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9 SOILS AND GEOLOGY

9.1 INTRODUCTION

The geology and soils at the proposed facility are described below. The information regarding the existing environment is based on investigations completed at the site in 2000 and 2001, a desk study and the Geological Survey of Ireland database.

The initial investigations were conducted to establish baseline conditions of soil beneath the site.

9.2 EXISTING GEOLOGY AND SOILS

The existing geology and soils is described under the two distinct units of solid bedrock geology and unconsolidated overburden deposits. The units are discussed below on both a regional and local basis.

9.2.1 Regional Geology

The site is located in a relatively narrow expanse of Carboniferous limestones that outcrops between the Lower Palaeozoic sandstones and shales of the Longford Down Massif to the north and the block of similarly aged meta-sedimentary rocks that extend between Julianstown and Balbriggan to the south (Figure 9.1). The Platin limestones extend westwards to connect with the Carboniferous rocks that underlie much of Meath. To the east and beyond Drogheda, this narrow band of limestones extends as far as the Irish Sea between the Boyne and Nanny estuaries.

9.2.2 Local Geology

The Platin outlier is fault bounded and the limestones at the nearby quarry have a general East North East strike with a shallow (10-20 degree) dip to the northwest. The deposit limestone consists of at least 300 metres deep of grainstones. The types of grainstones that have been recorded at Platin include crinoidal pepper-type, intra-clastic and skeletal. In general, the limestones are massive with few bedding structures clearly developed. The Platin limestones display karst features in and around the nearby Platin quarry.

The geological structure of the proposed site has been determined from boreholes and trial pits undertaken during the May and December 2000 and July 2001 investigations, the location of which are shown on Figure 9.2. Detailed borehole and trial pit logs are presented in Appendix 9.1 and 9.2 respectively. A complete geotechnical report completed by Alpha Engineering Services in March 2000 is presented in Appendix 9.3.

Two cross sections across the site (namely A – A' and B – B') are shown in Figure 9.3.

9.2.3 Soils

The Carranstown site is underlain by soils from the Dunboyne-Ashbourne soil complex. The parent material of the soil is drift deposits intermixed with local limestone and shale. This type of soil is generally poorly drained.

9.2.4 Overburden Geology

The overburden geology consists predominantly of brown silty clays generically known as boulder clays. These consist of medium dense brown silty clays with pebbles, cobbles and occasional boulders. The boulder clay varies in thickness across the site, ranging from 5.0 metres towards the west of the site, to greater than 20 metres towards the centre. Sand and gravel lenses are found throughout the boulder clays.

A total of seven trial pits (TP-1 to TP-7) were excavated across the site during the May 2000 investigation (see Figure 9.2 for locations). These excavations were undertaken to allow representative soil sample collection. Based on visual observations made on site, one composite soil sample was collected from each trial pit location. Samples were sealed in a laboratory-supplied sample container and maintained at a temperature of $<4^0$C in a mobile field laboratory.

Seven soil samples (TP-1 to TP-7) were submitted to Geochem Group Laboratories Ltd. and analysed for the following parameters:

- Metals and Total Phenols
- Volatile Organic Compounds (VOCs)
- Polycyclic Aromatic Hydrocarbons (PAHs)
- Polychlorinated Biphenyls (PCBs)
- Pesticides (OPPs, OCPs, ONPs)

Trial pit sampling logs are included in Appendix 9.2.

9.2.5 Analytical Results

The analytical results presented in Tables 9.1 to 9.5. Where relevant, the soil analytical results are discussed below with reference to the Dutch MAC (Maximum Admissible Concentration) thresholds, as standards for soil are not available in Ireland at present.

Under the Dutch criteria for soil, the degree of contamination is assessed using the following guidelines:

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

Heavy Metals

The analytical results for heavy metals are presented in Table 9.1. Detected concentrations for Cadmium, Copper, Mercury and Nickel slightly exceeded their respective Dutch S-Values for normal uncontaminated soil at a number of trial pit locations. In particular, the Copper and Nickel results exceeded the S-Values at a number of the soil sampling locations.

Results for Total Phenols did not exceed the laboratory detection limits of 0.01 mg/kg, indicating the absence of Phenols in the soil environment.

Volatile Organic Compounds (VOCs)

The VOC analytical results for soils are presented in Table 9.2. ALcontrol Laboratories (formerly Geochem Group Laboratories Ltd.) analysed for 40 individual VOCs, in accordance with the US EPA Method 624 list

None of the samples analysed exceeded either the laboratory detection limit of 1 µg/kg or the relevant Dutch S- value.

Polynuclear Aromatic Hydrocarbons (PAHs)

The analytical results for the PAHs are presented in Table 9.3 and consist of the 16 Priority PAHs (EPA List). The sum of the PAHs analysed for did not exceed the Dutch S-value for Total PAHs of 1 mg/kg for normal background soil concentrations.

Polychlorinated Biphenyls (PCBs)

The analytical results for PCBs are presented in Table 9.4. No PCBs were detected in any soil sample above the laboratory detection limit of 1 µg/kg (laboratory detection limit).

Pesticides

The analytical results for Pesticides are presented in Table 9.5 of this report. The Geochem suite consists of three separate types of pesticides including Organochloride, Organonitrate and Organophosphate Pesticides, covering a wide range of these parameters. No pesticides were detected in any soil sample above the laboratory detection limit of 1 µg/kg (laboratory detection limit).

9.2.5.1 Summary of Findings

Soil samples taken during the trial pit investigation indicated concentrations above the Dutch S-Value for some of the heavy metals, including the following:

Parameter	Trial Pit
Cadmium	TP-1
Copper	TP-1, TP-2 and TP-7
Mercury	TP-1 and TP-6
Nickel	TP-2, TP-3, TP-4, TP-5, TP-6 and TP-7

All other soil samples taken across the site reflected normal background conditions for the different indicator parameters including the Volatile Organics, PAHs, PCBs and Pesticides.

9.2.5.2 Conclusions

The results of the soil sampling suggest that there is no significant soil contamination at the Carranstown greenfield site in Duleek. However some traces of heavy metals were identified in the soil across the site. It should be noted that the levels of contamination are slight. These trace levels would commonly reflect agricultural activity within the area.

9.3 PERCOLATION TESTING

A test was conducted in December 2000 to assess the suitability of the site for the installation of a Puraflo™ system (see Appendix 9.4 for full report). The test results indicated that a suitable percolation area could be constructed to comply with national guidelines.

On-site investigations were carried out as follows:

- Two trial pits (Test Trial pits 1 and 2) were dug at the site of the proposed percolation area (Figure 9.2). The trial pits were excavated to a depth of 2.8 m and 3 m respectively. Both encountered similar overburden deposits-1.2-1.8m of boulder clay and then a clayey gravel which became more gravelly with depth. No seepages were encountered during the digging and after 48 hours, no water had entered the holes.

- Four percolation pits (PP 1-4) were dug at the site of the proposed percolation area (Figure 9.2). The site failed the percolation test as the T value obtained was greater than 50 (EPA Wastewater Manual). This is due to the presence of clays immediately beneath the site which had become highly saturated during bad weather.

- However, and in accordance with EPA Guidelines, the site can be engineered to meet the required specifications for percolation areas. This will involve the removal of the existing overburden material over an area of 300 m^2 and the importing of material with a suitable T value-preferably a

fine sand or clayey sand with a T value of between 5 and 15. A reserve percolation area should also be constructed in the event of the main area malfunctioning.

- Alternatively, a sand filter could be constructed with an associated polishing filter. The advantage of this type of sand filter is that it takes up considerably less area than the trenched percolation area. The disadvantages are that a polishing filter is necessary and pumping of wastewater might be required to transfer effluent from the sand filter to the polishing filter.

9.4 POTENTIAL IMPACTS

The following details the potential impacts on soils and geology for both the construction and operational phases of the project.

9.4.1 Construction Phase

Excavation works below the existing ground level will be required during the construction of the facility. All excavated material will be reused onsite.

Potential impacts during the construction phase would be associated with accidental spillage of potentially polluting substances including oils, paints and liquid wastes and any additional substances associated with the construction activities.

The development site is underlain by karst limestone which by its nature can pose difficulties for building foundations due to the unpredictable occurrence, extent and depth of underground cavities. The facility is located in a wide expanse of limestone strata. The development of this facility will not materially impact on the available reserves of limestone in the east Meath area.

9.4.2 Operational Phase

The potential impacts during the operation phase would be limited to accidental spillage of potentially polluting substances including oils, paints, liquid wastes, or raw materials such as lime, caustic soda or ammonia/urea. However it should be noted that with good management practices in place it is expected that the development will not cause any impact on the soils and geology of the site.

The location of the proposed facility in close proximity to the Irish Cement quarry may give rise to concerns relating to impacts from vibration.

9.5 MITIGATION MEASURES

9.5.1 Construction Phase

All oils, chemicals, paints, fuels or other potentially polluting substances used during construction will be stored in designated storage areas which will be bunded to a volume of 110% capacity of the largest tank/container within the bunded area(s).

Filling and draw-off points will be fully located within the bunded area(s).

Drainage for the bunded area(s) will be diverted for collection and safe disposal.

All domestic effluent generated on site will be discharged to temporary sewage containment facilities prior to transport and treatment off site.

A detailed site investigation programme will be carried out in advance of the building works. The planned site investigation programme will define the geo-technical conditions on the development site. The construction of the facility will incorporate the findings of the geo-technical study to ensure that the plant is built to the highest structural standards. The construction and operation of the nearby cement works confirms that it is possible to construct major plants safely in this geological environment.

The founding of the structure on different bearing strata (due to different foundation levels) will be accommodated by the inclusion in the substructure and superstructure of structural joints. These joints will allow sections of the building to act independently of each other with respect to settlements etc.

The implementation of good construction management practices will minimise the risk of pollution to geology and soils.

9.5.2 Operational Phase

All substances that would have the potential to cause a negative impact on the soils and geology will be stored in appropriate containers and/or placed within bunded areas. Raw materials for the process will be stored in containers/silos within the process building. Residues will be stored in a bunker and silos within the process building.

All waste entering the facility will be stored in fully contained structures therefore there will be no potential for leakage to soils. All waste storage facilities will be rendered impervious to the materials stored therein. All concrete underground storage structures whether for waste or liquid (as there is a possibility that firewater run-off may enter any of the tanks) will be constructed as watertight structures in accordance with the requirements of relevant Codes of practice such as BS 8007 British Standard for design and Construction of Aqueous Liquid Retaining Structures. Typically these structures will be

reinforced concrete with minimum wall and base thicknesses of 250 mm or greater depending on the structural requirements. Details for the construction of these tanks will follow good building practice, the guidelines in the Code of Practice and details used successfully in other similar structures. The structures will be integrity tested in accordance with the guidelines given in the Code of Practice for leakage to confirm that they are watertight. This will be demonstrated to the satisfaction of the local authority following installation and prior to use for storage. Similarly in the instance of the storm water attenuation tank (which can also contain fire-water run-off) it is proposed that this will be constructed from a sealed Hydrocell type storage unit. The sealing membrane will be welded HDPE membrane which is commonly used for forming secondary containment liners in effluent tanks. The attenuation tank will be tested and demonstrated to be watertight to the satisfaction of the local Authority.

All underground piping will be maintained and regularly inspected for integrity.

All domestic effluent will be treated by an appropriate system prior to discharge to the percolation area. All chemicals or other potentially polluting substances will be stored within the main process building and will be provided with adequate containment.

A petrol interceptor will be placed on the surface water drainage outfall line from hardstanding areas to contain any leakages from vehicles on site. Full details of the proposed on site drainage network are presented in Section 11.

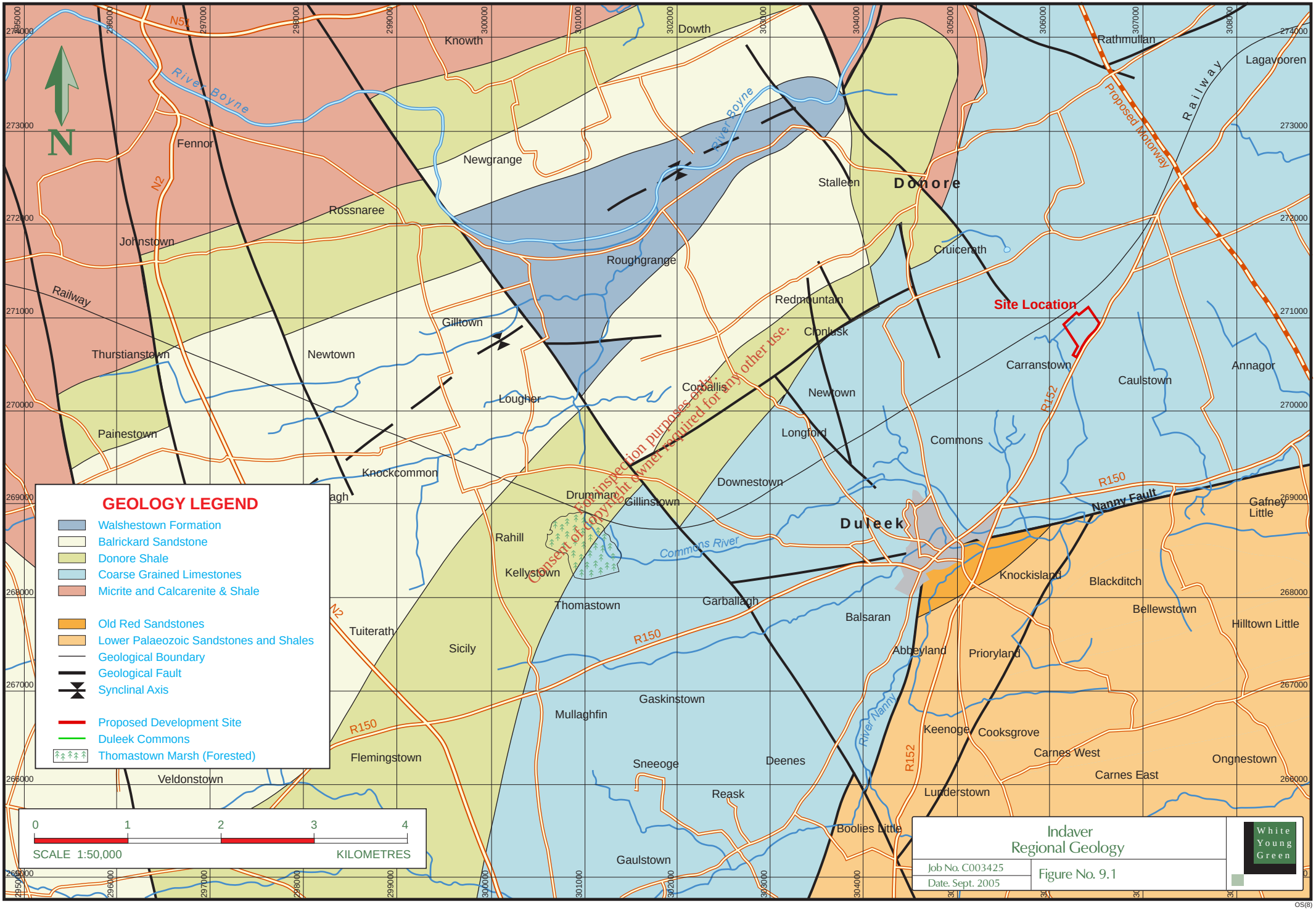
The Irish Cement quarry is operated under an Integrated Pollution Control (IPC) Licence issued by the EPA. The licence specifies limits on noise, vibration and overpressure resulting from explosive activity in the quarry. The limit of vibration i.e. 12mm/sec is sufficiently low to prevent interference with monitoring equipment and items of plant associated with the proposed facility.

9.6 RESIDUAL IMPACTS

There are no sites of geological interest within the proposed development property. The impact to the soils and geology of the site will be limited to the excavation works. The excavations will vary in depth across the development site with the greatest level of impact being within waste bunker and ash bunker areas where the overburden will be excavated to a level of 24.0 mOD. At the location of the waste bunker the rock level is approximately 15m OD which is well below the construction level. However there may be local outcrops which protrude in to the construction area. Elsewhere the overburden will be excavated to shallow depths along the site roads and other infrastructure. As part of the detailed design a second stage site investigation will be carried out in order to map in greater detail the soils characteristics of the site and to minimise their potential impacts on the construction. These additional investigation works will include additional boreholes, trial pits, geophysics, rock proving (to confirm if any cavities exist) etc.

The bedrock is karst limestone which can pose difficulties for building foundations however, as is demonstrated by the nearby cement works, the ground conditions here can accommodate the type and scale of industrial building proposed for this development. Should cavities exist the effects of these will be considered in the detailed design of the facility. Typically swallow holes or cavities can be dealt with by bridging over the area or by grouting if appropriate.

The proposed facility will not have a significant impact on the soils and geology of the site or the surrounding lands.



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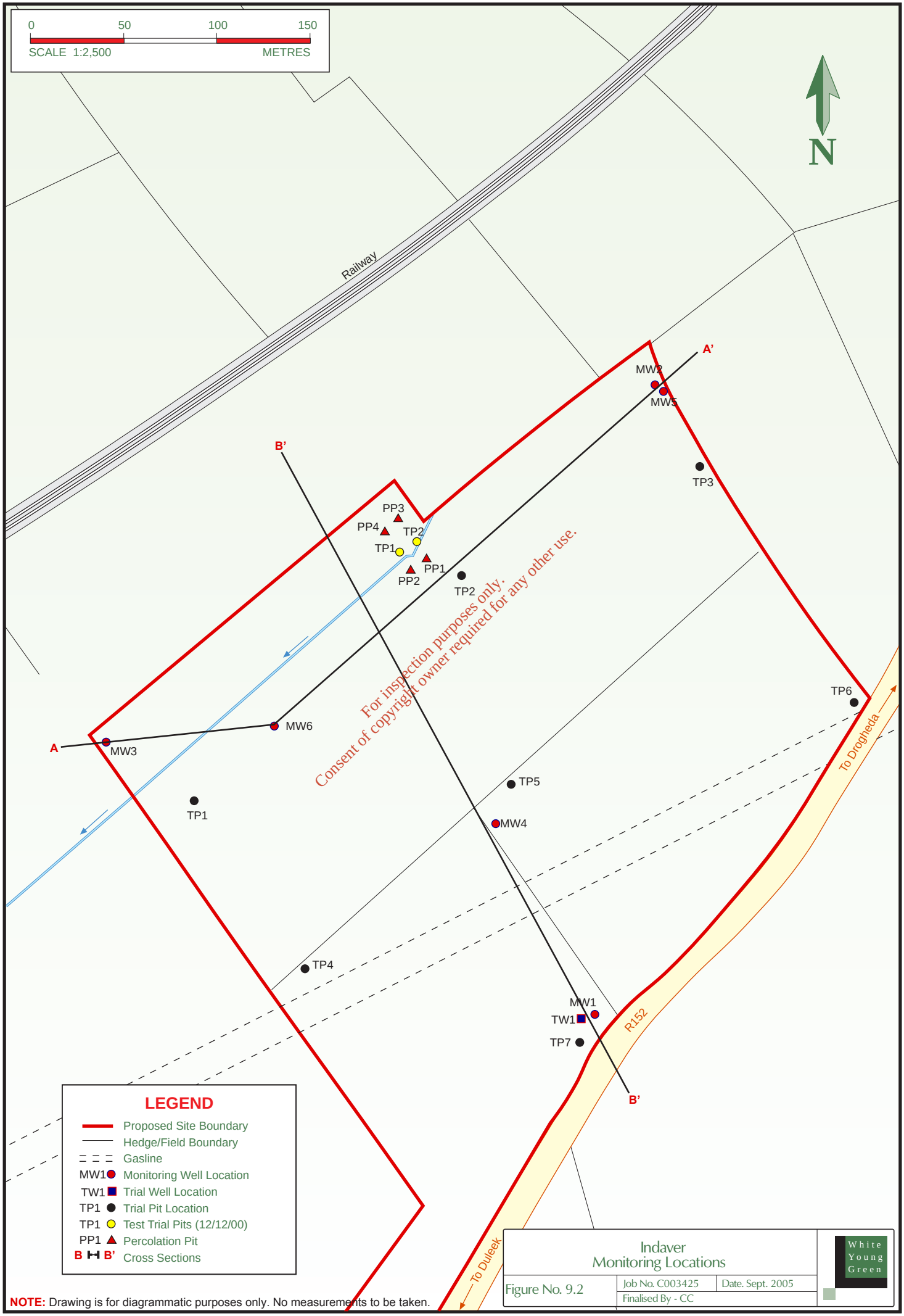
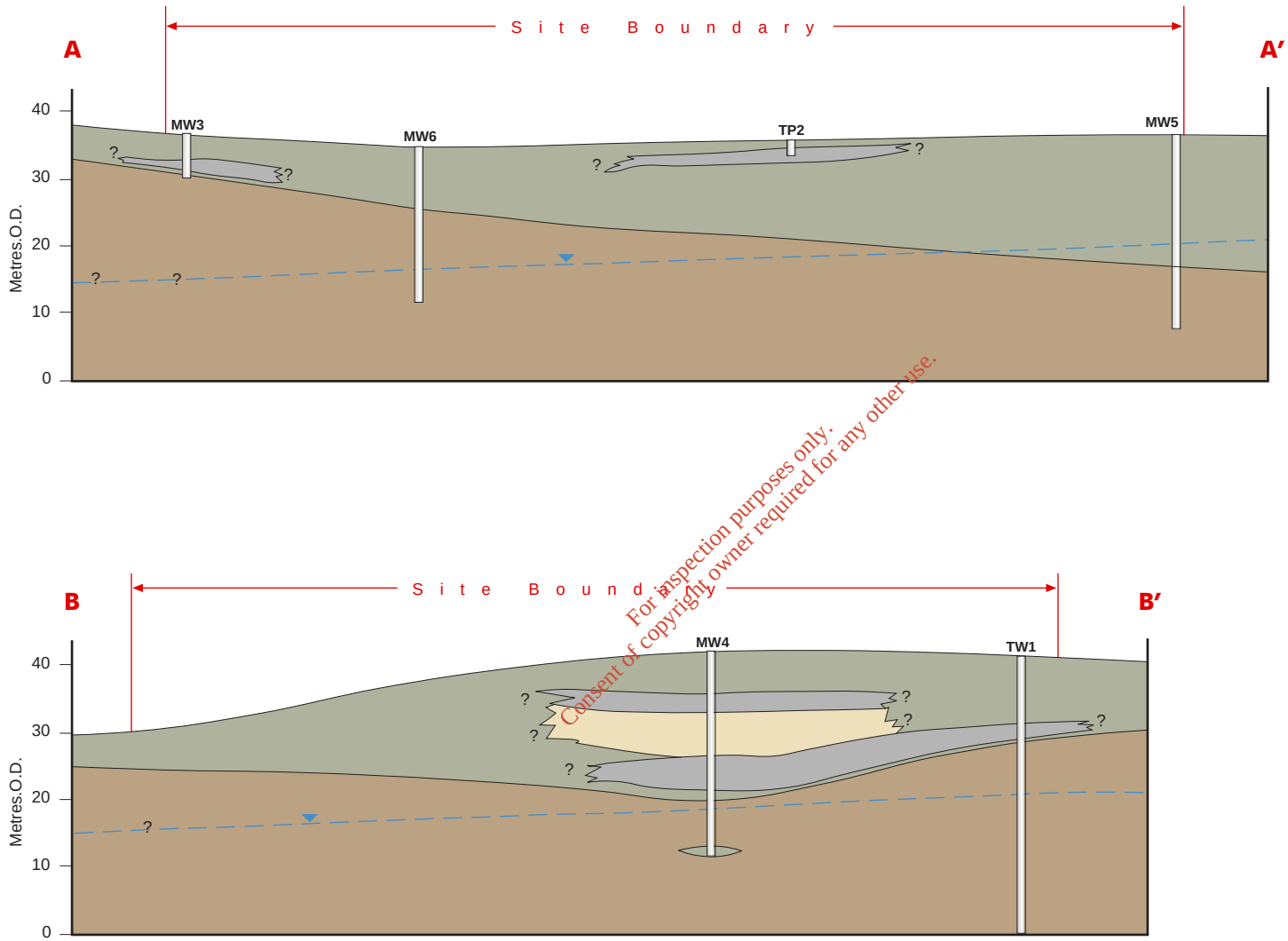




LEGEND

- Limestone Bedrock
- Clay
- Gravel
- Silt
- MW — Monitoring Well
- TW — Trial Well
- TP — Trial Pit
- Water Table

Note: Any Overburden water could reasonably be assumed to be locally perched.

0 50 100 150
Horizontal Scale 1:2,500 METRES

NOTE: Drawing is for diagrammatic purposes only. No measurements to be taken.

Indaver
Cross Section A - A′ & B - B′

Figure No. 9.3 | Job No. C003425 | Date. Sept. 2005 | Finalised By - CC

White Young Green

JF(10)

Table 9.1: Soil Analytical Results - Metals Phenols (28/4/00)

Sample Identity	Depth (m)	Arsenic mg/kg	Cadmium mg/kg	Chromium mg/kg	Copper mg/kg	Mercury mg/kg	Nickel mg/kg	Lead mg/kg	Selenium mg/kg	Zinc mg/kg	Total Phenols mg/kg
TP1	0 - 3.3	<1	2	16	37	2	33	10	<1	54	0.01
TP2	0 - 3.4	1	<1	44	48	<1	58	13	<1	72	<0.01
TP3	0 - 3.4	<1	<1	46	26	1	46	9	<1	54	<0.01
TP4	0 - 3.5	<1	<1	49	30	<1	54	12	<1	66	<0.01
TP5	0 - 3.4	19	<1	43	25	<1	43	11	<1	51	<0.01
TP6	0 - 3.1	<1	<1	36	29	3	47	11	<1	59	<0.01
TP7	0 - 3.3	23	<1	39	37	<1	55	13	<1	60	<0.01
TP-7 Duplicate	0 - 3.3	3	<1	42	38	<1	39	9	<1	46	n.a.
Dutch MAC S Values		29	0.8	100	36	0.3	35	85	-	140	-
Dutch MAC I Values		55	12	380	190	10	210	530	-	720	-

Legend

mg/kg: milligrams per kilogram

MAC: Dutch Standard Maximum Admissible Concentration

S Value: Dutch Guidline for normal uncontaminated soil

I Value: Dutch Guideline for Intervention

"-": MAC Guideline not available

n.a. = not analysed

"<" = below detection limit

Table 9.2: Soil Analytical Results - VOCs (28/4/00)

Trace Organics (VOCs)		TP1	TP2	TP3	TP4	TP5	TP6	TP7	Dutch MACs	
									S-Value	I-Value
Dichlorofluoromethane	µg/kg	<1	<1	<1	<1	<1	<1	<1	-	-
Chloromethane	µg/kg	<1	<1	<1	<1	<1	<1	<1	-	-
Vinylchloride	µg/kg	<1	<1	<1	<1	<1	<1	<1	-	100
Bromomethane	µg/kg	<1	<1	<1	<1	<1	<1	<1	-	-
Chloroethane	µg/kg	<1	<1	<1	<1	<1	<1	<1	-	-
Trichlorofluoromethane	µg/kg	<1	<1	<1	<1	<1	<1	<1	-	-
trans-1,2-Dichloroethene	µg/kg	<1	<1	<1	<1	<1	<1	<1	-	-
Dichloromethane	µg/kg	<1	<1	<1	<1	<1	<1	<1	-	20,000
1,1 Dichloroethene	µg/kg	<1	<1	<1	<1	<1	<1	<1	-	-
1,1 Dichloroethane	µg/kg	<1	<1	<1	<1	<1	<1	<1	-	-
cis-1,2-Dichloroethene	µg/kg	<1	<1	<1	<1	<1	<1	<1	-	-
Bromochloromethane	µg/kg	<1	<1	<1	<1	<1	<1	<1	-	-
Chloroform	µg/kg	<1	<1	<1	<1	<1	<1	<1	-	-
2,2-Dichloropropane	µg/kg	<1	<1	<1	<1	<1	<1	<1	-	-
1,2-Dichloroethane	µg/kg	<1	<1	<1	<1	<1	<1	<1	-	4,000
1,1,1-Trichloroethane	µg/kg	<1	<1	<1	<1	<1	<1	<1	-	-
1,1-Dichloropropene	µg/kg	<1	<1	<1	<1	<1	<1	<1	-	-
Benzene	µg/kg	<1	<1	<1	<1	<1	<1	<1	50	1,000
Carbontetrachloride	µg/kg	<1	<1	<1	<1	<1	<1	<1	-	-
Dibromomethane	µg/kg	<1	<1	<1	<1	<1	<1	<1	-	-
1,2-Dichloropropane	µg/kg	<1	<1	<1	<1	<1	<1	<1	-	-
Bromodichloromethane	µg/kg	<1	<1	<1	<1	<1	<1	<1	-	-
Trichloroethene	µg/kg	<1	<1	<1	<1	<1	<1	<1	1	60,000
cis-1,3-Dichloropropene	µg/kg	<1	<1	<1	<1	<1	<1	<1	-	-
trans-1,3-Dichloropropene	µg/kg	<1	<1	<1	<1	<1	<1	<1	-	-
1,1,2-Trichloroethane	µg/kg	<1	<1	<1	<1	<1	<1	<1	-	-
Toluene	µg/kg	<1	<1	<1	<1	<1	<1	<1	50	130,000
1,3-Dichloropropane	µg/kg	<1	<1	<1	<1	<1	<1	<1	-	-
Dibromochloromethane	µg/kg	<1	<1	<1	<1	<1	<1	<1	-	-
1,2-Dibromoethane	µg/kg	<1	<1	<1	<1	<1	<1	<1	-	-
Tetrachloroethene	µg/kg	<1	<1	<1	<1	<1	<1	<1	10	4,000
1,1,1,2 -Tetrachloroethane	µg/kg	<1	<1	<1	<1	<1	<1	<1		
Chlorobenzene	µg/kg	<1	<1	<1	<1	<1	<1	<1	-	-
Ethylbenzene	µg/kg	<1	<1	<1	<1	<1	<1	<1	50	50,000
p/m Xylenes	µg/kg	<1	<1	<1	<1	<1	<1	<1	50	25,000
Bromoform	µg/kg	<1	<1	<1	<1	<1	<1	<1	-	-
Styrene	µg/kg	<1	<1	<1	<1	<1	<1	<1	100	100,000
1,1,2,2-Tetrachloroethane	µg/kg	<1	<1	<1	<1	<1	<1	<1	-	-
o - Xylene	µg/kg	<1	<1	<1	<1	<1	<1	<1	-	-
1,2,3-Trichloropropane	µg/kg	<1	<1	<1	<1	<1	<1	<1	-	-
Isopropylbenzene	µg/kg	<1	<1	<1	<1	<1	<1	<1	-	-
Bromobenzene	µg/kg	<1	<1	<1	<1	<1	<1	<1	-	-
2-Chlorotoluene	µg/kg	<1	<1	<1	<1	<1	<1	<1	-	-
Propylbenzene	µg/kg	<1	<1	<1	<1	<1	<1	<1	-	-
4-Chlorotoluene	µg/kg	<1	<1	<1	<1	<1	<1	<1	-	-
1,2,4-Trimethylbenzene	µg/kg	<1	<1	<1	<1	<1	<1	<1	-	-
4-Isopropyltoluene	µg/kg	<1	<1	<1	<1	<1	<1	<1	-	-
1,3,5-Trimethylbenzene	µg/kg	<1	<1	<1	<1	<1	<1	<1	-	-
1,2-Dichlorobenzene	µg/kg	<1	<1	<1	<1	<1	<1	<1	10	-
1,4-Dichlorobenzene	µg/kg	<1	<1	<1	<1	<1	<1	<1	10	-
sec-Butylbenzene	µg/kg	<1	<1	<1	<1	<1	<1	<1	-	-
tert-Butylbenzene	µg/kg	<1	<1	<1	<1	<1	<1	<1	-	-
1,3-Dichlorobenzene	µg/kg	<1	<1	<1	<1	<1	<1	<1	10	-
n-Butylbenzene	µg/kg	<1	<1	<1	<1	<1	<1	<1	-	-
1,2-Dibromo-3-Chloropropane	µg/kg	<1	<1	<1	<1	<1	<1	<1	-	-
1,2,4-Trichlorobenzene	µg/kg	<1	<1	<1	<1	<1	<1	<1	10	-
Naphthalene	µg/kg	<1	<1	<1	<1	<1	<1	<1	-	-
1,2,3-trichlorobenzene	µg/kg	<1	<1	<1	<1	<1	<1	<1	-	-
Hexachlorobutadiene	µg/kg	<1	<1	<1	<1	<1	<1	<1	-	-

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

Table 9.3: Soil Analytical Results - Polynuclear Aromatic Hydrocarbons (28/4/00)

Parameters	Depth (m)	TP1 -	TP2 -	TP3 -	TP4 -	TP5 -	TP6 -	TP7 -	Dutch MAC Values	
	Units								S-Value	I-Value
Acenaphthene	µg/kg	<1	12	<1	<1	<1	<1	5	-	-
Acenaphthylene	µg/kg	<1	<1	<1	<1	<1	<1	<1	-	-
Benzo(B)fluoranthene	µg/kg	38	25	5	9	5	11	9	-	-
Dibenz(AH)anthracene	µg/kg	<1	<1	<1	<1	<1	<1	<1	-	-
Fluorene	µg/kg	5	25	3	12	4	3	3	-	-
Pyrene	µg/kg	12	25	6	7	9	16	4	-	-
PAHs included in 'PAH (Sum of 10)' Dutch S and I MAC values for PAHs in soil										
Anthracene	µg/kg	28	13	9	7	4	9	5	-	-
Benzo(a)anthracene	µg/kg	65	18	5	<1	6	4	10	-	-
Benzo(a)pyrene	µg/kg	21	21	2	<1	<1	<1	<1	-	-
Benzo(ghi)perylene	µg/kg	<1	<1	<1	<1	<1	<1	<1	-	-
Benzo(k)flouranthene	µg/kg	22	15	4	4	2	6	4	-	-
Chrysene	µg/kg	51	28	7	<1	2	10	7	-	-
Fluoranthene	µg/kg	17	28	8	9	12	14	5	-	-
Indeno(123-cd)pyrene	µg/kg	4	10	<1	<1	<1	<1	3	-	-
Naphthalene	µg/kg	67	148	59	94	10	54	34	-	-
Phenanthrene	µg/kg	120	63	13	21	16	18	12	-	-
PAH (Sum of 10)	µg/kg	395	344	105	135	82	115	80	1000	40000
PAH (Total)	µg/kg	449	432	118	162	100	148	100	-	-

Legend

µg/kg: micrograms per kilogram

MAC: Maximum admissable concentration

S-level: Dutch guideline for normal uncontaminated soil

I-Level: Dutch guideline for Intervention

Results awaiting confirmation

"-": MAC not available

< = below laboratory detection limit

Table 9.4: Soil Analytical Results - Polychlorinated Biphenyls (28/4/00)

Parameters		TP1	TP2	TP3	TP4	TP5	TP6	TP7	Dutch MAC Values	
	Depth								S	I
	Units									
PCB Aroclor 1016	µg/kg	<1	<1	<1	<1	<1	<1	<1	-	-
PCB Aroclor 1221	µg/kg	<1	<1	<1	<1	<1	<1	<1	-	-
PCB Aroclor 1232	µg/kg	<1	<1	<1	<1	<1	<1	<1	-	-
PCB Aroclor 1242	µg/kg	<1	<1	<1	<1	<1	<1	<1	-	-
PCB Aroclor 1248	µg/kg	<1	<1	<1	<1	<1	<1	<1	-	-
PCB Aroclor 1254	µg/kg	<1	<1	<1	<1	<1	<1	<1	-	-
PCB Aroclor 1260	µg/kg	<1	<1	<1	<1	<1	<1	<1	-	-
PCB total	µg/kg	<1	<1	<1	<1	<1	<1	<1	20	1000

Legend

µg/kg: micrograms per kilogram

MAC: Maximum admissable concentration

S-level: Dutch guideline for normal uncontaminated soil

I-Level: Dutch guideline for Intervention

-: MAC not available

< = below laboratory detection limit

Table 9.5: Soil Analytical Results - Pesticide Analysis (28/4/00)

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

Legend

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

Appendix 9.1

Borehole Logs

WELL LOG

Well No.	Description	Client
TW1	Trial Well	Project Management
	Location: Carranstown, Duleek	Driller: Tom Briody & Son

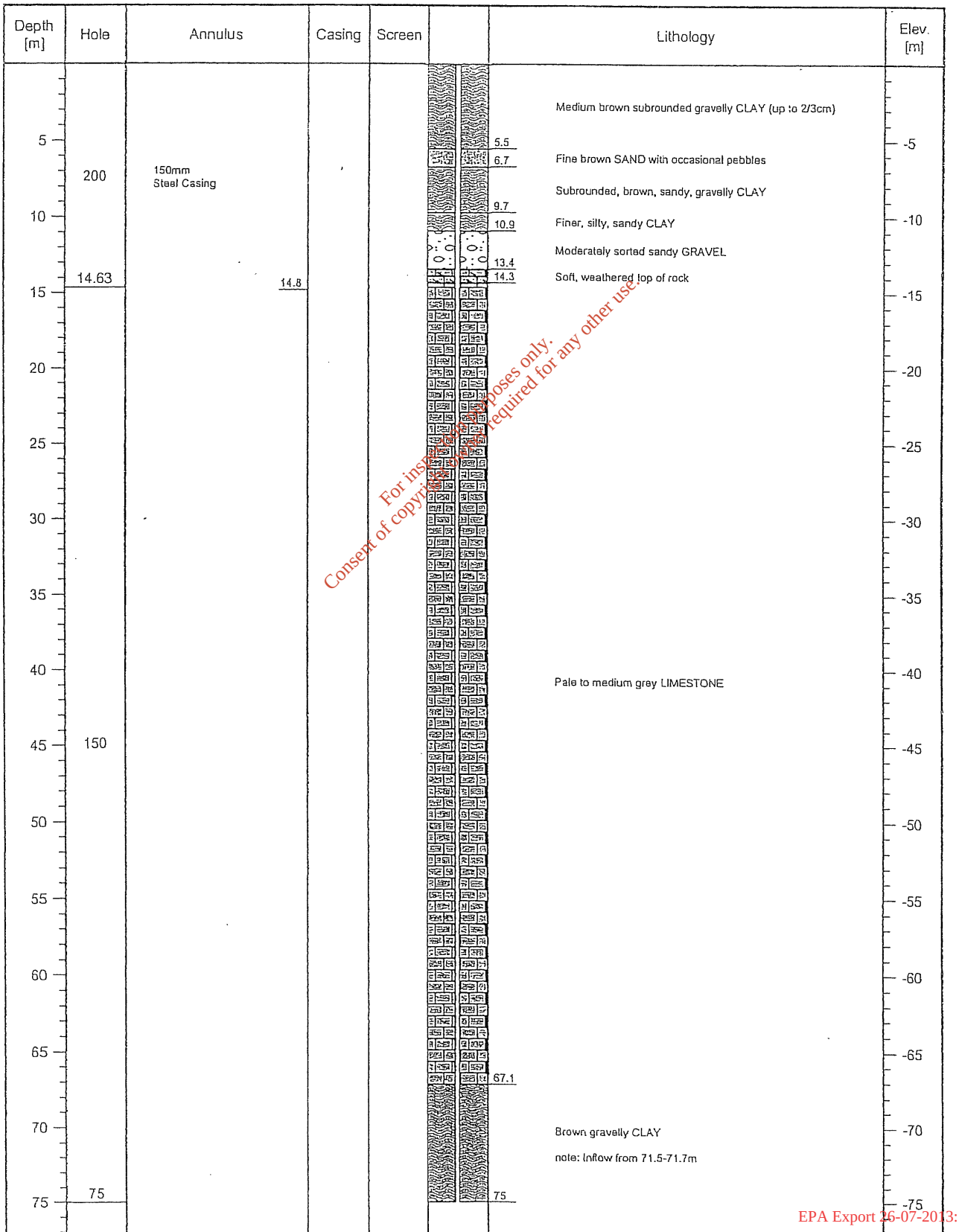
Date Drilled: 26/4/00

Water Level (mbtoc)

All diameters in mm
All depths in metres

Scale

Vertical	Horizontal
375.0	250.0



WELL LOG

Well No.	Description	Client
MW1	Overburden well	Project Management
	Location: Carranstown, Duleek	Driller: Tom Briody & Son

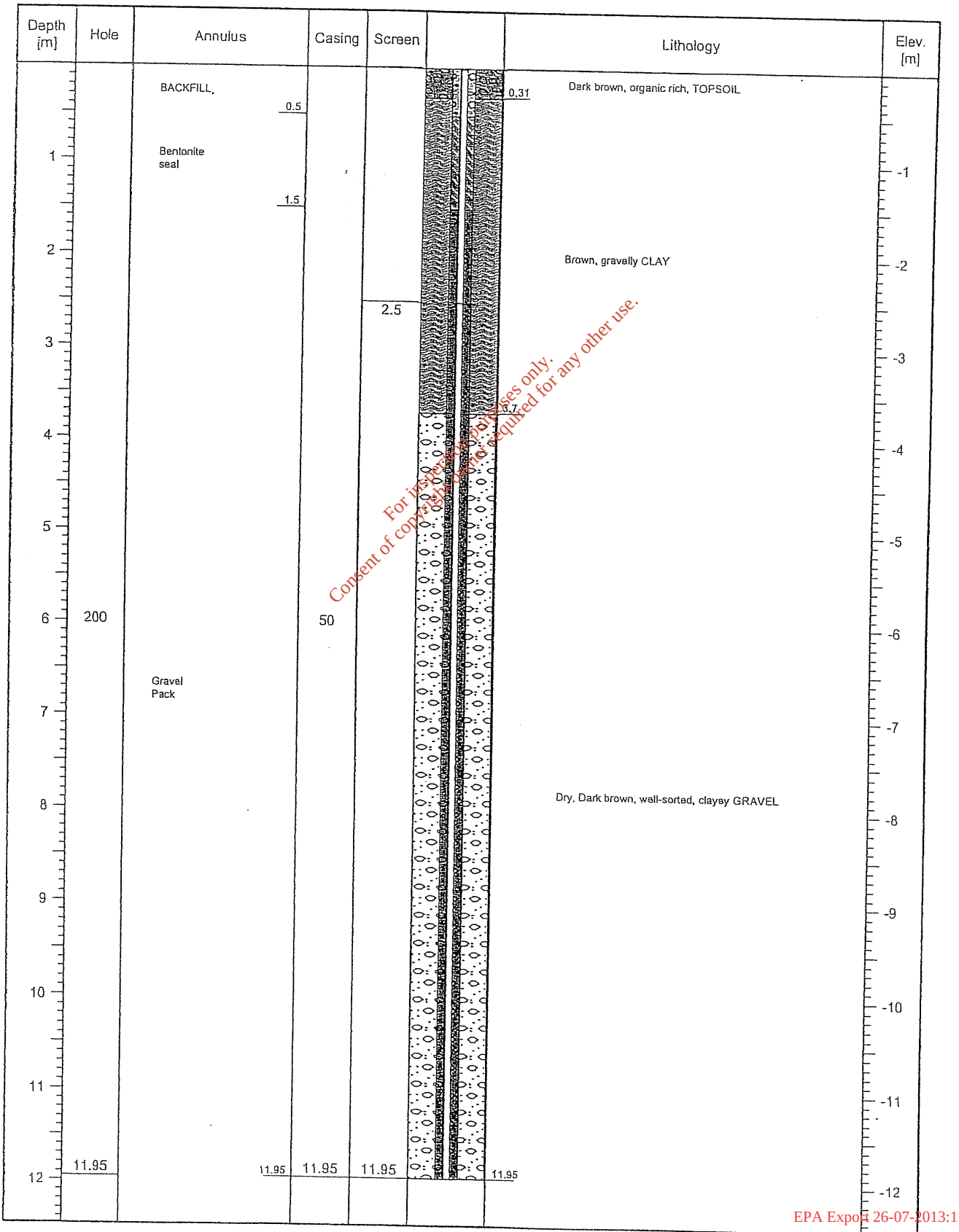
Date Drilled: 2/5/00

Water Level (mbtoc):

All diameters in mm
All depths in metres

Scale

Vertical	Horizontal
60.0	50.0



WELL LOG

Well No.	Description	Client
MW2	Overburden well	Project Management
	Location: Carranstown, Duleek	Driller: Tom Briody & Son

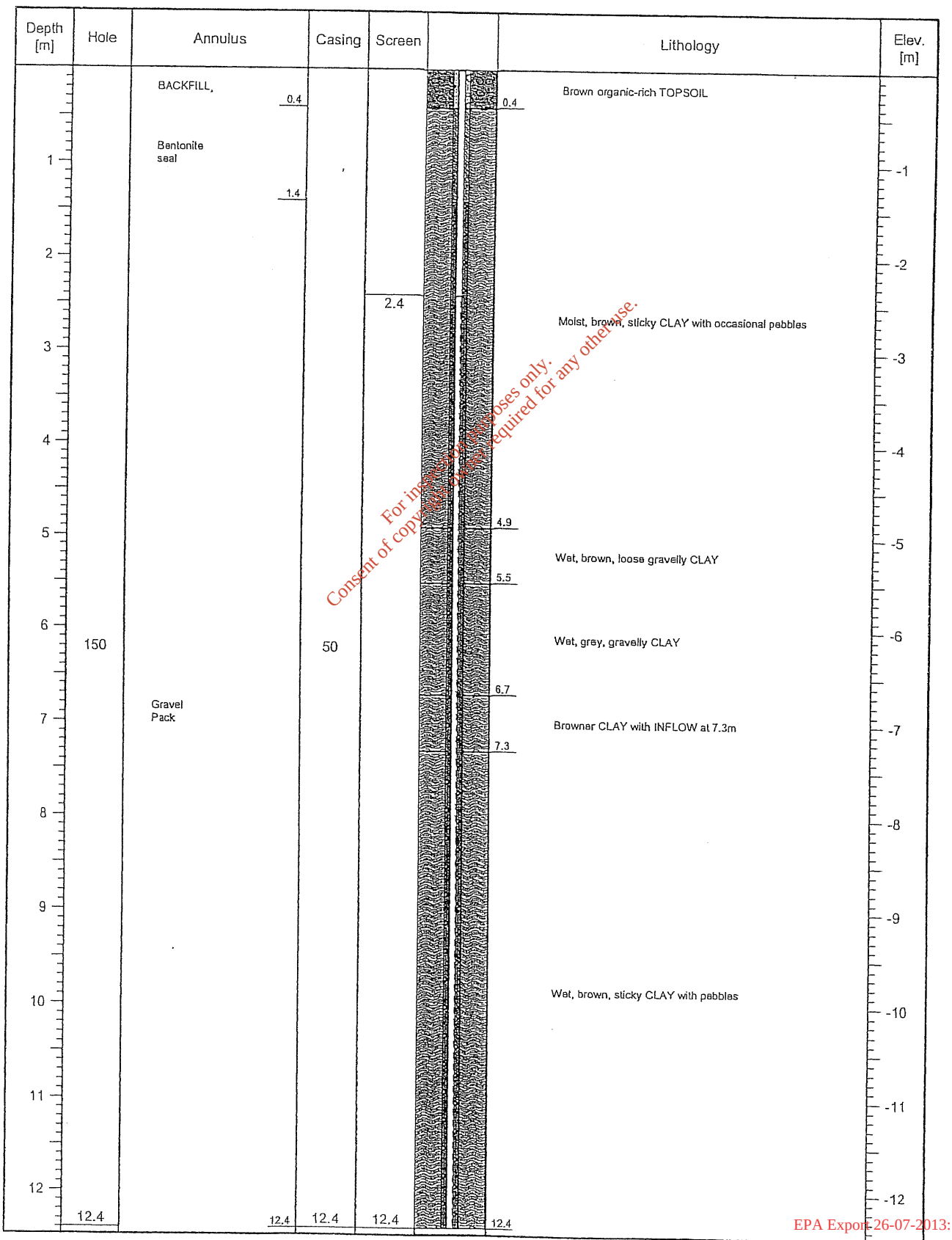
Date Drilled: 3/5/00

Water Level (mbtoc):

All diameters in mm
All depths in metres

Scale

Vertical	Horizontal
60.0	50.0



WELL LOG

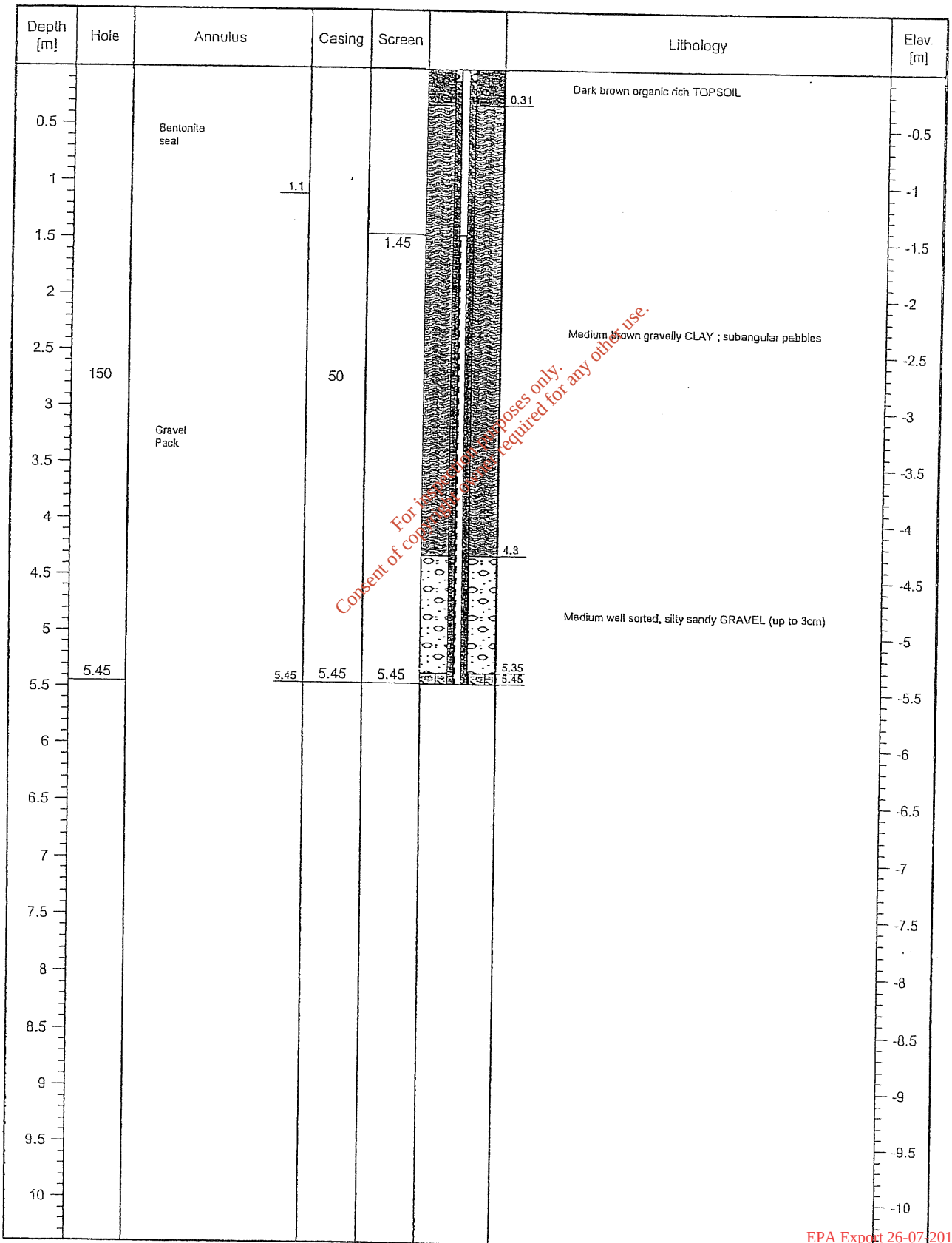
Well No.	Description	Client
MW3	Overburden well	Project Management
	Location: Carranstown, Duleek.	Driller: Tom Briody & Son

Date Drilled: 3/5/00

Water Level (mbtoc):

All diameters in mm
All depths in metres

Scale — Vertical: 50.0 — Horizontal: 40.0



WELL LOG

Well No.	Description	Client
MW4	Bedrock monitoring Well	Project Management
	Location: Carranstown, Duleek	Driller: Tom Briody & Son

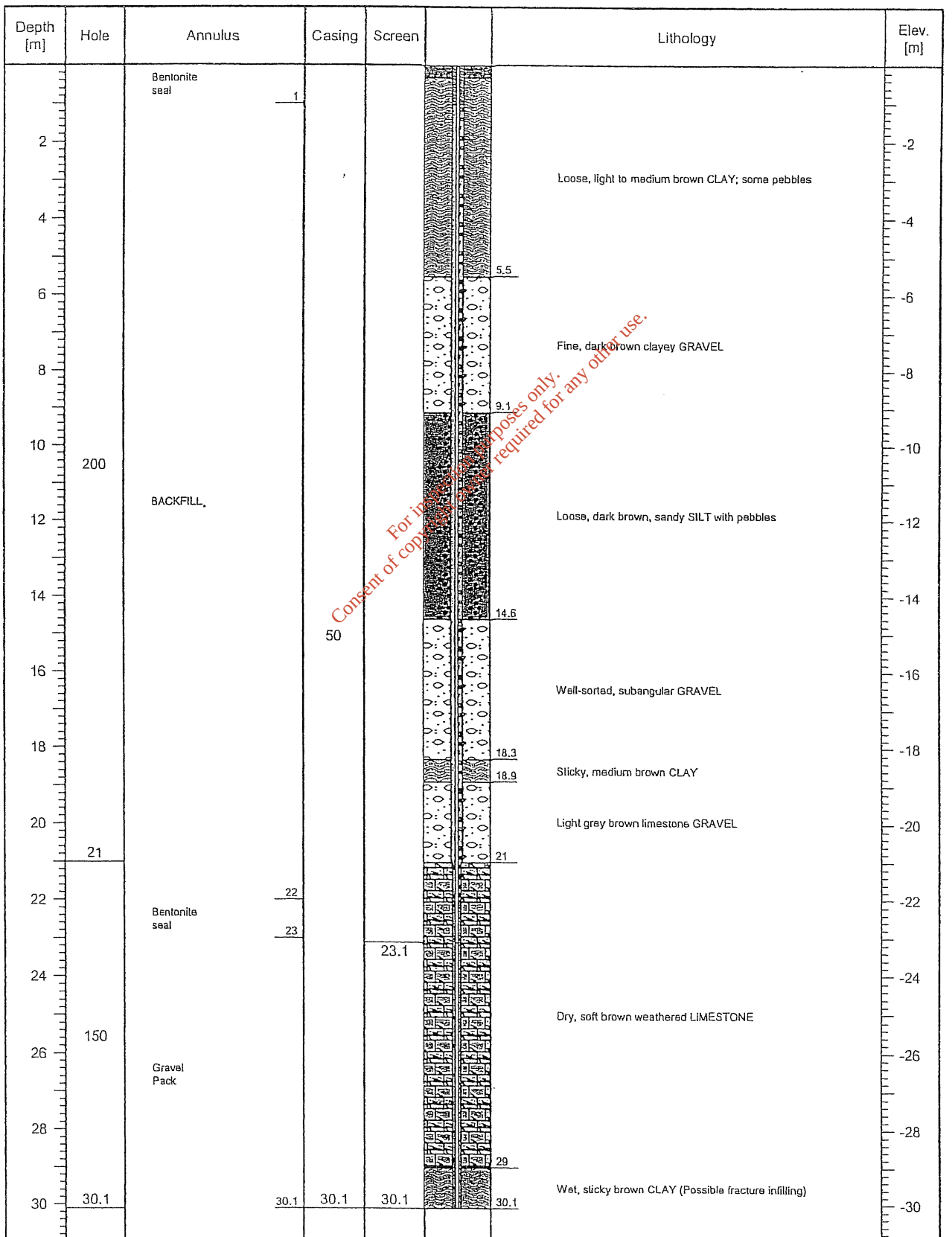
Date Drilled: 5/4/00

Water Level (mbtoc):

All diameters in mm
All depths in metres

Scale

Vertical	Horizontal
150.0	100.0



Appendix 9.2

Trial Pit Logs

Trial Pit Records

Project No. : 2175 **Location :** Duleek, Co. Meath **Date :** 28/4/00

Drilling Method : JCB **Supervisor :** Amy Brennan

TRIAL PIT NO.1

Geology :

0 - 0.25	Dark brown organic-rich TOPSOIL
0.25 - 0.9	Medium brown silty CLAY with occasional subrounded pebbles.
0.9 - 3.0	Fine grained, homogeneous, brown SAND.
3.0 - 3.2	Brown BOULDER CLAY with occasional large limestone boulders
3.2 - 3.3	Stiff, black BOULDER CLAY

Depth to Rock : >3.3m

Rock Type :

Water Entry : None

Static Water :

Total Depth : 3.3m

Comments : Composite soil samples taken; Dry deposits. No unusual colours o odours noted.

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

Trial Pit Records

Project No. : 2175 **Location :** Duleek, Co. Meath **Date :** 28/4/00

Drilling Method : JCB **Supervisor :** Amy Brennan

TRIAL PIT NO.2

Geology :

0 - 0.2	Brown organic-rich TOPSOIL
0.2 - 1.1	Medium brown silty CLAY with occasional subangular pebbles.
1.1 - 1.6	Medium brown, silty BOULDER CLAY with large limestone boulders
1.6 - 3.4	Extremely coarse, clayey GRAVEL deposits (boulders up to 40 - 45cm), with water.

Depth to Rock : >3.4m

Rock Type :

Water Entry : 3.2m

Static Water : 3.2

Total Depth : 3.4m

Comments : Water seen to be flowing in through the gravels. Composite soil sample taken. No unusual colours or odours noted.

-

Trial Pit Records

Project No. : 2175 **Location :** Duleek, Co. Meath **Date :** 28/4/00

Drilling Method : JCB **Supervisor :** Amy Brennan

TRIAL PIT NO.3

Geology :

0 - 0.15	Dark brown organic-rich TOPSOIL
0.15 - 1.9	Dark brown, moderately well-sorted , dry, clayey, sandy GRAVEL.
1.9 - 3.4	Lighter brown, clayey SAND with occasional pebbles up to 3-4cm in size.

Depth to Rock : >3.4m

Rock Type :

Water Entry : Seepage into the excavation from approx. 1.9m

Static Water :

Total Depth : 3.4m

Comments : Water was seen to be seeping in through the clayey SAND layer. Composite soil sample was taken. No unusual colours or odours.

-

Trial Pit Records

Project No. : 2175 **Location :** Duleek, Co. Meath **Date :** 28/4/00

Drilling Method : JCB **Supervisor :** Amy Brennan

TRIAL PIT NO.4

Geology :

0 - 0.15	Brown organic-rich TOPSOIL
0.15 - 0.4	Medium brown subsoil.
0.4 - 1.25	Loose, light brown, silty, sandy, CLAY with occasional rounded pebbles.
1.25 - 3.45	Poorly sorted, subrounded brown, clayey, sandy, GRAVEL with some black colouration due to presence od shaley fragments.

Depth to Rock : >3.45m

Rock Type :

Water Entry : Gravels moist- Very small amount of seepage.

Static Water :

Total Depth : 3.45m

Comments : Gravel layer collapsing into the hole. No unusual colours or odours noted. Composite soil samples taken.

Trial Pit Records

Project No. : 2175 **Location :** Duleek, Co. Meath **Date :** 28/4/00

Drilling Method : JCB **Supervisor :** Amy Brennan

TRIAL PIT NO.5

Geology :

0 - 0..12	Medium brown organic-rich TOPSOIL
0.12 - 1.3	Loose, light brown, sandy CLAY.
1.3 - 2.7	Loose, fine grained, homogeneous brown SAND.
2.7 - 3.4	Quite stiff, light brown BOULDER CLAY

Depth to Rock : >3.4m

Rock Type :

Water Entry : Water seeping into the hole at approx 2.7m through the bottom of the sands.

Static Water : Not available. Hole filled up with sand.

Total Depth : 3.4m

Comments : Walls of the excavation very unstable and sand collapsing into the hole. No unusual colours or odours noted. Composite soil samples taken.

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

Trial Pit Records

Project No. : 2175 **Location :** Duleek, Co. Meath **Date :** 28/4/00

Drilling Method : JCB **Supervisor :** Amy Brennan

TRIAL PIT NO.6

Geology :

0 - 0.15	Dark brown organic-rich TOPSOIL
0.15 - 0.6	Medium brown silty CLAY with only occasional subrounded pebbles.
0.6 - 1.85	Grey brown, loose, silty CLAY with boulders up to 25cm in size.
1.85 - 3.15	Moderately well sorted, clayey GRAVEL, with occasional large boulders (up to 30cm).

Depth to Rock : >3.15m

Rock Type :

Water Entry : Spring seen to be flowing into the excavation at approx 1.85m

Static Water : 3.0m and rising

Total Depth : 3.15m

Comments : Spring flowing in from the northern side of the excavation, quite quickly. No unusual colours or odours. Composite soil sample taken.

Trial Pit Records

Project No. : 2175 **Location :** Duleek, Co. Meath **Date :** 28/4/00

Drilling Method : JCB **Supervisor :** Amy Brennan

TRIAL PIT NO.7

Geology :

0 - 0.3	Dark brown organic-rich TOPSOIL & subsoil
0.3 - 0.95	Dark brown, clayey, sandy, SILT with occasional pebbles
0.95 - 3.1	Moderatley well-sorted, dark brown, sandy, clayey, GRAVEL
3.1 - 3.3	Tight, dark brown BOULDER CLAY .

Depth to Rock : >3.3m

Rock Type :

Water Entry : None

Static Water :

Total Depth : 3.3m

Comments : Composite soil samples taken; Dry deposits. No unusual colours or odours noted.

-

Appendix 9.3

Geotechnical Report

GEOTECHNICAL REPORT

FOR

GREEN FIELD SITE

AT

PLATIN, CO. MEATH

FOR

PROJECT MANAGEMENT LTD.

Alpha Engineering Services
Consulting Engineers, Land Surveyors
March 2000
A228

REPORT ISSUE

Report Title: Draft Geotechnical Report For Green Field Site at Platin, Co. Meath for Project Management.

Issue No.	Date	Checked	Passed
1 (Draft)	February 2000	MAL	
2	March 2000	MAL	

Alpha Engineering Services
Consulting Engineers, Land Surveyors
Unit 6, Crumlin Business Centre, Stannaway Drive, Dublin 12, Ireland
Tel 01 4563362, Fax 01 4563372, e-mail: alphaeng@iol.ie

CONTENTS

1.0 INTRODUCTION

Alpha Engineering Services (AES) have been requested by Project Management Ltd. to carry out a site investigation at a green field site in Platin, Co. Meath. The total area investigated is approximately 45 acres, which is subdivided into 6 fields.

The site investigation was carried out on the 22nd January 2000 and consisted of excavating fifteen trial pits. This report details the findings of the site investigation along with making a number of geotechnical recommendations.

The trial pits were excavated on the 24th January 2000 using a 13 tonne excavator and were logged by a geotechnical engineer from Alpha Engineering Services.

2.0 SITE INVESTIGATION

2.1 Introduction

15 No. trial pits were excavated on the site at the locations indicated on Drawing No. A228-02. All ground stratas revealed in the trial pits were classified in accordance with BS 5930 "British Standard Code of Practice for Site Investigation". The trial pit logs are represented in Appendix A.

The site is bounded to the north by a railway embankment, to the west by a small side road and the south by the R152 road.

A gas pipe is located through the centre of the site. In order to avoid the pipe, trial pits were not excavated within 25m of the pipeline.

Topographical levels on the site were noted to vary from approximately 34 mOD in the north west corner of the site to 43 mOD in the south east corner of the site. Topographical low points of 32 mOD were noted in the centre and the south east corner of the site.

2.2 Site Stratigraphy

The trial pits were examined by a Geotechnical Engineer from AES. The stratigraphy varied across the site but generally consisted of topsoil overlaying brown boulder clay on a clayey gravel layer which was in turn underlain by a black boulder clay. Bedrock was noted to be carboniferous limestone. In both the gravel and clay layers large boulders up to 600mm in diameter were noted. A summary of the stratigraphy is presented in Table 1 below.

STRATUM	Depth (m bgl)
TOPSOIL	0 – 0.4
Soft to firm brown silty CLAY with cobbles.	0.4 – 1.0
Firm to hard brown silty CLAY with cobbles and large boulders (Brown boulder clay).	0.4 – 4.0
Medium dense to dense sandy GRAVEL approximately 1m in depth with local sand lenses.	0.4 – 5.0
Hard black silty CLAY cobbles and large boulders (Black boulder clay)	2.5 – 4.0

Table1 – Summary of Ground Stratigraphy Revealed by the Site Investigation

2.3 Brown Boulder Clay

In TP No.'s 1, 2, 5, 6, 7, 8, 9 & 12 a soft to firm brown silty clay was noted to a maximum depth of 0.9 m bgl, directly under the topsoil.

The brown boulder clays which underlay the upper soft to firm layer were noted as being firm to stiff silty gravelly low plasticity clays, with a high cobble and boulder content. The undrained shear strength of the clay was estimated to be in the order of 50kPa to 100kPa.

In TP 8 a soft clay layer was noted between 1.5mbgl and 2.6mbgl. The material was of low strength while significant side collapsing of the sides of

the pit and ground water seepage were noted. In TP 14 adjacent to TP 8 a similar soft sandy clay was noted to extend from 2.4 to 4.4 mbgl however collapsing was not as significant and ground water ingress was not noted.

In TP 11 a soft clay with large boulder clay was noted to extend from 2.0 to 2.7 mbgl.

2.4 Gravel

Gravel layers were noted to underlay the brown boulder clay layer in all trial pits excluding TP No.'s 1, 2, 4, 10 & 11.

The gravels were generally noted as a competent medium dense to dense sandy clayey gravels with large boulders. Intermittent localised sand lenses typically in the order of 100 – 200mm were also noted. In TP 15 2m of loose sand was noted from 1.5m bgl.

The gravels were generally noted to be dry and stable with only moderate localised seepage occurring in some trial pits (TP 16). However, it is noted that trial pits were generally were not left over for a significant length of time, typically in the order of 15 – 25 minutes.

TP 13 was left open for five hours and significant ground water seepage was noted, localised failure of side slopes had occurred.

2.5 Black Boulder Clay

The black boulder clay stratum was noted in trial pits No.'s 1, 2, 5, 6, 8 & 15.

The black clay layer was noted to be a hard silty gravelly clay with cobbles and large boulders.

As with the brown clay it was described as a low plasticity clay while the undrained strength is estimated to be in the order of 75kPa to 150kPa.

2.6 Bedrock

Refusal was noted at shallow depth in trial pit No. 4 and No. 10 at 2.6 and 2.2m bgl respectively. From a visual inspection the refusal was attributed to the presence of limestone bedrock (rather than large boulders).

3.0 RECOMMENDATIONS

3.1 Excavation

Excavations of subsoils, to the depth investigated by the trial pits, will not require any extraordinary means. Use of conventional excavation plant will be sufficient. However, the presence of large boulders (diameter greater than 0.5m) could make excavation more difficult and slower than would be normally expected in such materials. Also, the preparation of formations may prove more difficult because of the presence of the boulders.

The trial pits were generally noted to be stable. However, when TP 5 was left open for five hours localised collapsing was noted. In TP No.'s 8 and 14 immediate collapsing was noted during excavation. It should be assumed, therefore, that excavations will require temporary support or the side slopes to be graded at a safe angle. Typical side slopes in the clayey subsoils encountered during the excavation would be 1.0 vertical to 1.5 horizontal for temporary slopes and 1.0 vertical to 2.0 horizontal for permanent slopes. Any gravel encountered should be graded tat 1.0 vertical to 2.0 horizontal in the temporary and permanent condition.

It is noted that the depth to bedrock is suspected to be shallow in a number of places across the site (TP 4 and TP 10). Therefore if deep excavations are required (for drainage pipes or localised lift pits etc.) it is recommended that the depth and integrity of the rock is proven by rotary coring.

3.2 Foundations

Given the variation in the upper layers of the brown clays noted in Section 2 the preferable foundation option is pad foundations bearing 1.5 onto the brown boulder clay stratum. It is noted that in some trial pits (TP 9 and TP 15), given the shallow depths of the gravel stratum, foundations will be required to founded on the same. The gravels typically are dense enough to provide adequate bearing capacity for shallow foundations. However, if the

site layout means that building will be founded on both strata (gravels and clays), pads should be designed such as to prevent differential settlement occurring.

A net allowable bearing pressure for sizing foundations would be 200kPa based on a steel frame building while for concrete buildings a bearing of 150kPa should be used.

In TP 3 a localised soft spot was noted between 2.0 and 2.7m bgl. It is recommended, therefore, that some contingency is allowed for extending structural pads deeper than such soft spots using leanmix. Foundation formations should be inspected by suitably qualified engineers to detect such layers. It is also recommended that further investigation (Dynamic Loads or similar) are carried out to confirm that such soft spots do not exist in other areas of the site. The probes should also be carried out in the location of Trial Pit 15, to confirm the extent and density of the sand stratum noted, to confirm the above bearing pressure are acceptable in this stratum.

In the area of TP 8 and TP 14 given the presence of low quality clays and sand, a suitable formation level for foundations would be in the order of 4m bgl making pad foundations impracticable. Pile foundations would most likely be the most cost effective and technically suitable solution.

Typically, allowable working of various driven piles are provided below:

Pile size (mm x mm)	Design Load Capacity (kN)
350 sq.	1300
300 sq.	900
250 sq.	600

It is recommended more detail site investigation is carried out in the area to confirm the ground conditions.

The brown and black clay layers would be very susceptible to moisture and will degrade if over exposed to water. Therefore all excavations should be kept as dry as possible and all formations blinded immediately when excavated.

3.3 Slabs

All topsoil and subsoil layers should be removed in the areas of all slabs and carparks.

The upper soft to firm clay layer is most likely not competent enough to support ground bearing slabs and trafficed areas. CBR tests should be carried out to confirm the consistency of these upper clay layers and if a capping layer/geotextile can be employed to avoid removing these layers. A contingency should be allowed for the removal and backfilling of soft spots.

The underlying firm brown boulder clay will be more than competent to support ground bearing slabs and trafficed areas.

It is noted that the upper soft to firm clays would be susceptible to temporary construction traffic and therefore sufficiently deep haul roads should be employed to prevent the permanent formation to be disturbed.

3.4 Groundwater

Groundwater was generally encountered in small quantities. However in TP No. 8 significant seepage was noted. Therefore any excavations in this area will mostly require de-watering methods (pumps etc.) to control groundwater.

3.5 Earthworks

From a visual inspection of the gravels and clays on site, it is estimated that reuse of excavated subsoils as fill under flexibly finished trafficed areas would be acceptable if finished floor/carpark levels result in significant cut and fill volumes.

However given the cost implication of overestimating the strengths of subsoils for reuse, it is recommended that detail classification tests are carried out if this is anticipated.

The upper soft to firm clay would only be suitable for reuse in soft landscape areas.

APPENDIX A – TRIAL PIT LOGS

Alpha	Alpha Engineering Services Site Investigation Field Report			Job No:	A228			
				Name	DW			
Job Title:	Platin S I Client: P M			Date:	24.01.00			
Remarks	Description Of Strata		Level (mOD)	Depth (m)	Samples			
					Type	Depth	Ref	Ms %
	Topsoil/Subsoil			0.4				
	Soft Brown CLAY			0.9				
	Firm becoming very stiff brown silty CLAY with cobbles and large boulders			2.8				
	Very stiff to hard black CLAY with cobbles and boulders End of Trail Pit			3.8				

Remarks	Trial Pit Stable, Minor Seepage at	Trial Pit No.	
Equiptment	1.1m bgl		
Personnel	15 Tonne Excavator	1	

Alpha	Alpha Engineering Services Site Investigation Field Report			Job No:	A228			
				Name	DW			
Job Title:	Platin S I Client: P M			Date:	24.01.00			
Remarks	Description Of Strata		Level (mOD)	Depth (m)	Samples			
					Type	Depth	Ref	Ms %
	Topsoil			0.5				
	Soft Brown CLAY			0.7				
	Firm brown silty CLAY with some cobbles			1.8				
	Stiff brown silty CLAY with some cobbles			2.3				
	Firm to stiff Brown Sandy SILT			4.0				
	Hard black silty CLAY with boulders			4.3				
Remarks	Pit Stable and No Seepage				Trial Pit No.			
Equiptment								
Personnel					2			

Alpha	Alpha Engineering Services Site Investigation Field Report			Job No:	A228			
				Name	DW			
Job Title:	Platin S I Client: P M			Date:	24.01.00			
Remarks	Description Of Strata		Level (mOD)	Depth (m)	Samples			
					Type	Depth	Ref	Ms %
	Topsoil			0.3				
	Firm Brown silty CLAY with cobbles			1.0				
	Firm brown silty CLAY with lots of cobbles and boulders			1.6				
	Medium dense clayey GRAVEL with cobbles and boulders			3.0				
	Medium dense silty Sand			3.1				
	Dense clayey GRAVEL with cobbles and boulders							
	Medium dense brown clayey SAND							
Remarks	Pit Dry and Stable				Trial Pit No.			
Equiptment	15 Tonne Excavotor							
Personnel					3			

Alpha	Alpha Engineering Services Site Investigation Field Report			Job No:	A228			
				Name	DW			
Job Title:	Platin S I Client: P M			Date:	24.01.00			
Remarks	Description Of Strata		Level (mOD)	Depth (m)	Samples			
					Type	Depth	Ref	Ms %
	Topsoil			0.3				
	Firm brown silty CLAY with cobbles and boulders			1.0				
Hard Digging	As above but becoming stiff with depth and site of boulders increasing			2.3				
	REFUSAL: PRESUMED BEDROCK							

Remarks	Pit Dry and Stable	Trial Pit No.	
Equiptment		4	
Personnel			

Alpha	Alpha Engineering Services Site Investigation Field Report			Job No:	A228			
				Name	DW			
Job Title:	Platin S I Client: P M			Date:	24.01.00			
Remarks	Description Of Strata		Level (mOD)	Depth (m)	Samples			
					Type	Depth	Ref	Ms %
	Topsoil			0.3				
	Soft to firm brown CLAY			0.7				
	Firm brown CLAY with cobbles and boulders			0.9				
Hard Digging	Dense clayey GRAVEL with cobbles and large boulders			2.1				
	Very dense clayey GRAVEL with cobbles and large boulders			2.7				
	Very dense GRAVEL with cobbles and boulders			4.0				
	Hard Black Silty CLAY with cobbles and boulders			4.5				
Remarks	TP open for 6 hours, Pit dry with				Trial Pit No.			
Equiptment	Local Collapsing							
Personnel	15 Tonn Excavator				5			

Alpha	Alpha Engineering Services Site Investigation Field Report			Job No:	A228			
				Name	DW			
Job Title:	Platin S I Client: P M			Date:	24.01.00			
Remarks	Description Of Strata		Level (mOD)	Depth (m)	Samples			
					Type	Depth	Ref	Ms %
	Topsoil			0.3				
	Soft to firm brown CLAY			0.7				
	Firm brown silty CLAY with cobbles and boulders			1.4				
	Medium Dense brown silty SAND			1.8				
	Stiff brown silty CLAY with cobbles and boulders			2.5				
	As above but "Very Stiff"			3.0				
Hard Digging	Hard black silty CLAY with cobbles and boulders			3.8				
Remarks	Trial Pit Stable, No Seepage				Trial Pit No.			
Equiptment								
Personnel					6			

Alpha	Alpha Engineering Services Site Investigation Field Report			Job No:	A228			
				Name	DW			
Job Title:	Platin S I Client: P M			Date:	24.01.00			
Remarks	Description Of Strata		Level (mOD)	Depth (m)	Samples			
					Type	Depth	Ref	Ms %
	Topsoil			0.4				
	Firm brown CLAY with cobbles			1.3				
	Sandy SILT			1.4				
	Stiff brown CLAY with cobbles and boulders			2.0				
	Clayey Sand Medium Dense			2.4				
Hard Digging	Dense clayey GRAVEL with cobbles and large boulders			3.9				
	Very dense clayey GRAVEL with cobbles and boulders			4.5				

Remarks	Trial Pit Dry and Stable	Trial Pit No.	
Equiptment		7	
Personnel			

Alpha	Alpha Engineering Services Site Investigation Field Report			Job No:	A228			
				Name	DW			
Job Title:	Platin S I Client: P M			Date:	24.01.00			
Remarks	Description Of Strata		Level (mOD)	Depth (m)	Samples			
					Type	Depth	Ref	Ms %
	Topsoil			0.3				
	Soft to firm brown CLAY			0.7				
Pit Collapsing at this depth. A lot of Seepage	Soft brown silty CLAY with cobbles and boulders			2.6				
Moderate Seepage	Dense brown silty sandy GRAVEL with cobbles and boulders			3.8				
Significant Seepage	Dense brown silty sandy GRAVEL with cobbles and boulders - a lot of seepage			4.3				
	Hard black Silty CLAY							
Remarks	Pit Unstable - Collapsing				Trial Pit No.			
Equiptment								
Personnel					8			

Alpha	Alpha Engineering Services Site Investigation Field Report			Job No:	A228			
				Name	DW			
Job Title:	Platin S I Client: P M			Date:	24.01.00			
Remarks	Description Of Strata		Level (mOD)	Depth (m)	Samples			
					Type	Depth	Ref	Ms %
	Topsoil			0.3				
	Soft to firm brown CLAY			0.7				
Pit Collapsing at this depth. A lot of Seepage	Soft brown silty CLAY with cobbles and boulders			2.6				
Moderate Seepage	Dense brown silty sandy GRAVEL with cobbles and boulders			3.8				
Significant Seepage	Dense brown silty sandy GRAVEL with cobbles and boulders - a lot of seepage			4.3				
	Hard black Silty CLAY							
Remarks	Pit Unstable - Collapsing				Trial Pit No.			
Equiptment								
Personnel					8			

Alpha	Alpha Engineering Services Site Investigation Field Report			Job No:	A228			
				Name	DW			
Job Title:	Platin S I Client: P M			Date:	24.01.00			
Remarks	Description Of Strata		Level (mOD)	Depth (m)	Samples			
					Type	Depth	Ref	Ms %
	Topsoil			0.3				
	Soft Brown CLAY			0.7				
	Sorf to firm brown CLAY with cobbles and boulders			1.4				
Hard Digging	Dense Slightly clayey GRAVEL with cobbles and boulders			2.8				
Hard Digging	Very dense slightly clayey GRAVEL with cobbles and boulders			3.1				
	Very Dense Clean GRAVEL with cobbles and boulders			3.7				
	END							

Remarks	Trial Pit Stable: Local	Trial Pit No.	
Equiptment	Collapsing and Dry		
Personnel		9	

Alpha	Alpha Engineering Services Site Investigation Field Report			Job No:	A288			
				Name	DW			
Job Title:	Platin S I Client: P M			Date:	24.01.00			
Remarks	Description Of Strata		Level (mOD)	Depth (m)	Samples			
					Type	Depth	Ref	Ms %
	Topsoil			0.3				
	Firm brown CLAY with cobbles			0.8				
Hard Digging	Stiff brown CLAY with lots of boulders and cobbles			2.2				
	REFUSAL: Possibly bedrock							
Remarks	Pit Dry and Stable				Trial Pit No.			
Equiptment								
Personnel					10			

Alpha	Alpha Engineering Services Site Investigation Field Report			Job No:	A288			
				Name	DW			
Job Title:	Platin S I Client: P M			Date:	24.01.00			
Remarks	Description Of Strata		Level (mOD)	Depth (m)	Samples			
					Type	Depth	Ref	Ms %
	Topsoil			0.3				
	Firm brown CLAY with cobbles and boulders			1.2				
	Hard brown boulder CLAY with cobbles			1.6				
	Loose to medium dense clayey SAND			2.0				
Pit Collapsing	Soft to firm brown CLAY with cobbles			2.7				
Hard Digging	Hard brown boulder CLAY with cobbles and boulders			3.5				

Remarks	Pit Dry	Trial Pit No.	
Equiptment			
Personnel		11	

Alpha	Alpha Engineering Services Site Investigation Field Report			Job No:	A288			
				Name	DW			
Job Title:	Platin S I Client: P M			Date:	24.01.00			
Remarks	Description Of Strata		Level (mOD)	Depth (m)	Samples			
					Type	Depth	Ref	Ms %
	Topsoil			0.4				
	Soft to firm brown CLAY with cobbles			0.8				
	Firm brown sandy CLAY with cobbles and boulders			1.6				
	Firm brown sandy CLAY with cobbles and boulders			2.1				
	Stiff brown silty CLAY with cobbles and boulders			2.7				
Hard Digging	Very dense clayey GRAVEL with cobbles and boulders			4.5				
Remarks	Trial Pit Dry and Stable				Trial Pit No.			
Equiptment								
Personnel					12			

Alpha	Alpha Engineering Services Site Investigation Field Report			Job No:	A288			
				Name	DW			
Job Title:	Platin S I Client: P M			Date:	24.01.00			
Remarks	Description Of Strata		Level (mOD)	Depth (m)	Samples			
					Type	Depth	Ref	Ms %
	Topsoil			0.4				
	Soft to firm CLAY			0.8				
	Firm brown CLAY with cobbles and boulders			1.8				
	Stiff brown CLAY with cobbles and boulders			2.6				
	Firm brown CLAY with cobbles and boulders			3.4				
	Dense clayey GRAVEL wth cobbles and boulders			4.4				
	Hard brown silty CLAY							
Remarks					Trial Pit No.			
Equiptment								
Personnel					13			

Alpha	Alpha Engineering Services Site Investigation Field Report			Job No:	A288			
				Name	DW			
Job Title:	Platin S I Client: P M			Date:	24.01.00			
Remarks	Description Of Strata		Level (mOD)	Depth (m)	Samples			
					Type	Depth	Ref	Ms %
	Topsoil			0.3				
	Soft to firm CLAY			0.7				
	Firm brown CLAY with cobbles and boulders			1.4				
	Stiff brown CLAY with cobbles and boulders			2.4				
Sides Collapsing	Soft sand CLAY with cobbles			4.4				
	Hard black boulder CLAY							
Remarks	Pit Collapsing - Minor Seepage				Trial Pit No.			
Equiptment								
Personnel					14			

Alpha	Alpha Engineering Services Site Investigation Field Report			Job No:	A288			
				Name	DW			
Job Title:	Platin S I Client: P M			Date:	24.01.00			
Remarks	Description Of Strata		Level (mOD)	Depth (m)	Samples			
					Type	Depth	Ref	Ms %
	Topsoil			0.45				
	Soft brown CLAY			0.70				
Sides Collapsing	Loose to medium dense grey SAND. No clay content			3.0				
	Medium dense GRAVEL with boulders and cobbles			4.0				
Hard Digging	Hard brown silty CLAY							
Remarks				Trial Pit No.				
Equiptment								
Personnel				15				

Alpha	Alpha Engineering Services Site Investigation Field Report			Job No:	A288			
				Name	DW			
Job Title:	Platin S I Client: P M			Date:	24.01.00			
Remarks	Description Of Strata		Level (mOD)	Depth (m)	Samples			
					Type	Depth	Ref	Ms %
	Topsoil			0.3				
	Soft to firm brown CLAY with cobbles			0.8				
	Firm brown CLAY with cobbles			1.2				
	Stiff brown CLAY with cobbles			1.4				
Hard Digging	Very stiff sandy gravelly CLAY with cobbles abd large boulders			2.6				
Hard Digging and Sides Collapsing	Dense clayey GRAVELS with cobbles and boulders			3.5				

Remarks	Sides Collapsing - Minor Seepage	Trial Pit No.	
Equiptment	at 24m bgl		
Personnel		16	

Appendix 9.4

Puraflo Report

Report on the Suitability of a Site for the Installation of a Puraflo™ System at Carranstown, Co Louth.

December 2000

Prepared by:

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

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Figures

Appendix

Bracken Business Park, Bracken Road,
Sandyford Ind. Estate, Dublin 18, Ireland.
V.A.T. Reg. No. IE 6554210 F
Tel. +353 1 2941717
Fax +353 1 2941823
eMail: info@ktcullen.ie

K.T.Cullen & Co. Ltd.

Report on the Suitability of a Site for the Installation of a Puraflo™ System at Carranstown, Co. Louth.

1. Introduction

K.T Cullen & Co. were requested by Project Management to carry out trial pitting and percolation tests at a site in Carranstown Co. Louth. The purpose of the work was to assess the suitability of the site for the installation of a Puraflo™ system with associated septic tank and percolation area. The system was designed to cater for a maximum of 100 people.

2. Field Work

2.1 On Site Assessment

The site is underlain by limestone bedrock. No outcrops, springs or karst features were seen at the site. Monitoring wells and trial wells drilled at the site in May 2000 indicate relatively deep overburden deposits varying from approximately 5 metres to 21 metres of clays and gravels. The water table in one of these boreholes (MW1) was measured as being approximately 10.5 metres below the ground level at the time of trial pitting (12/12/00).

The field in which the work was carried out has a shallow ditch to the south-east which had water in it at the time of trial pitting. Prior to fieldwork, the weather in general had been extremely wet and parts of the field near the ditch were experiencing ponding of surface water.

The site is presently under grass and apart from the localised ponding appears to be well-drained. The brown/red colour of the subsoil would also indicate a well-drained site.

2.2 Trial Pits

Two trial pits were dug at the site of the proposed percolation area. The trial pit logs are shown in Appendix A and their location is shown in Figure 1. The trial pits were excavated to a depth of 2.8 m and 3 m respectively. Both encountered similar overburden deposits-1.2-1.8 m of boulder clay and then

a clayey gravel which became more gravelly with depth. No seepages were encountered during the digging and after 48 hours, no water had entered the hole.

2.3 Percolation Pits

Four percolation pits were dug at the site of the proposed percolation area. The top 0.30 metres of soil was removed at the location of each of the four pits by the JCB. 0.30 metres was chosen as this is the depth at which effluent will be introduced to the soil according to Puraflo™ Agrément Certificate 97/00060. The pits were then dug in these depressions with in accordance to dimensions specified in the EPA's Wastewater Treatment Manuals. The percolation pits measured 0.3 m by 0.3 m and were completed at a depth of 0.4 m-approximately 0.7 m below the ground surface.

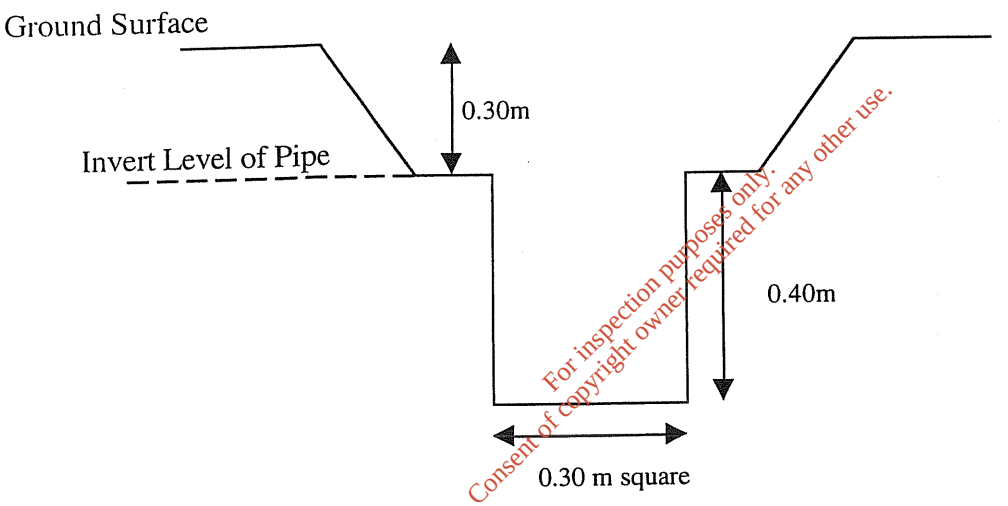


Figure 2: Design of the Percolation Pits as recommended by EPA Wastewater Treatment Manual.

The sides of the percolation pits were scored with a trowel and filled with water to simulate fully saturated soil conditions. The pits were then left overnight to soak.

On the following day the water had still not drained completely out of the holes even though it had dropped in each of them. The holes were refilled to a depth of 0.30 m with water, in order to assess the time taken for the water level to drop 0.1 m (100 mm). After 4 hours the water level had dropped 0.04 m in Percolation Pits 1 and 4, 0.01 m in Percolation Pit 2 and 0 m in Percolation Pit 3. This would give a minimum T value of 150.

3. Conclusions

The site has failed the percolation test as the T value obtained was greater than 50 (EPA Wastewater Manual). This is due to the presence of clays beneath the site which had become highly saturated during the recent bad weather.

The water table at the site is not high and no seepages were seen in the trial pits.

4. Recommendations

- We would recommend, in accordance with EPA Guidelines, that the site be engineered to meet the required specifications. This will involve the removal of the existing overburden material over an area of 300 m^2 and the importing of material with a suitable T value-preferably a fine sand or clayey sand with a T value of between 5 and 15. The imported soil can be placed in layers 0.3 m thick and each layer should be compacted lightly prior to the adding of the next layer. Percolation tests should be carried out on every 0.3 m thick layer. The depth of the fill should be approximately 2 metres to allow at least 1 m between the lowest level of a percolation trench (0.7 m below ground level) and the original soil level. This is a total volume of material of 600 m^3. Once the overburden material is in place a full percolation test should be carried out. A reserve percolation area should also be constructed in the event of the main area malfunctioning.

- Alternatively, a sand filter could be constructed with associated polishing filter. The loading rate on this constructed filter is recommended to be 50 l/m^2/day. The advantage of this type of sand filter is that it takes up considerably less area than the trenched percolation area. The disadvantages are that a polishing filter is necessary and pumping of wastewater might be needed to transfer effluent from the sand filter to the polishing filter. Sand filters are used in conjunction with septic tanks in soil which is unsuitable for conventional percolation areas. The filter system consists of 600-900 mm of graded sand underlain by 200 mm of gravel. The filter system is overlain by the natural topsoil but is separated from it by a geotextile membrane. The wastewater is treated by moving through the sand filter and can then be directed under gravity or pumping to a final polishing filter. (EPA Wastewater Treatment Manual).

Respectfully Submitted

Victoria Conlon

Victoria Conlon B.Sc.M.Sc.

8/01/01

Date

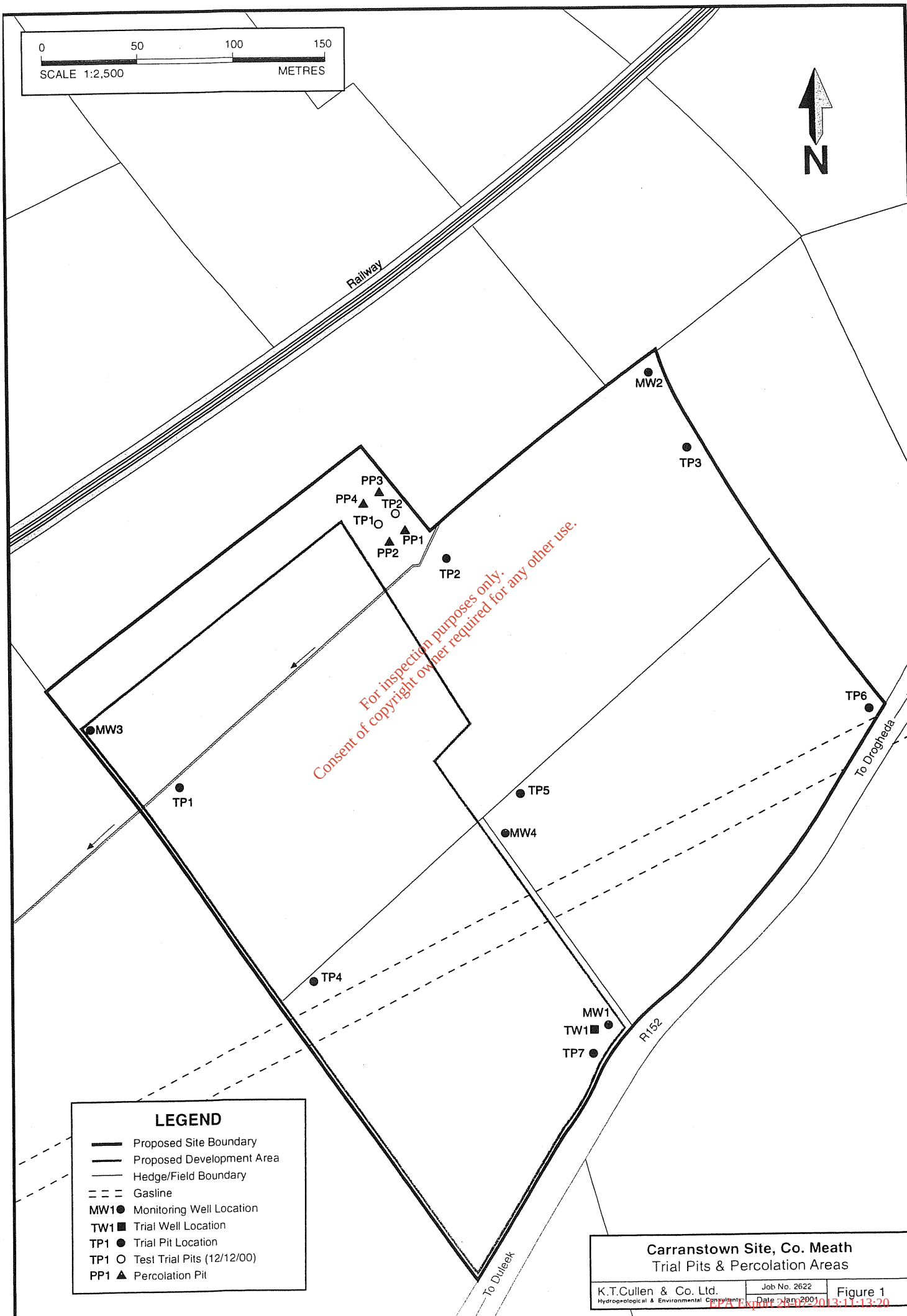
K O'Dwyer

Kieran O Dwyer BE MIEI

8/01/01

Date

FIGURE



APPENDIX A

Trial Pit Records

Project No. : 2622 **Location :** Carranstown Duleek **Date :** 12/12/00

Drilling Method : JCB **Supervisor :** VC

TRIAL PIT NO. 1

Geology :

0 - 0.1	Grass and Topsoil
0.1 - 1.8	Light Brown Silty BOULDER CLAY with pebbles and cobbles
1.8-2.8	Light Grey Clayey Sandy GRAVEL with well rounded boulders, becoming more gravelly with depth.

Depth to Rock : >2.8

Rock Type : None Encountered

Water Entry : None Encountered

Static Water : None after 48 hours

Total Depth : 2.8 metres

Elevation

Comments : N/A

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

Trial Pit Records

Project No. : 2622 **Location :** Carranstown Duleek **Date :** 12/12/00

Drilling Method : JCB **Supervisor :** VC

TRIAL PIT NO. 2

Geology :

0 - 0.1	Grass and Topsoil
0.1 - 1.2	Light Brown Silty BOULDER CLAY with pebbles and cobbles
1.2 - 3.0	Light Grey Clayey, Sandy GRAVEL with well rounded boulders, becoming more gravelly with depth. Mostly limestone boulders

Depth to Rock : >3 metres

Rock Type : None Encountered

Water Entry : None Encountered

Static Water : None after 48 hours

Total Depth : 3 metres

Elevation

Comments :

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

10 GROUNDWATER / HYDROGEOLOGY

10.1 INTRODUCTION

The information regarding the existing hydrogeological environment is based on investigations completed at the site in 2000 and 2001, a desk study and the Geological Survey of Ireland database.

10.2 OVERBURDEN HYDROGEOLOGY

The development site is underlain by a thick deposit of low permeability brown silty clays.

The vulnerability of the entire proposed site has been classified by the Geological Survey of Ireland (GSI) as Moderate (Figure 10.1).

The boulder clay varies in thickness across the site, ranging from 5.0 metres towards the west of the site, to greater than 20 metres towards the centre.

10.3 BEDROCK AQUIFER

As detailed in Section 9, the limestones found beneath the development site are part of the Platin Formation. The grey limestone which was weathered at the surface was proven by borehole drilling at the site. The limestone is typical of the Lower Carboniferous shallow water limestones. These are typically pale thick-bedded with minor shales, possible dolomitised, with palaeokarstic features (GSI Sheet 16 and Meath Groundwater Protection Scheme). The Platin Formation has been classified by the GSI as; *regionally important, diffuse karst aquifer, good development potential (Rkd)* (Figure 10.2). This classification was determined by the GSI in 2004.This regionally important aquifer displays both karst and fracture flow features.

The karstic nature and productivity of the Platin Formation are demonstrated at the nearby Platin Quarry where a significant dewatering operation is required to maintain dry working conditions at the quarry floor.

The development site is located within the local groundwater regime which is now largely determined by the Platin Quarry dewatering programme.

10.4 Aquifer Vulnerability and Resource Protection

The GSI/EPA/DoEHLG Groundwater Protection Scheme Classification (see table below) ranks the site as having a moderate (M) vulnerability due to the thickness and type of overburden cover present at the site.

Table 10.1 GSI Vulnerability Mapping Guidelines.

Vulnerability Rating	Hydrogeological Requirements (below the point of release of contaminants)				
	Subsoil Permeability (Type) and Thickness			Unsaturated Zone	Recharge Type
	high permeability (sand/gravel)	moderate permeability (sandy till)	low permeability (clayey till, clay, peat)	(sand & gravel aquifers only)	
Extreme	0-3.0m	0-3.0 m	0-3.0m	0-3.0m	point (<30 m radius)
High	>3.0	3.0-10.0m	3.0-5.0m	>3.0m	N/A
Moderate	N/A	>10m	5.0-10.0m	N/A	N/A
Low	N/A	N/A	>10.0m	N/A	N/A

Notes: i)N/A =not applicable

ii) Precise permeability values cannot be given at present

iii) Release point of contaminants is assumed to be 1-2 m below ground surface

(from Daly & Warren 1997)

Figures 9.2 and 9.3 present the location of the soil borings and trial pits across the site together with lines of cross section. The lines of cross section are presented on Figure 10.3 and show schematically that the shallow geology across the site comprises boulder clays for the most part with some discontinuous lenses of silts and gravels. In addition, percolation testing was undertaken at the site which measured extremely low percolation rates due to the presence of these clays.

10.4.1 Assessment of Resource Protection Zonation

As the bedrock is considered Regionally important, and the soil cover varies from 5 metres in thickness to at least 20 metres in thickness, the site is assigned a rating of Regionally important-moderate (Rk/M) under the GSI classification system for designating resource protection zones.

Response levels have been developed for three polluting activities (septic tanks, landspreading and landfills) using this matrix of resource protection zones. Based on the risk involved in each of these potentially polluting activities, they are either acceptable, acceptable subject to conditions, not acceptable with some exemptions or not acceptable. There is no response level developed for waste-to-energy facilities.

10.5 GROUNDWATER FLOW

Groundwater flow beneath the development site is now determined by cone of depression centred on the Platin excavation (see Figures 10.3 and 10.4). Prior to the quarry development, the groundwater flow beneath the development site would have been towards the River Nanny and in a general south easterly direction.

Today, the groundwater flow beneath the development site has been reversed and is now northwards towards the nearby Platin quarry due to the lowering of the water table within the excavation.

The groundwater abstracted from the excavation is piped directly to the River Nanny and so there is no loss of groundwater to this river. In fact there is a small increase due to the Platin excavation drawing some groundwater from the Boyne River catchment.

Details of the wells completed on the development site and the results of a pump test are provided in Appendix 9.1 and 10.1 respectively.

10.6 GROUNDWATER ABSTRACTIONS

Groundwater is extensively used by the local community as a source of water supply. A GSI well search revealed 22 recorded wells within 3km of the proposed site (see Table 10.1 for well data).

10.6.1 On Site Groundwater Abstraction

Following the installation of trials wells at the site, it is intended to install a production well from which the water requirements of the site will be supplied.

Trial wells have been drilled on the site and one of the trial wells, TW1, was tested to assess the available sustainable yield. The pumping test indicated that a yield in the order of 300m³/d could be sustainably abstracted from a well at the site.

The production well will be drilled adjacent to TW1. The well will be drilled using an air-rotary rig and will take 3-4 days to complete. The target depth of the well is 75m. The well will be initially opened at 200mm (8”) and steel casing will be grouted several metres into bedrock. The grout cement will take 24 – 48 hours to set. Bedrock was encountered at 14.3m bGL in TW1. Once in bedrock the well will be drilled on at 150mm (6”). PVC well screen will be installed adjacent to any water bearing zones to facilitate the ingress of water and PVC well casing will be installed elsewhere in the well. The PVC casing/screen will have a closed bottom and will be placed centrally in the hole.

It will be necessary to develop the well with compressed air for a period of at least 3 hours once the drilling is completed.

10.7 SITE SELECTION

The proposed facility is for the treatment of non hazardous waste however it should be noted that the WHO publication *Site Selection for New Hazardous Waste Management Facilities* have been incorporated as one aspect of the site selection process for the proposed facility thus adopting a conservative approach in the overall assessment.

The screening criteria in the guidelines are to:

assist in judging the overall suitability of a location, but are not necessarily decisive in the choice of location

For example, in the case of landfill sites, the production of leachate and its potential to pollute groundwater would limit/prevent the siting of such facilities on limestone deposits Whereas a waste-to –energy facility, as that proposed, handles all waste within a contained building and water tight bunker thus preventing the generation of leachate would not require the same criteria to be applied.

10.8 POTENTIAL IMPACTS

The main potential impacts relate to the abstraction of groundwater from the proposed supply well to be located on the development site and for groundwater contamination relating to the storage of chemicals on the site and the percolation of treated waste water.

10.8.1 Construction Phase

Potential impacts during the construction phase would be associated with accidental spillage of potentially polluting substances including oils, paints and liquid wastes and any additional substances associated with the construction activities.

All potentially polluting chemicals will be securely stored during the construction phase and refuelling of earth moving machinery will be carried out according to an appropriate Method Statement. Waste water generated during the construction phase will be removed from the development site for disposal in an approved waste water treatment plant. Meath County Council has confirmed its agreement to accept domestic effluent generated during construction of the facility for treatment in an appropriate wastewater treatment plant (see Appendix 10.2).

Table 10.2 GSI Well search (3km radius around 306300, 270900)

DTB	DEPTH	GSI HOLENAME	TYPE	EASTING	NORTHING	TOWNLAND	USAGE	YIELD	YIELD CLASS	AVE DAILY ABSTRACT	WATER STRIKE	MAIN AQUIFER	ABSTR-ACTION
8.2	22.9	2925NWW070	Bored Well	30460	26835	DULEEK		109	Good			Limestone	
7.6	48.2	2925NWW071	Bored Well	30460	26830	DULEEK	Agri/ domestic use	101	Good			Limestone & Drift	
31.5	63.1	2925NWW072	Unknown well	30460	26825	DULEEK		12.5	Poor			Boulder Clay, Sand & Gravel, Limestone	
	18.9	2925NEW070	Bored Well	30855	26910	BEAUMONT		49	Moderate				
0	61	2927SEW047	Bored Well	30605	27150	PLATIN	Industrial	3600	Excellent	3600	41	Limestone with fissures.	137.5
	30	2927SEW048	Bored Well	30590	27135	PLATIN	Industrial	3600	Excellent	3600		Limestone	
	24.4	2925NWW060	Bored Well	30359	26852	DOWNESTOWN	Public supply		Poor	10			
	4.6	2925NEW058	Dug Well	30551	26899	BELLEWSTOWN	Public supply	3.3	Poor				
9.1	42.7	2927SEW036	Bored Well	30665	27210	PLATIN	Public supply	54.5	Moderate				
0	61	2927SEW037	Bored Well	30600	27150	PLATIN, DULEEK	Industrial		Unknown		2.5		
15.2	47.2	2927SEW038	Bored Well	30665	27190	PLATIN	Industrial	872.7	Excellent		28.9		51.12
11.3	34.1	2927SEW039	Bored Well	30665	27185	PLATIN	Industrial	164	Good		14.6		
	21.9	2927SEW041	Bored Well	30630	27335	DROGHEDA		28	Poor				
		2927SEW035	Bored Well	30665	27205	PLATIN			Unknown				
	6.7	2927SEW001	Dug Well	30745	27211	BEYMORE			Unknown				
		2927SEW003	Dug Well	30500	27200	DONORE			Unknown				
	6.1	2927SEW106	Dug Well	30387	27362	OLDBRIDGE							
9.8	10.3	2927SEW107	Dug Well	30380	27363	OLDBRIDGE							

Table 10.2 GSI Well search (3km radius around 306300, 270900) Contd.

DTB	DEPTH	GSI HOLENAME	TYPE	EASTING	NORTHING	TOWNLAND	USAGE	YIELD	YIELD CLASS	AVE DAILY ABSTRACT	WATER STRIKE	MAIN AQUIFER	ABSTR-ACTION
5.1	5.1	2927SEW108	Dug Well	30372	27364	DOWTH							
1.8	1.8	2927SEW109	Dug Well	30367	27365	DOWTH							
0	76.2	2927SEW110	Bored Well	30601	27258	DONORE	Agri/ domestic use	21.8	Poor				
0	42.7	2827SEW111	Bored Well	30602	27251	DONORE	Agri/ domestic use	1091	Excellent		36.5		

10.8.2 Operational Phase

The potential impacts during the operation phase would include;

- Impact on groundwater levels and quality in private wells
- Impact on regional groundwater quality

The development site lies within the groundwater regime now established by the Platin dewatering programme. The quarry abstracts sufficient groundwater to maintain the water table just below the working quarry floor. This operation has resulted in a cone of depression in the water table that is centred on the deep excavation.

The proposed groundwater abstraction at the development site will be located within the Platin cone of depression. The proposed abstraction will not alter the extent of the Platin cone of depression as the planned abstraction is relatively small in comparison to the Platin extraction.

Also, as the amount Platin abstracts is varied to maintain the water table level at or just below the quarry floor the proposed abstraction will not materially add to the total amount of groundwater abstracted from the aquifer. Rather the planned abstraction at the development site will probably result in a small net reduction in the amount of groundwater abstracted from beneath the nearby quarry excavation with the total being abstracted from the aquifer remaining largely unchanged.
However, if the planned abstraction on the development site were to impact on the groundwater levels in nearby private wells, the Company would remedy the situation by deepening the impacted well(s).

The planned disposal of treated waste water to the ground has the potential to impact on groundwater quality immediately below the percolation area.

This discharge of treated effluent would normally have the potential to impact on private wells located downgradient of the percolation area. However, as the development site is located beside the Platin excavation and within its cone of depression any plume of contaminated groundwater generated below the percolation area will now move towards the Platin excavation and eventually form part of the quarry's piped discharge to the River Nanny. As the percolated water will be treated and then passed through different filtering layers before mixing with the local groundwater it will not result in significant contamination of the groundwater beneath the site or that being pumped from the Platin excavation.

The same situation applies to the potential for contamination of the groundwater beneath the development site through accidental spillage of potentially polluting substances including oils, paints and liquid wastes. In such circumstances, any resulting plume would move in the direction of the Platin excavation and potentially result in the deterioration of the groundwater being pumped from the quarry.

10.9 MITIGATION MEASURES

10.9.1 Construction Phase

All oils, chemicals, paints or other potentially polluting substances used during construction will be stored in designated storage areas which will be bunded to a volume of 110% capacity of the largest tank/container within the bunded area(s).

Filling and draw-off points will be fully located within the bunded area(s).

Drainage for the bunded area(s) will be diverted for collection and safe disposal.

All domestic effluent generated on site will be discharged to temporary sewage containment facilities prior to transport and treatment off site.

10.9.2 Operational Phase

Monitoring wells will be located around the perimeter of the facility. These will be sampled in advance of the facility becoming occupied and then sampled frequently to ensure continuation of the base line conditions. Where there is deterioration in groundwater beneath the development site the cause of the contamination will be identified and removed. The company will consult with Irish Cement to ensure that the quality of the groundwater being pumped to the River Nanny is not compromised as a result of any discharge or leakage from the development site.

All substances that would have the potential to cause a negative impact on groundwater will be stored in appropriate containers and/or placed within bunded areas. Raw materials for the process will be stored in containers/silos within the process building. Residues will be stored in a bunker and silos within the process building.

All waste entering the facility will be stored in fully contained structures therefore there will be no potential for leakage to soils. All waste storage facilities will be rendered impervious to the materials stored therein. All concrete underground storage structures whether for waste or liquid (as there is a possibility that firewater run-off may enter any of the tanks) will be constructed as watertight structures in accordance with the requirements of relevant Codes of practice such as BS 8007 British Standard for design and Construction of Aqueous Liquid Retaining Structures. Typically these structures will be reinforced concrete with minimum wall and base thicknesses of 250 mm or greater depending on the structural requirements. Details for the construction of these tanks will follow good building practice, the guidelines in the Code of Practice and details used successfully in other similar structures. The structures will be integrity tested in accordance with the guidelines given in the Code of Practice for leakage to confirm that they are watertight. This will be demonstrated to the satisfaction of the Local Authority following installation and prior to use for storage.

Similarly in the instance of the storm water attenuation tank (which can also contain fire-water run-off) it is proposed that this will be constructed from a sealed Hydrocell type storage unit. The sealing membrane will be welded HDPE membrane which is commonly used for forming secondary containment liners in effluent tanks. The attenuation tank will be tested and demonstrated to be watertight to the satisfaction of the local Authority.

All underground piping will be maintained and regularly inspected for integrity.

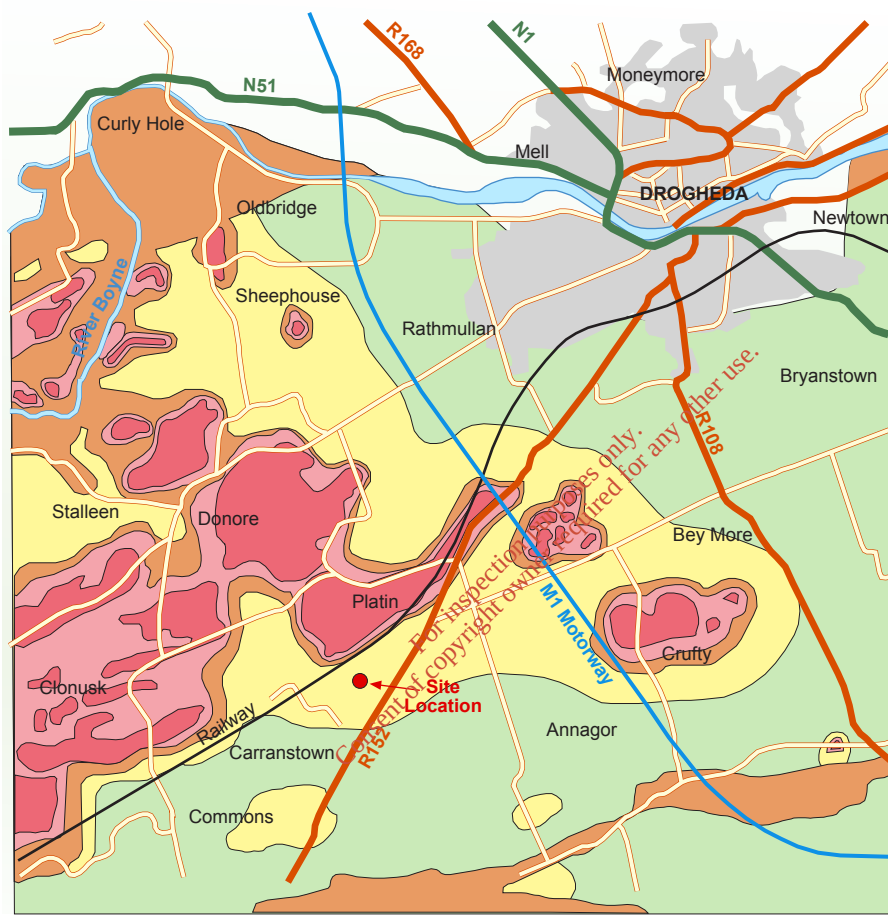
All domestic effluent will be treated by an appropriate system prior to its discharge to the percolation area.

All underground piping will be maintained and regularly inspected for integrity.

A petrol interceptor will be placed on the surface water drainage outfall line from hardstanding areas to contain any leakages from vehicles on site. Full details of the proposed on site drainage network are presented in Section 11.

10.10 RESIDUAL IMPACTS

The proposed facility will not have a significant impact on the hydrogeology of the development site or beneath the surrounding lands.



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KILOMETRES

N

LEGEND

- E (Rock near Surface or Karst)
- E - Extreme
- H - High
- M - Moderate
- L - Low

NOTE: Drawing is for diagrammatic purposes only. No measurements to be taken.

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Figure No. 10.1	Job No. C003425	Date. Nov.2005
	Finalised By -	

White Young Green

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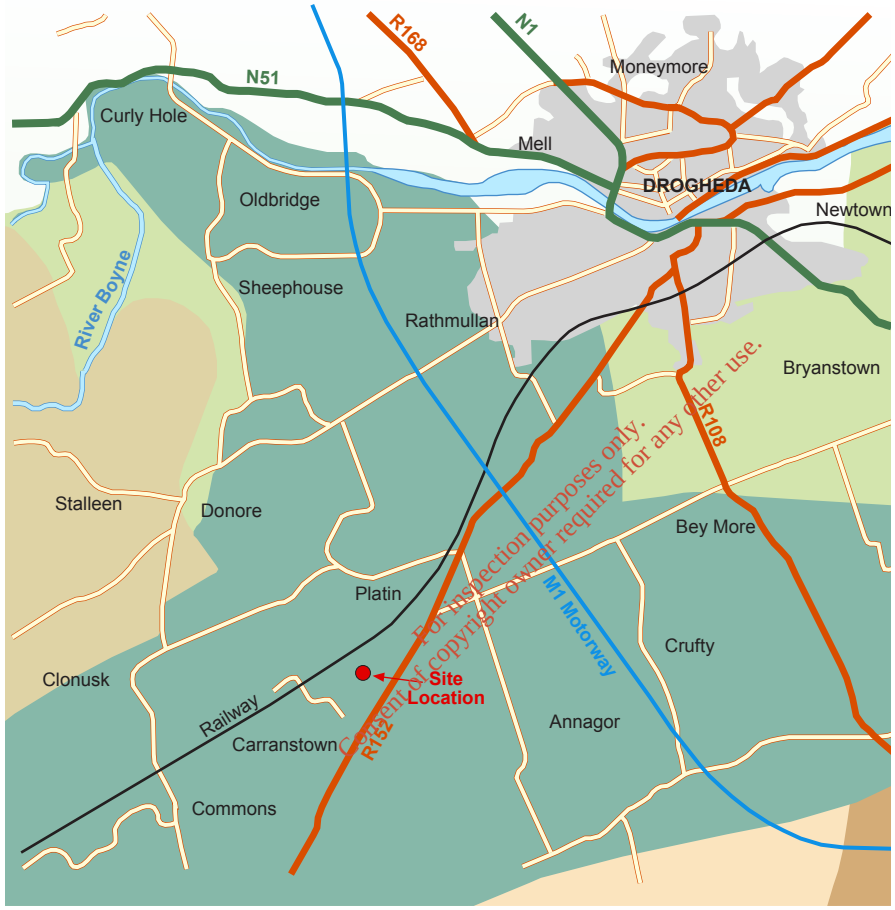

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KILOMETRES

N

LEGEND

- Rkd - Regionally important, diffuse karst aquifer, good development potential
- Lm - Locally important, generally moderately productive
- Ll - Locally important , generally moderate productive in local zones
- Lg - Locally important, sand/gravel aquifers
- Pl - Poor aquifer, generally unproductive except in local zones
- Pu - Poor aquifer, bedrock which is generally unproductive

NOTE: Drawing is for diagrammatic purposes only. No measurements to be taken.

Indaver
Regional Aquifers

Figure No. 10.2	Job No. C003425	Date. Nov.2005
	Finalised By -	

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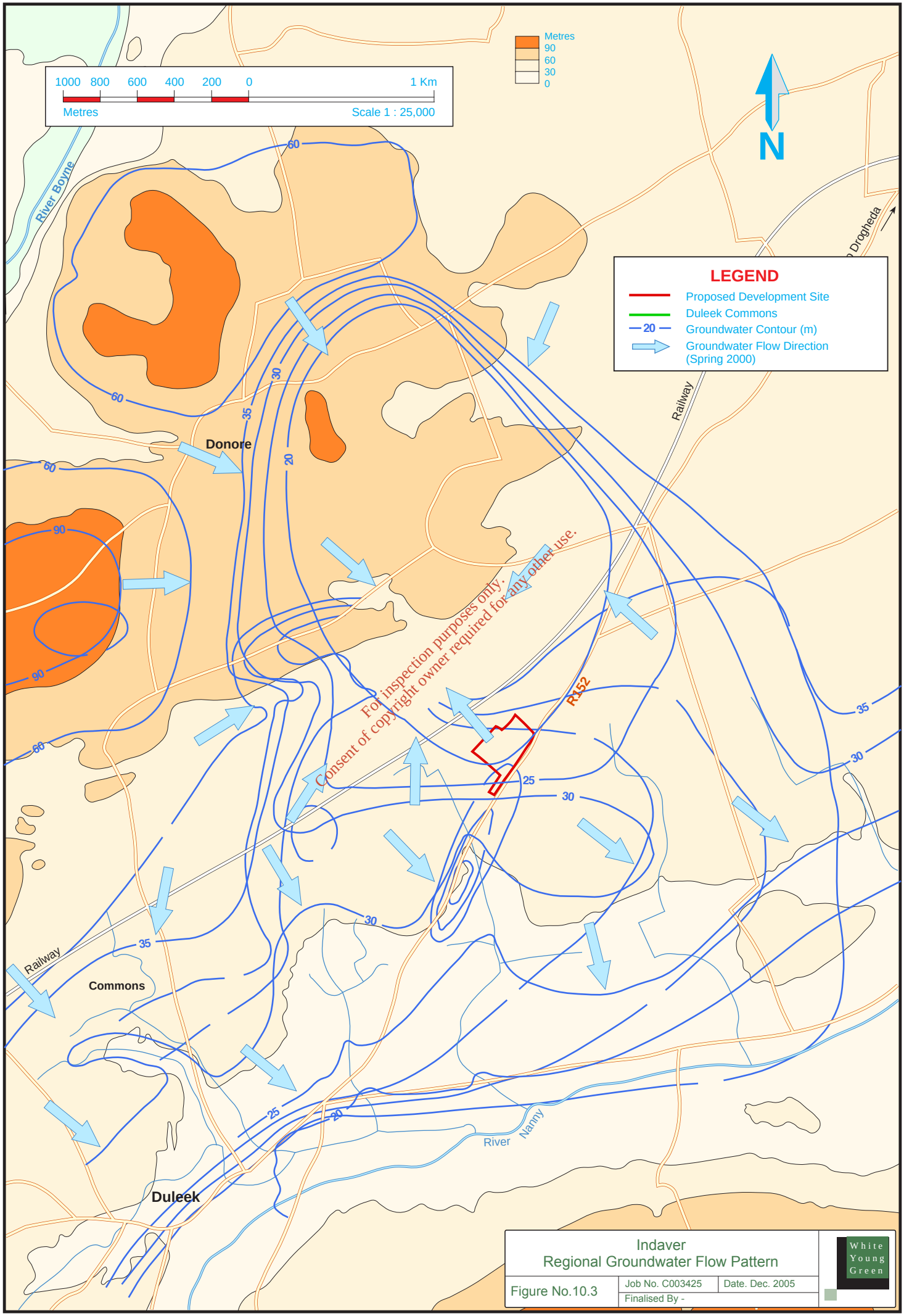
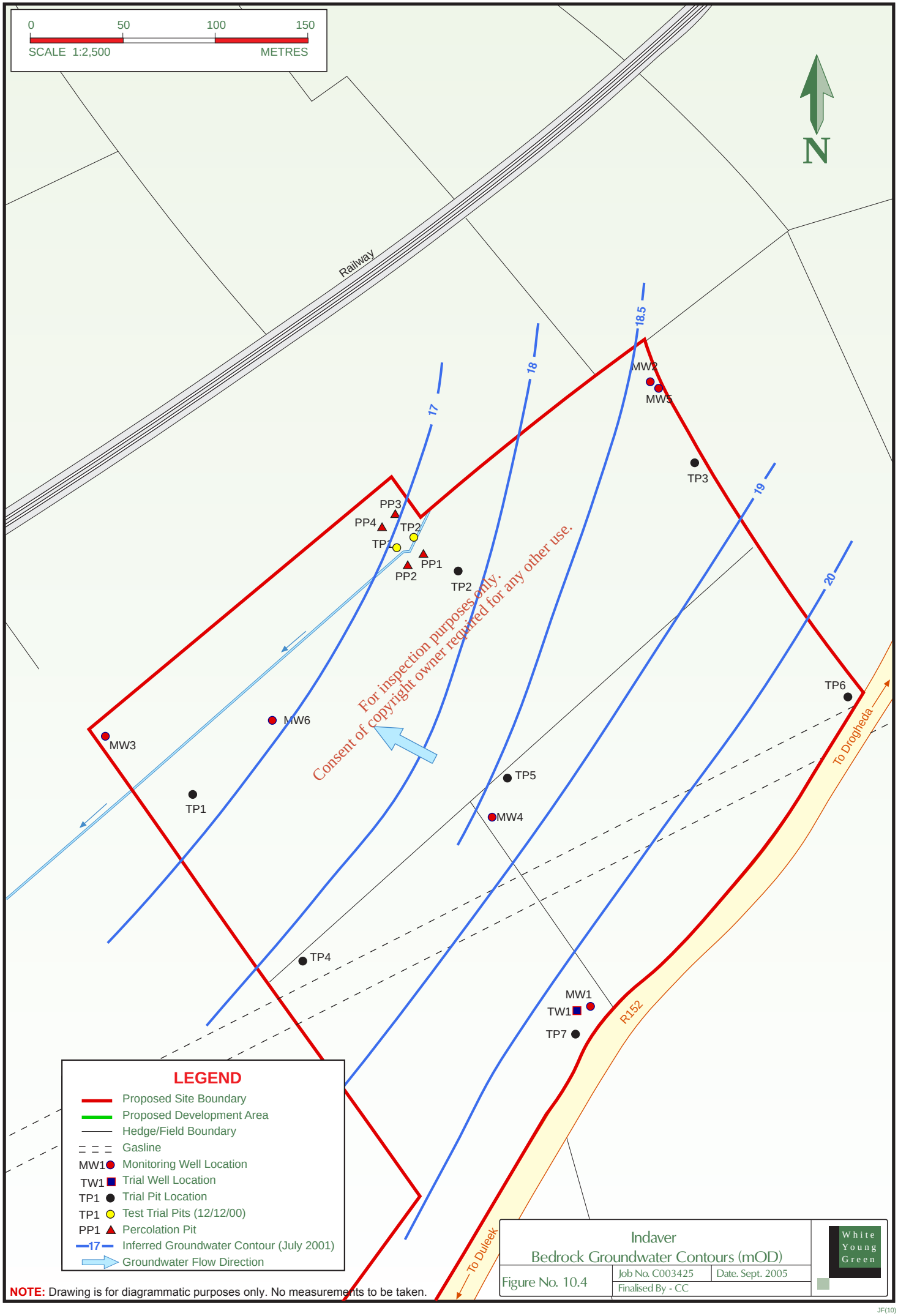
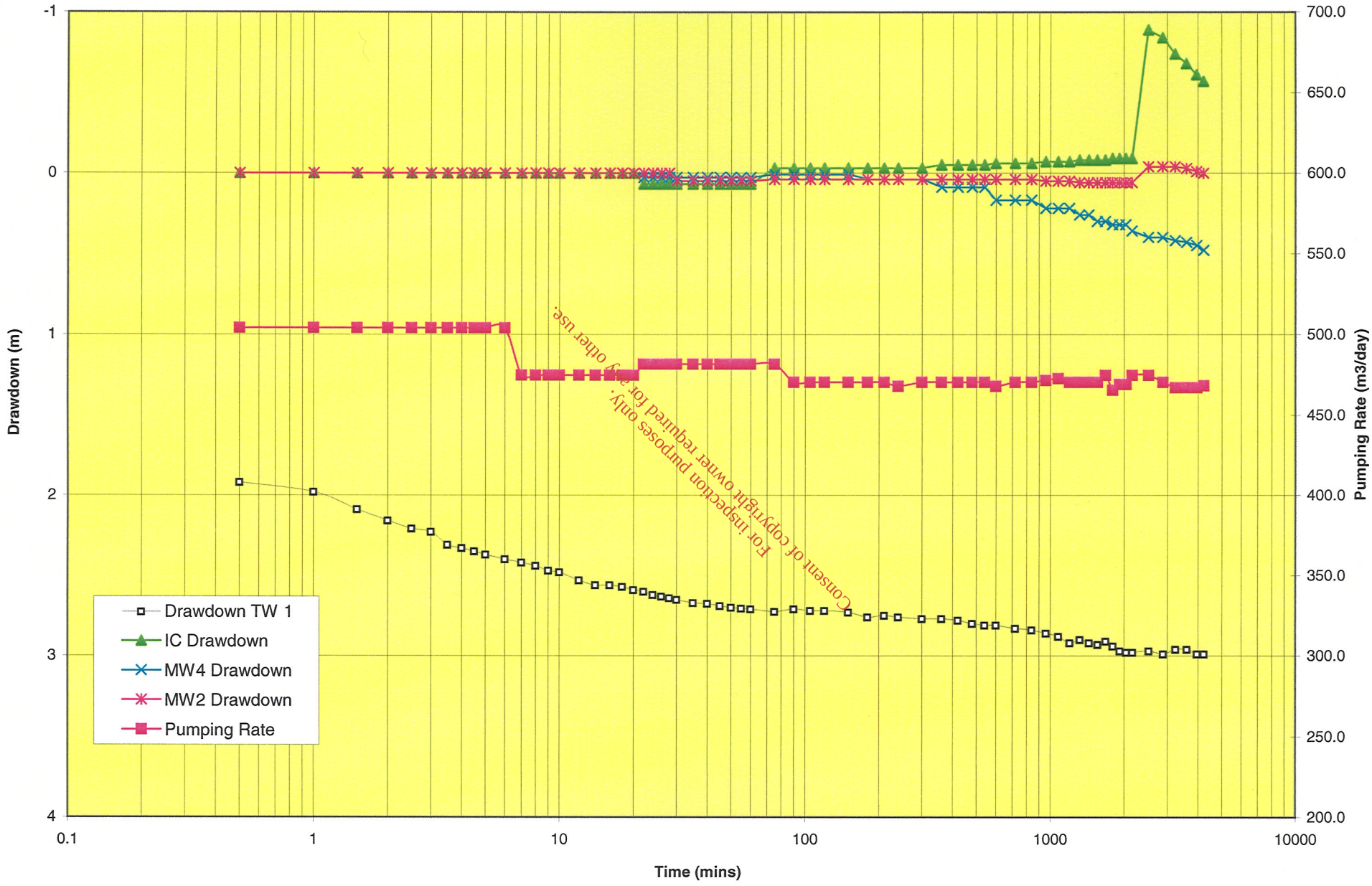




Appendix 10.1

Pump Test



Pumping Rate and Drawdown versus Time for TW 1 and Monitoring Wells 70hr Pumping Test, at Carranstown, Co. Meath, May 2000

Elapsed Time (MINS)	WATER LEVEL BELOW G.L. (m.)	DRAWDOWN (METRES)	YIELD (M3/DAY)
	TW 1		
0	20.73	0.00	0.0
0.5	22.65	1.92	504.0
1	22.71	1.98	504.0
1.5	22.82	2.09	504.0
2	22.89	2.16	504.0
2.5	22.94	2.21	504.0
3	22.96	2.23	504.0
3.5	23.04	2.31	504.0
4	23.06	2.33	504.0
4.5	23.08	2.35	504.0
5	23.10	2.37	504.0
6	23.13	2.40	504.0
7	23.15	2.42	474.8
8	23.17	2.44	474.8
9	23.20	2.47	474.8
10	23.21	2.48	474.8
12	23.26	2.53	474.8
14	23.29	2.56	474.8
16	23.29	2.56	474.8
18	23.30	2.57	474.8
20	23.32	2.59	474.8
22	23.33	2.60	481.7
24	23.35	2.62	481.7
26	23.36	2.63	481.7
28	23.37	2.64	481.7
30	23.38	2.65	481.7
35	23.40	2.67	481.7
40	23.41	2.68	481.7
45	23.42	2.69	481.7
50	23.43	2.70	481.7
55	23.44	2.71	481.7
60	23.44	2.71	481.7
75	23.46	2.73	481.7
90	23.44	2.71	470.4
105	23.45	2.72	470.4
120	23.45	2.72	470.4
150	23.46	2.73	470.4
180	23.49	2.76	470.4
210	23.48	2.75	470.4
240	23.49	2.76	468.0
300	23.50	2.77	470.4
360	23.50	2.77	470.4
420	23.51	2.78	470.4
480	23.53	2.80	470.4
540	23.54	2.81	470.4
600	23.54	2.81	468.0
720	23.56	2.83	470.4
840	23.57	2.84	470.4
960	23.59	2.86	471.6
1080	23.61	2.88	472.8
1200	23.65	2.92	470.4
1320	23.63	2.90	470.4
1440	23.65	2.92	470.4
1560	23.66	2.93	470.4
1680	23.64	2.91	474.8
1800	23.67	2.94	465.6
1920	23.70	2.97	469.2
2040	23.71	2.98	469.2
2160	23.71	2.98	474.8
2520	23.70	2.97	474.8
2880	23.72	2.99	470.4
3240	23.69	2.96	467.2
3600	23.69	2.96	467.2
3960	23.72	2.99	467.2
4230	23.72	2.99	468.3

Time Drawdown Data from 70.5 hour Pumping Test on TW 1 at Carranstown, Co. Meath, May 2000

Appendix 10.2

Meath County Council Correspondence

10th July, 2003

Ms L. Burke,
Indaver Ireland,
Kilakee House,
Tallaght,
Dublin 24

Re: Disposal of Domestic type effluent for construction stage of thermal threatment plant at Carranstown Duleek

Dear Ms Burke,

I refer to your query on the above matter.

Please note that domestic effluent may be tankered to Duleek waste water treatment plant or other such plant as may be determined by the Area Engineer from time to time during the construction stage.

Yours sincerely

John Quinlivan
Area Administrator

11 SURFACE WATER

11.1 DRAINAGE NETWORK

Regional

The proposed development site lies in the River Nanny catchment (Figure 11.1). The River Nanny rises in the south-east of Co. Meath and flows through Duleek towards Laytown, where it discharges to the sea.

A hydrological station located on the River Nanny at Duleek has an estimated dry weather flow of 0.04 m^3/s and a 95 percentile flow of 0.25 m^3/s.

The River Nanny channel is located approximately 2 km south of the development site. Surface water in the vicinity of the site drains naturally towards the river.

Local

Surface water on and in the vicinity of the site drains through land drains and ditches towards the local streams that flow to the River Nanny. The drainage ditches are mostly dry in the summer months.

11.2 SURFACE WATER QUALITY

As the Nanny River is considered a major tributary of the River Boyne, reference was made to the River Boyne Water Quality Management Plan (1997) and the Three Rivers Project, Water Quality Monitoring and Management (2002).

Chemical and biological data for the River Nanny are available from the EPA. The EPA sampling stations are shown in Figure 1 of Appendix 11.1, and the data is given in Appendix 11.1

11.2.1 River Water Quality

The biological records showed that the water quality has improved in this section of the River Nanny (i.e. Stations 4 and 5 in Figure 1, Appendix 11.1) from an average Q-value rating of 3 in 1988 - 1996 to a Q-rating of 3-4 in 1998 – 2001.

11.3 PROPOSED DRAINAGE NETWORK

11.3.1 Foul Water/Sanitary Management

Construction

During the construction phase, domestic effluent generated on the site will discharge to temporary sewage containment facilities prior to its transport and treatment off site. Meath County Council has confirmed their agreement to accept domestic effluent generated during the construction of the facility for treatment in an appropriate wastewater treatment plant. See Appendix 10.2.

Operation

Domestic sewage from toilets, changing and kitchen areas will discharge via the foul drainage system into an on site effluent treatment system which will then pass through a percolation area to ground. The percolation area will be constructed in accordance with the guidelines in the EPA's Wastewater Treatment Manual. (See Section 9 and Appendix 9.4 for details of assessment of the site for the installation of a Puraflo^{TM} system and associated percolation testing).

11.3.2 Industrial Effluent

Operation

Industrial effluent will be contained within the site and evaporated within the incineration process. There will be no discharge of effluent to the drainage network.

11.3.3 Storm Water Management

Construction

The construction stage will be controlled under an Environmental monitoring process to be agreed with the Local Authority. As noted elsewhere in the EIS this process will monitor such issues as dust generation, noise generation, traffic management and surface water run-off.

Run off during the construction will be directed towards settlement tanks for treatment prior to its discharge to the drainage network.A wheel wash will be installed during construction. The discharge from the wheel wash will be directed to the settlement tanks or will be a self-contained unit.

The settlement tanks will be regularly inspected and subsequently de-silted by the site contractor.

The final discharge from the settlement tanks will pass through an oil interceptor prior to its discharge to the existing drainage ditch network.

Operation

Process Building

All waters produced from wash down etc within the waste processing building will be directed to a spill tank located beneath the floor of the building. The spill tanks will have a capacity of 100m^3. Water from this spill tank will be used to supplement process water requirements as detailed in Section 5.2.3.5.1.

Site Drainage

The storm water drainage system will collect rainwater from all roofs, hardstands, roads and grassed areas which fall naturally towards these areas. This area will amount to approximately 6.8Ha. A portion of the site, approximately 3.6Ha will continue to drain naturally to the existing drainage ditches and have not been catered for under the proposed storm water drainage system (all of this area is landscaped).

In order to prevent flooding of the ditches downstream of the facility a discharge rate from the site based on the Dublin City Council Storm Water Management Policy has been incorporated into the drainage design. This discharge rate will be controlled via a hydrobake system. Attenuation for a 1 in 30 year storm will be provided by means of a sealed underground attenuation tank which discharges to the hydrobrake. Attenuation of 1 in 100 year storms will be provided by means of flooding of the kerbed yard and kerbed hardstand areas (see Appendix 11.2 for calculations). The provision of the above system allows the maintenance of the current discharge characteristics to the ditches serving the site ie flows similar to that generated from agricultural land. This will prevent downstream flooding due to “flash flooding” from the site.

The drainage design allows for the monitoring of the storm water discharge at two locations in order to prevent any uncontrolled water discharges from oil leakages, spillages etc entering the watercourses. The parameters required and resultant level limits will be agreed with Meath County Council and the EPA. The first monitoring point will be located prior to the attenuation tank and can divert suspect flows to a watertight storage tank (600m^3) located beneath the pump house. This storage tank has been designed to cater for a 1 in 5 year storm event for 15 minutes (502m^3) in order to provide adequate capacity should an uncontrolled spillage occur during a rainstorm. The stored suspect water will be re-used in the process where possible while the remainder will be stored within the tank for on site treatment or off site disposal to an authorised facility. Should this storage tank be filled the first monitoring chamber will go into overflow mode and allow water to pass into the attenuation tank (4,100m^3) at the outfall of which it will be further sampled by a second monitoring chamber located prior to discharge to the outfall pumps. Should suspect water be detected at this monitoring chamber, the outlet from the attenuation tanks will be shut by an automated valve and the discharge pumps will shut down. In this instance the attenuation tank will be allowed to fill with no discharge.

The outfall from the attenuation tank will be directed to a petrol interceptor. The petrol interceptors will be Class II full retention separator and the separator will be in accordance with European Standard prEN 858 (installations for the separation of light liquids). See Figure 11.2 for a flow diagram of the proposed storm water management system.

11.4 POTENTIAL IMPACTS

Construction Phase

The construction phase will consist, in the main, of the construction of the landscaping bunds, excavation and the construction of the buildings, roads, hardstanding areas, car parks and other ancillary structures.

The main potential impacts arising out of these works will consist of the following:

- Run-off from bare earth surfaces will contain silt and clay particles. Excessive amounts of silt entering the surface water system could clog the stream beds.
- Hydrocarbon contaminated water entering the drainage network has the potential to contaminate the surface water.
- Sewage or canteen effluent entering the surface water system has the potential to contaminate the surface waters.

Operational Phase

The main potential impacts associated with the operational phase will comprise the following:

- Run-off from the site has the potential to impact on surface water quality.
- Fire water run-off generated by a fire occurring in any of the buildings causing uncontrolled flows to the storm water drainage system have the potential to impact on surface water quality.

11.5 MITIGATION MEASURES

Construction Phase

The following mitigation measures will be implemented during the construction phase:

Temporary settlement tanks and interceptors will be constructed as necessary during the early stages of construction mitigating against silt laden run off to the existing drainage network. Prior to commencement of development, written agreement will be sought from the planning authority for details of temporary settlement tanks/silt traps/oil interceptors to control discharges of site surface water run-off during the construction period in advance of the construction of the proposed permanent attenuation tanks. The concentration of suspended solids (SS) of the surface water run-off from the site construction works, for discharge to surface waters, will not exceed 30 mg/litre.

It is proposed to seed and grass the perimeter/screening bunds at the earliest opportunity.

During the construction phase of the development, oil and fuel storage tanks, chemicals and all other materials that pose a risk to waters if spilled, will be stored in designated storage areas, which will be bunded to a volume of 110% of the capacity of the largest tank/container within the bunded area(s). Filling and draw-off points will be located entirely within the bunded area(s). Drainage from the bunded area(s) will be diverted for collection and safe disposal. Bunded pallets will be used for storage of drums.

During the construction phase all domestic effluent generated on site will discharge to temporary sewage containment facilities prior to transport and treatment off site. Meath County Council has confirmed their agreement to accept domestic effluent generated during construction of the facility for treatment in an appropriate wastewater treatment plant.

During the construction stage a temporary wheel wash will be located along the access road to the facility. Site construction roads will be sprayed with water during dry periods to mitigate against the formation of dry dust particles and road sweepers will be operated as required to keep public roads clean.

Operational Phase

There will be no discharge of effluent to the drainage network.

Fuels and oils used on site during the operational phase will be stored in tanks located in concrete containment bunds.

Domestic effluent will be treatment by an appropriate system and discharged to the percolation area. Chemicals or other potentially polluting substances will be stored within the main process.

Run-off from clean hard surfaces on site including the roofs of the buildings, site roads, car parks, hardstanding areas and ancillary buildings will be collected into the surface water drainage system as detailed in Section 11.2.2 above.

All drainage arrangements will comply with the requirements of the planning authority for such works and services.

All sludge from the drainage system, bunds, silt traps and oil interceptors will be regularly collected for safe disposal.

An adequate supply of containment booms and/or suitable absorbent material to control, contain and absorb any potential spillages will be maintained at the facility.

Firefighting and Firewater Retention

Fire suppression is provided by an on site water storage tank with a fire fighting volume of 1200m^3 which is fed by fire pumps to a fire main and hydrant system throughout both the site and buildings. This will be further augmented by Local Fire Service capabilities. Staff will be trained in Emergency Response techniques in order to deal with emergencies including fire fighting. As part of the detailed design and further to discussions with the local Fire service, an application for a Fire safety Certificate will be made to the Local Fire Service and this application will detail in full all fire fighting capabilities for the Facility.

The greatest potential for fire at the facility arises within the 16,000m^3 waste bunker where localised heating can occur due to decomposition of organic material or in the 1,600m^{3}ash bunker from hot ashes.

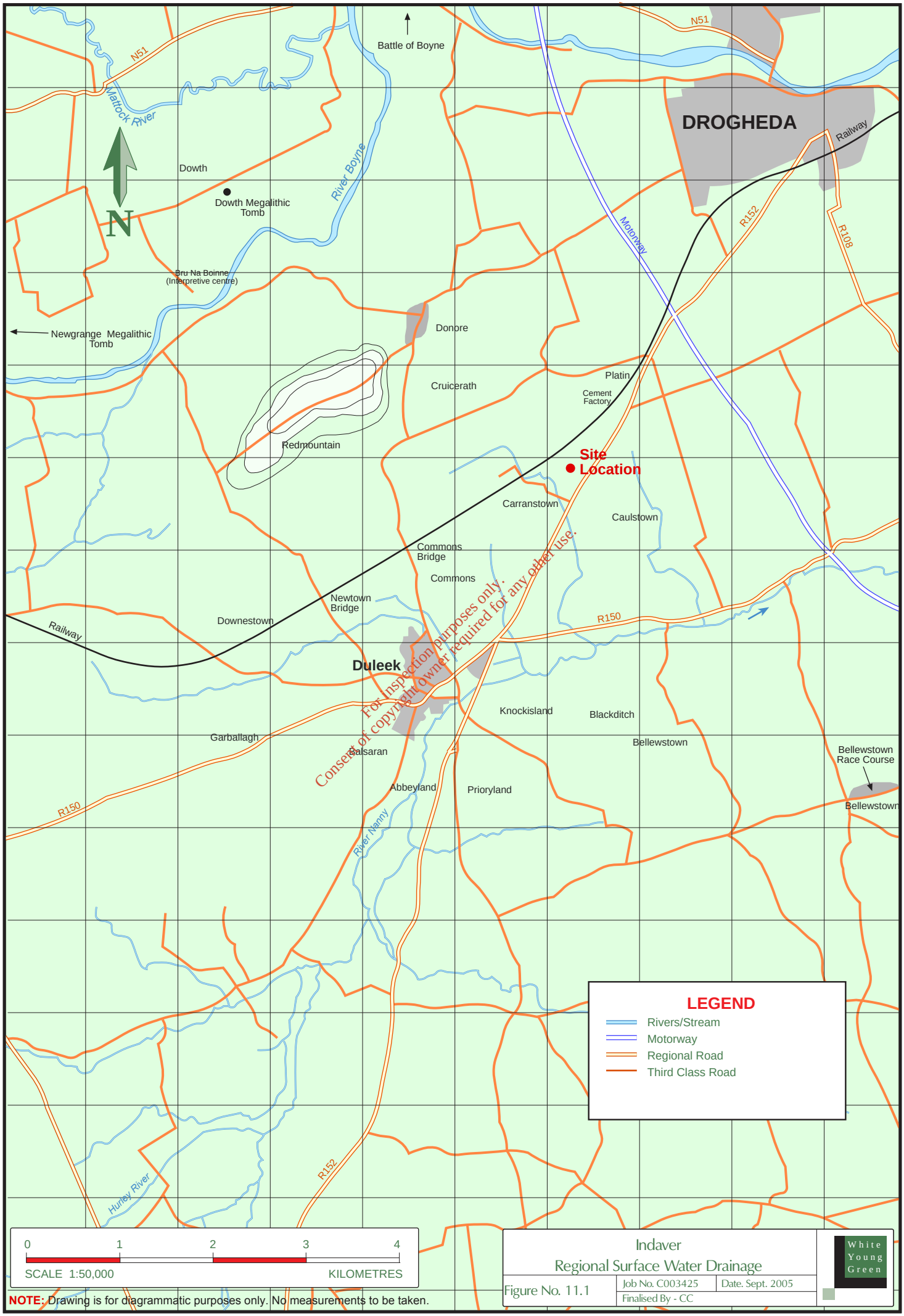
As detailed in Section 5, localised fires within the waste bunker are lifted using the grab crane, into the hoppers which transfer the waste directly to the furnace. Similarly for the Ash Bunker, should a fire occur, water hoses fed from local hydrants/hose reels within the building will be played on the bunker area to suppress the fire. As for the waste bunker, the Ash Bunker will be designed as a water retaining structure and will thus contain any fire water generated within the bunker. The Ash bunker will be integrity tested during construction.

With respect to fire occurring elsewhere in the process building or other buildings on site the run-off will be contained by collection in the surface water drainage system. This in turn will drain to both the diverted water tank located under the pumphouse and also to the attenuation tank (This will be achieved by the provision of an actuated shut-off valve, controlled by the fire alarm/detection system, at the outfall to the attenuation tank. This water will be stored for on site treatment/reuse or removal from site for disposal. The storage volume has been sized to reflect the guidelines provided in the EPA Guidance note on the Requirements for Fire water Retention Facilities which requires the storage volume to be adequate to contain the total volume of fire water plus the possible rainfall run-off from a 1 in 20 year storm over a 24 hour period which respectively give volumes of 1,200m^3 and 3498m^3. This will be provided by the diverted water tank 600m^3 and the attenuation tank 4,100m^3 respectively. As part of the detailed design a full analysis of the Fire water retention requirements will be carried out.

A schematic of the effluent streams and their management is presented in Figure 11.2.

11.5.1 RESIDUAL IMPACTS

The proposed system prevents uncontrolled discharges to the outfall ditch by the provision of two layers of monitoring and a controlled discharge system. As such there will be no significant negative impacts on the existing surface water.



NOTE: Drawing is for diagrammatic purposes only. No measurements to be taken.

Indaver

Regional Surface Water Drainage

Figure No. 11.1	Job No. C003425	Date. Sept. 2005
	Finalised By - CC	

White Young Green

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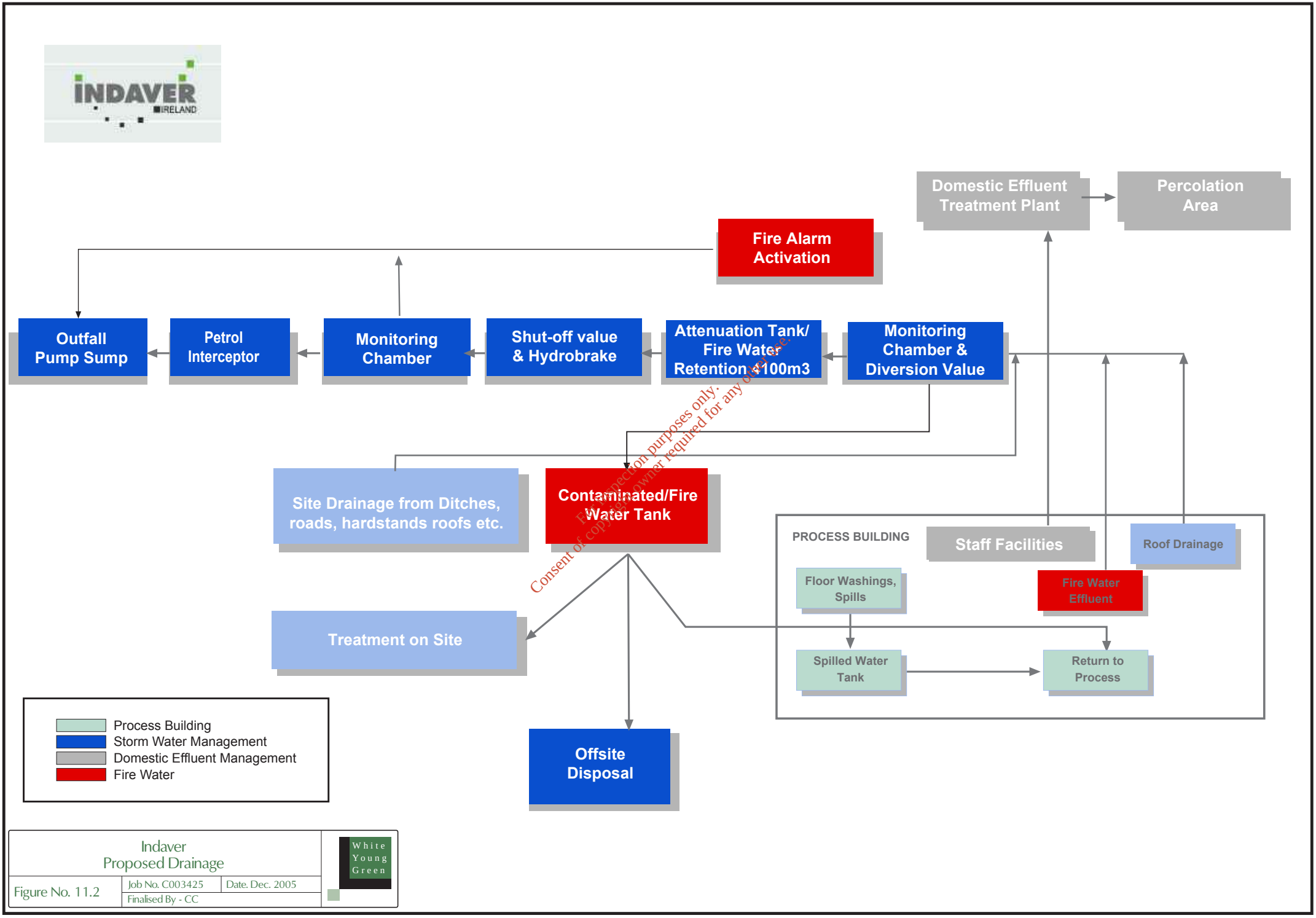

Appendix 11.1

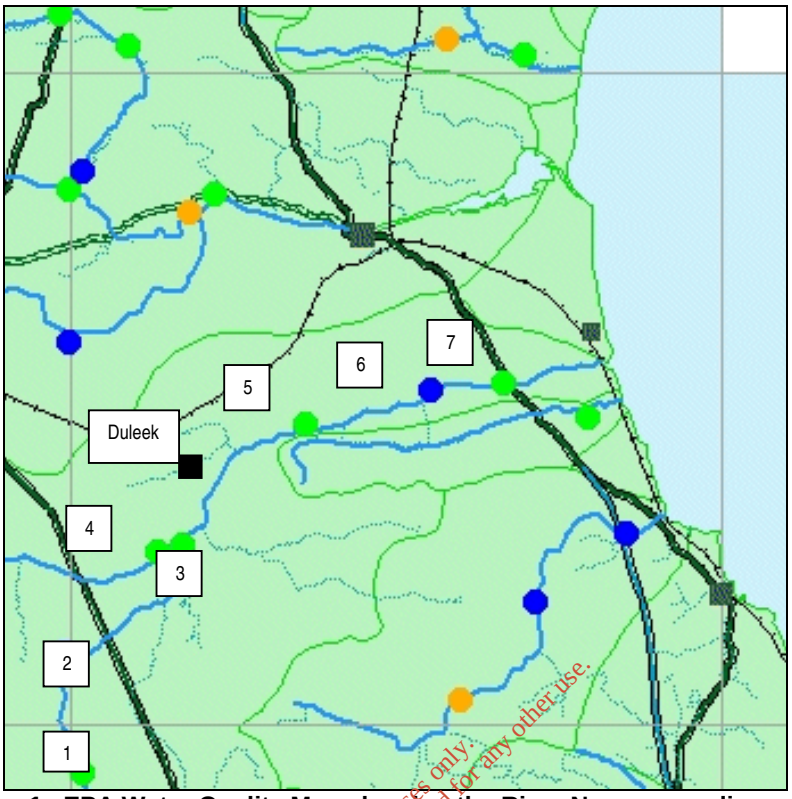

Figure 1. EPA Water Quality Map showing the River Nanny sampling points

EPA data sampling points.

1. Bridge at Painestown
2. Rathfeigh Old Bridge
3. Just upstream River Nanny Confluence
4. **Bridge downstream of Nanny Bridge**
5. **Bridge NE Bellewstown House**
6. Daristown Bridge
7. Bridge at Julianstown

1 Biological Quality

Current data for biological data show that this section of the river has a Q-value of 3-4, indicating slightly polluted (McGarrigle *et al*., 2004). The biological records showed that the water quality has improved in this section of the River Nanny from an average Q-value rating of 3 in 1988 - 1996 to a Q-rating of 3-4 in 1998 – 2001.

Comparable biological data are available for the years: 2001, 1998, 1996, 1991 and 1988. A direct comparison between years showed that in 1991 there was an improvement in water quality at the station downstream of Duleek. In other sampling years, there was no change recorded between stations upstream and downstream.

Table 1 Comparable Biological Data (2001, 1998, 1996, 1991 and 1988)

Year	Upstream	Downstream	Change
2001	3-4	3-4	No change
1998	3-4	3-4	No change
1996	3	3	No change
1991	3	3-4	Improvement
1988	3	3	No change

2 Chemical Quality

For the assessment of organic pollution, the more commonly measured parameters include BOC, DO, Phosphates, Oxidised Nitrogen and Ammonia (McGarrigle *et al*., 2002). The most recent chemical data available for the stations upstream and downstream of Duleek are given in Tables 2 and 3 respectively. There is an increase in median values downstream of Duleek for B.O.D., Ortho-Phosphate and Total Ammonia. Oxidised nitrogen values are higher upstream. D.O values are higher downstream.

EPA guidelines for maximum BOD values are < 3mg/l in unpolluted waters (< 5mg/l Freshwater Fish Regulations and ≤ 4 mg/l Water Quality Guidelines). Maximum values at both stations are in excess of this indicating a high BOD upstream and downstream. DO values in unpolluted waters should be between 80 -120%. Maximum values downstream are slightly in excess of this value. Recommended median values for Ortho-Phosphate are <0.030 mg/l P. Both stations are well in excess of this value. Oxidised Nitrogen and Total Ammonia at both stations are below the recommended maximum of 50mg/l and 0.3 mg/l (Drinking Water Standards).

BOD and Ortho-Phosphate values are higher than recommended values at both stations but there is no clear change in values between these points. This indicates that there is no obvious change in chemical water quality standards between these two stations.

Table 2 Chemical Data Upstream of Duleek (Location 4, Figure 1)

Station No: 0280 **Location:** Downstream Nanny Bridge **Date From:** 2001 **To:** 2005

Parameter	Parameter Units	Minimum	Median	Maximum	No of Samples	Source	Source Type
B.O.D	mg/l O^2		1.17	6.55	12	Meath Co Co	LA
Dissolved Oxygen	% Saturation	84.5		111.1	12	Meath Co Co	LA
Ortho-Phosphate	mg/l P		0.100	0.261	12	Meath Co Co	LA
Oxidised Nitrogen	mg/l N		4.889	5.975	12	Meath Co Co	LA
Total Ammonia	mg/l N		0.042	0.948	12	Meath Co Co	LA

Table 3 Chemical Data Downstream of Duleek (Location 5, Figure 1)

Station No: 0500 **Location**: Bridge NE Bellewstown House **Date From:** 2001 **To:** 2005

Parameter	Parameter Units	Minimum	Median	Maximum	No of Samples	Source	Source Type
B.O.D	mg/l O^2		1.68	5.73	12	Meath Co Co	LA
Dissolved Oxygen	% Saturation	92.2		122.4	12	Meath Co Co	LA
Ortho-Phosphate	mg/l P		0.120	0.235	12	Meath Co Co	LA
Oxidised Nitrogen	mg/l N		4.827	5.819	12	Meath Co Co	LA
Total Ammonia	mg/l N		0.093	0.541	12	Meath Co Co	LA

Appendix 11.2

Calculations

SITE ATTENUATION

Indaver, Carranstown

Site Area: 67960 m^2
6.796 ha
0.06796 km^2

SAAR 760 mm per Met Eireann fax 03/07/01 letter of 03/07/01
SOIL Index 0.3 per Dublin Corp Stormwater Policy Document Jan 1999

Mean Annual Peak Flow (Permissible Outflow Rate)

QBAR = 0.00108 x(AREA)$^{0.89}$(SAAR)$^{1.17}$(SOIL)$^{2.17}$ m^3/s
(per Dublin Corp Stormwater Policy Document Jan 1999)
QBAR = 0.01698 m^3/s
QBAR = 16.98 l/s

TABLE 1

Attentuation Areas (Developed site):

	Area m^2	Permblty Co-eff	Net non Permeable Area m^2
Roads	24000	1	24000.0
Main Bldg	24960	1.0	24960.0
Grass	19000	0.3	5700.0
TOTAL	67960	-	54,660.0

TABLE 2: User to input site specific information

Duleek Co.Louth Ave Annual Rain Fall = 760 mm											
Maximum Rainfall (mm) over indicated duration, expected in the indicated return period											
Duration			Return Period (Years)								
									Ave:20&50		
		Seconds	0.5	1	2	5	10	20	Assume 30	50	100
1	min	60	0.0	0.0	0.0	1.7	2.0	2.4	2.8	3.1	3.5
2	min	120	0.0	0.0	0.0	2.9	3.5	4.2	4.8	5.3	6.1
5	min	300	0.0	0.0	0.0	5.2	6.3	7.6	8.7	9.7	11.1
10	min	600	0.0	0.0	0.0	7.5	9.0	11.0	12.6	14.2	16.4
15	min	900	4.5	5.7	6.5	9.2	11.4	14.0	16.2	18.3	21.0
30	min	1800	6.1	7.3	8.6	12.2	15.1	18.4	21.2	24.0	28.0
60	min	3600	8.0	10.2	11.3	15.7	19.3	23.0	26.5	30.0	35.0
2	hours	7200	10.8	13.4	15.0	20.1	24.0	29.0	32.5	36.0	42.0
4	hours	14400	14.8	18.1	20.0	26.0	31.0	36.0	40.5	45.0	51.0
6	hours	21600	17.8	21.8	24.0	31.0	37.0	43.0	47.5	52.0	60.0
12	hours	43200	23.1	28.0	31.0	39.0	46.0	53.0	59.0	65.0	73.0
24	hours	86400	29.0	34.0	38.0	48.0	56.0	64.0	71.0	78.0	88.0
48	hours	172800	36.0	43.0	46.0	58.0	68.0	77.0	84.5	92.0	103.0

TABLE 3: = Table 2 x 54,660.0 (Net non permeable area m2)

TOTAL WATER ON SITE (m^3)											
Duration			Return Period (Years)								
									Ave:20&50		
		Seconds	0.5	1	2	5	10	20	Assume 30	50	100
1	min	60	0.0	0.0	0.0	92.9	109.3	131.2	150.3	169.4	191.3
2	min	120	0.0	0.0	0.0	158.5	191.3	229.6	259.6	289.7	333.4
5	min	300	0.0	0.0	0.0	284.2	344.4	415.4	472.8	530.2	606.7
10	min	600	0.0	0.0	0.0	410.0	491.9	601.3	688.7	776.2	896.4
15	min	900	246.0	311.6	355.3	502.9	623.1	765.2	882.8	1000.3	1147.9
30	min	1800	333.4	399.0	470.1	666.9	825.4	1005.7	1158.8	1311.8	1530.5
60	min	3600	437.3	557.5	617.7	858.2	1054.9	1257.2	1448.5	1639.8	1913.1
2	hours	7200	590.3	732.4	819.9	1098.7	1311.8	1585.1	1776.5	1967.8	2295.7
4	hours	14400	809.0	989.3	1093.2	1421.2	1694.5	1967.8	2213.7	2459.7	2787.7
6	hours	21600	972.9	1191.6	1311.8	1694.5	2022.4	2350.4	2596.4	2842.3	3279.6
12	hours	43200	1262.6	1530.5	1694.5	2131.7	2514.4	2897.0	3224.9	3552.9	3990.2
24	hours	86400	1585.1	1858.4	2077.1	2623.7	3061.0	3498.2	3880.9	4263.5	4810.1
48	hours	172800	1967.8	2350.4	2514.4	3170.3	3716.9	4208.8	4618.8	5028.7	5630.0

TABLE 4: = Time (secs) x 0.01698 (QBAR allowable discharge rate in m3/sec)

ALLOWABLE RUN OFF m^3 OVER GIVEN PERIOD OF TIME											
Duration			Return Period (Years)								
									Ave:20&50		
		Seconds	0.5	1	2	5	10	20	Assume 30	50	100
1	min	60	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0
2	min	120	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0
5	min	300	5.1	5.1	5.1	5.1	5.1	5.1	5.1	5.1	5.1
10	min	600	10.2	10.2	10.2	10.2	10.2	10.2	10.2	10.2	10.2
15	min	900	15.3	15.3	15.3	15.3	15.3	15.3	15.3	15.3	15.3
30	min	1800	30.6	30.6	30.6	30.6	30.6	30.6	30.6	30.6	30.6
60	min	3600	61.1	61.1	61.1	61.1	61.1	61.1	61.1	61.1	61.1
2	hours	7200	122.3	122.3	122.3	122.3	122.3	122.3	122.3	122.3	122.3
4	hours	14400	244.5	244.5	244.5	244.5	244.5	244.5	244.5	244.5	244.5
6	hours	21600	366.8	366.8	366.8	366.8	366.8	366.8	366.8	366.8	366.8
12	hours	43200	733.5	733.5	733.5	733.5	733.5	733.5	733.5	733.5	733.5
24	hours	86400	1467.1	1467.1	1467.1	1467.1	1467.1	1467.1	1467.1	1467.1	1467.1
48	hours	172800	2934.1	2934.1	2934.1	2934.1	2934.1	2934.1	2934.1	2934.1	2934.1

TABLE 5: = Table 3 - Table 4

STORAGE REQUIRED m^3											
Duration			Return Period (Years)								
									Ave:20&50		
		Seconds	0.5	1	2	5	10	20	Assume 30	50	100
1	min	60	0.0	0.0	0.0	91.9	108.3	130.2	149.3	168.4	190.3
2	min	120	0.0	0.0	0.0	156.5	189.3	227.5	257.6	287.7	331.4
5	min	300	0.0	0.0	0.0	279.1	339.3	410.3	467.7	525.1	601.6
10	min	600	0.0	0.0	0.0	399.8	481.8	591.1	678.5	766.0	886.2
15	min	900	230.7	296.3	340.0	487.6	607.8	750.0	867.5	985.0	1132.6
30	min	1800	302.9	368.5	439.5	636.3	794.8	975.2	1128.2	1281.3	1499.9
60	min	3600	376.2	496.4	556.5	797.0	993.8	1196.1	1387.4	1578.7	1852.0
2	hours	7200	468.1	610.2	697.6	976.4	1189.6	1462.9	1654.2	1845.5	2173.5
4	hours	14400	564.5	744.8	848.7	1176.6	1449.9	1723.2	1969.2	2215.2	2543.1
6	hours	21600	606.2	824.8	945.1	1327.7	1655.7	1983.6	2229.6	2475.6	2912.8
12	hours	43200	529.1	796.9	960.9	1398.2	1780.8	2163.4	2491.4	2819.4	3256.6
24	hours	86400	118.1	391.4	610.0	1156.6	1593.9	2031.2	2413.8	2796.4	3343.0
48	hours	172800	0.0	0.0	0.0	236.1	782.7	1274.7	1684.6	2094.6	2695.8
								MAX STORAGE REQUIRED = (m^3)	**2491.4**		**3343.0**

In order to allow for the volumes generated by Fire Water run-off the attenuation tank is to be greater than the volumes above.