Appendix 13.1

Soil and Hydrogeological Investigation by KT Cullen & Co Report (November 2000 and January 2001)

soils + geology

ARUP Cork
Job No: 079610
File A / B C
Proj Man: RL Init: RL Date: 9-2-01
Date: 09 FEB 2001
OM

To:	Init.	Date	To:	Init.	Date
EF					
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SOIL AND HYDROGEOLOGICAL INVESTIGATION

Greenfield Site,
Ringaskiddy,
Co. Cork,

FINAL REPORT
Janaury 2001

Prepared for:

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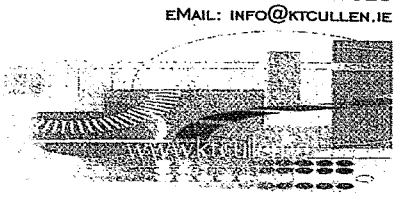
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Soil and Hydrogeological Investigation

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 ite, 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^3day - 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

T' 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 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 — DATE 1/2/01

Senior Environmental Scientist

MICHAEL CUNNINGHAM — DATE 1/2/2001

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
Bed rock	4-4.5	Pale green broken MUDSTONE

Dominant Matrix:

Dominant Clasts:

Depth to Rock: 4m

Rock Type: Pale green mudstone

Static 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

Geology:	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
Bedrock	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:

Depth 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: -

c 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

Matrix:

Clasts:

o Rock: -

k Type: -

r Level: 2m

r Entry: 1m, 2.5m

Depth: 2.8m

ments: Pit collapsing

Sample 0 - 2.8m

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:
ll	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:

De h to Rock: 3m

Rock Type: Green mudstone

tic Water Level: 3m

Water Entry: 3m

Total Depth: 4m

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

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

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

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

ominant Matrix:

minant 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

ominant Matrix:

ominant Clasts:

Depth to Rock: 2.6m

Rock Type: Pale green mudstone bedrock

atic 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:
ll	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: -

tic 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: -

Static 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: -

Static Water Level: 1.5m

Water Entry: 2.5m

Total Depth: 2.5m

Comments: Sampled 0-2.5m

No odour

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

t Matrix:

Clasts:

to Rock: -

Type: -

ter Level: 1m

ter Entry: 1.5m

al Depth: 2m

mments: Sampled 0-2m

No odour

Co. Ltd.

APPENDIX B

WELL LOG

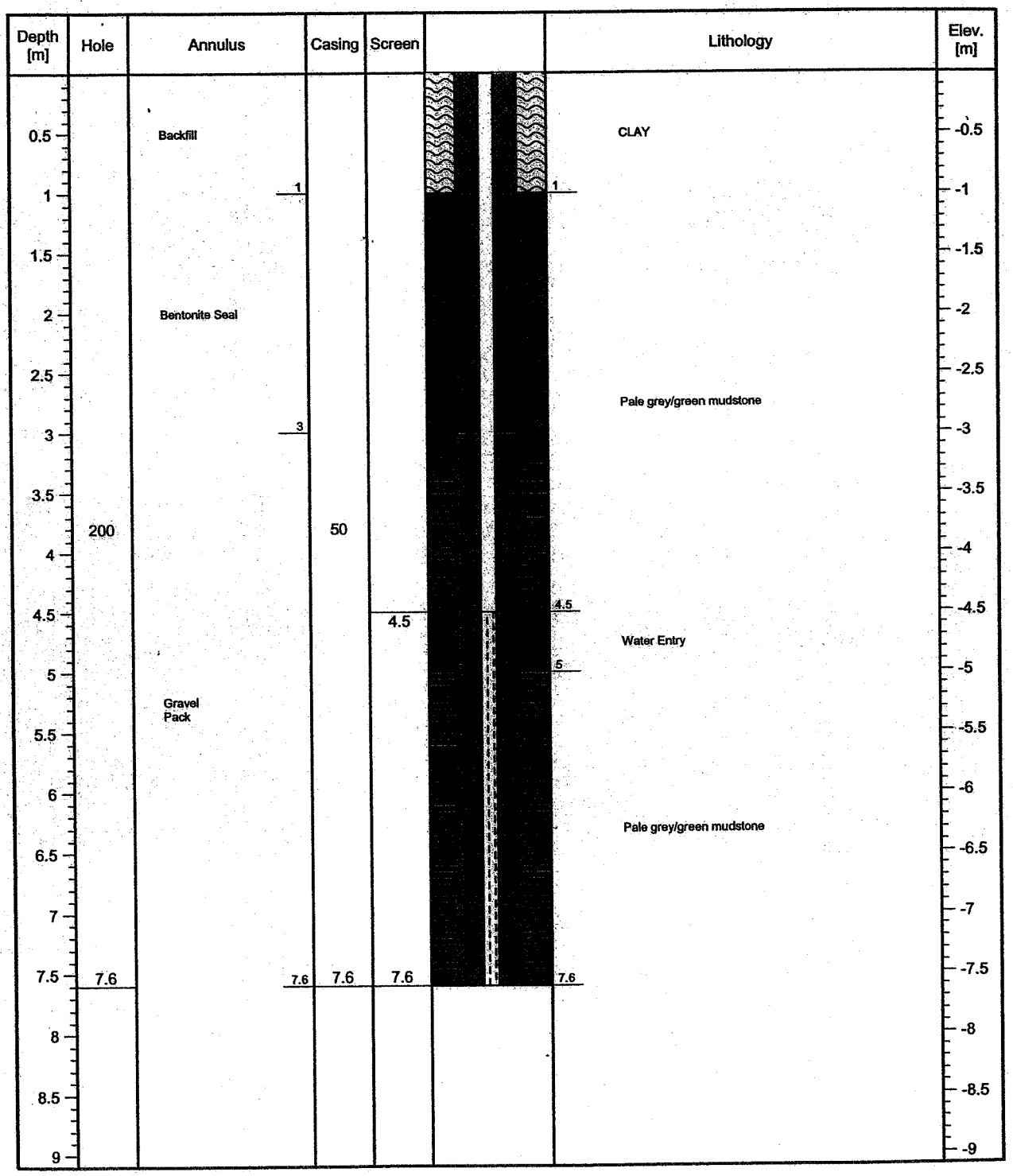
Well Ident	Description	Location
2626/BH1	Monitoring Well	Ringaskiddy, Co. Cork

Drilling Date:

All diameters in mm
All depths in metres

Scale

Water Level (mOD)	Level-Date	Vertical	Horizontal
		50.0	



WELL LOG

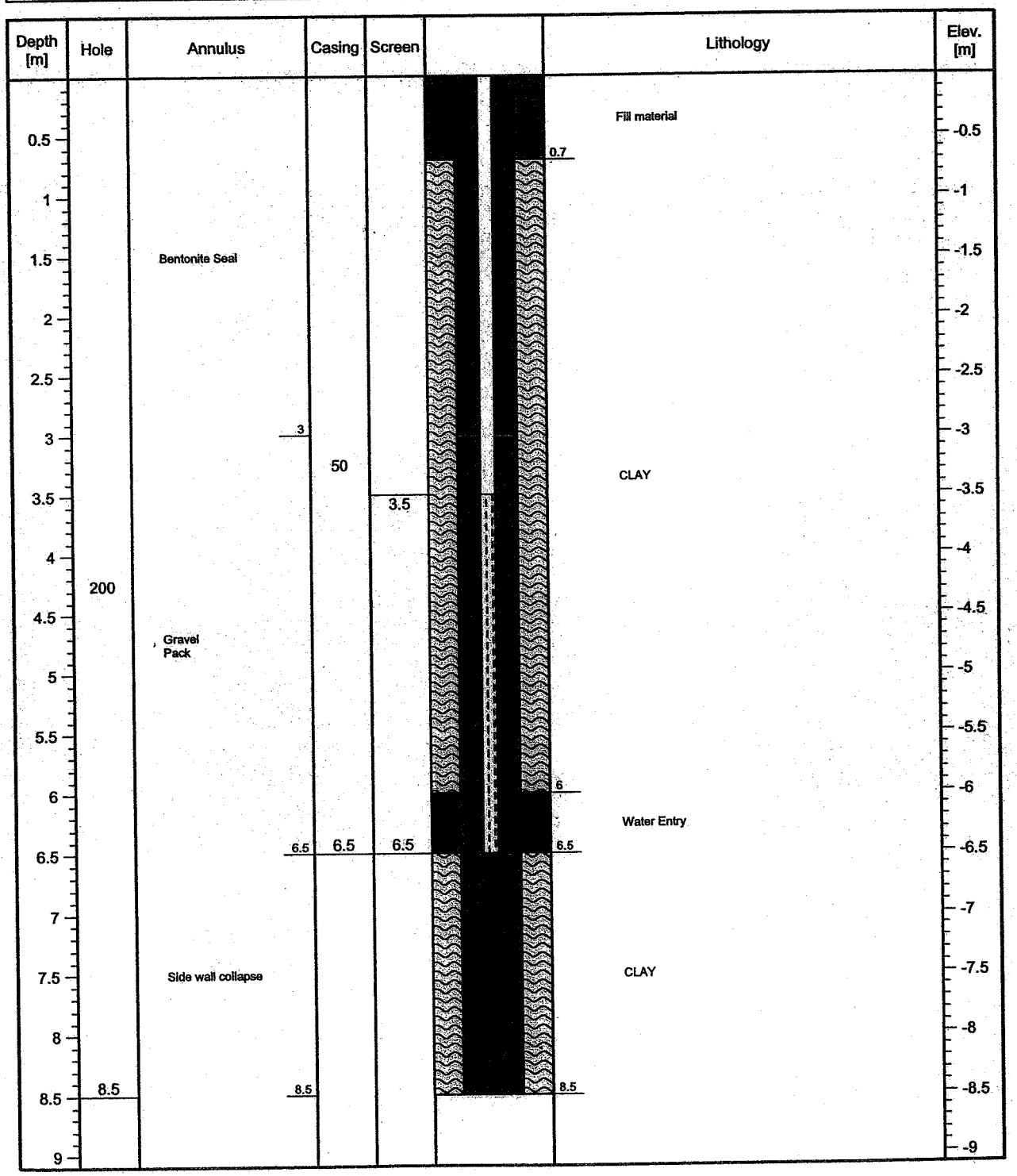
Well Ident	Description	Location
2626/BH2	Monitoring Well	Ringaskiddy, Co. Cork

Drilling Date

All diameters in mm
All depths in metres

Scale

Water Level (mOD)	Level-Date	Vertical	Horizontal
		50.0	



WELL LOG

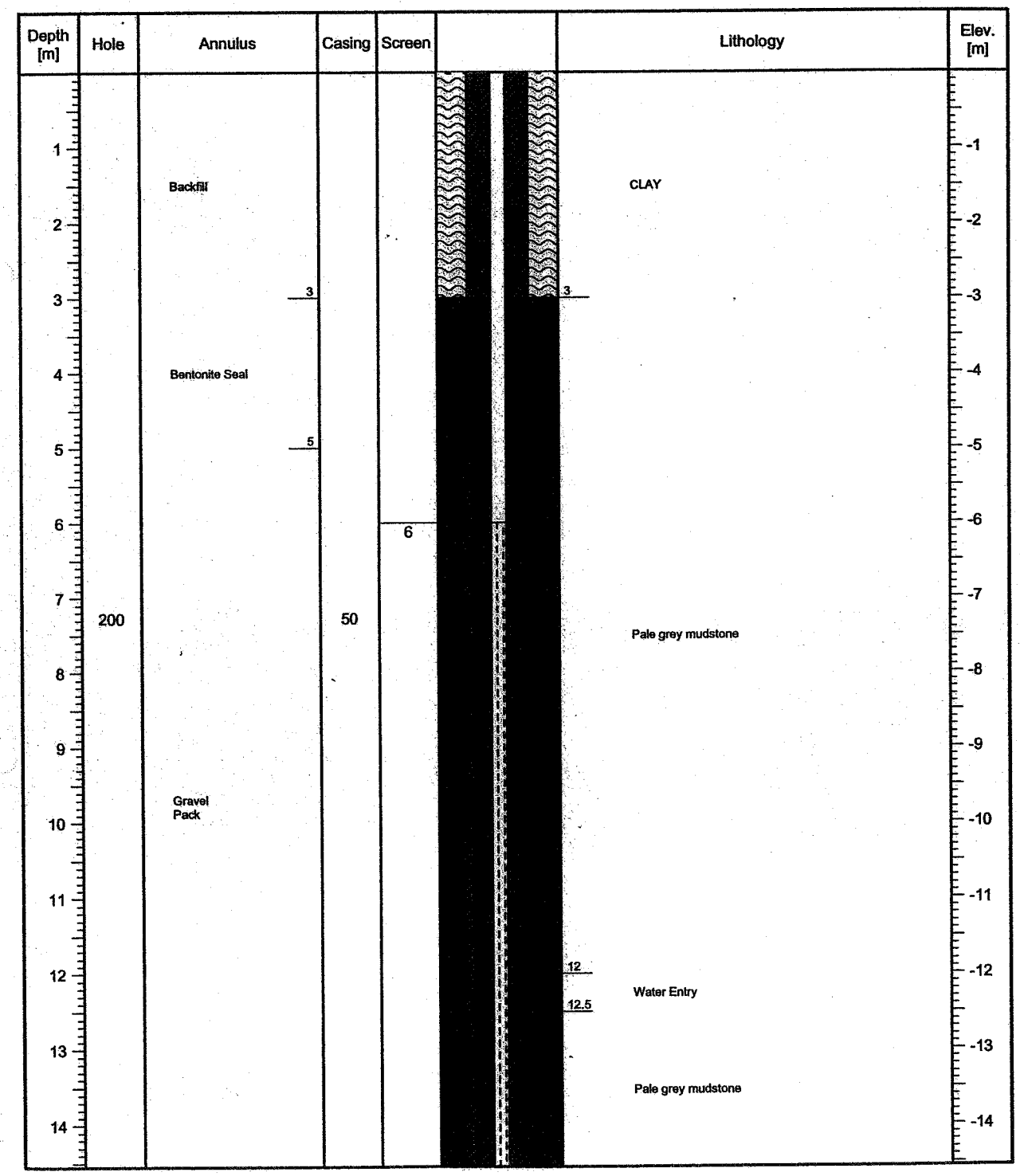
Well Ident	Description	Location
2626/BH3	Monitoring Well	Ringaskiddy, Co. Cork

Drilling Date

All diameters in mm
All depths in metres

Scale

Water Level (mOD)	Level-Date	Vertical	Horizontal
		80.0	



WELL LOG

Well Ident	Description	Location
2626/BH3	Monitoring Well	Ringaskiddy, Co. Cork

Drilling Date

All diameters in mm
All depths in metres

Scale

Water Level (mOD)	Level-Date	Vertical	Horizontal
		80.0	

Depth [m]	Hole	Annulus	Casing	Screen		Lithology	Elev. [m]
15	200 15	Gravel Pack 15	50 15	15	15	Pale grey mudstone	-15
16							-16
17							-17
18							-18
19							-19
20							-20
21							-21
22							-22
23							-23
24							-24
25							-25
26							-26
27							-27
28							-28

WELL LOG

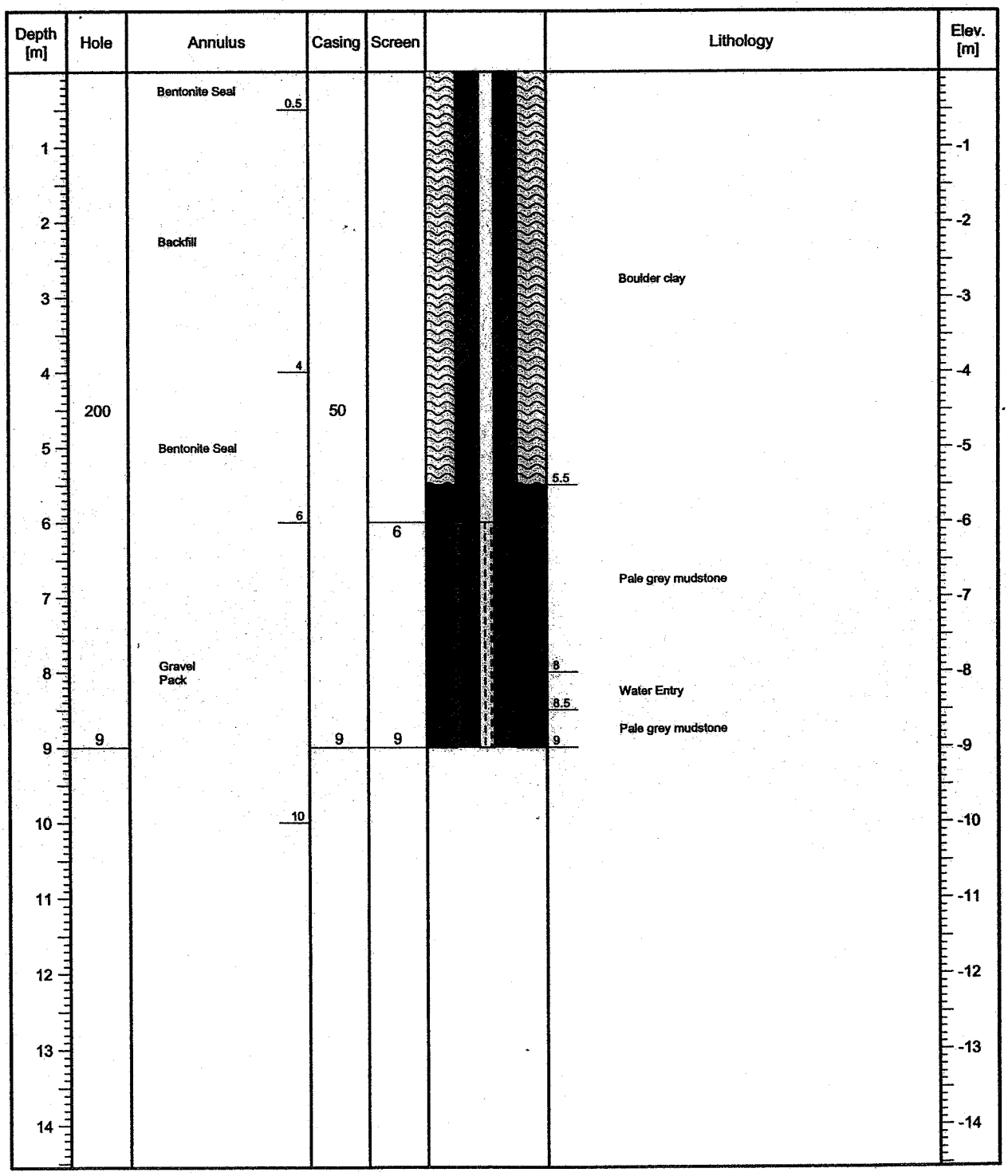
Well Ident	Description	Location
2626/BH4	Monitoring Well	Ringaskiddy, Co. Cork

Drilling Date

All diameters in mm
All depths in metres

Scale

Water Level (mOD)	Level-Date	Vertical	Horizontal
		80.0	



WELL LOG

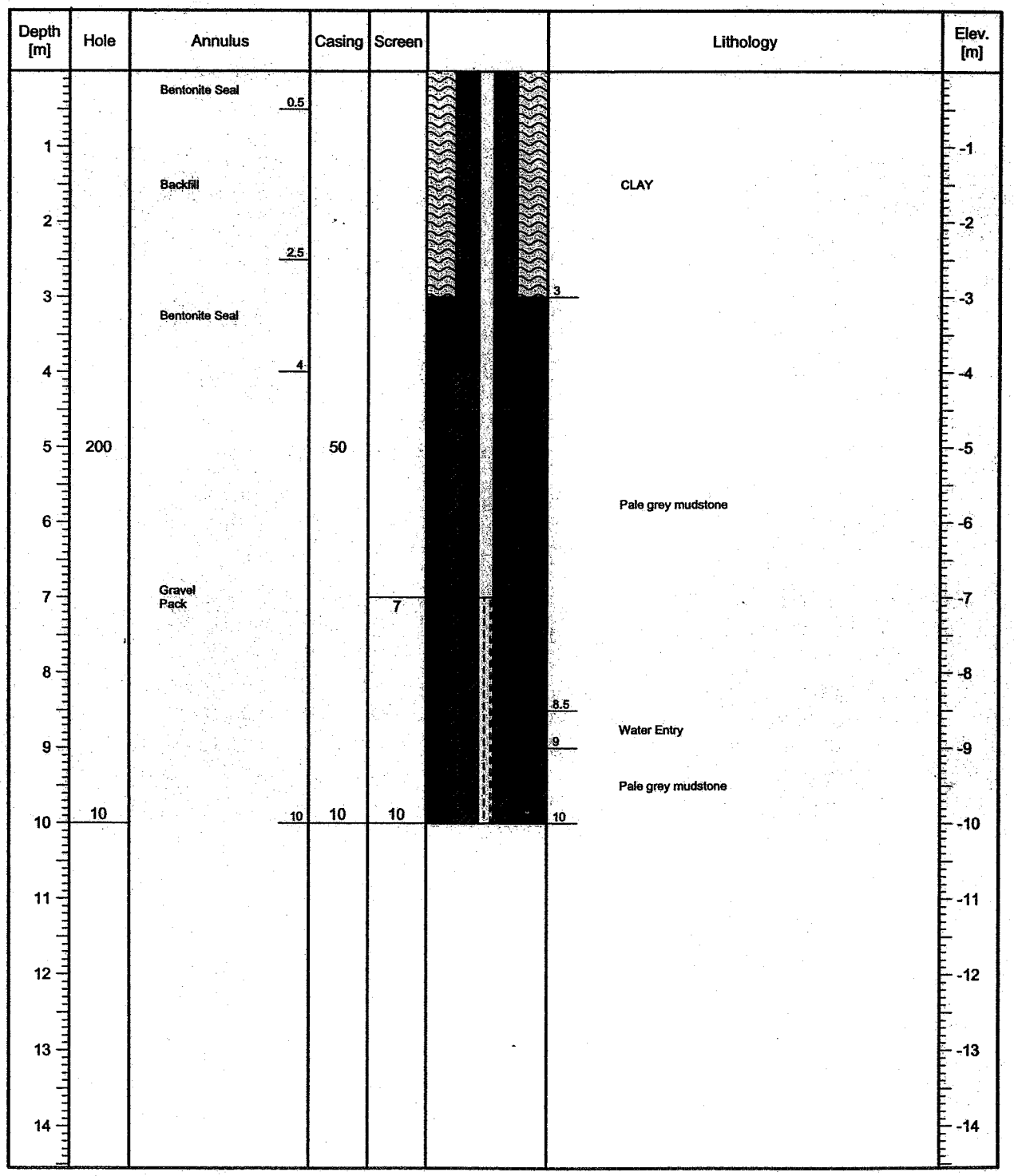
Well Ident	Description	Location
2626/BH5	Monitoring Well	Ringaskiddy, Co. Cork

Drilling Date
29.11.2000

All diameters in mm
All depths in metres

Scale

Water Level (mOD)	Level-Date	Vertical	Horizontal
		80.0	



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.

Fo 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

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Marketing Info : mkt@geochem.com
The information in this e-mail is confidential and may also be legally privileged.
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Registered Office : Templeborough House, Mill Close, Rotherham S60 1BZ
Registered in England & Wales No. 4057291

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 hyc geological data. This is illustrated in Figure 4.

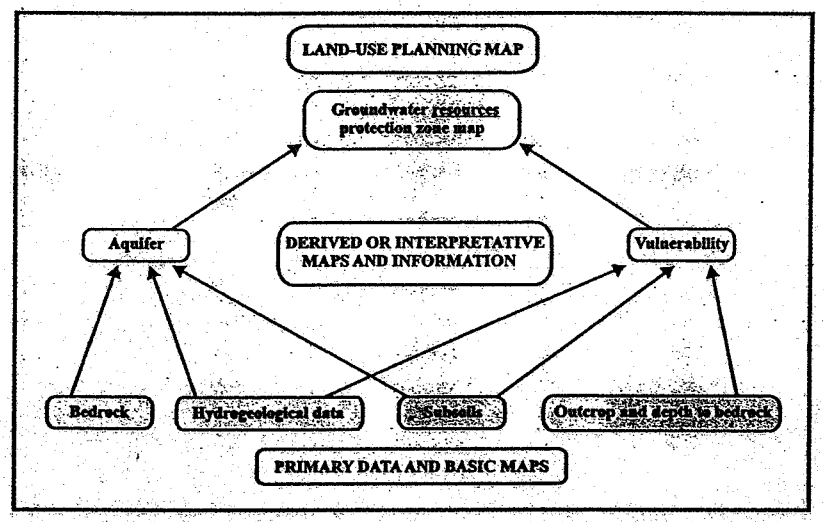


Figure 3. Conceptual framework for production of groundwater resource protection zones, indicating information needs and links

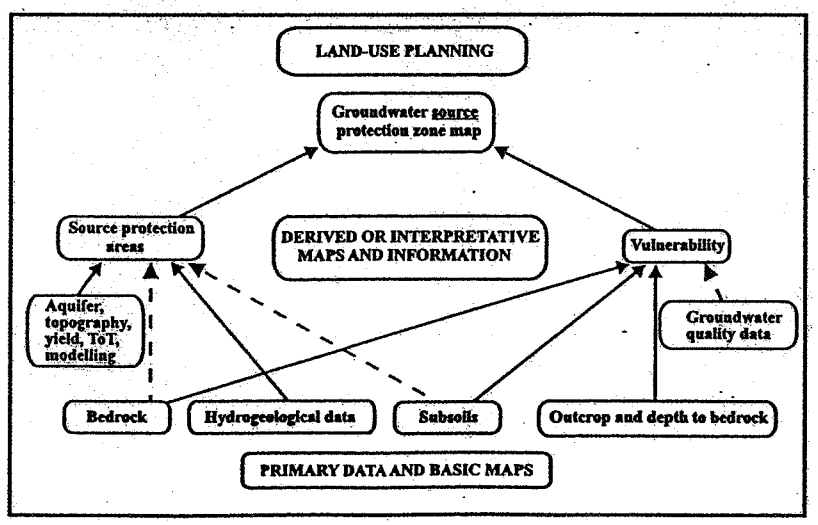


Figure 4. Conceptual framework for production of groundwater source protection zones, indicating information needs and links

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

3.3 Source Protection Zones

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

There 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.

These elements are integrated to give the source protection zones.

3.1 Delineation of Source Protection Areas

Two 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.

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

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

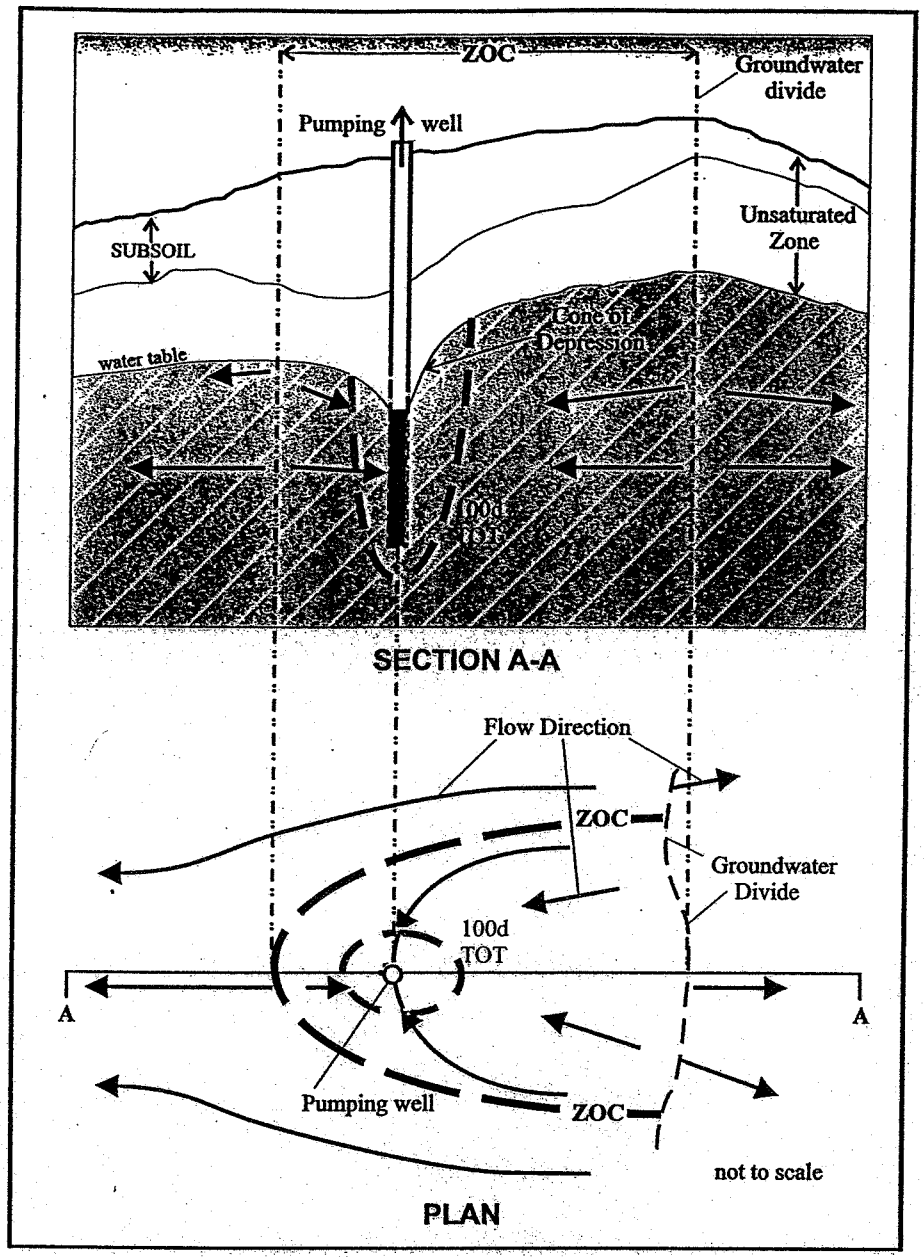


Figure 5. Conceptual Model of the Zone of Contribution (ZOC) at a Pumping Well (adapted from US EPA, 1987)

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.

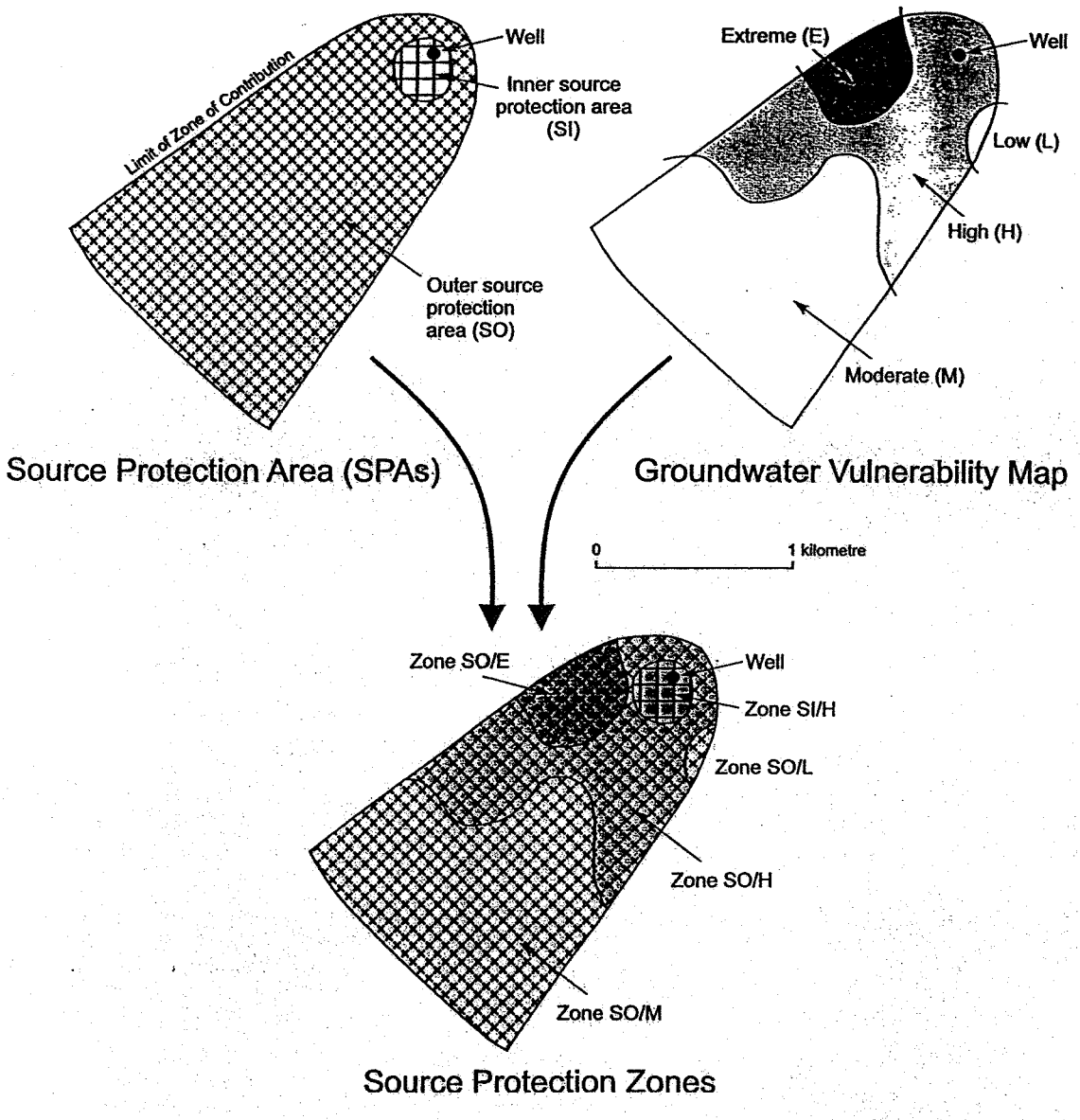


Figure 6. Delineation of source protection zones around a public supply well from the integration of the source protection area map and the vulnerability map.

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	Ll	Pl	Pu
Extreme (E)	Rk/E	Rf/E	Lm/E	Ll/E	Pl/E	Pu/E
High (H)	Rk/H	Rf/H	Lm/H	Ll/H	Pl/H	Pu/H
Moderate (M)	Rk/M	Rf/M	Lm/M	Ll/M	Pl/M	Pu/M
Low (L)	Rk/L	Rf/L	Lm/L	Ll/L	Pl/L	Pu/L

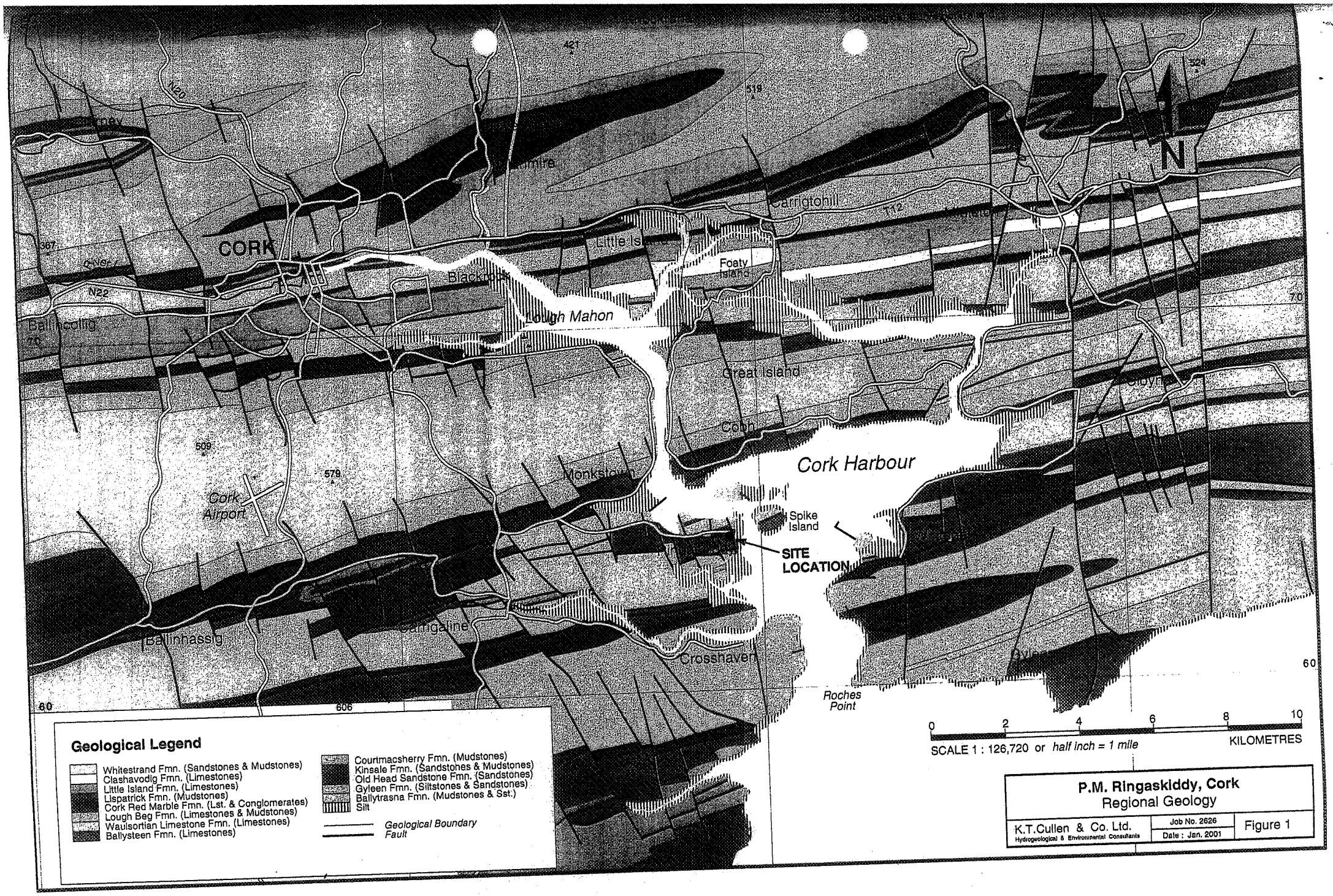
Table 3. Matrix of Resource Protection Zones

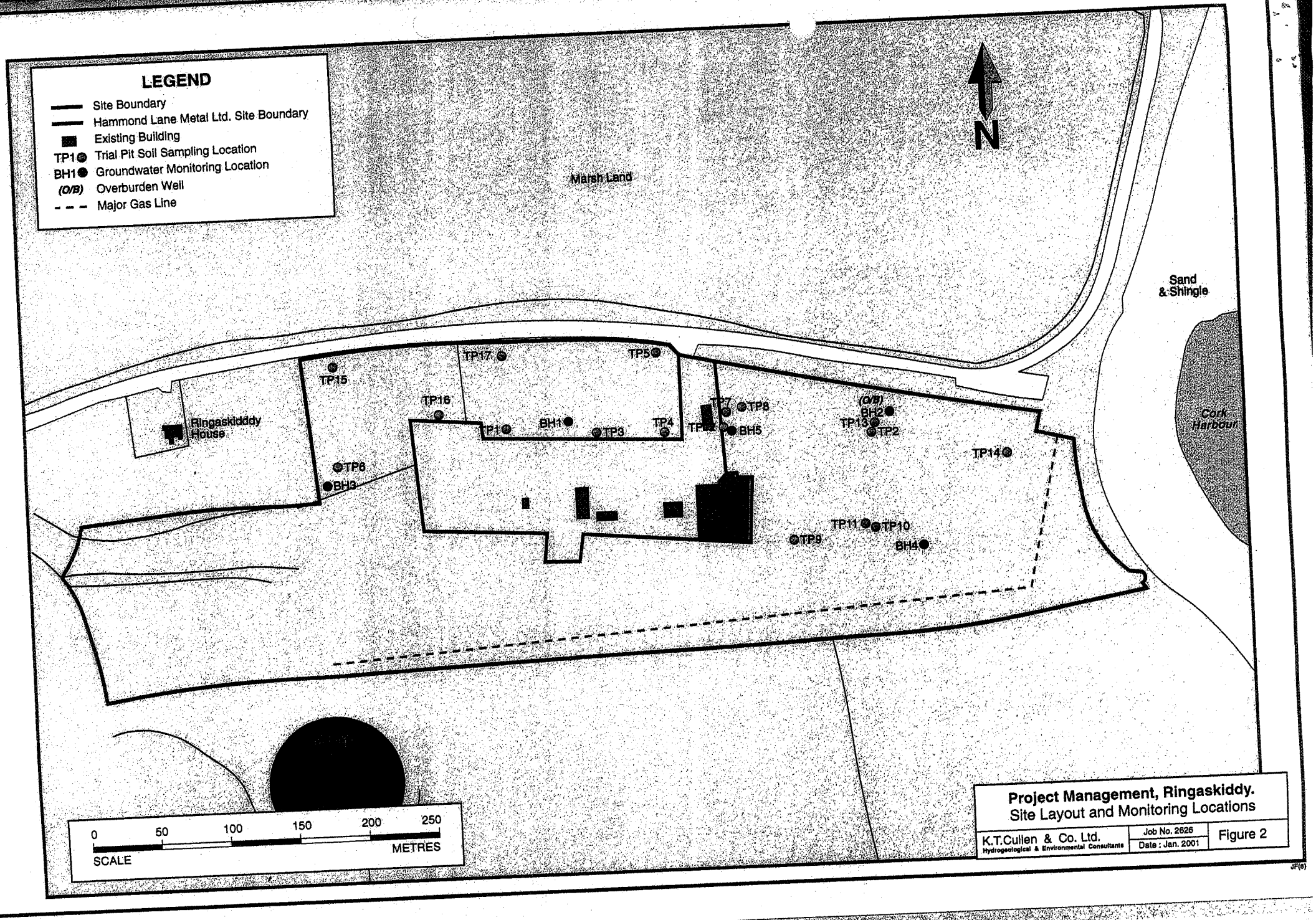
3.5 Flexibility, Limitations and Uncertainty

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


CORK
Blackpool
Lough Mahon
Foaty Island
Carrigtohill
Little Island
Great Island
Cobh
Cloyne
Cork Harbour
Monkstown
Cork Airport
Spike Island
SITE LOCATION
Carrigaline
Crosshaven
Ballinhassig
Roches Point
Ballincollig
N
421
519
324
367
509
579
606
112
70
60
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


LEGEND
Site Boundary
Hammond Lane Metal Ltd. Site Boundary
Existing Building
TP1 Trial Pit Soil Sampling Location
BH1 Groundwater Monitoring Location
(O/B) Overburden Well
Major Gas Line
N
Marsh Land
Sand & Shingle
Cork Harbour
Ringaskidddy House
TP15
TP17
TP5
TP16
TP1
BH1
TP3
TP4
TP7
TP8
BH5
(O/B)
BH2
TP13
TP2
TP14
TP6
BH3
TP11
TP10
TP9
BH4
0 50 100 150 200 250
METRES
SCALE
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(6)

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
-	-

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

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 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	Dutch MACs	
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
Units	mg/kg	mg/kg	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	0.05	1
Toluene	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	0.05	130
Ethylbenzene	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	0.05	50
Xylene	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	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	Dutch MACs	
	Depth (m)	1.8	0 - 1.5	0 - 3.0	0 - 3.0	S-Value	I-Value
	Units						
Dichlorofluoromethane	µg/kg	<1	<1	<1	<1	-	-
Chloromethane	µg/kg	<1	<1	<1	<1	-	-
Vinylchloride	µg/kg	<1	<1	<1	<1	-	100
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	-	20,000
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	-	4,000
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	50	1,000
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	1	60,000
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	50	130,000
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	10	4,000
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	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	10	-
1,2-Dichlorobenzene	µg/kg	<1	<1	<1	<1	10	-
1,4-Dichlorobenzene	µg/kg	<1	<1	<1	<1	-	-
sec-Butylbenzene	µg/kg	<1	<1	<1	<1	-	-
tert-Butylbenzene	µg/kg	<1	<1	<1	<1	10	-
1,3-Dichlorobenzene	µg/kg	<1	<1	<1	<1	-	-
n-Butylbenzene	µg/kg	<1	<1	<1	<1	-	-
1,2-Dibromo-3-Chloropropane	µg/kg	<1	<1	<1	<1	10	-
1,2,4-Trichlorobenzene	µg/kg	<1	<1	<1	<1	-	-
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	S-Value	I-Value
	Units											
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

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	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	S-Value	I-Vales
	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	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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Location	BH 1	BH 2	BH 3	BH 4	BH 5	Dutch MACs	
Units	µg/l	µg/l	µg/l	µg/l	µg/l	S-Value µg/l	I-Value µg/l
Benzene	<10	<10	<10	<10	<10	0.20	30
Toluene	<10	<10	<10	<10	<10	0.20	1000
Ethylbenzene	<10	<10	<10	<10	<10	0.20	150
Xylene	<10	<10	<10	<10	<10	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	-	-
1,3,5-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	Dutch MAC Values	
							S-Value	I-Vales
	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	-	-

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