Appendix 13.1

Soil and Hydrogeological Investigation (K.T. Cullen & Co. Ltd) & Hydrogeological Assessment for Hammond Lane Metal Company

soils + geology

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SOIL AND HYDROGEOLOGICAL INVESTIGATION

Greenfield Site,
Ringaskiddy,
Co. Cork,

FINAL REPORT

Janaury 2001

Prepared for:

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Soil and Hydrogeological Investigation
at
Greenfield Site, Ringaskiddy, Co. Cork

1 INTRODUCTION

At the request of Project Management Ltd., K.T. Cullen & Co. Ltd were requested to undertake a full baseline hydrogeological investigation of a greenfield site at Ringaskiddy, Co. Cork.

This hydrogeological investigation involved the excavation of trial pits, installation of monitoring wells, and sampling/analyses of both soil and groundwater.

The investigation was carried out to establish baseline conditions of soil and groundwater beneath the site, and to determine any going concerns regarding potential contamination in the subsurface. Field data was also collected on the hydrogeological conditions encountered on site.

2 SITE DESCRIPTION

2.1 Physical Features

The site is currently covered with grassland and appears to have been used for agricultural purposes in the past. The east of the site is covered with gorse scrub. It is understood that large amounts of soil was removed from the site in the past for reclamation purposes in the vicinity of the site, resulting in the steep embankment located towards the southern boundary of the site.

2.2 Land Use

The surrounding land is predominantly agricultural but industrial sites are common in the Ringaskiddy area. Existing developments include the Hammond Lane Metal Company (HLM), located in the centre of the proposed site for development. Ispat Metal Processors are located to the north of the site, and Ringaskiddy Port to the northeast of the site.

2.3 Hydrology

2.3.1 Regional Drainage

The proposed area for development lies within 50m of the West Channel into Cork Harbour.

2.3.2 Local Drainage

Surface water within the site boundary appears to drain naturally through land drains along the field boundaries, following the natural topography of the landscape, generally towards the north of the site. Drainage is poor close to the road due to recent site activities, resulting in some flooding on site.

2.4 General Geology and Hydrogeology

In considering the impact of the proposed development on the geology and groundwater quality, K.T. Cullen & Co. Ltd. have examined the following factors:

- Rock type and permeability
- Overburden type, thickness and, permeability
- Depth to water table
- Importance of groundwater as a resource
- Groundwater vulnerability

Data has been collated from previous investigations undertaken by this office in the Cork region, from the GSI database for County Cork, and on-site observations.

2.4.1 Bedrock Geology

At this site the bedrock consists of pale green/grey mudstone, and is typical of the Lower Carboniferous Kinsale Formation (Cuskinny Member). It is thought to be between 235 metres and 243 metres thick. This member is typically made up of flaser-bedded sandstones and lenticular-bedded mudstones. It has been described as being composed of relatively thick sometimes conglomeratic sandstone units, alternating with thin sandstone laminated mudstones, massive claystones and heterolithic sediments (Geological Survey of Ireland - Geology of South Cork, 1994)

2.4.2 *Overburden Geology*

The overburden geology consists of a shallow topsoil layer underlain by soft silty clays with some fine sands and gravels. Depth to bedrock varies across the site, from 1.0 metres below ground level (bgl) at BH-1, to greater than 9.0 metres bgl at BH-2. This thickness variation is a reflection of the undulating pre-glacial topography.

Sands were encountered in TP-1, TP-7, TP-16 and TP-17, and these areas are likely to allow water to be stored and to move through the subsurface. As some of the overburden is less than 1.0 metre in thickness (i.e. BH1), vertical migration of water directly into the bedrock aquifer is likely.

2.4.3 *Hydrogeology*

The groundwater potential of Irish rocks is typically a function of fissure flow movement and storage, which is controlled by the intensity and development status of fissures, fractures and joints. The rocks are thought to be generally unproductive (i.e. individual well yields of less than 100 m^3/day and often lower than 40 m^{3}day - Geological Survey of Ireland "Geology of South Cork", 1995) although hydrogeological data is limited. This situation could be confirmed at the site by the drilling of a deep water well into the bedrock.

Water strikes in the bedrock were observed between 5 and 12 metres bgl in the overburden, typically occurring beneath the clays and immediately above the clean bedrock in the fractured/weathered zone.

2.4.4 *Aquifer Vulnerability*

The GSI's Groundwater Protection Scheme Classification ranks the site as having **extreme (E)** vulnerability due to the limited overburden cover, which is less than 1.0 metres in thickness at some of the soil and groundwater survey points. As the bedrock is considered to be a poor but locally productive aquifer **(Pl)**, the area can be assigned the rating **Pl/E** under the GSI classification system.

3 FIELD ACTIVITIES

Field activities for the purpose of this hydrogeological investigation were undertaken in November 2000 and consisted of the following stages:

- Desktop Review of Geology and Hydrogeology
- Soil Sampling
- Monitoring Well Installation

- Groundwater Sampling
- Elevation Survey (yet to be undertaken)

3.1 Soil Sampling

A total of ten trial pits (TP-1 to TP-10) were initially excavated across the site in late November 2000. Additional sampling was undertaken in January 2001 (TP-11 to TP-17) and all sampling locations are shown in Figure 2 of this report. These excavations were undertaken to allow representative soil sample collection. Based on visual observations made on site, soil samples from varying layers were taken from each of the seventeen trial pit locations. Samples were sealed in a laboratory-supplied sample container and maintained at a temperature of <4°C in a mobile field laboratory.

The seventeen soil samples were submitted to Geochem Group Laboratories Ltd. and analysed for the following parameters:

- Petrol and Diesel Range Organics, Mineral Oils
- BTEX Compounds
- Volatile Organic Compounds (VOCs)
- Polycyclic Aromatic Hydrocarbons (PAHs)
- Metals and Total Phenols
- Pesticides (OPPs, OCPs, ONPs)
- Polychlorinated Biphenyls (PCBS)

Trial pit sampling logs are included in Appendix A.

3.2 Monitoring Well Installation

Five permanent monitoring boreholes locations (BH-1, BH-2, BH-3, BH-4, and BH-5) were drilled under the continuous supervision of a K.T. Cullen & Co. Ltd. (KTC) Geologist. The well locations are shown in Figure 2 of this report. These locations were selected during the preliminary site walkover, and are based on the topography and geography of the site.

Items of concern noted during the site walkover include the Hammond Lane Metal Co. (HLM), which is located in the centre of the proposed site. Current activities at this site include the preparation of scrap metal, primarily from crushed cars, for reprocessing at the Ispat site located to the north of the property. The metal is crushed and sorted using magnetic techniques. Potential sources of contamination from this site would include hydrocarbon products remaining in the crushed cars.

Four of the monitoring wells are installed in bedrock. BH-2 was drilled to a depth of 8.5 metres bgl in the overburden, but did not encounter bedrock. Drilling and well construction logs are included in Appendix B of this report.

Narrow slotted screen was installed at all well borings locations, with an internal diameter of 0.05 metres. All screens were connected to the surface by PVC risers. A fine gravel pack was installed around each screen in order to filter water entering the well. Each pack was sealed above by a bentonite seal in order to prevent the vertical migration of fluids through the well annulus.

3.3 Groundwater Sampling

Following installation, each monitoring well was developed by the evacuation of more than three times the annular volume of the well. Well development grades the gravel pack into more complete contact with the aquifer and allows removal of suspended sediment which may remain following the drilling of the monitoring wells. More importantly, well development ensures that future sampling is representative of the quality of water in the surrounding aquifer.

All five monitoring wells were sampled on November 30th 2000, and these samples were subsequently forwarded to Alcontrol/ Geochem Group Laboratories in the U.K. for the following detailed analysis:

- Petrol and Diesel Range Organics, Mineral Oils
- BTEX Compounds
- Volatile Organic Compounds (VOCs)
- Polycyclic Aromatic Hydrocarbons (PAHs)
- Metals
- Pesticides (OPPs, OCPs, ONPs)
- Polychlorinated Biphenyls (PCBS)
- Inorganics

All samples were filled directly from a PVC bailer, preserved at <4°C and shipped to the laboratory in dedicated containers. The number of bottles, their codes and volumes were recorded on Monitoring Well Sampling Logs and on Chain of Custody forms.

4. ANALYTICAL RESULTS

The analytical results for both soil and groundwater are presented in Tables 1 – 15 of this report.

Where relevant, the soil analytical results are discussed below with reference to the Dutch MAC (Maximum Admissible Concentration) thresholds, as standards for soil are not available in Ireland at present.

Groundwater analytical results are compared to the Irish Water Quality Standard for Drinking Water (S.I. No 81 of 1988) and the Dutch MAC Guidelines for groundwater as no other guidelines are currently available. Under the Dutch criteria for both soil and groundwater, the degree of contamination is assessed using the following guidelines:

S-Value	Reference for normal uncontaminated soil/groundwater
I-Value	Threshold for intervention

4.1 Soil Analytical Results

The soil analytical results are presented in Tables 1 – 7 of this report.

4.1.1 PROs, DROs and Mineral Oils

The analytical results for PROS, DROs and Mineral Oils are presented in Table 1. Detected concentrations for PROs, DROs and Mineral Oils reflect normal background concentrations for these parameters.

4.1.2 BTEX Compounds

Results for the BTEX compounds are included in Table 2. Detected concentrations for these parameters were all below the laboratory detection limit of <0.01 mg/kg at all sampling locations.

4.1.3 Volatile Organic Compounds

The analytical results for the VOCs are presented in Tables 3a and 3b and consist of 59 VOC parameters (EPA List). Detected concentrations for all VOCs were below the laboratory detection limit of 1 µg/kg.

4.1.4 Polycyclic Aromatic Hydrocarbons (PAHs)

The analytical results for PAHs are presented in Tables 4a and 4b. The initial PAH results (sum of 10) included in Table 4a indicated concentrations for this parameter at all sampling locations, ranging between 1530 µg/kg to 29282 µg/kg across the site. These values exceed the Dutch MAC S-value of

1000 µg/kg for this parameter.

As the site is a greenfield site, and these values were not expected, a second series of trial pits were excavated in January 2001. TP-11 was placed immediately adjacent to TP-10 following a particularly elevated PAH concentration at this location. A further seven trial pits were excavated around the site. The results for this second sampling round are presented in Table 4b.

In the samples from the repeat trial pits, detected concentrations for the sum of 10 PAHs are considerably lower than in the original sampling round, ranging from 6µg/kg in TP-11 to 54µg/kg again in TP-11. None of the detected concentrations exceed the Dutch MAC S-value for the sum of 10 PAHs.

4.1.5 Metals and Total Phenols

The analytical results for Metals and Total Phenols are presented in Table 5 of this report. All metal parameters were detected below their respective Dutch MAC S-Values.

4.1.6 Pesticides

The analytical results for Pesticides are presented in Table 6 of this report. The Geochem suite consists of three separate types of pesticides including Organochloride, Organonitrate and Organophosphate Pesticides, covering a wide range of these parameters. No pesticides were detected in any soil sample above the laboratory detection limit of 1 µg/kg (laboratory detection limit).

4.1.7 Polychlorinated Biphenyls (PCBs)

Analytical results for PCBs are included in Table 7a and Table 7b of this report. Detected concentrations for the 7 congeners (total) were elevated above the Dutch MAC S-Value for background conditions (20 µg/kg) at TP-2 (0-5.5 metres), and TP-7 (0-2 metres), with levels of 643 µg/kg and 98 µg/kg respectively.

As the site is a greenfield location, KTC rescheduled this analysis to confirm the Alcontrol/ Geochem analytical results. These results are included in Table 7b. The repeated results give values of 13µgkg in TP-2 and 2µgkg in TP7, using a different extraction method, which is more applicable for greenfield sites. These values are less than the Dutch MAC S-Value.

To confirm the above finding, KTC resampled the site at 7 additional sampling locations (TP-11 to TP-17 inclusive). Results for this analysis are included in Table 7 (c) of this report. Detected concentrations for the repeat analysis were below the laboratory detection limit of 1 µg/kg.

4.2 Groundwater Analytical Results

Groundwater analytical results for the five monitoring wells sampled, BH-1 to BH-5 inclusive, are presented in Tables 8 to 15 of this report.

4.2.1 PROs, DROs, Mineral Oils

The analytical results for PROs, DROs and Mineral Oils are included in Table 8 of this report. Concentrations were all below the laboratory detection limit of 10µg/l.

4.2.2 BTEX Compounds

Detected concentrations for the BTEX parameters (Table 9) were below the laboratory detection limit of 10 µg/l at all well sampling locations.

4.2.3 Volatile Organic Compounds

All VOC parameters analysed for in the five groundwater sampling locations were below the laboratory detection limit of 1 µg/l (Table 10a and Table 10b)

4.2.4 Polycyclic Aromatic Hydrocarbons (PAHs)

The 16 priority PAH pollutants, for groundwater are presented in Table 11. Two of the PAHs, in particular Flouranthene and Phenanthrene, were slightly above their respective Dutch MAC S-values in BH-2, however these can be found naturally at such low concentrations.

4.2.5 Toxic Metals

Details of the toxic metal results are included in Table 12 of this report. Arsenic was detected in BH-2 'ightly above the laboratory detection limit of 0.05, and appears to be an anomalous result. KTC has discussed this result with Alcontrol Geochem Ltd and has concluded that sample 'noise' may have affected the reading. Detected concentrations of the other eight metals analysed for are below their respective laboratory detection limits.

4.2.6 Pesticides

The analytical results for Pesticides are presented in Table 13 of this report. Pesticide compounds were not detected in any samples above the laboratory detection limit of 1 µg/l.

4.2.7 Polychlorinated Biphenyls (PCBs)

The analytical results for PCBs are presented in Table 14. PCBs were not detected in any samples above the laboratory detection limit of 1 µg/l.

4.2.8 *Inorganics*

Results for the inorganic parameters are included in Table 15 of this report. Detected concentrations for many of these parameters are indicative of this type of agricultural setting.

However, Ammonia and Nitrite values across the site appear slightly elevated above background concentrations at some of the sampling locations. Ammonia concentrations ranged between 1.0 mg/l and 1.9 mg/l, and Nitrite concentrations reached 0.1 mg/l in BH-3 and BH-4. Elevated concentrations for these parameters suggest slight organic contamination, and may be of an agricultural nature.

5 SUMMARY OF FINDINGS

5.1 Physical Observations

The initial visual walkover survey showed no physical evidence of contamination across the c. 30 acre site.

The physical examination of the soil and groundwater samples carried out at the Greenfield Site, Ringaskiddy, Co. Cork revealed no physical evidence of contamination, such as chemical odours, iridescence, or other signs of contamination in any of the samples.

Much of the soil at the ~~south~~ north and east end of the site has been removed for use in reclamation work in the vicinity of the site to the north. The west of the site has been used for agricultural purposes only, and excluding the Hammond Lane Metal Co. located in the centre of the site, there is no evidence of other developments at the site.

5 Soil Quality Investigation

Initial soil samples taken from the site indicated concentrations for PAHs and PCBs above normal background levels. These results did not reflect on-site observations, and additional samples were taken to establish true conditions on site.

Results from samples taken during the repeat sampling round showed the soil to contain normal concentrations below background levels for these parameters. Following detailed queries regarding the PAH and PCB analysis, Alcontol Geochem has issued an explanation for the anomalous results (Appendix C). It appears that there was a problem with the solvent extraction process during the preparation of the soil samples.

Following detailed soil sampling and repeat analysis, the soil is free of industrial contaminants.

5.3 Groundwater Quality Investigation

Slightly elevated Ammonia and Nitrite concentrations suggest potential organic contamination in the bedrock aquifer. Due to the shallow overburden cover and agricultural activity in this area, these values are not uncommon and are likely to be of agricultural origin.

All other groundwater results reflected normal background conditions for this type of environmental setting.

6 CONCLUSIONS

6.1 Soil and Groundwater Quality

The results of the soil and groundwater sampling suggest that there is no significant soil or groundwater contamination at the Ringaskiddy Greenfield site in Co. Cork.

Repeat sampling for PAHs and PCBs in the soils revealed that previous elevated results were erroneous.

High inorganics in the bedrock aquifer can most likely be attributed to agricultural activities on a site with very little or no overburden cover. It should also be noted that the levels of contamination in the groundwater are only slightly elevated above background.

6.2 Site Vulnerability

Based on visual observations made on site during drilling and soil sampling, the overburden cover is very shallow, in some cases less than 1.0 metres in thickness in parts of the site.

Based on the thickness and type of overburden cover, the aquifer vulnerability for this site is considered extreme (GSI Guidelines for aquifer protection). As the bedrock is considered to be a poor but locally productive aquifer (Pl), the area can be assigned the rating Pl/E under the GSI classification system. (See Appendix D)

6.3 Future Monitoring

To assess any variations in groundwater during the development of the Ringaskiddy Greenfield Site, monitoring of certain indicator parameters at all groundwater sampling locations is recommended.

Respectively submitted,

K. T. Cullen & Co. Ltd.

Conor Wall

1/2/01

CONOR WALL

DATE

Senior Environmental Scientist

1/2/2001

MICHAEL CUNNINGHAM

DATE

Industry Division Manager

APPENDIX A

Trial Pit Records

Project No.: 2626 **Location:** Ringaskiddy, Co. Cork **Date:** 29/11/2000

Excavation Method: HyMac **Supervisor:** Andrew Skelton

TRIAL PIT NO.

TP1

Geology:	Depth (m):	Description:
Till	0-0.1	TOPSOIL comprising medium brown soft damp silty clay with rootlets
	0.1-0.4	Greyish brown loose dry gravelly silty CLAY
	0.4-0.9	Orange loose dry gravelly silty CLAY
	0.9-4	Greyish brown loose gravelly silty CLAY with some greenish horizons with sands becoming frequent
Bedrock	4-4.5	Pale green broken MUDSTONE

Dominant Matrix:

ominant Clasts:

pth to Rock: 4m

Rock Type: Pale green mudstone

tatic Water Level: 1m

Water Entry: 1.8m

Total Depth: 4.5m

Comments: Pit collapsing from 2.5m

Sampled at 1.8m

Trial Pit Records

Project No.: 2626 **Location:** Ringaskiddy, Co. Cork **Date:** 29/11/2000

Excavation Method: HyMac **Supervisor:** Andrew Skelton

TRIAL PIT NO.

TP2

eology:	Depth (m):	Description:
Till	0-0.2	TOPSOIL comprising medium brown moist sandy silt with rootlets
	0.2-0.5	Orange slightly loose dry sandy clayey SILT
	0.5-5.5	Medium brown slightly loose dry gravelly sandy SILT with occasional boulders
edrock	5.5-5.6	Pale green broken MUDSTONE

minant Matrix:

minant Clasts:

Depth to Rock: 5.5m

Rock Type: Pale green mudstone

ic Water Level: 4.5m

Water Entry: 5m

Total Depth: 5.6m

Comments: Sampled from 0-5.5m

Trial Pit Records

Project No.: 2626 **Location:** Ringaskiddy, Co. Cork **Date:** 30/11/2000

Excavation Method: HyMac **Supervisor:** Andrew Skelton

TRIAL PIT NO.

TP3

eology:	Depth (m):	Description:
ill	0-0.1	TOPSOIL comprising medium brown soft silty clay with rootlets
	0.1-0.6	Orange brown silty CLAY
edrock	0.6-1.9	Weathered fractured green MUDSTONE

ominant Matrix:

ominant Clasts:

pth to Rock: 0.6m

Rock Type: Green mudstone

atic Water Level: -

Water Entry: -

Total Depth: 1.9m

Comments: Sampled 0-1.9m

Trial Pit Records

Project No.: 2626 **Location:** Ringaskiddy, Co. Cork **Date:** 30/11/2000

Excavation Method: HyMac **Supervisor:** Conor Wall

TRIAL PIT NO.

TP4

eology:	**Depth (m):**	**Description:**
ll	0-0.1	TOPSOIL
	0.1-2.4	Medium brown silty gravelly CLAY
	2.4-4	Medium brown clayey SILT with fine sands

minant Matrix:

minant Clasts:

Depth to Rock: -

ock Type: -

Water Level: -

Water Entry: Slight entry at 3.4m

Total Depth: 4m

Comments: Sampled 0-3.5m

Trial Pit Records

No.: 2626 **Location:** Ringaskiddy, Co. Cork **Date:** 30/11/2000

tion Method: HyMac **Supervisor:** Andrew Skelton

TRIAL PIT NO.

TP5

Depth (m):	Description:
0-0.2	TOPSOIL
0.2-1	Medium brown soft clayey SILT with occasional gravels
1-2.8	Medium brown soft clayey SILT with sands and gravels

/latrix:

:lasts:

o Rock: -

k Type: -

r Level: 2m

r Entry: 1m, 2.5m

Depth: 2.8m

ıments: Pit collapsing

Sample 0 - 2.8m

o. Ltd.

Trial Pit Records

Project No.: 2626 **Location:** Ringaskiddy, Co. Cork **Date:** 30/11/2000

Excavation Method: HyMac **Supervisor:** Andrew Skelton

TRIAL PIT NO.

TP7

eology:	Depth (m):	Description:
ill	0-2	Medium brown soft clayey SILT with subrounded gravels and frequent subrounded cobbles
	2-3	Medium brown soft clayey fine SAND with subrounded cobbles
edrock	3-4	Broken green mudstone BEDROCK

minant Matrix:

minant Clasts:

Depth to Rock: 3m

Rock Type: Green mudstone

tic Water Level: 3m

Water Entry: 3m

Total Depth: 4m

Comments: Sampled 0-2m and 3-4m

llen & Co. Ltd.

Trial Pit Records

Project No.: 2626 **Location:** Ringaskiddy, Co. Cork **Date:** 30/11/2000

Excavation Method: HyMac **Supervisor:** Andrew Skelton

TRIAL PIT NO.

TP9

eology:	Depth (m):	Description:
ill	0-0.3	Medium brown soft clayey SILT with subrounded gravels and frequent subrounded cobbles
edrock	0.3-1	Pale green broken mudstone BEDROCK

minant Matrix:

minant Clasts:

Depth to Rock: 0.3m

ock Type: Green mudstone

tic Water Level: -

Water Entry: -

Total Depth: 1m

Comments: Sampled 0-1m

ullen & Co. Ltd.

Trial Pit Records

Project No.: 2626 **Location:** Ringaskiddy, Co. Cork **Date:** 30/11/2000

Excavation Method: HyMac **Supervisor:** Andrew Skelton

TRIAL PIT NO.

TP10

eology:	Depth (m):	Description:
ill	0-1	Medium brown gravelly SILT withj frequent subrounded cobbles
edrock	1-1.2	Pale green broken mudstone BEDROCK

ominant Matrix:

ominant Clasts:

Depth to Rock: 1m

Rock Type: Green mudstone

tic Water Level: -

Water Entry: -

Total Depth: 1.2m

Comments: Sampled 0-1m

Trial Pit Records

Project No.: 2626 **Location:** Ringaskiddy, Co. Cork **Date:** 12/1/2001

Excavation Method: HyMac **Supervisor:** Andrew Skelton

TRIAL PIT NO.

TP11

eology:	Depth (m):	Description:
ill	0-3	Medium brown firm dry clayey SILT with frequent angular gravels and frequent angular cobbles and boulders

ominant Matrix:

ominant Clasts:

Depth to Rock: -

Rock Type: -

tic Water Level: -

Water Entry: 2.1m

Total Depth: 3m

Comments: Sampled 0-1m

Sampled 1-3m

No odour

Trial Pit Records

Project No.: 2626 **Location:** Ringaskiddy, Co. Cork **Date:** 12/1/2001

Excavation Method: HyMac **Supervisor:** Andrew Skelton

TRIAL PIT NO.

TP12

eology:	Depth (m):	Description:
ill	0-2.6	Medium brown firm dry gravelly clayey SILT with frequent angular cobbles
ock	2.6-	Pale green fissile mudstone BEDROCK

minant Matrix:

minant Clasts:

Depth to Rock: 2.6m

Rock Type: Pale green mudstone bedrock

tic Water Level: -

Water Entry: -

Total Depth: 2.6m

Comments: Sampled 0-1m

Sampled 1-2.6m

No odour

Trial Pit Records

Project No.: 2626 **Location:** Ringaskiddy, Co. Cork **Date:** 12/1/2001

Excavation Method: HyMac **Supervisor:** Andrew Skelton

TRIAL PIT NO.

TP13

eology:	**Depth (m):**	**Description:**
ill	0-0.2	Grey brown silty GRAVEL
	0.2-2	Medium brown firm dry sandy clayey SILT with frewuent subrounded cobbles and gravels
	2-3.6	Medium brown soft damp silty SAND

ominant Matrix:

ominant Clasts:

Depth to Rock: -

Rock Type: -

atic Water Level: -

Water Entry: 3.4m

Total Depth: 3.6m

Comments: Sampled 0-1m

Sampled 1-3.4m

No odour

Trial Pit Records

roject No.: 2626 **Location:** Ringaskiddy, Co. Cork **Date:** 12/1/2001

Excavation Method: HyMac **Supervisor:** Andrew Skelton

TRIAL PIT NO.

TP14

ology:	**Depth (m):**	**Description:**
	0-2.6	Medium brown firm to soft dry clayey gravelly SILT with subangular cobbles
	2.6-3.8	Medium brown soft damp fine sandy CLAY

minant Matrix:

minant Clasts:

Depth to Rock: -

Rock Type: -

tic Water Level: -

Water Entry: 3m

Total Depth: 3.8m

Comments: Sampled 0-3.8m

No odour

Trial Pit Records

Project No.: 2626 **Location:** Ringaskiddy, Co. Cork **Date:** 12/1/2001

Excavation Method: HyMac **Supervisor:** Andrew Skelton

TRIAL PIT NO.

TP15

Geology:	Depth (m):	Description:
Till	0-0.3	Medium brown loose dry silty TOPSOIL
	0.3-0.5	Orange clayey gravelly SILT
	0.5-2	Medium brown loose gravelly clayey SILT

Dominant Matrix:

Dominant Clasts:

Depth to Rock: -

Rock Type: -

tatic Water Level: 1m

Water Entry: 1m (field drain)

Total Depth: 2m

Comments: Sampled 0-2m

No odour

Trial Pit Records

Project No.: 2626 **Location:** Ringaskiddy, Co. Cork **Date:** 12/1/2001

Excavation Method: HyMac **Supervisor:** Andrew Skelton

TRIAL PIT NO.

TP16

Geology:	Depth (m):	Description:
Till	0-0.3	Medium brown loose dry clayey SILT
	0.3-0.5	Orangey brown loose dry clayey SILT
	0.5-1.5	Medium brown soft silty fine SAND
	1.5-2.5	Medium brown soft wet fine SAND with gravels

Dominant Matrix:

Dominant Clasts:

Depth to Rock: -

Rock Type: -

tatic Water Level: 1.5m

Water Entry: 2.5m

Total Depth: 2.5m

Comments: Sampled 0-2.5m

No odour

T.Cullen & Co. Ltd.

Trial Pit Records

ct No.: 2626 **Location:** Ringaskiddy, Co. Cork **Date:** 12/1/2001

avation Method: HyMac **Supervisor:** Andrew Skelton

TRIAL PIT NO.

TP17

y:	Depth (m):	Description:
	0-0.4	Greyish brown soft dry clayey SILT
	0.4-1.4	Medium brown to pale brown soft very fine sandy SILT
	1.4-2	Medium brown wet silty fine SAND

Matrix:

Clasts:

to Rock: -

Type: -

ter Level: 1m

ter Entry: 1.5m

al Depth: 2m

omments: Sampled 0-2m

No odour

APPENDIX B

WELL LOG

Well Ident
2626/BH1

Description
Monitoring Well

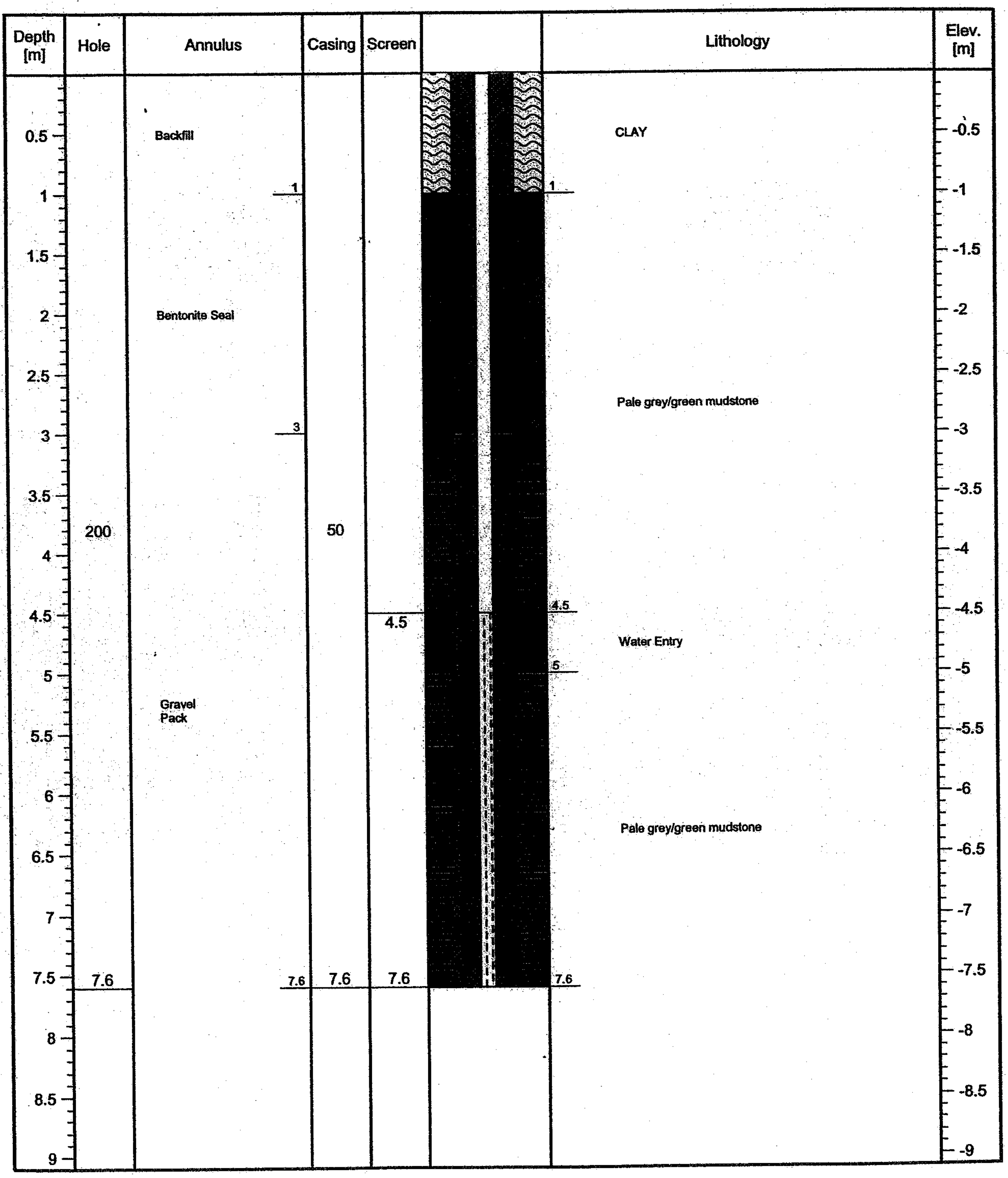
Location
Ringaskiddy, Co. Cork

Drilling Date

All diameters in mm
All depths in metres

Scale

Water Level (mOD)	Level-Date	Vertical	Horizontal
		50.0	



WELL LOG

Well Ident
2626/BH2

Description
Monitoring Well

Location
Ringaskiddy, Co. Cork

Drilling Date

All diameters in mm
All depths in metres

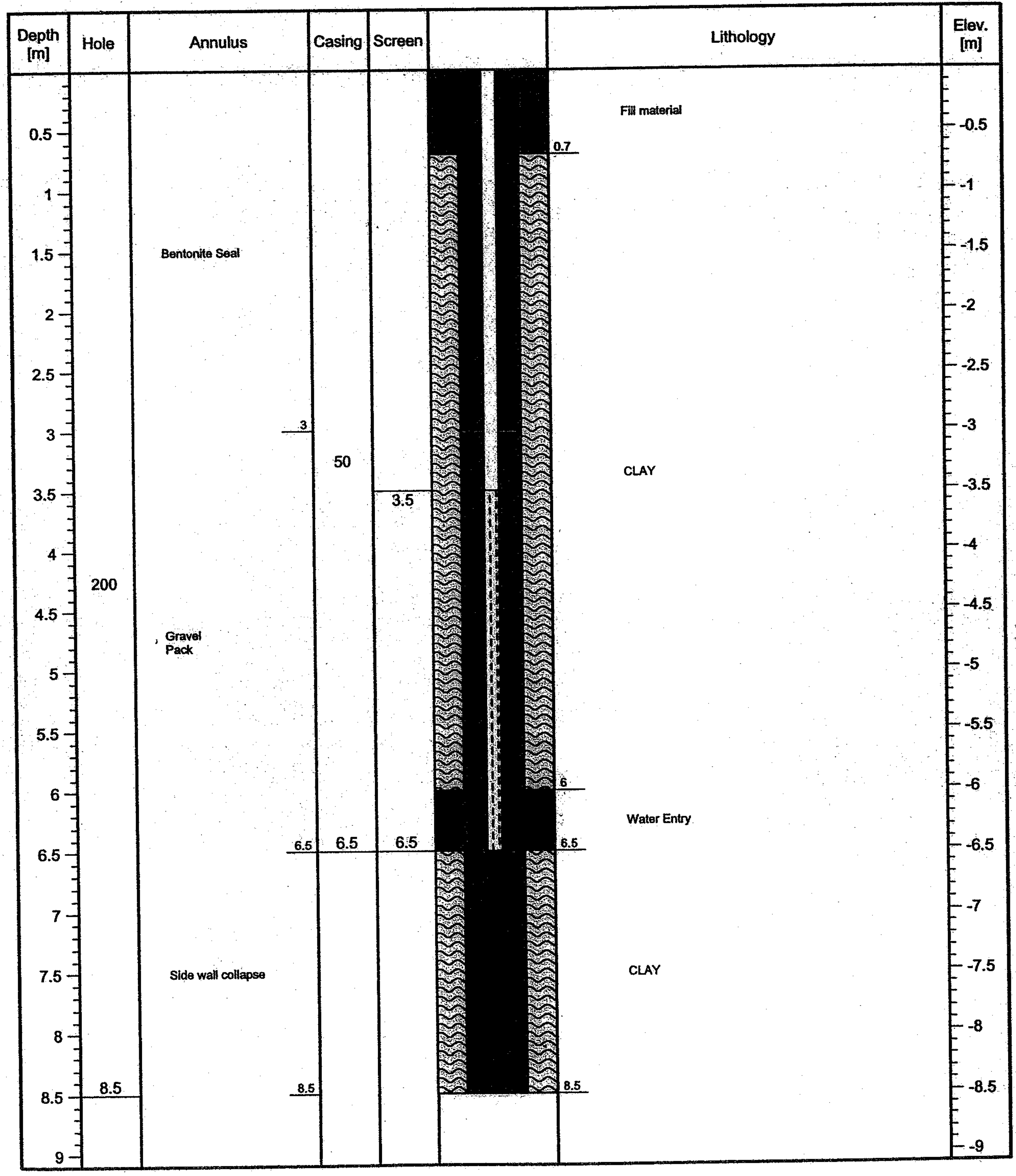
Scale

Water Level (mOD)

Level-Date

Vertical
50.0

Horizontal



WELL LOG

Well Ident
2626/BH3

Description Monitoring Well

Location Ringaskiddy, Co. Cork

Drilling Date

All diameters in mm
All depths in metres

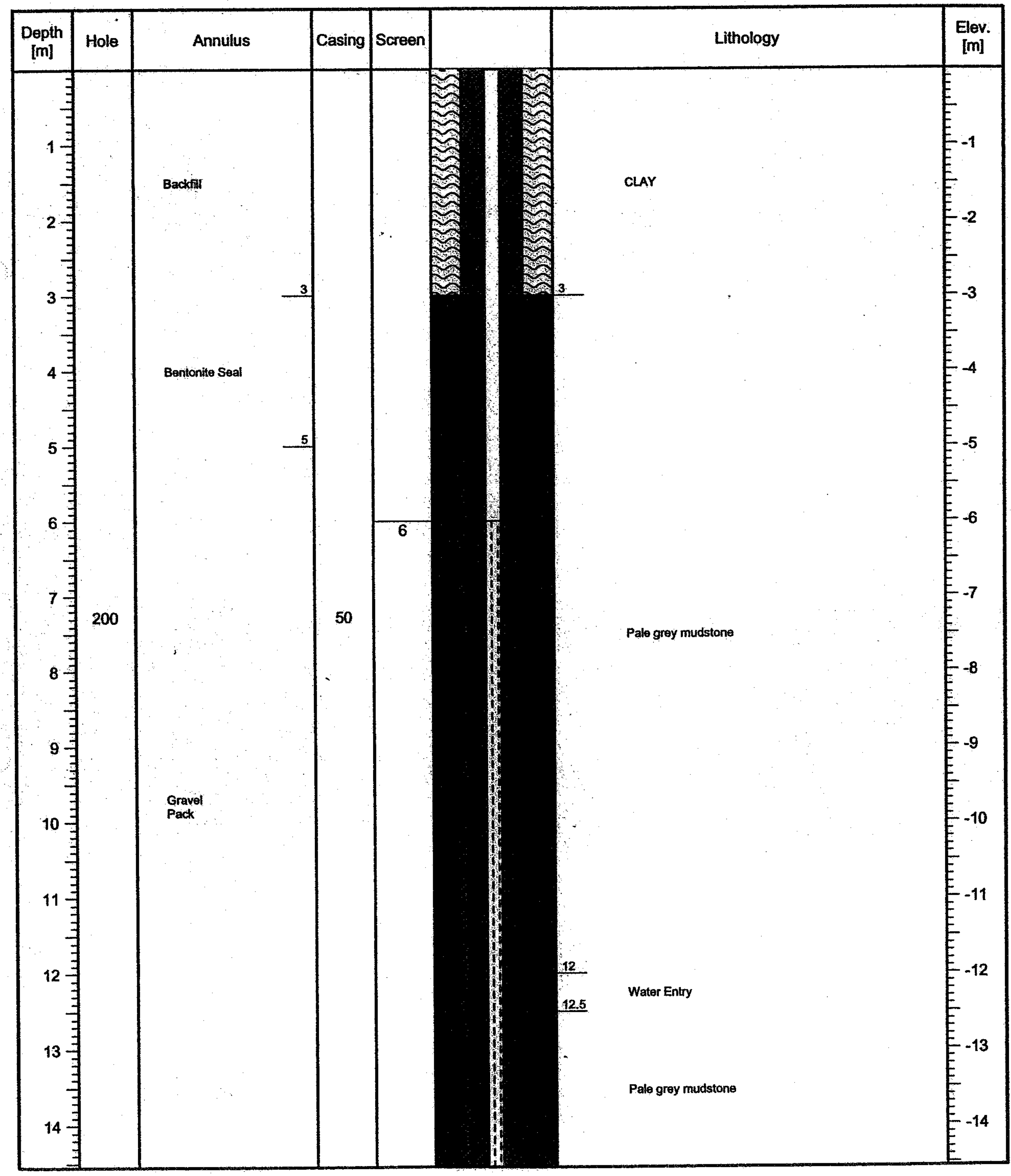
Scale

Water Level (mOD)

Level-Date

Vertical 80.0

Horizontal



WELL LOG

Well Ident
2626/BH3

Description Monitoring Well

Location Ringaskiddy, Co. Cork

Drilling Date

All diameters in mm
All depths in metres

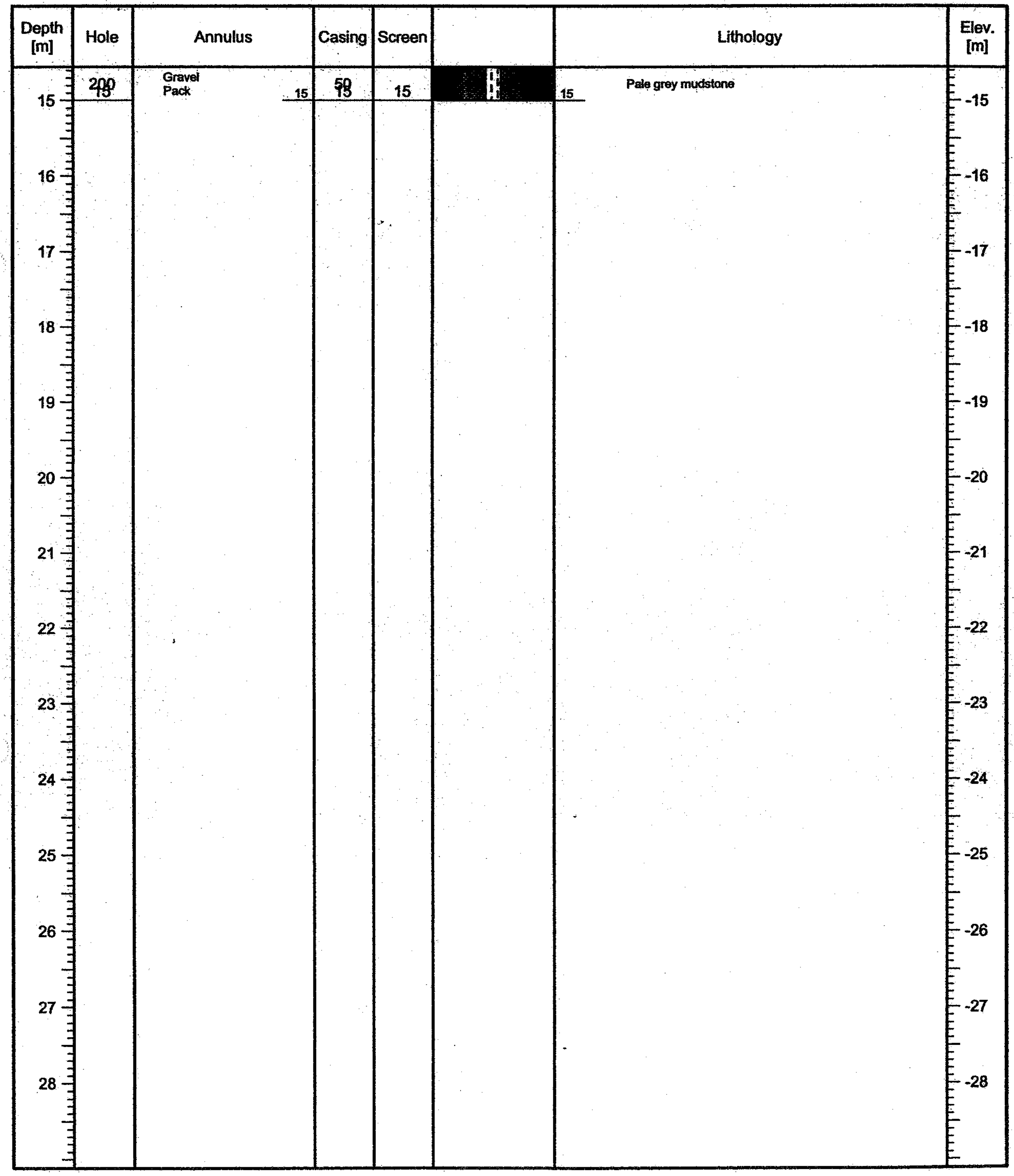
Scale

Water Level (mOD)

Level-Date

Vertical 80.0

Horizontal



WELL LOG

Well Ident
2626/BH4

Description
Monitoring Well

Location
Ringaskiddy, Co. Cork

Drilling Date

All diameters in mm
All depths in metres

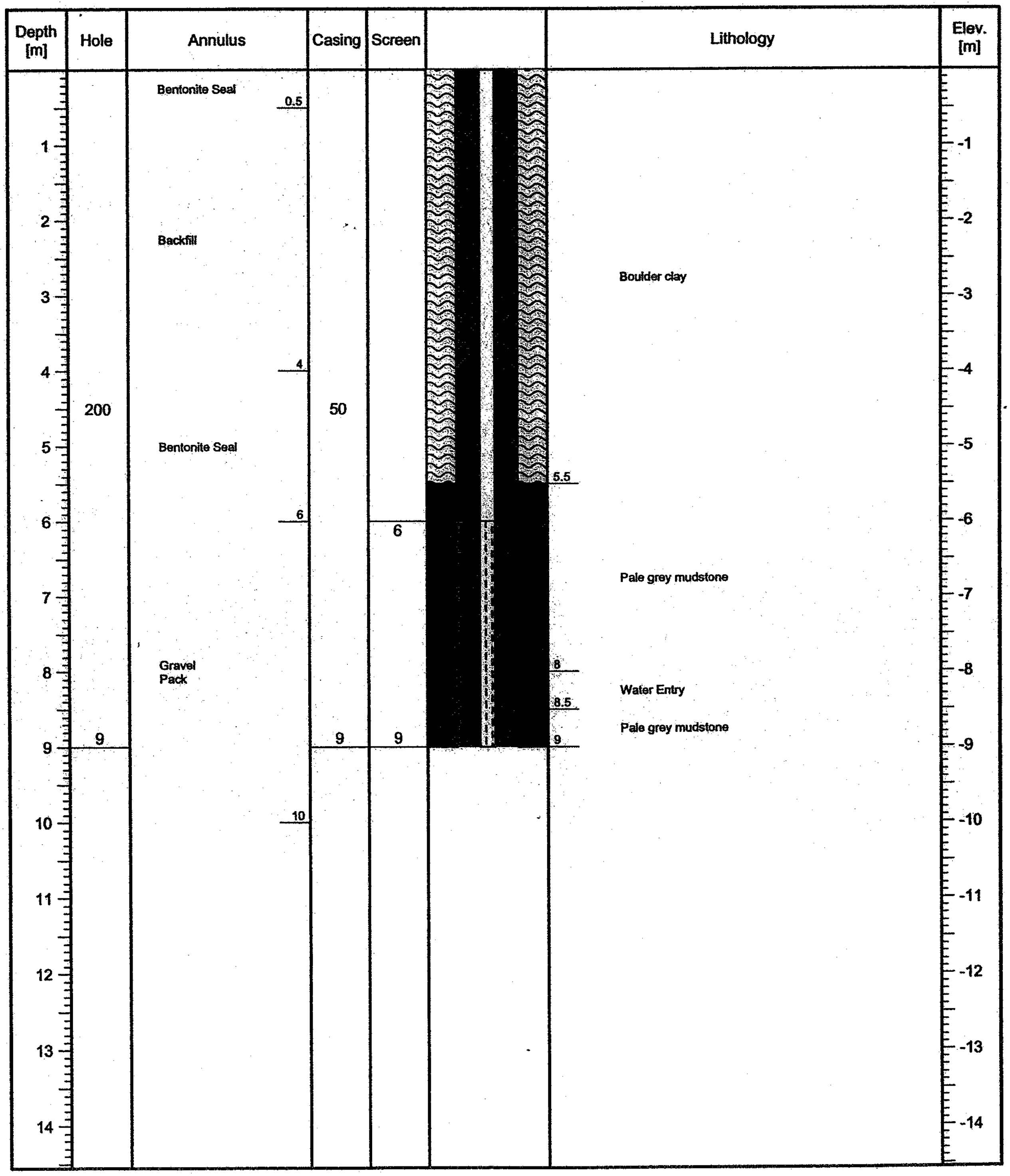
Scale

Water Level (mOD)

Level-Date

Vertical
80.0

Horizontal



WELL LOG

Well Ident
2626/BH5

Description
Monitoring Well

Location
Ringaskiddy, Co. Cork

Drilling Date
29.11.2000

All diameters in mm
All depths in metres

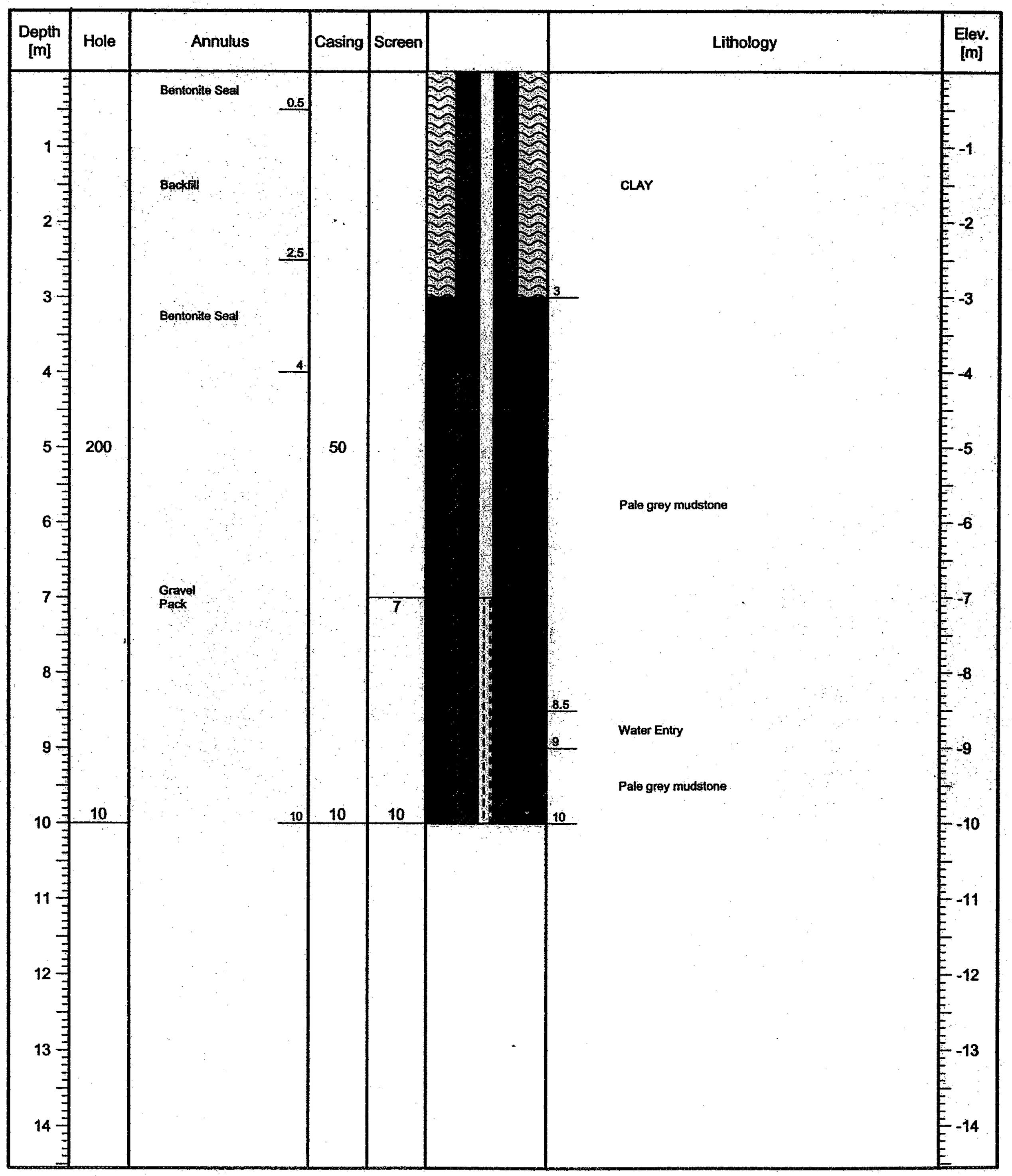
Scale

Water Level (mOD)

Level-Date

Vertical
80.0

Horizontal



APPENDIX C

From: Hazel Davidson <hazel.davidson@geochem.com>
To: "'cwall@ktcullen.ie'" <cwall@ktcullen.ie>
Date: Tue, Dec 19, 2000, 18:27
Subject: repeat data

Dear Conor

With reference to the repeated PAH data, the tests confirm the presence of trace amounts fof PAHs, but the naphthalene levels are significantly reduced. Upon investigation, this was found to be due to an artefact introduced during the solvent extraction process, caused by a particular batch of solvent. This has now been rectified.

The soil samples do appear to be contaminated with PCBs, but the inconsistency in the repeat analyses is probably due to a lack of homogeneity in the wet soil samples, as small inclusions of contaminated material may cause 'hot spots'. We would recommend further analysis of these samples to provide a better overview of the site.

For our own benefit, we are running two of the samples using a semi-volatile full scan, which will enable us to carry out a full library search.

We will endeavour to provide this additional data as soon as possible, and please do not hesitate to contact me if you wish to discuss this further.

Regards

Hazel

For and on behalf of
ALcontrol Geochem
Chester Street
Chester, CH4 8RD
United Kingdom

Phone: +44 (0)1244 671121

Fax: +44 (0)1244 683306
Website: www.alcontrol.com
Earth Sciences & Environmental Laboratory Services
Marketing Info : mkt@geochem.com

APPENDIX D

3. Land Surface Zoning for Groundwater Protection

3.1 Information and Mapping Requirements for Land Surface Zoning

The **groundwater resources protection zone map** is a land-use planning map, and therefore is the most useful map for the decision-making process. It is the ultimate or final map as it is obtained by combining the **aquifer** and **vulnerability maps.** The **aquifer map** boundaries, in turn, are based on the **bedrock map** boundaries and the **aquifer categories** are obtained from an assessment of the available **hydrogeological data**. The **vulnerability map** is based on the **subsoils map**, together with an assessment of relevant **hydrogeological data**, in particular indications of permeability and karstification. This is illustrated in Figure 3.

Similarly, the **source protection zone maps** result from combining **vulnerability** and **source protection area maps**. The **source protection areas** are based largely on assessments of **hydrogeological data**. This is illustrated in Figure 4.

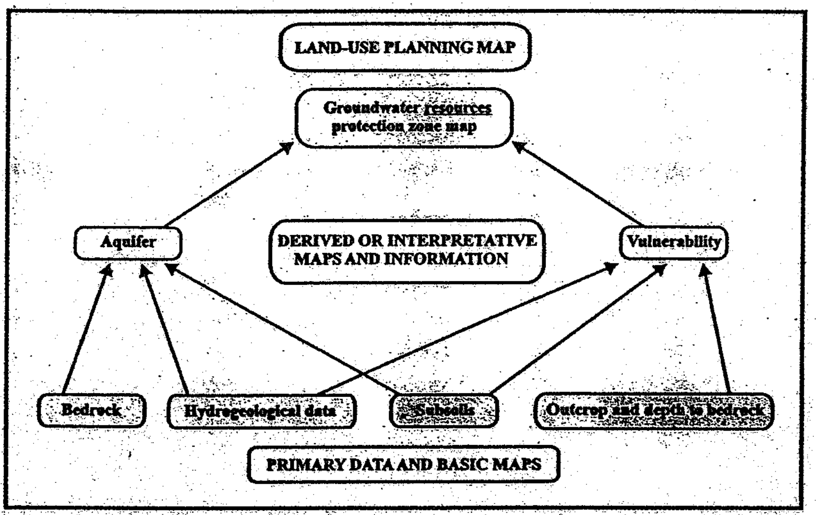


Figure 3. Conceptual framework for production of groundwater resource protection zones, indicating information needs and links

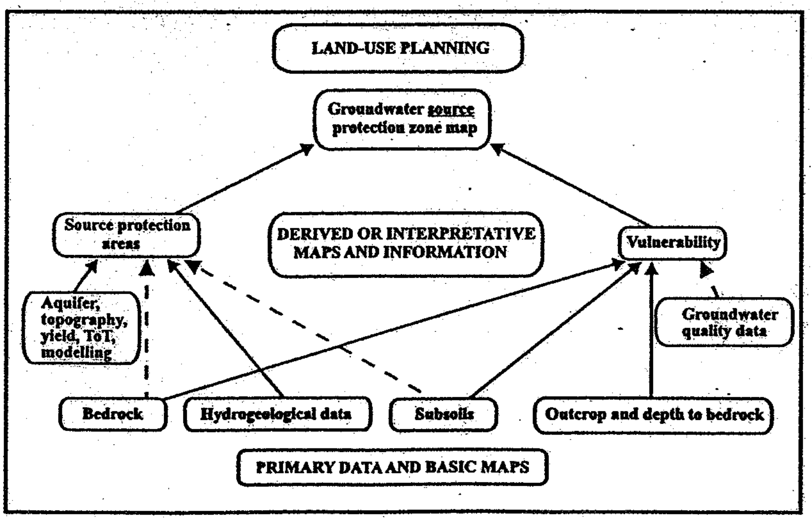


Figure 4. Conceptual framework for production of groundwater source protection zones, indicating information needs and links

3.2 Vulnerability Categories

Vulnerability is a term used to represent the intrinsic geological and hydrogeological characteristics that determine the ease with which groundwater may be contaminated by human activities.

The vulnerability of groundwater depends on: (i) the time of travel of infiltrating water (and contaminants); (ii) the relative quantity of contaminants that can reach the groundwater; and (iii) the contaminant attenuation capacity of the geological materials through which the water and contaminants infiltrate. As all groundwater is hydrologically connected to the land surface, it is the effectiveness of this connection that determines the relative vulnerability to contamination. Groundwater that readily and quickly receives water (and contaminants) from the land surface is considered to be more vulnerable than groundwater that receives water (and contaminants) more slowly and in lower quantities. The travel time, attenuation capacity and quantity of contaminants are a function of the following natural geological and hydrogeological attributes of any area:

(i) the subsoils that overlie the groundwater;

(ii) the type of recharge - whether point or diffuse; and

) the thickness of the unsaturated zone through which the contaminant moves.

In general, little attenuation of contaminants occurs in the bedrock in Ireland because flow is almost wholly via fissures. Consequently, the subsoils (sands, gravels, glacial tills (or boulder clays), peat, lake and alluvial silts and clays), are the single most important natural feature influencing groundwater vulnerability and groundwater contamination prevention. Groundwater is most at risk where the subsoils are absent or thin and, in areas of karstic limestone, where surface streams sink underground at swallow holes.

The geological and hydrogeological characteristics can be examined and mapped, thereby providing a groundwater vulnerability assessment for any area or site. Four groundwater vulnerability categories are used in the scheme - **extreme (E)**, **high (H)**, **moderate (M)** and **low (L)**. The hydrogeological basis for these categories is summarised in Table 1 and further details can be obtained from the GSI. The ratings are based on pragmatic judgements, experience and available technical and scientific information. However, provided the limitations are appreciated, vulnerability assessments are essential when considering the location of potentially polluting activities. As groundwater is considered to be present everywhere in Ireland, the vulnerability concept is applied to the entire land surface. The ranking of vulnerability does not take into consideration the biologically-active soil zone, as contaminants from point sources are usually discharged below this zone, often at depths of at least 1m. However, the groundwater protection responses take account of the point of discharge for each activity.

Vulnerability maps are an important part of groundwater protection schemes and are an essential element in the decision-making on the location of potentially polluting activities. Firstly, the vulnerability rating for an area indicates, and is a measure of, the likelihood of contamination. Secondly, the vulnerability map helps to ensure that a groundwater protection scheme is not unnecessarily restrictive on human economic activity. Thirdly, the vulnerability map helps in the choice of preventative measures and enables developments, which have a significant potential to contaminate, to be located in areas of lower vulnerability.

In summary, the entire land surface is divided into four vulnerability categories - extreme (E), high (H), moderate (M) and low (L) - based on the geological and hydrogeological factors described above. This subdivision is shown on a groundwater vulnerability map. The map shows the vulnerability of the first groundwater encountered (in either sand/gravel aquifers or in bedrock) to contaminants released at depths of 1-2 m below the ground surface. Where contaminants are released at significantly different depths, there will be a need to determine groundwater vulnerability using site-specific data. The characteristics of individual contaminants are not taken into account.

Vulnerability Rating	Hydrogeological Conditions				
	Subsoil Permeability (Type) and Thickness			Unsaturated Zone	Karst Features
	High permeability (sand/gravel)	Moderate permeability (e.g. Sandy subsoil)	Low permeability (e.g. Clayey subsoil, clay, peat)	(Sand/gravel aquifers only)	(<30 m radius)
Extreme (E)	0 - 3.0m	0 - 3.0m	0 - 3.0m	0 - 3.0m	-
High (H)	>3.0m	3.0 - 10.0m	3.0 - 5.0m	>3.0m	N/A
Moderate (M)	N/A	> 10.0m	5.0 - 10.0m	N/A	N/A
Low (L)	N/A	N/A	> 10.0m	N/A	N/A

Notes: (1) N/A = not applicable.
(2) Precise permeability values cannot be given at present.
(3) Release point of contaminants is assumed to be 1-2 m below ground surface.

Table 1. Vulnerability Mapping Guidelines

.3 Source Protection Zones

roundwater sources, particularly public, group scheme and industrial supplies, are of critical nportance in many regions. Consequently, the objective of source protection zones is to rovide protection by placing tighter controls on activities within all or part of the zone of ontribution (ZOC) of the source.

here are two main elements to source protection land surface zoning:

Areas surrounding individual groundwater sources; these are termed source protection areas (SPAs)

Division of the SPAs on the basis of the vulnerability of the underlying groundwater to contamination.

ese elements are integrated to give the source protection zones.

3.1 Delineation of Source Protection Areas

vo source protection areas are recommended for delineation:

Inner Protection Area (SI);

Outer Protection Area (SO), encompassing the remainder of the source catchment area or ZOC.

delineating the inner (SI) and outer (SO) protection areas, there are two broad approaches: st, using arbitrary fixed radii, which do not incorporate hydrogeological considerations; and condly, a scientific approach using hydrogeological information and analysis, in particular e hydrogeological characteristics of the aquifer, the direction of groundwater flow, the pumping e and the recharge.

ere the hydrogeological information is poor and/or where time and resources are limited, e simple zonation approach using the arbitrary fixed radius method is a good first step that quires little technical expertise. However, it can both over- and under-protect. It usually er-protects on the downgradient side of the source and may under-protect on the upgradient e, particularly in karst areas. It is particularly inappropriate in the case of springs where re is no part of the downgradient side in the ZOC. Also, the lack of a scientific basis reduces defensibility as a method.

There are several hydrogeological methods for delineating SPAs. They vary in complexity, cost and the level of data and hydrogeological analysis required. Four methods, in order of increasing technical sophistication, are used by the GSI:

(i) calculated fixed radius;

(ii) analytical methods;

(iii) hydrogeological mapping; and

(iv) numerical modelling.

Each method has limitations. Even with relatively good hydrogeological data, the heterogeneity of Irish aquifers will generally prevent the delineation of definitive SPA boundaries. Consequently, the boundaries must be seen as a <u>guide</u> for decision-making, which can be reappraised in the light of new knowledge or changed circumstances.

3.3.1.1 Inner Protection Area (SI)

This area is designed to protect against the effects of human activities that might have an immediate effect on the source and, in particular, against microbial pollution. The area is defined by a 100-day time of travel (TOT) from any point below the water table to the source. (The TOT varies significantly between regulatory agencies in different countries. The 100-day limit is chosen for Ireland as a relatively conservative limit to allow for the heterogeneous nature of Irish aquifers and to reduce the risk of pollution from bacteria and viruses, which in some circumstances can live longer than 50 days in groundwater.) In karst areas, it will not usually be feasible to delineate 100-day TOT boundaries, as there are large variations in permeability, high flow velocities and a low level of predictability. In these areas, the total catchment area of the source will frequently be classed as SI.

If it is necessary to use the arbitrary fixed radius method, a distance of 300m is normally used. A semi-circular area is used for springs. The distance may be increased for sources in karst aquifers and reduced in granular aquifers and around low yielding sources.

3.3.1.2 Outer Protection Area (SO)

This area covers the remainder of the ZOC (or complete catchment area) of the groundwater source. It is defined as the area needed to support an abstraction from long-term groundwater recharge i.e. the proportion of effective rainfall that infiltrates to the water table. The abstraction rate used in delineating the zone will depend on the views and recommendations of the source owner. A factor of safety can be taken into account whereby the maximum daily abstraction rate is increased (typically by 50%) to allow for possible future increases in abstraction and for expansion of the ZOC in dry periods. In order to take account of the heterogeneity of many Irish aquifers and possible errors in estimating the groundwater flow direction, a variation in the flow direction (typically ±10-20°) is frequently included as a safety margin in delineating the ZOC.

A conceptual model of the ZOC and the 100-day TOT boundary is given in Figure 5.

If the arbitrary fixed radius method is used, a distance of 1000m is recommended with, in some instances, variations in karst aquifers and around springs and low-yielding wells.

The boundaries of the SPAs are based on the horizontal flow of water to the source and, in the case particularly of the Inner Protection Area, on the time of travel in the aquifer. Consequently, the vertical movement of a water particle or contaminant from the land surface to the water table is not taken into account. This vertical movement is a critical factor in contaminant attenuation, contaminant flow velocities and in dictating the likelihood of contamination. It can be taken into account by mapping the groundwater vulnerability to contamination.

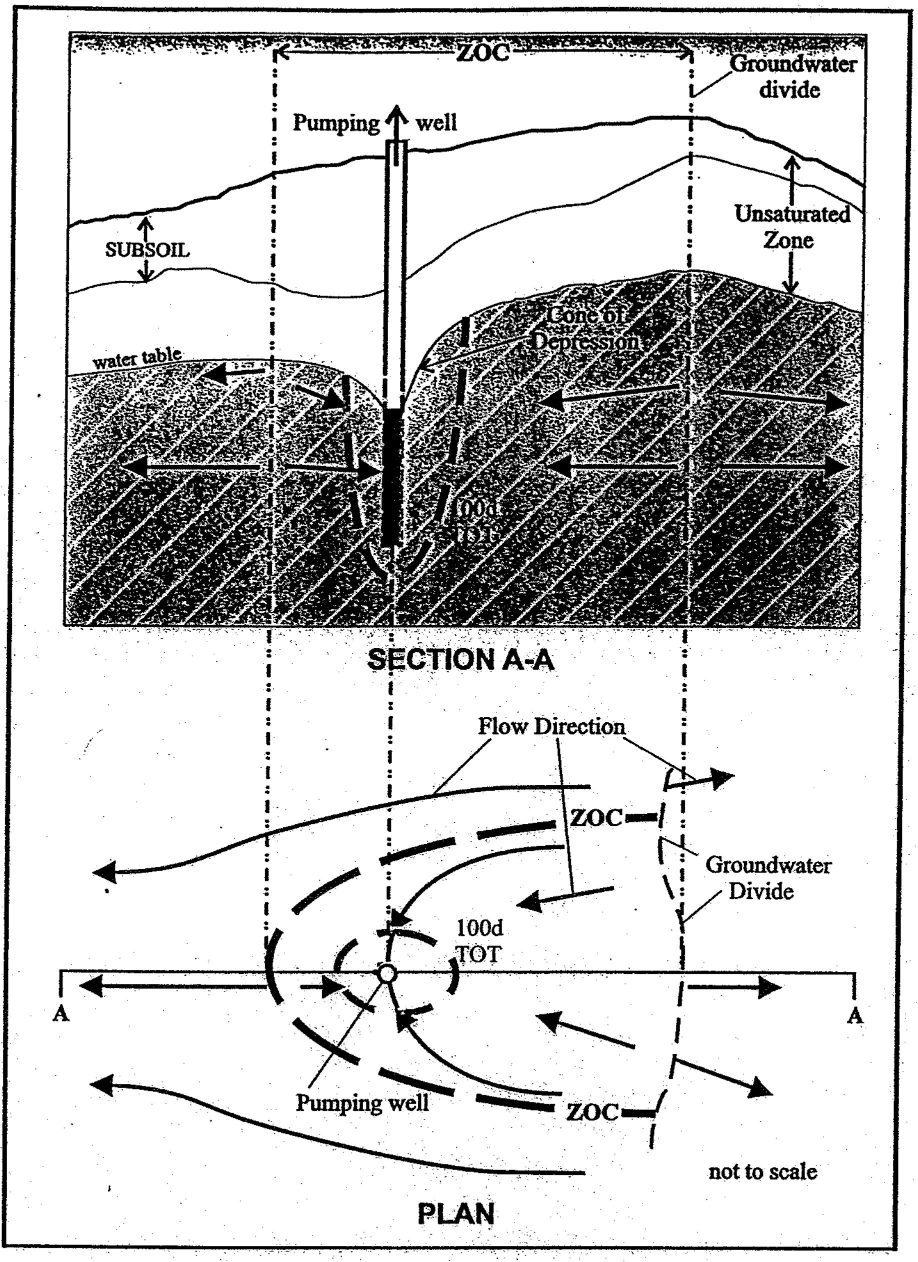


Figure 5. Conceptual Model of the Zone of Contribution (ZOC) at a Pumping Well (adapted from US EPA, 1987)

3.3.2 Delineation of Source Protection Zones

The matrix in Table 2 below gives the result of integrating the two elements of land surface zoning (SPAs and vulnerability categories) – a possible total of eight source protection zones. In practice, the source protection zones are obtained by superimposing the vulnerability map on the source protection area map. Each zone is represented by a code e.g. **SO/H**, which represents an Outer Source Protection area where the groundwater is highly vulnerable to contamination. The recommended map scale is 1:10,560 (or 1:10,000 if available), though a smaller scale may be appropriate for large springs.

VULNERABILITY RATING	SOURCE PROTECTION ZONE	
	Inner (SI)	Outer (SO)
Extreme (E)	SI/E	SO/E
High (H)	SI/H	SO/H
Moderate (M)	SI/M	SO/M
Low (L)	SI/L	SO/L

Table 2. Matrix of Source Protection Zones

All of the hydrogeological settings represented by the zones may not be present around each groundwater source. The integration of the SPAs and the vulnerability ratings is illustrated in Figure 6.

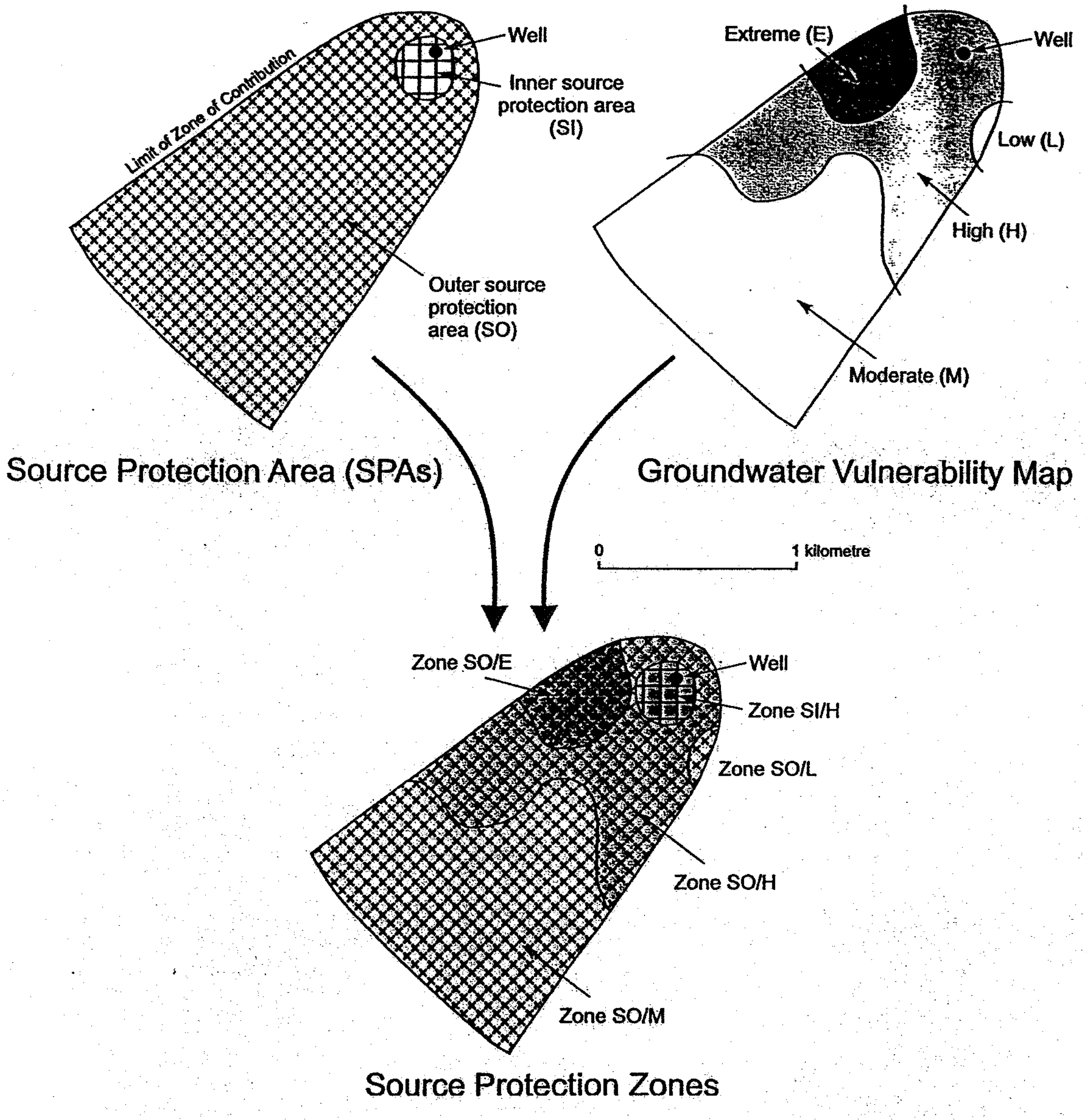


Figure 6. Delineation of source protection zones around a public supply well from the integration of the source protection area map and the vulnerability map.

3.4 Resource Protection Zones

For any region, the area outside the SPAs can be subdivided, based on the value of the resource and the hydrogeological characteristics, into eight aquifer categories:

Regionally Important (R) Aquifers

(i) Karstified aquifers **(Rk)**

(ii) Fissured bedrock aquifers **(Rf)**

(iii) Extensive sand/gravel aquifers **(Rg)**

Locally Important (L) Aquifers

(i) Sand/gravel **(Lg)**

(ii) Bedrock which is Generally Moderately Productive **(Lm)**

(iii) Bedrock which is Moderately Productive only in Local Zones **(Ll)**

Poor (P) Aquifers

(i) Bedrock which is Generally Unproductive except for Local Zones **(Pl)**

(ii) Bedrock which is Generally Unproductive **(Pu)**

These aquifer categories are shown on an aquifer map, which can be used not only as an element of a groundwater protection scheme but also for groundwater development purposes.

The matrix in Table 3 below gives the result of integrating the two regional elements of land surface zoning (vulnerability categories and resource protection areas) – a possible total of 24 resource protection zones. In practice this is achieved by superimposing the vulnerability map on the aquifer map. Each zone is represented by a code e.g. **Rf/M**, which represents areas of regionally important fissured aquifers where the groundwater is moderately vulnerable to contamination. In land surface zoning for groundwater protection purposes, regionally important sand/gravel **(Rg)** and fissured aquifers **(Rf)** are zoned together, as are locally important sand/gravel **(Lg)** and bedrock which is moderately productive **(Lm)**. All of the hydrogeological settings represented by the zones may not be present in each local authority area.

VULNERABILITY RATING	**RESOURCE PROTECTION ZONES**					
	Regionally Important Aquifers (R)		**Locally Important Aquifers (L)**		**Poor Aquifers (P)**	
	Rk	**Rf/Rg**	**Lm/Lg**	**L1**	**P1**	**Pu**
Extreme (E)	Rk/E	Rf/E	Lm/E	L1/E	P1/E	Pu/E
High (H)	Rk/H	Rf/H	Lm/H	L1/H	P1/H	Pu/H
Moderate (M)	Rk/M	Rf/M	Lm/M	L1/M	P1/M	Pu/M
Low (L)	Rk/L	Rf/L	Lm/L	L1/L	P1/L	Pu/L

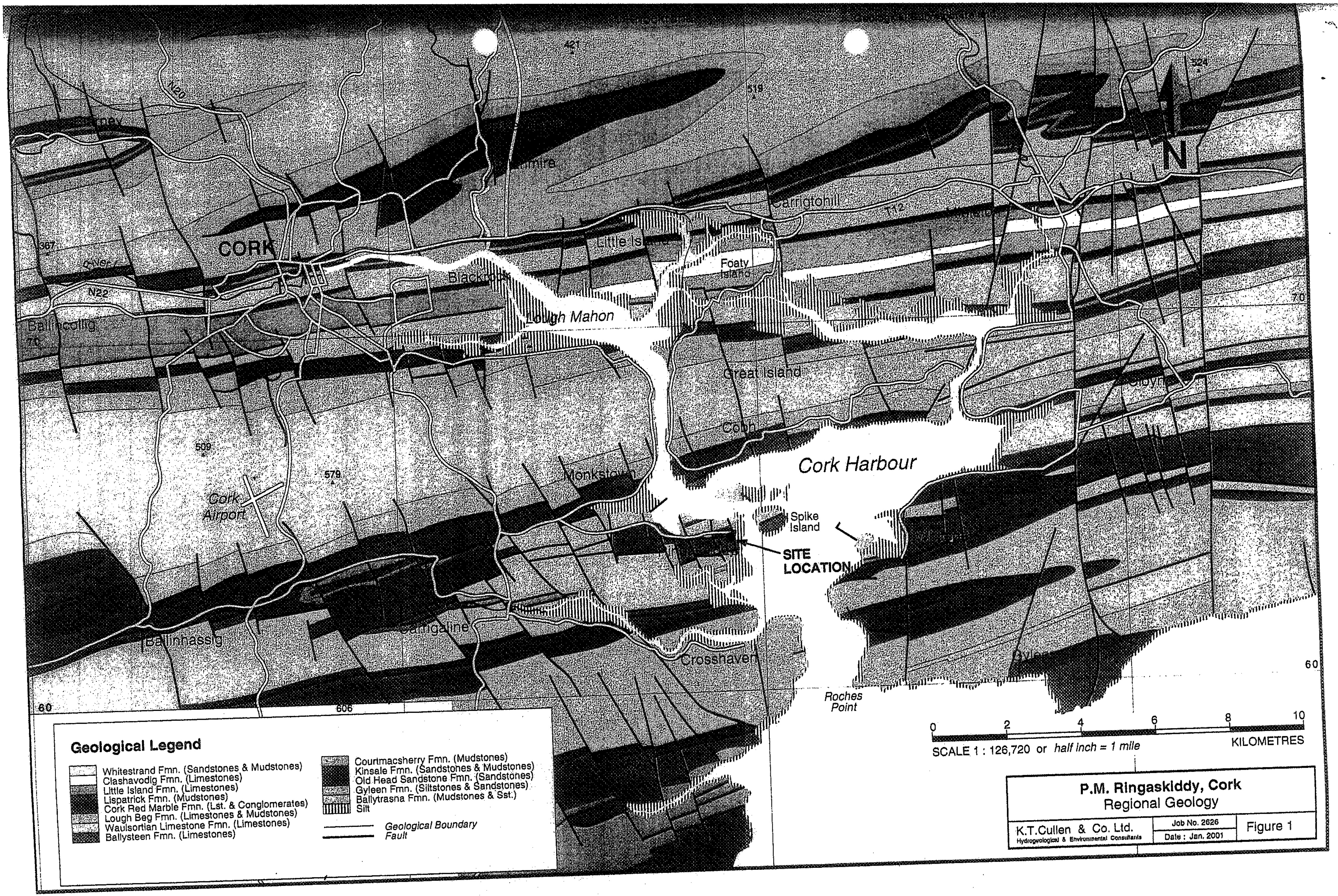
Table 3. Matrix of Resource Protection Zones

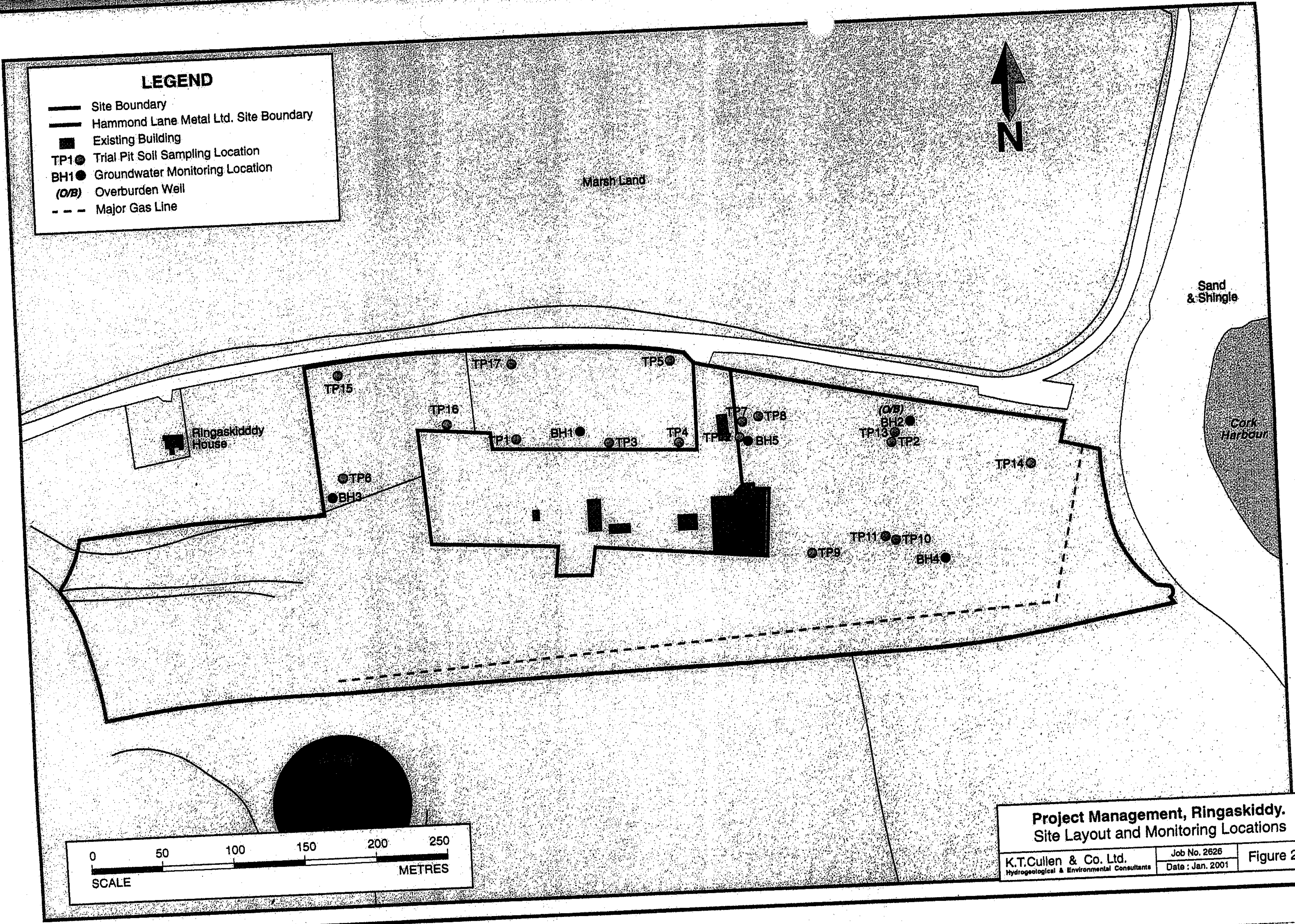
3.5 Flexibility, Limitations and Uncertainty

The land surface zoning is only as good as the information which is used in its compilation (geological mapping, hydrogeological assessment, etc.) and these are subject to revision as new information is produced. Therefore a scheme must be flexible and allow for regular revision.

Uncertainty is an inherent element in drawing geological boundaries and there is a degree of generalisation because of the map scales used. Therefore the scheme is not intended to give sufficient information for site-specific decisions. Also, where site specific data received by a regulatory body in the future are at variance with the maps, this does not undermine a scheme, but rather provides an opportunity to improve it.

FIGURES


421
519
324
N
N20
Blarney
Whitemire
Carrigtohill
112
CORK
Little Is.
Foaty Island
367
River Lee
N22
Blackrock
Lough Mahon
Ballincollig
70
Great Island
Cloyne
Cobh
Cork Harbour
509
579
Monkstown
Cork Airport
Spike Island
SITE LOCATION
Carrigaline
Ballinhassig
Crosshaven
Roches Point
60
606
60
70
0
2
4
6
8
10
KILOMETRES
SCALE 1 : 126,720 or half inch = 1 mile
Geological Legend
Whitestrand Fmn. (Sandstones & Mudstones)
Clashavodig Fmn. (Limestones)
Little Island Fmn. (Limestones)
Lispatrick Fmn. (Mudstones)
Cork Red Marble Fmn. (Lst. & Conglomerates)
Lough Beg Fmn. (Limestones & Mudstones)
Waulsortian Limestone Fmn. (Limestones)
Ballysteen Fmn. (Limestones)
Courtmacsherry Fmn. (Mudstones)
Kinsale Fmn. (Sandstones & Mudstones)
Old Head Sandstone Fmn. (Sandstones)
Gyleen Fmn. (Siltstones & Sandstones)
Ballytrasna Fmn. (Mudstones & Sst.)
Silt
Geological Boundary
Fault
P.M. Ringaskiddy, Cork
Regional Geology
K.T.Cullen & Co. Ltd.
Hydrogeological & Environmental Consultants
Job No. 2626
Date : Jan. 2001
Figure 1



Project Management, Ringaskiddy.
Site Layout and Monitoring Locations

K.T.Cullen & Co. Ltd.
Hydrogeological & Environmental Consultants

Job No. 2626
Date : Jan. 2001

Figure 2

JF(8)

TABLES

Table 1. Soil Analytical Results - PRO, DRO, Mineral Oil - PM, Ringaskiddy (Dec 2000)

Location	TP 1	TP 2	TP 3	TP 4	TP 5	TP 6	TP 7	TP 7	TP 10
Depth (m)	1.8	0 - 5.5	0 - 1.5	0 - 3	0 - 3	0 - 3.2	0 - 2	3 - 4.1	0 - 1
Units	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg
Diesel Range Organics	60	43	95	29	45	27	181	-	28
Mineral Oil	18	13	29	9	13	8	18	-	8
Petrol Range Organics	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01

Dutch MACs	
S-Value	I-Value
mg/kg	mg/kg
-	-
50	5000
-	-

Legend:
mg/kg - milligrams per kilogram
Dutch MACs - Dutch Maximum Admissible Concentration guidelines
S-Value= Target Value
I-Value= Intervention Value
Results are underlined where the Dutch S-MAC for Mineral Oil is exceeded.
"-" = Dutch MAC not available
"<" = Less than

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Table 2. Soil Analytical Results - BTEX - PM Ringaskiddy (Dec 2000)

Location	TP 1	TP 2	TP 3	TP 4	TP 5	TP 6	TP 7	TP 7	TP 10
Depth (m)	1.8	0 - 5.5	0 - 1.5	0 - 3	0 - 3	0 - 3.2	0 - 2	3 - 4.1	0 - 1
Units	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg
Benzene	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Toluene	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Ethylbenzene	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Xylene	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01

Dutch MACs	
S-Value	I-Value
mg/kg	mg/kg
0.05	1
0.05	130
0.05	50
0.05	25

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Legend:
mg/kg - milligrams per kilogram
Dutch MACs - Dutch Maximum Admissible Concentration guidelines
S-Value= Target Value
I-Value= Intervention Value
Results are underlined where the Dutch S-MAC for Mineral Oil is exceeded.
"-" = Dutch MAC not available
"<" = Less than

Table 3a. Soil Analytical Results - VOCs - PM, Ringaskiddy (Dec 2000)

Trace Organics (VOCs)		TP1	TP3	TP4	TP5
	Depth (m)	1.8	0 - 1.5	0 - 3.0	0 - 3.0
	Units				
Dichlorofluoromethane	µg/kg	<1	<1	<1	<1
Chloromethane	µg/kg	<1	<1	<1	<1
Vinylchloride	µg/kg	<1	<1	<1	<1
Bromomethane	µg/kg	<1	<1	<1	<1
Chloroethane	µg/kg	<1	<1	<1	<1
Trichlorofluoromethane	µg/kg	<1	<1	<1	<1
trans-1,2-Dichloroethene	µg/kg	<1	<1	<1	<1
Dichloromethane	µg/kg	<1	<1	<1	<1
1,1 Dichloroethene	µg/kg	<1	<1	<1	<1
1,1 Dichloroethane	µg/kg	<1	<1	<1	<1
cis-1,2-Dichloroethene	µg/kg	<1	<1	<1	<1
Bromochloromethane	µg/kg	<1	<1	<1	<1
Chloroform	µg/kg	<1	<1	<1	<1
2,2-Dichloropropane	µg/kg	<1	<1	<1	<1
1,2-Dichloroethane	µg/kg	<1	<1	<1	<1
1,1,1-Trichloroethane	µg/kg	<1	<1	<1	<1
1,1-Dichloropropene	µg/kg	<1	<1	<1	<1
Benzene	µg/kg	<1	<1	<1	<1
Carbontetrachloride	µg/kg	<1	<1	<1	<1
Dibromomethane	µg/kg	<1	<1	<1	<1
1,2-Dichloropropane	µg/kg	<1	<1	<1	<1
Bromodichloromethane	µg/kg	<1	<1	<1	<1
Trichloroethene	µg/kg	<1	<1	<1	<1
cis-1,3-Dichloropropene	µg/kg	<1	<1	<1	<1
trans-1,3-Dichloropropene	µg/kg	<1	<1	<1	<1
1,1,2-Trichloroethane	µg/kg	<1	<1	<1	<1
Toluene	µg/kg	<1	<1	<1	<1
1,3-Dichloropropane	µg/kg	<1	<1	<1	<1
Dibromochloromethane	µg/kg	<1	<1	<1	<1
1,2-Dibromoethane	µg/kg	<1	<1	<1	<1
Tetrachloroethene	µg/kg	<1	<1	<1	<1
1,1,1,2 -Tetrachloroethane	µg/kg	<1	<1	<1	<1
Chlorobenzene	µg/kg	<1	<1	<1	<1
Ethylbenzene	µg/kg	<1	<1	<1	<1

Dutch MACs	
S-Value	I-Value
-	-
-	-
-	100
-	-
-	-
-	-
-	-
-	20,000
-	-
-	-
-	-
-	-
-	-
-	-
-	4,000
-	-
-	-
50	1,000
-	-
-	-
-	-
-	-
1	60,000
-	-
-	-
-	-
50	130,000
-	-
-	-
-	-
10	4,000
-	-
50	50,000

LEGEND

µg/kg: micrograms per kilogram
MAC: Maximum Admissible Concentration
Dutch S-Value: Target Value
Dutch I-Value: Intervention Value
-': MAC Guideline Not Available
< = Below current laboratory detection limit

Trace Organics (VOCs)		TP1	TP3	TP4	TP5	Dutch MACs	
	Depth (m)	1.8	0 - 1.5	0 - 3.0	0 - 3.0	S-Value	I-Value
	Units						
p/m Xylenes	µg/kg	<1	<1	<1	<1	50	25,000
Bromoform	µg/kg	<1	<1	<1	<1	-	-
Styrene	µg/kg	<1	<1	<1	<1	100	100,000
1,1,2,2-Tetrachloroethane	µg/kg	<1	<1	<1	<1	-	-
o - Xylene	µg/kg	<1	<1	<1	<1	-	-
1,2,3-Trichloropropane	µg/kg	<1	<1	<1	<1	-	-
Isopropylbenzene	µg/kg	<1	<1	<1	<1	-	-
Bromobenzene	µg/kg	<1	<1	<1	<1	-	-
2-Chlorotoluene	µg/kg	<1	<1	<1	<1	-	-
Propylbenzene	µg/kg	<1	<1	<1	<1	-	-
4-Chlorotoluene	µg/kg	<1	<1	<1	<1	-	-
1,2,4-Trimethylbenzene	µg/kg	<1	<1	<1	<1	-	-
4-Isopropyltoluene	µg/kg	<1	<1	<1	<1	-	-
1,3,5-Trimethylbenzene	µg/kg	<1	<1	<1	<1	-	-
1,2-Dichlorobenzene	µg/kg	<1	<1	<1	<1	10	-
1,4-Dichlorobenzene	µg/kg	<1	<1	<1	<1	10	-
sec-Butylbenzene	µg/kg	<1	<1	<1	<1	-	-
tert-Butylbenzene	µg/kg	<1	<1	<1	<1	-	-
1,3-Dichlorobenzene	µg/kg	<1	<1	<1	<1	10	-
n-Butylbenzene	µg/kg	<1	<1	<1	<1	-	-
1,2-Dibromo-3-Chloropropane	µg/kg	<1	<1	<1	<1	-	-
1,2,4-Trichlorobenzene	µg/kg	<1	<1	<1	<1	10	-
Naphthalene	µg/kg	<1	<1	<1	<1	-	-
1,2,3-trichlorobenzene	µg/kg	<1	<1	<1	<1	-	-
Hexachlorobutadiene	µg/kg	<1	<1	<1	<1	-	-

LEGEND
µg/kg: micrograms per kilogram
MAC: Maximum Admissible Concentration
Dutch S-Value: Target Value
Dutch I-Value: Intervention Value
-': MAC Guideline Not Available
< = Below current laboratory detection limit

Table 4a. Soil Analytical Results - PAHs - PM, Ringaskiddy (Dec 2000)

Parameters		TP1	TP2	TP3	TP4	TP5	TP6	TP7	TP7	TP10	Dutch MAC Values	
	Depth (m)	1.8	0 - 5.5	0 - 1.5	0 - 3	0 - 3	0 - 3.2	0 - 2	3 - 4.1	0 - 1		
	Units										S-Value	I-Value
Acenaphthene	µg/kg	24	27	56	14	32	<1	<1	<1	55	-	-
Acenaphthylene	µg/kg	<1	<1	<1	<1	<1	<1	<1	<1	340	-	-
Benzo(B)fluoranthene	µg/kg	30	149	27	<1	27	26	<1	31	1142	-	-
Dibenz(AH)anthracene	µg/kg	<1	<1	<1	<1	<1	<1	<1	<1	<1	-	-
Fluorene	µg/kg	<1	29	<1	<1	<1	<1	<1	<1	250	-	-
Pyrene	µg/kg	244	308	202	<1	<1	<1	<1	95	6321	-	-
PAHs included in 'PAH (Sum of 10)' Dutch S and I MAC values for PAHs in soil												
Anthracene	µg/kg	25	25	25	5	14	17	7	14	862	-	-
Benzo(a)anthracene	µg/kg	113	183	147	1	67	97	<1	121	1081	-	-
Benzo(a)pyrene	µg/kg	12	131	14	1	31	14	<1	27	245	-	-
Benzo(ghi)perylene	µg/kg	<1	<1	<1	<1	<1	<1	<1	<1	<1	-	-
Benzo(k)flouranthene	µg/kg	29	277	22	<1	31	22	<1	30	979	-	-
Chrysene	µg/kg	65	295	97	<1	83	74	<1	97	3064	-	-
Fluoranthene	µg/kg	261	281	216	<1	<1	<1	<1	100	5804	-	-
Indeno(123-cd)pyrene	µg/kg	<1	<1	<1	<1	<1	<1	<1	<1	<1	-	-
Naphthalene	µg/kg	2112	2153	2731	1932	1190	2291	2162	1821	10024	-	-
Phenanthrene	µg/kg	149	152	203	98	112	119	95	144	7221	-	-
PAH (Sum of 10)	µg/kg	2768	3499	3457	2042	1530	2636	2271	2356	29282	1000	40000
PAH (Total)	µg/kg	3066	4010	3741	2049	1588	2659	2264	2480	37388	-	-

Legend

µg/kg: micrograms per kilogram
MAC: Maximum admissable concentration
S-level: Dutch guideline for normal uncontaminated soil
I-Level: Dutch guideline for Intervention
Results awaiting confirmation
"-": MAC not available
< = below laboratory detection limit

Table 4b. Soil Analytical Results - PAHs - PM, Ringaskiddy (Dec 2000)

Parameters		TP11	TP11	TP12	TP12	TP13	TP13	TP14	TP15	TP16	TP17	Dutch MAC Values	
	Depth (m)	0-1	1-3	0-1	1-2.6	0-1	1-3.4	0-3.8	0-2	0-2.5	0-2	S-Value	I-Value
	Units												
Acenaphthene	µg/kg	1	<1	66	4	45	45	2	4	2	26	-	-
Acenaphthylene	µg/kg	1	<1	37	<1	<1	13	<1	<1	<1	2	-	-
Benzo(B)fluoranthene	µg/kg	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	-	-
Dibenz(AH)anthracene	µg/kg	2	<1	<1	<1	<1	<1	<1	<1	<1	<1	-	-
Fluorene	µg/kg	1	<1	5	<1	<1	1	<1	<1	<1	1	-	-
Pyrene	µg/kg	5	<1	3	<1	<1	2	<1	1	1	4	-	-
PAHs included in 'PAH (Sum of 10)' Dutch S and I MAC values for PAHs in soil													
Anthracene	µg/kg	2	<1	2	<1	<1	3	4	<1	<1	2	-	-
Benzo(a)anthracene	µg/kg	1	<1	<1	<1	<1	3	<1	<1	<1	1	-	-
Benzo(a)pyrene	µg/kg	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	-	-
Benzo(ghi)perylene	µg/kg	2	<1	<1	<1	<1	1	<1	<1	<1	<1	-	-
Benzo(k)flouranthene	µg/kg	1	<1	<1	<1	<1	<1	<1	<1	<1	<1	-	-
Chrysene	µg/kg	6	<1	2	<1	<1	3	<1	<1	1	4	-	-
Fluoranthene	µg/kg	20	1	10	4	2	8	1	2	6	13	-	-
Indeno(123-cd)pyrene	µg/kg	2	<1	<1	<1	<1	1	<1	<1	<1	<1	-	-
Naphthalene	µg/kg	2	1	14	2	3	8	<1	1	<1	2	-	-
Phenanthrene	µg/kg	18	4	20	7	5	19	4	4	7	23	-	-
PAH (Sum of 10)	µg/kg	54	6	48	13	10	46	9	7	14	45	1000	40000
PAH (Total)	µg/kg	64	6	159	17	55	107	11	12	17	78	-	-

Legend

µg/kg: micrograms per kilogram
MAC: Maximum admissable concentration
S-level: Dutch guideline for normal uncontaminated soil
I-Level: Dutch guideline for Intervention
"-": MAC not available
< = below laboratory detection limit

Table 5. Soil Analytical Results Metals - PM, Ringaskiddy (Dec 2000)

Sample Identity	Depth (m)	Arsenic mg/kg	Cadmium mg/kg	Chromium mg/kg	Copper mg/kg	Mercury mg/kg	Nickel mg/kg	Lead mg/kg	Selenium mg/kg	Zinc mg/kg	Total Phenols mg/kg
TP1	1.8	11	<1	14	15	<1	26	18	<1	83	<0.01
TP2	0 - 5.5	14	<1	15	19	<1	24	12	<1	95	<0.01
TP3	0 - 1.5	16	<1	20	17	<1	32	13	<1	92	0.04
TP4	0 - 3	17	<1	18	24	<1	25	9	<1	76	<0.01
TP5	0 - 3	13	<1	16	18	<1	20	10	<1	58	<0.01
TP6	0 - 3.2	16	<1	15	21	<1	29	17	<1	126	<0.01
TP7	0 - 2	14	<1	18	16	<1	19	13	<1	62	<0.01
TP-7	3 - 4.1	15	<1	15	18	<1	23	10	<1	62	<0.01
TP-10	0 - 1	15	<1	17	25	<1	23	10	<1	76	<0.01

Dutch MAC S Values	29	0.8	100	36	0.3	35	85	-	140	0.05
Dutch MAC I Values	55	12	380	190	10	210	530	-	720	40

Legend

mg/kg: milligrams per kilogram

MAC: Dutch Standard Maximum Admissible Concentration

S Value: Dutch Guidline for normal uncontaminated soil

I Value: Dutch Guideline for Intervention

"-": MAC Guideline not available

n.a. = not analysed

"<" = below detection limit

ble 6. Soil Analytical Results - Pesticides - PM, Ringaskidd ec 2000)

Pesticide	Units	TP 1	TP 2	TP 3	TP 4	TP 5	TP 6	TP 7	TP 7	TP 10	Dutch Values	
	Depth (m)	1.8	0 - 5.5	0 - 1.5	0 - 3	0 - 3	0 - 3.2	0 - 2	3 - 4.1	0 - 1	S- Value	I Value
Dichlorvos	µg/kg	<1	<1	<1	<1	<1	<1	<1	<1	<1	-	-
Mevinphos	µg/kg	<1	<1	<1	<1	<1	<1	<1	<1	<1	-	-
Phorate	µg/kg	<1	<1	<1	<1	<1	<1	<1	<1	<1	-	-
Alpha-BHC	µg/kg	<1	<1	<1	<1	<1	<1	<1	<1	<1	2.5	-
Beta-BHC	µg/kg	<1	<1	<1	<1	<1	<1	<1	<1	<1	1	-
Gamma-BHC	µg/kg	<1	<1	<1	<1	<1	<1	<1	<1	<1	0.05	-
Diazinon	µg/kg	<1	<1	<1	<1	<1	<1	<1	<1	<1	-	-
Disulfoton	µg/kg	<1	<1	<1	<1	<1	<1	<1	<1	<1	-	-
Delta-BHC	µg/kg	<1	<1	<1	<1	<1	<1	<1	<1	<1	-	-
Methyl Parathion	µg/kg	<1	<1	<1	<1	<1	<1	<1	<1	<1	-	-
Heptachlor	µg/kg	<1	<1	<1	<1	<1	<1	<1	<1	<1	-	-
Fenitrothion	µg/kg	<1	<1	<1	<1	<1	<1	<1	<1	<1	-	-
Aldrin	µg/kg	<1	<1	<1	<1	<1	<1	<1	<1	<1	2.5	-
Malathion	µg/kg	<1	<1	<1	<1	<1	<1	<1	<1	<1	-	-
Parathion	µg/kg	<1	<1	<1	<1	<1	<1	<1	<1	<1	-	-
Heptachlor Epoxide	µg/kg	<1	<1	<1	<1	<1	<1	<1	<1	<1	-	-
Endosulfan I	µg/kg	<1	<1	<1	<1	<1	<1	<1	<1	<1	-	-
Dieldrin	µg/kg	<1	<1	<1	<1	<1	<1	<1	<1	<1	0.5	-
4,4-DDE	µg/kg	<1	<1	<1	<1	<1	<1	<1	<1	<1	2.5	4000
Endrin Ketone	µg/kg	<1	<1	<1	<1	<1	<1	<1	<1	<1	-	-
Endosulfan II	µg/kg	<1	<1	<1	<1	<1	<1	<1	<1	<1	-	-
4,4-DDD	µg/kg	<1	<1	<1	<1	<1	<1	<1	<1	<1	2.5	4000
Ethion	µg/kg	<1	<1	<1	<1	<1	<1	<1	<1	<1	-	-
Endrin	µg/kg	<1	<1	<1	<1	<1	<1	<1	<1	<1	1	-
Endosulfan Sulphate	µg/kg	<1	<1	<1	<1	<1	<1	<1	<1	<1	-	-
4,4-DDT	µg/kg	<1	<1	<1	<1	<1	<1	<1	<1	<1	2.5	4000
Methoxychlor	µg/kg	<1	<1	<1	<1	<1	<1	<1	<1	<1	-	-
Azinphos Methyl	µg/kg	<1	<1	<1	<1	<1	<1	<1	<1	<1	-	-

Legend
µg/kg: micrograms per kilogram
MAC: Maximum Admissable Concentration
S-level: Dutch guideline for normal uncontaminated soil
I-Level: Dutch guideline for Intervention
-: MAC not available
< = below laboratory detection limit

Table 7a. Soil Analytical Results - PCBs - PM, Ringaskiddy (Dec 2000)

Parameters		TP 1	TP 2	TP 3	TP 4	TP 5	TP 6	TP 7	TP 7	TP10
	Depth (m)	1.8	0 - 5.5	0 - 1.5	0 - 3	0 - 3	0 - 3.2	0 - 2	3 - 4.1	0 - 1
	Units									
PCB Congener 28	µg/kg	<1	<1	<1	<1	<1	<1	<1	<1	<1
PCB Congener 52	µg/kg	<1	<1	<1	<1	<1	<1	<1	<1	<1
PCB Congener 101	µg/kg	<1	50	<1	<1	<1	<1	23	<1	<1
PCB Congener 118	µg/kg	<1	14	<1	<1	<1	<1	<1	<1	<1
PCB Congener 153	µg/kg	<1	182	<1	<1	<1	<1	23	<1	<1
PCB Congener 138	µg/kg	<1	214	<1	<1	<1	<1	27	<1	<1
PCB Congener 180	µg/kg	<1	183	<1	<1	<1	<1	25	<1	<1
PCB total	µg/kg	<1	643	<1	<1	<1	<1	98	<1	<1

Dutch MAC Values	
S-Value	I-Vales
-	-
-	-
-	-
-	-
-	-
-	-
-	-
-	-
20	1000

Legend
µg/kg: micrograms per kilogram
MAC: Maximum admissable concentration
S-level: Dutch guideline for normal uncontaminated soil
I-Level: Dutch guideline for Intervention
-: MAC not available
< = below laboratory detection limit

Table 7b. Soil Analytical Results - PCBs (repeat analysis) - PM, Ringaskiddy (Dec 2000)

Parameters		TP 2	TP 7	Dutch MAC Values	
	Depth (m)	0 - 5.5	0 - 2	S-Value	I-Vales
	Units			-	-
PCB Congener 28	µg/kg	1	<1	-	-
PCB Congener 52	µg/kg	<1	<1	-	-
PCB Congener 101	µg/kg	<1	<1	-	-
PCB Congener 118	µg/kg	<1	<1	-	-
PCB Congener 153	µg/kg	3	1	-	-
PCB Congener 138	µg/kg	4	1	-	-
PCB Congener 180	µg/kg	5	<1	-	-
PCB total	µg/kg	13	2	20	1000

Legend

µg/kg: micrograms per kilogram
MAC: Maximum admissable concentration
S-level: Dutch guideline for normal uncontaminated soil
I-Level: Dutch guideline for Intervention
-: MAC not available
< = below laboratory detection limit

Table 8. Groundwater Analytical Results - PRO, DRO, Mineral Oils - PM, Ringaskiddy (Dec 2000)

Location	BH 1	BH 2	BH 3	BH 4	BH 5
Units	µg/l	µg/l	µg/l	µg/l	µg/l
Diesel Range Organics	<10	<10	<10	<10	<10
Mineral Oil	<10	<10	<10	<10	<10
Petrol Range Organics	<10	<10	<10	<10	<10

Dutch MACs	
S-Value µg/l	I-Value µg/l
-	-
50	600
-	-

Legend:
µg/l - micrograms per Litre
Dutch MACs - Dutch Maximum Admissible Concentration guidelines
S-Value= Target Value
I-Value= Intervention Value
"-" = Dutch MAC not available
"<" = Less than

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Table [illegible]. Groundwater Analytical Results - BTEX - PM, Ringaskiddy (Dec 2000)

Location	BH 1	BH 2	BH 3	BH 4	BH 5
Units	µg/l	µg/l	µg/l	µg/l	µg/l
Benzene	<10	<10	<10	<10	<10
Toluene	<10	<10	<10	<10	<10
Ethylbenzene	<10	<10	<10	<10	<10
Xylene	<10	<10	<10	<10	<10

Dutch MACs	
S-Value µg/l	I-Value µg/l
0.20	30
0.20	1000
0.20	150
0.20	70

Legend:
µg/l - micrograms per Litre
Dutch MACs - Dutch Maximum Admissible Concentration guidelines
S-Value= Target Value
I-Value= Intervention Value
Results are underlined where the Dutch S-MAC for Mineral Oil is exceeded.
"-" = Dutch MAC not available
"<" = Less than

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Table 10a. Groundwater Analytical Results - VOCs - PM, Ringaskiddy (Dec 2000)

Trace Organics (VOCs)	Location	BH 1	BH 2	BH 3	BH 4	BH 5	Dutch MACs	
	Units						S-Value	I-Value
Dichlorofluoromethane	µg/l	<1	<1	<1	<1	<1	-	-
Chloromethane	µg/l	<1	<1	<1	<1	<1	-	-
Vinylchloride	µg/l	<1	<1	<1	<1	<1	-	-
Bromomethane	µg/l	<1	<1	<1	<1	<1	-	-
Chloroethane	µg/l	<1	<1	<1	<1	<1	-	-
Trichlorofluoromethane	µg/l	<1	<1	<1	<1	<1	-	-
trans-1,2-Dichloroethene	µg/l	<1	<1	<1	<1	<1	-	-
Dichloromethane	µg/l	<1	<1	<1	<1	<1	-	-
1,1 Dichloroethene	µg/l	<1	<1	<1	<1	<1	-	-
1,1 Dichloroethane	µg/l	<1	<1	<1	<1	<1	-	-
cis-1,2-Dichloroethene	µg/l	<1	<1	<1	<1	<1	-	-
Bromochloromethane	µg/l	<1	<1	<1	<1	<1	-	-
Chloroform	µg/l	<1	<1	<1	<1	<1	-	-
2,2-Dichloropropane	µg/l	<1	<1	<1	<1	<1	0.01	50
1,2-Dichloroethane	µg/l	<1	<1	<1	<1	<1	0.01	400
1,1,1-Trichloroethane	µg/l	<1	<1	<1	<1	<1	-	-
1,1-Dichloropropene	µg/l	<1	<1	<1	<1	<1	-	-
Benzene	µg/l	<1	<1	<1	<1	<1	0.01	50
Carbontetrachloride	µg/l	<1	<1	<1	<1	<1	-	-
Dibromomethane	µg/l	<1	<1	<1	<1	<1	0.01	50
1,2-Dichloropropane	µg/l	<1	<1	<1	<1	<1	-	-
Bromodichloromethane	µg/l	<1	<1	<1	<1	<1	-	-
Trichloroethene	µg/l	<1	<1	<1	<1	<1	-	-
cis-1,3-Dichloropropene	µg/l	<1	<1	<1	<1	<1	-	-
trans-1,3-Dichloropropene	µg/l	<1	<1	<1	<1	<1	0.20	30
1,1,2-Trichloroethane	µg/l	<1	<1	<1	<1	<1	-	-
Toluene	µg/l	<1	<1	<1	<1	<1	-	-
1,3-Dichloropropane	µg/l	<1	<1	<1	<1	<1		
Dibromochloromethane	µg/l	<1	<1	<1	<1	<1	-	-
1,2-Dibromoethane	µg/l	<1	<1	<1	<1	<1		
Tetrachloroethene	µg/l	<1	<1	<1	<1	<1	-	-
1,1,1,2 -Tetrachloroethane	µg/l	<1	<1	<1	<1	<1	-	-
Chlorobenzene	µg/l	<1	<1	<1	<1	<1		
Ethylbenzene	µg/l	<1	<1	<1	<1	<1	-	-

LEGEND

µg/l: micrograms per litre
MAC: Maximum Admissible Concentration
Dutch S-Value: Target Value
Dutch I-Value: Intervention Value
-': MAC Guideline Not Available
< = Below current laboratory detection limit

Table 10b. Groundwater Analytical Results - VOCs - PM, Ringaskiddy (Dec 2000)

Trace Organics (VOCs)	Location	BH 1	BH 2	BH 3	BH 4	BH 5	Dutch MACs	
	Units						S-Value	I-Value
p/m Xylenes	µg/l	<1	<1	<1	<1	<1	-	-
Bromoform	µg/l	<1	<1	<1	<1	<1	-	-
Styrene	µg/l	<1	<1	<1	<1	<1	-	-
1,1,2,2-Tetrachloroethane	µg/l	<1	<1	<1	<1	<1	-	-
o - Xylene	µg/l	<1	<1	<1	<1	<1	-	-
1,2,3-Trichloropropane	µg/l	<1	<1	<1	<1	<1	-	-
Isopropylbenzene	µg/l	<1	<1	<1	<1	<1		
Bromobenzene	µg/l	<1	<1	<1	<1	<1	0.2	150
2-Chlorotoluene	µg/l	<1	<1	<1	<1	<1	-	-
Propylbenzene	µg/l	<1	<1	<1	<1	<1	-	-
4-Chlorotoluene	µg/l	<1	<1	<1	<1	<1	-	-
1,2,4-Trimethylbenzene	µg/l	<1	<1	<1	<1	<1	-	-
4-Isopropyltoluene	µg/l	<1	<1	<1	<1	<1	-	-
5-Trimethylbenzene	µg/l	<1	<1	<1	<1	<1		
1,2-Dichlorobenzene	µg/l	<1	<1	<1	<1	<1	0.2	70
1,4-Dichlorobenzene	µg/l	<1	<1	<1	<1	<1	-	-
sec-Butylbenzene	µg/l	<1	<1	<1	<1	<1	0.5	300
tert-Butylbenzene	µg/l	<1	<1	<1	<1	<1	-	-
1,3-Dichlorobenzene	µg/l	<1	<1	<1	<1	<1	0.01	40
n-Butylbenzene	µg/l	<1	<1	<1	<1	<1	0.2	1000
1,2-Dibromo-3-Chloropropane	µg/l	<1	<1	<1	<1	<1	-	-
1,2,4-Trichlorobenzene	µg/l	<1	<1	<1	<1	<1	-	-
Naphthalene	µg/l	<1	<1	<1	<1	<1	-	-
1,2,3-trichlorobenzene	µg/l	<1	<1	<1	<1	<1	-	-
Hexachlorobutadiene	µg/l	<1	<1	<1	<1	<1	-	0.7

LEGEND

µg/l: micrograms per litre
MAC: Maximum Admissible Concentration
Dutch S-Value: Target Value
Dutch I-Value: Intervention Value
-': MAC Guideline Not Available
< = Below current laboratory detection limit

Table 11. Groundwater Analytical Results - PAHs - PM, Ringaskiddy (Dec 2000)

Parameters	Units	BH 1	BH 2	BH 3	BH 4	BH 5	Dutch MAC Values S-Value	Dutch MAC Values I-Value
Acenaphthene	ng/l	131	<10	135	<10	<10	-	-
Acenaphthylene	ng/l	28	21	285	<10	25	-	-
Benzo(B)fluoranthene	ng/l	<10	<10	<10	<10	<10	-	-
Dibenz(AH)anthracene	ng/l	<10	<10	<10	<10	<10	-	-
Fluorene	ng/l	<10	<10	<10	<10	<10	-	-
Pyrene	ng/l	<10	19	<10	<10	<10	-	-
PAHs included in 'PAH (Sum of 10)' Dutch S and I MAC values for PAHs in soil								
Anthracene	ng/l	20	17	19	11	<10	20	5000
Benzo(a)anthracene	ng/l	<10	<10	<10	<10	<10	2	500
Benzo(a)pyrene	ng/l	<10	<10	<10	<10	<10	1	50
Benzo(ghi)perylene	ng/l	<10	<10	<10	<10	<10	0.2	50
Benzo(k)flouranthene	ng/l	<10	<10	<10	<10	<10	0.2	50
Chrysene	ng/l	<10	<10	<10	<10	<10	2	50
Fluoranthene	ng/l	<10	26	<10	<10	<10	5	1000
Indeno(123-cd)pyrene	ng/l	<10	<10	<10	<10	<10	0.4	50
Naphthalene	ng/l	35	19	36	65	25	100	70000
Phenanthrene	ng/l	13	43	11	14	18	20	5000

Legend

ng/l: nanograms per litre
MAC: Maximum admissable concentration
S-level: Dutch guideline for normal uncontaminated groundwater
I-Level: Dutch guideline for Intervention
"-": MAC not available
< = below laboratory detection limit

Table 12. Groundwater Analytical Results - Metals - PM, Ringaskiddy (Dec 2000)

Sample Identity	Arsenic mg/l	Cadmium mg/l	Chromium mg/l	Copper mg/l	Mercury mg/l	Nickel mg/l	Lead mg/l	Selenium mg/l	Zinc mg/l
BH 1	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.1	<0.05
BH 2	0.06	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.1	<0.05
BH 3	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.1	<0.05
BH 4	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.1	<0.05
BH 5	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.1	<0.05

Dutch MAC S Values	0.01	0.0004	0.001	0.03	0.005	0.015	0.015	-	0.065
Dutch MAC I Values	0.06	0.006	0.03	0.075	0.003	0.075	0.075	-	0.80

Legend

mg/l: milligrams per Litre

MAC: Dutch Standard Maximum Admissible Concentration

S Value: Dutch Guidline for normal uncontaminated soil

I Value: Dutch Guideline for Intervention

"-": MAC Guideline not available

n.a. = not analysed

"<" = below detection limit

Table 13. Groundwater Analytical Results - Pesticides - PM, Ringaskiddy (Dec 2000)

Pesticide	Location	BH 1	BH 2	BH 3	BH 4	BH 5	Dutch Values	
	Units						S- Value	I Value
Dichlorvos	µg/l	<1	<1	<1	<1	<1	-	-
Mevinphos	µg/l	<1	<1	<1	<1	<1	-	-
Phorate	µg/l	<1	<1	<1	<1	<1	-	-
Alpha-BHC	µg/l	<1	<1	<1	<1	<1	-	-
Beta-BHC	µg/l	<1	<1	<1	<1	<1	-	-
Gamma-BHC	µg/l	<1	<1	<1	<1	<1	200	
Diazinon	µg/l	<1	<1	<1	<1	<1	-	-
Disulfoton	µg/l	<1	<1	<1	<1	<1	-	-
Delta-BHC	µg/l	<1	<1	<1	<1	<1	-	-
Methyl Parathion	µg/l	<1	<1	<1	<1	<1	-	-
Heptachlor	µg/l	<1	<1	<1	<1	<1	-	-
Fenitrothion	µg/l	<1	<1	<1	<1	<1	-	-
Aldrin	µg/l	<1	<1	<1	<1	<1	-	-
Malathion	µg/l	<1	<1	<1	<1	<1	-	-
Parathion	µg/l	<1	<1	<1	<1	<1	-	-
Heptachlor Epoxide	µg/l	<1	<1	<1	<1	<1	-	-
Endosulfan I	µg/l	<1	<1	<1	<1	<1	-	-
Dieldrin	µg/l	<1	<1	<1	<1	<1	20	-
4,4-DDE	µg/l	<1	<1	<1	<1	<1	-	-
Endrin Ketone	µg/l	<1	<1	<1	<1	<1	-	-
Endosulfan II	µg/l	<1	<1	<1	<1	<1	-	-
4,4-DDD	µg/l	<1	<1	<1	<1	<1	-	-
Ethion	µg/l	<1	<1	<1	<1	<1	-	-
Endrin	µg/l	<1	<1	<1	<1	<1	-	-
Endosulfan Sulphate	µg/l	<1	<1	<1	<1	<1	-	-
4,4-DDT	µg/l	<1	<1	<1	<1	<1	-	-
Methoxychlor	µg/l	<1	<1	<1	<1	<1	-	-
Azinphos Methyl	µg/l	<1	<1	<1	<1	<1	-	-

Legend
µg/l: micrograms per litre
MAC: Maximum Admissable Concentration
S-level: Dutch guideline for normal uncontaminated soil
I-Level: Dutch guideline for Intervention
-: MAC not available
< = below laboratory detection limit

Table 14. Groundwater Analytical Results - PCBs - PM, Ringaskiddy (Dec 2000)

Parameters	Location	TP 1	TP 2	TP 3	TP 4	TP 5
	Units					
PCB Congener 28	µg/l	<1	<1	<1	<1	<1
PCB Congener 52	µg/l	<1	<1	<1	<1	<1
PCB Congener 101	µg/l	<1	<1	<1	<1	<1
PCB Congener 118	µg/l	<1	<1	<1	<1	<1
PCB Congener 153	µg/l	<1	<1	<1	<1	<1
PCB Congener 138	µg/l	<1	<1	<1	<1	<1
PCB Congener 180	µg/l	<1	<1	<1	<1	<1
PCB total	µg/l	<1	<1	<1	<1	<1

Dutch MAC Values	
S-Value	I-Vales
-	-
-	-
-	-
-	-
-	-
-	-
-	-
-	-
-	-

Legend

µg/kg: micrograms per Litre
MAC: Maximum admissable concentration
S-level: Dutch guideline for normal uncontaminated groundwater
I-Level: Dutch guideline for Intervention
-: MAC not available
< = below laboratory detection limit

Table 15. Groundwater Analytical Results - Inorganics - PM, Ringaskiddy (Dec 2000)

PARAMETERS	UNIT	BH 1	BH 2	BH 3	BH 4	BH 5	POTABLE WATER M.A.C.
pH	units	7.8	6.9	7.6	6.8	6.8	6 - 9
Conductivity	µS/cm	1002	407	892	708	825	1500
Total Hardness	CaCO3 mg/l	342	328	203	154	238	n.a.
Total Alkalinity	CaCO3 mg/l	100	250	270	250	180	n.a.
Aluminium	mg/l	0	<0.05	<0.05	<0.05	<0.05	<0.05
Boron	mg/l	<0.05	0.05	<0.05	<0.05	<0.05	<0.05
Calcium	mg/l	34	90	66	46	68	200
Iron	mg/l	<0.05	<0.05	<0.05	<0.05	<0.05	200
Magnesium	mg/l	6	22	8	8	13	50
Manganese	mg/l	0.05	0.05	<0.05	0.05	0.38	50
Phosphorous	mg/l	<0.05	0	0	0	0	-
Sodium	Na mg/l	33	56	68	29	93	150
Potassium	K mg/l	3.1	7.0	3.9	1.8	2.6	12
Nitrate	NO3 mg/l	11.3	3.9	7.4	29.4	3.7	50
Nitrite	NO2 mg/l	<0.05	<0.05	0.1	0.1	<0.05	0.1
Chloride	Cl mg/l	230	145	94	49	132	250
Sulphate	SO4 mg/l	24	105	71	26	90	250
Ammonia	NH4 mg/l	1.4	1.2	1.3	1.9	1.0	0.3
Total Phenols	mg/l	<0.01	<0.01	<0.01	<0.01	<0.01	0.0005

LEGEND
M.A.C. = Maximum Admissible Concentration under Drinking Water Regulation S.I. No. 81 of 1988
"-": MAC not available
< = Less Than
mg/l = milligram per litre

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HYDROGEOLOGICAL ASSESSMENT

HAMMOND LANE METAL COMPANY

RINGASKIDDY

CORK

Prepared For: -

Hammond Lane Metal Company,
Ringaskiddy,
County Cork.

Prepared By: -

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

23rd August 2011

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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.

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CLIENT

Hammond Lane Metal Co.

TITLE

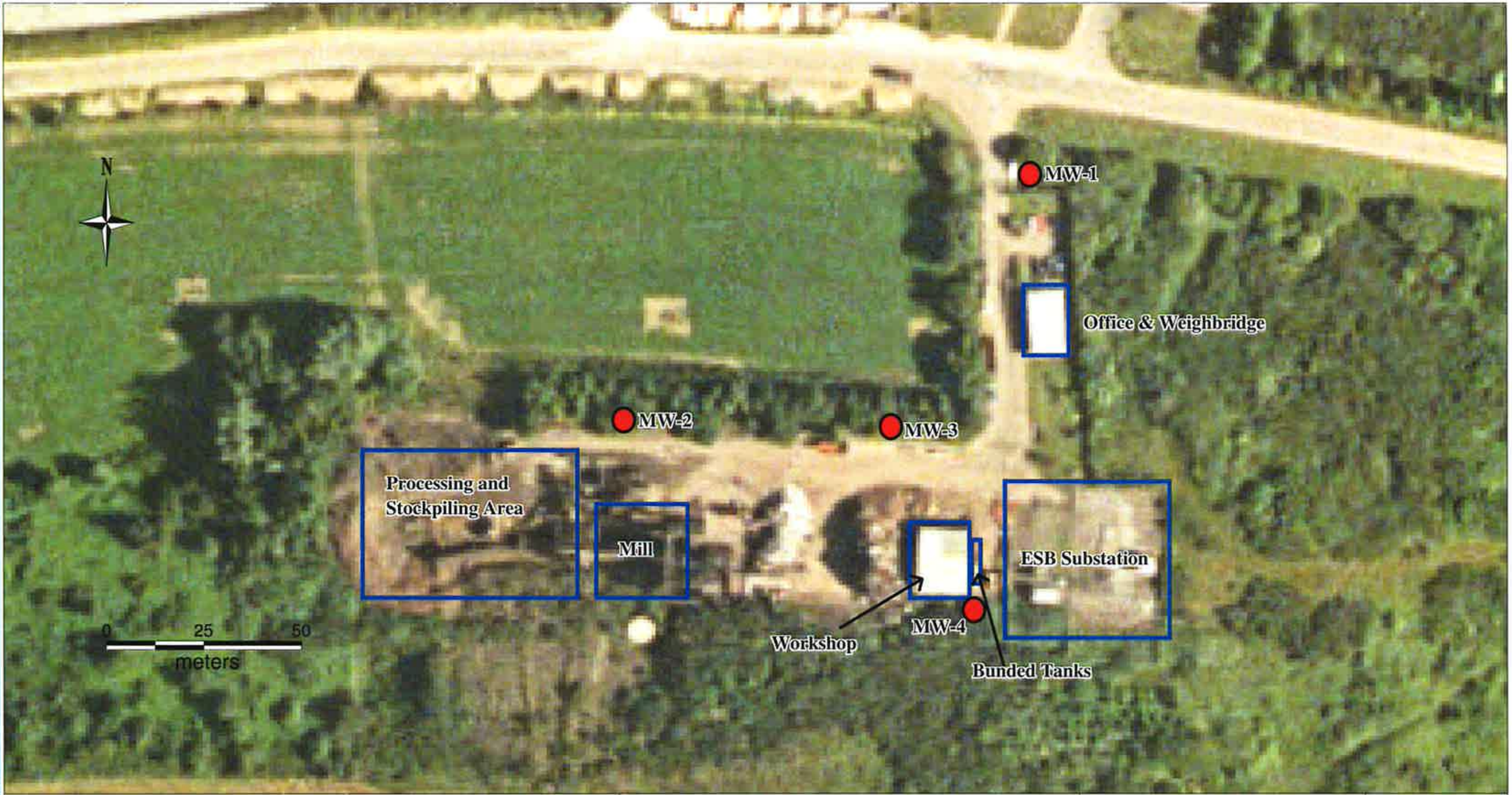
Site Location

Legend

FIGURE No.

2.1

SCALE



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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.

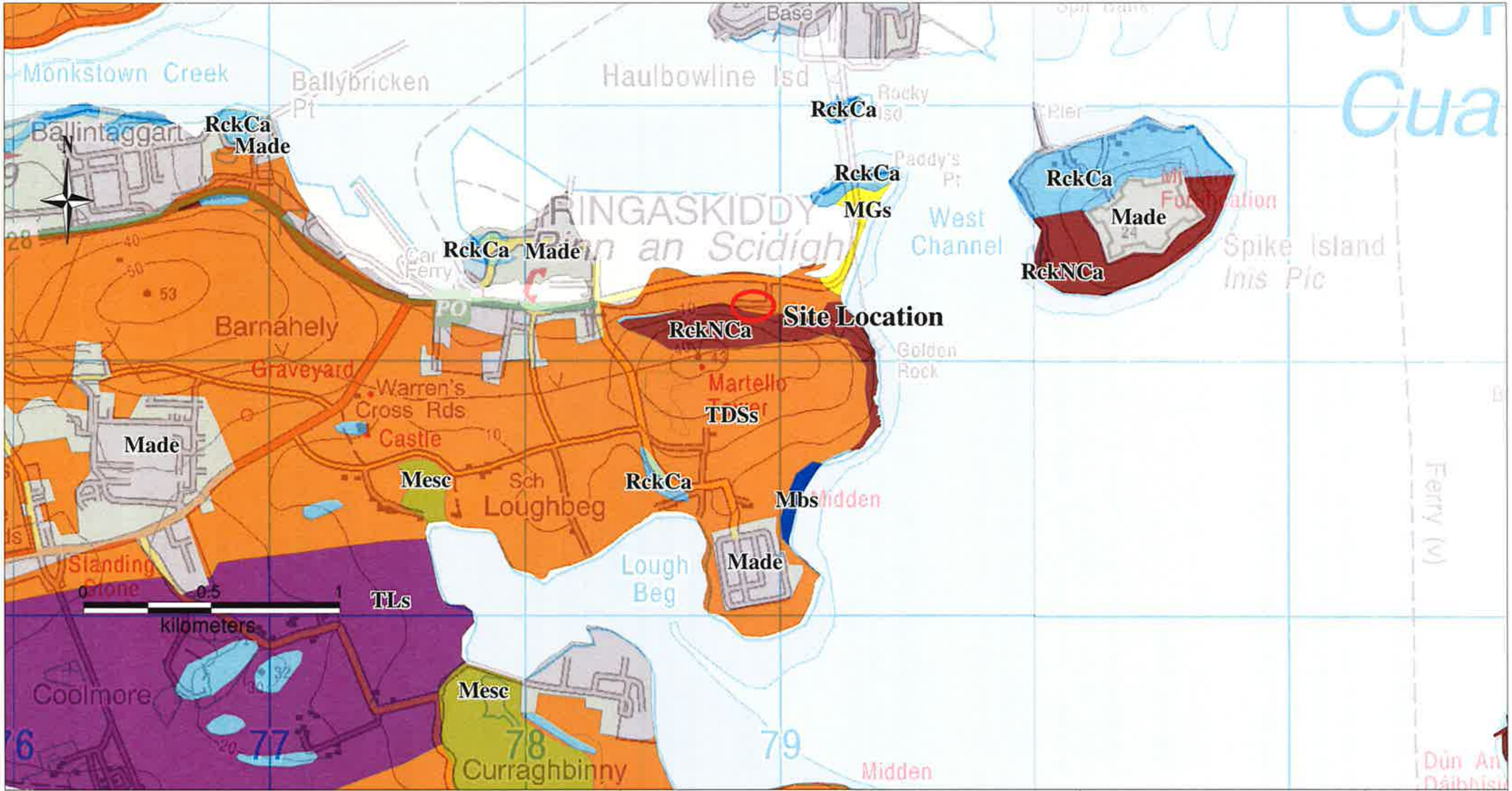
2.4.2 Bedrock

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 (**LI**), which is moderately productive in local zones. The aquifer classification is illustrated on Figure 2.5.



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Subsoil Classification

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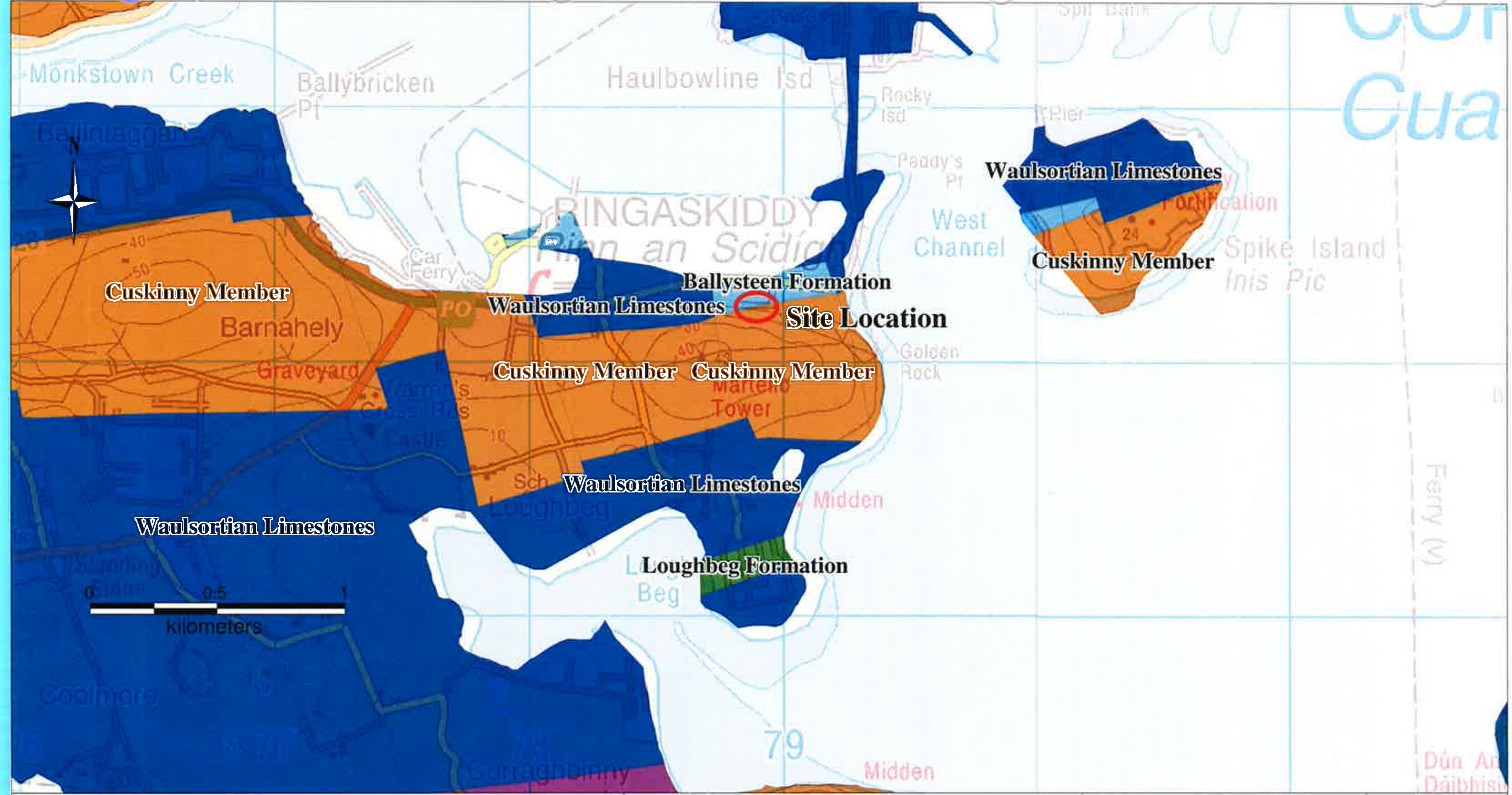
Subsoil Classification

🟧 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



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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*

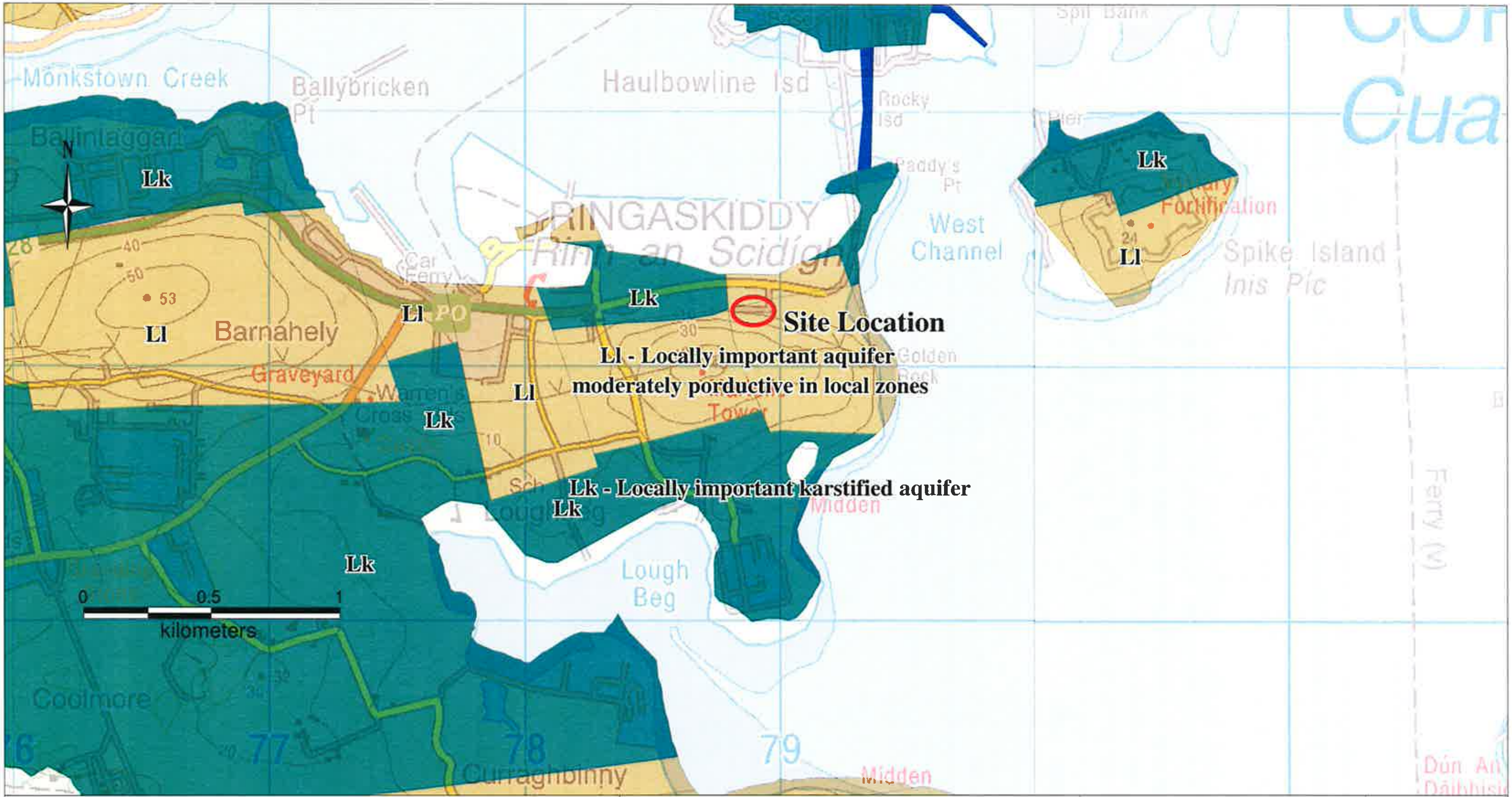
The nearest designated area is a Special Protected Area (SPA) located approximately 600m to the south in Lough Beg. Lough Beg is also a Proposed Natural Heritage Area (PNHA). The closest Special Area of Conservation (SAC) is approximately 6km to the north, in Great Island Channel.

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.



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Aquifer Classification

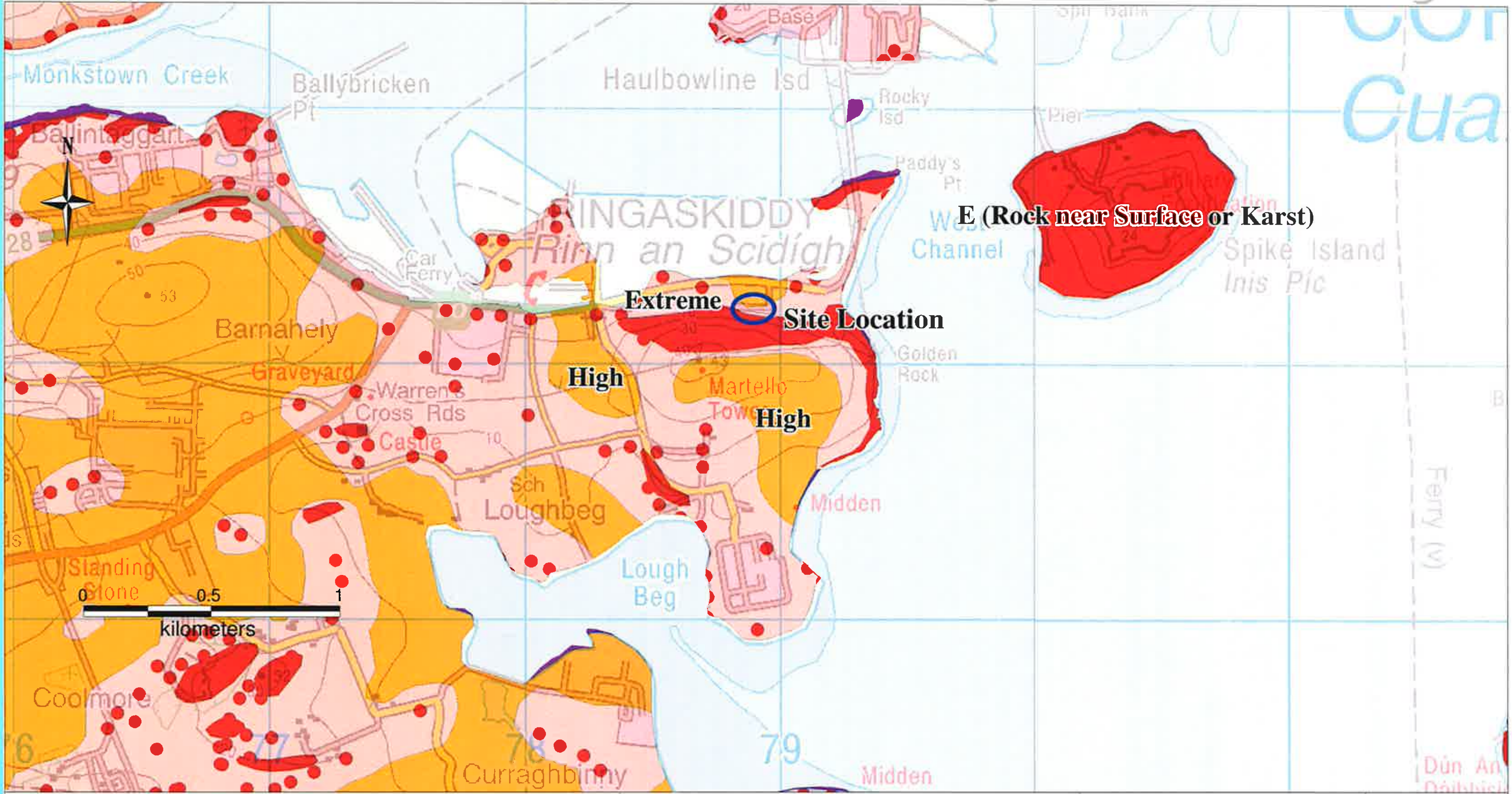
Legend

Aquifer Classification
- 🟩 Lk
- 🟨 Ll
- 🟦 Unclassified

FIGURE No.

2.5

SCALE



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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 2.66 8.43 6.97 Not Known

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

Water level - mOD 0.11 .23 0.25 ????

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

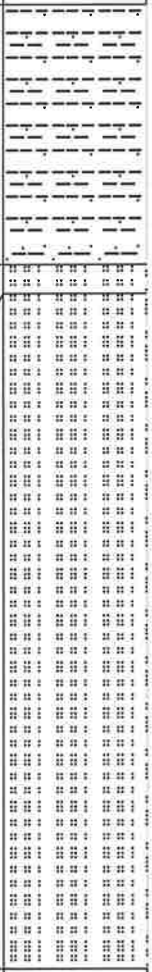
Borehole Logs

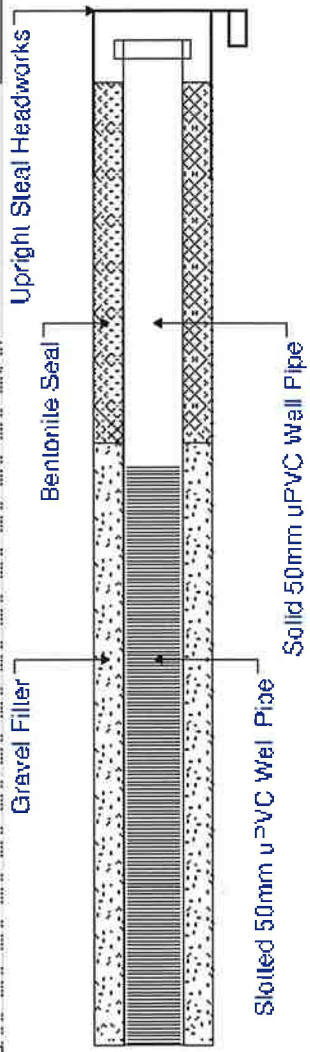
O'Callaghan Moran & Associates
Phone: 021-4321521 Fax: 021-4321522

Borehole I.D. MW-1

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

Depth (m)	Lithology Description	Lithology	Well Construction Details
-1 to 0	Ground Surface		
0 to 2.7	**Clay** Brown sandy slightly gravelly Clay.		
2.7 to 3.7	**Rock** Very broken green/grey fine grained Sandstone. Top of bedrock slightly damp.		
3.7 to 10	**Rock** Competent green grey fine grained sandstone. Very slight inflow of water at 3.5m. Water strike at 6.5m.		



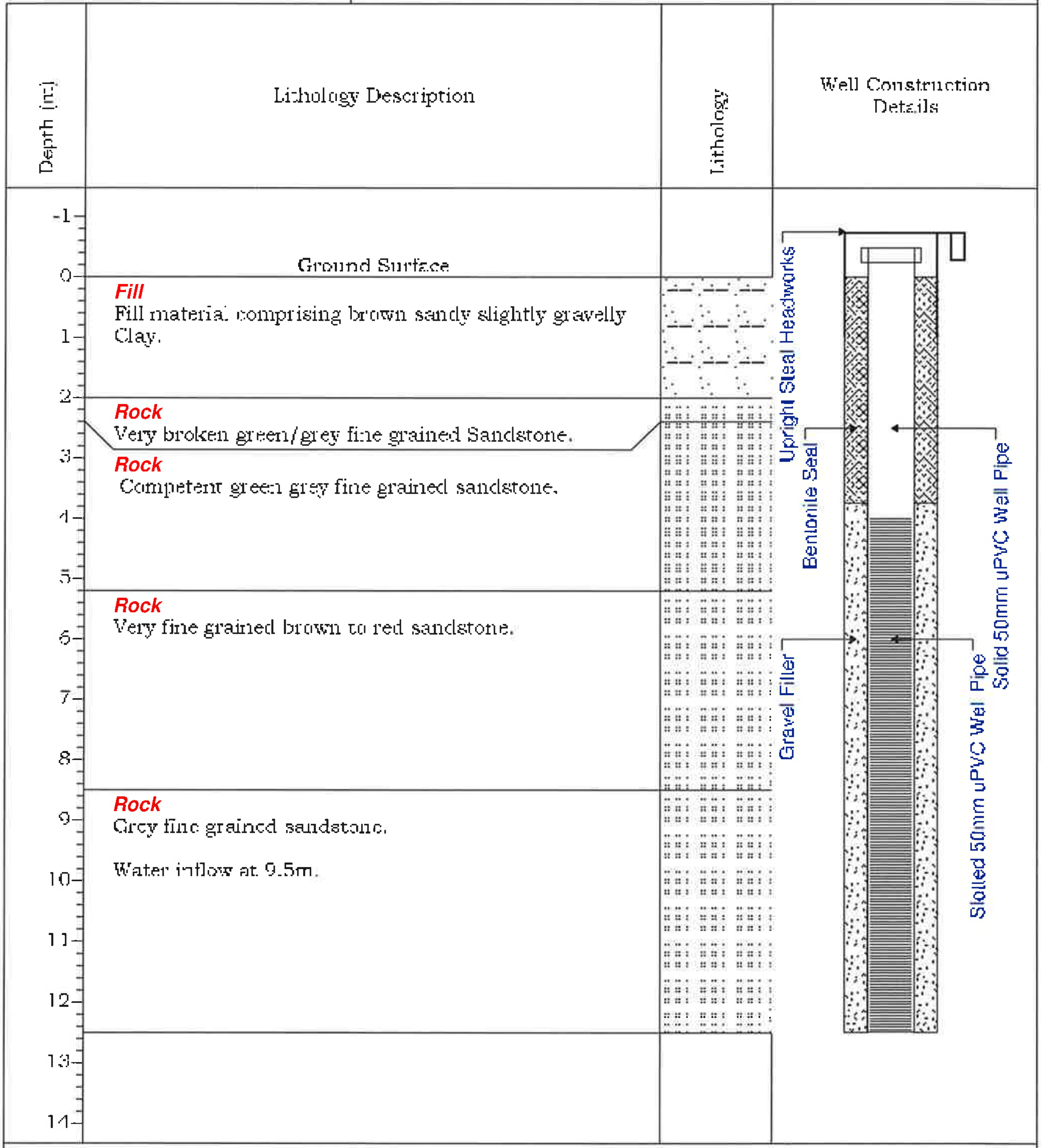


Drilling Contractor: Ground Investigations Ireland
Hole Size: 150mm
Drill Method: Air Rotary
Geologist: B. Sexton
Drill Date: 21/07/2011
Sheet: 1 of 1

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

Borehole I.D. MW-2

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



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
Very fine grained brown to red sandstone.

Rock
Grey fine grained sandstone.

Water inflow at 9.5m.

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-3

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

Depth (m) | Lithology Description | Lithology | Well Construction Details

Ground Surface

Concrete
Concrete

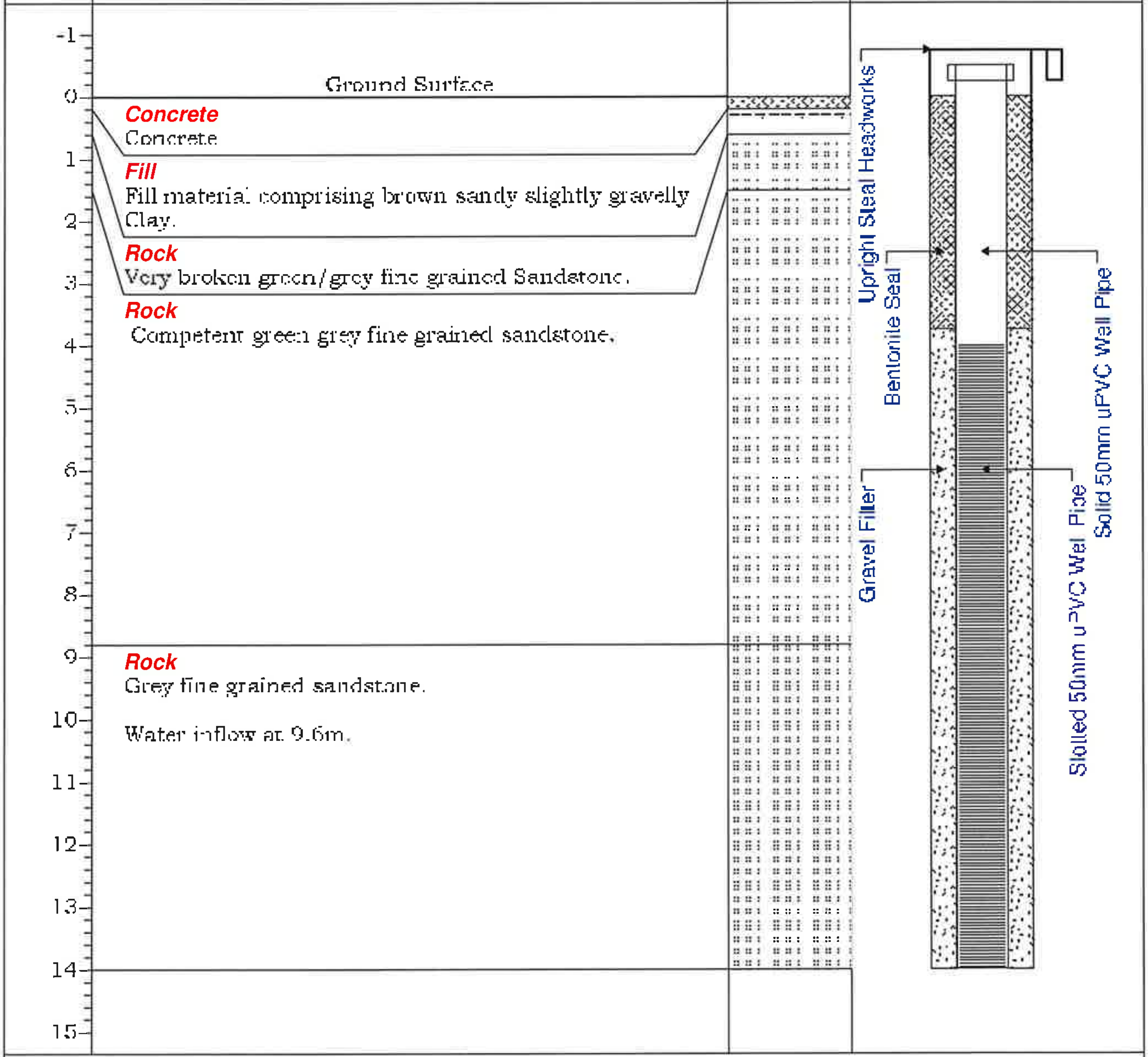
Fill
Fill material comprising brown sandy slightly gravelly Clay.

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

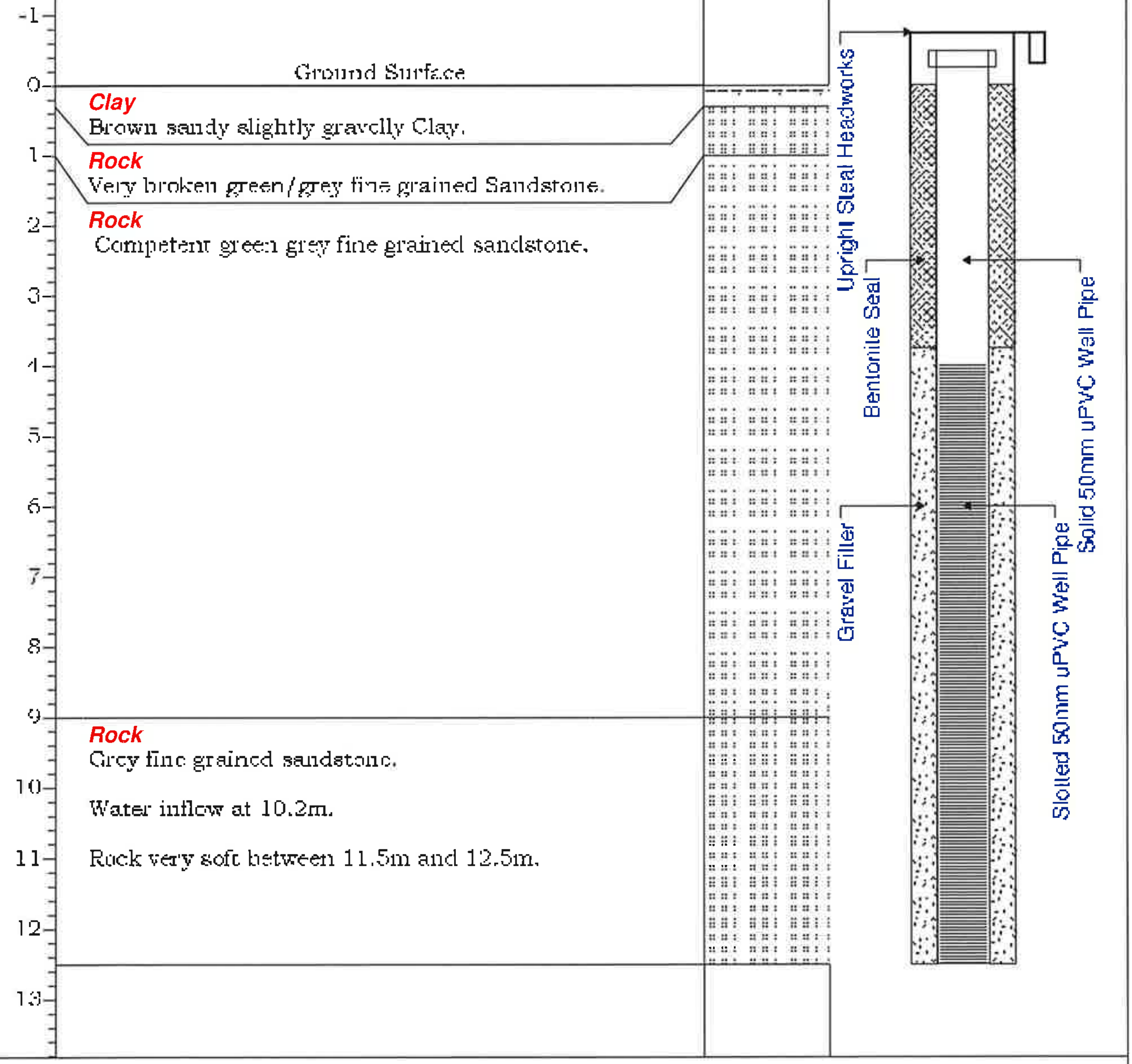
Borehole I.D. MW-4

Project: 11 099 10
Borehole Depth: 12.5m

Client: Hammond Lane Metal Co.
SWL (m):

Location: Ringaskiddy, Cork
Borehole Type: Monitoring Well

Depth (m)	Lithology Description	Lithology	Well Construction Details
0	Ground Surface		
0–0.8	**Clay** Brown sandy slightly gravelly Clay.		
0.8–1.6	**Rock** Very broken green/grey fine grained Sandstone.		
1.6–9	**Rock** Competent green grey fine grained sandstone.		
9–12.5	**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

No.4225

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

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	**Liquids/products:**	V=40ml vial, G=glass bottle, P=plastic bottle
JE Job No.:	11/5533		$H=H_2SO_4$, Z=ZnAc, N=NaOH, $HN=HN0_3$

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

Please include all sections of this report if it is reproduced
All solid results are expressed on a dry weight basis unless stated otherwise.

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.

Method Code Appendix

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			