4 THE PHYSICAL ENVIRONMENT

4.1 Introduction

This Section considers the physical environment onto which the proposed expansion will be built. The characteristics of the environment will influence the design criteria of the foundations of structures, access roads and construction methods. This section presents the information relevant to the physical environment. Other physical aspects such as climate and air quality, mineral resources and waste are dealt with in other chapters.

The following assessment assumes a full build out of FAB 24-3 – Option 2.

4.2 Study Methodology

A desk-based assessment has been undertaken to assess the potential impact of the proposed development on soils, topography, geology, hydrogeology and hydrology of the site. This involved obtaining the following:

- geological and hydrogeological records from The Geological Survey of Ireland;
- water quality records;
- IPC licence for existing site activities;
- other existing records, reports and surveys; and
- details of previous or on-going Site Investigations, groundwater monitoring and contamination analyses.

Data was obtained for the specific site and the surrounding area in order to develop an understanding of the physical environmental setting of the site and of the likely environmental impacts of the proposed development.

4.2.1 Assessment of Significance

Having established the existing environmental conditions through the utilisation of the methods discussed above, the EIA process then aims to assess the significance of the construction and operation of the proposed development on the physical environment. The general methodology used for the assessment of significance is described in detail in Section, 1.10.

The specific criteria used to determine the significance of the residual effects, i.e. those remaining after mitigation measures, on the physical environment is presented in this section of the report.

4.2.1.1 Magnitude of Impact

The magnitudes of the impacts are defined as follows:

Table 4.1: Magnitude of Impact

Magnitude	Description
High	Irreversible change to a large area over a long period of time, or a small area irreversibly affected of a highly sensitive site.
Medium	A moderate change (outside the bounds of natural variation) to an area extending outside the site, which will recover over a medium period of time (5-10 years).
Low	A slight change (within the bounds of natural variation) to an area in close proximity to the site, which will recover over a short period of time (1-5 yrs).
Negligible	No effect detectable

4.2.1.2 *Sensitivity of receptors in the physical environment*

In order to evaluate the relative sensitivity of receptors to the proposed development, it is necessary to produce a reference list defining the degree of sensitivity as indicated by the amount of change noted in the physical environment.

Table 4.2: Receptor Sensitivity

Receptor Sensitivity	End users	Surrounding land uses	Ecological sites	Construction workers
High	Residential allotments and play areas.	Residential allotments and play areas	Nationally or internationally designated sites including rivers and streams,	Extensive earthworks and demolition of buildings
Medium	Commercial landscaping or open space areas	Commercial landscaping or open space areas	Rivers and streams that are not designated as well as adjacent undesignated land.	Limited earthworks
Low	Industrial buildings or car parking	Industrial areas	No sites of significant ecological value close by	Minimal disturbance of ground

4.2.1.3 *Potential significance*

Potential significance has been assessed for the physical environment, based on the combination of the magnitude of change and the sensitivity of the receptor (see Drawing 1.2) and is described below:

The threshold for significant impacts, where monitoring measures may be required, is where residual impacts are considered to be significant or very significant, as defined in Table 4.3 below.

Table 4.3: Significance

<table>
<tr><th>Significance</th><th colspan="2">Description</th></tr>
<tr><td>Very Significant</td><td>Irreversible change to a designated geological site or to the physical environment which could have an extensive effect and include areas remote to the development area over a long time period (greater than 20 years).</td><td rowspan="2">Significant Impacts where monitoring may be required</td></tr>
<tr><td>Significant</td><td>Moderate adverse change to the physical environment with changes to areas remote from the site over a moderate time period (20 years).</td></tr>
<tr><td>Moderate</td><td colspan="2">Slight changes local to the development area just outside the accepted limits of normal variation with little or contained offsite effects, detectable within a medium time period (5-10 years).</td></tr>
<tr><td>Slight</td><td colspan="2">Change only just detectable within the site and surrounding areas over a short timescale (less than 10 years).</td></tr>
<tr><td>None</td><td colspan="2">An impact causing effects that are not readily noticeable.</td></tr>
</table>

4.3 Soils

4.3.1 Existing Environment

It is anticipated that the site will be underlain by an unknown thickness of Made Ground resulting from previous developments of the site.

Previous intrusive investigations undertaken at the site indicate that drift deposits comprising glacial tills underlie the site. Soils originating from the glacial till are usually grey and brown podzolics (Elton and Grange Series) and mineral soils (Straffon Series). Soils underlying the area of site for proposed development include those from the Grange Series and potentially the Straffon Series.

Glacial till comprises silty to sandy clays underlain by stiff brown and grey/black silty clays with abundant gravels, cobbles and boulders. The thickness is reported to vary across the site, ranging from 0 to 8.5 metres. The thinnest deposits occur to the east of the plant and the thickest deposits were noted beneath the plant. The variation in thickness is interpreted to reflect the undulating pre-glacial topography.

Ground conditions adjacent to the Rye Water are understood to comprise alluvial sands and gravels associated with historical drainage overlying bedrock.

4.3.2 Characteristics of the Proposed Development

4.3.2.1 During Construction

As described in the 'Proposed Development' (Section 2) the construction of the proposed FAB 24-3 structure will entail the removal of some soils beneath the proposed building location, and its relocation to the west of the existing spoil mound. The quantity is expected to be approximately 250,000m^3. Although the potential exists that some of the soil may be contaminated, this is unlikely based on the absence of contaminants during previous excavations, (e.g. FAB 24 and 24-2).

4.3.2.2 During Operation

Upon completion of construction, the land will be reinstated in accordance with the proposed plans and landscape strategy.

4.3.3 Assessment of Impacts

4.3.3.1 Do Nothing Scenarios'

If the project did not proceed the areas identified for development would be graded and used for additional surface car parking.

4.3.3.2 During Construction

Impacts on soils of low sensitivity may occur during construction as a result of plant construction activities. This means that beneath the footprint of the new building all soils will be removed. If these soils are clean topsoil they will be safely stockpiled and/or used for landscaping. Should any contaminated soils be identified, appropriate testing will be commissioned prior to removal and subsequent treatment/disposal. At present however, no contamination is envisaged arising from current production activities.

Where topsoil is present beyond the building footprint but within the area likely to be impacted by the construction process these soils will also be removed to stockpile.

The potential for the impact from dust depends on the distance to potentially sensitive locations and whether the wind can carry the dust to these locations. The majority of any dust produced will be deposited close to the potential source and any impacts from dust deposition will typically be within several hundred metres of the construction area.

The construction area and provisional location of the associated haul road is significantly removed and screened from the nearest private dwelling. Dust generation during construction of the proposed FAB 24-3 expansion is therefore unlikely to generate dust nuisance even in the absence of control measures.

The impact on the soils will therefore be moderate which is no different from any construction project where ground works are involved.

4.3.3.3 During Operation

It is considered very unlikely there will be any impact on soils during operation of FAB 24-3.

4.3.4 Proposed Mitigation

Where possible clean soils will be preserved by stripping in advance of construction and stockpiling for re-use. The construction area will be fenced in order to avoid damaging adjacent soils by accidental impact from traffic on site.

Particular care will be taken to ensure that this spoil does not impact on the Rye Water Valley/Carton candidate Special Area of Conservation (cSAC) and is located outside of the existing flood plain. A Rye Water Flood Plain Study (a copy of which is available upon request) has indicated that the proposed location is indeed outside a 1 in 100 year floodplain provided no part of the mound is located closer than 25m to the river centreline.

Where the results of analysis show that the soils cannot either be retained on site in their current condition or remediated on site in order to reduce the concentration of pollutants, they will be sent to an appropriate licenced landfill site.

To eliminate or minimise the impact of dust, a control strategy will be imposed on contractors.

Dust emissions are reduced when soil has a high water content due to the cohesion between soil particles and water. The level of dust generation is therefore highest during weather that leads to dry soil conditions. It is this cohesive property of water that makes dust emissions easy to control.

To control dust generation from the construction activities the following practices will be employed during the construction activities:

- the surface of roads around the construction area will be sprayed with water during dry periods;
- haul roads will be surfaced and road sweepers employed to ensure spillages of materials are swept up and a build up of mud does not occur;
- speed restrictions will be applied to vehicles travelling on site;
- vehicles will preferentially have upward directed exhausts to reduce disturbance;
- vehicles carrying fine materials remain sheeted for as long as practicable on-site to prevent dust blow and spillages;
- the wheels of all vehicles leaving the site onto the local road network will be washed to minimise transfer of mud and dust is not onto public roads;
- open ground will be seeded at the earliest opportunity to reduce dust entrain by wind passing over the ground;
- planting of vegetation and landscaping will provide a surface for any dust to deposit on and reduce near ground wind speeds;
- existing tree and shrub lines along with proposed landscaping will also reduce the impact of dust on nearby sensitive locations including residents, flora and fauna; and
- Silt from surface run-off will be collected in a temporary settlement pond.

No further mitigation measures are required in respect of the soils at the site.

4.3.5 Residual Impacts

The long-term impact on the clean soils stockpiled for re-use soils on site would be negligible. Where soils were removed from site to landfill or where insitu remediation was required the impact is assessed as low to medium.

4.4 Site Setting

The site is situated approximately 2km to the west of the town of Leixlip and approximately 19km from Dublin. Located within a gently undulating valley, the Intel site covers an area of around 350 acres, comprising roughly 150 acres dedicated to industrial usage and 200 acres for amenities.

Open ground, Rye Water and residential properties are located to the north of the site. To the east of the site lies open ground, the Royal Canal and the town of Leixlip. The R148 road, Royal Canal, railway, motorway link road and M4 motorway are situated to the south of the site. To the west of the site is open ground, beyond which lies the Carton Demesne and town of Maynooth. Isolated properties are located within the surrounding area.

4.5 Geology

4.5.1 Existing Environment

Lower Carboniferous mudstones and limestones underlie the site and surrounding area of Leixlip. The Waulsortian Reef Limestone Formation, the Tobercelleen Formation, the Rush Shales Formation and the Dublin Formation underlie the Leixlip area. The site itself is underlain by the Dublin Formation comprising basinal limestone facies (dark/black argillaceous limestones and calcareous shales). The limestone deposits are understood to be fine grained and are mainly found in beds of less than 0.5m in thickness. The Rush Shales are determined by the absence of limestone deposits and the dark coloured mudstones and shales present. The underlying Reef Limestone is reported to be pale grey and micritic with an absence of bedding structures.

The common term for the limestone deposits is 'Calp' limestones or Canal Formation. Outcrops are visible at locations surrounding the site, to the east of the plant and in proximity to the Rye Water. The limestone is tightly folded and has a predominant north-south strike. The Celbridge syncline trends in a north-east south-west direction with the axis lying beneath the Leixlip area. A fault is indicated to lie sub-parallel to the N4 roadway, located to the south of the site boundary. Previous intrusive investigations did not detect any evidence of secondary permeability due to faulting on the site.

A search conducted by the Geological Survey of Ireland indicated there was no record of quarries or mines within the site or surrounding area.

4.5.2 Characteristics of the Proposed Development

4.5.2.1 During Construction

It is planned that limited drift and/or bedrock may be excavated for the construction of the FAB 24-3 building and associated process and utility support. The amount of earth to be removed and proposed foundation designs are 250,000m^3.

4.5.2.2 During Operation

The actual operation of FAB 24-3 will have no noticeable impacts on the geological environment.

4.5.3 Assessment of Potential Impacts

4.5.3.1 Do Nothing Scenario

If the project did not proceed the areas identified for development would be graded and used for additional surface car parking.

4.5.3.2 *During Construction*

Drift deposits and underlying bedrock are not expected to be adversely affected during construction activities. However, removal of some materials will be necessary for construction. The geology (of low sensitivity) will be impacted at the site where the foundations are to be constructed. However, it is not anticipated that this impact will have a detrimental affect on the wider geology of the area and is therefore negligible. The impact on the geology is therefore assessed as low.

4.5.3.3 *During Operation*

There will be no impact on geology during the operation of the building

4.5.4 *Proposed Mitigation*

No mitigation measures are required in respect of the geology at the site other than good practice during construction to ensure that there is no potential for any accidental spills or releases to enter the ground. This is defined within Intel's codes of construction practice to which approved contractors must sign up to. They include for example the requirement to provide temporary bunding of potentially contaminating construction materials e.g. for diesel bowsers.

4.5.5 *Residual Impacts*

No residual impacts on the geology of the area are anticipated as a result of the development. Where the additional building is located the impact will be of slight significance.

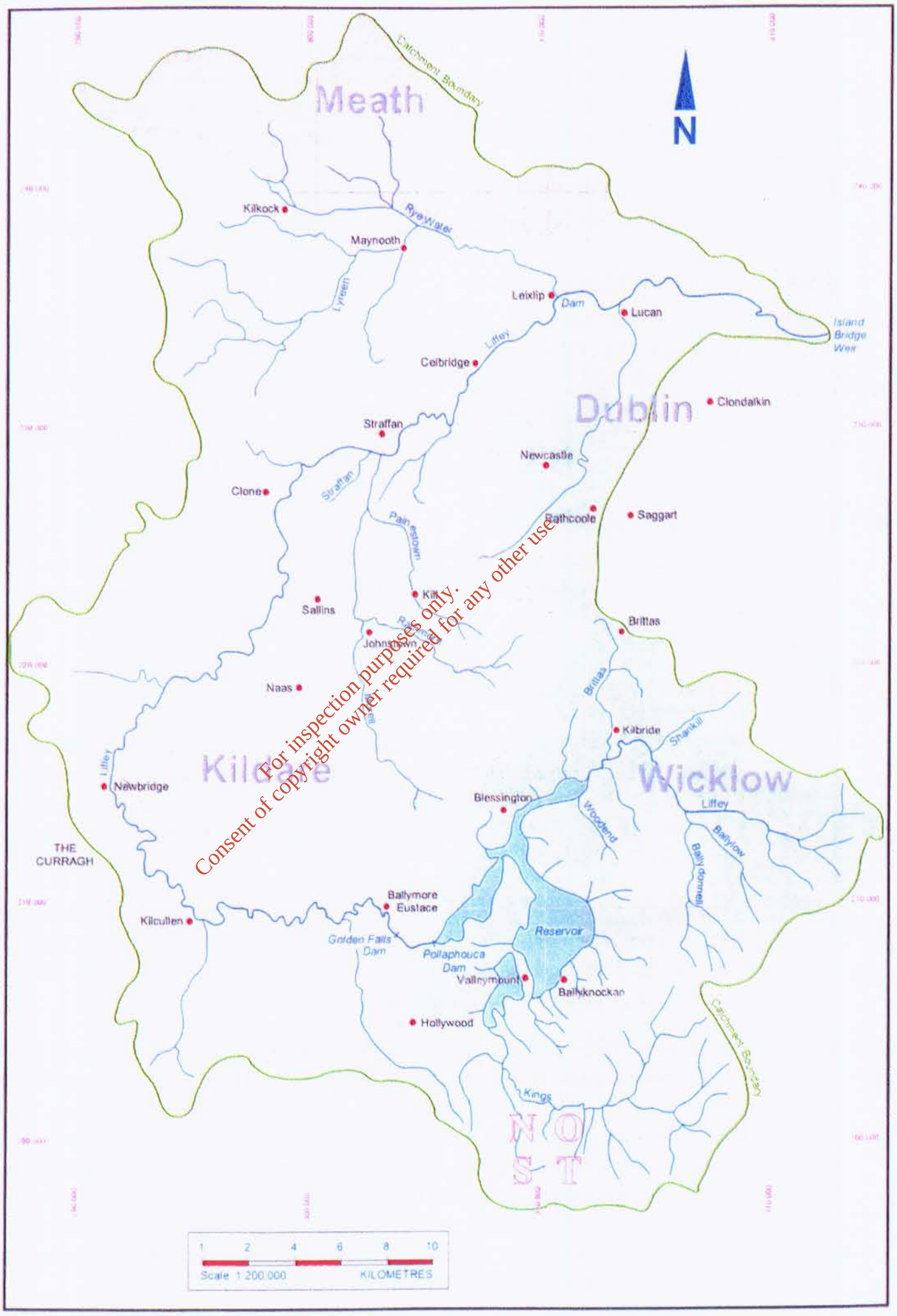
4.6 Hydrology and Hydrogeology

Rye Water bounds the site to the north, the Royal Canal is situated to the south of the site and a retention pond situated to the north of the site. Rye Water flows in a south easterly direction and is a tributary of the River Liffey. A dam is situated upstream of the Rye Water and River Liffey confluence for the generation of electricity.

The River Liffey is one of Ireland's major rivers and has numerous valuable applications. For example, it is used for the generation of power, water abstraction, wastewater treatment plants, recreational activities and amenities. Water sports and angling are popular recreational activities.

The River Liffey catchment encompasses an area of approximately 1,369km^2. The river extends from the mountains of Kippure and Tonduff in County Wicklow to the sea at Dublin Bay. See Map 4.1. The main channel covers a distance of approximately 120km and numerous tributaries enter along its course. The river also passes through Blessington Lakes that were constructed in 1940 to provide a water supply and source of power for Dublin. Pollaphouca and Golden Falls Dams control the lake water levels and are a source of hydroelectric power. The dam was constructed at Leixlip in 1949. The construction of dams along the watercourse has enabled the flow rate of water to be controlled.

Map 4.1: Liffey Catchment



4.6.1 Existing Environment

4.6.1.1 The River Liffey

The Three Rivers Project – Interim Report was available for review; this includes discussion of the current water quality for the Liffey catchment. This is discussed further in the water and effluent chapter.

The River Liffey was divided into three catchments:

- Upper;
- Middle; and
- Lower.

The upper catchment was generally observed to have good water quality. Land use within the area is predominately forestry and agriculture, and the area has a low-density, rural population. The water is soft due to the underlying granite bedrock. Urban expansion is anticipated to influence the water quality in the future.

The middle catchment was noted to have elevated median Molybdate Reactive Phosphorus (MRP) and occasionally elevated ammonia concentrations. The surrounding area is observed to be higher intensity farming and urban developments with associated contributions of MRP and ammonia arising from wastewater treatment.

The Intel site is located within the lower catchment, which previously has had relatively poor water quality based on MRP. The water in the lower catchment is classed as moderately hard due to the acquisition of soluble salts from the river passing through areas of limestone. Levels of MRP were noted to be consistently high and occasional elevated concentrations of ammonia were reported. Land use is mainly urban and the drainage and wastewater from these urban areas are thought to impact the water quality. Improvements have been made to Waste Water Treatment Plants (WWTPs) in Osberstown and Leixlip between 1997 and 2000. Corresponding river quality data shows MRP and ammonia levels have decreased at sampling stations located downstream of the WWTPs.

The Boyne/Liffey Water Quality Monitoring & Management Status Report dated September 2003 produced by Meath County Council and Kildare County Council was available for review. Water quality information and also an indication of changes in water quality following completion of the Three Rivers Project was provided. Annual median MRP concentrations along Rye Water (in the vicinity of the site) and also at the confluence of Rye Water and the River Liffey ranged from 0.07 to 0.3mg P/L. Annual median TON concentrations at the same sampling points ranged from 0-2mg N/L and 2-3mg N/L respectively. The maximum dissolved oxygen saturation at both sampling locations was noted to be >125%. The minimum levels ranged from 70-100% dissolved oxygen.

An improvement in the biological water quality classification along the main channel of the River Liffey downstream of Osberstown was noted. A reduction in MRP between 2000 and 2003 was also observed along the same stretch of river. The report concluded that Rye Water should be targeted as a watercourse where further reductions in MRP are required. The upgrading of WWTPs to include nutrient removal is attributed as the major factor influencing the improvement in water quality. Further upgrading of WWTPs is reported to be planned for the future.

Data taken from the 'River Water Quality Report 2002, The Biological Survey of River Quality – Results of the 2001 Investigation' obtained from the EPA website, has been used during the writing of this report. The river water was assessed using the biological river water classification scheme where 'Q' values are assigned.

Table 4.4: The Biological Survey of River Quality 2001

'Q' Value	Community Diversity	Water Quality	Condition *
Q5	High	Good	Satisfactory
Q4	Reduced	Fair	Satisfactory
Q3	Much Reduced	Doubtful	Unsatisfactory
Q2	Low	Poor	Unsatisfactory
Q1	Very Low	Bad	Unsatisfactory

* likelihood of interference with beneficial or potentially beneficial uses

The scheme is based on the effects of biodegradable organic wastes (deoxygenation and eutrophication). If toxic effects are suspected or confirmed the suffix '0' is combined with the 'Q' value. The biological indices are related to the four water quality classes as follows:

Table 4.5: Water Quality Classes

Biotic Index	Quality Status	Quality Class
Q5, 4-5, 4	Unpolluted	Class A
Q3-4	Slightly polluted	Class B
Q3, 2-3	Moderately polluted	Class C
Q2, 1-2, 1	Seriously polluted	Class D

The detailed data covering the period 1971 to 2002 is presented in Table 4.6 in Appendix 4.1.

Generally the River Liffey was indicated to have a satisfactory water quality condition at the majority of the sampling stations in 2002. A large improvement was noted in the water quality at Castlekeeely Ford. Effluent from water treatment works is thought to marginally lower water quality at Ballymore Eustace and Leixlip.

The river water quality at five locations in proximity to the Intel site was noted to be as follows:

Table 4.7: River Water Quality Close to the Intel Site

Sampling Point	Watercourse	Location to site	River Quality 'Q' value
Kildare Bridge	Rye Water	Upstream	Moderately polluted (2-3 or 3)
Sandford's Bridge	Rye Water	Upstream	Moderately polluted (2-3 or 3)
Bridge in Leixlip	Rye Water	Downstream	Moderately polluted (2-3 or 3)

Sampling Point	Watercourse	Location to site	River Quality 'Q' value
Leixlip Bridge (RHS)	Rye Water	Downstream	Moderately polluted (2-3 or 3)
Lucan Bridge	River Liffey	Downstream	Moderately polluted (2-3 or 3)

The water quality of Rye Water and the River Liffey is noted to be moderately polluted upstream and downstream of the site. The Intel site therefore does not appear to be creating a significant impact to the surface water quality. For Rye Water, this has been confirmed by monitoring of water quality upstream and downstream of Intel's surface water discharge point, which is carried out as a requirement of the current IPC licence.

4.6.1.1.1 Water Quality Standards

The water quality standards for the River Liffey are detailed below and are taken from the Water Quality Management Plan (WQMP).

Table 4.8: Water Quality Standards (Liffey)

Parameter	Percentile	Standard
Dissolved Oxygen (mg/l O2)	99.9	> or equal to 4
	99	> or equal to 6
	50	> or equal to 9
BOD (mg/l O2)	95	< or equal to 5
	50	< or equal to 3
Total ammonia (mg/l N)	95	< or equal to 0.5
	50	< or equal to 0.2
Oxidised nitrogen (mg/l N)	99.9	< or equal to 11
	95	< or equal to 5
	50	< or equal to 3
Ortho-Phosphate (mg/l P)		< or equal to 0.1
		< or equal to 0.05
Suspended solids		25 *

Further parameters were recommended due to the presence of Intel and included:

- lead (0.05mg/l);
- free cyanide (0.01mg/l);
- fluoride (1.5mg/l); and
- sulphate (200mg/l).

4.6.1.1.2 Water Abstraction

Surface water was historically abstracted from the River Liffey at Lucan for use within a woollen mill. A water powered food processing mill was also noted at Lucan and was reportedly operational in 2000.

Dublin City Council and Fingal County Council (FCC) are understood to abstract water from the river for public supply. Water is returned to the river system downstream in Dublin Bay. The WWTPs at Osberstown and Leixlip, operated by Kildare County Council, abstract and return water to the river system locally.

4.6.1.2 Rye Water

Intel Ireland Ltd commissioned a survey in 1998 to determine the water quality of Rye Water. The data collected from the hydrochemical surveys indicated that since the Intel plant commenced production, it has not affected the water quality of Rye Water. No notable differences were identified from water samples obtained upstream and downstream of the plant. However, Rye Water was deemed to be 'mildly polluted, in the form of organic enrichment'. The following data are compiled:

Table 4.9: Water Quality Data (1996-1998) Rye Water near the Intel plant

Parameter	Upstream			Downstream		
mg/l	1996	1997	1998	1996	1997	1998
pH	8.2	8.2	8.2	7.9	8.1	8.4
Conductivity	623	585	593	384	428	551
DO	132	-	223	83	97	128
BOD	1.9	1.2	1.8	1.9	3.0	11.9
Parameter	**Upstream**			**Downstream**		
mg/l	**May 1998**	**August 1998**		**May 1998**	**August 1998**	
Amm, N	0.4	<0.1		<0.1	<0.1	
oxid-N,N	3.6	1.6		3.6	1.5	
o-P,P	<0.1	0.2		<0.1	0.1	

The data below is taken from the 'River Water Quality Report 2002, The Biological Survey of River Quality – Results of the 2001 Investigation' obtained from the EPA website. The river water was assessed using the biological river water classification scheme where 'Q' values are assigned.

Table 4.10: Biological Quality Ratings (Q Values)

Station No.	1971	1973	1975	1977	1979	1981	1983	1985	1988	1989	1991	1996	1998	2002
0100 Balfeaghan Br	4-5	4	3-4	3-4	3-4	3-4	3	3-4	3	-	3	3-4	3-4	4
0200- 500 m d/s Kilcock Br	1-2	1-2	2	1	1	2-3	1/0	2-3	2/0	-	3/0	3-4	3*	3
0300- Anne's Br	2	4	3	2-3	3	3-4	1	3-4	2-3	3	3-4	3-4	3	3-4
0400- Kildare Br	2	3-4	1	1	2-3	3	1	2-3	2	2-3	3	3	3	3
0500- Sandford's Br	3-4	4	3	3	3-4	4	3	4	3-4	-	3-4	3	3	3-4
0600- Br in	4	4	3-4	3-4	4	4	3-4	-	3-4	-	3-4	3	3	3

Station No.	1971	1973	1975	1977	1979	1981	1983	1985	1988	1989	1991	1996	1998	2002
Leixlip														

* - siltation

The upper reaches of Rye Water are classified as fair. However, as the watercourse flows downstream, it becomes slightly or moderately polluted. During recent years, no notable changes in the water quality have been observed.

4.6.1.2.1 Monitoring Programme

Conditions of the existing Intel IPC licence stipulate water quality shall be monitored annually along Rye Water for an agreed set of parameters at 5 (RW1 – RW5) specified sampling points. Results are to be submitted annually within the Annual Environmental Report (AER).

The water quality of the river water was monitored on the basis of the Irish standard S.I 294 of 1989, taken from the EC (Quality of Surface Water Intended for the Abstraction of Drinking Water) Regulations, 1989. These Regulations categorise surface water as A1, A2 or A3, depending on the suitability for the abstraction of surface water for drinking water. A1 requires very little treatment and A3 would require more treatment. All reported parameters for each monitoring point are within the limits set out for surface waters in categories A1, A2 and A3.

The results obtained for this monitoring event are indicative of a good quality surface water environment. It is noted that the quality of the surface waters sampled from the River Rye are broadly similar both upstream and downstream of the Intel Ireland Site, indicating the surface water discharges from this site have no significant impact on its quality. Monitoring results for 2003 and 2004 are presented in Table 4.11 to 4.14

Table 4.11: Monitoring Results for Rye Water – May 28, 2003

Parameter	Units	RW1	RW2	RW3	RW4	RW5	Water quality standards
pH	pH Units	8.2	8.3	8.3	8.3	8.3	5.8-8.5
Conductivity	µS/cm	284	270	269	271	276	1000
Temperature	°C	13.9	13.9	14.2	14.1	14.2	25
D.O.	%	97.2	98.6	98.2	104.2	100.1	>60
BOD	mg/l	<2	<2	<2	<2	<2	5
Suspended Solids	mg/l	<5	<5	<5	<5	<5	50
Nitrate (as N)	mg/l	1.5	1.4	1.4	1.6	1.5	11.3
Nitrite	mg/l	0.06	0.06	0.06	0.06	0.06	-
Ammonia (as N)	mg/l	0.06	0.06	0.06	0.06	0.06	0.2
Chloride	mg/l	18.4	17.8	17.9	19.2	18.2	250
Fluoride	mg/l	0.1	<0.1	0.1	<0.1	0.1	1
Phosphate (as P)	mg/l	<0.16	<0.16	<0.16	<0.16	<0.16	0.22

Parameter	Units	RW1	RW2	RW3	RW4	RW5	Water quality standards
Arsenic	µg/ml	<2	<2	<2	<2	<2	50
Chromium	µg/ml	<2	<2	<2	<2	<2	50
Copper	µg/ml	<2	<2	3	<2	<2	50
Nickel	µg/ml	2	2	2	2	2	-
Lead	µg/ml	<2	<2	<2	<2	<2	50
Tin	µg/ml	<2	<2	<2	<2	2	-
Cobalt	µg/ml	<2	<2	<2	<2	<2	-

Table 4.12: Monitoring Results for Rye Water – Sept, 2003

Parameter	Units	RW1	RW2	RW3	RW4	RW5	Water Quality Standard
pH	pH Units	8.2	8.2	8.4	8.5	8.4	5.5-8.5
Conductivity	µS/cm	631	629	615	623	633	1000
Temperature	°C	17.6	17.8	17.4	16.3	16.6	25
D.O.	%	134.4	76.9	84.8	107.9	88.1	>60
BOD	mg/l	<2	<2	<2	<2	3	5
Suspended Solids	mg/l	5	<5	<5	<5	<5	50
Nitrate (as N)	mg/l	1.06	1.18	1.11	1.02	0.46	11.3
Nitrite	mg/l	0.27	<0.03	<0.36	<0.20	0.46	-
Ammonia (as N)	mg/l	<0.02	<0.02	<0.02	<0.02	<0.02	0.2
Chloride	mg/l	18.6	19.2	19.8	19.0	21.1	250
Fluoride	mg/l	<0.1	<0.1	<0.1	<0.1	<0.1	1
Phosphate (as P)	mg/l	<0.16	<0.16	<0.16	<0.16	<0.16	0.22
Arsenic	µg/l	<2	<2	<2	<2	<2	50
Chromium	µg/l	<2	<2	<2	<2	<2	50
Copper	µg/l	<2	<2	<2	<2	<2	50
Nickel	µg/l	<2	<2	<2	<2	<2	
Lead	µg/l	<2	<2	<2	<2	<2	50
Tin	µg/l	<2	<2	<2	<2	<2	-
Cobalt	µg/l	<2	<2	<2	<2	<2	-

Table 4.13: Monitoring Results for Rye Water – April, 2004

Parameter	Units	RW1	RW2	RW3	RW4	RW5	Water Quality Standard
pH	pH Units	8.4	8.4	8.4	8.5	8.3	5.5-8.5
Conductivity	µS/cm	678	675	674	670	643	1000
Temperature	°C	10.5	10.9	11.9	11.8	11.5	25
D.O.	%	61	64	66	67	68	>60
BOD	mg/l	<2	<2	<2	<2	<2	5
Suspended Solids	mg/l	<5	<5	<5	<5	<5	50
Nitrate (as N)	mg/l	2.5	2.5	2.4	2.4	2.3	11.3
Nitrite	mg/l	<0.02	<0.02	<0.02	<0.02	<0.02	-
Ammonia (as N)	mg/l	0.1	0.06	0.06	0.03	0.04	0.2
Chloride	mg/l	22.5	22.5	22.3	22.2	22.1	250
Fluoride	mg/l	<0.1	<0.1	<0.1	<0.1	<0.1	1
Phosphate (as P)	mg/l	0.04	<0.16	<0.16	<0.16	<0.16	0.22
Arsenic	µg/l	<2	<2	<2	<2	<2	50
Chromium	µg/l	<2	<2	<2	<2	<2	50
Copper	µg/l	<2	<2	<2	<2	<2	50
Nickel	µg/l	5	4	4	4	4	
Lead	µg/l	<2	<2	<2	<2	<2	50
Tin	µg/l	<2	<2	<2	<2	<2	-
Cobalt	µg/l	<2	<2	<2	<2	<2	-

Table 4.14: Monitoring Results for Rye Water – November, 2004

Parameter	Units	RW1	RW2	RW3	RW4	RW5	Water Quality Standard
pH	pH Units	8.1	8.1	8.2	8.2	8.2	5.5-8.5
Conductivity	µS/cm	708	712	714	715	715	1000
Temperature	°C	9.0	9.4	9.0	9.7	9.2	25
D.O.	%	79.2	78.2	77.4	71.6	73.5	>60
BOD	mg/l	<2	3	<2	4	4	5
Suspended Solids	mg/l	<5	10	14	13	<5	50
Nitrate (as N)	mg/l	2.08	2.08	2.08	2.17	2.15	11.3

Parameter	Units	RW1	RW2	RW3	RW4	RW5	Water Quality Standard
Nitrite	mg/l	0.03	<0.03	<0.03	<0.03	<0.03	-
Ammonia (as N)	mg/l	0.05	0.07	0.06	0.07	0.07	0.2
Chloride	mg/l	22.6	22.8	21.8	22.7	22.5	250
Fluoride	mg/l	<0.1	<0.1	<0.1	<0.1	<0.1	1
Phosphate (as P)	mg/l	<0.16	<0.16	<0.16	<0.16	<0.16	0.22
Arsenic	µg/l	<2	<2	<2	<2	<2	50
Chromium	µg/l	<2	<2	<2	<2	<2	50
Copper	µg/l	<2	<2	6	<2	<2	50
Nickel	µg/l	2	3	3	4	2	
Lead	µg/l	<2	<2	<2	<2	<2	50
Tin	µg/l	<2	<2	<2	<2	<2	-
Cobalt	µg/l	<2	<2	<2	<2	<2	-

4.6.1.3 *Surface Water Discharge*

The current site operations are authorised under IPC to discharge to the neighbouring surface water, Rye Water, via a retention pond. The table below summarises the monitoring required at emission point SW1.

Table 4.15: Surface Water Monitoring

Parameter	Monitoring Frequency	Analysis Method/Technique
Visual Inspection	Daily	Not applicable
pH	Continuous	pH electrode/meter
COD	Weekly	Standard Method
TOC	Weekly	Standard Method
Conductivity	Weekly	Standard Method
Heavy Metals *	Bi-annually	Standard Method

* sum of arsenic, chromium, copper, nickel, lead, tin and cobalt

A summary report detailing the monitoring data must be submitted to the EPA every quarter and as part of the AER. The results from 2004 are presented in Table 4.16:

Table 4.16: Monitoring Results SW1 (Surface Water Outlet), 2004

Parameter	Monitoring Freq.	Units	Average Emission Conc. 2003	Average Emission Conc. 2003	Lower Warning Limit	Lower Action Limit	Higher Warning Limit	Higher Action Limit
pH	Continuous	pH Units	7.8		6.6	6.3	9.1	9.3
Conductivity	Weekly	µS/cm	436	455	N/A	N/A	N/A	914
COD	Weekly	mg/l	20.2	12.3	N/A	N/A	N/A	36
TOC	Weekly	mg/l	8.75	6.7	N/A	N/A	N/A	21

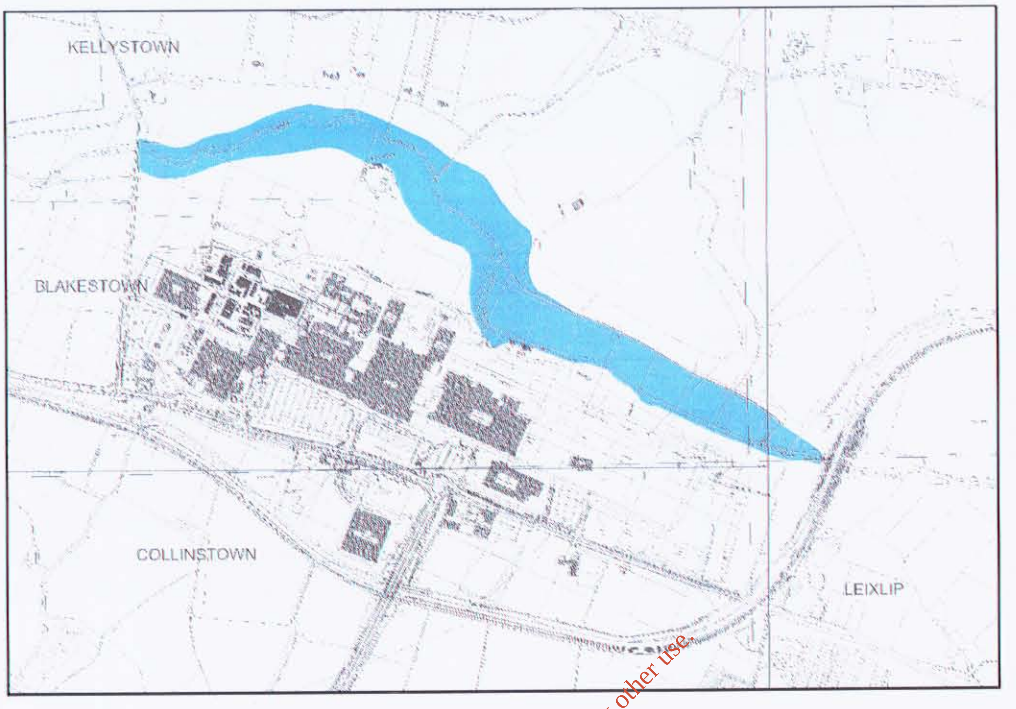
The site is not permitted to discharge any potentially polluting substance to off-site surface waters or sewers. If pH levels from surface water discharges deviate from the acceptable range, a response programme must be set up and actioned immediately. If an uncontrolled release to surface waters was made, the site must immediately investigate and isolate the contaminative source, prevent further contamination occurring, aim to minimise the environmental impact and inform the EPA.

4.6.1.4 Flooding and Floodplains

Intel Ireland Ltd commissioned a Floodplain Study to be undertaken for Rye Water, (a copy of which is available upon request). "Microdrainage Channel" software package was used to estimate water levels along the river during flooding.

Cross Sections and Hydraulic Characteristics of the river channel and flood plain were estimated, (the model assumes that a length of channel can be represented by the average of the cross sections at either end). New Topographical Survey information was obtained and was used to provide cross-sections at key points along the river and floodplain, on the 2.1 km section of River between the Aqueduct and Sandfords Bridge.

Map 4.2: Indicative Flood Risk Map



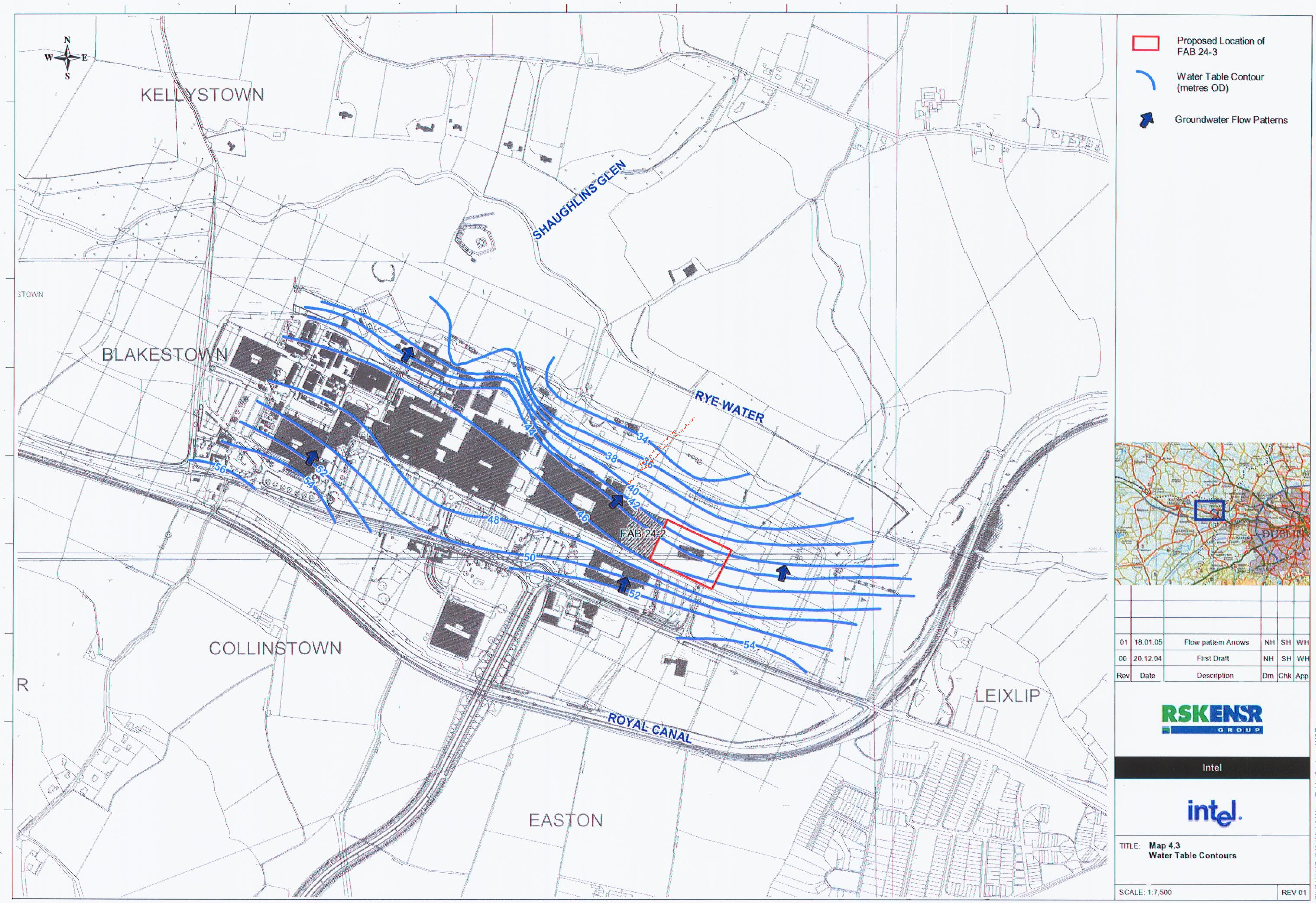
4.6.2 Hydrogeology

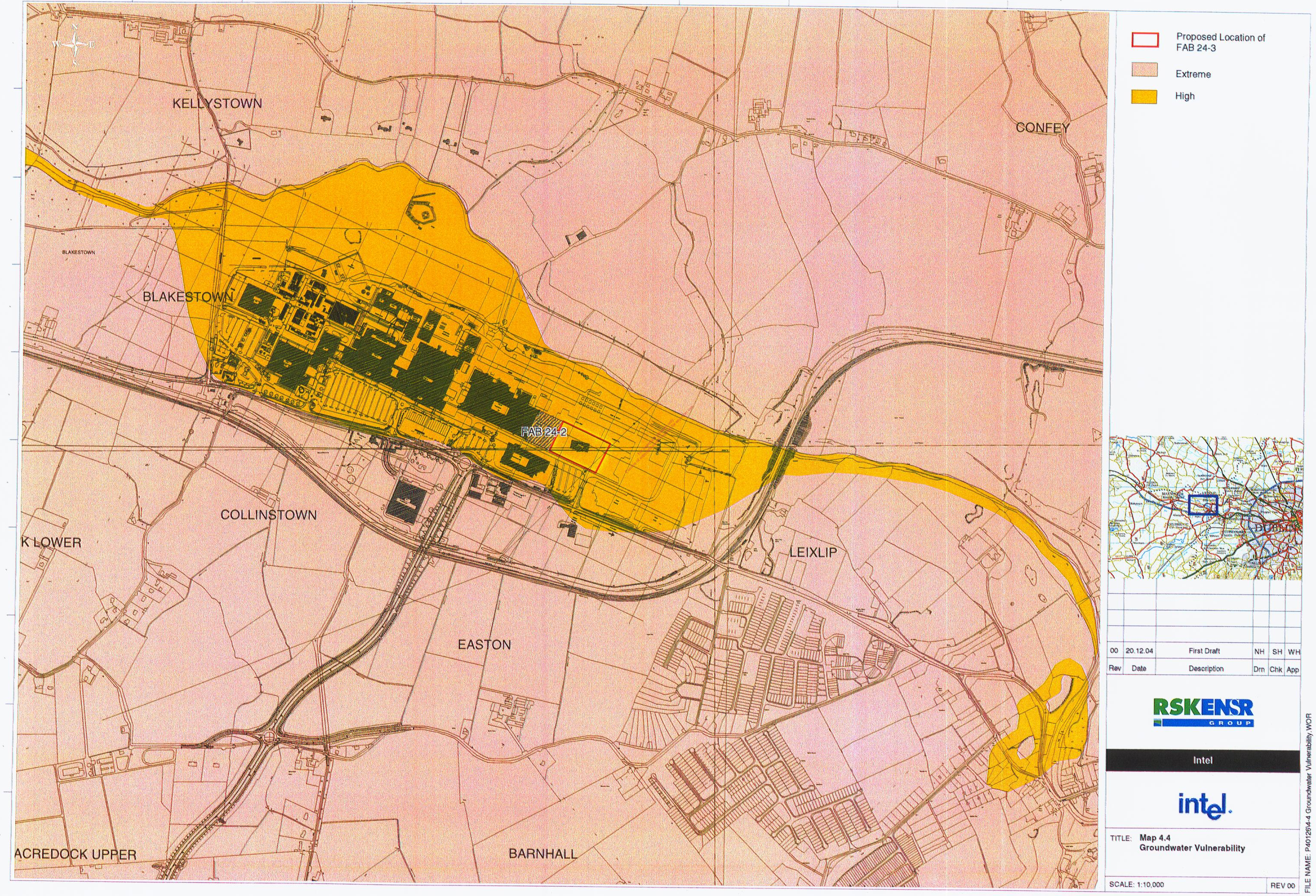
Previous reports indicate there are two separate aquifers located beneath the site. Shallow perched groundwater that is seasonally influenced is located within the glacial till deposits. Deeper groundwater has been identified within the underlying limestone formation (Map 4.3). The general groundwater flow direction is interpreted as being in a north/north easterly direction.

The underlying limestone aquifer is classified as being locally important and it is generally productive in local zones. A classification of LI (Locally Important) has been assigned to the site for aquifer data. Two abstraction wells are reportedly located on site and extend up to 10m bgl Historically they have been used for domestic and farm supplies. The Lambert site, located to the east of the subject property, has had previous chemical analysis of groundwater carried out. Analytical results suggested groundwater contamination from previous farming of effluent disposal had occurred. During intrusive site investigations no major fractures have been encountered.

The vulnerability for the site is deemed high. Locally surrounding areas are deemed high or extreme. It lies within a groundwater protection zone category LI/H (Locally Important/High), Map 4.4 and 4.5.

Deep faults within the limestone bedrock are thought to be associated with the Celbridge Syncline. The hydrochemistry of local spring water infers the water has originated from depth (>1,000m) and increased concentrations of potassium and sodium suggest evaporite deposits are incorporated into the Carboniferous sequence. Chalybeate spring is situated near Louisa Bridge, located approximately 1km to the south east of the site. The warm water (16-17°C) emerges from along the edge of the Royal Canal. The spring was reportedly discovered in 1793 during canal excavations. Similar warm springs have not been noted along Rye Water and the local topography does not appear to influence location.


N
S
E
W
KELLYSTOWN
SHAUGHLINS GLEN
STOWN
BLAKESTOWN
RYE-WATER
34
36
38
40
42
44
46
48
50
52
54
56
52
54
FAB 24-2
COLLINSTOWN
R
ROYAL CANAL
LEIXLIP
EASTON
DUBLIN
Proposed Location of FAB 24-3
Water Table Contour (metres OD)
Groundwater Flow Patterns
01 | 18.01.05 | Flow pattern Arrows | NH | SH | WH
00 | 20.12.04 | First Draft | NH | SH | WH
Rev | Date | Description | Dm | Chk | App
RSKENSR GROUP
Intel
intel.
TITLE: Map 4.3
Water Table Contours
SCALE: 1:7,500
REV 01
FILE NAME: P401264-3 Water Table Contours.WOR



Rev	Date	Description	Drn	Chk	App
00	20.12.04	First Draft	NH	SH	WH

RSKENSR GROUP

Intel

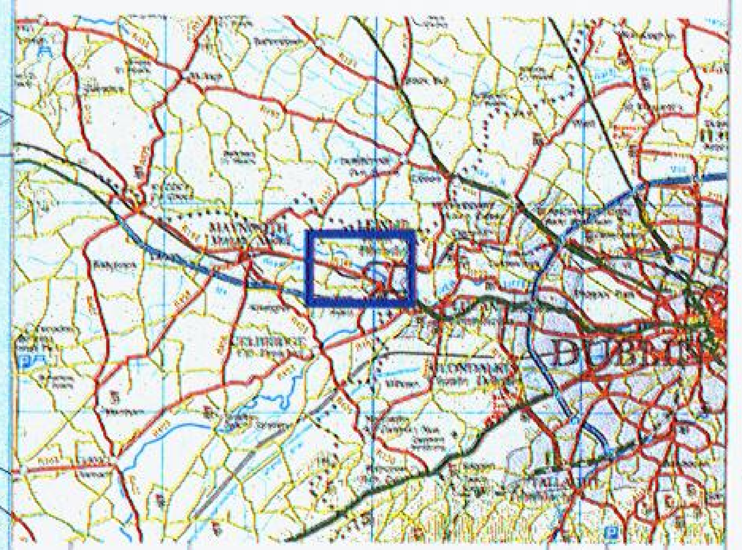
intel.

TITLE: **Map 4.4 Groundwater Vulnerability**

SCALE: 1:10,000 REV 00

FILE NAME: P40126l4-4 Groundwater Vulnerability.WOR

(red outline)	Proposed Location of FAB 24-3
LI	Bedrock which generally moderately productive only in local zones
PI	Bedrock which generally unproductive except for local zones



Rev	Date	Description	Drn	Chk	App
00	20.12.04	First Draft	NH	SH	WH

RSKENSR GROUP

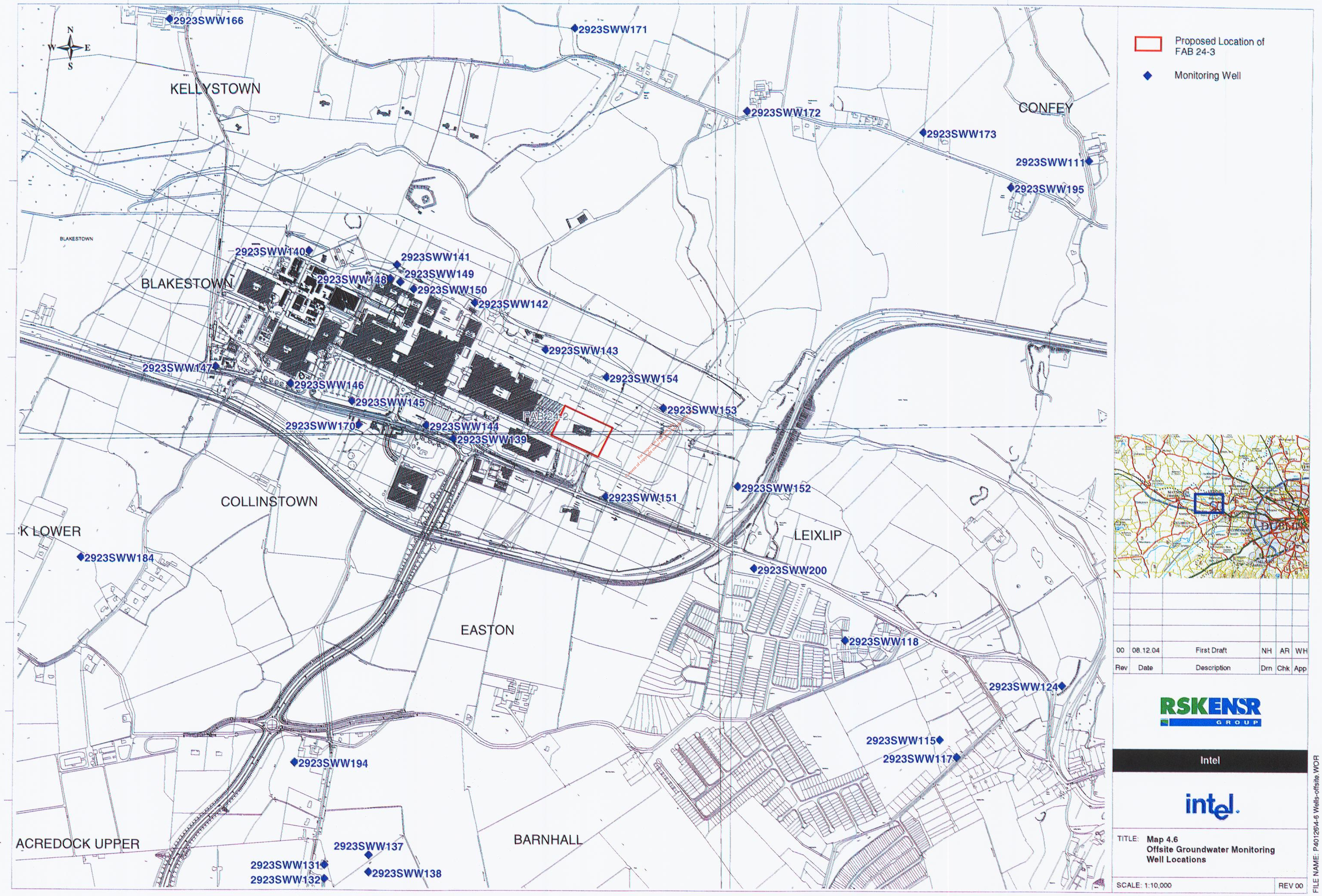
Intel

intel.

TITLE: **Map 4.5**
Draft Aquifer Classification

SCALE: 1:10,000 | REV 00

FILE NAME: P401264-5 Aquifer.WOR


Proposed Location of FAB 24-3
Monitoring Well
N
S
E
W
KELLYSTOWN
CONFEY
BLAKESTOWN
COLLINSTOWN
K LOWER
LEIXLIP
EASTON
BARNHALL
ACREDOCK UPPER
FAB 24-2
2923SWW166
2923SWW171
2923SWW172
2923SWW173
2923SWW111
2923SWW195
2923SWW140
2923SWW141
2923SWW149
2923SWW148
2923SWW150
2923SWW142
2923SWW143
2923SWW154
2923SWW147
2923SWW146
2923SWW145
2923SWW153
2923SWW170
2923SWW144
2923SWW139
2923SWW152
2923SWW151
2923SWW184
2923SWW200
2923SWW118
2923SWW124
2923SWW115
2923SWW117
2923SWW194
2923SWW137
2923SWW131
2923SWW132
2923SWW138
00 08.12.04 First Draft NH AR WH
Rev Date Description Drn Chk App
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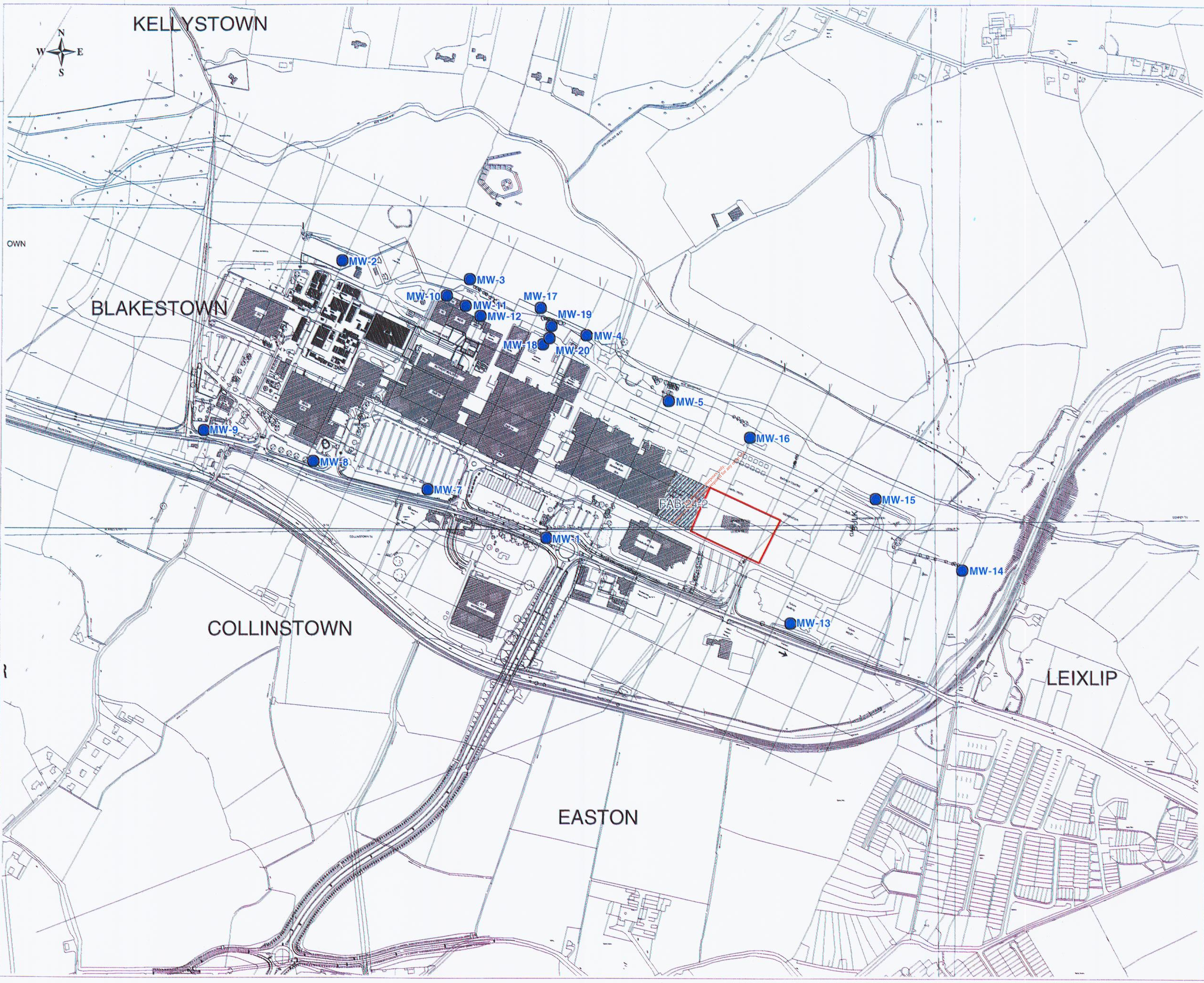
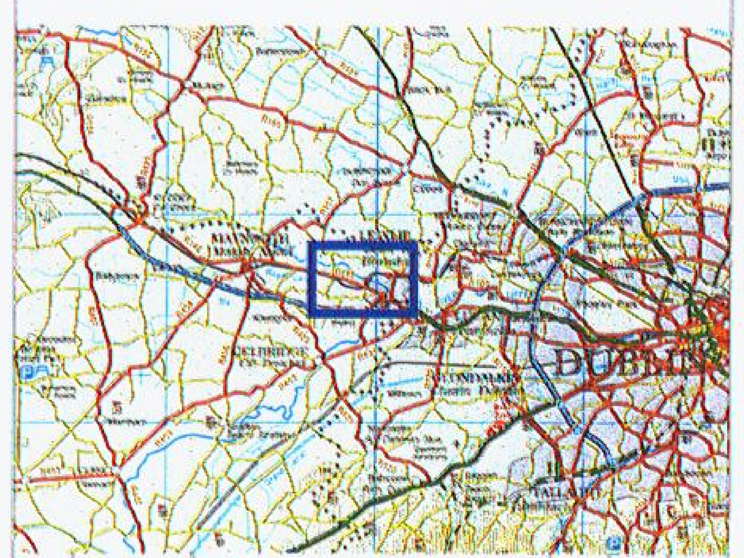
TITLE: Map 4.6
Offsite Groundwater Monitoring
Well Locations
SCALE: 1:10,000
REV 00
FILE NAME: P4012654-6 Wells-offsite.WOR



Proposed Location of FAB 24-3

Monitoring Well



Rev	Date	Description	Drn	Chk	App
00	08.12.04	First Draft	NH	AR	WH

RSKENSR GROUP

Intel

intel.

TITLE: **Map 4.7 Onsite Groundwater Monitoring Well Locations**

SCALE: 1:7,500 REV 00

FILE NAME: P401264-7 Wells Onsite WOR

A search conducted by the Geological Survey of Ireland indicated there were a large number of groundwater wells located on and near to the site. The grid references are consistent with the locations of the monitoring wells installed during the intrusive investigation. Within a 2km radius of the proposed new buildings, more than 10 groundwater wells were also identified, Map 4.6. The closest (SWW170) is located immediately to the south of the road R148. It is reported to be 6.1m in depth and water is abstracted for domestic usage. Map 4.6 illustrates the monitoring well locations.

4.6.2.1 *Groundwater Monitoring*

Nineteen groundwater monitoring wells have been installed on-site during development programmes of the site (Map 4.7). The monitoring wells were positioned down hydraulic gradient of potential contaminative site sources. The intrusive investigation was used to determine the baseline quality of the site and also to assess whether site processes have impacted the underlying ground. The monitoring wells provide the basis for on-going sampling and are reportedly sampled each year for a full analytical suite. Interim monitoring is conducted every quarter.

Sampling and analysis of monitoring wells is required to follow the schedule below:

Table 4.17: Ground Water Monitoring

Parameter	Monitoring Frequency		Analysis Method/Technique
	Group 1	Group 2	
pH	Quarterly	Annually	pH electrode/meter
COD	Quarterly	Annually	Standard method
Total nitrogen	Quarterly	Annually	Standard method
Heavy metals	Bi-annually	Annually	Standard method
Conductivity	Quarterly	Annually	Standard method
Trace organics	Bi-annually	Annually	US EPA Method 524.2- measurement of purgeable organic compounds in water by capillary column GC/MS Non-purgeable organic compounds by GC or GC/MS
Major anions	Quarterly	Annually	Standard method
Major cations	Quarterly	Annually	Standard method
Fluoride	Quarterly	Annually	Standard method

*Group 1 – MW4, MW5, MW8, MW10, MW11, MW12, MW16 and MW19

*Group 2 – MW1, MW2, MW3, MW7, MW9, MW13, MW14, MW15, MW17, MW20 and any other well as required by the EPA.

Results are required to be submitted on a quarterly basis to the EPA and annually as part of the AER.

The spring at Louise Bridge is also required to be monitored on an annual basis for a pre-determined set of parameters. Monitoring data is to be submitted annually within the AER.

Laboratory results for groundwater monitoring undertaken in 2003 and 2004 were available for review. A brief summary of data is provided in Table 4.18 and 4.19 in Appendix 4.2.

4.6.3 *Characteristics of the Proposed Development*

4.6.3.1 *During Construction*

The site does not currently abstract groundwater or surface water from local watercourses and it is understood this will not change during construction of further buildings. During construction of FAB 24-3, the site will incorporate additional spill and leak abatements facilities to protect surface and groundwaters.

4.6.3.2 *During Operation*

The site does not currently abstract groundwater or surface water from local watercourses and it is understood this will not change during operation.

The proposed development includes effective containment of hazardous chemicals in designated areas. This has been proven to be effective in the past, with Intel maintaining a good history of environmental protection and spill prevention/response. All surface run off is directed through retention ponds before entering Rye Water (see Section 2).

4.6.4 *Potential Impacts*

4.6.4.1 *Do Nothing Scenario*

The groundwater at the site has not been impacted by the existing development to any significant degree. Whilst there is some evidence in a few samples of elevated organics the majority of groundwater samples did not have organic or metal constituents above detection limits. If the development did not proceed then the groundwater quality would not be expected to change significantly since it is not certain that the few elevated concentration are attributable to Intel operations.

4.6.4.2 *During Construction*

The potential to impact the ground water during construction exists. There is the potential for silt to be generated during construction works and the accidental release of liquids or other materials that could enter the ground water. To prevent this from entering watercourses or drainage systems appropriate mitigation measures will be required. Groundwater has been assessed as having medium to high sensitivity and potentially a medium to high magnitude of impact without mitigation measures.

4.6.4.3 *During Operation*

No impact on hydrogeology or hydrology during the operation of the building unless uncontained accidental releases of contaminants occur.

The risk to surface water and groundwater is considered to remain low due to the mitigation measures and spill control programme already in place at the site.

The area of the new construction is 120,769m^2 (0.12km^2) compared to 1369km^2 for the Liffey Catchment.

The sensitivity of the ground water is assessed as medium to high and potential impact during operation as medium without any mitigation.

4.6.5 Proposed Mitigation

There will be no impact on hydrogeology or hydrology during the construction of the building provided construction procedures are adhered to at all times. Mitigation measures are already in place on site to prevent the adverse impact on surface water, ground or groundwater occurring from accidental releases of contaminants or in the event of fire.

The site has installed provisions to minimise any potential release of contaminants. A list of set requirements to minimise the potential for surface water and groundwater pollution is specified within the sites existing IPC licence and is anticipated in the IPPC Licence for which application will be made. Installation of temporary provisions to minimise silt generated during construction from entering watercourse and drainage will also be present.

The existing surface water drainage system on the Intel property consists of a number of independent drainage routes from roofs, paved areas and sub-drainage systems covering the Site. These systems combine prior to entering the Retention Pond and discharge via a single outlet pipe to the Rye Water.

Under normal operating conditions the retention pond acts as an attenuation pond reducing peak flows to the Rye Water and also allowing any silt or grit to settle prior to the discharge to the River. In the event of a fire or spill on site, the pond inlet/outlet may be closed and storm systems diverted individually around the retention pond so that the pond's full storage volume may be utilised to contain potentially contaminated surface run-off.

Surface water drainage from yard areas where chemicals are handled on site may also be diverted independently to on-site treatment or storage areas via contained storm systems. Specific unloading or storage areas are also protected with further valves and sumps to minimise any risk of spillage.

Surface water drainage systems on the site are comprised of the below systems: -

- FAB 10 storm system;
- FAB 14 / FAB 24 storm system;
- FAB 14 contained storm system; and
- FAB 24 contained storm system;

As part of FAB 24-3 Development it is proposed to increase the drained impermeable surface areas contributing to the FAB 14 / FAB 24 storm system and the FAB 24 contained storm system. Surface water drainage has been assessed on the basis of 20-year return period storm events for low-risk areas (car parks and site roads) and 50-year return period storm events for areas of higher risk (yards, low-points, and areas drained by contained storm systems).

The impermeable surface area drained by the existing FAB 14 and FAB 24 storm system shall increase by almost 40% (16.1 Ha – 22.4 Ha). Analysis demonstrates that the existing piped system has sufficient capacity to accommodate this as the increase in peak discharge to the retention pond is negligible (less than 2%). This is due to the additional large diameter pipe lengths having the effect of maximising the in-line storage volume utilised during extreme storm events and increasing the effective 'time of entry' to downstream pipes on the system.

While flood risk on the site does not arise for storm events of design rainfall return periods up to 50 years, it is possible to reduce site flood risk that may generate for exceptional events in excess of this by the application of one or more of the following: -

- The provision of flow controls and additional system storage volume from proposed new paved areas;
- The provision of flow controls and tolerance of short duration surface flooding in low-risk areas (i.e. car parks) during extreme rainfall events;
- The provision of soakaways or infiltration pavements (subject to site ground conditions);
- The provision of overflows that would operate during extreme storm events.

One or more of the above schemes may be adopted provided that any resultant impacts to the Storm Outfall to the Rye Water are minimised.

Class 1 storm separator units shall be provided where required on the new storm system draining additional paved areas.

The impermeable surface area drained by the Existing FAB 24 contained storm system shall increase by approximately 20% (1.8 Ha – 2.2 Ha). The existing piped system has sufficient capacity to accommodate this increase. An additional class 1 surface water separator shall be installed in parallel with an existing separator unit prior to the retention pond facilitating treatment of the additional peak flow.

Due to the fact that the increase in peak flow rates are negligible, it is not proposed to upgrade the Storm Outfall to the Rye Water as part of this development.

Discharges of surface water from the site have been demonstrated by extensive surface water monitoring and monitoring of the Rye Water to have no detrimental impact on water quality.

4.6.6 Residual Impacts

No residual impacts on the hydrogeology of the area are anticipated as a result of the development.

Although the deep aquifer is classified as locally important, generally productive and is within a high to extreme vulnerability zone, groundwater abstractions are not recorded between the site and Rye Water. The local area is also not understood to rely on groundwater for potable usage.

The risk to groundwater is considered to remain low due to the mitigation measures and spill control programme in place at the site.

The predicted or residual impact based on the planned mitigation measures is negligible.

APPENDIX 4.1: THE RIVER LIFFEY WATER QUALITY BIOLOGICAL QUALITY RATINGS (Q VALUES)

Table 4.6: The River Liffey Water Quality Biological Quality Ratings (Q Values)

Station No.	1971	1974	1977	1978	1980	1981	1983	1988	1991	1995	1998	2002
0100- 2km NW of Sally Gap	-	-	-	-	5	-	-	4	4-5	4-5	4-5	5
0200- Br E of Ballysmuttan	-	-	-	-	5	-	5	4-5	4-5	4-5	4	5
0250- 0.5km d/s Ballyward Br	-	-	-	-	-	-	5	5	5	5	5	4
0400- Ballymore Eustace Br	5	5	-	3	4	-	2	4	4	2-3*	3-4	3-4*
0500- 1km d/s Ballymore Br	5	4-5	-	3	4	-	2	-	4	4	3-4*	4
0600- New Br u/s Kilcullen	5	4-5	-	4-5	5	-	4-5	5	4-5	4	4-5	4-5
0700- Kilcullen Br	-	5	-	4-5	5	-	5	4-5	4-5	4	4-5	4-5
0800- Athgarvan Br	5	5	-	-	5	-	4-5	4-5	4-5	-	-	-
0850- Connell Ford	-	-	-	-	-	-	-	-	-	4	4	4-5
0900- Br in Newbridge	5	-	4-5	-	5	5	5	5	4	-	-	-
1000- 2.5 km d/s Newbridge	2/0	-	4	-	3	3-4	3-4	4-5	4	4	4-5	4
1050- Victoria Br	2/0	-	4-5	-	-	-	4-5	5	4	4	4	4
1100- Caragh Br	3/0	3-4	4-5	-	5	4-5	4-5	4-5	4-5	-	-	-
1200- Castlekeely Ford (RHS)	-	-	-	-	-	-	-	4-5	3-4	3-4	2	4
1400- Millicent Br	3	-	3-4	-	3-4	4	4-5	4-5	3-4	3-4	3	-
1500- Alexandra Br, Clane (d/s side)	3-4	4	-	4	-	4	4-5	4-5	3-4	3	3-4	4
1600- Straffan,Turnings Lr (RHS & Mid)	4	4	-	3-4	-	4	4-5	4	3-4	3-4	3-4	4

Station No.	1971	1974	1977	1978	1980	1981	1983	1988	1991	1995	1998	2002
1610- Straffan, Turnings Lr (LHS)	-	-	-	-	-	-	4-5	-	-	1	3-4	4
1700- Br in Celbridge	4	4	-	3-4	-	4	4-5	4	3	3-4	3-4	4
1900- Leixlip Br (RHS)	3	4	2-3	3	-	3	4	3-4	3-4	-	3	3-4*
2100- Lucan Br	4	4	3	3	-	3	3-4	3-4	2-3	2-3	2-3	3
2327- Mill Lane Studio	-	-	-	-	-	-	-	-	-	-	-	3

APPENDIX 4.2: GROUND WATER MONITORING 2003 AND 2004

Table 4.18: Ground Water Monitoring 2003

Determinand	Units	Q1 Min	Q1 Max	Q2 Min	Q2 Max	Q3 Min	Q3 Max	Q4 Min	Q5 Max
pH		7.36 (MW19)	8.06 (MW8)	7.26 (MW4)	7.68 (MW12)	7.2 (MW4)	7.64 (MW8)	6.87 (MW4)	7.47 (MW16)
COD	mg/l	<5 (MW4)	537 (MW8)	<5	8 (MW8)	<5	24 (MW7)	<5	21 (MW8)
Total nitrogen	mg/l (as N)	2.1 (MW5 and MW10)	22.6 (MW16)	1.9 (MW5)	31.5 (MW16)	<0.5	7.81 (MW4)	0.02 (MW12)	8.1 (MW5)
Conductivity	uS/cm	231 (MW8)	928 (MW16)	373 (MW8)	1035 (MW4)	376 (MW7)	1106 (MW14)	628 (MW12)	1092 (MW4)
Major cations, anions and other parameters									
Calcium	mg/l	144 (MW8)	473 (MW4)	100 (MW12)	201 (MW4)	90 (MW20)	234 (MW15)	103 (MW5)	213 (MW4)
Sodium	mg/l	2.85 (MW8)	53.7 (MW19)	12.6 (MW8)	44 (MW16)	6 (MW7)	174 (MW14)	14 (MW10)	68 (MW19)
Potassium	mg/l	0.882 (MW11)	5.33 (MW5)	2.58 (MW12)	3.23 (MW16)	1.9 (MW7)	20.74 (MW9)	1.74 (MW8)	4.8 (MW4)
Nitrate	mg/l (as N)	<0.68	7.55 (MW16)	<0.5	44 (MW16)	<0.5	24 (MW16)	<0.23	3.16 (MW16)
Nitrite	mg/l (as N)	<0.005	0.26 (MW16)	<0.005	0.07 (MW16)	<0.005	0.66 (MW5)	<0.005	0.059 (MW8)
Chloride	mg/l	17.3 (MW8)	68 (MW19)	28	80 (MW16)	17 (MW7)	223 (MW14)	14 (MW14)	73 (MW19)
Sulphate	mg/l	26 (MW8)	419 (MW4)	35 (MW8)	352 (MW4)	36 (MW8)	289 (MW15)	39 (MW8)	375 (MW4)
Ammoniacal N	mg/l (as N)	<0.06	5.81 (MW16)	<0.01	0.25 (MW16)	<0.06	0.26 (MW4)	<0.01	0.44 (MW8)
Fluoride	mg/l	0.183 (MW8)	0.711 (MW5)	0.16 (MW8)	0.86 (MW5)	<0.1 (MW7)	1.11 (MW12)	0.111 (MW8)	0.598 (MW5)
Heavy Metals									
Iron	mg/l	-	-	0.002 (MW5)	0.738 (MW11)	<0.00009	<0.00009	-	-
Manganese	mg/l	-	-	<0.003	0.803 (MW12)	<0.00003	<0.00003	-	-
Copper	mg/l	-	-	0.001 (MW5)	0.003	<0.00005	<0.00005	-	-
Lead	mg/l	-	-	<0.0005	<0.0005	<0.0005	<0.0005	-	-
Cobalt	mg/l	-	-	<0.001	<0.001	<0.0001	<0.0001	-	-
Nickel	mg/l	-	-	<0.0006	<0.0006	<0.0004	<0.0004	-	-
Arsenic	mg/l	-	-	<0.004	<0.004	<0.004	<0.004	-	-
Tin	mg/l	-	-	<0.002	<0.002	<0.002	<0.002	-	-
Chromium	mg/l	-	-	0.004	0.005 (MW11)	<0.00006	<0.00006	-	-

Table 4.19: Ground Water Monitoring 2004

Determinand	Units	Q1 Min	Q1 Max	Q2 Min	Q2 Max	Q3 Min	Q3 Max	Q4 Min	Q5 Max
pH		7.16 (MW10)	7.41 (MW8)	6.93 (MW19)	7.64 (MW18)	6.92 (MW4)	7.55 (MW8)	7.16 (MW19)	7.41 (MW8)
COD	mg/l	<5	20 (MW11)	<5	470 (MW18)	<5	42 (MW16)	<5	22 (MW8)
Total nitrogen	mg/l (as N)	2 (MW10)	29 (MW16)	1.5 (MW9)	7.7 (MW20)	3.2 (MW10)	31 (MW16)	0.76 (MW19)	21 (MW10)
Conductivity	uS/cm	318 (MW11)	1025 (MW16)	478 (MW18)	1198 (MW14)			373 (MW8)	1001 (MW16)
Major cations, anions and other parameters									
Calcium	mg/l	66 (MW11)	240 (MW16)	101 (MW14)	298 (MW4)	622 (MW8)	924 (MW16)	7.8 (MW8)	218 (MW16)
Sodium	mg/l	7.2 (MW11)	60 (MW8)	9.2 (MW7)	31 (MW17)	14 (MW10)	26 (MW11)	8.1 (MW8)	21 (MW16)
Potassium	mg/l	1.0 (MW11)	4.7 (MW16)	1 (MW4)	24 (MW9)	2 (MW10)	4.4 (MW5)	1.8 (MW8)	4.4 (MW5)
Nitrate	mg/l (as N)	<1.13	4.67 (MW16)	<5	20 (MW20)	<0.2	4.5 (MW	<0.23	2.9 (MW16)
Nitrite	mg/l (as N)	<0.005	0.063 (MW16)	<0.005	0.045 (MW5)	<0.005	0.158 (MW8)	<0.005	0.042 (MW4)
Chloride	mg/l	16 (MW11)	33 (MW16)	15 (MW9)	230 (MW14)	25 (MW5)	69 (MW11)	15 (MW8)	40 (MW11)
Sulphate	mg/l	18.0 (MW11)	411.8 (MW16)	21 (MW8)	370 (MW4)	10 (MW8)	459 (MW4)	16 (MW8)	323 (MW16)
Ammoniacal N	mg/l (as N)	<0.02	0.041 (MW4)	<0.02	0.046 (MW11)	<0.02	1 (MW8)	<0.02	0.096 (MW5)
Fluoride	mg/l	0.086 (MW11)	0.497 (MW12)	0.08	0.2 (MW5)	<0.02	0.61 (MW5)	0.19 (MW8)	0.66 (MW5)
Heavy Metals									
Iron	mg/l	<0.005	<0.005	<0.005	0.8 (MW10)	<0.005	0.079 (MW11)		
Manganese	mg/l	<0.005	<0.005	<0.005	0.13 (MW15)	<0.005	0.258 (MW11)		
Copper	mg/l	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005		
Lead	mg/l	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005		
Cobalt	mg/l	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005		
Nickel	mg/l	<0.005	<0.005	<0.005	<0.005	<0.005	9.6 (MW19)		
Arsenic	mg/l	<0.005	<0.005	<0.005	<0.005	<0.01	<0.01		
Tin	mg/l	<0.005	<0.005	<0.005	<0.005	<0.01	<0.01		
Chromium	mg/l	<0.005	<0.005	<0.005	<0.005	<0.01	<0.01		