DECCO Consortium

George Town Landfill

Environmental Risk Based Assessment

May 2021

Executive summary

Introduction

This environmental risk based assessment has been prepared by GHD on behalf of DECCO Consortium as part of its tender to Cayman Islands Government to provide and operate an Integrated Solid Waste Management System (ISWMS) for the Cayman Islands.

The purpose of this assessment is to evaluate the environmental risks posed by the George Town Landfill (the site) to sensitive receptors surrounding the site, comparing the impacts under *status quo* conditions against those once an engineered cap has been installed at the site.

Site Setting

George Town Landfill is located to the north of central George Town, covering a total area of approximately 73 acres. It is owned by Cayman Islands Government and operated by the Department of Environmental Health.

The landfill is predominantly a land raise, formed by tipping over an area of former mangrove swamp. Current tipping operations commenced in 1989, with waste inputs comprising a combination of residential and commercial waste, plus small *ad hoc* quantities of other materials.

The existing site has no engineering containment (basal lining and/or capping system) and operates generally on an uncontrolled dilute and disperse basis, with previously infilled areas having been covered with a thin layer of soil and allowed to naturally revegetate.

The current landfilling operations at the site are due to cease at the end of June 2023, after the new ISWMS becomes operational.

Environmental Setting

This environmental risk assessment is predominantly based on data and information pertaining to the site in two reports by Amec Foster Wheeler (now Wood Group): *Landfill Site Environmental Review, Task 1, Environmental Investigations and Risk Assessments, February 2015*; and, *Landfill Site Environmental Review, Task 2, Environmental Investigations Interpretive Report, March 2016*. GHD has also been provided with additional monitoring data for the site from 2016 and 2019.

The two main sources of contaminants at the site are the deposited wastes within the landfill and a waste oil storage area. Previous assessments have identified metals, hydrocarbons, ammonia[1] and orthophosphate as the main contaminants of concern at the site. The contaminants are present in the soils and/or the groundwater at the site. Landfill gases and waste fires are also considered as sources due to their asphyxiant, explosive, flammable and odourous properties. Various potential pathways have been considered for these contaminant sources as part of this assessment, including but not limited to: ingestion, inhalation, direct contact, leaching, vertical and lateral migration, fire and explosion.

Human health receptors are identified as site workers and visitors, adjacent residents and adjacent commercial and industrial properties. The main controlled water receptors are the surface water in the canals adjacent to the site and marine waters of the North Sound. Groundwater abstraction wells are not considered to be a main receptor due to their distance from the site (more than half a mile) and the presence of low permeability strata reducing the vertical migration of contaminants to the aquifer that is exploited by the abstractions.

[1] Wood Group has since informed GHD that the analytical results for ammonia in their reports pertain to 'ammoniacal nitrogen as ammonia'. Throughout this report, ammoniacal nitrogen as ammonia has been abbreviated to ammonia. The assumption that the ammoniacal nitrogen is ammonia results in a conservative assessment of risk.

Ecological receptors include insects, birdlife and iguanas that come into contact with the exposed waste, site soils and the water/sediment in the surrounding canals. Fish populations are not considered to be a current receptor due to the poor quality water in the surrounding canals, notwithstanding which the risk to the surface water habitat (and therefore fish populations) has still been considered as part of the risk based assessment).

Environmental Risk Assessment Findings

A tiered approach was used to assess the risks posed to sensitive receptors from contaminants at the site. In the first instance, a conceptual site model was prepared to identify potential pollutant linkages (source-pathway-receptor). These linkages were then assessed to determine their significance by way of generic quantitative (by comparison to published target criteria) and qualitative (considering the effect of adding a cap to the landfill) assessment. Risks that were deemed feasible with credible pollutant linkages were then progressed further to detailed quantitative assessment. A summary of the assessment results is provided below.

Conceptual Site Model

The conceptual site model considers combinations of sources, pathways and receptors to form pollutant linkages that require assessment to determine whether these pose unacceptable risks that need to be mitigated. The general sources, pathways and receptors pertaining to the site's conceptual site model are listed below:

- Sources: contaminants in waste/soils, contaminants in groundwater, landfill gases
- Receptors: human health receptors (site workers, site visitors, off-site residents and commercial/industrial properties), ecological receptors, controlled waters receptors (marine surface water, groundwater abstractions), and structures (with respect to explosion risk from landfill gas)
- Pathways (relevant to human health receptors): dermal contact, inhalation, ingestion
- Pathways (relevant to controlled waters receptors): surface water run-off, leaching of contaminants to site groundwater, off-site migration of contaminants in groundwater
- Pathways (relevant to landfill gas): vertical and lateral migration off-site

However, only the particular combinations of sources, pathways and receptors that form pollutant linkages are applicable and require assessment, for example a combination of: waste (source)-dermal contact (pathway)-site user (receptor).

Generic Risk Assessment

A generic risk assessment comprises a combination of quantitative and qualitative assessments. Quantitative risk assessment is carried out where there are available published target criteria which provide acceptable contaminant concentrations that are protective of certain types of receptors. Known contaminant concentrations at the site are then compared to those criteria, with further detailed assessment being required where they exceed the published target criteria. The qualitative assessment uses professional judgement to describe the anticipated impact of mitigation measures to be employed at the site on the pollutant linkages.

The generic risk assessment for the site identified several pollutant linkages that remain without an engineered cap or gas management systems being installed at the site, namely:

- Risk posed to human health and ecological receptors from the contaminated soil/waste
- Risk posed by surface water run-off that has contacted contaminated soil/waste
- Risk posed to groundwater and off-site migration to marine water
- Risk posed to human health receptors and structures from exposure to landfill gas (including consideration of health impact, explosion and fire risk)

However, the inclusion of a landfill cap provides a physical barrier that disrupts the pollutant linkages in the source-pathway-receptor model and removes or significantly reduces the potential for contaminant exposure to sensitive receptors. Similarly, the provision of a landfill gas management system enables the better control, collection and management of landfill gas (and odours) from the site.

Accordingly, the provision of a landfill cap and landfill gas management system in the generic risk assessment breaks the majority of the pollutant linkages. As such, the only remaining risk which required taking forward for detailed quantitative risk assessment was to marine surface water from groundwater contaminants.

Detailed Quantitative Risk Assessment

The detailed quantitative risk assessment for the site involved using ConSim software to model the migration of known groundwater contaminant concentrations from the site to the North Canal, as well as assessing the degree of the betterment associated with the provision of an engineered landfill cap. The North Canal was selected for modelling due to its being the closest receptor to the site; with the risk posed to other receptors at a greater distance being lower.

The detailed assessment results showed that the majority of the contaminants at the site no longer exceeded the relevant Generic Assessment Criteria threshold levels at the North Canal and subsequently the North Sound, even without a landfill cap. An engineered cap is, however, required to be provided to remove the risk posed by cyanide and diesel range organics, and to provide betterment with respect to ammonia.

Sensitivity Analysis

A sensitivity analysis was carried out to assess the impacts of increasing non-site-specific input parameters and the aquifer porosity by 10%; evaluating the resulting change in predicted concentrations at the nearest sensitive receptor. The majority of the increased parameters caused the predicted peak concentrations to change by 1% or less. Increasing the aquifer porosity by 10% resulted in the highest change in the peak concentrations, but still with no significant increase (ammonia concentration increased from 15.9188 mg/l to 17.3267 mg/l, Diesel Range Organics concentration increased from 0.713545 mg/l to 0.837172 mg/l). These changes do not affect the conclusions of the risk assessment.

Conclusion

Overall, the risk assessment shows that certain contaminants within the wastes deposited at the existing George Town Landfill are currently impacting the surrounding environment in terms of elevating emissions to air, surface water and groundwater - and will continue to do so for the foreseeable future without the provision of an engineered landfill cap. The addition of a cap over the landfill site breaks the majority of pollutant linkages, leaving only a limited number of areas of concern relating to risk to marine surface water from groundwater contaminants.

Detailed quantitative risk assessment modelling demonstrates that an engineered landfill cap reduces the migration of contaminants to the North Canal (and subsequently the North Sound), with contaminant concentrations generally falling within acceptable limits at the receptor thereafter.

The only exception to this is ammonia, which exceeds the stringent criterion for un-ionised ammonia[2], but falls well below the total ammonia limit for river water (the most applicable criterion for this project); with the betterment provided by the engineered cap resulting in an overall 85% reduction in the peak concentration compared to the *status quo*.

As such, the risk assessment demonstrates overall that - including the provision of a landfill cap - the site will be suitable for use as public open space (subject to on-going practical restrictions, such as access to critical infrastructure) in future.

[2] Note that as salinity increases in a water body, the portion of unionised ammonia decreases; with the North Canal being brackish and the North Sound being marine water.

Addendum 1

Following agreement of the original environmental risk assessment with CIG, GHD was commissioned by DC to consider potential alternative capping options for the older, less active South Mound.

This area, which ceased receiving waste circa 1999, has naturally revegetated following the cessation of tipping operations and is now covered with dense layer of undergrowth. The area shows no sign of vegetation stress (an indicator of landfill gas emissions) and appears from recent monitoring results to be having little if any unacceptable impact on the surrounding environment.

Accordingly, the purpose of the additional study was to assess whether a cap is required for South Mound and, if so, whether a less conservative cap design may be appropriate.

South Mound

The revised modelling shows that, even without a cap, the South Mound does not pose an unacceptable risk to the nearest sensitive receptor (North Canal). As such, it is not necessary to provide any engineered capping over the South Mound.

North Mound

A cap is required at the North Mound to remove the risk posed by iron, cyanide and DRO. The assessment also demonstrates that the cap provides significant betterment in terms of ammonia concentrations in the North Canal; with an 80% reduction in the peak ammonia concentrations compared to the status quo.

As betterment has been demonstrated for the closest receptor, betterment of risk posed to receptors at a greater distance, such as North Sound and groundwater abstractions, is also confirmed.

Addendum 2

Following the issue of Addendum 1, the envisaged footprint and date of closure of the North Mound changed slightly in line with operational developments and additional groundwater monitoring results became available.

Accordingly, GHD updated its risk assessment to reflect the more recent understanding, with the following modelling results:

South Mound

The revised modelling shows that, even without a cap, the South Mound contaminants continue not to pose an unacceptable risk to the nearest sensitive receptor (North Canal). As such, it is not necessary to provide any engineered capping over the South Mound.

North Mound

A cap is required at the North Mound to remove the risk posed by iron and DRO. The assessment also demonstrates that the cap provides significant betterment in terms of ammonia concentrations in the North Canal; with an 87% reduction in the peak total ammonia and unionised ammonia concentrations compared to the status quo.

A cap is required at the northwest expansion area to remove the risk posed by iron, DRO and cyanide. The assessment also demonstrates that the cap provides significant betterment in terms of ammonia concentrations in the North Canal; with a 78% reduction in the peak total ammonia and unionised ammonia concentrations compared to the status quo.

As betterment has been demonstrated for the closest receptor, betterment of risk posed to receptors at a greater distance, such as North Sound and groundwater abstractions, is also confirmed.

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1. Introduction

This report has been prepared by GHD on behalf of DECCO Consortium (DC) to document the environmental risk assessment completed for the George Town Landfill (hereafter referred to as the site) located to the north of central George Town, towards the western coast of Grand Cayman. The purpose of the report is to understand the environmental risk posed to the sensitive receptors surrounding the site due to the presence of the landfill, considering the level of risk posed by the *status quo* conditions and comparing this to the level of risk following the installation of an engineered landfill cap at the site. The remedial options for the site are described in detail in the GHD report *George Town Landfill, Remediation Options Report, January 2020*.

1.1 Site setting

The site is owned by the Cayman Island Government (CIG) and operated by the Department of Environmental Health (DEH). The total site area is approximately 73 acres. The landfill is predominantly a land raise, formed by tipping over an area of former mangrove swamp that was partially excavated to recover the underlying marls (calcareous soils).

The site has no engineering containment (basal lining and/or capping system), and operates on an uncontrolled dilute and disperse basis. Tipping operations commenced in the mid-1960s, with the waste volume being reduced by burning until 1985. Thereafter, the mode of tipping switched to placing and compacting waste with heavy equipment (still with no formal landfill engineering) in 1989; which approach continues to this day. Waste inputs comprise a combination of residential and commercial waste, with small *ad hoc* quantities of other materials. Previously infilled areas having been covered with a thin layer of soil and allowed to naturally revegetate. The site is due to cease receiving waste at the end of June 2023, until which time waste will continue to be deposited in the northwest/western portion of the site.

The site will subsequently be capped and restored, encouraging naturally occurring flora and fauna, potentially supported by limited new infrastructure development. An annotated plan of the site and the neighbouring water treatment facility is provided in Figure 1 below.

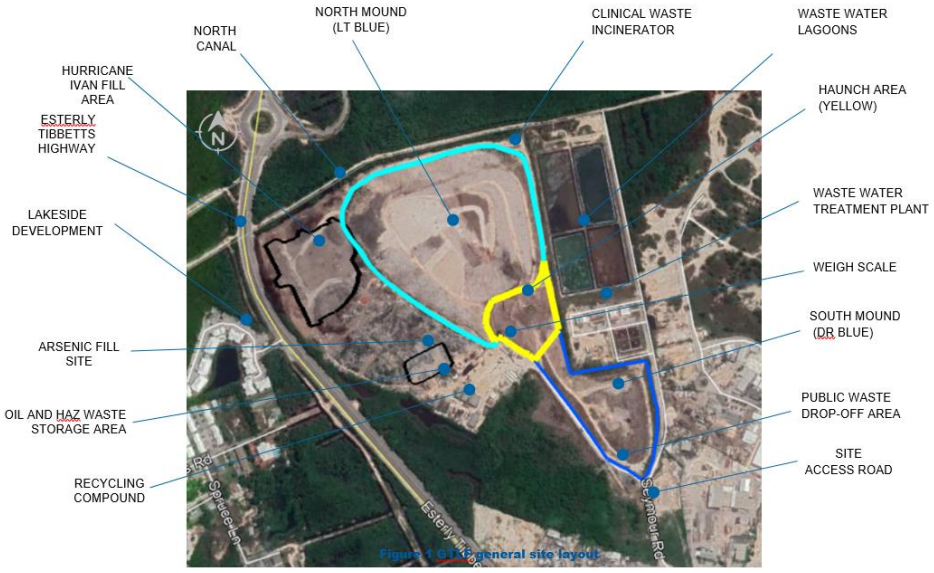

Figure 1 Site layout and features

Overall, the site can broadly be divided into six interlinking parts:

- An older, inactive area known as the South Mound (approx. 8.0 acres of landfill in 10.2 acres of property to be retained by CIG)
- A newer, active landfilling area known as the North Mound (approx. 25.2 acres)
- Current tipping area referred to as Haunch Area (approx. 3.6 acres) and generally considered part of the North Mound in the technical closure considerations
- A small lined landfill that received arsenic contaminated material resulting from burning treated lumber after Hurricane Ivan (approx. 0.9 acres)
- Approximately 5.7 acres of previous pond (west of the North Mound) created by mining for marl and infilled with debris created by Hurricane Ivan in 2004
- The remaining site area, some of which has historically been contaminated by waste or waste related activities

1.2 Limitations

This report has been prepared by GHD for DC and may only be used and relied on by DC for the purpose agreed between GHD and DC. GHD otherwise disclaims responsibility to any person other than DC arising in connection with this report. GHD also excludes implied warranties and conditions, to the extent legally permissible. The services undertaken by GHD in connection with preparing this report were limited to those specifically detailed in the report and are subject to the scope limitations set out in the report.

The opinions, conclusions and any recommendations in this report are based on conditions encountered and information reviewed at the date of preparation of the report. GHD has no responsibility or obligation to update this report to account for events or changes occurring subsequent to the date that the report was prepared.

The opinions, conclusions and any recommendations in this report are based on assumptions made by GHD described in this report. GHD disclaims liability arising from any of the assumptions being incorrect.

GHD has prepared this report on the basis of information provided by DC, based on CIG, Wood/Amec Foster Wheeler (Amec)[3] and other publicly available data sources, which GHD has not independently verified or checked beyond the agreed scope of work. GHD does not accept liability in connection with such unverified information, including errors and omissions in the report which were caused by errors or omissions in that information.

[3] Amec now Wood Group.

2. Environmental setting

The site setting is described comprehensively in the following reports by Amec:

- Landfill Site Environmental Review, Task 1, Environmental Investigations and Risk Assessments, February 2015.
- Landfill Site Environmental Review, Task 2, Environmental Investigations Interpretive Report, March 2016.

A summary of the pertinent information is provided below.

2.1 Topography

The land surrounding the landfill is mainly flat. Where developed, the profile comprises reclaimed former mangrove swamp. The height of land surrounding the site varies between approximately 2 and 5 feet (ft) above Mean Sea Level (MSL). The highest part of site is the top of the North Mound at approximately 90 ft above MSL.

2.2 Surrounding land use

The land usage surrounding the site is summarised as follows:

- Immediately to the north of the site is a tidal drainage channel (canal) developed for mosquito control that connects with North Sound to the east. The area immediately north of the drainage channel is mangrove swamp. A Water Authority Cayman (WAC) pressurised pipeline that conveys sewage to the wastewater treatment plant (WWTP) is located immediately north of the property. The Cayman International School and Camana Bay development are located approximately 0.2 and 0.5 miles north of the landfill respectively.
- Beyond the eastern boundary of the site is land owned by Cayman Water Authority and comprises four large former wastewater treatment lagoons that are still used for sludge storage. The lagoons are lined and filled with sludge and water. To the south of the lagoons is the current WWTP including some buildings and four smaller basins. Some 0.1 to 0.2 miles east of the site is land zoned for industrial use. This is mainly undeveloped or used for open storage. DEH's collections depot (comprising several trailers for staff facilities and parking for staff and collection vehicles) is located on approximately 1 acre of land to the east of the wastewater treatment lagoons.
- To the south of the site is an area of mangrove with industrial and commercial development beyond. This land is occupied by a variety of businesses, including a concrete batching plant, and a concrete block and paver stone manufacturer.
- The Esterly Tibbetts Highway (the main arterial road to West Bay) is immediately adjacent to the fence line forming the western boundary of the site. The Lakeside residential development is located west of the road and approximately 330 ft from the landfill boundary and a further 610 ft from the area currently used for active landfilling of waste. This development comprises 12 three-storey residential apartments with car parking and leisure/landscape areas (including a small lake). The North Mound of the site is visible from the easternmost lakeside buildings.

2.3 Geology and hydrogeology

2.3.1 Geological setting

The geology in the vicinity of the site is summarised in Table 1, taken from the Amec reports.

Table 1 Geological succession adjacent to site

Elevation (m)	Thickness (m)	Period	Series	Formation
+0.45 to +1.2	0.75	Made Ground	Made Ground	Imported fill
0.0 to +0.45	0.45	Quaternary	Holocene	Peat (swamp deposits)
0.0 to -0.9	0.9	Quaternary	Pleistocene	Ironshore Formation (calcareous marl)
-0.9 to -2.3	1.4	Quaternary	Pleistocene	Ironshore Formation (very soft friable limestone)
-2.3 to -7.6	5.3	Quaternary	Pleistocene	Ironshore Formation (soft friable limestone and marl
-7.6 to -13.7	6.1	Tertiary	Oligocene-Pliocene	Pedro Castle Formation (hard dolomite and limestone)
-13.7 to >91.4	>76	Tertiary	Oligocene-Pliocene	Cayman Formation (dolostone)

2.3.2 Hydrogeology

The Amec Task 1 describes the regional hydrogeological setting with the following points noted:

- The Ironshore Formation beneath the adjacent WWTP is found to 25 ft (7.5 m) depth containing large corals and bivalves. The Ironshore Formation's permeability varies significantly over the island. At the WWTP the permeability increases with depth where poorly cemented rock fragments are encountered.
- The Pedro Castle Formation was encountered at 25-45 ft (7.5-13.5 m) below MSL at the WWTP. The top of the formation is 'hard' and the vertical permeability is low.
- The Cayman Formation starts at 13.5 m below MSL and continues to at least 480 ft (144 m) below MSL. At the WWTP a cap rock with low vertical permeability sits at the top of the Cayman Formation.

There are no known groundwater abstractions in the immediate vicinity of the site (i.e. within 1,000 ft / 300 m). WAC operates two reverse osmosis plants at the Red Gate Water Works approximately 1 mile (1.6 km) south east of the landfill. The abstraction of saline water occurs from wells with response zones over 100 ft (30 m) deep. The saline water remaining from the reverse osmosis process is then disposed of via deeper reinjection wells (response zones over 210 ft (63 m) deep) at the same location.

The Caribbean Utilities Company (CUC) abstract groundwater for cooling purposes at their site approximately 0.7 miles (1.1 km) south east of the site.

The groundwater beneath the site is reportedly brackish as per the Amec Task 1 report.

Monitoring of on-site groundwater levels by Post, Buckley, Schuh & Jernigan (PBS&J)[4] in 1991 indicated that the groundwater is subject to tidal cycles with a tidal lag, with a head difference of between 0.45 ft and 0.68 ft (mean 0.56 ft) above the corresponding tidal level in the North Sound. The hydraulic gradient is expected to be very shallow in the groundwater at the site due to the flat topography of the surrounding land and the proximity to the tidal canals. The hydraulic conductivity has been estimated by PBS&J as 3.6 m per day. This hydraulic conductivity value is the most recent available site-specific data and is comparable to typical hydraulic conductivity for limestone (dolomite or karst/reef), sands and silts[5].

2.4 Hydrology

The Amec Task 1 report summarises the drainage network / canals surrounding the site from aerial photography. Drainage channels are located along the western and northern site boundaries, with the northern channel (North Canal) connecting to the North Sound. The North Sound is approximately 2,000 ft (600 m) to the east of the site. The water levels are expected to fluctuate due to tidal influence and are hydraulically connected to the groundwater at the site.

Historically, the site itself contained canals and, in the past, parts of the North Sound have been subject to dredging to supply marl for land reclamation purposes, including the area to the east of the landfill.

A surface water run-off interception trench for storm events is located at the site to prevent ingress to the North Canal.

The surrounding surface water is reportedly brackish as per the Amec Task 1 report, and the canals are not used for recreational purposes. The Amec Task 2 report stated that fish populations in the canals are unlikely due to the poor water quality. Rainfall conditions

The annual rainfall in Grand Cayman is highly variable year to year and depends on individual storm events; however, the long term annual average rainfall is 1.63 m (64.3 inches). Rainfall currently infiltrates into the site as it is not capped. However, some of the rainfall will evaporate or migrate as run-off across the site surface. The effective rainfall (the amount that will infiltrate and recharge the groundwater) will also be seasonal and variable throughout the year.

2.5 Contaminants in groundwater and surface water

Amec's Task 2 report provides information pertaining to the condition of the soil, groundwater, surface water and sediment at the site and immediate surroundings. The report suggests there is a potential risk posed to human health, groundwater and surface water bodies (hereafter referred to as controlled waters receptors) receptors on and near to the site. Arsenic and hydrocarbons were identified as potential hazards in the soils; ammonia, iron and orthophosphate were identified as potential hazards in the groundwater; ammonia, metals, nutrients, turbidity and dissolved solids were identified as potential hazards in the surface water; and, sulphate was identified as a potential hazard in sediment.

Although the Amec reports discuss ammonia concentrations only, Wood has since informed GHD that the analytical results pertain to 'ammoniacal nitrogen as ammonia'. Throughout this report, ammoniacal nitrogen as ammonia has therefore been abbreviated to ammonia. The assumption that the ammoniacal nitrogen is ammonia results in a conservative assessment of risk.

[4] Environmental Assessment of Grand Cayman Sanitary Landfill, Grand Cayman Island, BWI. Post Buckley, Schuh & Jernigan Report for CIG, 1991.
[5] Default values within the ConSim software manual.

2.6 Landfill gas generation

Amec's Task 2 report further states that the site receives municipal wastes including organic materials such as food and kitchen wastes, garden wastes, paper, cardboard and timber and can therefore be expected to be producing landfill gas. This is typically a mixture of methane and carbon dioxide together with trace components such as hydrogen, hydrogen sulphide and volatile organic compounds (VOCs) including halogenated organics, aromatic hydrocarbons, alkanes and ketones. The trace compounds present in landfill gas give it an odour. In 2014, Amec confirmed that the landfill was actively generating landfill gas, with methane concentrations detected in surface cracks and fissures up to 0.8%v/v. In 2015, further gas monitoring was completed using gas probes. Carbon dioxide and methane concentrations were generally detected above 30%v/v and 50%v/v respectively. Hydrogen sulphide concentrations were mainly below 20 parts per million (ppm).

3. Preliminary conceptual site model

3.1 Conceptual site model

A conceptual site model (CSM) forms the basis of a risk assessment, with the aim of identifying potential unacceptable risks to vulnerable human and environmental receptors. The risk-based approach is founded on the concept of the 'source-pathway-receptor' pollutant linkage, as defined below:

- **Source**: An area that contains a constituent at a concentration that is potentially hazardous (i.e. has the potential to cause harm)
- **Pathway**: The means by which a constituent comes into contact with, or otherwise affects, a receptor (see below)
- **Receptor**: The entity that is vulnerable to the adverse effects of the hazardous contaminant

Where all three elements are present, a potential pollutant linkage is formed resulting in a potential risk to the receptor. A detailed list of potential on-site sources, pathways and receptors is provided in the GHD report George Town Landfill Remediation Options Report and summarised below. It is noted that a WWTP to the east of the site is considered to be a potential off-site source of contaminants; however, this assessment is focused on the risk posed to receptors from the landfill site only.

3.2 Identified sources

The two main sources of contaminants at the site are the deposited wastes within the land raise and the waste oil storage area. Previous assessments have identified soil and groundwater metals, hydrocarbons, ammonia and orthophosphate as the main contaminants of concern at the site. It is noted that the condition of leachate produced by landfills is variable over time and the source is not consistent. This has been considered in the risk assessment by involving all relevant historical data that is available to GHD.

Landfill gases including methane, carbon dioxide, hydrogen sulphide and other trace gases are considered as a source due to the gases being asphyxiant, explosive, flammable, or odourous.

The potential for waste fires at uncapped landfills is also considered a source of contamination, with regard to air emissions, firewater run-off and infiltration and deposition of combustion contaminants.

3.3 Potential pathways

The following potential pathways with regards to controlled waters have been identified for the site:

- Run-off of rainwater across the site surface
- Leaching of soil/waste contaminants to shallow groundwater
- Vertical migration of shallow groundwater contaminants to deep groundwater
- Lateral migration of shallow and deep groundwater to potential receptors

The following potential pathways with regards to human health have been identified for the site:

- Soil and dust ingestion
- Dermal contact
- Inhalation of vapours
- Inhalation of dusts

Pathways reliant upon direct exposure to soil (i.e. ingestion and dermal exposure) may not be present during the normal operation of the site once the source has been covered, and may only occur during excavation and earthworks.

3.4 Potential receptors

The human health receptors have been identified as site workers and visitors, adjacent residents and adjacent commercial and industrial properties. The site can be accessed by the public and the Lakeside development is located approximately 100 m downwind of the site.

With respect to controlled waters the receptors are the groundwater beneath the site, the surface water in the adjacent canals, which are linked to the marine waters of the North Sound, and groundwater abstraction wells.

The groundwater abstraction wells are not considered to be a main receptor due to their distance from the site (>1 kilometre) and the depth at which the water is abstracted (>100 ft / 30 m) in the Cayman Formation. The geology beneath the site will inhibit vertical migration of contaminants, i.e. the Pedro Castle Formation is 'hard' at the top and has low vertical permeability. Additionally, a low permeability cap rock is located at the top of the Cayman Formation.

The groundwater flow direction at the site was not determined by Amec in the Task 1 or 2 reports. It can be assumed that the groundwater at the site is flowing towards the canals and North Sound due to their closer proximity and proven tidal influence. This further supports the unlikely link between the site's groundwater to the WAC and CUC abstraction wells located in the opposite direction. It is noted that the abstractions will have a cone of influence in the aquifer that is exploited, however, the aquifer's connectivity to the shallower horizons is considered to be low due to the low permeability strata described above.

The ecological receptors include insects, birdlife and iguanas that come into contact with the exposed waste, site soils and the water/sediment in the surrounding canals. The Amec Task 2 report stated that fish populations in the canals are unlikely due to the poor water quality, however, the risk to the surface water habitat, and therefore fish, has still been considered as part of the risk based assessment.

3.5 Potential pollutant linkages

The feasible pollutant linkages described above are summarised in Table 2.

Table 2 Pollutant linkages

Source	Pathway	Receptor
Contaminants within soils/deposited wastes	Ingestion, dermal contact and inhalation (soil, dust and vapours)	Site workers and visitors
	Ingestion and inhalation (dust)	Nearby residents and commercial/industrial property users/workers
	Ingestion, dermal contact and inhalation	Ecological receptors
	Leaching and migration	Groundwater
	Run-off	Canals
Contaminants within groundwater	Migration	Canals (main surface water receptor) and North Sound

Source	Pathway	Receptor
	Ingestion, dermal contact and inhalation	Ecological receptors that inhabit the canals
Contaminants within surface water (canals)	Migration	North Sound (secondary down-gradient surface water receptor)
	Ingestion, dermal contact and inhalation	Ecological receptors that inhabit the North Sound
Landfill gases	Lateral and vertical migration with subsequent inhalation, or damage caused by fire/explosion	Site workers and visitors, ecological receptors, nearby residents and commercial/industrial property users/workers
Waste fires	Air emissions, run-off, infiltration and migration	Site workers and visitors, nearby residents and commercial/industrial property users/workers, ecological receptors, groundwater and surface water

3.6 Risk assessment approach

A tiered approach has been implemented to assess the risks posed to sensitive receptors from contaminants at the site, as follows.

- In the first instance, a conceptual site model was prepared to identify potential pollutant linkages (source-pathway-receptor)
- These linkages are then assessed to determine their significance by way of generic quantitative (by comparison to published target criteria) and qualitative assessment (using professional judgement to consider the effect of adding a cap to the landfill) in Section 4 of this report
- Risks that are deemed feasible with credible pollutant linkages are then progressed further to detailed quantitative assessment in Section 5

4. Generic risk assessment

4.1 Introduction

A generic risk assessment comprises a combination of quantitative and qualitative assessment. The quantitative risk assessment for the site compares site-specific soil and groundwater data to published screening criteria pertinent to the protection of the types of receptors and land uses that have been identified in the CSM. Not all pollutant linkages in the CSM can be assessed in this manner due to lack of appropriate comparison criteria; the risks posed by these pollutant linkages have been assessed qualitatively using professional judgement considering the potential betterment of installing a cap at the site in Section 4.5.

An up-to-date landfill gas assessment is included, based on an update of GasSim assessment undertaken Amec's Task 2 report.

4.2 Assessment of data adequacy for risk assessment

The site soil, groundwater and landfill gas data available to GHD for the purpose of this assessment are taken from the Amec Task 2 report and updated 2019 data tables provided by DEH. With respect to soil and groundwater, the sample locations and the dates the samples were collected are presented in Table 3 and The data available for soil and sediment contaminants is over seven years old, the significance of this is discussed in Section 4.4. All of the soil/sediment samples were analysed for metals. In 2011 and 2013 the samples were also analysed for cyanide sulphate and PCBs. In 2013 the samples were analysed for pesticides.

Table 4. The sample locations are presented on the figures below as, taken from Amec's Technical Note *George Town and Cayman Brac Landfills: Review of DEH Monitoring Report, 31 January 2017* dated 5th June 2017.

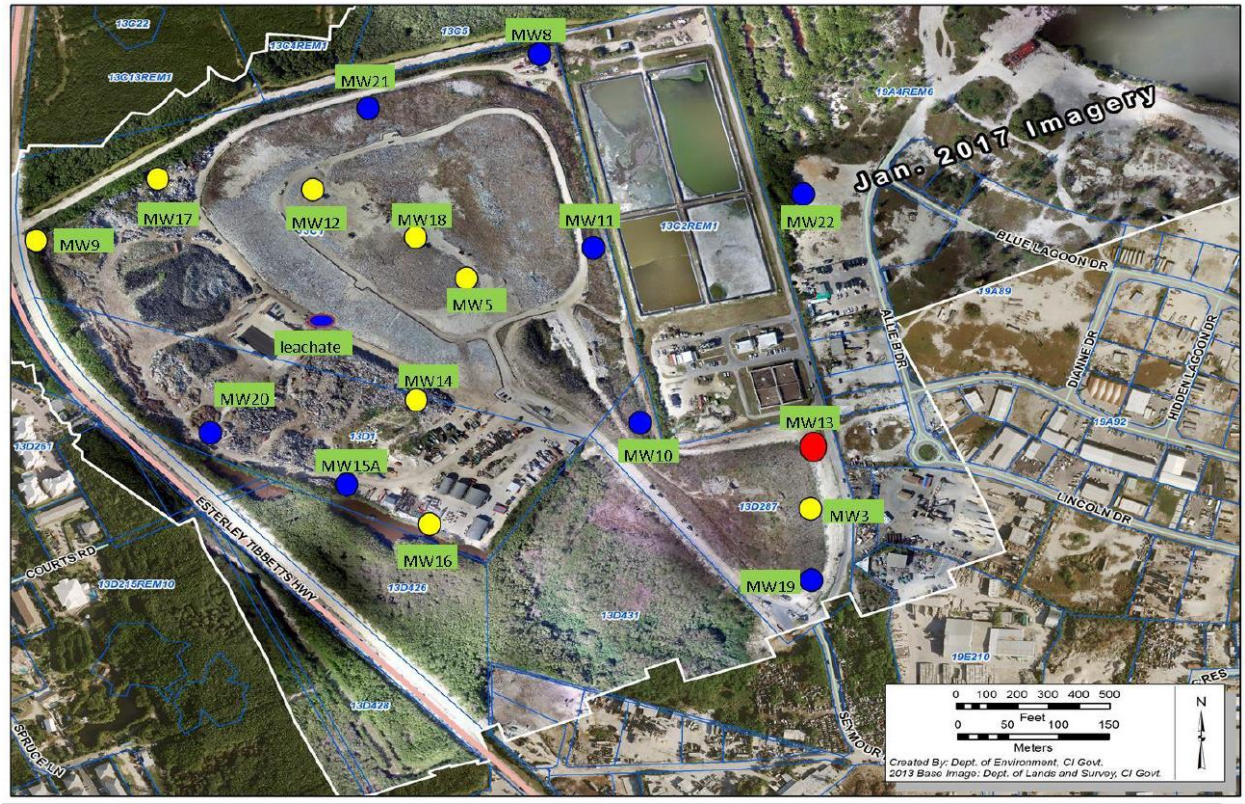

Figure 2 Sampling locations – monitoring wells

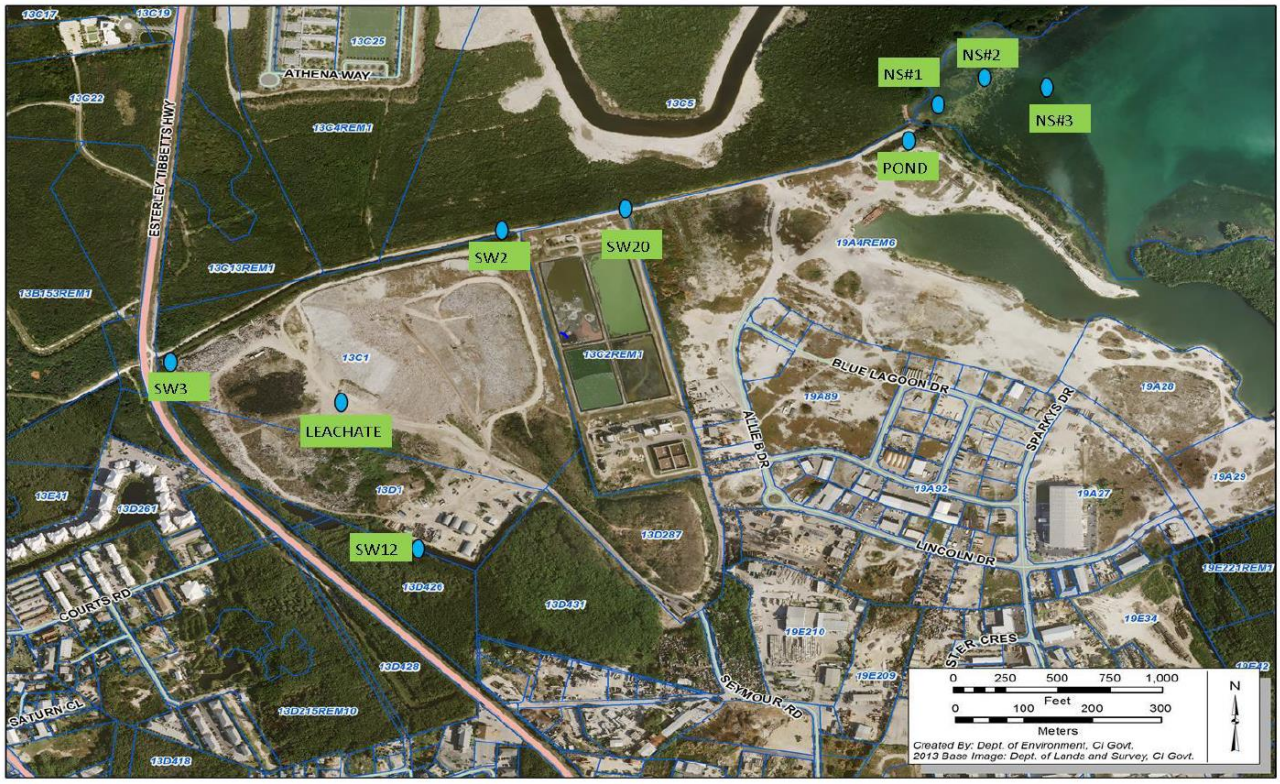

Figure 3 Sampling locations – surface water and sediment

Amec also carried out a review of monitoring round data collected by DEH in December 2016. The findings of this review were presented in the form of a Technical Note; with the data obtained during 2016 being found to be comparable to the previous monitoring results. DEH also completed monitoring in 2019, with the data again being comparable to the previous results[6].

Based on the above, GHD has assumed for the purposes of this report that the types and levels of contaminant loadings identified in Amec's Task 2 report will be broadly consistent with those encountered over the remainder of the landfill life (estimated to be completed no later than July 2023); with any additional load contribution from future waste deposits being offset by the proposed programme of capping and restoration commencing in 2020.

Analysis of leachate from soils and sediments were not available in the Amec reports; however, this is not deemed to be of high importance due to the availability of directly relevant groundwater analysis data. This is considered to be a more reliable site-specific source of data rather than a laboratory based measurement of leachable contaminants.

Table 3 Soil and sediment sample locations and sampling dates

Soil sample Location	Sampling Date
SW1	2010, 2011, 2013
SW2	2010, 2011, 2013
SW3	2010, 2011, 2013
SW7	2010, 2011, 2013
SW12	2010, 2011, 2013

[6] Additional 2016 and 2019 monitoring data for wells MW8, MW10, MW11, MW13, MW19, MW21 and MW22 received direct from CIG in Excel spreadsheet format.

Soil sample Location	Sampling Date
Drain 1	2010, 2011
Drain 2	2011
MW1B	2010
MW1	2011
MW5	2011, 2013
MW8	2010, 2011, 2013
MW9	2010, 2011, 2013
MW9B	2010
MW10	2011
MW11	2011
MW12	2010
MW13	2011, 2013
MW14	2011, 2013
MW15	2011, 2013
MW17	2011
MW18	2011

The data available for soil and sediment contaminants is over seven years old, the significance of this is discussed in Section 4.4. All of the soil/sediment samples were analysed for metals. In 2011 and 2013 the samples were also analysed for cyanide sulphate and PCBs. In 2013 the samples were analysed for pesticides.

Table 4 Groundwater sample locations and sampling dates

Groundwater sample Location	Sampling Date
MW1	2007, 2008, 2011
MW5	2006, 2007, 2011, 2013
MW8	2006, 2007, 2008, 2010, 2011, 2013, 2015, 2016, 2019
MW9	2006, 2007, 2008, 2010, 2011, 2013, 2015
MW9B	2010
MW10	2006, 2007, 2011, 2016, 2019
MW11	2011, 2015, 2016, 2019
MW12	2007, 2008, 2010, 2011
MW13	2011, 2013, 2015, 2019

Groundwater sample Location	Sampling Date
MW14	2006, 2011, 2013, 2015
MW15 / MW15A	2006, 2007, 2011, 2013, 2015, 2016
MW16	2006, 2013
MW17	2011
MW18	2011, 2013
MW19	2015, 2016, 2019
MW20	2015. 2016
MW21	2015, 2016, 2019
MW22 (External to site, east of WWTP)	2016, 2019

The majority of the groundwater samples were analysed for: metals, ammonia, nitrate, orthophosphate, chemical oxygen demand (COD), pH, specific conductance, total dissolved solids, turbidity, biological oxygen demand (BOD), VOCs, PCBs, and cyanide. A selection of the groundwater samples were also analysed for: Kjeldahl nitrogen, phosphorous, total suspended solids, pesticides, and hydrocarbons.

The groundwater monitoring analysis suite is more comprehensive than the soils/sediment analysis suite. It is unclear why the Amec analysis suites differ between soil/sediment and groundwater (for those parameters applicable to both media). The lack of certain contaminants from the soil/sediment analysis is discussed in the qualitative risk assessment in Section 4.5.

The vertical and lateral distribution of data is considered to be adequate for the assessment of risk to the identified receptors.

It is noted that some of the data supplied to GHD appeared to be anomalous:

- The pH recorded for the sample collected from MW22 was pH 1.4 in 2019, compared to pH 7.4 that was recorded for this well in 2016. The well is located off-site, therefore this anomaly has not affected the assessment of risk from on-site contaminants
- The 2011 boron concentrations appear to have been included in Amec Task 2 data tables with incorrect unit conversion i.e. the 2011 data are 1,000 times higher than all other rounds. GHD adjusted the data accordingly for the risk assessment

It is assumed that the contaminants present at the site are a result of the landfilling activities and a detailed scientific evaluation of why these contaminants are present has not been carried out as the aim of this assessment it to determine whether their presence poses an unacceptable risk to receptors.

4.3 Human health quantitative assessment

For human health receptors, the soil chemical data have been compared to the Florida Administrative Code contaminant clean up target levels for commercial and industrial sites (*Chapter 62-777 contaminant clean-up target levels, Florida Department of State, 2005*). These are considered to be most relevant to the Cayman Islands considering geography and climate.

There are no Florida criteria for assessing soils at public open spaces, which is the currently envisaged future end use of the site (at a time to be determined following capping and restoration). Therefore, the soil data were also compared to UK Suitable for Use Levels (S4UL) for public open spaces (i.e. the currently envisaged future end use), published by LQM/CIEH in 2015.

Appendix A attached to this report presents the soil analysis results compared to the generic assessment criteria (GAC), within which the only contaminant with concentrations exceeding the Florida clean up target levels for commercial/industrial land use is arsenic.

The associated exceedances compared to the Florida clean up target level for arsenic of 12 mg/kg are summarised in Table 5.

Table 5 Summary of arsenic concentrations above 12 mg/kg

Sample Location	Sampling Dates	Exceeding Concentrations (mg/kg)
SW7	2010, 2011, 2013	13, 25 and 60 respectively
MW5	2011	38
MW13	2011, 2013	35 and 16 respectively
MW14	2011	13

While the arsenic concentrations exceeded the Florida GAC, they do not exceed the UK arsenic Suitable for Use Level (S4UL) of 170 mg/kg for public open spaces; which is considered to be relevant to the currently envisaged future use of the site - and are broadly equivalent to the background arsenic concentrations noted in a 2015 WHO study of Grand Cayman[7]. None of the S4ULs were exceeded.

The human health generic quantitative risk assessment shows there is a risk posed to site workers from arsenic concentrations, as a commercial/industrial property; however, as a public open space there is no unacceptable risk to site visitors. The public open space criteria are only applicable once the site is capped and vegetated.

4.4 Controlled waters quantitative assessment

With regard to controlled waters the following GAC have been used from *Chapter 62-777 contaminant clean-up target levels, Florida Department of State, 2005*:

- Site soil concentrations compared to Florida clean up target levels for leachability protective of low yield/poor quality groundwater (due to brackish groundwater).
- Site groundwater concentrations compared to Florida target levels protective of low yield/poor quality groundwater (due to brackish groundwater).
- Site groundwater concentrations compared to Florida target levels protective of marine surface water (due to proximity to marine surface water features).

Where a criterion is not available from the above sources for a contaminant that had been detected at the site, an alternative has been sought from other published sources, where possible, including: the USEPA, European Water Framework Directive (WFD) and World Health Organisation (WHO). It is noted that the comparison of groundwater data to the Florida target levels protective of low yield/poor quality groundwater is for information only as the groundwater is not exploited as a drinking water resource in close proximity to the site, as discussed in Sections 2.3 and 3.4. Where concentrations exceed the criteria there could be a risk posed to the receptor from the site's contaminants, depending on how the contaminants are transported/migrate to the receptor.

Appendix A presents the soil analytical data compared to Florida leachability target criteria for the protection of low yield/poor quality groundwater; with none of the soil concentrations exceeding these criteria. Appendix B attached to this report presents the groundwater analysis results compared to the Florida target criteria for the protection of low yield/poor quality groundwater and marine surface water.

[7] https://caymannewsservice.com/wp-content/uploads/2015/10/Arsenic-exposure-investigation-Cayman-Report-October-2015.pdf

Based on these tables, various contaminant concentrations exceed the GAC protective of the surface water and groundwater receptors. Table 6 and Table 7 list the contaminants exceeding the specified GAC concentrations, the number of samples that reported exceeding concentrations, and the maximum concentrations. The exceedances of groundwater GAC are provided for information only, as the groundwater in vicinity of the site is not currently exploited for drinking water purposes. It is anticipated that new abstractions for drinking water purposes would not be sited in close proximity to a landfill, operational or closed.

It is noted that in some monitoring rounds the laboratory detection limits were greater than the GAC, meaning there may be contaminants present in the groundwater at concentrations above the GAC but below the reporting limits.

Table 6 Groundwater contaminant concentrations exceeding marine surface water GAC

Contaminant	Surface water GAC thresholds	Number of exceedances and samples analysed	Maximum concentration
Ammonia	0.021 to 6 mg/l	61 samples analysed 61 exceed lower limit 53 exceed higher limit	330 mg/l
Orthophosphate	0.0036 to 1 mg/l	58 samples analysed 49 exceed lower limit 5 exceed higher limit	1.2 mg/l
Turbidity	29 NTU	56 samples analysed 35 exceed criterion	3,000 NTU
1,4-dichlorobenzene	3 µg/l	54 samples analysed 1 exceed criterion	3.1 µg/l
Arsenic	0.05 mg/l	56 samples analysed 1 exceed criterion	0.063 mg/l
Beryllium	0.00013 mg/l	56 samples analysed 3 exceed criterion	0.00036 mg/l
Chromium	0.05 mg/l	56 samples analysed 2 exceed criterion	0.083 mg/l
Copper	0.0037 mg/l	56 samples analysed 12 exceed criterion	0.31 mg/l
Iron	0.3 mg/l	44 samples analysed 20 exceed criterion	11 mg/l
Lead	0.0085 mg/l	56 samples analysed 8 exceed criterion	0.05 mg/l
Nickel	0.0083 mg/l	56 samples analysed 2 exceed criterion	0.042 mg/l

Contaminant	Surface water GAC thresholds	Number of exceedances and samples analysed	Maximum concentration
Silver	0.0004 mg/l	56 samples analysed 1 exceed criterion	0.00045 mg/l
Zinc	0.086 mg/l	56 samples analysed 6 exceed criterion	2.5 mg/l
Mercury	0.000025 mg/l	56 samples analysed 3 exceed criterion	0.00032 mg/l
Total cyanide	0.001 mg/l	43 samples analysed 11 exceed criterion	0.15 mg/l
NTU = Nephelometric Turbidity Unit Ammonia GAC = 0.021 mg/l for unionised ammonia, 6 mg/l for total ammonia			

Table 7 Groundwater contaminant concentrations exceeding groundwater GAC

Contaminant	Groundwater GAC threshold	Number of exceedances of groundwater criteria	Maximum concentration
Ammonia	28 mg/l	61 samples analysed 10 exceed criterion	330 mg/l
Total dissolved solids (TDS)	5,000 mg/l	65 samples analysed 64 exceed criterion	19,000 mg/l
Total suspended solids (TSS)	500 mg/l	18 samples analysed 2 exceed criterion	2,600 mg/l
Iron	3 mg/l	44 samples analysed 10 exceed criterion	11 mg/l
Hydrocarbons	0.3 mg/l	28 samples analysed 20 exceed criterion	26 mg/l

Ammonia concentrations were found above GAC in the groundwater. The following is noted with respect to the properties and fate of ammonia in water:

"Ammonia is lost from water by volatilisation and, under aerobic conditions, it is oxidised by nitrifying bacteria to nitrite and then to nitrate. Ammonia is not expected to adsorb to soil particulate matter, suspended solids or sediment. Although ammonia is assimilated by aquatic plants for use as a nitrogen source, its bioaccumulation in biota is not important."[8]

[8] https://www.wfduk.org/sites/default/files/Media/ammonia.pdf - Proposed EQS for Water Framework Directive Annex VIII substances: ammonia (un-ionised) Science Report: SC040038/SR2 Environment Agency 2007.

Nitrate is a source of nutrient that can lead to eutrophication in surface water bodies; while nitrate concentrations in the site's groundwater were below the GAC, the potential exists for ammonia to migrate to the surface water receptors and convert to nitrate.

The surface water analytical data available in the Amec Task 2 report and updated 2019 data tables were evaluated to determine if nitrate concentrations have been elevated historically in the surrounding water bodies. Since 2006, nitrate and nitrite as N were detected in 22 out of 62 samples analysed with a maximum concentration of 2.9 mg/l, which is below the GAC of 22 mg/l (UK[9]) and 110 mg/l (Florida). The maximum concentration was detected at a sample point called 'Drain'.

The ammonia concentrations in the groundwater at the site appear to have remained stable since 2006 and in some wells have been decreasing, therefore any historical link between the site and the surface water does not appear to have caused an elevated presence of nitrate.

It is noted that orthophosphate and turbidity exceeded the GAC for surface water receptors, but do not have available GAC for groundwater receptors.

Similarly, TDS, TSS and hydrocarbons exceeded the GAC for groundwater, but do not have GAC available for surface water receptors.

[9] https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/307788/river-basin-planning-standards.pdf.

The pH recorded for the sample collected from MW22, located outside of the site boundary, was pH 1.4; this falls outside the required pH range of pH 6-8.5 for surface water and pH 6-9 for drinking water sources. As previously described, the result appears to be anomalous, however, this is the value within the data tables supplied to DC by the Cayman Islands Government in December 2019. The pH recorded for MW22 in 2016 was pH 7.4.

The generic quantitative assessment of risk to controlled waters receptors does not take into consideration whether there is a cap on the site or not. The assessment identifies that the concentrations of certain contaminants in the groundwater at the site are at levels that may pose a risk to off-site receptors. The addition of a cap is assessed qualitatively with respect to this pollutant linkage in Section 4.5 below.

4.5 Human health and controlled waters discussion

No unacceptable risks have been identified with regard to human health receptors for use of the site as a commercial/industrial property. While the soil contaminant concentrations are below the available S4ULs for public open spaces, these criteria assume the land will be vegetated and soil exposure will be limited; therefore, the addition of a cap to the deposited wastes will offer protection to human health, removing the direct exposure pathway and breaking the pollutant linkage. The soil analytical suite was limited in comparison to the groundwater data available for the site and the data is over seven years old; however, this is not deemed to be significant with regard to this assessment due to the proposed cap removing the direct exposure pathway to human health receptors. The risk to human health does not require further detailed assessment. Similarly, there will be no unacceptable risk to ecological receptors from direct exposure to contaminated soils once the cap has been installed. Areas within the site that are not capped will comprise the storm water management system or will be vegetated – removing the direct exposure pathway. The surface water run-off pathway is also removed by addition of a cap to the site. Rainwater is unlikely to come into contact with the contaminated soils/deposited wastes. Therefore, this pathway does not require further detailed assessment.

The risk of waste fires at the surface will be mitigated by addition of the cap to the landfill.

As previously discussed, the risk posed to groundwater abstraction wells is not considered to be feasible, due to the large distance to those types of receptors from the site, the presence of low permeability layers in the geology beneath the site, and the direction of groundwater flow.

The main receptor of concern is the surface water in the surrounding canals and the North Sound, which is the subsequent receiving water body. In addition, the site's shallow groundwater is known to be in connectivity with the surrounding tidal waters. While the addition of a cap reduces the amount of infiltration into the deposited wastes and soils, the degree of improvement in contaminant concentrations reaching the surface water receptors remains unknown. Therefore, further detailed assessment is required for this pollution pathway.

The further detailed assessment will comprise modelling groundwater contamination sources through the shallow aquifer to the North Canal to predict the contaminant concentrations reaching the receptors, with two scenarios, one for the *status quo* and another with reduced infiltration to simulate the addition of a cap to the site. The North Sound is located 600 metres from the site, whereas the North Canal is at the site's boundary. Therefore, understanding the risk to the North Canal will inform the potential risk to receptors located at a great distance. Where betterment is demonstrated at the North Canal due to reduced contaminant flux, betterment would be expected at all receptors via the groundwater pathway or the discharge of the North Canal waters directly into the North Sound.

In general, contaminant concentrations do not show a clear increasing trend in the groundwater over time as additional waste has been added to the site; therefore, the additional deposition of waste prior to the site's restoration is presumed unlikely to have a significant effect on the types and magnitude of contaminants present in the groundwater. This assumption is based on similar types of waste being deposited at the site until 2023. In addition, the capping of the site will commence during the extension of the landfill, meaning the amount of exposed waste will not generally increase. The short term higher leaching from newer waste deposits is not anticipated to significantly impact the groundwater and will be assessed during the long term monitoring programme to be implemented during and post restoration.

4.6 Landfill gas assessment

The risk posed by landfill gases at the site is discussed in detail in GHD report *George Town Landfill, Remedial Options Report, January 2020*. A GasSim model for the site was generated by Wood Group and has since been updated by GHD. The GasSim model predicts the bulk gas generated over time by the waste deposits at the site during operation and after closure in June 2023, as well as the volume of gas that can feasibly be recovered from the landfill for energy recovery or flaring. Figure 4 and Figure 5 present the graphical results from the GasSim model.

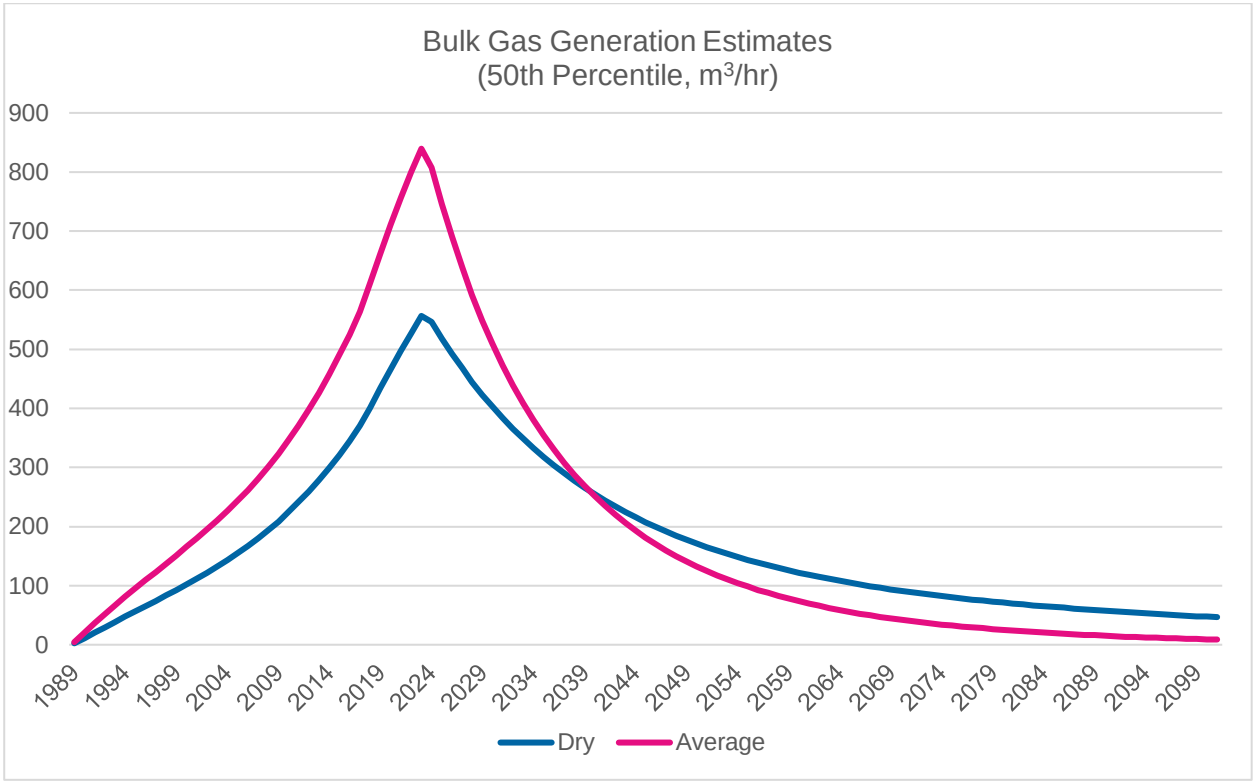

Figure 4 GasSim model results – gas production

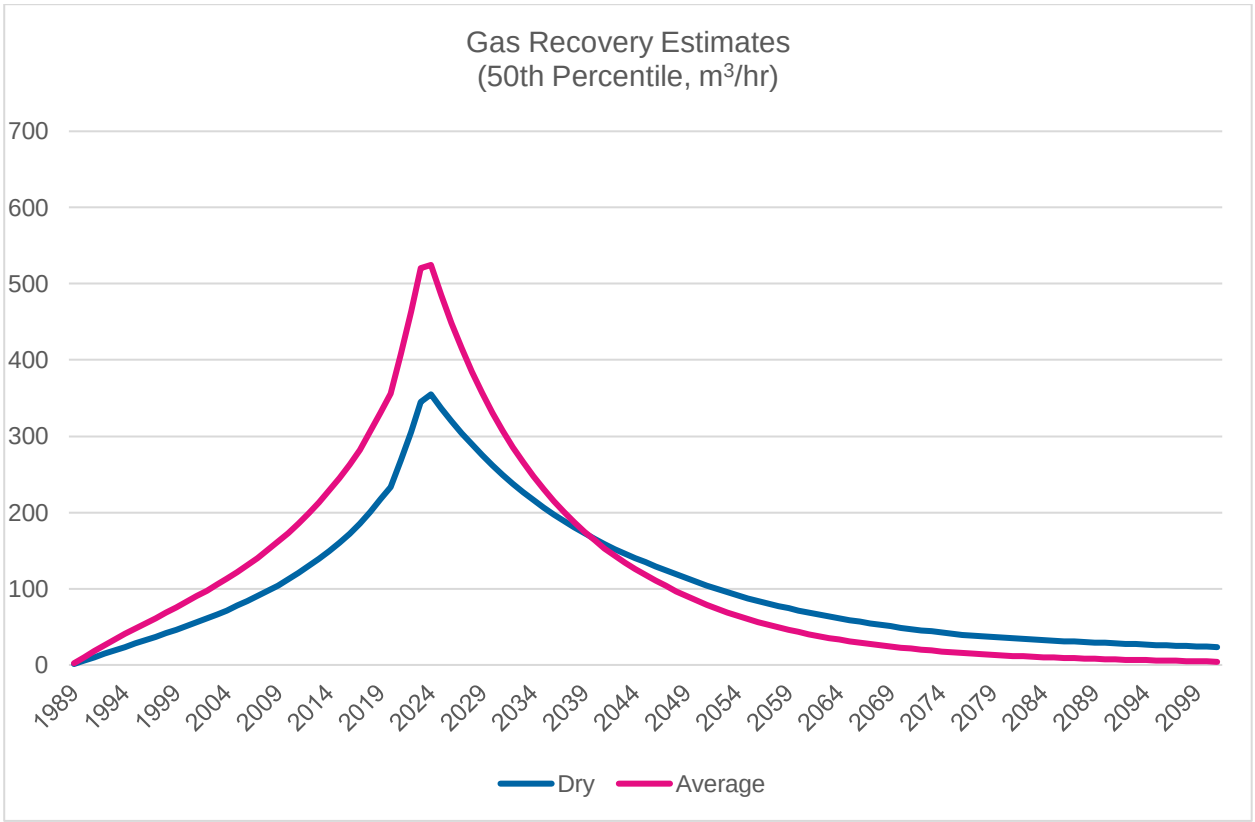

Figure 5 GasSim model results – gas recovery

The graphs reflect LFG volumes increasing as waste inputs continue over the remaining operational life of the landfill (to June 2023), with a peak concentration in the final year of waste deposition. Following closure of the landfill, the gas production volume declines steeply as the volatile organics are consumed, with the percentage of gas collected improving to an estimated 70% collection efficiency due to the phased installation of a landfill cap and gas management system over the period 2021 to 2023. The non-recoverable gases still have the potential to migrate vertically and laterally, but at greatly reduced quantities and quality - and are not considered to pose a material risk post capping.

4.7 Generic risk assessment summary and updated CSM

In summary, the generic risk assessment identified that several of the pollutant linkages remain, without an engineered cap or gas management systems installed at the site. The inclusion of a landfill cap provides a physical barrier that disrupts the pollutant linkages in the source-pathway-receptor model and removes or significantly reduces the potential for contaminant exposure to sensitive receptors. Similarly, the provision of a landfill gas management system enables the better control, collection and management of landfill gas (and odours) from the site.

Accordingly, the provision of a landfill cap and landfill gas management system in the generic risk assessment breaks the majority of the pollutant linkages - the only remaining risk being to marine surface water from groundwater contaminants, which was carried forward for detailed quantitative risk assessment.

The following are the main findings of the generic risk assessment of the scenarios where an engineered cap is installed at the site:

- No unacceptable risk has been identified with regard to human health or ecological receptors making contact with contaminants in soil; further assessment of this pollutant linkage is not required
- The surface water run-off pathway will be removed by addition of a cap to the site, as rainwater is unlikely to come into contact with the contaminated soils/deposited wastes; further assessment of this pollutant linkage is not required
- Turbidity exceedances of the marine water criterion are widespread across the site. The fate and transport of turbidity cannot be modelled as it is a measure of transparency of the water, but it is expected that reduced run-off and infiltration will improve turbidity in the receiving surface waters
- The volume of landfill gas generation is predicted to sharply decline once the site ceases receipt of waste, and an estimated 70% reduction in gases will be achieved by recovery and installation of a cap at the site. The non-recoverable gases will still have the potential to migrate vertically and laterally but this will be greatly reduced

With or without a cap, the following groundwater contaminants of concern require further assessment with respect to the marine surface water receptors:

- Ammonia and orthophosphate concentrations in exceedance of the marine water criteria are widespread across the site. The GAC used for ammonia and orthophosphate are UK allowable levels at marine surface water receptors
- Iron concentrations in groundwater frequently exceed the marine water criterion. The GAC used for iron is the Florida target level
- There is only one exceedance of the marine water criterion for 1,4-dichlorobenzene at MW10 in 2006. 1,4-dichlorobenzene has also been detected in this location below the criterion, but not detected in any other of the site wells. The GAC used for 1,4-dichlorobenzene is the Florida target level
- Arsenic, beryllium, chromium, copper, lead, nickel, silver and zinc concentrations have been identified above the marine water criteria on occasion, but no consistent presence of metals contamination has been identified at the site. The GAC used for these metals are the Florida target levels

- There are three exceedances of the marine water criterion for mercury at MW16 and MW20 at the site and MW22 external to site; MW22 is not located near to MW16 or MW20. All other samples tested for mercury returned non-detect concentrations. The GAC used for mercury is the Florida target level
- Cyanide concentrations have been detected in 11 of the 43 samples analysed for cyanide; each detection is an exceedance of the marine water criteria. There is no distinct source area for the cyanide contamination. The GAC used for cyanide is the Florida target level
- There are no applicable marine water criteria for hydrocarbons; therefore, the WHO drinking water criteria[10] have been used as an alternative. Analysis of 28 samples for hydrocarbons detected 20 exceedances of the drinking water criteria; the exceedances are in samples collected from wells located across the site
- The surface water criteria are protective of wildlife inhabiting the canals and North Sound; therefore, the further detailed risk assessment required for the above contaminants will be protective of ecological receptors

Based on these findings, the pollutant linkages contained within the CSM therefore require updating as presented in Table 8.

Table 8 Updated pollutant linkages following generic risk assessment

Source	Pathway	Receptor	*Status quo* risk	Risk after addition of cap
Contaminants within soils/deposited wastes	Ingestion, dermal contact and inhalation (soil, dust and vapours)	Site workers and visitors	Arsenic was found to exceed Florida GAC but was below UK S4ULs for public open spaces, which assumes the site would be vegetated with limited bare soils; therefore, the risk of human health and ecological receptor exposure remains during *status quo*.	No unacceptable risk has been identified once site is capped and restored. This is due to removal of the exposure pathway.
	Ingestion and inhalation (dust)	Nearby residents and commercial/industrial property users/workers		
	Ingestion, dermal contact and inhalation	Ecological receptors		
	Run-off	Canals	During status quo, the risk of run-off being contaminated due to contact with waste/contaminated soils will remain.	No unacceptable risk identified once site is capped and restored.
	Leaching and migration	Groundwater	No risk to drinking water abstraction receptors is anticipated due to their distance from the site, the	The rate of infiltration and contaminant flux is expected to be reduced when site is capped and restored. Further assessment is
Contaminants within groundwater	Migration	Canals (main surface water receptor) and North Sound		

[10] Petroleum Products in Drinking-water, Background document for development of WHO *Guidelines for Drinking-water Quality,* WHO/SDE/WSH/05.08/123, World Health Organization 2005

Source	Pathway	Receptor	*Status quo* risk	Risk after addition of cap
	Ingestion, dermal contact and inhalation	Ecological receptors that inhabit the canals	geological conditions and the groundwater flow direction. The potential for leaching and migration of groundwater contaminants to off-site surface water receptors, and therefore ecological receptors, remains during *status quo*.	required to understand the effect of reduced infiltration on the risk to plausible receptors: modelling migration of known groundwater concentrations to the canal to understand the degree of betterment from addition of the cap. Understanding the degree of betterment at the closest receptor will inform the understanding of risk posed to those further away, such as North Sound (i.e. lesser risk at greater distance)
Contaminants within surface water (canals)	Migration	North Sound (secondary down-gradient surface water receptor)	There is the potential for surface water contaminants to migrate to the North Sound during *status quo*.	Further assessment is required to understand risk posed to the canals that flow into the North Sound. The risk is expected to reduce once the site has been capped, reducing contaminant flux to the canals.
	Ingestion, dermal contact and inhalation	Ecological receptors that inhabit the North Sound		
Landfill gases	Lateral and vertical migration with subsequent inhalation, or damage caused by fire/explosion	Site workers and visitors Ecological receptors Nearby residents and commercial/industrial property users/workers	During status quo, the risk to the identified receptors remains possible.	Once the site stops receiving waste, gas production will decline steeply. Installation of a landfill cap and operation of an active gas management system will further reduce the quantity of non-recovered gas by approximately 70%. The risk of off-site migration and receptor exposure will therefore be greatly reduced due to the new measures.

Source	Pathway	Receptor	*Status quo* risk	Risk after addition of cap
Waste fires	Air emissions, run-off, infiltration and migration	Site workers and visitors, nearby residents and commercial/industrial property users/workers, ecological receptors, groundwater and surface water	During status quo, the risk of waste fires remains possible.	The risk of waste fires at the surface will be mitigated by addition of the cap to the landfill.

It is noted that the contaminants present in the soil/waste/sediment and groundwater at the site are assumed to be a result of the landfill operations at the site and their presence above GAC has identified a potential risk to receptor(s). A detailed scientific review of how those contaminants are present has not been undertaken, however, as they are known to be present at the site the risk they pose has been assessed.

5. Detailed quantitative risk assessment

5.1 Detailed quantitative risk assessment levels

Detailed quantitative risk assessment (DQRA) is an in-depth assessment of the subsurface conditions where contaminants of concern which exceeded the published GAC are modelled to determine their concentration at a receptor using site specific geology and hydrogeology information. The predicted concentration at the receptor is then compared against the applicable assessment criterion to determine if any exceedances are present. Where an unacceptable risk to a receptor is identified, both soil and groundwater may require further assessment or remediation.

The approach for DQRA is a staged method with each stage referred to as a 'Level'. At each assessment Level, the fate and transport of constituents in the subsurface is modelled with respect to a particular on or offsite receptor. The various levels include:

- **Level 1**, constituent source assessment: leachate or pore water concentrations within the source area are compared to screening criteria. The leachate concentrations can be entered as site-specific data or as soil data from which the resulting leachate concentrations are predicted
- **Level 2**, unsaturated zone transport and aquifer dilution: downward leaching and migration of dissolved constituents through the unsaturated soil zone to the water table (aquifer) and assessment of constituent concentrations in groundwater directly beneath the source area
- **Level 3**, saturated zone transport: assessment of the migration of dissolved groundwater constituents to the receptor of interest via steady state groundwater flow and constituent transport, including an assessment of the natural effects of attenuation, dispersion and biodegradation on constituent concentrations
- **Level 3A**, independent groundwater transport: groundwater concentrations are assessed without the need to determine transport through the unsaturated zone, by simulating the time it takes for constituents to reach a receptor and the expected concentrations at the receptor. This level can include an assessment of the attenuation effects of retardation, dispersion and biodegradation on constituent concentrations; however, this level does not allow for a declining source to be modelled. This means the source of environmental impact is assumed to remain constant

The ConSim model (version 2.05.0005)[11] has been used for this risk assessment. ConSim was produced by Golder Associates (UK) Ltd for the Environment Agency and the software and its manual constitute Environment Agency R&D Publication 132, copyright Environment Agency 2003. Since 2003, various software updates have been released.

ConSim has been selected to model the migration of contamination to off-site receptors, as the site does not comprise a traditional engineered landfill. ConSim is able to assess multiple sources that have various contaminant concentrations within them, along with an in-depth assessment of attenuation, fate and transport. The forward modelling element of the software results in a prediction of contaminant concentrations at the receptor, which is beneficial when comparing the effects of remedial scenarios to *status quo*.

It is noted that the contaminant concentration predicted by the model at Level 3 and Level 3A is the concentration at the point where the groundwater body meets the receptor, not the concentration that might occur in the receiving water (i.e. the model does not include an assessment of contaminant loading or dilution in the receptor).

The pollutant linkages requiring evaluation by DQRA are set out in the following Table 9:

[11] http://www.consim.co.uk/

Table 9 Pollutant linkages for DQRA evaluation

Source	Pathway	Receptor
Contaminants within soils/deposited wastes and contaminants in groundwater	Leaching and migration	Canals (main surface water receptor)
Contaminants within surface water (canals)	Migration	North Sound (secondary down-gradient surface water receptor)

The risk posed to the North Sound via migration of contaminants in the groundwater has not been assessed at this time, as understanding the degree of betterment at the closest receptor will inform the understanding of betterment at receptors located further from the site, i.e. lesser risk is expected at greater distance.

The risk to the surface water receptors has been assessed at both Level 3 and Level 3A. The main receptor is considered to be the North Canal, which subsequently discharges into the North Sound; therefore, the models consider the transport of contaminants from the site to the North Canal. Where a risk is posed to the North Canal, it is assumed there is also a risk posed to the North Sound.

At Level 3A, the ConSim model cannot take into account a declining source of contamination, whereas Level 3 has this capability. Once the site ceases to receive waste and is restored with a cap, the addition of waste, and therefore the addition of sources of contamination, will not be continuous. While Level 3A is considered to be conservative for the restored landfill scenario, it has been included in the assessment to provide understanding of how the landfill could impact the receptors if it continued to operate. At Level 3A, the site-specific groundwater data have been entered into the model to represent the concentrations within the aquifer at the site; at Level 3, the groundwater data have been assumed equal to leachate produced at the site in the unsaturated zone.

As this assessment comprises comparison of concentrations reaching the receptor under different scenarios, the inputs to the ConSim model have been selected as single values, to provide deterministic results rather than probabilistic. When ConSim is run as a probabilistic model with ranges of data as inputs, the model results are not repeatable; therefore, to make a comparison when one element of the model is changed, e.g. infiltration, it is better to remove the probabilistic element. This single value approach is considered more scientific when comparing scenarios to avoid probabilistic skew between models.

5.2 Input parameters

5.2.1 Model simulation parameters

The model produces predicted concentrations at the receptor over time; the model has been run with time slices ranging from 1 year to 1,000 years for the scenarios presented in Table 10; however, the main focus is the foreseeable future of 100 years. It is anticipated that attenuation will occur within the aquifer at the site, mainly due to tidal dispersion.

Table 10 Model scenarios

Scenario	Model level	Description
1	Level 3A	Site uncapped receiving waste (i.e. continuous source)
2	Level 3A	Site capped continuous source (for information only, no continuous source once the site is capped)
3	Level 3	Site no longer receiving waste, remaining uncapped
4	Level 3	Site no longer receiving waste, restored with a cap

5.2.2 Source and receptor input parameters

The main receptor has been identified as the North Canal, in close proximity to the site. The North Sound is a secondary receptor as water from the North Canal discharges into the North Sound.

The groundwater contaminant sources identified by the generic risk assessment are summarised in Table 11 and shown on Figure 66. The source areas are based on the spatial distribution of the contaminants detected in groundwater at the site.

Table 11 Source areas

Source ID	Source Location	Contaminants of concern	Description
Source A	Whole site area	Ammonia	Ammonia exceedances were detected in all site wells
		Orthophosphate	Orthophosphate exceedances were detected in all site wells
		Arsenic	While there was only one arsenic exceedance, arsenic has been detected in the majority of the site wells
		Beryllium	There were three exceedances of the beryllium criterion in three separate wells, however, the detection limits used prior to 2016 were higher than the concentrations detected. Therefore, beryllium could be widespread
		Chromium	Chromium exceedances were detected in two wells; however, chromium was present in all site wells
		Copper	Copper exceedances detected in ten wells, with concentrations widespread at the site
		Iron	Iron exceedances were detected in the majority of site wells
		Silver	One silver exceedance was detected at MW11, with lower concentrations found in three more site wells. The wells are not situated in one specific area of the site
		Zinc	Zinc exceedances were detected in five wells; however, zinc was present in the majority of site wells
		Cyanide	Cyanide exceedances were detected in the wells around the site boundary
		Hydrocarbons	Hydrocarbon exceedances were detected across the site in eleven wells

Source ID	Source Location	Contaminants of concern	Description
Source B	Eastern portion of the site	Lead	Lead exceedances were detected in five wells, with lower concentrations in wells in the eastern portion of the site
		Nickel	Nickel exceedances were detected in two wells, with lower concentrations in wells in the eastern portion of the site
Source C	Hotspot MW10	1,4-dichlorobenzene	Exceedance detected at MW10; no other detections at the site
Source D	Hotspot MW16 and MW20	Mercury	Exceedances detected at MW16 and MW20; no other detections at the site

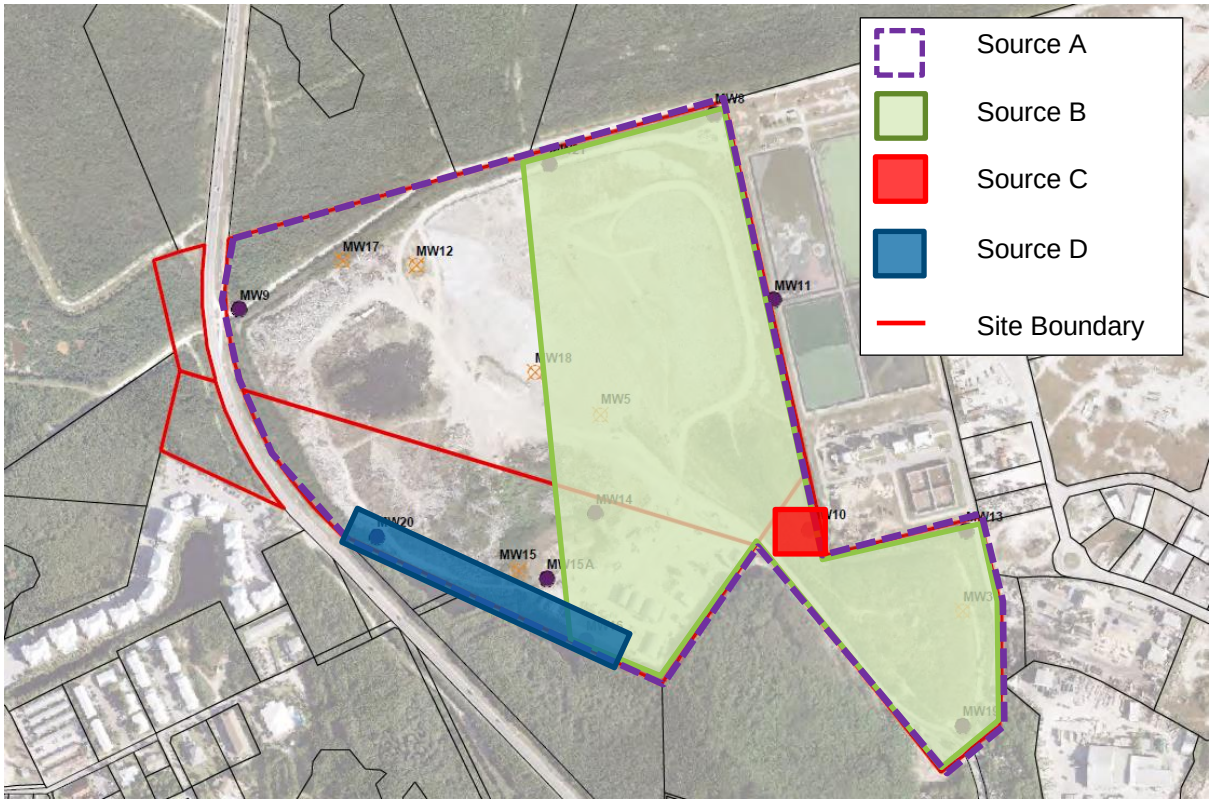

Figure 6 Source locations

The mercury contamination at Source D is thought to be linked to a specific contamination event caused by Hurricane Ivan in 2004, with the two isolated instances of mercury in MW16 and MW20 being detected after this event. It is not anticipated that there is an ongoing source of mercury in the area of Source D and there are no other exposed wastes in this location.

The source contaminants' mean concentrations are summarised in Table 12. Where the source concentration data populations included values less than detection limit, the concentration was assumed equal to half the lowest detection limit applicable to that contaminant.

Table 12 Source groundwater concentrations

Source	Contaminant	Mean concentration (mg/l)
Source A	Ammonia	28.41
	Orthophosphate	0.31
	Arsenic	0.007
	Beryllium	0.00009
	Chromium	0.02
	Copper	0.01
	Iron	1.5
	Silver	0.00007
	Zinc	0.095
	Cyanide	0.01
	GRO	0.04
	DRO	3.2
	C16-C21 aromatic	0.18
	C16-C35 aliphatic	0.2
Source B	Lead	0.006
	Nickel	0.004
Source C	1,4-dichlorobenzene	0.0019
Source D	Mercury	0.0001

The infiltration at the source areas has been calculated using the long-term annual average rainfall for Grand Cayman of 64 inches/1.63 m. The effective rainfall is the amount that will infiltrate the ground, as some of the water will migrate as run-off or will evaporate; typically, 25% of rainfall is used for infiltration on soft ground in the UK. Using 25% is considered to be a conservative assumption for the Cayman Islands considering the difference in climate. Therefore, without an engineered cap it is assumed that the infiltration rate is 16 inches/408 mm per year. The addition of an engineered cap is expected to reduce the rate of infiltration by approximately 90%, equating to 1.6 inches/40.8 mm per year. It is noted that the effective rainfall at Grand Cayman may be lower than 25% due to the climate and evaporation.

The source porosity and dry bulk density have been estimated as 0.55 (fraction) and 0.54 g/cm^3 using the following literature source, which also estimates a 50% moisture content for municipal solid waste: *Settlement and characteristics of waste at a municipal solid waste landfill in Melbourne, by Samuel T. Yuen and John R. Styles, Department of Civil & Environmental Engineering, University of Melbourne.*

The thickness of the source is assumed to be the thickness of the deposited waste at the site, with the highest part of the site being the top of the North Mound at approximately 90 feet above MSL. As a single value is required in this assessment, the source thickness has been estimated as an average of 59 ft/18 m, for the entire source area. The waste deposits at the site range in thickness from 5 ft to 90 ft (1.5 m to 27.4 m).

5.2.3 Contaminant input parameters

The DQRA contaminant target criteria are those used in the generic risk assessment, described in Section 4. It is noted that the GAC for the majority of the contaminants assessed are the Florida target levels.

Table 13 presents the contaminant specific input parameters for the source areas. These have been collated from various literature sources. The use of degradation in the model has been applied to the dissolved phase contaminants only.

Metals do not readily degrade in the environment, but a degradation rate is a required entry value in ConSim. As such, a half-life of 1 x 10^{30} years has been entered into the model, effectively removing any degradation impact on the model results.

Many literature sources discuss the behaviour of cyanide in soils and groundwater, however a half-life has not been published. The WHO anticipates cyanide to have a half-life of 'weeks' in the water environment[12]; therefore, a half-life of 1 year has been used as a conservative assumption. Where a range of values were provided in the literature sources, a median value was selected.

Table 13 Contaminant specific input parameters

Contaminant	Partition Coefficient (kd) ml/g	Organic Carbon Partition Coefficient (koc) mg/l	Half Life in Groundwater (years)	Henry's Law Constant
Ammonia	1.5 (EA[13], 1 to 2)	N/A	2 (EA)	N/A
Orthophosphate	3.50E+00 (RAIS[14])	N/A	1 (ATSDR[15], 0.003 to 2)	N/A
Arsenic	2.90E+01 (RAIS)	N/A	1E+30	N/A
Beryllium	7.90E+02 (RAIS)	N/A	1E+30	N/A
Chromium	1.80E+06 (RAIS)	N/A	1E+30	N/A
Copper	3.50E+01 (RAIS)	N/A	1E+30	N/A
Iron	2.50E+01 (RAIS)	N/A	1E+30	N/A
Silver	8.30E+00 (RAIS)	N/A	1E+30	N/A
Zinc	6.20E+01 (RAIS)	N/A	1E+30	N/A
Cyanide	9.90E+00 (RAIS)	N/A	1 (WHO)	N/A
GRO C6-C10 – ethylbenzene used as an alternative	N/A	5.37E+02 (CWG[16])	0.32 (Howard[17], 0.016 to 0.625)	3.58E-01 (CWG)

[12] Cyanide in Drinking-water, Background document for development of WHO Guidelines for Drinking-water Quality, World Health Organization 2007.
[13] Groundwater risk assessments for infiltration systems: calculations and examples, https://www.gov.uk/guidance/infiltration-systems-groundwater-risk-assessments#calculate-the-infiltration-rate-summary.
[14] Risk assessment information system https://rais.ornl.gov/.
[15] Toxicological profile for white phosphorous, US Department of Health and Human Services, Public Health Service, Agency for Toxic Substances and Disease Registry, September 1997.
[16] Total Petroleum Hydrocarbon Criteria Working Group Series Volume 3 Selection of Representative TPH Fractions Based on Fate and Transport Considerations 1997.
[17] Handbook of Environmental Degradation Rates, Howard et al, 1991.

Contaminant	Partition Coefficient (kd) ml/g	Organic Carbon Partition Coefficient (koc) mg/l	Half Life in Groundwater (years)	Henry's Law Constant
DRO C10-C28 – naphthalene used as an alternative	N/A	8.44E+02 (CWG)	0.36 (Howard, 0.003 to 0.707)	1.74E-02 (CWG)
C16-C21 aromatic – pyrene used as an alternative	N/A	2.57E+04 (CWG)	5.8 (Howard, 1.15 to 10.4)	3.71E-04 (CWG)
C16-C35 aliphatic – n-octadecane used as an alternative[18]	N/A	6.39E+07 (CWG)	1 (PubChem, 0.007 to 2[19])	2.51E+02 (CWG)
Lead	9.00E+02 (RAIS)	N/A	1E+30	N/A
Nickel	6.50E+01 (RAIS)	N/A	1E+30	N/A
1,4-dichlorobenzene	N/A	3.75E+02 (RAIS)	0.58 (Howard, 0.154 to 1)	9.85E-02 (RAIS)
Mercury	5.20E+01 (RAIS)	N/A	1E+30	N/A

To determine the soil-water partition coefficient (kd) for organic contaminants, the ConSim model requires the fraction of organic carbon (foc) at the source and the contaminant's organic carbon partition coefficient (koc), i.e. kd = foc x koc. GHD has not been provided with a site-specific foc; therefore a default value of 0.05 (fraction) has been taken from the ConSim model to reflect the aquifer geology at the site (marl – which contains silts and clays). The foc for the waste materials at the site has been estimated as 0.2 (fraction) using literature source: *Landfill Impacts on the Environment - Review by Magdalena Daria Vaverková, MDPI Geosciences Journal, published 3 October 2019.*

5.2.4 Unsaturated zone parameters

Level 3 requires input parameters pertaining to the unsaturated zone within the waste materials. For the purpose of the Level 3 modelling, it has been assumed that there is a minimal unsaturated zone thickness of 0.25 m beneath the source and above the water table. This is due to the waste deposits extending beneath the water table. The unsaturated zone dry bulk density and porosity are equal to those parameters used for the source materials. A site-specific unsaturated zone conductivity is not available, therefore a typical conductivity for compacted municipal solid waste of 5.5×10^{-6} m/s has been taken from literature[20]. The vertical dispersivity has been estimated as 10% of the unsaturated zone thickness, as per Environment Agency guidance[21].

[18] Aliphatic hydrocarbons are relatively insoluble, but have been included in the assessment as they have been detected in the site's groundwater
[19] https://pubchem.ncbi.nlm.nih.gov/compound/octadecane#section=Ecological-Information
[20] www.landss.soton.ac.uk/hydraulic-conductivity-landfilled-waste
[21] Groundwater risk assessments for infiltration systems: calculations and examples, https://www.gov.uk/guidance/infiltration-systems-groundwater-risk-assessments#calculate-the-infiltration-rate-summary

5.2.5 Aquifer input parameters

The aquifer thickness has been selected as 7.6 m, as this is the approximate depth to the hard dolomite strata beneath the site. The dry bulk density for the aquifer has been selected as 1.85 g/cm^3 using ConSim model's default values appropriate for the aquifer geology. The effective porosity of 0.31 has also been selected from the ConSim model's default values appropriate for the aquifer geology; it is assumed that porosity is equal to effective porosity due to the lack of site-specific data.

The hydraulic conductivity in the shallow aquifer has been estimated by PBS&J as 3.6 m per day, which equates to 4.17 x10^{-5} m/s. The hydraulic gradient is expected to be very shallow; therefore a gradient of 1:1,000 has been used (fraction 0.001). The flow direction has been entered into the ConSim model as towards the northeast, towards the North Canal and North Sound.

The longitudinal and lateral dispersivities have been calculated as 10% and 1% of the distance to the receptor (assumed to be 25 m minimum due to the close proximity to the North Canal) as per Environment Agency guidance[22].

5.3 Model results

While the models have been run over a time period of 1,000 years to examine the trend of the predicted concentrations at the receptor, the contaminants are only considered to exceed when the concentrations at the North Canal are above the GAC within the foreseeable future, i.e. 100 years.

Table 14 summarises the DQRA results for Scenarios 1 and 2 (Level 3A assessment) and Scenarios 3 and 4 (Level 3 assessment). The contaminant concentration predicted by the model at Level 3 and Level 3A is the concentration at the point where the groundwater body meets the receptor, not the concentration that might occur in the receiving water (i.e. the model does not include an assessment of contaminant loading or dilution in the receptor).

[22] Remedial Targets Methodology, Hydrogeological Risk Assessment for Land Contamination, Environment Agency, 2006.

Table 14 GAC exceedances predicted at North Canal receptor within 100 years

Source ID	Contaminants of concern	Scenario 1 Uncapped continuing source (3A)	Scenario 2 Capped continuing source (3A)	Scenario 3 Uncapped declining source (3)	Scenario 4 Capped declining source (3)
Source A	Ammonia	Yes (low GAC)	Yes (low GAC)	Yes (low and high GAC)	Yes (low GAC)
	Orthophosphate	No	No	No	No
	Arsenic	No	No	No	No
	Beryllium	No	No	No	No
	Chromium	No	No	No	No
	Copper	No	No	No	No
	Iron	No	No	No	No
	Silver	No	No	No	No
	Zinc	No	No	No	No
	Cyanide	No	No	Yes	No
	GRO C6-C10	No	No	No	No
	DRO C10-C28	No	No	Yes	No
	C16-C21 aromatic	No	No	No	No
	C16-C35 aliphatic	No	No	No	No
Source B	Lead	No	No	No	No
	Nickel	No	No	No	No
Source C	1,4-dichlorobenzene	No	No	No	No
Source D	Mercury	No	No	No	No

Yes = exceedance of GAC at the receptor, No = no exceedance of GAC at the receptor

As noted in Section 5.2.1, the Source D area does not contain exposed waste and is not proposed be capped due to (i) the isolated source of contamination in this area and (ii) the fact that even without a cap the predicted mercury concentrations reaching the North Canal do not exceed the GAC for the uncapped scenarios modelled (Scenarios 1 and 3).

It is noted that cyanide and DRO concentrations do not exceed the GAC in the Level 3A assessment (Scenarios 1 and 2) but are predicted to exceed GAC at the receptor under Scenario 3, where the landfill has ceased to receive waste but has not been capped; once capped, in Scenario 4, cyanide and DRO concentrations are no longer predicted to exceed the GAC at the North Canal.

The 95th percentile concentrations are being used to determine whether the GAC are being exceeded for this assessment; however, the 90th percentile DRO concentrations do not exceed the GAC under Scenario 3. In addition, the peak predicted cyanide concentration for Scenario 3 is 0.004 mg/l at 60 years versus the GAC of 0.001 mg/l, both in the same order of magnitude.

As ammonia concentrations are predicted to exceed the GAC at the North Canal within 100 years for all four of the modelled scenarios, the results have been examined to determine the degree of betterment once a cap is installed at the site. The Level 3 assessment is more realistic and demonstrates the declining source once the site stops receiving waste; therefore, the Level 3 results have been used to evaluate betterment. It is noted that the GAC used for ammonia are UK based quality standards in the absence of criteria in the Florida standards. The ammonia GAC range comprises of a stringent GAC for unionised ammonia of 0.021 mg/l (the principal toxic form of ammonia) in marine waters, to a 'poor' river standard of 6 mg/l for total ammonia (in freshwater). It is noted that as salinity increases in a water body, the portion of unionised ammonia decreases[23].

Figure 7 and Figure 8 provide a graphical representation of the predicted concentrations at the point where the groundwater body meets the North Canal receptor (not the concentration that might occur in the receiving water) for ammonia over 1,000 and 100 years.

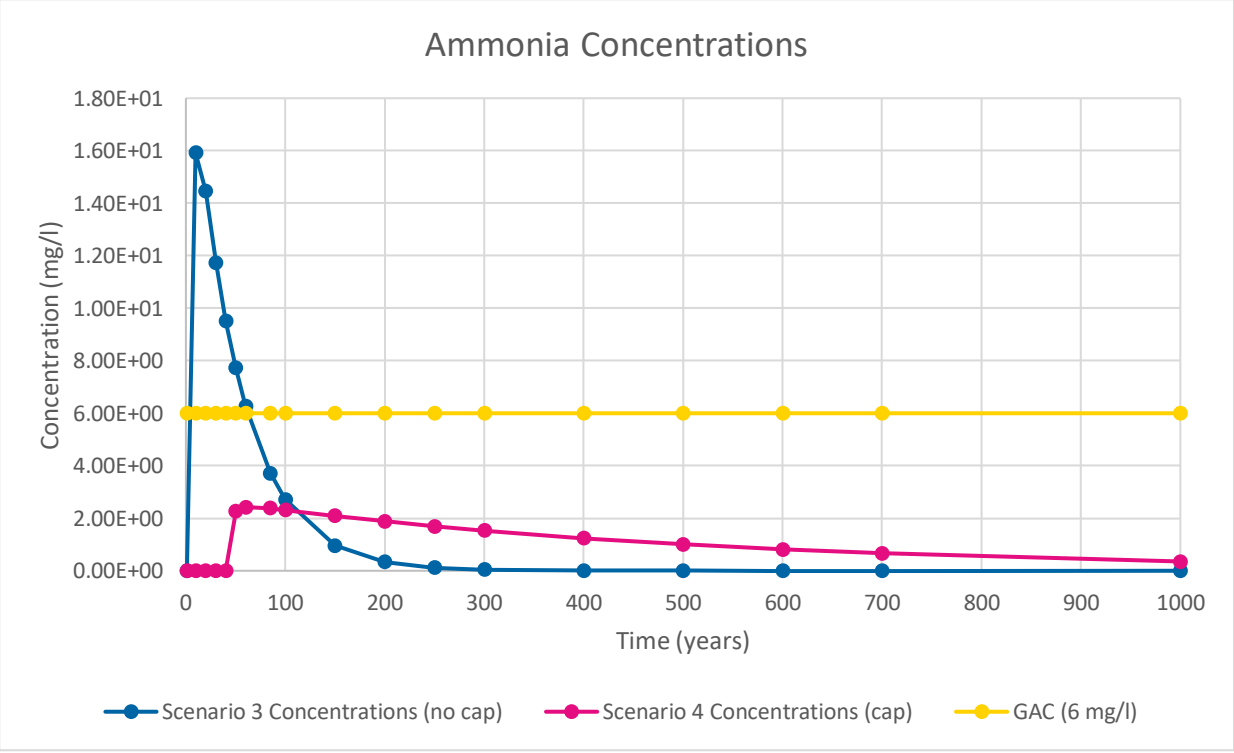

Figure 7 Ammonia concentrations at point of North Canal receptor over 1,000 years

[23] https://www.wfduk.org/sites/default/files/Media/ammonia.pdf - Proposed EQS for Water Framework Directive Annex VIII substances: ammonia (un-ionised) Science Report: SC040038/SR2 Environment Agency 2007.

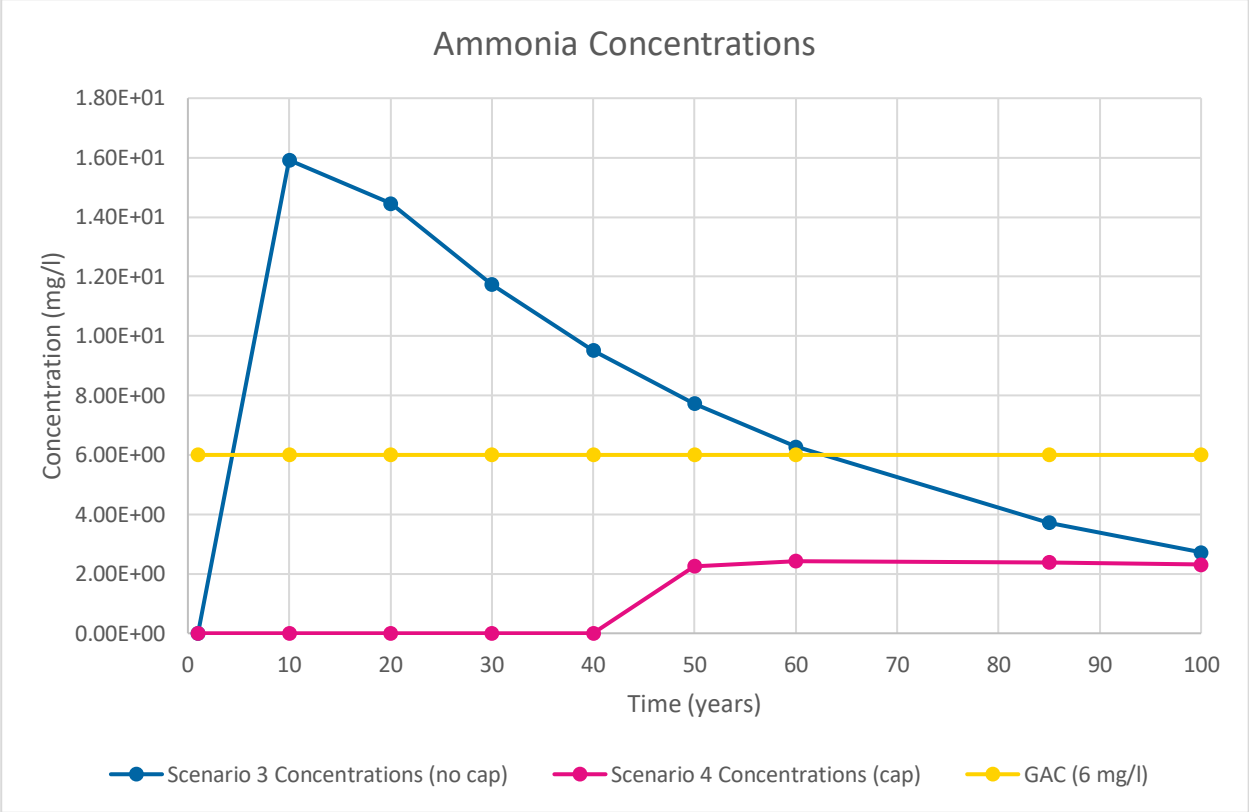

Figure 8 Ammonia concentrations at point of North Canal receptor over 100 years

The Scenario 3 (without cap) ammonia concentrations are shown to peak at 10 years with a concentration in exceedance of both GAC; the concentrations then decline over time, as expected with a declining source. With a cap on the site (Scenario 4) the ammonia concentrations peak at a much lower concentration that does not exceed the higher GAC.

Overall, there is an 85% reduction in the peak concentrations with a cap on the site compared to the *status quo*, with the peak concentration of 2.42 mg/l falling within a 'moderate' river status for total ammonia. As such, the graph demonstrates that there is significant betterment in terms of ammonia concentrations in the North Canal with a cap added to the site.

5.4 Sensitivity analysis

The inbuilt sensitivity analysis in ConSim cannot be used when parameters entered into the model are single values. Therefore, to assess the impact of non-site-specific input parameters and the aquifer hydraulic conductivity value used in the model, each has been increased by 10% to evaluate the change in the predicted concentrations at the receptor. Each parameter has been changed separately within the model to understand the individual effect of that parameter. The Scenario 3 model has been selected for the sensitivity analysis and the changes to the peak ammonia concentration of 15.92 mg/l have been assessed. These are considered the most sensitive scenario and contaminant of concern for the site. An organic contaminant is also required for the assessment as parameters such as foc will have an impact on the partitioning of organic chemicals. DRO has been selected as the organic contaminant with the peak concentration of 0.71 mg/l used for comparison. The results of the sensitivity analysis are provided in Table 15 below.

Table 15 Sensitivity analysis

Input parameter	Value used in original model	Value increased by 10%	Predicted peak concentration at receptor (mg/l)	Change in result
Source porosity	0.55 fraction (water filled 0.275 and air filled 0.275)	0.605 fraction (water filled 0.3025 and air filled 0.3025)	Ammonia: 16.351 DRO: 0.750	Ammonia: +2.71% DRO: +5.05%
Source bulk density	0.54 g/cm^3	0.594 g/cm^3	Ammonia: 15.991 DRO: 0.721	Ammonia: +0.46% DRO: +1.02%
foc (source)	0.2 fraction	0.22 fraction	Ammonia: N/A DRO: 0.721	Ammonia: N/A DRO: +1.02%
foc (aquifer)	0.05 fraction	0.055 fraction	Ammonia: N/A DRO: 0.716	Ammonia: N/A DRO: +0.32%
Unsaturated zone porosity	0.55 fraction	0.605 fraction (water filled 0.3025)	Ammonia: 15.909 DRO: 0.714	Ammonia: -0.06% DRO: +0.03%
Unsaturated zone conductivity	5.5x10^{-6} m/s	6.05x10^{-6} m/s	Ammonia: 15.919 DRO: 0.714	Ammonia: No change DRO: No change
Aquifer bulk density	1.85 g/cm^3	2.04 g/cm^3	Ammonia: 15.091 DRO: 0.716	Ammonia: -5.20% DRO: +0.33%
Aquifer porosity	0.31 fraction	0.34 fraction	Ammonia: 17.327 DRO: 0.837	Ammonia: +8.84% DRO: +17.33
Aquifer hydraulic gradient	0.001 fraction	0.0011 fraction	Ammonia: 15.892 DRO: 0.714	Ammonia: -0.17% DRO: +0.11%
Aquifer hydraulic conductivity	4.17x10^{-5} m/s	4.59x10^{-5} m/s	Ammonia: 15.891 DRO: 0.714	Ammonia: -0.17% DRO: +0.11%

The majority of the increased parameters caused the predicted peak concentrations to change by a minimal amount of approximately 1% or less. The parameters that had a greater effect were source porosity, aquifer bulk density and aquifer porosity. Increasing the aquifer porosity by 10% resulted in the highest change in the peak concentrations; the ammonia and DRO peak concentrations increased by 8.84% and 17.33% respectively. However, percentage change can be misleading as a high percentage of a low concentration pertains to a small overall change in concentration, i.e. the magnitude of the peak concentrations has not increased significantly: original ammonia concentration of 15.912 mg/l versus increased concentration of 17.327 mg/l, and original DRO concentration of 0.714 mg/l versus increased concentration of 0.837 mg/l. These changes do not significantly affect the outcome of the risk assessment.

5.5 Summary

A total of four source areas were included in the model, of which:

- Source A comprises a site-wide source area with a range of inorganic, metal and hydrocarbon contaminants
- Source B covers the eastern portion of the site with metals contaminants
- Sources C and D comprise smaller hotspots pertaining to 1,4-dichlorobenzene and mercury respectively

These source areas and contaminants were identified to pose a potential risk in the generic risk assessment comparison to published GAC protective of marine surface waters.

ConSim model version 2.5 was used to predict the concentrations of contaminants migrating from the source areas to the point where the groundwater body meets the North Canal, which is considered to be the main receptor that subsequently discharges into the North Sound. The model has been run assuming attenuation is occurring in the aquifer due to tidal dispersion. Model Level 3 and Level 3A were implemented to enable both a continuous (conservative) and declining (realistic) source to be assessed. The DQRA has used site-specific inputs as a priority and relevant literature inputs where needed.

The model results show that the majority of the contaminants at the site do not exceed GAC at the North Canal (at point of entry to the receptor) and subsequently the North Sound, with Sources B, C and D do posing an unacceptable risk under any of the scenarios that were modelled.

However, a cap is required to remove the risk posed by cyanide and DRO, and to provide betterment with respect to ammonia. These contaminants were modelled in Source A. The Scenario 3 (no cap) ammonia concentrations were shown to peak at 10 years and decline over time. With a cap on the site (Scenario 4) the ammonia concentrations peak at a much lower concentration that does not exceed the higher GAC, but exceeds the more stringent criteria for unionised ammonia.

Overall, there is an 85% reduction in the peak concentrations with a cap on the site compared to the *status quo*, with the peak concentration of 2.42 mg/l falling within a 'moderate' river status for total ammonia. As such, the graph demonstrates that there is significant betterment in terms of ammonia concentrations in the North Canal with a cap added to the site.

The sensitivity analysis has shown that the majority of the non-site-specific values used in the risk assessment model and the aquifer hydraulic conductivity had little impact on the predicted peak concentrations, when increased by 10%. Increasing the aquifer porosity by 10% resulted in the highest change in the peak concentrations; the ammonia and DRO peak concentrations increased by 8.84% (to 17.327 mg/l) and 17.33% (to 0.837 mg/l) respectively. These changes do not significantly affect the outcome of the risk assessment.

6. Conclusions

GHD has prepared an environmental risk assessment for the site with the purpose of understanding the risk posed to sensitive receptors surrounding the site, comparing risk under the *status quo* conditions to the risk posed once the site has been capped. The remedial options for the site are described in detail in the GHD report *George Town Landfill, Remedial Options Report, January 2020*.

The data and information available to GHD pertaining to the site were reviewed to prepare a CSM, with pollutant linkages then evaluated by generic risk assessment and DQRA. The pollutant linkages assessed and the findings are presented in Table 16.

Table 16 CSM pollutant linkages and risk assessment findings

Source	Pathway	Receptor	Status quo risk	Risk after addition of a cap
Contaminants within soils/deposited wastes	Ingestion, dermal contact and inhalation (soil, dust and vapours)	Site workers and visitors	Arsenic was found to exceed Florida GAC but was below UK S4ULs for public open spaces, which assumes the site would be vegetated with limited bare soils; therefore, the risk of human health and ecological receptor exposure remains during *status quo*.	No unacceptable risk has been identified once site is capped and restored. This is due to removal of the exposure pathway.
	Ingestion and inhalation (dust)	Nearby residents and commercial/industrial property users/workers		
	Ingestion, dermal contact and inhalation	Ecological receptors		
	Run-off	Canals	During status quo, the risk of run-off being contaminated due to contact with waste/contaminated soils will remain.	No unacceptable risk identified once site is capped and restored.
	Leaching and migration	Groundwater	No risk to drinking water abstraction receptors is anticipated due to their distance from the site, the	The risk assessment has shown that the addition of a cap will remove the risk posed by the majority of contaminants and will
Contaminants within groundwater	Migration	Canals (main surface water receptor) and North Sound		

Source	Pathway	Receptor	Status quo risk	Risk after addition of a cap
	Ingestion, dermal contact and inhalation	Ecological receptors that inhabit the canals	geological conditions and the groundwater flow direction. The potential for leaching and migration of groundwater contaminants to off-site surface water receptors, and therefore ecological receptors, remains during *status quo*.	provide betterment with respect to ammonia.
Contaminants within surface water (canals)	Migration	North Sound (secondary down-gradient surface water receptor)	There is the potential for surface water contaminants to migrate to the North Sound during *status quo*.	The risk assessment has shown that the addition of a cap will remove the risk posed by the majority of contaminants and will provide betterment with respect to ammonia.
	Ingestion, dermal contact and inhalation	Ecological receptors that inhabit the North Sound		
Landfill gases	Lateral and vertical migration with subsequent inhalation, or damage caused by fire/explosion	Site workers and visitors Ecological receptors Nearby residents and commercial/industrial property users/workers	During status quo, the risk to the identified receptors remains possible.	Once the site stops depositing waste, gas production will decline steeply. Installation of a landfill cap and operation of an active gas management system will further reduce the quantity of non-recovered gas by approximately 70%. The risk of off-site migration and receptor exposure will therefore be greatly reduced due to the new measures.

Source	Pathway	Receptor	Status quo risk	Risk after addition of a cap
Waste fires	Air emissions, run-off, infiltration and migration	Site workers and visitors, nearby residents and commercial/industrial property users/workers, ecological receptors, groundwater and surface water	During status quo, the risk of waste fires remains possible.	The risk of waste fires at the surface will be mitigated by addition of the cap to the landfill.

Overall, the generic and detailed findings of the environmental risk assessment undertaken for the George Town Landfill show that the wastes deposited at the existing site are likely impacting the surrounding environment in terms of human health, surface water run-off, risk to groundwater and exposure to landfill gas - and will continue to do so for the foreseeable future without the provision of an engineered landfill cap.

The addition of a cap over the landfill site breaks the majority of pollutant linkages, leaving only a limited number of areas of concern relating to risk to marine surface water from groundwater contaminants.

DQRA modelling of the risk to marine surface water demonstrates that the engineered landfill cap reduces the migration of contaminants to the North Canal (and subsequently the North Sound), with the contaminant concentrations falling within acceptable limits at the receptor thereafter.

The only exception to this is ammonia, which exceeds the stringent criterion for un-ionised ammonia but falls below the total ammonia limit for river water of moderate quality (the most applicable criterion for this project); with the betterment provided by the engineered cap resulting in an overall 85% reduction in the peak concentration compared to the *status quo*. As betterment has been demonstrated for the closet receptor, betterment of risk posed to receptors at a greater distance, such as North Sound and groundwater abstractions, is also confirmed.

As such, the risk assessment demonstrates overall that - including the provision of a landfill cap - the site will be suitable for use as public open space (subject to on-going practical restrictions, such as access to critical infrastructure) in future.

7. Addendum 1

7.1 Introduction

Following agreement of the original environmental risk assessment with CIG, GHD was commissioned by DC to consider potential alternative capping options for the older, less active South Mound.

This area, which ceased receiving municipal solid waste (MSW) circa 1999, has naturally revegetated following the cessation of tipping operations and is now covered with dense layer of undergrowth. The area shows no sign of vegetation stress (an indicator of landfill gas emissions) and appears from recent monitoring results to be having little if any unacceptable impact on the surrounding environment.

Accordingly, the purpose of the additional study was to assess whether a cap is required for South Mound and, if so, whether a less conservative cap design may be appropriate.

7.2 Assessment approach

In the first instance, GHD revised its modelling scenarios to consider the impact of the GTLF on the surrounding environment with the South Mound left 'as is' (i.e. with no cap and no gas control).

Accordingly, the modelled scenarios and input parameters specific to those new scenarios were adapted as set out in Table 17.

Table 17 Revised model scenarios

Landfill Area	Scenario	Description
North Mound	1	Model Level 3A, site uncapped receiving waste (continuous source)
	2	Model Level 3A, site capped continuous source (for information only, no continuous source once the site is capped)
	3	Model Level 3, site no longer receiving waste, remaining uncapped (declining source)
	4	Model Level 3, site no longer receiving waste, restored with a cap (declining source)
South Mound	5	Model Level 3, site no longer receiving waste, remaining uncapped (declining source)

The following subsections describe the input parameters that have been updated to model the new scenarios and the results of the additional risk based assessment.

7.3 North Mound Risk Based Assessment

7.3.1 Input parameters

Scenarios 1 to 4 required the source area and the source contaminant concentrations to be split up between North Mound and South Mound to consider North Mound only. Source C, a hotspot at well MW10, is therefore not applicable to the North Mound such that only Sources A, B and D were included in Scenarios 1 to 4, as shown in Figure 9 below.

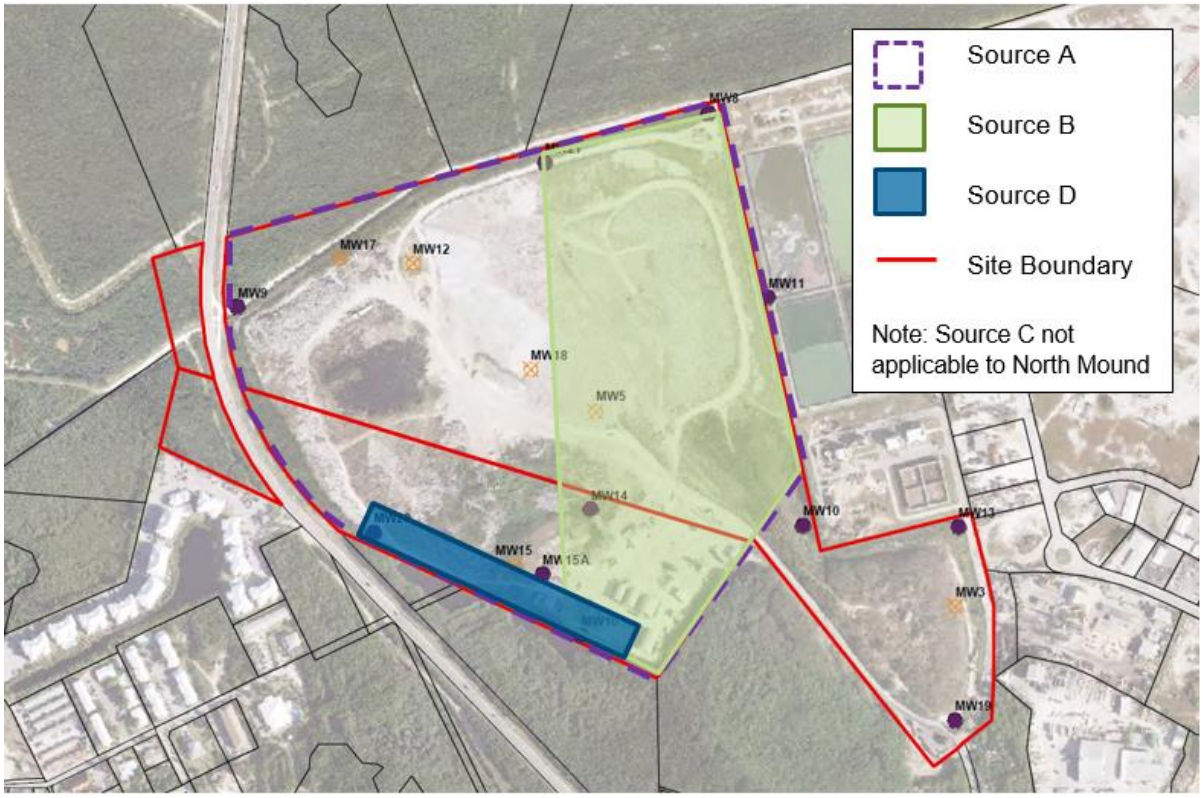

Figure 9 Revised source locations (North Mound)

The updated mean contaminant concentrations for the applicable North Mound source areas are provided in Table 18 below. It is noted that the mean concentration for Source D did not change, as this source area is wholly within the North Mound.

Table 18 Mean contaminant concentrations (North Mound)

Source	Contaminant	Mean concentration (mg/l)
Source A	Ammonia	32.697
	Orthophosphate	0.301
	Arsenic	0.012
	Beryllium	0.0001
	Chromium	0.021
	Copper	0.015
	Iron	1.513
	Silver	0.0001
	Zinc	0.121
	Cyanide	0.011
	Gasoline range organics (GRO)	0.043
	Diesel range organics (DRO)	4.127
	C16-C21 aromatic	0.223

Source	Contaminant	Mean concentration (mg/l)
	C16-C35 aliphatic	0.277
Source B	Lead	0.003
	Nickel	0.003
Source D	Mercury	0.0001

7.3.2 Model results

The following table summarises the results for revised model Scenarios 1 to 4, showing whether a contaminant's concentration is predicted to exceed the relevant GAC at the point where the groundwater body meets the receptor. The model does not predict the concentration that might occur in the receiving water (i.e. the model does not include an assessment of contaminant loading or dilution in the receptor).

Table 19 GAC exceedances at North Canal within 100 years (North Mound sources)

Source ID	Contaminants of concern	Scenario 1 Uncapped continuing source	Scenario 2 Capped continuing source	Scenario 3 Uncapped declining source	Scenario 4 Capped declining source
Source A	Ammonia	Yes*	Yes*	Yes*	Yes*
	Orthophosphate	No	No	No	No
	Arsenic	No	No	No	No
	Beryllium	No	No	No	No
	Chromium	No	No	No	No
	Copper	No	No	No	No
	Iron	No	No	Yes	No
	Silver	No	No	No	No
	Zinc	No	No	No	No
	Cyanide	No	No	Yes	No
	GRO	No	No	No	No
	DRO	No	No	Yes	No
	C16-C21 aromatic	No	No	No	No
	C16-C35 aliphatic	No	No	No	No
Source B	Lead	No	No	No	No
	Nickel	No	No	No	No

Source ID	Contaminants of concern	Scenario 1 Uncapped continuing source	Scenario 2 Capped continuing source	Scenario 3 Uncapped declining source	Scenario 4 Capped declining source
Source D	Mercury	No	No	No	No

* The predicted ammonia concentrations exceed only a stringent, less applicable GAC for unionised ammonia of 0.021 mg/l for Scenarios 1, 2 and 4. The Scenario 4 predicted ammonia concentrations exceed both the stringent GAC and the more applicable GAC of 6 mg/l for total ammonia (poor river standard)

To understand the degree of betterment provided by the addition of an engineered cap to the North Mound only, the predicted ammonia concentrations were also updated. From these updates, Figures 10 and 11 provide graphical representations of the revised concentration predictions at the point where the groundwater body meets the North Canal receptor (not the concentration that might occur in the receiving water) for ammonia over 1,000 and 100 years.

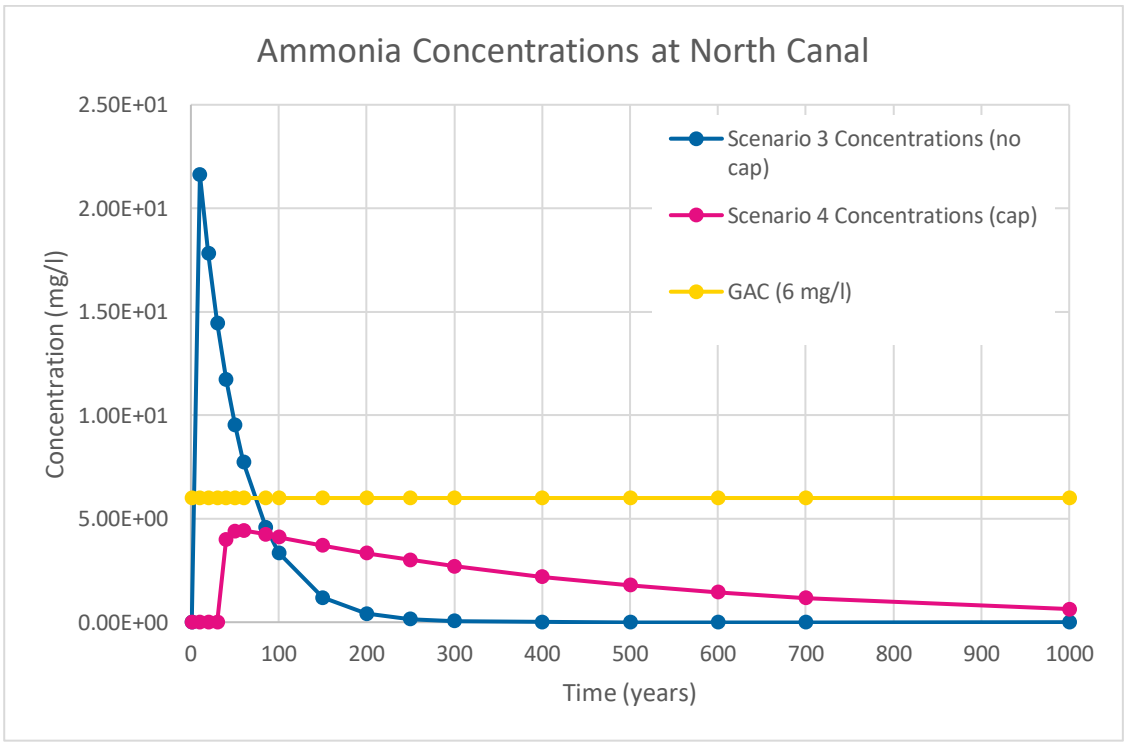

Figure 10 Ammonia concentrations at point of North Canal receptor over 1,000 years

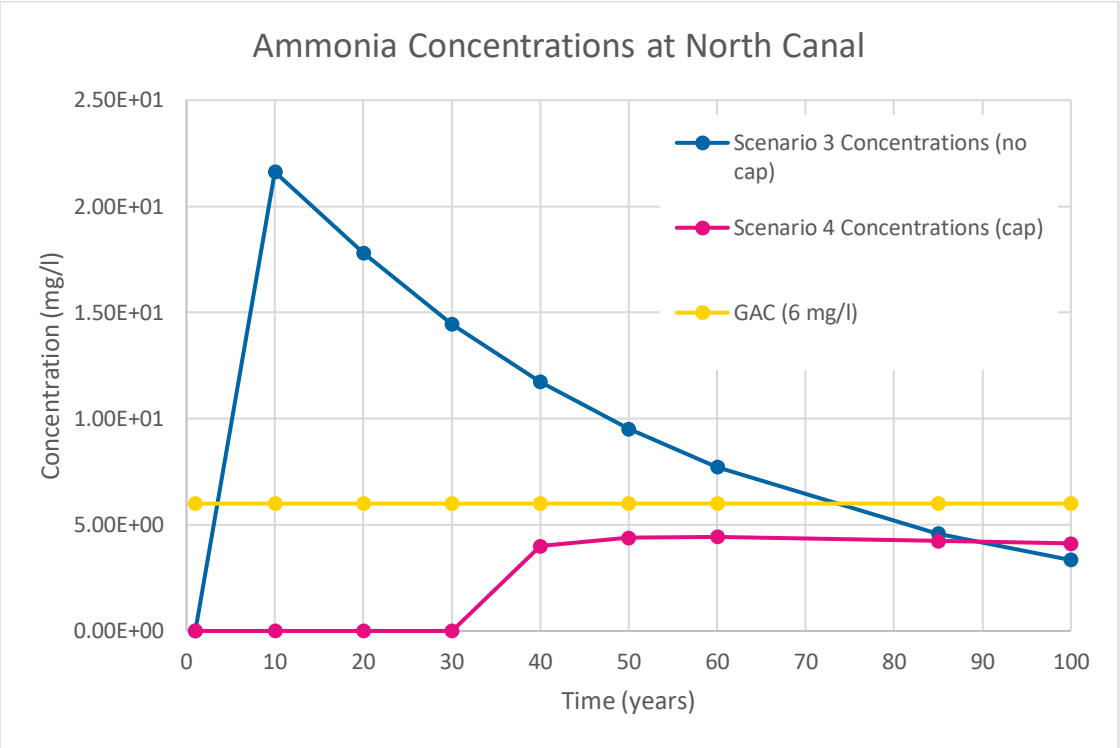

Figure 11 Ammonia concentrations at point of North Canal receptor over 100 years

The revised model Scenario 3 (without cap) ammonia concentrations are shown to peak at 10 years with a concentration in exceedance of both GAC; the concentrations then decline over time, as expected with a declining source. With a cap on the North Mound (revised model Scenario 4) the ammonia concentrations peak at a much lower concentration that does not exceed the more applicable GAC.

Overall, there is an 80% reduction in the peak concentrations with a cap on the North Mound compared to the *status quo*. As such, the graph demonstrates that there is significant betterment in terms of ammonia concentrations in the North Canal with a cap added to the North Mound.

7.4 South Mound Risk Based Assessment

7.4.1 Input parameters

Scenario 5 also required the source area and the source contaminant concentrations to be adjusted, so as to consider those relevant to the South Mound only (i.e. using data from wells MW10, MW13, and MW19). Source D lies within the North Mound and is not applicable to the South Mound. Sources A, B and C were included in Scenario 5, as per the layout in Figure 12 below.

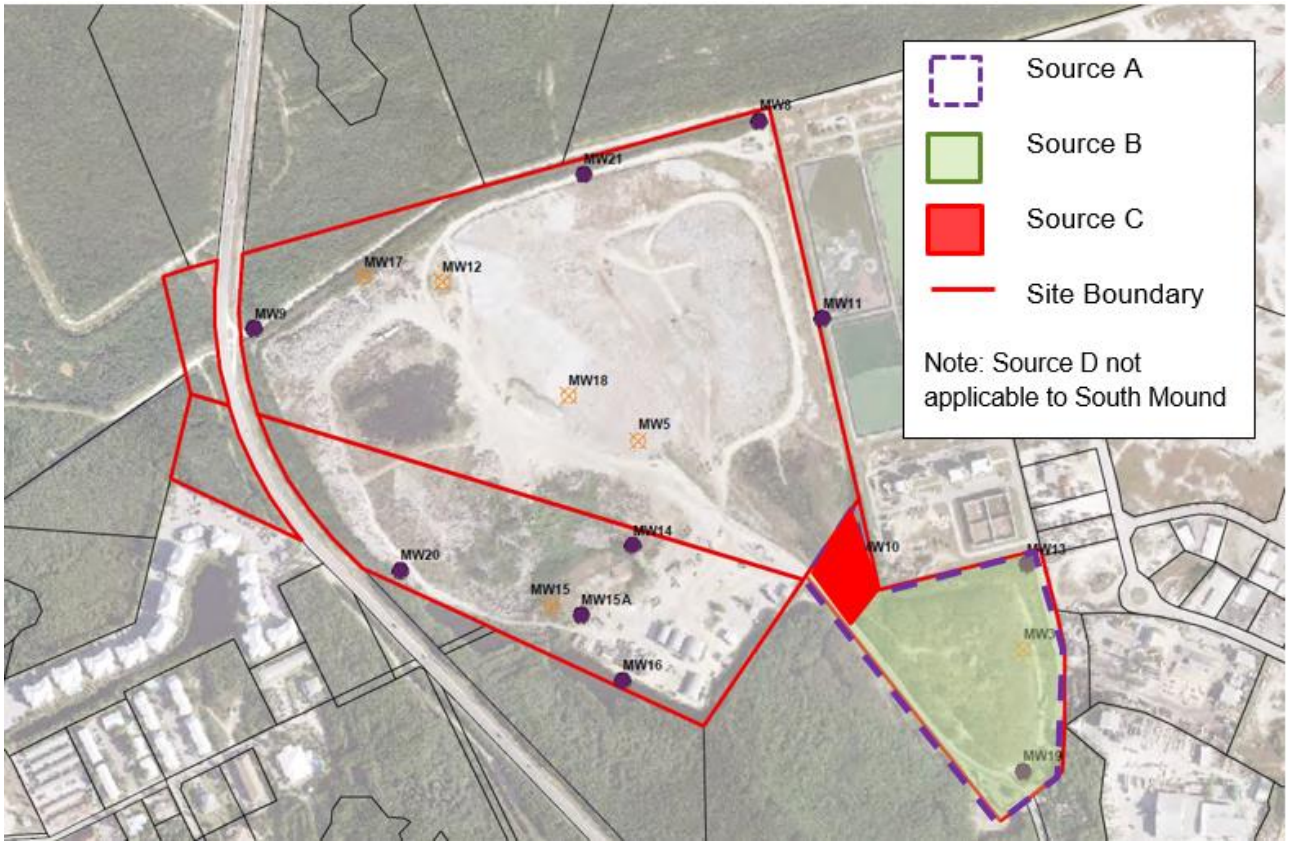

Figure 12 A Revised source locations (South Mound)

The updated mean contaminant concentrations for the applicable South Mound source areas are provided in Table 20 below. It is noted that the mean concentration for Source C did not change, as this source area is wholly within the South Mound. Some of the contaminants were also removed from the sources, as their concentrations did not exceed GAC in the South Mound wells.

Table 20 GAC exceedances at North Canal within 100 years (South Mound sources)

Source	Contaminant	Scenario 5 Uncapped declining source
Source A	Ammonia	No
	Orthophosphate	No
	Copper	No
	Iron	No
	Cyanide	No
	DRO	No
Source B	Lead	No
Source C	1,4-dichlorobenzene	No

The predicted concentrations for all contaminants assessed for Scenario 5 are below the GAC at the point of reaching the North Canal receptor.

7.5 Sensitivity analysis

To assess the impact of non-site-specific input parameters and the aquifer hydraulic conductivity value used in the model, each was increased by 10% to evaluate the change in the predicted concentrations at the receptor. Each parameter was changed separately within the model to understand the individual effect of that parameter. Revised model Scenario 3 was selected for the sensitivity analysis and the changes to the peak ammonia concentration of 21.6 mg/l were assessed[24]. An organic contaminant is also required for the assessment as parameters such as foc will have an impact on the partitioning of organic chemicals. DRO has been selected as the organic contaminant with the peak concentration of 1.34 mg/l used for comparison. The results of the sensitivity analysis are provided in Table 21 below.

Table 21 Revised sensitivity analysis

Input parameter	Value used in original model	Value increased by 10%	Change in result
Source porosity	0.55 fraction (water filled 0.275 and air filled 0.275)	0.605 fraction (water filled 0.3025 and air filled 0.3025)	Ammonia: -2.35% DRO: -9.40%
Source bulk density	0.54 g/cm^3	0.594 g/cm^3	Ammonia: -6.34% DRO: -20.20%
Foc (source)	0.2 fraction	0.22 fraction	Ammonia: N/A DRO: -6.34%
Foc (aquifer)	0.05 fraction	0.055 fraction	Ammonia: N/A DRO: -20.81%
Unsaturated zone porosity	0.55 fraction	0.605 fraction (water filled 0.3025)	Ammonia: -6.89% DRO: -21.01%
Unsaturated zone conductivity	5.5x10^{-6} m/s	6.05x10^{-6} m/s	Ammonia: -6.87% DRO: -21.03%
Aquifer bulk density	1.85 g/cm^3	2.04 g/cm^3	Ammonia: -9.42% DRO: -20.80%
Aquifer porosity	0.31 fraction	0.34 fraction	Ammonia: -9.48% DRO: -28.80%
Aquifer hydraulic gradient	0.001 fraction	0.0011 fraction	Ammonia: -7.15% DRO: -21.01%
Aquifer hydraulic conductivity	4.17x10^{-5} m/s	4.59x10^{-5} m/s	Ammonia: 0.19% DRO: 2.90%

[24] Revised model Scenario 3 being the most sensitive scenario and ammonia the most significant contaminant of concern for the site.

The majority of the increased parameters caused the predicted peak concentrations to change by less than 10%. The greatest changes occurred to the DRO concentrations, up to -28.80%. However, percentage change can be misleading as a high percentage of a low concentration pertains to a small overall change in concentration, i.e. the DRO concentration reduced from 1.34 mg/l to 0.95 mg/l when the aquifer porosity was increased by 10%. These changes do not significantly affect the outcome of the risk assessment.

7.6 Revised landfill gas assessment

7.6.1 South Mound

Recent gas studies show that gas production from the older wastes in the South Mound has largely ceased, with only low flow emissions of low-quality gas remaining.

As an independent check of this, GHD has rerun the GasSim model for the site considering predicted bulk gas production and recoverable landfill gas from the South Mound only excluding any form of cap as shown in Figures 13 and 14.

This modelling confirms that estimated bulk gas generation from the South Mound is currently around 35 m^3/hr and the estimated recoverable volume of landfill gas without a cap is currently less than 20 m^3/hr; both of which figures will continue to decline over time.

Accordingly, the quantity of landfill gas being produced by the South Mound is already below the minimum practicable level for recovery and/or active management.

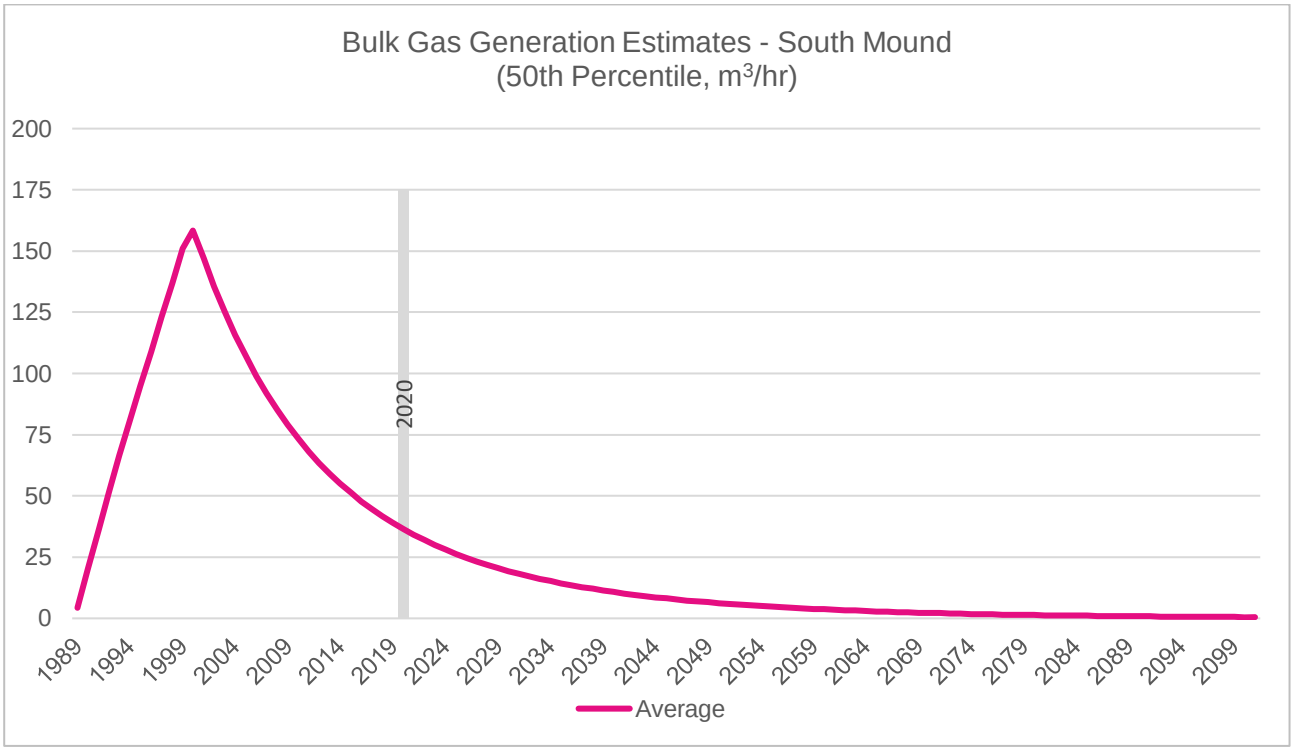

Figure 13 GasSim model results – gas production (South Mound)

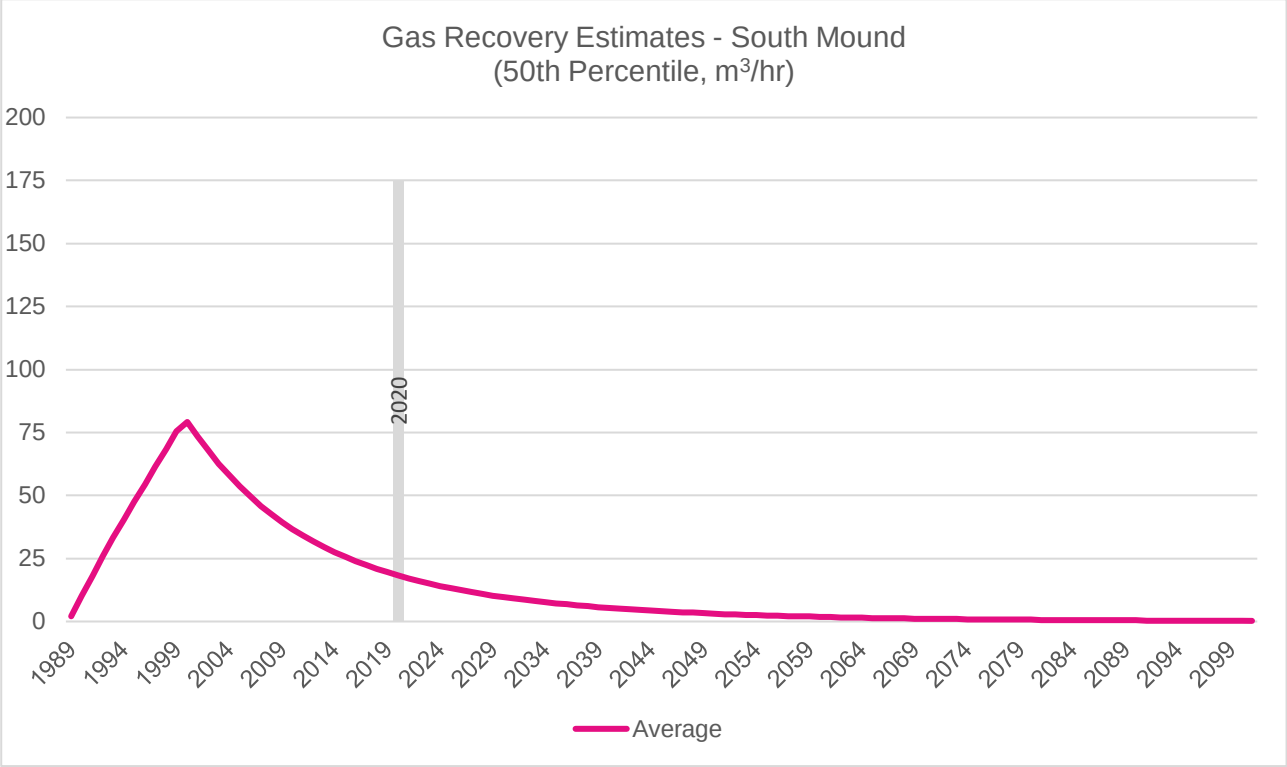

Figure 14 GasSim model results – gas recovery (South Mound)

7.6.2 North Mound

As evidenced above, removing the South Mound contribution has minimal impact on the overall GTLF GasSim Model projections. As such, the non-recoverable gases from the North Mound still have the potential to migrate vertically and laterally and will continue to require active management for at least the term of the ISWMS project concession period (25 years).

7.7 Summary and conclusions

7.7.1 Summary

The modelled source areas at the North Mound and South Mound included contaminants that were identified to pose a potential risk due to their exceedance of published GAC protective of marine surface waters. ConSim model version 2.5 was used to predict the concentrations of contaminants migrating from the source areas to the point where the groundwater body meets the North Canal, which is considered to be the main receptor that subsequently discharges into the North Sound. The model was run assuming attenuation is occurring in the aquifer due to tidal dispersion. Model Level 3 and Level 3A were implemented to enable both a continuous (conservative) and declining (realistic) source to be assessed where applicable to the modelled scenarios.

The assessment used site-specific inputs as a priority and relevant literature inputs where needed. To test the impact of non-site-specific values on the model results, a sensitivity analysis was carried out. The sensitivity analysis has shown that the majority of the non-site-specific values used in the risk assessment model and the aquifer hydraulic conductivity had little impact on the predicted peak concentrations, when increased by 10%.

The model results show that the majority of the contaminants at the site do not exceed GAC at the North Canal (at point of entry to the receptor) and subsequently the North Sound. In particular, none of the contaminants modelled in the uncapped South Mound source areas were found to exceed GAC at the North Canal.

Ammonia concentrations were found to exceed a stringent unionised ammonia GAC at the North Canal, from North Mound Source A for all scenarios; however, ammonia only exceeded the more applicable total ammonia GAC in Scenario 3, where the landfill is uncapped. In addition, iron, cyanide and DRO concentrations were predicted to exceed GAC at the point of reaching the North Canal under Scenario 3. Once the landfill is capped (Scenario 4), none of the contaminants were found to exceed the GAC, with the exception of the stringent unionised ammonia criterion.

GasSim modelling confirms that bulk gas generation from the South Mound is already below the minimum practicable level for recovery and/or active management and will continue to decline over time.

7.7.2 Conclusions

South Mound

The revised modelling shows that, even without a cap, the South Mound contaminants do not pose an unacceptable risk to the nearest sensitive receptor (North Canal). As such, it is not necessary to provide any engineered capping over the South Mound.

Additionally, landfill gas management is not required for the South Mound.

North Mound

A cap is required at the North Mound to remove the risk posed by iron, cyanide and DRO. The assessment also demonstrates that the cap provides significant betterment in terms of ammonia concentrations in the North Canal; with an 80% reduction in the peak ammonia concentrations compared to the *status quo*.

As betterment has been demonstrated for the closest receptor, betterment of risk posed to receptors at a greater distance, such as North Sound and groundwater abstractions, is also confirmed.

Active landfill gas management will still be required for the North Mound for at least the term of the ISWMS project concession period.

8. Addendum 2

8.1 Introduction

Following the issue of the August 2020 addendum (renamed Addendum 1 herein), the envisaged footprint and date of closure of the North Mound changed slightly in line with operational developments and additional groundwater monitoring results became available.

Accordingly, GHD updated its risk assessment to reflect the more recent understanding as set out in this Addendum 2.

8.2 Assessment approach

GHD revised its modelling scenarios to consider the impact of the GTLF based on the new footprint information. The groundwater concentration data were also updated to include newly available 2020 monitoring results.

Sources C and D from the original risk assessment were not remodelled for the following reasons:

- Source C: no new groundwater data were available for the hotspot at Source C, which did not present a risk to the receptors during the previous assessments and will be capped and/or excavated in future.
- Source D: pertains to mercury in groundwater in the area of the residual waste landfill; Source D was not found to present a risk to the receptors during the previous assessments and the mercury concentrations available in the most recent groundwater monitoring were below the laboratory detection limit.

Accordingly, the modelled scenarios and input parameters specific to those new scenarios were adapted as set out in Table 22 below.

Table 22 Revised model scenarios

Landfill Area	Scenario	Scenario Description
North Mound (body)	A	Model Level 3A, site uncapped receiving waste (continuous source)
	B	Model Level 3, site no longer receiving waste, remaining uncapped (declining source)
	C	Model Level 3, site no longer receiving waste, restored with a cap (declining source)
North Mound (NW expansion area)	D	Model Level 3A, site uncapped receiving waste (continuous source)
	E	Model Level 3, site no longer receiving waste, remaining uncapped (declining source)
	F	Model Level 3, site no longer receiving waste, restored with a cap (declining source)
South Mound	G	Model Level 3, site no longer receiving waste, remaining uncapped (declining source)

The following subsections describe the input parameters that have been updated to model the new scenarios and the results of the additional risk-based assessment.

8.3 North Mound Risk Based Assessment

8.3.1 Input parameters

Scenarios A to F required the source layouts and the source contaminant concentrations to be split between the area that will be capped in the short term (North Mound Source Area), and the northwest expansion area that will be capped at a later date (NW Expansion Source Area), as shown in Figure 15 below.

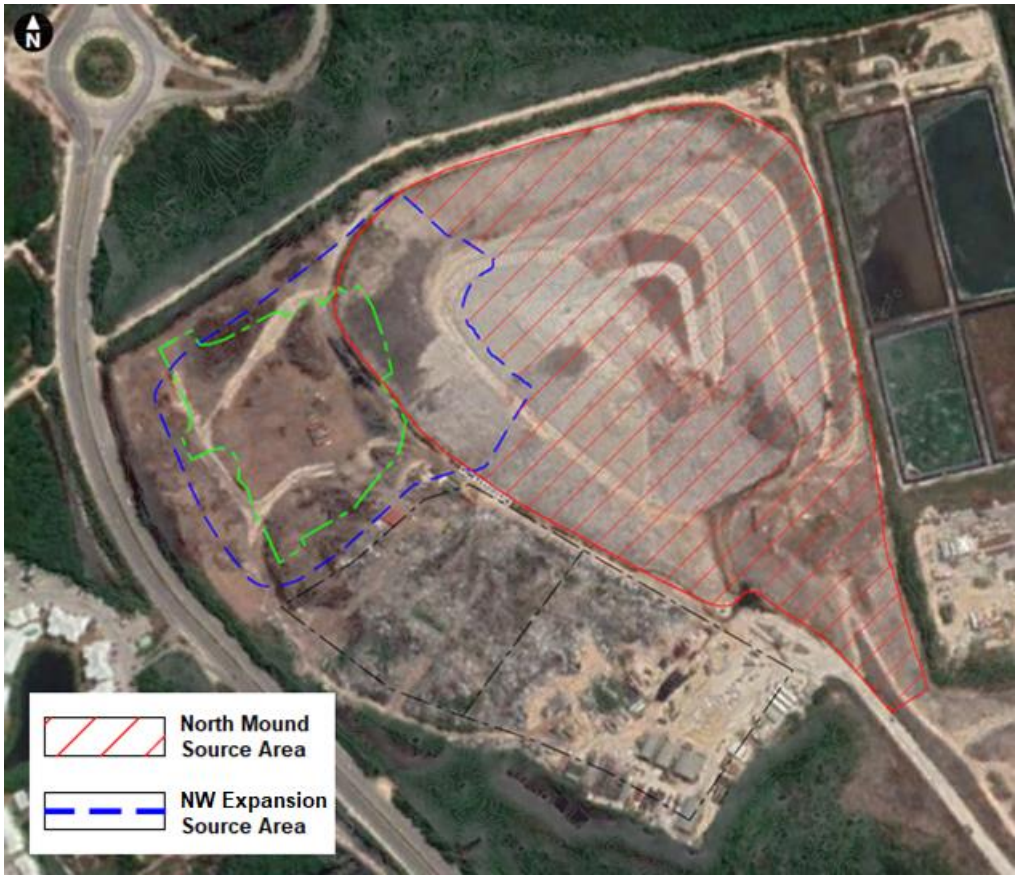

Figure 15 Revised source locations (North Mound and NW Expansion Area)

The thicknesses of the source areas were estimated from the thickness of waste deposited/to be deposited. The North Mound extends to a height of 95 ft above MSL, with waste ranging in thickness from 5 ft to 95 ft. The northwest expansion area is due to reach a height of 60 ft above MSL, with waste ranging in thickness from 5 ft to 60 ft. As single values are required for the inputs in this assessment, the average source thicknesses were estimated as 45 ft and 27 ft for the North Mound and northwest expansion area respectively.

The updated mean contaminant concentrations for the applicable source areas are provided in Table 23 below; the concentrations were calculated using the groundwater data from the previous assessment and the newly available 2020 monitoring results. It is assumed that the contaminant concentrations in groundwater will not significantly vary from those seen over the previous years of waste deposition at the GTLF. The source concentrations for the NW Expansion Source Area have been assumed equal to that of the North Mound, representing typical waste deposition at the site.

It is also noted that the unionised ammonia data is limited to one groundwater monitoring round (2020) and long-term monitoring data is not available. Therefore, the unionised ammonia data represent a ‘snapshot in time’ during an anecdotally wet year for Grand Cayman.

The GAC used for ammonia (total) in the model is 6 mg/l in accordance with the previous assessment. The criterion of 0.021 mg/l for unionised ammonia was provided for information during previous assessment; however, this is now applicable for the new unionised ammonia concentrations available for the site.

Table 23 Mean contaminant concentrations (North Mound sources)

Source	Contaminant	Mean concentration (mg/l)
North Mound and NW Expansion Source Areas	Ammonia, total	59
	Unionised ammonia	0.88
	Orthophosphate	0.49
	1,4-Dichlorobenzene	0.00044
	Arsenic	0.012
	Beryllium	0.00010
	Chromium	0.028
	Copper	0.0041
	Iron	2.17
	Lead	0.0033
	Nickel	0.0051
	Silver	0.00007
	Zinc	0.036
	DRO	4.04
	GRO	0.078
	Cyanide, total	0.013

8.3.2 Model results

The following Table 24 summarises the results for revised model Scenarios A to F, showing whether a contaminant's concentration is predicted to exceed the relevant GAC at the point where the groundwater body meets the receptor. The model does not predict the concentration that might occur in the receiving water (i.e. the model does not include an assessment of contaminant loading or dilution in the receptor).

Table 24 GAC exceedances at North Canal within 100 Years (North Mound sources)

Source Area	Contaminant	Scenario A + D	Scenario B + E	Scenario C + F
North Mound Source Area	Ammonia, total	Yes	Yes	Yes
	Unionised ammonia	Yes	Yes	Yes
	Orthophosphate	No	No	No
	1,4-Dichlorobenzene	No	No	No
	Arsenic	No	No	No
	Beryllium	No	No	No

Source Area	Contaminant	Scenario A + D	Scenario B + E	Scenario C + F
	Chromium	No	No	No
	Copper	No	No	No
	Iron	No	**Yes**	No
	Lead	No	No	No
	Nickel	No	No	No
	Silver	No	No	No
	Zinc	No	No	No
	DRO	No	**Yes**	No
	GRO	No	No	No
	Cyanide, total	No	No	No
NW Expansion Area	Ammonia, total	**Yes**	**Yes**	**Yes**
	Unionised ammonia	**Yes**	**Yes**	**Yes**
	Orthophosphate	No	No	No
	1,4-Dichlorobenzene	No	No	No
	Arsenic	No	No	No
	Beryllium	No	No	No
	Chromium	No	No	No
	Copper	No	No	No
	Iron	No	**Yes**	No
	Lead	No	No	No
	Nickel	No	No	No
	Silver	No	No	No
	Zinc	No	No	No
	DRO	No	**Yes**	No
	GRO	No	No	No
	Cyanide, total	No	**Yes**	No

In summary:

- North Mound Source Area (capped): only total ammonia and unionised ammonia were predicted at concentrations exceeding the GAC at the North Canal receptor once the cap has been installed at the North Mound.
- North Mound Source Area (uncapped): while uncapped, total ammonia, unionised ammonia, iron and DRO concentrations were predicted at concentrations exceeding the GAC at the North Canal receptor.
- NW Expansion Source Area (capped): only total ammonia and unionised ammonia concentrations were predicted at concentrations exceeding the GAC at the North Canal receptor once the cap has been installed at the NW Expansion Area.
- NW Expansion Source Area (uncapped): while the NW Expansion Area is uncapped, total ammonia, unionised ammonia, iron, DRO and cyanide concentrations exceed the GAC at the North Canal.

To understand the degree of betterment provided by the addition of engineered caps to the revised extent of the North Mound and northwest expansion areas, the predicted total ammonia concentration graphs were also updated, see Figure 16 to Figure 19.

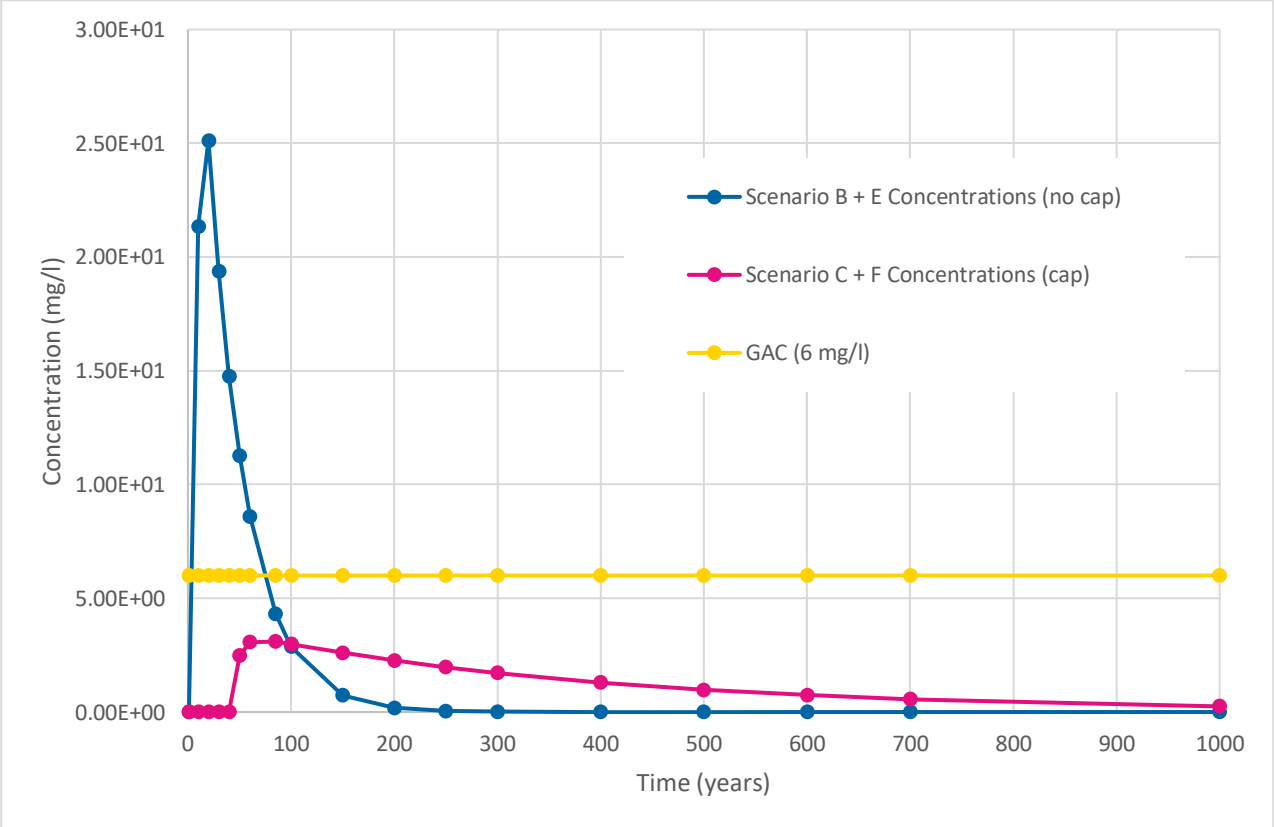

Figure 16 Total ammonia concentrations at point of North Canal receptor over 1,000 years from North Mound Source Area

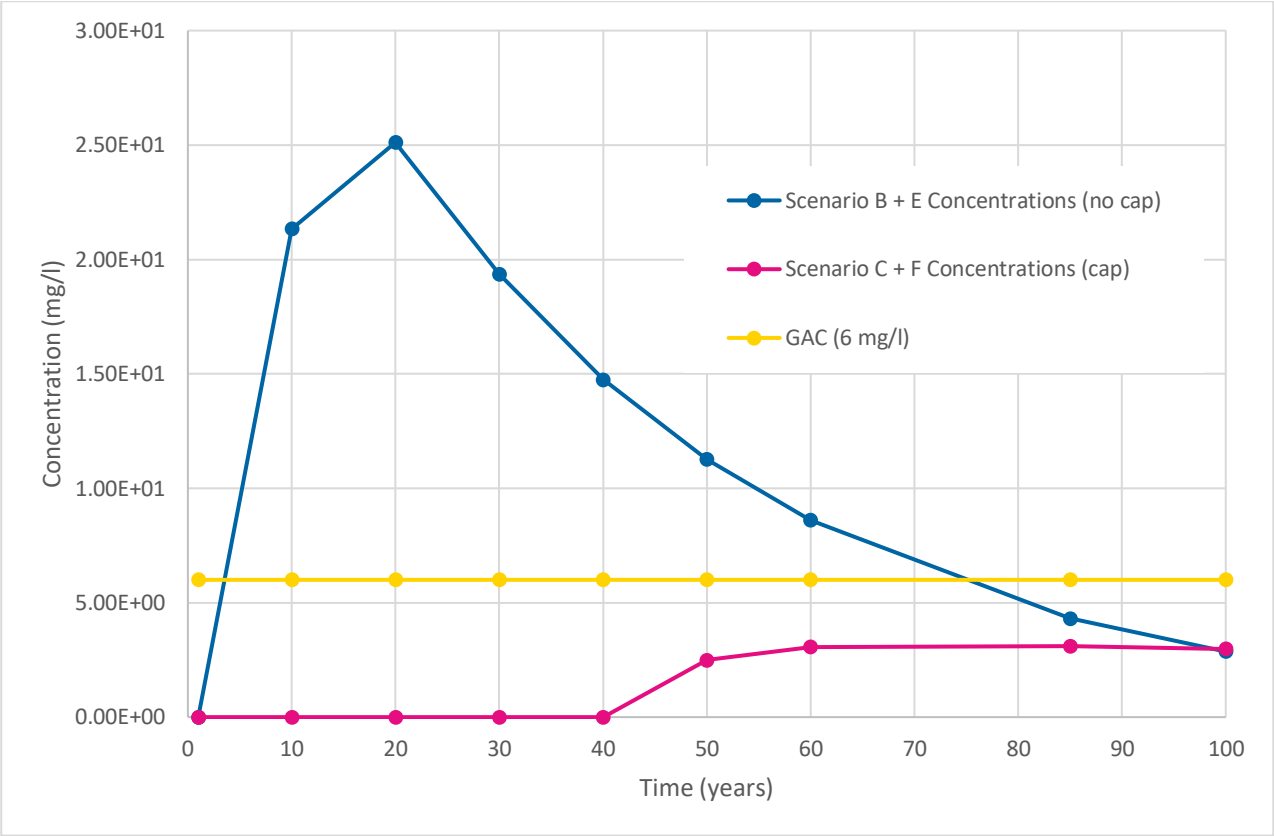

Figure 17 Total ammonia concentrations at point of North Canal receptor over 100 years from North Mound Source Area

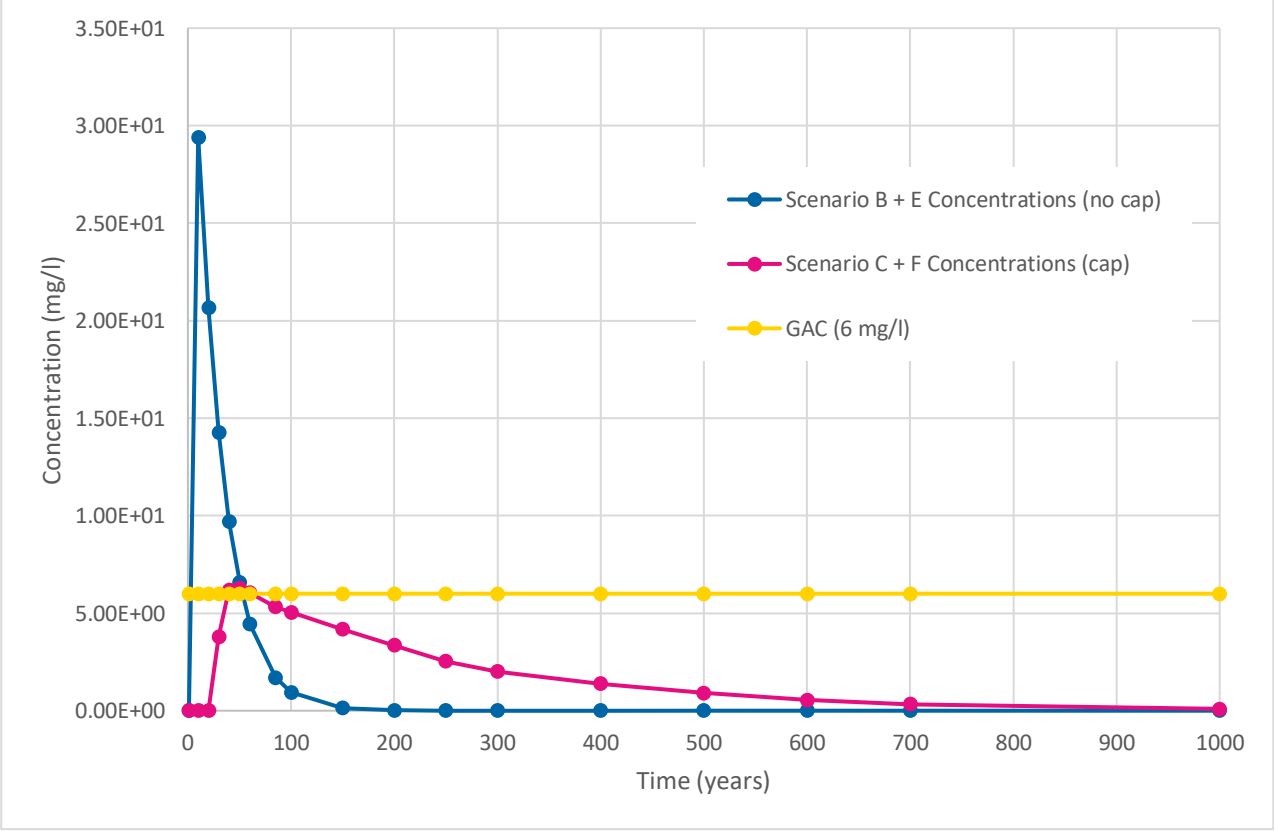

Figure 18 Total ammonia concentrations at point of North Canal receptor over 1,000 years from NW Expansion Source Area

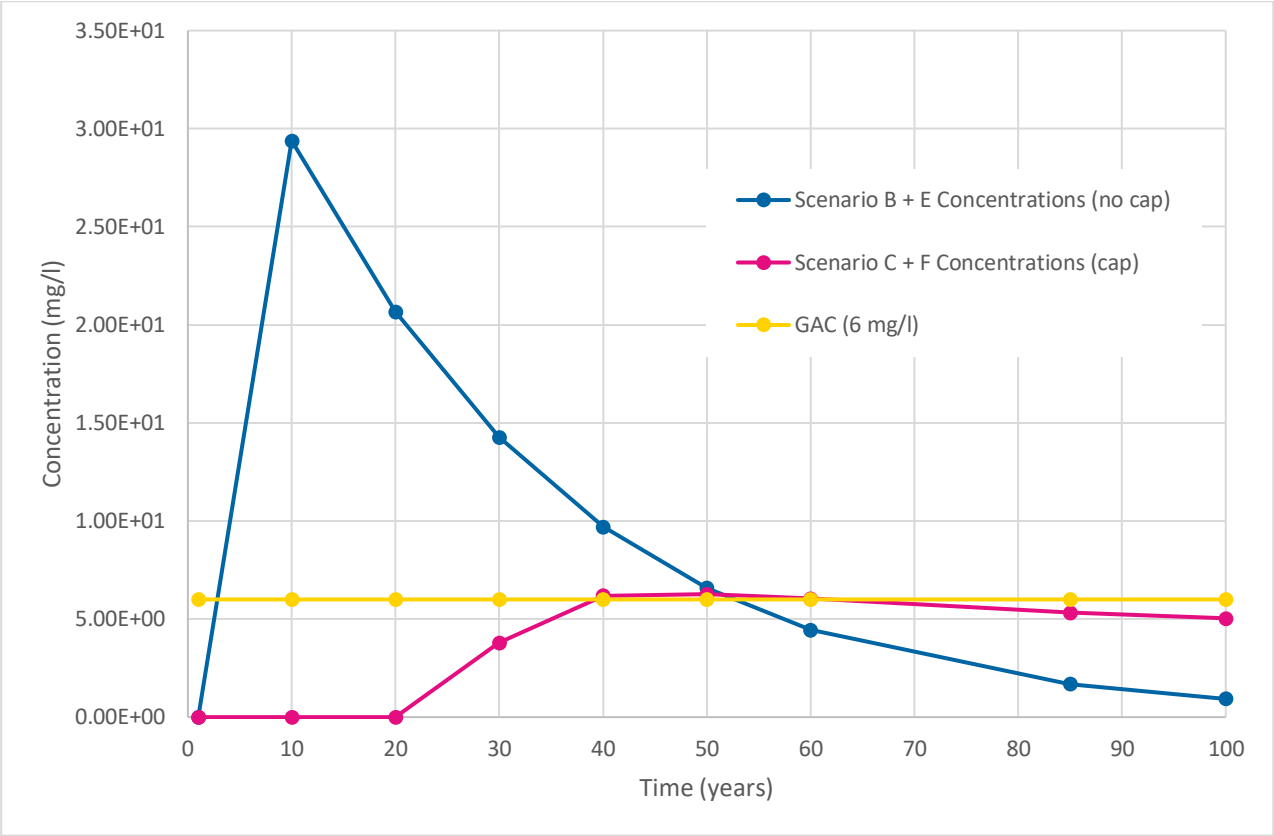

Figure 19 Total ammonia concentrations at point of North Canal receptor over 100 years from NW Expansion Source Area

For additional information, predicted unionised ammonia concentration graphs have also been provided for the North Mound and NW expansion area sources, see Figure 20 to Figure 23. The graphs represent the concentration predictions at the point where the groundwater body meets the North Canal receptor (not the concentration that might occur in the receiving water) over 1,000 and 100 years.

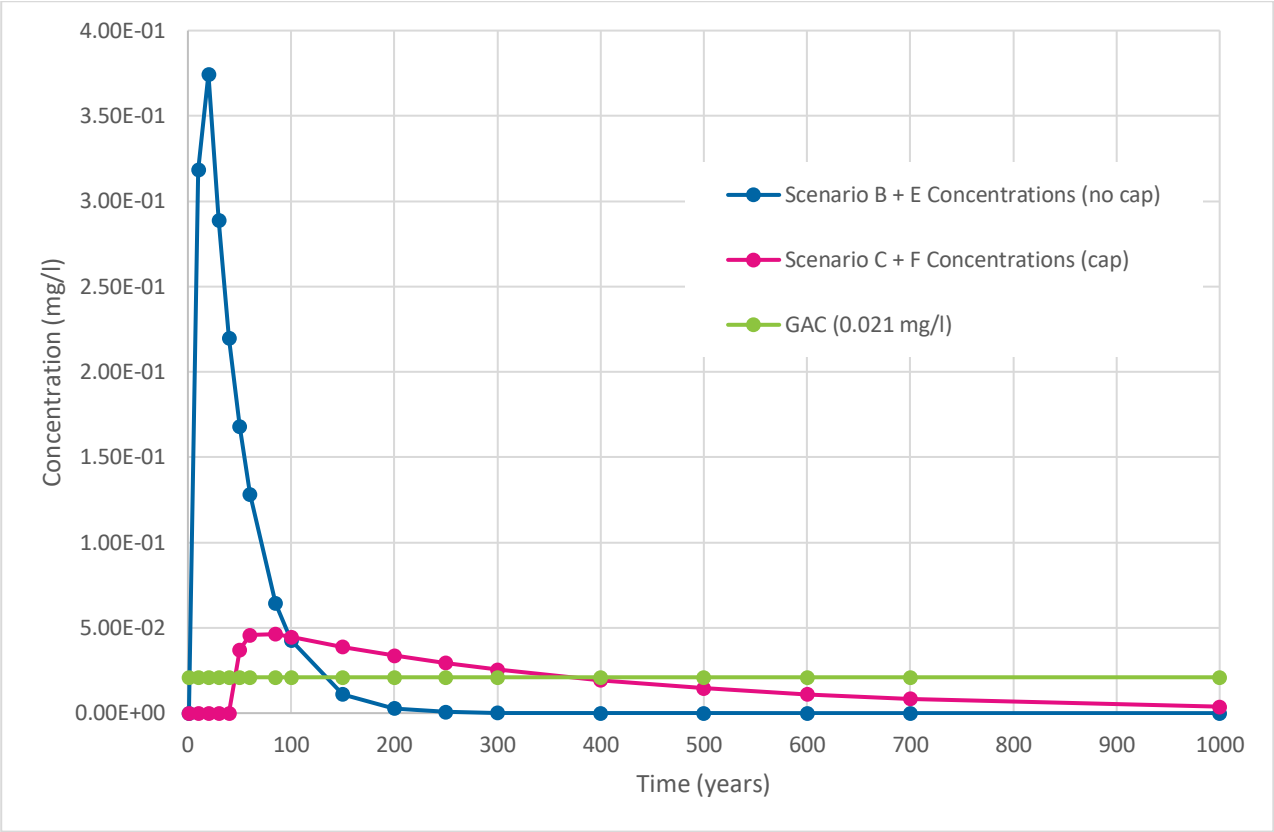

Figure 20 Unionised ammonia concentrations at point of North Canal receptor over 1,000 years from North Mound Source Area

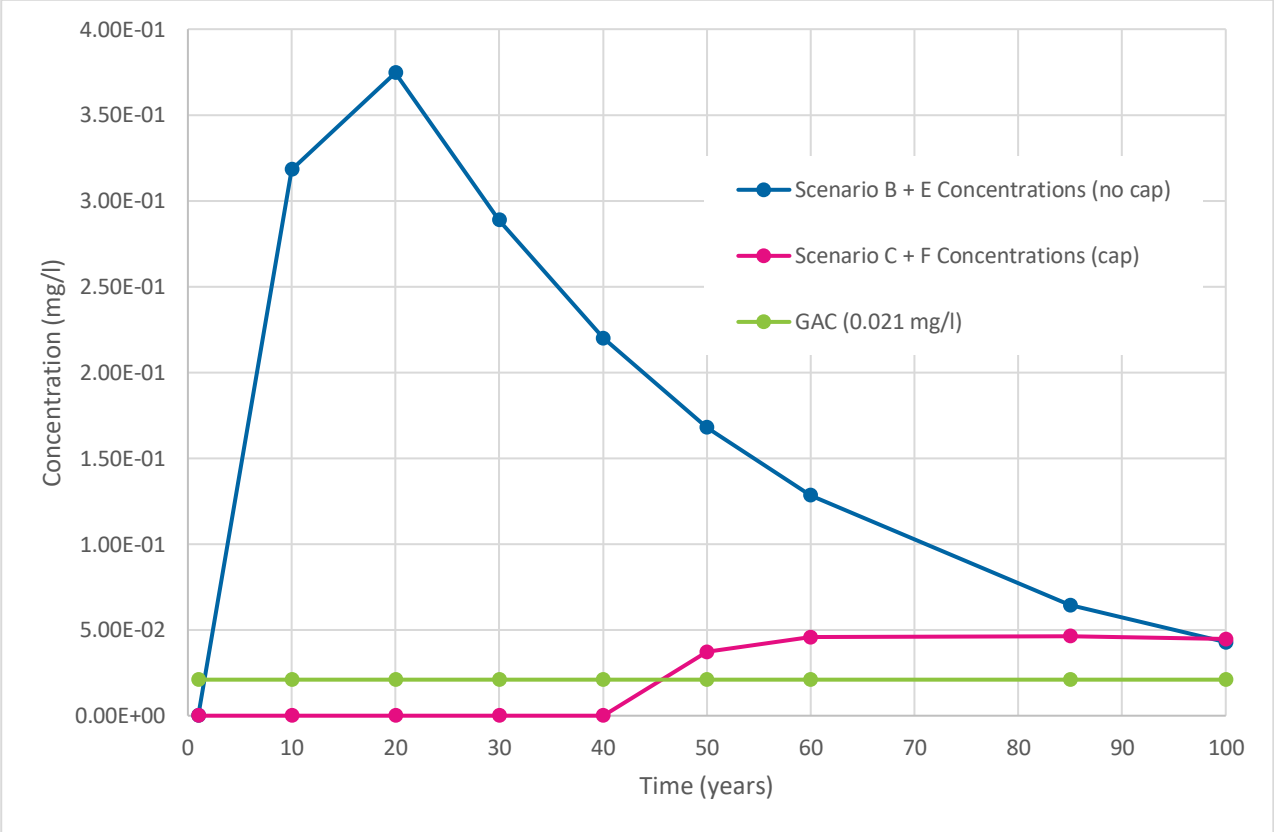

Figure 21 Unionised ammonia concentrations at point of North Canal receptor over 100 years from North Mound Source Area

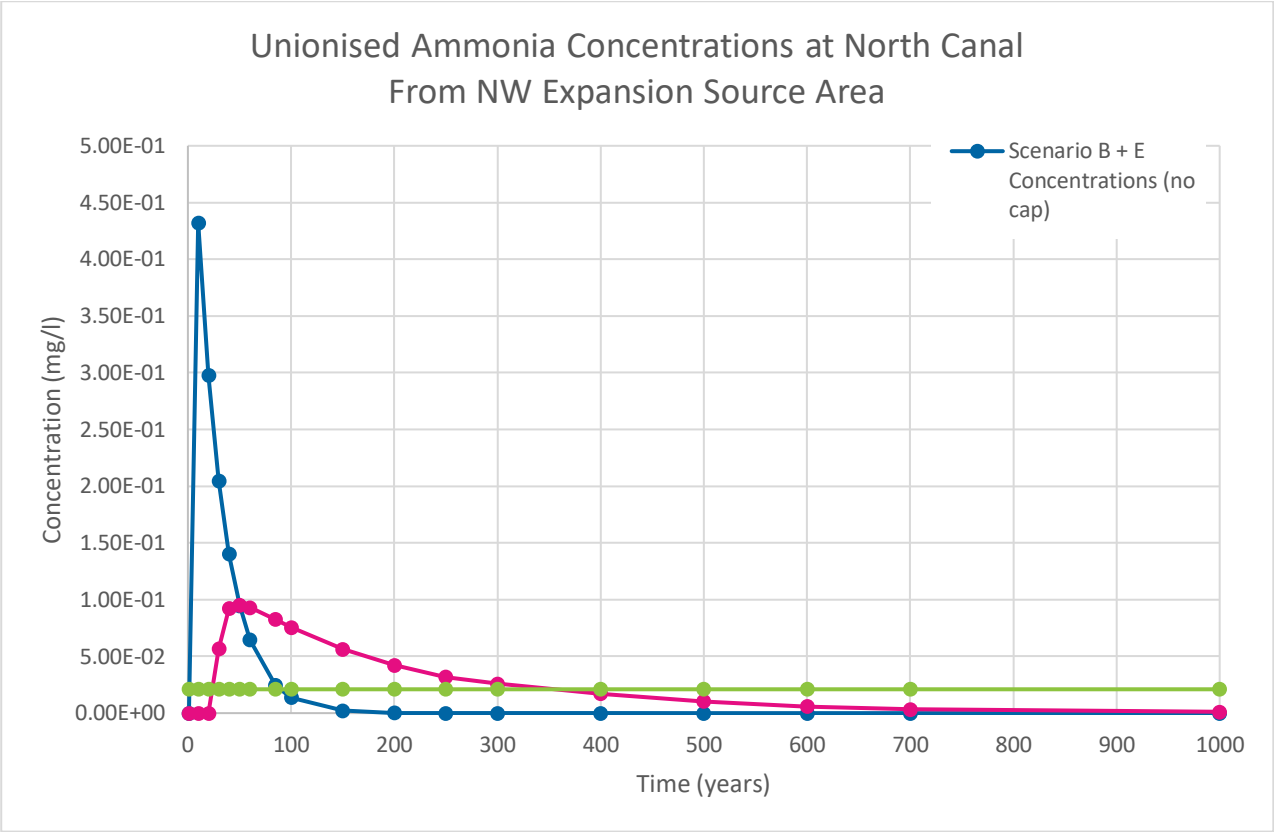

Figure 22 Unionised ammonia concentrations at point of North Canal receptor over 1,000 years from NW Expansion Source Area

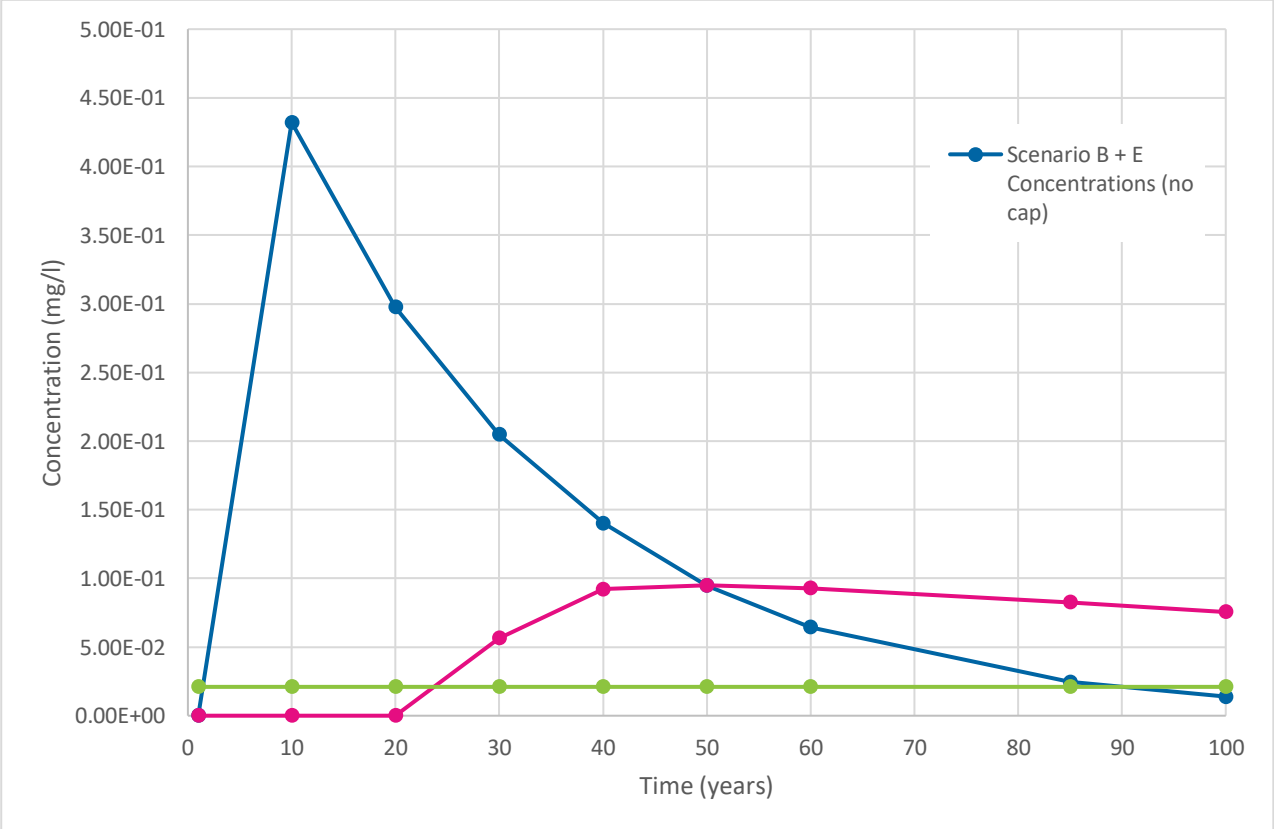

Figure 23 Unionised ammonia concentrations at point of North Canal receptor over 100 years from NW Expansion Source Area

The following Table 25 summarises the predicted peak concentrations and the percentage reduction comparison from *status quo* versus installation of the caps. The assessment demonstrates that there is significant betterment in terms of ammonia and unionised ammonia concentrations in the North Canal with a cap added to the North Mound and the NW expansion areas.

Table 25 Comparison of predicted peak concentrations

Source Area	Contaminant	Uncapped peak concentration (mg/l)	Capped peak concentration (mg/l)	Percentage difference
North Mound	Total ammonia	25	3.1	**87% reduction when capped**
	Unionised ammonia	0.37	0.05	**87% reduction when capped**
NW Expansion	Total ammonia	29	6.2	**78% reduction when capped**
	Unionised ammonia	0.43	0.09	**78% reduction when capped**

8.4 South Mound Risk Based Assessment

8.4.1 Input parameters

Scenario G also required the source area and the source contaminant concentrations to be adjusted, so as to consider new data and the wells relevant to the South Mound only (i.e. using data from wells MW13, and MW19), as per the layout in Figure 24 below.

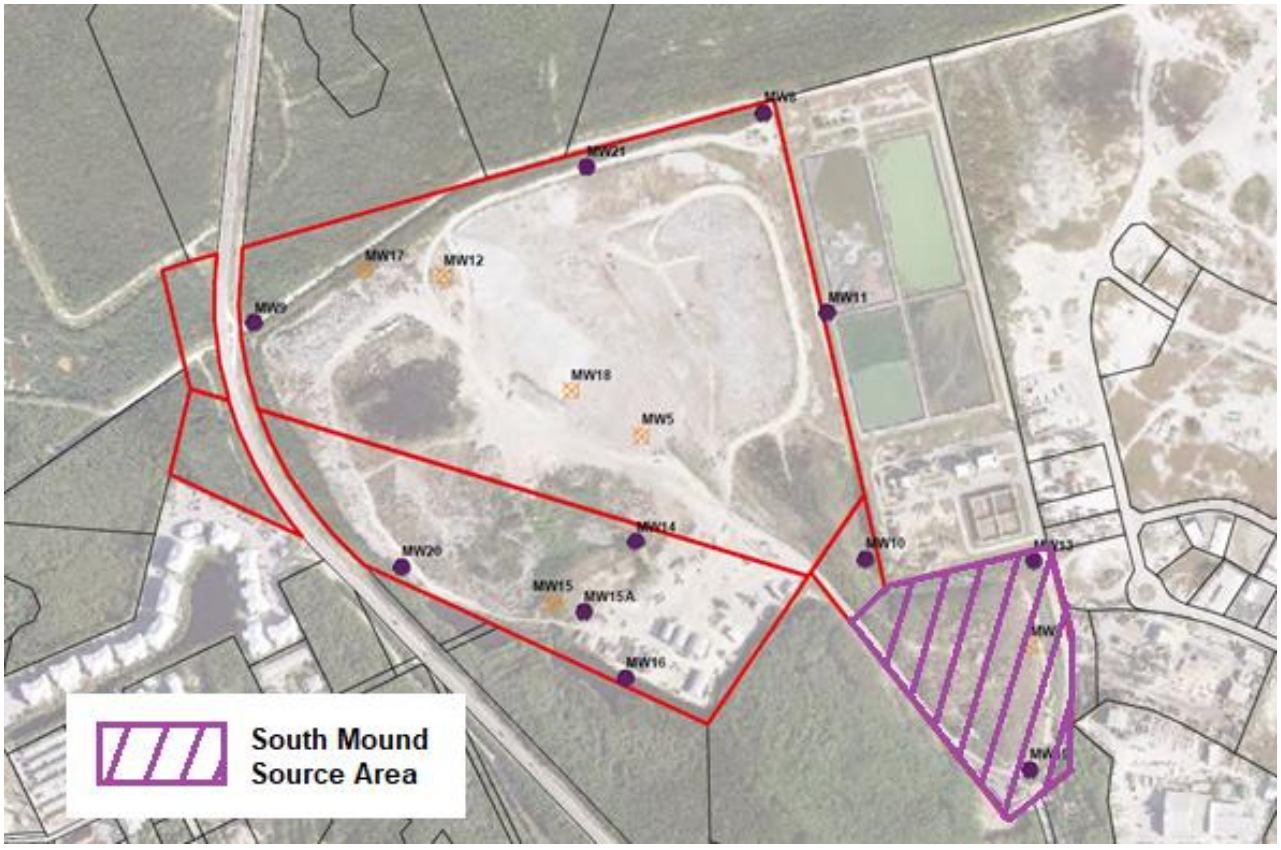

Figure 24 Revised source locations (South Mound)

The updated mean contaminant concentrations for the applicable South Mound source area are provided in Table 26 below. It is noted that during the 2020 groundwater monitoring, additional metals contaminants were detected in the South Mound well MW19, and at elevated concentrations in comparison to previous monitoring rounds.

Table 26 Mean contaminant concentrations

Source	Contaminant	Mean concentration (mg/l)
South Mound Source Area	**Ammonia**	**7.7**
	Unionised ammonia	**0.056**
	Orthophosphate	**0.24**
	Arsenic	**1.06**
	Chromium	**0.45**
	Copper	**1.63**
	Iron	**950**
	Lead	**1.50**
	Nickel	**0.92**
	Zinc	**4.64**
	DRO	**0.34**
	Cyanide, total	**0.007**

8.4.2 Model results

The following Table 27 summarises the results for revised model Scenario G, showing whether a contaminant's concentration is predicted to exceed the relevant GAC at the point where the groundwater body meets the receptor. The model does not predict the concentration that might occur in the receiving water (i.e. the model does not include an assessment of contaminant loading or dilution in the receptor).

Table 27 GAC exceedances at North Canal within 100 years (South Mound Source)

Source	Contaminant	Scenario G
South Mound Source Area	Ammonia	No
	Unionised ammonia	No
	Orthophosphate	No
	Arsenic	No
	Chromium	No
	Copper	No
	Iron	No
	Lead	No

Source	Contaminant	Scenario G
	Nickel	No
	Zinc	No
	DRO	No
	Cyanide, total	No

The predicted concentrations for all contaminants assessed for Scenario G are below the GAC at the point of reaching the North Canal receptor.

8.5 Sensitivity analysis

To assess the impact of non-site-specific input parameters and the aquifer hydraulic conductivity value used in the model, each was increased by 10% to evaluate the change in the predicted concentrations at the receptor. Each parameter was changed separately within the model to understand the individual effect of that parameter. Revised model Scenario B was selected for the sensitivity analysis and the changes to the peak ammonia concentration were assessed[25]. An organic contaminant is also required for the assessment as parameters such as foc will have an impact on the partitioning of organic chemicals. DRO has been selected as the organic contaminant. The results of the sensitivity analysis are provided in Table 28 below.

Table 28 Revised sensitivity analysis

Input parameter	Value used in original model	Value increased by 10%	Change in result
Source porosity	0.55 fraction (water filled 0.275 and air filled 0.275)	0.605 fraction (water filled 0.3025 and air filled 0.3025)	Total ammonia: 3.54% DRO: 8.99%
Source bulk density	0.54 g/cm^3	0.594 g/cm^3	Total ammonia: -13.48% DRO: -28%
foc (source)	0.2 fraction	0.22 fraction	Total ammonia: N/A DRO: 6.97%
foc (aquifer)	0.05 fraction	0.055 fraction	Total ammonia: N/A DRO: -19%
Unsaturated zone porosity	0.55 fraction	0.605 fraction (water filled 0.3025)	Total ammonia: -21% DRO: -37.73%
Unsaturated zone conductivity	5.5x10^{-6} m/s	6.05x10^{-6} m/s	Total ammonia: -13% DRO: -28%
Aquifer bulk density	1.85 g/cm^3	2.04 g/cm^3	Total ammonia: -23% DRO: -40%

[25] Revised model Scenario 3 being the most sensitive scenario and ammonia the most significant contaminant of concern for the site.

Input parameter	Value used in original model	Value increased by 10%	Change in result
Aquifer porosity	0.31 fraction	0.34 fraction	Total ammonia: -19% DRO: -39%
Aquifer hydraulic gradient	0.001 fraction	0.0011 fraction	Total ammonia: -8% DRO: -19%
Aquifer hydraulic conductivity	$4.17x10^{-5}$ m/s	$4.59x10^{-5}$ m/s	Total ammonia: -10% DRO: -24%

The majority of the increased parameters caused the predicted peak concentrations to change by less than 20%. The greatest changes occurred to the DRO concentrations. However, percentage change can be misleading as a high percentage of a low concentration pertains to a small overall change in concentration. These changes do not significantly affect the outcome of the risk assessment.

8.6 Summary and conclusions

8.6.1 Summary

The modelled source areas at the North Mound, northwest expansion area and South Mound included contaminants that were identified to pose a potential risk due to their exceedance of published GAC protective of marine surface waters. ConSim model version 2.5 was used to predict the concentrations of contaminants migrating from the source areas to the point where the groundwater body meets the North Canal, which is considered to be the main receptor that subsequently discharges into the North Sound. The model was run assuming attenuation is occurring in the aquifer due to tidal dispersion. Model Level 3 and Level 3A were implemented to enable both a continuous (conservative) and declining (realistic) source to be assessed where applicable to the modelled scenarios.

The assessment used site-specific inputs as a priority and relevant literature inputs where needed. To test the impact of non-site-specific values on the model results, a sensitivity analysis was carried out. The sensitivity analysis has shown that the majority of the non-site-specific values used in the risk assessment model and the aquifer hydraulic conductivity had little impact on the predicted peak concentrations, when increased by 10%.

The model results show that the majority of the contaminants at the site do not exceed GAC at the North Canal (at point of entry to the receptor) and subsequently the North Sound. In particular, none of the contaminants modelled in the uncapped South Mound source areas were found to exceed GAC at the North Canal.

Total ammonia and unionised ammonia concentrations were found to exceed the GAC at the North Canal, from the North Mound Source, for all scenarios. In addition, iron and DRO concentrations were predicted to exceed GAC at the point of reaching the North Canal under Scenario B (uncapped, declining source) for the North Mound Source. Once the North Mound is capped (Scenario C), only total and unionised ammonia were found to exceed the GAC; however, betterment was demonstrated with a 87% reduction in concentrations when capped.

Total ammonia and unionised ammonia concentrations were found to exceed the GAC at the North Canal, from the NW Expansion Source Area for all scenarios, and iron, DRO and cyanide were found to exceed under Scenario E (uncapped, declining source). Once the northwest expansion area was capped (Scenario F), only total ammonia and unionised ammonia were found to exceed the GAC; however, betterment was demonstrated with a 78% reduction in concentrations when capped.

8.6.2 Conclusions

South Mound

The revised modelling shows that, even without a cap, the South Mound contaminants do not pose an unacceptable risk to the nearest sensitive receptor (North Canal). As such, it is not necessary to provide any engineered capping over the South Mound.

North Mound

A cap is required at the North Mound to remove the risk posed by iron and DRO. The assessment also demonstrates that the cap provides significant betterment in terms of ammonia concentrations in the North Canal; with an 87% reduction in the peak total ammonia and unionised ammonia concentrations compared to the *status quo*.

A cap is required at the northwest expansion area to remove the risk posed by iron, DRO and cyanide. The assessment also demonstrates that the cap provides significant betterment in terms of ammonia concentrations in the North Canal; with a 78% reduction in the peak total ammonia and unionised ammonia concentrations compared to the *status quo*.

As betterment has been demonstrated for the closest receptor, betterment of risk posed to receptors at a greater distance, such as North Sound and groundwater abstractions, is also confirmed.

Appendices

Appendix A Soil data and generic assessment criteria

Chemical Parameters Metals	Reporting Unit	UK Public Open Spaces - Park S4ULs/C4SLs	Florida Soil Clean Up - Commercial Industrial	Florida Soil Clean Up - Leachability Low Yield Poor Quality Groundwater	Maximum	SW1				SW2			SW3		
						2010	2011	2011 Duplicate	2013	2010	2011	2013	2010	2011	2013
Antimony	mg/kg		370	54	6.5	<7.4	<3	<3.2	<2.5	<9.7	<3.2	<2.6	<3.9	<3	<2.3
Arsenic	mg/kg	170	12		60	<7.4	<3	4.4	<5	<9.7	<3.2	<5.1	<3.9	<3	<4.5
Barium	mg/kg		130000	16000	76	<3.7	4.8	6	5.5	9.9	5.9	7.8	5.4	7.9	12
Berylium	mg/kg	63	1400	630	ND	<1.5	<0.59	<0.65	<0.5	<1.9	<0.65	<0.51	<0.78	<0.6	<0.45
Boron	mg/kg	46000	430000		110		28	28	40		<12	19		28	26
Cadmium	mg/kg	560	1700	75	2.2	<1.8	<0.74	<0.81	<0.63	<2.4	<0.81	<0.64	<0.97	<0.75	<0.57
Chromium	mg/kg	220 to 33000	470	380	76	4.3	6.1	10	7.3	23	6.5	13	10	14	19
Cobalt	mg/kg		42000		3.1	<3.7	<1.5	<1.6	<1.3	<4.9	<1.6	<1.3	<1.9	<1.5	<1.1
Copper	mg/kg	44000	89000		170	<9.2	<3.7	<4	<3.1	<12	<4.1	<3.2	<4.9	<3.7	4.9
Iron	mg/kg				44000	660	720	1300	1100	4400	1000	3100	1600	2200	4000
Lead	mg/kg		1400		530	<3.7	<1.5	<1.6	1.6	5.9	<1.6	3.5	2.7	3.9	8
Magnesium	mg/kg				72000	4200	1900	1900	3800	7600	1600	2600	2900	1800	3300
Nickel	mg/kg	800	35000	1300	130	<15	<5.9	<6.5	<5	<19	<6.5	<5.1	<7.8	<6	<4.5
Selenium	mg/kg	1800	11000	52	ND	<9.2	<3.7	<4	<3.1	<12	<4.1	<3.2	<4.9	<3.7	<2.8
Silver	mg/kg		8200	170	1.4	<3.7	<1.5	<1.6	<1.3	<4.9	<1.6	<1.3	<1.9	<1.5	<1.1
Thalium	mg/kg		150	28	ND	<9.2	<3.7	<4	<3.1	<12	<4.1	<3.2	<4.9	<3.7	<2.8
Vanadium	mg/kg	5000	10000	9800	28	6.6	4.7	6.2	7	16	2.4	7	6.9	6.6	9.2
Zinc	mg/kg	170000	630000		9600	<7.4	<3	<3.2	<2.5	32	<3.2	12	9.4	9.5	26
Mercury	mg/kg	30 to 240	17	21	0.26	<0.074	0.08	<0.03	0.041	<0.096	<0.027	0.031	<0.041	<0.03	0.044
PCBs															
PCB-1016	ug/kg		2.6	170	ND		<51	<55	<46		<44	<44		<54	<40
PCB-1221	ug/kg		2.6	170	ND		<100	<110	<94		<89	<90		<110	<80
PCB-1232	ug/kg		2.6	170	ND		<51	<55	<46		<44	<44		<54	<40
PCB-1242	ug/kg		2.6	170	ND		<51	<55	<46		<44	<44		<54	<40
PCB-1248	ug/kg		2.6	170	ND		<51	<55	<46		<44	<44		<54	<40
PCB-1254	ug/kg		2.6	170	ND		<51	<55	<46		<44	<44		<54	<40
PCB-1260	ug/kg		2.6	170	ND		<51	<55	<46		<44	<44		<54	<40
Pesticides															
4,4'-DDD	ug/kg		22	58	11				<2.4			<2.3			<2
4,4'-DDE	ug/kg		15	180	4.1				<2.4			<2.3			<2
4,4'-DDT	ug/kg		15	110	ND				<2.4			<2.3			<2
Aldrin	ug/kg	31000	0.3	2	ND				<2.4			<2.3			<2
alpha-BHC	ug/kg	48000	0.6	0.003	ND				<2.4			<2.3			<2
beta-BHC	ug/kg	16000	2.4	0.01	ND				<2.4			<2.3			<2
Chlordane (technical)	ug/kg		14	96	ND				<24			<23			<20
delta-BHC	ug/kg		490	2	ND				<2.4			<2.3			<2
Dieldrin	ug/kg	31000	0.3	0.02	ND				<2.4			<2.3			<2
Endosulfan I	ug/kg	2400000	7600	38	ND				<2.4			<2.3			<2
Endosulfan II	ug/kg	2400000	7600	38	ND				<2.4			<2.3			<2
Endosulfan sulfate	ug/kg	2400000	7600	38	ND				<2.4			<2.3			<2
Endrin	ug/kg		510	10	ND				<2.4			<2.3			<2
Endrin aldehyde	ug/kg		510	10	7.8				<2.4			<2.3			3.5
Endrin ketone	ug/kg		510	10	ND				<2.4			<2.3			<2
gamma-BHC (Lindane)	ug/kg	15000	2.5	0.09	ND				<2.4			<2.3			<2
Heptachlor	ug/kg		1	230	ND				<2.4			<2.3			<2
Heptachlor epoxide	ug/kg		0.5	6	ND				<2.4			<2.3			<2
Methoxychlor	ug/kg		8800	1600	ND				<2.4			<2.3			<2
Toxaphene	ug/kg		4.5	310	ND				<240			<230			<200
Other															
Cyanide, Total	mg/kg		11000	8	ND		<0.75	<0.82	<0.69		<0.64	<0.66		<0.79	<0.6
Sulfate	mg/kg				5300		1800	2300	2800		<130	1200		1600	1500

ND Not detected

Exceedance of Florida Soil Clean Up criteria

Chemical Parameters Metals	Reporting Unit	UK Public Open Spaces - Park S4ULs/C4SLs	Florida Soil Clean Up - Commercial Industrial	Florida Soil Clean Up - Leachability Low Yield Poor Quality Groundwater	SW7			SW12			Drain 1		Drain 2	MW1 B	MW1	MW
					2010	2011	2013	2010	2011	2013	2010	2011	2011	2010	2011	2011
Antimony	mg/kg		370	54	<6	<9.6	<2.3	<2.1	<2.5	<2	<4.6	<2.3	<3	<2.7	6.5	<2.1
Arsenic	mg/kg	170	12		**13**	**25**	**60**	<2.1	5.4	<20	9.7	5.1	4.5	3.3	9	**38**
Barium	mg/kg		130000	16000	32	22	20	1.2	3.9	<9.9	14	14	13	33	76	7.6
Berylium	mg/kg	63	1400	630	<1.2	<1.9	<0.46	<0.42	<0.5	<0.4	<0.91	<0.46	<0.6	<0.54	<0.56	<0.42
Boron	mg/kg	46000	430000			30	29		110	<9.9		18	25		20	13
Cadmium	mg/kg	560	1700	75	<1.5	<2.4	<0.58	<0.52	<0.62	<0.5	<1.1	<0.57	<0.75	1.1	2.2	<0.53
Chromium	mg/kg	220 to 33000	470	380	23	38	53	3.4	18	25	34	24	20	30	33	71
Cobalt	mg/kg		42000		<3	<4.8	<1.2	<1	<1.2	<0.99	<2.3	<1.1	<1.5	1.7	3.1	1.4
Copper	mg/kg	44000	89000		33	72	65	<2.6	<3.1	4.5	68	59	12	42	110	27
Iron	mg/kg				2800	14000	4000	310	2900	4800	7200	5400	3700	12000	44000	16000
Lead	mg/kg		1400		35	22	47	<1	2.1	3.6	58	70	13	220	530	25
Magnesium	mg/kg				9600	8500	4900	67000	64000	72000	13000	24000	12000	5200	4200	36000
Nickel	mg/kg	800	35000	1300	<12	<19	<4.6	<4.2	<5	5.7	<9.1	4.9	<6	8.4	22	19
Selenium	mg/kg	1800	11000	52	<7.5	<12	<2.9	<2.6	<3.1	<2.5	<5.7	<2.9	<3.7	<3.4	<3.5	<2.6
Silver	mg/kg		8200	170	<3	<4.8	<1.2	<1	<1.2	<0.99	<2.3	<1.1	<1.5	<1.3	<1.4	<1.1
Thalium	mg/kg		150	28	<7.5	<12	<2.9	<2.6	<3.1	<2.5	<5.7	<2.9	<3.7	<3.4	<3.5	<2.6
Vanadium	mg/kg	5000	10000	9800	7.3	20	6.1	2.1	13	14	18	13	9.4	12	12	28
Zinc	mg/kg	170000	630000		140	980	110	2.9	9.4	21	180	81	38	240	700	53
Mercury	mg/kg	30 to 240	17	21	<0.057	0.16	0.09	0.035	0.068	0.06	0.18	0.26	0.077	0.22	0.11	0.099
PCBs																
PCB-1016	ug/kg		2.6	170		<52	<39		<170	<33		<42	<50		<45	<38
PCB-1221	ug/kg		2.6	170		<110	<79		<340	<67		<84	<100		<92	<77
PCB-1232	ug/kg		2.6	170		<52	<39		<170	<33		<42	<50		<45	<38
PCB-1242	ug/kg		2.6	170		<52	<39		<170	<33		<42	<50		<45	<38
PCB-1248	ug/kg		2.6	170		<52	<39		<170	<33		<42	<50		<45	<38
PCB-1254	ug/kg		2.6	170		<52	<39		<170	<33		<42	<50		<45	<38
PCB-1260	ug/kg		2.6	170		<52	<39		<170	<33		<42	<50		<45	<38
Pesticides																
4,4'-DDD	ug/kg		22	58			<2			<1.7						
4,4'-DDE	ug/kg		15	180			<2			<1.7						
4,4'-DDT	ug/kg		15	110			<2			<1.7						
Aldrin	ug/kg	31000	0.3	2			<2			<1.7						
alpha-BHC	ug/kg	48000	0.6	0.003			<2			<1.7						
beta-BHC	ug/kg	16000	2.4	0.01			<2			<1.7						
Chlordane (technical)	ug/kg		14	96			<20			<17						
delta-BHC	ug/kg		490	2			<2			<1.7						
Dieldrin	ug/kg	31000	0.3	0.02			<2			<1.7						
Endosulfan I	ug/kg	2400000	7600	38			<2			<1.7						
Endosulfan II	ug/kg	2400000	7600	38			<2			<1.7						
Endosulfan sulfate	ug/kg	2400000	7600	38			<2			<1.7						
Endrin	ug/kg		510	10			<2			<1.7						
Endrin aldehyde	ug/kg		510	10			<2			<1.7						
Endrin ketone	ug/kg		510	10			<2			<1.7						
gamma-BHC (Lindane)	ug/kg	15000	2.5	0.09			<2			<1.7						
Heptachlor	ug/kg		1	230			<2			<1.7						
Heptachlor epoxide	ug/kg		0.5	6			<2			<1.7						
Methoxychlor	ug/kg		8800	1600			<2			<1.7						
Toxaphene	ug/kg		4.5	310			<200			<170						
Other																
Cyanide, Total	mg/kg		11000	8		<0.76	<0.57		<2.5	<0.49		<0.63	<0.74		<0.7	<0.58
Sulfate	mg/kg					1600	<1200		<520	<100		<130	<150		<140	140

ND Not detected

Exceedance of Florida Soil Clean Up criteria

Chemical Parameters Metals	Reporting Unit	UK Public Open Spaces - Park S4ULs/C4SLs	Florida Soil Clean Up - Commercial Industrial	Florida Soil Clean Up - Leachability Low Yield Poor Quality Groundwater	W5	MW8			MW9			MW9B	MW 10	MW 11	MW12	MW
					2013	2010	2011	2013	2010	2011	2013	2010	2011	2011	2010	2011
Antimony	mg/kg		370	54	<1.9	<3.9	<2.2	<1.8	<4.6	<2.4	<2.4	<2.4	<2.6	<2.7	<2.3	3.2
Arsenic	mg/kg	170	12		<19	5.7	4.6	<18	<4.6	3.1	<4.8	<2.4	5.6	8.3	4.8	**35**
Barium	mg/kg		130000	16000	14	20	13	20	16	9.3	9.8	11	11	8.8	20	23
Berylium	mg/kg	63	1400	630	<0.38	<0.78	<0.44	<0.37	<0.93	<0.48	<0.48	<0.49	<0.52	<0.54	<0.46	<0.52
Boron	mg/kg	46000	430000		20		11	13		26	23		20	16		40
Cadmium	mg/kg	560	1700	75	<0.48	<0.97	<0.55	<0.46	<1.2	<0.6	<0.6	<0.61	<0.64	<0.67	<0.57	<0.65
Chromium	mg/kg	220 to 33000	470	380	20	19	17	30	19	10	13	12	22	21	19	76
Cobalt	mg/kg		42000		<0.96	<1.9	<1.1	1.2	<2.3	<1.2	<1.2	<1.2	<1.3	1.4	<1.1	2.9
Copper	mg/kg	44000	89000		34	27	11	28	9	14	8.3	9	15	<3.3	30	170
Iron	mg/kg				5000	11000	4300	5000	3300	1800	2200	2400	5200	3700	6100	18000
Lead	mg/kg		1400		50	13	5.8	11	8.1	35	21	13	29	2	37	80
Magnesium	mg/kg				34000	3100	68000	55000	3700	10000	9500	6100	2000	790	13000	9900
Nickel	mg/kg	800	35000	1300	5.8	<7.8	<4.4	6.2	<9.3	<4.8	<4.8	<4.9	5.4	7	<4.6	15
Selenium	mg/kg	1800	11000	52	<2.4	<4.8	<2.7	<2.3	<5.8	<3	<3	<3	<3.2	<3.3	<2.9	<3.3
Silver	mg/kg		8200	170	1.4	<1.9	<1.1	<0.92	<2.3	<1.2	<1.2	<1.2	<1.3	<1.3	<1.1	<1.3
Thalium	mg/kg		150	28	<2.4	<4.8	<2.7	<2.3	<5.8	<3	<3	<3	<3.2	<3.3	<2.9	<3.3
Vanadium	mg/kg	5000	10000	9800	10	7	12	16	9.6	5.1	5.7	6.3	10	14	9.8	23
Zinc	mg/kg	170000	630000		95	250	41	51	78	9600	2600	1100	61	5	81	660
Mercury	mg/kg	30 to 240	17	21	0.051	0.075	0.051	0.054	<0.053	0.035	0.04	<0.024	0.062	0.12	0.098	0.21
PCBs																
PCB-1016	ug/kg		2.6	170	<67		<37	<34		<44	<40		<42	<43		<43
PCB-1221	ug/kg		2.6	170	<140		<76	<69		<90	<82		<86	<88		<88
PCB-1232	ug/kg		2.6	170	<67		<37	<34		<44	<40		<42	<43		<43
PCB-1242	ug/kg		2.6	170	<67		<37	<34		<44	<40		<42	<43		<43
PCB-1248	ug/kg		2.6	170	<67		<37	<34		<44	<40		<42	<43		<43
PCB-1254	ug/kg		2.6	170	<67		<37	<34		<44	<40		<42	<43		<43
PCB-1260	ug/kg		2.6	170	<67		<37	<34		<44	<40		<42	<43		<43
Pesticides																
4,4'-DDD	ug/kg		22	58	11			<1.7			<2.1					
4,4'-DDE	ug/kg		15	180	4.1			<1.7			<2.1					
4,4'-DDT	ug/kg		15	110	<3.5			<1.7			<2.1					
Aldrin	ug/kg	31000	0.3	2	<3.5			<1.7			<2.1					
alpha-BHC	ug/kg	48000	0.6	0.003	<3.5			<1.7			<2.1					
beta-BHC	ug/kg	16000	2.4	0.01	<3.5			<1.7			<2.1					
Chlordane (technical)	ug/kg		14	96	<35			<17			<21					
delta-BHC	ug/kg		490	2	<3.5			<1.7			<2.1					
Dieldrin	ug/kg	31000	0.3	0.02	<3.5			<1.7			<2.1					
Endosulfan I	ug/kg	2400000	7600	38	<3.5			<1.7			<2.1					
Endosulfan II	ug/kg	2400000	7600	38	<3.5			<1.7			<2.1					
Endosulfan sulfate	ug/kg	2400000	7600	38	<3.5			<1.7			<2.1					
Endrin	ug/kg		510	10	<3.5			<1.7			<2.1					
Endrin aldehyde	ug/kg		510	10	<3.5			<1.7			<2.1					
Endrin ketone	ug/kg		510	10	<3.5			<1.7			<2.1					
gamma-BHC (Lindane)	ug/kg	15000	2.5	0.09	<3.5			<1.7			<2.1					
Heptachlor	ug/kg		1	230	<3.5			<1.7			<2.1					
Heptachlor epoxide	ug/kg		0.5	6	<3.5			<1.7			<2.1					
Methoxychlor	ug/kg		8800	1600	<3.5			<1.7			<2.1					
Toxaphene	ug/kg		4.5	310	<350			<170			<210					
Other																
Cyanide, Total	mg/kg		11000	8	<0.51		<0.54	<0.52		<0.66	<0.61		<0.63	<0.64		<0.66
Sulfate	mg/kg				<100		<110	1200		<140	780		<130	440		5300

ND Not detected

Exceedance of Florida Soil Clean Up criteria

Chemical Parameters Metals	Reporting Unit	UK Public Open Spaces - Park S4ULs/C4SLs	Florida Soil Clean Up - Commercial Industrial	Florida Soil Clean Up - Leachability Low Yield Poor Quality Groundwater	13	MW 14		MW 15		MW 17	MW 18
					2013	2011	2013	2011	2013	2011	2011
Antimony	mg/kg		370	54	2.2	<2	<2	<2.2	<1.9	<2.2	<2.5
Arsenic	mg/kg	170	12		16	13	<20	9.7	<19	3.2	<2.5
Barium	mg/kg		130000	16000	38	2.4	23	22	12	9	4.2
Berylium	mg/kg	63	1400	630	<0.42	<0.41	<0.4	<0.44	<0.37	<0.45	<0.51
Boron	mg/kg	46000	430000		26	<10	21	16	25	16	<13
Cadmium	mg/kg	560	1700	75	1.4	<0.51	<0.49	<0.55	<0.47	<0.56	<0.64
Chromium	mg/kg	220 to 33000	470	380	59	6.6	39	27	21	9.1	4.7
Cobalt	mg/kg		42000		2.5	<1	1.4	1.7	<0.93	<1.1	<1.3
Copper	mg/kg	44000	89000		120	4.3	68	40	21	5.5	<3.2
Iron	mg/kg				18000	4000	8000	9000	3600	2200	310
Lead	mg/kg		1400		180	3.1	120	90	12	11	<1.3
Magnesium	mg/kg				5500	6400	39000	8900	2700	5900	3000
Nickel	mg/kg	800	35000	1300	130	<4.1	8	8.1	<3.7	<4.5	<5.1
Selenium	mg/kg	1800	11000	52	<2.6	<2.5	<2.5	<2.7	<2.3	<2.8	<3.2
Silver	mg/kg		8200	170	<1	<1	<0.99	<1.1	<0.93	<1.1	<1.3
Thalium	mg/kg		150	28	<2.6	<2.5	<2.5	<2.7	<2.3	<2.8	<3.2
Vanadium	mg/kg	5000	10000	9800	14	7.5	13	18	8.7	5.7	2.2
Zinc	mg/kg	170000	630000		440	24	390	150	84	51	3.5
Mercury	mg/kg	30 to 240	17	21	0.19	0.024	0.056	0.12	0.05	0.024	<0.025
PCBs											
PCB-1016	ug/kg		2.6	170	<170	<36	<33	<39	<67	<38	<42
PCB-1221	ug/kg		2.6	170	<350	<72	<67	<79	<140	<77	<85
PCB-1232	ug/kg		2.6	170	<170	<36	<33	<39	<67	<38	<42
PCB-1242	ug/kg		2.6	170	<170	<36	<33	<39	<67	<38	<42
PCB-1248	ug/kg		2.6	170	<170	<36	<33	<39	<67	<38	<42
PCB-1254	ug/kg		2.6	170	<170	<36	<33	<39	<67	<38	<42
PCB-1260	ug/kg		2.6	170	<170	<36	<33	<39	<67	<38	<42
Pesticides											
4,4'-DDD	ug/kg		22	58	<8.8		<1.7		<3.4		
4,4'-DDE	ug/kg		15	180	<8.8		<1.7		<3.4		
4,4'-DDT	ug/kg		15	110	<8.8		<1.7		<3.4		
Aldrin	ug/kg	31000	0.3	2	<8.8		<1.7		<3.4		
alpha-BHC	ug/kg	48000	0.6	0.003	<8.8		<1.7		<3.4		
beta-BHC	ug/kg	16000	2.4	0.01	<8.8		<1.7		<3.4		
Chlordane (technical)	ug/kg		14	96	<88		<17		<34		
delta-BHC	ug/kg		490	2	<8.8		<1.7		<3.4		
Dieldrin	ug/kg	31000	0.3	0.02	<8.8		<1.7		<3.4		
Endosulfan I	ug/kg	2400000	7600	38	<8.8		<1.7		<3.4		
Endosulfan II	ug/kg	2400000	7600	38	<8.8		<1.7		<3.4		
Endosulfan sulfate	ug/kg	2400000	7600	38	<8.8		<1.7		<3.4		
Endrin	ug/kg		510	10	<8.8		<1.7		<3.4		
Endrin aldehyde	ug/kg		510	10	<8.8		<1.7		7.8		
Endrin ketone	ug/kg		510	10	<8.8		<1.7		<3.4		
gamma-BHC (Lindane)	ug/kg	15000	2.5	0.09	<8.8		<1.7		<3.4		
Heptachlor	ug/kg		1	230	<8.8		<1.7		<3.4		
Heptachlor epoxide	ug/kg		0.5	6	<8.8		<1.7		<3.4		
Methoxychlor	ug/kg		8800	1600	<8.8		<1.7		<3.4		
Toxaphene	ug/kg		4.5	310	<880		<170		<340		
Other											
Cyanide, Total	mg/kg		11000	8	<0.53	<0.52	<0.49	<0.59	<0.48	<0.56	<0.62
Sulfate	mg/kg				<1100	<110	<1000	<120	2200	<120	<130

ND Not detected

Exceedance of Florida Soil Clean Up criteria

Appendix B Groundwater data and generic assessment criteria

Chemical Parameters	Reporting Unit	Florida clean up: Low Yield/Poor Quality Groundwater	Florida clean up: Marine Surface Water	Alternative Criteria	Maximum	Number of samples analysed	MW1			MW5			
							2007	2008	2011	2006	2007	2011	2013
General Chemistry													
Ammonia	mg/l	28		0.021 to 6a	330	69	1.3	0.073	0.66	30	20	11	22
Unionised ammonia	mg/l			0.021	1.6	7							
Nitrogen, Kjeldahl	mg/l				190	28	1.8	1.4			23		
Nitrate plus Nitrite, as N	mg/l	110		22b	0.83	71	<0.050	<2.5	0.83	<0.050	<0.050	<0.05	<0.05
Orthophosphate	mg/l			0.0036 to 1c	1.2	66	<0.050	<0.050	<0.05		0.15	<0.05	0.12
Phosphorus	mg/l				1.3	30	0.13	0.35		0.4	0.2		
Chemical Oxygen Demand	mg/l				2100	73	310	100	64	340	760	420	230
pH	pH units			pH6-8.5d	8.1	64	7.66	7.44	7.64	7.06	7.2	7.34	7.4
Specific Conductance	umhos/cm				33000	64	3000	2600	2700	12000	13000	7900	11000
Total Dissolved Solids	mg/l	5000			27000	73	4700	1600	1400	6300	7900	4800	6500
Total Suspended Solids	mg/l			500e	2600	21	75	680		87	34		
Turbidity	NTU		29		3000	64	5.2	74	0.68	50	36	2200	130
Biochemical Oxygen Demand	mg/l				1800	67	<2.0	<2.0	<2.0	4.4	12	7.8	14
Volatile Organic Compounds													
Acetone	ug/L	63000	1700		14	57	<25	<25	<25		<25	<25	<25
Acrylonitrile	ug/L	420	0.2		ND	57	<20	<20	<20		<20	<20	<20
Benzene	ug/L	10	71.28		6.2	62	<1	<1	<1		<1	<1	<1
Bromochloromethane	ug/L	910	N/A		ND	62	<1	<1	<1		<1	<1	<1
Bromodichloromethane	ug/L	6	22		ND	62	<1	<1	<1		<1	<1	<1
Bromoform	ug/L	44	360		ND	62	<1	<1	<1		<1	<1	<1
Carbon disulfide	ug/L	7000	110		4.2	57	<2	<2	<2		<2	<2	<2
Carbon tetrachloride	ug/L	30	4.42		ND	62	<1	<1	<1		<1	<1	<1
Chlorobenzene	ug/L	1,000	17		8.5	62	<1	<1	<1		<1	<1	<1
Chloroethane	ug/L	120	N/A		ND	62	<1	<1	<1		<1	<1	<1
Chloroform	ug/L	700	470.8		ND	62	<1	<1	<1		<1	<1	<1
Dibromochloromethane	ug/L	4	34		ND	62	<1	<1	<1		<1	<1	<1
1,2-Dibromo-3-Chloropropane	ug/L	2	N/A		ND	57	<1	<1	<1		<1	<1	<1
1,2-Dibromoethane (EDB)	ug/L	0.2	13		ND	57	<1	<1	<1		<1	<1	<1
1,2-Dichlorobenzene	ug/L	6,000	99		ND	62	<1	<1	<1		<1	<1	<1
1,4-Dichlorobenzene	ug/L	750	3		3.1	62	<1	<1	<1		<1	<1	<1
trans-1,4-Dichloro-2-butene	ug/L				ND	57	<2	<2	<2		<2	<2	<2
1,1-Dichloroethane	ug/L	700	N/A		ND	62	<1	<1	<1		<1	<1	<1
1,2-Dichloroethane	ug/L	30	37		ND	62	<1	<1	<1		<1	<1	<1
1,1-Dichloroethene	ug/L	70	3.2		ND	62	<1	<1	<1		<1	<1	<1
cis-1,2-Dichloroethene	ug/L	700	N/A		1	62	<1	<1	<1		<1	<1	<1
trans-1,2-Dichloroethene	ug/L	1,000	11000		ND	62	<1	<1	<1		<1	<1	<1
1,2-Dichloropropane	ug/L	50	14		ND	62	<1	<1	<1		<1	<1	<1
cis-1,3-Dichloropropene	ug/L	4	12		ND	62	<1	<1	<1		<1	<1	<1
trans-1,3-Dichloropropene	ug/L	4	12		ND	62	<1	<1	<1		<1	<1	<1
Ethylbenzene	ug/L	300	610		9.8	62	<1	<1	<1		<1	<1	<1
2-Hexanone	ug/L	2800	NA		ND	57	<10	<10	<10		<10	<10	<10
Bromomethane	ug/L	98	35		ND	62	<1	<1	<1		<1	<1	<1
Chloromethane (methyl chloride)	ug/L	27	470.8		ND	62	<1	<1	<1		<1	<1	<1
Dibromomethane (EDB)	ug/L	0.2	13		ND	62	<1	<1	<1		<1	<1	<1
Methylene Chloride	ug/L	50	1580		ND	55	<5	<5	<5		<5	<5	<5
Methyl Ethyl Ketone	ug/L	42000	120000		ND	49	<10	<10	<10		<10	<10	<10
Iodomethane	ug/L				ND	57	<5	<5	<5		<5	<5	<5
methyl isobutyl ketone	ug/L	5600	23000		ND	49	<10	<10	<10		<10	<10	<10
Styrene	ug/L	1,000	460		ND	62	<1	<1	<1		<1	<1	<1
1,1,1,2-Tetrachloroethane	ug/L	13	N/A		ND	62	<1	<1	<1		<1	<1	<1
1,1,2,2-Tetrachloroethane	ug/L	2	10.8		ND	62	<1	<1	<1		<1	<1	<1
Tetrachloroethene	ug/L	30	8.85		ND	62	<1	<1	<1		<1	<1	<1
Toluene	ug/L	400	480		2.8	62	<1	<1	<1		<1	<1	<1
1,1,1-Trichloroethane	ug/L	2,000	270		ND	62	<1	<1	<1		<1	<1	<1
1,1,2-Trichloroethane	ug/L	50	16		ND	62	<1	<1	<1		<1	<1	<1
Trichloroethene	ug/L	30	80.7		ND	62	<1	<1	<1		<1	<1	<1
Trichlorofluoromethane	ug/L	21000	N/A		ND	62	<1	<1	<1		<1	<1	<1
1,2,3-Trichloropropane	ug/L	0.2	0.2		ND	62	<1	<1	<1		<1	<1	<1
Vinyl acetate	ug/L	880	700		ND	57	<2	<2	<2		<2	<2	<2
Vinyl chloride	ug/L	10	2.4		ND	62	<1	<1	<1		<1	<1	<1
Xylenes, Total	ug/L	200	370		7.9	57	<2	<2	<2		<2	<2	<2
Metals													
Antimony	mg/L	0.06	4.3		0.66	64	<0.0060	<0.0060	<0.02	<0.0060	<0.0060	<0.02	<0.02
Arsenic	mg/L	0.1	0.05		8.5	64	<0.010	<0.010	<0.02	<0.010	<0.010	<0.02	<0.02
Barium	mg/L	20	N/A		290.00	64	0.07	0.11	0.095	0.045	0.018	0.085	0.044
Beryllium	mg/L	0.04	0.00013		0.00036	64	<0.0030	<0.0030	<0.004	<0.0030	<0.0030	<0.004	<0.004
Boron	mg/l	14000		7h	4	19			0.65			2.7	2.5
Cadmium	mg/L	0.05	0.0088		0.00099	64	<0.0050	<0.0050	<0.005	<0.0050	<0.0050	<0.005	<0.005
Chromium	mg/L	1	0.05		3.6	64	<0.010	<0.010	<0.01	0.012	<0.010	<0.01	<0.01
Cobalt	mg/L	1400	N/A		0.78	64	<0.010	<0.010	<0.01	<0.010	<0.010	<0.01	<0.01
Copper	mg/L	10	0.0037		13	64	0.033	0.083	<0.02	<0.020	<0.020	<0.02	<0.02
Iron	mg/L	3	0.3		5700	52	0.7	3.4	<0.05	5.2	0.8	7.3	6.9
Lead	mg/L	0.15	0.0085		12	64	0.014	0.05	<0.01	<0.0050	<0.0050	<0.01	<0.01
Magnesium	mg/L				630	44	58	58	43	180	270	210	280
Nickel	mg/L	1	0.0083		7.3	64	<0.040	<0.040	<0.04	<0.040	<0.040	<0.04	<0.04
Selenium	mg/L	0.5	71		0.0054	64	<0.010	<0.010	<0.02	<0.010	<0.010	<0.02	<0.04
Silver	mg/L	1	0.0004		0.00045	64	<0.010	<0.010	<0.01	<0.010	<0.010	<0.01	<0.01
Thallium	mg/L	0.02	0.0063		ND	64	<0.025	<0.025	<0.025	<0.025	<0.025	<0.025	<0.025
Vanadium	mg/L	490	N/A	0.1f	0.11	64	<0.010	<0.010	<0.01	0.011	0.011	<0.01	<0.01
Zinc	mg/L	50	0.086		37	64	0.048	0.19	0.047	0.035	<0.020	<0.02	<0.02
Mercury	mg/L	0.02	0.000025		0.00032	64	<0.00020	<0.00020	<0.0002	<0.00020	<0.00020	<0.00020	<0.00020
PCBs													
PCB-1016	ug/l	***	**		ND	64			<1			<0.95	<0.96
PCB-1221	ug/l	***	**		ND	64			<2			<1.9	<1.9
PCB-1232	ug/l	***	**		ND	64			<1			<0.95	<0.96
PCB-1242	ug/l	***	**		ND	64			<1			<0.95	<0.96
PCB-1248	ug/l	***	**		ND	64			<1			<0.95	<0.96
PCB-1254	ug/l	***	**		ND	64			<1			<0.95	<0.96
PCB-1260	ug/l	***	**		ND	64			<1			<0.95	<0.96
Pesticides													
4,4'-DDD	ug/l	1	0.0003		ND	36							<0.048
4,4'-DDE	ug/l	1	0.0002		ND	36							<0.048
4,4'-DDT	ug/l	1	**		ND	36							<0.048
Aldrin	ug/l	0.02	**		ND	36							<0.048
alpha-BHC	ug/l	0.06	0.005		ND	36							<0.048
beta-BHC	ug/l	0.2	**		ND	36							<0.048
Chlordane (technical)	ug/l	***	**		ND	36							<0.48
delta-BHC	ug/l	21	NA		ND	36							<0.048
Dieldrin	ug/l	0.02	**		ND	36							<0.048
Endosulfan I	ug/l	420	**		ND	36							<0.048
Endosulfan II	ug/l	420	**		ND	36							<0.048
Endosulfan sulfate	ug/l	420	**		ND	36							<0.048
Endrin	ug/l	***	**		ND	36							<0.048
Endrin aldehyde	ug/l	***	**		ND	36							<0.048
Endrin ketone	ug/l	***	**		ND	36							<0.048
gamma-BHC (Lindane)	ug/l	***	**		ND	36							<0.048
Heptachlor	ug/l	***	**		ND	36							<0.048
Heptachlor epoxide	ug/l	***	**		ND	36							<0.048
Methoxychlor	ug/l	***	**		ND	36							<0.048
Toxaphene	ug/l	***	**		ND	36							<4.8
Hydrocarbons													
Diesel Range Organics [C10-C28]	mg/l				26	21							
Gasoline Range Organics (GRO)-C6-C10	mg/l				0.3	20							
Over C10-C12 aliphatics	mg/l				ND	7							
Over C10-C12 aromatics	mg/l				ND	7							
Over C12-C16 aliphatics	mg/l				ND	7							
Over C12-C16 aromatics	mg/l				ND	7							
Over C16-C21 aromatics	mg/l				0.37	7							
Over C16-C35 aliphatics	mg/l				0.53	7							
Over C21-C35 aromatics	mg/l				ND	7							
Over C5-C6 aliphatics	mg/l				ND	7							
Over C5-C7 aromatics	mg/l				ND	7							
Over C6-C8 aliphatics	mg/l				ND	7							
Over C7-C8 aromatics	mg/l				ND	7							
Over C8-C10 aliphatics	mg/l				ND	7							
Over C8-C10 aromatics	mg/l				ND	7							
sum of hydrocarbons	mg/l			0.3g	26	28							
Other													
Cyanide, Total	mg/l	2	0.001		0.15	51			<0.01			<0.01	<0.01
Sulphate	mg/l												

Chemical Parameters	MW8										MW9							
	2006	2007	2008	2010	2011	2013	2015	2016	2019	2020	2006	2007	2008	2010	2011	2013	2015	2020
General Chemistry																		
Ammonia		14	14	21	35	35	28	17	16	18		6.4	6.6	7.4	7.7	8.1	8.0	9.2
Unionised ammonia										0.14								
Nitrogen, Kjeldahl	17	17	14	2**						12	17	8.8	8.5	7**				4.2
Nitrate plus Nitrite, as N		0.18	0.15	<0.050	0.69	<0.05	<0.018	<0.25	<0.010	<0.010	<0.050	<0.050	<2.5	<0.050	0.12	<0.05	<0.018	0.29
Orthophosphate		0.51	0.55	0.76	0.63	0.48	0.47	0.37	1.10	0.15		0.071	0.069	<0.050	0.051	<0.05	0.060	<0.016
Phosphorus	0.57	0.7	0.53	0.28						0.24	<0.10	<0.10	<0.10	<0.10				<0.041
Chemical Oxygen Demand	250	1100	250	2100	800	320	250	230	280	180	240	640	1600	830	470	160	190	160
pH	7.39	7.33	7.27	7.34	7.46	7.38		7.4	7.40	7.5	7.28	7.33	7.28	7.33	7.5	7.43		8.1
Specific Conductance	20000	19000	18000	25000	24000	12000		17000	33000	13000	20000	15000	17000	12000	13000	13000		6700
Total Dissolved Solids	11000	9600	9100	9700	13000	7100	15000	14000	18000	7100	9600	7300	8500	4100	3900	7700	8800	8500
Total Suspended Solids	250	170	24								67	18	12					
Turbidity	220	67	8.9	12	8.5	14		13	56	120	76	50	64	50	3.2	35		330
Biochemical Oxygen Demand		18	18	11	19	38	<81.00	190	29 b		38	32	32	<2.0	31	14	<72	
Volatile Organic Compounds																		
Acetone		<25	<25	<25	<25	<25		NS	<7.0	<7.0		<25	<25	<25	<25	<25		<7.0
Acrylonitrile		<20	<20	<20	<20	<20		NS	<10	<10		<20	<20	<20	<20	<20		<10
Benzene		<1	<1	<1	<1	<1	<0.38	NS	<0.43	<0.43		<1	<1	<1	<1	<1		<0.43
Bromochloromethane		<1	<1	<1	<1	<1	<0.52	NS	<0.45	<0.45		<1	<1	<1	<1	<1		<0.45
Bromodichloromethane		<1	<1	<1	<1	<1	<0.50	NS	<0.44	<0.44		<1	<1	<1	<1	<1		<0.44
Bromoform		<1	<1	<1	<1	<1	<0.71	NS	<0.43	<0.43		<1	<1	<1	<1	<1		<0.43
Carbon disulfide		<2	<2	<2	<2	<2		0.002	<1.0	1.7		<2	<2	<2	<2	<2		<1.0
Carbon tetrachloride		<1	<1	<1	<1	<1	<0.50	NS	<0.33	<0.33		<1	<1	<1	<1	<1		<0.33
Chlorobenzene		<1	<1	<1	<1	<1	<0.50	NS	<0.26	0.53		<1	<1	<1	<1	<1		<0.26
Chloroethane		<1	<1	<1	<1	<1	<0.76	NS	<2.5	<2.5		<1	<1	<1	<1	<1		<2.5
Chloroform		<1	<1	<1	<1	<1	<0.60	NS	<0.50	<0.50		<1	<1	<1	<1	<1		<0.50
Dibromochloromethane		<1	<1	<1	<1	<1	<0.85	NS	<0.32	<0.32		<1	<1	<1	<1	<1		<0.32
1,2-Dibromo-3-Chloropropane		<1	<1	<1	<1	<1		NS	<1.1	<1.1		<1	<1	<1	<1	<1		<1.1
1,2-Dibromoethane (EDB)		<1	<1	<1	<1	<1		NS	<0.44	<0.44		<1	<1	<1	<1	<1		<0.44
1,2-Dichlorobenzene		<1	<1	<1	<1	<1	<0.50	NS	<0.37	<0.37		<1	<1	<1	<1	<1		<0.37
1,4-Dichlorobenzene		<1	<1	<1	<1	<1	<0.64	NS	<0.46	<0.46		<1	<1	<1	<1	<1		<0.46
trans-1,4-Dichloro-2-butene		<2	<2	<2	<2	<2		NS	<0.51	<0.51		<2	<2	<2	<2	<2		<0.51
1,1-Dichloroethane		<1	<1	<1	<1	<1	<0.50	NS	<0.38	<0.38		<1	<1	<1	<1	<1		<0.38
1,2-Dichloroethane		<1	<1	<1	<1	<1	<0.50	NS	<0.50	<0.50		<1	<1	<1	<1	<1		<0.50
1,1-Dichloroethene		<1	<1	<1	<1	<1	<0.50	NS	<0.36	<0.36		<1	<1	<1	<1	<1		<0.36
cis-1,2-Dichloroethene		1	<1	<1	<1	<1	<0.50	NS	<0.41	<0.41		<1	<1	<1	<1	<1		<0.41
trans-1,2-Dichloroethene		<1	<1	<1	<1	<1	<0.50	NS	<0.37	<0.37		<1	<1	<1	<1	<1		<0.37
1,2-Dichloropropane		<1	<1	<1	<1	<1	<0.50	NS	<0.67	<0.67		<1	<1	<1	<1	<1		<0.67
cis-1,3-Dichloropropene		<1	<1	<1	<1	<1	<0.50	NS	<0.40	<0.40		<1	<1	<1	<1	<1		<0.40
trans-1,3-Dichloropropene		<1	<1	<1	<1	<1	<0.50	NS	<0.42	<0.42		<1	<1	<1	<1	<1		<0.42
Ethylbenzene		<1	<1	<1	<1	<1	<0.50	NS	<0.33	<0.33		<1	<1	<1	<1	<1		<0.33
2-Hexanone		<10	<10	<10	<10	<10		NS	<2.0	<2.0		<10	<10	<10	<10	<10		<2.0
Bromomethane		<1	<1	<1	<1	<1	<0.98	NS	<2.5	<2.5		<1	<1	<1	<1	<1		<2.5
Chloromethane (methyl chloride)		<1	<1	<1	<1	<1	<0.83	NS	<2.5	<0.40		<1	<1	<1	<1	<1		<0.40
Dibromomethane (EDB)		<1	<1	<1	<1	<1	<0.59	NS	<0.35	<0.35		<1	<1	<1	<1	<1		<0.35
Methylene Chloride		<5	<5	<5	<5	<5	<3.0	NS		<2.5		<5	<5	<5	<5	<5		<2.5
Methyl Ethyl Ketone		<10	<10	<10	<10	<10		NS	<3.4			<10	<10	<10	<10	<10		
Iodomethane		<5	<5	<5	<5	<5		NS	<5.0	<5.0		<5	<5	<5	<5	<5		<5.0
methyl isobutyl ketone		<10	<10	<10	<10	<10		NS	<2.1			<10	<10	<10	<10	<10		
Styrene		<1	<1	<1	<1	<1	<1.0	NS	<0.27	<0.27		<1	<1	<1	<1	<1		<0.27
1,1,1,2-Tetrachloroethane		<1	<1	<1	<1	<1	<0.52	NS	<0.37	<0.37		<1	<1	<1	<1	<1		<0.37
1,1,2,2-Tetrachloroethane		<1	<1	<1	<1	<1	<0.50	NS	<0.62	<0.62		<1	<1	<1	<1	<1		<0.62
Tetrachloroethene		<1	<1	<1	<1	<1	<0.58	NS	<0.74	<0.74		<1	<1	<1	<1	<1		<0.74
Toluene		<1	<1	<1	<1	<1	<0.70	NS	<0.48	<0.48		<1	<1	<1	<1	<1		<0.48
1,1,1-Trichloroethane		<1	<1	<1	<1	<1	<0.50	NS	<0.37	<0.37		<1	<1	<1	<1	<1		<0.37
1,1,2-Trichloroethane		<1	<1	<1	<1	<1	<0.50	NS	<0.33	<0.33		<1	<1	<1	<1	<1		<0.33
Trichloroethene		<1	<1	<1	<1	<1	<0.50	NS	<0.48	<0.48		<1	<1	<1	<1	<1		<0.48
Trichlorofluoromethane		<1	<1	<1	<1	<1	<0.52	NS	<0.42	<0.42		<1	<1	<1	<1	<1		<0.42
1,2,3-Trichloropropane		<1	<1	<1	<1	<1	<0.84	NS	<0.39	<0.39		<1	<1	<1	<1	<1		<0.39
Vinyl acetate		<2	<2	<2	<2	<2		NS	<0.81	<0.81		<2	<2	<2	<2	<2		<0.81
Vinyl chloride		<1	<1	<1	<1	<1	<0.50	NS	<0.50	<0.50		<1	<1	<1	<1	<1		<0.50
Xylenes, Total		<2	<2	<2	<2	<2		NS	<0.23	<0.23		<2	<2	<2	<2	<2		<0.23
Metals																		
Antimony	<0.0060	<0.0060	<0.0060		<0.02	<0.02	<0.010	0.00096	<0.0005	0.00099	<0.0060	<0.0060	<0.0060		<0.02	<0.02		0.0011
Arsenic	0.019	<0.010	<0.010		<0.02	<0.02	<0.070	0.008	0.0054	0.0047	0.013	0.011	<0.010		<0.02	<0.02		0.0026
Barium	0.029	0.019	0.015		0.015	<0.01	0.017	0.021	0.025	0.021	0.014	0.013	0.013		<0.01	<0.01		0.028
Beryllium	<0.0030	<0.0030	<0.0030		<0.004	<0.004	<0.0010	0.00018	<0.00017	<0.00017	<0.0030	<0.0030	<0.0030		<0.004	<0.004		<0.00017
Boron					3.4	3.3									2.5	2.1		
Cadmium	<0.0050	<0.0050	<0.0050		<0.005	<0.005	<0.0010	0.00027	<0.00015	<0.00015	<0.0050	<0.0050	<0.0050		<0.005	<0.005		<0.00015
Chromium	0.03	0.02	<0.010		0.016	0.023	0.018	0.014	0.0076	0.01	0.012	<0.010	<0.010		<0.01	<0.01		0.009
Cobalt	<0.010	<0.010	<0.010		<0.01	<0.01	<0.0030	0.0014	0.0003	0.00081	<0.010	<0.010	<0.010		<0.01	<0.01		0.00052
Copper	<0.020	<0.020	<0.020		<0.02	<0.02	0.0025	0.007	<0.0017	0.006	<0.020	<0.020	<0.020		<0.02	<0.02		0.0023
Iron	5.6	3.3	0.72		<0.05	<0.05			<2.5	0.24	0.16	0.051	0.096		<0.05	<0.05		0.94
Lead	<0.0050	<0.0050	<0.0050		<0.01	<0.01	0.0058	0.0026	<0.00098	<0.00098	<0.0050	<0.0050	<0.0050		<0.01	<0.01		<0.00098
Magnesium	300	410	310		530	290			580		330	290	330		270	270		
Nickel	<0.040	<0.040	<0.040		<0.04	<0.04	<0.0030	0.0059	<0.0019	0.0057	<0.040	<0.040	<0.040		<0.04	<0.04		0.0091
Selenium	<0.010	<0.010	<0.010		<0.02	<0.04	<0.0040	0.0022	0.0020	<0.001	<0.010	<0.010	<0.010		<0.02	<0.04		<0.001
Silver	<0.010	<0.010	<0.010		<0.01	<0.01	<0.0020	0.00016	<0.0001	0.00011	<0.010	<0.010	<0.010		<0.01	<0.01		<0.00010
Thallium	<0.025	<0.025	<0.025		<0.025	<0.025	<0.0040	<0.00049	<0.00049	<0.00049	<0.025	<0.025	<0.025		<0.025	<0.025		<0.00049
Vanadium	0.025	0.021	0.011		0.019	0.016	0.013	0.014	0.0080	0.0088	<0.010	<0.010	<0.010		<0.01	<0.01		0.019
Zinc	0.027	0.067	0.027		<0.02	<0.02	<0.0080	0.05	<0.0096	0.026	0.069	0.043	0.12		<0.02	<0.02		0.022
Mercury	<0.00020	<0.00020	<0.00020		<0.00020	<0.00020	<0.00020	NS	<0.00008	<0.000080	<0.00020	<0.00020	<0.00020		<0.00020	<0.00020		<0.000080
PCBs																		
PCB-1016					<1	<0.97	<0.11	NS	NS	<0.19	NS	NS	NS	NS	NS	NS	NS	<0.19
PCB-1221					<2	<1.9	<0.088	NS	NS	<0.15	NS	NS	NS	NS	NS	NS	NS	<0.15
PCB-1232					<1	<0.97	<0.040	NS	NS	<0.13	NS	NS	NS	NS	NS	NS	NS	<0.13
PCB-1242					<1	<0.97	<0.014	NS	NS	<0.18	NS	NS	NS	NS	NS	NS	NS	<0.18
PCB-1248					<1	<0.97	<0.0080	NS	NS	<0.082	NS	NS	NS	NS	NS	NS	NS	<0.080
PCB-1254					<1	<0.97	<0.023	NS	NS	<0.15	NS	NS	NS	NS	NS	NS	NS	<0.15
PCB-1260					<1	<0.97	<0.061	NS	NS	<0.13	NS	NS	NS	NS	NS	NS	NS	<0.13
Pesticides																		
4,4'-DDD						<0.049	<0.0012	NS	<0.0012	<0.0079						<0.95		<0.0077
4,4'-DDE						<0.049	<0.00088	NS	<0.00086	<0.0076						<0.95		<0.0074
4,4'-DDT						<0.049	<0.0016	NS	<0.0015	<0.0087						<0.95		<0.0085
Aldrin						<0.049	<0.0012	NS	<0.0012	<0.0075						<0.95		<0.0073
alpha-BHC						<0.049	<0.0014	NS	<0.0014	<0.0080						<0.95		<0.0078
beta-BHC						<0.049	<0.0012	NS	<0.0012	<0.012						<0.95		<0.012
Chlordane (technical)						<0.49	<0.0017	NS	<0.051	<0.11						<9.5		<0.11
delta-BHC						<0.049	<0.00084	NS	<0.00082	<0.013						<0.95		<0.013
Dieldrin						<0.049	<0.0012	NS	<0.0012	<0.0088						<0.95		<0.0086
Endosulfan I						<0.049	<0.0012	NS	<0.0012	<0.0084						<0.95		<0.0082
Endosulfan II						<0.049	<0.0030	NS	<0.0029	<0.0087						<0.95		<0.0085
Endosulfan sulfate						<0.049	<0.00084	NS	<0.00082	<0.0085						<0.95		<0.0083
Endrin						<0.049	<0.0012	NS	<0.0012	<0.0090						<0.95		<0.0088
Endrin aldehyde						<0.049	<0.0011	NS	<0.0011	<0.017						<0.95		<0.017
Endrin ketone						<0.049	<0.0015	NS	<0.0015	<0.0091						<0.95		<0.0089
gamma-BHC (Lindane)						<0.049	<0.010	NS	<0.0098	<0.0085						<0.95		<0.0083
Heptachlor						<0.049	<0.0012	NS	<0.0012	<0.0081						<0.95		<0.0079
Heptachlor epoxide						<0.049	<0.0013	NS	<0.0013	<0.0083						<0.95		<0.0081
Methoxychlor						<0.049	<0.0016	NS	<0.0016	<0.0095						<0.95		<0.0093
Toxaphene						<4.9	<0.12	NS	<0.12	<0.19						<95		<0.19
Hydrocarbons																		
Diesel Range Organics [C10-C28]							1.1	1.2									1.4	
Gasoline Range Organics (GRO)-C6-C10							<0.047	<0.050									<0.047	
Over C10-C12 aliphatics									<0.30									
Over C10-C12 aromatics									<0.30									
Over C12-C16 aliphatics									<0.30									
Over C12-C16 aromatics									<0.30									
Over C16-C21 aromatics									<0.30									
Over C16-C35 aliphatics									<0.30									
Over C21-C35 aromatics									<0.30									
Over C5-C6 aliphatics									<0.30									
Over C5-C7 aromatics									<0.30									
Over C6-C8 aliphatics									<0.30									
Over C7-C8 aromatics									<0.30									
Over C8-C10 aliphatics									<0.30									
Over C8-C10 aromatics									<0.30									
sum of hydrocarbons							1.10	1.2	ND								1.40	
Other																		
Cyanide, Total					<0.01	<0.01	0.020	0.0047	<0.0025	<0.0025					<0.01	<0.01	0.022	0.007
Sulphate										580								270

Chemical Parameters	MW9B	MW10					MW11					MW12				
	2010	2006	2007	2011	2016	2019	2011	2015	2016	2019	2020	2007	2008	2010	2011	2011
General Chemistry																
Ammonia	7.1	41		37	12	21	150	16	19	15	120	19	15	9.4	0.74	6.4
Unionised ammonia											0.91					
Nitrogen, Kjeldahl	6.6**	46	16								75	21	17	11		
Nitrate plus Nitrite, as N	<0.050		<0.050	<0.05	<0.2	<0.010	<0.05	<0.018	<0.2	<0.010	0.024	<0.050	<0.050	<0.050		<0.05
Orthophosphate	<0.050	0.18		0.28	0.53	0.41	0.71	1.2	1.1	1.10	0.48	0.15	0.16	0.088		0.12
Phosphorus	<0.10	0.41	0.18								0.93	0.18	0.19	0.29		
Chemical Oxygen Demand	620	700	340	260	230	55	1300	220	260	280	460	1100	1600	460		570
pH	7.36	7.12	7.48	7.17	7.6	7.3	7.33		7.5	7.4	7.5	7.41	7.34	7.58		7.24
Specific Conductance	11000	7000	18000	6200	28000	5100	8700		27000	33000	18000	24000	2300	10000		9700
Total Dissolved Solids	5100	4100	9100	4100	20000	510	4800	18000	25000	18000	14000	12000	13000	3400		5800
Total Suspended Solids		180	28									17	20			
Turbidity	25	70	160	160	22	110	290		130	56	280	120	70	75		2100
Biochemical Oxygen Demand	18	15	26	17	110	11	36	<168.00	43	29		26	25	14		6
Volatile Organic Compounds																
Acetone	<25	<25		<25	NS	<7.0	<25		NS	<7.0	9.3	<25	<25	<25		<25
Acrylonitrile	<20	<20		<20	NS	<10	<20		NS	<10	<10	<20	<20	<20		<20
Benzene	<1	<1		<1	NS	<0.43	<1	<0.38	NS	<0.43	<0.43	<1	<1	<1		<1
Bromochloromethane	<1	<1		<1	NS	<0.45	<1	<0.52	NS	<0.45	<0.45	<1	<1	<1		<1
Bromodichloromethane	<1	<1		<1	NS	<0.44	<1	<0.50	NS	<0.44	<0.44	<1	<1	<1		<1
Bromoform	<1	<1		<1	NS	<0.43	<1	<0.71	NS	<0.43	<0.43	<1	<1	<1		<1
Carbon disulfide	<2	<2		<2	NS	1.40	2.5		4.2	<1.0	3.4	<2	<2	<2		<2
Carbon tetrachloride	<1	<1		<1	NS	<0.33	<1	<0.50	NS	<0.33	<0.33	<1	<1	<1		<1
Chlorobenzene	<1	<1		8.5	NS	<0.26	<1	<0.50	NS	<0.26	<0.26	<1	<1	<1		<1
Chloroethane	<1	<1		<1	NS	<2.5	<1	<0.76	NS	<2.5	<2.5	<1	<1	<1		<1
Chloroform	<1	<1		<1	NS	<0.50	<1	<0.60	NS	<0.50	<0.50	<1	<1	<1		<1
Dibromochloromethane	<1	<1		<1	NS	<0.32	<1	<0.85	NS	<0.32	<0.32	<1	<1	<1		<1
1,2-Dibromo-3-Chloropropane	<1	<1		<1	NS	<1.1	<1		NS	<1.1	<1.1	<1	<1	<1		<1
1,2-Dibromoethane (EDB)	<1	<1		<1	NS	<0.44	<1		NS	<0.44	<0.44	<1	<1	<1		<1
1,2-Dichlorobenzene	<1	<1		<1	NS	<0.37	<1	<0.50	NS	<0.37	<0.37	<1	<1	<1		<1
1,4-Dichlorobenzene	<1	3.1		2.4	NS	<0.46	<1	<0.64	NS	<0.46	<0.46	<1	<1	<1		<1
trans-1,4-Dichloro-2-butene	<2	<2		<2	NS	<0.51	<2		NS	<0.51	<0.51	<2	<2	<2		<2
1,1-Dichloroethane	<1	<1		<1	NS	<0.38	<1	<0.50	NS	<0.38	<0.38	<1	<1	<1		<1
1,2-Dichloroethane	<1	<1		<1	NS	<0.50	<1	<0.50	NS	<0.50	<0.50	<1	<1	<1		<1
1,1-Dichloroethene	<1	<1		<1	NS	<0.36	<1	<0.50	NS	<0.36	<0.36	<1	<1	<1		<1
cis-1,2-Dichloroethene	<1	<1		<1	NS	<0.41	<1	<0.50	NS	<0.41	<0.41	<1	<1	<1		<1
trans-1,2-Dichloroethene	<1	<1		<1	NS	<0.37	<1	<0.50	NS	<0.37	<0.37	<1	<1	<1		<1
1,2-Dichloropropane	<1	<1		<1	NS	<0.67	<1	<0.50	NS	<0.67	<0.67	<1	<1	<1		<1
cis-1,3-Dichloropropene	<1	<1		<1	NS	<0.40	<1	<0.50	NS	<0.40	<0.40	<1	<1	<1		<1
trans-1,3-Dichloropropene	<1	<1		<1	NS	<0.42	<1	<0.50	NS	<0.42	<0.42	<1	<1	<1		<1
Ethylbenzene	<1	<1		<1	NS	<0.33	<1	<0.50	NS	<0.33	<0.33	<1	<1	<1		<1
2-Hexanone	<10	<10		<10	NS	<2.0	<10		NS	<2.0	<2.0	<10	<10	<10		<10
Bromomethane	<1	<1		<1	NS	<2.5	<1	<0.98	NS	<2.5	<2.5	<1	<1	<1		<1
Chloromethane (methyl chloride)	<1	<1		<1	NS	<2.5	<1	<0.83	NS	<2.5	<0.40	<1	<1	<1		<1
Dibromomethane (EDB)	<1	<1		<1	NS	<0.35	<1	<0.59	NS	<0.35	<0.35	<1	<1	<1		<1
Methylene Chloride	<5	<5		<5	NS		<5	<3.0	NS		<2.5	<5	<5	<5		<5
Methyl Ethyl Ketone	<10	<10		<10	NS	<3.4	<10		NS	<3.4		<10	<10	<10		<10
Iodomethane	<5	<5		<5	NS	<5.0	<5		NS	<5.0	<5.0	<5	<5	<5		<5
methyl isobutyl ketone	<10	<10		<10	NS	<2.1	<10		NS	<2.1		<10	<10	<10		<10
Styrene	<1	<1		<1	NS	<0.27	<1	<1.0	NS	<0.27	<0.27	<1	<1	<1		<1
1,1,1,2-Tetrachloroethane	<1	<1		<1	NS	<0.37	<1	<0.52	NS	<0.37	<0.37	<1	<1	<1		<1
1,1,2,2-Tetrachloroethane	<1	<1		<1	NS	<0.62	<1	<0.50	NS	<0.62	<0.62	<1	<1	<1		<1
Tetrachloroethene	<1	<1		<1	NS	<0.74	<1	<0.58	NS	<0.74	<0.74	<1	<1	<1		<1
Toluene	<1	<1		<1	NS	<0.48	<1	<0.70	NS	<0.48	1.4	<1	<1	<1		<1
1,1,1-Trichloroethane	<1	<1		<1	NS	<0.37	<1	<0.50	NS	<0.37	<0.37	<1	<1	<1		<1
1,1,2-Trichloroethane	<1	<1		<1	NS	<0.33	<1	<0.50	NS	<0.33	<0.33	<1	<1	<1		<1
Trichloroethene	<1	<1		<1	NS	<0.48	<1	<0.50	NS	<0.48	<0.48	<1	<1	<1		<1
Trichlorofluoromethane	<1	<1		<1	NS	<0.42	<1	<0.52	NS	<0.42	<0.42	<1	<1	<1		<1
1,2,3-Trichloropropane	<1	<1		<1	NS	<0.39	<1	<0.84	NS	<0.39	<0.39	<1	<1	<1		<1
Vinyl acetate	<2	<2		<2	NS	<0.81	<2		<0.81	<0.81	<0.81	<2	<2	<2		<2
Vinyl chloride	<1	<1		<1	NS	<0.50	<1	<0.50	<0.50	<0.50	<0.50	<1	<1	<1		<1
Xylenes, Total	<2	<2		<2	NS	<0.23	<2		<0.023	<0.23	<0.23	<2	2.5	<2		<2
Metals																
Antimony		<0.0060		<0.02	0.00067	<0.0005	<0.02	<0.010	0.0014	<0.0005	0.0017	<0.0060	<0.0060	<0.0060		<0.02
Arsenic		<0.010		<0.02	0.0049	0.003	0.044	0.0078	0.029	0.003	0.019	<0.010	<0.010	0.014		<0.02
Barium		0.062		0.062	0.072	0.069	0.051	0.02	0.028	0.014	0.035	0.072	0.082	0.068		0.05
Beryllium		<0.0030		<0.004	<0.00017	<0.00017	<0.004	<0.0010	<0.00017	<0.00017	<0.00017	<0.0030	<0.0030	<0.0030		<0.004
Boron				1.4			4.0									1.8
Cadmium		<0.0050		<0.005	<0.00015	<0.00015	<0.005	<0.0010	<0.00015	<0.00015	<0.00015	<0.0050	<0.005	<0.0050		<0.005
Chromium		0.011		<0.01	0.0055	0.0043	0.079	0.014	0.017	0.003	0.033	0.011	<0.010	0.015		<0.01
Cobalt		<0.010		<0.01	0.00063	0.00068	<0.01	<0.0030	0.0032	0.00022	0.0049	<0.010	<0.010	<0.010		<0.01
Copper		<0.020		<0.02	0.0085	0.0037	<0.02	0.011	0.021	<0.0017	0.01	<0.020	<0.020	<0.020		<0.02
Iron		6.5		3.6		<2.5	0.67			0.031	8	0.46	0.066	0.59		<0.05
Lead		0.042		<0.01	0.0083	<0.00098	<0.01	0.011	0.0025	<0.00098	0.0012	<0.0050	<0.005	<0.0050		<0.01
Magnesium		160		170		390	140			630		420	<0.010	290		370
Nickel		<0.040		<0.04	0.0037	0.0066	<0.04	<0.0030	0.0092	0.0019	0.023	<0.040	<0.040	<0.040		<0.04
Selenium		<0.010		<0.02	<0.001	<0.001	<0.02	<0.0040	<1.0	0.0018	0.0014	<0.010	<0.010	<0.010		<0.02
Silver		<0.010		<0.01	<0.0001	<0.0001	<0.01	<0.0020	0.0001	0.00045	<0.00010	<0.010	<0.010	<0.010		<0.01
Thallium		<0.025		<0.025	<0.00049	<0.00049	<0.025	<0.0040	<0.00049	<0.00049	<0.00049	<0.025	<0.025	<0.025		<0.025
Vanadium		<0.010		<0.01	0.0057	<0.0053	0.018	<0.0030	0.0099	<0.0053	0.013	<0.010	<0.010	<0.010		<0.01
Zinc		0.052		<0.02	0.044	0.0160	<0.02	0.040	0.2	<0.0096	0.19	0.042	<0.020	0.069		<0.02
Mercury		<0.00020		<0.0002	NS	<0.00008	<0.0002	<0.070	NS	<0.00008	<0.000080	<0.00020	<0.00020	<0.00020		<0.0002
PCBs																
PCB-1016	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	<1.8	NS	NS	NS	NS	NS
PCB-1221	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	<1.4	NS	NS	NS	NS	NS
PCB-1232	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	<1.2	NS	NS	NS	NS	NS
PCB-1242	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	<1.7	NS	NS	NS	NS	NS
PCB-1248	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	<0.75	NS	NS	NS	NS	NS
PCB-1254	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	<1.4	NS	NS	NS	NS	NS
PCB-1260	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	<1.2	NS	NS	NS	NS	NS
Pesticides																
4,4'-DDD					NS	<0.0012		<0.0012	NS	<0.0012	<0.072					
4,4'-DDE					NS	<0.00086		<0.00088	NS	<0.00086	<0.070					
4,4'-DDT					NS	<0.0015		<0.0016	NS	<0.0015	<0.080					
Aldrin					NS	<0.0012		<0.0012	NS	<0.0012	<0.069					
alpha-BHC					NS	<0.0014		<0.0014	NS	<0.0014	<0.073					
beta-BHC					NS	<0.0012		<0.0012	NS	<0.0012	<0.11					
Chlordane (technical)					NS	<0.051		<0.0017	NS	<0.051	<1.0					
delta-BHC					NS	<0.00082		<0.00084	NS	<0.00082	<0.12					
Dieldrin					NS	<0.0012		<0.0012	NS	<0.0012	<0.081					
Endosulfan I					NS	<0.0012		<0.0012	NS	<0.0012	<0.077					
Endosulfan II					NS	<0.0029		<0.0030	NS	<0.0029	<0.080					
Endosulfan sulfate					NS	<0.00082		<0.00084	NS	<0.00082	<0.078					
Endrin					NS	<0.0012		<0.0012	NS	<0.0012	<0.083					
Endrin aldehyde					NS	<0.0011		<0.0011	NS	<0.0011	<0.16					
Endrin ketone					NS	<0.0015		<0.0015	NS	<0.0015	<0.084					
gamma-BHC (Lindane)					NS	<0.0098		<0.010	NS	<0.0098	<0.078					
Heptachlor					NS	<0.0012		<0.0012	NS	<0.0012	<0.074					
Heptachlor epoxide					NS	<0.0012		<0.0013	NS	<0.0013	<0.076					
Methoxychlor					NS	<0.0016		<0.0016	NS	<0.0016	<0.087					
Toxaphene					NS	<0.12		<0.12	NS	<0.12	<1.8					
Hydrocarbons																
Diesel Range Organics [C10-C28]					0.77			0.48	1.9							
Gasoline Range Organics (GRO)-C6-C10					<0.050			<0.047	<0.050							
Over C10-C12 aliphatics						<0.30				<0.30						
Over C10-C12 aromatics						<0.30				<0.30						
Over C12-C16 aliphatics						<0.30				<0.30						
Over C12-C16 aromatics						<0.30				<0.30						
Over C16-C21 aromatics						<0.30				<0.30						
Over C16-C35 aliphatics						<0.30				<0.30						
Over C21-C35 aromatics						<0.30				<0.30						
Over C5-C6 aliphatics						<0.30				<0.30						
Over C5-C7 aromatics						<0.30				<0.30						
Over C6-C8 aliphatics						<0.30				<0.30						
Over C7-C8 aromatics						<0.30				<0.30						
Over C8-C10 aliphatics						<0.30				<0.30						
Over C8-C10 aromatics						<0.30				<0.30						
sum of hydrocarbons					0.77	ND		0.48	1.9	ND						
Other																
Cyanide, Total				<0.01	<0.0025	0.0079	<0.01	0.052	<0.0025	<0.0025	<0.0025					<0.01
Sulphate											930					

a. UK standard for unionised ammonia (NH3-N) in marine waters is 0.021mg/l; Ammonia Standards for total ammonia 6 (poor status river)
b. UK standard for nitrate for wetlands
c. Reactive Phosphorus Standards in Lowland High Alkalinity Rivers (UK)
d. UK other surface water maximum allowable concentration
e. USEPA MCL for drinking water
f. UK other surface water annual average for vanadium
g. WHO guidance recommends this value for total hydrocarbons
h. UK other surface water annual average for boron

Exceedance of surface water criteria
Exceedance of gorundwater criteria

** As provided in Chapter 62-302, F.A.C.
*** Equal to 10 times the value provided in Chapter 62-520, F.A.C.
ND Not Detected
NTU Nephelometric Turbidity Unit
NS - data not supplied, assume less than detection limit
It is noted that the 2011 monitoring data for boron were provided in the incorrect units in the Task 2 Amec report and have been corrected in this table

Chemical Parameters	Reporting Unit	Florida clean up: Low Yield/Poor Quality Groundwater	Florida clean up: Marine Surface Water	Alternative Criteria	MW13				MW14				MW15			
					2013	2015	2019	2020	2006	2011	2013	2015	2006	2007	2011	2013
General Chemistry																
Ammonia	mg/l	28		0.021 to 6a	6.9	9.0	6.5	3.5		13	12	16		6.6	6.3	6.9
Unionised ammonia	mg/l			0.021				0.017								
Nitrogen, Kjeldahl	mg/l							6	39				13	8.2		
Nitrate plus Nitrite, as N	mg/l	110		22b	<0.05	<0.018	0.019	0.01	<0.050	0.093	<0.05	<0.018	<0.050	<0.050	0.69	<0.05
Orthophosphate	mg/l			0.0036 to 1c	0.58	0.52	0.42	0.31		0.073	0.11	0.099		0.073	0.055	0.067
Phosphorus	mg/l							0.35	0.51				0.22	<0.10		
Chemical Oxygen Demand	mg/l				340	150	<50	90 J	330	430	170	130	240	540	640	210
pH	pH units			pH6-8.5d	7.38		7.40	7.6	7.35	7.26	7.38		7.53	7.17	7.2	7.42
Specific Conductance	umhos/cm				22000		4800	14000	8900	9100	14000		13000	18000	14000	16000
Total Dissolved Solids	mg/l	5000			13000	16000	330	20000	4900	4300	8600	7900	6900	3300	3500	10000
Total Suspended Solids	mg/l			500e					16				33	<5.0		
Turbidity	NTU		29		72		61	170	400	69	18		120	0.33	17	2.8
Biochemical Oxygen Demand	mg/l				<2	18	4.0		42	7.4	6.5	<90	11	20	10	1800
Volatile Organic Compounds																
Acetone	ug/L	63000	1700		<25		<7.0	14		<25	<25			<25	<25	<25
Acrylonitrile	ug/L	420	0.2		<20		<10	<10		<20	<20			<20	<20	<20
Benzene	ug/L	10	71.28		<1	<0.38	<0.43	<0.43		<1	<1			<1	<1	<1
Bromochloromethane	ug/L	910	N/A		<1	<0.52	<0.45	<0.45		<1	<1			<1	<1	<1
Bromodichloromethane	ug/L	6	22		<1	<0.50	<0.44	<0.44		<1	<1			<1	<1	<1
Bromoform	ug/L	44	360		<1	<0.71	<0.43	<0.43		<1	<1			<1	<1	<1
Carbon disulfide	ug/L	7000	110		<2		<1.0	<1.0		<2	<2			<2	<2	<2
Carbon tetrachloride	ug/L	30	4.42		<1	<0.50	<0.33	<0.33		<1	<1			<1	<1	<1
Chlorobenzene	ug/L	1,000	17		<1	<0.50	<0.26	<0.26		<1	<1			<1	<1	<1
Chloroethane	ug/L	120	N/A		<1	<0.76	<2.5	<2.5		<1	<1			<1	<1	<1
Chloroform	ug/L	700	470.8		<1	<0.60	<0.50	<0.50		<1	<1			<1	<1	<1
Dibromochloromethane	ug/L	4	34		<1	<0.85	<0.32	<0.32		<1	<1			<1	<1	<1
1,2-Dibromo-3-Chloropropane	ug/L	2	N/A		<1		<1.1	<1.1		<1	<1			<1	<1	<1
1,2-Dibromoethane (EDB)	ug/L	0.2	13		<1		<0.44	<0.44		<1	<1			<1	<1	<1
1,2-Dichlorobenzene	ug/L	6,000	99		<1	<0.50	<0.37	<0.37		<1	<1			<1	<1	<1
1,4-Dichlorobenzene	ug/L	750	3		<1	<0.64	<0.46	<0.46		<1	<1			<1	<1	<1
trans-1,4-Dichloro-2-butene	ug/L				<2		<0.51	<0.51		<2	<2			<2	<2	<2
1,1-Dichloroethane	ug/L	700	N/A		<1	<0.50	<0.38	<0.38		<1	<1			<1	<1	<1
1,2-Dichloroethane	ug/L	30	37		<1	<0.50	<0.50	<0.50		<1	<1			<1	<1	<1
1,1-Dichloroethene	ug/L	70	3.2		<1	<0.50	<0.36	<0.36		<1	<1			<1	<1	<1
cis-1,2-Dichloroethene	ug/L	700	N/A		<1	<0.50	<0.41	<0.41		<1	<1			<1	<1	<1
trans-1,2-Dichloroethene	ug/L	1,000	11000		<1	<0.50	<0.37	<0.37		<1	<1			<1	<1	<1
1,2-Dichloropropane	ug/L	50	14		<1	<0.50	<0.67	<0.67		<1	<1			<1	<1	<1
cis-1,3-Dichloropropene	ug/L	4	12		<1	<0.50	<0.40	<0.40		<1	<1			<1	<1	<1
trans-1,3-Dichloropropene	ug/L	4	12		<1	<0.50	<0.42	<0.42		<1	<1			<1	<1	<1
Ethylbenzene	ug/L	300	610		<1	<0.50	<0.33	1.2		<1	<1			<1	<1	<1
2-Hexanone	ug/L	2800	NA		<10		<2.0	<2.0		<10	<10			<10	<10	<10
Bromomethane	ug/L	98	35		<1	<0.98	<2.5	<2.5		<1	<1			<1	<1	<1
Chloromethane (methyl chloride)	ug/L	27	470.8		<1	<0.83	<2.5	<0.40		<1	<1			<1	<1	<1
Dibromomethane (EDB)	ug/L	0.2	13		<1	<0.59	<0.35	<0.35		<1	<1			<1	<1	<1
Methylene Chloride	ug/L	50	1580		<5	<3.0		<2.5		<5	<5			<5	<5	<5
Methyl Ethyl Ketone	ug/L	42000	120000		<10		<3.4			<10	<10			<10	<10	<10
Iodomethane	ug/L				<5		<5.0	<5.0		<5	<5			<5	<5	<5
methyl isobutyl ketone	ug/L	5600	23000		<10		<2.1			<10	<10			<10	<10	<10
Styrene	ug/L	1,000	460		<1	<1.0	<0.27	<0.27		<1	<1			<1	<1	<1
1,1,1,2-Tetrachloroethane	ug/L	13	N/A		<1	<0.52	<0.37	<0.37		<1	<1			<1	<1	<1
1,1,2,2-Tetrachloroethane	ug/L	2	10.8		<1	<0.50	<0.62	<0.62		<1	<1			<1	<1	<1
Tetrachloroethene	ug/L	30	8.85		<1	<0.58	<0.74	<0.74		<1	<1			<1	<1	<1
Toluene	ug/L	400	480		<1	<0.70	<0.48	2.8		<1	<1			<1	<1	<1
1,1,1-Trichloroethane	ug/L	2,000	270		<1	<0.50	<0.37	<0.37		<1	<1			<1	<1	<1
1,1,2-Trichloroethane	ug/L	50	16		<1	<0.50	<0.33	<0.33		<1	<1			<1	<1	<1
Trichloroethene	ug/L	30	80.7		<1	<0.50	<0.48	<0.48		<1	<1			<1	<1	<1
Trichlorofluoromethane	ug/L	21000	N/A		<1	<0.52	<0.42	<0.42		<1	<1			<1	<1	<1
1,2,3-Trichloropropane	ug/L	0.2	0.2		<1	<0.84	<0.39	<0.39		<1	<1			<1	<1	<1
Vinyl acetate	ug/L	880	700		<2		<0.81	<0.81		<2	<2			<2	<2	<2
Vinyl chloride	ug/L	10	2.4		<1	<0.50	<0.50	<0.50		<1	<1			<1	<1	<1
Xylenes, Total	ug/L	200	370		<2		<0.23	4.4		<2	<2			<2	<2	<2
Metals																
Antimony	mg/L	0.06	4.3		<0.02	<0.010	0.0012	0.00075	<0.0060	<0.02	<0.02		<0.0060	<0.0060	<0.02	<0.02
Arsenic	mg/L	0.1	0.05		<0.02	<0.020	0.0022	0.0018	0.049	<0.02	<0.02		0.031	<0.010	<0.02	<0.02
Barium	mg/L	20	N/A		0.022	0.022	0.037	0.045	0.11	0.068	0.018		0.057	0.014	<0.01	0.014
Beryllium	mg/L	0.04	0.00013		<0.004	<0.0010	<0.00017	<0.00017	<0.0030	<0.004	<0.004		<0.0030	<0.0030	<0.004	<0.004
Boron	mg/l	14000		7h	2.7					2.3	1.8				1.4	1.7
Cadmium	mg/L	0.05	0.0088		<0.005	<0.0010	<0.00015	0.00038	<0.0050	<0.005	<0.005		<0.0050	<0.0050	<0.005	<0.005
Chromium	mg/L	1	0.05		<0.01	0.0060	0.0046	0.0011	0.025	<0.01	<0.01		0.021	<0.010	<0.01	<0.01
Cobalt	mg/L	1400	N/A		<0.01	<0.0030	0.0004	0.00093	<0.010	<0.01	<0.01		<0.010	<0.010	<0.01	<0.01
Copper	mg/L	10	0.0037		<0.02	0.0062	0.0074	0.055	<0.020	<0.02	<0.02		<0.020	<0.020	<0.02	<0.02
Iron	mg/L	3	0.3		0.49		<2.5	2.1	0.96	<0.05	<0.05		3.8	<0.050	<0.05	<0.05
Lead	mg/L	0.15	0.0085		<0.01	0.0079	<0.00098	0.0051	<0.0050	<0.01	<0.01		<0.0050	<0.0050	<0.01	<0.01
Magnesium	mg/L				590		330		120	200	320		210	350	90	350
Nickel	mg/L	1	0.0083		<0.04	<0.0030	0.0049	0.0069	<0.040	<0.04	<0.04		<0.040	<0.040	<0.04	<0.04
Selenium	mg/L	0.5	71		<0.04	<0.0040	<0.001	0.0011	<0.010	<0.02	<0.04		<0.010	<0.010	<0.02	<0.04
Silver	mg/L	1	0.0004		<0.01	<0.0020	<0.0001	<0.00010	<0.010	<0.01	<0.01		<0.010	<0.010	<0.01	<0.01
Thallium	mg/L	0.02	0.0063		<0.025	<0.0040	<0.00049	<0.00049	<0.025	<0.025	<0.025		<0.025	<0.025	<0.025	<0.025
Vanadium	mg/L	490	N/A	0.1f	<0.01	<0.0030	<0.0053	0.0069	<0.010	<0.01	<0.01		<0.010	<0.010	<0.01	<0.01
Zinc	mg/L	50	0.086		<0.02	0.017	0.0160	0.045	0.19	<0.02	<0.02		0.46	<0.020	<0.02	<0.02
Mercury	mg/L	0.02	0.000025		<0.0002	<0.070	<0.00008	<0.000080	<0.00020	<0.0002	<0.0002		<0.00020	<0.00020	<0.00020	<0.00020
PCBs																
PCB-1016	ug/l	***	**		NS	NS	NS	<0.20	NS	NS	NS	NS	NS	NS	NS	NS
PCB-1221	ug/l	***	**		NS	NS	NS	<0.16	NS	NS	NS	NS	NS	NS	NS	NS
PCB-1232	ug/l	***	**		NS	NS	NS	<0.13	NS	NS	NS	NS	NS	NS	NS	NS
PCB-1242	ug/l	***	**		NS	NS	NS	<0.19	NS	NS	NS	NS	NS	NS	NS	NS
PCB-1248	ug/l	***	**		NS	NS	NS	<0.083	NS	NS	NS	NS	NS	NS	NS	NS
PCB-1254	ug/l	***	**		NS	NS	NS	<0.16	NS	NS	NS	NS	NS	NS	NS	NS
PCB-1260	ug/l	***	**		NS	NS	NS	<0.13	NS	NS	NS	NS	NS	NS	NS	NS
Pesticides																
4,4'-DDD	ug/l	1	0.0003		<0.24	<0.0012	<0.0013	<0.0080			<0.048					<0.048
4,4'-DDE	ug/l	1	0.0002		<0.24	<0.00088	<0.00093	<0.0077			<0.048					<0.048
4,4'-DDT	ug/l	1	**		<0.24	<0.0016	<0.0016	<0.0088			<0.048					<0.048
Aldrin	ug/l	0.02	**		<0.24	<0.0012	<0.0013	<0.0076			<0.048					<0.048
alpha-BHC	ug/l	0.06	0.005		<0.24	<0.0014	<0.0015	<0.0081			<0.048					<0.048
beta-BHC	ug/l	0.2	**		<0.24	<0.0012	<0.0013	<0.012			<0.048					<0.048
Chlordane (technical)	ug/l	***	**		<2.4	<0.0017	<0.055	<0.11			<0.48					<0.48
delta-BHC	ug/l	21	NA		<0.24	<0.00084	<0.00088	<0.013			<0.048					<0.048
Dieldrin	ug/l	0.02	**		<0.24	<0.0012	<0.0013	<0.0089			<0.048					<0.048
Endosulfan I	ug/l	420	**		<0.24	<0.0012	<0.0013	<0.0085			<0.048					<0.048
Endosulfan II	ug/l	420	**		<0.24	<0.0030	<0.0031	<0.0088			<0.048					<0.048
Endosulfan sulfate	ug/l	420	**		<0.24	<0.00084	<0.00088	<0.0086			<0.048					<0.048
Endrin	ug/l	***	**		<0.24	<0.0012	<0.0013	<0.0091			<0.048					<0.048
Endrin aldehyde	ug/l	***	**		<0.24	<0.0011	<0.0012	<0.018			<0.048					<0.048
Endrin ketone	ug/l	***	**		<0.24	<0.0015	<0.0016	<0.0092			<0.048					<0.048
gamma-BHC (Lindane)	ug/l	***	**		<0.24	<0.010	<0.011	<0.0086			<0.048					<0.048
Heptachlor	ug/l	***	**		<0.24	<0.0012	<0.0013	<0.0082			<0.048					<0.048
Heptachlor epoxide	ug/l	***	**		<0.24	<0.0013	<0.0013	<0.0084			<0.048					<0.048
Methoxychlor	ug/l	***	**		<0.24	<0.0016	<0.0017	<0.0096			<0.048					<0.048
Toxaphene	ug/l	***	**		<24	<0.12	<0.13	<0.20			<4.8					<4.8
Hydrocarbons																
Diesel Range Organics [C10-C28]	mg/l				0.19	0.066						1.0				
Gasoline Range Organics (GRO)-C6-C10	mg/l				<0.05	<0.047						<0.047				
Over C10-C12 aliphatics	mg/l						<0.30									
Over C10-C12 aromatics	mg/l						<0.30									
Over C12-C16 aliphatics	mg/l						<0.30									
Over C12-C16 aromatics	mg/l						<0.30									
Over C16-C21 aromatics	mg/l						<0.30									
Over C16-C35 aliphatics	mg/l						<0.30									
Over C21-C35 aromatics	mg/l						<0.30									
Over C5-C6 aliphatics	mg/l						<0.30									
Over C5-C7 aromatics	mg/l						<0.30									
Over C6-C8 aliphatics	mg/l						<0.30									
Over C7-C8 aromatics	mg/l						<0.30									
Over C8-C10 aliphatics	mg/l						<0.30									
Over C8-C10 aromatics	mg/l						<0.30									
sum of hydrocarbons	mg/l			0.3g	0.19	0.07	ND					1.00				
Other																
Cyanide, Total	mg/l	2	0.001		<0.01	<0.0070	0.021	0.003		<0.01	<0.01	<0.007			<0.01	<0.01
Sulphate	mg/l							540								

Chemical Parameters	MW-15A		MW16		MW 17	MW 18		MW 19			
	2015	2016	2006	2013	2011	2011	2013	2015	2016	2019	2020
General Chemistry											
Ammonia	14	8.3	3.2	8.3	5.4	12	34	4.4	14	5.6	9.4
Unionised ammonia											0.095
Nitrogen, Kjeldahl											20
Nitrate plus Nitrite, as N	<0.018	0.048	<0.050	<0.05	0.15	0.17	<0.05	<0.018	<0.010	0.017	0.013
Orthophosphate	0.067	<0.016		0.16	0.082	<0.05	0.15	0.052	0.11	0.076	<0.016
Phosphorus			1.3								0.13
Chemical Oxygen Demand	110	150	140	290	470	460	430	18	48	<50	57
pH		7.6	7.47	7.35	7.29	7.22	7.26		7.6	7.6	7.7
Specific Conductance		17000	12000	19000	10000	6400	10000		4200	2900	3400
Total Dissolved Solids	11000	13000	6300	12000	5400	3500	6300	2600	2100	2100	1900
Total Suspended Solids			2600								
Turbidity		8.5	330	4	160	3000	41		1.4	0.76	65
Biochemical Oxygen Demand	5.1	5.1	3.8	46	29	18	10	<2.0	98	2.2	
Volatile Organic Compounds											
Acetone		NS		<25	<25	<25	<25		NS	<7.0	<7.0
Acrylonitrile		NS		<20	<20	<20	<20		NS	<10	<10
Benzene		NS		<1	<1	<1	<1	<0.38	NS	<0.43	<0.43
Bromochloromethane		NS		<1	<1	<1	<1	<0.52	NS	<0.45	<0.45
Bromodichloromethane		NS		<1	<1	<1	<1	<0.50	NS	<0.44	<0.44
Bromoform		NS		<1	<1	<1	<1	<0.71	NS	<0.43	<0.43
Carbon disulfide		NS		<2	<2	<2	<2		NS	<1.0	<1.0
Carbon tetrachloride		NS		<1	<1	<1	<1	<0.50	NS	<0.33	<0.33
Chlorobenzene		NS		<1	<1	<1	<1	<0.50	NS	<0.26	<0.26
Chloroethane		NS		<1	<1	<1	<1	<0.76	NS	<2.5	<2.5
Chloroform		NS		<1	<1	<1	<1	<0.60	NS	<0.50	<0.50
Dibromochloromethane		NS		<1	<1	<1	<1	<0.85	NS	<0.32	<0.32
1,2-Dibromo-3-Chloropropane		NS		<1	<1	<1	<1		NS	<1.1	<1.1
1,2-Dibromoethane (EDB)		NS		<1	<1	<1	<1		NS	<0.44	<0.44
1,2-Dichlorobenzene		NS		<1	<1	<1	<1	<0.50	NS	<0.37	<0.37
1,4-Dichlorobenzene		NS		<1	<1	<1	<1	<0.64	NS	<0.46	<0.46
trans-1,4-Dichloro-2-butene		NS		<2	<2	<2	<2		NS	<0.51	<0.51
1,1-Dichloroethane		NS		<1	<1	<1	<1	<0.50	NS	<0.38	<0.38
1,2-Dichloroethane		NS		<1	<1	<1	<1	<0.50	NS	<0.50	<0.50
1,1-Dichloroethene		NS		<1	<1	<1	<1	<0.50	NS	<0.36	<0.36
cis-1,2-Dichloroethene		NS		<1	<1	<1	<1	<0.50	NS	<0.41	<0.41
trans-1,2-Dichloroethene		NS		<1	<1	<1	<1	<0.50	NS	<0.37	<0.37
1,2-Dichloropropane		NS		<1	<1	<1	<1	<0.50	NS	<0.67	<0.67
cis-1,3-Dichloropropene		NS		<1	<1	<1	<1	<0.50	NS	<0.40	<0.40
trans-1,3-Dichloropropene		NS		<1	<1	<1	<1	<0.50	NS	<0.42	<0.42
Ethylbenzene		NS		<1	<1	<1	<1	<0.50	NS	<0.33	<0.33
2-Hexanone		NS		<10	<10	<10	<10		NS	<2.0	<2.0
Bromomethane		NS		<1	<1	<1	<1	<0.98	NS	<2.5	<2.5
Chloromethane (methyl chloride)		NS		<1	<1	<1	<1	<0.83	NS	<2.5	<0.40
Dibromomethane (EDB)		NS		<1	<1	<1	<1	<0.59	NS	<0.35	<0.35
Methylene Chloride		NS		<5	<5	<5	<5	<3.0	NS		<2.5
Methyl Ethyl Ketone		NS		<10	<10	<10	<10		NS	<3.4	
Iodomethane		NS		<5	<5	<5	<5		NS	<5.0	<5.0
methyl isobutyl ketone		NS		<10	<10	<10	<10		NS	<2.1	
Styrene		NS		<1	<1	<1	<1	<1.0	NS	<0.27	<0.27
1,1,1,2-Tetrachloroethane		NS		<1	<1	<1	<1	<0.52	NS	<0.37	<0.37
1,1,2,2-Tetrachloroethane		NS		<1	<1	<1	<1	<0.50	NS	<0.62	<0.62
Tetrachloroethene		NS		<1	<1	<1	<1	<0.58	NS	<0.74	<0.74
Toluene		NS		<1	<1	<1	<1	<0.70	NS	<0.48	<0.48
1,1,1-Trichloroethane		NS		<1	<1	<1	<1	<0.50	NS	<0.37	<0.37
1,1,2-Trichloroethane		NS		<1	<1	<1	<1	<0.50	NS	<0.33	<0.33
Trichloroethene		NS		<1	<1	<1	<1	<0.50	NS	<0.48	<0.48
Trichlorofluoromethane		NS		<1	<1	<1	<1	<0.52	NS	<0.42	<0.42
1,2,3-Trichloropropane		NS		<1	<1	<1	<1	<0.84	NS	<0.39	<0.39
Vinyl acetate		<0.81		<2	<2	<2	<2		NS	<0.81	<0.81
Vinyl chloride		<0.5		<1	<1	<1	<1	<0.50	NS	<0.50	<0.50
Xylenes, Total		<0.23		<2	<2	<2	<2		NS	<0.23	<0.23
Metals											
Antimony		0.002	<0.0060	<0.02	<0.02	<0.02	<0.02	<0.010	NS	<0.0005	0.66
Arsenic		0.0051	0.015	<0.02	<0.02	<0.02	<0.02	<0.0040	NS	<0.0015	8.5
Barium		0.0063	0.082	0.013	0.061	0.056	0.012	0.018	0.091	0.056	290
Beryllium		0.00017	<0.0030	<0.004	<0.004	<0.004	<0.004	<0.0010	NS	<0.00017	<0.17
Boron				2.1	1.9	2.0	2.4				
Cadmium		0.00071	<0.0050	<0.005	<0.005	<0.005	<0.005	<0.0010	NS	<0.00015	<0.15
Chromium		0.00036	0.035	<0.01	<0.01	<0.01	<0.01	<0.0020	NS	0.0076	3.6
Cobalt		0.00097	<0.010	<0.01	<0.01	<0.01	<0.01	<0.0030	0.00025	0.00037	0.78
Copper		0.19	0.055	<0.02	<0.02	<0.02	<0.02	<0.0020	NS	0.0063	13
Iron			11	1.1	<0.05	<0.05	<0.05			<2.5	5700
Lead		0.0086	0.034	<0.01	<0.01	<0.01	<0.01	0.0043	NS	<0.00098	12
Magnesium			200	420	200	170	260			82	
Nickel		0.021	<0.040	<0.04	<0.04	<0.04	<0.04	<0.0030	NS	0.0045	7.3
Selenium		0.0036	<0.010	<0.04	<0.02	<0.02	<0.04	<0.0040	NS	<0.001	<1.0
Silver		0.00022	<0.010	<0.01	<0.01	<0.01	<0.01	<0.0020	NS	<0.0001	<0.10
Thallium		<0.00049	<0.025	<0.025	<0.025	<0.025	<0.025	<0.0040	NS	<0.00049	<0.49
Vanadium		0.0089	0.037	0.016	<0.01	<0.01	<0.01	<0.0030	NS	<0.0053	<5.3
Zinc		2.5	0.077	<0.02	<0.02	<0.02	<0.02	<0.0080	NS	<0.0096	37
Mercury		NS	0.00032	<0.0002	<0.0002	<0.0002	<0.0002	<0.070	NS	<0.00008	<0.000080
PCBs											
PCB-1016	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	<0.20
PCB-1221	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	<0.15
PCB-1232	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	<0.13
PCB-1242	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	<0.19
PCB-1248	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	<0.083
PCB-1254	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	<0.15
PCB-1260	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	<0.13
Pesticides											
4,4'-DDD		NS		<0.05			<0.95	<0.0012	NS	<0.0012	<0.0079
4,4'-DDE		NS		<0.05			<0.95	<0.00088	NS	<0.00087	<0.0076
4,4'-DDT		NS		<0.05			<0.95	<0.0016	NS	<0.0015	<0.0088
Aldrin		NS		<0.05			<0.95	<0.0012	NS	<0.0012	<0.0075
alpha-BHC		NS		<0.05			<0.95	<0.0014	NS	<0.0014	<0.0080
beta-BHC		NS		<0.05			<0.95	<0.0012	NS	<0.0012	<0.012
Chlordane (technical)		NS		<0.5			<9.5	<0.0017	NS	<0.052	<0.11
delta-BHC		NS		<0.05			<0.95	<0.00084	NS	<0.00083	<0.013
Dieldrin		NS		<0.05			<0.95	<0.0012	NS	<0.0012	<0.0089
Endosulfan I		NS		<0.05			<0.95	<0.0012	NS	<0.0012	0.038
Endosulfan II		NS		<0.05			<0.95	<0.0030	NS	<0.0029	<0.0088
Endosulfan sulfate		NS		<0.05			<0.95	<0.00084	NS	<0.00083	<0.0086
Endrin		NS		<0.05			<0.95	<0.0012	NS	<0.0012	<0.0091
Endrin aldehyde		NS		<0.05			<0.95	<0.0011	NS	<0.0011	<0.018
Endrin ketone		NS		<0.05			<0.95	<0.0015	NS	<0.0015	<0.0092
gamma-BHC (Lindane)		NS		<0.05			<0.95	<0.010	NS	<0.0099	<0.0086
Heptachlor		NS		<0.05			<0.95	<0.0012	NS	<0.0012	<0.0082
Heptachlor epoxide		NS		<0.05			<0.95	<0.0013	NS	<0.0013	<0.0084
Methoxychlor		NS		<0.05			<0.95	<0.0016	NS	<0.0016	<0.0096
Toxaphene		NS		<5			<95	<0.12	NS	<0.12	<0.20
Hydrocarbons											
Diesel Range Organics [C10-C28]	0.38	0.74		1.7		1	3.8	0.61	0.86		
Gasoline Range Organics (GRO)-C6-C10	<0.047	<0.050		<0.05			<0.05	<0.047	<0.050		
Over C10-C12 aliphatics										<0.30	
Over C10-C12 aromatics										<0.30	
Over C12-C16 aliphatics										<0.30	
Over C12-C16 aromatics										<0.30	
Over C16-C21 aromatics										<0.30	
Over C16-C35 aliphatics										<0.30	
Over C21-C35 aromatics										<0.30	
Over C5-C6 aliphatics										<0.30	
Over C5-C7 aromatics										<0.30	
Over C6-C8 aliphatics										<0.30	
Over C7-C8 aromatics										<0.30	
Over C8-C10 aliphatics										<0.30	
Over C8-C10 aromatics										<0.30	
sum of hydrocarbons	0.38	0.74		1.70		1.00	3.80	0.61	0.86	ND	
Other											
Cyanide, Total	<0.0070	NS		<0.01	<0.01	<0.01	<0.01	<0.0035	<0.0025	0.031	<0.0025
Sulphate											330

Chemical Parameters	MW 20			MW 21				MW23	MW22 (external)	
	2015	2016	2020	2015	2016	2019	2020	2020	2016	2019
General Chemistry										
Ammonia	6.6	16	8.3	270	330	200	150	44	8.6	12
Unionised ammonia			0.039				1.6	0.64		
Nitrogen, Kjeldahl			13				190	76		
Nitrate plus Nitrite, as N	<0.018	<0.20	<0.010	<0.018	0.16	<0.10	<0.010	<0.010	0.05	0.034
Orthophosphate	0.061	0.076	0.086	1.1	0.85	0.53	0.36	0.16	0.68	0.99
Phosphorus			0.12				0.54	0.37		
Chemical Oxygen Demand	170	220	170	1000	1500	650	510	380	170	130
pH		7.5	7.8		7.6	7.2	7.6	7.8	7.4	1.4
Specific Conductance		19000	14000		15000	4900	13000	12000	29000	34000
Total Dissolved Solids	11000	20000	8300	19000	8200	16000	7500	7400	27000	19000
Total Suspended Solids										
Turbidity		53	190		46	16	48	39	28	6.0
Biochemical Oxygen Demand	20	110		80	49	19			180	27
Volatile Organic Compounds										
Acetone		NS	8.1		NS	<7.0	9.5	<7.0	NS	<7.0
Acrylonitrile		NS	<10		NS	<10	<10	<10	NS	<10
Benzene	<0.38	NS	<0.43		6.2	1.8	1.5	<0.43	NS	<0.43
Bromochloromethane	<0.52	NS	<0.45		NS	<0.45	<0.45	<0.45	NS	<0.45
Bromodichloromethane	<0.50	NS	<0.44		NS	<0.44	<0.44	<0.44	NS	<0.44
Bromoform	<0.71	NS	<0.43		NS	<0.43	<0.43	<0.43	NS	<0.43
Carbon disulfide		3.6	2.8		NS	<1.0	1.8	3.7	1	1.10
Carbon tetrachloride	<0.50	NS	<0.33		NS	<0.33	<0.33	<0.33	NS	<0.33
Chlorobenzene	<0.50	NS	<0.26		NS	<0.26	<0.26	<0.26	NS	<0.26
Chloroethane	<0.76	NS	<2.5		NS	<2.5	<2.5	<2.5	NS	<2.5
Chloroform	<0.60	NS	<0.50		NS	<0.50	<0.50	<0.50	NS	<0.50
Dibromochloromethane	<0.85	NS	<0.32		NS	<0.32	<0.32	<0.32	NS	<0.32
1,2-Dibromo-3-Chloropropane		NS	<1.1		NS	<1.1	<1.1	<1.1	NS	<1.1
1,2-Dibromoethane (EDB)		NS	<0.44		NS	<0.44	<0.44	<0.44	NS	<0.44
1,2-Dichlorobenzene	<0.50	NS	<0.37		NS	<0.37	<0.37	<0.37	NS	<0.37
1,4-Dichlorobenzene	<0.64	NS	<0.46		NS	<0.46	<0.46	<0.46	NS	<0.46
trans-1,4-Dichloro-2-butene		NS	<0.51		NS	<0.51	<0.51	<0.51	NS	<0.51
1,1-Dichloroethane	<0.50	NS	<0.38		NS	<0.38	<0.38	<0.38	NS	<0.38
1,2-Dichloroethane	<0.50	NS	<0.50		NS	<0.50	<0.50	<0.50	NS	<0.50
1,1-Dichloroethene	<0.50	NS	<0.36		NS	<0.36	<0.36	<0.36	NS	<0.36
cis-1,2-Dichloroethene	<0.50	NS	<0.41		NS	<0.41	<0.41	<0.41	NS	<0.41
trans-1,2-Dichloroethene	<0.50	NS	<0.37		NS	<0.37	<0.37	<0.37	NS	<0.37
1,2-Dichloropropane	<0.50	NS	<0.67		NS	<0.67	<0.67	<0.67	NS	<0.67
cis-1,3-Dichloropropene	<0.50	NS	<0.40		NS	<0.40	<0.40	<0.40	NS	<0.40
trans-1,3-Dichloropropene	<0.50	NS	<0.42		NS	<0.42	<0.42	<0.42	NS	<0.42
Ethylbenzene	<0.50	NS	<0.33		9.8	<0.33	1	<0.33	NS	<0.33
2-Hexanone		NS	<2.0		NS	<2.0	<2.0	<2.0	NS	<2.0
Bromomethane	<0.98	NS	<2.5		NS	<2.5	<2.5	<2.5	NS	<2.5
Chloromethane (methyl chloride)	<0.83	NS	<0.40		NS	<2.5	<0.40	<0.40	NS	<2.5
Dibromomethane (EDB)	<0.59	NS	<0.35		NS	<0.35	<0.35	<0.35	NS	<0.35
Methylene Chloride	<3.0	NS	<2.5		NS		<2.5	<2.5	NS	
Methyl Ethyl Ketone		NS			NS	<3.4			NS	<3.4
Iodomethane		NS	<5.0		NS	<5.0	<5.0	<5.0	NS	<5.0
methyl isobutyl ketone		NS			NS	<2.1			NS	<2.1
Styrene	<1.0	NS	<0.27		NS	<0.27	<0.27	<0.27	NS	<0.27
1,1,1,2-Tetrachloroethane	<0.52	NS	<0.37		NS	<0.37	<0.37	<0.37	NS	<0.37
1,1,2,2-Tetrachloroethane	<0.50	NS	<0.62		NS	<0.62	<0.62	<0.62	NS	<0.62
Tetrachloroethene	<0.58	NS	<0.74		NS	<0.74	<0.74	<0.74	NS	<0.74
Toluene	<0.70	NS	1.6		NS	<0.48	<0.48	<0.48	NS	<0.48
1,1,1-Trichloroethane	<0.50	NS	<0.37		NS	<0.37	<0.37	<0.37	NS	<0.37
1,1,2-Trichloroethane	<0.50	NS	<0.33		NS	<0.33	<0.33	<0.33	NS	<0.33
Trichloroethene	<0.50	NS	<0.48		NS	<0.48	<0.48	<0.48	NS	<0.48
Trichlorofluoromethane	<0.52	NS	<0.42		NS	<0.42	<0.42	<0.42	NS	<0.42
1,2,3-Trichloropropane	<0.84	NS	<0.39		NS	<0.39	<0.39	<0.39	NS	<0.39
Vinyl acetate		NS	<0.81		<8.1	<0.81	<0.81	<0.81	<0.81	<0.81
Vinyl chloride	<0.50	NS	<0.50		<5	<0.50	<0.50	<0.50	<0.5	<0.50
Xylenes, Total		NS	<0.23		7.9	1.5	1.4	<0.23	<0.23	<0.23
Metals										
Antimony		0.0094	0.00066		0.0024	0.00066	0.0011	0.0028	0.00052	<0.0005
Arsenic		0.035	0.002		0.063	0.014	0.02	0.016	0.0083	0.0021
Barium		0.032	0.018		0.13	0.15	0.12	0.1	0.017	0.011
Beryllium		<0.17	<0.00017		0.00036	<0.00017	<0.00017	<0.00017	<0.00017	<0.00017
Boron										
Cadmium		0.00099	<0.00015		0.00017	<0.00015	<0.00015	<0.00015	0.00023	<0.00015
Chromium		0.014	0.0063		0.31	0.083	0.05	0.032	0.011	0.0027
Cobalt		0.003	0.00077		0.01	0.0059	0.0032	0.0024	0.0017	0.0002
Copper		0.18	<0.0017		0.026	<0.0017	0.01	0.024	0.0032	<0.0017
Iron			0.22			1.2	0.91	1.5		<2.5
Lead		0.019	<0.00098		0.014	<0.00098	<0.00098	0.0017	0.0028	<0.00098
Magnesium						250				630
Nickel		0.0068	0.0038		0.042	0.020	0.017	0.019	0.0065	0.0026
Selenium		0.0016	<0.001		<0.001	0.0022	<0.001	<0.001	0.0054	0.0023
Silver		0.00038	<0.0001		<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001
Thallium		<0.00049	<0.00049		<0.00049	<0.00049	<0.00049	<0.00049	<0.00049	<0.00049
Vanadium		0.019	0.011		0.11	0.063	<0.0053	0.074	0.013	<0.0053
Zinc		0.64	<0.0096		0.05	<0.0096	<0.0096	0.049	<0.0096	<0.0096
Mercury		0.0001	<0.000080		<0.080	<0.00008	<0.000080	<0.000080	0.000094	<0.00008
PCBs										
PCB-1016	NS	NS	<0.19		<0.19	<0.11	<0.19	<0.19		<0.11
PCB-1221	NS	NS	<0.15		<0.15	<0.086	<0.15	<0.15		<0.088
PCB-1232	NS	NS	<0.13		<0.13	<0.039	<0.13	<0.13		<0.040
PCB-1242	NS	NS	<0.18		<0.18	<0.013	<0.18	<0.18		<0.014
PCB-1248	NS	NS	<0.079		<0.078	<0.0078	<0.082	<0.079		<0.0080
PCB-1254	NS	NS	<0.15		<0.15	<0.022	<0.15	<0.15		<0.023
PCB-1260	NS	NS	<0.13		<0.13	<0.060	<0.13	<0.13		<0.061
Pesticides										
4,4'-DDD	<0.0012	NS	<0.0076		NS	<0.0012	<0.0079	<0.0076	NS	<0.0012
4,4'-DDE	<0.00088	NS	<0.0073		NS	<0.00086	<0.0076	<0.0073	NS	<0.00088
4,4'-DDT	<0.0016	NS	<0.0084		NS	<0.0015	<0.0087	<0.0084	NS	<0.0016
Aldrin	<0.0012	NS	<0.0072		NS	<0.0012	<0.0075	<0.0072	NS	<0.0012
alpha-BHC	<0.0014	NS	<0.0077		NS	<0.0014	<0.0080	<0.0077	NS	<0.0014
beta-BHC	<0.0012	NS	<0.012		NS	<0.0012	<0.012	<0.012	NS	<0.0012
Chlordane (technical)	<0.0017	NS	<0.11		NS	<0.051	<0.11	<0.11	NS	<0.052
delta-BHC	<0.00084	NS	<0.013		NS	<0.00082	<0.013	<0.013	NS	<0.00084
Dieldrin	<0.0012	NS	<0.0085		NS	<0.0012	<0.0088	<0.0085	NS	<0.0012
Endosulfan I	<0.0012	NS	<0.0081		NS	<0.0012	0.061 p	0.027 J	NS	<0.0012
Endosulfan II	<0.0030	NS	<0.0084		NS	<0.0029	<0.0087	<0.0084	NS	<0.0030
Endosulfan sulfate	<0.00084	NS	<0.0082		NS	<0.00082	<0.0085	<0.0082	NS	<0.00084
Endrin	<0.0012	NS	<0.0087		NS	<0.0012	<0.0090	<0.0087	NS	<0.0012
Endrin aldehyde	<0.0011	NS	<0.017		NS	<0.0011	<0.017	<0.017	NS	<0.0011
Endrin ketone	<0.0015	NS	<0.0087		NS	<0.0015	<0.0091	<0.0088	NS	<0.0015
gamma-BHC (Lindane)	<0.010	NS	<0.0082		NS	<0.0098	<0.0085	<0.0082	NS	<0.010
Heptachlor	<0.0012	NS	<0.0078		NS	<0.0012	<0.0081	<0.0078	NS	<0.0012
Heptachlor epoxide	<0.0013	NS	<0.0080		NS	<0.0013	<0.0083	<0.0080	NS	<0.0013
Methoxychlor	<0.0016	NS	<0.0091		NS	<0.0016	<0.0095	<0.0091	NS	<0.0016
Toxaphene	<0.12	NS	<0.19		NS	<0.12	<0.19	<0.19	NS	<0.12
Hydrocarbons										
Diesel Range Organics [C10-C28]	1.5	1.7		18	26				0.54	
Gasoline Range Organics (GRO)-C6-C10	<0.047	<0.050		0.3	<1.0				<0.050	
Over C10-C12 aliphatics						<0.30				<0.30
Over C10-C12 aromatics						<0.30				<0.30
Over C12-C16 aliphatics						<0.30				<0.30
Over C12-C16 aromatics						<0.30				<0.30
Over C16-C21 aromatics						0.37				<0.30
Over C16-C35 aliphatics						0.53				<0.30
Over C21-C35 aromatics						<0.30				<0.30
Over C5-C6 aliphatics						<0.30				<0.30
Over C5-C7 aromatics						<0.30				<0.30
Over C6-C8 aliphatics						<0.30				<0.30
Over C7-C8 aromatics						<0.30				<0.30
Over C8-C10 aliphatics						<0.30				<0.30
Over C8-C10 aromatics						<0.30				<0.30
sum of hydrocarbons	1.50	1.7		18.30	26	0.90			0.54	ND
Other										
Cyanide, Total	<0.0070	NS	0.0045	0.15	0.0089	0.044	0.0039	0.0054	NS	0.043
Sulphate			300				1700	620		

a. UK standard for unionised ammonia (NH3-N) in marine waters is 0.021mg/l; Ammonia Standards for total ammonia 6 (poor status
b. UK standard for nitrate for wetlands
c. Reactive Phosphorus Standards in Lowland High Alkalinity Rivers (UK)
d. UK other surface water maximum allowable concentration
e. USEPA MCL for drinking water
f. UK other surface water annual average for vanadium
g. WHO guidance recommends this value for total hydrocarbons
h. UK other surface water annual average for boron

Exceedance of surface water criteria

Exceedance of gorundwater criteria

** As provided in Chapter 62-302, F.A.C.
*** Equal to 10 times the value provided in Chapter 62-520, F.A.C.
ND Not Detected
NTU Nephelometric Turbidity Unit
NS - data not supplied, assume less than detection limit
It is noted that the 2011 monitoring data for boron were provided in the incorrect units in the Task 2 Amec report and have been correc

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Document Status

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