# Appendix 13.2

# Hydrogeological Assessment for Hammond Lane Metal Company by O'Callaghan Moran & Associates (2011)

# 13.2 Hydrogeological Assessment for Hammond Lane Metal Company

See over leaf for Hydrogeological Assessment for Hammond Lane Metal Company by O'Callaghan Moran & Associates (2011).

Granary House
Rutland Street
Cork

environmental management for business

Tel. (021) 4321521
Fax. (021) 4321522

# HYDROGEOLOGICAL ASSESSMENT

# HAMMOND LANE METAL COMPANY

# RINGASKIDDY

# CORK

**Prepared For: -**

Hammond Lane Metal Company,
Ringaskiddy,
County Cork.

**Prepared By: -**

O' Callaghan Moran & Associates,
Granary House,
Rutland Street,
Cork.

**23rd August 2011**

# TABLE OF CONTENTS

**PAGE**

| | | |
|---|---|---|
| **APPENDIX 1** | - | OCM 2010 Report |
| **APPENDIX 2** | - | Borehole Logs |
| **APPENDIX 3** | - | OCM Sampling Protocol |
| **APPENDIX 4** | - | Laboratory Results |

# 1 INTRODUCTION

Hammond Lane Metal Company commissioned O'Callaghan Moran & Associates (OCM) to carry out a hydrogeological assessment of their scrap metal processing facility in Ringaskiddy. The facility operates under Waste Permit No WFP-CK-10-0077-02 issued by Cork County Council in 2010.

The assessment was requested by the planning authority as part of a planning application to expand the facility operations. The objective is to determine if there are any impacts on groundwater quality associated with the past use of the site.

An initial assessment of the subsoils within the site boundary, undertaken in 1997 by Mayer Environmental, did not identify the presence of any significant impacts on the subsoils. In 2010 OCM completed a further assessment of the subsoils, which confirmed that there was no evidence of any impact on the soils associated with site operations. The 2010 OCM Report is included in Appendix 1.

The 1997 and 2010 investigations were confined to the investigation of the soils and did not include an assessment of groundwater quality beneath the site. As there were no on-site monitoring wells, the hydrogeological assessment involved the installation and monitoring of four groundwater wells.

This report describes the well installation and groundwater monitoring programme. It also presents an update of site operations and revises the environmental risk assessment, based on the additional monitoring data.

# 2 SITE DESCRIPTION

## 2.1 Site Location

The site location and layout is shown on the Figure 2.1. The site encompasses approximately 1 hectare (ha) and is benched into the hillside to the south of the main Ringaskiddy to Haulbowline Island road.

Immediately to the north, the ground slopes to a low lying field which is the site of the proposed incinerator and is currently used for tillage. The Naval Maritime College is across the public road to the north and further north is Cork Harbour. The bridge crossing to Haulbowline Island is to the northeast. The lands to the west comprise open scrub land, overgrown with furze. There is an ESB Sub-Station adjacent to the northeastern site boundary.

## 2.2 Site History

Hammond Land Metal Company developed the facility in 1989 on a greenfield site previously used for agricultural purposes and the site has always been used as a metal processing facility since that time.

## 2.3 Site Layout

The site is accessed from the public road to the north. There is a weighbridge on the access road, with a site office to the east. The office houses administration, canteen, stores and toilets facilities. Sanitary wastewater discharges to a septic tank and percolation area located to the north of the building. The system was installed when the site was initially developed and Hammond Lane Metal Company informed OCM that it has always operated satisfactorily.

The access road slopes to the south towards the main yard area, which is located at a higher bench level cut into the hillside. The road is paved with tarmac, while the main operational area on site is concrete paved. The concrete is in generally good repair, however there are cracks and damaged areas along the northeast section of the access road. This damaged will be repaired as part of the proposed expansion of facility operations.

Storm water run-off from the site is collected in an ACCO type drain covered with a steel grid that runs along the northern site boundary. OCM inspected drain and the the northern boundary with the adjoining agricultural land and did not identify any evidence of the overflow of oil contaminated run-off from the drain.

In 2010, OCM noted a section of the drain in the western part of the site was partially covered with scrap metal over spilling from the site and that some debris has also fallen into the drain. These materials were since removed and the drain cleared.

The drain connects to a settlement tank located to the east of access road and south of the offices. The settlement tank overflows to an oil interceptor located the west of the site access road. The water from the interceptor discharges to the local authority storm water sewer.

The oil interceptor is routinely inspected and the discharge is monitored. OCM understand that the monitoring has established that the discharge complies with the emission limit values set in the Waste Permit. The oil accumulating in the interceptor is routinely skimmed of and used to lubricate the on-site shredder.

The settlement tank is de-sludged every six weeks and the contents are recycled over the scrap metal stock pile.

A steel frame and metal clad garage is located at the southern site boundary. Some oil staining was observed in 2010 and 2011 on the concrete floor, however the floor appears to be in good condition. There is a 1000 litre (l) polyethylene waste oil storage tank sitting in a steel bund, with two other smaller (205 l) waste oil tanks in an adjoining bund. Oil spill clean-up materials (Oil Dry) are stored inside the building and used to clean-up any minor spills that occur. The waste oil is collected as by ENVA a permitted waste contractor, and removed from the site for treatment.

There are two fuel oil tanks in a concrete bund to the east of the garage. The first is a steel rectangular tank c1500l and the second is a polyethylene cylindrical tank of similar capacity. Both tanks appear to be in good repair. The bund is roofed and enclosed on three sides. At the time of the inspection in 2011, OCM noted the presence of a small amount of water in the bund, most likely from rainfall entering the open side to the enclosure. There were four 205l steel waste oil drums located on a drum storage pallet in this area.

OCM did not observe any evidence of leaks at any of the bunds though some staining is present along the fill port of the steel rectangular tank.

Any oil spill within the garage that was not contained by site staff could escape onto the paved yard and ultimately be collected in the surface drain located in the drain along the northern boundary.

To the west of the garage is the incoming scrap metal stockpile, where materials are stored pending processing in the nearby shredder unit. The shredded metal is stockpiled to the west of the shredder.

O' Callaghan Moran & Associates.
Granary House, Rutland Street,
Cork, Ireland.
Tel. (021) 4321521 Fax. (021) 4321522
email : info@ocallaghanmoran.com

environmental management for business

CLIENT

**Hammond Lane Metal Co.**

TITLE

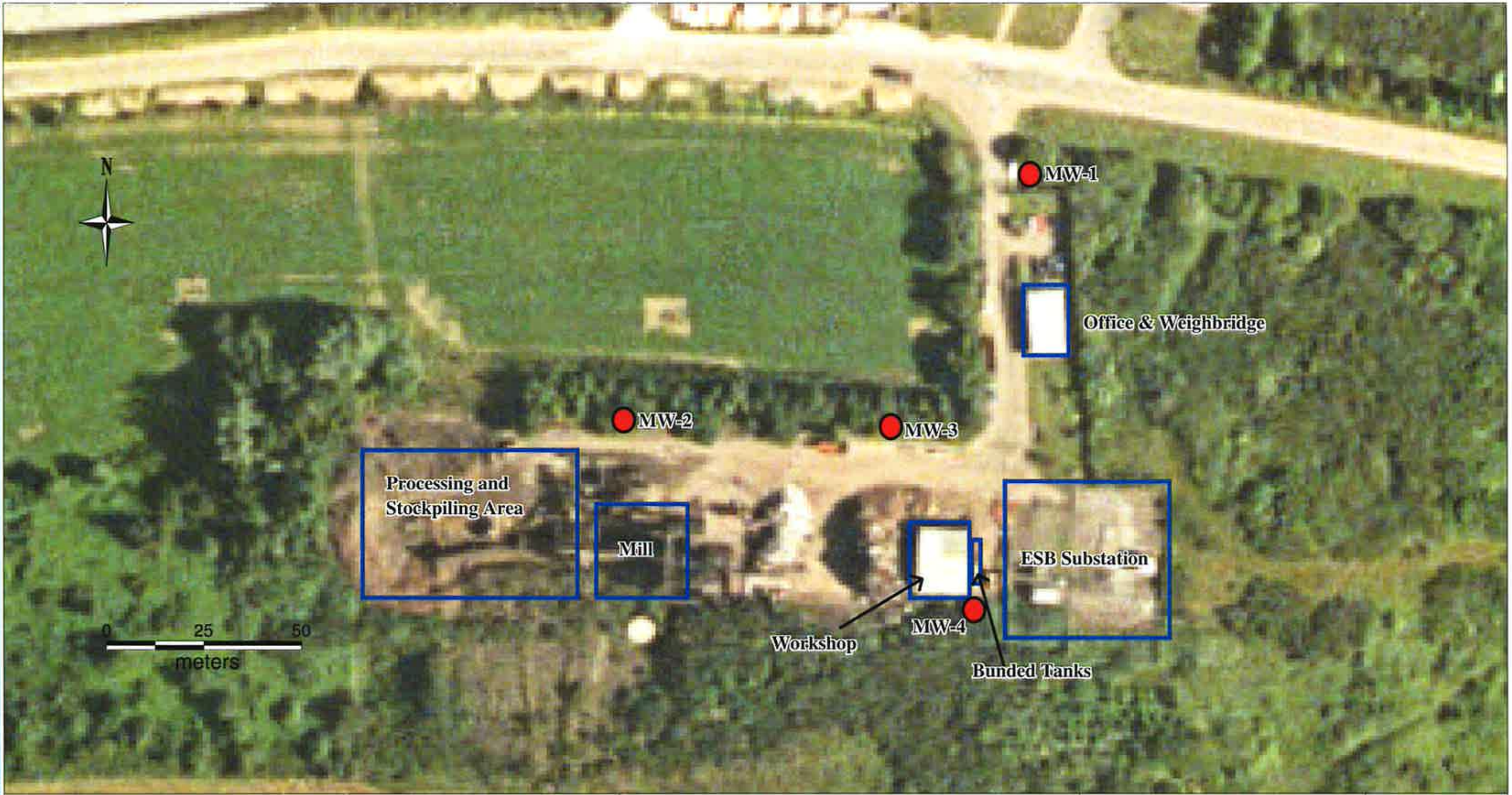
**Site Location**

Legend

FIGURE No.

**2.1**

SCALE



O' Callaghan Moran & Associates.
Granary House, Rutland Street,
Cork, Ireland.
Tel. (021) 4321521 Fax. (021) 4321522
email : info@ocallaghanmoran.com

environmental management for business

CLIENT

**Hammond Lane Metal Co.**

TITLE

**Site Layout**

Legend

● **Groundwater Well**

FIGURE No.

**2.2**

SCALE

## 2.4 Geology and Hydrogeology

Information on the local and regional geology and hydrogeology was derived from a desk study, which included Geological Survey of Ireland (GSI) geology databases; Teagasc Soil Maps for the region; in-house databases prepared by OCM and the well installation programme undertaken by OCM in July 2011. The latter is described in Section 3.

### *2.4.1 Soils and Subsoil*

The subsoil distribution is shown on Figure 2.3. The site is underlain by 0.3 – 0.75m of gravelly fill partially comprising in-situ weathered and broken shale and sandstone bedrock. The Teagasc Soil Maps indicate the in-situ soils in the northern section of the site comprise Devonian Sandstone Till (**TDSs**). The southern section of the site is described as being underlain by non calcareous rock (**RckNCa**). This classification was confirmed by the 2011 investigation.

The depth of subsoils ranges from 2.7m in the north of the site to 0.3m near the southern boundary. Rock is exposed along the southern site boundary and also along the northwest site boundary, where the site is benched into the bedrock.

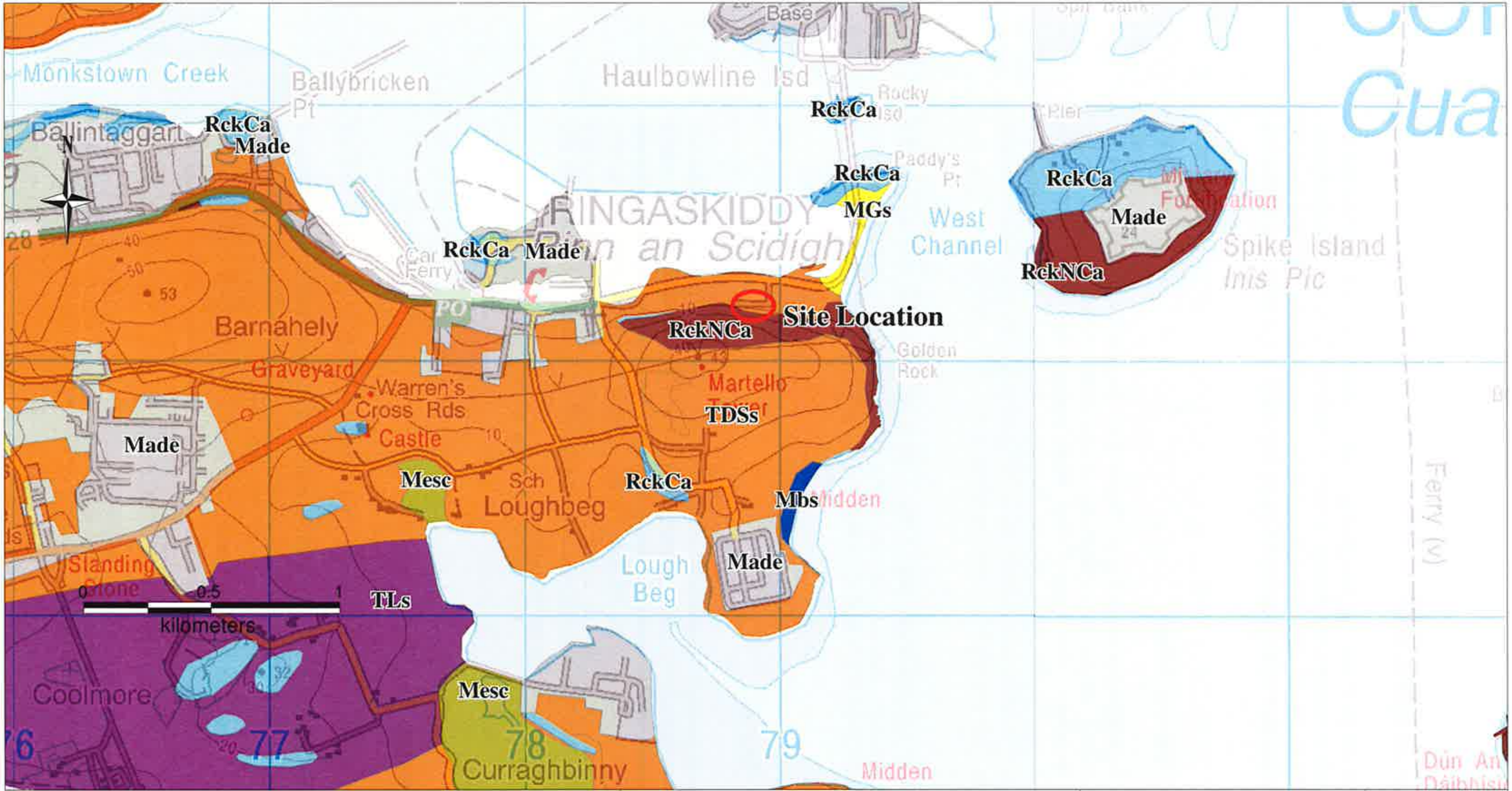
### *2.4.2 Bedrock*

The bedrock geology is illustrated on Figure 2.4. The GSI maps indicated that northern section of the site is underlain by the Ballysteen formation, which comprises dark muddy limestone and shale, while the southern section of the site is underlain by the Cuskinny Member of the Kinsale formation, which comprises Flaser-bedded sandstone & mudstone. However, based on the bedrock encountered during the monitoring well installation, it appears that the entire site is underlain by the Cuskinny Member.

## 2.5 Hydrogeology

### *2.5.1 Aquifer Classification*

The GSI has developed a classification system for aquifers based on the value of the resource and the hydrogeological characteristics. The bedrock aquifer beneath the site is characterised by the GSI as a Locally Important Aquifer (**Ll**), which is moderately productive in local zones. The aquifer classification is illustrated on Figure 2.5.



O' Callaghan Moran & Associates.
Granary House, Rutland Street,
Cork, Ireland.
Tel. (021) 4321521 Fax. (021) 4321522
email : info@ocallaghanmoran.com

environmental management for business

CLIENT

**Hammond Lane Metal Co.**

TITLE

**Subsoil Classification**

Legend

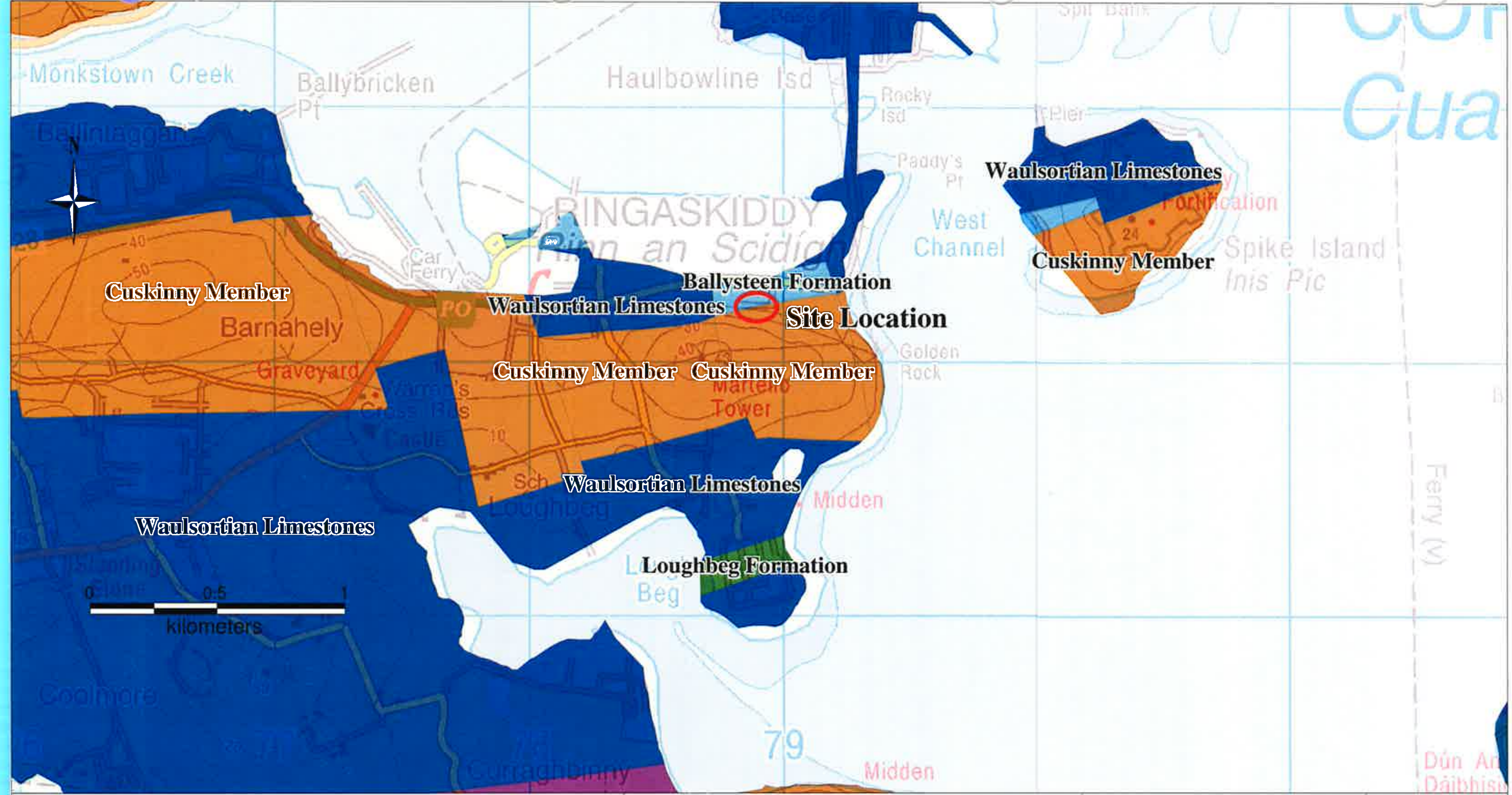
Subsoil Classification

- 🟧 TDSs - Sandstone Till
- 🟫 RckNCa - Non Cal Rock
- ⬜ Made
- 🟦 RckCa - Cal Rock
- 🟩 Mesc - Esturine Seds
- 🟦 Mbs - Raised Beach Sand
- 🟥 A - Alluvium
- 🟨 MGs - Marine Sand and Gravel

FIGURE No.

2.3

SCALE



O' Callaghan Moran & Associates.
Granary House, Rutland Street,
Cork, Ireland.
Tel. (021) 4321521 Fax. (021) 4321522
email : info@ocallaghanmoran.com

environmental management for business

This drawing is the property of O'Callaghan Moran & Associates and shal not be used, reproduced or disclosed to anyone without the prior written permission of O'Callaghan Moran & Associates and shall be returned upon request.

CLIENT

**Hammond Lane Metal Co.**

TITLE

**Bedrcok Geology**

Legend

Bedrock Geology

- 🟧 Cuskinny Member
- 🟦 Waulsortian Limestones
- 🟦 Ballysteen Formation
- 🟩 Loughbeg Formation
- 🟦 Ballyknock Member
- 🟦 Ballytrasna Formation
- ▨ Gyleen Formation
- 🟦 Lispatrick Formation

FIGURE No.

**2.4**

SCALE

### 2.5.2 *Aquifer Vulnerability*

Vulnerability is defined by the GSI as the intrinsic geological and hydrogeological characteristics that determine the ease with which groundwater may be contaminated by human activities. Vulnerability categories range from Extreme (**E**) to High (**H**) to Moderate (**M**) to Low (**L**) and are dependant on the nature and thickness of subsoils above the water table.

The GSI vulnerability map indicates that the rating at the site ranges from extreme (**E**) in the northern part of the site to x-extreme (**X**) in the south. The site investigation confirmed this classification. The depth to bedrock in the northern section of the site at MW-1 was 2.7m, while in the south of the site (MW-4) the depth was 0.3m. The aquifer vulnerability is illustrated on Figure 2.6.

### 2.5.3 *Aquifer Characteristics*

The Cuskinny shale and sandstone and the Ballysteen Limestone formations are characterised by the GSI as a Locally Important Aquifers that are productive only in local zones (Ll) and are essentially poor aquifers. Typically groundwater yields from these aquifers are very low and in this area and they are not deemed to be a significant resource given that much of the land to the north of the site is reclaimed from the estuary and the likely impacts of saline intrusion.

### 2.5.4 *Groundwater Flow Direction*

Groundwater flow follows the local topography and is from the south to the north toward Cork Harbour.

### 2.5.5 *Neighbouring Wells and Karst Features*

The closest recorded wells are approximately 1km to the south in the Lough Beg Hovione facility. These wells are in a separate hydrologic catchment and range in depth from 7m to 21m. There is no information of what the wells are used for. There are no karst features recorded in the vicinity of the site.

### 2.5.6 *Designated Areas*

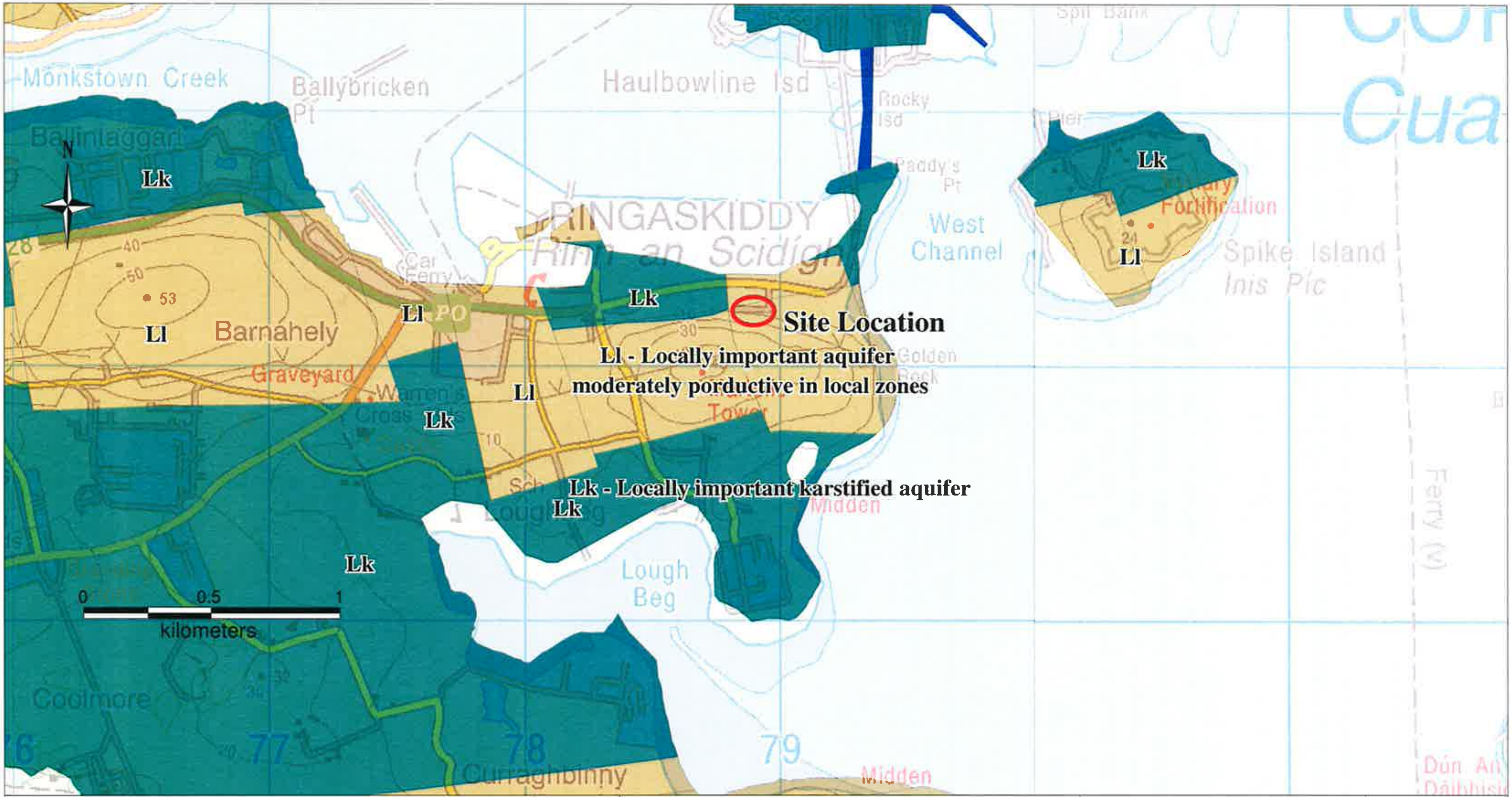
The nearest designated area is a Special Protected Area (SPA) located approximately 600m to the south in Lough Beg. Lough Beg is also a Proposed Natural Heritage Area (PNHA). The closest Special Area of Conservation (SAC) is approximately 6km to the north, in Great Island Channel.

## 2.6 Conceptual Model

There are no surface water streams or springs in the vicinity of the site. The site is entirely covered with impermeable concrete paved yards and buildings, which means that rainfall recharge does not occur within the site boundaries.

Groundwater flow locally is expected to be from the high ground south of the site toward the harbour to the north. The bedrock aquifer comprises low permeability sandstone and shale. Groundwater flowing beneath the site is expected to discharge either to the low reclaimed land to the north and/or the estuary further to the north. The lands to the north of the public road and east of the Navy College have been reclaimed by progressively infilling with dredge spoil and construction demolition debris over many years.

Groundwater moving to the north from the poor aquifer beneath the site is likely to connect to the brackish groundwater near the estuary rather than moving deeper into the bedrock.



O' Callaghan Moran & Associates.
Granary House, Rutland Street,
Cork, Ireland.
Tel. (021) 4321521 Fax. (021) 4321522
email : info@ocallaghanmoran.com

environmental management for business

This drawing is the property of O'Callaghan Moran & Associates and shall not be used, reproduced or disclosed to anyone without the prior written permission of O'Callaghan Moran & Associates and shall be returned upon request.

CLIENT

**Hammond Lane Metal Co.**

TITLE

**Aquifer Classification**

Legend

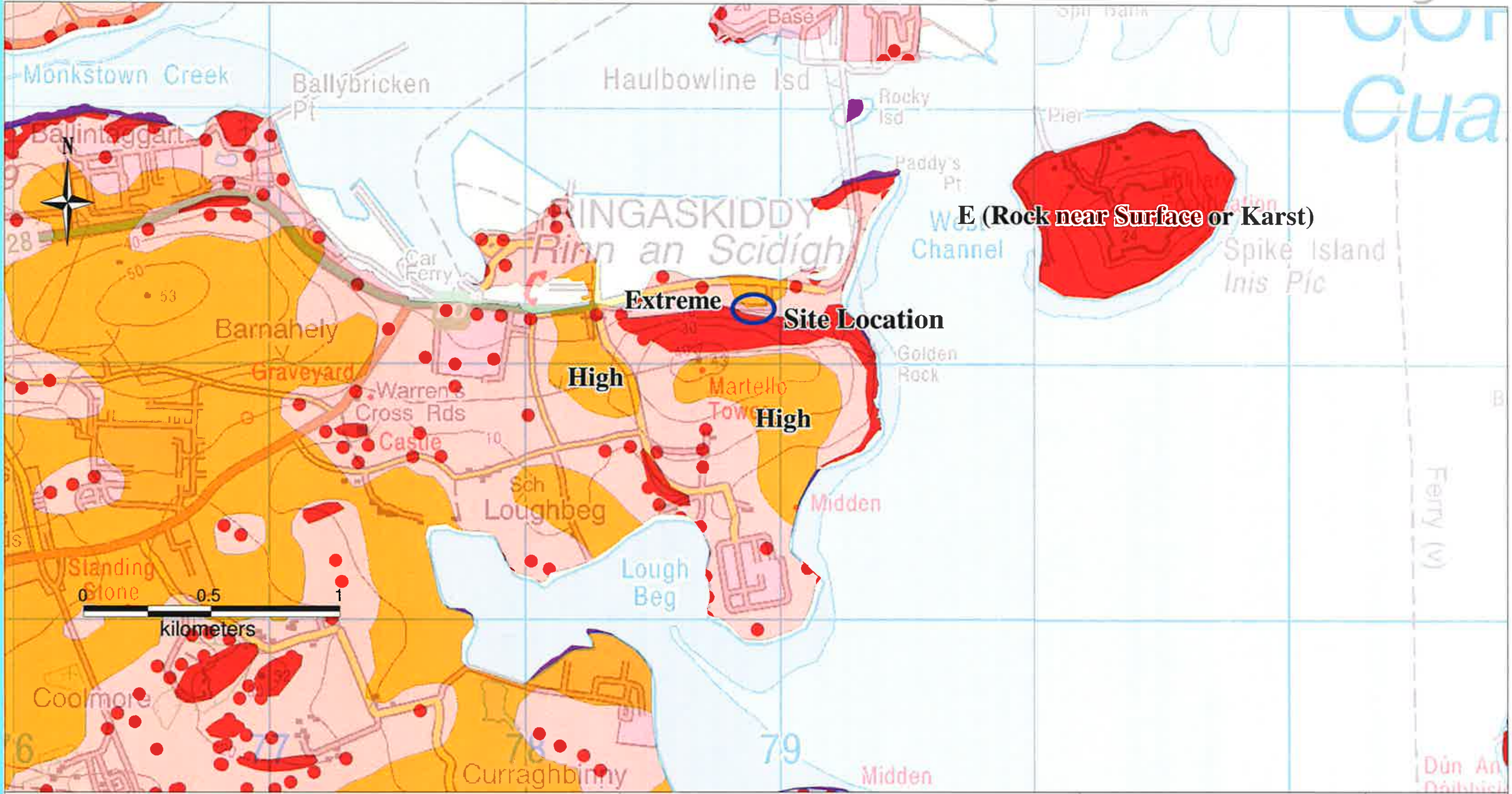
Aquifer Classification

- 🟦 Lk
- 🟨 Ll
- 🟦 Unclassified

FIGURE No.

**2.5**

SCALE



**O' Callaghan Moran & Associates.**
Granary House, Rutland Street,
Cork, Ireland.
Tel. (021) 4321521 Fax. (021) 4321522
email : info@ocallaghanmoran.com

environmental management for business

This drawing is the property of O'Callaghan Moran & Associates and shall not be used, reproduced or disclosed to anyone without the prior written permission of O'Callaghan Moran & Associates and shall be returned upon request.

CLIENT

**Hammond Lane Metal Co.**

TITLE

**Aquifer Vulnerability**

Legend

Vulnerability

- ▨ E - Extreme
- 🟧 H - High
- 🟪 HL - High to Low
- 🟥 X - Rock Close to Surface

FIGURE No.

2.6

SCALE

# 3 GROUNDWATER INVESTIGATION

## 3.1 Well Installation

Four monitoring wells (MW-1 to MW-4) were installed at the site between the 21st and 22nd July 2011. The well locations are shown on Figure 3.1. The well locations were selected by OCM.

MW-1 is located along the northern site boundary and immediately down hydraulic gradient of the oil interceptor and the septic tank. MW-2 and MW-3 are directly down hydraulic gradient of the main operational area, while MW-4 is along the southern site boundary and upgradient of the operational areas.

The wells were installed by Ground Investigations Ireland using a rotary percussion drill rig under the supervision of an OCM hydrogeologist. The borehole logs and well construction details are presented in Appendix 2.

The boreholes were drilled at 150mm diameter and cased to the top of bedrock. Groundwater strikes were not recorded in the subsoils. Bedrock was encountered in MW-1 at 2.7m, MW-2 at 2m, MW-3 at 1.5m and in MW-4 at 0.3m. Groundwater was encountered in MW-1 at 3.56m, in MW-2 at 9.5m, in MW-3 at 9.6m and in MW-4 at 10.2m. The total depths of the boreholes ranged from 10m in MW-1 to 14m in MW-3.

The monitoring wells were constructed using uPVC 50 mm diameter standpipe. A slotted section of standpipe was installed in the water bearing section of the bedrock in each borehole. The remainder of the well piping above the slotted section comprised solid 50mm uPVC pipe.

The annulus surrounding the slotted section in each well was back filled with washed pea gravel to act as a filter. Above the pea gravel the annulus surrounding the solid well pipe was back filled with bentonite to act as a seal to prevent the infiltration of surface water into the water bearing section of the well. Each borehole was finished with an upright steel well head set in concrete.

## 3.2 Groundwater Sampling

Groundwater samples were collected from the wells on the 27th July 2011 in accordance with OCM sampling protocols, a copy of which is included in Appendix 3. pH, temperature and electrical conductivity were measured in the field and the results are presented in Table 3.1.

**Table 3.1**

| Well ID | MW-1 | MW-2 | MW-3 | MW-4 |
|---|---|---|---|---|
| Sample Date | 27th July 2011 | 27th July 2011 | 27th July 2011 | 27th July 2011 |
| Water Level (mBTOC) | 3.14 | 8.45 | 7.15 | 8.87 |
| Stick Up (m) | 0.37 | 0.25 | 0.43 | 0.30 |
| Water Level (mBGL) | 2.77 | 8.2 | 6.72 | 8.57 |
| pH (pH Units) | 6.96 | 7.26 | 7.55 | 7.47 |
| Electrical Conductivity (µS/cm) | 789 | 969 | 897 | 776 |
| Temperature (°C) | 13.1 | 13.2 | 13.3 | 13.1 |

After completion of groundwater level measurements, the wells were purged to remove the stagnant water from the well pipe and the surrounding gravel packs. Purging is necessary to ensure that the groundwater parameters measured are representative of the formation and not the stagnant water in the monitoring well or surrounding gravel filter.

The samples were placed in laboratory prepared containers and stored in coolers prior to shipment to Jones Environmental Forensics in the UK.

## 3.3 Groundwater Analysis

The samples were analysed for a range of parameters based on the use of the site as a metal processing facility. The parameters included heavy metals (lead, nickel, copper, zinc, arsenic, antimony, cadmium, chromium and mercury), phenols, Petrol Range Organics, Diesel Range Organics, Benzene, Toluene, Ethylbenzene, and Xylene (BTEX), polycyclic aromatic hydrocarbons (PAH). The methodologies used by the laboratory were ISO/CEN approved or equivalent and the method detection limits (MDL) were all below relevant limits and comparative guidance values.

The laboratory reports are included in Appendix 4 and the results are summarised in Tables 3.2 to 3.4. The table includes Interim Guideline Values (IGV) published by the EPA. The IGVs are not statutory, but were developed to assist in the assessment of impacts on groundwater quality in the context of the implementation of the EU Water Framework Directive. The guidelines are based on, but are more conservative than the Drinking Water quality standards. The table also includes for comparative purposes the Groundwater Threshold Values (GTV) set out in the European Communities Environmental Objectives (Groundwater) Regulations (S.I. 9 of 2010).

With the exception of low levels of nickel in MW-2 (at the MDL) and zinc in MW-2, 3 and 4, heavy metals were not detected. The levels of nickel and zinc are below the IGV. Petroleum hydrocarbons were not detected. With the exception of naphthalene, PAH were not detected. While naphthalene was detected in all the samples, the levels were significantly lower than the IGV. There is no GTV for naphthalene.

## 3.4 Data Interpretation

The analytical results confirm that site activities have not impacted on the quality of the groundwater beneath the site. The data also indicates that the septic tank is not having any impact on the shallow groundwater immediately down hydraulic gradient at MW-1.

**Table 3.2** Metals

| Parameter | Units | MW-1 | MW-2 | MW-3 | MW-4 | IGV | GTV |
|---|---|---|---|---|---|---|---|
| | | 21/07/2011 | 21/07/2011 | 21/07/2011 | 21/07/2011 | | |
| Chromium | mg/l | <0.0015 | <0.0015 | <0.0015 | <0.0015 | 0.03 | 0.0375 |
| Copper | mg/l | <0.007 | <0.007 | <0.007 | <0.007 | 0.03 | 1.5 |
| Arsenic | mg/l | <0.0025 | <0.0025 | <0.0025 | <0.0025 | 0.01 | 0.0075 |
| Antimony | mg/l | <0.002 | <0.002 | <0.002 | <0.002 | - | - |
| Cadmium | mg/l | <0.0015 | <0.0015 | <0.0015 | <0.0015 | 0.005 | 0.00375 |
| Nickel | mg/l | <0.002 | 0.002 | <0.002 | <0.002 | 0.02 | 0.015 |
| Lead | mg/l | <0.005 | <0.005 | <0.005 | <0.005 | 0.01 | 0.01875 |
| Zinc | mg/l | <0.003 | 0.012 | 0.012 | 0.015 | 0.1 | - |
| Mercury | mg/l | <0.001 | <0.001 | <0.001 | <0.001 | 0.001 | 0.00075 |

**Table 3.3** Hydrocarbons

| Parameter | Units | MW-1 | MW-2 | MW-3 | MW-4 | IGV | GTV |
|---|---|---|---|---|---|---|---|
| | | 21/07/2011 | 21/07/2011 | 21/07/2011 | 21/07/2011 | | |
| EPH (C8-C40) | ug/l | <10 | <10 | <10 | <10 | 10 | - |
| Mineral Oil (Calculation) | ug/l | <10 | <10 | <10 | <10 | 10 | - |
| Total Phenols | mg/l | <0.15 | <0.15 | <0.15 | <0.15 | 0.0005 | - |
| GRO (C4-C8) | ug/l | <100 | <100 | <100 | <100 | 10 | - |
| GRO (C8-C12) | ug/l | <100 | <100 | <100 | <100 | 10 | - |
| GRO (C4-12) | ug/l | <100 | <100 | <100 | <100 | 10 | - |
| MTBE | ug/l | <5 | <5 | <5 | <5 | 30 | - |
| Benzene | ug/l | <5 | <5 | <5 | <5 | 1 | 0.75 |
| Toluene | ug/l | <5 | <5 | <5 | <5 | 10 | - |
| Ethyl benzene | ug/l | <5 | <5 | <5 | <5 | 10 | - |
| m/p-Xylene | ug/l | <5 | <5 | <5 | <5 | 10 | - |
| o-Xylene | ug/l | <5 | <5 | <5 | <5 | 10 | - |

**Table 3.4** PAHs

| Parameter | Units | MW-1 | MW-2 | MW-3 | MW-4 | IGV | GTV |
|---|---|---|---|---|---|---|---|
| | | 21/07/2011 | 21/07/2011 | 21/07/2011 | 21/07/2011 | | |
| Naphthalene | ug/l | 0.020 | 0.020 | 0.030 | 0.020 | 1 | - |
| Acenaphthylene | ug/l | <0.013 | <0.013 | <0.013 | <0.013 | - | - |
| Acenaphthene | ug/l | <0.013 | <0.013 | <0.013 | <0.013 | - | - |
| Fluorene | ug/l | <0.014 | <0.014 | <0.014 | <0.014 | - | - |
| Phenanthrene | ug/l | <0.011 | <0.011 | <0.011 | <0.011 | - | - |
| Anthracene | ug/l | <0.013 | <0.013 | <0.013 | <0.013 | - | - |
| Fluoranthene | ug/l | <0.012 | <0.012 | <0.012 | <0.012 | 1 | - |
| Pyrene | ug/l | <0.013 | <0.013 | <0.013 | <0.013 | - | - |
| Benz(a)anthracene | ug/l | <0.015 | <0.015 | <0.015 | <0.015 | - | - |
| Chrysene | ug/l | <0.011 | <0.011 | <0.011 | <0.011 | - | - |
| Benzo(bk)fluoranthene | ug/l | <0.018 | <0.018 | <0.018 | <0.018 | 0.5 | - |
| Benzo(a)pyrene | ug/l | <0.016 | <0.016 | <0.016 | <0.016 | 0.01 | - |
| Indeno(123cd)pyrene | ug/l | <0.011 | <0.011 | <0.011 | <0.011 | 0.05 | - |
| Dibenzo(ah)anthracene | ug/l | <0.01 | <0.01 | <0.01 | <0.01 | - | 0.0075 |
| Benzo(ghi)perylene | ug/l | <0.011 | <0.011 | <0.011 | <0.011 | 0.05 | - |
| PAH 16 Total | ug/l | <0.195 | <0.195 | <0.195 | <0.195 | - | 0.075 |
| Benzo(b)fluoranthene | ug/l | <0.01 | <0.01 | <0.01 | <0.01 | - | - |
| Benzo(k)fluoranthene | ug/l | <0.01 | <0.01 | <0.01 | <0.01 | - | - |

# 4 CONCLUSIONS AND RECOMMENDATIONS

## 4.1 Conclusions

The site is entirely covered with impermeable hardstanding and buildings, which prevents infiltration of rainfall to the subsoils. The surface water drainage system, including the settlement tank and interceptor appear to be functioning properly.

The bedrock aquifer beneath the site is characterised by the GSI as a Locally Important Aquifer (**Ll**), which is moderately productive only in local zones. Based on the site investigation data, the aquifer vulnerability is extreme. There are no public or private groundwater wells used for potable supply within 2km of the site.

The groundwater quality monitoring has established that the groundwater beneath the site has not been impacted by either the historical or current use of the site. The findings support the conclusions of the 2010 Environmental Site Assessment that the site activities are not impacting on the subsoil or groundwater quality beneath or down gradient of the facility.

## 4.2 Recommendations

The groundwater monitoring should wells be clearly identified and protected by providing buffer areas around the wells where material cannot be placed on the ground. This is to prevent damage to the wells during day to day site activities.

# APPENDIX 1

OCM 2010 Report

(Refer to Appendix 6.4.2 for this document)

# APPENDIX 2

## Borehole Logs

O'Callaghan Moran & Associates
Phone: 021-4321521 Fax: 021-4321522

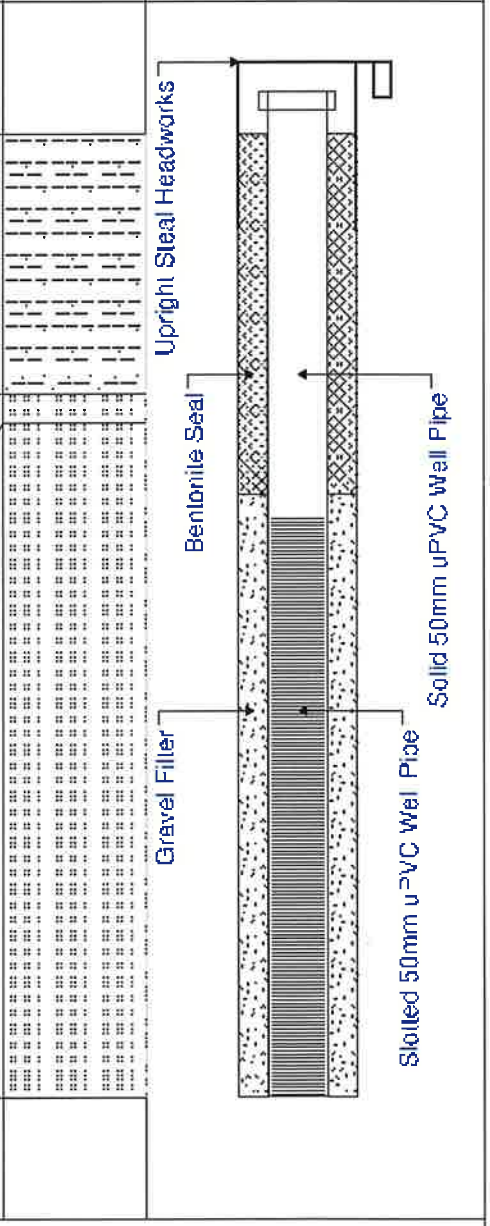
# Borehole I.D. MW-1

Project: 11 099 10
Client: Hammond Lane Metal Co.
Location: Ringaskiddy, Cork
Borehole Depth: 10m
SWL (m): 2.66m
Borehole Type: Monitoring Well

| Depth (m) | Lithology Description |
|---|---|
| 0 | Ground Surface |
| 0 | **Clay**<br>Brown sandy slightly gravelly Clay. |
| 2.7 | **Rock**<br>Very broken green/grey fine grained Sandstone. Top of bedrock slightly damp. |
| 3.7 | **Rock**<br>Competent green grey fine grained sandstone.<br>Very slight inflow of water at 3.5m.<br>Water strike at 6.5m. |
| 10 | |

Lithology

Well Construction Details



Drilling Contractor: Ground Investigations Ireland
Drill Method: Air Rotary
Drill Date: 21/07/2011
Hole Size: 150mm
Geologist: B. Sexton
Sheet: 1 of 1

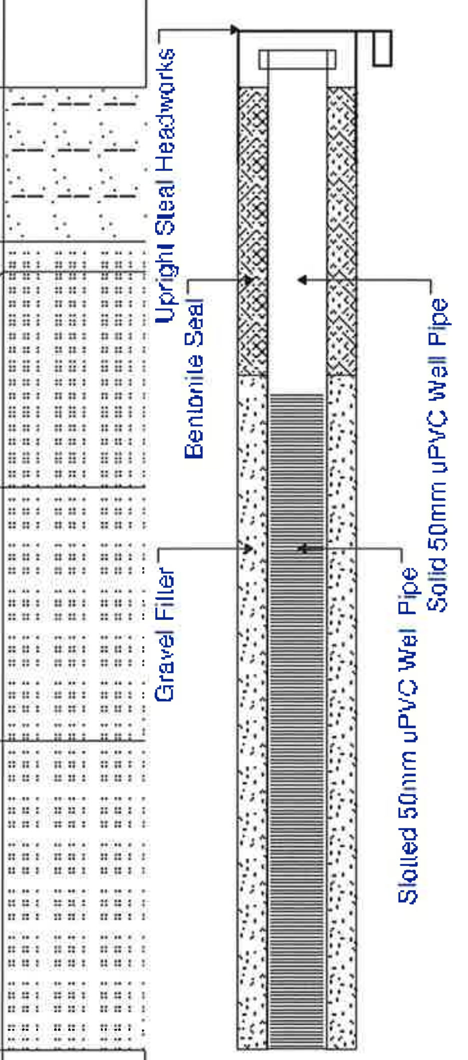
O'Callaghan Moran & Associates
Phone: 021-4321521 Fax: 021-4321522

# Borehole I.D. MW-2

Project: 11 099 10
Client: Hammond Lane Metal Co.
Location: Ringaskiddy, Cork
Borehole Depth: 12.5m
SWL (m): 8.43m
Borehole Type: Monitoring Well

| Depth (m) | Lithology Description |
|---|---|
| -1 | |
| 0 | Ground Surface |
| | **Fill**<br>Fill material comprising brown sandy slightly gravelly Clay. |
| 2 | **Rock**<br>Very broken green/grey fine grained Sandstone. |
| 3 | **Rock**<br>Competent green grey fine grained sandstone. |
| 5 | **Rock**<br>Very fine grained brown to red sandstone. |
| 9 | **Rock**<br>Grey fine grained sandstone.<br>Water inflow at 9.5m. |

Lithology | Well Construction Details

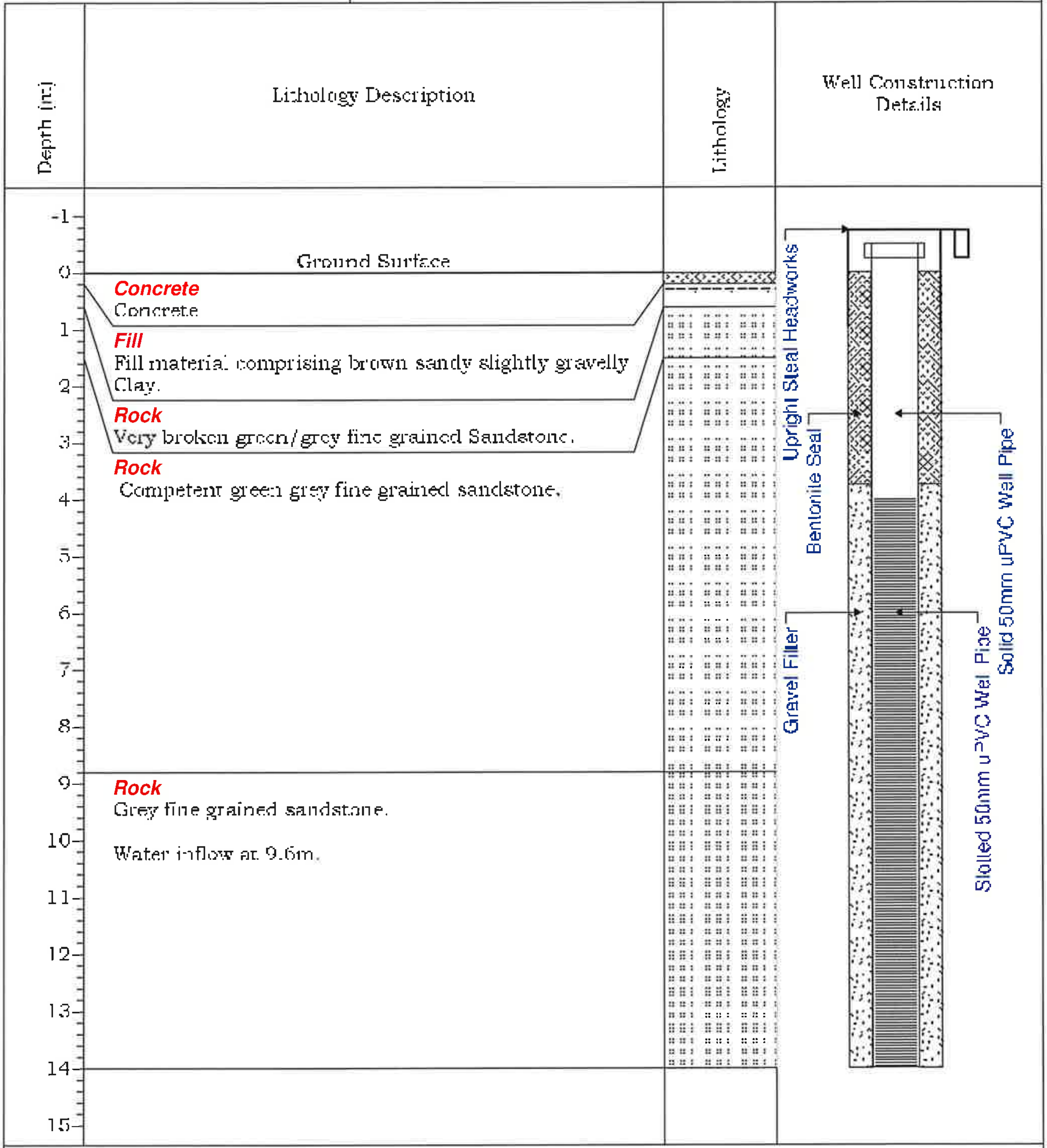


Drilling Contractor: Ground Investigations Ireland
Drill Method: Air Rotary
Drill Date: 21/07/2011
Hole Size: 150mm
Geologist: B. Sexton
Sheet: 1 of 1

O'Callaghan Moran & Associates
Phone: 021-4321521 Fax: 021-4321522

# Borehole I.D. MW-3

| | |
|---|---|
| Project: 11 099 10 | Borehole Depth: 14m |
| Client: Hammond Lane Metal Co. | SWL (m): 6.97m |
| Location: Ringaskiddy, Cork | Borehole Type: Monitoring Well |



**Concrete**
Concrete

**Fill**
Fill material comprising brown sandy slightly gravelly Clay.

**Rock**
Very broken green/grey fine grained Sandstone.

**Rock**
Competent green grey fine grained sandstone.

**Rock**
Grey fine grained sandstone.

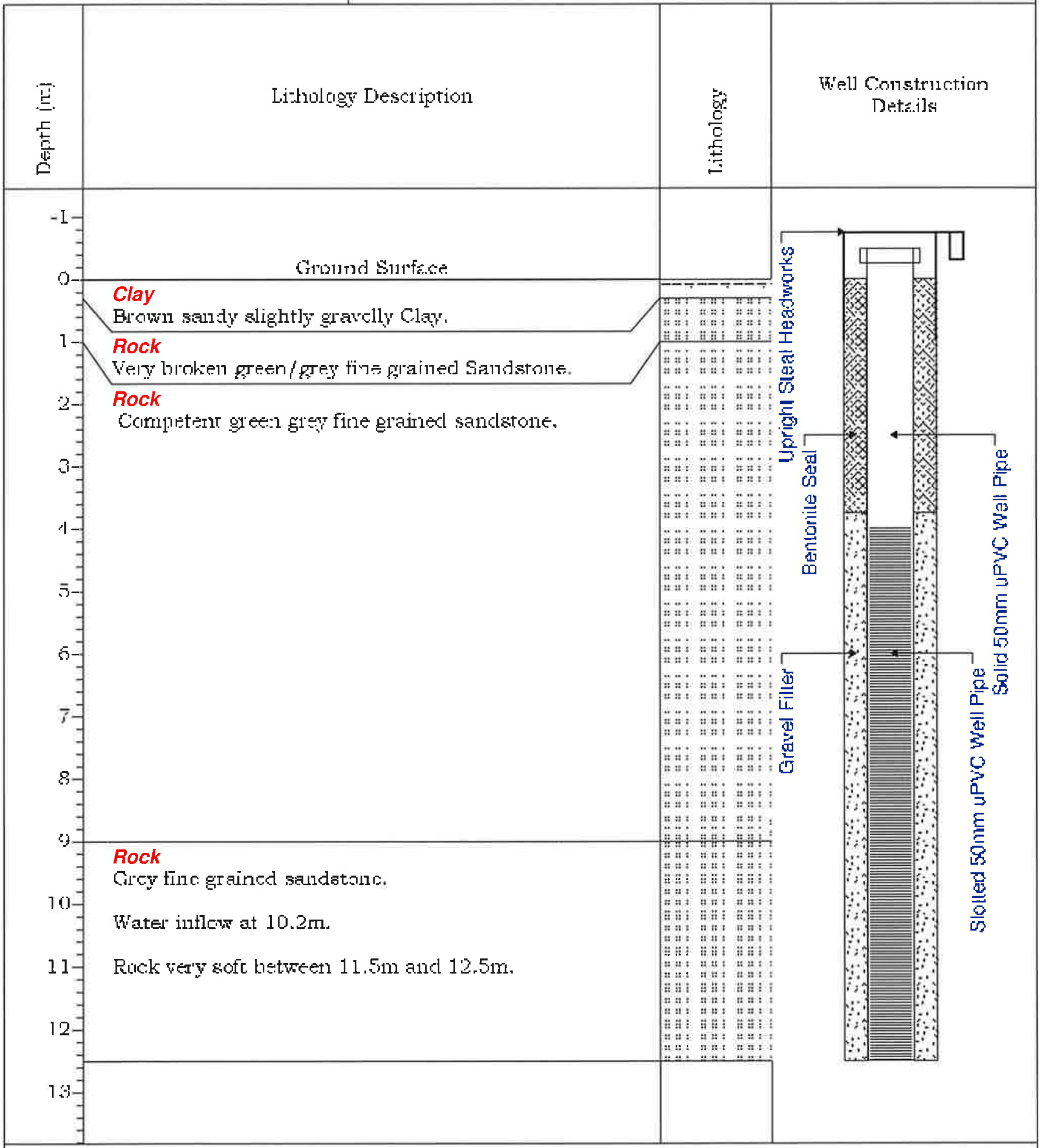
Water inflow at 9.6m.

| | |
|---|---|
| Drilling Contractor: Ground Investigations Ireland | Hole Size: 150mm |
| Drill Method: Air Rotary | Geologist: B. Sexton |
| Drill Date: 21/07/2011 | Sheet: 1 of 1 |

O'Callaghan Moran & Associates
Phone: 021-4321521 Fax: 021-4321522

# Borehole I.D. MW-4

| | |
|---|---|
| Project: 11 099 10 | Borehole Depth: 12.5m |
| Client: Hammond Lane Metal Co. | SWL (m): |
| Location: Ringaskiddy, Cork | Borehole Type: Monitoring Well |



**Clay**
Brown sandy slightly gravelly Clay.

**Rock**
Very broken green/grey fine grained Sandstone.

**Rock**
Competent green grey fine grained sandstone.

**Rock**
Grey fine grained sandstone.

Water inflow at 10.2m.

Rock very soft between 11.5m and 12.5m.

| | |
|---|---|
| Drilling Contractor: Ground Investigations Ireland | Hole Size: 150mm |
| Drill Method: Air Rotary | Geologist: B. Sexton |
| Drill Date: 22/07/2011 | Sheet: 1 of 1 |

# APPENDIX 3

## OCM Sampling Protocol

# STANDARD OPERATING PROCEDURE

# GROUNDWATER SAMPLING

---

The primary objective of groundwater sampling is to evaluate whether the potential contaminant sources at a site have impacted the quality of the groundwater in the underlying aquifer. The additional objective is to measure hydraulic gradient, or slope, of the water table in the shallow aquifer in an effort to evaluate the direction of groundwater flow.

The purpose of this procedure is to ensure that representative samples of groundwater are collected and documented using consistent methods to ensure sample integrity.

## 1.0 SAMPLING PROCEDURES

### 1.1 Well Operating and Purging Procedures

All groundwater sampling will be conducted after the installed and developed wells have been allowed to equilibrate for at least 2 to 3 days. A Field Data Sheet for Well Sampling will be completed for each well.

Groundwater sampling teams will use to following procedure for approaching, opening, purging and sampling all wells unless directed otherwise by the workplan.

1) Prior to placing any equipment into the well, decontaminate the sampling equipment according to standard decontamination protocol.

2) Approach the well with a working FID/PID , a well key, and a depth-to-water meter.

3) Unlock and open the well cap just enough to insert the probe of the PID/FID. Take and record a reading. A decision to upgrade PPE may be necessary based on the FID/PID readings in the breathing zone.

4) Where practical, the surface water column will be visually examined for the presence of hydrocarbons, if present or suspected, the thickness of the hydrocarbon layer will be measured using either an oil/water interface probe or transparent bailer prior to taking the depth-to-water measurement.

5) Insert the water level probe into the well and measure and record the static water level to the nearest 0.01 m with respect to the established survey point on top of the well casing.

6) Decontaminate the water level probe with DDI water (Do not rinse with any solvents unless product was encountered).

7) Calculate and record the minimum volume of water to be purged according to the following conversion factors: -

1 well volume = water column in metres x litres/linear metre

2 inch casing = 2.0 LPM
4 inch casing = 8.1 LPM
6 inch casing = 18.2 LPM
8 inch casing = 32.4 LPM

8) Purge the well of at least 3 casing volumes by pumping using a peristaltic pump with flow controller or bailing with a decontaminated submersible pump or PVC bailer equipped with a bottom filling check valve (if the purge volume is low, generally less than 100 litres, the sampling team might find it more efficient to purge with a bailer than a pump). Use a graduated bucket to track the amount of water removed from the well. The determination of purging and sampling will depend on parameters being analysed. Periodically determine the pH, temperature and specific conductance of the purged water. Continue purging until the well has been completely evacuated or until the pH and specific conductance measurements have stabilised for at least one well volume. Wells that become dewatered prior to producing three casing volumes will be sampled as soon as practical once they recover sufficiently.

9) Dispose of purge water collected in the graduated bucket by dumping onto the ground at a distance of 50 to 60 metres from the vicinity of the well. If the water is known or suspected to be significantly contaminated, it may be necessary to store the purge water in a secure container, such as a drum, pending proper disposal.

10) Be aware and record any unusual occurrence during purging such as cascading (a shallow water entry zone that trickles into the borehole).

## 1.2 <u>Field Parameter Measurement</u>

Measurements of field parameters of pH, temperature and electrical conductivity are collected and organic vapour screening is conducted while the well is purged. To facilitate the collection of basic field parameters, the field team needs to: -

- Purge three well volumes of water from the well and measure field parameters for each well volume removed.

- Collection of water samples should take place after stabilisation of the following parameters: -

  - Temperature $^{+}$/- 1°C
  - pH (meter or paper) $^{+}$/- 0.2 units
    Dissolved Oxygen +/-0.1 mg/l
  - Specific conductivity $^{+}$/- 5%

- If the aforementioned parameters do not stabilise within three purge volumes, the well will be purged up to a maximum of six borehole volumes unless two consecutive sets of stabilised parameters are obtained.

- Note any observations in the field logbook.

## 1.3 Collection of Water Samples

All samples or chemical analysis will be placed in laboratory prepared bottles. The types of sample containers and preservative required for each type of analysis are described in the workplan. Where product layers are present a procedure and rational for the collection of such layers should be outlined in the site specific work plan. If required, preservatives will be placed in the sample containers prior to collecting the samples.

The following procedure will be used to sample a well: -

1) After the well has been purged and allowed to recover, sample the well using a properly decontaminated or dedicated disposable bailer. Gently lower the bailer into the water column. Allow the bailer to sink and fill with a minimum of surface disturbance.

2) Slowly raise the bailer out of the well. Do not allow the bailer line to contact the ground, either by coiling it on a clean plastic sheet or by looping it from arm to arm as the line is extracted from the well.

3) Samples will be collected for VOCs analysis immediately after purging is complete and before other samples are collected. Pour the samples slowly into the laboratory prepared 40 ml glass vial. Overfill each vial slightly to eliminate air bubbles, a convex meniscus should be present at the top of the vial. Ensure that the Teflon liner of the septum cap is facing inward and that no bubbles are entrapped. After capping securely, turn bottle upside-down, tap it against your other hand, and observe sample water for bubbles. If bubbles are observed, remove the cap, overfill the vial and reseal. Repeat this step for each vial until the samples with no bubbles are obtained.

4) Place a label on the container and enter the following information: -

   Client/Site Name
   Date Collected
   Time Collected
   Analysis
   Preservative
   Sample Identification Number

5) Record pertinent information in the field logbook and on the Field Data Sheet for Well Sampling. Complete chain-of-custody form.

6) Place custody seals on the container caps. As soon as possible, place sample containers in a cooler with bagged ice and maintain at 4°C until extraction. Surround the bottles with vermiculite.

7) Obtain the semi-volatile compound/pesticides/PCBs sample(s) by transferring the water to a laboratory prepared 1000 ml amber glass bottle with Teflon-lined cap. Fill the bottle to the bottom of the neck and follow steps 4, 5 and 6 above.

8) Dissolved metals (if necessary) requires the team to filter the sample water through a .45 micron filter. The water is collected in a 1 litre, unpreserved, plastic or glass bottle with $HNO_3$ preservative. Filtering must be done within 15 minutes of sample collection.

9) Obtain the total metals sample by directly transferring the water from the bailer into a laboratory prepared 1000 ml plastic or glass bottle with $HNO_3$ preservative.

10) Be sure the pH of the metals sampled is less than 2 by pouring off an aliquot in a clean jar and testing for pH using litmus paper. Dispose of this water and rinse the jar.

11) Collect and prepare Field QA/QC samples in accordance with separate SOP.

12) Be sure to record all data required on the Field Data Sheet or Well Sampling and appropriate entries into the field logbook.

13) Secure the well cap and replace the locking cover.

14) Decontaminate all sampling equipment according to procedure.

15) Decontaminate submersible pumps as follows: -

Scrub pump and cord in a tub of Liquinox/or similar and potable water
Pump at least 80 litres of soapy water through pump
Rinse with potable water
Pump at least 80 litres of rinse water through the pump
Rinse with D1 water before lowering pump into the next well.

END.

# APPENDIX 4

## Laboratory Results

# *Jones Environmental Laboratory*

Unit 3 Deeside Point
Zone 3
Deeside Industrial Park
Deeside
CH5 2UA

Tel: +44 (0) 1244 833780
Fax: +44 (0) 1244 833781

O'Callaghan Moran & Associates
Granary House
Rutland Street
Cork
Ireland

**No.4225**

**Attention :** Barry Sexton

**Date :** 4th August, 2011

**Your reference :** 11-099-10

**Our reference :** Test Report 11/5533 Batch 1

**Location :** HAMMOND LANE RINGASKIDDY

**Date samples received :** 28th July, 2011

**Status :** Final report

**Issue :** 1

Four samples were received for analysis on 28th July, 2011. Please find attached our Test Report which should be read with notes at the end of the report and should include all sections if reproduced. Interpretations and opinions are outside the scope of any accreditation, and all results relate only to samples supplied.
All analysis is carried out on as received samples and reported on a dry weight basis unless stated otherwise. Results are not surrogate corrected.

**J W Farrell- Jones CChem FRSC**
**Chartered Chemist**

## *Jones Environmental Laboratory*

***Client Name:*** O'Callaghan Moran & Associates **Report : Liquid**
***Reference:*** 11-099-10
***Location:*** HAMMOND LANE RINGASKIDDY
***Contact:*** Barry Sexton
***JE Job No.:*** 11/5533

**Liquids/products:** V=40ml vial, G=glass bottle, P=plastic bottle
H=$H_2SO_4$, Z=ZnAc, N=NaOH, HN=$HNO_3$

Please see attached notes for all abbreviations and acronyms

| **J E Sample No.** | 1-5 | 6-10 | 11-15 | 16-20 | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Sample ID** | MW-1 | MW-2 | MW-3 | MW-4 | | | | | | | | | |
| **Depth** | | | | | | | | | | | | | |
| **COC No / misc** | | | | | | | | | | | | | |
| **Containers** | V H P G | V H P G | V H P G | V H P G | | | | | | | | | |
| **Sample Date** | 21/07/2011 | 21/07/2011 | 21/07/2011 | 21/07/2011 | | | | | | | | | |
| **Sample Type** | Ground Water | Ground Water | Ground Water | Ground Water | | | | | | | | | |
| **Batch Number** | 1 | 1 | 1 | 1 | | | | | | | **LOD** | **Units** | **Method No.** |
| **Date of Receipt** | 28/07/2011 | 28/07/2011 | 28/07/2011 | 28/07/2011 | | | | | | | | | |
| Dissolved Antimony # | <2 | <2 | <2 | <2 | | | | | | | <2 | ug/l | TM30/PM14 |
| Dissolved Arsenic # | <2.5 | <2.5 | <2.5 | <2.5 | | | | | | | <2.5 | ug/l | TM30/PM14 |
| Dissolved Cadmium # | <0.5 | <0.5 | <0.5 | <0.5 | | | | | | | <0.5 | ug/l | TM30/PM14 |
| Total Dissolved Chromium # | <1.5 | <1.5 | <1.5 | <1.5 | | | | | | | <1.5 | ug/l | TM30/PM14 |
| Dissolved Copper # | <7 | <7 | <7 | <7 | | | | | | | <7 | ug/l | TM30/PM14 |
| Dissolved Lead # | <5 | <5 | <5 | <5 | | | | | | | <5 | ug/l | TM30/PM14 |
| Dissolved Mercury # | <1 | <1 | <1 | <1 | | | | | | | <1 | ug/l | TM30/PM14 |
| Dissolved Nickel # | <2 | 2 | <2 | <2 | | | | | | | <2 | ug/l | TM30/PM14 |
| Dissolved Zinc # | <3 | 12 | 12 | 15 | | | | | | | <3 | ug/l | TM30/PM14 |
| | | | | | | | | | | | | | |
| **PAH MS** | | | | | | | | | | | | | |
| Naphthalene # | 0.020 | 0.020 | 0.030 | 0.020 | | | | | | | <0.014 | ug/l | TM4/PM30 |
| Acenaphthylene # | <0.013 | <0.013 | <0.013 | <0.013 | | | | | | | <0.013 | ug/l | TM4/PM30 |
| Acenaphthene # | <0.013 | <0.013 | <0.013 | <0.013 | | | | | | | <0.013 | ug/l | TM4/PM30 |
| Fluorene # | <0.014 | <0.014 | <0.014 | <0.014 | | | | | | | <0.014 | ug/l | TM4/PM30 |
| Phenanthrene # | <0.011 | <0.011 | <0.011 | <0.011 | | | | | | | <0.011 | ug/l | TM4/PM30 |
| Anthracene # | <0.013 | <0.013 | <0.013 | <0.013 | | | | | | | <0.013 | ug/l | TM4/PM30 |
| Fluoranthene # | <0.012 | <0.012 | <0.012 | <0.012 | | | | | | | <0.012 | ug/l | TM4/PM30 |
| Pyrene # | <0.013 | <0.013 | <0.013 | <0.013 | | | | | | | <0.013 | ug/l | TM4/PM30 |
| Benz(a)anthracene # | <0.015 | <0.015 | <0.015 | <0.015 | | | | | | | <0.015 | ug/l | TM4/PM30 |
| Chrysene # | <0.011 | <0.011 | <0.011 | <0.011 | | | | | | | <0.011 | ug/l | TM4/PM30 |
| Benzo(bk)fluoranthene # | <0.018 | <0.018 | <0.018 | <0.018 | | | | | | | <0.018 | ug/l | TM4/PM30 |
| Benzo(a)pyrene # | <0.016 | <0.016 | <0.016 | <0.016 | | | | | | | <0.016 | ug/l | TM4/PM30 |
| Indeno(123cd)pyrene # | <0.011 | <0.011 | <0.011 | <0.011 | | | | | | | <0.011 | ug/l | TM4/PM30 |
| Dibenzo(ah)anthracene # | <0.01 | <0.01 | <0.01 | <0.01 | | | | | | | <0.01 | ug/l | TM4/PM30 |
| Benzo(ghi)perylene # | <0.011 | <0.011 | <0.011 | <0.011 | | | | | | | <0.011 | ug/l | TM4/PM30 |
| PAH 16 Total # | <0.195 | <0.195 | <0.195 | <0.195 | | | | | | | <0.195 | ug/l | TM4/PM30 |
| Benzo(b)fluoranthene | <0.01 | <0.01 | <0.01 | <0.01 | | | | | | | <0.01 | ug/l | TM4/PM30 |
| Benzo(k)fluoranthene | <0.01 | <0.01 | <0.01 | <0.01 | | | | | | | <0.01 | ug/l | TM4/PM30 |
| PAH Surrogate % Recovery | 121 | 99 | 134 | 124 | | | | | | | <0 | % | TM4/PM30 |
| | | | | | | | | | | | | | |
| EPH (C8-C40) # | <10 | <10 | <10 | <10 | | | | | | | <10 | ug/l | TM5/PM30 |
| Mineral Oil (Calculation) | <10 | <10 | <10 | <10 | | | | | | | <10 | ug/l | TM5/PM30 |
| Total Phenols HPLC | <0.15 | <0.15 | <0.15 | <0.15 | | | | | | | <0.15 | mg/l | TM26/PM0 |
| GRO (C4-C8) # | <100 | <100 | <100 | <100 | | | | | | | <100 | ug/l | TM36/PM12 |
| GRO (C8-C12) # | <100 | <100 | <100 | <100 | | | | | | | <100 | ug/l | TM36/PM12 |
| GRO (C4-12) # | <100 | <100 | <100 | <100 | | | | | | | <100 | ug/l | TM36/PM12 |
| MTBE # | <5 | <5 | <5 | <5 | | | | | | | <5 | ug/l | TM36/PM12 |
| Benzene # | <5 | <5 | <5 | <5 | | | | | | | <5 | ug/l | TM36/PM12 |
| Toluene # | <5 | <5 | <5 | <5 | | | | | | | <5 | ug/l | TM36/PM12 |
| Ethyl benzene # | <5 | <5 | <5 | <5 | | | | | | | <5 | ug/l | TM36/PM12 |
| m/p-Xylene # | <5 | <5 | <5 | <5 | | | | | | | <5 | ug/l | TM36/PM12 |
| o-Xylene # | <5 | <5 | <5 | <5 | | | | | | | <5 | ug/l | TM36/PM12 |

# NOTES TO ACCOMPANY ALL SCHEDULES AND REPORTS

## SOILS

Please note we are only MCERTS accredited for sand, loam and clay and any other matrix is outside our scope of accreditation.

Where an MCERTS report has been requested, you will be notified within 48 hours of any samples that have been identified as being outside our MCERTS scope. As validation has been performed on clay, sand and loam, only samples that are predominantly these matrices, or combinations of them will be within our MCERTS scope. If samples are not one of a combination of the above matrices they will not be marked as MCERTS accredited.

It is assumed that you have taken representative samples on site and require analysis on a representative subsample. Stones will generally be included unless we are requested to remove them.

All samples will be discarded one month after the date of reporting, unless we are instructed to the contrary. If we are instructed to keep samples, a storage charge of £1 (1.5 Euros) per sample per month will be applied until we are asked to dispose of them.

If you have not already done so, please send us a purchase order if this is required by your company.

Where appropriate please make sure that our detection limits are suitable for your needs, if they are not, please notify us immediately.

All analysis is reported on a dry weight basis unless stated otherwise. Results are not surrogate corrected. Samples are dried at 35°C unless otherwise stated. Moisture content for CEN Leachate tests are dried at 105°C

## WATERS

Please note we are not a Drinking Water Inspectorate (DWI) Approved Laboratory . It is important that detection limits are carefully considered when requesting water analysis.

UKAS accreditation applies to surface water and groundwater and one other matrix which is analysis specific, any other liquids are outside our scope of accreditation

As surface waters require different sample preparation to groundwaters the laboratory must be informed of the water type when submitting samples. All samples are treated as groundwaters and analysis performed on settled samples unless we are instructed otherwise.

## DEVIATING SAMPLES

Samples must be received in a condition appropriate to the requested analyses. All samples should be submitted to the laboratory in suitable containers with sufficient ice packs to sustain an appropriate temperature for the requested analysis. If this is not the case you will be informed and any analysis that may be compromised highlighted on your schedule/ report by the use of a symbol.

*The use of any of the following symbols indicates that the sample was deviating and the test result may be unreliable:*

| | |
|---|---|
| $ | Sample temperature on receipt considered inappropriate for analysis requested. |
| ^ | Samples exceeding recommended holding times. |
| & | Samples received in inappropriate containers (e.g. volatile samples not submitted in VOC jars/vials). |
| ~ | No sampling date given, unable to confirm if samples are with acceptable holding times. |

## SURROGATES

Surrogate compounds are added during the preparation process to monitor recovery of analytes. However low recovery in soils is often due to peat, clay or other organic rich matrices. For waters this can be due to oxidants, surfactants, organic rich sediments or remediation fluids. Acceptable limits for most organic methods are 70 - 130% and for VOCs are 50 - 150%. When surrogate recoveries are outside the performance criteria but the associated AQC passes this is assumed to be due to matrix effect. Results are not surrogate corrected.

## AQCs

Where AQC's fall outside UKAS/MCERTS criteria analysis is repeated if possible.

## NOTE

Data is only accredited when all the requirements of our Quality System have been met. In certain circumstances where the requirements have not been met, the laboratory may issue the data in its final report if it believes that the validity of the data has not been conpromised but will remove the accreditation. Please do not hesitate to contact the laboratory if further details are required of the circumstances which have led to the removal of accreditation.

**ABBREVIATIONS and ACRONYMS USED**

| | |
|---|---|
| # | UKAS accredited. |
| M | MCERTS accredited. |
| NAD | No Asbestos Detected. |
| NFD | No Fibres Detected |
| ND | None Detected (usually refers to VOC and/SVOC TICs). |
| SS | Calibrated against a single substance. |
| * | Analysis subcontracted to a Jones Environmental approved laboratory. |
| W | Results expressed on as received basis. |
| + | Accreditation has been removed from this result, if appropriate, see 'Note' on previous page. |
| ++ | Result outside calibration range, results should be considered as indicative only and are not accredited. |
| SV | Surrogate recovery outside performance criteria. This may be due to a matrix effect. |
| DR | Dilution required. |

| Test Method No. | Description | Prep Method No. (if appropriate) | Description | UKAS | MCERTS (soils only) | Analysis done on As Received (AR) or Air Dried (AD) | Solid Results expressed on Dry/Wet basis |
|---|---|---|---|---|---|---|---|
| TM4 | 16 PAH by GC-MS, modified USEPA 8270 | PM30 | Magnetic stirrer extraction | | | | |
| TM4 | 16 PAH by GC-MS, modified USEPA 8270 | PM30 | Magnetic stirrer extraction | Yes | | | |
| TM5 | EPH by GC-FID, modified USEPA 8015 | PM30 | Magnetic stirrer extraction | | | AR | |
| TM5 | EPH by GC-FID, modified USEPA 8015 | PM30 | Magnetic stirrer extraction | Yes | | AR | |
| TM26 | Phenols by HPLC | PM0 | No Preparation | | | | |
| TM30 | Metals by ICP-OES | PM14 | Metals by ICP (Waters) | Yes | | | |
| TM36 | GRO by Headspace GC-FID | PM12 | GRO GC-FID | Yes | | | |
| | | | | | | | |
| | | | | | | | |
| | | | | | | | |
| | | | | | | | |
| | | | | | | | |
| | | | | | | | |
| | | | | | | | |
| | | | | | | | |
| | | | | | | | |
| | | | | | | | |
| | | | | | | | |
| | | | | | | | |
| | | | | | | | |
| | | | | | | | |
| | | | | | | | |
| | | | | | | | |
| | | | | | | | |
| | | | | | | | |
| | | | | | | | |
| | | | | | | | |
| | | | | | | | |
| | | | | | | | |
| | | | | | | | |
| | | | | | | | |
| | | | | | | | |
| | | | | | | | |
| | | | | | | | |
| | | | | | | | |
| | | | | | | | |
| | | | | | | | |
| | | | | | | | |
| | | | | | | | |
| | | | | | | | |
| | | | | | | | |
| | | | | | | | |