SWOLLEN LEGS AND SICK FISH

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Abstract

Introduction: On 16 September 2011, Fisheries Queensland closed Gladstone Harbour and the surrounding area to fishing under section 46 of the *Fisheries Act 1994* while the Queensland Government investigated a condition affecting some locally caught fish. At that time, and contributing to the harbour closure, health issues were noted in 37 fishermen, who reported a variety of symptoms. The health department was tasked to investigate the symptoms in fishermen.

Methods: A review of data was conducted based on evidence from the Gladstone Ports website, DERM, Fisheries Queensland, the Gladstone Fish Report and the Health Department.

Results: There were multiple infections reported in the fishermen. The health department found there was no link between the fish disease and the human symptoms. A significant portion of affected fishermen were suboptimally investigated. The aetiological agent was not identified in the majority of fishermen. Blind treatment with antibiotic occurred in a significant sample of fishermen reporting infections making identification difficult. The health department failed to find Shewanella infections and Vibrio infections, both known marine organisms associated with turbid marine water. They reported 10 staphylococcus infections 5 of which were MRSA (methicillin resistant Staphylococcus Aureus). There was poor follow up. Fish, mud crabs and humans were identified with Shewanella infections. The water quality was poor at the time of the fishermen's complaints which peaked in August, September and October 2011, and the mean turbidity at that time was over three times the historical mean and exceeded the agreed 99th centile. (25 days out of the 100 last days of 2012 were over the 99th Centile instead of the predicted 1 day e.g. September to December 31, 2011.) Turbidity was noted to be associated with dredging activities and high total metals was associated with high turbidity. No independent environmental samples or water quality measurements were taken by Queensland Health. Despite experienced fishermen linking their disease with dredging, there was no Health Department testing for toxic algae and associated bacteria done in the turbid water associated with dredging. There was no investigation of the live coral trout boats which experienced high infections rates. The reports of toxic algae identified by DERM appeared to have been ignored. There was no bacterial analysis by Qld health of the boats, the water or the fish, though reports of Shewanella in the fish were noted by Biosecurity Qld.

Discussion: A cut exposed to dirty marine water laden with bacteria is at risk of a marine infection. Algal toxins are known to cause illness. The temporal association of health symptoms with high turbidity and high total metals associated with dredging, in combination with illness in multiple marine organisms and toxic algal blooms, including the identification of marine bacteria such as Shewanella in an occupationally exposed group (fishermen) is highly suggestive of environmental exposure as a contributor to these health symptoms. The investigation conducted by the health department was suboptimal. It did not include an occupational and environmental physician. It did not effectively assess the available data on water quality, or take independent samples. Qld Health ignored important data such as toxic algal blooms as potential source of health symptoms. Instead of analysing the bloom, notifying and educating the public, this data was hidden. WA by contrast at the same time in August 2011 used the media to protect the public from a harmful algal bloom. The decades of industrial development in Gladstone have resulted in high metals settling in the sediment of the harbour including aluminium, copper, arsenic and iron. Shewanella is an anaerobic bacteria associated with heavy metals and polluted marine environments. It is postulated that dredging and dumping of dredge spoil in Gladstone harbour may have created an environment conducive to toxic algal blooms such as lyngbya and associated bacteria such as Shewanella, vibrios and other marine bacteria. This investigation should have been given more resources, to better investigate the occupationally related health symptoms. Tourism could be jeopardized if swimming/ diving/ fishing in the Great Barrier Reef were to become a health hazard due to marine infections associated with dredging and dredge spoil. As future dredging projects and dredge spoil will be dumped in recreation areas such as Townsville and Holbourne Reef near Abbott point, the associated health risks and infections in and around Gladstone harbour require a more in depth investigation.

Introduction

On 16 September 2011, shortly after the dredging commenced in the Western Basin, Fisheries Queensland closed Gladstone Harbour and the surrounding area to fishing under section 46 of the *Fisheries Act 1994* while the Queensland Government investigated a condition affecting some locally caught fish. The Gladstone Harbour and the surrounding areas were closed to all forms of commercial and recreational fishing from 16 September 2011 and 7 October 2011.

The cause of the fish disease and the human disease was never really identified, though the harbour was reopened. A Queensland Health investigation did not identify "any link between the diseases in Gladstone fish and human health issues". 3 people, 2 confirmed and one suspected with Shewanella consulted a Brisbane specialist. Shewanella was identified in catfish [i] and mud crabs[ii]. The quite debilitating symptoms experienced from Shewanella infections and the potential loss of limb, prompted a review of the health investigation to assess if it was conducted to an appropriate standard.

Queensland Health interviewed 27 people who were concerned they may have been unwell, in particular with infections and other skin conditions, as a result of contact with diseased fish from the Gladstone area. They reviewed the statements of 10 other people. The interviews were conducted in order to establish whether there was any clear pattern of illness among interviewees, and to identify possible links between diseased fish and risks to human health. A range of symptoms were described by interviewees, including 'flu-like' illnesses, infected injuries, boils, eye discharge and redness, swelling or rashes on the hands and feet. The majority of interviewees reported infected injuries and skin infections. 24 of these people reported infected injuries (e.g. barramundi spikes) or skin infections (e.g. boils). 10 swabs were taken and all grew *Staph aureus of which half* grew MRSA. The department reviewed the transmission of *Staphylococcus* finding it occurred via:
– Direct person-to-person contact, especially in crowded situations
– Sharing of personal items, e.g.towels, razors
– Breaks in skin, e.g. cuts and scratches; and
– Not related to handling of fish

They concluded it was most likely that this infection was contracted through contact with other people. Queensland health stated that there was "No clear pattern to reported conditions" and "No link identified between conditions found in fish and human health issues."

At the same time as the health department were reporting their findings the *Courier Mail* [iii] was reporting that toxic algae had been identified. (excerpts from the *Courier Mail* articles – 'The mystery of ill and diseased fish in Gladstone continues, with two types of poisonous algae found in the harbour, one of them known to kill fish. Sampling conducted last month for the Gladstone Ports Corporation found blue-green algae and a second species known as a diatom…..The report also detected Cattonella, which has been associated with fish deaths in other parts of the world, but there have been no reports of widespread fish deaths in Gladstone Harbour area," Ms Darling said. "Cattonella has an extreme impact and generally causes quite large fish kills." ') Another scientist Dr Matt Landos later also identified Lyngbya and Tricodesmium in 25 plankton net samples taken in February 2012.[iv] Lyngbya was not mentioned in the *Courier Mail* media reports, but is well known to cause health effects in humans. The possibility that it was present but not detected in the initial sampling was hypothesised as some of the non infectious symptoms in fishermen could be attributed to Lyngbya or other algal toxins. Osborne et al describe Lyngbya majuscula as "a benthic filamentous marine cyanobacterium, which in recent years appears to have been increasing in frequency and size of blooms in Moreton Bay, Queensland. It has a worldwide distribution

throughout the inftropics and subtropics in water to 30m. It has been found to contain a variety of chemicals that exert a range of biological effects, including skin, eye and respiratory irritation." [v]

The algal blooms noted in August 2011, were associated with media reports of sick fish and fishermen with health issues. Barramundi in particular were affected. When the Awoonga Dam spilled over between December 2010 and March 2011, an estimated 30,000 barramundi were washed into the Boyne River estuary. [vi] The predominant organisms found in the infected eye and red skin lesions in barramundi were the parasite Neobenedenia. The exact cause of this outbreak of Neobenedenia was not identified. It was postulated they were stressed and immune-suppressed and that this may have made them susceptible to hyperparisitism.

A review of medical and scientific literature found that *Neobenedenia* spp. (parasitic flatworms) are not known to cause disease in humans. Likewise red-spot disease, the condition identified in one barramundi sample from Port Alma, is not known to cause human illness. The health department stated there were no major zoonoses (illnesses transmitted to humans from animals) in the literature related to handling of fish.

An article entitled "Patera foot" shows a link between refugees being exposed to rotten fish in extreme conditions leading to severe illness and amputations from the Shewanella bacteria. "An unusual skin and soft tissue infection of the lower limbs has been observed in immigrants from sub-Saharan Africa who cross the Atlantic Ocean crowded on small fishing boats (*pateras*). Response to conventional treatment is usually poor. We speculate that specific etiologic agents (mainly gram negative bacteria, including *Shewanella. algae*) present in densely contaminated water enter through macerated skin, then reach deep tissues." [vii]

The Gladstone Fish Health Scientific Panel released a report on 5th January 2011. [viii] The Panel noted that identifying the cause(s) of the disease(s) and prevalence of parasites on fish in Gladstone Harbour is a complex and difficult task. This task is further complicated by the extreme flood events of the 2010-2011 summer and the historical and ongoing industrial development of the Harbour, which have changed the local environment. Determining conclusively whether any environmental changes have anything to do with the reported fish and human health problems is a formidable and perhaps impossible undertaking given the available data for fish and human diseases has been collected using descriptive study designs (e.g. case series, cross sectional surveys) without the benefit of normal baseline values for fish and human diseases making determination of causation difficult. Nevertheless, it is the Panel's view there is an issue of concern around the health of some species of fish in Gladstone Harbour and this is possibly caused by environmental factors.

Fish are normally good integrative indicators of eco-system and environmental health. The Panel concluded there was an issue of concern around the health of some species of fish in Gladstone Harbour and this was possibly caused by environmental factors. However it concluded that the water quality results received to date "indicate the observed values of the measured water quality parameters are not unusual (compared to historical values and trends), except for extremely low salinity during the 2010-2011 wet season."

The panel failed to discuss markedly high turbidity in the DERM data and the Gladstone Ports water quality monitoring data. The panel failed to mention the increased turbidity in and around the dredging activities and the spring tides effect on that turbidity. They failed to discuss the toxic algal blooms - "Chlorophyll *a* concentrations in the Western Basin and Narrows area were highest during August 2011 (when algal blooms were recorded)" [ix] The panel was tasked to review the available test results, and assess previous water quality data and the current water quality and sediment monitoring regime. The panel recommended further tests of sediment in the water column and

noted the lack of monitoring data for metals in sediments and the apparent lack of monitoring data for organic chemicals in sediments. The panel requested the Queensland Government to conduct further study on the potential of chemicals to cause the observed signs in fish and have a program to test for metals and organic chemicals.

The panel recommended further experimental work with diseased fish and fish with Neobenedinia and to conduct studies on wild fish with lesions held in captivity and exposed to water of different quality (e.g. with muddy Gladstone water). The panel did not reference any studies on issues such as acid sulphate soils or aluminium toxicity. They did not know about the Shewanella disease at the time as the diagnosis of these human infections were not made until 2012. In one case it occurred 4 months after the panel and in the other case over 12 months after the panel met. Similarly the Queensland health investigation was unaware of these cases until I notified them about the cases.

The panel recommended that the Queensland Government commission or conduct a comprehensive literature review on the potential of chemicals to cause the observed signs in fish and then design a test program for metals and organic chemicals, as well as natural toxins that target the chemicals that may be associated with the observed signs in fish. The panel was not tasked to consider dredging and its potential impact and did not discuss it or conduct the literature review themselves. With regard to human health a number of recommendations were made. These recommendations were reviewed and the results of these recommendations are below. Two of the actions were closed and only one was implemented:

Human Health 1. Baseline for illness in commercial fishers
Conduct a study to establish a baseline for commercial fishers in Gladstone and possibly other areas of Queensland. - Activities completed - Options to progress a study to establish a baseline for illness in commercial fishers in Gladstone and possibly other areas of Queensland have been discussed. **In September 2012, based on advice from Workplace Health and Safety Queensland, the Gladstone Harbour Interdepartmental Committee agreed that implementation of this recommendation is not feasible. = Action closed**

HH2. OH&S statistics for commercial fishers
Appropriate OH&S statistics be routinely collected for the Queensland commercial fishing industry. - Activities completed - Mechanisms to capture work-related injury and disease data for commercial fishing industry have been investigated. **In September 2012, based on advice from Workplace Health and Safety Queensland, the Gladstone Harbour Interdepartmental Committee agreed that implementation of this recommendation is not feasible due to limited data sources. = Action closed**

HH3. OH&S guidelines for fishing
Appropriate best practice OH&S guidelines for fishing and fish handling be developed in collaboration with the commercial fishing industry - Activities completed - OH&S information has been developed and published on DAFF Gladstone webpage: http://www.dpi.qld.gov.au/28_20898.htm A fact sheet on "Managing skin infections in the fishing industry" has been produced. Workplace Health and Safety Queensland has written to commercial fishers to gauge their interest in working collaboratively to develop further understanding of OH&S issues for commercial fishing industry = Implemented

Workplace Health and Safety vetoed the recommended baseline health study and the collection of statistics regarding work-related injuries and disease among commercial fishers. They were unaware of Shewanella infections as there was no information published regarding this bacterial infection. Likewise there was little information regarding Vibrio infections and toxic algal blooms.

Figure 1. Diagram of Official View

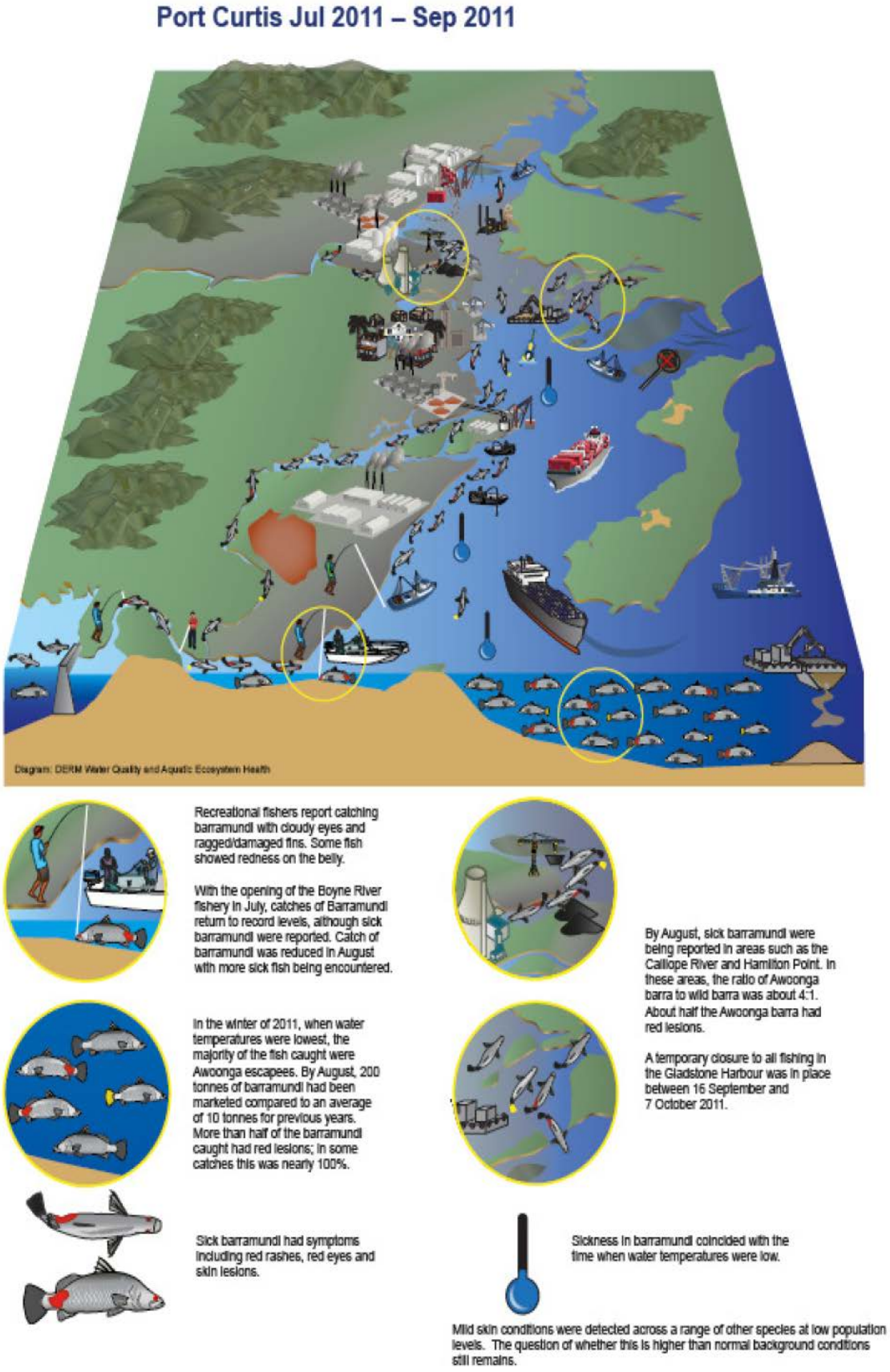


Figure 10: Graphic depicting events, activities and observations from the Gladstone area between July 2011 and September 2011.

Gladstone harbour has been dredged for decades. In the 1980s a large dredging project was associated with a shell disease in crabs. The Western Basin Dredging project was implemented to deepen and widen existing channels and swing basins, create new channels, swing basins and berth pockets and use dredged material to reclaim land, including 153 ha north of Fisherman's Landing. The dredging companies started on 10 June 2011 with two small backhoe dredges. A third small grab dredge commenced operation in August and the main cutter suction dredge Almahaar, commenced operations on 5 September 2011.

The geological review of the area being dredged showed "Holocene sediments below an elevation of five metres AHD. These sediments "are also commonly associated with acid sulfate soils (ASS)" and potential acid sulphate soils (PASS). Disturbing these sediments may lead to the formation of sulphuric acid, releasing iron, aluminium, and other heavy metals. It was during this time that a sudden increase in illness was noted in the fishermen, and fish disease leading to the harbour closure. It was also noted at that time the live trout were becoming sick on entering Gladstone harbour as harbour water was pumped through their tanks and that the deckhands working on the live coral trout boats were reporting health effects and infections.

Numerous studies relating to water and sediment quality in Port Curtis have been undertaken since the 1990's. There is a good review of these studies in a report to provide baseline information on water and sediment quality in Port Curtis. [x] It includes multiple papers of interest which demonstrate the impact of dredging such as heavy metal uptake in transplanted oysters close to dredging.

In view of high turbidity during spring tides noted on the DERM and GPC website and high metals noted in the sediment on CSIRO reports and reports of Algal blooms in August 2011 by Vision Environment in addition to the Shewanella cases in humans, mud crabs and fish, it was thought important to closely review the data from the Health department, DERM reports, the GPC website and assess if the infections identified in the fishermen could be related to marine bacteria, such as Shewanella, (a metal metabolizing bacteria) and other potential marine bacteria such as Vibrio. It also reviewed if non infectious cases may be related to toxic algal blooms such as Lyngbya.

Methods

All the data available from the Queensland Government's monitoring regimes, results and analysis in Gladstone Harbour and surrounds including consideration of water quality monitoring and fish health where relevant and appropriate were reviewed. The relevant data regarding turbidity and aluminium levels were extracted from the DERM reports and presented in the results.

Results from the Gladstone Ports Water Quality Monitoring sites were used to assess turbidity. A water quality monitoring program was implemented to monitor water quality within zones of predicted high, medium and low impact, with water quality triggers based on background conditions and predicted sediment plume loading from dredging. Monitoring sites have been nominated in each designated impact zone and where practical have been situated over or near sensitive receptor locations within those zones.

A Water Quality Management Plan was established based on turbidity as an indicator of water quality, with limits set for key environmentally sensitive locations that trigger an operational response. The Internal Alert and External Reporting Trigger Levels have been set based on the application of the 6 hourly Exponentially Weighted Moving Average (EWMA) to raw background turbidity data collected. The 6 hour ERMA turbidity levels must not exceed the seasonal 99th percentile turbidity level for a period of greater than 48 hours, unless it can be demonstrated to the

satisfaction of the administering authority that the elevated turbidity is the result of errors of measurement or natural background variations.

The ST1 site, is a dredge plume site that has consistently recorded high turbidity. The other sites such as QE4 and BG10 have all recorded exceedances, but for simplicity the statistical analysis has focused on ST1. Further data has been requested from the Gladstone Ports Authority (both historical and recent) to assess the changes at all the sites and test for statistical significance. The ST1 site was monitored over the last 6 months and exceedances are presented in the results section. (www.westernbasinportdevelopment.com.au/water_quality_monitoring/section/environmental)

The available test results from DERM and results from the monitoring regime by Gladstone Ports corporation published on their websites were used to assess the current water quality and compared to previous water quality data. A review of media releases by Gladstone Ports and DERM was also undertaken. Prior to analysis any metal concentration reported as "below detection level", half the detection level was used as the nominal concentration to allow comparison with other sites/samples. A review of clinical notes and / or statements of people who experienced adverse health effects was undertaken. Data was entered into Xcel and analysis of that data performed.

Results

Attached you will see statements from 48 fishermen that were reviewed. Of note 37 of them reported infections of some kind. All had a common exposure to marine water or sick fish. There were two cases of confirmed Shewanella. One case Mr JC, was a 59 year old commercial fisherman who had his Shewanella infection first diagnosed at Gladstone hospital. He presented with a unilateral swollen leg. He believes he got the infection from dirty marine water when washing the deck of his boat or adjusting the pump. He had a crack on the heel of his foot that may have been the point of entry. I have attached his statement. He was treated in the Gladstone hospital HDU with IV antibiotics and was later discharged from that hospital on oral antibiotics. He then travelled to Bundaberg where he became unwell again. He was hospitalised for a number of weeks receiving intravenous antibiotics at Bundaberg hospital. His illness was severe.

Figure 1. Picture of JC leg before and after treatment.

J C leg before and after treatment remained swollen. He was discharged from Gladstone and readmitted himself to Bundaberg for further care

The second case Mr JE was a 58 year old man who had a business selling shark fin. He believed he got his case from the diseased sharks and the water and "juices" associated with them. He had sharks on a steel table and would chop off their fins. The "juices" would run off the table onto his left leg. He first became ill in December 2011, but I did not see him until March, 2012. He was seen by a number of specialists. An infectious disease specialist, a dermatologist, a vascular surgeon and an occupational physician. It was thought he had an infection but this could not be proved at the time. Biopsies were taken from his unilateral swollen left foot. They did not grow anything but did not heal. Later secondary infections were grown. In October he spoke to the 1st patient and suggested he had Shewanella to the occupational phsycian. IV antibiotics (Gentamicin, Ciprofloxacin) were arranged at Gladstone Mater Private as an outpatient visiting daily. He improved slightly and treatment was stopped after 2 weeks. In December 2012 his condition worsened and he was suffering severe pain. He was advised to go to Gladstone hospital where he was admitted and Shewanella was diagnosed. Due to the severity of the infection in his leg he was transferred to the ID team in Mater hospital Brisbane. He was admitted for 4 weeks on IV antibiotics. Amputation was considered at one stage however his leg eventually improved with treatment, though a recent picture confirms the leg remains swollen.

Figure 3 JE's leg time sequence. Even months after IV antibiotics for 4 weeks it remains very swollen. It is presumed that this is scar tissue – very hard and will remain.

March 2012

April 2012 – After biopsy – No treatment

June 2012 - Oral antibiotics Minor improvement only

October 2012 – After daily IV antibiotics as outpatient - mild improvement

December 2012 Shewanella identified, IV treatment inpatient Mater Brisbane.

Picture of a diseased shark - JE and KE were exporting shark fins - business has collapsed.

5 months post treatment June 2013 Leg remains swollen/ scarred - no longer painful.

His wife Mrs KE also suffered from a unilateral swollen leg. She had similar exposures, similar time frames. It began in December 2011, and I saw her in March 2012 with her swollen painful leg. A biopsy was taken and the histology was identical to that seen in her husbands leg, suggesting a similar diagnosis. She also had treatment in October 2012, with IV Gentamicin and Ciprofloxacin and noted an improvement in her leg. To date we have not been able to isolate Shewanella from her leg, but in view of the ongoing prolonged unilateral swelling and the similar environmental circumstances and exposures as her husband, and the fact that histology from both her and her husband were identical and there was some improvement on antibiotics, this case has been classified as a suspected Shewanella case. Her leg remains swollen as well.

Picture March 2012 - Swollen Right Foot - Painful Histology - same as husbands foot. Improved slightly with oral antibiotics in April 2012 then IV abs in October

June 2013 Still swollen/scarred similar to husband's foot.

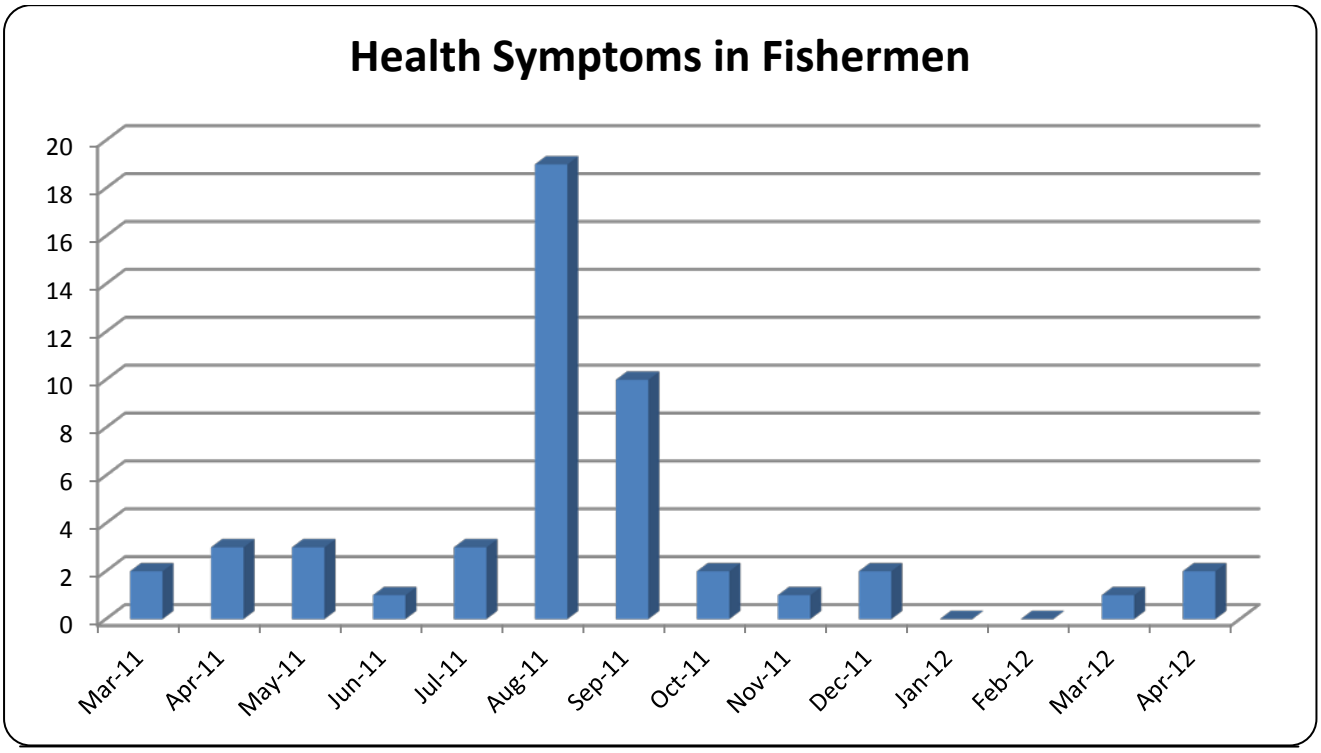
On discussion with the pathology labs (Queensland Pathology, Mater Pathology, Sullivan and Nicolaides, QML and Healthscope) from November 2011 to March 2013 there were over 100 cases of Shewanella. A significant number of those cases are from Central Qld, but it is not known if there is a higher prevalence from Gladstone. It was also noted that there have been a number of infections/ wound swabs that have grown Vibrio and that there is an indication that this is higher than expected in the Gladstone region, but it is not statistically significant, (personal communication from Dr Jenny Robson from her analysis of Sullivan and Nicolaides data). It is possible that some of these cases are related to exposure to the harbour water. It has not been possible to do any further analysis due to privacy issues, however a more detailed paper that is planned to be published under ethics guidance will hopefully contain some further analysis of these infections and their locations.

There were multiple infections reported in the fishermen. The health department found "no link between fish disease and disease in the fishermen." It should be noted that Shewanella was identified in both catfish and mudcrabs from Gladstone harbour as well as fishermen.

The Queensland Health study was unable to identify causative agents in fishermen describing infections. The majority of fishermen were suboptimally investigated with no wound swabs taken. The aetiological agent was not identified in the majority of fishermen. Blind treatment with antibiotics by GPs occurred in fishermen reporting infections making identification of the infection difficult for Queensland Health. The health department failed to identify Shewanella infections and Vibrio infections, both known marine organisms associated with turbid marine water. They reported 10 staphylococcus infections. There was poor follow up. (One Shewanella case was identified over 12 months after the Queensland health investigation).

One of the principle investigators in Queensland health stated that there was “no outbreak”.

Figure 5 an outbreak graph of reporting of fishermen illness.



A number of fishermen reported reactions consistent with reactions to toxic algae such as Lyngbya. A report by Vision Environment post dredging documented elevations in Chlorophyll-a in August, 2011 and algal blooms. This report of algal blooms coincides with the peak in health symptoms. Blooms of harmful algae are found in water with elevated nutrient sources.

Neither DERM nor GPC provided Queensland Health with reports or evidence of “toxic blue green algae and dangerous diatoms”. The report about the findings was leaked to the Courier Mail in November 2011; the findings were confirmed by the then Environment Minister, Ms. Darling, in early December 2011. *http://www.couriermail.com.au/ipad/possible-algae-link-to-fish-deaths/story-fn6ck51p-1226207534864* *http://www.couriermail.com.au/ipad/all-clear-on-algae-but-fish-still-sick/story-fn6ck51p-1226211701523*

In May 2012, two fishermen were hospitalised after cleaning slime off their nets around 19 km from the ocean spoil disposal ground. They had an acute reaction. “While helping clean fishing nets in our back yard my eyes, nose and throat started burning, I become short of breath and developled server chest pains. I also felt nauseas and shakey.” The other fisherman described “a dry mouth, running nose, felt hot and thirsty and then began vomiting - white and froth like. My eyes and nose were really burning. “ The nets were tested and found Lyngbya Majuscula.

Another case described an immediate burning sensation when on a boat cruise some water spashed in his eye. 10 cases described immediate reactions to harbour water, including rashes, pain, blistered skin, peeling skin, gastrointestinal irritation, (e.g. nausea) sinus issues, headaches, cough, breathing difficulties and shortness of breath that healed without antibiotics. Many of the cases that describe infections also relate a similar picture prior to getting their infections. No algal tests were conducted by Queensland health to our knowledge.

Turbidity levels as an environmental factor

We reviewed the early water quality reports relating to water quality tests done in September and October 2011. The water quality was poor at the time of the fishermen's peak complaints in August and September 2011. The mean turbidity at that time was over three times the historical mean and exceeded the agreed 99th centile. (It was noted that 25 days out of the 100 last days of 2012 were over the 99th Centile instead of the predicted 1 day e.g. September to December, 2011.) Over 20 cases reported health symptoms in August, September and October 2011 when the turbidity was high. Turbidity was noted to be associated with dredging activities and high total metals was associated with high turbidity. (Turbidity 90% correlated with total aluminium and 70% with total copper) No independent environmental samples or water quality measurements were taken by Queensland Health, and despite the fishermen linking their disease with dredging, there was no health department testing for toxic algae and associated bacteria done in the turbid water associated with dredging. The reports of toxic algae identified by DERM, Vision Environment and the Courier Mail reports appeared to have been ignored. There was no bacterial analysis by Qld health of the live trout boats, the water or the fish, though reports of Shewanella were noted by Biosecurity Qld with relation to catfish and mudcrabs.

Gladstone turbidity 5.8 NTU on average (2004)

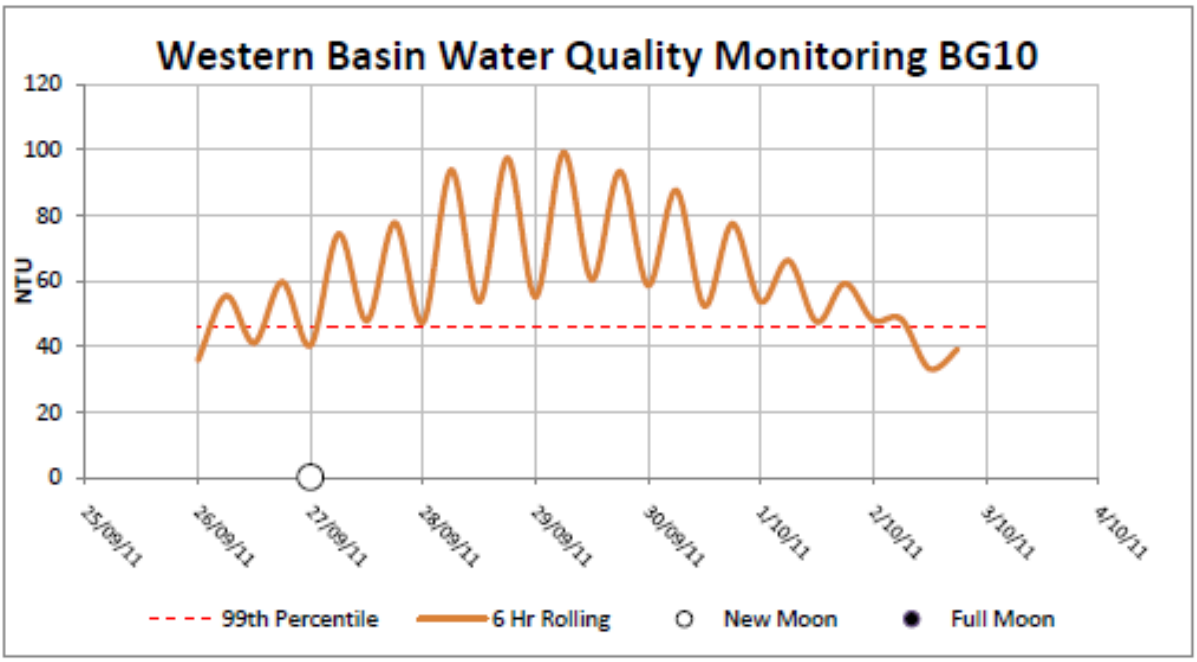
Gladstone Turbidity averages ~20 NTU (2011)

Vision Environment stated in their May 2012 water quality report that "Clorophyll A concentrations in the Western Basin and Narrows area were highest in August 2011 algal blooms(when algal blooms were recorded) and remained high during the 2011/2012 wet seasons." This was the time that multiple infections and irritations were most prevalent in the fishermen (see statements.)
Algal blooms occur in association with high turbidity and high nutrient levels. They are often accompanied by high levels of marine bacteria.

Water quality was tested on the 26th September and results released in the Port Curtis - Current and Historical Water Quality in October 2011. The turbidity at site BG10 was found to be 136NTU and at site ST1 to be 75 NTU. These both exceeded the 99th percentile. The 99th percentile is listed for

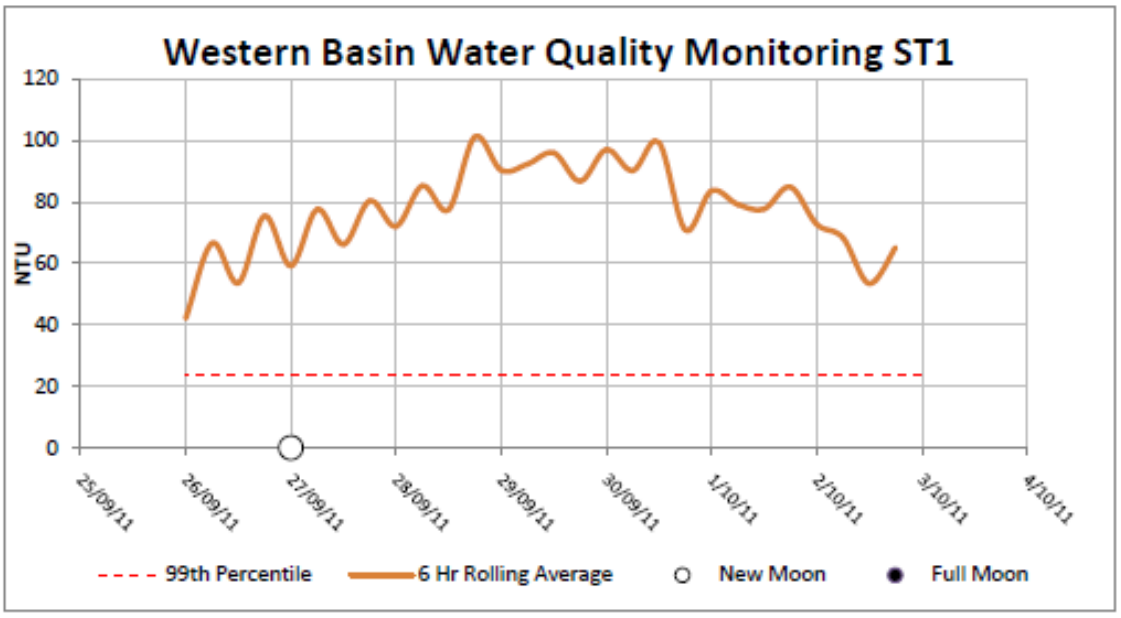
BG10 and ST1 as 46 and 24 NTU respectively for the dry season which runs from the 1st April to 19th November.

The Gladstone ports turbidity data also noted the high turbidity at site BG10 and ST1. "Turbidity has increased significantly and exceeded the 99th percentile during the spring tides with high tidal ranges. Mitigations actions are currently being undertaken. The Cutter Section Dredge was suspended on 29/09/11 to assist with settling the turbidity. Turbidity is expected to return below the trigger level naturally due to the lower tidal ranges. The exceedences have been reported to the Regulator."



Monitoring Point ID: ST1	
Maximum 99th Percentile Turbidity (NTU)	
38 (Wet)	24 (Dry)
'Wet' season is from 20 November to 31 March inclusive. The remainder of the year is taken to be the 'Dry' season.	

Monitoring Point ID: BG10	
Maximum 99th Percentile Turbidity (NTU)	
56 (Wet)	46 (Dry)
'Wet' season is from 20 November to 31 March inclusive. The remainder of the year is taken to be the 'Dry' season.	



The DERM Director General Mr Reeves in a media statement commented on the high turbidity in September. He stated that "the September testing found turbidity levels were higher than the licensed levels. This confirms the decision taken soon after the samples were collected to temporarily cease dredging operations until turbidity returned to below the licensed levels." that dredging was ceased from 29th September to the 3rd October. September also experienced a high number of health symptoms in the fishermen.

In November 2011, DERM released a supplementary report "**Water Quality of Port Curtis and Tributaries,** Supplementary Report Based on Data Collected in the week of 26th September 2011". DERM Director-General Jim Reeves said this built on the previous report and reflected further analysis of the level of metals in the water column that could potentially impact on fish and other aquatic organisms. "This report describes levels of metals in waters around Port Curtis and Gladstone Harbour, particularly in terms of the levels of metals that might be taken up by fish and other organisms living in these waters." The test samples, which were taken before dredging was temporarily halted by Gladstone Ports Corporation, confirm turbidity levels were higher at locations close to the dredging.

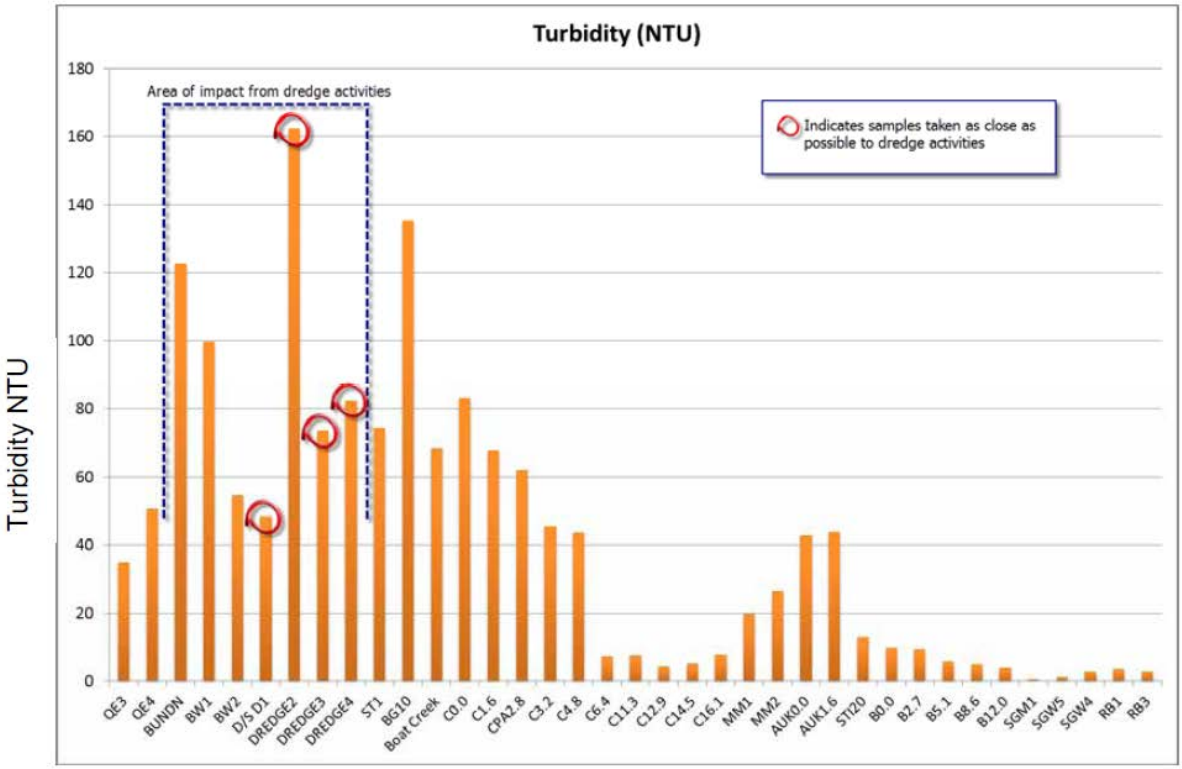


Figure 10 Turbidity measurements at all sites monitored by DERM in September 2011

In the DERM report it was stated “It can be seen in Figure 10 (above) the turbidity measurements are generally highest closest to the dredging operations, both close to dredging activities and outside of the bund wall (which holds dredging spoils).” Sealing of the bund wall apparently resulted in reduced turbidity at BW2. The northeast corner of the Bund Wall had high turbidity as fast currents were scouring over the mudflats. Higher turbidity was also noted at BW1, an unsealed section of the bund wall. As well as dredging, spring tides during the sampling period added to the turbidity in the water.

The Government Department of Resource Management (DERM) has stated they use turbidity as a proxy for the measurement of total suspended solids in a water column." DERM also noted in its October 2011 report that "turbidity in Gladstone harbour was found to be higher in the area most likely to be affected by dredging and associated activities." Turbidity triggers have been set in the EIS and is regulated by DERM. If turbidity exceeds the 99th perentile for 48 hours, at the principal contractor is responsible for acting on a turbidity trigger. The principal contractor has the obligation to report (weekly) non conformance, high/ low monitoring exceedances and actions taken and any complaints. DERM found that turbidity levels in dredge sites, dredge spoil sites and dredge plume sites were 20 to 60 times higher than in the control sites (Rodds Bay). The aluminium was also closely correlated to total suspended metals in the 2012 CSIRO report. [xiv]

In September, turbidity exceeded the turbidity limits, and DERM requested they suspend dredging. In October turbidity exceeded the 99th centile, but no environmental protection order was given to cease the cutter dredge. "The highest subsurface turbidity recorded from the October sampling was at site BG10 in the harbour with a value of 71 NTU. (above the 99th percentile) However, an examination of historical turbidity data collected by the GPC at site BG10 since October 2010

suggests that turbidity levels greater than 50 NTU are common at this site around spring tides." (Jim Reeves DERM) The high turbidity in site ST1 was noted again at Christmas time from the 23rd to the 27th (4 days over the 99th percentile) and the dredging was not ceased, though when confronted the GPC admitted they reduced it by 3 hours a day. The turbidity again exceeded the 99th centile on the 8th January and an environmental protection order was issued and dredging was stopped on the 10th of January. No environmental protection orders were issued during the period October 2011 to January 2012 as the primary cause of high turbidity was attributed to spring tides.

In January 2012 DERM released a second supplementary report "**Second Update on the Water Quality of Port Curtis and Tributaries Including Data Collected in the Week of 24 October 2011."** In the report it was stated "Turbidity levels in parts of the harbour and river estuaries were higher in September and October 2011 than the preceding months but were consistent with those from summer and autumn (compare Figures 2, 3 with DERM, 2011a). The highest subsurface turbidity recorded from the October sampling was at site BG10 in the harbour (Figure 2; Zone 3–Table 1) with a value of 71 NTU. However, an examination of historical turbidity data collected by the GPC at site BG10 since October 2010 suggests that turbidity levels greater than 50 NTU are common at this site around spring tides."

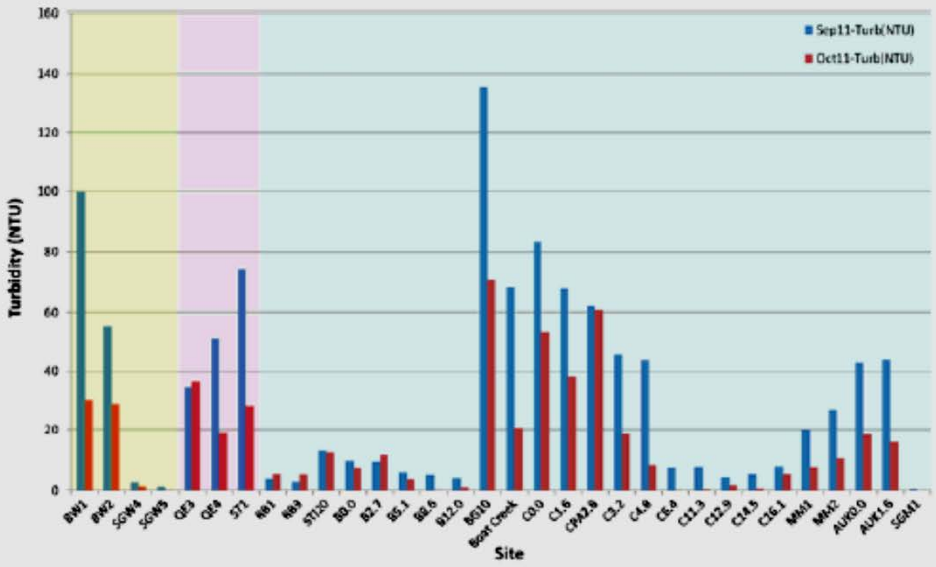
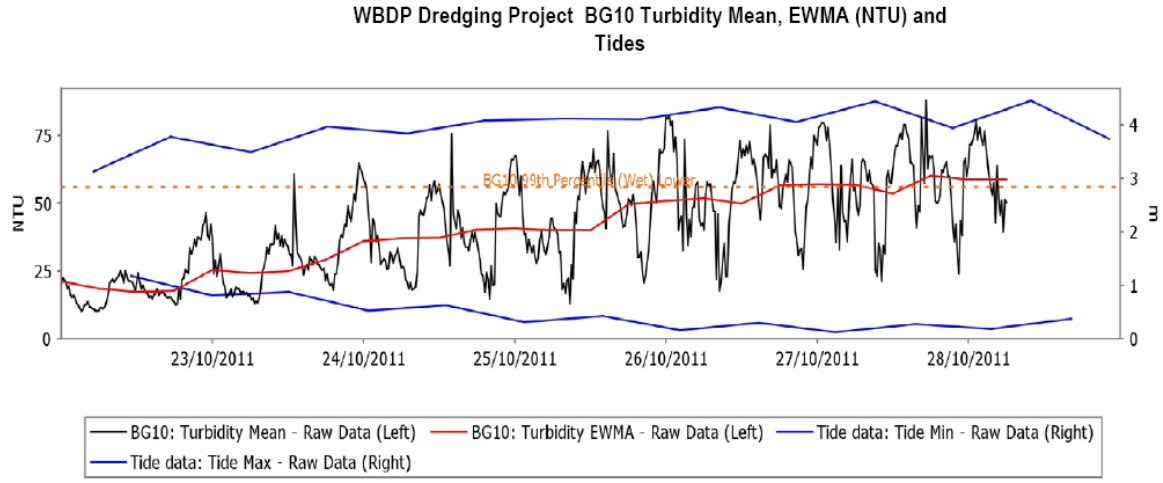


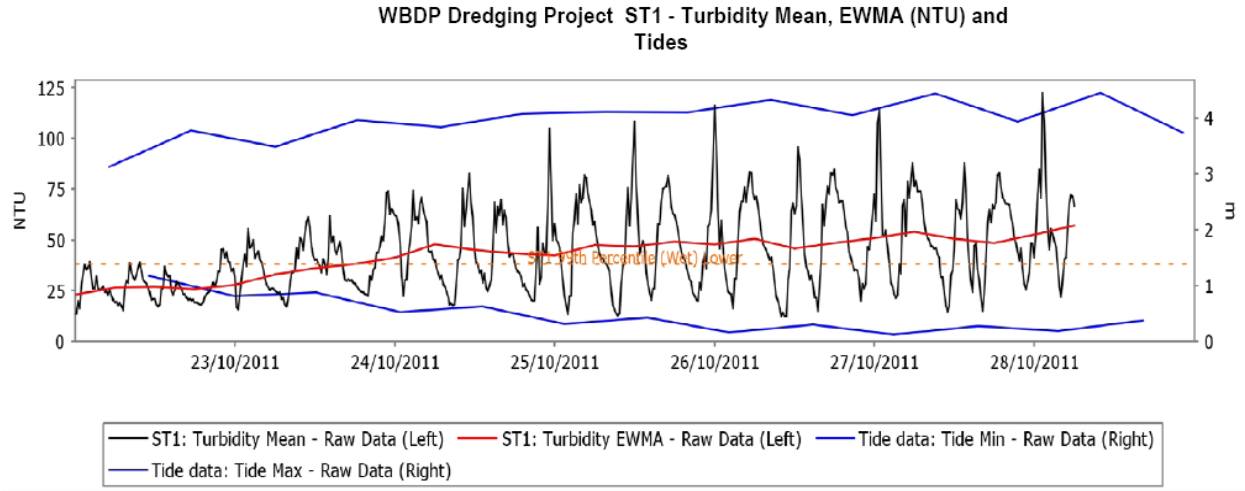
Figure 2: Subsurface turbidity for sites from Port Curtis sampled in September and October, 2011 (based on one observation per site). Blue bars are the results of the September 2011 sampling and red bars are the results of the October 2011 sampling, with yellow shading Zone 1 sites, pink, Zone 2 sites and blue, Zone 3 sites.

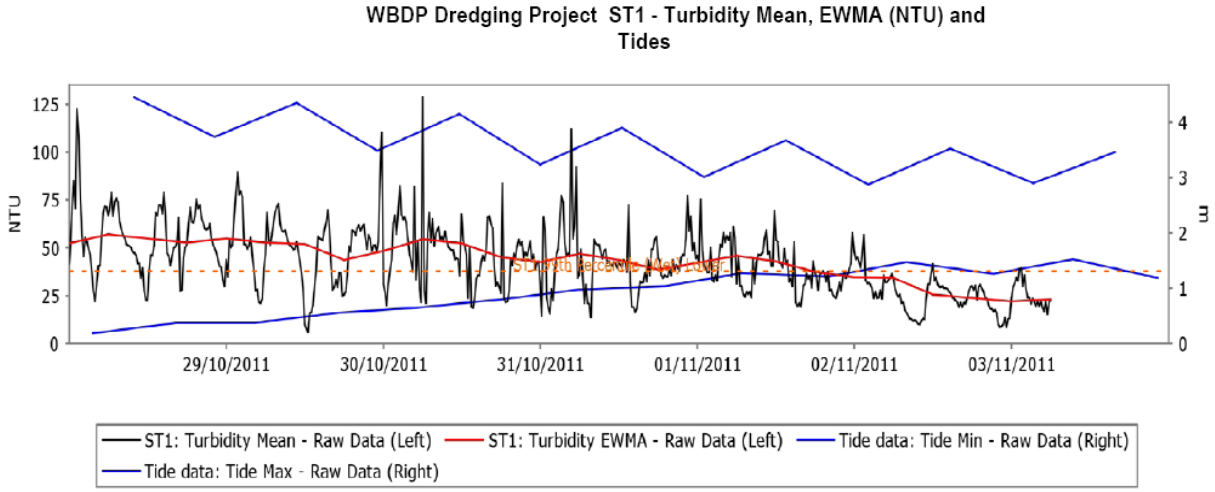
In media statements DERM continued to assert that there were no problems: "The sampling shows no clear pattern in the water quality results taken across the Port Curtis region to suggest that dredging was having any obvious impact on water quality," Mr Reeves said. "What we are seeing is a natural month to month variation across all testing zones. "There was no evidence that turbidity, pH, oxygen levels, salinity or temperature had any negative impact on water quality in Port Curtis harbour or its estuaries, or fish health concerns," (or human health concerns).

Gladstone Ports data for BG10 is found below over the period when DERM conducted testing. Turbidity was above the 99th percentile, however it is noted that Gladstone Ports was using the wet season turbidity level of 56 which was not meant to start until the 20th November.



In site ST1, it was raised for 9 days above the wet season levels. No environmental exceedance was reported. It was stated the primary cause for the high turbidity was spring tides. Examining historical data shows no period of nine days of high turbidity over the 99th centile. The use of the wet season turbidity triggers, which were not due to start until the 20th November is not explained.





It was also noted that earlier in the month from October 10th to October 14th the Al Mahaar Cutter Suction Dredge was suspended to assist in mitigating the natural turbidity cycles in the harbour.

Role of the Western Basin Dredging & Disposal Project and the Bund Wall

There was high turbidity in the Western Basin and a leaking bund wall at the time the human illnesses was reported in August and September. This bund wall was not repaired until June 2012. There were reports of algal blooms, high clorophyl-a and high nutrient, sediment and total suspended solids associated with the leaking bund wall.

A Transitional Environment Programme (TEP) was allowed to fix this "turbidity problem

> "And in breaking news, the GPC has admitted that a leaking section of bund wall around the Fisherman's Landing reclamation area had contributed to higher turbidity levels. In a media release, it said the reclamation area would undergo extra works over the next month to seal porous sections of the wall. Western Basin project manager Peter O'Sullivan said leakages through the bund wall were contributing to increased turbidity in the harbour during high spring tides, as the water seeped through and under the wall and scoured the ocean floor directly in front of the wall. "GPC became aware of the bund wall leakage in September last year and took remedial action by building an internal wall and sealing the southern cell of the reclamation area," Mr O'Sullivan said. "However, as this area has filled, it is now imperative the northern bund wall is sealed." The works, carried out under a Transitional Environmental Program (TEP) issued by Department of Environment and Heritage Protection, will be implemented and overseen by the independent Dredge Technical Reference Panel.".
>
> "The Gladstone Ports Corporation has admitted that a bund, or dam which stores dredging sediment, has been leaking into the ocean and has increased water turbidity. A state MP in Central Queensland has accused the operators of the state's largest port of a cover-up and the Queensland Premier says their operations lack transparency."
> http://www.abc.net.au/news/2012-06-28/gladstone-ports-corp-accused-of-cover-up/4097246

The water quality reports released by DERM at the time of the TEP stated "*Results of water quality investigations between September 2011 and May 2012, with the exception of a cluster of elevated metal concentrations around South Trees Inlet, have shown that none of the water quality properties measured was of significant environmental concern.*" This was despite the GPC admitting that the leaking bund wall and associated dredging has contributed to the high turbidity in the harbour having approved the TEP to fix the Bund wall leak, and approving dredging above the turbidity limits.

The multiple breaches over the 99th Centile for greater than 48 hours most likely due to the bund wall leak was contravening the conditions of their approvals. The Ports were not held accountable except for the one EPO on January 10th 2012. The ports continued to escape prosecution under the w2 clause – "the natural variation clause" - The *Courier Mail* wrote about this loophole that allowed the ports to dredge over the agreed limits. Previously the ports and government departments had been explaining the high turbidity away due to natural variation so that they were not punished for each exceedance (e,g, blaming tides or winds.) The W2 clause states – " Should turbidity levels exceed the above levels it is not a contravention of condition (W1) when it can be demonstrated to the satisfaction of the administering authority that elevated turbidity is the result of external factors (for example erroneous or invalid data, wave height, rainfall, tides, wind etc) and

not affected by sediment from the dredging to a greater extent than the modelled turbidity increase used for the purpose of developing the dredge management plan. "

Presuming that the leaking Bund wall contributed to the high turbidity which was admitted in the media and in the requests for the TEP, than some of that turbidity was not due to natural variation but due to the leaking bund wall. This therefore makes those exceedances breaches of their conditions.

http://www.gladstoneobserver.com.au/news/bund-wall-progress-gladstone-harbour/1453349/

The DEHP/DERM disguised these breaches explaining them away as natural variation when this was not the case. They continued to not enforce the rules despite monthly or fortnightly exceedances. This was the background to introducing the new light monitoring. Under that scheme high turbidity was not a breach as long as the light monitoring was within normal limits. As light monitoring has a 14 day rolling average, it would not pick up a breach until turbidity was well over the limits for over a week. In effect light monitoring has meant they are now allowed to dredge during periods of high turbidity. For example after the recent floods in January 2013 they started dredging when the turbidity was 300 NTU.

It was noted that in the end of October, 2011, where turbidity had exceeded the dry season limit for over 48 hours, that dredging was not ceased until 96 hours. This was raised with Arthur Dahl at DERM. It was noted that the Ports were on their website showing the turbidity 99th centile as wet season when in actual fact it was the dry season and their request to alter the dates had not been approved.

It is concerning that turbidity has continued to be high in 2012 and up to the wet season of 2013. A picture from the Space station of Gladstone Harbour, after the floods. After the floods turbidity went up to almost 300 at site ST1 and over 100 at site QE4. The GPC was allowed to dredge from the 27th January onwards despite the high turbidity because all light monitors were fine. The astronaut picture taken from the space station on 29th January, 2013 showed clearly the brown harbour and dredging at this time would have increased the sediment and contribute to seagrass death. Dredging continued throughout this period of brown turbidity because the rules are so relaxed that with light monitoring they can dredge 24 hours a day despite high turbidity.

Role of Aluminium and other Heavy Metals in Gladstone Harbour

The Gladstone area is a major industrial centre. It is the location of one of Queensland's major ports, and is the site of many industries including alumina refining and aluminium smelting, power generation and various other manufacturing facilities. There are two refineries and a smelter making Gladstone one of the most important aluminium centres in the world. Rio Tinto Alcan Yarwun (RTAY) is situated in the Yarwun area, 10km north-west of Gladstone in Central Queensland. QAL operates the Gladstone Alumina Refinery, on a site relatively close to the harbour. Rio Tinto and QAL have both had to significantly improve emissions control and environmental performance including reducing alumina dust. (A recent example is the replacement of the chute for loading of alumina recently at the wharf facility which reduced alumina dust emissions significantly.)[xi] Both refineries produce a white powder that is used to make aluminium metal. The process includes grinding the bauxite, dissolving aluminium hydroxide from the bauxite, then separating and precipitating the alumina and removal of water to produce alumina powder. This powder is stored for shipment to domestic and international customers. Pollution with Alumina dust is an ongoing issue.

The Boyne Smelters, one of the largest in the world, turns alumina into the metal aluminium. The Boyne smelters also have been required to improve their handling of alumina dust. The Boyne Smelter Development (BSD) which was to be completed by 2012 is expected to improve the plant's alumina handling equipment and alumina losses / alumina dust around the site. This should have positive effects on the environment with respect to alumina dust. [xii]

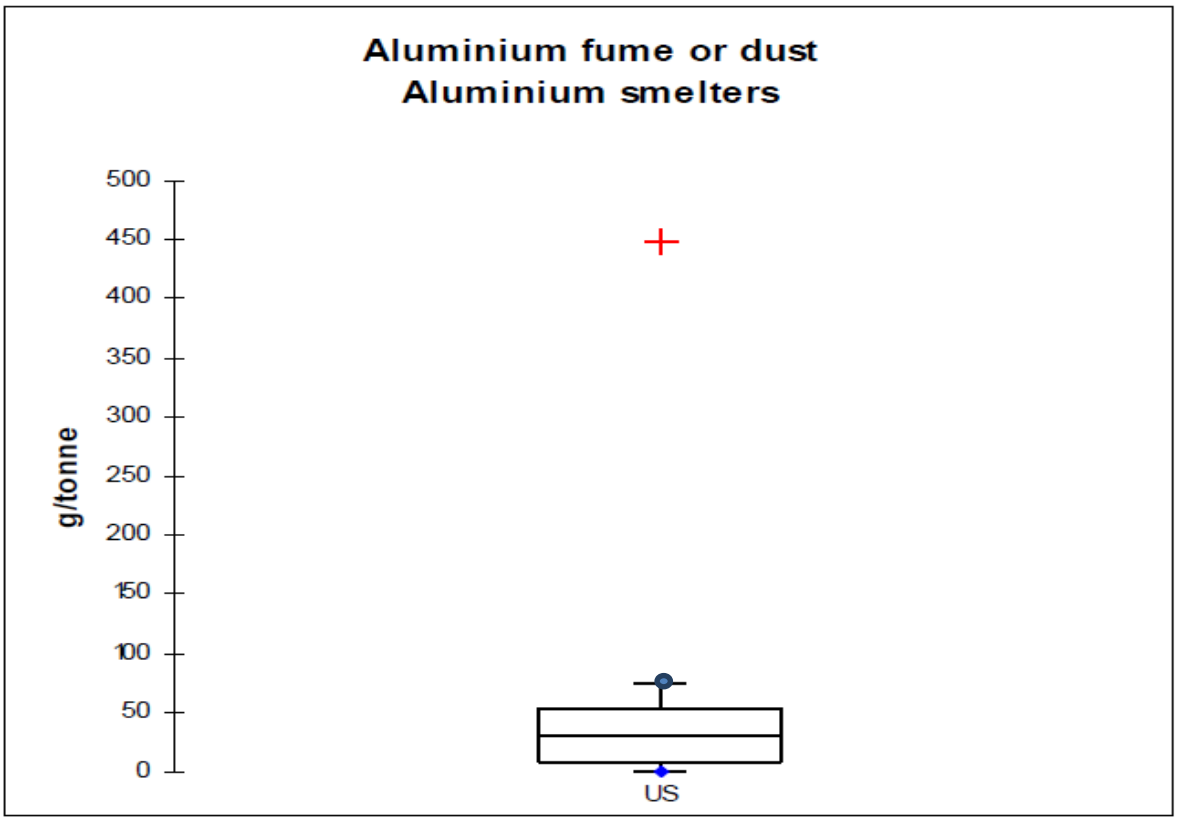
Figure 2: Escaping Alumina dust in Gladstone.

Alumina Dust

It is unavoidable that with 2 refineries and a smelter that over the decades significant amounts of fine particulate alumina dust and other materials have polluted the Gladstone Environs. Though reduction attempts have occurred and are still underway, there has been and will continue to be a significant legacy of alumina dust. Much of this alumina dust will find its way into the harbour either directly through the wind or indirectly as run-off during heavy rains.

The Gladstone area community has raised concerns about the cumulative impact of air emissions from industry on the health and well-being of the community and the environment. A “clean and healthy air” testing program has been implemented. A higher prevalence of self-reported asthma in Gladstone was noted in the Gladstone Community Health Survey compared with estimates around Queensland. Queensland health has reviewed the data around asthma, miscarriages, and total cancers due to higher rates of asthma. This review showed no differences in rates between Gladstone and the rest of Queensland, except for chronic lymphoid leukaemia (CLL). Between 1996 and 2004, 19 cases of CLL were reported in Gladstone, whereas only 9 would have been expected. Dust in Gladstone has been reported as including silica, clays, pollens, coal dust, alumina, magnesite and other particulates e.g. diesel. (http://gilg.com.au/faq/index/1)

Figure 3. This is a box plot of how much aluminium fume or dust is released from Boyne Smelters in Gladstone in comparison to other smelters in US



The box plot compares international data to Boyne Smelters:
• *Minimum and maximum overseas* – are small **blue dots** at the bottom and top of the range
• *3rd quartile* – the top of the enclosed rectangular box is the 3rd quartile limit
• *Median* - the line within the box is the median,
• *1st quartile* – the bottom of the box is the 25%ile
• *Whisker* – a whisker line extends both upward and downward represents the statistical limits beyond which values are considered anomalous
• *Mean* – is the **red cross** (***Boyne smelters mean dust levels are much higher than internationally***)

Alumina and Red Mud Residue

The QAL refinery has used a seawater neutralization process for its red mud for over 40 years. Red mud is the fine-grained residue left after alumina has been extracted from bauxite at the QAL refinery. The red mud is washed several times with water to recover caustic soda. Sea water is then added to neutralise any remaining caustic soda, before being pumped to the Residual Disposal Area (RDA) on Boyne Island. The overflow from the dam discharges into South Trees Inlet. Magnesium depleted seawater that is contaminated with iron, copper and aluminium is returned to South Trees Inlet. During the heavy rainfall such as occurred in the floods, the seawater neutralization may have been suboptimal due to the freshwater influx. This may have led to higher levels of contaminants entering South Trees Inlet.

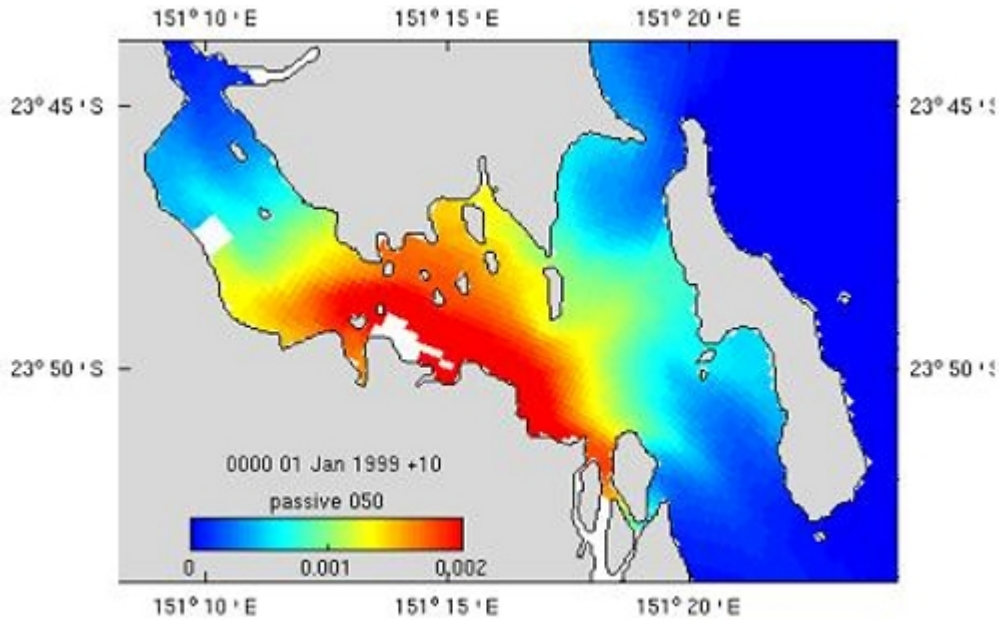
A better understanding of the process can be found at this link.
http://www.outotec.com/imagevaultfiles/id_558/cf_2/case_study-_queensland_alumina_ltd.pdf

Red Wall Dam Boyne Island Gladstone

Testing by DEHP found five sites with aluminium levels above the trigger value - all five were in the South Trees Inlet area. http://media2.apnonline.com.au/img/media/pdf/port-curtis-11th-update-report.pdf The levels could be a threat to fish health and link the high metals to the red mud dam at the refinery. DEHP has asked QAL to conduct further toxicity and chemical tests on waters from its red mud dam and the waters of South Trees inlet and whetherthey are safe for aquatic species.

The red colour in the red wall dam is due to iron. It is probable that not only aluminium but other metals such as iron are being released to the environment from this process. Shewanella is well known to be found in areas with high iron content. Shewanella is able to metabolise iron. [xiii]

Aluminium and other heavy metals may be toxic to the marine environment especially if combined with acid sulphate soils. A study of the Port Curtis estuary region shows the estuary is poorly connected with the offshore region seaward of Facing Island and would be prone to the sedimentation of aluminium dust. [xiv] The flushing time for the estuary is of the order of 19 days in January 1999. (This was evident in flushing, passive tracer and particle analyses. Tracers are transported efficiently throughout the estuary but inefficiently transported out of the estuary to offshore regions. This estimate is not expected to dramatically alter seasonally.) This flushing time is large in comparison with the time required for most particulates to settle from the water column, in particular aluminium hence the estuary may accumulate aluminium and other contaminants in the sediment over time.



Median tracer distribution resulting from a release site at Gladstone.

In contrast to Port Curtis estuary, Rodds Bay is well flushed and well connected to offshore regions, with an e-folding flushing time of 5 days in January 1999. Rodds Bay was used as a control site in the DERM study when studying metals and metalloids.

Heavy metals and other nutrients were high at the time of infections in the fishermen. It is possible that metals and metalloids contributed to poor water quality and health effects in the fishermen. The Aluminium results and quotes from the supplementary report in October 2011 are given below. "The total aluminium concentrations measured at the sampling sites in the September 2011 survey were mostly aluminium associated with the particles in the water column and a very small amount was in the dissolved form in the water (Figure 6). Aluminium is often closely associated with the amount of sediment in the water. There is a strong relationship between total aluminium and turbidity at the sites (R2 = 0.90) (Figure 7).

As turbidity is used as a proxy for the measurement of total suspended solids in a water column, this means that approximately 90% of the variation in total aluminium concentrations is explained by the total suspended solids concentration of the waters in and around Port Curtis. This was also found by the CSIRO metal report in 2012 which found that 70% of the variation could be explained by the total suspended solids concentration.

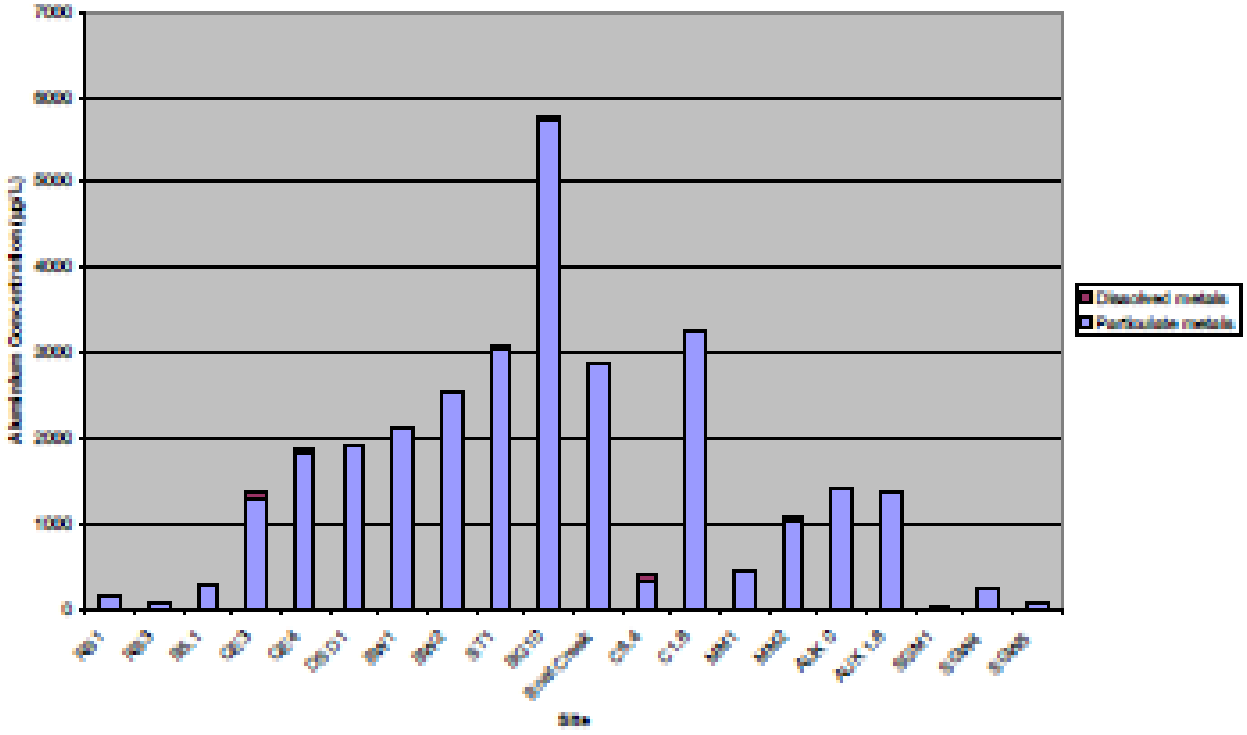


Figure 6 Measured concentrations of dissolved and particulate aluminium at DERM sampling sites in Port Curtis, September 2011.

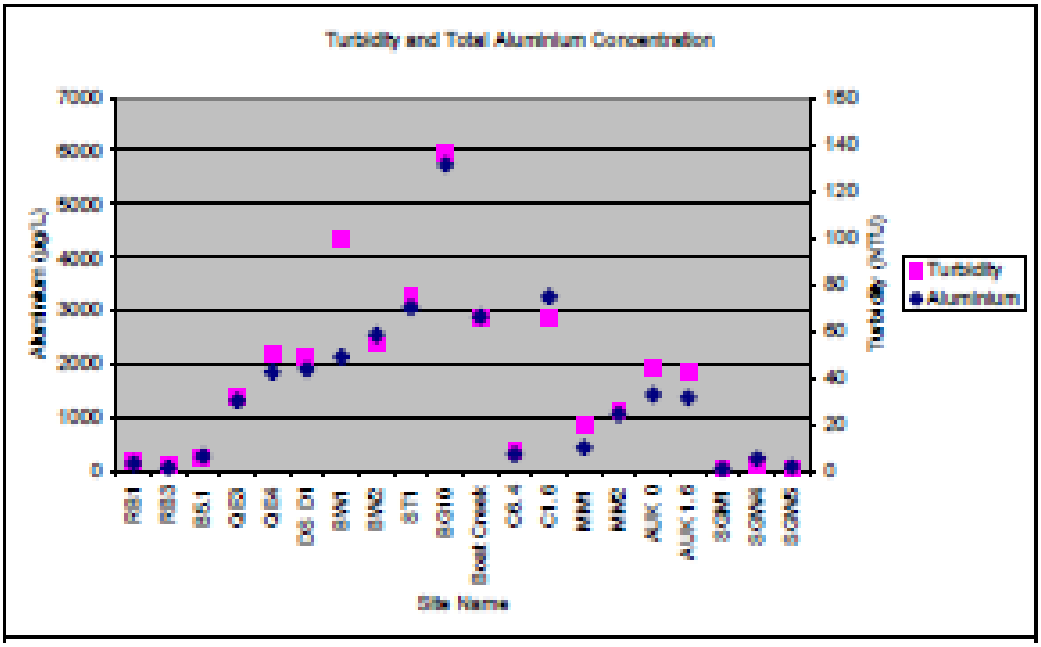
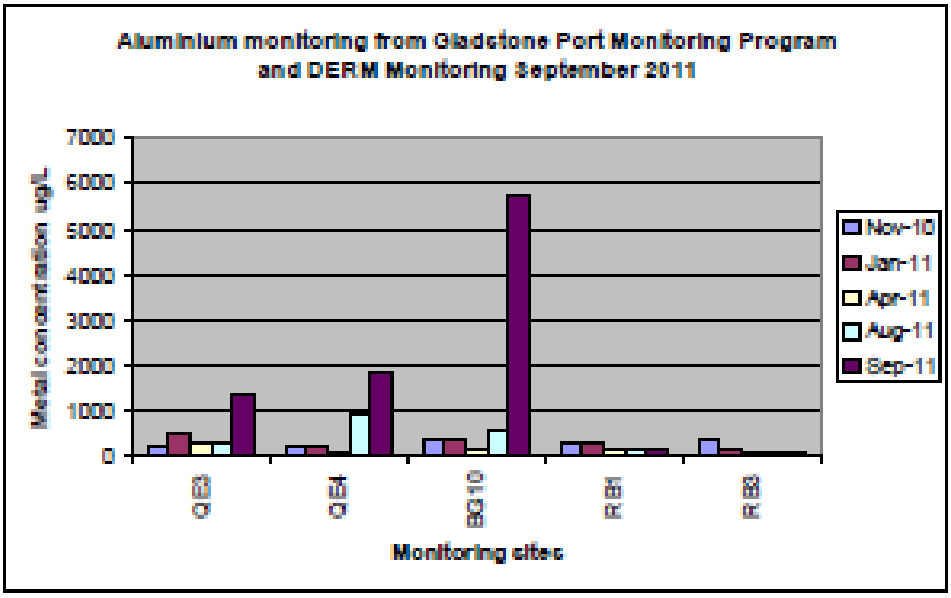
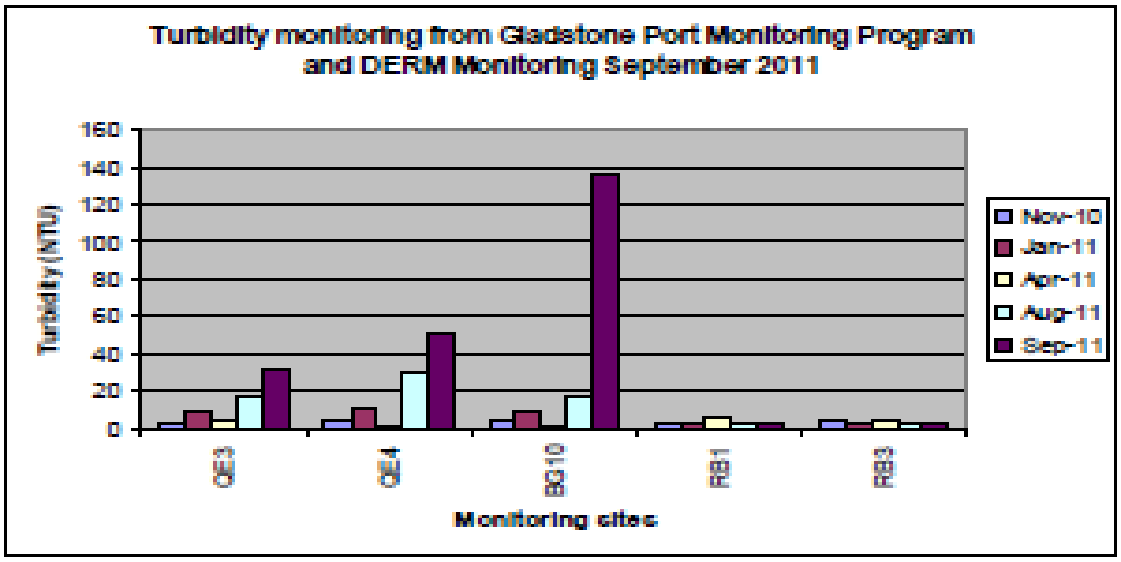


Figure 7 Measured concentrations of total aluminium at DERM sampling sites in Port Curtis, September 2011 compared to turbidity values recorded at the same time.

The CSIRO investigation assessed "whether there was a decline in water quality in and around Port Curtis ... previously collected total metal concentration data were compared with the totals metal concentration data collected during the September 2011 survey. Five sites that were surveyed in September 2011 had been previously surveyed by the Gladstone Port Monitoring Program. These were two sites north of the dredging area (QE3 and QE4), one site south of the dredging area (BG10) and two reference sites in Rodds Bay (RB1 and RB3)." It is noted that the Aluminium was over 10 to 60 times higher than the control sites.



(a)

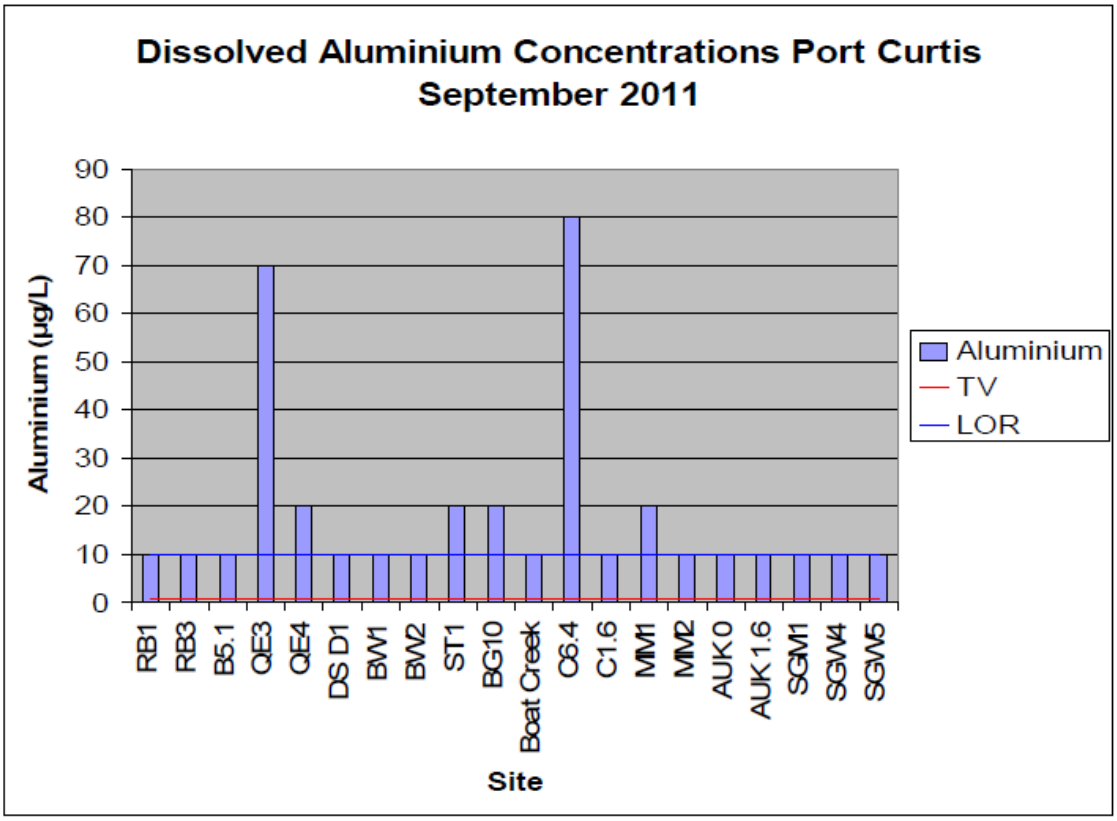


(b)

Figure 8 (a) Measured total aluminium concentrations at sites monitored by DERM in September 2011 compared to the same sites in previous sampling by Vision Environment QLD for the Gladstone Ports Corporation and (b) the corresponding graph for turbidity.

“There was an increase in the total aluminium concentrations at three of the five sites (QE3, QE4 and BG10) in September 2011 compared to previous months. This pattern is very similar to that for the measured turbidity at the sites (Figure 8), indicating that the apparent increase associated with total (but not dissolved) aluminium concentrations was related to the increased suspended sediment in the water column at these sites. Total aluminium is particularly high at BG10 in the area of potential impact from dredging plume (as is the turbidity reading) “

For 14 of the 20 sites surveyed for aluminium, including the sites in Zone 1, it could not be determined whether the TV had been exceeded or not. This occurred because the concentrations at these sites were reported as being below the level of reporting (LOR) which is the lowest concentration the laboratory will confidently state as being measured (Figure 2). Of the six that exceeded the aluminium TV, three of the sites (QE3, QE4, and ST1) were from Zone 2 and three sites (MM1, BG10 and C6.4) were from Zone 3. The two highest concentrations measured were at QE3 (70 µg/L in Zone 2) and C6. 4 (80 µg/L in Zone 3).



Total aluminium was not reported in the second supplementary report. Dissolved aluminium was reported. It was found “For 18 of the 19 sites surveyed for aluminium in October 2011 no aluminium could be quantified (i.e., measured aluminium was below the limit of reporting) In September 2011, quantifiable concentrations of dissolved aluminium were detected at six sites, with four sites (QE4, ST1, BG10, and MM1) having concentrations of 20 µg/L and two sites (QE3 and C6.4) having concentrations of 70 and 80 µg/L, respectively. For the 18 sites with concentrations less than the LOR it could not be determined whether the aluminium TV had been exceeded or not as the LOR was greater than the TV. The only site that exceeded the aluminium LOR in October was MM2 in Zone 3 (within the Gladstone Marina at 20 µg/L).”

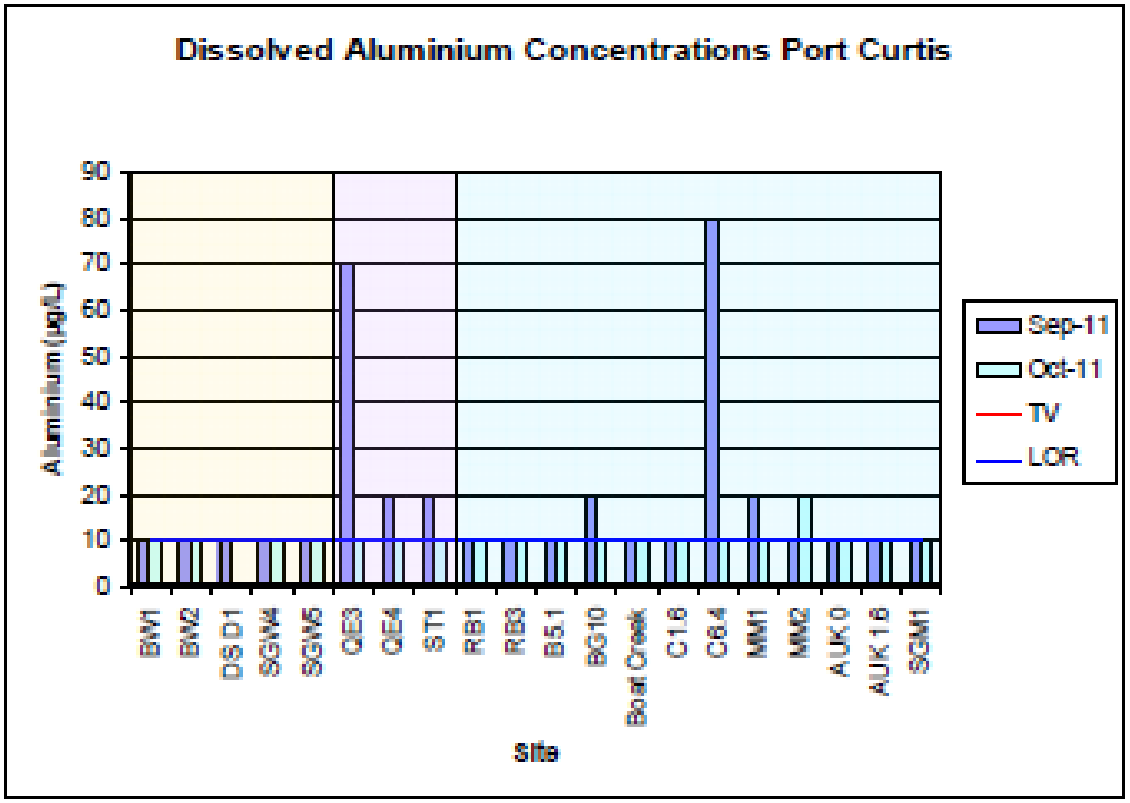


Figure 12: Measured concentrations (based on one sample per site) of dissolved aluminium (Al) in water samples collected in September and October 2011 from Port Curtis compared to Australian and New Zealand Water Quality Guideline trigger values (TVs) and the limit of reporting (LOR). Samples that are shown as equal to the LOR may have metal concentrations less than or equal to the LOR. In this case, LOR is above the TV. D/S D1 was not sampled in the October 2011 sampling round. Yellow shading indicates Zone 1 sites, pink, Zone 2 sites and blue, Zone 3 sites.

There was high aluminium in Water Samples Collected by WBM Oceanics (2002) and URS (2007). [xv] In a study assessing the effects of Harbour dredging using transplanted oysters as biomonitors, dredging showed significant effects on Aluminium concentration which increased over time. The concentrations were higher in the east and north than in the south and higher near the dredging activity than in the control locations. [xvi] The importance of this study is that it shows aluminium uptake is occurring by oysters and it is higher near dredging. This confirms that aluminium is made bioavailable after dredging. An Assessment of the Effects of Dredging at Fisherman's Landing by Andersen *et al* [xvii] also found high aluminium associated with dredging. Aluminium is often closely associated with the amount of sediment in the water and turbidity at the site. The CSIRO conducted a study in 2012 [xviii] **Aluminium was extremely high in the sediment, but there are no set guidelines. The values in the CSIRO report ranged from 14600 to 19500 ug/g dry weight. In comparison arsenic was above the guidelines and its value was 1.11 ug/g to 1.3 ug/g dry weight. Iron and copper were also high, but again no guidelines for sediment values exist, so the CSIRO report did not point out these high values. (Iron 29400 to 31,200 ug/g dry weight Copper 289 to 297 ug/g dry weight) Shewanella is well known to metabolise these heavy metals in particular iron in anaerobic conditions. A test of sediment to assess Shewanella growth was not done.**

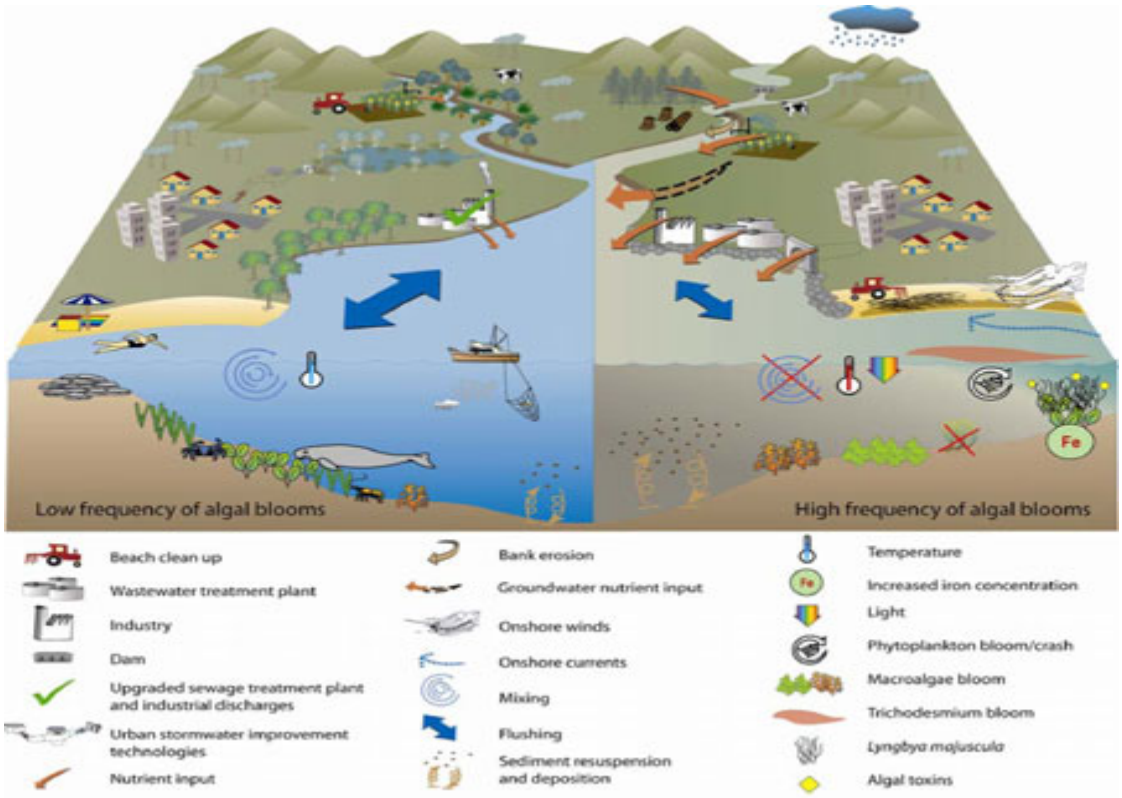
Aluminium has been demonstrated to be high with high turbidity. Other metals such as copper have also been linked to high turbidity. Statistical analysis of turbidity shows that there was a significantly higher level of turbidity in the last 100 days of 2011 (September 26 to December 31) 2011 when compared to all previous years. (Further data to be provided) Over 25 days out of last 100 days of

2011 were above the 99th centile when the expected rate was 1 day per 100 above this level. If the wet season dates had not been adjusted the results were even higher. This high level of turbidity and associated heavy metals may have contributed to the algal blooms and marine bacteria such as shewenella.

Discussion

The number of skin infections and other health symptoms reported in fishermen indicates that common environmental exposures may be contributing to the illnesses in the fishermen. The link to algal blooms, high nutrients, high turbidity and associated marine bacteria can be postulated but not proven. In particular the 2 confirmed cases of Shewanella and one suspected case and the Shewanella identified in catfish and mudcrabs in Gladstone suggest a link to the fish disease is possible. The disease in fish and the disease in fishermen that all occurred at the same time (temporal link) may not be proven, but that does not mean there was no link as suggested by the health department. The lack of a statistically significant result should not mean the null hypothesis is proven, just that it is not disproved. Many other factors are suggestive of a link.

Algal blooms refer to the overgrowth of algae (e.g. microalgae, macroalgae or cyanobacteria) in response to natural or human-induced changes to the environment. Algal blooms can have a major detrimental effect on estuarine and marine environments. Toxic algal blooms can degrade fisheries, affect natural ecosystems and potentially impact on the tourism industry. A harmful algal bloom is one where the alga species produces toxins that pose a threat to human and/or animal health or the environment, such as Lyngbya. Blooms occur when favourable conditions cause the rapid growth of one (or several) algae species allowing them to dominate the aquatic ecosystem. Environmental conditions influencing algae growth include high nutrients, high trace elements such as metals amongst other factors. [xix] Many factors in Gladstone harbour favour high frequency of algal blooms.



Harmful Algal Blooms (HABs) are common seasonal phenomena occurring throughout Queensland in fresh, estuarine and coastal marine waters. HABs may be potentially toxic thus posing a direct threat to human and animal health. Consequently, a HAB may have economic and social impacts There is a standard operational procedure to follow given the identification and/or receipt of a public enquiry regarding a potential HAB. The roles and responsibilities of the various response agencies with the capacity and expertise to deal with specific HAB incidences, ensure that the situation is handled by the appropriate agency within a consistent response framework.

The five steps include

1. Receiving the public inquiry

2. Provide general advice

3. Inspect the bloom

4. Analyse the bloom

5. Communicate the findings

6. Clear the bloom

Harmful algal blooms were notified in Gladstone harbour in August 2011, at a time of human illness yet the procedures to deal with it were not put in place. Fishermen were not notified or advised, the bloom appears not to be analysed, and the communication was leaked to the media and later confirmed. The health department put out no notices with regard to the bloom.

In contrast a harmful algal bloom in WA in August 2011 was handled very differently "Health officials have discovered a toxic microscopic algae at 'very high levels' in the Peel-Harvey Estuary, near Mandurah, WA, prompting a warning for people to avoid eating wild-caught shellfish." "As a general rule people should not eat wild shellfish as their safety cannot be guaranteed." [xx]

This stark contrast between WA's proactive warnings to the public in the media, compared to the leaked reports to media in Qld needs to be further investigated. Intoxication with blue-green algae can lead to convulsions, diarrhea and sudden death. The species *Anabaena circinalis* was the cause of the Darling River bloom in 1990-91. Paralytic poisons were found in the dead sheep and cattle along the river at that time. In the 1970s *Cylindrospermosis*, in a dam in Palm Island Queensland, was treated with copper sulphate. As the algae died, it released toxins into the water which were responsible for approximately 150 people being taken ill. Medical symptoms included gastrointestinal, liver and kidney damage. (High levels of copper and acid sulphate soils in Gladstone harbour could lead to copper sulphate) Direct contact to cyanobacteria (e.g. Lyngbya) of exposed parts of the body including the ears, eyes, mouth and throat as well as ingestion of water containing cells by swallowing are cited as risks resulting from exposure at recreational water sites.

Turbidity has been elevated in the Gladstone harbour and exceeded the 99th Percentile ("the licensed level") for over 48 hours in at least one site, nearly every month from August, 2011 to April 2013. It is a statistically significant difference from previous years and the historical data and therefore should have been noted in all the reports.

Though spring tides contributed to turbidity, media statements simply do not reflect the science. Only 1 day in 100 would expect to be above the 99th percentile. 25 days in the last 100 days of 2011 being over the 99th percentile is not natural month to month variation. The turbidity results show that dredging is having an impact on water quality in Port Curtis harbour.

As the Gladstone Ports Corporation did not receive an environmental protection order, they were not required to stop dredging during times of high turbidity between October, 2011 and January, 2012. The Gladstone Ports stated they have voluntarily taken action and reduced the hours of dredging during periods of high turbidity. The use of the natural variation clause and attributing the high turbidity primarily to spring tides was repeated continuously. The high turbidity was noted on the Christmas holidays, Australia Day, Easter holidays and Labour day. High turbidity (dirty water) on public holidays when people are using the harbour for recreation is an unnecessary risk. The cutter dredge continued to operate in periods of high turbidity. The Ports were "asked" to stop dredging in September 2011, by DERM around the time of the fishermen's illness.

As locations within the Dredging Area have been identified as containing acid sulphate soils (ASS) and potential acid sulphate soils (PASS) management of the issue was required in the EIS. The majority of the sediments underlying the proposed Western Basin Reclamation Area contain excess sulphur acidity and net acidity at varying depths. Based on laboratory testing the majority of the samples from the Reclamation Area do not appear to contain enough buffering capacity to self-neutralise.

Acid Sulfate Soils and Potential Acid Sulfate soils (ASS/PASS) in an undisturbed state below the water table are benign. During dredging the soils are drained, excavated and exposed and the sulfides react with oxygen to form sulphuric acid which can in turn release iron, aluminium and other heavy metals. Once mobilized in this way, the acid and metals can create a variety of adverse impacts. Total Aluminium and total copper was associated with the amount of sediment in the water and DERM found a strong relationship between total aluminium and copper and turbidity.

There has been a legacy of Aluminium pollution in Gladstone harbour and other heavy metals from industry over decades. Aluminium and its compounds are known to cause health effects in humans such as osteomalacia and encephalopathy in people with kidney disease. A number of human health studies have been conducted on the air quality of Gladstone and can be found on the DERM website. Alumina dust has been measured in some of these air quality studies ,[xxi] even though Queensland health does not consider it a key pollutant. The level of alumina dust in Gladstone is significantly higher when benchmarked against industry in other countries. [xxii] Aluminium compounds can be irritating to the skin and it is possible that this may have contributed to illness in fishermen. Aluminium is the metal most consistently high heavy metal in the water quality reports, but it is possible that other metals such as copper and iron may also be involved. These heavy metals may not be causing direct effects but may also be contributing indirectly. Shewenella, a marine bacteria is found in sites with high heavy metal content.

As turbidity associated with the dredging and leaking bund wall was proven to be a difficult problem to manage, it is likely that the associated high total aluminium and other metals may have contributed to "bioavailability" of toxic algae and marine bacteria such as Shewanella.

The panel has recommended testing of sediments should accompany future water quality sampling campaigns. There is no recommendation to look at the bacterial content of the sediment and this could be considered. The Panel recommended the water quality monitoring be expanded to include analysis for dissolved metals (operationally defined as the fraction of metals in the water column that pass through a 0.45 µm filter). The Queensland Department of Environment and Resource Management (DERM) completed additional monitoring including dissolved metals during the week of 26 September 2011. Though the panel recommended expanding testing to include dissolved metals, DERM appeared to stop reporting total metals in their subsequent report on October water quality data. They reported dissolved aluminium but not total aluminium.

The ph of Gladstone harbour water was 7.6 to 7.9 and it is a typical estuary and thus saline. At this ph, even with high total aluminium the dissolved portion will only be small. The study assessing the effects of dredging using transplanted oysters as biomonitors in Curtis Harbour showed significant effects on Aluminium concentration and other metals which increased over time in the oysters. The concentrations were higher in the east and north than in the south and higher near the dredging activity than in the control locations. (Andersen *et al.* 2002)

Biomonitors may be a more accurate indication of bioavailability than dissolved aluminium and other metals because the effects of aluminium attached to acid sulphate soils may be more complex. CSIRO sediment analyses found high levels of aluminium, iron and copper in the sediment. [xv]

Complexity occurs because heavy metal bio-availablity and associated bacteria may result from fluxes into pore water from sediments to the overlying water. [xxiii] Dredging of sediment also leads to oxygenation to the acid sulphate soils. The possibility of microniches of acidity and high metals associated with the acid sulphate soil combination in the sediment should be explored. [xxiv] This may favour the growth of some bacteria such as Shewanella. The complexity is increased when the sediment is then transported to shallow hot water, which can be quite favourable to Shewanella growth. There is some suggestion that climate change and warmer water may also contribute to Shewanella infections

The fish with bacterial infections such as Shewanella and hyperparisitism e.g. neobenedenia may be like the canary in the coal mine, when it comes to dredging Gladstone harbour. A large group of unaffected Barramundi have been transplanted by the spillover from the Awoonga dam and are now acting as biomonitors as they swim through the turbid waters during the spring tides to spawn. They were previously healthy and then turbidity is worsened with heavy metals and metalloids. This may contribute to poor fish health, potential immuno- compromise and the stress seen in Barramundi. This may lead to the hyperparasitism and bacterial overgrowth including marine organisms such as Shewanella and Vibrio. It would suggest that if fish and multiple species are unwell at the same time as humans are reporting health symptoms that a link is possible.

The Panel noted that “fish are normally good integrative indicators of eco-system and environmental health. The Panel concluded there is an issue of concern around the health of some species of fish in Gladstone Harbour and this is possibly caused by environmental factors, but the extent of the issue is currently not known. The pathology data and other information for barramundi indicates this species may be stressed and potentially immuno-compromised.

The Panel reviewed the data for the parasite (*Neobenedenia* sp.) which was affecting the eye and skin particularly in the barramundi. “Reports of high prevalences in wild fish are unusual, While the presence of *Neobenedenia* on barramundi explains many of the lesions reported, the reasons for the current high prevalence and abundance of the parasite are unclear

The Panel noted that identifying the cause(s) of the disease(s) and prevalence of parasites on fish in Gladstone Harbour is a complex and difficult task. This task is further complicated by the extreme flood events of the 2010-2011 summer and the historical and ongoing industrial development of the Harbour, which have changed the local environment. Determining conclusively whether any environmental changes have anything to do with the reported fish health problems is a formidable and perhaps impossible undertaking given the available data for fish and human diseases has been collected using descriptive study designs (e.g. case series, cross sectional surveys) without the benefit of normal baseline values for fish and human diseases making determination of causation difficult.

Nevertheless, it is the Panel's view there is an issue of concern around the health of some species of fish in Gladstone Harbour and this is possibly caused by environmental factors. It would follow that there may also be a concern around the outbreak of infections in humans and it could possibly be caused by environmental factors.

Dr Matt Landos in his report found that the re-suspension of contaminated sediments by the Western Basin Dredging and Disposal Project may have caused toxic exposures in aquatic animals. It would follow the Gladstone fishermen were also exposed to that same toxic environment. He also found increased parasitism of aquatic animals due to stress, immunosuppression and external irritation from poor water quality.

It is important that if a risk is identified that controls are put in place. Dredging can be done using silk curtains. Closed containment systems and systems that remove soil from under the seabed are also possible. Rules regarding turbidity should be enforced, particularly when there is unexplained disease around. The Ports have dredged over the limit generally once but often twice a month since dredging monitoring in August 2010 until March 2013. They also dredged over the limit to 'fix' the leaking bund in June, July and August 2012 wall and have continued to dredge over the limit every month since then." They continue to ask for exemptions based on light monitoring, including October, November, December, January and March 2013.

It is postulated that the high turbidity and associated heavy metals may have contributed to the documented algal blooms and associated marine bacteria which has contributed to the illness in multiple species including fish and fishermen. The Ports dredging over the limit on Christmas, Easter, Australia day and Labor day when people recreate in the waters of Gladstone harbour may increase the risk of marine infections. The government and the ports changed the turbidity levels in May 2102. The new levels were increased at Site QE4 - 28 Nephelometric Turbidity Units (NTU) to 30 NTU (dry season); and 34 to 55 in the wet season and Site ST1 - 24 NTU to 35 NTU (dry season) and 38 to 65 in the wet season. They were unable to comply with these new levels and so then introduced light monitoring which in effect further relaxed the limits. The seagrass has been suffering and has been unable to recover during the growth season. In conjunction with the floods in 2011 and 2013 the dredging smothers the grass and impedes its regrowth. "The state government has ruled because the light monitors on top of the dead seagrass say the light is OK the Ports can keep dredging. This will continue, because the light monitors work on a 14 day rolling average while turbidity is on a 6 hour rolling average, which means that the dredging can continue 24 hours a day despite high coverage of seagrass and high turbidity."

CSIRO sediment data showed high arsenic levels in the sediment. It is possible this may be contributing to the high arsenic found in the turtles from the Great Barrier Reef. Tests released by the Department of Environment and Heritage Protection found high arsenic levels above trigger values. Testing of diseased turtle blood in Gladstone Harbour has also found high arsenic levels.

The high aluminium, iron, copper and arsenic levels that are in the sediment tests support the theory that metalloids may be contributing to disease in multiple species including barramundi, prawn and dewfish. This cocktail of heavy metals and metal compounds that is coating seagrass and partially inhibiting its growth, may also be contributing to turtle illness. The reason why Aluminium was not an exceedance in the CSIRO report is that currently there is no trigger value for aluminium in sediments. These sediment results are further evidence of high metal concentration in the dredging area and therefore dredging these sediments will increase these metals and their bioavailability in the environment. Dumping these dredge spoils will also increase the harm and this is also shown in the sediment testing of the dump spoil areas, (e.g. aluminium 18000 mg/kg) The high metals in dredge spoils can contribute to environmental harm

The dramatic pictures of the Queensland flood plume taken by astronauts showing a brown muddy harbour from outer space (January 2013), suggest that dredging at this time may not be conducive to harbour health. Yet Gladstone Ports Corporation's [GPC] water quality monitoring program found it was safe to dredge the inner harbour at this time. Gladstone Ports Corporation's light monitors say conditions are OK in a flood plume despite turbidity over 300 NTU in some areas. The 14 day rolling average, is a poor tool to control dredging. This may not only harm the seagrass but also make conditions more favourable for algal blooms and bacterial overgrowth. It would be preferable they were stopped from dredging when the turbidity is so high.

The data suggests that turbidity, total metals and metalloids and potentially acid sulphate soils, may be contributing to the immune stress in fish. It may also be contributing to disease in humans through irritation of the skin. Dirty polluted water has health risks not only for the skin but for sinuses and respiratory tract as well. It is suggested that heavy metals in the harbour and dredge spoil should be further investigated. It is also suggested the panel and DERM and Qld health may have been more thorough in noting, discussing and recommending further studies with regards to metalloids, algal blooms and pathogens in fish and humans such as Shewanella and Vibrio.

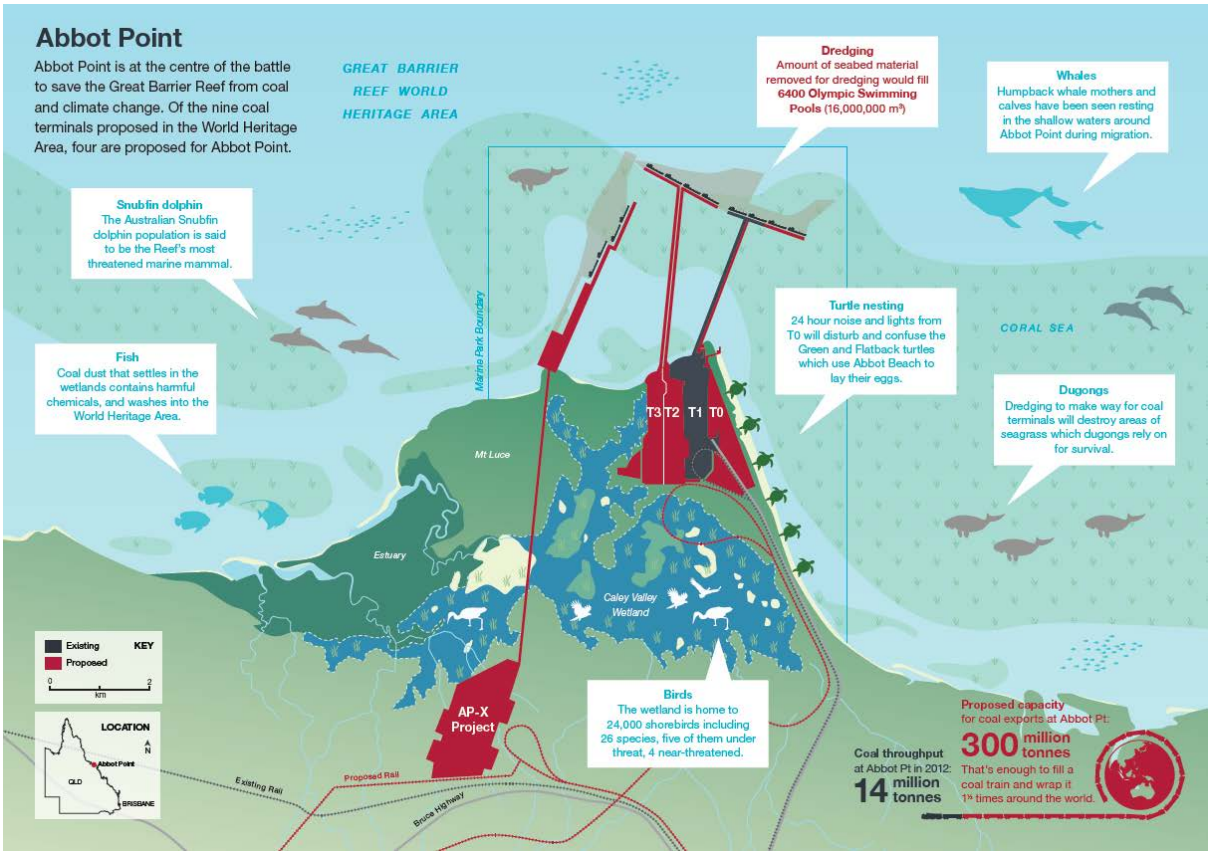
The Gladstone Ports Authority has requested all MPs consider removing Gladstone Harbour from the World Heritage area. Environmental damage has occurred in Gladstone harbour. High turbidity associated with dredging and associated high contaminants such as heavy metals may have contributed to the illness in the fishermen and environmental harm. Further studies and increased monitoring as recommended by the scientific panel are required and it is hoped this is undertaken by DERM, the Gladstone Ports Corporation and Qld health. Support for further analysis of Shewanella and Vibrio data from Central Queensland may provide further answers. Though we can not at the moment determine if there is an increased incidence of Shewanella in and around Gladstone over the last 2 years, it is worthwhile considering further analysing the data and ensuring that there are no statistical aberrations.

The Australian Society for Microbiology National Conference in Sydney has heard that there has been a rise in *Shewanella algae* infections. Infections typically peaked around January and February when temperatures were highest, said Rodney McDougall, a laboratory scientist with, Sullivan Nicolaides Pathology in Queensland at the conference. He said the majority of patients who had been infected by *Shewanella algae* had contact with sea water and some had developed septicaemia. "We are not sure why it causes disease, when another strain of the bacteria - *Shewanella putrefaciens* - doesn't." *Shewanella algae* thrives in salty conditions and warm water. In some parts of the reef temperatures reached 35 degrees. The high water temperatures were also evidenced by coral bleaching in the Great Barrier Reef, McDougall said. A similar correlation between high water temperature, presence of *Shewanella algae* and human infection occurred in Denmark after an unseasonably hot summer in 1994, and was reported in the journal *Applied and Environmental Microbiology* in 2000.

The investigation conducted by the health department could have been improved. It did not include an occupational and environmental physician despite this being an occupational group that reported the symptoms. It did not effectively assess the available data on water quality, or take independent samples. It seemed to ignore important data such as toxic algal blooms. They stated they could find no link between fish disease and human health. Later both fish and humans were found to have the Shewanella bacteria. Though the human infection is caused by Shewanella algae and the fish infections had Shewanella putrefaciens involved it is likely a similar environment has contributed to both infections in humans and fish.

The decades of Gladstone industry has contributed to high metals in the sediment of the harbour including aluminium, copper, arsenic and iron. Shewanella is an anaerobic bacteria that in the absence of oxygen can metabolise heavy metals. Shewanella is a rare infection that may be associated with heavy metals and polluted marine environments. Acid sulphated soils with high total metals are likely to be a food source for Shewanella. It is postulated dredging this material and dumping the spoil in Gladstone harbour may have created an environment conducive to toxic algal blooms such as lyngbya and associated bacteria such as Shewanella, vibrios and other marine bacteria.

This investigation should have been given more resources, to better investigate these occupationally related health symptoms. Tourism could be jeapordized if swimming/diving/fishing in the Great Barrier Reef were to become a health hazard due to marine infections associated with dredging and dredge spoil. As future dredging projects and dredge spoil will be dumped in recreation areas such as Townsville near Magnetic Island and Holbourne Reef near Abbott point, the associated health risks and infections in and around Gladstone harbour require a more in depth investigation.
It is important to assess the health risks from Gladstone so that the health risks associated with dredging in Abbott point and Townsville and other ports of the Great Barrier Reef can be managed. It is hoped that by further analysing data regarding infections and other health symptoms that we will have a more complete understanding of health risks. There is the possibility to mitigate environmental harm and health risks if appropriate steps are taken to ensure the environment can recover and the dredging companies stay within their regulated limits such as turbidity. The potential to damage the tourism industry exists if harm to tourists or young children are caused by rare marine infections. The Great Barrier Reef is a national treasure, a tourism icon, a world heritage listed area. It deserves to be protected.



Greenpeace - Simple diagram of Abbott Point - proposed development including dredging and dumping in the Great Barrier Reef Marine Park.

Pertinent media reports

http://www.sunshinecoastdaily.com.au/news/just-317500-fees-dump-spoil-reef/1731262/

Just $317,500 in fees to dump spoil on the reef

25th Jan 2013 9:51 AM

THREE Queensland port corporations paid the Federal Government just $317,500 in fees to allow them to dump more than 27 million cubic metres of dredge spoil in the Great Barrier Reef World Heritage Area in the past 12 years.

The ports at Gladstone, Mackay, Townsville and Hay Point applied for a total of 22 permits to dump dredge spoil within the limits of the WHA between 2000 and September last year.

Of the total 22 permits applied for, 21 were approved by the Federal Government, allowing more than 27 million cubic metres of dredged sea bed to be dumped in the world heritage-listed site.

The latest application, for a permit to dump a further 3.4 million cubic metres near Townsville, has not yet been approved by the nation's environmental regulator.

Under the Sea Dumping Act, the government charges ports to dump the dredged spoil, with applications to dump more than 100,000m3 costing $23,500 each, and those less than 100,000 cubic metres, charged $16,500.

The act has been updated several times since it was first created in the early 1980s, with most changes to marginally increase the cost of permit fees for port authorities.

But in the latest changes, which came in 2009 under Federal Labor, the government also removed strict provisions that previously governing sea dumping in Australian waters.

Those amendments included removing the distinction between contaminated and non-contaminated materials and removing the distinction between environmentally sensitive and non-environmentally sensitive areas.

The 2009 changes to the Act also removed the fee category payable for permits allowing more than 500,000 cubic metres of dredged material to be dumped - a move which removed higher fees for the larger amount of dumped sediment.

Since those changes were made, 10 of the 19 applications approved have been for sea dumping permits more than 500,000 cubic metres - ranging between 548,000 cubic metres and 11 million cubic metres of spoil.

The figures of approved sea dumping permits were released after Federal Environment Minister Tony Burke answered questions Queensland Greens Senator Larissa Waters posed last year during Senate Estimates.

In addition to the 21 permits already approved by the regulator, 12 other applications within the marine park boundaries were also approved under the Great Barrier Reef Marine Park Act.

Those applications totalled more than 25 million cubic metres of dredge spoil, largely for maintenance projects at ports at Hay Point, Cairns, Abbot Point and fishing marina Rosslyn Bay.

Barge dumped dredge spoil 'to safeguard crew and vessel'

5th Dec 2012 5:40 PM

A BARGE working on the Western Basin Dredging and Disposal project dumped dredge spoil in the Great Barrier Reef World Heritage Area, breaching Commonwealth environmental approval conditions, in January this year.
The dumping of 730 cubic metres of dredge spoil within the World Heritage Area led to a $6600 fine for the Gladstone Ports Corporation.
As part of federal environmental conditions on the massive dredging project, spoil could only be dumped in approved areas, including the East Banks Sea Disposal Site.
But a spokeswoman for the Federal Environment department said the dumping of the spoil outside of the disposal site had contravened environmental approval conditions.
She also confirmed the spoil was dumped within the Great Barrier Reef World Heritage Area, although the department did not believe it resulted in any adverse impacts on the reef.
Western Basin Dredging and Disposal Project Manager Peter O'Sullivan confirmed the breach occurred on January 28 at 5.10am, after a split hopper barge was loaded with dredge spoil by backhoe dredge Razende Bol.
Mr O'Sullivan said after the loading of the spoil, the barge set sail for the disposal site, but "when confronted with rapidly deteriorating weather conditions", the captain decided an emergency dump was needed to safeguard the crew and vessel.
"This decision was based on the hydraulic pressure in the system controlling the opening of the split hopper being approximately 50bar above the nominal level of 250bar, indicating that an excessive amount of water had entered the hopper and increased the downward pressure on the hopper," he said.
Mr O'Sullivan said the barge was about 1.25 nautical miles from the approved disposal site when it was forced to dump the spoil.
He said there was 730 cubic metres of dredge spoil dumped, and the spoil was not potential acid sulphate soil.
The dredge contractor, Van Oord Dredging International, had since made changes to more accurately predict weather forecasts, including wave heights and strong winds.
"The dumping procedures and the use of the alternative sailing channel were reviewed to limit the risk of any reoccurrence," he said.
"At this time there are no backhoe dredge tug and barge combination barges working on the Western Basin Dredging and Disposal Project."
Mr O'Sullivan said the dump position was recorded and both state and federal

environmental regulators were notified, before video cameras were towed through the area to show the dump had no impacts on marine plants or corals.
"A repeat survey was done to ensure material had not migrated out of the area. All these reports were provided to the regulators," he said.
The departmental spokeswoman said the payment of such fines "should not be taken as an admission of liability for contraventions of national environmental law".
The $6600 fine was the maximum amount the federal environment department can charge a company for breaches of approval conditions under the Environmental Protection, Biodiversity and Conservation Act.
http://www.sunshinecoastdaily.com.au/news/companies-dump-dredge-great-barrier-reef/1729527/

Companies dump dredge in the Great Barrier Reef

- 24th Jan 2013 10:00 AM

TWO Queensland port corporations paid less than $100,000 to dump nearly 2.5 million cubic metres of dredge spoil in the Great Barrier Reef World Heritage Area last year.
Under the Federal Government's Sea Dumping Act, companies can apply for permits to dump dredge spoil and other things such as marine vessels at sea.
In the last financial year, the Environment Department handed out 14 approvals for sea dumping, 10 of which were for dredge spoil to be dumped around the country.
Of those approved, three applications came from the North Queensland Bulk Ports Corporation and the Port of Townsville, to dump a total of 2.44 million cubic metres of dredged sediment in the World Heritage Area.
The approvals were for new dumps at the Townsville and Mackay ports under the Sea Dumping Act and one at Hay Point port under the approval of the Great Barrier Marine Park Authority.
In total, the 10 sea dumping application approved would see more than 100,000,000 cubic metres of dredge spoil dumped at sea in Australian waters.
The majority of that dumping would be conducted on the Western Australian coast, as part of massive off-shore gas projects near Onslow and Port Hedland.
Under the Sea Dumping Act, any dredge spoil dumping application involving more than 100,000 cubic metres can only be approved if the company pays a fee costing $23,500.
Sea Dumping approvals for dredged material under 100,000 cubic metres costs a company only $10,000.
For the four approvals in the Great Barrier Reef World Heritage Area, each company paid the fee, totalling $80,500, as the Hay Point proposal was for only 17,000 cubic metres.
The Federal Environment Department did not turn down any applications for sea dumping permits in 2011-12.

Santos Gladstone LNG fined for late reporting of oil spills

11th Dec 2012 6:00 PM

THE company behind one of Queensland's massive gas projects, Santos Gladstone LNG, was fined nearly $20,000 for the late reporting of oil spills and other breaches of environmental approval conditions in the Great Barrier Reef World Heritage Area last year.

The fines totalled $19,800 and were related to the company's late reporting of five minor oil spills and two increases in turbidity levels near the Curtis Island site in the World Heritage Area (WHA).

The first public references to the fines were released in a departmental report tabled in parliament in late October this year.

A Santos spokesman confirmed the spills were of no more than 40 litres of biodegradable hydraulic vegetable oil, and all spills occurred between March 21 and September 17 last year.

The delay between the first spill and the actual reporting of the spill was about eight months, with all five oil spills reported on November 29, last year.

That was despite Commonwealth environmental conditions on the Santos GLNG project demanding the proponent report any such breaches to the federal environment department within five business days of the breach occurring.

A departmental spokeswoman confirmed the three infringement notices also related to the late reporting of two increases in turbidity levels in the WHA during the same period.

She said the two increases in turbidity levels resulted from "inadequate sediment and erosion controls following significant rainfall events" at the Santos GLNG project.

"The conditions associated with infrastructure development at Curtis Island allow for the close monitoring of incidents that may adversely impact upon the Great Barrier Reef World Heritage Area," she said.

"These conditions were put in place to allow the timely and thorough appraisal of any potential impacts."

She said the department believed the five oil spills had not resulted in any adverse impacts on the reef WHA, and the fines should not be taken as an admission of liability for contraventions of national environmental law.

A spokesman for Santos said the company had stringent reporting requirements required by the state government, Gladstone Ports Corporation, Marine Safety Queensland and the Federal Government.

He said that while the company had reported "every incident" within the required timeframe to the state government, GPC and MSQ; the reporting to the Commonwealth agency was late.

The company spokesman said the company undertook an "internal reporting change in November 2011", and since then, no reporting timeframe had been missed, and all reports were made in accordance with federal environmental approval requirements.

He said the company took its environmental responsibilities seriously, and the fines related to a "technical breach of a state government-imposed condition", despite

the fines being imposed by the federal government in relation to its approval conditions.
The three fines, of $6,600, were each the maximum individual amount the department can fine a company for breaches of approval conditions under the Environment Protection and Biodiversity Conservation Act.

Recent environment fines on the Great Barrier Reef:

- Santos LNG: Three fines totalling $19,800 for five minor oil spills and turbidity increases in the Great Barrier Reef World Heritage Area during 2011.
- Gladstone Ports Corporation: One fine, of $6,600, for a load of 730 cubic metres of dredge spoil dumped in the WHA in January, 2011.
- Hope Star Shipping Company: Company fined $5000 and captain fined $300 for dumping food waste in the WHA in June, 2012.

Other relevant interviews and programmes.
Interviews

http://blogs.abc.net.au/queensland/2012/04/is-gladstone-harbour-part-of-the-great-barrier-reef.html

http://blogs.abc.net.au/queensland/2011/10/gladstone-dredging-and-fish-problems-andrew-jeremijenko.html

http://blogs.abc.net.au/queensland/2011/11/story-1-4.html?site=westqld&program=612_evenings

http://blogs.abc.net.au/queensland/2011/12/gladstone-harbour-test-results-andrew-jeremijenko.html

http://blogs.abc.net.au/queensland/2012/05/gladstone-harbours-water-turbidity-increased-3rd-may-2012.html?site=goldcoast&program=612_evenings

http://www.thepunch.com.au/articles/somethings-really-fishy-in-the-gladstone-waters/

Programmes

- http://www.abc.net.au/catalyst/stories/3593812.htm Catalyst, high turbidity and heavy metals.
- http://www.abc.net.au/4corners/stories/2011/11/03/3355047.htm Great Barrier Grief
- https://www.youtube.com/watch?v=uGsa_-5uh-Q 7.30 report dead dugong, fish disease
- https://www.youtube.com/watch?v=Q_9Gr3mDMX0 Heritage authority worried by dredging

- https://www.youtube.com/watch?v=MVKlmvNApbc Gladstone Harbour Dredge Protest - LNG Coal Seam Gas Port - TV media coverage
- https://www.youtube.com/watch?v=6AzHlxwj91Q Environmental concern over Gladstone harbour channel 'significant project'
- https://www.youtube.com/watch?v=DRLRcwgFHYI catalyst s13 ep18 GladstoneDredging
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- https://www.youtube.com/watch?v=tRQVZE0uEgI Gladstone Harbour Fish Disease - Government Says Nothing Wrong
- https://www.youtube.com/watch?v=b5QUnMdtXy4 Harbour Mystery – high turbidity

- https://www.youtube.com/watch?v=4Qr5YJjZXGI Report Scientific Panel-Crab Health -
- https://www.youtube.com/watch?v=D-nGtbQmd-I New report blames dredging for Gladstone fish kills

- https://www.youtube.com/watch?v=p4Bm-eT-sW4 Senator Larissa Waters - Gladstone Harbour contamination - Ch 10
- https://www.youtube.com/watch?v=ApbVL3fwEgA Gladstone residents warned over toxic chemical spill - ABC News
- https://www.youtube.com/watch?v=t-K6B9G32zc Report to Scientific Panel EstuaryFish Health Gladstone Harbour November 2011
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- http://www.ozcoasts.gov.au/pdf/CRC/12-intertidal_fidler_crabs.pdf

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