APPENDIX 6D

PREVIOUS GROUNDWATER STUDIES ON ROADSTONE LANDS

Roadstone (Dublin) Ltd.

EXTENSION TO BLESSINGTON SAND AND GRAVEL PIT, CO. WICKLOW

ENVIRONMENTAL IMPACT STATEMENT

Brady Shipman Martin

April 1999

9 WATER

Receiving Environment

Site Location and Description

9.1 The proposed pit is located approximately 2 km northwest of Blessington village (Figure 9.1). Access to the site is from the main Blessington to Dublin road (N81) approximately 1 km north of the village. The total Roadstone landholding is highlighted on Figure 9.1 and covers an area of 276 hectares centred in the townlands of Dillonsdown and Deerpark. The proposed application area (5.9 hectares in total) is in a south-westerly direction into a parcel of afforested land purchased by Roadstone from the Department of Energy in 1992. Roadstone propose to extract sand and gravel from approximately 4.2 hectares in the south-eastern part of the proposed area and retain the remaining area of forest in its present state to provide visibility screening for the development.

Programme of Works

9.2 The following works were carried out as part of the investigation :

- A desk study was carried out to investigate the geology and hydrogeology of the area. This involved:
- interrogation of all available maps, reports, well records, etc. in the Geological Survey as well as own in-house records of K.T. Cullen and Co.,
- compiling information on public and group scheme water supplies in the area.
- Six boreholes were drilled around the site to augment the geological data collected in the desk study and to provide permanent groundwater monitoring stations.
- The six boreholes were surveyed and tied in to the existing topographical map, which in turn is tied in to the Malin Head datum.
- Water level measurements were taken at each of the wells to determine the water table elevation and groundwater flow direction beneath the site
- Three of the monitoring wells and two streams were sampled in order to provide baseline information on the water quality of the area.

Desk Study

9.3 The bedrock geology and overburden geology as interpreted by the Geological Survey are depicted on Figures 9.2 and 9.3 respectively. Eighteen boreholes were drilled by the Department of Energy at the site in the late 1980s. The drilling locations are shown on Figure 9.4 while the bedrock depths and approximate elevations are given in Table 9.1. The logs of these boreholes were not made available to K.T. Cullen and Co. or to Roadstone so the nature of the overburden or bedrock encountered during this drilling programme is unknown to the consultants.

Table 9.1 : Summary of Boreholes. - Dillonsdown and Deerpark, Blessington.

Number	T.O.C. Elevation (mOD)	Ground Elevation (mOD)	Depth Bored (m)	Base of Well Elevation (mOD)	Bedrock Depth (m)	Bedrock Elevation (mOD)	Standpipe	Water Level Depth (bTOC) (20/11/96)	Water Level Elevation (20/11/96)
BH-1	247.22	246.63	31.10	215.53	29.30	217.33	110 mm Wavin	19.06	228.16
BH-2	237.00	236.56	22.50	214.06	18.00	218.56	110 mm Wavin	20.36	216.64
BH-3	271.42	270.90	38.30	232.60	9.10	261.80	110 mm Wavin	13.85	257.57
BH-4	267.54	267.11	40.50	226.61	13.10	254.01	110 mm Wavin	18.76	248.78
BH-5	243.92	243.57	20.50	223.07	4.60	238.97	110 mm Wavin	10.78	233.14
BH-6	237.16	236.67	10.00	226.67	>10.00	<226.67	110 mm Wavin	4.80	232.36
GSI-1	no casing	272.0	n.a.	n.a.	11.0	261.0	None	n.a.	n.a.
GSI-2	no casing	271.0	n.a.	n.a.	17.0	254.0	None	n.a.	n.a.
GSI-3	no casing	265.0	n.a.	n.a.	11.5	253.5	None	n.a.	n.a.
GSI-4	no casing	272.0	n.a.	n.a.	9.0	263.0	None	n.a.	n.a.
GSI-5	no casing	271.0	n.a.	n.a.	17.5	253.5	None	n.a.	n.a.
GSI-6	no casing	255.0	n.a.	n.a.	17.0	238.0	None	n.a.	n.a.
GSI-7	no casing	247.0	n.a.	n.a.	29.0	218.0	None	n.a.	n.a.
GSI-8	no casing	242.0	n.a.	n.a.	27.0	215.0	None	n.a.	n.a.
GSI-9	no casing	270.0	n.a.	n.a.	9.0	261.0	None	n.a.	n.a.
GSI-10	no casing	279.0	n.a.	n.a.	33.0	246.0	None	n.a.	n.a.
GSI-11	no casing	260.0	n.a.	n.a.	40.0	220.0	None	n.a.	n.a.
GSI-12	no casing	226.0	n.a.	n.a.	24.0	202.0	None	n.a.	n.a.
GSI-13	no casing	265.0	n.a.	n.a.	9.0	256.0	None	n.a.	n.a.
GSI-14	no casing	270.0	n.a.	n.a.	24.0	246.0	None	n.a.	n.a.
GSI-15	no casing	252.0	n.a.	n.a.	26.0	226.0	None	n.a.	n.a.
GSI-16	no casing	256.0	n.a.	n.a.	24.0	232.0	None	n.a.	n.a.
GSI-17	no casing	248.0	n.a.	n.a.	40.0	208.0	None	n.a.	n.a.
GSI-18	no casing	220.0	n.a.	n.a.	10.0	210.0	None	n.a.	n.a.

Note

T.O.C = Top of Steel Casing/Cover.
m.O.D. = metres over Malin Head Datum
n.a. = Information not available.
Elevations for GSI wells are approximate.
Numbering system for GSI wells is arbitrary and used only in this report.

Drilling

9.4 Glover Site Investigation Ltd. was retained to carry out the drilling operation. The most efficient method to drill thick sand and gravel deposits in a short time period is by using ODEX. This is a technique whereby the air rotary hammer drills a hole that has a larger diameter than the steel casing which falls down behind the hammer. This has the advantage of closing off sand and gravel layers as drilling proceeds and so prevents collapsing. This technique was used for most of the overburden drilling at the Blessington site. The driller reverted to conventional air rotary drilling when stable bedrock was encountered.

9.5 Six boreholes, labelled BH-1 to BH-6, were drilled to 31.1 m, 22.5 m, 38.3 m, 40.5 m, 20.5 m and 10.0 metres respectively. Bedrock was reached in boreholes BH-1 to BH-5 at depths of 29.3, 18.0, 9.1, 13.1 and 4.6 metres respectively while BH-6 did not encounter bedrock. A summary of drilling depths and elevations is presented in Table 9.1.

9.6 After drilling each borehole, a 110 mm slotted Wavin standpipe was installed with a gravel pack and a bentonite seal. The gravel pack was placed around the entire length of the hole with the exception of the top 2 to 3 metres. This construction will allow groundwater from any of the overburden or bedrock formations to enter the well. The bentonite seal was placed in the top 2 to 3 metres of the borehole to prevent the ingress of surface water. The borehole locations are shown on Figure 9.4 while the logs are presented in Appendix 1.

Bedrock Geology

9.7 The bedrock geology is shown on Figure 9.2. The site is underlain by sedimentary and low-grade metamorphic rocks of Silurian age. The Glen Ding, Slate Quarries and Pollaphuca formations are all part of the Kilcullen Group, which consists of greywackes, and shales that were primarily deposited as turbidites. The shales have generally undergone low-grade metamorphism to slates or phyllites.

Overburden Geology

9.8 The overburden geology of the area is shown on Figure 9.3. The sand and gravel underlying the site was deposited via meltwater channels from glacial ice sheets that melted 10,000 to 12,000 years ago. A thin boulder clay deposit was found beneath these glaciofluvial (sand and gravel) deposits in parts of the site. This boulder clay was deposited directly by the ice sheets rather than by meltwater flowing out of, or under, them. Figure 9.3 shows more extensive boulder clay (till) deposits south, west and east of the site. The overburden thickness at the site, based on information from 24 boreholes, is shown on Figure 9.5 and also shown in cross-section on Figures 9.6, 9.7 and 9.8. The thickest deposits are in the southern and eastern parts of the property with bedrock outcropping on the steep slopes of Glen Ding Wood at the western edge of the property.

Hydrogeology

9.9 The bedrock formations of the Kilcullen Group are considered by the Geological Survey of Ireland to be poor aquifers. This was confirmed by the drilling programme in which a total of 78.8 metres of bedrock was drilled in five (5) boreholes without encountering any significant water entries. Permeability tests on BH-3 and BH-4 revealed bulk bedrock permeabilities of 3.2×10^{-7} m/s and 1.7×10^{-7} m/s respectively. The desk study indicated that most groundwater supplies in the Blessington area target the sand and gravel deposits. According to Wicklow County Council records there are five (5) or six (6) group scheme wells drilled into the sand and gravel on the Naas side of Blessington which supply a number of new housing estates. The

Wicklow and Kildare County Council mains water supplies do not pass the site so it can be assumed that any houses in the vicinity are supplied by private wells, probably sourced in the sand and gravel.

9.10 The water table contours at the site are shown on Figure 9.9 and in cross-section on Figures 9.6, 9.7 and 9.8. The proposed site is split by a catchment divide, therefore groundwater flow is towards the north-west (in the northern part of the extension) and south-east (in the southern part of the extension). The sand and gravel deposits by their nature should be very permeable (in the 10^{-2} to 10^{-3} m/s range) and would act as a good reservoir for groundwater. However in each of the 6 monitoring wells the clean sand and gravel deposits were entirely above the water table. The only sand or gravel found below the water table was in BH-1 and BH-6 where the sand was very fine and silty and would have a lower permeability than cleaner deposits. It can be seen from Figure 9.9 and the cross-sections that the water table at the centre of the site is at a high elevation with steep gradients on either side. This scenario is usually a sign that the formations below the water table are of low permeability and will not allow water through fast enough to establish a more stable shallow gradient. A rough permeability test on BH-6 gave a bulk permeability of 1.4×10^{-6} m/s for the silty fine sand and boulder clay deposits. Indications from drilling and sampling suggest that BH-1, BH-2 and BH-5 have similar bulk permeabilities to the three boreholes that were tested and could be expected to be in the 10^{-6} to 10^{-7} m/s range.

Surface Water

9.11 The nearest surface water feature to the proposed extension is a wet area on the high ground just east of BH-3 which may pond during very wet periods. It can be seen from the log of BH-3 that this is not a surface representation of the permanent water table but is caused by the slow drainage of the 5 metre deep silty sand layer beneath it. Water overflowing from this area disappears into a cleaner sand and gravel layer approximately 50 metres to the west.

9.12 The streams in the vicinity of the site are shown on Figure 9.1. The surface water regime is heavily influenced by the nature of the overburden deposits with streams perched above the water table disappearing as soon as they meet a sand or gravel layer. A surface water catchment divide runs from south-west to north-east through the site. Streams to the southeast of this divide make their way directly to Pollaphuca Reservoir and the River Liffey while surface water to the north-west flows towards the Liffey downstream of Newbridge and Naas via the Morell River. The receiving waters in both cases are important for reasons of water supply, fishing and general amenity and as with the groundwater the surface water quality should not be impaired in any way.

Water Quality

9.13 Water samples were taken from boreholes BH-2, BH-4 and BH-5 and from surface water stations SW-1 and SW-2 and sent to the Forbairt Inorganic laboratory in Glasnevin, Dublin for analyses. The results of these analyses are presented in Table 9.2 and provide baseline information on water quality prior to developing the site.

9.14 The surface water samples appear to be of good quality while the groundwater samples are very high in iron, manganese and aluminium. Because of the low permeability of the wells, water was extracted by bailing rather than by pumping. This meant that the samples contained a lot of suspended solids. The high metal values were measurements of total ions in the sample and were caused by suspended clay particles rather than dissolved ions. The laboratory repeated the tests for these three parameters on filtered groundwater samples and much lower values were measured.

Table 9.2 : Water Quality at Roadstone, Blessington. - 21/11/96

Parameters	Units	M.A.C.	Surface Water		Groundwater		
			SW 1	SW 2	BH-2	BH-4	BH-5
pH	pH units	6 - 9	7.9	7.6	7.5	7.3	7.6
Colour	Hazen Units	20	25	15	<5	<5	<5
Turbidity	N.T.U.	4	4.5	5.1	5500	158	260
Conductivity	µS/cm @ 20°C	1500	385	180	530	510	430
Total Hardness	mg/l CaCO3	-	207	74	303	298	228
Total Alkalinity	mg/l CaCO3	-	185	42	256	269	218
Non Carbonate Hardness	mg/l CaCO3	-	22	32	45	29	10
Calcium	mg/l Ca	200	72	23	100	105	70
Magnesium	mg/l Mg	50	6.6	4.0	13	8.8	13
Sodium	mg/l Na	150	6.9	7.6	13	7.5	10
Potassium	mg/l K	12	2.5	<1.0	1.7	1.6	2.7
Iron (Total)	mg/l Fe	0.2	0.15	0.15	6.6	4.5	4.5
Iron (Dissolved)	mg/l Fe	0.2	-	-	<0.01	<0.01	<0.01
Manganese (Total)	mg/l Mn	0.05	0.02	<0.01	0.42	0.32	0.31
Manganese (Dissolved)	mg/l Mn	0.05	-	-	0.05	0.04	0.12
Copper	mg/l Cu	0.5	<0.01	<0.01	<0.01	<0.01	<0.01
Aluminium (Total)	mg/l Al	0.2	0.07	0.08	3.8	2.8	2.4
Aluminium (Dissolved)	mg/l Al	0.2	-	-	<0.05	<0.05	<0.05
Nitrate	mg/l NO3	50	4.0	29	12	7.6	5.2
Nitrite	mg/l NO2	0.1	0.05	0.03	0.15	<0.01	0.02
Chloride	mg/l Cl	250	11	18	28	14	12
Sulphate	mg/l SO4	250	18	7.3	20	8.8	9.2
Total Ammonia	mg/l NH4	0.3	0.12	0.05	<0.05	<0.05	<0.05
Non Purg. Org. Carbon	mg/l C	-	6.0	3.6	2.1	0.6	0.9
Sulphur	mg/l S	-	6.8	2.7	7.2	3.3	4.5
Arsenic	mg/l As	0.05	<0.05	<0.05	<0.05	<0.05	<0.05
Tin	mg/l Sn	-	<0.05	<0.05	<0.05	<0.05	<0.05
Mercury	mg/l Hg	0.001	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005
Chromium	mg/l Cr	0.05	<0.01	<0.01	0.01	<0.01	<0.01
Phosphorous	mg/l P	1.09	0.08	0.05	0.13	0.05	0.11
Zinc	mg/l Zn	5	<0.01	<0.01	0.02	0.02	0.03
Cadmium	mg/l Cd	0.005	<0.005	<0.005	<0.005	<0.005	<0.005
Lead	mg/l Pb	0.05	<0.05	<0.05	<0.05	<0.05	<0.05
Cobalt	mg/l Co	-	<0.01	<0.01	<0.01	<0.01	<0.01
Nickel	mg/l Ni	0.05	<0.01	<0.01	0.01	0.01	0.01
Boron	mg/l B	2	0.01	0.03	0.01	0.01	0.02
Strontium	mg/l Sr	-	0.16	0.06	0.25	0.20	0.18
Barium	mg/l Ba	0.5	0.05	0.23	0.22	0.13	0.20

M.A.C. = Maximum Admissable Concentration (S.I. No. 81 of 1988)

\- = Not Examined

Summary

9.15 The property owned by Roadstone Ltd. contains overburden deposits which are up to 40 metres thick (between BH-2 and BH-3), however these deposits are generally 10 to 20 metres thick in much of the portion around the proposed extension. These deposits are predominantly sands and gravels that are underlain by silty fine sand and/or boulder clay. The underlying bedrock consists of greywackes, slates and phyllites of Silurian age.

9.16 The highly permeable sand and gravel deposits are generally above the water table. The underlying low permeability strata are generally saturated but yield only low quantities of water. The water table mounds in the centre of the site and flow directions are to the north-west and south-east either side of the groundwater catchment divide.

9.17 The surface water features are dominated by the overburden geology with ponds caused by slow percolation into low permeability strata and perched streams disappearing into high permeability sand or gravel layers.

9.18 Maintaining the good quality of the surface water downstream from the site is important as the River Liffey is used to supply water to the public at Pollaphuca and Leixlip Reservoirs.

Impact of Development

9.19 The potential water related impacts of a sand and gravel pit according to the Environmental Protection Agency are as follows :

- Lowering of water tables
- Changes in volume of water discharges
- Changes to surface water character
- Contamination of surface water from accidental spills fo fuel or lubricants
- Contamination of groundwater from surface during working and after closure

9.20 The depth of sand and gravel extraction will be controlled by the bedrock surface. Figure 9.8 suggests that the extraction will be entirely above the water table and hence, the groundwater levels will be unaffected. If the bedrock surface is found to be deeper than predicted, the extraction of sand and gravel could slightly lower the water table in the centre of the site. This however would not cause any effects to groundwater supplies in the area as the volumes of water encountered during excavation would be minimal.

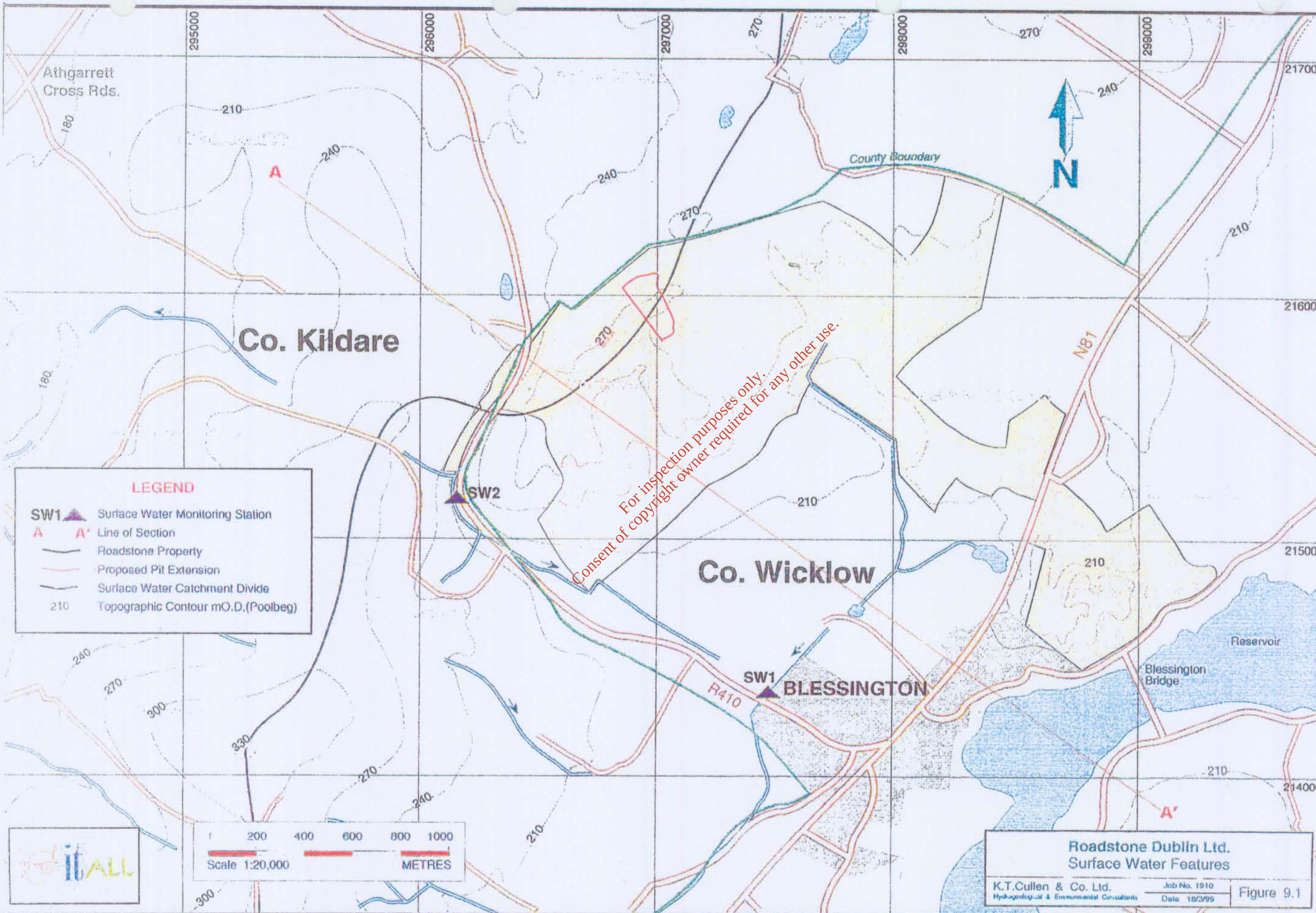
9.21 Lowering a portion of the hill will reduce the catchment area of the streams to the south and east of the site. The proposed extension covers an area of only 4.2 hectares. The 30 year annual average rainfall at Blessington is 938 mm. Potential Evapotranspiration at the nearest synoptic weather station (Casement Aerodrome) is 504 mm. This would suggest that the effective rainfall at the site is in the region of 430 mm per annum. Infiltration rates for sand and gravel according to studies carried out by the Ontario Water Resources Commission are calculated as 250 mm/annum. This would leave 180 mm/annum over a 4.2 hectare area or a volume of 7,560 m^3/annum (or 0.00024m^3/sec.) available for run-off. The bulk of this water will run-off to existing silt ponds and be used to process the extracted sand and gravel. This potential loss of water is insignificant in terms of the overall surface water catchments.

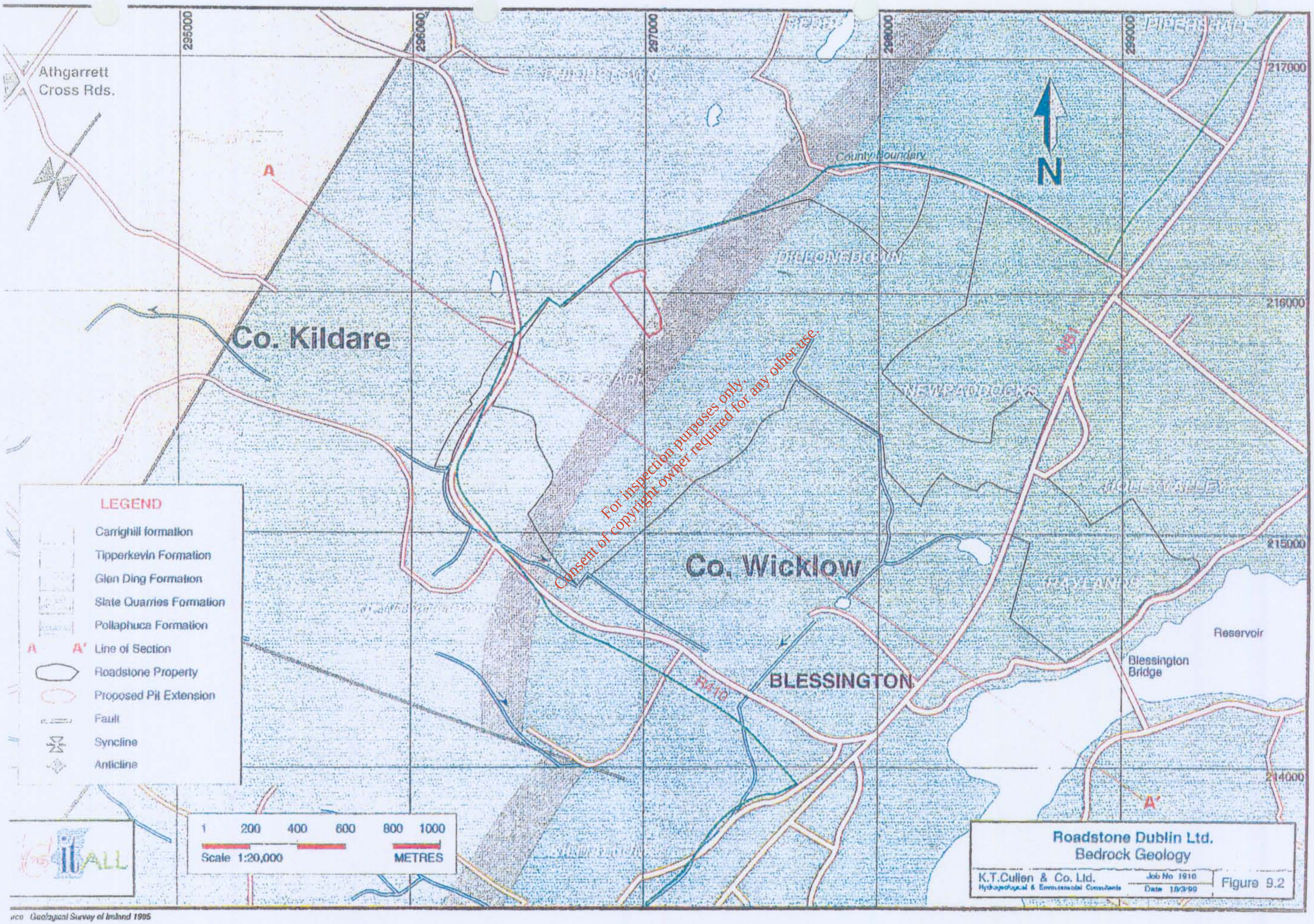
9.22 The wet area near BH-3 will not be impacted upon. No other impact is expected on the surface water character in the vicinity of the site.

9.23 The proposed extension will maintain rather than increase the current level of sand and gravel extraction at the pit. There will therefore be no requirement to increase the number of machines or installations at the site and so the probability of groundwater contamination will not be increased.

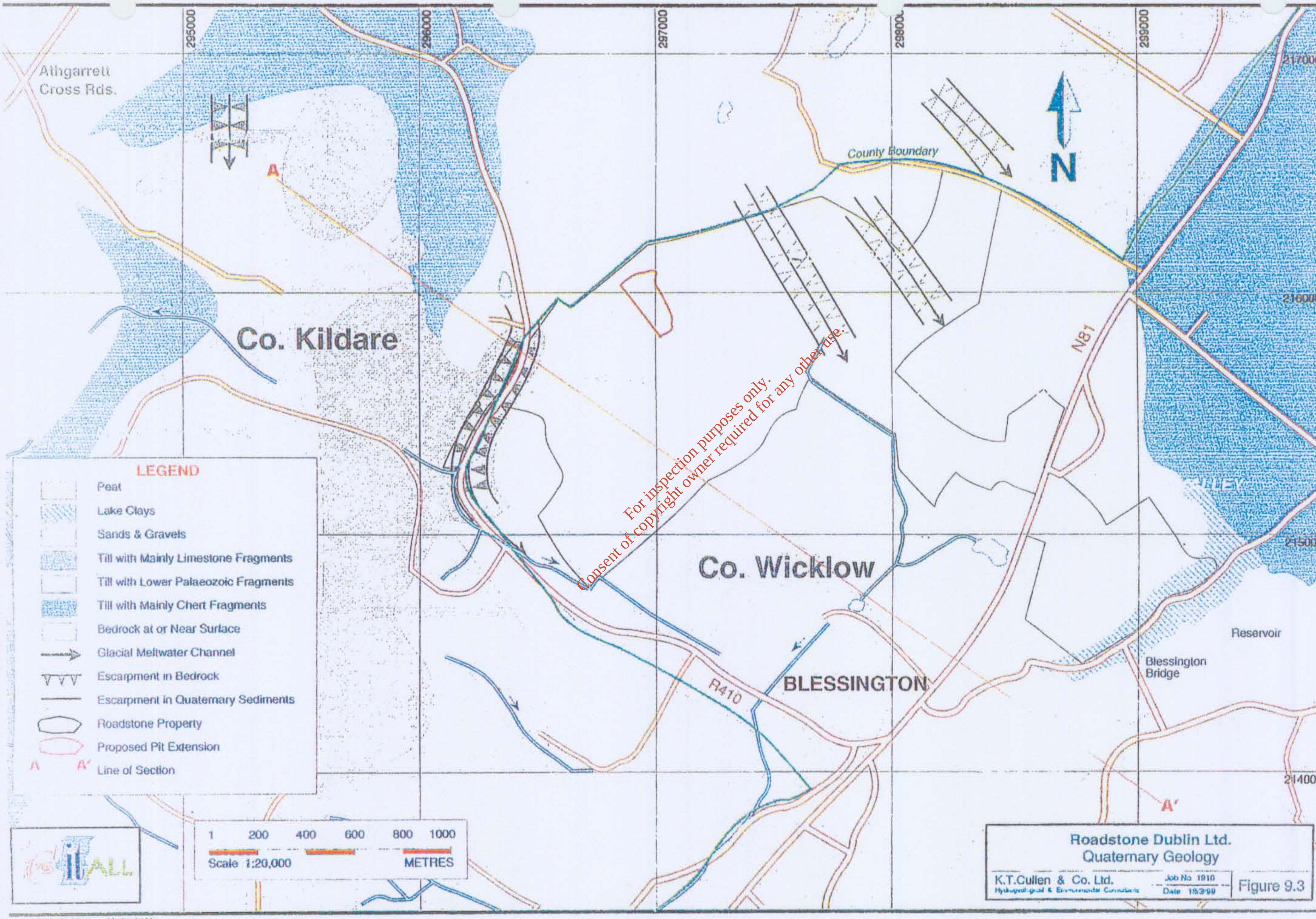
Mitigation Measures

9.24 Standard work practices on this site such as regular maintenance of machinery will prevent any spillage that could lead to contamination of either the groundwater or surface water.

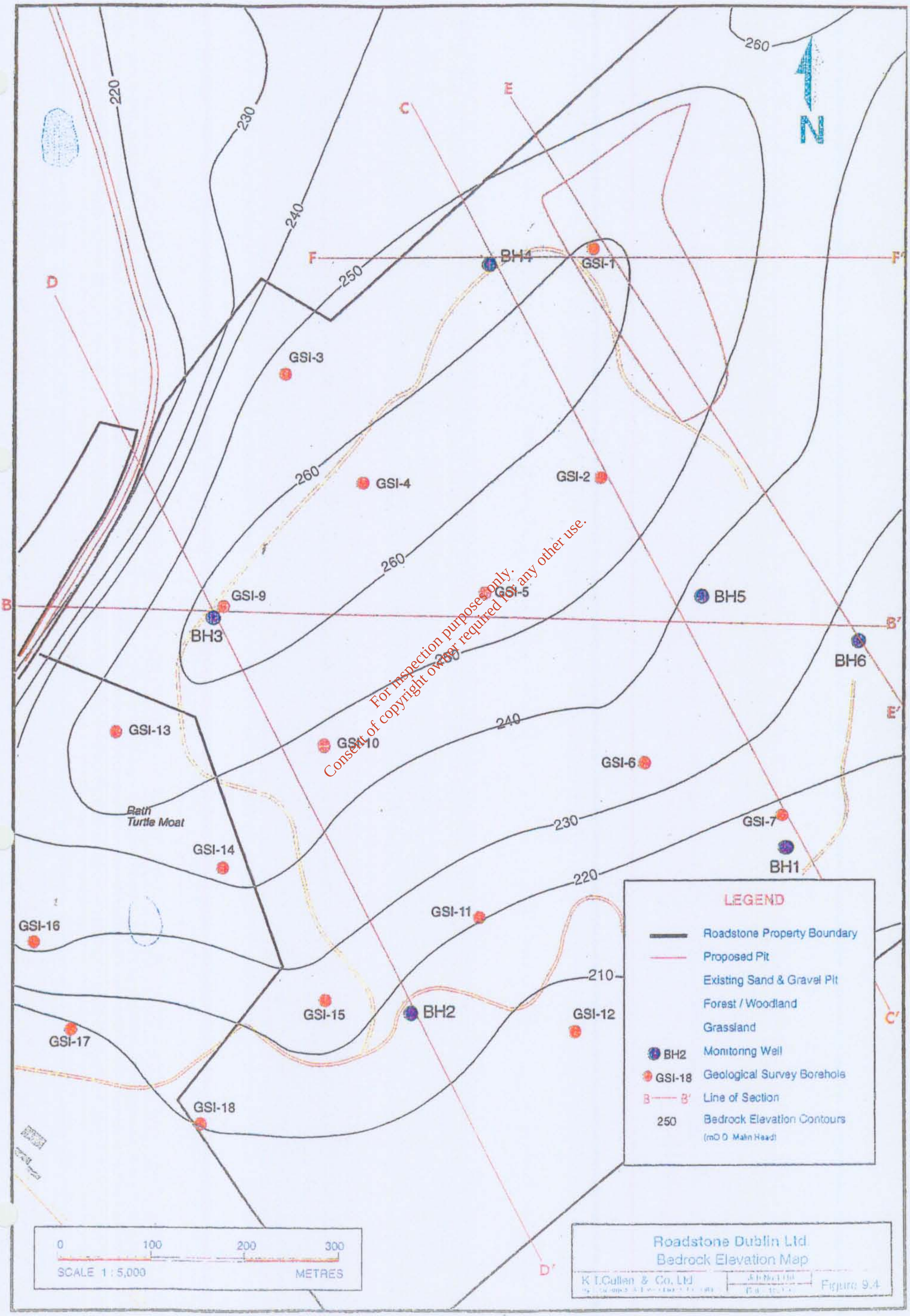

LEGEND
SW1 Surface Water Monitoring Station
A A' Line of Section
Roadstone Property
Proposed Pit Extension
Surface Water Catchment Divide
210 Topographic Contour mO.D.(Poolbeg)
Athgarrett Cross Rds.
Co. Kildare
Co. Wicklow
County Boundary
N
N81
R410
SW1
SW2
BLESSINGTON
Reservoir
Blessington Bridge
A
A'
295000
296000
297000
298000
299000
217000
216000
215000
214000
Scale 1:20,000
METRES
200 400 600 800 1000
Roadstone Dublin Ltd.
Surface Water Features
K.T.Cullen & Co. Ltd.
Job No. 1910
Date 18/3/99
Figure 9.1

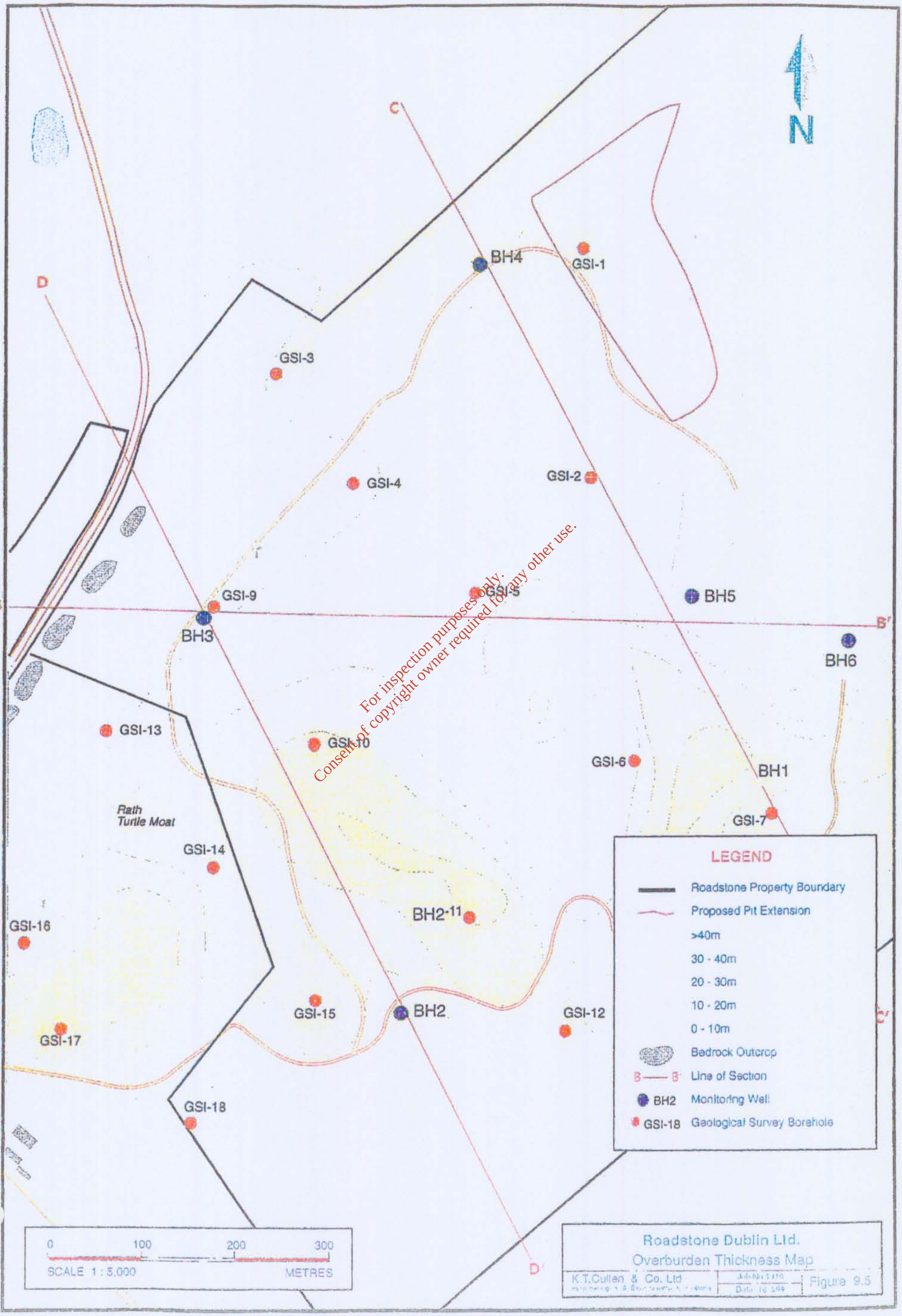


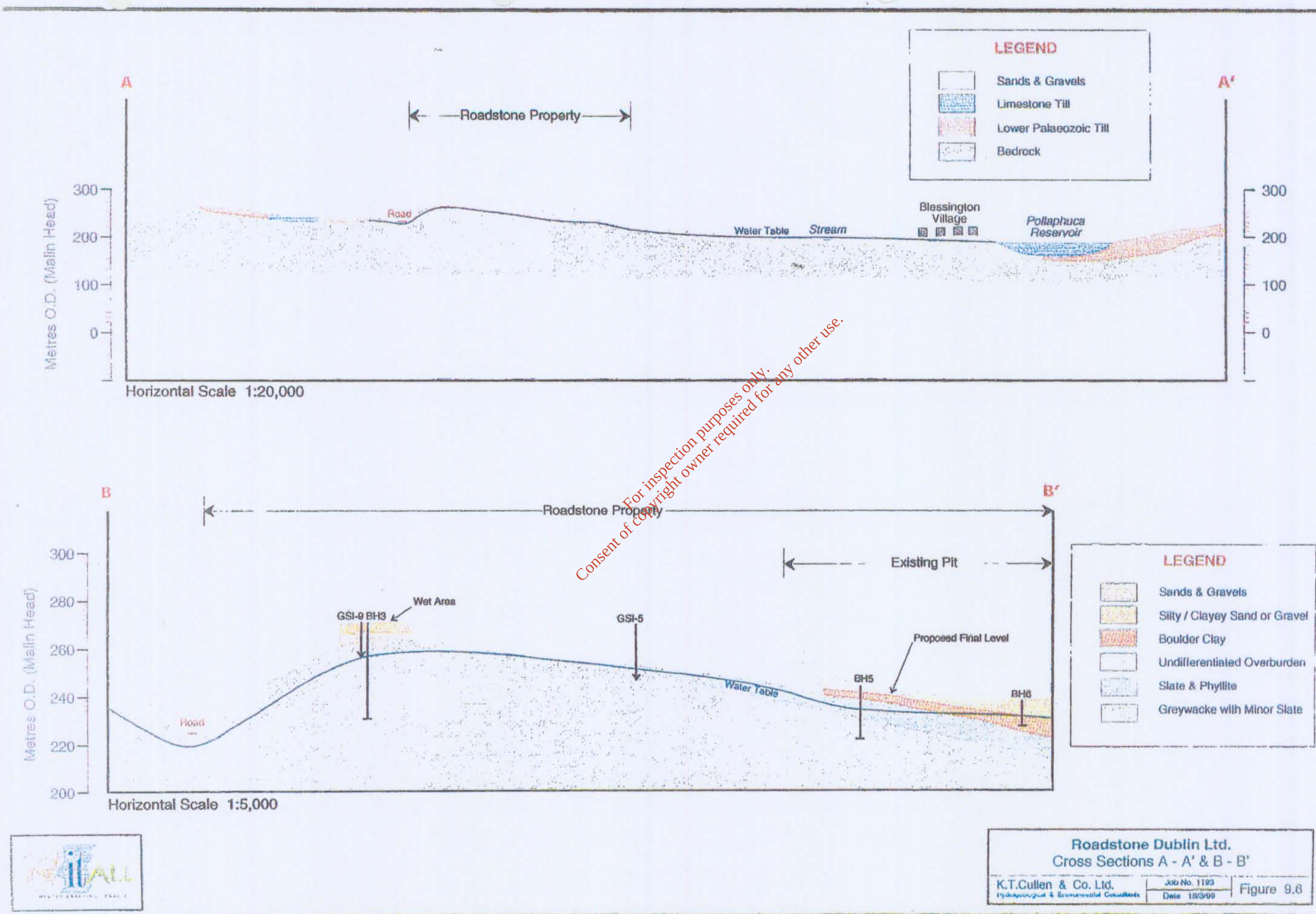
...ce Geological Survey of Ireland 1995

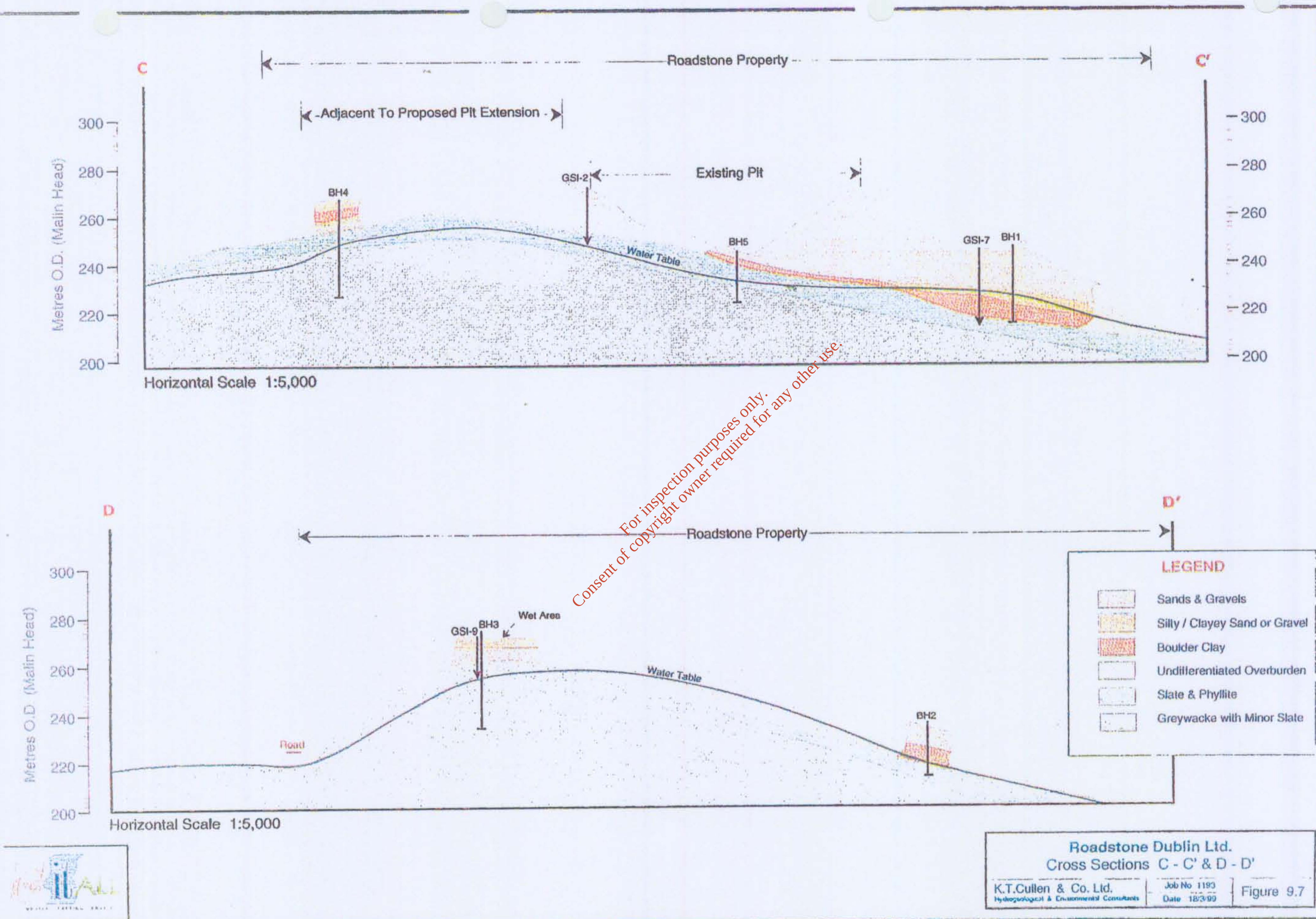


Athgarrett Cross Rds.
295000
296000
297000
298000
299000
217000
216000
215000
214000
County Boundary
N
Co. Kildare
Co. Wicklow
N81
R410
BLESSINGTON
Blessington Bridge
Reservoir
A
A'
LEGEND
Peat
Lake Clays
Sands & Gravels
Till with Mainly Limestone Fragments
Till with Lower Palaeozoic Fragments
Till with Mainly Chert Fragments
Bedrock at or Near Surface
Glacial Meltwater Channel
Escarpment in Bedrock
Escarpment in Quaternary Sediments
Roadstone Property
Proposed Pit Extension
Line of Section
1 200 400 600 800 1000
Scale 1:20,000
METRES
Roadstone Dublin Ltd.
Quaternary Geology
K.T.Cullen & Co. Ltd.
Job No 1910
Date 18/3/99
Figure 9.3


260
N
230
220
240
250
260
260
250
240
230
220
210
C
E
F
F'
D
B
B'
E'
C'
D'
BH1
BH2
BH3
BH4
BH5
BH6
GSI-1
GSI-2
GSI-3
GSI-4
GSI-5
GSI-6
GSI-7
GSI-9
GSI-10
GSI-11
GSI-12
GSI-13
GSI-14
GSI-15
GSI-16
GSI-17
GSI-18
Rath
Turtle Moat
LEGEND
Roadstone Property Boundary
Proposed Pit
Existing Sand & Gravel Pit
Forest / Woodland
Grassland
BH2 Monitoring Well
GSI-18 Geological Survey Borehole
B — B' Line of Section
250 Bedrock Elevation Contours
(mO.D. Malin Head)
0 100 200 300
SCALE 1 : 5,000
METRES
Roadstone Dublin Ltd.
Bedrock Elevation Map
K.T.Cullen & Co. Ltd
Figure 9.4


N
C
D
B
B'
C'
D'
BH1
BH2
BH3
BH4
BH5
BH6
GSI-1
GSI-2
GSI-3
GSI-4
GSI-5
GSI-6
GSI-7
GSI-9
GSI-10
BH2-11
GSI-12
GSI-13
GSI-14
GSI-15
GSI-16
GSI-17
GSI-18
Rath
Turtle Moat
LEGEND
Roadstone Property Boundary
Proposed Pit Extension
>40m
30 - 40m
20 - 30m
10 - 20m
0 - 10m
Bedrock Outcrop
B —— B' Line of Section
BH2 Monitoring Well
GSI-18 Geological Survey Borehole
0
100
200
300
SCALE 1 : 5,000
METRES
Roadstone Dublin Ltd.
Overburden Thickness Map
K.T.Cullen & Co. Ltd
Figure 9.5


LEGEND
Sands & Gravels
Limestone Till
Lower Palaeozoic Till
Bedrock
A
A'
Roadstone Property
Metres O.D. (Malin Head)
300
200
100
0
Road
Water Table
Stream
Blessington Village
Pollaphuca Reservoir
Horizontal Scale 1:20,000
B
B'
Roadstone Property
Existing Pit
Wet Area
GSI-9 BH3
GSI-5
Proposed Final Level
BH5
BH6
Water Table
Road
300
280
260
240
220
200
Horizontal Scale 1:5,000
LEGEND
Sands & Gravels
Silty / Clayey Sand or Gravel
Boulder Clay
Undifferentiated Overburden
Slate & Phyllite
Greywacke with Minor Slate
Roadstone Dublin Ltd.
Cross Sections A - A' & B - B'
K.T.Cullen & Co. Ltd.
Job No. 1193
Date 18/3/99
Figure 9.6

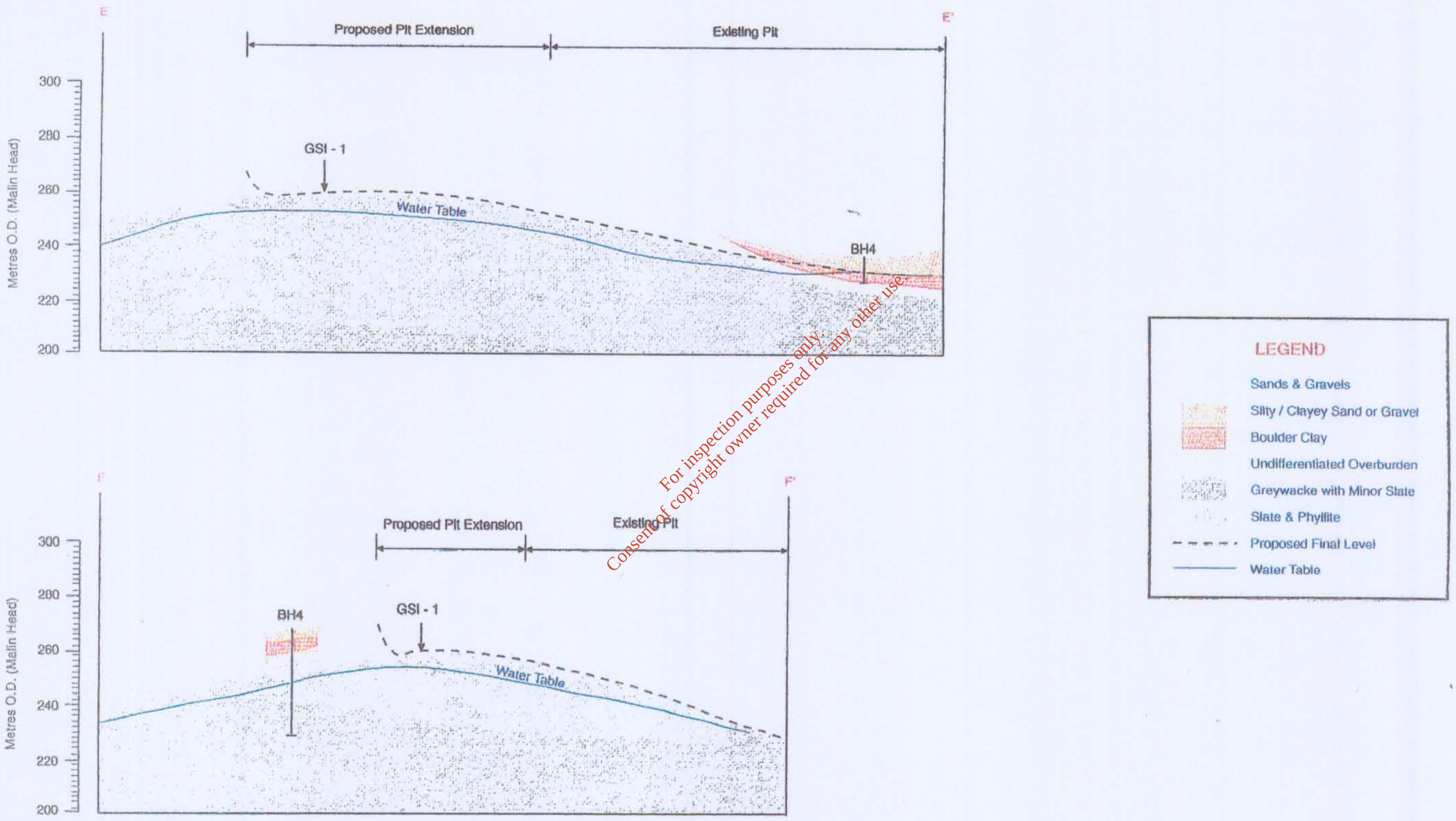


Roadstone Dublin Ltd.
Cross Sections C - C' & D - D'

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

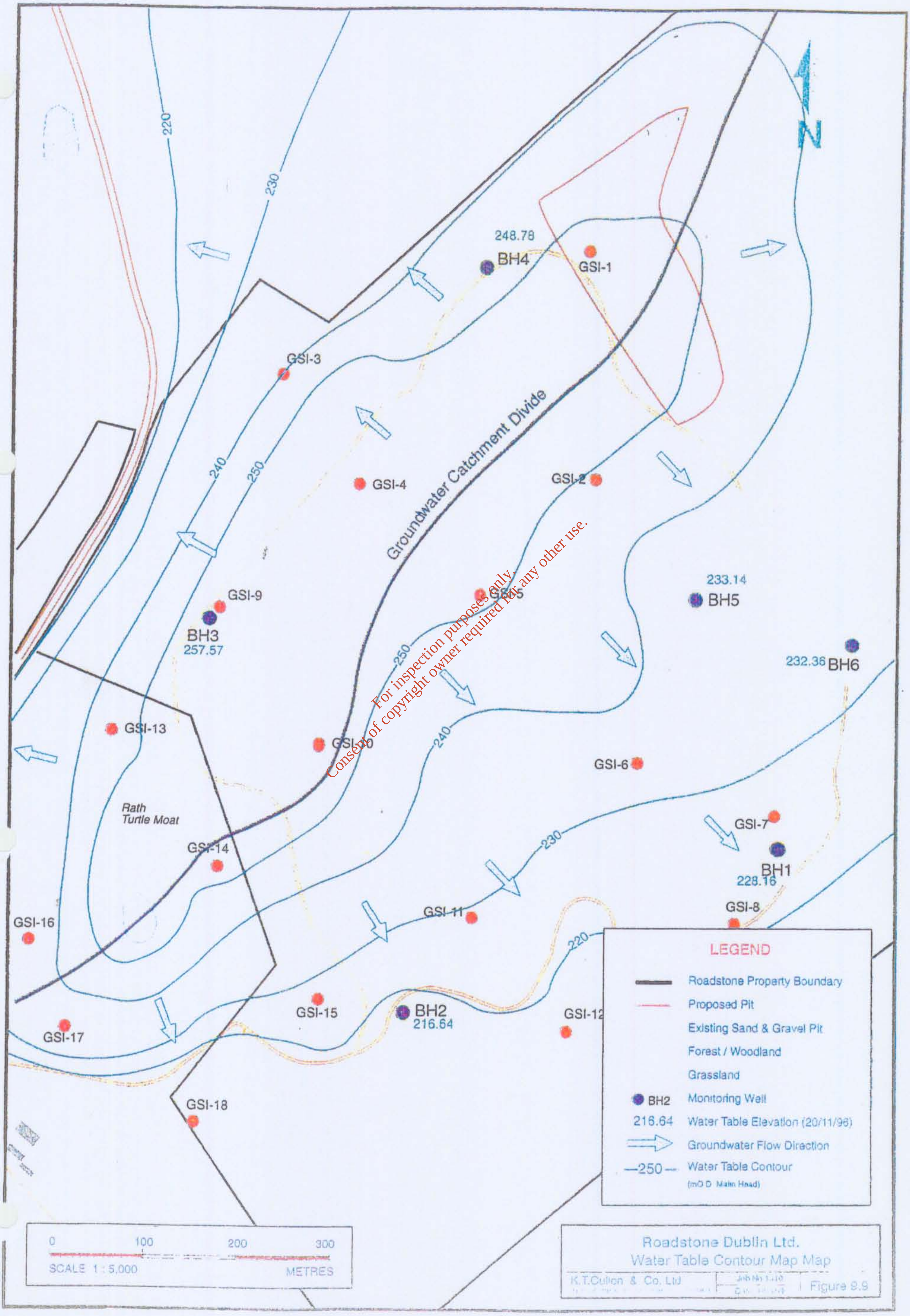
Job No 1193
Date 18/3/99

Figure 9.7



Roadstone Dublin Ltd
Cross Sections E - E' & F -F'

K.T.Cullen & Co. Ltd. Hydrogeological & Environmental Consultants	Job No 1193 Date 23/3/99	Figure 9.8


220
230
240
250
248.78
BH4
GSI-1
GSI-3
Groundwater Catchment Divide
GSI-4
GSI-2
GSI-9
BH3
257.57
GSI-5
233.14
BH5
232.36 BH6
GSI-13
GSI-10
GSI-6
Rath
Turtle Moat
GSI-7
GSI-14
BH1
228.16
GSI-8
GSI-16
GSI-11
GSI-15
BH2
216.64
GSI-12
GSI-17
GSI-18
N
LEGEND
Roadstone Property Boundary
Proposed Pit
Existing Sand & Gravel Pit
Forest / Woodland
Grassland
BH2 Monitoring Well
216.64 Water Table Elevation (20/11/96)
Groundwater Flow Direction
—250— Water Table Contour
(mO.D. Malin Head)
0
100
200
300
SCALE 1 : 5,000
METRES
Roadstone Dublin Ltd.
Water Table Contour Map Map
K.T.Cullen & Co. Ltd
Figure 9.9

Roadstone Dublin Ltd.

ENVIRONMENTAL IMPACT STATEMENT for SAND PROCESSING PLANT at Blessington, Co. Wicklow

June 2001

BRADY SHIPMAN MARTIN

7 WATER

Introduction

7.1 This reports investigates the geological, hydrological and hydrogeological aspects of the construction of a proposed sand processing facility within Roadstone (Dublin) Ltd's property near Blessington, Co. Wicklow. The current sand processing facility is located at Dorans Pit to the east of the main Dublin to Blessington road (N81). The proposed new site is located to the north-west of the main road, Figure 7-1. The proposed activity and details of the existing environment are described below. Potential impacts on the surface and groundwater environment and their respectively mitigation measures are also detailed.

Description of the Activity

7.2 Aggregate from the pit face will be loaded into the primary feed hopper and dry screened to provide <25mm material for the aggregate washing plant via primary stockpiles. The <25mm material will pass through a number of washing processes and screenings to produce a range of grit and sand products. The wash-water from the washing plant will be pumped to the water treatment plant and from here the clean water will then be recirculated into the washing plant via a clean water storage tank. The silt and clay laden residue from the water treatment plant will be diverted to the settling ponds. A flocculent will be added to the wash-water to assist in the separation of the silts and clays from the water. The flocculent, an organic polymer (Magnafloc® LT27), will be added at a dosage rate of 0.003 kg/m^3, approximately 21 kgs per day. The flocculent, Magnafloc® LT27, conforms to European Standard EN 1407 which covers chemicals for use in the treatment of water intended for human consumption. It is not potentially harmful to humans or fauna.

7.3 The washing plant will use approximately 6.8 m^3/min of water over a 17 hour shift of which some 80% will be recycled through the water treatment plant. The remaining 20% of the wash water will be either retained within the washed products and leave the site with the products or drain from the stockpiles to the settling ponds. The daily supply will be augmented from a spring discharge located to the north of the settling ponds, as is the case with the existing sand processing plant (Figure 7-2). This spring feeds into the clean water pond under gravity via a 4" pipe. From here it will be piped into the plant. The clean water pond will also receive water from both other ponds via vertical overflow pipe systems that can be raised or lowered depending on the height of the materials in the ponds. In drought conditions, when the water levels in the clean water pond are low, the make up water from the spring discharge will be supplemented by water taken from the nearby Blessington Reservoir by way of an existing agreement with the Electricity Supply Board, as at present.

Groundwater Quality

7.9 Groundwater in the overburden is characterised by a conductivity in the range of 500 uS/cm and a calcium concentration of the order of 100mg/l. Table 7-2 gives analyses of groundwater collected from boreholes completed within the outwash deposit.

Surface Water Flow

7.10 The streams in the vicinity of the site are shown on Figure 7-1. The surface water regime is locally influenced by the nature of the overburden deposits with streams perched above the water table and then disappearing as soon as they meet a sand or gravel layer.

7.11 A surface water catchment divide runs from south-west to north-east through the site. Streams to the south-east of this divide make their way directly to Pollaphuca Reservoir and the River Liffey while surface water to the north-west flows towards the Liffey downstream of Newbridge and Naas via the Morell River. The receiving waters in both cases are important for reasons of water supply, fishing and general amenity.

Quality of Surface Water

7.12 Analyses of water samples collected from points SW-1 to SW-6 are presented in Table 7-2. The surface water samples appear to be of good quality, especially downstream of the settling ponds. The elevated calcium values in the stream samples indicate that the stream water has a high percentage of groundwater discharge and this is consistent with it acting as a local groundwater discharge area.

7.13 In contrast the pond water analyses returned relatively lower conductivity and calcium values which indicate a higher percentage of rainfall in comparison to the stream water due to either direct precipitation or collected run-off. This result is consistent with the pond levels being perched with respect to the water table.

7.14 For the purpose of this report samples were taken at the location of the original SW 4 and at the location of the spring which will supplement the water supply. The results are shown in Table 7-3. The quality of the water is very good with only manganese the MAC for Drinking Water. These analyses can act as baseline quality against which any changes can be compared.

Impact of Development

7.15 The impacts on the soil of the area relates to the quarrying of the sand and gravel deposit and are covered by the planning permission for this excavation.

7.16 Impacts to the water environment will be a function of discharges to the surface water and groundwater regimes and any water abstractions related to the washing plant.

7.17 A positive impact of the proposed development will be the increase in water recycling in the proposed plant, and the consequent reduction in make-up water required.

Table 7-2 : Surface and Groundwater Quality at Roadstone, Blessington.

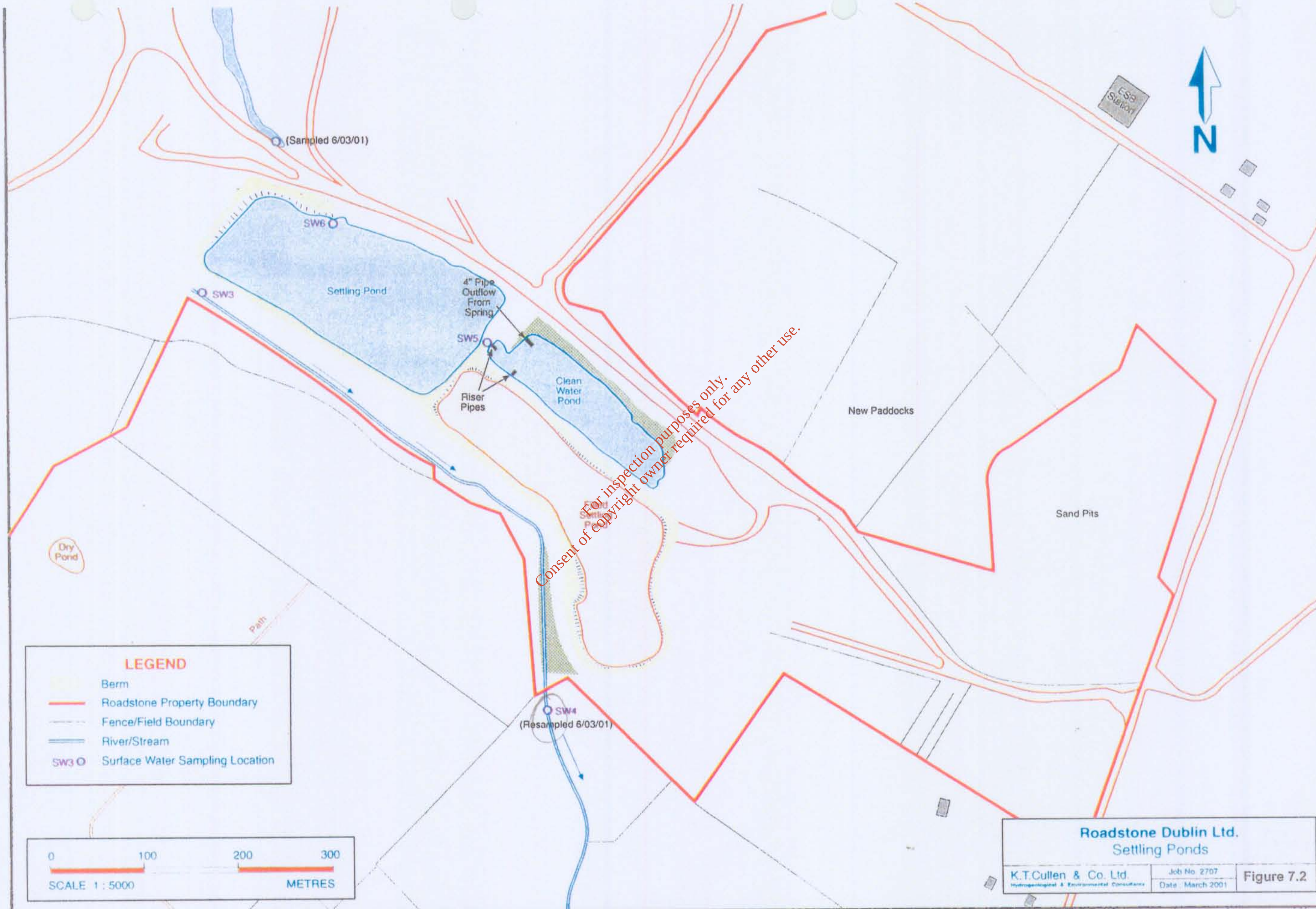
Parameters	Units	M.A.C.	Surface Water						Groundwater		
			SW 1	SW 2	SW 3 upstream stream	SW 4 downstream stream	SW 5 between ponds	SW 6 first pond	BH-2	BH-4	BH-5
			20/11/92	21/11/92	01/07/93	02/07/93	03/07/93	04/07/93	21/11/92	21/11/92	21/11/92
pH	pH units	6 - 9	7.9	7.6	7.6	7.9	8.5	8.4	7.5	7.3	7.6
Colour	Hazen Units	20	25	15	5	<5	NE	<5	<5	<5	<5
Turbidity	N.T.U.	4	4.5	5.1	0.85	0.50	1.8	12	5500	158	260
Conductivity	µS/cm @ 20°C	1500	385	180	480	460	230	225	530	510	430
Total Hardness	mg/l CaCO3	-	207	74	353	314	116	113	303	298	228
Total Alkalinity	mg/l CaCO3	-	185	42	320	283	103	107	256	269	218
Non Carbonate Hardness	mg/l CaCO3	-	22	32	33	31	13	6	45	29	10
Calcium	mg/l Ca	200	72	23	130	110	40	39	100	105	70
Magnesium	mg/l Mg	50	6.6	4.0	6.9	9.5	3.8	3.7	13	8.8	13
Sodium	mg/l Na	150	6.9	7.6	6.8	6.6	7.2	8.7	13	7.5	10
Potassium	mg/l K	12	2.5	<1.0	<1.0	<1.0	<1.0	<1.0	1.7	1.6	2.7
Iron (Total)	mg/l Fe	0.2	0.15	0.15	0.01	0.07	0.06	0.38	6.6	4.5	4.5
Iron (Dissolved)	mg/l Fe	0.2	-	-	-	-	-	-	<0.01	<0.01	<0.01
Manganese (Total)	mg/l Mn	0.05	0.02	<0.01	1.1	0.15	<0.01	0.01	0.42	0.32	0.31
Manganese (Dissolved)	mg/l Mn	0.05	-	-	-	-	-	-	0.05	0.04	0.12
Copper	mg/l Cu	0.5	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Aluminium (Total)	mg/l Al	0.2	0.07	0.08	<0.05	<0.05	0.08	0.38	3.8	2.8	2.4
Aluminium (Dissolved)	mg/l Al	0.2	-	-	-	-	-	-	<0.05	<0.05	<0.05
Nitrate	mg/l NO3	50	4.0	29	1.0	4.4	2.9	2.9	12	7.6	5.2
Nitrite	mg/l NO2	0.1	0.05	0.03	0.01	0.01	0.03	0.02	0.15	<0.01	0.02
Chloride	mg/l Cl	250	11	18	14	12	13	11	28	14	12
Sulphate	mg/l SO4	250	18	7.3	14	11	12	13	20	8.8	9.2
Total Ammonia	mg/l NH4	0.3	0.12	0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05
Non Purg. Org. Carbon	mg/l C	-	6.0	3.6	4.4	2.4	3.3	3.0	2.1	0.6	0.9
Biochemical Oxygen Demand	mg/l (A.T.U.)	-	-	-	5	<2	NE	<2	-	-	-
Suspended Solids	mg/l	-	-	-	34	<10	NE	570.00	-	-	-
Sulphur	mg/l S	-	6.8	2.7	-	-	-	-	7.2	3.3	4.5
Arsenic	mg/l As	0.05	<0.05	<0.05	-	-	-	-	<0.05	<0.05	<0.05
Tin	mg/l Sn	-	<0.05	<0.05	-	-	-	-	<0.05	<0.05	<0.05
Mercury	mg/l Hg	0.001	<0.0005	<0.0005	-	-	-	-	<0.0005	<0.0005	<0.0005

Table 7-3 Analyses of Water Samples from Roadstone, Blessington

PARAMETERS	UNIT	Spring	Stream	POTABLE
		05-Mar-97	05-Mar-97	WATER M.A.C.
pH	units	7.8	8.1	6 - 9
Conductivity	µS/cm	400	475	1500
Total Hardness	CaCO3 mg/l	226	273	-
Total Alkalinity	CaCO3 mg/l	205	262	-
Non-Carbonate Hardness	CaCO3 mg/l	21	11	-
Calcium	Ca mg/l	74	95	200
Magnesium	Mg mg/l	10	8.8	50
Sodium	Na mg/l	8	6.2	150
Potassium	K mg/l	1.8	0.6	12
Iron	Fe mg/l	0.04	0.16	0.2
Manganese	Mn mg/l	0.02	**0.11**	0.05
Copper	Cu mg/l	<0.01	<0.01	0.5
Aluminium	Al mg/l	0.18	0.1	0.2
Nitrate	NO3 mg/l	5.6	5.6	50
Nitrite	NO2 mg/l	<0.01	0.04	0.1
Chloride	Cl mg/l	16	19	250
Sulphate	SO4 mg/l	20	10	250
Total Ammonia	NH3 mg/l	0.08	<0.05	0.3
Benzene	µg/l	<10	<10	30µg/l
Toluene	µg/l	<10	<10	1,000µg/l
Ethyl Benzene	µg/l	<10	<10	150µg/l
Total Xylene	µg/l	<10	<10	70µg/l
MTBE	µg/l			Background=10µg/l
Diesel Range Organics	µg/l	<10	<10	
Mineral Oil	mg/l	<10	<10	-

Shaded Areas=Values exceeding the MAC according to SI 81/1988

Athgarrett Cross Rds.
Co. Kildare
Co. Wicklow
County Boundary
New Sand Washing Plant
Sludge Pond
Clean Water Pond
Filled Pond
BLESSINGTON
Blessington Bridge
Reservoir
N81
R410
N
217000
216000
215000
214000
LEGEND
Roadstone Property
Surface Water Catchment Divide
Topographic Contour mO D (Poolbeg)
Recent Sampling Location
200
400
600
800
1000
Scale 1:20,000
METRES
Roadstone Dublin Ltd.
Surface Water Features
K T Cullen & Co. Ltd.
Date March 2001
Figure 7.1



(Sampled 6/03/01)
SW6
Settling Pond
SW3
4" Pipe Outflow From Spring
SW5
Riser Pipes
Clean Water Pond
ESB Station
N
New Paddocks
Sand Pits
Dry Pond
Path
SW4
(Resampled 6/03/01)
LEGEND
Berm
Roadstone Property Boundary
Fence/Field Boundary
River/Stream
SW3 Surface Water Sampling Location
0 100 200 300
SCALE 1 : 5000
METRES
Roadstone Dublin Ltd.
Settling Ponds
K.T.Cullen & Co. Ltd.
Job No. 2707
Date: March 2001
Figure 7.2

White Young Green
Ireland

Groundwater and Surface Water Sampling at Roadstone Quarry, Blessington, Co.Wicklow October 2002

HYDROGEOLOGICAL & ENVIRONMENTAL CONSULTANTS

K.T.Cullen & Co. Ltd.

K.T.Cullen & Co. Ltd.

White Young Green Ireland

Environmental

Groundwater and Surface Water Sampling at Roadstone Quarry, Blessington, Co.Wicklow

October 2002

1. Background

White Young Green Ireland were requested by Roadstone Dublin Ltd., to carry out groundwater and surface water sampling at their Blessington quarry. Two previous set of samples were taken at the same site on the 4th of June and the 3rd of September 2002. Both sets of these results are detailed in reports from this office entitled "Groundwater and Surface Water Sampling at Roadstone Quarry, Blessington, Co. Wicklow", dated June and September 2002, respectively.

A third set of samples was taken at the site in Blessington on the 30th of September 2002. Three groundwater and two surface water samples were taken and sent to an accredited laboratory for analysis of the baseline EPA parameters. The sample locations are shown in Figure 1. The results of this sampling round are shown in Tables 1 (groundwater) and 1a (surface water), along with the results of the June 4th and 3rd September sampling rounds. All three sets of analyses are compared to the groundwater and surface water MACs and the typical leachate composition values.

2. September 30th Groundwater Sampling (Table 1)

2.1 BH1

The results of the 30th of September sampling show very little difference from the 3rd of September sampling round. All of the parameters remain below the Drinking Water MAC and are significantly below the typical parameters for leachate.

2.2 BH2

The results of the 30th of September sampling show very little difference from the 3rd of September sampling round. All of the parameters remain below the Drinking Water MAC and are significantly below the typical parameters for leachate.

2.3 BH3

The quality of BH 3 has improved since the 3rd of September sampling round. Iron and manganese levels which were formerly high have reduced to below the Drinking Water MAC. There has been very little change in the other chemical parameters. All parameters are significantly below the typical leachate values.

3. September 30th Surface Water Sampling (Table 1a)

3.1 SW 1

The overall quality of SW1 has not changed much since the last sampling round. Manganese remains slightly above the Surface Water MAC at 0.09 mg/l. There has been a slight increase ammonium but no significant changes in nitrate or nitrite. All parameters remain below the typical leachate values.

3.2 SW 2

The overall chemical composition of SW1 has not altered significantly since the last sampling round. Manganese has now decreased below the Surface Water MAC. SW 2 has experienced a slight increase in ammonia but it is still below the Surface Water MAC and is significantly below the typical value for leachate.

4. Summary

Three groundwater and two surface water samples were collected at the Roadstone Blessington Quarry on the 30th of September 2002. These were analysed for the baseline EPA list of parameters to investigate the possible presence of leachate beneath the quarry site. These results obtained are compared to previous analyses carried out on the 4th of June and the 3rd of September 2002.

The continuing good quality of the end of September results confirm the results of the previous sampling i.e. that there is no indication of the presence of leachate in the groundwater or surface water at the Blessington site. The overall groundwater quality is very good-all of the samples are chemically suitable for drinking.

5. Recommendations

Sampling should be continued at intervals agreed between the Consultant, Roadstone and the Planning Authority and should be considered in conjunction with the application for the sand-washing facility at the site. Future sampling for the complete set of baseline parameters is not deemed necessary. A reduced number of chemical parameters should be sampled for instead.

Respectfully Submitted

Victoria Conlon 11/11/02

Victoria Conlon B.Sc. M.Sc.

Teri Hayes 11/11/02

Teri Hayes M.Sc. P.Geo

Table 1 : Groundwater Sample Analyses Roadstone Blessington

Sample Reference		BH1	BH1	BH1	BH2	BH2	BH2	BH3	BH3	BH4	TW 5	Drinking water	Typical
Sample Type		Groundwater	Groundwater	Groundwater	Groundwater	Groundwater	Groundwater	Groundwater	Groundwater	Groundwater	Groundwater	MAC Value	Leachate composition
		Upgradient	Upgradient	Upgradient	Downgradient	Downgradient	Downgradient	Downgradient	Downgradient	Upgradient	Downgradient		
Sample Date	Units	4/6/02	3/9/02	30/09/02	4/6/02	3/9/02	30/09/02	3/09/02	30/09/02	4/6/02	4/6/02	SI 81/1988	EPA 1992
pH Value in Water	mg/l	8.0	7.5	7.4	7.4	7.3	7.2	7.6	7.2	8.0	7.7	6 to 9	7.2
Sulphate as SO_4	mg/l	44	11	11	8.4	5.2	5.2	18	10	18	8	250	136
Nitrate as NO_3	mg/l	9.2	7.6	7.6	15	16	17	4.4	10	20	6.8	50	10.6
Nitrite as NO_2	mg/l	0.84	<0.01	<0.01	0.16	<0.01	<0.01	0.08	<0.01	<0.01	<0.01	0.1	0.66
Total Oxidised Nitrogen as N	mg/l	2.3	1.7	1.7	3.4	3.6	3.8	1	2.2	4.5	1.5	-	-
Ammonium as NH_4	mg/l	0.32	<0.05	<0.05	0.07	<0.05	0.08	<0.05	0.05	<0.05	<0.06	0.3	614
Chloride as Cl	mg/l	18	9.2	9.2	17	18	20	16	18	21	17	250	1256
Conductivity	µS/cm	330	455	450	630	700	690	500	610	350	485	1500	7789
Alkalinity	mg/l	120	255	240	345	370	380	250	330	140	250	-	3438
Non Purgeable Organic Carbon	mg/l	1.4	0.9	<0.5	1.4	1.3	1.2	3.5	3.6	<0.5	2.1	-	-
Mercury as Hg	mg/l	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	0.001	0.1
Chromium as Cr	mg/l	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	0.05	0.07
Zinc as Zn	mg/l	0.02	<0.01	0.01	0.07	<0.01	0.01	<0.01	0.01	0.06	<0.01	1	0.58
Cadmium as Cd	mg/l	<0.005	<0.01	<0.01	<0.005	<0.01	<0.01	<0.01	<0.01	<0.005	<0.005	0.005	<0.01
Lead as Pb	mg/l	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	0.05	0.1
Nickel as Ni	mg/l	<0.01	0.01	0.02	<0.01	<0.01	<0.01	<0.01	0.02	<0.01	<0.01	0.05	0.1
Iron as Fe	mg/l	<0.01	0.08	0.02	<0.01	0.01	<0.01	0.2	0.03	0.13	<0.01	0.2	54.5
Manganese as Mn	mg/l	<0.01	0.03	0.02	<0.01	<0.01	<0.01	0.09	0.03	<0.01	<0.01	0.05	1.99
Magnesium as Mg	mg/l	8.7	9.5	9.6	19	20	20	8.7	17	7.1	5.6	50	151
Calcium as Ca	mg/l	42	84	86	110	130	129	82	116	57	96	200	250
Copper as Cu	mg/l	<0.01	<0.01	0.02	<0.01	0.03	<0.01	0.05	<0.01	<0.01	<0.01	0.5	0.04
Sodium as Na	mg/l	19	8.8	7.6	11	9.6	8.8	18	11	11	9.3	150	904
Potassium as K	mg/l	1.6	<1	<1	0.8	1	<1	9	2.8	0.5	2.2	12	491
Residue on Evaporation	mg/l	464	n/a	1138	1817	n/a	460	n/a	3917	2224	505	-	-
Cyanide as CN	mg/l	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	0.05	<0.05
Phenol as C_6H_5OH	mg/l	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	0.005	-
Fluoride as F	mg/l	0.25	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	1	-
Arsenic as As	mg/l	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	0.05	0.008
Phosphorus as P	mg/l	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	2.2	-
Boron as B	mg/l	<0.1	<0.01	0.01	<0.1	<0.01	0.03	<0.01	0.02	<0.1	<0.1	2	7
Barium as Ba	mg/l	0.08	0.06	0.07	0.26	0.14	0.13	0.08	0.13	0.18	0.04	0.5	-
Selenium as Se	mg/l	<0.05	<0.01	<0.05	<0.05	<0.01	<0.05	<0.01	<0.05	<0.05	<0.05	0.01	-
Silver as Ag	mg/l	<0.01	<0.05	<0.01	<0.01	<0.05	<0.01	<0.05	<0.01	<0.01	<0.01	0.01	-

Notes:

n/a-not analysed

MAC=Maximum Admissible Concentration

Shaded digits=Exceedences of Drinking Water MAC

Table 1a : Surface Water Sample Analyses Roadstone Blessington

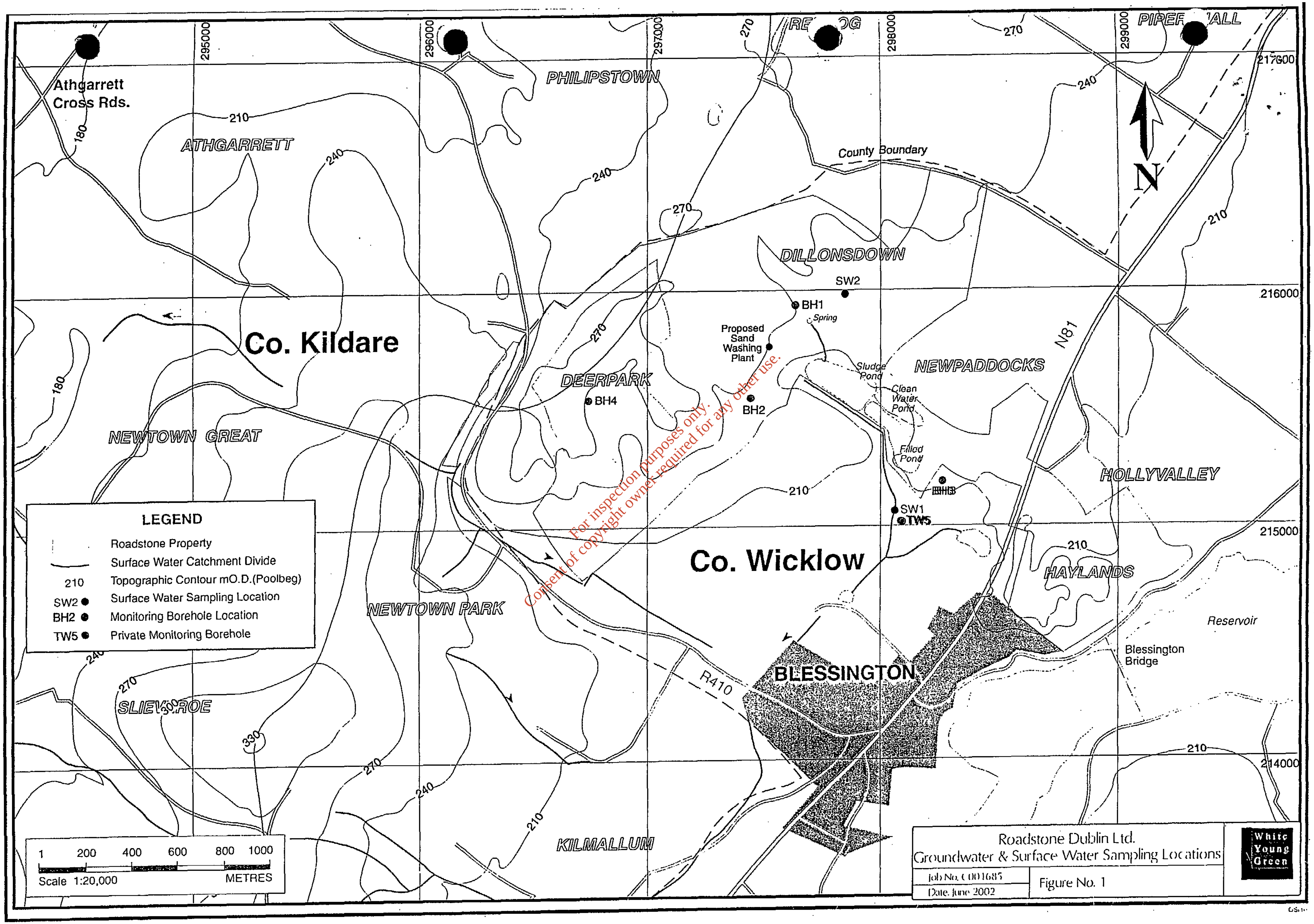
Sample Reference		SW1	SW1	SW1	SW2	SW2	SW2	Surface Water MAC Value	Typical Leachate composition
Sample Type		Surfacewater	Surfacewater	Surfacewater	Surfacewater	Surfacewater	Surfacewater		
		Stream	*Stream*	*Stream*	Quarry	Quarry	Quarry		
Sample Date	Units	4/6/02	3/09/02	30/09/02	4/6/02	3/09/02	30/09/02	SI 294/1998	EPA 1992
pH Value in Water	mg/l	7.9	7.8	7.5	8.2	8.1	7.8	6 to 9	7.2
Sulphate as SO_4	mg/l	11	10	10	26	24	24	200	136
Nitrate as NO_3	mg/l	2.4	3.8	4	4.4	2.2	2.4	50	10.6
Nitrite as NO_2	mg/l	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	-	0.66
Total Oxidised Nitrogen as	mg/l	0.54	0.86	0.9	1	0.5	0.54	-	-
Ammonium as NH_4	mg/l	<0.05	<0.05	0.06	0.06	<0.05	0.16	0.2	614
Chloride as Cl	mg/l	11	10	12	14	13	14	250	1256
Conductivity	µS/cm	485	480	485	300	285	305	1000	7789
Alkalinity	mg/l	265	263	270	130	125	138	-	3438
Non Purgeable Organic Cs	mg/l	1.3	1.5	1.6	1.4	1.4	1.8	-	-
Mercury as Hg	mg/l	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	0.001	0.1
Chromium as Cr	mg/l	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	0.05	0.07
Zinc as Zn	mg/l	<0.01	<0.01	<0.01	0.21	<0.01	<0.01	3	0.58
Cadmium as Cd	mg/l	<0.005	<0.01	<0.01	<0.005	<0.01	<0.01	0.005	<0.01
Lead as Pb	mg/l	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	0.05	0.1
Nickel as Ni	mg/l	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	-	0.1
Iron as Fe	mg/l	0.04	0.17	0.07	0.06	0.03	0.03	0.2	54.5
Manganese as Mn	mg/l	0.03	0.09	0.09	0.02	0.1	<0.01	0.05	1.99
Magnesium as Mg	mg/l	9.7	10	10	9.4	9.6	9	-	151
Calcium as Ca	mg/l	96	96	94	52	115	48	-	250
Copper as Cu	mg/l	<0.01	0.02	0.02	<0.01	<0.01	0.01	0.05	0.04
Sodium as Na	mg/l	6.0	5.7	6.5	7.4	7.4	7.5	-	904
Potassium as K	mg/l	<0.5	<1	1.6	0.8	<1	<1	-	491
Residue on Evaporation	mg/l	n/a	n/a	n/a	n/a	n/a	n/a	-	-
Cyanide as CN	mg/l	n/a	n/a	n/a	n/a	n/a	n/a	0.05	<0.05
Phenol as C_6H_5OH	mg/l	n/a	n/a	n/a	n/a	n/a	n/a	0.005	-
Fluoride as F	mg/l	n/a	n/a	n/a	n/a	n/a	n/a	1	-
Arsenic as As	mg/l	n/a	n/a	n/a	n/a	n/a	n/a	0.05	0.008
Phosphorus as P	mg/l	n/a	n/a	n/a	n/a	n/a	n/a	0.22	-
Boron as B	mg/l	n/a	n/a	n/a	n/a	n/a	n/a	2	7
Barium as Ba	mg/l	n/a	n/a	n/a	n/a	n/a	n/a	0.1	-
Selenium as Se	mg/l	n/a	n/a	n/a	n/a	n/a	n/a	0.01	-
Silver as Ag	mg/l	n/a	n/a	n/a	n/a	n/a	n/a	-	-
BOD	mg/l	<2	<0.5	n/a	<2	1.5	n/a	5	>834
COD	mg/l	<20	<20	<20	<20	<20	<20	-	3078

Notes:

n/a-not analysed

MAC=Maximum Admissible Concentration

Shaded digits=Exceedences of Surface Water MAC



295000
296000
297000
298000
299000
217000
216000
215000
214000
Athgarrett Cross Rds.
PHILIPSTOWN
ATHGARRETT
County Boundary
DILLONSDOWN
SW2
BH1
Spring
Proposed Sand Washing Plant
Co. Kildare
DEERPARK
BH4
BH2
Sludge Pond
Clean Water Pond
Filled Pond
NEWPADDOCKS
N81
NEWTOWN GREAT
HOLLYVALLEY
BH3
SW1
TW5
Co. Wicklow
HAYLANDS
NEWTOWN PARK
Reservoir
Blessington Bridge
BLESSINGTON
R410
SLIEVEROE
KILMALLUM
N
LEGEND
Roadstone Property
Surface Water Catchment Divide
210 Topographic Contour mO.D.(Poolbeg)
SW2 Surface Water Sampling Location
BH2 Monitoring Borehole Location
TW5 Private Monitoring Borehole
1 200 400 600 800 1000
Scale 1:20,000
METRES
Roadstone Dublin Ltd.
Groundwater & Surface Water Sampling Locations
Job No. C001685
Date. June 2002
Figure No. 1
White Young Green

White Young Green Ireland

Groundwater and Surface Water Sampling at Roadstone Quarry, Blessington, Co.Wicklow

Hydrogeological & Environmental Consultants

K.T.Cullen & Co. Ltd.

Groundwater and Surface Water Sampling at Roadstone Quarry, Blessington, Co.Wicklow

K.T.Cullen & Co. Ltd.

White Young Green Ireland

Environmental

Groundwater and Surface water Sampling at Roadstone Quarry, Blessington, Co.Wicklow

June 2002

1. Background

White Young Green Ireland were requested by Brady Shipman Martin, Consulting Planners to comply with a request for further information from Wicklow County Council dated 6th March 2002. Roadstone Dublin Ltd., plan to construct a sand-washing facility across the road from their existing Doran's Pit washing facilities. As part of the planning application for the facilities an EIS was carried out, including a description of the groundwater and surface water regime of the site. Wicklow County Council requested that additional ground and surface water sampling be carried out and that a monitoring programme be put in place.

2. Groundwater Sampling Procedure and Analysis

Four groundwater and two surface water samples were taken at Roadstone Dublin Quarry at Blessington Co Wicklow on the 4th of June 2002. Roadstone further requested that sampling programme be designed to include analysing the EPA list of baseline parameters for landfill monitoring in order to ascertain the possible presence of decaying organic matter beneath a section of the quarry.

Groundwater samples were taken from the four boreholes at the Roadstone site as indicated on Figure 1. Two of the boreholes were drilled specifically for the purposes of sampling (BH1 and BH2). BH1 is located upgradient of the proposed facility and BH 2 is located downgradient. BH2 is situated at an area which is the subject of debate over the possible presence of illegally dumped waste. TW1 was drilled as a water supply on private property downgradient of the quarry. BH4 was drilled as part of the original quarry EIS in 1996 and is located upgradient of the proposed sand-washing plant. BHs 1 and 2 and TW 1 are drilled into the gravel aquifer to depths of 18, 17 and 21.5m respectively. BH 4 is drilled to 38.3 m into the bedrock aquifer beneath the gravel. BH4 is also on the other side of the catchment divide and may not be indicative of groundwater flow through the gravel aquifer beneath the site for both of these reasons.

Bracken Business Park, Bracken Road, Sandyford Industrial Estate, Dublin 18, Ireland.
Tel. +353 1 2941717 Fax +353 1 2941823 eMail: enviro.dublin@wyg.com

The groundwater samples were sent to an accredited laboratory for analysis. The results are shown in Table 1. The groundwater analyses are compared against:

- Drinking Water Standards, SI 81 of 1988
- Typical Leachate Composition, EPA 1992

2.1 Drinking Water Standards

The overall groundwater quality is very good. The only parameters which exceed the Maximum Admissible Concentrations (MAC) for Drinking Water are nitrite in BH 1 and BH 2 and ammonia (as ammonium) in BH 1.
Nitrite exceedences are generally indicative of recent organic pollution from either land-spreading or animal slurry. Nitrite rapidly breaks down to nitrate therefore the fact that nitrate is not elevated in BH 1 would indicate that there is not a long-term pollution source in the vicinity of the borehole. This borehole is located in the centre of the quarry area, removed from sheep and any form of land-spreading so the source of the nitrite and ammonia is not obvious.

BH 2's nitrite content only slightly exceeds the Drinking Water MAC of 0.1 mg/l. This is located near to an area which is grazed by sheep and may be linked to the animal slurry.

Both BH4 and TW1 display excellent groundwater quality which regard to chemical parameters is suitable for consumption.

2.2 Leachate Composition

BH2 is the closest borehole to the proposed are of illegal dumping. As such it would be expected that if leachate was being generated in this area, then the chemical signature of the groundwater in this borehole would reflect this. BH2's chemical parameters are significantly less than the typical leachate composition values.

The most common indicator parameters of pollution from leachate are chloride, ammonia and conductivity. Chloride is possibly the most useful as it is it the most mobile ion in groundwater. Typical background chloride levels in Irish groundwaters are between 15 and 30 mg/l. Values higher than 30 mg/l in areas which are not close to the coast can be indicative of organic pollution. The chloride levels at the site range from 17 to 21 mg/l, indicating that the groundwater in the four wells is not impacted by leachate. The conductivity levels are quite variable in the four wells, ranging from 330 mg/l to 630 mg/l in BH 2. These levels relate directly to the calcium and bicarbonate (alkalinity) levels in each sample and are indicative of the calcium carbonate in the overburden deposits.

2.3 Organic Analyses

The samples were sent to an accredited laboratory for organic analyses, consisting of Diesel Range Organics, Petroleum Range Organics, Mineral Oils and BTEX compounds. The results are show in Table 2. All of the analyses are below the detection limit of 10 μg/l, indicating the absence of organic pollution for diesel or petroleum products.

3. Surface water Sampling Procedure

Two surface water samples were taken from the stream which runs along the south-western boundary of the quarry (SW1) and from the main area of open water within the quarry (SW2). Both of these locations were sampled previously on the 6th of March 2001. The recent samples were analysed according to the EPA baseline parameters for surface waters (apart from dissolved oxygen).

The surface water values were compared against:

- Surface Water for Human Consumption Standards for A1 waters SI 294 of 1989
- Typical Leachate Composition, EPA 1992.

3.1 Surface Water Standards

The quality of the surface water is very good with all parameters meeting the requirements for A1 surface waters. Incidentally, the surface water is of a similar quality to the groundwater, indicating the close link between the two within the quarry environment.

3.2 Comparison with Typical Leachate Composition

Both surface water samples show no evidence of leachate contamination. The most obvious indicators are chloride, conductivity, and ammonium in addition to BOD and COD. None of these parameters are elevated.

4. Summary

Four groundwater samples were taken at the Roadstone quarry site: two upgradient of the proposed sand-washing facility and two downgradient. All of the samples are of good chemical and organic quality. Levels of nitrite above the MAC for Drinking Water are found in BH1 and BH2 and elevated ammonium in BH1. These values are not found in conjunction with other indicators of organic pollution i.e. chloride, sodium and potassium are slightly anomalous.

BHs 2, 4 and TW1 show no evidence of leachate contamination. BH1 shows slightly elevated nitrite and ammonia levels but sodium and potassium are all at background levels indicating that the groundwater is not impacted by leachate.

Surface water quality is also good with values similar to those of groundwater and no exceedences of either the Drinking Water and Surface water Standards. The surface water values are all lower than the leachate levels.

The groundwater upgradient and downgradient of the sand-washing facility and in the location of the possible area of illegal dumping is of good quality and shows no evidence of leachate contamination.

5. Recommendations

The results show no indication of the presence of leachate in the groundwater or surfacewater systems. If decaying matter is present at the site and has not yet leached contaminated water into the groundwater system, then trial pitting may be necessary to ascertain the physical presence of decaying material. This would involve the use of a JCB over the period of one day to excavate 3 metre deep pits at intervals over the site. The trial pits would be logged by White Young Green personnel and any waste material would be identified and photographed. The trial pits may be inspected by Wicklow County Council representatives. If a less invasive survey is required by Roadstone then shallow monitoring boreholes can be drilled with a window sampling rig and a landfill gas analyser can be used to assess the presence of landfill gases.

Respectfully Submitted

Victoria Conlon B.Sc. M.Sc.

Conor Walsh B.Sc P.Geo.

TABLES

Table 1 : Groundwater and Surface Water Sample Analyses Roadstone Blessington

JBA Ref.		GW 4/1	GW 4/2	—	—	BSW1	SW5			
Sample Reference		BH1	BH2	BH4	TW 1	SW1	SW2	Drinking water MAC value	Surface Water MAC Value	Typical Leachate composition
Sample Type		Groundwater	Groundwater	Groundwater	Groundwater	Surfacewater	Surfacewater			
		Upgradient	Downgradient	Upgradient	Downgradient	Stream	Quarry			
Sample Date	Units	4/6/02	4/6/02	4/6/02	4/6/02	4/6/02	4/6/02	SI 81/1988	SI 294/1998	EPA 1992
pH Value In Water	mg/l	8.0	7.4	8.0	7.7	7.9	8.2	6 to 9	6 to 9	7.2
Sulphate as SO_4	mg/l	44	8.4	18	8	11	26	250	200	136
Nitrate as NO_3	mg/l	9.2	15	20	6.8	2.4	4.4	50	50	10.6
Nitrite as NO_2	mg/l	**0.84**	**0.16**	<0.01	<0.01	<0.01	<0.01	0.1	-	0.66
Total Oxidised Nitrogen as N	mg/l	2.3	3.4	4.5	1.5	0.54	1	-	-	-
Ammonium as NH_4	mg/l	**0.32**	0.07	<0.05	<0.06	<0.05	0.06	0.3	0.2	614
Chloride as Cl	mg/l	18	17	21	17	11	14	250	250	1256
Conductivity	µS/cm	330	630	350	485	485	300	1500	1000	7789
Alkalinity	mg/l	120	345	140	250	265	130	-	-	3438
Non Purgeable Organic Carbon	mg/l	1.4	1.4	<0.5	2.1	1.3	1.4	-	-	-
Mercury as Hg	mg/l	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	0.001	0.001	0.1
Chromium as Cr	mg/l	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	0.05	0.05	0.07
Zinc as Zn	mg/l	0.02	0.07	0.06	<0.01	<0.01	0.21	1	3	0.58
Cadmium as Cd	mg/l	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	0.005	0.005	<0.01
Lead as Pb	mg/l	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	0.05	0.05	0.1
Nickel as Ni	mg/l	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	0.05	-	0.1
Iron as Fe	mg/l	<0.01	<0.01	0.13	<0.01	0.04	0.06	0.2	0.2	54.5
Manganese as Mn	mg/l	<0.01	<0.01	<0.01	<0.01	0.03	0.02	0.05	0.05	1.99
Magnesium as Mg	mg/l	8.7	19	7.1	5.6	9.7	9.4	50	-	151
Calcium as Ca	mg/l	42	110	57	96	96	52	200	-	250
Copper as Cu	mg/l	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	0.5	0.05	0.04
Sodium as Na	mg/l	19	11	11	9.3	6.0	7.4	150	-	904
Potassium as K	mg/l	1.6	0.8	0.5	2.2	<0.5	0.8	12	-	491
Residue on Evaporation	mg/l	464	1817	2224	505	n/a	n/a	-	-	-
Cyanide as CN	mg/l	<0.1	<0.1	<0.1	<0.1	n/a	n/a	0.05	0.05	<0.05
Phenol as C_6H_5OH	mg/l	<0.1	<0.1	<0.1	<0.1	n/a	n/a	0.005	0.005	-
Fluoride as F	mg/l	0.25	<0.2	<0.2	<0.2	n/a	n/a	1	1	-
Arsenic as As	mg/l	<0.05	<0.05	<0.05	<0.05	n/a	n/a	0.05	0.05	0.008
Phosphorus as P	mg/l	<0.05	<0.05	<0.05	<0.05	n/a	n/a	2.2	0.22	-
Boron as B	mg/l	<0.1	<0.1	<0.1	<0.1	n/a	n/a	2	2	7
Barium as Ba	mg/l	0.08	0.26	0.18	0.04	n/a	n/a	0.5	0.1	-
Selenium as Se	mg/l	<0.05	<0.05	<0.05	<0.05	n/a	n/a	0.01	0.01	-
Silver as Ag	mg/l	<0.01	<0.01	<0.01	<0.01	n/a	n/a	0.01	-	-
BOD	mg/l	n/a	n/a	n/a	n/a	<2	<2	-	5	>834
COD	mg/l	n/a	n/a	n/a	n/a	<20	<20	-	-	3078

Notes:

n/a-not analysed

MAC=Maximum Admissible Concentration

Block digits=Exceedences of MAC

Table 2. Groundwater Analytical Results - Roadstone Blessington, Mineral Oil, Diesel Range Organics, Petrol Range Organics, BTEX

Location JBA Ref. Units	BH1 GW 4/1 µg/l	BH2 GW 4/2 µg/l	BH4 — µg/l	TW1 — µg/l	Dutch Values S-value µg/l	Dutch Values I-value µg/l
Mineral Oil	<10	<10	<10	<10	50	600
Diesel Range Organics	<10	<10	<10	<10	-	-
Petrol Range Organics	<10	<10	<10	<10	-	-
Benzene	<10	<10	<10	<10	0.2	30
Toluene	<10	<10	<10	<10	7	1000
Ethylbenzene	<10	<10	<10	<10	4	150
Xylene	<10	<10	<10	<10	0.2	70

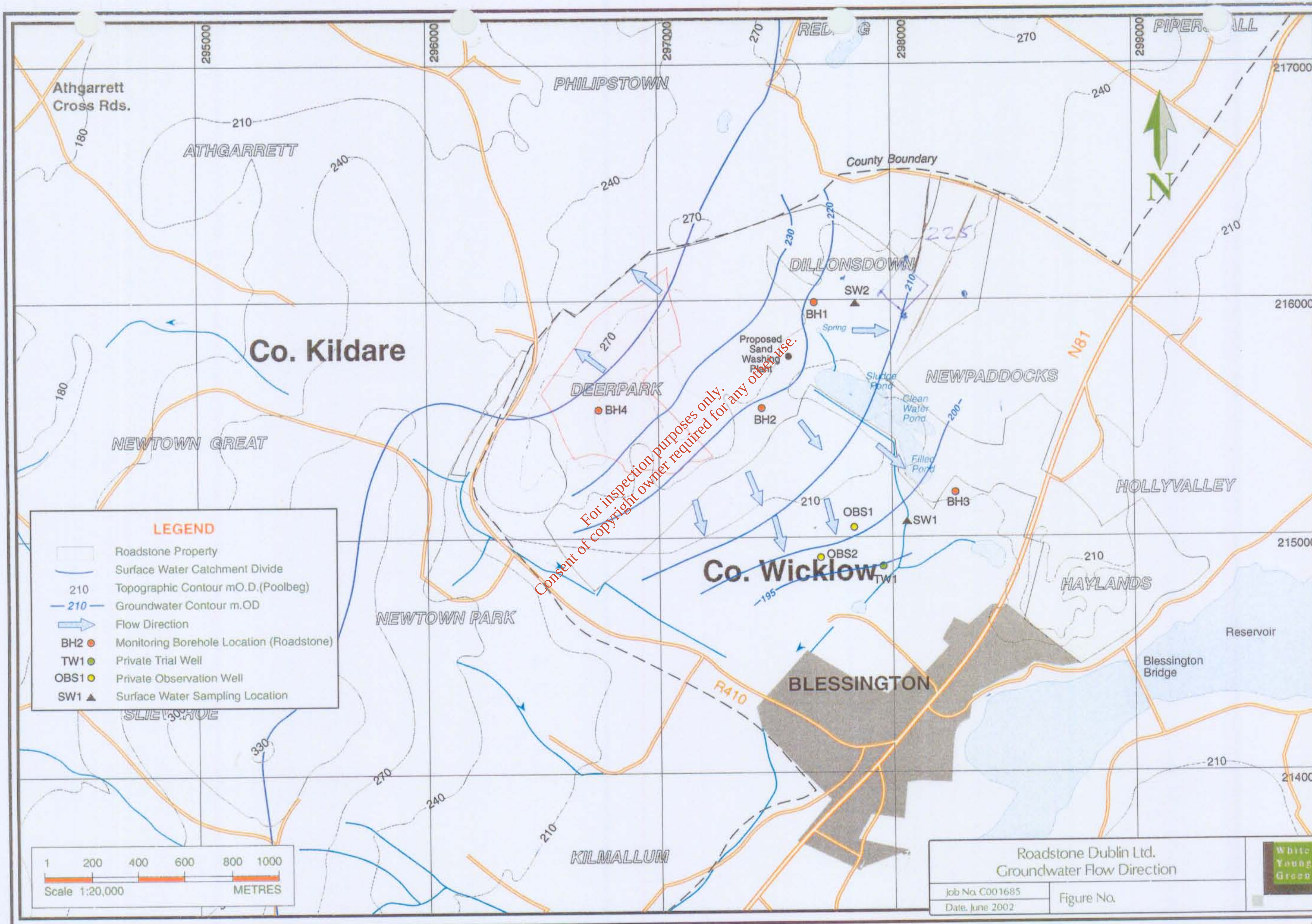
Legend:
Date of Sample Collection: 4/6/02
µg/l-Micrograms/litre
Dutch Values: RIVM 2000
S-Value= Target Value
I-Value= Intervention Value

White Young Green Ireland
Hydrogeological and Environmental Consultants
Job No. C00 1685

White Young Green (IRL) Ltd.
Engineering & Environmental Consultants

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

FIGURE



Athgarrett Cross Rds.
ATHGARRETT
PHILIPSTOWN
DILLONSDOWN
Co. Kildare
Co. Wicklow
DEERPARK
NEWPADDOCKS
NEWTOWN GREAT
HOLLYVALLEY
HAYLANDS
NEWTOWN PARK
KILMALLUM
BLESSINGTON
Blessington Bridge
Reservoir
County Boundary
N81
R410
Proposed Sand Washing Plant
Spring
Sludge Pond
Clean Water Pond
Filled Pond
BH1
BH2
BH3
BH4
SW1
SW2
OBS1
OBS2
TW1
N
LEGEND
Roadstone Property
Surface Water Catchment Divide
210 Topographic Contour mO.D.(Poolbeg)
210 Groundwater Contour m.OD
Flow Direction
BH2 Monitoring Borehole Location (Roadstone)
TW1 Private Trial Well
OBS1 Private Observation Well
SW1 Surface Water Sampling Location
1 200 400 600 800 1000
Scale 1:20,000
METRES
Roadstone Dublin Ltd.
Groundwater Flow Direction
Job No. C001685
Date. June 2002
Figure No.
White Young Green

White Young Green Ireland

Groundwater and Surface Water Sampling at Roadstone Quarry, Blessington, Co.Wicklow

February 2003

Hydrogeological & Environmental Consultants

K.T.Cullen & Co. Ltd.

Groundwater and Surface Water Sampling
at Roadstone Quarry,
Blessington, Co.Wicklow
February 2003

Produced For:
Roadstone Dublin Ltd.,
Fortunestown,
Dublin 24.

Issue	Date	Prepared by:	Verified by:
28/02	2003	Victoria Conlon	[signature]

White Young Green Environmental, Unit 2, Bracken Business Park, Bracken Road, Sandyford, Dublin 18.
Telephone: +353 1 2941717, Facsimile: +353 1 2941823

K.T.Cullen & Co. Ltd.
HYDROGEOLOGICAL & ENVIRONMENTAL CONSULTANTS

White Young Green (IRL) Ltd.
Engineering & Environmental Consultants

TABLE OF CONTENTS

LIST OF FIGURES

LIST OF TABLES

APPENDICES

K.T.Cullen & Co. Ltd.

White Young Green Ireland

Environmental

Groundwater and Surface Water Sampling at Roadstone Quarry, Blessington, Co.Wicklow

February 2003

1. Background

White Young Green Ireland were requested by Roadstone Ltd., to carry out groundwater and surface water sampling at their Blessington quarry. Three previous sets of chemical samples were taken at the same site on the 4th of June, 3rd of September and the 30th of September 2002. These results are detailed in reports from this office entitled " *Groundwater and Surface Water Sampling at Roadstone Quarry, Blessington, Co. Wicklow* ", dated June, September and October 2002, respectively.

A forth set of samples was collected at the site in Blessington on the 4th of February 2003. Three groundwater and four surface water samples were collected and sent to an accredited laboratory for analysis of the baseline EPA parameters. A set of samples were analysed for bacteria as well. Previous bacteriological sampling was carried out at the site on the 16th of November 2002. The sample locations are shown in Figure 1. The results of this sampling round are presented in Tables 1, 2 and 3, along with the results of the June 4th, 3rd and 30th of September sampling rounds. All four sets of analyses are compared to European Drinking Water (S. I. 81 of 1988) and Surface Water (S.I. 294 of 1989) Standards.

The Drinking Water Standards, S.I. 81 of 1988, refer to water which is to be used as a potable supply. As such they are rigorous, defining Maximum Admissible Concentrations (MACs) for 53 parameters in water. It should be noted that the waters sampled for the purpose of this report are not drinking water supplies and the use of the Standards is for comparison purposes only.

The Surface Water Standards, S.I. 294 of 1989 refer to surface waters which are to be abstracted for consumption. These Standards "categorise surface waters into A1, A2 or A3 depending on the (increasing) degree of treatment which will be applied"- *Parameters of Water Quality 2001, EPA*. Again the surface waters sampled in this report are not used as drinking water supplies and therefore the A1 standard is used for comparison purposes only.

Bracken Business Park, Bracken Road, Sandyford Industrial Estate, Dublin 18, Ireland.

Tel. +353 1 2941717 Fax +353 1 2941823 eMail: enviro.dublin@wyg.com

The analyses are also compared to typical leachate composition values as defined by the Environmental Protection Agency (EPA), in their publication, *Landfill Operational Practices, 1997*. The mean value for each parameter was calculated from the leachate compostion of 30 samples from UK and Irish landfills.

2. Surface Water Sampling

2.1 Chemical Sampling

Chemical sampling was carried out on the 4th of February 2003 at four surface water sampling locations (SWs) 1, 2, 3, and 4. The locations are shown on Figure 1. The results are shown in Table 1. The results are compared to the A1 Surface Water MACs under S.I. 294 of 1989 and also to the values for typical leachate composition.

The chemical parameters in SW 1 have not altered significantly since the 30th September sampling round. There has been a slight improvement in the manganese levels. None of the parameters exceed the A1 MACs and there is no evidence of organic or inorganic pollution.

SW 2 has not altered significantly in terms of chemical quality. There has been a very slight increase in nitrate, but at 7 mg/l it is still very low especially for a surface water.

SW 3 and SW 4 are new sampling locations. The quality of the water is generally good with none of the parameters exceeding acceptable surface water limits. Neither sample shows evidence of pollution, apart from elevated nitrate levels in SW 4. At 46 mg/l this is still within acceptable levels (50mg/l) but is indicative of contamination from either organic or inorganic sources. *E.Coli* and Faecal Streptococci are also present (see section 2.2 below) which may point to an organic source of pollution such as cattle or sheep grazing nearby.

2.2 Bacteriological Sampling

Bacteriological sampling was carried out at SWs 1, 2, 3 and 4 on the 4th of February 2003. Previous bacteriological sampling was carried out on the 16th of November 2002. Both sets of results are shown in Table 2 and are compared against the standards for A1 surface waters, to be used for consumption (S.I. 294 of 1989). Surface waters, in general, have higher bacteria counts than groundwater as polluting material can run-off into rivers without being attenuated by overburden material. This is reflected in the very high levels of bacteria, which are allowed to occur in surface waters to be used for consumption, according to S.I. 294 of 1989. *E.Coli* and Total coliform levels of 1,000 and 5,000/100ml respectively are acceptable in A1 Surface Waters to be used for Human Consumption.

E.Coli is an indicator of pollution of faecal (human or animal) origin. Its presence in surface waters in upland, rural areas is common due to the run-off of animal waste from adjacent farmland. Faecal Streptococci are also indicators of faecal pollution but are more short lived than *E. Coli* and so are usually present in smaller numbers. Total coliforms are a measure of the general microbial quality of the water and include bacteria which can occur naturally in soil. If they occur without *E.Coli* or Faecal Streptococci then the source of the bacteria is considered less likely to be faecal in origin.

In SW 1, the bacteriological quality has improved since the 16th of November sampling round, with respect to *E.Coli* and total coliforms. Taking this into consideration, the surface water quality is relatively good, as bacteria counts in surface waters are normally significantly higher. *E.Coli* is present which indicates that faecal contamination is occurring. The quality of SW 2 has improved with respect to *E.Coli*, coliforms and Faecal Streptococci-all of which have reduced in number. The quality of SW 2 is good apart from the presence of 6 coliforms. There is no indication of faecal pollution.

SW 3 is a new sampling location. This shows low values of *E.Coli* and coliforms and no Faecal Streptococci. This indicates that faecal contamination is occurring but it is probably minor.

SW 4 shows the presence of all three bacteria but in very low concentrations. Faecal pollution is occurring as both Faecal Streptococci and *E.Coli* are present.

3. Groundwater Sampling

3.1 Chemical Sampling

Groundwater samples were taken at Boreholes (BHs) 1, 2 and 3 on the 4th of February. The locations of the boreholes are shown in Figure 1. The chemical results, along with previous chemical analyses, are shown in Table 3. These results are compared with the Drinking Water Standards and the values for typical leachate composition.

The quality of the sample taken from BH 1 compares well with the Drinking Water Standard. None of the parameters exceed the MAC for Drinking Waters and none approach concentrations indicative of leachate contamination. The high nitrite and ammonium levels, which were observed in the June sampling round, have not been repeated again.

The quality of the sample taken from BH 2, remains similar to previous sampling rounds. No parameters exceed the Drinking Water MAC and there is no evidence of leachate contamination.

The quality of the sample taken from BH 3 also remains good with no parameters exceeding the MAC for Drinking Water or showing signs of leachate contamination.

The Potassium to Sodium (K:Na) ratio of the three boreholes was checked as an indication of pollution from inorganic or organic sources. A ratio of $\leq$ 0.3 or 0.4 is indicative of uncontaminated groundwaters. The ratios for BHs 1, 2 and 3 were 0.14, 0.14 and 0.045, respectively.

3.2 Bacteriological Sampling

The groundwater bacteriological results are shown in Table 2. They are compared with the Drinking Water Standards S.I. 81 of 1988.

The quality of the water in BH 1 has improved with regard to coliforms since previous sampling rounds. It now complies with the Drinking Water Standard.

The water in BH 2 now has 1 coliform but still does not show any *E.Coli* or Faecal Streptococci, which suggests that no animal or human wastes are polluting the groundwater at this borehole. It is likely that if the groundwater was resampled at this site, the coliform would not be present.

BH 3 shows the presence of coliforms and Faecal Streptococci but no *E.Coli*. The Faecal Streptococci are indicative of pollution from human or animal wastes. Because of their relatively short residence time in aquatic environments, the pollution source may be quite close. BH 3 is adjacent to farmland, which has cattle grazing on it, which may explain the presence of the bacteria.

4. Macroinvertebrate Survey

At the request of Roadstone, White Young Green contracted Ecoserve Ecological Consultancy Services to carry out a macroinvertebrate survey of the stream running along the perimeter of the Blessington site. The survey was carried out on the 31st of January 2003 and is included in Appendix A of this report. Three stream sites were sampled (S 1, 2 and 3). These are shown on Figure 1.

Macroinvertebrates are sensitive to changes in river quality due to pollution. By dividing aquatic organisms into Groups ranging from sensitive to tolerant species, a Biotic Index or "Q" value can be assigned to each river/stream depending on the amount and diversity of organisms in the water-body (Table 4). In turn this "Q" value can be used to define a water-body's pollution level (Table 5).

"Q" Value	Diversity	Water Quality
Q5	High	Good
Q4	Reduced	Fair
Q3	Low	Doubtful
Q2	Very Low	Poor
Q1	Little/None	Bad

Table 4: The EPA Scheme of Biotic Indices or Quality (Q) Values and their relationship to water quality.

Q Value	Quality Status	Quality Class
Q5, Q4-5, Q4	Unpolluted	Class A
Q3-4	Slightly Polluted	Class B
Q3, Q2-3	Moderately Polluted	Class C
Q2, Q1-2, Q1	Seriously Polluted	Class D

Table 5: The relationship between Macroinvertebrate Quality (Q) values and water pollution:

Macroinvertebrate surveys have the advantage over chemical sampling in that they are a better indication of the long-term quality of the water in a river. They are best carried out in the period June to October when water temperatures are at their highest and flows are at their lowest and therefore the macroinvertebrate communities are under the most environmental stress.

The Ecoserve study concludes that the quality of the water at S 1 has a Q value of 3, making it moderately polluted. S 2 has a Q value of 3-4 making it slightly polluted. S 3 has a Q value of 3-4 making it slightly polluted. The origin of the pollution is not known. Siltation is present at all three sites which may have lead to a decrease in species diversity. The EPA publication on Water Quality in Ireland 1998-2000 has shown an increase in the length of river channels in Wicklow which show slight to moderate pollution. The causes of slight pollution are mainly agricultural although cases of quarry siltation have been noted.

The chemical sampling point at SW 1, which is close to the location of macroinvertebrate sampling point S1, does not show any evidence of nitrate pollution (6 mg/l) or pollution from inorganic fertilizers etc. It should be noted that chemical sampling is only an indication of water quality at a particular time.

5. Conclusions

The chemical quality of the surface water quality remains good in SW 1 and SW 2. SW 3 and SW 4 were newly sampled sites, both of which are of good quality apart from high nitrate levels at SW 4. The source is not obvious but appears to be organic in origin.

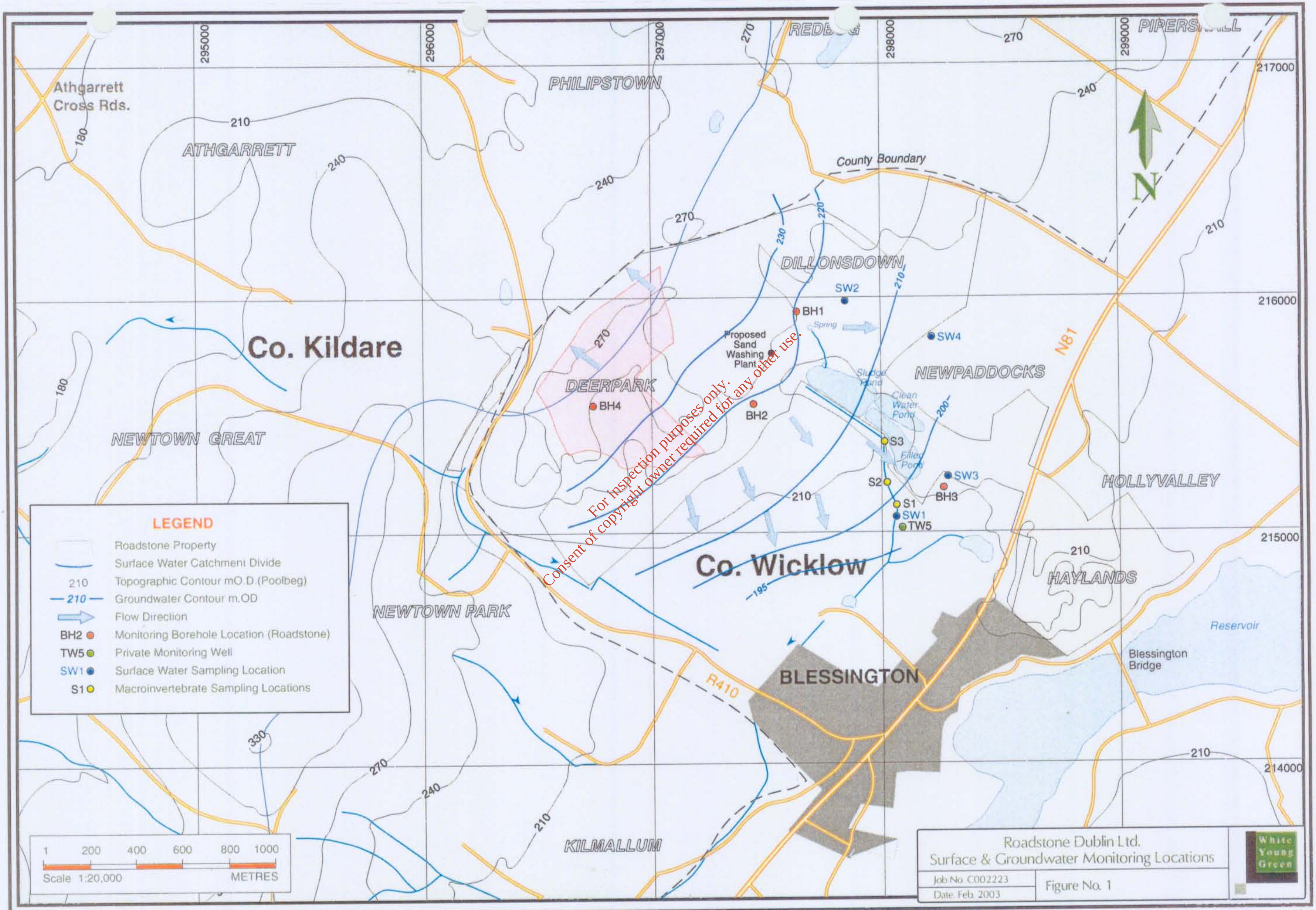
The macroinvertebrate sampling carried out at S 1-3 indicates slight to moderate pollution which may be linked to siltation. The overall trend in the quality of rivers and streams in Wicklow is towards an increase in slight and moderate pollution. It is recommended that this type of sampling be carried out again in the period June to October, when environmental stresses are at their highest.

The bacteriological quality of the surface waters is relatively good when compared with surface waters, in general.

Chemical groundwater quality is excellent with none of the boreholes exceeding the Drinking Water MAC. Bacteriological quality is excellent in BH 1. Apart from 1 coliform in BH 2 the quality is good. The bacteriological quality of the water in BH 3 is poor and shows evidence of slight faecal contamination which may be linked to adjacent land-use.

Overall, the chemical analyses show no evidence, at this time, of contamination of either the ground or surface waters by leachate.

FIGURE


Athgarrett Cross Rds.
PHILIPSTOWN
ATHGARRETT
County Boundary
DILLONSDOWN
Co. Kildare
Proposed Sand Washing Plant
NEWPADDOCKS
DEERPARK
NEWTOWN GREAT
HOLLYVALLEY
Co. Wicklow
HAYLANDS
NEWTOWN PARK
BLESSINGTON
Reservoir
Blessington Bridge
KILMALLUM
N81
R410
BH1
BH2
BH3
BH4
SW1
SW2
SW3
SW4
S1
S2
S3
TW5
Spring
Sludge Pond
Clean Water Pond
Filled Pond
N
LEGEND
Roadstone Property
Surface Water Catchment Divide
210 Topographic Contour mO.D.(Poolbeg)
210 Groundwater Contour m.OD
Flow Direction
BH2 Monitoring Borehole Location (Roadstone)
TW5 Private Monitoring Well
SW1 Surface Water Sampling Location
S1 Macroinvertebrate Sampling Locations
Scale 1:20,000
METRES
Roadstone Dublin Ltd.
Surface & Groundwater Monitoring Locations
Job No. C002223
Date. Feb. 2003
Figure No. 1
White Young Green

TABLE

Table 1 : Surface Water Sample Analyses Roadstone Blessington

JBA Rd. BSW1 ——→ JBA Rd. SW5 ——→ JBA Rd. SW6 JBA Rd. SW1

Sample Reference		SW1	SW1	SW1	SW1	SW2	SW2	SW2	SW2	SW3	SW4	Surface Water	Typical
Sample Type		Surfacewater	Surfacewater	Surfacewater	Surfacewater	Surfacewater	Surfacewater	Surfacewater	Surfacewater	Surfacewater	Surfacewater	MAC Value	Leachate composition
		Stream	*Stream*	*Stream*	*Stream*	*Quarry*	*Quarry*	*Quarry*	*Quarry*	*Pond*	*Dillonsdown*		
Sample Date	Units	4/6/02	3/09/02	30/09/02	4/02/03	4/6/02	3/09/02	30/09/02	4/02/03	4/02/03	4/02/03	SI 294/1998	EPA 1992
Temperature of Water	°C	n/a	n/a	n/a	7.3	n/a	n/a	n/a	4.1	3.1	2.4		
pH Value In Water Lab	pH Units	7.9	7.8	7.5	7.8	8.2	8.1	7.8	8	8.1	8.1	6 to 9	7.2
pH Value In Water on Site	pH Units	n/a	n/a	n/a	8.01	n/a	n/a	n/a	8.05	8.33	8.48		
Sulphate as SO_4	mg/l	11	10	10	11	26	24	24	24	0.5	1.9	200	136
Nitrate as NO_3	mg/l	2.4	3.8	4	6	4.4	2.2	2.4	7	<0.5	46	50	10.6
Nitrite as NO_2	mg/l	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	0.02	0.02	-	0.66
Total Oxidised Nitrogen as N	mg/l	0.54	0.86	0.9	1.4	1	0.5	0.54	1.6	<0.5	10	-	-
Ammonium as NH_4	mg/l	<0.05	<0.05	0.06	<0.1	0.06	<0.05	0.16	<0.1	<0.1	<0.1	0.2	614
Chloride as Cl	mg/l	11	10	12	11	14	13	14	12	6	17	250	1256
Conductivity	µS/cm	485	480	485	510	300	285	305	345	265	280	1000	7789
Conductivity on Site	µS/cm				554				400	295	321		
Alkalinity	mg/l	265	263	270	270	130	125	138	150	152	100	-	3438
Non Purgeable Organic Carbon	mg/l	1.3	1.5	1.6	1.3	1.4	1.4	1.8	0.8	4.1	2.3	-	-
Mercury as Hg	mg/l	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	0.001	0.1
Chromium as Cr	mg/l	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	0.05	0.07
Zinc as Zn	mg/l	<0.01	<0.01	<0.01	<0.01	0.21	<0.01	<0.01	<0.01	<0.01	<0.01	3	0.58
Cadmium as Cd	mg/l	<0.005	<0.01	<0.01	<0.005	<0.005	<0.01	<0.01	<0.005	<0.005	<0.005	0.005	<0.01
Lead as Pb	mg/l	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	0.05	0.1
Nickel as Ni	mg/l	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	-	0.1
Iron as Fe	mg/l	0.04	0.17	0.07	0.03	0.06	0.03	0.03	<0.01	<0.01	0.16	0.2	54.5
Manganese as Mn	mg/l	0.03	0.09	0.09	<0.01	0.02	0.1	<0.01	<0.01	<0.01	<0.01	0.05	1.99
Magnesium as Mg	mg/l	9.7	10	10	5	9.4	9.6	9	3.9	1.9	2.3	-	151
Calcium as Ca	mg/l	96	96	94	104	52	115	48	60	58	49	-	250
Copper as Cu	mg/l	<0.01	0.02	0.02	<0.01	<0.01	<0.01	0.01	<0.01	<0.01	<0.01	0.05	0.04
Sodium as Na	mg/l	6.0	6.7	6.5	7.2	7.4	7.4	7.5	6.8	3.2	8.2	-	904
Potassium as K	mg/l	<0.5	<1	1.6	<1	0.8	<1	<1	<1	2.4	4.2	-	491
BOD	mg/l	<2	<0.5	n/a	<0.5	<2	1.5	n/a	<0.5	1.7	<0.5	5	>834
COD	mg/l	<20	<20	n/a	<20	<20	<20	n/a	<20	<20	<20	-	3078

Notes:

n/a-not analysed

MAC=Maximum Admissible Concentration

Shaded digits=Exceedences of Surface Water MAC

Table 2: Ground and Surface Water Bacterial Analyses Roadstone, Blessington

		JBA Ref.		GW 4/1		GW 4/2		GW 6/4	BSW1		SWS		SW6	SW1
Sample Reference	Drinking Water MAC	Surface Water MAC	TW1	BH1	BH1	BH2	BH2	BH3	SW1	SW1	SW2	SW2	SW3	SW4
Sample Type	SI 81 of 1988	SI 294/1998 (A1 waters)	Groundwater	Groundwater	Groundwater	Groundwater	Groundwater	Groundwater	Surface Water	Surface Water	Surface Water	Surface Water	Surface Water	Groundwater
Sample Date			4/6/02	16/11/02	4/2/03	16/11/02	4/2/03	4/2/03	16/11/02	4/2/03	16/11/02	4/2/03	4/2/03	4/2/03
TCC/ml at 37°C	No increase above background levels	No increase above background levels	11	>300	3	3	>300	>300	123	142	47	1	111	155
TCC/ml at 22°C	No increase above background levels	No increase above background levels	>300	>300	>300	>300	>300	>300	>300	>300	>300	>300	>300	>300
E.Coli/100ml	0/100ml	1000	Nil	Nil	Nil	Nil	Nil	Nil	35	11	35	Nil	4	3
Coliforms/100ml	0/100ml	5000	1	7	Nil	Nil	1	9	48	16	>100	6	2	17
Faecal Streptococci/100 ml	0/100ml	200	Nil	Nil	Nil	Nil	Nil	15	2	2	7	Nil	Nil	12

Shaded digits = Exceedence of Drinking Water MAC SI 81 of 1988

Table 3 : Groundwater Sample Analyses Roadstone Blessington

JBA Ref.		GW 4/1 →				GW 4/2 →				GW 6/4 →						
Sample Reference		BH1	BH1	BH1	BH1	BH2	BH2	BH2	BH2	BH3	BH3	BH3	BH4	TW 5	Drinking water MAC Value	Typical Leachate composition
Sample Type		Groundwater	Groundwater	Groundwater	Groundwater	Groundwater	Groundwater	Groundwater	Groundwater	Groundwater	Groundwater	Groundwater	Groundwater	Groundwater		
Sample Date	Units	4/6/02	3/9/02	30/09/02	4/02/03	4/6/02	3/9/02	30/09/02	4/02/03	3/09/02	30/09/02	4/02/03	4/6/02	4/6/02	SI 81/1988	EPA 1992
Temperature	°C	n/a	n/a	n/a	9.3	n/a	n/a	n/a	9.4	n/a	n/a	7.2	n/a	n/a		
pH Value in Water on Site	pH Units	n/a	n/a	n/a	7.6	n/a	n/a	n/a	7.34	n/a	n/a	7.82	n/a	n/a		
pH Value in Water Lab	pH Units	8.0	7.5	7.4	7.6	7.4	7.3	7.2	7.5	7.6	7.2	7.7	8.0	7.7	6 to 9	7.2
Sulphate as SO_4	mg/l	44	11	11	12	8.4	5.2	5.2	8.4	18	10	14	18	8	250	136
Nitrate as NO_3	mg/l	9.2	7.6	7.6	8	15	16	17	19	4.4	10	2.4	20	6.8	50	10.6
Nitrite as NO_2	mg/l	0.11	<0.01	<0.01	<0.01	0.16	<0.01	<0.01	<0.01	0.08	<0.01	<0.01	<0.01	<0.01	0.1	0.66
Total Oxidised Nitrogen as N	mg/l	2.3	1.7	1.7	1.8	3.4	3.6	3.8	4.3	1	2.2	0.5	4.5	1.5	-	-
Ammonium as NH_4	mg/l	0.32	<0.05	<0.05	<0.1	0.07	<0.05	0.08	<0.1	<0.05	0.05	<0.1	<0.05	<0.06	0.3	614
Chloride as Cl	mg/l	18	9.2	9.2	11	17	18	20	18	16	18	14	21	17	250	1256
Conductivity on Site	µS/cm	n/a	n/a	n/a	499	n/a	n/a	n/a	742	n/a	n/a	541	n/a			
Conductivity Lab	µS/cm	330	455	450	435	630	700	690	685	500	610	490	350	485	1500	7789
Alkalinity	mg/l	120	255	240	245	345	370	380	310	250	330	238	140	250	-	3438
Non Purgeable Organic Carbon	mg/l	1.4	0.9	<0.5	<0.5	1.4	1.3	1.2	1	3.5	3.6	2.7	<0.5	2.1	-	-
Mercury as Hg	mg/l	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	0.001	0.1
Chromium as Cr	mg/l	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	0.05	0.07
Zinc as Zn	mg/l	0.02	<0.01	0.01	<0.01	0.07	<0.01	0.01	<0.01	<0.01	0.01	<0.01	0.06	<0.01	1	0.58
Cadmium as Cd	mg/l	<0.005	<0.01	<0.01	<0.005	<0.005	<0.01	<0.01	<0.005	<0.01	<0.01	<0.005	<0.005	<0.005	0.005	<0.01
Lead as Pb	mg/l	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	0.05	0.1
Nickel as Ni	mg/l	<0.01	0.01	0.02	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	0.02	<0.01	<0.01	<0.01	0.05	0.1
Iron as Fe	mg/l	<0.01	0.08	0.02	0.03	<0.01	<0.01	<0.01	<0.01	[illegible]	0.03	0.14	0.13	<0.01	0.2	54.5
Manganese as Mn	mg/l	<0.01	0.03	0.02	<0.01	<0.01	<0.01	<0.01	<0.01	0.09	0.03	<0.01	<0.01	<0.01	0.05	1.99
Magnesium as Mg	mg/l	8.7	9.5	9.6	4.5	19	20	20	9.7	8.7	17	4.5	7.1	5.6	50	151
Calcium as Ca	mg/l	42	84	86	89	110	130	129	106	82	116	84	57	96	200	250
Copper as Cu	mg/l	<0.01	<0.01	0.02	<0.01	<0.01	0.03	<0.01	<0.01	0.05	<0.01	<0.01	<0.01	<0.01	0.5	0.04
Sodium as Na	mg/l	19	8.8	7.6	7.3	11	9.6	8.8	8.8	18	11	10	11	9.3	150	904
Potassium as K	mg/l	1.6	<1	<1	1	0.8	1	<1	1.2	9	2.8	3.7	0.5	2.2	12	491
Residue on Evaporation	mg/l	464	n/a	1138	n/a	1817	n/a	460	n/a	n/a	3917	n/a	2224	505	-	-
Cyanide as CN	mg/l	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	0.05	<0.05
Phenol as C_6H_5OH	mg/l	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	0.005	-
Flouride as F	mg/l	0.25	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	1	-
Arsenic as As	mg/l	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	0.05	0.008
Phosphorus as P	mg/l	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	2.2	-
Boron as B	mg/l	<0.1	<0.01	0.01	<0.1	<0.1	<0.01	0.03	<0.1	<0.01	0.02	<0.1	<0.1	<0.1	2	7
Barium as Ba	mg/l	0.08	0.06	0.07	0.06	0.26	0.14	0.13	0.12	0.08	0.13	0.1	0.18	0.04	0.5	-
Selenium as Se	mg/l	<0.05	<0.01	<0.05	<0.01	<0.05	<0.01	<0.05	<0.01	<0.01	<0.05	<0.01	<0.05	<0.05	0.01	-
Silver as Ag	mg/l	<0.01	<0.05	<0.01	<0.01	<0.01	<0.05	<0.01	<0.01	<0.05	<0.01	<0.01	<0.01	<0.01	0.01	-

Notes:

n/a-not analysed

MAC=Maximum Admissible Concentration

Shaded digits=Exceedences of Drinking Water MAC

APPENDIX A

Freshwater macroinvertebrate survey and biological pollution assessment for the Doran's Pit Quarry, Blessington, Co. Wicklow.

Report
for:

K.T. Cullen & Co Ltd
Bracken Business Park
Bracken Road
Sandyford Industrial Estate
Dublin 18

February 2003

Report prepared by:
Ecological Consultancy Services Ltd,
B19 KCR Industrial Estate,
Kimmage,
Dublin 12.
www.ecoserve.ie

EcoServe

	Print name	Signature
Prepared by:	Avril Tierney	Avril Tierney 19/2/03
Checked by:	Brian Beckett	Brian Beckett 19/02/03
Authorised by:	CHRIS EMBLOW	C S Emblow

TABLE OF CONTENTS

INTRODUCTION

Ecological Consultancy Services Ltd have been contracted by K.T. Cullen & Co. Ltd, Dublin to conduct an assessment of the freshwater macroinvertebrate ecology and water quality of a stream adjacent to the Doran's Pit quarry, at Blessington quarry, Co. Wicklow.

METHODS

Macroinvertebrates

Freshwater macroinvertebrate surveys were undertaken on the 31st January 2003. Three sites were examined in total, one downstream of the quarry, one along the quarry boundary and one upstream along the quarry boundary (Appendix 1, Figure 1).

One macroinvertebrate sample was collected at each site (Appendix A, Figure 1, Appendix B, Table 1). The samples were collected by 'kick' sampling for approximately 3 minutes in the faster flowing (riffle) areas of the river where possible, using a standard hand net (250 mm width, mesh size 1 mm). Macroinvertebrates collected from each sample were preserved in 70% Industrial Methylated Spirits (IMS) and returned to the laboratory for identification. A variety of data were recorded at each sampling site including, substratum type, water temperature, dissolved oxygen, channel width, channel depth, and aquatic macrophytes (Appendix B, Tables 2 and 3).

Macroinvertebrate specimens were identified using the following literature, Elliott *et al.* (1988) for Ephemeroptera, Hynes (1977) for Plecoptera, Macan (1977) for Gastropoda, Edington & Hildrew (1981) for caseless caddis larvae, Wallace *et al.* (1990) for cased caddis larvae, Friday, (1986) for adult water beetles and for other fauna, Nilsson (1996), Nilsson (1997), and Fitter & Manuel (1986).

Q-indices

The Environmental Protection Agency (EPA) has developed a biological quality ratings index (Q-values) that rates river quality on the relative abundance of macroinvertebrates that have different sensitivities to organic pollutants (McGarrigle *et al.*, 2002). The indicator groups of sensitivity to pollution are A (sensitive), B (less sensitive), C (tolerant), D (very tolerant) and E (most tolerant). The Q values derived from this method give an indication of the water quality status, with a value of Q5 representing pristine, unpolluted conditions whereas Q1 represents grossly polluted conditions (Appendix B, Table 4). A Q-value was assigned to each site where possible based on the EPA methods (McGarrigle *et al.*, 2002). The Q-index scheme should be based on fauna and other observations taken from riffles and eroding substrata.

RESULTS

Site 1 was located just downstream of the quarry on an open unshaded section of channel. Adjacent to the site on the right bank was grassland, recently disturbed in preparation for a road development. On the left bank was grassland leading to the boundary of the quarry. A new housing development was under construction immediately south of site 1. The channel had also been culverted just downstream of the sampling point as part of road development works. The stream was 1.5 m wide, with a mean depth 0.2 m. Flow was moderate, and conditions were slightly silted. The substrata consisted of gravel (50%) with sand and silt. Extensive growth of water celery, *Apium nodiflorum*, occurred just upstream of the sampling point.

Site 1 had the lowest number of organisms and the lowest species richness of the three sites surveyed. The fauna was dominated by species from the more tolerant indicator groups, with Group C (tolerant fauna) accounting for three quarters of the sample and Group D (very tolerant) accounting for 15% of the sample. The Group C fauna consisted of high numbers of the shrimp *Gammarus* sp. and small numbers of the mayfly *Baetis rhodani*, dipteran larvae, and beetle larvae *Elodes* sp. Group B (less sensitive fauna) organisms were present in small numbers. These consisted of cased caddis larvae, *Potamophylax* sp. a genus which is widespread and common in the British Isles, in waters with a stony substratum (Wallace *et al.* 1990). Sensitive fauna (Group A) were scarce, and comprised stonefly larvae *Nemurella picteti*. This stonefly species is abundant in Ireland in permanent trickles and particularly among dense vegetation (Costello, 1988). Overall tolerant species dominated the macrofaunal sample and sensitive species were scarce. Consequently a Q-value of 3 was assigned indicating moderate organic pollution.

Site 2

Site 2 was located approximately 300 m upstream of site 1 and along the boundary of the quarry. The channel was sampled just downstream of a small bridge, marking the end of a section of woodland. Channel width at this point was 1.5 m and depth ranged between 0.1 and 0.2 m. The stream was open, and the shallow banks were covered with mosses, dock, grasses and herbs. Leaf debris was abundant instream, and the edges of the channel were heavily silted. As at site 1, water celery covered most of the channel just upstream of the sampling point.

Site 2 contained the highest number of organisms, and had the highest species richness of the sites surveyed. The fauna was dominated by Group C, or tolerant organisms, with Group B common, Group D scarce and Group A recorded in fair numbers. Group C fauna was characterised by shrimp *Gammarus* sp. and chironomid larvae in large numbers. Other fauna from this group, included mayfly *Baetis rhodani*, uncased caddis *Plectronemia conspersa*, blackfly larvae Simuliidae, and a variety of aquatic beetle larvae. This site had the most diverse trichopteran fauna containing 7 species or higher taxa. Caddis larvae using plant fragments for case construction such as *Limnephilus nigriceps*, *Glyphotaelius pellucidus* and *Halesus* sp. were common. The Group A fauna consisted entirely of the stonefly *Nemurella picteti*. At this site, tolerant fauna dominated, however pollution sensitive fauna were abundant, consequently a Q-value of 3-4 was assigned indicating moderate to slight organic pollution.

Site 3

Site 3 was located approximately 200 m upstream of site 2, along the quarry boundary. The stream widened around a fenced area which may have previously been a cattle watering/feeding area. The stream was 3 m wide and the instream habitats consisted of relatively deep (0.2 – 0.4 cm) slow moving water. The stream at this point was quite heavily silted with deep silt and mud in the centre of the channel. Samples therefore could not be taken using conventional kick sampling and sweeping of the bottom, margins and aquatic vegetation with a pond net was employed. The instream substrata was entirely comprised of silt, sand and mud, and immediately upstream of the sample point water celery, *Apium nodiflorum*, was growing throughout the width of the channel, with some pockets of starwort, *Callitriche* sp. also present. Bankside vegetation on both sides included mosses, ferns, shrubs and trees such as hawthorne.

Sixteen species/taxa and 505 organisms were recorded at site 3. Tolerant species were dominant, with Group C organisms forming 50% of the sample, and Group D (very tolerant) forming a further 20%. The Group D fauna consisted entirely of water louse *Asellus aquaticus*. Group C organisms mainly consisted of chironommid larvae, shrimp *Gammarus* sp., mayfly *Baetis rhodani*, and beetle larvae *Elodes* sp. Uncased caddis *Plectronemia conspersa* were also recorded. Both Groups A and B were common in the sample. Group B comprised cased caddis larvae from the family Limnephilidae, including *Limnephilus nigriceps*, which generally utilises plant fragments in case building. Group A consisted entirely of the stonefly nymphs *Nemurella picteti*. The habitats sampled were not conventional riffle habitats and sampling methods differed from previous sites due to the nature of the substratum. Q-indices are normally calculated on kick samples taken in riffle habitats (Mc Garrigle *et al.*, 2002). However the faunal sample would indicate a mainly pollution tolerant assemblage although sensitive species were well represented. A Q-value of 3-4 was assigned indicating slight to moderate organic pollution.

DISCUSSION

Ideally, channel morphology characterised by a high proportion of riffle areas where conditions are more oxygenated, are suitable for more sensitive macroinvertebrates such as stoneflies and mayflies. Overall, the stream under study did not have a high proportion of riffle habitats. Instream flow regimes at site 1, contained some riffle habitats (30%) and glides (10%), with slower moving water and silt deposition towards the margins of the channel. Dissolved oxygen levels were highest at this site and were of suitable levels for fish and macroinvertebrate life. Conductivity and pH, which were similar to those recorded at sites 2 and 3, fell within normal range of values for these parameters. It must be noted that these measurements are only indicative of conditions at time of sampling

Luxuriant growth of *Apium nodiflorum*, upstream of the sampling point, may suggest some enrichment of the stream. Extensive macrophytic growth can choke up stream beds affecting flow regimes and encouraging silt deposition, as well as reducing the diversity of stream bed habitats. *Apium nodiflorum* is a common species in fertile, shallow water sites where the growth of taller vegetation is restricted by disturbance such as grazing, erosion or ditch clearance (Preston & Croft, 1997).

The stream is characterised by moderate water quality. Some enrichment may be occurring, as tolerant fauna were dominant and habitats were not optimum for macroinvertebrate colonisation. However further sampling would be recommended in late spring or summer months when conditions are more suitable for Q-value assessment.

At site 2, stream cross section was reduced where flow was faster and the channel contained a higher percentage of riffles. Dissolved oxygen levels were slightly reduced at this site, while conductivity and pH were similar those at site 1 and within normal range of values for these parameters.

Immediately upstream of this point, extensive growth of *Apium nodiflorum* was evident and again may indicate enriched conditions. The channel was also generally silted, with heaviest deposits along the margins of the banks. Results of macrofaunal sampling, would suggest slightly improved water quality when compared to site 1 downstream. Habitats were more suited to macroinvertebrate colonisation with a range of eroding substrata, riffle habitats and faster flow. Despite this however, siltation and excessive macrophytic growth were evident. Further macroinvertebrate sampling in late spring or summer months would be recommended to provide a more accurate picture of water quality and macroinvertebrate communities at the site.

Site 3 was located downstream of the quarry. Flow was very slow and the channel was infilled with deep mud and silt. Conventional kick samples could not be taken and sweeps of the instream habitats were made using the net. The channel was approximately 3 m wide and ranged from 20 - 50 cm in depth. The water was clear, and partial shading was afforded by trees and shrubs. This area may have recently been a cattle/sheep watering point as a pen was present and previous trampling evident. Dissolved oxygen was lower at this site (6.3 mg/l and 52% saturation), approaching levels which could inhibit freshwater fish and macroinvertebrate life.

Instream colouration of the water was noted and appeared to stem from a discharge or seepage on the left bank. An orange fungus/bacterial growth was present at points within the channel, which may suggest an iron-rich influx into the stream. Further chemical testing would be required to determine the nature and cause of this growth.

Results of macrofaunal sampling again indicate slightly improved conditions from site 1, with a higher proportion of sensitive organisms recorded. However the habitats and silted substratum conditions at this point are not optimal for macroinvertebrate colonisation. High levels of siltation and lack of suitable substratum and flow were apparent. Higher numbers of Group D organisms *Asellus aquaticus* were recorded here than at sites 1 and 2.

The macrofauna recorded in this survey are all relatively common in Ireland. Stoneflies from the family Nemouridae were the most sensitive organisms recorded, but these can occur in a wide range of habitats (Costello, 1988). The next most sensitive fauna were cased caddis fly larvae *Limnephilus* sp., *Halesus* sp., all of which are widespread and common in Ireland. The only mayfly found was *Baetis rhodani* which is one of the more tolerant species of mayfly and common and abundant in Ireland occurring in all relatively clean rivers (Kelly-Quinn & Bracken, 2000). Other tolerant organisms recorded included the waterlouse *Asellus aquaticus* and the freshwater shrimp *Gammarus* sp., dipteran larvae and beetle larvae, all of which are common and widely distributed in Ireland (Woods, 1974). .

CONCLUSIONS

In general the macroinvertebrate fauna at all three sites were dominated by more pollution tolerant organisms (Groups C and D). Siltation was noted at all sites, as was luxuriant growth of macrophytes. Species assemblages were similar between sites, but sensitive species from Groups A and B were more abundant at sites 2 and 3, while very tolerant Group D fauna were abundant at site 3. Levels of dissolved oxygen at site 3 may also be indicative of impaired water quality.

Faunal sampling of the stream and observations on it's flora and physical characteristics, suggest that the length of channel surveyed is undergoing, or has undergone, some organic enrichment resulting in a degradation in water quality. This enrichment is reflected in the faunal community. Other factors, such as siltation and extensive macrophytic growth reduce the value of the macroinvertebrate habitats instream. Physio-chemical analysis may help to identify the nature and possible sources of pollution along the channel.

It is also recommended that further macroinvertebrate monitoring be carried out in the late spring or summer months, since it is advised that Q-indices are calculated on samples taken during periods of low flow and higher temperatures (generally late spring and early summer months), when environmental stressors are at their peak.

REFERENCES

Costello, M J. (1988). A review of the distribution of stoneflies (Insecta, Plecoptera) in Ireland. *Proceedings of the Royal Irish Academy*, 88B (No1).

Edington, J. M. & A. G. Hildrew (1981). Caseless caddis larvae of the British Isles. *Freshwater Biological Association, Scientific Publication No. 43.*

Elliott, J. M., U. H. Humpesch, & T.T. Macan (1988). Larvae of the British Ephemeroptera - a key with ecological notes. *Freshwater Biological Association, Scientific Publication No. 49.*

Fitter, R. & R. Manuel (1986). *Collins field guide to freshwater life.* London, Collins.

Friday L.E. (1986). *A Key to the adults of British Water Beetles.* Field Studies Council. Henry Ling Ltd., Dorset press.

Hynes, H. B. N. (1977). A key to the adults and nymphs of British stoneflies (Plecoptera). *Freshwater Biological Association, Scientific Publication No. 17.*

Kelly-Quinn, M., Bracken, J. (2000) The Distribution of the Ephemeroptera in Ireland, *Occassional publication of the Irish Biogeographical Society, No 5.*

Macan, T. T. (1977). A key to the British fresh and brackish water gastropods with notes on their ecology. *Freshwater Biological Association, Scientific Publication No. 13.*

McGarrigle, M. L., Bowman, J. J., Clabby, K. J., Lucey, J., Cunningham, P., MacCarthaigh, M., Keegan, M., Cantrell, B., Lehane, M., Clenaghan, C., Toner, P. F. (2002). *Water Quality in Ireland 1998 - 2000*, EPA Publications, Ireland.

Nilsson, A. [*ed.*]. (1996). *Aquatic Insects of North Europe: A Taxonomic Handbook. Vol. 1*, Apollo Books, Denmark.

Nilsson, A. [*ed.*]. (1997). *Aquatic Insects of North Europe: A Taxonomic Handbook. Vol. 2*, Apollo Books, Denmark.

Preston, C. D., Croft, J. M. (1997). Aquatic Plants in Britain and Ireland, Harley Books, U.K.

Wallace, I. D., Wallace, B. and Philipson, G. N. (1990). A Key to the Case-Bearing Caddis Larvae of Britain and Ireland, *Freshwater Biological Association Scientific Publication No. 51.*

Woods, C. S. (1974). Freshwater Life in Ireland, Irish University press, Dublin.

APPENDIX A. MAP

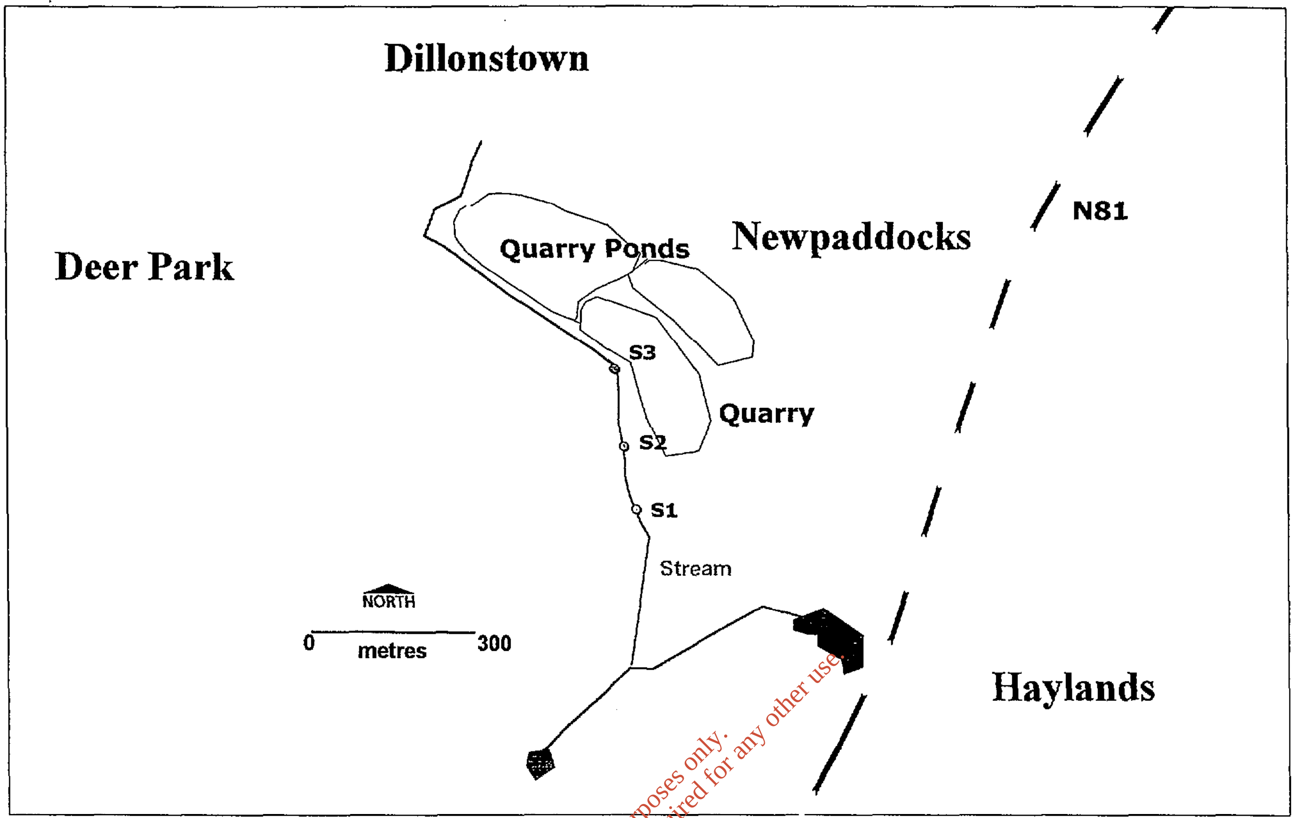


Figure 1. Map showing locations of the macroinvertebrate sampling sites S1-S3 (in red), stream in blue.

APPENDIX B. TABLES

Table 1. Macroinvertebrate species list. 1 or 2 individuals = Present, <1% = Scarce/Few, <5% = Small numbers, 5-10% = Fair numbers, 10-20% = Common, 25-50% = Numerous, 50-75% = Dominant, >75% = Excessive. The EPA faunal indicator groups of sensitivity to pollution are A (sensitive), B (less sensitive), C (tolerant), D (very tolerant) and E (most tolerant).

Site Name:	**1**	**2**	**3**	**EPA**
ANNELIDA				
Hirudinea (leeches)				
Glossiphonidae indet.	-	-	1	**D**
Oligochaeta (worms)	-	-	-	
Lumbricidae	1	1	-	--
Oligochaeta indet.	-	-	1	--
CRUSTACEA				
Amphipoda: *Gammarus duebeni*	121	296	56	**C**
Isopoda: *Asellus aquaticus*	-	5	108	**D**
MOLLUSCA				
Bivalvia: Sphaeridae indet.	28	-	-	**D**
ARTHROPODA – INSECTA				
Collembola (springtails)				
Isotomidae indet.	-	-	1	--
Ephemeroptera (mayflies)				
Baetidae: *Baetis rhodani*	3	21	16	**C**
Plecoptera (stoneflies)				
Nemouridae: *Nemurella picteti*	4	80	49	**A**
Trichoptera (caddis flies)				**B**
Limnephilidae: *Halesus radiatus*	-	1	-	**B**
Halesus digitatus	-	4	-	
Halesus sp.	-	10	-	**B**
Potamophylax sp.	6	-	-	**B**
Glyphotaelius pellucidus	-	20	2	**B**
Limnephilus nigriceps	-	42	56	**B**
Limnephilidae indet.	1	11	30	**B**
Polycentropodidae: *Plectronemia conspersa*	-	9	19	**C**
Diptera				
Chironomidae	1	483	125	**C**
Simulidae	1	12		**C**
Tipulidae	2	-	-	**C**
Ptychoptera sp.	1	-	7	--
Dinocras sp.	2	-	1	--
Coleoptera (beetles)				**C**
Dysticidae: *Dytiscus* sp. (larvae)	-	-	4	**C**
Colyembetinae indet.	-	2	-	**C**
Scirtidae: *Elodes* sp. (larvae)	15	15	30	**C**
Elmidae: *Elmis aenea*	-	1	-	**C**
Curculionidae indet.	-	1	-	**C**
No. of species/taxa	13	18	16	
No. of organisms	199	1032	621	
Q-index	**3**	**3-4**	**3**	

Table 2. Summary of locations and descriptions of sites where macroinvertebrate kick samples were taken.

Site	Location and Description	Coordinates
1	Downstream of the quarry and just above the point where the stream has been culverted. The stream lies in an open area, with the quarry to the east and grassland to the west. The stream was unshaded and dense growth of *Apium nodiflorum* was present in the channel. Macroinvertebrate samples were taken in the riffle areas.	53° 10 66 006° 32.01
2	Along the quarry boundary downstream of an old bridge over the stream. Some riffle habitats were present. Macrophytic growth was dense immediately upstream of the sample point. Banks were steeper and vegetated with bramble, moss, dock and ferns.	53° 10 72 006° 32.02
3	Upstream of the area being quarried near the site tailings lagoons. No riffle habitats were present and macroinvertebrate samples were taken by sweeping the surface of instream habitats with a pond net. Siltation was heavy and a seepage was entering the channel from the left bank. The channel was wider and heavily shaded at this point by trees such as Hawthorne, brambles, mosses and ferns.	53° 10 80 006° 32 05

Table 3. Summary of the physical data recorded from each site.

Site	Dissolved Oxygen %	Dissolved Oxygen mg/l	Conductivity	Temp °C	Width m	Depth cm	Siltation	Flow	Water clarity	Habitats sampled	Shading
1	77	9.6	582	6.2	1.5	20	Slight	Moderate	Clear	Riffles	Open
2	67	8.2	576	6.4	1.5	10-20	Moderate – heavy	Fast	Clear	Riffles	Open
3	51	6.3	592	7.4	3	20-40	Heavy	Slow	Clear, some coloured areas (orange discharge)	Glides/ margins	Partly shaded

Table 4. EPA biotic indices and water quality classes (McGarrigle *et al.* 2002).

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