality monitoring results indicate few, if any issues regarding contamination. Certainly there is no evidence of either metal accumulation in sediments or concerning levels of dissolved (bioavailable) metals and petroleum hydrocarbons in the water column, though given the agricultural landuse in the Styx River catchment, consideration should be given to analysing organic biocides as part of future monitoring rounds. Slightly elevated nitrogen and phosphorus levels were recorded in the water column, but of the two, exceedances for phosphorus were more exaggerated. While estuaries are mainly nitrogen limited systems, the findings of this study with respect to nutrients in general indicate that there is a need to limit further nutrient enrichment of the Styx River estuary through activities associated with the Styx Coal Project. Other water quality issues include elevated turbidity and reduced dissolved oxygen, though it is yet to be determined whether or not the latter is a consistent feature of these estuaries. While preliminary, the water and sediment quality data indicate that the resident benthic fauna are adapted to a relatively low-pollution environment with respect to contaminants tested. They are therefore, potentially vulnerable to increases in metals and metal bioavailability associated with un-mitigated mine construction activities and mine worked water release practices.

4 Potential Impacts & Mitigation Measures

Given that only concept mine mine plans are available (and these do not show the proposed locations of wastewater treatment ponds or wasterock dumps relative to the Styx River esruary), it is not possible to provide any spatial context to the potential impacts associated with the Styx River Coal Project. However, some generalisations can be made regarding the nature of potential impacts (see discussion below). This generic-level assessment has been provided for consideration as part of planning purposes and will be re-drawn at a later date once specific details are known of the precise location, scale and design of the mining operation.

4.1 Construction Phase

Activities associated with the construction phase with the potential to impact on the surface water aquatic ecosystem values in the Project will likely include:

- Pit construction;
- Instream works associated with road, rail and conveyor crossings;
- Creek diversionsl and
- Movement of vehicles and the plant to and from and around the construction site.

The potential impacts of these activities and suggested mitigation measures are detailed below.

4.1.1 Sediment Mobilisation during Construction

Earthworks associated with the construction phase have the potential to result in sediment mobilisation to waterways through direct disturbance to bed and banks, runoff from stockpiled material or the clearing of vegetation near waterways. This could result in increases in turbidity and, in extreme cases, the smothering of benthic organisms by sediment deposition or sediment slug bed form movement. Metals present in the mobilised sediment could also impact benthic organisms in the estuary. The key mitigation actions to counter such impacts include:

- Wherever practical, avoid construction works near streams. If possible a buffer of at least 100m from the banks of waterways should be maintained;
- Where the avoidance of construction works in, near, or adjacent to streams is not practicable, these works should be performed during the dry season. If exposed soils cannot be rehabilitated prior to the wet season, appropriate barriers to reduce sediment transport (e.g. silt curtains) should be installed well before significant rainfall occurs. Such measures must be adequate to cope with the very heavy rainfall events experienced at the site;
- Where possible, carry out construction in stages such that cleared areas can be rehabilitated quickly while construction progresses;
- Stockpiled excavated earth material should be kept well away from waterways and bunded such that runoff does not enter the waterway, but is captured in a temporary storage reservoir and either treated or removed from site; and
- The use of vegetation such as grasses and macrophytes as sediment filters should be considered where practical. Where this is not practicable, geotextile, rip rap and stabilisation techniques should be considered.

4.1.2 Chemical Spills

Apart from the potential for increased sediment mobilisation, chemical spills could arise through traffic accidents or through chemicals not being stored appropriately. Those spills would most likely involve grease and oils and, in most cases, spills would be small and localised, such that minimal environmental harm occurs. However, there is a slight chance that large spills could occur or that other toxic chemicals could be involved. These could affect benthic fauna and other fauna in the estuary. To reduce the risks of such spills and their associated impacts:

- Current best practice for the management of fuels, oils and chemicals on site must be adhered to at all times;
- All chemicals should be stored appropriately in a secure area with MSDS for each chemical stored and spills kits made readily available in that area;
- Construction staff to be trained in how to use spill kits to contain spills;
- All spills are to be reported, no matter how minor, and the impacts and reasons for their occurrence investigated. In the event of fuel, chemical or oil spills outside of bunded areas the material must be contained to prevent transport into waterways. Removal and secure disposal of contaminated soils and rehabilitation of exposed soil should be performed;
- All chemical loads are to be properly secured during transport and MSDS sheets for each are to be stored with the transport vehicle. Checks should be made before loading which chemicals can be stored with which; and
- Safe driving and general safe work practices should be applied when transporting chemicals. It is assumed that random drug and alcohol testing would be applied to all staff on site, including drivers of chemical transport and earthworks vehicles.

4.2 Operation Phase

The key activities associated the operation phase of the Styx Coal Project relates to managing water on-site. The potential impacts associated with these activities and the mitigation options recommended for reducing the risks of those impacts are discussed below.

4.2.1.1 Releases of Mine Wastewater

Various surface water management components will be constructed to collect and store mine runoff and water from pit dewatering. Current best practice is for surface water management infrastructure to be designed to contain and manage runoff from a 1 in 1,000 year rainfall event. These standards should be considered for this Project. The quality and release of mine worked water infrastructure will need to be managed in accordance with the Environmental Authority for the Styx River Coal Project, with release limits to be set as part of the EM Plan. Often the default guidelines used are the 95% Level Ecosystem Protection based on Slightly to Moderately Disturbed Streams outlined in ANZECC & ARMCANZ (2000) and / or the Queensland Water Quality Guidelines (DERM, 2009b). Given the high integrity of habitats in the estuary and the fact that they occur within a DIWA-listed wetland and declared Fish Habitat Area, it may be more pertinent to apply the 99% Level Ecosystem Protection trigger values for water quality. The same argument could be made with respect to targets for controlling runoff during the construction phase.

A network of monitoring sites and a sampling regime should be set up under a Receiving Environment Monitoring Program (REMP) before mine operation commences. These should ideally include estuarine sites (in the main estuarine channel) downstream of the release point and more than one of each so that statistical comparisons can be made. Reference sites in the Waverley Creek and St Lawrence Creek should also be sampled as part the REMP water quality monitoring as there is no upstream reference estuarine site apart from that in Wellington Creek, which should also be sampled. Note that several land-based access points were identified in this study for Waverley Creek and St Lawrence Creek, negating the need for access to sites by sea. Additional land-based access points for the Styx River estuary should be investigated through contact with local landowners and/ or commercial crab fisherman. Consideration should be given to adding an extra estuarine water and sediment quality sampling site upstream near the tidal limit as this area was noted as a depositional area as part of the aquatic ecology survey.

4.3 Considerations for Future Estuarine Sampling

Additional estuarine surveys are required to adequately characterise diversity and composition of the benthic fauna and habitat conditions. Apart from seasonal / temporal; replication generally being a requirement of the Generic DERM EIS Terms of Reference, a number of unresolved questions were identified as part of this study that would require further sampling to address.

Any additional sampling should consider the following:

- The combined use of 0.25mm and 0.5mm mesh sieves to process estuarine benthic samples so that data from this study and other relevant studies can be compared and, so any effects of mesh size on characterising benthic fauna in these estuaries can be determined;
- The potential sampling of the large estuary / embayment to the immediate south of the Styx River as another 'reference' system. This region is not within the GBRMPA 'green' zone, so no GBRMPA permit would be required. Sampling this estuary/ embayment would, however, require a modification to our existing Queensland Parks and Wildlife Service permit;
- The potential need to specify lower LOR's for metals analysed so that they are lower than the specified guideline trigger levels;
- The potential need to test for organic biocides as part of further monitoring given the agricultural land use in the Styx river catchment; and
- Consideration of other indicators besides the ones used for this study, given that the depauperate benthic community of the study area may mean that benthic fauna do not lend themselves well to impact assessment (though further sampling will be required to confirm this).

The above relate to sampling in the estuarine reaches. Field observations suggest that the neighbouring coastal habitats within the GBRMP may be more at risk of mine runoff impacts, so a separate marine monitoring program would ideally be undertaken as part of the Styx Coal Project. ALS can provide details of suitable service suppliers to undertake such work.

This study uncovered a range of logistical issues not observed in prior studies and these have resulted in the following recommendations:

- The use of deep draught vessels is not recommended due to the extreme shallowness of the Broad Sound off-shore of Rosewood Island. This resulted in extensive dinghy travel in craft which are not suitable for such use and this could at times trigger OH&S and safety issues;

- Boat ramps for both the St Lawrence Creek and Waverley Creek estuaries have been sourced and will enable safer future sampling of these estuaries. A suitable boat ramp in the Styx River estuary has not been sourced and may not exist. It is therefore recommended that the lower Styx Sites be accessed from the Waverley Creek estuary via the adjacent coastline at suitable periods of the tidal cycle;
- Staff working in these estuaries and in particular the Styx Estuary need to be aware of the extreme nature of the tides, and the occasional presence of the Styx River tidal bore.

5 References

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Appendix A – Habitat Assessment Field Sheet

Styx Estuarine Field Sheet

PROJECT NAME: Styx Estuarine Project	SITE CODE_______________________
SITE NAME ____	
DATE: _____/_____/_____ TIME: [ ]	PARTY______________________________
LATITUDE _____________________________	LONGITUDE__________________________________
PHOTO #'s____	

Shore-side Habitat Evaluation		Shore within 100m?		Yes	No
Adult Mangroves	N	L	S	M	E
Juvenile Mangroves	N	L	S	M	E
Salt Marsh	N	L	S	M	E
Sea Grass	N	L	S	M	E
Other:	N	L	S	M	E
Other:	N	L	S	M	E
Key:	N = None	L = 1-10%	S = 10-50%	M = 50-75%	E = >75%

Observation of Water Conditions					
Waves	Small (< 0.3m)		Medium (0.3 -0.6m)		High (>0.6m)
Tide level	Low		Middle		High
Tidal Direction	Coming In		Slack Tide		Going Out
Surface Condition/Scum	Normal	Slick	Scum	Foaming	Other:
Comments					

Water Quality sample:				
Depth	WQ Parameter	Pool	WQ Parameter	Pool
TOP (If depth < 5m)	WQ Sample Depth (m)		DO (mg/L)	
	Water Temperature (°C)		DO (% sat)	
	Conductivity (μS/cm)		Turbidity (NTU)	
	pH		Time collected	
MIDDLE (if depth >5m)	WQ Sample Depth (m)		DO (mg/L)	
	Water Temperature (°C)		DO (% sat)	
	Conductivity (μS/cm)		Turbidity (NTU)	
	pH		Time collected	
BOTTOM (if depth >5m)	WQ Sample Depth (m)		DO (mg/L)	
	Water Temperature (°C)		DO (% sat)	
	Conductivity (μS/cm)		Turbidity (NTU)	
	pH		Time collected	

Laboratory Water Quality samples: Tick when collected			
500ml Green Plastic	1	TPH: - 100ml Amber Glass	6
Metals: Dissolved – Red 60ml Plastic	2	TPH: - 100ml Amber Glass	7
Metals: Total – Red 60ml Plastic	3	TPH: - 100ml Amber Glass	8
BTEX: Purple - 40ml Amber Vial	4	Nutrients: 125ml Purple plastic	9
TPH: Purple - 40ml Amber Vial	5	Ice and ice blocks?	

Sediment Sample: Particle Sizes					
Pebbles (4-64mm)	N	L	S	M	E
Gravel (2-4mm)	N	L	S	M	E
Sand (0.05-2mm)	N	L	S	M	E
Silt/Clay (<0.05mm)	N	L	S	M	E
Key	N = 0%	L = 1-10%	S = 10-50%	M = 50-75%	E = >75%
Sediment Sample: Composition					
Depth in Sample	0-5cm	5-10cm	10-15cm	15-20cm	other
Redocline					
Colour					
Texture					
Odour					

Laboratory Sediment Quality samples: Tick when collected	
Metals: Total – Orange 250ml Wide Mouth Clear Glass Jar	10
TOC: – Orange 150ml Wide Mouth Clear Glass Jar	11
Particle Sizings – Black on White Labels – 250g resealable plastic bags	12
Ice and Ice Blocks?	

Comments:

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Appendix B – Raw Water Quality and Sediment Quality Laboratory Results

ALS Group

Environmental Division

QUALITY CONTROL REPORT

Work Order	: **ES1126395**	Page	: 1 of 7
Client	: **ALS WATER RESOURCES GROUP**	Laboratory	: Environmental Division Sydney
Contact	: MR MARK DAHM	Contact	: Client Services
Address	: PO BOX 3216 YERONGA 4104	Address	: 277-289 Woodpark Road Smithfield NSW Australia 2164
E-mail	: mark.dahm@alsglobal.com	E-mail	: sydney@alsglobal.com
Telephone	: +61 07 3859 7800	Telephone	: +61-2-8784 8555
Facsimile	: +61 07 3859 7820	Facsimile	: +61-2-8784 8500
Project	: CQ212766	QC Level	: NEPM 1999 Schedule B(3) and ALS QCS3 requirement
Site	: ----		
C-O-C number	: ----	Date Samples Received	: 29-NOV-2011
Sampler	: ----	Issue Date	: 14-DEC-2011
Order number	: ----		
		No. of samples received	: 9
Quote number	: BN/623/11	No. of samples analysed	: 9

This report supersedes any previous report(s) with this reference. Results apply to the sample(s) as submitted. All pages of this report have been checked and approved for release.

This Quality Control Report contains the following information:

- Laboratory Duplicate (DUP) Report; Relative Percentage Difference (RPD) and Acceptance Limits
- Method Blank (MB) and Laboratory Control Spike (LCS) Report; Recovery and Acceptance Limits
- Matrix Spike (MS) Report; Recovery and Acceptance Limits

NATA

WORLD RECOGNISED ACCREDITATION

NATA Accredited Laboratory 825

This document is issued in accordance with NATA accreditation requirements.

Accredited for compliance with ISO/IEC 17025.

Signatories

This document has been electronically signed by the authorized signatories indicated below. Electronic signing has been carried out in compliance with procedures specified in 21 CFR Part 11.

Signatories	*Position*	*Accreditation Category*
Ankit Joshi	Inorganic Chemist	Sydney Inorganics
Dianne Blane	Laboratory Supervisor	Newcastle
Evie.Sidarta	Inorganic Chemist	Sydney Inorganics
Jonathon Angell	Inorganic Coordinator	Stafford Minerals - AY
Sarah Millington	Senior Inorganic Chemist	Sydney Inorganics
Wisam Marassa	Inorganics Coordinator	Sydney Inorganics

General Comments

The analytical procedures used by the Environmental Division have been developed from established internationally recognized procedures such as those published by the USEPA, APHA, AS and NEPM. In house developed procedures are employed in the absence of documented standards or by client request.

Where moisture determination has been performed, results are reported on a dry weight basis.

Where a reported less than (<) result is higher than the LOR, this may be due to primary sample extract/digestate dilution and/or insuffient sample for analysis.

Where the LOR of a reported result differs from standard LOR, this may be due to high moisture content, insufficient sample (reduced weight employed) or matrix interference.

Key : Anonymous = Refers to samples which are not specifically part of this work order but formed part of the QC process lot

CAS Number = CAS registry number from database maintained by Chemical Abstracts Services. The Chemical Abstracts Service is a division of the American Chemical Society.

LOR = Limit of reporting

RPD = Relative Percentage Difference

= Indicates failed QC

Laboratory Duplicate (DUP) Report

The quality control term Laboratory Duplicate refers to a randomly selected intralaboratory split. Laboratory duplicates provide information regarding method precision and sample heterogeneity. The permitted ranges for the Relative Percent Deviation (RPD) of Laboratory Duplicates are specified in ALS Method QWI-EN/38 and are dependent on the magnitude of results in comparison to the level of reporting: Result < 10 times LOR:- No Limit; Result between 10 and 20 times LOR:- 0% - 50%; Result > 20 times LOR:- 0% - 20%.

Sub-Matrix: **SOIL**

				Laboratory Duplicate (DUP) Report					
Laboratory sample ID	*Client sample ID*	*Method: Compound*	*CAS Number*	*LOR*	*Unit*	*Original Result*	*Duplicate Result*	*RPD (%)*	*Recovery Limits (%)*
EA055: Moisture Content (QC Lot: 2073358)									
ES1126234-006	Anonymous	EA055-103: Moisture Content (dried @ 103°C)	----	1.0	%	7.6	6.8	11.5	No Limit
ES1126395-004	Styx D/S2	EA055-103: Moisture Content (dried @ 103°C)	----	1.0	%	30.1	29.5	1.8	0% - 20%
ED040T : Total Sulfate by ICPAES (QC Lot: 2074945)									
ES1126395-001	Styx U/S	ED040T: Sulfate as SO4 2-	14808-79-8	100	mg/kg	5900	5300	10.6	0% - 20%
ED042T: Total Sulfur by LECO (QC Lot: 2079782)									
ES1126395-001	Styx U/S	ED042T: Sulfur - Total as S (LECO)	----	0.01	%	0.15	0.16	0.0	0% - 50%
EG005T: Total Metals by ICP-AES (QC Lot: 2075914)									
ES1126395-001	Styx U/S	EG005T: Aluminium	7429-90-5	50	mg/kg	4590	4960	7.6	0% - 20%
		EG005T: Iron	7439-89-6	50	mg/kg	6630	6780	2.2	0% - 20%
EG020T: Total Metals by ICP-MS (QC Lot: 2075917)									
ES1126395-001	Styx U/S	EG020X-T: Arsenic	7440-38-2	0.1	mg/kg	2.2	2.3	0.0	0% - 20%
		EG020X-T: Cobalt	7440-48-4	0.1	mg/kg	3.6	3.8	4.8	0% - 20%
		EG020X-T: Chromium	7440-47-3	0.1	mg/kg	8.2	8.9	8.1	0% - 20%
		EG020X-T: Copper	7440-50-8	0.1	mg/kg	3.0	2.8	7.1	0% - 20%
		EG020X-T: Manganese	7439-96-5	0.1	mg/kg	479	495	3.3	0% - 20%
		EG020X-T: Molybdenum	7439-98-7	0.1	mg/kg	0.2	0.2	0.0	No Limit
		EG020X-T: Nickel	7440-02-0	0.1	mg/kg	3.6	4.2	13.2	0% - 20%
		EG020X-T: Lead	7439-92-1	0.1	mg/kg	3.6	3.6	0.0	0% - 20%
		EG020X-T: Uranium	7440-61-1	0.1	mg/kg	0.6	0.7	0.0	No Limit
		EG020X-T: Zinc	7440-66-6	0.1	mg/kg	7.1	7.7	8.4	0% - 20%
		EG020X-T: Vanadium	7440-62-2	1	mg/kg	9	11	12.3	0% - 50%
EG020T: Total Metals by ICP-MS (QC Lot: 2075918)									
ES1126395-001	Styx U/S	EG020Y-T: Cadmium	7440-43-9	0.1	mg/kg	<0.1	<0.1	0.0	No Limit
		EG020Y-T: Selenium	7782-49-2	1	mg/kg	<1	<1	0.0	No Limit
EG020T: Total Metals by ICP-MS (QC Lot: 2075919)									
ES1126395-001	Styx U/S	EG020Z-T: Silver	7440-22-4	0.1	mg/kg	<0.1	<0.1	0.0	No Limit
EG035T: Total Recoverable Mercury by FIMS (QC Lot: 2075916)									
ES1126395-001	Styx U/S	EG035T: Mercury	7439-97-6	0.1	mg/kg	<0.1	<0.1	0.0	No Limit
EK055: Ammonia as N (QC Lot: 2080080)									
ES1126395-001	Styx U/S	EK055: Ammonia as N	7664-41-7	20	mg/kg	<20	<20	0.0	No Limit
ES1126725-002	Anonymous	EK055: Ammonia as N	7664-41-7	20	mg/kg	<20	<20	0.0	No Limit
EK057G: Nitrite as N by Discrete Analyser (QC Lot: 2073694)									
ES1126395-001	Styx U/S	EK057G: Nitrite as N (Sol.)	----	0.1	mg/kg	<0.1	<0.1	0.0	No Limit
EK059G: Nitrite plus Nitrate as N (NOx) by Discrete Analyser (QC Lot: 2073695)									

Sub-Matrix: **SOIL**

Laboratory sample ID	Client sample ID	Method: Compound	CAS Number	Laboratory Duplicate (DUP) Report					
				LOR	Unit	Original Result	Duplicate Result	RPD (%)	Recovery Limits (%)
EK059G: Nitrite plus Nitrate as N (NOx) by Discrete Analyser (QC Lot: 2073695) - continued									
ES1126395-001	Styx U/S	EK059G: Nitrite + Nitrate as N (Sol.)	----	0.1	mg/kg	0.3	0.2	40.0	No Limit
EK061G: Total Kjeldahl Nitrogen By Discrete Analyser (QC Lot: 2073095)									
ES1126395-001	Styx U/S	EK061G: Total Kjeldahl Nitrogen as N	----	20	mg/kg	260	260	0.0	0% - 50%
ES1126430-001	Anonymous	EK061G: Total Kjeldahl Nitrogen as N	----	20	mg/kg	5670	5790	2.0	0% - 20%
EK067G: Total Phosphorus as P by Discrete Analyser (QC Lot: 2073096)									
ES1126395-001	Styx U/S	EK067G: Total Phosphorus as P	----	2	mg/kg	269	292	8.2	0% - 20%
ES1126430-001	Anonymous	EK067G: Total Phosphorus as P	----	2	mg/kg	987	969	1.8	0% - 20%
EP003: Total Organic Carbon (TOC) in Soil (QC Lot: 2079783)									
ES1126395-001	Styx U/S	EP003: Total Organic Carbon	----	0.02	%	0.09	0.09	0.0	No Limit

Method Blank (MB) and Laboratory Control Spike (LCS) Report

The quality control term Method / Laboratory Blank refers to an analyte free matrix to which all reagents are added in the same volumes or proportions as used in standard sample preparation. The purpose of this QC parameter is to monitor potential laboratory contamination. The quality control term Laboratory Control Sample (LCS) refers to a certified reference material, or a known interference free matrix spiked with target analytes. The purpose of this QC parameter is to monitor method precision and accuracy independent of sample matrix. Dynamic Recovery Limits are based on statistical evaluation of processed LCS.

Sub-Matrix: **SOIL**

				Method Blank (MB) Report	*Laboratory Control Spike (LCS) Report*			
					Spike	*Spike Recovery (%)*	*Recovery Limits (%)*	
Method: Compound	*CAS Number*	*LOR*	*Unit*	*Result*	*Concentration*	*LCS*	*Low*	*High*
ED040T : Total Sulfate by ICPAES (QCLot: 2074945)								
ED040T: Sulfate as SO4 2-	14808-79-8	100	mg/kg	<100	----	----	----	----
ED042T: Total Sulfur by LECO (QCLot: 2079782)								
ED042T: Sulfur - Total as S (LECO)	----	0.01	%	<0.01	100 %	95.9	70	130
EG005T: Total Metals by ICP-AES (QCLot: 2075914)								
EG005T: Aluminium	7429-90-5	50	mg/kg	<50	----	----	----	----
EG005T: Iron	7439-89-6	50	mg/kg	<50	----	----	----	----
EG020T: Total Metals by ICP-MS (QCLot: 2075915)								
EG020T: Boron	7440-42-8	0.1	mg/kg	<0.1	----	----	----	----
EG020T: Total Metals by ICP-MS (QCLot: 2075917)								
EG020X-T: Arsenic	7440-38-2	0.1	mg/kg	<0.1	13.1 mg/kg	# 122	77	119
EG020X-T: Cobalt	7440-48-4	0.1	mg/kg	<0.1	24.5 mg/kg	108	73.9	118
EG020X-T: Chromium	7440-47-3	0.1	mg/kg	<0.1	60.9 mg/kg	# 106	70	101
EG020X-T: Manganese	7439-96-5	0.1	mg/kg	<0.1	136 mg/kg	# 114	70	96.2
EG020X-T: Molybdenum	7439-98-7	0.1	mg/kg	<0.1	----	----	----	----
EG020X-T: Nickel	7440-02-0	0.1	mg/kg	<0.1	55.2 mg/kg	# 113	76.2	113
EG020X-T: Lead	7439-92-1	0.1	mg/kg	<0.1	54.8 mg/kg	# 112	70	105
EG020X-T: Uranium	7440-61-1	0.1	mg/kg	<0.1	----	----	----	----
EG020X-T: Zinc	7440-66-6	0.1	mg/kg	<0.1	104 mg/kg	100	74.9	110
EG020X-T: Vanadium	7440-62-2	1	mg/kg	<1	34 mg/kg	96.7	70	130
EG020T: Total Metals by ICP-MS (QCLot: 2075918)								
EG020Y-T: Selenium	7782-49-2	1	mg/kg	<1	----	----	----	----
EG020Y-T: Cadmium	7440-43-9	0.1	mg/kg	<0.1	2.76 mg/kg	101	76.4	110
EG020T: Total Metals by ICP-MS (QCLot: 2075919)								
EG020Z-T: Silver	7440-22-4	0.1	mg/kg	<0.1	5.6 mg/kg	107	70	130
EG035T: Total Recoverable Mercury by FIMS (QCLot: 2075916)								
EG035T: Mercury	7439-97-6	0.1	mg/kg	<0.1	1.4 mg/kg	77.5	67	118
EK055: Ammonia as N (QCLot: 2080080)								
EK055: Ammonia as N	7664-41-7	20	mg/kg	<20	100 mg/kg	91.8	70	130
EK057G: Nitrite as N by Discrete Analyser (QCLot: 2073694)								
EK057G: Nitrite as N (Sol.)	----	0.1	mg/kg	<0.1	2.5 mg/kg	106	70	130
EK059G: Nitrite plus Nitrate as N (NOx) by Discrete Analyser (QCLot: 2073695)								
EK059G: Nitrite + Nitrate as N (Sol.)	----	0.1	mg/kg	<0.1	4.8 mg/kg	95.1	70	130
EK061G: Total Kjeldahl Nitrogen By Discrete Analyser (QCLot: 2073095)								

Sub-Matrix: **SOIL**

Method: Compound	CAS Number	LOR	Unit	Method Blank (MB) Report	Laboratory Control Spike (LCS) Report			
					Spike	Spike Recovery (%)	Recovery Limits (%)	
				Result	Concentration	LCS	Low	High
EK061G: Total Kjeldahl Nitrogen By Discrete Analyser (QCLot: 2073095) - continued								
EK061G: Total Kjeldahl Nitrogen as N	----	20	mg/kg	<20	1000 mg/kg	76.8	70	130
EK067G: Total Phosphorus as P by Discrete Analyser (QCLot: 2073096)								
EK067G: Total Phosphorus as P	----	2	mg/kg	<2	442 mg/kg	81.0	69	111
EP003: Total Organic Carbon (TOC) in Soil (QCLot: 2079783)								
EP003: Total Organic Carbon	----	0.02	%	<0.02	100 %	103	70	130

Matrix Spike (MS) Report

The quality control term Matrix Spike (MS) refers to an intralaboratory split sample spiked with a representative set of target analytes. The purpose of this QC parameter is to monitor potential matrix effects on analyte recoveries. Static Recovery Limits as per laboratory Data Quality Objectives (DQOs). Ideal recovery ranges stated may be waived in the event of sample matrix interference.

Sub-Matrix: **SOIL**

				Matrix Spike (MS) Report			
				Spike	Spike Recovery (%)	Recovery Limits (%)	
Laboratory sample ID	Client sample ID	Method: Compound	CAS Number	Concentration	MS	Low	High
EG020T: Total Metals by ICP-MS (QCLot: 2075917)							
ES1126395-001	Styx U/S	EG020X-T: Arsenic	7440-38-2	50 mg/kg	100	70	130
		EG020X-T: Chromium	7440-47-3	50 mg/kg	98.4	70	130
		EG020X-T: Nickel	7440-02-0	50 mg/kg	97.1	70	130
		EG020X-T: Lead	7439-92-1	250 mg/kg	103	70	130
		EG020X-T: Zinc	7440-66-6	250 mg/kg	78.7	70	130
EG020T: Total Metals by ICP-MS (QCLot: 2075918)							
ES1126395-001	Styx U/S	EG020Y-T: Selenium	7782-49-2	50 mg/kg	89.8	70	130
		EG020Y-T: Cadmium	7440-43-9	50 mg/kg	97.4	70	130
EG035T: Total Recoverable Mercury by FIMS (QCLot: 2075916)							
ES1126395-001	Styx U/S	EG035T: Mercury	7439-97-6	5 mg/kg	81.8	70	130
EK055: Ammonia as N (QCLot: 2080080)							
ES1126395-001	Styx U/S	EK055: Ammonia as N	7664-41-7	20 mg/kg	# Not Determined	70	130
EK057G: Nitrite as N by Discrete Analyser (QCLot: 2073694)							
ES1126395-001	Styx U/S	EK057G: Nitrite as N (Sol.)	----	2.5 mg/kg	104	70	130
EK059G: Nitrite plus Nitrate as N (NOx) by Discrete Analyser (QCLot: 2073695)							
ES1126395-001	Styx U/S	EK059G: Nitrite + Nitrate as N (Sol.)	----	2.5 mg/kg	91.0	70	130
EK061G: Total Kjeldahl Nitrogen By Discrete Analyser (QCLot: 2073095)							
ES1126395-001	Styx U/S	EK061G: Total Kjeldahl Nitrogen as N	----	500 mg/kg	116	70	130
EK067G: Total Phosphorus as P by Discrete Analyser (QCLot: 2073096)							
ES1126395-001	Styx U/S	EK067G: Total Phosphorus as P	----	100 mg/kg	76.6	70	130

ALS Group

Environmental Division

CERTIFICATE OF ANALYSIS

Work Order	: **ES1126395**	Page	: 1 of 6
Client	: **ALS WATER RESOURCES GROUP**	Laboratory	: Environmental Division Sydney
Contact	: MR MARK DAHM	Contact	: Client Services
Address	: PO BOX 3216 YERONGA 4104	Address	: 277-289 Woodpark Road Smithfield NSW Australia 2164
E-mail	: mark.dahm@alsglobal.com	E-mail	: sydney@alsglobal.com
Telephone	: +61 07 3859 7800	Telephone	: +61-2-8784 8555
Facsimile	: +61 07 3859 7820	Facsimile	: +61-2-8784 8500
Project	: CQ212766	QC Level	: NEPM 1999 Schedule B(3) and ALS QCS3 requirement
Order number	: ----		
C-O-C number	: ----	Date Samples Received	: 29-NOV-2011
Sampler	: ----	Issue Date	: 14-DEC-2011
Site	: ----		
		No. of samples received	: 9
Quote number	: BN/623/11	No. of samples analysed	: 9

This report supersedes any previous report(s) with this reference. Results apply to the sample(s) as submitted. All pages of this report have been checked and approved for release.

This Certificate of Analysis contains the following information:

- General Comments
- Analytical Results

NATA

WORLD RECOGNISED ACCREDITATION

NATA Accredited Laboratory 825

This document is issued in accordance with NATA accreditation requirements.

Accredited for compliance with ISO/IEC 17025.

Signatories

This document has been electronically signed by the authorized signatories indicated below. Electronic signing has been carried out in compliance with procedures specified in 21 CFR Part 11.

Signatories	*Position*	*Accreditation Category*
Ankit Joshi	Inorganic Chemist	Sydney Inorganics
Dianne Blane	Laboratory Supervisor	Newcastle
Evie.Sidarta	Inorganic Chemist	Sydney Inorganics
Jonathon Angell	Inorganic Coordinator	Stafford Minerals - AY
Sarah Millington	Senior Inorganic Chemist	Sydney Inorganics
Wisam Marassa	Inorganics Coordinator	Sydney Inorganics

General Comments

The analytical procedures used by the Environmental Division have been developed from established internationally recognized procedures such as those published by the USEPA, APHA, AS and NEPM. In house developed procedures are employed in the absence of documented standards or by client request.

Where moisture determination has been performed, results are reported on a dry weight basis.

Where a reported less than (<) result is higher than the LOR, this may be due to primary sample extract/digestate dilution and/or insuffient sample for analysis.

Where the LOR of a reported result differs from standard LOR, this may be due to high moisture content, insufficient sample (reduced weight employed) or matrix interference.

When sampling time information is not provided by the client, sampling dates are shown without a time component. In these instances, the time component has been assumed by the laboratory for processing purposes.

Key : CAS Number = CAS registry number from database maintained by Chemical Abstracts Services. The Chemical Abstracts Service is a division of the American Chemical Society.
LOR = Limit of reporting
^ = This result is computed from individual analyte detections at or above the level of reporting

- **EG020: LCS recoveries for some elements fall outside ALS Dynamic Control Limit. However, they are within the acceptance criteria based on ALS DQO. No further action is required.**

Analytical Results

Sub-Matrix: SOIL			Client sample ID	Styx U/S	Styx Mid	Styx D/S1	Styx D/S2	Est2 U/S
			Client sampling date / time	29-NOV-2011 15:00	29-NOV-2011 15:00	29-NOV-2011 15:00	29-NOV-2011 15:00	29-NOV-2011 15:00
Compound	CAS Number	LOR	Unit	ES1126395-001	ES1126395-002	ES1126395-003	ES1126395-004	ES1126395-005
EA150: Particle Sizing								
+75µm	----	1	%	81	6	15	41	13
+150µm	----	1	%	8	<1	<1	2	<1
+300µm	----	1	%	<1	<1	<1	<1	<1
+425µm	----	1	%	<1	<1	<1	<1	<1
+600µm	----	1	%	<1	<1	<1	<1	<1
+1180µm	----	1	%	<1	<1	<1	<1	<1
+2.36mm	----	1	%	<1	<1	<1	<1	<1
+4.75mm	----	1	%	<1	<1	<1	<1	<1
+9.5mm	----	1	%	<1	<1	<1	<1	<1
+19.0mm	----	1	%	<1	<1	<1	<1	<1
+37.5mm	----	1	%	<1	<1	<1	<1	<1
+75.0mm	----	1	%	<1	<1	<1	<1	<1
EA055: Moisture Content								
Moisture Content (dried @ 103°C)	----	1.0	%	36.4	40.5	43.4	30.1	44.9
EA150: Soil Classification based on Particle Size								
Clay (<2 µm)	----	1	%	12	32	35	20	33
Silt (2-60 µm)	----	1	%	5	49	38	32	45
Sand (0.06-2.00 mm)	----	1	%	83	19	27	48	22
Gravel (>2mm)	----	1	%	<1	<1	<1	<1	<1
Cobbles (>6cm)	----	1	%	<1	<1	<1	<1	<1
ED040T : Total Sulfate by ICPAES								
Sulfate as SO4 2-	14808-79-8	100	mg/kg	5900	5400	4450	3650	3190
ED042T: Total Sulfur by LECO								
Sulfur - Total as S (LECO)	----	0.01	%	0.15	0.19	0.21	0.10	0.24
EG005T: Total Metals by ICP-AES								
Aluminium	7429-90-5	50	mg/kg	4590	13800	15300	10000	15600
Iron	7439-89-6	50	mg/kg	6630	15500	17000	11100	17400
EG020T: Total Metals by ICP-MS								
Arsenic	7440-38-2	0.1	mg/kg	2.2	4.9	4.3	3.0	5.9
Selenium	7782-49-2	1	mg/kg	<1	<1	<1	<1	<1
Silver	7440-22-4	0.1	mg/kg	<0.1	<0.1	<0.1	<0.1	<0.1
Cadmium	7440-43-9	0.1	mg/kg	<0.1	<0.1	<0.1	<0.1	<0.1
Cobalt	7440-48-4	0.1	mg/kg	3.6	5.9	6.5	4.5	6.8
Chromium	7440-47-3	0.1	mg/kg	8.2	21.4	24.5	15.2	25.3
Copper	7440-50-8	0.1	mg/kg	3.0	6.4	6.7	4.1	6.2
Boron	7440-42-8	0.1	mg/kg	33.8	33.8	37.8	24.0	35.1

Analytical Results

Sub-Matrix: SOIL			Client sample ID	Styx U/S	Styx Mid	Styx D/S1	Styx D/S2	Est2 U/S
			Client sampling date / time	29-NOV-2011 15:00	29-NOV-2011 15:00	29-NOV-2011 15:00	29-NOV-2011 15:00	29-NOV-2011 15:00
Compound	CAS Number	LOR	Unit	ES1126395-001	ES1126395-002	ES1126395-003	ES1126395-004	ES1126395-005
EG020T: Total Metals by ICP-MS - Continued								
Manganese	7439-96-5	0.1	mg/kg	479	379	335	322	421
Molybdenum	7439-98-7	0.1	mg/kg	0.2	0.3	0.3	0.3	0.4
Nickel	7440-02-0	0.1	mg/kg	3.6	10.5	11.8	7.4	12.0
Lead	7439-92-1	0.1	mg/kg	3.6	6.7	7.2	5.0	7.2
Uranium	7440-61-1	0.1	mg/kg	0.6	0.7	0.7	0.6	0.8
Zinc	7440-66-6	0.1	mg/kg	7.1	19.8	21.9	13.1	22.2
Vanadium	7440-62-2	1	mg/kg	9	22	24	16	25
EG035T: Total Recoverable Mercury by FIMS								
Mercury	7439-97-6	0.1	mg/kg	<0.1	0.1	<0.1	<0.1	<0.1
EK055: Ammonia as N								
Ammonia as N	7664-41-7	20	mg/kg	<20	<20	<20	<20	20
EK057G: Nitrite as N by Discrete Analyser								
Nitrite as N (Sol.)	----	0.1	mg/kg	<0.1	<0.1	<0.1	<0.1	<0.1
EK058G: Nitrate as N by Discrete Analyser								
Nitrate as N (Sol.)	----	0.1	mg/kg	0.3	<0.1	0.2	0.1	<0.1
EK059G: Nitrite plus Nitrate as N (NOx) by Discrete Analyser								
Nitrite + Nitrate as N (Sol.)	----	0.1	mg/kg	0.3	<0.1	0.2	0.1	<0.1
EK061G: Total Kjeldahl Nitrogen By Discrete Analyser								
Total Kjeldahl Nitrogen as N	----	20	mg/kg	260	530	500	240	540
EK062: Total Nitrogen as N (TKN + NOx)								
^ Total Nitrogen as N	----	20	mg/kg	260	530	500	240	540
EK067G: Total Phosphorus as P by Discrete Analyser								
Total Phosphorus as P	----	2	mg/kg	269	304	278	241	360
EK085M: Sulfide as S2-								
Sulfide as S	----	0.01	%	<0.01	0.01	0.06	<0.01	0.13
EP003: Total Organic Carbon (TOC) in Soil								
Total Organic Carbon	----	0.02	%	0.09	0.35	0.42	0.22	0.52

Analytical Results

Sub-Matrix: SOIL			Client sample ID	Est2 D/S	Est3 U/S	Est3 D/S	Wellington Creek D/S	----
			Client sampling date / time	29-NOV-2011 15:00	29-NOV-2011 15:00	29-NOV-2011 15:00	29-NOV-2011 15:00	----
Compound	CAS Number	LOR	Unit	ES1126395-006	ES1126395-007	ES1126395-008	ES1126395-009	----
EA150: Particle Sizing								
+75µm	----	1	%	5	8	16	22	----
+150µm	----	1	%	<1	<1	1	1	----
+300µm	----	1	%	<1	<1	<1	<1	----
+425µm	----	1	%	<1	<1	<1	<1	----
+600µm	----	1	%	<1	<1	<1	<1	----
+1180µm	----	1	%	<1	<1	<1	<1	----
+2.36mm	----	1	%	<1	<1	<1	<1	----
+4.75mm	----	1	%	<1	<1	<1	<1	----
+9.5mm	----	1	%	<1	<1	<1	<1	----
+19.0mm	----	1	%	<1	<1	<1	<1	----
+37.5mm	----	1	%	<1	<1	<1	<1	----
+75.0mm	----	1	%	<1	<1	<1	<1	----
EA055: Moisture Content								
Moisture Content (dried @ 103°C)	----	1.0	%	47.9	50.9	43.5	48.4	----
EA150: Soil Classification based on Particle Size								
Clay (<2 µm)	----	1	%	43	42	38	39	----
Silt (2-60 µm)	----	1	%	42	43	34	35	----
Sand (0.06-2.00 mm)	----	1	%	15	15	28	26	----
Gravel (>2mm)	----	1	%	<1	<1	<1	<1	----
Cobbles (>6cm)	----	1	%	<1	<1	<1	<1	----
ED040T : Total Sulfate by ICPAES								
Sulfate as SO4 2-	14808-79-8	100	mg/kg	5080	4230	4820	3870	----
ED042T: Total Sulfur by LECO								
Sulfur - Total as S (LECO)	----	0.01	%	0.21	0.22	0.18	0.22	----
EG005T: Total Metals by ICP-AES								
Aluminium	7429-90-5	50	mg/kg	19900	18700	15000	16000	----
Iron	7439-89-6	50	mg/kg	20500	20000	16300	18500	----
EG020T: Total Metals by ICP-MS								
Arsenic	7440-38-2	0.1	mg/kg	6.6	5.6	4.6	4.2	----
Selenium	7782-49-2	1	mg/kg	<1	<1	<1	<1	----
Silver	7440-22-4	0.1	mg/kg	<0.1	<0.1	<0.1	<0.1	----
Cadmium	7440-43-9	0.1	mg/kg	<0.1	<0.1	<0.1	<0.1	----
Cobalt	7440-48-4	0.1	mg/kg	8.0	7.5	5.8	7.3	----
Chromium	7440-47-3	0.1	mg/kg	32.2	28.4	23.5	24.4	----
Copper	7440-50-8	0.1	mg/kg	7.5	8.2	5.9	8.6	----
Boron	7440-42-8	0.1	mg/kg	35.9	41.5	35.2	36.6	----

Analytical Results

Sub-Matrix: SOIL			Client sample ID	Est2 D/S	Est3 U/S	Est3 D/S	Wellington Creek D/S	----
			Client sampling date / time	29-NOV-2011 15:00	29-NOV-2011 15:00	29-NOV-2011 15:00	29-NOV-2011 15:00	----
Compound	CAS Number	LOR	Unit	ES1126395-006	ES1126395-007	ES1126395-008	ES1126395-009	----
EG020T: Total Metals by ICP-MS - Continued								
Manganese	7439-96-5	0.1	mg/kg	353	342	261	380	----
Molybdenum	7439-98-7	0.1	mg/kg	0.4	0.4	0.4	0.3	----
Nickel	7440-02-0	0.1	mg/kg	15.8	14.1	11.0	12.7	----
Lead	7439-92-1	0.1	mg/kg	8.0	8.4	6.7	7.8	----
Uranium	7440-61-1	0.1	mg/kg	0.8	0.9	0.8	0.7	----
Zinc	7440-66-6	0.1	mg/kg	28.8	26.5	20.2	24.2	----
Vanadium	7440-62-2	1	mg/kg	29	28	23	29	----
EG035T: Total Recoverable Mercury by FIMS								
Mercury	7439-97-6	0.1	mg/kg	<0.1	<0.1	<0.1	<0.1	----
EK055: Ammonia as N								
Ammonia as N	7664-41-7	20	mg/kg	<20	<20	<20	<20	----
EK057G: Nitrite as N by Discrete Analyser								
Nitrite as N (Sol.)	----	0.1	mg/kg	<0.1	<0.1	<0.1	<0.1	----
EK058G: Nitrate as N by Discrete Analyser								
Nitrate as N (Sol.)	----	0.1	mg/kg	<0.1	0.1	0.2	0.9	----
EK059G: Nitrite plus Nitrate as N (NOx) by Discrete Analyser								
Nitrite + Nitrate as N (Sol.)	----	0.1	mg/kg	<0.1	0.1	0.2	0.9	----
EK061G: Total Kjeldahl Nitrogen By Discrete Analyser								
Total Kjeldahl Nitrogen as N	----	20	mg/kg	670	580	520	340	----
EK062: Total Nitrogen as N (TKN + NOx)								
^ Total Nitrogen as N	----	20	mg/kg	670	580	520	340	----
EK067G: Total Phosphorus as P by Discrete Analyser								
Total Phosphorus as P	----	2	mg/kg	366	319	293	268	----
EK085M: Sulfide as S2-								
Sulfide as S	----	0.01	%	0.04	0.08	0.02	0.09	----
EP003: Total Organic Carbon (TOC) in Soil								
Total Organic Carbon	----	0.02	%	0.47	0.44	0.58	0.52	----

QUALITY CONTROL REPORT

Work Order	: **EB1125529**	Page	: 1 of 13
Client	: **ALS WATER RESOURCES GROUP**	Laboratory	: Environmental Division Brisbane
Contact	: MR MARK DAHM	Contact	: Customer Services
Address	: PO BOX 3216 YERONGA 4104	Address	: 32 Shand Street Stafford QLD Australia 4053
E-mail	: mark.dahm@alsglobal.com	E-mail	: Brisbane.Enviro.Services@alsglobal.com
Telephone	: +61 07 3859 7800	Telephone	: +61 7 3243 7222
Facsimile	: +61 07 3859 7820	Facsimile	: +61 7 3243 7218
Project	: CQ212766	QC Level	: NEPM 1999 Schedule B(3) and ALS QCS3 requirement
Site	: ----		
C-O-C number	: ----	Date Samples Received	: 30-NOV-2011
Sampler	: Mark Dahm	Issue Date	: 09-DEC-2011
Order number	: ----		
		No. of samples received	: 9
Quote number	: BN/623/11	No. of samples analysed	: 9

This report supersedes any previous report(s) with this reference. Results apply to the sample(s) as submitted. All pages of this report have been checked and approved for release.

This Quality Control Report contains the following information:

- Laboratory Duplicate (DUP) Report; Relative Percentage Difference (RPD) and Acceptance Limits
- Method Blank (MB) and Laboratory Control Spike (LCS) Report; Recovery and Acceptance Limits
- Matrix Spike (MS) Report; Recovery and Acceptance Limits

NATA WORLD RECOGNISED ACCREDITATION

NATA Accredited Laboratory 825

This document is issued in accordance with NATA accreditation requirements.

Accredited for compliance with ISO/IEC 17025.

Signatories

This document has been electronically signed by the authorized signatories indicated below. Electronic signing has been carried out in compliance with procedures specified in 21 CFR Part 11.

Signatories	*Position*	*Accreditation Category*
Andrew Matheson	Senior Organic Instrument Chemist	Brisbane Organics
Kim McCabe	Senior Inorganic Chemist	Brisbane Inorganics
Matt Frost	Senior Organic Chemist	Brisbane Organics
Stephen Hislop	Senior Inorganic Chemist	Brisbane Inorganics

General Comments

The analytical procedures used by the Environmental Division have been developed from established internationally recognized procedures such as those published by the USEPA, APHA, AS and NEPM. In house developed procedures are employed in the absence of documented standards or by client request.

Where moisture determination has been performed, results are reported on a dry weight basis.

Where a reported less than (<) result is higher than the LOR, this may be due to primary sample extract/digestate dilution and/or insuffient sample for analysis.

Where the LOR of a reported result differs from standard LOR, this may be due to high moisture content, insufficient sample (reduced weight employed) or matrix interference.

Key : Anonymous = Refers to samples which are not specifically part of this work order but formed part of the QC process lot

CAS Number = CAS registry number from database maintained by Chemical Abstracts Services. The Chemical Abstracts Service is a division of the American Chemical Society.

LOR = Limit of reporting

RPD = Relative Percentage Difference

= Indicates failed QC

Laboratory Duplicate (DUP) Report

The quality control term Laboratory Duplicate refers to a randomly selected intralaboratory split. Laboratory duplicates provide information regarding method precision and sample heterogeneity. The permitted ranges for the Relative Percent Deviation (RPD) of Laboratory Duplicates are specified in ALS Method QWI-EN/38 and are dependent on the magnitude of results in comparison to the level of reporting: Result < 10 times LOR:- No Limit; Result between 10 and 20 times LOR:- 0% - 50%; Result > 20 times LOR:- 0% - 20%.

Sub-Matrix: **WATER**

				Laboratory Duplicate (DUP) Report					
Laboratory sample ID	Client sample ID	Method: Compound	CAS Number	LOR	Unit	Original Result	Duplicate Result	RPD (%)	Recovery Limits (%)
EA025: Suspended Solids (QC Lot: 2073880)									
EB1125529-001	Styx U/S	EA025H: Suspended Solids (SS)	----	5	mg/L	316	328	3.7	0% - 20%
EB1125637-001	Anonymous	EA025H: Suspended Solids (SS)	----	5	mg/L	7	7	0.0	No Limit
ED040F: Dissolved Major Anions (QC Lot: 2070435)									
EB1125494-001	Anonymous	ED040F: Sulfate as SO4 2-	14808-79-8	1	mg/L	880	893	1.4	0% - 20%
EB1125529-005	Est2U/S	ED040F: Sulfate as SO4 2-	14808-79-8	1	mg/L	2940	2990	1.8	0% - 20%
ED045G: Chloride Discrete analyser (QC Lot: 2070437)									
EB1125494-001	Anonymous	ED045G: Chloride	16887-00-6	1	mg/L	460	463	0.6	0% - 20%
EB1125529-005	Est2U/S	ED045G: Chloride	16887-00-6	1	mg/L	18600	18700	0.5	0% - 20%
ED093F: Dissolved Major Cations (QC Lot: 2070436)									
EB1125494-001	Anonymous	ED093F: Calcium	7440-70-2	1	mg/L	240	242	1.1	0% - 20%
		ED093F: Magnesium	7439-95-4	1	mg/L	62	62	0.0	0% - 20%
		ED093F: Sodium	7440-23-5	1	mg/L	347	350	0.8	0% - 20%
		ED093F: Potassium	7440-09-7	1	mg/L	22	22	0.0	0% - 20%
EB1125529-005	Est2U/S	ED093F: Calcium	7440-70-2	1	mg/L	412	416	1.1	0% - 20%
		ED093F: Magnesium	7439-95-4	1	mg/L	1450	1460	0.6	0% - 20%
		ED093F: Sodium	7440-23-5	1	mg/L	12000	12000	0.2	0% - 20%
		ED093F: Potassium	7440-09-7	1	mg/L	477	479	0.4	0% - 20%
EG020F: Dissolved Metals by ICP-MS (QC Lot: 2077578)									
EB1125529-001	Styx U/S	EG020A-F: Cadmium	7440-43-9	0.0001	mg/L	<0.0050	<0.0050	0.0	No Limit
		EG020A-F: Arsenic	7440-38-2	0.001	mg/L	<0.050	<0.050	0.0	No Limit
		EG020A-F: Chromium	7440-47-3	0.001	mg/L	<0.010	<0.010	0.0	No Limit
		EG020A-F: Cobalt	7440-48-4	0.001	mg/L	<0.010	<0.010	0.0	No Limit
		EG020A-F: Copper	7440-50-8	0.001	mg/L	<0.050	<0.050	0.0	No Limit
		EG020A-F: Lead	7439-92-1	0.001	mg/L	<0.010	<0.010	0.0	No Limit
		EG020A-F: Manganese	7439-96-5	0.001	mg/L	<0.010	<0.010	0.0	No Limit
		EG020A-F: Molybdenum	7439-98-7	0.001	mg/L	0.012	0.012	0.0	0% - 50%
		EG020A-F: Nickel	7440-02-0	0.001	mg/L	<0.050	<0.050	0.0	No Limit
		EG020A-F: Zinc	7440-66-6	0.005	mg/L	<0.250	<0.250	0.0	No Limit
		EG020A-F: Aluminium	7429-90-5	0.01	mg/L	<0.50	<0.50	0.0	No Limit
		EG020A-F: Selenium	7782-49-2	0.01	mg/L	<0.10	<0.10	0.0	No Limit
		EG020A-F: Vanadium	7440-62-2	0.01	mg/L	<0.10	<0.10	0.0	No Limit
		EG020A-F: Boron	7440-42-8	0.05	mg/L	4.53	4.43	2.3	0% - 20%
		EG020A-F: Iron	7439-89-6	0.05	mg/L	<0.50	0.51	0.0	0% - 50%
EB1125816-001	Anonymous	EG020A-F: Cadmium	7440-43-9	0.0001	mg/L	0.0002	0.0002	0.0	No Limit
		EG020A-F: Arsenic	7440-38-2	0.001	mg/L	0.004	0.005	0.0	No Limit

Sub-Matrix: **WATER**

				Laboratory Duplicate (DUP) Report					
Laboratory sample ID	**Client sample ID**	**Method: Compound**	**CAS Number**	**LOR**	**Unit**	**Original Result**	**Duplicate Result**	**RPD (%)**	**Recovery Limits (%)**
EG020F: Dissolved Metals by ICP-MS (QC Lot: 2077578) - continued									
EB1125816-001	Anonymous	EG020A-F: Chromium	7440-47-3	0.001	mg/L	0.002	0.002	0.0	No Limit
		EG020A-F: Cobalt	7440-48-4	0.001	mg/L	<0.001	<0.001	0.0	No Limit
		EG020A-F: Copper	7440-50-8	0.001	mg/L	0.007	0.007	0.0	No Limit
		EG020A-F: Lead	7439-92-1	0.001	mg/L	<0.001	<0.001	0.0	No Limit
		EG020A-F: Manganese	7439-96-5	0.001	mg/L	0.050	0.052	5.3	0% - 20%
		EG020A-F: Molybdenum	7439-98-7	0.001	mg/L	0.002	0.002	0.0	No Limit
		EG020A-F: Nickel	7440-02-0	0.001	mg/L	<0.001	<0.001	0.0	No Limit
		EG020A-F: Zinc	7440-66-6	0.005	mg/L	0.006	0.006	0.0	No Limit
		EG020A-F: Aluminium	7429-90-5	0.01	mg/L	<0.01	<0.01	0.0	No Limit
		EG020A-F: Selenium	7782-49-2	0.01	mg/L	<0.01	<0.01	0.0	No Limit
		EG020A-F: Vanadium	7440-62-2	0.01	mg/L	<0.01	<0.01	0.0	No Limit
		EG020A-F: Boron	7440-42-8	0.05	mg/L	0.13	0.11	14.1	No Limit
		EG020A-F: Iron	7439-89-6	0.05	mg/L	<0.05	<0.05	0.0	No Limit
EG020F: Dissolved Metals by ICP-MS (QC Lot: 2077579)									
EB1125529-001	Styx U/S	EG020B-F: Silver	7440-22-4	0.001	mg/L	<0.010	<0.010	0.0	No Limit
		EG020B-F: Uranium	7440-61-1	0.001	mg/L	<0.010	<0.010	0.0	No Limit
EG020T: Total Metals by ICP-MS (QC Lot: 2077582)									
EB1125529-001	Styx U/S	EG020A-T: Cadmium	7440-43-9	0.0001	mg/L	<0.0050	<0.0050	0.0	No Limit
		EG020A-T: Arsenic	7440-38-2	0.001	mg/L	<0.050	<0.050	0.0	No Limit
		EG020A-T: Chromium	7440-47-3	0.001	mg/L	0.012	0.012	0.0	0% - 50%
		EG020A-T: Cobalt	7440-48-4	0.001	mg/L	<0.010	<0.010	0.0	No Limit
		EG020A-T: Copper	7440-50-8	0.001	mg/L	<0.050	<0.050	0.0	No Limit
		EG020A-T: Lead	7439-92-1	0.001	mg/L	<0.010	<0.010	0.0	No Limit
		EG020A-T: Manganese	7439-96-5	0.001	mg/L	0.172	0.178	3.8	0% - 20%
		EG020A-T: Molybdenum	7439-98-7	0.001	mg/L	0.010	0.010	0.0	0% - 50%
		EG020A-T: Nickel	7440-02-0	0.001	mg/L	<0.050	<0.050	0.0	No Limit
		EG020A-T: Zinc	7440-66-6	0.005	mg/L	<0.250	<0.250	0.0	No Limit
		EG020A-T: Aluminium	7429-90-5	0.01	mg/L	2.26	2.10	7.2	0% - 20%
		EG020A-T: Selenium	7782-49-2	0.01	mg/L	<0.10	<0.10	0.0	No Limit
		EG020A-T: Vanadium	7440-62-2	0.01	mg/L	<0.10	<0.10	0.0	No Limit
		EG020A-T: Boron	7440-42-8	0.05	mg/L	4.18	4.27	2.1	0% - 20%
		EG020A-T: Iron	7439-89-6	0.05	mg/L	4.25	4.24	0.0	0% - 20%
EB1125816-001	Anonymous	EG020A-T: Cadmium	7440-43-9	0.0001	mg/L	0.0005	0.0005	0.0	No Limit
		EG020A-T: Arsenic	7440-38-2	0.001	mg/L	0.004	0.004	0.0	No Limit
		EG020A-T: Chromium	7440-47-3	0.001	mg/L	0.001	0.001	0.0	No Limit
		EG020A-T: Cobalt	7440-48-4	0.001	mg/L	<0.001	<0.001	0.0	No Limit
		EG020A-T: Copper	7440-50-8	0.001	mg/L	0.017	0.017	0.0	0% - 50%
		EG020A-T: Lead	7439-92-1	0.001	mg/L	0.012	0.013	0.0	0% - 50%
		EG020A-T: Manganese	7439-96-5	0.001	mg/L	0.127	0.129	1.6	0% - 20%
		EG020A-T: Molybdenum	7439-98-7	0.001	mg/L	0.002	0.002	0.0	No Limit

Sub-Matrix: **WATER**

Laboratory sample ID	Client sample ID	Method: Compound	CAS Number	LOR	Unit	Original Result	Duplicate Result	RPD (%)	Recovery Limits (%)
				Laboratory Duplicate (DUP) Report					
EG020T: Total Metals by ICP-MS (QC Lot: 2077582) - continued									
EB1125816-001	Anonymous	EG020A-T: Nickel	7440-02-0	0.001	mg/L	0.001	<0.001	0.0	No Limit
		EG020A-T: Zinc	7440-66-6	0.005	mg/L	0.022	0.022	0.0	No Limit
		EG020A-T: Aluminium	7429-90-5	0.01	mg/L	0.26	0.31	17.6	0% - 20%
		EG020A-T: Selenium	7782-49-2	0.01	mg/L	<0.01	<0.01	0.0	No Limit
		EG020A-T: Vanadium	7440-62-2	0.01	mg/L	<0.01	<0.01	0.0	No Limit
		EG020A-T: Boron	7440-42-8	0.05	mg/L	0.13	0.11	17.0	No Limit
		EG020A-T: Iron	7439-89-6	0.05	mg/L	0.54	0.57	6.0	0% - 50%
EG020T: Total Metals by ICP-MS (QC Lot: 2077583)									
EB1125529-001	Styx U/S	EG020B-T: Silver	7440-22-4	0.001	mg/L	<0.010	<0.010	0.0	No Limit
		EG020B-T: Uranium	7440-61-1	0.001	mg/L	<0.010	<0.010	0.0	No Limit
EG035F: Dissolved Mercury by FIMS (QC Lot: 2077577)									
EB1125529-001	Styx U/S	EG035F: Mercury	7439-97-6	0.0001	mg/L	<0.0001	<0.0001	0.0	No Limit
EB1125816-001	Anonymous	EG035F: Mercury	7439-97-6	0.0001	mg/L	<0.0001	<0.0001	0.0	No Limit
EG035T: Total Recoverable Mercury by FIMS (QC Lot: 2077319)									
EB1125365-001	Anonymous	EG035T: Mercury	7439-97-6	0.0001	mg/L	<0.0001	<0.0001	0.0	No Limit
EB1125365-011	Anonymous	EG035T: Mercury	7439-97-6	0.0001	mg/L	<0.0001	<0.0001	0.0	No Limit
EG035T: Total Recoverable Mercury by FIMS (QC Lot: 2077320)									
EB1125529-007	Est3U/S	EG035T: Mercury	7439-97-6	0.0001	mg/L	<0.0001	<0.0001	0.0	No Limit
EB1125549-001	Anonymous	EG035T: Mercury	7439-97-6	0.0001	mg/L	<0.0001	<0.0001	0.0	No Limit
EK040P: Fluoride by PC Titrator (QC Lot: 2069652)									
EB1125517-001	Anonymous	EK040P: Fluoride	16984-48-8	0.1	mg/L	3.2	3.3	0.0	0% - 20%
EB1125529-003	Styx D/S1	EK040P: Fluoride	16984-48-8	0.1	mg/L	0.8	0.8	0.0	No Limit
EK055G: Ammonia as N by Discrete Analyser (QC Lot: 2077236)									
EB1125529-001	Styx U/S	EK055G: Ammonia as N	7664-41-7	0.01	mg/L	0.06	0.05	22.6	No Limit
EB1125628-001	Anonymous	EK055G: Ammonia as N	7664-41-7	0.01	mg/L	0.04	0.03	40.0	No Limit
EK057G: Nitrite as N by Discrete Analyser (QC Lot: 2070438)									
EB1125494-001	Anonymous	EK057G: Nitrite as N	----	0.01	mg/L	<0.01	<0.01	0.0	No Limit
EB1125529-005	Est2U/S	EK057G: Nitrite as N	----	0.01	mg/L	<0.01	<0.01	0.0	No Limit
EK057G: Nitrite as N by Discrete Analyser (QC Lot: 2070440)									
EB1125552-006	Anonymous	EK057G: Nitrite as N	----	0.01	mg/L	<0.01	<0.01	0.0	No Limit
EB1125680-001	Anonymous	EK057G: Nitrite as N	----	0.01	mg/L	<0.01	<0.01	0.0	No Limit
EK059G: Nitrite plus Nitrate as N (NOx) by Discrete Analyser (QC Lot: 2077235)									
EB1125529-001	Styx U/S	EK059G: Nitrite + Nitrate as N	----	0.01	mg/L	0.01	0.01	0.0	No Limit
EB1125628-001	Anonymous	EK059G: Nitrite + Nitrate as N	----	0.01	mg/L	0.02	0.01	0.0	No Limit
EK061G: Total Kjeldahl Nitrogen By Discrete Analyser (QC Lot: 2075031)									
EB1125529-001	Styx U/S	EK061G: Total Kjeldahl Nitrogen as N	----	0.1	mg/L	0.7	0.7	0.0	No Limit
EK067G: Total Phosphorus as P by Discrete Analyser (QC Lot: 2075032)									
EB1125529-001	Styx U/S	EK067G: Total Phosphorus as P	----	0.01	mg/L	0.27	0.35	25.8	0% - 20%

Sub-Matrix: **WATER**

Laboratory sample ID	Client sample ID	Method: Compound	CAS Number	LOR	Unit	Original Result	Duplicate Result	RPD (%)	Recovery Limits (%)
				Laboratory Duplicate (DUP) Report					
EK071G: Reactive Phosphorus as P by discrete analyser (QC Lot: 2070439)									
EB1125494-001	Anonymous	EK071G: Reactive Phosphorus as P	----	0.01	mg/L	<0.01	<0.01	0.0	No Limit
EB1125529-005	Est2U/S	EK071G: Reactive Phosphorus as P	----	0.01	mg/L	0.01	0.01	0.0	No Limit
EP075(SIM)B: Polynuclear Aromatic Hydrocarbons (QC Lot: 2069784)									
EB1125529-001	Styx U/S	EP075(SIM): Benzo(a)pyrene	50-32-8	0.5	µg/L	<0.5	<0.5	0.0	No Limit
		EP075(SIM): Sum of polycyclic aromatic hydrocarbons	----	0.5	µg/L	<0.5	<0.5	0.0	No Limit
		EP075(SIM): Naphthalene	91-20-3	1.0	µg/L	<1.0	<1.0	0.0	No Limit
		EP075(SIM): Acenaphthylene	208-96-8	1.0	µg/L	<1.0	<1.0	0.0	No Limit
		EP075(SIM): Acenaphthene	83-32-9	1.0	µg/L	<1.0	<1.0	0.0	No Limit
		EP075(SIM): Fluorene	86-73-7	1.0	µg/L	<1.0	<1.0	0.0	No Limit
		EP075(SIM): Phenanthrene	85-01-8	1.0	µg/L	<1.0	<1.0	0.0	No Limit
		EP075(SIM): Anthracene	120-12-7	1.0	µg/L	<1.0	<1.0	0.0	No Limit
		EP075(SIM): Fluoranthene	206-44-0	1.0	µg/L	<1.0	<1.0	0.0	No Limit
		EP075(SIM): Pyrene	129-00-0	1.0	µg/L	<1.0	<1.0	0.0	No Limit
		EP075(SIM): Benz(a)anthracene	56-55-3	1.0	µg/L	<1.0	<1.0	0.0	No Limit
		EP075(SIM): Chrysene	218-01-9	1.0	µg/L	<1.0	<1.0	0.0	No Limit
		EP075(SIM): Benzo(b)fluoranthene	205-99-2	1.0	µg/L	<1.0	<1.0	0.0	No Limit
		EP075(SIM): Benzo(k)fluoranthene	207-08-9	1.0	µg/L	<1.0	<1.0	0.0	No Limit
		EP075(SIM): Indeno(1.2.3.cd)pyrene	193-39-5	1.0	µg/L	<1.0	<1.0	0.0	No Limit
		EP075(SIM): Dibenz(a.h)anthracene	53-70-3	1.0	µg/L	<1.0	<1.0	0.0	No Limit
		EP075(SIM): Benzo(g.h.i)perylene	191-24-2	1.0	µg/L	<1.0	<1.0	0.0	No Limit
EP080/071: Total Petroleum Hydrocarbons (QC Lot: 2069783)									
EB1125529-001	Styx U/S	EP071: C15 - C28 Fraction	----	100	µg/L	<100	<100	0.0	No Limit
		EP071: C10 - C14 Fraction	----	50	µg/L	<50	<50	0.0	No Limit
		EP071: C29 - C36 Fraction	----	50	µg/L	<50	<50	0.0	No Limit
EP080/071: Total Petroleum Hydrocarbons (QC Lot: 2075447)									
EB1125529-001	Styx U/S	EP080: C6 - C9 Fraction	----	20	µg/L	<20	<20	0.0	No Limit
EB1125529-009	Wellington Creek D/S	EP080: C6 - C9 Fraction	----	20	µg/L	<20	<20	0.0	No Limit
EP080/071: Total Recoverable Hydrocarbons - NEPM 2010 Draft (QC Lot: 2069783)									
EB1125529-001	Styx U/S	EP071: >C10 - C16 Fraction	----	100	µg/L	<100	<100	0.0	No Limit
		EP071: >C16 - C34 Fraction	----	100	µg/L	<100	<100	0.0	No Limit
		EP071: >C34 - C40 Fraction	----	100	µg/L	<100	<100	0.0	No Limit
EP080/071: Total Recoverable Hydrocarbons - NEPM 2010 Draft (QC Lot: 2075447)									
EB1125529-001	Styx U/S	EP080: C6 - C10 Fraction	----	20	µg/L	<20	<20	0.0	No Limit
		EP080: C6 - C10 Fraction minus BTEX (F1)	----	20	µg/L	<20	<20	0.0	No Limit
EB1125529-009	Wellington Creek D/S	EP080: C6 - C10 Fraction	----	20	µg/L	<20	<20	0.0	No Limit
		EP080: C6 - C10 Fraction minus BTEX (F1)	----	20	µg/L	<20	<20	0.0	No Limit
EP080: BTEXN (QC Lot: 2075447)									
EB1125529-001	Styx U/S	EP080: Benzene	71-43-2	1	µg/L	<1	<1	0.0	No Limit

Sub-Matrix: **WATER**

Laboratory sample ID	Client sample ID	Method: Compound	CAS Number	LOR	Unit	Original Result	Duplicate Result	RPD (%)	Recovery Limits (%)
				Laboratory Duplicate (DUP) Report					
EP080: BTEXN (QC Lot: 2075447) - continued									
EB1125529-001	Styx U/S	EP080: Sum of BTEX	----	1	µg/L	<1	<1	0.0	No Limit
		EP080: Toluene	108-88-3	2	µg/L	<2	<2	0.0	No Limit
		EP080: Ethylbenzene	100-41-4	2	µg/L	<2	<2	0.0	No Limit
		EP080: meta- & para-Xylene	108-38-3 106-42-3	2	µg/L	<2	<2	0.0	No Limit
		EP080: ortho-Xylene	95-47-6	2	µg/L	<2	<2	0.0	No Limit
		EP080: Total Xylenes	1330-20-7	2	µg/L	<2	<2	0.0	No Limit
		EP080: Naphthalene	91-20-3	5	µg/L	<5	<5	0.0	No Limit
EB1125529-009	Wellington Creek D/S	EP080: Benzene	71-43-2	1	µg/L	<1	<1	0.0	No Limit
		EP080: Sum of BTEX	----	1	µg/L	<1	<1	0.0	No Limit
		EP080: Toluene	108-88-3	2	µg/L	<2	<2	0.0	No Limit
		EP080: Ethylbenzene	100-41-4	2	µg/L	<2	<2	0.0	No Limit
		EP080: meta- & para-Xylene	108-38-3 106-42-3	2	µg/L	<2	<2	0.0	No Limit
		EP080: ortho-Xylene	95-47-6	2	µg/L	<2	<2	0.0	No Limit
		EP080: Total Xylenes	1330-20-7	2	µg/L	<2	<2	0.0	No Limit
		EP080: Naphthalene	91-20-3	5	µg/L	<5	<5	0.0	No Limit

Method Blank (MB) and Laboratory Control Spike (LCS) Report

The quality control term Method / Laboratory Blank refers to an analyte free matrix to which all reagents are added in the same volumes or proportions as used in standard sample preparation. The purpose of this QC parameter is to monitor potential laboratory contamination. The quality control term Laboratory Control Sample (LCS) refers to a certified reference material, or a known interference free matrix spiked with target analytes. The purpose of this QC parameter is to monitor method precision and accuracy independent of sample matrix. Dynamic Recovery Limits are based on statistical evaluation of processed LCS.

Sub-Matrix: **WATER**

				Method Blank (MB) Report	Laboratory Control Spike (LCS) Report			
					Spike	Spike Recovery (%)	Recovery Limits (%)	
Method: Compound	**CAS Number**	**LOR**	**Unit**	**Result**	**Concentration**	**LCS**	**Low**	**High**
EA025: Suspended Solids (QCLot: 2073880)								
EA025H: Suspended Solids (SS)	----	5	mg/L	<5	150 mg/L	104	82	120
ED040F: Dissolved Major Anions (QCLot: 2070435)								
ED040F: Sulfate as SO4 2-	14808-79-8	1	mg/L	<1	----	----	----	----
ED045G: Chloride Discrete analyser (QCLot: 2070437)								
ED045G: Chloride	16887-00-6	1	mg/L	<1	1000 mg/L	99.4	70	128
ED093F: Dissolved Major Cations (QCLot: 2070436)								
ED093F: Calcium	7440-70-2	1	mg/L	<1	----	----	----	----
ED093F: Magnesium	7439-95-4	1	mg/L	<1	----	----	----	----
ED093F: Sodium	7440-23-5	1	mg/L	<1	----	----	----	----
ED093F: Potassium	7440-09-7	1	mg/L	<1	----	----	----	----
EG020F: Dissolved Metals by ICP-MS (QCLot: 2077578)								
EG020A-F: Aluminium	7429-90-5	0.01	mg/L	<0.01	0.500 mg/L	98.3	83	125
EG020A-F: Arsenic	7440-38-2	0.001	mg/L	<0.001	0.100 mg/L	97.8	86	124
EG020A-F: Cadmium	7440-43-9	0.0001	mg/L	<0.0001	0.100 mg/L	96.2	89	117
EG020A-F: Chromium	7440-47-3	0.001	mg/L	<0.001	0.100 mg/L	96.8	89	127
EG020A-F: Cobalt	7440-48-4	0.001	mg/L	<0.001	0.100 mg/L	103	88	116
EG020A-F: Copper	7440-50-8	0.001	mg/L	<0.001	0.200 mg/L	101	86	115
EG020A-F: Lead	7439-92-1	0.001	mg/L	<0.001	0.100 mg/L	97.6	91	111
EG020A-F: Manganese	7439-96-5	0.001	mg/L	<0.001	0.100 mg/L	106	85	118
EG020A-F: Molybdenum	7439-98-7	0.001	mg/L	<0.001	0.100 mg/L	97.8	91	113
EG020A-F: Nickel	7440-02-0	0.001	mg/L	<0.001	0.100 mg/L	102	88	115
EG020A-F: Selenium	7782-49-2	0.01	mg/L	<0.01	0.100 mg/L	99.1	86	122
EG020A-F: Vanadium	7440-62-2	0.01	mg/L	<0.01	0.100 mg/L	95.5	81	113
EG020A-F: Zinc	7440-66-6	0.005	mg/L	<0.005	0.200 mg/L	104	86	120
EG020A-F: Boron	7440-42-8	0.05	mg/L	<0.05	0.50 mg/L	105	70	129
EG020A-F: Iron	7439-89-6	0.05	mg/L	<0.05	0.50 mg/L	109	84	124
EG020F: Dissolved Metals by ICP-MS (QCLot: 2077579)								
EG020B-F: Silver	7440-22-4	0.001	mg/L	<0.001	0.100 mg/L	94.6	82	118
EG020B-F: Uranium	7440-61-1	0.001	mg/L	<0.001	----	----	----	----
EG020T: Total Metals by ICP-MS (QCLot: 2077582)								
EG020A-T: Aluminium	7429-90-5	0.01	mg/L	<0.01	0.500 mg/L	102	70	120
EG020A-T: Arsenic	7440-38-2	0.001	mg/L	<0.001	0.100 mg/L	94.1	78	120
EG020A-T: Cadmium	7440-43-9	0.0001	mg/L	<0.0001	0.100 mg/L	92.0	84	114
EG020A-T: Chromium	7440-47-3	0.001	mg/L	<0.001	0.100 mg/L	99.1	86	121

Sub-Matrix: **WATER**

Method: Compound	CAS Number	LOR	Unit	Method Blank (MB) Report Result	Laboratory Control Spike (LCS) Report Spike Concentration	Spike Recovery (%) LCS	Recovery Limits (%) Low	Recovery Limits (%) High
EG020T: Total Metals by ICP-MS (QCLot: 2077582) - continued								
EG020A-T: Cobalt	7440-48-4	0.001	mg/L	<0.001	0.100 mg/L	109	86	120
EG020A-T: Copper	7440-50-8	0.001	mg/L	<0.001	0.200 mg/L	105	70	119
EG020A-T: Lead	7439-92-1	0.001	mg/L	<0.001	0.100 mg/L	98.3	70	117
EG020A-T: Manganese	7439-96-5	0.001	mg/L	<0.001	0.100 mg/L	112	87	123
EG020A-T: Molybdenum	7439-98-7	0.001	mg/L	<0.001	0.100 mg/L	100	70	114
EG020A-T: Nickel	7440-02-0	0.001	mg/L	<0.001	0.100 mg/L	108	86	119
EG020A-T: Selenium	7782-49-2	0.01	mg/L	<0.01	0.100 mg/L	90.6	70	112
EG020A-T: Vanadium	7440-62-2	0.01	mg/L	<0.01	0.100 mg/L	93.2	76	120
EG020A-T: Zinc	7440-66-6	0.005	mg/L	<0.005	0.200 mg/L	97.5	81	123
EG020A-T: Boron	7440-42-8	0.05	mg/L	<0.05	0.500 mg/L	104	76	129
EG020A-T: Iron	7439-89-6	0.05	mg/L	<0.05	0.500 mg/L	115	70	130
EG020T: Total Metals by ICP-MS (QCLot: 2077583)								
EG020B-T: Silver	7440-22-4	0.001	mg/L	<0.001	0.100 mg/L	95.2	83	121
EG020B-T: Uranium	7440-61-1	0.001	mg/L	<0.001	----	----	----	----
EG035F: Dissolved Mercury by FIMS (QCLot: 2077577)								
EG035F: Mercury	7439-97-6	0.0001	mg/L	<0.0001	0.010 mg/L	90.1	84	116
EG035T: Total Recoverable Mercury by FIMS (QCLot: 2077319)								
EG035T: Mercury	7439-97-6	0.0001	mg/L	<0.0001	0.0100 mg/L	95.1	80	116
EG035T: Total Recoverable Mercury by FIMS (QCLot: 2077320)								
EG035T: Mercury	7439-97-6	0.0001	mg/L	<0.0001	0.0100 mg/L	95.3	80	116
EK040P: Fluoride by PC Titrator (QCLot: 2069652)								
EK040P: Fluoride	16984-48-8	0.1	mg/L	<0.1	10 mg/L	105	85	115
EK055G: Ammonia as N by Discrete Analyser (QCLot: 2077236)								
EK055G: Ammonia as N	7664-41-7	0.01	mg/L	<0.01	0.5 mg/L	104	70	129
EK057G: Nitrite as N by Discrete Analyser (QCLot: 2070438)								
EK057G: Nitrite as N	----	0.01	mg/L	<0.01	0.5 mg/L	102	78	126
EK057G: Nitrite as N by Discrete Analyser (QCLot: 2070440)								
EK057G: Nitrite as N	----	0.01	mg/L	<0.01	0.5 mg/L	103	78	126
EK059G: Nitrite plus Nitrate as N (NOx) by Discrete Analyser (QCLot: 2077235)								
EK059G: Nitrite + Nitrate as N	----	0.01	mg/L	<0.01	0.5 mg/L	116	70	130
EK061G: Total Kjeldahl Nitrogen By Discrete Analyser (QCLot: 2075031)								
EK061G: Total Kjeldahl Nitrogen as N	----	0.1	mg/L	<0.1	10.0 mg/L	88.7	70	115
EK067G: Total Phosphorus as P by Discrete Analyser (QCLot: 2075032)								
EK067G: Total Phosphorus as P	----	0.01	mg/L	<0.01	4.2 mg/L	103	76	117
EK071G: Reactive Phosphorus as P by discrete analyser (QCLot: 2070439)								
EK071G: Reactive Phosphorus as P	----	0.01	mg/L	<0.01	0.5 mg/L	103	81	121
EP075(SIM)B: Polynuclear Aromatic Hydrocarbons (QCLot: 2069784)								

Sub-Matrix: **WATER**

Method: Compound	CAS Number	LOR	Unit	Method Blank (MB) Report	Laboratory Control Spike (LCS) Report			
					Spike	Spike Recovery (%)	Recovery Limits (%)	
				Result	Concentration	LCS	Low	High
EP075(SIM)B: Polynuclear Aromatic Hydrocarbons (QCLot: 2069784) - continued								
EP075(SIM): Naphthalene	91-20-3	1	µg/L	<1.0	10 µg/L	91.2	46	115
EP075(SIM): Acenaphthylene	208-96-8	1	µg/L	<1.0	10 µg/L	100	51	122
EP075(SIM): Acenaphthene	83-32-9	1	µg/L	<1.0	10 µg/L	92.3	50	118
EP075(SIM): Fluorene	86-73-7	1	µg/L	<1.0	10 µg/L	81.6	55	121
EP075(SIM): Phenanthrene	85-01-8	1	µg/L	<1.0	10 µg/L	96.4	54	110
EP075(SIM): Anthracene	120-12-7	1	µg/L	<1.0	10 µg/L	97.8	49	118
EP075(SIM): Fluoranthene	206-44-0	1	µg/L	<1.0	10 µg/L	96.9	51	117
EP075(SIM): Pyrene	129-00-0	1	µg/L	<1.0	10 µg/L	103	51	117
EP075(SIM): Benz(a)anthracene	56-55-3	1	µg/L	<1.0	10 µg/L	95.2	53	120
EP075(SIM): Chrysene	218-01-9	1	µg/L	<1.0	10 µg/L	100	48	114
EP075(SIM): Benzo(b)fluoranthene	205-99-2	1	µg/L	<1.0	10 µg/L	88.9	48	133
EP075(SIM): Benzo(k)fluoranthene	207-08-9	1	µg/L	<1.0	10 µg/L	85.1	43	127
EP075(SIM): Benzo(a)pyrene	50-32-8	0.5	µg/L	<0.5	10 µg/L	90.4	44	120
EP075(SIM): Indeno(1.2.3.cd)pyrene	193-39-5	1	µg/L	<1.0	10 µg/L	103	45	132
EP075(SIM): Dibenz(a.h)anthracene	53-70-3	1	µg/L	<1.0	10 µg/L	104	47	135
EP075(SIM): Benzo(g.h.i)perylene	191-24-2	1	µg/L	<1.0	10 µg/L	102	42	131
EP075(SIM): Sum of polycyclic aromatic hydrocarbons	----	1	µg/L	<1.0	----	----	----	----
EP080/071: Total Petroleum Hydrocarbons (QCLot: 2069783)								
EP071: C10 - C14 Fraction	----	50	µg/L	<50	1275 µg/L	59.5	49	125.5
EP071: C15 - C28 Fraction	----	100	µg/L	<100	1850 µg/L	63.7	58	131
EP071: C29 - C36 Fraction	----	50	µg/L	<50	----	----	----	----
EP080/071: Total Petroleum Hydrocarbons (QCLot: 2075447)								
EP080: C6 - C9 Fraction	----	20	µg/L	<20	160 µg/L	102	69	135
EP080/071: Total Recoverable Hydrocarbons - NEPM 2010 Draft (QCLot: 2069783)								
EP071: >C10 - C16 Fraction	----	100	µg/L	<100	1670 µg/L	59.7	49	125.5
EP071: >C16 - C34 Fraction	----	100	µg/L	<100	1285 µg/L	66.0	58	131
EP071: >C34 - C40 Fraction	----	100	µg/L	<100	----	----	----	----
EP080/071: Total Recoverable Hydrocarbons - NEPM 2010 Draft (QCLot: 2075447)								
EP080: C6 - C10 Fraction	----	20	µg/L	<20	185 µg/L	102	64	136
EP080: C6 - C10 Fraction minus BTEX (F1)	----	20	µg/L	<20	----	----	----	----
EP080: BTEXN (QCLot: 2075447)								
EP080: Benzene	71-43-2	1	µg/L	<1	10 µg/L	102	76	124
EP080: Toluene	108-88-3	2	µg/L	<2	10 µg/L	103	71	123
EP080: Ethylbenzene	100-41-4	2	µg/L	<2	10 µg/L	104	73	125
EP080: meta- & para-Xylene	108-38-3 106-42-3	2	µg/L	<2	20 µg/L	103	70.4	129
EP080: ortho-Xylene	95-47-6	2	µg/L	<2	10 µg/L	105	72	124
EP080: Total Xylenes	1330-20-7	2	µg/L	<2	----	----	----	----

Sub-Matrix: **WATER**

Method: Compound	CAS Number	LOR	Unit	Method Blank (MB) Report Result	Laboratory Control Spike (LCS) Report Spike Concentration	Spike Recovery (%) LCS	Recovery Limits (%) Low	Recovery Limits (%) High
EP080: BTEXN (QCLot: 2075447) - continued								
EP080: Sum of BTEX	----	1	µg/L	<1	----	----	----	----
EP080: Naphthalene	91-20-3	5	µg/L	<5	10 µg/L	104	77	119

Matrix Spike (MS) Report

The quality control term Matrix Spike (MS) refers to an intralaboratory split sample spiked with a representative set of target analytes. The purpose of this QC parameter is to monitor potential matrix effects on analyte recoveries. Static Recovery Limits as per laboratory Data Quality Objectives (DQOs). Ideal recovery ranges stated may be waived in the event of sample matrix interference.

Sub-Matrix: **WATER**

				Matrix Spike (MS) Report			
				Spike	Spike Recovery (%)	Recovery Limits (%)	
Laboratory sample ID	Client sample ID	Method: Compound	CAS Number	Concentration	MS	Low	High
ED045G: Chloride Discrete analyser (QCLot: 2070437)							
EB1125494-002	Anonymous	ED045G: Chloride	16887-00-6	400 mg/L	82.8	70	130
EG020F: Dissolved Metals by ICP-MS (QCLot: 2077578)							
EB1125529-002	Styx Mid	EG020A-F: Aluminium	7429-90-5	5 mg/L	94.8	70	130
		EG020A-F: Arsenic	7440-38-2	0.100 mg/L	103	70	130
		EG020A-F: Cadmium	7440-43-9	0.100 mg/L	97.3	70	130
		EG020A-F: Chromium	7440-47-3	0.100 mg/L	92.1	70	130
		EG020A-F: Cobalt	7440-48-4	0.100 mg/L	100	70	130
		EG020A-F: Copper	7440-50-8	0.200 mg/L	93.7	70	130
		EG020A-F: Lead	7439-92-1	0.100 mg/L	87.5	70	130
		EG020A-F: Manganese	7439-96-5	0.100 mg/L	100	70	130
		EG020A-F: Molybdenum	7439-98-7	0.100 mg/L	87.0	70	130
		EG020A-F: Nickel	7440-02-0	0.100 mg/L	97.2	70	130
		EG020A-F: Selenium	7782-49-2	0.100 mg/L	112	70	130
		EG020A-F: Vanadium	7440-62-2	1 mg/L	98.1	70	130
		EG020A-F: Zinc	7440-66-6	2 mg/L	104	70	130
		EG020A-F: Boron	7440-42-8	5 mg/L	115	70	130
EG020T: Total Metals by ICP-MS (QCLot: 2077582)							
EB1125529-002	Styx Mid	EG020A-T: Arsenic	7440-38-2	1.000 mg/L	116	70	130
		EG020A-T: Cadmium	7440-43-9	0.500 mg/L	98.5	70	130
		EG020A-T: Chromium	7440-47-3	1.000 mg/L	98.6	70	130
		EG020A-T: Cobalt	7440-48-4	1.000 mg/L	120	70	130
		EG020A-T: Copper	7440-50-8	1.000 mg/L	104	70	130
		EG020A-T: Lead	7439-92-1	1.000 mg/L	94.9	70	130
		EG020A-T: Manganese	7439-96-5	1.000 mg/L	119	70	130
		EG020A-T: Nickel	7440-02-0	1.000 mg/L	112	70	130
		EG020A-T: Vanadium	7440-62-2	1.000 mg/L	108	70	130
		EG020A-T: Zinc	7440-66-6	1.000 mg/L	107	70	130
EG035F: Dissolved Mercury by FIMS (QCLot: 2077577)							
EB1125529-002	Styx Mid	EG035F: Mercury	7439-97-6	0.010 mg/L	89.3	70	130
EG035T: Total Recoverable Mercury by FIMS (QCLot: 2077319)							
EB1125365-002	Anonymous	EG035T: Mercury	7439-97-6	0.010 mg/L	70.8	70	130
EG035T: Total Recoverable Mercury by FIMS (QCLot: 2077320)							
EB1125529-008	Est3D/S	EG035T: Mercury	7439-97-6	0.010 mg/L	95.9	70	130
EK040P: Fluoride by PC Titrator (QCLot: 2069652)							
EB1125517-001	Anonymous	EK040P: Fluoride	16984-48-8	6.1 mg/L	114	70	130

Sub-Matrix: **WATER**

				Matrix Spike (MS) Report			
				Spike	Spike Recovery (%)	Recovery Limits (%)	
Laboratory sample ID	Client sample ID	Method: Compound	CAS Number	Concentration	MS	Low	High
EK055G: Ammonia as N by Discrete Analyser (QCLot: 2077236)							
EB1125529-002	Styx Mid	EK055G: Ammonia as N	7664-41-7	.8 mg/L	87.0	70	130
EK057G: Nitrite as N by Discrete Analyser (QCLot: 2070438)							
EB1125494-002	Anonymous	EK057G: Nitrite as N	----	0.4 mg/L	101	70	130
EK057G: Nitrite as N by Discrete Analyser (QCLot: 2070440)							
EB1125552-001	Anonymous	EK057G: Nitrite as N	----	0.4 mg/L	100	70	130
EK059G: Nitrite plus Nitrate as N (NOx) by Discrete Analyser (QCLot: 2077235)							
EB1125529-002	Styx Mid	EK059G: Nitrite + Nitrate as N	----	0.4 mg/L	79.8	70	130
EK061G: Total Kjeldahl Nitrogen By Discrete Analyser (QCLot: 2075031)							
EB1125529-002	Styx Mid	EK061G: Total Kjeldahl Nitrogen as N	----	25 mg/L	94.5	70	130
EK067G: Total Phosphorus as P by Discrete Analyser (QCLot: 2075032)							
EB1125529-002	Styx Mid	EK067G: Total Phosphorus as P	----	5 mg/L	109	70	130
EK071G: Reactive Phosphorus as P by discrete analyser (QCLot: 2070439)							
EB1125494-002	Anonymous	EK071G: Reactive Phosphorus as P	----	0.4 mg/L	96.5	70	130
EP080/071: Total Petroleum Hydrocarbons (QCLot: 2075447)							
EB1125529-002	Styx Mid	EP080: C6 - C9 Fraction	----	40 µg/L	100	70	130
EP080/071: Total Recoverable Hydrocarbons - NEPM 2010 Draft (QCLot: 2075447)							
EB1125529-002	Styx Mid	EP080: C6 - C10 Fraction	----	40 µg/L	107	70	130
EP080: BTEXN (QCLot: 2075447)							
EB1125529-002	Styx Mid	EP080: Benzene	71-43-2	10 µg/L	100	70	130
		EP080: Toluene	108-88-3	10 µg/L	100	70	130

ALS Group
Environmental Division

Minerals Coal Environmental Tribology Food & Pharmaceutical Industrial

CERTIFICATE OF ANALYSIS

Work Order	: **EB1125529**	Page	: 1 of 11
Client	: **ALS WATER RESOURCES GROUP**	Laboratory	: Environmental Division Brisbane
Contact	: MR MARK DAHM	Contact	: Customer Services
Address	: PO BOX 3216 YERONGA 4104	Address	: 32 Shand Street Stafford QLD Australia 4053
E-mail	: mark.dahm@alsglobal.com	E-mail	: Brisbane.Enviro.Services@alsglobal.com
Telephone	: +61 07 3859 7800	Telephone	: +61 7 3243 7222
Facsimile	: +61 07 3859 7820	Facsimile	: +61 7 3243 7218
Project	: CQ212766	QC Level	: NEPM 1999 Schedule B(3) and ALS QCS3 requirement
Order number	: ----		
C-O-C number	: ----	Date Samples Received	: 30-NOV-2011
Sampler	: Mark Dahm	Issue Date	: 09-DEC-2011
Site	: ----		
		No. of samples received	: 9
Quote number	: BN/623/11	No. of samples analysed	: 9

This report supersedes any previous report(s) with this reference. Results apply to the sample(s) as submitted. All pages of this report have been checked and approved for release.

This Certificate of Analysis contains the following information:

- General Comments
- Analytical Results
- Surrogate Control Limits

NATA WORLD RECOGNISED ACCREDITATION

NATA Accredited Laboratory 825

This document is issued in accordance with NATA accreditation requirements.

Accredited for compliance with ISO/IEC 17025.

Signatories

This document has been electronically signed by the authorized signatories indicated below. Electronic signing has been carried out in compliance with procedures specified in 21 CFR Part 11.

Signatories	*Position*	*Accreditation Category*
Andrew Matheson	Senior Organic Instrument Chemist	Brisbane Organics
Kim McCabe	Senior Inorganic Chemist	Brisbane Inorganics
Matt Frost	Senior Organic Chemist	Brisbane Organics
Stephen Hislop	Senior Inorganic Chemist	Brisbane Inorganics

General Comments

The analytical procedures used by the Environmental Division have been developed from established internationally recognized procedures such as those published by the USEPA, APHA, AS and NEPM. In house developed procedures are employed in the absence of documented standards or by client request.

Where moisture determination has been performed, results are reported on a dry weight basis.

Where a reported less than (<) result is higher than the LOR, this may be due to primary sample extract/digestate dilution and/or insuffient sample for analysis.

Where the LOR of a reported result differs from standard LOR, this may be due to high moisture content, insufficient sample (reduced weight employed) or matrix interference.

When sampling time information is not provided by the client, sampling dates are shown without a time component. In these instances, the time component has been assumed by the laboratory for processing purposes.

Key : CAS Number = CAS registry number from database maintained by Chemical Abstracts Services. The Chemical Abstracts Service is a division of the American Chemical Society.
LOR = Limit of reporting
^ = This result is computed from individual analyte detections at or above the level of reporting

- **EG020-F/T (Dissolved/Total Metals): LORs for EB1125529 have been raised due to saline matrix interference.**
- **EK061G (TKN as N)/EK067G (Total Phosphorus as P) : The LOR for EB1125529 has been raised due to matrix interference.**

Analytical Results

Sub-Matrix: **MARINE WATER**

			Client sample ID	Styx U/S	Styx Mid	Styx D/S1	Styx D/S2	Est2U/S
			Client sampling date / time	[29-NOV-2011]	[29-NOV-2011]	[29-NOV-2011]	[29-NOV-2011]	[29-NOV-2011]
Compound	*CAS Number*	*LOR*	*Unit*	**EB1125529-001**	**EB1125529-002**	**EB1125529-003**	**EB1125529-004**	**EB1125529-005**
EA025: Suspended Solids								
Suspended Solids (SS)	----	5	mg/L	**316**	**621**	**231**	**349**	**359**
ED040F: Dissolved Major Anions								
Sulfate as SO4 2-	14808-79-8	1	mg/L	**2990**	**3010**	**2940**	**2940**	**2940**
ED045G: Chloride Discrete analyser								
Chloride	16887-00-6	1	mg/L	**18700**	**18700**	**18600**	**18500**	**18600**
ED093F: Dissolved Major Cations								
Calcium	7440-70-2	1	mg/L	**420**	**426**	**418**	**412**	**412**
Magnesium	7439-95-4	1	mg/L	**1460**	**1450**	**1440**	**1440**	**1450**
Sodium	7440-23-5	1	mg/L	**12100**	**12100**	**12000**	**12000**	**12000**
Potassium	7440-09-7	1	mg/L	**483**	**487**	**480**	**479**	**477**
EG020F: Dissolved Metals by ICP-MS								
Aluminium	7429-90-5	0.01	mg/L	<0.50	<0.50	<0.50	<0.50	<0.50
Arsenic	7440-38-2	0.001	mg/L	<0.050	<0.050	<0.050	<0.050	<0.050
Cadmium	7440-43-9	0.0001	mg/L	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050
Chromium	7440-47-3	0.001	mg/L	<0.010	<0.010	<0.010	<0.010	<0.010
Copper	7440-50-8	0.001	mg/L	<0.050	<0.050	<0.050	<0.050	<0.050
Cobalt	7440-48-4	0.001	mg/L	<0.010	<0.010	<0.010	<0.010	<0.010
Nickel	7440-02-0	0.001	mg/L	<0.050	<0.050	<0.050	<0.050	<0.050
Lead	7439-92-1	0.001	mg/L	<0.010	<0.010	<0.010	<0.010	<0.010
Zinc	7440-66-6	0.005	mg/L	<0.250	<0.250	<0.250	<0.250	<0.250
Manganese	7439-96-5	0.001	mg/L	<0.010	<0.010	<0.010	<0.010	<0.010
Molybdenum	7439-98-7	0.001	mg/L	**0.012**	**0.012**	**0.014**	<0.010	<0.010
Selenium	7782-49-2	0.01	mg/L	<0.10	<0.10	<0.10	<0.10	<0.10
Silver	7440-22-4	0.001	mg/L	<0.010	<0.010	<0.010	<0.010	<0.010
Uranium	7440-61-1	0.001	mg/L	<0.010	<0.010	<0.010	<0.010	<0.010
Vanadium	7440-62-2	0.01	mg/L	<0.10	<0.10	<0.10	<0.10	<0.10
Boron	7440-42-8	0.05	mg/L	**4.53**	**4.41**	**4.32**	**4.36**	**4.19**
Iron	7439-89-6	0.05	mg/L	<0.50	**0.58**	**0.66**	**0.72**	**0.73**
EG020T: Total Metals by ICP-MS								
Aluminium	7429-90-5	0.01	mg/L	**2.26**	**10.7**	**1.20**	**2.11**	**2.46**
Arsenic	7440-38-2	0.001	mg/L	<0.050	<0.050	<0.050	<0.050	<0.050
Cadmium	7440-43-9	0.0001	mg/L	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050
Chromium	7440-47-3	0.001	mg/L	**0.012**	**0.027**	**0.012**	**0.013**	**0.014**
Copper	7440-50-8	0.001	mg/L	<0.050	<0.050	<0.050	<0.050	<0.050
Cobalt	7440-48-4	0.001	mg/L	<0.010	<0.010	<0.010	<0.010	<0.010
Nickel	7440-02-0	0.001	mg/L	<0.050	<0.050	<0.050	<0.050	<0.050

Analytical Results

Sub-Matrix: MARINE WATER			Client sample ID	Styx U/S	Styx Mid	Styx D/S1	Styx D/S2	Est2U/S
			Client sampling date / time	[29-NOV-2011]	[29-NOV-2011]	[29-NOV-2011]	[29-NOV-2011]	[29-NOV-2011]
Compound	CAS Number	LOR	Unit	EB1125529-001	EB1125529-002	EB1125529-003	EB1125529-004	EB1125529-005
EG020T: Total Metals by ICP-MS - Continued								
Lead	7439-92-1	0.001	mg/L	<0.010	<0.010	<0.010	<0.010	<0.010
Zinc	7440-66-6	0.005	mg/L	<0.250	<0.250	<0.250	<0.250	<0.250
Manganese	7439-96-5	0.001	mg/L	**0.172**	**0.302**	**0.100**	**0.175**	**0.164**
Molybdenum	7439-98-7	0.001	mg/L	**0.010**	**0.012**	**0.011**	**0.014**	**0.014**
Selenium	7782-49-2	0.01	mg/L	<0.10	<0.10	<0.10	<0.10	<0.10
Silver	7440-22-4	0.001	mg/L	<0.010	<0.010	<0.010	<0.010	<0.010
Uranium	7440-61-1	0.001	mg/L	<0.010	<0.010	<0.010	<0.010	<0.010
Vanadium	7440-62-2	0.01	mg/L	<0.10	<0.10	<0.10	<0.10	<0.10
Boron	7440-42-8	0.05	mg/L	**4.18**	**4.22**	**4.23**	**4.16**	**4.11**
Iron	7439-89-6	0.05	mg/L	**4.25**	**15.4**	**2.87**	**4.28**	**4.86**
EG035F: Dissolved Mercury by FIMS								
Mercury	7439-97-6	0.0001	mg/L	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001
EG035T: Total Recoverable Mercury by FIMS								
Mercury	7439-97-6	0.0001	mg/L	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001
EK040P: Fluoride by PC Titrator								
Fluoride	16984-48-8	0.1	mg/L	**0.8**	**0.8**	**0.8**	**0.8**	**0.8**
EK055G: Ammonia as N by Discrete Analyser								
Ammonia as N	7664-41-7	0.01	mg/L	**0.06**	**0.06**	**0.07**	**0.05**	**0.05**
EK057G: Nitrite as N by Discrete Analyser								
Nitrite as N	----	0.01	mg/L	<0.01	<0.01	<0.01	<0.01	<0.01
EK058G: Nitrate as N by Discrete Analyser								
Nitrate as N	14797-55-8	0.01	mg/L	**0.01**	**0.01**	**0.02**	**0.01**	**0.01**
EK059G: Nitrite plus Nitrate as N (NOx) by Discrete Analyser								
Nitrite + Nitrate as N	----	0.01	mg/L	**0.01**	**0.01**	**0.02**	**0.01**	**0.01**
EK061G: Total Kjeldahl Nitrogen By Discrete Analyser								
Total Kjeldahl Nitrogen as N	----	0.1	mg/L	**0.7**	**0.9**	**0.6**	**0.7**	**0.8**
EK062G: Total Nitrogen as N (TKN + NOx) by Discrete Analyser								
^ Total Nitrogen as N	----	0.1	mg/L	**0.7**	**0.9**	**0.6**	**0.7**	**0.8**
EK067G: Total Phosphorus as P by Discrete Analyser								
Total Phosphorus as P	----	0.01	mg/L	**0.27**	<0.05	**0.11**	**0.08**	<0.05
EK071G: Reactive Phosphorus as P by discrete analyser								
Reactive Phosphorus as P	----	0.01	mg/L	**0.02**	**0.02**	**0.03**	**0.01**	**0.01**
EP075(SIM)B: Polynuclear Aromatic Hydrocarbons								
Naphthalene	91-20-3	1.0	µg/L	<1.0	<1.0	<1.0	<1.0	<1.0
Acenaphthylene	208-96-8	1.0	µg/L	<1.0	<1.0	<1.0	<1.0	<1.0

Analytical Results

Sub-Matrix: **MARINE WATER**			Client sample ID	Styx U/S	Styx Mid	Styx D/S1	Styx D/S2	Est2U/S
			Client sampling date / time	[29-NOV-2011]	[29-NOV-2011]	[29-NOV-2011]	[29-NOV-2011]	[29-NOV-2011]
Compound	*CAS Number*	*LOR*	*Unit*	**EB1125529-001**	**EB1125529-002**	**EB1125529-003**	**EB1125529-004**	**EB1125529-005**
EP075(SIM)B: Polynuclear Aromatic Hydrocarbons - Continued								
Acenaphthene	83-32-9	1.0	µg/L	<1.0	<1.0	<1.0	<1.0	<1.0
Fluorene	86-73-7	1.0	µg/L	<1.0	<1.0	<1.0	<1.0	<1.0
Phenanthrene	85-01-8	1.0	µg/L	<1.0	<1.0	<1.0	<1.0	<1.0
Anthracene	120-12-7	1.0	µg/L	<1.0	<1.0	<1.0	<1.0	<1.0
Fluoranthene	206-44-0	1.0	µg/L	<1.0	<1.0	<1.0	<1.0	<1.0
Pyrene	129-00-0	1.0	µg/L	<1.0	<1.0	<1.0	<1.0	<1.0
Benz(a)anthracene	56-55-3	1.0	µg/L	<1.0	<1.0	<1.0	<1.0	<1.0
Chrysene	218-01-9	1.0	µg/L	<1.0	<1.0	<1.0	<1.0	<1.0
Benzo(b)fluoranthene	205-99-2	1.0	µg/L	<1.0	<1.0	<1.0	<1.0	<1.0
Benzo(k)fluoranthene	207-08-9	1.0	µg/L	<1.0	<1.0	<1.0	<1.0	<1.0
Benzo(a)pyrene	50-32-8	0.5	µg/L	<0.5	<0.5	<0.5	<0.5	<0.5
Indeno(1.2.3.cd)pyrene	193-39-5	1.0	µg/L	<1.0	<1.0	<1.0	<1.0	<1.0
Dibenz(a.h)anthracene	53-70-3	1.0	µg/L	<1.0	<1.0	<1.0	<1.0	<1.0
Benzo(g.h.i)perylene	191-24-2	1.0	µg/L	<1.0	<1.0	<1.0	<1.0	<1.0
^ **Sum of polycyclic aromatic hydrocarbons**	----	0.5	µg/L	<0.5	<0.5	<0.5	<0.5	<0.5
EP080/071: Total Petroleum Hydrocarbons								
C6 - C9 Fraction	----	20	µg/L	<20	<20	<20	<20	<20
C10 - C14 Fraction	----	50	µg/L	<50	<50	<50	<50	<50
C15 - C28 Fraction	----	100	µg/L	<100	<100	<100	<100	<100
C29 - C36 Fraction	----	50	µg/L	<50	<50	<50	<50	<50
^ **C10 - C36 Fraction (sum)**	----	50	µg/L	<50	<50	<50	<50	<50
EP080/071: Total Recoverable Hydrocarbons - NEPM 2010 Draft								
C6 - C10 Fraction	----	20	µg/L	<20	<20	<20	<20	<20
^ **C6 - C10 Fraction minus BTEX (F1)**	----	20	µg/L	<20	<20	<20	<20	<20
>C10 - C16 Fraction	----	100	µg/L	<100	<100	<100	<100	<100
>C16 - C34 Fraction	----	100	µg/L	<100	<100	<100	<100	<100
>C34 - C40 Fraction	----	100	µg/L	<100	<100	<100	<100	<100
^ **>C10 - C40 Fraction (sum)**	----	100	µg/L	<100	<100	<100	<100	<100
EP080: BTEXN								
Benzene	71-43-2	1	µg/L	<1	<1	<1	<1	<1
Toluene	108-88-3	2	µg/L	<2	<2	<2	<2	<2
Ethylbenzene	100-41-4	2	µg/L	<2	<2	<2	<2	<2
meta- & para-Xylene	108-38-3 106-42-3	2	µg/L	<2	<2	<2	<2	<2
ortho-Xylene	95-47-6	2	µg/L	<2	<2	<2	<2	<2
^ **Total Xylenes**	1330-20-7	2	µg/L	<2	<2	<2	<2	<2
^ **Sum of BTEX**	----	1	µg/L	<1	<1	<1	<1	<1

Analytical Results

Sub-Matrix: **MARINE WATER**			Client sample ID	Styx U/S	Styx Mid	Styx D/S1	Styx D/S2	Est2U/S
			Client sampling date / time	[29-NOV-2011]	[29-NOV-2011]	[29-NOV-2011]	[29-NOV-2011]	[29-NOV-2011]
Compound	*CAS Number*	*LOR*	*Unit*	EB1125529-001	EB1125529-002	EB1125529-003	EB1125529-004	EB1125529-005
EP080: BTEXN - Continued								
Naphthalene	91-20-3	5	µg/L	<5	<5	<5	<5	<5
EP075(SIM)S: Phenolic Compound Surrogates								
Phenol-d6	13127-88-3	0.1	%	50.4	48.7	53.9	53.2	49.8
2-Chlorophenol-D4	93951-73-6	0.1	%	112	109	122	115	107
2.4.6-Tribromophenol	118-79-6	0.1	%	113	107	124	113	109
EP075(SIM)T: PAH Surrogates								
2-Fluorobiphenyl	321-60-8	0.1	%	119	111	126	121	108
Anthracene-d10	1719-06-8	0.1	%	124	121	137	126	109
4-Terphenyl-d14	1718-51-0	0.1	%	131	127	139	132	111
EP080S: TPH(V)/BTEX Surrogates								
1.2-Dichloroethane-D4	17060-07-0	0.1	%	100	102	100	99.3	101
Toluene-D8	2037-26-5	0.1	%	102	102	102	100	100
4-Bromofluorobenzene	460-00-4	0.1	%	105	104	103	102	99.6

Analytical Results

Sub-Matrix: MARINE WATER			Client sample ID	Est2D/S	Est3U/S	Est3D/S	Wellington Creek D/S	----
			Client sampling date / time	[29-NOV-2011]	[29-NOV-2011]	[29-NOV-2011]	[29-NOV-2011]	----
Compound	CAS Number	LOR	Unit	EB1125529-006	EB1125529-007	EB1125529-008	EB1125529-009	----
EA025: Suspended Solids								
Suspended Solids (SS)	----	5	mg/L	204	380	175	256	----
ED040F: Dissolved Major Anions								
Sulfate as SO4 2-	14808-79-8	1	mg/L	2950	2960	2930	2990	----
ED045G: Chloride Discrete analyser								
Chloride	16887-00-6	1	mg/L	18700	18800	18500	18800	----
ED093F: Dissolved Major Cations								
Calcium	7440-70-2	1	mg/L	414	421	409	418	----
Magnesium	7439-95-4	1	mg/L	1440	1450	1420	1480	----
Sodium	7440-23-5	1	mg/L	12000	12000	11800	12200	----
Potassium	7440-09-7	1	mg/L	477	482	473	482	----
EG020F: Dissolved Metals by ICP-MS								
Aluminium	7429-90-5	0.01	mg/L	<0.50	<0.50	<0.50	<0.50	----
Arsenic	7440-38-2	0.001	mg/L	<0.050	<0.050	<0.050	<0.050	----
Cadmium	7440-43-9	0.0001	mg/L	<0.0050	<0.0050	<0.0050	<0.0050	----
Chromium	7440-47-3	0.001	mg/L	<0.010	<0.010	<0.010	<0.010	----
Copper	7440-50-8	0.001	mg/L	<0.050	<0.050	<0.050	<0.050	----
Cobalt	7440-48-4	0.001	mg/L	<0.010	<0.010	<0.010	<0.010	----
Nickel	7440-02-0	0.001	mg/L	<0.050	<0.050	<0.050	<0.050	----
Lead	7439-92-1	0.001	mg/L	<0.010	<0.010	<0.010	<0.010	----
Zinc	7440-66-6	0.005	mg/L	<0.250	<0.250	<0.250	<0.250	----
Manganese	7439-96-5	0.001	mg/L	<0.010	<0.010	<0.010	<0.010	----
Molybdenum	7439-98-7	0.001	mg/L	0.013	<0.010	0.012	0.012	----
Selenium	7782-49-2	0.01	mg/L	<0.10	<0.10	<0.10	<0.10	----
Silver	7440-22-4	0.001	mg/L	<0.010	<0.010	<0.010	<0.010	----
Uranium	7440-61-1	0.001	mg/L	<0.010	<0.010	<0.010	<0.010	----
Vanadium	7440-62-2	0.01	mg/L	<0.10	<0.10	<0.10	<0.10	----
Boron	7440-42-8	0.05	mg/L	4.20	4.08	4.14	4.18	----
Iron	7439-89-6	0.05	mg/L	0.80	0.82	0.83	0.89	----
EG020T: Total Metals by ICP-MS								
Aluminium	7429-90-5	0.01	mg/L	3.53	2.93	0.89	5.88	----
Arsenic	7440-38-2	0.001	mg/L	<0.050	<0.050	<0.050	<0.050	----
Cadmium	7440-43-9	0.0001	mg/L	<0.0050	<0.0050	<0.0050	<0.0050	----
Chromium	7440-47-3	0.001	mg/L	0.014	0.015	<0.010	0.019	----
Copper	7440-50-8	0.001	mg/L	<0.050	<0.050	<0.050	<0.050	----
Cobalt	7440-48-4	0.001	mg/L	<0.010	<0.010	<0.010	<0.010	----
Nickel	7440-02-0	0.001	mg/L	<0.050	<0.050	<0.050	<0.050	----

Analytical Results

Sub-Matrix: **MARINE WATER**			Client sample ID	**Est2D/S**	**Est3U/S**	**Est3D/S**	**Wellington Creek D/S**	----
			Client sampling date / time	[29-NOV-2011]	[29-NOV-2011]	[29-NOV-2011]	[29-NOV-2011]	----
Compound	*CAS Number*	*LOR*	*Unit*	**EB1125529-006**	**EB1125529-007**	**EB1125529-008**	**EB1125529-009**	**----**
EG020T: Total Metals by ICP-MS - Continued								
Lead	7439-92-1	0.001	mg/L	<0.010	<0.010	<0.010	<0.010	----
Zinc	7440-66-6	0.005	mg/L	<0.250	<0.250	<0.250	<0.250	----
Manganese	7439-96-5	0.001	mg/L	**0.085**	**0.203**	**0.059**	**0.152**	----
Molybdenum	7439-98-7	0.001	mg/L	**0.013**	**0.010**	**0.010**	**0.012**	----
Selenium	7782-49-2	0.01	mg/L	<0.10	<0.10	<0.10	<0.10	----
Silver	7440-22-4	0.001	mg/L	<0.010	<0.010	<0.010	<0.010	----
Uranium	7440-61-1	0.001	mg/L	<0.010	<0.010	<0.010	<0.010	----
Vanadium	7440-62-2	0.01	mg/L	<0.10	<0.10	<0.10	<0.10	----
Boron	7440-42-8	0.05	mg/L	**4.02**	**4.18**	**3.97**	**3.96**	----
Iron	7439-89-6	0.05	mg/L	**5.54**	**5.44**	**2.40**	**8.67**	----
EG035F: Dissolved Mercury by FIMS								
Mercury	7439-97-6	0.0001	mg/L	<0.0001	<0.0001	<0.0001	<0.0001	----
EG035T: Total Recoverable Mercury by FIMS								
Mercury	7439-97-6	0.0001	mg/L	<0.0001	<0.0001	<0.0001	<0.0001	----
EK040P: Fluoride by PC Titrator								
Fluoride	16984-48-8	0.1	mg/L	**0.8**	**0.8**	**0.8**	**0.8**	----
EK055G: Ammonia as N by Discrete Analyser								
Ammonia as N	7664-41-7	0.01	mg/L	**0.05**	**0.06**	**0.03**	**0.05**	----
EK057G: Nitrite as N by Discrete Analyser								
Nitrite as N	----	0.01	mg/L	<0.01	<0.01	<0.01	<0.01	----
EK058G: Nitrate as N by Discrete Analyser								
Nitrate as N	14797-55-8	0.01	mg/L	**0.01**	<0.01	<0.01	**0.01**	----
EK059G: Nitrite plus Nitrate as N (NOx) by Discrete Analyser								
Nitrite + Nitrate as N	----	0.01	mg/L	**0.01**	<0.01	<0.01	**0.01**	----
EK061G: Total Kjeldahl Nitrogen By Discrete Analyser								
Total Kjeldahl Nitrogen as N	----	0.1	mg/L	**0.5**	**0.8**	<0.5	<0.5	----
EK062G: Total Nitrogen as N (TKN + NOx) by Discrete Analyser								
^ **Total Nitrogen as N**	----	0.1	mg/L	**0.5**	**0.8**	<0.5	<0.5	----
EK067G: Total Phosphorus as P by Discrete Analyser								
Total Phosphorus as P	----	0.01	mg/L	<0.05	**0.25**	<0.05	**0.17**	----
EK071G: Reactive Phosphorus as P by discrete analyser								
Reactive Phosphorus as P	----	0.01	mg/L	<0.01	<0.01	<0.01	**0.02**	----
EP075(SIM)B: Polynuclear Aromatic Hydrocarbons								
Naphthalene	91-20-3	1.0	µg/L	<1.0	<1.0	<1.0	<1.0	----
Acenaphthylene	208-96-8	1.0	µg/L	<1.0	<1.0	<1.0	<1.0	----

Analytical Results

Sub-Matrix: **MARINE WATER**			Client sample ID	Est2D/S	Est3U/S	Est3D/S	Wellington Creek D/S	----
			Client sampling date / time	[29-NOV-2011]	[29-NOV-2011]	[29-NOV-2011]	[29-NOV-2011]	----
Compound	*CAS Number*	*LOR*	*Unit*	**EB1125529-006**	**EB1125529-007**	**EB1125529-008**	**EB1125529-009**	----
EP075(SIM)B: Polynuclear Aromatic Hydrocarbons - Continued								
Acenaphthene	83-32-9	1.0	µg/L	<1.0	<1.0	<1.0	<1.0	----
Fluorene	86-73-7	1.0	µg/L	<1.0	<1.0	<1.0	<1.0	----
Phenanthrene	85-01-8	1.0	µg/L	<1.0	<1.0	<1.0	<1.0	----
Anthracene	120-12-7	1.0	µg/L	<1.0	<1.0	<1.0	<1.0	----
Fluoranthene	206-44-0	1.0	µg/L	<1.0	<1.0	<1.0	<1.0	----
Pyrene	129-00-0	1.0	µg/L	<1.0	<1.0	<1.0	<1.0	----
Benz(a)anthracene	56-55-3	1.0	µg/L	<1.0	<1.0	<1.0	<1.0	----
Chrysene	218-01-9	1.0	µg/L	<1.0	<1.0	<1.0	<1.0	----
Benzo(b)fluoranthene	205-99-2	1.0	µg/L	<1.0	<1.0	<1.0	<1.0	----
Benzo(k)fluoranthene	207-08-9	1.0	µg/L	<1.0	<1.0	<1.0	<1.0	----
Benzo(a)pyrene	50-32-8	0.5	µg/L	<0.5	<0.5	<0.5	<0.5	----
Indeno(1.2.3.cd)pyrene	193-39-5	1.0	µg/L	<1.0	<1.0	<1.0	<1.0	----
Dibenz(a.h)anthracene	53-70-3	1.0	µg/L	<1.0	<1.0	<1.0	<1.0	----
Benzo(g.h.i)perylene	191-24-2	1.0	µg/L	<1.0	<1.0	<1.0	<1.0	----
^ Sum of polycyclic aromatic hydrocarbons	----	0.5	µg/L	<0.5	<0.5	<0.5	<0.5	----
EP080/071: Total Petroleum Hydrocarbons								
C6 - C9 Fraction	----	20	µg/L	<20	<20	<20	<20	----
C10 - C14 Fraction	----	50	µg/L	<50	<50	<50	<50	----
C15 - C28 Fraction	----	100	µg/L	<100	<100	<100	<100	----
C29 - C36 Fraction	----	50	µg/L	<50	<50	<50	<50	----
^ C10 - C36 Fraction (sum)	----	50	µg/L	<50	<50	<50	<50	----
EP080/071: Total Recoverable Hydrocarbons - NEPM 2010 Draft								
C6 - C10 Fraction	----	20	µg/L	<20	<20	<20	<20	----
^ C6 - C10 Fraction minus BTEX (F1)	----	20	µg/L	<20	<20	<20	<20	----
>C10 - C16 Fraction	----	100	µg/L	<100	<100	<100	<100	----
>C16 - C34 Fraction	----	100	µg/L	<100	<100	<100	<100	----
>C34 - C40 Fraction	----	100	µg/L	<100	<100	<100	<100	----
^ >C10 - C40 Fraction (sum)	----	100	µg/L	<100	<100	<100	<100	----
EP080: BTEXN								
Benzene	71-43-2	1	µg/L	<1	<1	<1	<1	----
Toluene	108-88-3	2	µg/L	<2	<2	<2	<2	----
Ethylbenzene	100-41-4	2	µg/L	<2	<2	<2	<2	----
meta- & para-Xylene	108-38-3 106-42-3	2	µg/L	<2	<2	<2	<2	----
ortho-Xylene	95-47-6	2	µg/L	<2	<2	<2	<2	----
^ Total Xylenes	1330-20-7	2	µg/L	<2	<2	<2	<2	----
^ Sum of BTEX	----	1	µg/L	<1	<1	<1	<1	----

Analytical Results

Sub-Matrix: **MARINE WATER**			*Client sample ID*	**Est2D/S**	**Est3U/S**	**Est3D/S**	**Wellington Creek D/S**	----
			Client sampling date / time	[29-NOV-2011]	[29-NOV-2011]	[29-NOV-2011]	[29-NOV-2011]	----
Compound	*CAS Number*	*LOR*	*Unit*	**EB1125529-006**	**EB1125529-007**	**EB1125529-008**	**EB1125529-009**	**----**
EP080: BTEXN - Continued								
Naphthalene	91-20-3	5	µg/L	<5	<5	<5	<5	----
EP075(SIM)S: Phenolic Compound Surrogates								
Phenol-d6	13127-88-3	0.1	%	**51.3**	**56.5**	**40.5**	**51.8**	----
2-Chlorophenol-D4	93951-73-6	0.1	%	**118**	**127**	**90.1**	**116**	----
2.4.6-Tribromophenol	118-79-6	0.1	%	**118**	**122**	**90.4**	**116**	----
EP075(SIM)T: PAH Surrogates								
2-Fluorobiphenyl	321-60-8	0.1	%	**129**	**135**	**94.8**	**120**	----
Anthracene-d10	1719-06-8	0.1	%	**136**	**136**	**99.2**	**130**	----
4-Terphenyl-d14	1718-51-0	0.1	%	**143**	**147**	**105**	**135**	----
EP080S: TPH(V)/BTEX Surrogates								
1.2-Dichloroethane-D4	17060-07-0	0.1	%	**101**	**101**	**102**	**103**	----
Toluene-D8	2037-26-5	0.1	%	**101**	**99.7**	**101**	**101**	----
4-Bromofluorobenzene	460-00-4	0.1	%	**102**	**101**	**105**	**103**	----

Surrogate Control Limits

Sub-Matrix: **MARINE WATER**

Compound	*CAS Number*	*Recovery Limits (%)* Low	*Recovery Limits (%)* High
EP075(SIM)S: Phenolic Compound Surrogates			
Phenol-d6	13127-88-3	10.0	71.9
2-Chlorophenol-D4	93951-73-6	26.8	130.2
2.4.6-Tribromophenol	118-79-6	19.3	180.8
EP075(SIM)T: PAH Surrogates			
2-Fluorobiphenyl	321-60-8	13.9	146.1
Anthracene-d10	1719-06-8	34.6	137.4
4-Terphenyl-d14	1718-51-0	36.2	154.2
EP080S: TPH(V)/BTEX Surrogates			
1.2-Dichloroethane-D4	17060-07-0	66.1	137.9
Toluene-D8	2037-26-5	79.2	119.6
4-Bromofluorobenzene	460-00-4	74.2	118.0