MEHL (Murphy Environmental Hollywood Ltd.)

Baseline Report in Accordance with Section 86B of the EPA Act 1992, as Amended

March 2014

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Report Issue Form

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Report Title: Baseline Report in Accordance with Section 86B of the EPA Act 1992, as Amended

Project Code: MU0119

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Appendices

1.0 Introduction and Background

1.1 Report Context

1.1.1 MEHL (Murphy Environmental Hollywood Ltd.) made an application to the EPA for a Waste Licence for an integrated waste management facility at its site at Hollywood Great, Nag's Head, Naul, Co. Dublin. The Application was lodged with the Agency on 17th December 2010, with additional information submitted post-December 2010.

1.1.2 Due to the recent enactment of new legislation[1], the MEHL application now falls under the 'Industrial Emissions' licensing regime.

1.1.3 The Agency issued correspondence to MEHL on 18th February 2014, requesting the Applicant to furnish such information as is necessary to comply with the requirements of Regulation 9 of the EPA (Industrial Emissions) (Licensing) Regulations, 2013.

1.1.4 This Baseline Report is presented with reference to Regulation 9(n) of the aforementioned Regulations, which states the following:

> *"provide, when requested by the Agency, in the case of an activity that involves the use, production or release of relevant hazardous substances (as defined in section 3 of the Act of 1992) and having regard to the possibility of soil and groundwater contamination at the site of the installation, a baseline report in accordance with section 86B of the Act of 1992".*

1.1.5 This report draws on extensive site investigation, analysis and information submitted to the Agency as part of the licence application process since December 2010; relevant cross-references are provided herein. In addition, the facility has collected significant amounts of data through the operation of the licensed inert landfill (EPA ref. W0129-02), which are relevant as baseline groundwater reference conditions.

1.1.6 In the interests of clarity, currently-licensed inert landfill operations on site are referred to under EPA licence no. **W0129-02**. The development of a proposed integrated waste management facility at the site is referenced under EPA application reference no. **W0129-03**.

1.2 Requirements of Section 86B of the EPA Act

1.2.1 The requirements of the Section 86B of the EPA Act, 1992 (as amended) are as follows:

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[1] European Union (Industrial Emissions) Regulations 2013, S.I. 138 of 2013, and Environmental Protection Agency (Industrial Emissions) (Licensing) Regulations 2013, S.I. 137 of 2013

"86B. (1) Where an industrial emissions directive activity involves the use, production or release of relevant hazardous substances, and having regard to the possibility of soil and groundwater contamination at the site of an installation concerned, the Agency shall require an applicant under this Part for a licence or review of a licence or a revised licence relating to the activity, including such a review by the Agency of its own volition, to furnish to the Agency a baseline report in accordance with regulations under section 89.

(2) In relation to an installation, a baseline report shall contain the information necessary to determine the state of contamination of soil and groundwater as the time that the report is drawn up in order that a quantified comparison may be made to the state of the site upon the permanent cessation (including cessation by abandonment) of the industrial emissions directive activity concerned and the applicant in preparing the baseline report shall include any information prescribed in regulations under section 89.

(3) Notwithstanding the generality of subsection (2), a baseline report shall include at least the following information –

(a) the current use and, where available, the past use of the site,

(b) any available information –

(i) on soil or groundwater measurements that reflect the state of the site at the time that the baseline report is drawn up, or

(ii) on new soil and groundwater measurements, having regard to the possibility of soil and groundwater contamination by the hazardous substances proposed to be used, produced or released by the installation concerned.

(4) Any information furnished to the Agency or to any other body under any enactment or rule of law or a law of the European Union, which complies with the requirements of subsection (2) or (3), may be furnished to the Agency in or with the baseline report.

(5) For the purposes of determining the information to be contained in a baseline report under this section the Agency shall have regard to, and shall for the purposes of subsection (2), make publicly available any guidance documents published by the Commission of the European Union in accordance with Article 22(2) of the Industrial Emissions Directive.

(6) Upon the permanent cessation (including cessation by abandonment) of an industrial emissions directive activity the licensee concerned shall assess the level of contamination of soil and groundwater by the relevant hazardous substances used, produced or released by the installation concerned, and where the installation has caused significant pollution of soil or groundwater by relevant hazardous substances compared to any levels of contamination of soil and groundwater established in the baseline report that licensee shall take the necessary measures, taking into account the technical feasibility of such measures, to address that pollution so as to return the site to the state established in the baseline report.

(7) Without prejudice to subsection (6) where, upon permanent cessation (including cessation by abandonment) of an industrial emissions directive activity the level of contamination of soil or groundwater at the site of the installation concerned –

(a) poses a significant risk to human health or the environment, and

(b) occurred as a result of any industrial emissions directive activity, to which Directive 2008/1/EC of the European Parliament and of the Council of 15 January 2008 applied and in respect of which a licence is or was in being under this Part or Part V of the Act of 1996, prior to review of the licence or revised licence under section 90, for the first time after the coming into operation of the European Union (Industrial Emissions) Regulations 2013, and taking account of the condition of the site of the installation established in information already furnished to the Agency, the licensee shall take all necessary actions aimed at removal, control, containment or reduction of relevant hazardous substances, so that the site, taking into account its current use or future use in relation to which necessary approval or consent has been granted, ceases to pose a significant risk.

(8) On permanent cessation (including cessation by abandonment) of an industrial emissions directive activity in relation to which, under this section, no baseline report is required, the licensee shall take all necessary actions aimed at removal, control, containment or reduction of relevant hazardous substances, so that the site, taking into account its current use or future use in relation to which a necessary licence, approval or consent under any enactment has been granted, ceases to pose any significant risk to human health or the environment due to contamination of soil and groundwater as a result of the licensed activities concerned and taking account of the condition of the site established in information, including information furnished with an application for a licence or revised licence, already furnished to the Agency.

(9) In subsections (7) and (8) information already furnished to the Agency is information furnished in relation to –

(a) a licence under this Part, in accordance with Regulations under section 89, or

(b) a licence under Part V of the Act of 1996 in accordance with Regulations under section 45 of that Act.

(10) The Agency shall make relevant information publicly available on the measures taken under subsection (6) or the necessary actions taken under subsection (7) or (8) upon the permanent cessation of an industrial emissions directive activity.

(11) In this section –

'baseline report' means information on the state of soil and groundwater contamination by relevant hazardous substances;

'soil' has the meaning given by section 86A(11).”

1.3 European Commission Guidance Concerning Baseline Reports

1.3.1 *European Commission Guidance concerning baseline reports under Article 22(2) of Directive 2010/75/EU on industrial emissions* (Draft 17 June 2013[2]) is intended to assist stakeholders by developing the wording and intent of Directive 2010/75/EU on industrial emissions (IED) so that Member States implement it in a consistent manner.

1.3.2 The guidance outlines the stages in producing a baseline report as follows:

- Stage 1: Identifying the hazardous substances that are currently used, produced or released at the installation ⇨ See Chapter 3
- Stage 2: Identifying the relevant hazardous substances, i.e. those which have the potential to cause soil and groundwater contamination ⇨ See Chapter 3
- Stage 3: Assessment of the site-specific pollution risk ⇨ See Chapter 3
- Stage 4: Site history ⇨ See Chapter 2
- Stage 5: Environmental setting ⇨ See Chapter 2
- Stage 6: Conceptual site model ⇨ See Chapter 4
- Stage 7: Site investigation ⇨ See Chapter 4
- Stage 8: Production of the baseline report ⇨ [this document]

1.3.3 Annex 1 of the guidance note lists 'baseline investigation and report checklist', which identifies 'essential' and 'optional' items. This is reproduced in **Appendix 1**. This Baseline Report has due regard for these requirements, as detailed in **Chapter 6**.

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[2] Patel Tonra Ltd. has confirmed with the Commission (06/03/2014) that this is the current/latest version of the document.

2.0 Site History and Environmental Setting

2.1 Review of Previous Reports

2.1.1 This report draws on extensive information submitted to the Agency as part of the licence application process since December 2010; relevant cross-references are provided.

2.1.2 The following summary list of information has been submitted to the Agency, and is available for inspection on epa.ie (IE Licence Ref. W0129-03):

1. Waste Licence Application and EIS, 17/12/10
2. Unsolicited information re. notices to Planning Authorities, 30/06/11
3. Unsolicited information re. revised drawings, 18/07/11
4. Article 14 information, 08/08/11
5. Correspondence to EPA re. status of application, 10/12/11 and 14/3/12
6. Article 16 information, 19/4/12
7. Unsolicited information re. An Bord Pleanála reports, 28/05/12
8. Article 14 information, 28/05/12
9. Article 16 information, 07/06/12
10. Article 16 information, 20/08/12
11. Article 14 information, 20/08/12
12. Report on Assessment of Hydrogeological Isolation (Bog of the Ring and the MEHL Site), 18/02/13
13. Article 16 information, 15/05/13
14. Article 16 information re. CRAMP, 21/05/13
15. Article 16 information, 21/05/13
16. Correspondence re. contact details, 02/07/13
17. IED Registration Form, 14/08/13
18. Unsolicited information re. management structure, 16/10/13
19. Article 16 information, 17/10/13
20. Correspondence re. time extension, 11/12/13

2.1.3 In addition, the facility has collected significant amounts of data through the operation of the licensed inert landfill (EPA ref. W0129-02), including environmental monitoring results, reports, investigations, waste analysis, etc.

2.2 Site Use and Site History

2.2.1 Murphy Environmental Hollywood Ltd (MEHL) owns and operates a licensed inert landfill located at Hollywood Great, Nag's Head, Naul, County Dublin. The facility is licensed by the Environmental Protection Agency (EPA), licence reference number W0129-02. The site has been EPA-licensed and operational since 2003. It was formerly a quarry from which limestone and shale were extracted.

2.2.2 The site is located at Hollywood Great, Nag's Head, Naul, Co. Dublin (National Grid Reference National Grid Reference E315810, N258015) approximately 32km north of Dublin City Centre. The site is bounded to the west and south by local primary roads LP01090 and LP01080. The regional road, R108, runs in a north-south direction approximately 1km west of the site. The M1 runs in a north-south direction, approximately 2.5km east of the site. The site is located at Nag's Head hill, the highest point of which is approximately 151 m.OD.

2.2.3 The site is a former quarry from which limestone and shale was extracted. The area of land in the ownership and control of MEHL is 54.4 hectares (the 'blue line' area); of which the proposed planning application and EPA waste licence application covers 39.8 hectares (the 'red line' area). The facility is a fully operational inert landfill regulated by the EPA under Waste Licence W0129-02 and Fingal County Council Planning Permission F04A/0363 and F07A/0262. It provides a strategically located waste disposal facility for inert wastes and mildly contaminated soils. The facility is operated to the highest standards in environmental management and control.

2.2.4 The site is licensed to accept up to 500,000 tonnes of inert waste per annum, comprising various forms of construction and demolition waste, soils and stone and other inert wastes. This includes mildly contaminated soils, which comply with the limit values for waste acceptable at landfills for inert waste as set out in Section 2.1.2 of EU Council Decision of 19 December 2002 (2003/33/EC) establishing criteria and procedures for the acceptance of waste at landfills. A copy of EPA waste licence W0129-02 is attached in **Appendix 2** (previously attached to the Waste Licence Application (Dec. 2010), which is available for inspection at epa.ie).

Planning History

2.2.5 Quarrying commenced at the Hollywood site in the late 1940s (pre the 1963 Planning and Development Act).

2.2.6 Planning permission was initially granted in 1988 to infill, restore and reinstate that portion of the quarry which had been excavated at that stage. That planning application, lodged with Dublin County Council on 15th January 1988, was for a proposed infill and land reclamation works at an existing quarry at Hollywood Great, Naul, Co. Dublin. The Register Reference was 88A/32. Notification of Decision to Grant Permission was dated 13th June 1988. The Final Grant of Permission was issued on 27th July 1988; that Permission ceased to have effect on 27th July 2003.

2.2.7 An application for an extension of duration of planning permission was lodged on the 19th June 2003. The Register Reference was 88A/0032/E1. A Decision to extend the life of the permission was granted on 12th August 2003. The life of the permission was extended for a period of 18 months up to and including 31st December 2004. The extension period provided the time to complete a full EIS and new planning application for the restoration of the site, in line with requirements of the EPA Waste Licence.

2.2.8 A planning application was lodged by Murphy Environmental dated 18th March 2004 (Register Reference F04A/0363) to infill with inert material the existing quarry as part of the restoration and reinstatement of that quarry. Permission was sought for a period of 15 years to continue to infill the quarry at a maximum rate of 340,000 tonnes per year in accordance with the limits set in the EPA licence. A Decision to Grant Permission was made by Fingal County Council dated 1st September 2004 and a Final Grant was issued on 7th October 2004.

2.2.9 An application was lodged by Murphy Environmental dated 8th March 2007 (Register Reference F07A/0262) to vary the permission F04A/0363, to permit the infill of an extended quarry area, and at an increased rate per year of 500,000 tonnes per annum. The Planning Authority decided to grant permission for this variation on 31st May 2007 and the Final Grant issued on 18th July 2007.

2.2.10 Copies of relevant planning permissions granted in 2004 (Register Reference F04A/0363) and 2007 (Register Reference F07A/0262) were attached in the Waste Licence Application (Dec. 2010) (available for inspection at epa.ie).

2.2.11 A Planning Application and EIS were submitted to An Bord Pleanála on the 10th December 2010 (An Bord Pleanála Ref. 06F.PC0087). The application was submitted as ‘Strategic Infrastructure Development’. The application relates to MEHL’s proposal for an integrated waste management facility for non-biodegradable waste, including hazardous waste, at EPA Licence W0129-02, Hollywood Great, Nag’s Head, Naul, Co. Dublin.

2.2.12 As a prescribed body for the planning application, full copies of the application (print and electronic copies) were delivered to the EPA on 10th December 2010. It is noted that the site falls within the functional area of Fingal County Council, and previous planning applications have been lodged with Fingal County Council. The Planning Authority for the purposes of this application is An Bord Pleanála, as the proposal is deemed ‘Strategic Infrastructure’ under the relevant planning legislation.

2.2.13 An Bord Pleanála and Fingal County Council were informed of MEHL’s intention to submit an application to the EPA for the proposed development

2.2.14 An Bord Pleanála granted permission for Strategic Infrastructure Development Ref. 06F.PA0018 for the proposed MEHL integrated waste management facility at Hollywood Great, Nag’s Head, Naul, Co. Dublin. A copy of the decision was submitted to the Agency on 28/05/12 (available for inspection at epa.ie).

2.3 Outline of Proposed Development

2.3.1 MEHL proposes to develop the current activities through the construction of an integrated waste management facility within the present boundaries for the acceptance of non-biodegradable waste, including hazardous and non-hazardous waste-to-energy incineration residues, hazardous and non-hazardous soils and inert soils, and other compatible waste streams.

2.3.2 The proposed MEHL facility will comprise of the following:

- Construction of fully engineered landfill cells, designed to international best practice standards, suitable for the acceptance of:
    - Hazardous ash and soils and other compatible non-biodegradable waste streams.
    - Non-hazardous, non-biodegradable wastes.
    - Inert wastes.
- Construction of administration building, car park and ancillary infrastructure.
- Provision of a new facility entrance and access road.
- Construction of a solidification plant, associated storage building and staff welfare facilities.

- Installation of leachate, surface water and other associated landfill management infrastructure.
- Development of landscaping, wetlands and biodiversity area.

2.3.3 The new entrance will cater for all construction and customer traffic into both the landfill and solidification plant. It is proposed to retain the existing entrance as an emergency entrance/exit only.

2.3.4 The total waste input will be up to 500,000 tonnes per annum, which is consistent with the existing planning permission and EPA licence and does not therefore represent an increase from that already approved.

2.3.5 Full details of the proposed development can be found in Chapter 4 *Proposed Site and Project Description* of the EIS, submitted to the Agency to accompany the Waste Licence Application (Dec. 2010) (available for inspection at epa.ie).

2.4 Environmental Setting; Soil/Groundwater Measurements that Reflect Current State of Site

2.4.1 The site is a former quarry and the facility is an existing and operational inert landfill (EPA Licence W0129-02) (See **Appendix 2**).

2.4.2 The operator is required to complete a range of environmental monitoring and reporting, in line with licence requirements. Full quarterly monitoring reports have been submitted to the Enforcement Section of the EPA since 2003, as required. Summary information was submitted to the EPA as part of the EIS (attached to the Waste Licence Application (Dec. 2010) and available for inspection at epa.ie) and updated information was submitted to the Agency as part of Article 16 information, 07/06/12 (available for inspection at epa.ie). This summary data is further updated and provided in **Appendix 3** for the following parameters:

- Rainfall and evapotranspiration
- Groundwater levels
- Groundwater quality
- Surface water quality

2.4.3 A full environmental impact assessment has been completed for the proposed integrated waste management facility. The EIS (authored by Arup (December 2010)) was attached to the Waste Licence Application (Dec. 2010) (available for inspection at epa.ie). Relevant text extracts were provided in Attachment I of the Waste Licence Application (Dec. 2010), as requested by the Agency. Attachment I, *Existing Environment and Impact of the Facility*, of the Waste Licence Application (Dec. 2010) is copied in **Appendix 4** of this report.

Landscape Character[3]

2.4.4 The area is part of the North Fingal Uplands which forms a high lying area to the north of the County around Naul. The topography of the area is quite pronounced and falls from west to east. Knockbrack is the highest point at 176 mA.O.D and forms part of a visual ridge to the north of the County. This visual ridgeline encloses the site to the west extending southwards to Hollywood Great at 151mA.O.D. Part of the eastern flank of this local hill at Hollywood Great has been removed by quarrying and is now part of the subject site. Some minor ridgelines run west to east from these higher lands along which are aligned local County roads. Walshestown Road (LP01080) on the southern boundary of the site parallels a ridge as does the County road to the north within the townlands of Walshestown and Rowans Little.

2.4.5 Typical land uses comprise a mix of arable and pasture. Hedgerows form strong field boundaries and are quite dense containing many mature trees. Mature tree and woodland groups tend to occur around old settlements and along rivers and ditches. A linear belt of mixed woodland runs along the ditch to the east of the site and there are wooded pockets within the townlands of Tooman and north of Walshestown.

2.4.6 The elevated nature of the Fingal Uplands allows panoramic and long range views from selected view-points, extending towards the Irish coast to the east and the Wicklow Mountains to the south. In other locations where the viewpoint is less elevated views tend to be more enclosed by topography and vegetation, such as the lands east of the site.

Bedrock Geology, Quaternary Geology and Soils[4]

2.4.7 A detailed bedrock geology assessment carried out by Tara Prospecting Ltd. (1985) deals with the rocks in the immediate vicinity of the site and is based on their borehole database and local investigations. In summary, their assessment indicated a complex sequence of lithologies in the area, ranging from Namurian and Brigantian shales to Asbian limestones and volcanics to the north. The Namurian shales dominate the eastern part of the area and the Brigantian shales surround these on all sides.

2.4.8 The rocks underlying the area around the site can be described, from youngest to oldest formation, as belonging to the following formations within the Carboniferous Period:

- Walshestown Formation
- Balrickard Formation
- Loughshinny Formation
- Naul Formation
- Lucan Formation

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[3] Extracted from EIS (2010), Section 12.3.2
[4] Extracted from EIS (2010), Section 14.3.2

2.4.9 The Quaternary (subsoil) strata data is scarce for this area; a map compiled from pre-existing data was produced to accompany an investigation for the location of landfill sites by the Geological Survey of Ireland for Dublin County Council (1979). This provides a guide to the depth and type of Quaternary sediment in the area. The map classifies all the tills as limestone dominated. However, the information presented in the Teagasc Soil Maps presented on the GSI website appears to describe these soils as tills containing Namurian Shales and Sandstones

2.4.10 The ice depositing the tills was most likely extending from the Irish midlands, southwards and eastwards across the area and may contain some far travelled limestone clasts. This till deposit is quite common in this region and is typical of the till dominated by clasts of Namurian lithologies, found in north County Dublin.

2.4.11 The Gley group of soils cover most of the region in which the MEHL site is located, with the exception of Knockbrack Hill/ Nags Head area and the Palmerstown townland area where the soils are of the Brown Earth Group. A small isolated area of peat occurs around the Bog of the Ring Commons area.

2.4.12 The MEHL site is located in the Knockbrack Hill/ Nags Head area and is therefore characterised by the Brown Earth Group soils. These are a relatively mature soil. They are generally well drained mineral soil. The typical profile is uniform with little or no differentiation into horizons. These soils are not extensively leached or degraded and thus there is little evidence in the soil profile of removal and deposition of iron oxides, humus or clay. The soils of this group are generally good arable soils although sometimes low on nutrients. They have good drainage and structure characteristics with medium textures.

MEHL Site Geology[5]

2.4.13 Numerous boreholes were drilled on the MEHL site between 1998-2010 as part of the work for the existing EPA waste licence for the MEHL facility. As part of the EIS investigation additional boreholes were drilled in the centre of the site at a later stage. This information was used to establish the geology in this area and further delineate the geological profile of the site (ARUP 2010).

2.4.14 The MEHL site is located on a significant bedrock feature that strikes in a WNW-ESE direction. Overall the geology of the site youngs to the north, starting with the Loughshinny formation passing upwards and eventually into the Walshestown formation (EIS, Arup 2010).

2.4.15 The majority of the site is underlain by the Namurian. The limestones of the Loughshinny Formation crop out in the southern part of the MEHL site and dip to the north, where they are covered by at least 60m of Namurian strata in the northern parts of the site.

2.4.16 Four formations (Carboniferous) have been identified on site. The Loughshinny and part of the Donore Formations are Dinantian in age, while the other part of the Donore Formation, along with the Balrickard and Walshestown Formations are Namurian in age.

2.4.17 The oldest formation observed on site is the Loughshinny Formation and consists of limestone breccias formed by debris flows and turbidites. Younger parts of this formation are made up of well graded limestones interbedded with argillaceous limestones and dark shales (EIS, Arup 2010).

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[5] Arup (Feb. 2013) *Assessment of Hydrogeological Isolation (Bog of the Ring and the MEHL Site)* (submitted to the EPA 18/2/13 and available for inspection in full at epa.ie)

2.4.18 The Namurian formations are encountered next and these are composed of shales with argillaceous limestones and sandstones. The oldest Namurian deposit beneath the MEHL site is the Donore Formation. It is thought to form part of an unconformity between the eroded older units of the Loughshinny Formation and the younger units of the Balrickard Formation. It is of Brigantian to Pendleian age and is estimated to have a thickness of up to 250m in the North Dublin Area. This formation was difficult to identify in both outcrops and core samples from the underlying and overlying units due its similarity to both in different areas and the poor quality of much of the core and/or chippings. In BH18 core samples taken at 15 mbgl appeared to be the Loughshinny Formation but palynology analysis proved them to be Namurian in age, indicating they were from the Donore Formation (EIS, Arup 2010).

2.4.19 The overlying Balrickard Formation is described in borehole logs as “Moderately strong to moderately weak, thickly laminated to thinly bedded (to structure-less where clay-filled), interbedded fine-grained sandstone and mudstone with large amounts of orange/yellow/brown clay infill”. It is assumed that the contact between the Walshestown Formation and the Balrickard formation is an erosional contact which follows the topography of the north-western corner of the site (EIS, Arup 2010).

2.4.20 In the north of the site, where the Walshestown formation is observed, the rocks are described as black shales with ironstone and subordinate siltstone with rippled fine sandstone bands, calcareous mudstone and biosparite. In the borehole logs it is described as “Moderately weak to moderately strong, thinly bedded to thinly laminated, dark grey/black, interbedded fine-grained sandstone and siltstone/mudstone with large amounts of black clay infill” (EIS, Arup 2010).

2.4.21 The Quaternary deposits on the site and in the immediate surrounding areas consist of till. They vary in thickness and texture but are generally less than 5m thick and have a clay/silt matrix with dispersed pebble clasts. The till contains weathered clasts of Namurian shale and sandstone, with some limestone. Where the till cover is thin it tends to have a coarser texture, being more silty to sandy. Much of the naturally occurring soils on-site have been stripped and stockpiled during the quarrying operations.

2.4.22 The MEHL site is located on the southern limb of the more regional WNW-ESE trending syncline which means that the Loughshinny Formation is dipping to the north and therefore is being buried deeper in that direction. Furthermore, the Loughshinny Formation appears to have been downthrown significantly by the EW trending fault so that in the north of the site there is over 60m of Namurian deposits above it. This means that the Loughshinny Formation is overlain by increasing thicknesses of the Donore, Balrickard and Walshestown formations moving northwards across the site (EIS, Arup 2010).

2.4.23 The geophysical and geological investigations conducted as part of the site investigation identified a number of faults across the MEHL site. The main fault (Hollywood Fault) appears to run roughly N-S (34°) through the site with another two faults running perpendicular to this aligned in an E-W direction. The strata in the Loughshinny and the lower parts of the Donore Formations are likely to therefore contain significant fractures and faults (EIS, Arup 2010).

2.4.24 The Hollywood Fault is near vertical and varies from 2 to 3.5m in width. Where exposed it is relatively fresh and appears to be quartz filled. There is a significant downthrow to the east that may amount to some tens or hundreds of metres. This is probably a continuation of the fault that the GSI shows on Sheet 13 (McConnell et al 2004) immediately north of the Hollywood site (Conodate, 2009).

MEHL Landfill Site Hydrogeology[6]

2.4.25 The bedrock succession in this former quarry site can be divided into an aquifer unit, the Loughshinny Formation and the lower part of the overlying Donore Formation and an aquitard unit which consists of the upper part of the Donore Formation and the overlying Balrickard and Walshestown Formations. The Loughshinny Formation, the effective aquifer in the system is classified by the GSI as a Locally Important Aquifer and the aquitard as a Poor Aquifer.

2.4.26 As stated earlier, the MEHL site is located in the southern limb of the Naul syncline. The effect of this synclinal structure is to bury the Loughshinny Formation deeper as it is traced northwards through the centre of the syncline.

2.4.27 The aquitard is composed of formations which were deposited during the Namurian period and is part of the Hynestown GWB. The upper part of the Donore Formation is similar to the overlying Namurian strata and therefore is considered to be part of the aquitard. The area defined as the aquitard consists of a hill of Namurian strata.

2.4.28 On site, both the aquifer and aquitard are old indurated rocks and therefore are dominated by secondary permeability, in the form of joints, fractures, weathered/broken zones and faults. The permeability is likely to be related to particular horizons within the formations. The limestones of the Loughshinny Formation crop out in the southern part of the MEHL site and dip to the north, where they are covered by at least 60 m of aquitard strata in the northern parts of the site.

2.4.29 Faults may influence the hydrogeology of the site either by acting as a conduit for flow or as a barrier to flow. Many of the production and monitoring wells drilled on site were positioned at locations to investigate these features via a pumping test.

Groundwater Flow

2.4.30 The regional groundwater level pattern is shown in Figure 3 of Article 16 information submitted to the Agency on 17/10/13 – copied in **Appendix 5** of this Baseline Report. The local groundwater flow pattern observed at the MEHL site is shown in Figure 4 of Article 16 information submitted to the Agency on 17/10/13 – copied in **Appendix 5** of this Baseline Report.

Drainage[7]

2.4.31 There are at least four surface water catchments (three NW-SE and one N-S) between the MEHL site and the Bog of the Ring Wellfield. The three NW-SE catchments originate in the upper reaches of Knockbrack Hill and extend in a southeast direction towards the lower lying areas of Rowans Little, Walshestown and Tooman. Each of the surface water catchments is drained by a stream and each stream is separated by elevated ground. To the northeast of Knockbrack Hill, a catchment area extends in a northeast direction towards Curragh Bridge. This catchment again is drained by a single stream which is flowing in a northerly direction.

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[6] Arup (Feb. 2013) *Assessment of Hydrogeological Isolation (Bog of the Ring and the MEHL Site)* (submitted to the EPA 18/2/13 and available for inspection in full at epa.ie)

[7] Arup (Feb. 2013) *Assessment of Hydrogeological Isolation (Bog of the Ring and the MEHL Site)* (submitted to the EPA 18/2/13 and available for inspection in full at epa.ie)

2.4.32 These surface water catchment areas would all have developed individual micro groundwater catchment areas where shallow groundwater flow would follow topography.

2.4.33 The MEHL site is located in the upper part of a groundwater catchment. This location, the general absence of large springs in the aquifer, the confined nature of much of the aquifer in the site area and the moderate gradient and velocity indicate that the natural groundwater throughput in the aquifer is relatively low.

2.5 Pollution History; Possible Sources of Historical Contamination

2.5.1 The site is licensed by the EPA as an inert landfill; licence reference number W0129-02. The site has been EPA-licensed and operational since 2003. It was formerly a quarry from which limestone and shale were extracted.

2.5.2 The licensed facility is an engineered landfill, designed to meet compliance with the Landfill Directive 1999. Incoming waste is subject to strict Waste Acceptance criteria and testing, in compliance with Council Decision (2003/33/EC) Establishing Criteria and Procedures for the Acceptance of Waste at Landfills.

2.5.3 There are no known sources of historical contamination and there is no history of pollution at the site. This is corroborated by environmental monitoring datasets discussed in **Section 2.4.2** above.

3.0 Potential Hazardous Substances and Risk

3.1 Pollution Risk Substances[8] – Current Activities

3.1.1 Under the terms of W0129-02, the licensee was required to complete and submit to the EPA assessments of (i) 'CRAMP' (Closure, Restoration & Aftercare Management Plan), (ii) ELRA (Environmental Liabilities Risk Assessment) and (iii) FP (Financial Provision). This report was completed in May 2010 (for the licence year 2009) on behalf of MEHL by Patel Tonra Ltd., Environmental Solutions.

3.1.2 Environmental Liability Risk Assessment (ELRA) considers the risk of unplanned events occurring during the operation of a facility that could result in unknown liabilities materialising. The process considered potential environmental risks, as follows:

- Breach of cell liner/leachate contamination of local waters; associated with cell construction/integrity of cell liner
- Groundwater/ surface water pollution associated with tank failure/ spillages/ leaks; associated with storage of machine diesel in vehicles/mobile plant and fuel bowser
- Groundwater/ surface water pollution; associated with storage of waste oil in garage
- Slope failure; associated with cell construction/slope stability issue
- Failure of septic tank; associated with septic tank
- Groundwater/ surface water pollution associated with tank failure/ spillages/ leaks; associated with storage of machine diesel at bunded fuel storage area
- Explosive gas/gas emissions to atmosphere; associated with landfill gas generation from deposited waste
- Vibration impacts/slope stability issues; associated with site operations/equipment
- Siltation of local surface waters; associated with surface water runoff
- Fire Risk; associated with fuel storage/ vehicles/ equipment/ offices
- Groundwater/ surface water pollution associated with interceptor failure/ leaks oil interceptor
- Groundwater/ surface water pollution storage of oils & chemicals in garage

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[8] *European Commission Guidance concerning baseline reports under Article 22(2) of Directive 2010/75/EU on industrial emissions* (Draft 17 June 2013), Annex I: "*Identification of substances in, on or under the land, from materials currently used or produced by the activities under the permit (or are likely to be used or produced in the future) which may be a pollution risk*".

3.1.3 There have been a number of adjustments to on-site activities/processes since the publication of the May 2010 report (aforementioned in **Section 3.1.1**). Under current arrangements/operations, the principal potentially-polluting substances relate to potential leachate emissions from the inert waste disposal area. This is mitigated via engineered lining systems, designed to meet compliance with the Landfill Directive 1999. Incoming waste is subject to strict Waste Acceptance criteria and testing, in compliance with Council Decision (2003/33/EC) Establishing Criteria and Procedures for the Acceptance of Waste at Landfills. The licensee is obliged to manage and operate the facility to ensure that the activities do not cause environmental pollution.

3.2 Pollution Risk Substances – Proposed Activities

3.2.1 Patel Tonra Ltd., Environmental Solutions was commissioned by MEHL to assess the company's obligations for a proposed integrated waste management facility at Hollywood Great, Nag's Head, Naul, Co. Dublin, in relation to Environmental Liability Risk Assessment (ELRA); Closure, Restoration and Aftercare Management Plan (CRAMP); and Financial Provision (FP).

3.2.2 The report is based on information pertaining to the proposed development set out in the planning and waste licence applications, and accompanying EIS. The report methodology was based on EPA guidance in force at the time of writing[9].

3.2.3 The report is dated May 2013 and was submitted to the Agency on 21/05/13 (available for inspection at epa.ie). The report is copied in **Appendix 6** of this Baseline Report.

Hazard Identification[10]

Legislation

3.2.4 Council Directive 96/82/EC of 9 December 1996 on the control of major-accident hazards involving dangerous substances as amended by 2003-105-EC is known as the Seveso Directive or COMAH Directive. This Directive has been transposed into Irish law by the European Communities (Control of Major Accident Hazards Involving Dangerous Substances) Regulations 2006 (S.I. No. 74 of 2006).

3.2.5 The objectives of the Directive are to minimise the risk of major accidents by applying loss prevention techniques to projects from the design stage onwards, and by providing appropriate mitigation measures to minimise the consequences of those major accidents that may occur.

Applicability of Seveso Directive

3.2.6 Incinerator fly ash and residues from gas cleaning are classified as "N" "dangerous to the aquatic environment" with combined risk phrases R51/53 – "Toxic to aquatic organisms; may cause long term adverse effects in the aquatic environment" because of the concentrations of heavy metals in these wastes. The quantities of these materials present at the MEHL facility will exceed the lower tier threshold of 200 tonnes, but not the upper tier threshold of 500 tonnes.

3.2.7 Incinerator ash i.e. bottom ash, fly ash and residues from gas cleaning is not classified as toxic (T) or very toxic (T+) to human health. It is classified as harmful (Xn) with combined risk phrase R20/21/22.

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[9] EPA (2006) *Guidance on Environmental Liability Risk Assessment, Residuals Management Plans and Financial Provision*

[10] EIS (Arup, 2010). Submitted to the Agency 17/12/10 and available for inspection at epa.ie

3.2.8 A notification has been made to the Health & Safety Authority under the European Communities (Control of Major Accidents involving Dangerous Substances) Regulations 2006.

Risk Assessment

3.2.9 The flue gas treatment residues are classified as hazardous to the aquatic environment. The solidified material (after processing) is not classified as hazardous.

3.2.10 This material will be present at the MEHL facility as follows:

(a) Storage silos (approximately 200 tonnes) to provide storage for 48 hours usage in the solidification plant.

(b) Road tanker (approximately 50 tonnes) based on two fully loaded 40 m^3 tankers

(c) In process (0.5 tonne)

3.2.11 The storage silos, road tanker and curing area will be located within a contained area, so that any loss of containment will be prevented from entering watercourses, etc. The storm water from the contained area will discharge to a hazardous waste leachate holding tank and used in the solidification process as described above.

3.2.12 Mixtures of flue gas treatment residues and other materials are not classified as hazardous to the aquatic environment, whether uncured, partially cured or totally cured.

3.2.13 Flue gas treatment residues and other incinerator ashes are not toxic to humans. Aqueous hydrochloric acid will be stored in a bunded tank. Hydrochloric acid is a corrosive material.

3.2.14 Small quantities of diesel oil will be stored in bunded tanks for refuelling site vehicles.

3.2.15 The physical form of the cured solidified waste and the containment measures adopted for other materials will ensure that the risk of a major accident is negligible.

Potential Major Accidents

3.2.16 Potential major accidents at the proposed development have been identified as the following:

- Loss of containment of incinerator ash from road tanker at the facility.
- Loss of containment of incinerator ash storage silo.

Measures for Preventing Major Accidents

3.2.17 Incinerator ash will be transported to the facility in fully enclosed and contained road tankers. Each road tanker will have a capacity of approximately 25 tonnes. Up to two such road tankers could be present at the facility at any one time.

3.2.18 The road tankers will be purpose-designed for the transport of incinerator ash and will be sealed to prevent loss of containment.

3.2.19 At the facility, tankers will be weighed in, directed to solidification plant; driven inside the solidification building and automatic doors will close behind the vehicle. Incinerator ash will be pneumatically transferred from the road tanker to the storage silos, which will have a capacity of 200 tonnes. Transfer hoses will be specified for transfer of incinerator ash and designed to withstand at least 1.5 times the operating pressure. Hoses will be regularly pressure tested and inspected, and will be replaced at regular intervals.

3.2.20 The storage silos will be designed to international standards and will be provided with a vent filter to prevent the escape of dust, although the dust does not present a toxic hazard to humans.

3.2.21 Procedures will be established and training provided for staff in the discharge of road tankers and the operation of all associated equipment.

Measures for Mitigating the Consequences of Major Accidents

3.2.22 The road tanker parking area, the ash storage silos and the solidification plant will be located within a kerbed area, providing containment in an emergency scenario. The area will be sloped to a collection sump, which will be provided with a valve.

Other Details

3.2.23 There will be diesel oil stored onsite in the proposed development. The maximum quantity of diesel oil stored will be 7,500 litres (or 6.26 tonnes). It is proposed to install a 7,500 litre diesel tank for site machinery, to be stored in a bunded and roofed storage building. It is proposed to construct this building adjacent to the solidification yard. The reinforced concrete bund walls will be constructed to watertight standard BS8007 and sized to retain 110% of the total diesel volume. A steel and single skin cladding will be provided to roof the building and prevent water ingress into the bund. The existing fuel storage area will be decommissioned when the new fuel storage area has been installed.

3.2.24 It is envisaged that the solidification process will use cement (or replacement binding materials, as appropriate), acid and water. 1 No. cement silo will be provided at the solidification plant, with capacity of 78m^3; equivalent to approximately 117 tonnes.

3.2.25 Under normal use, cement is not expected to be hazardous to the environment[11]. If acid is accidently released to the environment, persons should wear appropriate protective clothing. Small spillages can be absorbed on an inert absorbent, transferred to a suitable container and removed to an appropriate off-site facility. For large acid spillages, liquids should be contained with sand or earth and both liquids and solids transferred to containers[12].

3.2.26 2 No. bunded acid tanks will be provided at the solidification plant, with capacity of 2 x 30m^3; equivalent to approximately 72 tonnes. Hydrochloric acid (HCl) will be the preferred acid type. At a throughput of 50,000 tpa through the solidification plant, it is estimated that approximately 7,500 tonnes of HCl will be used per annum (this may be subject to variation on the basis of mixing ratios to be applied at MEHL).

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[11] Irish Cement (2007) Safety Data Sheet for Cement

[12] VWR International (2006) Safety Data Sheet for Hydrochloric Acid

3.2.27 The process water required for the solidification will be supplied from the leachate holding tank. Limited quantities of additional water may be required during extended dry periods. The use of leachate in the solidification plant (initially from the hazardous waste cells) is effectively an on-site 'closed loop' system.

3.3 Relevant Plans of the Installation

3.3.1 A full range of site drawings showing existing and proposed site layout arrangements (including boundaries and key points of interest) was included in the Waste Licence Application and EIS, submitted to the Agency on 17/12/10 (available for inspection on epa.ie).

3.3.2 2 No. drawings have been extracted from application documents to show existing and proposed site layouts and are included in **Appendix 7**.

3.4 Mitigation Measures[13]

3.4.1 Mitigation measures for soils, geology and groundwater were presented in the EIS, Chapter 14.8 (attached to the Waste Licence Application (Dec. 2010) and available for inspection at epa.ie). These mitigation measures were reproduced in the Waste Licence Application (Dec. 2010), Attachment I.4.194 to I.4.204. Attachment I of the Waste Licence Application (Dec. 2010) is copied in **Appendix 4** of this Baseline Report.

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[13] Section 86B of EPA Act 1992, as amended: *"New soil and groundwater measurements, having regard to the possibility of soil and groundwater contamination by the hazardous substances proposed to be used, produced or released by the installation concerned".*

4.0 Site Investigation and Conceptual Site Model

4.1 Site Investigations

Introduction

4.1.1 Boreholes were drilled on the subject site on at least five occasions prior to the work undertaken at the MEHL facility in May and June of 2013.

4.1.2 As part of the hydrogeological site investigation at MEHL in 2013, seven new boreholes were installed to better define the geology and hydrogeology throughout the site. Four of the new boreholes namely BH24, BH26, BH27 and BH30 were cored using Geobore-S technique with a drilling diameter of 146mm. The remaining three boreholes, BH25, BH28 and BH29 were developed by standard open-hole drilling with an outer diameter of 120mm.

4.1.3 Both the new and pre-existing installations were utilised in pumping tests of the aquifer to gather groundwater level information throughout the site.

4.1.4 The geological information obtained during the drilling and installation of the new boreholes was used to improve the conceptual model of the complex geology and hydrogeology of the site.

Existing Monitoring Wells

4.1.5 The site has a network of monitoring points along the perimeter which has been expanding since 1998. This monitoring network was installed to fulfil a requirement of the EPA licence for the MEHL facility (EPA waste licence number W0129-02). 10 No. wells are included in the routine monitoring regime under W0129-02. The well logs for the newly drilled monitoring boreholes are available in Article 16 information, Appendix D1 (submitted to the Agency 17/10/13 and copied in **Appendix 5** of this Baseline Report). Details of the drilling programmes undertaken to date at the MEHL site are also included in Article 16 information, Appendix C (submitted to the Agency 17/10/13 and copied in **Appendix 5** of this Baseline Report).

New Monitoring Wells

4.1.6 Article 16 information, Figure 1 (submitted to the Agency 17/10/13 and copied in **Appendix 5** of this Baseline Report) shows the locations of the new monitoring boreholes as well as the historic monitoring locations. Article 16 information, Table D1 (submitted to the Agency 17/10/13 and copied in **Appendix 5** of this Baseline Report) outlines the rationale behind the selection of the locations. The locations were chosen by taking into account all available geological and hydrogeological information, and constrained by restrictions to site access. There were no changes between the proposed and final locations. This phase of Site Investigation was designed to address the following:

- EPA Notice under Article 16(1) of the Waste Management (Licensing) Regulations issued on 23 March 2012 (EPA Ref: W0129-03);
- Clarification to notice in accordance with Article 16(1) of the Waste Management (Licensing) Regulations issued on 3 May 2012 (EPA Ref: W0129-03);
- Subsequent meetings and communications with the EPA informed the SI design.

Rationale for investigation - may include list of potential contaminant sources relevant to each proposed investigation location

4.1.7 See **Appendix 5**: Article 16 information submitted to the Agency on 17/10/13 (available for inspection at epa.ie), Pg. 5-7

Constraints applicable to the placement of site investigation locations

4.1.8 No particular constraints noted.

Methods used for forming exploratory holes e.g. boreholes, trial pits, window samples

4.1.9 Numerous boreholes were drilled on the site between 1998-2008 as part of the work for the existing EPA waste licence for the MEHL facility (EPA waste licence number W0129-02).

4.1.10 As part of the EIS assessment additional boreholes were drilled in the centre of the site in the proposed locations for the proposed hazardous and non-hazardous waste cells. These works consisted of:

- 3 No. Cable Percussion (Shell and Auger) Boreholes
- 3 No. Geobore S cored boreholes
- 3 No. Monitoring wells
- 1 No. Pump well
- 22 No. Trial pits
- 3 No. Soakaway pits
- 6 No. Side Slope surveys
- Laboratory testing for soil properties
- Groundwater quality analysis
- In situ testing consisting of pump tests, falling and rising head tests, soakaway testing, and SPT's in shell and auger boreholes
- Well development of new and existing wells

4.1.11 A programme of additional site investigation was undertaken on the MEHL site [as part of 'Article 16' information] to supplement the information available. New groundwater monitoring wells were drilled across the site. Further details are provided in **Section 4.1.6**.

Methods used for collecting, preserving and transporting samples to the analytical laboratory

4.1.12 'Best practice' principles in relation to sample collection, preservation and transportation were employed at all times. Sample bottles as per laboratory requirements were used, with preservatives, as appropriate. All samples were appropriately stored at 4°C and returned to the laboratory according to standard sampling techniques. Field sampling records and Chain of Custody documentation were retained for all samples.

Plan showing monitoring and sample point locations

4.1.13 See Article 16 information, Figure 1 (submitted to the Agency 17/10/13 and copied in **Appendix 5** of this Baseline Report).

Description of site works and on-site observations

4.1.14 See **Section 4.1.8**. Further details are available in the EIS (attached to the Waste Licence Application (Dec. 2010), submitted to the Agency 17/12/10 and available for inspection at epa.ie) and Article 16 information submitted to the Agency on 17/10/13 (copied in **Appendix 5** and available for inspection at epa.ie).

Exploratory borehole, core or drilling logs

4.1.15 Borehole logs were included in Article 16 information submitted to the Agency on 17/10/13, Appendix C and D (available for inspection at epa.ie); this information is copied in **Appendix 5**.

Details of response zone and other construction details of borehole monitoring installations

4.1.16 See **Section 4.1.14**.

Monitoring results

4.1.17 Monitoring of groundwater levels and groundwater and surface water quality has been undertaken on the site since 2003 as part of the existing landfill licence (W0129-02). Summary data is provided in **Appendix 3** for the following parameters: (i) Rainfall and evapotranspiration; (ii) Groundwater levels; (iii) Groundwater quality; and (iv) Surface water quality.

Description of samples submitted for analysis

4.1.18 Field sampling records have been retained for all samples and were submitted to the Agency as part of quarterly monitoring reports since 2003 (too voluminous to reproduce in this report, but available for inspection at the offices of the Agency and the licensee).

Relevant Quality Assurance/Quality Control data

4.1.19 Laboratory accreditation details are included in **Appendix 8**.

Laboratory analytical reports, completed in accordance with the relevant QA/QC data, including relevant international analytical or test method standards

4.1.20 Laboratory analytical reports have been retained for all samples and were submitted to the Agency as part of quarterly monitoring reports since 2003 (too voluminous to reproduce in this report, but available for inspection at the offices of the Agency and the licensee).

Chain of custody records for sample and data collected

4.1.21 Chain of Custody records have been retained for all samples and were submitted to the Agency as part of quarterly monitoring reports since 2003 (too voluminous to reproduce in this report, but available for inspection at the offices of the Agency and the licensee).

4.2 Conceptual Site Model

4.2.1 A summary of the hydrogeology of the MEHL site has been prepared in the form of a site conceptual model (CSM). The conceptual model for the site has evolved through the various stages of the project from initial desk study through the interpretation of site specific data. The CSM is presented in Figure 8 of Article 16 information submitted to the Agency on 17/10/13, and is included in **Appendix 5**

4.2.2 The CSM was presented in the EIS (attached to the Waste Licence Application (Dec. 2010), submitted to the Agency 17/12/10 and available for inspection at epa.ie). This version was updated as part of Article 16 information submitted to the Agency on 17/10/13 (available for inspection at epa.ie) and incorporates additional site investigation information gathered in June and July 2013.

4.2.3 An extract from Article 16 information submitted to the Agency on 17/10/13 is included in **Appendix 5**. Due to the volume of pages relating to certain appendices to that report, some appendices been omitted from **Appendix 5** (as indicated); however the report and appendices are available for inspection in full at epa.ie (EPA ref. W0129-03).

4.3 Quantitative Risk Assessment

4.3.1 The Quantitative Risk Assessment (QRA) was presented in the EIS (attached to the Waste Licence Application (Dec. 2010), submitted to the Agency 17/12/10 and available for inspection at epa.ie). This QRA was updated as part of Article 16 information submitted to the Agency on 17/10/13 (available for inspection at epa.ie), in line with additional site investigation information, changes to the conceptual model and questions from the EPA.

4.3.2 An extract from Article 16 information submitted to the Agency on 17/10/13 is included in **Appendix 5**. Due to the volume of pages relating to certain appendices to that report, some appendices been omitted from **Appendix 5** (as indicated); however the report and appendices are available for inspection in full at epa.ie (EPA ref. W0129-03).

Model Discussion and Conclusion[14]

4.3.3 A detailed hydrogeological investigation in 2010 was undertaken on the MEHL site in order to develop a conceptual model for the site using site specific data that describes the groundwater system in the vicinity of the site. Additional investigation was undertaken in 2013 and the CSM was updated based on this.

4.3.4 The LandSim modelling was updated to reflect queries from the EPA and changes in the CSM based on additional information. Separate models were created for the hazardous and non-hazardous cells and were run for a number of scenarios, including varying the leachate heads.

4.3.5 The hazardous cells were amended from the original model to reflect the following changes:

- The formation level of the landfill cells has been raised to 104.5 mOD.
- The unsaturated zone thickness has been reduced to 2 m across the site.
- Representation of the hazardous waste as a constant source rather than a declining source

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[14] Arup, 2013. Article 16 information submitted to the Agency on 17/10/13; extract included in **Appendix 5**

- Increasing the leachate head in hazardous cells to 2 m and 5 m

4.3.6 A summary of the results of the hazardous models are presented below:

- No 'hazardous substances' (List 1) predicted to be in groundwater beneath the site (and therefore none detected at the phantom receptor well);
- No contaminants at concentrations above Drinking Water Standards predicted to be present at the phantom well receptor.
- The results of the LandSim modelling indicate the risk to groundwater quality at wells down gradient of the hazardous cells will be insignificant.

4.3.7 The non-hazardous models were amended from the original models to reflect the following changes:

- The formation level of the landfill cells has been raised to 104.5 mOD. This has also led to a change in the area of the base of the landfill.
- The vertical pathway has been removed from beneath the non-hazardous cells.
- Only the artificial replacement layer beneath the non-hazardous cells have been modelled as the unsaturated zone. The 'real' unsaturated zone was not included in the model allowing an additional element of conservatism to be built into the model.
- Increasing the leachate head in hazardous and non-hazardous cells to 2 m and 5 m.
- The non-hazardous models were run with management control periods of 35 and 20,000 (infinity) years.

4.3.8 A summary of the results of the non-hazardous model are presented below:

- The models with high leachate heads are unstable and the results unreliable. However, those with those with the predicted lower heads were stable and the results reliable.
- No 'hazardous substances' (List 1) predicted to be in groundwater beneath the site (and therefore none detected at the phantom receptor well);
- 'Non-hazardous pollutants' (List 2), metals, chloride and sulphate predicted to be present in groundwater beneath the site above Drinking Water Standards after 20,000 years;
- No contaminants at concentrations above Drinking Water Standards predicted to be present at the phantom well receptor.

4.3.9 The results of the LandSim modelling indicate the risk to groundwater quality at wells down gradient of the site will be insignificant.

4.3.10 Although the modelling is designed to represent the landfill and surrounding environment it should be noted that these results are considered conservative for the following reasons:

- Lower liner (0.5 m of material with a hydraulic conductivity of 1x10-9 m/s) within the DAC system has not been modelled.

- The natural unsaturated zone beneath the non-hazardous cells has not been modelled.

4.3.11 A Groundwater and Surface Water Monitoring Plan, incorporating level and quality monitoring, will be a requirement of the waste licence.

4.3.12 A Closure Restoration and Aftercare Management Plan (CRAMP) will be developed and submitted to the Environmental Protection Agency for approval. Following the cessation of operation at the site the CRAMP will be implemented to the satisfaction of the Environmental Protection Agency.

4.4 Sampling, Monitoring and Analysis

Rationale for sampling strategy e.g. if targeted rationale of targets; if non-targeted justification for spacing and layout

4.4.1 Numerous boreholes were drilled on the site between 1998-2008 as part of the work for the existing EPA waste licence for the MEHL facility (EPA waste license number W0129-02). These are situated on the site perimeter and have been used to provide preliminary information on the geology of the site.

4.4.2 As part of the EIS assessment, additional boreholes were drilled in the centre of the site in the proposed locations for the proposed hazardous and non-hazardous waste cells. This information was used to establish the geology in this area and further delineate the geological profile of the site. The new boreholes were also completed as groundwater monitoring installations to allow the groundwater regime beneath the site to be interpreted further.

4.4.3 A programme of additional site investigation was undertaken on the MEHL site [as part of ‘Article 16’ information] to supplement the information available. These investigations and the reasons they were undertaken are summarised in **Table 4.1** below. Further details in **Appendix 5**: Article 16 information submitted to the Agency on 17/10/13 (available for inspection at epa.ie), Chapter 3.

Table 4.1 Summary of Additional Site Investigation [Article 16]

Timescale	Work summary	Purpose of work
March 2013	Downhole geophysics on existing wells	Aid the interpretation of the lithologies encountered on site
June 2013	Drilling 7no. new groundwater monitoring wells	Provide additional information on the geology and hydrogeology of the site
	Collection of samples for palynology and micropalaeontology analysis	Aid the interpretation of the lithologies encountered on site
	Downhole geophysics on newly drilled wells	Aid the interpretation of the lithologies encountered on site
July 2013	Groundwater monitoring	Establish current groundwater levels
	7 day pumping test	Provide additional information on the hydrogeological conditions beneath the site

Description and explanation of monitoring programmes for groundwater and surface waters

4.4.4 Monitoring of groundwater levels and groundwater and surface water quality has been undertaken on the site since 2003 as part of the existing landfill licence (W0129-02). Summary data is provided in **Appendix 3** for the following parameters: (i) Rainfall and evapotranspiration; (ii) Groundwater levels; (iii) Groundwater quality; and (iv) Surface water quality.

4.4.5 Monitoring data collected for the EIS 2010 was presented in the EIS in Appendix A14.7 and Appendix A14.8 (attached to the Waste Licence Application (Dec. 2010) and available for inspection at epa.ie).

Details of monitoring and sampling including locations, depths, frequencies

4.4.6 The following groundwater monitoring locations (**Table 4.2**) are specified in Waste Licence W0129-02 and are sampled on a quarterly basis. See Figure 1 of Article 16 information submitted to the Agency on 17/10/13, copied in **Appendix 5**.

Table 4.2: Location of Groundwater Monitoring Locations W0129-02

BH ID	Easting	Northing	Location	Finished Depth	Top of Casing (mAOD Malin)
BH4A	316271	257891	East of site	12m	91.96
BH5	315796	258328	Within site – north	35m	118.72
BH6	315644	258507	North of site – *ca.* 240m	20m	117.31
BH8	315479	258069	Within site - west	27m	136.73
BH9	315560	258280	Within site – north west	50m	128.81
BH10A	315522	257697	Within site – south west	68m	137.14
BH11A	316112	258249	Within site – north east	30m	100.01
BH12	315439	257925	Within site – west	65m	146.99
BH13	315444	257925	Within site – west	48m	146.92
BH14	315938	257631	Within site – south east	38m	125.06

4.4.7 The following surface water monitoring locations (**Table 4.3**) are specified in Waste Licence W0129-02 and are sampled on a bi-annual basis.

Table 4.3: Location of Surface water Monitoring Locations W0129-02

Ref	**Easting**	**Northing**	**Location**
SW1	315677	258518	Clonany Bridge (North (upstream) of site, *ca.* 280m)
SW2	317230	257820	Joinery Bridge (East (downstream) of site, *ca.* 1630m)
SWD1	315660	258522	Discharge after flowing through silt trap/oil interceptor
SWD2*	315847	258415	Surface water run-off
SWD3*	315937	258366	Water discharge from settlement pond
SWD4*	315999	258306	Surface water run-off
SWD5*	316139	258267	Surface water run-off
SWD6*	316068	257856	Surface water run-off
SWD7*	315779	257719	Surface water run-off

* SWD2 to SWD7 were previously surface water discharge points from surface water pumping associated with quarrying operations. The water pumping activities have been suspended; therefore any water/flow now observed at these locations is sourced from surface water run-off from non-landfill areas. The norm is that these locations are dry; however this is verified during each surface water sampling event.

4.4.8 The following additional boreholes (**Table 4.4**) were drilled and monitored as part of EIS (2010) and Article 16 (2013) works (as indicated). See Figure 1 of Article 16 information submitted to the Agency on 17/10/13, copied in **Appendix 5**.

Table 4.4: Additional Groundwater Monitoring Locations W0129-03

BH ID	**Easting**	**Northing**	**Location**	**Finished Depth**	**Ref / Purpose**
BH-15A	315786	257850	Quarry Floor	30m	A
BH-16	315862	258218	Quarry Floor	24m	A
BH-17	315795	258003	Quarry Floor	54m	A
BH-18	315711	257996	Quarry Floor	21m	A
BH-19	315887	258059	Quarry Floor	18m	A
BH-20	315863	258102	Quarry Floor	52m	A
BH-21	316075	258200	NE corner of site	20m	B
BH-22A	315961	258091	Floor of quarry, in N of site	21m	B
BH-23	315960	257969	Floor of quarry; east of site	23m	B
BH-24	315955	258209	Floor of quarry, in N of site	48m	C
BH-25	315713	257876	Within site – south/centre	26m	C

BH ID	Easting	Northing	Location	Finished Depth	Ref / Purpose
BH-26	315881	258086	Within site – north/centre	24m	C
BH-27	315757	258018	Within site - centre	14m	C
BH-28	258018	257916	Within site – centre/east	40m	C
BH-29	315986	258071	Within site – north-east	48m	C
BH-30	315970	258073	Within site – north-east	62m	C

A = EIS 2010/W0129-03 Application 2010

B = Geotechnical shell and auger borehole for SI No.1 for EIS 2010/W0129-03 Application 2010 (Backfilled as part of the SI works)

C = SI No. 2, W0129-03 Application (Article 16)

Rationale for selection of analytical parameters

4.4.9 The parameters required to be tested are stipulated under EPA licence W0129-02 (see **Appendix 2**). Additional parameters were analysed for the purposes of the W0129-03 application in order to fully understand the water chemistry of the site.

Description of chemical analyses, in accordance with relevant national based accreditation schemes (if available); Quality assurance and quality control requirements for laboratory analyses

4.4.10 Accredited laboratories have been used for the analysis of all samples. Jones Environmental Laboratory (UK) has completed laboratory testing. Laboratory accreditation details are included in **Appendix 8**.

4.5 Presentation and Interpretation of Data within Text of Report

Description of ground conditions encountered at the site, including groundwater regime and surface water features

4.5.1 Ground conditions, groundwater regime and surface water features were described in the EIS (attached to the Waste Licence Application (Dec. 2010), submitted to the Agency 17/12/10 and available for inspection at epa.ie). This information was updated as part of Article 16 information submitted to the Agency on 17/10/13 (available for inspection at epa.ie) and copied in **Appendix 5**.

Cross-sections showing site strata and shallow and deep groundwater levels

4.5.2 Cross-sections were provided in the EIS (attached to the Waste Licence Application (Dec. 2010), submitted to the Agency 17/12/10 and available for inspection at epa.ie). This information was updated as part of Article 16 information submitted to the Agency on 17/10/13 (available for inspection at epa.ie) and copied in **Appendix 5**.

Summary tables of chemical analyses and site monitoring

4.5.3 Groundwater level and groundwater and surface water quality monitoring has been undertaken on the site since 2003 as part of the existing landfill licence (W0129-02). Updated summary data is provided in **Appendix 2** for the following parameters: (i) Rainfall and evapotranspiration; (ii) Groundwater levels; (iii) Groundwater quality; and (iv) Surface water quality.

Description of type, nature and spatial distribution of contamination, with plans where appropriate

4.5.4 There is no evidence of existing or historic contamination. Contamination risk has been considered in the context of the Conceptual Site Model and Quantitative Risk Assessment, see **Sections 4.2** and **4.3**, respectively, of this Baseline Report.

4.5.5 See QRA discussion and conclusion in **Section 4.3**.

Statistical analysis of the data set and derivation of representative concentrations for individual contaminants to a suitable level of statistical significance

4.5.6 Concentrations of individual contaminants have been considered in the context of the Conceptual Site Model and Quantitative Risk Assessment, see **Sections 4.2** and **4.3**, respectively, of this Baseline Report.

4.5.7 See QRA discussion and conclusion in **Section 4.3**.

Evaluation of site investigation results against the outline conceptual model

4.5.8 The evaluation of site investigation results is considered in the context of the Conceptual Site Model and Quantitative Risk Assessment; see **Sections 4.2** and **4.3**, respectively, of this Baseline Report.

5.0 Cessation of Activity and Site Closure

5.1 Operational Management and Environmental Monitoring Programme

5.1.1 The Waste Licence Application (submitted to the EPA on 17/12/10 and available for inspection at epa.ie), and related application documentation (as Section **2.1.2**) provides details in relation to (*inter alia*): Technical Competence and Site Management, Environmental Management System (EMS), Infrastructure, Facility Operation, Liner System, Leachate Management, Capping System, Treatment, Abatement and Control System, Surface Water Monitoring, Groundwater Monitoring, Other Environmental Monitoring, Waste Acceptance Procedures, Waste Handling, Accident Prevention and Emergency Response, Remediation, Decommissioning, Restoration and Aftercare.

5.1.2 All of these items further the objectives of avoidance of environmental pollution. It is not anticipated, therefore, that remediation works will be required at the facility's end-of-life.

5.2 Closure Requirements

5.2.1 The licensee will be required to comply with closure conditions relating to the licence, or any revised licence, which may be issued.

5.2.2 Patel Tonra Ltd., Environmental Solutions was commissioned by MEHL to assess the company's obligations for a proposed integrated waste management facility at Hollywood Great, Nag's Head, Naul, Co. Dublin, in relation to Environmental Liability Risk Assessment (ELRA); Closure, Restoration and Aftercare Management Plan (CRAMP); and Financial Provision (FP). The report methodology was based on EPA guidance in force at the time of writing[15].

5.2.3 The report is dated May 2013 and was submitted to the Agency on 21/05/13 (available for inspection at epa.ie). The report is copied in **Appendix 6** of this Baseline Report.

5.2.4 The CRAMP report commits the licensee to complete the following (*inter alia*) (extracted from the CRAMP report, May 2013, **Appendix 6**):

- *Upon cessation of waste activities at the facility, decommissioning and demolition activities will be carried out.*
- *An independent verification audit will be completed to verify that all closure criteria have been adequately addressed and the closure phase will be agreed with the Agency. The independent audit will include a soil/groundwater investigation/verification by an appropriately-qualified and experienced hydrogeologist.*
- *It is anticipated that the EPA will conduct its own post-closure audit of the facility also.*

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[15] EPA (2006) *Guidance on Environmental Liability Risk Assessment, Residuals Management Plans and Financial Provision*

5.3 Criteria for Successful Closure

5.3.1 The Applicant has established the following criteria for the successful closure of the facility (extracted from the CRAMP report, May 2013, **Appendix 6**):

- *The site has been restored in a manner fitting the surrounding landscape; final capping, grassing and planting has been completed across all areas*
- *Site buildings and related services and infrastructure have been decommissioned/demolished, as appropriate, and materials have been moved off-site for recovery*
- *All plant and equipment has been safely decontaminated or decommissioned and removed off-site, as appropriate*
- *Site security measures are in place*
- *Leachate and surface water collection infrastructure has been checked and verified and an aftercare maintenance programme agreed*
- *Monitoring points have been checked and verified and an aftercare monitoring programme agreed*
- *The Environmental Management System has been actively implemented during the closure period*
- *All relevant site records, including monitoring data, have been managed appropriately retained in an off-site location*
- *A Verification Audit / Certification has been independently completed on behalf of the operator and associated report submitted to the Agency*
- *Financial provision has been updated and agreed with the Agency*
- *CRAMP has been agreed formally with the Agency*
- *Other notice parties (e.g. the neighbouring community, the local authority) are informed of CRAMP status*

5.4 Corrective Actions, as may be required

5.4.1 The facility has been designed to mitigate against potential environmental pollution. In the unlikely event that the independent Verification Audit (as **Sections 5.2** and **5.3**) indicates contamination of soil and/or groundwater, the licensee will take all necessary actions aimed at removal, control, containment or reduction of relevant hazardous substances, such that the site ceases to pose a significant risk.

5.4.2 Only upon completion of the necessary corrective actions will the site be independently certified for closure, subject to agreement with the EPA.

6.0 Summary/Conclusion

6.0.1 This Baseline Report has been prepared for the purpose of an application to the EPA by MEHL for an integrated waste management facility at Hollywood Great, Nag's Head, Naul, Co. Dublin (EPA Ref. W0129-03).

6.0.2 The subject facility is a former quarry and the facility is an existing and operational inert landfill (EPA Licence W0129-02).

6.0.3 The report has been prepared with reference to legislative provisions and guidance, as follows:

- Regulation 9 of the EPA (Industrial Emissions) (Licensing) Regulations, 2013
- Section 86B of the EPA Act, 1992 (as amended)
- *European Commission Guidance concerning baseline reports under Article 22(2) of Directive 2010/75/EU on industrial emissions* (Draft 17 June 2013)

6.0.4 The report complies with Annex 1, 'Baseline Investigation and Report Checklist' of European Commission Guidance concerning Baseline Reports, as per **Appendix 1** of this report.

6.0.5 This report draws on extensive site investigation, analysis and information submitted to the Agency as part of the licence application process since December 2010; relevant cross-references are provided herein. In addition, the facility has collected significant amounts of data through the operation of the licensed inert landfill (EPA ref. W0129-02), which are relevant as baseline groundwater reference conditions.

6.0.6 The licensed facility is an engineered landfill, designed to meet compliance with the Landfill Directive 1999. Incoming waste is subject to strict Waste Acceptance criteria and testing, in compliance with Council Decision (2003/33/EC) Establishing Criteria and Procedures for the Acceptance of Waste at Landfills.

6.0.7 There are no known sources of historical contamination and there is no history of pollution at the site.

6.0.8 The operator's obligations in relation to Environmental Liability Risk Assessment (ELRA), Closure, Restoration and Aftercare Management Plan (CRAMP) and Financial Provision (FP) for the proposed integrated waste management facility have been assessed and submitted to the EPA.

6.0.9 Numerous boreholes were drilled on the site between 1998-2008 as part of the work for the existing EPA waste licence for the MEHL facility (EPA waste licence number W0129-02). As part of the EIS assessment (2010) additional boreholes were drilled in the centre of the site in the proposed locations for the proposed hazardous and non-hazardous waste cells. A programme of additional site investigation was undertaken on the MEHL site [as part of 'Article 16' information] to supplement the information available. New groundwater monitoring wells were drilled across the site. Drawings showing the location of all monitoring wells are included herein.

6.0.10 A summary of the hydrogeology of the MEHL site has been prepared in the form of a site conceptual model (CSM). The conceptual model for the site has evolved through the various stages of the project from initial desk study through the interpretation of site specific data.

6.0.11 A Quantitative Risk Assessment (QRA) was presented in the EIS (2010). This QRA was updated as part of Article 16 information submitted to the Agency on 17/10/13, in line with additional site investigation information, changes to the conceptual model and questions from the EPA.

6.0.12 A summary of the results of the hazardous models are presented below:

- No 'hazardous substances' (List 1) predicted to be in groundwater beneath the site (and therefore none detected at the phantom receptor well);
- No contaminants at concentrations above Drinking Water Standards predicted to be present at the phantom well receptor.
- The results of the LandSim modelling indicate the risk to groundwater quality at wells down gradient of the hazardous cells will be insignificant.

6.0.13 A summary of the results of the non-hazardous model are presented below:

- The models with high leachate heads are unstable and the results unreliable. However, those with those with the predicted lower heads were stable and the results reliable.
- No 'hazardous substances' (List 1) predicted to be in groundwater beneath the site (and therefore none detected at the phantom receptor well);
- 'Non-hazardous pollutants' (List 2), metals, chloride and sulphate predicted to be present in groundwater beneath the site above Drinking Water Standards after 20,000 years;
- No contaminants at concentrations above Drinking Water Standards predicted to be present at the phantom well receptor.

6.0.14 The results of the LandSim modelling indicate the risk to groundwater quality at wells down gradient of the site will be insignificant.

6.0.15 A Groundwater and Surface Water Monitoring Plan, incorporating level and quality monitoring, will be a requirement of the waste licence.

6.0.16 The CRAMP report for the proposed integrated waste management facility commits the licensee to complete the following (*inter alia*):

- *Upon cessation of waste activities at the facility, decommissioning and demolition activities will be carried out.*
- *An independent verification audit will be completed to verify that all closure criteria have been adequately addressed and the closure phase will be agreed with the Agency. The independent audit will include a soil/groundwater investigation/verification by an appropriately-qualified and experienced hydrogeologist.*
- *It is anticipated that the EPA will conduct its own post-closure audit of the facility also.*

6.0.17 The facility has been designed to mitigate against potential environmental pollution. In the unlikely event that the independent Verification Audit indicates contamination of soil and/or groundwater, the licensee will take all necessary actions aimed at removal, control, containment or reduction of relevant hazardous substances, such that the site ceases to pose a significant risk. Only upon completion of the necessary corrective actions will the site be independently certified for closure, subject to agreement with the EPA.

Appendix 1: European Commission Guidance concerning Baseline Reports, Annex 1, 'Baseline Investigation and Report Checklist'

ANNEX I – BASELINE INVESTIGATION AND REPORT CHECKLIST

	Essential (E) Optional (O)
PRELIMINARY REQUIREMENTS	
Identification of the environmental setting and pollution history of the installation	E
Identification of any possible sources of historical contamination	E
Identification of substances in, on or under the land, from materials currently used or produced by the activities under the permit (or are likely to be used or produced in the future) which may be a pollution risk	E
Relevant plans of the installation (showing boundaries and key points of interest).	E
Review and summary of previous reports, with report references	O
Summary of risk based requirements for baseline data collection	O
DETAILS OF DATA COLLECTION	
Site Investigation	
Rationale for investigation – may include list of potential contaminant sources relevant to each proposed investigation location	O
Constraints applicable to the placement of site investigation locations	O
Methods used for forming exploratory holes e.g. boreholes, trial pits, window samples	E
Methods used for collecting, preserving and transporting samples to the analytical laboratory	E
Sampling & Monitoring	
Rationale for sampling strategy e.g. if targeted rationale of targets; if non-targeted justification for spacing and layout	E
Description and explanation of monitoring programmes for groundwater and surface waters	E
Details of monitoring and sampling including locations, depths, frequencies	E
Analysis	
Rationale for selection of analytical parameters	E
Description of chemical analyses, in accordance with relevant national based accreditation schemes (if available)	E
Quality assurance and quality control requirements for laboratory analyses	E
PRESENTATION & INTERPRETATION OF DATA WITHIN TEXT OF REPORT	
Description of ground conditions encountered at the site, including groundwater regime and surface water features	E
Cross-sections showing site strata and shallow and deep groundwater levels	E
Summary tables of chemical analyses and site monitoring	O
Description of type, nature and spatial distribution of contamination, with plans where appropriate	E
Statistical analysis of the data set and derivation of representative concentrations for individual contaminants to a suitable level of statistical significance	E
Evaluation of site investigation results against the outline conceptual model	O
PRESENTATION OF RAW DATA (ANNEX TO REPORT)	
Plan showing monitoring and sample point locations	E
Description of site works and on-site observations	E
Exploratory borehole, core or drilling logs	E
Details of response zone and other construction details of borehole monitoring installations	E
Monitoring results	E
Description of samples submitted for analysis	E
Relevant Quality Assurance/Quality Control data – this may include accreditations of staff, calibration certificates of equipment, laboratory accreditations (national and international standards)	E
Laboratory analytical reports, completed in accordance with the relevant QA/QC data, including relevant international analytical or test method standards.	E
Chain of custody records for sample and data collected	E

Appendix 2: Copy of EPA Licence W0129-02

(Currently-licensed inert landfill activity at MEHL)

LICENCE REG NO. W0129-02 HAS BEEN TRANSFERRED
Please note that licence Reg. No. W0129-02 was transferred to
Murphy Environmental Hollywood Limited on 01/10/2008.
For further information on this please refer to the Transfer Notification on the Agency's website.

This licence was amended on 23rd June, 2011 under Section 42B(1) of the Waste Management Acts, 1996 to 2011. The details of Amendment A must be read in conjunction with this licence. The amendment document is entitled "Clerical Amendment A"

Environmental Protection Agency
An Ghníomhaireacht um Chaomhnú Comhshaoil

Headquarters
P.O. Box 3000
Johnstown Castle Estate
County Wexford
Ireland

WASTE LICENCE

Licence Register Number:	W0129-02
Licensee:	Murphy Concrete Manufacturing Limited
Location of Facility:	Hollywood Great, Nags Head, The Naul,

	County Dublin

INTRODUCTION

This introduction is not part of the licence and does not purport to be a legal interpretation of the licence.

This licence is for the purpose of an inert landfill at Hollywood Great, Nags Head, The Naul, County Dublin. The site is an active shale and limestone quarry that has been in operation since the 1940's.

The landfill will accept not more than 500,000 tonnes per annum of inert waste arising from construction & demolition activities (e.g. soil & stones, concrete, bricks, tiles, etc.), to infill the quarry void.

The licence sets out in detail the conditions under which Murphy Concrete Manufacturing Limited will operate and manage this facility.

Table of Contents

Glossary of Terms

All terms in this licence should be interpreted in accordance with the definitions in the Environmental Protection Agency Acts 1992 and 2003/Waste Management Acts 1996 to 2007, unless otherwise defined in this section.

Adequate lighting	20 lux measured at ground level.
AER	Annual Environmental Report.
Aerosol	A suspension of solid or liquid particles in a gaseous medium.
Agency/EPA	Environmental Protection Agency.
Agreement	Agreement in writing.
Annually	At approximately twelve-monthly intervals.
Application	The application by the licensee for this licence.
Appropriate facility	A waste management facility, duly authorised under relevant law and technically suitable.
Attachment	Any reference to Attachments in this licence refers to attachments submitted as part of this licence application.
BAT	Best Available Techniques.
Biannually	All or part of a period of six consecutive months.
Biennially	Once every two years.
BOD	5 day Biochemical Oxygen Demand.
CEN	Comité Européen De Normalisation – European Committee for Standardisation.
COD	Chemical Oxygen Demand.
Construction and demolition (C & D) waste	Wastes that arise from construction, renovation and demolition activities: Chapter 17 of the EWC or as otherwise may be agreed.
Containment boom	A boom that can contain spillages and prevent them from entering drains or watercourses or from further contaminating watercourses.
Daily	During all days of plant operation, and in the case of emissions, when emissions are taking place; with at least one measurement on any one day.
Day	Any 24 hour period.
Daytime	0800 hrs to 2200 hrs.
dB(A)	Decibels (A weighted).
DO	Dissolved oxygen.

Documentation	Any report, record, result, data, drawing, proposal, interpretation or other document in written or electronic form which is required by this licence.
Drawing	Any reference to a drawing or drawing number means a drawing or drawing number contained in the application, unless otherwise specified in this licence.
EMP	Environmental Management Programme.
Emission limits	Those limits, including concentration limits and deposition rates, established in *Schedule B: Emission Limits* of this licence.
Environmental damage	Has the meaning given it in Directive 2004/35/EC.
EPA	Environmental Protection Agency.
European Waste Catalogue (EWC)	A harmonised, non-exhaustive list of wastes drawn up by the European Commission and published as Commission Decision 2000/532/EC and any subsequent amendment published in the Official Journal of the European Community.
Facility	Any site or premises used for the purposes of the recovery or disposal of waste.
Fortnightly	A minimum of 24 times per year, at approximately two week intervals.
GC/MS	Gas chromatography/mass spectroscopy.
Green waste	Waste wood (excluding timber), plant matter such as grass cuttings, and other vegetation.
Heavy metals	This term is to be interpreted as set out in "Parameters of Water Quality, Interpretation and Standards" published by the Agency in 2001. ISBN 1-84095-015-3.
HFO	Heavy fuel oil.
Hours of operation	The hours during which the facility is authorised to be operational.
Hours of waste acceptance	The hours during which the facility is authorised to accept waste.
ICP	Inductively coupled plasma spectroscopy.
Incident	The following shall constitute an incident for the purposes of this licence: i. an emergency; ii. any emission which does not comply with the requirements of this licence; iii. any exceedance of the daily duty capacity of the waste handling equipment; iv. any trigger level specified in this licence which is attained or exceeded; and, v. any indication that environmental pollution has, or may have, taken place
Industrial waste	As defined in Section 5(1) of the Waste Management Acts 1996 to 2007.

Inert Waste	Waste that does not undergo any significant physical, chemical or biological transformations. Inert waste will not dissolve, burn or otherwise physically or chemically react, biodegrade or adversely affect other matter with which it comes into contact in a way likely to give rise to environmental pollution or harm human health. The total leachability and pollutant content of the waste and the ecotoxicity of the leachate must be insignificant, and in particular not endanger the quality of surface water and/or groundwater.
IPPC	Integrated Pollution Prevention & Control.
Landfill Directive	Council Directive 1999/31/EC.
Landfill Footprint	The area of the facility where waste is deposited.
Landfill Gas	Gases generated from landfilled waste.
Leq	Equivalent continuous sound level.
Licensee	Murphy Concrete Manufacturing Limited, Hollywood Great, Nags Head, The Naul, County Dublin.
Liquid waste	Any waste in liquid form and containing less than 2% dry matter.
List I	As listed in the EC Directives 76/464/EEC and 80/68/EEC and amendments.
List II	As listed in the EC Directives 76/464/EEC and 80/68/EEC and amendments.
Local Authority	Fingal County Council.
Maintain	Keep in a fit state, including such regular inspection, servicing, calibration and repair as may be necessary to adequately perform its function.
Mass flow limit	An emission limit value, which is expressed as the maximum mass of a substance that can be emitted per unit time.
Mass flow threshold	A mass flow rate above which a concentration limit applies.
Monthly	A minimum of 12 times per year, at intervals of approximately one month.
Night-time	2200 hrs to 0800 hrs.
Noise-sensitive location (NSL)	Any dwelling house, hotel or hostel, health building, educational establishment, place of worship or entertainment, or any other facility or area of high amenity, which for its proper enjoyment requires the absence of noise at nuisance levels.
Oil separator	Device installed according to the International Standard I.S. EN 858-2:2003 (Separator systems for light liquids, (e.g. oil and petrol) - Part 2: Selection of nominal size, installation, operation and maintenance).
PRTR	Pollutant Release and Transfer Register.

Pre-treatment/ treatment	As per Article 6(a) of the Council Directive 1999/31/EC on the landfill of waste, only waste that has been subject to treatment is landfilled. This provision may not apply to inert waste for which treatment is not technically feasible, or to any other waste for which such treatment does not contribute to the objectives of the Council Directive 1999/31/EC on the landfill of waste, by reducing the quantity of waste or the hazards to human health or the environment.
Quarterly	All or part of a period of three consecutive months beginning on the first day of January, April, July or October.
Regional Fisheries Board	Eastern Regional Fisheries Board.
Water Services Authority	Fingal County Council.
Sanitary effluent	Wastewater from facility toilet, washroom and canteen facilities.
Sample(s)	Unless the context of this licence indicates to the contrary, samples shall include measurements by electronic instruments.
SOP	Standard operating procedure.
Source segregated waste	Waste, which is separated at source. Meaning that the waste is sorted at the point of generation into a recyclable fraction(s) for separate collection (e.g. paper, metal, glass, plastic, bulk dry recyclables, biodegradables, etc) and a residual fraction. And the expression 'separate at source' shall be construed accordingly.
Specified emissions	Those emissions listed in *Schedule B: Emission Limits* of this licence.
Standard method	A National, European or internationally recognised procedure (eg, I.S. EN, ISO, CEN, BS or equivalent) or an in-house documented procedure based on the above references; a procedure as detailed in the current edition of "Standard Methods for the Examination of Water and Wastewater" (prepared and published jointly by A.P.H.A., A.W.W.A. & W.E.F.), American Public Health Association, 1015 Fifteenth Street, N.W., Washington DC 20005, USA; or, an alternative method as may be agreed by the Agency.
Storm water	Rain water run-off from roof and non-process areas.
TOC	Total organic carbon.
Trade effluent	Trade effluent has the meaning given in the Water Pollution Acts 1977 and 1990.
Trigger level	A parameter value, the achievement or exceedance of which requires certain actions to be taken by the licensee.
Weekly	During all weeks of plant operation, and in the case of emissions, when emissions are taking place; with at least one measurement in any one week.
WWTP	Waste water treatment plant.

Decision & Reasons for the Decision

The Environmental Protection Agency is satisfied, on the basis of the information available, that subject to compliance with the conditions of this licence, any emissions from the activity will comply with and will not contravene any of the requirements of Section 40(4) of the Waste Management Acts 1996 to 2007.

In reaching this decision the Environmental Protection Agency has considered the application, supporting documentation and objection received from the applicant, all submissions and objections received from other parties and the reports of its inspectors.

Part I Schedule of Activities Licensed

In pursuance of the powers conferred on it by the Waste Management Acts 1996 to 2007, the Environmental Protection Agency (the Agency), under Section 46(8)(a) of the said Act hereby grants this reviewed Waste Licence to Murphy Concrete Manufacturing Limited, Hollywood Great, Nags Head, The Naul, County Dublin, to carry on the waste activities listed below at Hollywood Great, Nags Head, The Naul, County Dublin, subject to conditions, with the reasons therefore and the associated schedules attached thereto set out in the licence. For the purposes of Article 48 of the Waste Management Licensing Regulations 2004 (SI 395) this facility is classed as an inert waste landfill.

Licensed Waste Disposal Activities, in accordance with the Third Schedule of the Waste Management Acts 1996 to 2007

Class 1.	Deposit on, in or under land (including landfill).
Class 5.	Specially engineered landfill, including placement into lined discrete cells, which are capped and isolated from one another and the environment.
Class 13.	Storage prior to submission to any activity referred to in a preceding paragraph of this Schedule, other than temporary storage, pending collection, on the premises where the waste concerned is produced.

Licensed Waste Recovery Activities, in accordance with the Fourth Schedule of the Waste Management Acts 1996 to 2007

Class 3.	Recycling or reclamation of metals and metal compounds.
Class 4.	Recycling or reclamation of other inorganic materials.
Class 13.	Storage of waste intended for submission to any activity referred to in a preceding paragraph of this Schedule, other than temporary storage, pending collection, on the premises where such waste is produced.

Part II Schedule of Activities Refused

None of the proposed activities as set out in the licence application have been refused.

Part III Conditions

Condition 1 Scope

1.1 Waste activities at this facility shall be restricted to those listed and described in *Part I: Schedule of Activities Licensed*, and shall be as set out in the licence application or as modified under Condition 1.5 of this licence and subject to the conditions of this licence.

1.2 Activities at this facility shall be limited as set out in *Schedule A: Limitations* of this licence.

1.3 The facility shall be controlled, operated, and maintained and emissions shall take place as set out in this licence. All programmes required to be carried out under the terms of this licence, become part of this licence.

1.4 For the purposes of this licence, the facility is the area of land outlined in red on Drawing No. WLR9 (Proposed monitoring locations) of the application. Any reference in this licence to "facility" shall mean the area thus outlined in red. The licensed activities shall be carried on only within the area outlined.

1.5 No alteration to, or reconstruction in respect of, the activity or any part thereof which would, or is likely to, result in:

(i) a material change or increase in:

- The nature or quantity of any emission,
- The abatement/treatment or recovery systems,
- The range of processes to be carried out,
- The fuels, raw materials, intermediates, products or wastes generated, or

(ii) any changes in:

- Site management infrastructure or control with adverse environmental significance,

shall be carried out or commenced without prior notice to, and without the agreement of, the Agency.

1.6 This licence is for the purposes of waste licensing under the Waste Management Acts 1996 to 2007 only and nothing in this licence shall be construed as negating the licensee's statutory obligations or requirements under any other enactments or regulations.

1.7 This licence is being granted in substitution for the waste licence granted to the licensee on 4th December 2002 (Register No: W0129-01). The previous waste licence (Register No: W0129-01) is superseded by this licence.

1.8 Only inert waste may be recovered and disposed of at the facility subject to the maximum quantities and other constraints listed in *Schedule A.1: Waste Acceptance* of this licence. No liquid wastes or sludges shall be accepted at the facility. No shredded mixed construction and demolition waste may be accepted at the facility.

1.9 Waste Acceptance Hours and Hours of Operation

1.9.1 Waste may be accepted at the facility, for disposal at the landfill, only between the hours of 0800 and 1800 Monday to Friday inclusive and 0700 and 1600 on Saturdays.

1.9.2 The facility may be operated only during the hours of 0700 to 1900 Monday to Friday, inclusive and 0700 to 1700 on Saturdays.

1.9.3 Waste shall not be accepted at the landfill on Bank Holidays.

Reason: To clarify the scope of this licence.

Condition 2 Management of the Facility

2.1 Facility Management

2.1.1 The licensee shall employ a suitably qualified and experienced facility manager who shall be designated as the person in charge. The facility manager or a nominated, suitably qualified and experienced, deputy shall be present on the facility at all times during its operation or as otherwise required by the Agency.

2.1.2 Both the facility manager and deputy, and any replacement manager or deputy, shall successfully complete both the FAS Waste Management Training Programme (or equivalent agreed with the Agency) and associated site assessment appraisal within twelve months of appointment.

2.1.3 The licensee shall ensure that personnel performing specifically assigned tasks shall be qualified on the basis of appropriate education, training and experience, as required and shall be aware of the requirements of this licence. In addition, the facility manager and his/her deputy shall successfully complete FAS waste management training programme or equivalent agreed by the Agency.

2.2 Environmental Management System (EMS)

2.2.1 The licensee shall maintain an Environmental Management System (EMS). The EMS shall be updated on an annual basis.

2.2.2 The EMS shall include as a minimum the following elements:

2.2.2.1 Management and Reporting Structure.

2.2.2.2 Schedule of Environmental Objectives and Targets

The licensee shall maintain a Schedule of Environmental Objectives and Targets. The schedule shall as a minimum provide for a review of all operations and processes, including an evaluation of practicable options as may be relevant to the licensed activity, for energy and resource efficiency, the use of cleaner technology, cleaner production, and the prevention, reduction and minimisation of waste, and shall include waste reduction targets. The schedule shall include time frames for the achievement of set targets and shall address a five-year period as a minimum. The schedule shall be reviewed annually and amendments thereto notified to the Agency for agreement as part of the Annual Environmental Report (AER).

2.2.2.3 Environmental Management Programme (EMP)

The licensee shall maintain an EMP, including a time schedule, for achieving the Environmental Objectives and Targets prepared under Condition 2.2.2.2. Once agreed the EMP shall be maintained by the licensee. It shall include:

(i) designation of responsibility for targets;

(ii) the means by which they may be achieved;

(iii) the time within which they may be achieved.

The EMP shall be reviewed annually and amendments thereto notified to the Agency for agreement as part of the Annual Environmental Report (AER) (Condition 11.7).

A report on the programme, including the success in meeting agreed targets, shall be prepared and submitted to the Agency as part of the AER. Such reports shall be retained on-site for a period of not less than seven years and shall be available for inspection by authorised persons of the Agency.

2.2.2.4 Documentation

(i) The licensee shall maintain an environmental management documentation system, which shall be to the satisfaction of the Agency.

(ii) The licensee shall issue a copy of this licence to all relevant personnel whose duties relate to any condition of this licence.

2.2.2.5 Corrective Action

The licensee shall establish procedures to ensure that corrective action is taken should the specified requirements of this licence not be fulfilled. The responsibility and authority for initiating further investigation and corrective action in the event of a reported non-conformity with this licence shall be defined.

2.2.2.6 Awareness and Training

The licensee shall maintain procedures for identifying training needs, and for providing appropriate training, for all personnel whose work can have a significant effect upon the environment. Appropriate records of training shall be maintained.

2.2.2.7 Communications Programme

The licensee shall maintain a Public Awareness and Communications Programme to ensure that members of the public are informed, and can obtain information at the facility, at all reasonable times, concerning the environmental performance of the facility.

2.2.2.8 Maintenance Programme

The licensee shall maintain a programme for maintenance of all plant and equipment based on the instructions issued by the manufacturer/supplier or installer of the equipment. Appropriate record keeping and diagnostic testing shall support this maintenance programme. The licensee shall clearly allocate responsibility for the planning, management and execution of all aspects of this programme to appropriate personnel (see Condition 2.1 above).

2.2.2.9 Efficient Process Control

The licensee shall maintain a programme to ensure there is adequate control of processes under all modes of operation. The programme shall identify the key indicator parameters for process control performance, as well as identifying methods for measuring and controlling these parameters. Abnormal process operating conditions shall be documented, and analysed to identify any necessary corrective action.

Reason: To make provision for management of the activity on a planned basis having regard to the desirability of ongoing assessment, recording and reporting of matters affecting the environment.

Condition 3 Infrastructure and Operation

3.1 The licensee shall establish all infrastructure referred to in this licence, to the design set out in the Application documentation or as may be otherwise specified or varied by the conditions of this licence.

3.2 Facility Notice Board

3.2.1 The licensee shall maintain a Facility Notice Board on the facility so that it is legible to persons outside the main entrance to the facility. The minimum dimensions of the board shall be 1200 mm by 750 mm.

3.2.2 The board shall clearly show:

(i) the name and telephone number of the facility;
(ii) the normal hours of operation;
(iii) the name of the licence holder;
(iv) an emergency out of hours contact telephone number;
(v) the licence reference number; and
(vi) where environmental information relating to the facility can be obtained.

3.2.3 A plan of the facility clearly identifying the location of each storage and treatment area shall be displayed as close as is possible to the entrance to the facility. The plan shall be displayed on a durable material such that it is legible at all times. The plan shall be replaced as material changes to the facility are made.

3.3 Specified Engineering Works (SEW)

3.3.1 The licensee shall submit proposals for any Specified Engineering Works, to the Agency for its agreement at least two months in advance of the intended date of commencement of any such works. No such works shall be carried out without the prior agreement of the Agency.

3.3.2 All specified engineering works shall be supervised by an appropriately qualified person, and that person, or persons, shall be present at all times during which relevant works are being undertaken.

3.3.3 Following the completion of any specified engineering works, the licensee shall complete a construction quality assurance validation. The validation report shall be made available to the Agency on request. The report shall, as appropriate, include the following information:

(i) A description of the works;
(ii) As-built drawings of the works;
(iii) Records and results of all tests carried out (including failures);
(iv) Drawings and sections showing the location of all samples and tests carried out;
(v) Name(s) of contractor(s)/individual(s) responsible for undertaking the specified engineering works;
(vi) Records of any problems and the remedial works carried out to resolve those problems; and
(vii) Any other information requested in writing by the Agency.

3.4 Tank, Container and Drum Storage Areas

3.4.1 All tank, container and drum storage areas shall be rendered impervious to the materials stored therein. Bunds should be designed having regard to Agency guidelines '*Storage and Transfer of Materials for Scheduled Activities*' (2004).

3.4.2 All tank and drum storage areas shall, as a minimum, be bunded, either locally or remotely, to a volume not less than the greater of the following:

(i) 110% of the capacity of the largest tank or drum within the bunded area; or

(ii) 25% of the total volume of substance, which could be stored within the bunded area.

3.4.3 All drainage from bunded areas shall be treated as hazardous waste unless it can be demonstrated to be otherwise. All drainage from bunded areas shall be diverted for collection and safe disposal.

3.4.4 All inlets, outlets, vent pipes, valves and gauges must be within the bunded area.

3.4.5 All tanks, containers and drums shall be labelled to clearly indicate their contents.

3.5 Landfill Lining

3.5.1 The landfill footprint (maximum lateral extent of landfilling) shall be as indicated in Drawing Reference WLR3 ("Existing waste licence (W0129-01) boundary and proposed landfill footprint").

3.5.2 The landfill liner shall comprise of the following:
Base and side wall:- A mineral layer of a minimum thickness of 1m with a hydraulic conductivity less than or equal to 1.0 x 10^{-7} m/s, or similar with equivalent protection to the foregoing.

3.5.3 The liner detailed design and its construction shall be in accordance with the guidelines provided in the Agency's Landfill Manual, *Landfill Site Design*.

3.5.4 All boreholes located under the footprint of the landfill shall be adequately sealed prior to the emplacement of the liner.

3.5.5 The formation level of the basal liner prior to emplacement of compacted clay shall be constructed at least one metre above the water table and in any event the formation level of the liner shall be no lower than 104.5 mAOD Malin. Any excavations deeper than the formation level shall only be backfilled with granular materials quarried from the facility.

3.6 Facility Security

3.6.1 Security and stockproof fencing and gates shall be installed and maintained. The base of the fencing shall be set in the ground. Subject to the implementation of the restoration and aftercare plan and to the agreement of the Agency, the requirement for such site security may be removed.

3.6.2 Gates shall be locked shut when the facility is unsupervised.

3.6.3 The licensee shall remedy any defect in the gates and/or fencing as follows:

(i) A temporary repair shall be made by the end of the working day; and

(ii) A repair to the standard of the original gates and/or fencing shall be undertaken within three working days.

3.7 Facility Roads and Hardstanding

3.7.1 Effective site roads shall be provided and maintained to ensure the safe movement of vehicles within the facility.

3.7.2 The facility entrance and hardstanding areas shall be appropriately paved and maintained in a fit and clean condition.

3.8 Facility Office

3.8.1 The licensee shall provide and maintain an office at the facility. The office shall be constructed and maintained in a manner suitable for the processing and storing of documentation.

3.8.2 The licensee shall provide and maintain a working telephone and a method for electronic transfer of information at the facility.

3.9 Waste Inspection and Quarantine Areas

3.9.1 A Waste Inspection Area and a Waste Quarantine Area shall be provided and maintained at the facility.

3.9.2 These areas shall be constructed and maintained in a manner suitable, and be of a size appropriate, for the inspection of waste and subsequent quarantine if required. The waste inspection area and the waste quarantine area shall be clearly identified and segregated from each other.

3.9.3 Drainage from these areas shall be directed to the leachate management system.

3.10 Weighbridge and Wheel Cleaner

3.10.1 The licensee shall provide and maintain a weighbridge and wheel cleaners at the facility.

3.10.2 The wheel cleaners shall be used by all vehicles leaving the facility as required to ensure that no process water or waste is carried off-site. All water from the wheel cleaning area shall be recycled.

3.11 Waste Water Treatment Plant

In the event that sanitary effluent is to be managed on-site, the licensee shall provide and maintain a Wastewater Treatment plant at the facility for the treatment of such sanitary effluents. Any percolation area shall satisfy the criteria set out in the *Wastewater Treatment Manual, Treatment Systems for Single Houses*, published by the Environmental Protection Agency.

3.12 The licensee shall install on all emission points such sampling points or equipment, including any data-logging or other electronic communication equipment, as may be required by the Agency. All such equipment shall be consistent with the safe operation of all sampling and monitoring systems.

3.13 In the case of composite sampling of aqueous emissions from the operation of the facility a separate composite sample or homogeneous sub-sample (of sufficient volume as advised) should be refrigerated immediately after collection and retained as required for EPA use.

3.14 The licensee shall clearly label and provide safe and permanent access to all on-site sampling and monitoring points and to off-site points as required by the Agency.

3.15 The licensee shall have in storage an adequate supply of containment booms and/or suitable absorbent material to contain and absorb any spillage at the facility. Once used the absorbent material shall be disposed of at an appropriate facility.

3.16 Silt Traps and Oil Separators

The licensee shall install and maintain silt traps and oil separators at the facility to ensure that *all* storm water discharges from yard areas of the facility pass through a silt trap and oil separator in advance of discharge. The separator shall be a Class I full retention separator and the silt traps and separator shall be in accordance with I.S. EN 858-2:2003 (separator systems for light liquids).

3.17 All pump sumps, storage tanks, lagoons or other treatment plant chambers from which spillage of environmentally significant materials might occur in such quantities as are likely to breach local or remote containment or separator, shall be fitted with high liquid level alarms (or oil detectors as appropriate) within 3 months from the date of grant of this licence.

~~3.19~~3.18 The licensee shall maintain in a prominent location on the site a wind sock, or other wind direction indicator, which shall be visible from the public roadway outside the site.

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~~3.20~~3.19 The licensee shall provide a minimum of one leachate monitoring borehole (50mm bore) per two hectares of landfill. These boreholes shall be designed to also facilitate landfill gas monitoring.

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~~3.21~~3.20 All groundwater boreholes shall have their Top of Casing (TOC) elevations (mAOD Malin) marked on their respective casings. The licensee shall within three months of the date of grant of this licence submit to the Agency TOC and ground level elevations for all groundwater boreholes.

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~~3.22~~3.21 No hedgerows shall be removed or damaged unless otherwise agreed by the Agency.

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Reason: To provide for appropriate operation of the facility to ensure protection of the environment.

Condition 4 Interpretation

4.1 Emission limit values for emissions to waters in this licence shall be interpreted in the following way:

4.1.1 Continuous Monitoring

(i) No flow value shall exceed the specified limit.

(ii) No pH value shall deviate from the specified range.

(iii) No temperature value shall exceed the limit value.

4.1.2 Composite Sampling

(i) No pH value shall deviate from the specified range.

(ii) For parameters other than pH and flow, eight out of ten consecutive composite results, based on flow proportional composite sampling, shall not exceed the emission limit value. No individual result similarly calculated shall exceed 1.2 times the emission limit value.

4.1.3 Discrete Sampling

For parameters other than pH and temperature, no grab sample value shall exceed 1.2 times the emission limit value.

4.2 Where the ability to measure a parameter is affected by mixing before emission, then, with agreement from the Agency, the parameter may be assessed before mixing takes place.

4.3 Noise

Noise from the facility shall not give rise to sound pressure levels (Leq, T) measured at the noise sensitive locations of the facility, which exceed the limit value(s).

4.4 Dust

Dust from the activity shall not give rise to deposition levels, which exceed the limit value(s).

Reason: To clarify the interpretation of limit values fixed under the licence.

Condition 5 Emissions

5.1 No specified emission from the facility shall exceed the emission limit values set out in *Schedule B: Emission Limits* of this licence. There shall be no other emissions of environmental significance.

5.2 No emissions, including odours, from the activities carried on at the site shall result in an impairment of, or an interference with amenities or the environment beyond the facility boundary or any other legitimate uses of the environment beyond the facility boundary.

5.3 No substance shall be discharged in a manner, or at a concentration, that, following initial dilution, causes tainting of fish or shellfish.

5.4 The road network in the vicinity of the facility shall be kept free from any debris caused by vehicles entering or leaving the facility. Any such debris or deposited materials shall be removed without delay.

5.5 The licensee shall ensure that all or any of the following – mud, dust, litter - associated with the activity do not result in an impairment of, or an interference with amenities or the environment at the facility or beyond the facility boundary or any other legitimate uses of the environment beyond the facility boundary. Any method used by the licensee to control or prevent any such impairment/interference shall not cause environmental pollution.

5.6 Groundwater Management

5.6.1 There shall be no direct emissions of polluting matter to groundwater.

5.6.2 Effective groundwater management infrastructure shall be maintained at the facility during construction, operation, restoration and aftercare of the facility. As a minimum, the infrastructure shall be capable of the following:

(i) The protection of the groundwater resources from pollution by the waste activities; and

(ii) The protection of other infrastructure, such as the liner, from any adverse effects caused by the groundwater.

Reason: To provide for the protection of the environment by way of control and limitation of emissions.

Condition 6 Control and Monitoring

6.1 The licensee shall carry out such sampling, analyses, measurements, examinations, maintenance and calibrations as set out below and as in accordance with *Schedule C: Monitoring & Control* of this licence:

6.1.1 Analysis shall be undertaken by competent staff in accordance with documented operating procedures;

6.1.2 Such procedures shall be assessed for their suitability for the test matrix and performance characteristics determined;

6.1.3 Such procedures shall be subject to a programme of Analytical Quality Control using control standards with evaluation of test responses;

6.1.4 Where analysis is sub-contracted it shall be to a competent laboratory.

6.2 The licensee shall ensure that:

(i) sampling and analysis for all parameters listed in the Schedules to this licence, and

(ii) any reference measurement methods to calibrate automated measurement systems,

shall be carried out in accordance with CEN-standards. If CEN standards are not available, ISO, national or international standards which will ensure the provision of data of an equivalent scientific quality shall apply.

6.3 Test Programme

6.3.1 The licensee shall prepare, to the satisfaction of the Agency, a test programme for abatement equipment installed to abate emissions to atmosphere. This programme shall be submitted to the Agency in advance of implementation.

6.3.2 This programme, following agreement with the Agency, shall be completed within three months of the commencement of operation of the abatement equipment.

6.3.3 The criteria for the operation of the abatement equipment as determined by the test programme, shall be incorporated into the standard operating procedures.

6.3.4 The test programme shall as a minimum:

(i) Establish all criteria for operation, control and management of the abatement equipment to ensure compliance with the emission limit values specified in this licence.

(ii) Assess the performance of any monitors on the abatement system and establish a maintenance and calibration programme for each monitor.

A report on the test programme shall be submitted to the Agency within one month of completion.

6.4 All automatic monitors and samplers shall be functioning at all times (except during maintenance and calibration) when the activity is being carried on unless alternative sampling or monitoring has been agreed in writing by the Agency for a limited period. In the event of the malfunction of any continuous monitor, the licensee shall contact the Agency as soon as practicable, and alternative sampling and monitoring facilities shall be put in place. Agreement for the use of alternative equipment, other than in emergency situations, shall be obtained from the Agency.

6.5 Monitoring and analysis equipment shall be operated and maintained as necessary so that monitoring accurately reflects the emission/discharge or ambient conditions.

6.6 The licensee shall ensure that groundwater monitoring well sampling equipment is available/installed on-site and is fit for purpose at all times. The sampling equipment shall be to Agency specifications.

6.7 All treatment/abatement and emission control equipment shall be calibrated and maintained in accordance with the instructions issued by the manufacturer/supplier or installer.

6.8 The frequency, methods and scope of monitoring, sampling and analyses, as set out in this licence, may be amended with the agreement of the Agency following evaluation of test results.

6.9 The integrity and water tightness of all underground pipes, tanks, bunding structures and containers and their resistance to penetration by water or other materials carried or stored therein shall be tested and demonstrated by the licensee. This testing shall be carried out by the licensee at least once every three years thereafter and reported to the Agency on each occasion. This testing shall be carried out in accordance with any guidance published by the Agency. A written record of all integrity tests and any maintenance or remedial work arising from them shall be maintained by the licensee.

6.10 The drainage system, bunds, silt traps and oil separators shall be inspected weekly, desludged as necessary and properly maintained at all times. All sludge and drainage from these operations shall be collected for safe disposal.

6.11 Storm Water

A visual examination of the storm water discharge shall be carried out daily. A log of such inspections shall be maintained.

6.12 Noise

The licensee shall carry out a noise survey of the site operations annually. The survey programme shall be undertaken in accordance with the methodology specified in the 'Environmental Noise Survey Guidance Document' as published by the Agency.

6.13 Pollutant Release and Transfer Register (PRTR)

The licensee shall prepare and report a PRTR for the site. The substances and/or waste to be included in the PRTR shall be agreed by the Agency each year by reference to EC Regulation No. 166/2006 concerning the establishment of the European Pollutant Release and Transfer Register and amending Council Directives 91/689/EEC and 96/61/EC. The PRTR shall be prepared in accordance with any relevant guidelines issued by the Agency and shall be submitted electronically in specified format and as part of the AER.

6.14 The licensee shall maintain a Data Management System for collation, archiving, assessing and graphically presenting the environmental monitoring data generated as a result of this licence.

6.15 In dry weather, stockpiles, site roads and any other areas used by vehicles shall be sprayed with water as and when required to minimise airborne dust nuisance.

6.16 Monitoring equipment, which is damaged or proves to be unsuitable for its purpose shall be replaced within three months of it being damaged or recognised as being unsuitable.

6.17 Operational Controls

6.17.1 The licensee shall ensure that inert waste is subject to pre-treatment off-site (see glossary) where technically feasible.

6.17.2 All large hollow objects and other large articles deposited at the facility shall be crushed, broken up, flattened or otherwise treated.

6.17.3 Wastes once deposited and covered shall not be excavated, disturbed or otherwise picked over, unless with the prior agreement of the Agency.

6.17.4 Completed areas of the landfill shall be profiled so that no depressions exist in which water may accumulate. Any depressions arising after profiling shall be rectified by the emplacement of suitable materials.

6.17.5 Wastes once deposited and covered shall not be excavated, disturbed or otherwise picked over with the exception of works associated with the construction and installation of necessary infrastructure or otherwise only with the prior agreement of the Agency.

6.17.6 There shall be no public access to the landfill.

6.17.7 Gates shall be locked shut when the facility is unsupervised.

6.17.8 The licensee shall provide and use adequate lighting during the operation of the facility in hours of darkness.

6.17.9 No smoking shall be allowed at the facility.

6.18 Meteorological Monitoring

The licensee shall maintain a meteorological station at the facility capable of monitoring the parameters listed in *Schedule C.4: Meteorological Monitoring* of this licence, or the licensee shall make arrangements for representative meteorological date to be collaged for the facility to fulfil the requirements of *Schedule C.4: Meteorological Monitoring* of this licence.

6.19 Topographical Monitoring

A topographical survey shall be carried out on an annual basis. The survey shall include a measurement of the remaining available void space (broken down into actual available void space and any estimated void space which will be generated by future quarrying activities). The survey shall be in accordance with any written instructions issued by the Agency.

6.20 Stability Assessment

The licensee shall carryout a stability assessment of the side slopes of the facility annually. The results of this assessment shall be reported as part of the Annual Environmental Report (AER).

6.21 Archaeological Assessment

Prior to the development of any undisturbed area, the advice of the Department of the Environment, Heritage & Local Government, (National Monuments Section), shall be sought. On completion of such development a report of the results of any archaeological monitoring shall be submitted to Dúchas and to the Agency.

Reason: To provide for the protection of the environment by way of treatment and monitoring of emissions.

Condition 7 Resource Use and Energy Efficiency

7.1 The licensee shall carry out an audit of the energy efficiency of the site within one year of the date of grant of this licence. The audit shall be carried out in accordance with the guidance published by the Agency, *"Guidance Note on Energy Efficiency Auditing"*. The energy efficiency audit shall be repeated at intervals as required by the Agency.

7.2 The audit shall identify all opportunities for energy use reduction and efficiency and the recommendations of the audit will be incorporated into the Schedule of Environmental Objectives and Targets under Condition 2.2.2.2 above.

7.3 The licensee shall identify opportunities for reduction in the quantity of water used on site including recycling and reuse initiatives, wherever possible. Reductions in water usage shall be incorporated into Schedule of Environmental Objectives and Targets.

7.4 The licensee shall undertake an assessment of the efficiency of use of raw materials in all processes, having particular regard to the reduction in waste generated. The assessment should take account of best international practice for this type of activity. Where improvements are identified, these shall be incorporated into the Schedule of Environmental Objectives and Targets.

Reason: To provide for the efficient use of resources and energy in all site operations.

Condition 8 Materials Handling

8.1 Disposal or recovery of waste on-site shall only take place in accordance with the conditions of this licence and in accordance with the appropriate National and European legislation and protocols.

8.2 Waste sent off-site for recovery or disposal shall be transported only by an authorised waste contractor. The waste shall be transported from the site of the activity to the site of recovery/disposal only in a manner that will not adversely affect the environment and in accordance with the appropriate National and European legislation and protocols.

8.3 The licensee shall ensure that waste in advance of transfer to another person shall be classified, packaged and labelled in accordance with National, European and any other standards which are in force in relation to such labelling.

8.4 The loading and unloading of materials shall be carried out in designated areas protected against spillage and leachate run-off.

8.5 Waste shall be stored in designated areas, protected as may be appropriate against spillage and leachate run-off. The waste is to be clearly labelled and appropriately segregated.

8.6 No waste classified as green list waste in accordance with the EU Transfrontier Shipment of Waste Regulations (Council Regulation EEC No. 259/1993, as amended) shall be consigned for recovery without the agreement of the Agency.

8.7 Waste for disposal/recovery off-site shall be analysed in accordance with *Schedule C: Control & Monitoring* of this licence.

8.8 Unless approved in writing by the Agency the licensee is prohibited from mixing a hazardous waste of one category with a hazardous waste of another category or with any other non-hazardous waste.

8.9 Waste Acceptance & Characterisation Procedures.

8.9.1 Waste shall only be accepted at the facility from Local Authority waste collection or transport vehicles or holders of waste permits, unless exempted or excluded, issued under the Waste Management (Collection Permit) Regulations, 2001, or as may be amended.

8.9.2 No hazardous or liquid wastes shall be disposed of at the facility.

8.9.3 The licensee shall maintain written procedures for the acceptance and handling of all wastes. These procedures shall include –

(i) details of the pre-treatment of all waste to be carried out in advance of acceptance at the facility and shall also include methods for the characterisation of waste in order to distinguish between inert, non-hazardous wastes.

(ii) the requirements of *Schedule A.1: Waste Acceptance, Schedule A.2: Acceptable Waste, Schedule A.3: Acceptance Criteria* and *Schedule A.4: Limit Values for Pollutant Content for Inert Waste Landfills* of this licence.

The procedures shall have regard to the EU Decision (2003/33/EC) on establishing the criteria and procedures for the acceptance of waste at landfills pursuant to Article 16 and Annex II of Directive (199/31/EC) on the landfill of waste.

8.9.4 *Schedule A.3: Acceptance Criteria* and *Schedule A.4: Limit Values for Pollutant Content for Inert Waste Landfills* of this licence will not apply to inert mineral extraction waste resulting form quarrying activities at the facility which are subsequently disposed of or recovered at the facility.

8.9.5 All inert waste accepted at the facility shall comply with the standards establishing in the EU Decision (2003/22/EC).

Reason: To provide for the appropriate handling of materials and the protection of the environment.

Condition 9 Accident Prevention & Emergency Response

9.1 The licensee shall, within six months of date of grant of this licence, ensure that a documented Accident Prevention Procedure is in place, which will address the hazards on-site, particularly in relation to the prevention of accidents with a possible impact on the environment. This procedure shall be reviewed annually and updated as necessary.

9.2 The licensee shall maintain a documented Emergency Response Procedure, which shall address any emergency situation, which may originate on-site. This procedure shall include provision for minimising the effects of any emergency on the environment. This procedure shall be reviewed annually and updated as necessary.

9.3 Incidents

9.3.1 In the event of an incident the licensee shall immediately:

(i) carry out an investigation to identify the nature, source and cause of the incident and any emission arising therefrom;

(ii) isolate the source of any such emission;

(iii) evaluate the environmental pollution, if any, caused by the incident;

(iv) identify and execute measures to minimise the emissions/malfunction and the effects thereof;

(v) identify the date, time and place of the incident;

(vi) notify the Agency and other relevant authorities.

9.3.2 The licensee shall provide a proposal to the Agency for its agreement within one month of the incident occurring or as otherwise agreed by the Agency to:

(i) identify and put in place measures to avoid reoccurrence of the incident; and

(ii) identify and put in place any other appropriate remedial action.

Reason: To provide for the protection of the environment.

Condition 10 Restoration and Aftercare Management

10.1 The final profile of the facility shall tie in the facility to the surrounding land levels and shall be as shown on *Figure 4.2 Phasing of Restoration* of the Environmental Impact Statement (March 1999). The final height shall not exceed 149.0 mAOD Malin.

10.2 The facility shall be restored as described in Attachment G.1 Restoration Scheme of the application for W0129-01 and Section 4.7 *Landscaping Plan* of the Environmental Impact Statement (March 1999) subject to the following:

10.2.1 The final capping shall consist of the following:

(i) Top soil (150-300mm); and,

(ii) Subsoils, such that total thickness of top soil and subsoils is at least 1m.

10.3 The licensee shall restore the facility on a phased basis as per Figure 4.2 *Phasing of Restoration* of the Environmental Impact Statement (March 1999). Unless otherwise agreed, filled cells shall be permanently capped within 24 months of the cells having been filled to the required level.

10.4 Following termination, or planned cessation for a period greater than six months, of use or involvement of all or part of the site in the licensed activity, the licensee shall, to the satisfaction of the Agency, decommission, render safe or remove for disposal/recovery, any soil, subsoils, buildings, plant or equipment, or any waste, materials or substances or other matter contained therein or thereon, that may result in environmental pollution.

10.5 No material or object that is incompatible with the proposed restoration of the facility shall be present within one metre of the final soil surface levels.

10.6 All waste activities at the facility shall cease upon the installation of the final capping unless agreed otherwise by the Agency.

10.7 All soils shall be stored to preserve the soil structure for future use.

10.8 Closure, Restoration & Aftercare Management Plan (CRAMP)

10.8.1 The licensee shall prepare for agreement by the Agency, a fully detailed and costed plan for the closure, restoration and aftercare of the site or part thereof, including details of the final profile.

10.8.2 The plan shall be maintained and reviewed annually and proposed amendments thereto notified to the Agency for agreement as part of the AER. No amendments may be implemented without the prior agreement of the Agency.

10.9 The National Parks and Wildlife Service shall be consulted as part of the preparation of the CRAMP regarding the presence of peregrine falcon nests at the site. The Agency shall be notified of the outcome of this consultation.

10.10 The CRAMP shall include as a minimum, the following:

(i) A scope statement for the plan.

(ii) The criteria, including those specified in this licence, which define the successful closure and restoration of the facility or part thereof, and which ensure minimum impact to the environment.

(iii) A programme to achieve the stated criteria.

(iv) Where relevant, a test programme to demonstrate the successful implementation of the plan.

(v) Details of any proposed or required aftercare supervision, monitoring, control, maintenance and reporting requirements for the restored facility.

(vi) Details of the costings for the plan and the financial provisions to underwrite those costs.

10.11 A final validation report to include a certificate of completion for the CRAMP, for all or part of the site as necessary, shall be submitted to the Agency within three months of execution of the plan. The licensee shall carry out such tests, investigations or submit certification, as requested by the Agency, to confirm that there is no continuing risk to the environment.

Reason: To make provision for the proper closure of the activity ensuring protection of the environment.

Condition 11 Notifications, Records and Reports

11.1 The licensee shall notify the Agency by both telephone and facsimile, if available, to the Agency's Office of Environmental Enforcement, EPA, McCumiskey House, Richview, Clonskeagh Road, Dublin 14, or to such other Agency office as may be specified by the Agency, as soon as practicable after the occurrence of any of the following:

(i) Any release of environmental significance to atmosphere from any potential emission point including bypasses.

(ii) Any emission, which does not comply with the requirements of this licence.

(iii) Any malfunction or breakdown of key control equipment or monitoring equipment set out in *Schedule C: Control & Monitoring* which is likely to lead to loss of control of the abatement system.

(iv) Any incident with the potential for environmental contamination of surface water or groundwater, or posing an environmental threat to air or land, or requiring an emergency response by the Local Authority.

The licensee shall include as part of the notification, date and time of the incident, summary details of the occurrence, and where available, the steps taken to minimise any emissions.

11.2 In the case of any incident which relates to discharges to water, the licensee shall notify the Local Authority and the Eastern Regional Fisheries Board as soon as practicable after such an incident.

11.3 The licensee shall make a record of any incident. This record shall include details of the nature, extent, and impact of, and circumstances giving rise to, the incident. The record shall include all corrective actions taken to manage the incident, minimise wastes generated and the effect on the environment, and avoid recurrence. The licensee shall, as soon as practicable following incident notification, submit to the Agency the incident record.

11.4 The licensee shall record all complaints of an environmental nature related to the operation of the activity. Each such record shall give details of the date and time of the complaint, the name of the complainant, (if provided), and give details of the nature of the complaint. A record shall also be kept of the response made in the case of each complaint.

11.5 The licensee shall record all sampling, analyses, measurements, examinations, calibrations and maintenance carried out in accordance with the requirements of this licence and all other such monitoring which relates to the environmental performance of the facility.

11.6 The licensee shall as a minimum keep the following documents at the site:

(i) the licences relating to the facility;

(ii) the current EMS for the facility;

(iii) the previous year's AER for the facility;

(iv) records of all sampling, analyses, measurements, examinations, calibrations and maintenance carried out in accordance with the requirements of this licence and all other such monitoring which relates to the environmental performance of the facility;

(v) relevant correspondence with the Agency;

(vi) up to date site drawings/plans showing the location of key process and environmental infrastructure, including monitoring locations and emission points;

(vii) up to date Standard Operational Procedures for all processes, plant and equipment necessary to give effect to this licence or otherwise to ensure that standard operation of such processes, plant or equipment does not result in unauthorised emissions to the environment;

(viii) any elements of licence application or EIS documentation referenced in this licence (including that relating to W0129-01).

and this documentation shall be available to the Agency for inspection at all reasonable times.

11.7 The licensee shall submit to the Agency, by the 31st March of each year, an AER covering the previous calendar year. This report, which shall be to the satisfaction of the Agency, shall include as a minimum the information specified in *Schedule E: Annual Environmental Report* of this licence and shall be prepared in accordance with any relevant guidelines issued by the Agency.

11.8 A full record, which shall be open to inspection by authorised persons of the Agency at all times, shall be kept by the licensee on matters relating to the waste management operations and practices at this site. This record shall be maintained on a monthly basis and shall as a minimum contain details of the following:

(i) The tonnages and EWC Code for the waste materials imported and/or sent off-site for disposal/recovery.

(ii) The names of the agent and carrier of the waste, and their waste collection permit details, if required (to include issuing authority and vehicle registration number).

(iii) Details of the ultimate disposal/recovery destination facility for the waste and its appropriateness to accept the consigned waste stream, to include its permit/licence details and issuing authority, if required.

(iv) Written confirmation of the acceptance and disposal/recovery of any hazardous waste consignments sent off-site.

(v) Details of all wastes consigned abroad for Recovery and classified as 'Green' in accordance with the EU Transfrontier Shipment of Waste Regulations (Council Regulation EEC No. 259/1993, as amended). The rationale for the classification must form part of the record.

(vi) Details of any rejected consignments.

(vii) Details of any approved waste mixing.

(viii) The results of any waste analyses required under *Schedule C: Control & Monitoring,* of this licence.

(ix) The tonnages and EWC Code for the waste materials recovered/disposed on-site.

11.9 The licensee shall submit report(s) as required by the conditions of this licence to the Agency's Office of Environmental Enforcement, EPA, McCumiskey House, Richview, Clonskeagh Road, Dublin 14, or to such other Agency office as may be specified by the Agency.

11.10 All reports shall be certified accurate and representative by the facility manager or a nominated, suitably qualified and experienced deputy.

Reason: To provide for the collection and reporting of adequate information on the activity.

Condition 12 Financial Charges and Provisions

12.1 Agency Charges

12.1.1 The licensee shall pay to the Agency an annual contribution of €16,275, or such sum as the Agency from time to time determines, having regard to variations in the extent of reporting, auditing, inspection, sampling and analysis or other functions carried out by the Agency, towards the cost of monitoring the activity as the Agency considers necessary for the performance of its functions under the Waste Management Acts 1996 to 2007. The first payment shall be a pro-rata amount for the period from the date of this licence to the 31st day of December, and shall be paid to the Agency within one month from the date of the licence. In subsequent years the licensee shall pay to the Agency such revised annual contribution as the Agency shall from time to time consider necessary to enable performance by the Agency of its relevant functions under the Waste Management Acts 1996 to 2007, and all such payments shall be made within one month of the date upon which demanded by the Agency.

12.1.2 In the event that the frequency or extent of monitoring or other functions carried out by the Agency needs to be increased the licensee shall contribute such sums as determined by the Agency to defraying its costs in regard to items not covered by the said annual contribution.

12.2 Environmental Liabilities

12.2.1 The licensee shall as part of the AER provide an annual statement as to the measures taken or adopted at the site in relation to the prevention of environmental damage, and the financial provisions in place in relation to the underwriting of costs for remedial actions following anticipated events (including closure) or accidents/incidents, as may be associated with the carrying on of the activity.

12.2.2 The licensee shall arrange for the completion, by an independent and appropriately qualified consultant, of a comprehensive and fully costed Environmental Liabilities Risk Assessment (ELRA), which addresses the liabilities from past and present activities. The assessment shall include those liabilities and costs identified in Condition 10 for execution of the CRAMP. A report on this assessment shall be submitted to the Agency for agreement within twelve months of date of grant of this licence. The ELRA shall be reviewed as necessary to reflect any significant change on site, and in any case every three years following initial agreement: review results are to be notified as part of the AER.

12.2.3 As part of the measures identified in Condition 12.2.1, the licensee shall, to the satisfaction of the Agency, make financial provision to cover any liabilities identified in Condition 12.2.2. The amount of indemnity held shall be reviewed and revised as necessary, but at least annually. Proof of renewal or revision of such financial indemnity shall be included in the annual 'statement of measures' report identified in Condition 12.2.1.

12.2.4 Unless otherwise agreed, any revision to that part of the indemnity dealing with restoration and aftercare liabilities (refer Condition 10.8.1) shall be computed using the following formula:

Cost = (ECOST x WPI) + CiCC

Where:

Cost = Revised restoration and aftercare cost.

ECOST = Existing restoration and aftercare cost.

WPI = Appropriate Wholesale Price Index [Capital Goods, Building & Construction (i.e. Materials & Wages) Index], as published by the Central Statistics Office, for the year since last closure calculation/revision.

CiCC = Change in compliance costs as a result of change in site conditions, changes in law, regulations, regulatory authority charges, or other significant changes.

12.3 Cost of landfill of waste

In accordance with the provisions of Section 53A of the Waste management Acts 1996 to 2007, the licensee shall ensure the costs in the setting up, operation of, provisions of financial security and closure and after-care for a period of at least 30 years shall be covered by the price to be charged for the disposal of waste at the facility. The statement required under Section 53A(5) of said Acts is to be included as part of the AER.

Reason: To provide for adequate financing for monitoring and financial provisions for measures to protect the environment.

SCHEDULE A: Limitations

A.1 Waste Acceptance

Table A.1 Waste Categories and Quantities

WASTE TYPE Note 1	**MAXIMUM (TONNES PER ANNUM)**
Inert Construction and Demolition Waste and inert dredging spoils.	500,000 Note 2
Inert mineral extraction wastes arising from quarrying activities at the facility.	No limit
TOTAL	**500,000**

Note 1: Any proposals to accept other compatible waste streams must be agreed in advance by the Agency and the total amount of waste must be within the amount specified.

Note 2: Excluding materials imported for engineering, capping or landscaping purposes.

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A.2 Acceptable Waste

Only the inert wastes in Table A.2.1 and Table A.2.2 are acceptable for disposal and recovery respectively at the facility unless otherwise agreed with the Agency. In addition the waste in Table A.2.1 below, unless otherwise specified therein and subject to Conditions 8.9.3 and 8.9.4, must satisfy the criteria in *Schedule A.3: Acceptance Criteria* and *Schedule A.4: Limit Values for Pollutant Content for Inert Waste Landfills* of this licence.

Table A.2.1 Waste for Disposal

EWC CODE	**DESCRIPTION**	**RESTRICTIONS**
Waste Resulting from Quarrying and Physical Treatment of Minerals		
010102	Wastes from mineral non-metalliferous excavation	Limited to such waste derived from on-site quarrying activities
010412	Tailings and other wastes from washing and cleaning of minerals other than those mentioned in 010407 and 010411	Limited to such waste derived from on-site quarrying activities
010409	Waste sand and clays	___________
010499	Wastes not otherwise specified	Subject to the prior agreement of the Agency and limited to such inert waste derived from on-site quarrying activities
Construction and Demolition Wastes		
170101	Concrete	**Note 1**
170102	Bricks	**Note 1**
170103	Tiles and ceramics	**Note 1**
170107	Mixture of concrete, bricks, tiles and ceramics	Other than those mentioned in EWC 170106: **Note 1**
170202	Glass	**Note 1**
170302	Bituminous mixtures	Other than those mentioned in EWC 170301
170504	Soil and stones	Other than those mentioned in EWC 170503: **Note 2**.
170506	Dredging spoil	Other than those mentioned in EWC 170505
170604	Insulation materials	other than those mentioned in EWC 170601 and 170603
170904	Mixed construction and demolition wastes	Other than those mentioned in EWC 170901, 170902 and 170903, and subject to the prior agreement of the Agency.
Other Inert Wastes		
101006	Casting cores and moulds which have not undergone pouring.	Subject to the prior written agreement of the Agency.
190902	Sludges from water clarification	Subject to the prior written agreement of the Agency .
190904	Spent Activated Carbon	Subject to the prior written agreement of the Agency.

Note 1: These wastes can be accepted without Level 1or Level 2 testing (see A.3 below) provided

- The waste is a pure, single stream from a single source.
- Different wastes denoted by Note 1 may be accepted together provided they are from the same source.
- In the case of suspicion of contamination (either from visual inspection or from knowledge of the origin of the waste) testing should be applied or the waste should be refused.

Note 2: The terms of Note 1 apply to soil and stones other than topsoil and peat and soil or stones from contaminated sites.

Table A.2.2 Waste for Recovery

EWC CODE	**DESCRIPTION**	**RESTRICTIONS** Note 1
Waste Resulting from Quarrying and Physical Treatment of Minerals		
010102	Wastes from mineral non-metalliferous excavation	Limited to such waste derived from on-site quarrying activities
010412	Tailings and other wastes from washing and cleaning of minerals other than those mentioned in 010407 and 010411	Limited to such waste derived from on-site quarrying activities
010499	Wastes not otherwise specified	Subject to the prior agreement of the Agency and limited to such waste derived from on-site quarrying activities
Construction and Demolition Wastes		
170101	Concrete	For development works only.
170102	Bricks	For development works only.
170103	Tiles and ceramics	For development works only.
170107	Mixture of concrete, bricks, tiles and ceramics	For development works only. Other than those mentioned in EWC 170106.
170504	Soil and stones	Other than those mentioned in EWC 170503 and excluding peat.

Note 1: In the case of suspicion of contamination (either from visual inspection or from knowledge of the origin of the waste) testing should be applied or the waste should be refused.

A.3 Acceptance Criteria

The general characterisation and testing must be based on the following three level hierarchy:

Level 1: Basic Characterisation
This constitutes a through determination, according to standardised analysis and behaviour testing methods, of the short and long-term leaching behaviour and/or characteristic properties of the waste.

Level 2: Compliance Testing
This constitutes periodical testing by simpler standard analysis and behaviour-testing methods to determine whether a waste complies with condition and /or specific reference criteria. The tests focus on key variables and behaviour identified by basic characterisation.

Level 3: On-site verification
This constitutes rapid check methods to confirm that a waste is the same as that which has been subjected to compliance testing and that which is described in any accompanying documents. It may merely consist of a visual inspection of a load of waste before and after unloading at the landfill site.

All waste loads must provide the following information (if available) :

Waste owner	Amount of waste
Source and origin of waste	Existing data on the waste
Description of the waste	Physical form
Waste Type and EWC code	Colour
Type of process producing the waste	Odour

All wastes accepted for disposal or recovery at the landfill shall undergo the Level 3: On-site verification at a minimum.

In addition to the above a representative load from every excavation/demolition/waste removal/dredging works is subjected to a comprehensive assessment which must satisfy Level 1 characterisation.

The comprehensive assessment must at a minimum include the following:

1. A chemical analysis of a representative sample. At least one sample per 1,500 tonnes or portion thereof must be taken for chemical analysis for each excavation or demolition works. However, if the comprehensive assessment is undertaken prior to the commencement of excavation or clearance activity, the licensee may reduce the number of samples for chemical analysis to one for each 7,500 tonnes or portion thereof. The sampling location must be identified on a sampling grid and enclosed in the comprehensive assessment.
2. An evaluation of the acceptability of the disposal of the waste at the landfill including observance of limits for total pollutants contents in *Schedule A.4*: *Limit Values for Pollutant Content for Inert Waste Landfills*, of this licence.
3. A statement of any pre-treatment requirement (if any).
4. Evidence that the waste displays no hazardous properties upon disposal.

If as a result of examinations undertaken in the course of excavation or clearance activity, the suspicion of contamination should arise, the type and concentration of the contamination must be determined, and its extent established through additional sampling.

Wastes of unknown origin or with insufficient waste description must be subjected to a chemical analysis.

In addition to the assessment above, representative samples upon delivery of wastes must be taken for compliance testing purposes (Level 2). The tests shall focus on key variables and behaviour identified by the chemical analysis.

A representative sample shall be taken from one in every 100 loads of waste accepted at the facility. This sample shall be subjected to Level 2 testing. Part of this sample shall be retained at the facility for three months and be available for inspection/analysis by the Agency.

A.4 Limit Values for Pollutant Content for Inert Waste Landfills.

Unless otherwise instructed in writing by the Agency, the following leaching limit values apply for waste acceptable at landfills for inert waste. The leaching limit values are calculated at liquid to solid ratios (L/S) of 2 l/kg and 10 l/kg for total release and directly expressed in mg/l for C_o (the first eluate of percolation test at L/S = 0.1 l/kg).

Table A.4.1: Limit Values for Pollutant Content for Inert Waste Landfills.

Parameter	**L/S = 2 l/kg**	**L/S = 10 l/kg**	**C_0 (percolation test)**	**Total Pollutant Content**
	mg/kg dry substance	**mg/kg dry substance**	**mg/l**	**mg/kg dry substance**
Arsenic (as As)	0.1	0.5	0.06	
Barium (as Ba)	7.0	20.0	4.0	
Cadmium (as Cd)	0.03	0.04	0.02	
Total Chromium (as Cr)	0.2	0.5	0.1	
Copper (as Cu)	0.9	2.0	0.6	
Mercury (as Hg)	0.003	0.01	0.002	
Molybdenum (as Mo)	0.3	0.5	0.2	
Nickel (as Ni)	0.2	0.4	0.12	
Lead (as Pb)	0.2	0.5	0.15	
Antimony (as Sb)	0.02	0.06	0.10	
Selenium (as Se)	0.06	0.1	0.04	
Zinc (as Zn)	2.0	4.0	1.2	
Chloride	550.0	800.0	460.0	
Fluoride	4.0	10.0	2.5	
Sulphate $^{\textbf{Note 1}}$	560.0	1000.0	1500.0	
Phenol index	0.50	1.0	0.3	
Dissolved Organic Carbon (DOC) $^{\textbf{Note 2}}$	240.0	500.0	160.0	
Total Dissolved Solids (TDS) $^{\textbf{Note 3}}$	2500.0	4000.0		
Total Organic Carbon (TOC) $^{\textbf{Note 4}}$				30,000.0
BTEX $^{\textbf{Note 5}}$				6.0
PCB (7 congeners)				1.0
Mineral Oil (C10 – C40)				500.0
Total PAH $^{\textbf{Note 6}}$				100.0

Note 1: If the waste does not meet these values for sulphate, it may still be considered as complying with the acceptance criteria if the leaching does not exceed either of the following values: 1500 mg/l as Co at L/S = 0.1 l/kg and 6000mg/kg at L/S = 10 l/kg. It will be necessary to use a percolation test to determine the limit value at L/S = 0.1 l/kg under initial equilibrium conditions, whereas the value at L/S = 10 l/kg may be determined either by a batch leaching test or by a percolation test under conditions approaching local equilibrium.

Note 2: If the waste does not meet these values for dissolved organic carbon (DOC) at its own pH value, it may alternatively be tested at L/S = 10 l/kg and a pH between 7.5 and 8.0. The waste may be considered as complying with the acceptance criteria for DOC, if the result of this determination does not exceed 500 mg/l. (A method based on CEN/TS 14429:2005 is available).

Note 3: The values for TDS (Total Dissolved Solids) can be used alternatively to the values for Sulphate and Chloride.

Note 4: The TOC limit value is complied with as long as the loss on ignition does not exceed 5% per weight. In the case of soils a higher limit value may be admitted by the Agency, provided the Dissolved Organic Carbon at pH 7 (DOC7) value of 500 mg/kg is achieved.

Note 5: Benzene, toluene, ethylbenzene, o-xylene, m-xylene and p-xylene.

Note 6: For determining the total of PAH, the following seventeen compounds must be added to a sum: Fluoranthene C16H10, Benzoic(a)pyrene C20H12, Benzoic(b)fluoranthene C20H12, Benzoic(k)fluoranthene C20H12, Benzoic(g,h,i)perylene C22H12, I, Indenoic(1,2,3-c,d)pyrene C22H1, Napthalene, Acenapthylene, Acenapthene, Anthracene, Benzo(a)anthracene, Chrysene, Coronene, Dibenzo(a,h)anthracene, Flourene, Phenanthrene, Pyrene.

Note 7: Any changes to limit values shall be by written agreement in advance with the Agency.

Sampling and Test Methods

Sampling and testing shall be carried out by independent and qualified persons and institutions. Laboratories shall have proven experience in waste testing and analysis and an efficient quality assurance system. The methods provided in the Council Decision 2003/33/EC establishing criteria and procedures for the acceptance of waste at landfills pursuant to Article 16 and Annex II of Council Directive 1999/31/EC on the landfill of waste shall be used.

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SCHEDULE B: Emission Limits

B.1 Emissions to Air

There shall be no Emissions to Air of environmental significance.

❖

B.2 Emissions to Surface Water

Level (Suspended Solids mg/l)
35

❖

B.3 Emission to Sewer

There shall be no Process Effluent Emissions to Sewer.

❖

B.4 Noise Emissions

Daytime dB(A) L_{Aeq}(30 minutes)	Night-time dB(A) L_{Aeq}(30 minutes)
55$^{\text{Note 1}}$	45 $^{\text{Note 1}}$

Note 1: There shall be no clearly audible tonal component or impulsive component in the noise emission from the activity at any noise-sensitive location.

❖

B.5 Dust Deposition Limits

(Measured at the monitoring points indicated in Table C.2.1)

Level (mg/m^2/day) $^{\text{Note 1}}$
350

Note 1: 30 day composite sample with the results expressed as mg/m^2/day.

❖

SCHEDULE C: Control & Monitoring

C.1.1 Control of Emissions to Air

There shall be no emissions to air of environmental significance.

C.1.2 Monitoring of Emissions to Air

There shall be no emissions to air of environmental significance.

C.2.1 Monitoring Locations

Table C.2.1: Environmental monitoring locations.

Surface Water	Groundwater	Leachate	Dust	Noise
SW1	BH4	LC1	D1	N4
SW2	BH5	LC2	D2	N5
SWD1*	BH6	LC3	D3a	N6
SWD2*	BH9		D5	N7
SWD3*	BH10a			N8
SWD4*	BH11a			
SWD5*	BH12			
SWD6*	BH13			
SWD7*	BH14			

* SWD1-7 to be monitored when there is water flow at these locations.

C.2.2 Monitoring of Emissions to Surface Water, Ground Water and of Leachate

PARAMETER Note 1	SURFACE WATER Monitoring Frequency	LEACHATE Monitoring Frequency	GROUNDWATER Monitoring Frequency
Visual Inspection/Odour	Weekly	Six Monthly	Quarterly
Groundwater Level	Not Applicable	Not Applicable	Quarterly
Leachate Level	Not Applicable	Six Monthly	Not Applicable
Ammoniacal Nitrogen	Six Monthly	Six Monthly	Quarterly
BOD	As may be required	Not Applicable	Not Applicable
COD	Six Monthly	Six Monthly	Not Applicable
Chloride	Six Monthly	Six Monthly	Quarterly
Dissolved Oxygen	Six Monthly	Not Applicable	Quarterly
Electrical Conductivity	Six Monthly	Six Monthly	Quarterly
pH	Six Monthly	Six Monthly	Quarterly
Total Suspended Solids	Six Monthly	Not Applicable	Not Applicable
Temperature	Six Monthly	Not Applicable	Quarterly
Boron	Not Applicable	Not Applicable	Annually
Cadmium	As may be required	Not Applicable	Annually
Calcium	Annually	Not Applicable	Quarterly
Chromium (Total)	Not Applicable	Not Applicable	Annually
Copper	Not Applicable	Not Applicable	Annually
Cyanide (Total)	Not Applicable	Not Applicable	Annually
Fluoride	Not Applicable	Not Applicable	Annually
Iron	Not Applicable	Not Applicable	Quarterly
Lead	Not Applicable	Not Applicable	Annually
List I/II organic substances Note 2	As may be required	Annually	Annually
Magnesium	Annually	Not Applicable	Annually
Manganese	Annually	Not Applicable	Quarterly
Mercury	Not Applicable	Not Applicable	Annually
Potassium	Not Applicable	Six Monthly	Quarterly
Sulphate	Annually	Six Monthly	Quarterly
Sodium	Annually	Six Monthly	Quarterly
Total Alkalinity	Annually	Not Applicable	Not Applicable
Total Phosphorus / ortho- P	Annually	Not Applicable	Annually
Total Oxidised Nitrogen	Not Applicable	Six Monthly	Quarterly
Total Organic Carbon	Not Applicable	Not Applicable	Quarterly
Residue on evaporation	Not Applicable	Not Applicable	Annually
Zinc	Not Applicable	Not Applicable	Annually
Phenols	Not Applicable	Six Monthly	Quarterly
Faecal Coliforms Note 3	Not Applicable	Not Applicable	Annually
Total Coliforms Note 3	Not Applicable	Not Applicable	Annually

Note 1: All the analysis shall be carried out by a competent laboratory using standard and internationally accepted procedures.

Note 2: Samples screened for the presence of organic compounds using Gas Chromatography / Mass Spectrometry (GC/MS) or other appropriate techniques and using the list I/II Substances from EU Directive 76/464/EEC and 80/68/EEC as a guideline. Recommended analytical techniques include: volatiles (US Environmental Protection Agency method 524 or equivalent), semi-volatiles (US Environmental Protection Agency method 525 or equivalent, and pesticides (US Environmental Protection Agency method 608 or equivalent).

Note 3: In the case where groundwater is extracted for drinking water and there is evidence of bacterial contamination, the analysis at monitoring points down-gradient of the landfill should include enumeration of total bacteria at 22°C and 37°C and faecal streptococci.

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C.2.3. Noise Monitoring

Table C.2.3. Noise Monitoring Frequency & Technique

Parameter	Monitoring Frequency	Analysis Method/Technique
L(A)$_{EQ}$[30 minutes]	Annually	Standard Note 1
L(A)$_{10}$[30 minutes]	Annually	Standard Note 1
L(A)$_{90}$[30 minutes]	Annually	Standard Note 1
Frequency Analysis (⅓ Octave band analysis)	Annually	Standard Note 1

Note 1: "International Standards Organisation. ISO 1996. Acoustics – description and measurement of Environmental noise. Parts 1, 2 and 3".

❖

C.2.4 Dust Monitoring

Table C.2.4. Dust Monitoring Frequency and Technique

Parameter	Monitoring Frequency	Analysis Method/Technique
Dust deposition (mg/m^2/day)	Six-Monthly	Standard Method

❖

C.3.1 Control of Emissions to Sewer

There shall be no process effluent emissions to sewer.

❖

C.3.2 Monitoring of Emissions to Sewer

There shall be no process effluent emissions to Sewer.

❖

C.4 Meteorological Monitoring

Data to be obtained from a source agreed by the Agency.

Table C.4.1. Meteorological Monitoring

Parameter	Monitoring Frequency	Analysis Method/Technique
Precipitation Volume	Daily	Standard
Temperature (min/max)	Daily	Standard
Wind Force and Direction	Daily	Standard
Evaporation	Daily	Standard
Evapotranspiration	Daily	Standard
Humidity	Daily	Standard
Atmospheric Pressure	Daily	Standard

❖

SCHEDULE D: Recording and Reporting to the Agency

Completed reports shall be submitted to:

The Office of Environmental Enforcement,
Environmental Protection Agency,
McCumiskey House,
Richview,
Clonskeagh Road,
Dublin 14. **or** Any other address as may be specified by the Agency

Reports are required to be forwarded as required in the licence and as may be set out below:

Report	Reporting Frequency Note 1	Report Submission Date
Annual Environment Report (AER)	Annually	By 31st March of each year.
Record of incidents	As they occur	Within five days of the incident.
Specified Engineering Works reports	As they arise	In advance of the works commencing.
Monitoring of surface water quality	Six-Monthly	Within ten days of obtaining results.
Monitoring of groundwater quality	Six-Monthly	Within ten days of obtaining results.
Monitoring of leachate	Six-Monthly	Within ten days of obtaining results.
Dust monitoring	Six-Monthly	Within ten days of obtaining results.
Noise Monitoring	Annually	As part of the AER.
Any other monitoring Note 2	As they occur	Within ten days of obtaining results.

Note 1: Unless altered at the request of the Agency.

Note 2: Other than nuisance monitoring reports.

SCHEDULE E: Annual Environmental Report

Annual Environmental Report Content Note 1
Emissions from the facility.
Waste management record.
Waste recovery report.
Remaining void, projected completion date.
Resource consumption summary.
Complaints summary.
Schedule of Environmental Objectives and Targets.
Environmental management programme – report for previous year.
Environmental management programme – proposal for current year.
Pollutant Release and Transfer Register – report for previous year.
Pollutant Release and Transfer Register – proposal for current year.
Noise monitoring report summary.
Dust monitoring report summary.
Meteorological data summary.
Current monitoring location reference drawing.
Tank and pipeline testing and inspection report.
Reported incidents summary.
Energy efficiency audit report summary.
Report on the assessment of the efficiency of use of raw materials in processes and the reduction in waste generated.
Development/Infrastructural works summary (completed in previous year or prepared for current year).
Reports on financial provision made under this licence, management and staffing structure of the facility, and a programme for public information.
Review of environmental liabilities.
Any amendments to the Closure, Restoration & Aftercare Management Plan.
Any other items specified by the Agency.

Note 1: Content may be revised subject to the agreement of the Agency.

Sealed by the seal of the Agency on this the 21st day of May 2008.

PRESENT when the seal of the Agency
Was affixed hereto:

Laura Burke, Director/Authorised Person

Appendix 3: Summary Monitoring Data (required under W0129-02)

Meteorological Monitoring

Table 1: Annual rainfall (mm) measured at Dublin Airport

Year	Rainfall (mm)
2013	772
2012	809
2011	672
2010	667

Table 2: Annual evapotranspiration (mm) measured at Dublin Airport

Year	Evapotranspiration (mm)
2013	531
2012	482
2011	401
2010	410

Table 3: Annual effective rainfall as calculated from rainfall and evapotranspiration recorded at Dublin Airport

Year	Rainfall (mm)	Evapotranspiration (mm)	Effective rainfall (mm)
2013	772	531	242
2012	809	482	327
2011	672	401	272
2010	667	410	256

Table 4: Total rainfall (mm) measured at Dublin Airport

Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
2013	95	47	87	40	46	61	69	49	35	128	27	90	**772**
2012	63	21	26	90	90	88	85	68	83	71	72	52	**809**
2011	29	76	19	28	37	65	43	40	65	170	49	52	**672**
2010	45	36	55	27	38	51	79	48	104	31	96	57	**667**

Meteorological Monitoring

Table 5: Evapotranspiration (mm) measured at Dublin Airport

Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
2013	14	18	28	50	60	63	140	61	34	28	15	20	**531**
2012	14	27	36	71	69	67	65	22	29	25	15	10	**482**
2011	15	17	32	51	48	48	54	39	38	30	18	13	**401**
2010	7	12	31	47	51	63	57	55	41	27	14	5	**410**

Table 6: Potential rainfall (mm) (Rainfall minus Evapotranspiration) measured at Dublin Airport

Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
2013	80	29	58	-9	-14	-2	-71	-13	1	100	12	70	**242**
2012	49	-6	-11	20	22	21	19	13	55	46	57	43	**327**
2011	14	59	-12	-23	-11	17	-11	1	28	139	31	39	**272**
2010	39	24	24	-21	-13	-12	21	-7	64	3	82	52	**256**

Groundwater Levels

Table 7: Groundwater Levels (mOD), 2010 to 2013

	27/09/2010	14/12/2010	22/02/2011	27/06/2011	14/09/2011	01/12/2011	22/03/2012	19/06/2012	26-27/07/2012	09/08/2012	11/12/2012	09/04/2013	25-26/06/2013	19/09/2013	05/11/2013
BH4A	91.96	91.96	91.96	91.96	91.96	91.96	91.96	91.96	91.96	91.96		91.96	91.96	93.54	93.61
BH5	101.26	101.75	102.75	101.88	101.04	101.74	-	102.42	102.76	102.81	103.52		103.35	102.22	102.4
BH6	117.31	117.31	117.31	117.31	117.31	117.31	117.31	117.31	117.31	117.31		117.31	117.31	117.52	117.92
BH8	133.73	134.5	133.53	133.52	133	133.62	133.52	133.75	133.68	133.63	133.71	133.46	133.49	132.82	133.5
BH9	104.59	105.41	107.47	105.27	104.18	104.76	106.11	106.09	106.82	107.01	108.09	109.17	107	105.4	105.11
BH10A	99.59	99.89	100.54	100.1	99.44	99.65	-			100.41	101.2	101.9	101.44	100.57	100.49
BH11A	98.48	98.49	98.47	98.41	98.37	98.4	98.4	98.43	98.42	98.44	98.43	98.46	98.45	98.46	98.45
BH12	100.35	100.72	101.53	100.82	100.2	100.36	100.83	100.39		101.3	102.13	102.91	102.26	101.44	101.25
BH13	108.78	111.39	112.86	111.7	111.61	112.67	113.51	113.46		114.43	117.11	118.37	121.46	112.25	111.05
BH14	98.73	98.09	99.65	99.03	98.5	98.83	99.1		99.52	99.59	100.06	100.62	100.11	99.41	99.42

Groundwater Quality

Table 8: Groundwater monitoring results for BH-4A, 2010-2013

Parameter	Units	Drinking Water Directive (98/83/EC)	EPA Trigger Levels for W0129-02	Q2, 2010	Q3, 2010	Q4, 2010	Q1, 2011	Q2, 2011	Q3, 2011	Q4, 2011	Q1, 2012	Q2, 2012	Q3, 2012	Q4, 2012	Q1, 2013	Q2, 2013	Q3, 2013	Q4, 2013
Date of Sampling:				17/06/2010	27/09/2010	14/12/2010	22/02/2011	27/06/2011	14/09/2011	01/12/2011	23/03/2012	19/06/2012	09/08/2012	11/12/2012	09/04/2013	25/06/2013	19/09/2013	05/11/2013
Ammoniacal Nitrogen	mg/l NH_4-N	0.39	N/A	<0.03	<0.03	<0.03	0.03	<0.03	<0.03	<0.03	0.03	<0.03	0.05	<0.03	0.03	0.08	0.05	0.12
Arsenic	mg/l	0.01	N/A	<0.0009			<0.0025	<0.0025	0.0065	<0.0025	<0.0025	<0.0025	<0.0025	<0.0025	<0.0025	<0.0025	0.0027	0.0036
Barium	mg/l	N/A	N/A	0.02			0.017	0.028	0.046	0.017	0.008	0.02	0.019	0.021	0.019	0.018	0.015	0.013
Calcium	mg/l	N/A	N/A	109.7	104.7	97.5	103.1	79.9	73.9	97.1	44.5	105.9	100	101.2	104.4	89	105.9	103.2
Chloride	mg/l	250	75	24.9	22.3	23.7	20.2	6.5	21.6	20.5	19.5	22.3	18.8	23.8	19.9	22.5	21.9	20.8
Colour	N/A	N/A	N/A	Clear	Clear	Clear	Clear	Clear	Clear	clear	Clear	Clear	Clear	Clear	Clear	Clear	Rust-coloured	Light brown
Conductivity	mS/cm	2.5	1	0.66	0.64	0.671	0.62	0.58	0.47	0.59	0.56	0.55	0.64	0.61	0.6	0.64	0.63	0.59
Cyanide	mg/l	0.05	N/A			<0.04	<0.01				<0.01				<0.01			
Dissolved Oxygen	mg/l	N/A	N/A	12%	2.44	1.88	0.88	4	0.76	0.63	2.75	1.63	1.8	1.62	3.47	1.92	1.78	1.65
Iron	mg/l	0.2	N/A	0.01	0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02
Level, Water	mOD	N/A	N/A	91.96	91.96	91.96	91.96	91.96	91.96	91.96	91.96	91.96	91.96	91.96	91.96	91.96	93.54	93.61
Manganese	mg/l	0.05	N/A	0.17	0.167	0.187	0.177	0.373	0.318	0.172	0.131	0.19	0.184	0.19	0.247	0.194	0.239	0.228
Odour	N/A	N/A	N/A	None	None	None	none	None	None	none	None	None	None	None	None	None	None	None
pH	pH	6.5<pH<9.5	6<pH<9	7.5	7.4	7.2	7.2	7.5	7.2	7.7	7.4	7.4	7.1	7.1	6.7	6.6	7.6	8.1
Phenols, Total	mg/l	N/A	0.1	<0.18	<0.18	<0.15	<0.0005	<0.15	<0.15	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Potassium	mg/l	N/A	N/A	1.2	1.3	1.2	1.2	1.2	1.4	1.5	1.6	1.6	1.2	1.1	1.4	1.2	1.5	1.3
Sodium	mg/l	200	80	10.7	10.8	8.9	9.9	10.1	11	15.2	657.3	11.2	13.5	13.2	13.1	9.8	16	15.1
Sulphate	mg/l	250	150	48.66	43.2	37.52	31.61	24.61	12.66	28.93	30.35	25.78	24.7	48.73	37.45	38.75	40.89	36.52
Temperature	°C	N/A	N/A	10.8	10.4	9.1	10.5	15.2	16.1	6.1	12.7	13.7	13.4	8.8	5.1	10.9	14.1	7.4
Total Organic Carbon	mg/l	N/A	50	<2	7	0.43	3	8	6	4	4	8	6	10	4	<2	<2	<2
Total Oxidized Nitrogen	mg/l	N/A	N/A	2.02	0.53	0.43	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	0.5	0.4	<0.2
Boron	mg/l	N/A	N/A				0.049				0.016				<0.012			
Cadmium	mg/l	0.005	0.004	0.0004			<0.0005				<0.0005		<0.00003		<0.0005	<0.0005		
Chromium, Total	mg/l	0.05	N/A	0.0001			<0.0015				<0.0015		<0.0015		<0.0015	<0.0015		
Coliforms, Faecal	cfus/100ml	0	N/A				0				0				0			
Coliforms, Total	cfus/100ml	0	N/A				0				0				0			
Copper	mg/l	2	0.5	<0.003			<0.007				<0.007		<0.007		0.025	<0.007		
Fluoride	mg/l	1.5	N/A				<0.3				<0.3				<0.3	<0.3		
Lead	mg/l	0.01	N/A	0.002			<0.005				<0.005		0.0015		<0.005	<0.005		
List I and II Substances	mg/l	N/A	N/A				<0.01				<0.01				<0.00001			
Magnesium	mg/l	N/A	N/A	9.7			9.2				8.9		8.9		9	9.3		
Mercury	mg/l	0.001	N/A	<0.0005			<0.001				<0.001		<0.0005		<0.001	<0.001		
Orthophosphates	mg/l	N/A	N/A				0.93				<0.03				<0.03			

Groundwater Quality

Parameter	Units	Drinking Water Directive (98/83/EC)	EPA Trigger Levels for W0129-02	Q2, 2010	Q3, 2010	Q4, 2010	Q1, 2011	Q2, 2011	Q3, 2011	Q4, 2011	Q1, 2012	Q2, 2012	Q3, 2012	Q4, 2012	Q1, 2013	Q2, 2013	Q3, 2013	Q4, 2013
Date of Sampling:				**17/06/2010**	**27/09/2010**	**14/12/2010**	**22/02/2011**	**27/06/2011**	**14/09/2011**	**01/12/2011**	**23/03/2012**	**19/06/2012**	**09/08/2012**	**11/12/2012**	**09/04/2013**	**25/06/2013**	**19/09/2013**	**05/11/2013**
PAHs, Total 6/16/17 (Note1)	mg/l	0.0001	N/A	<0.0001				<0.0003			<0.0001				<0.0001			
Phosphorus, Total	mg/l	N/A	N/A				0.069				<0.005				0.049			
Total Solids	mg/l	N/A	N/A				347				233				293			
Zinc	mg/l	N/A	N/A	0.004			0.004				0.049		<0.0015		0.154	0.005		

Groundwater Quality

Table 9: Groundwater monitoring results for BH-5, 2010-2013

Parameter	Units	Drinking Water Directive (98/83/EC)	EPA Trigger Levels for W0129-02	Q2, 2010	Q3, 2010	Q4, 2010	Q1, 2011	Q2, 2011	Q3, 2011	Q4, 2011	Q1, 2012	Q2, 2012	Q3, 2012	Q4, 2012	Q1, 2013	Q2, 2013	Q3, 2013	Q4, 2013
Date of Sampling:				17/06/2010	27/09/2010	14/12/2010	22/02/2011	27/06/2011	14/09/2011	01/12/2011	23/03/2012	19/06/2012	09/08/2012	11/12/2012	09/04/2013	25/06/2013	19/09/2013	05/11/2013
Ammoniacal Nitrogen	mg/l NH_4-N	0.39	N/A	0.11	0.05	<0.03	<0.03		0.11	<0.03	0.12	0.12	0.13	0.03		0.19	0.14	0.16
Arsenic	mg/l	0.01	N/A	0.0154			0.0065		0.0075	0.0033	0.0163	0.0166	<0.0025	0.0051		0.005	<0.0025	0.0281
Barium	mg/l	N/A	N/A	0.04			0.012		0.03	0.018	0.012	0.013	0.014	0.014		0.024	0.01	0.011
Calcium	mg/l	N/A	N/A	113	78.1	97.5	75.9		88.1	78.3	86.7	87.5	78.7	69.9		98.6	95.6	94.9
Chloride	mg/l	250	75	21.9	20.1	22.6	19.2		22.9	20.4	21	20	20.5	20.1		24.5	26	23.6
Colour	N/A	N/A	N/A	Quite black in colour	Slightly Cloudy	Cloudy, Light brown	Clear		Some sediment	clear	Clear	Clear	Clear	Clear		Grey/black	clear	Clear
Conductivity	mS/cm	2.5	1	0.7	0.57	0.657	0.66		0.6	0.61	0.55	0.52	0.56	0.55		0.73	0.61	0.58
Cyanide	mg/l	0.05	N/A			<0.04	<0.01				<0.01							
Dissolved Oxygen	mg/l	N/A	N/A		4.6	4.05	3.3		0.79	1.97	0.75	2.81	1.38	2.22		1.47	3.22	2.43
Iron	mg/l	0.2	N/A	0.007	<0.02	<0.020	<0.02		<0.02	<0.02	<0.02	<0.02	<0.02	<0.02		<0.02	<0.02	<0.02
Level, Water	mOD	N/A	N/A	101.25	101.26	101.75	102.75	101.88	101.04	101.74		102.42	102.81	103.52		103.35	102.22	102.4
Manganese	mg/l	0.05	N/A	0.241	0.12	0.072	0.116		0.156	0.17	0.269	0.274	0.28	0.207		0.408	0.355	0.344
Odour	N/A	N/A	N/A	None	None	None	none		None	none	None	None	None	None		None	None	None
pH	pH	6.5<pH<9.5	6<pH<9	7.3	6.9	7.2	7.3		6.6	7.4	7	7.1	7	7		6.2	7	6.2
Phenols, Total	mg/l	N/A	0.1	<0.18	<0.18	<0.15	<0.0005		<0.15	<0.1	<0.1	<0.1	<0.1	<0.1		<0.1	<0.1	<0.1
Potassium	mg/l	N/A	N/A	1	1.1	1.2	1.4		1.3	1.5	1.2	1.1	1.1	1.3		1.4	1.1	1.1
Sodium	mg/l	200	80	16.2	29.3	52.3	52.1		31.8	42.2	18.1	15.8	17.1	37.5		18	16.4	16.9
Sulphate	mg/l	250	150	55.71	62.26	74.6	63.13		84.34	62.3	77.28	64.51	64.35	70.31		70.77	84.06	75.15
Temperature	^oC	N/A	N/A	11.6	10.4	6.5	8.9		12.1	7.2	11.5	15.2	13.8	8.4		12.5	11.3	8.9
Total Organic Carbon	mg/l	N/A	50	<2	7	0.45	4		5	4	<2	5	7	8		<2	<2	<2
Total Oxidized Nitrogen	mg/l	N/A	N/A	1	0.22	0.45	0.2		<0.2	<0.2	<0.2	<0.2	<0.2	<0.2		<0.2	1.3	<0.2
Boron	mg/l	N/A	N/A				0.054				0.017							
Cadmium	mg/l	0.005	0.004	0.0017			<0.0005				<0.0005		0.002			0.0022		
Chromium, Total	mg/l	0.05	N/A	0.0009			<0.0015				<0.0015		<0.0015			<0.0015		
Coliforms, Faecal	cfus/100 ml	0	N/A				4				0							
Coliforms, Total	cfus/100 ml	0	N/A				4				0							
Copper	mg/l	2	0.5	0.0006			<0.007				<0.007		<0.007			<0.007		
Fluoride	mg/l	1.5	N/A				<0.3				<0.3					<0.3		
Lead	mg/l	0.01	N/A	0.0003			<0.005				<0.05		0.0013			0.005		
List I and II Substances	mg/l	N/A	N/A				<0.01				<0.01							
Magnesium	mg/l	N/A	N/A	8.6			6.5				8.1		6.9			9.8		
Mercury	mg/l	0.001	N/A	<0.0005			<0.001				<0.001		<0.0005			<0.001		

Groundwater Quality

Parameter	Units	Drinking Water Directive (98/83/EC)	EPA Trigger Levels for W0129-02	Q2, 2010	Q3, 2010	Q4, 2010	Q1, 2011	Q2, 2011	Q3, 2011	Q4, 2011	Q1, 2012	Q2, 2012	Q3, 2012	Q4, 2012	Q1, 2013	Q2, 2013	Q3, 2013	Q4, 2013
Date of Sampling:				17/06/2010	27/09/2010	14/12/2010	22/02/2011	27/06/2011	14/09/2011	01/12/2011	23/03/2012	19/06/2012	09/08/2012	11/12/2012	09/04/2013	25/06/2013	19/09/2013	05/11/2013
Orthophosphates	mg/l	N/A	N/A				<0.06				<0.03							
PAHs, Total 6/16/17 (Note1)	mg/l	0.0001	N/A	<0.0001							<0.0001							
Phosphorus, Total	mg/l	N/A	N/A				0.625				0.013							
Total Solids	mg/l	N/A	N/A				347				346							
Zinc	mg/l	N/A	N/A	0.019			0.033				0.211		0.257			0.208		

Groundwater Quality

Table 10: Groundwater monitoring results for BH-6, 2010-2013

Parameter	Units	Drinking Water Directive (98/83/EC)	EPA Trigger Levels for W0129-02	Q2, 2010	Q3, 2010 EPA Samples	Q3, 2010 EPA Samples - MEHL Split	Q3, 2010	Q4, 2010	Q1, 2011	Q1, 2011 EPA: MEHL Split	Q1, 2011 EPA	Q2, 2011	Q3, 2011	Q4, 2011	Q1, 2012	Q2, 2012	Q3, 2012	Q4, 2012	Q1, 2013	Q2, 2013	Q3, 2013	Q4, 2013
Date of Sampling:				17/06/2010	13/09/2010	13/09/2010	27/09/2010	14/12/2010	22/02/2011	28/03/2011	28/03/2011	27/06/2011	14/09/2011	01/12/2011	23/03/2012	19/06/2012	09/08/2012	11/10/2010	11/12/2012	09/04/2013	26/06/2013	04/09/2013
Ammoniacal Nitrogen	mg/l NH_4-N	0.39	N/A	0.28	0.26	0.27	0.27	0.28	0.28	0.26	0.28	0.52	0.29	0.32	0.3	0.29	0.27	0.3	0.29	0.34	0.28	0.29
Arsenic	mg/l	0.01	N/A	<0.0009	0.0009	<0.0025			<0.0025	<0.0025		<0.0025	<0.0025	<0.0025	<0.0025	<0.0025	<0.0005	<0.0025	<0.0025	<0.0025	<0.0005	<0.0025
Barium	mg/l	N/A	N/A	0.065		0.061			0.061	0.066		0.239	0.076	0.061	<0.003	0.057	0.0582	0.061	0.063	0.064	0.059	0.054
Calcium	mg/l	N/A	N/A	95.9	101.2	72.7	93.3	97.5	95.5	94.1	99	58.9	101.9	97.2	0.6	97.4	106	97.8	102.2	85.2	98.8	106
Chloride	mg/l	250	75	21.7	20.1	20.5	19.9	23.2	20.1	21.4	19.4	22.8	21.7	21	20.6	19.2	20.1	20.2	20.1	20.1	19.6	21.1
Colour	N/A	N/A	N/A	Clear			Clear	Clear	Clear			Clear	Clear	Clear	Clear	Clear		Clear	Clear	Clear		Black
Conductivity	mS/cm	2.5	1	0.7	0.58	0.608	0.66	0.622	0.66		0.596	0.53	0.66	0.7	0.67	0.7	0.625	0.67	0.73	0.7	0.617	0.7
Cyanide	mg/l	0.05	N/A			<0.02		<0.04	<0.01						<0.01				<0.01			
Dissolved Oxygen	mg/l	N/A	N/A			10	5.2	3.86	2.54			5%	0.7	1.07	0.34	1.19		2.12	2.07	0.89	nm	2.32
Iron	mg/l	0.2	N/A	0.008	1.37	<0.020	<0.02	<0.02	<0.02	<0.02		<0.02	<0.02	<0.02	0.065	0.089	1.56	<0.02	<0.02	<0.02	1.17	<0.02
Level, Water	mOD	N/A	N/A	117.31			117.31	117.31	117.31			117.31	117.31	117.31	117.31	117.31		117.31	117.31	117.31		117.52
Manganese	mg/l	0.05	N/A	0.202	0.217	0.124	0.218	0.259	0.218	0.203		0.164	0.197	0.157	0.012	0.238	0.242	0.177	0.218	0.225	0.273	0.367
Odour	N/A	N/A	N/A	None			None	None	none			none	None	None	None	None		None	None	None		None
pH	pH	6.5<pH<9.5	6<pH<9	7.2	7.3	8.05	7.2	7.3	7.2		7.3	7.6	6.8	7.5	7.2	7.1	7.1	7.1	7	6.5	7.2	6.7
Phenols, Total	mg/l	N/A	0.1	<0.18		<0.18	<0.18	<0.15	<0.0005	<0.15		<0.15	<0.15	<0.1	<0.1	<0.1		<0.1	<0.1	<0.1		<0.1
Potassium	mg/l	N/A	N/A	4.8	5.4	5.2	5	4.6	5	5	5.1	6	5.8	6.8	6.1	5.6	6.36	5.7	6.1	5.9	5.69	6.1
Sodium	mg/l	200	80	16.9	17.8	17.4	17	52.3	16.7	17.9	17.1	27.3	17.5	20.7	675	18.2	19.2	17.3	18.1	15.8	16.1	19.4
Sulphate	mg/l	250	150	25.75	25.8	28.57	27.32	28.01	23.99	29.74	25	2.31	40.63	59.5	64.65	32.84	37.7	31.26	38.22	35.85	38.3	36.45
Temperature	^{o}C	N/A	N/A	11.3			11.5	8	9.8			5.7	12.6	7.2	9.7	16.2		5.6	9.4	13	15.1	14.9
Total Organic Carbon	mg/l	N/A	50	<2		9	8	18	4	<2		9	2	7	<2	7		6	3	5		<2
Total Oxidized Nitrogen	mg/l	N/A	N/A	0.72	<0.1	0.2	0.09	0.2	<0.2	<0.2	0.4	<0.2	<0.2	<0.2	<0.2	<0.2	0.1	<0.2	<0.2	<0.2	<0.1	<0.2
Boron	mg/l	N/A	N/A			0.063			0.105						0.065		0.082		0.07		0.075	
Cadmium	mg/l	0.005	0.004	<0.00003	<0.0001	<0.00005			<0.0005						<0.0005	0.00004	<0.0001		<0.0005	<0.0005	<0.0001	
Chromium, Total	mg/l	0.05	N/A	0.001	<0.0005	<0.0015			<0.0015						<0.0015	<0.0015	0.0024		<0.0015	<0.0015		
Coliforms, Faecal	cfus/100ml	0	N/A			0			0						5				0			
Coliforms, Total	cfus/100ml	0	N/A			0			0						5				0			
Copper	mg/l	2	0.5	<0.003	<0.0005	<0.007			<0.007						<0.007	<0.007	<0.0005		<0.007	<0.007	0.0008	
Fluoride	mg/l	1.5	N/A		0.19	0.3			0.4		0.27				<0.3				<0.3	<0.3		
Lead	mg/l	0.01	N/A	0.001	<0.000	<0.005			<0.005						<0.005	0.0013	<0.000		<0.005	<0.005	<0.000	

Groundwater Quality

Parameter	Units	Drinking Water Directive (98/83/EC)	EPA Trigger Levels for W0129-02	Q2, 2010	Q3, 2010 EPA Samples	Q3, 2010 EPA Samples - MEHL Split	Q3, 2010	Q4, 2010	Q1, 2011	Q1, 2011 EPA: MEHL Split	Q1, 2011 EPA	Q2, 2011	Q3, 2011	Q4, 2011	Q1, 2012	Q2, 2012	Q3, 2012	Q4, 2012	Q1, 2013	Q2, 2013	Q3, 2013	Q4, 2013
Date of Sampling:				**17/06/2010**	**13/09/2010**	**13/09/2010**	**27/09/2010**	**14/12/2010**	**22/02/2011**	**28/03/2011**	**28/03/2011**	**27/06/2011**	**14/09/2011**	**01/12/2011**	**23/03/2012**	**19/06/2012**	**09/08/2012**	**11/10/2010**	**11/12/2012**	**09/04/2013**	**26/06/2013**	**04/09/2013**
					5												5				5	
List I and II Substances	mg/l	N/A	N/A						<0.01						<0.01				<0.00001			
Magnesium	mg/l	N/A	N/A	17.9	19.3	17.7			17.6		18.4				0.8	17.9	19.6		20.2	18.9	17.6	
Mercury	mg/l	0.001	N/A	<0.0005	<0.00005	<0.001			<0.001						<0.001	<0.0005	<0.00005		<0.001	<0.001	<0.00005	
Orthophosphates	mg/l	N/A	N/A		0.005	<0.06			<0.06		<0.05				<0.03		<0.005		<0.03		<0.005	
PAHs, Total 6/16/17 (Note1)	mg/l	0.0001	N/A	<0.0001								<0.0003			<0.0001				<0.0001			
Phosphorus, Total	mg/l	N/A	N/A			0.018			0.02						<0.005				<0.007			
Total Solids	mg/l	N/A	N/A			107			358						406				354			
Zinc	mg/l	N/A	N/A	0.003	0.006	<0.003			0.015						0.031	0.246	0.206		0.141	0.022	0.004	

Groundwater Quality

Table 11: Groundwater monitoring results for BH-8, 2010-2013

Parameter	Units	Drinking Water Directive (98/83 /EC)	EPA Trigger Levels for W0129-02	Q2, 2010	Q3, 2010	Q4, 2010	Q1, 2011	Q2, 2011	Q3, 2011	Q4, 2011	Q1, 2012	Q2, 2012	Q3, 2012	Q4, 2012	Q1, 2013	Q2, 2013	Q3, 2013	Q4, 2013
Date of Sampling:				17/06/2010	27/09/2010	14/12/2010	22/02/2011	27/06/2011	14/09/2011	01/12/2011	23/03/2012	19/06/2012	09/08/2012	11/12/2012	09/04/2013	26/06/2013	19/09/2013	05/11/2013
Ammoniacal Nitrogen	mg/l NH_4-N	0.39	N/A	0.49	1.66	9.57	0.98	0.77	0.44	0.77	0.83	2.21	1.81	6.31	2.52	1.13	0.2	0.22
Arsenic	mg/l	0.01	N/A	0.0015			<0.0025	<0.0025	<0.0025	<0.0025	<0.0025	0.0032	<0.0025	<0.0025	<0.0025	<0.0025	0.01	<0.0025
Barium	mg/l	N/A	N/A	0.071			0.058	0.068	0.077	0.05	0.062	0.064	0.056	0.049	0.061	0.043	0.051	0.056
Calcium	mg/l	N/A	N/A	121.4	80.7	105.8	89.8	115.6	117.6	74.2	88.8	81.4	72.2	87.4	88	46.9	63.8	66.1
Chloride	mg/l	250	75	49.7	51.7	56.5	74.5	42.1	47	59.4	147.4	68.1	66.3	51.7	65.2	42.8	29.5	63
Colour	N/A	N/A	N/A	Muddy; High sediment		Very dark brown. High Sediment content	Very brown; sediment	Clear, red	Brown - high sediment loading	brown sediment	Brown sediment; iron flakes	Orange-brown; high sediment	Orange-brown; sediment	Orange; high sediment	Orange-red	Brown/red; sediment	Brown; sediment	Brown
Conductivity	mS/cm	2.5	1	0.8	0.68	0.832	0.75	0.71	0.77	0.62	0.84	0.65	0.7	0.8	0.65	0.54	0.56	0.56
Cyanide	mg/l	0.05	N/A			<0.04	<0.01				<0.01				<0.01			
Dissolved Oxygen	mg/l	N/A	N/A		2.51	2.55	1.68	4	1.23	0.68	1	0.64	2.58	1.9	3.6	1.72	0.86	2.57
Iron	mg/l	0.2	N/A	0.035	1.007	0.507	0.074	0.026	0.099	0.179	0.347	4.172		6.38	3.58	0.103	25.47	0.197
Level, Water	mOD	N/A	N/A	133.43	133.73	134.5	133.53	133.52	133	133.62	133.52	133.75	133.63	133.71	133.46	133.49	132.82	133.5
Manganese	mg/l	0.05	N/A	1.54	1.978	3.906	1.731	0.673	1.352	1.225	1.301	1.941	2.225	3.845	2.14	1.495	1.664	0.292
Odour	N/A	N/A	N/A	None		none	None	None	None	None	None	None	None	slight metallic	None	None	None	None
pH	pH	6.5<pH<9.5	6<pH<9	6.8	6.7	6.6	7.3	6.8	6.7	6.9	6.5	6.6	6.9	6.9	6.9	6.5	6.8	6.5
Phenols, Total	mg/l	N/A	0.1	<0.18	<0.18	<0.15	0.0026	<0.15	<0.15	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<1	<0.1
Potassium	mg/l	N/A	N/A	3.9	4.4	11.6	3.4	4.8	3.6	3.5	3.8	5.2	4.2	7.8	4.9	3.2	3.3	2.4
Sodium	mg/l	200	80	32.8	27.7	26.1	34.2	30.5	33	27.6	62.3	33	29	26.6	34.3	20.5	21.8	34.6
Sulphate	mg/l	250	150	120.28	113.73	154.12	121.44	165.41	186.86	92.98	96.95	107.6	91.19	87.85	111.32	70.32	59.19	133.42
Temperature	^{o}C	N/A	N/A	12.1	15.1	8.9	9	11.9	14.1	9.8	12.7	13.8	14.8	8	5.3	10.8	12.7	10.8
Total Organic Carbon	mg/l	N/A	50	6	13	48	16	19	21	20	18	25	19	70	27	14	27	8
Total Oxidized Nitrogen	mg/l	N/A	N/A	0.71	1.16	0.1	1.2	0.4	<0.2	0.7	1.1	<0.2	0.6	<0.2	<0.2	<0.2	0.3	1.7
Boron	mg/l	N/A	N/A				0.047				0.013				<0.012			
Cadmium	mg/l	0.005	0.004	0.0008			0.0006				<0.0005		0.0014		0.0005	<0.0005		
Chromium, Total	mg/l	0.05	N/A	0.0013			<0.0015				<0.0015		0.011		0.0037	0.0016		
Coliforms, Faecal	cfus/100 ml	0	N/A				0				0				0			
Coliforms, Total	cfus/100 ml	0	N/A				0				2				0			
Copper	mg/l	2	0.5	0.016			0.008				<0.007		<0.007		0.008	0.007		
Fluoride	mg/l	1.5	N/A				<0.3				<0.3				<0.3	<0.3		
Lead	mg/l	0.01	N/A	0.001			<0.005				<0.005		0.0013		<0.005	<0.005		
List I and II Substances	mg/l	N/A	N/A				<0.01				<0.01				<0.00001			
Magnesium	mg/l	N/A	N/A	9.9			11.4				12.1		9.7		13.2	7.3		

Groundwater Quality

Parameter	Units	Drinking Water Directive (98/83/EC)	EPA Trigger Levels for W0129-02	Q2, 2010	Q3, 2010	Q4, 2010	Q1, 2011	Q2, 2011	Q3, 2011	Q4, 2011	Q1, 2012	Q2, 2012	Q3, 2012	Q4, 2012	Q1, 2013	Q2, 2013	Q3, 2013	Q4, 2013
Date of Sampling:				17/06/2010	27/09/2010	14/12/2010	22/02/2011	27/06/2011	14/09/2011	01/12/2011	23/03/2012	19/06/2012	09/08/2012	11/12/2012	09/04/2013	26/06/2013	19/09/2013	05/11/2013
Mercury	mg/l	0.001	N/A	<0.0005			<0.001				<0.001		<0.0005		<0.001	<0.001		
Orthophosphates	mg/l	N/A	N/A				<0.06				<0.03				<0.03			
PAHs, Total 6/16/17 (Note1)	mg/l	0.0001	N/A	<0.0001				<0.0003			<0.0001				<0.0001			
Phosphorus, Total	mg/l	N/A	N/A				1.955				<0.005				2.957			
Total Solids	mg/l	N/A	N/A				864				653				1530			
Zinc	mg/l	N/A	N/A	0.005			0.01				0.007		0.0035		0.003	0.004		

Groundwater Quality

Table 12: Groundwater monitoring results for BH-9, 2010-2013

Parameter	Units	Drinking Water Directive (98/83/EC)	EPA Trigger Levels for W0129-02	Q2, 2010	Q3, 2010	Q4, 2010	Q1, 2011	Q2, 2011	Q3, 2011	Q4, 2011	Q1, 2012	Q2, 2012	Q3, 2012	Q4, 2012	Q1, 2013	Q2, 2013	Q3, 2013	Q4, 2013
Date of Sampling:				17/06/2010	27/09/2010	14/12/2010	22/02/2011	27/06/2011	14/09/2011	01/12/2011	23/03/2012	19/06/2012	09/08/2012	11/12/2012	09/04/2013	26/06/2013	19/09/2013	05/11/2013
Ammoniacal Nitrogen	mg/l NH_4-N	0.39	N/A	0.19	0.11	0.13	0.11	0.05	0.11	0.09	0.12	<0.03	0.07	0.12	0.13	0.27	0.05	0.11
Arsenic	mg/l	0.01	N/A	0.0077			0.0028	<0.0025	0.0053	0.0026	<0.0025	0.0057	0.0052	<0.0025	0.0039	<0.0025	0.0043	0.0041
Barium	mg/l	N/A	N/A	0.067			<0.003	0.004	0.017	<0.003	0.003	0.003	0.005	0.003	0.004	0.039	<0.003	0.004
Calcium	mg/l	N/A	N/A	87.8	86	79.1	85.4	92.9	92	84.5	89.1	91.5	89	89.1	91.9	81.8	98.5	95.9
Chloride	mg/l	250	75	19.6	22.8	25.9	22.2	24.3	25.4	24.6	25.9	24.7	25.4	26.4	26.2	25.9	27	26
Colour	N/A	N/A	N/A	Slightly Cloudy	Orange with some orange sediment	Orange with some orange sediment	Slight brown	clear, red	Clear	Brown sediment	Clear; Iron flakes (low No.)	Rust/orange with sediment	Clear	Clear	Slight orange colour	Clear	Orange	Light brown
Conductivity	mS/cm	2.5	1	0.55	0.53	0.49	0.51	0.51	0.52	0.51	0.51	0.49	0.56	0.53	0.61	0.57	0.53	0.52
Cyanide	mg/l	0.05	N/A			<0.04	<0.01				<0.01				<0.01			
Dissolved Oxygen	mg/l	N/A	N/A	14%	2.31	3.36	2.56	6	0.51	0.52	0.43	0.91	1.6	2.45	2.73	2.38	2.05	1.46
Iron	mg/l	0.2	N/A	0.01	<0.020	0.022	0.031	<0.02	<0.02	<0.02	<0.02	<0.02	0.038	<0.02	<0.02	<0.02	<0.02	<0.02
Level, Water	mOD Malin	N/A	N/A	105.76	104.59	105.41	107.47	105.27	104.18	104.76	106.11	106.09	107.01	108.09	109.17	107	105.4	105.11
Manganese	mg/l	0.05	N/A	0.093	0.099	0.086	0.075	0.101	0.029	0.054	0.045	0.026	0.072	0.074	0.026	0.071	0.009	0.009
Odour	N/A	N/A	N/A	None	None	None	None	none	None	None	None	Slight odour (metallic)	None	None	None	None	None	None
pH	pH	6.5<pH<9.5	6<pH<9	7	6.9	7.2	6.9	6.8	6.8	6.9	6.7	6.7	7	6.9	7.2	6.5	7.4	6.6
Phenols, Total	mg/l	N/A	0.1	<0.18		<0.15	0.003	<0.15	<0.15	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Potassium	mg/l	N/A	N/A	0.7	0.6	0.6	0.5	0.6	0.7	0.7	0.5	0.6	0.6	0.6	0.7	0.7	0.7	0.7
Sodium	mg/l	200	80	15.5	14.7	12.3	13.7	15.5	15.3	14	14.5	14	14.6	15.5	17.5	15.5	15.9	16
Sulphate	mg/l	250	150	33.96	40.28	40.48	34.58	40.72	40.52	32	38.68	37.32	36.39	41.22	42.67	88.6	44.38	45.47
Temperature	°C	N/A	N/A	12.8	10.8	9.6	10.1	12.4	11.6	9.7	13.9	13	15.4	9.1	7.4	12.4	11.8	10
Total Organic Carbon	mg/l	N/A	50	<2	7	18	7	11	9	5	6	9	9	8	10	3	<2	<2
Total Oxidized Nitrogen	mg/l	N/A	N/A	0.51	0.08	0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2
Boron	mg/l	N/A	N/A				0.038				<0.012				<0.012			
Cadmium	mg/l	0.005	0.004	0.0001			<0.0005				<0.0005		0.00005		<0.0005	<0.0005		
Chromium, Total	mg/l	0.05	N/A	0.0011			<0.0015				<0.0015		<0.0015		<0.0015	<0.0015		
Coliforms, Faecal	cfus/100 ml	0	N/A				0				0				0			
Coliforms, Total	cfus/100 ml	0	N/A				0				0				0			
Copper	mg/l	2	0.5	0.004			<0.007				<0.007		<0.007		0.032	<0.007		
Fluoride	mg/l	1.5	N/A				<0.3				<0.3				<0.3	<0.3		
Lead	mg/l	0.01	N/A	0.003			<0.005				<0.005		0.0007		0.005	<0.005		

Groundwater Quality

Parameter	Units	Drinking Water Directive (98/83/EC)	EPA Trigger Levels for W0129-02	Q2, 2010	Q3, 2010	Q4, 2010	Q1, 2011	Q2, 2011	Q3, 2011	Q4, 2011	Q1, 2012	Q2, 2012	Q3, 2012	Q4, 2012	Q1, 2013	Q2, 2013	Q3, 2013	Q4, 2013
Date of Sampling:				17/06/2010	27/09/2010	14/12/2010	22/02/2011	27/06/2011	14/09/2011	01/12/2011	23/03/2012	19/06/2012	09/08/2012	11/12/2012	09/04/2013	26/06/2013	19/09/2013	05/11/2013
List I and II Substances	mg/l	N/A	N/A								<0.01				<0.0001			
Magnesium	mg/l	N/A	N/A	6.6			4.3				4.8		4.5		5.1	6.3		
Mercury	mg/l	0.001	N/A	<0.0005			<0.001				<0.001		<0.0005		<0.001	<0.001		
Orthophosphates	mg/l	N/A	N/A				<0.06				<0.03				<0.03			
PAHs, Total 6/16/17 (Note1)	mg/l	0.0001	N/A	<0.0001				<0.0003			<0.0001				<0.0001			
Phosphorus, Total	mg/l	N/A	N/A				0.387				<0.005				1.495			
Total Solids	mg/l	N/A	N/A				348				309				360			
Zinc	mg/l	N/A	N/A	0.011			0.011				0.005		0.0058		<0.003	0.008		

Groundwater Quality

Table 13: Groundwater monitoring results for BH-10A, 2010-2013

Parameter	Units	Drinking Water Directive (98/83/EC)	EPA Trigger Levels for W0129-02	Q2, 2010	Q3, 2010 EPA Samples	Q3, 2010 EPA Samples - MEHL Split	Q3, 2010	Q4, 2010	Q1, 2011	Q1, 2011 EPA: MEHL Split	Q1, 2011 EPA	Q2, 2011	Q3, 2011	Q4, 2011	Q1, 2012	Q2, 2012	Q3, 2012	Q4, 2012	Q1, 2013	Q2, 2013	Q3, 2013	Q4, 2013
Date of Sampling:				17/06/2010	13/09/2011	13/09/2010	27/09/2010	14/12/2010	22/02/2011	28/03/2011	28/03/2011	27/06/2011	14/09/2011	01/12/2011	23/03/2012	19/06/2012	09/08/2012	11/12/2012	09/04/2013	26/06/2013	04/09/2013	19/09/2013
Ammoniacal Nitrogen	mg/l NH_4-N	0.39	N/A	<0.03	0.02	<0.03	<0.03	0.03	0.03	0.09	<0.01	<0.03		<0.03	<0.03	<0.03	<0.03	<0.03	<0.03	0.09	0.04	0.06
Arsenic	mg/l	0.01	N/A	0.0011	0.0023	<0.0025			<0.0025	<0.0025		<0.0025		<0.0025	<0.0025	<0.0025	<0.0025	<0.0025	0.0035	<0.0025	<0.0025	0.0034
Barium	mg/l	N/A	N/A	0.019		0.018			0.014	0.018		0.015		0.012	0.013	0.012	0.012	0.012	0.011	0.013	0.012	0.013
Calcium	mg/l	N/A	N/A	159.6	188.3	160.3	158	274.4	213.8	170.9	189.5	164.7		163.4	150.3	164.5	144.3	134.4	142.4	109	137.6	137.7
Chloride	mg/l	250	75	33.3	31.7	31.5	32.5	23.6	28.9	34.5	32.7	37.6		38.8	40	39.5	39.4	41.2	42.3	43.9	46.6	46.4
Colour	N/A	N/A	N/A	Clear			Clear	Cloudy	Clear			Cloudy		Clear	Clear	Slightly cloudy	Clear	Clear	Clear	Brown; sediment	None	Clear
Conductivity	mS/cm	2.5	1	0.94	0.83	0.89		1.318	1.15		0.892	0.85		0.91	0.83	0.79	0.85	0.78	0.84	0.84	0.7	0.77
Dissolved Oxygen	mg/l	N/A	N/A			11	6.48	3.36				11		1.74	2.22	1.94	3.46	6.19	7.19	2.59	3.19	4.66
Iron	mg/l	0.2	N/A	0.007	<0.01	<0.020	<0.02	<0.020	<0.02	<0.02		<0.02		<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02
Level, Water	mOD Malin	N/A	N/A	99.73			99.59	99.89	100.54			100.1	99.44	99.65			100.41	101.2	101.9	101.44	100.57	100.49
Manganese	mg/l	0.05	N/A	<0.0015	0.024	<0.002	0.003	0.044	0.002	0.005		<0.002		<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002
Odour	N/A	N/A	N/A	None			None	None	None			None		None	None	None	None	None	None	None	None	None
pH	pH	6.5<pH<9.5	6<pH<9	7.7	7.5	8.05	7.6	7.2	7		7.5	7.8		7.7	7.3	7.5	7.6	7.4	6.5	7.9	7.6	6.5
Phenols, Total	mg/l	N/A	0.1	<0.18		<0.18	<0.18	<0.15	0.0013	<0.15		<0.15		<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Potassium	mg/l	N/A	N/A	2.3	2.5	2.5	2.6	2.5	2.7	2.3	2.4	2.8		3.1	2.6	3.1	2.5	2.3	2.3	2.4	2.5	2.6
Sodium	mg/l	200	80	15.5	16	16.3	16.5	10.6	29.3	17.2	16.7	18.6		18.5	19.2	22.2	18.6	18.5	21.6	17.4	21.7	22
Sulphate	mg/l	250	150	292.66		330.22	293.11	548.19	401.65	346.71	354.2	283.64		276.45	278.19	256.9	236.15	224.79	227.8	228.1	236.79	240.38
Temperature	°C	N/A	N/A	11.8			11.8	7.4	10.6			13.1		9	10.6	15.8	14.1	7.3	6.6	12.7	13.9	8.6
Total Organic Carbon	mg/l	N/A	50	<2		10	5	18	5	7		10		6	27	7	9	6	6	<2	<2	<2
Total Oxidized Nitrogen	mg/l	N/A	N/A	2.21	0.9	0.7	1.23	0.29	0.9	0.6	0.8	0.7		0.2	0.6	<0.2	0.4	<0.2	0.2	0.2	0.2	<0.2
Boron	mg/l	N/A	N/A		0.016	0.017			0.054						<0.012				<0.012			
Cadmium	mg/l	0.005	0.004	0.0002	0.0002	<0.0005			<0.0005						<0.0005		0.00014		<0.0005	<0.0005		
Chromium, Total	mg/l	0.05	N/A	0.0011	<0.0005	<0.0015			<0.0015						<0.0015		<0.0015		<0.0015	<0.0015		
Coliforms, Faecal	cfus/100ml	0	N/A			0			0						0				0			
Coliforms, Total	cfus/100ml	0	N/A			28			0						0				0			
Copper	mg/l	2	0.5	<0.003	<0.0005	<0.007			<0.007						<0.007		<0.007		<0.007	<0.007		
Cyanide	mg/l	0.05	N/A			<0.02		<0.04	<0.01						<0.01				<0.01			

Groundwater Quality

Parameter	Units	Drinking Water Directive (98/83/EC)	EPA Trigger Levels for W0129-02	Q2, 2010	Q3, 2010 EPA Samples	Q3, 2010 EPA Samples - MEHL Split	Q3, 2010	Q4, 2010	Q1, 2011	Q1, 2011 EPA: MEHL Split	Q1, 2011 EPA	Q2, 2011	Q3, 2011	Q4, 2011	Q1, 2012	Q2, 2012	Q3, 2012	Q4, 2012	Q1, 2013	Q2, 2013	Q3, 2013	Q4, 2013
Date of Sampling:				17/06/2010	13/09/2011	13/09/2010	27/09/2010	14/12/2010	22/02/2011	28/03/2011	28/03/2011	27/06/2011	14/09/2011	01/12/2011	23/03/2012	19/06/2012	09/08/2012	11/12/2012	09/04/2013	26/06/2013	04/09/2013	19/09/2013
Fluoride	mg/l	1.5	N/A		0.1	<0.3			0.3		0.08				<0.3				<0.3	<0.3		
Lead	mg/l	0.01	N/A	0.001	<0.0005	<0.005			<0.005						<0.005		0.0005		<0.005	<0.005		
List I and II Substances	mg/l	N/A	N/A												<0.01				<0.00001			
Magnesium	mg/l	N/A	N/A	9.8	11.9	11.4			15.6		13.7				10.7		9.4		11.1	9.8		
Mercury	mg/l	0.001	N/A	<0.0005	<0.00005	<0.001			<0.001						<0.001		<0.0005		<0.001	<0.001		
Orthophosphates	mg/l	N/A	N/A		0.033	<0.06			<0.06		<0.005				<0.03				<0.03			
PAHs, Total 6/16/17 (Note1)	mg/l	0.0001	N/A	<0.0001								<0.0003			<0.0001				<0.0001			
Phosphorus, Total	mg/l	N/A	N/A			0.332			0.136						<0.005				0.29			
Total Solids	mg/l	N/A	N/A			420			1024						642				580			
Zinc	mg/l	N/A	N/A	0.004	0.0072	<0.003			0.009						0.004		<0.0015		<0.003	0.003		

Groundwater Quality

Table 14: Groundwater monitoring results for BH-11A, 2010-2013

Parameter	Units	Drinking Water Directive (98/83/EC)	EPA Trigger Levels for W0129-02	Q2, 2010	Q3, 2010 EPA Samples	Q3, 2010 EPA Samples - MEHL Split	Q3, 2010	Q4, 2010	Q1, 2011	Q1, 2011 EPA: MEHL Split	Q1, 2011 EPA	Q2, 2011	Q3, 2011	Q4, 2011	Q1, 2012	Q2, 2012	Q3, 2012	Q4, 2012	Q1, 2013	Q2, 2013	Q3, 2013	Q4, 2013
Date of Sampling:				17/06/2010	13/09/2011	13/09/2010	27/09/2010	14/12/2010	22/02/2011	28/03/2011	28/03/2011	27/06/2011	14/09/2011	01/12/2011	23/03/2012	19/06/2012	09/08/2012	11/10/2012	11/12/2012	09/04/2013	25/06/2013	04/09/2013
Ammoniacal Nitrogen	mg/l NH_4-N	0.39	N/A	0.19	0.22	0.2	0.21	0.23	0.24	0.23	0.29	0.19	0.23	0.21	0.23	0.2	0.21	0.24	0.2	0.28	0.26	0.3
Arsenic	mg/l	0.01	N/A	0.0144	0.0579	0.0054			0.0267	0.0269		0.0168	0.0077	0.0149	0.0176	0.0126	0.0336	<0.0025	0.0116	0.0056	0.0059	0.0078
Barium	mg/l	N/A	N/A	0.025		0.033			0.019	0.035		0.021	0.032	0.018	0.017	0.02	0.02	0.021	0.02	0.023	0.021	0.022
Calcium	mg/l	N/A	N/A	94.9	97.5	68.5	91.8	86.8	92.4	93.7	101.5	70.8	90.5	93	93.9	106	93.5	91.7	94.7	71.4	97.9	96.6
Chloride	mg/l	250	75	23.4	22.2	22.6	22.1	25	21.7	23.4	22.1	23.9	25	24	22.8	22.1	22	23	23.1	22.7	24	22.9
Colour	N/A	N/A	N/A	Clear			Slightly Cloudy	Very light brown	Clear			Cloudy	Clear	Clear	Clear	Clear	Clear	Clear	Clear	Clear	Clear	Clear
Conductivity	mS/cm	2.5	1	0.63	0.532	0.542	0.62	0.593	0.62		0.053	0.54	0.6	0.6	0.58	0.57	0.64	0.59	0.65	0.63	0.61	0.58
Dissolved Oxygen	mg/l	N/A	N/A			11	2.62	3.16	0.97			4	1.69	0.95	1.51	3.86	2.37	1	2.12	1.95	2.55	2.11
Iron	mg/l	0.2	N/A	0.008	1.36	<0.020	0.3	<0.020	<0.02	<0.02		<0.02	<0.02	<0.02	<0.02	0.038	0.083	<0.02	0.031	<0.02	<0.02	<0.02
Level, Water	mOD Malin	N/A	N/A	98.49			98.48	98.49	98.47			98.41	98.37	98.4	98.4	98.43	98.44	98.43	98.46	98.45	98.46	98.45
Manganese	mg/l	0.05	N/A	0.352	0.354	0.161	0.358	0.376	0.372	0.314		0.371	0.363	0.358	0.357	0.374	0.379	0.387	0.36	0.384	0.358	0.369
Odour	N/A	N/A	N/A	None			None	None	None			None	None	None	None	None	None	None	None	None	None	None
pH	pH	6.5<pH<9.5	6<pH<9	7.1	7.2	7.77	7.2	7.4	7		7.2	7.6	6.7	7.9	7	7	7	7	6.9	6.8	7.2	7.2
Phenols, Total	mg/l	N/A	0.1	<0.18		<0.18	<0.18	<0.15	0.0007	<0.15		<0.15	<0.15	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Potassium	mg/l	N/A	N/A	1.9	2	2	1.9	1.8	1.9	1.9	2	2	2	2.4	2.2	2	1.9	1.7	2	2	2	2
Sodium	mg/l	200	80	16.3	16.4	15.7	16.2	13.9	15.6	16.4	16.1	16.5	16.5	16.5	16.6	17.8	15.6	15.8	17.3	13.9	16.1	16.5
Sulphate	mg/l	250	150	10.35	10	11.52	11.18	15.26	11.67	9.05	10.3	9.28	9.74	7.06	31.3	17.71	10.85	9.76	9.2	12.2	5.41	10.65
Temperature	°C	N/A	N/A	11.2			10.3	8.4	9.7			13.6	11.7	9.4	12.8	15.2	12	9.4	7	12.3	11.3	9.7
Total Organic Carbon	mg/l	N/A	50	<2		9	8	17	5	<2		9	3	3	4	8	6	6	13	<2	<2	<2
Total Oxidized Nitrogen	mg/l	N/A	N/A	0.43	<0.1	0.2	0.08	0.2	<0.2	<0.2	0.1	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2
Boron	mg/l	N/A	N/A		0.022	0.021			0.053						0.019				0.016			
Cadmium	mg/l	0.005	0.004	0.001	0.0002	<0.0005			<0.005						<0.0005		0.00012		<0.0005	0.0056		
Chromium, Total	mg/l	0.05	N/A	0.001	<0.0005	<0.0015			<0.0015						<0.0015		0.0016		<0.0015	<0.0015		
Coliforms, Faecal	cfus/100ml	0	N/A			0			0						0				0			
Coliforms, Total	cfus/100ml	0	N/A			0			0						0				0			
Copper	mg/l	2	0.5	<0.003	<0.0005	<0.007			<0.007						<0.007		<0.007		<0.007	<0.007		
Cyanide	mg/l	0.05	N/A			<0.02		<0.04	<0.01						<0.01				<0.01			

Groundwater Quality

Parameter	Units	Drinking Water Directive (98/83/EC)	EPA Trigger Levels for W0129-02	Q2, 2010	Q3, 2010 EPA Samples	Q3, 2010 EPA Samples - MEHL Split	Q3, 2010	Q4, 2010	Q1, 2011	Q1, 2011 EPA: MEHL Split	Q1, 2011 EPA	Q2, 2011	Q3, 2011	Q4, 2011	Q1, 2012	Q2, 2012	Q3, 2012	Q4, 2012	Q1, 2013	Q2, 2013	Q3, 2013	Q4, 2013
Date of Sampling:				17/06/2010	13/09/2011	13/09/2010	27/09/2010	14/12/2010	22/02/2011	28/03/2011	28/03/2011	27/06/2011	14/09/2011	01/12/2011	23/03/2012	19/06/2012	09/08/2012	11/10/2012	11/12/2012	09/04/2013	25/06/2013	04/09/2013
Fluoride	mg/l	1.5	N/A		0.33	0.5			0.6		0.36				0.5				0.5	0.5		
Lead	mg/l	0.01	N/A	0.0001	<0.0005	<0.005			<0.005						<0.005		0.0004		<0.005	<0.005		
List I and II Substances	mg/l	N/A	N/A						<0.01						<0.01				<0.00001			
Magnesium	mg/l	N/A	N/A	12.1	12.4	11			11.9		12.2				12.6		11.5		12.8	11.6		
Mercury	mg/l	0.001	N/A	<0.0005	<0.00005	<0.001			<0.001						<0.001		<0.0005		<0.001	<0.001		
Orthophosphates	mg/l	N/A	N/A		0.022	<0.06			<0.06		<0.05				<0.03				<0.03			
PAHs, Total 6/16/17 (Note1)	mg/l	0.0001	N/A	<0.0001								<0.0003			<0.0001				<0.0001			
Phosphorus, Total	mg/l	N/A	N/A			0.463			0.02						<0.005				0.024			
Total Solids	mg/l	N/A	N/A			1257			348						233				322			
Zinc	mg/l	N/A	N/A	0.016	0.0145	<0.003			0.018						0.017		0.019		0.019	0.07		

Groundwater Quality

Table 15: Groundwater monitoring results for BH-12, 2010-2013

Parameter	Units	Drinking Water Directive (98/83/EC)	EPA Trigger Levels for W0129-02	Q2, 2010	Q3, 2010	Q4, 2010	Q1, 2011	Q2, 2011	Q3, 2011	Q4, 2011	Q1, 2012	Q2, 2012	Q3, 2012	Q4, 2012	Q1, 2013	Q2, 2013	Q3, 2013	Q4, 2013
Date of Sampling:				17/06/2010	27/09/2010	14/12/2010	22/02/2011	27/06/2011	14/09/2011	01/12/2011	23/03/2012	19/06/2012	09/08/2012	11/12/2012	09/04/2013	25/06/2013	19/09/2013	05/11/2013
Ammoniacal Nitrogen	mg/l NH_4-N	0.39	N/A	<0.03	0.03	0.02	0.03	0.05	0.14	0.9	<0.03	0.05	0.03	<0.03	0.04	0.12	0.19	0.1
Arsenic	mg/l	0.01	N/A	0.0102			<0.0025	<0.0025	0.0055	<0.0025	<0.0025	<0.0025	<0.0025	<0.0025	<0.0025	<0.0025	<0.0025	0.0041
Barium	mg/l	N/A	N/A	0.004			0.02	0.028	0.036	0.016	0.013	0.015	0.007	0.012	0.016	0.023	0.025	0.009
Calcium	mg/l	N/A	N/A	84.7	23.9	14.5	16.7	40.3	16.6	18.1	14.1	29.9	21.9	16.2	25	32.8	34.1	17.2
Chloride	mg/l	250	75	30.9	2.2	21.8	9.6	7.4	2.5	5.6	3	1.7	1.3	1.9	18.8	13.7	3	5.3
Colour	N/A	N/A	N/A	Dark colour/muddy	Slight Brown	Light brown	Light brown	V slight brown	Light brown	Clear	Light sediment	Dark brown/ sediment	Light sediment	Brown sediment	Light brown	Brown - sediment	Black	Light brown
Conductivity	mS/cm	2.5	1	0.54	0.16	0.179	0.14	0.11	0.11	0.2	0.09	0.15	0.12	0.1	0.17	0.28	0.16	0.7
Dissolved Oxygen	mg/l	N/A	N/A		8.01	7.72	1.47	8	2.72	1.95	2.29	2.12	5.78	3.31	7.2	6.06	3.16	3.41
Iron	mg/l	0.2	N/A	0.007	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02
Level, Water	mOD Malin	N/A	N/A	100.64	100.35	100.72	101.53	100.82	100.2	100.36	100.83	100.39	101.3	102.13	102.91	102.26	101.44	101.25
Manganese	mg/l	0.05	N/A	<0.0015	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	0.035	0.123	0.003
Odour	N/A	N/A	N/A	None	None	None	None	None	None	None	None	None	None	None	None	None	None	None
pH	pH	6.5<pH<9.5	6<pH<9	7.8	7.3	7.8	7.8	8.1	7.9	7.3	7.6	7.4	7.9	7.2	6.7	6.8	7	6.9
Phenols, Total	mg/l	N/A	0.1	<0.18		<0.15	0.0017	<0.15	<0.15	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Potassium	mg/l	N/A	N/A	1.9	3.7	2.8	2	2.9	4.1	2.8	3.6	2.8	1.8	2.5	2.3	2.3	3.7	2.3
Sodium	mg/l	200	80	15.1	4.6	11.4	11.9	7	4.7	4.5	4	3.5	1.7	3.2	12.1	6.8	3.9	4
Sulphate	mg/l	250	150	25.6	3.92	4.86	2.65	9.81	2.95	1.29	7.28	4.39	2.04	4.54	12.74	11.11	2.05	4.37
Temperature	°C	N/A	N/A	13.3	10.8	6.1	10	12	11.1	9.5	10.3	14.1	13.3	7.4	4.5	11.6	11	9.5
Total Organic Carbon	mg/l	N/A	50	<2	4	10	5	12	9	8	5	5	6	5	3	<2	<2	<2
Total Oxidized Nitrogen	mg/l	N/A	N/A	8.46	0.77	0.41	0.4	0.5	0.4	0.5	0.3	<0.2	0.5	<0.2	1.3	5.3	1.8	0.8
Boron	mg/l	N/A	N/A				0.056				<0.012				<0.012			
Cadmium	mg/l	0.005	0.004	<0.00003			<0.0005				<0.0005		<0.00003		<0.0005	<0.0005		
Chromium, Total	mg/l	0.05	N/A	0.0018			<0.0015				<0.0015		<0.0015		<0.0015	<0.0015		
Coliforms, Faecal	cfus/100 ml	0	N/A				0				0				0			
Coliforms, Total	cfus/100 ml	0	N/A				0				0				0			
Copper	mg/l	2	0.5	<0.003			<0.007				<0.007		<0.007		<0.007	<0.007		
Cyanide	mg/l	0.05	N/A			<0.04	<0.01				<0.01				<0.01			
Fluoride	mg/l	1.5	N/A				<0.3				<0.3				<0.3	<0.3		
Lead	mg/l	0.01	N/A	0.001			<0.005				<0.005		0.0007		<0.005	<0.005		
List I and II Substances	mg/l	N/A	N/A				<0.01				<0.01				<0.00001			
Magnesium	mg/l	N/A	N/A	4.1			0.7				0.7		5.5		1.4	1.8		

Groundwater Quality

Parameter	Units	Drinking Water Directive (98/83/EC)	EPA Trigger Levels for W0129-02	Q2, 2010	Q3, 2010	Q4, 2010	Q1, 2011	Q2, 2011	Q3, 2011	Q4, 2011	Q1, 2012	Q2, 2012	Q3, 2012	Q4, 2012	Q1, 2013	Q2, 2013	Q3, 2013	Q4, 2013
Date of Sampling:				17/06/2010	27/09/2010	14/12/2010	22/02/2011	27/06/2011	14/09/2011	01/12/2011	23/03/2012	19/06/2012	09/08/2012	11/12/2012	09/04/2013	25/06/2013	19/09/2013	05/11/2013
Mercury	mg/l	0.001	N/A	<0.0005			<0.001				<0.001		<0.0005		<0.001	<0.001		
Orthophosphates	mg/l	N/A	N/A				<0.06				<0.03				<0.03			
PAHs, Total 6/16/17 (Note1)	mg/l	0.0001	N/A	<0.001				<0.0003			<0.0001				<0.0001			
Phosphorus, Total	mg/l	N/A	N/A				0.511				<0.005				0.536			
Total Solids	mg/l	N/A	N/A				358				64				927			
Zinc	mg/l	N/A	N/A	0.003			0.006				0.005		<0.0015		<0.003	0.01		

Groundwater Quality

Table 16: Groundwater monitoring results for BH-13, 2010-2013

Parameter	Units	Drinking Water Directive (98/83/EC)	EPA Trigger Levels for W0129-02	Q2, 2010	Q3, 2010	Q4, 2010	Q1, 2011	Q2, 2011	Q3, 2011	Q4, 2011	Q1, 2012	Q2, 2012	Q3, 2012	Q4, 2012	Q1, 2013	Q2, 2013	Q3, 2013	Q4, 2013
Date of Sampling:				17/06/2010	27/09/2010	14/12/2010	22/02/2011	27/06/2011	14/09/2011	01/12/2011	23/03/2012	19/06/2012	09/08/2012	11/12/2012	09/04/2013	25/06/2013	19/09/2013	05/11/2013
Ammoniacal Nitrogen	mg/l NH_4-N	0.39	N/A	0.05	0.04	0.03	0.04	0.03	0.05	0.05	0.04	0.04	<0.03	0.05	0.06	0.12	0.07	0.14
Arsenic	mg/l	0.01	N/A	0.0025			0.0025	<0.0025	0.008	<0.0025	<0.0025	<0.0025	<0.0025	<0.0025	<0.0025	<0.0025	<0.0025	0.0034
Barium	mg/l	N/A	N/A	0.008			0.008	0.009	0.016	0.005	0.008	0.007	0.009	0.018	0.016	0.02	0.013	0.013
Calcium	mg/l	N/A	N/A	59.6	51.7	49	54.8	60.8	44.9	43.5	42.8	55.6	45.8	34.8	40.6	26.3	67.4	68.4
Chloride	mg/l	250	75	37.4	35.3	40.1	35.3	39.8	35.7	34.5	32.9	30	29	20.3	22.7	24.8	35.2	34.2
Colour	N/A	N/A	N/A	Dark colour/muddy	Brown Sediment	Dark brown	Very brown	Brown	Dark brown - high sediment	sediment	Brown sediment	Brown/ sediment	Brown/ sediment	V brown; v high sediment	Brown; v. high sediment	Brown; high sediment	Brown; sediment	Brown
Conductivity	mS/cm	2.5	1	0.42	0.39	0.44	0.44	0.41	0.35	0.34	0.3	0.33	0.31	0.28	0.33	0.34	0.44	0.43
Dissolved Oxygen	mg/l	N/A	N/A			10.44	1.35	11	3.19	3.07	2.38	3.21	5.44	8.32	8.82	6.2	3.17	6.85
Iron	mg/l	0.2	N/A	0.024	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.2
Level, Water	mOD Malin	N/A	N/A	108.38	108.78	111.39	112.86	111.7	111.61	112.67	113.51	113.46	114.43	117.11	118.37	121.46	112.55	111.05
Manganese	mg/l	0.05	N/A	<0.0015	0.005	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	0.018	0.013	0.038	<0.002	<0.002
Odour	N/A	N/A	N/A	None	None	None	None	None	None	None	None	None	None	None	None	None	None	None
pH	pH	6.5<pH<9.5	6<pH<9	7.1	7.2	7.5	7.3	7.5	8	7.4	7.7	7	7.7	7.1	6.1	6.7	6.9	6.7
Phenols, Total	mg/l	N/A	0.1	<0.18	<0.18	<0.15	0.0028	<0.15	<0.15	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Potassium	mg/l	N/A	N/A	2	2.1	2	2.1	2.1	1.6	1.7	1.6	1.2	1.5	1	1.3	1.4	1.5	1.4
Sodium	mg/l	200	80	17.1	16.5	14.7	17.7	18.5	16.6	16.8	16.2	17	15.2	12.4	14.5	12.2	17.7	17.3
Sulphate	mg/l	250	150	10.3	12.22	12.8	9.65	10.37	17.44	9.75	15.53	16.67	19.4	43.09	62.99	61.54	18.99	22.12
Temperature	^{o}C	N/A	N/A	12.6	12.5	7.2	10.1	11.4	11.3	9.2	10.2	12.1	13.9	6.8	5.1	12.1	11.4	10.3
Total Organic Carbon	mg/l	N/A	50	<2	4	10	3	10	6	6	9	9	7	4	3	<2	<2	<2
Total Oxidized Nitrogen	mg/l	N/A	N/A	11.48	9.81	11.75	10.3	10.8	7.9	7.8	8.9	4.5	5.8	1.7	1.9	1.6	9.1	8.7
Boron	mg/l	N/A	N/A				<0.012				<0.0012				<0.012			
Cadmium	mg/l	0.005	0.004	0.0001			<0.0005				<0.0005		<0.00003		<0.0005	<0.0005		
Chromium, Total	mg/l	0.05	N/A	0.0017			<0.0015				<0.0015		0.002		<0.0015	<0.0015		
Coliforms, Faecal	cfus/100 ml	0	N/A				0				0				0			
Coliforms, Total	cfus/100 ml	0	N/A				0				0				0			
Copper	mg/l	2	0.5	<0.003			<0.007				<0.007		<0.007		<0.007	<0.007		
Cyanide	mg/l	0.05	N/A				<0.01				<0.01				<0.01			
Fluoride	mg/l	1.5	N/A				<0.3				<0.3				<0.0003	<0.3		
Lead	mg/l	0.01	N/A	0.002			<0.005				<0.005		0.0004		<0.005	<0.005		
List I and II Substances	mg/l	N/A	N/A				<0.01				<0.01				<0.00001			

Groundwater Quality

Parameter	Units	Drinking Water Directive (98/83/EC)	EPA Trigger Levels for W0129-02	Q2, 2010	Q3, 2010	Q4, 2010	Q1, 2011	Q2, 2011	Q3, 2011	Q4, 2011	Q1, 2012	Q2, 2012	Q3, 2012	Q4, 2012	Q1, 2013	Q2, 2013	Q3, 2013	Q4, 2013
Date of Sampling:				17/06/2010	27/09/2010	14/12/2010	22/02/2011	27/06/2011	14/09/2011	01/12/2011	23/03/2012	19/06/2012	09/08/2012	11/12/2012	09/04/2013	25/06/2013	19/09/2013	05/11/2013
Magnesium	mg/l	N/A	N/A	4			3.9				4.1		10.5		9.5	7.7		
Mercury	mg/l	0.001	N/A	<0.0005			<0.001				<0.001		<0.0005		<0.001	<0.001		
Orthophosphates	mg/l	N/A	N/A				0.81				0.13				<0.03			
PAHs, Total 6/16/17 (Note1)	mg/l	0.0001	N/A	<0.0001				<0.0003			<0.0001				<0.0001			
Phosphorus, Total	mg/l	N/A	N/A				6.415				0.194				1.904			
Total Solids	mg/l	N/A	N/A				4669				187				14420			
Zinc	mg/l	N/A	N/A	0.003			<0.003				0.005		<0.0015		0.016	0.055		

Groundwater Quality

Table 17: Groundwater monitoring results for BH-14, 2010-2013

Parameter	Units	Drinking Water Directive (98/83/EC)	EPA Trigger Levels for W0129-02	Q2, 2010	Q3, 2010	Q4, 2010	Q1, 2011	Q2, 2011	Q3, 2011	Q4, 2011	Q1, 2012	Q2, 2012	Q3, 2012	Q4, 2012	Q1, 2013	Q2, 2013	Q3, 2013	Q4, 2013
Date of Sampling:				17/06/2010	27/09/2010	14/12/2010	22/02/2011	27/06/2011	14/09/2011	01/12/2011	23/03/2012	19/06/2012	09/08/2012	11/12/2012	09/04/2013	26/06/2013	19/09/2013	05/11/2013
Ammoniacal Nitrogen	mg/l NH_4-N	0.39	N/A	0.03	<0.03	0.03	0.03	<0.03	0.04	0.07	<0.03	<0.03	<0.03	0.03	0.09	0.13	0.03	0.07
Arsenic	mg/l	0.01	N/A	<0.0009			<0.0025	<0.0025	0.0026	<0.0025	<0.0025	<0.0025	<0.0025	<0.0025	<0.0025	<0.0025	<0.0025	0.028
Barium	mg/l	N/A	N/A	0.011			0.033	0.022	0.018	0.018	0.027	0.035	0.032	0.037	0.044	0.013	0.004	0.044
Calcium	mg/l	N/A	N/A	41.1	35.5	18.5	20	32.2	29	24.8	24.7	20.4	20.5	19.6	18.4	18.6	25.9	23.5
Chloride	mg/l	250	75	25.5	18.8	12.9	11.4	22	30.5	21.8	21.8	12.1	15.5	10.7	18.5	30.6	32.7	23.2
Colour	N/A	N/A	N/A	Clear			Light brown	Clear	Clear	clear	Clear	Clear	Clear	Clear	Light brown; sediment	Light brown; sediment	clear	Clear
Conductivity	mS/cm	2.5	1	0.35	0.31	0.18	0.18	0.27	0.28	0.22	0.22	0.21	0.19	0.19	0.2	0.27	0.24	0.21
Dissolved Oxygen	mg/l	N/A	N/A		6.51	8.56	1.38	8	1.79	3	2.55	1.84	6.12	6.36	3.06	3.66	2.49	5.48
Iron	mg/l	0.2	N/A	0.008	<0.020	<0.020	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	0.163	<0.02	<0.02	<0.02	<0.02	<0.02
Level, Water	mOD Malin	N/A	N/A	98.81	98.73	98.09	99.65	99.03	98.5	98.83	99.1		99.59	100.06	100.62	100.11	99.41	99.42
Manganese	mg/l	0.05	N/A	0.012	0.01	0.017	0.02	0.01	0.007	0.007	0.007	0.016	0.013	0.021	0.017	0.019	0.009	0.013
Odour	N/A	N/A	N/A	None			None	None	None	None	None	None	None	None	None	None	None	None
pH	pH	6.5<pH<9.5	6<pH<9	6.1	6.6	7.5	6.3	7.8	6.3	7.7	6.8	7.4	7.6	7.7	6.2	6.1	6.7	7.4
Phenols, Total	mg/l	N/A	0.1	<0.18	<0.18	<0.15	0.0025	<0.15	<0.15	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Potassium	mg/l	N/A	N/A	2.2	2.7	3.8	3.2	2.3	1.8	2.9	3.2	3.5	3.3	3.6	4.2	1.8	1.5	4.4
Sodium	mg/l	200	80	12.7	11.5	6	6.1	11.3	13.9	10.7	10.5	7.5	8.6	7	8.4	11.2	15.3	9.5
Sulphate	mg/l	250	150	59.98	51.99	34	26.44	39.04	23.68	25.62	29.9	25.68	21.53	23.61	19.83	12.59	9.6	24.42
Temperature	°C	N/A	N/A	12.6	11.4	8.5	10.1	12.6	10.9	9.1	12.2	15.5	14.6	8.9	9.6	11.9	11.2	9.5
Total Organic Carbon	mg/l	N/A	50	<2	3	11	7	9	7	11	9	7	10	8	10	<2	<2	4
Total Oxidized Nitrogen	mg/l	N/A	N/A	7.31	5.55	3.91	3.2	6.7	9.8	6.3	7.5	3.1	4.9	3.1	4.2	10.6	10.3	5.7
Boron	mg/l	N/A	N/A				0.069				0.028				0.032			
Cadmium	mg/l	0.005	0.004	0.004			0.0006				0.0015		0.00124		0.0009	0.0023		
Chromium, Total	mg/l	0.05	N/A	0.0009			0.0018				<0.0015		<0.0015		<0.0015	<0.0015		
Coliforms, Faecal	cfus/100 ml	0	N/A				1				0				0			
Coliforms, Total	cfus/100 ml	0	N/A				24				0				5			
Copper	mg/l	2	0.5	0.007			0.011				0.012		0.009		0.011	<0.007		
Cyanide	mg/l	0.05	N/A				<0.01				<0.01				<0.01			
Fluoride	mg/l	1.5	N/A				<0.3				<0.3				<0.3	<0.3		
Lead	mg/l	0.01	N/A	0.002			<0.005				<0.005		0.0006		<0.005	<0.005		
List I and II Substances	mg/l	N/A	N/A				<0.01				<0.01				<0.00001			
Magnesium	mg/l	N/A	N/A	4.8			1.8				3		2		1.9	3.1		
Mercury	mg/l	0.001	N/A	<0.0005			<0.001				<0.001		<0.0005		<0.001	<0.001		

Groundwater Quality

Parameter	Units	Drinking Water Directive (98/83/EC)	EPA Trigger Levels for W0129-02	Q2, 2010	Q3, 2010	Q4, 2010	Q1, 2011	Q2, 2011	Q3, 2011	Q4, 2011	Q1, 2012	Q2, 2012	Q3, 2012	Q4, 2012	Q1, 2013	Q2, 2013	Q3, 2013	Q4, 2013
Date of Sampling:				17/06/2010	27/09/2010	14/12/2010	22/02/2011	27/06/2011	14/09/2011	01/12/2011	23/03/2012	19/06/2012	09/08/2012	11/12/2012	09/04/2013	26/06/2013	19/09/2013	05/11/2013
Orthophosphates	mg/l	N/A	N/A				0.37				0.1				0.04			
PAHs, Total 6/16/17 (Note1)	mg/l	0.0001	N/A	<0.0001				<0.0003			<0.0001				<0.0001			
Phosphorus, Total	mg/l	N/A	N/A				0.124				0.073				0.585			
Total Solids	mg/l	N/A	N/A				315				187				227			
Zinc	mg/l	N/A	N/A	0.025			0.027				0.026		0.0106		0.022	0.048		

Surface Water Quality

Table 18: Surface Water monitoring results for SW-1, 2010-2013

Parameter	Units	Surface Water Regulations Class 3	Salmonid Water Regulations	Q2, 2010	Q4, 2010	Q2, 2011	Q4, 2011	Q2, 2012	Q4, 2012	Q2, 2013	Q4, 2013
Date of Sampling:				**17/06/2010**	**14/12/2010**	**27/06/2011**	**01/12/2011**	**19/06/2012**	**11/12/2012**	**25/06/2013**	**05/11/2013**
Ammoniacal Nitrogen	mg/l NH$_4$-N	3.11	0.7	0.06	0.04	0.11	0.12	0.12	0.12	0.15	0.15
Calcium	mg/l	N/A	N/A	120.7		134.5		113.4		77.1	
Chemical Oxygen Demand	mg/l	40	N/A		14	11	16	15	20	14	22
Chloride	mg/l	250	N/A	30	24.2	47.5	44	27.1	31.9	37.9	39.6
Conductivity	mS/cm	1	N/A	0.86	0.663	0.92	0.77	0.63	0.63	0.71	0.69
Dissolved Oxygen	mg/l	N/A	N/A	48%	9.57	9	3.56	2.99	8.17	6.21	8.16
Magnesium	mg/l	N/A	N/A	13.6		14.6		11.5		11.9	
Manganese	mg/l	1	N/A	0.009		0.284		0.657		<0.002	
Orthophosphate/Phosphorus	mg/l	N/A	N/A	1.31		<0.06		<0.03		0.053	
PAHs, Total 6/16/17 (Note1)	mg/l	0.001	N/A								
pH	pH	5.5 – 9.0	6 – 9	8.2	8.1	7.9	7.8	7.8	7.6	8.2	7.8
Sodium	mg/l	N/A	N/A	33.2		38.6		21.3		19.3	
Sulphate	mg/l	200	N/A	25.75		210.13		102.14		89.36	
Temperature	^{o}C	25	N/A	15.1	6	13.3	7	15.9	5.9	12.2	8.1
Total Alkalinity	mg/l	N/A	N/A			168		196		202	
Total Suspended Solids	mg/l	-	25	18	<10	<10	<10	<10	<10	<10	<10

Surface Water Quality

Table 19: Surface Water monitoring results for SW-2, 2010-2013

Parameter	Units	Surface Water Regulations Class 3	Salmonid Water Regulations	Q2, 2010	Q4, 2010	Q2, 2011	Q4, 2011	Q2, 2012	Q4, 2012	Q2, 2013	Q4, 2013
Date of Sampling:				17/06/2010	14/12/2010	27/06/2011	01/12/2011	19/06/2012	11/12/2012	26/06/2013	05/11/2013
Ammoniacal Nitrogen	mg/l NH$_4$-N	3.11	0.7	<0.03	0.04	<0.03	0.05	<0.03	0.03	0.09	0.07
Calcium	mg/l	N/A	N/A	133		111.8		143.9		99.4	
Chemical Oxygen Demand	mg/l	40	N/A		7	<7	15	10	12	14	10
Chloride	mg/l	250	N/A	23.5	24.2	31.6	33.9	48.2	29.6	30.3	33.2
Conductivity	mS/cm	1	N/A	0.82	0.752	0.82	0.69	0.71	0.76	0.81	0.74
Dissolved Oxygen	mg/l	N/A	N/A		10.76	10	3.4	2.86	8.34	6.62	7.57
Magnesium	mg/l	N/A	N/A	11		10.8		13.1		10.6	
Manganese	mg/l	1	N/A	0.004		0.003		0.028		0.016	
Orthophosphate/Phosphorus	mg/l	N/A	N/A	0.65		<0.06		<0.03		0.039	
PAHs, Total 6/16/17 (Note1)	mg/l	0.001	N/A								
pH	pH	5.5 – 9.0	6 – 9	8.4	8.2	7.6	7.6	7	7.9	7.1	7.9
Sodium	mg/l	N/A	N/A	16.5		18.2		17.9		12.5	
Sulphate	mg/l	200	N/A	8.09		160.89		173.66		132.9	
Temperature	^{o}C	25	N/A	12.7	8.2	12.9	7.4	15.4	6.8	11.4	9
Total Alkalinity	mg/l	N/A	N/A			126		188		218	
Total Suspended Solids	mg/l	-	25	<10	<10	<10	<10	<10	<10	<10	<10

Surface Water Quality

Table 20: Surface Water monitoring results for SWD-1, 2010-2013

Parameter	Units	EPA Trigger Level	Surface Water Regulations Class 3	Salmonid Water Regulations	Q1, 2010	Q2, 2010	Q3, 2010	Q4, 2010	Q2, 2011	Q4, 2011	Q2, 2012	Q4, 2012	Q2, 2013	Q4, 2013
Date of Sampling:									27/06/2011	01/12/2011	19/06/2012	11/12/2012	26/06/2013	05/11/2013
					Dry	Dry	Dry	Dry	Dry	Dry	Dry	Dry	Dry	Dry
Ammoniacal Nitrogen	mg/l NH_4-N	N/A	3.11	0.7										
Calcium	mg/l	N/A	N/A	N/A										
Chemical Oxygen Demand	mg/l	N/A	40	N/A										
Chloride	mg/l	N/A	250	N/A										
Conductivity	mS/cm	N/A	1	N/A										
Dissolved Oxygen	mg/l	N/A	N/A	N/A										
Magnesium	mg/l	N/A	N/A	N/A										
Manganese	mg/l	N/A	1	N/A										
Odour	-	-	-	-										
Orthophosphate	mg/l	N/A	N/A	N/A										
pH	pH	N/A	5.5 – 9.0	6 – 9										
Sodium	mg/l	N/A	N/A	N/A										
Sulphate	mg/l	N/A	200	N/A										
Suspended Solids	mg/l	35	N/A	N/A										
Temperature	^{o}C	N/A	25	N/A										
Total Alkalinity	mg/l	N/A	N/A	N/A										
Visual	-	-	-	-										

Surface Water Quality

Table 20: Surface Water monitoring results for SWD-2, 2010-2013

Parameter	Units	EPA Trigger Level	Surface Water Regulations Class 3	Salmonid Water Regulations	Q1, 2010	Q2, 2010	Q3, 2010	Q4, 2010	Q2, 2011	Q4, 2011	Q2, 2012	Q4, 2012	Q2, 2013	Q4, 2013
Date of Sampling:									27/06/2011	01/12/2011	19/06/2012	11/12/2012	26/06/2013	05/11/2013
					Dry	Dry	Dry	Dry	Dry	Dry	Dry	Dry	Dry	Dry
Ammoniacal Nitrogen	mg/l NH_4-N	N/A	3.11	0.7										
Calcium	mg/l	N/A	N/A	N/A										
Chemical Oxygen Demand	mg/l	N/A	40	N/A										
Chloride	mg/l	N/A	250	N/A										
Conductivity	mS/cm	N/A	1	N/A										
Dissolved Oxygen	mg/l	N/A	N/A	N/A										
Magnesium	mg/l	N/A	N/A	N/A										
Manganese	mg/l	N/A	1	N/A										
Odour	-	-	-	-										
Orthophosphate	mg/l	N/A	N/A	N/A										
pH	pH	N/A	5.5 – 9.0	6 – 9										
Sodium	mg/l	N/A	N/A	N/A										
Sulphate	mg/l	N/A	200	N/A										
Suspended Solids	mg/l	35	N/A	N/A										
Temperature	^{o}C	N/A	25	N/A										
Total Alkalinity	mg/l	N/A	N/A	N/A										
Visual	-	-	-	-										

Surface Water Quality

Table 21: Surface Water monitoring results for SWD-3, 2010-2013

Parameter	Units	EPA Trigger Level	Surface Water Regulations Class 3	Salmonid Water Regulations	Q1, 2010	Q2, 2010	Q3, 2010	Q4, 2010	Q2, 2011	Q4, 2011	Q2, 2012	Q4, 2012	Q2, 2013	Q4, 2013
Date of Sampling:									27/06/2011	01/12/2011	19/06/2012	11/12/2012	26/06/2013	05/11/2013
					Dry	Dry	Dry		Dry	Dry	Dry	Dry	Dry	Dry
Ammoniacal Nitrogen	mg/l NH_4-N	N/A	3.11	0.7				0.04						
Calcium	mg/l	N/A	N/A	N/A										
Chemical Oxygen Demand	mg/l	N/A	40	N/A				<7						
Chloride	mg/l	N/A	250	N/A				24.2						
Conductivity	mS/cm	N/A	1	N/A				0.663						
Dissolved Oxygen	mg/l	N/A	N/A	N/A				11.7						
Magnesium	mg/l	N/A	N/A	N/A										
Manganese	mg/l	N/A	1	N/A										
Odour	-	-	-	-				None						
Orthophosphate	mg/l	N/A	N/A	N/A										
pH	pH	N/A	5.5 – 9.0	6 – 9				8						
Sodium	mg/l	N/A	N/A	N/A										
Sulphate	mg/l	N/A	200	N/A										
Suspended Solids	mg/l	35	N/A	N/A				<10						
Temperature	^oC	N/A	25	N/A				5.5						
Total Alkalinity	mg/l	N/A	N/A	N/A										
Visual	-	-	-	-				Clear						

Surface Water Quality

Table 22: Surface Water monitoring results for SWD-4, 2010-2013

Parameter	Units	EPA Trigger Level	Surface Water Regulations Class 3	Salmonid Water Regulations	Q1, 2010	Q2, 2010	Q3, 2010	Q4, 2010	Q2, 2011	Q4, 2011	Q2, 2012	Q4, 2012	Q2, 2013	Q4, 2013
Date of Sampling:									27/06/2011	01/12/2011	19/06/2012	11/12/2012	26/06/2013	05/11/2013
					Dry	Dry	Dry	Dry	Dry	Dry	Dry	Dry	Dry	Dry
Ammoniacal Nitrogen	mg/l NH_4-N	N/A	3.11	0.7										
Calcium	mg/l	N/A	N/A	N/A										
Chemical Oxygen Demand	mg/l	N/A	40	N/A										
Chloride	mg/l	N/A	250	N/A										
Conductivity	mS/cm	N/A	1	N/A										
Dissolved Oxygen	mg/l	N/A	N/A	N/A										
Magnesium	mg/l	N/A	N/A	N/A										
Manganese	mg/l	N/A	1	N/A										
Odour	-	-	-	-										
Orthophosphate	mg/l	N/A	N/A	N/A										
pH	pH	N/A	5.5 – 9.0	6 – 9										
Sodium	mg/l	N/A	N/A	N/A										
Sulphate	mg/l	N/A	200	N/A										
Suspended Solids	mg/l	35	N/A	N/A										
Temperature	^oC	N/A	25	N/A										
Total Alkalinity	mg/l	N/A	N/A	N/A										
Visual	-	-	-	-										

Surface Water Quality

Table 23: Surface Water monitoring results for SWD-5, 2010-2013

Parameter	Units	EPA Trigger Level	Surface Water Regulations Class 3	Salmonid Water Regulations	Q1, 2010	Q2, 2010	Q3, 2010	Q4, 2010	Q2, 2011	Q4, 2011	Q2, 2012	Q4, 2012	Q2, 2013	Q4, 2013
Date of Sampling:									27/06/2011	01/12/2011	19/06/2012	11/12/2012	26/06/2013	05/11/2013
					Dry	Dry	Dry	Dry	Dry	Dry	Dry	Dry	Dry	Dry
Ammoniacal Nitrogen	mg/l NH_4-N	N/A	3.11	0.7										
Calcium	mg/l	N/A	N/A	N/A										
Chemical Oxygen Demand	mg/l	N/A	40	N/A										
Chloride	mg/l	N/A	250	N/A										
Conductivity	mS/cm	N/A	1	N/A										
Dissolved Oxygen	mg/l	N/A	N/A	N/A										
Magnesium	mg/l	N/A	N/A	N/A										
Manganese	mg/l	N/A	1	N/A										
Odour	-	-	-	-										
Orthophosphate	mg/l	N/A	N/A	N/A										
pH	pH	N/A	5.5 – 9.0	6 – 9										
Sodium	mg/l	N/A	N/A	N/A										
Sulphate	mg/l	N/A	200	N/A										
Suspended Solids	mg/l	35	N/A	N/A										
Temperature	°C	N/A	25	N/A										
Total Alkalinity	mg/l	N/A	N/A	N/A										
Visual	-	-	-	-										

Surface Water Quality

Table 24: Surface Water monitoring results for SWD-6, 2010-2013

Parameter	Units	EPA Trigger Level	Surface Water Regulations Class 3	Salmonid Water Regulations	Q1, 2010	Q2, 2010	Q3, 2010	Q4, 2010	Q2, 2011	Q4, 2011	Q2, 2012	Q4, 2012	Q2, 2013	Q4, 2013
Date of Sampling:									27/06/2011	01/12/2011	19/06/2012	11/12/2012	25/06/2013	05/11/2013
					Dry		Dry	Dry						
Ammoniacal Nitrogen	mg/l NH_4-N	N/A	3.11	0.7		<0.03			<0.03	0.03	<0.03	0.03	0.09	0.09
Calcium	mg/l	N/A	N/A	N/A		174.7			191.8		669.9		199.9	
Chemical Oxygen Demand	mg/l	N/A	40	N/A					<7	<7	<7	<7	21	14
Chloride	mg/l	N/A	250	N/A		34.1			26.2	22.8	20.3	22.7	25.5	24.9
Conductivity	mS/cm	N/A	1	N/A		0.99			0.99	1.27	1.24	1.23	1.06	1.08
Dissolved Oxygen	mg/l	N/A	N/A	N/A		15%			7	2.96	3.71	5.18	3.78	6.85
Magnesium	mg/l	N/A	N/A	N/A		13.6			13.4		23.8		16	
Manganese	mg/l	N/A	1	N/A		0.177			0.2		1.014		0.214	
Odour	-	-	-	-		None					None	None		None
Orthophosphate	mg/l	N/A	N/A	N/A		0.31			<0.06		<0.03		0.302	
pH	pH	N/A	5.5 – 9.0	6 – 9		6.8			6.9	7.7	6.6	6.9	6.5	8.5
Sodium	mg/l	N/A	N/A	N/A		13.7			14.6		16.7		14.1	
Sulphate	mg/l	N/A	200	N/A		289.19			280.21		489.74		257.64	
Suspended Solids	mg/l	35	N/A	N/A		14			<10	<10	<10	<10	<10	12
Temperature	^oC	N/A	25	N/A		13.2			12	9.6	13.3	9.5	11.8	10.6
Total Alkalinity	mg/l	N/A	N/A	N/A					170		164		228	
Visual	-	-	-	-		Clear			Clear		Clear	Clear	Clear; some suspended organic matter; stagnant water	clear

Surface Water Quality

Table 24: Surface Water monitoring results for SWD-7, 2010-2013

Parameter	Units	EPA Trigger Level	Surface Water Regulations Class 3	Salmonid Water Regulations	Q1, 2010	Q2, 2010	Q3, 2010	Q4, 2010	Q2, 2011	Q4, 2011	Q2, 2012	Q4, 2012	Q2, 2013	Q4, 2013
Date of Sampling:									27/06/2011	01/12/2011	19/06/2012	11/12/2012	26/06/2013	05/11/2013
					Dry	Dry	Dry	Dry	Dry	Dry	Dry	Dry	Dry	Dry
Ammoniacal Nitrogen	mg/l NH_4-N	N/A	3.11	0.7										
Calcium	mg/l	N/A	N/A	N/A										
Chemical Oxygen Demand	mg/l	N/A	40	N/A										
Chloride	mg/l	N/A	250	N/A										
Conductivity	mS/cm	N/A	1	N/A										
Dissolved Oxygen	mg/l	N/A	N/A	N/A										
Magnesium	mg/l	N/A	N/A	N/A										
Manganese	mg/l	N/A	1	N/A										
Odour	-	-	-	-										
Orthophosphate	mg/l	N/A	N/A	N/A										
pH	pH	N/A	5.5 – 9.0	6 – 9										
Sodium	mg/l	N/A	N/A	N/A										
Sulphate	mg/l	N/A	200	N/A										
Suspended Solids	mg/l	35	N/A	N/A										
Temperature	^{o}C	N/A	25	N/A										
Total Alkalinity	mg/l	N/A	N/A	N/A										
Visual	-	-	-	-										

Appendix 4: Copy of Attachment I of the Waste Licence Application (Dec. 2010)

Attachment I

Existing Environment and Impact of the Facility

Attachment I: Existing Environment & Impact of the Facility

I.0 Background

I.0.1 The site is a former quarry and the facility is an existing and operational inert landfill (EPA Licence W0129-02). A full environmental impact assessment has been completed for the proposed integrated waste management facility. The EIS (authored by Arup (December 2010)) is attached to this Waste Licence Application; relevant text **extracts** are provided throughout Attachment I, as requested by the Agency.

I.1 Assessment of atmospheric emissions

I.1.1 Chapter 9 of the EIS presents the results of an assessment of the impact on air quality of the proposed MEHL integrated waste management facility during construction and during operation. Key extracts are provided here in the Waste Licence Application; the full EIS (authored by Arup) accompanies this application.

Receiving Environment

EPA Background Concentrations

I.1.2 The EPA is the designated Competent Authority in Ireland for the co-ordination of ambient air quality monitoring in accordance with EU Directives. The most recent report relating to the monitoring of ambient air at a number of locations around Ireland is 'Air Quality in Ireland 2009 – Key Indicators of Ambient Air Quality' (EPA, 2010). This report outlines the scope and range of monitoring carried out throughout the country during that period. A number of the parameters examined as part of this air quality assessment are reported by the EPA. The EPA carries out ambient air quality monitoring under the specific requirements of the Air Quality Standards Regulations, 2002.

I.1.3 The regulations require that the EPA provide the public with information on ambient air quality. The regulations are a result of the Air Framework Directive 96/62/EC. This Directive requires that Member States divide their territory into zones for the assessment and management of air quality. In Ireland's case there are four zones ranging from Zone A to Zone D. The areas covered by the Zones are as follows:

- Zone A: Dublin City and environs
- Zone B: Cork City and environs
- Zone C: 16 urban areas with population greater than 15,000
- Zone D: Remainder of State (excluding Zones A, B and C)

I.1.4 The extent of monitoring and assessment in each zone is determined by population size and air quality status. The proposed development falls within Zone D. Average values were obtained from monitoring stations within Zone D which collated one year of continuous monitoring data (refer to Table **I.1.1**). All measured values are easily in compliance with relevant limit values.

I.1.5 Fingal County Council has been granted planning permission for a landfill facility in Tooman-Nevitt, Lusk, Co. Dublin (Waste Licence W0231-01). As this facility is approximately 2km from the proposed site, no cumulative impacts are anticipated and it is not considered further.

Table I.1.1: Annual Mean Background Pollutant Concentrations for Zone D (EPA, 2010)

	Annual average NO2 µg/m^3	**Annual average NOx3 µg/m^3**	**Annual average PM10 µg/m^3**	**Annual average PM2.5 µg/m^3**	**Annual average CO µg/m^3**	**Annual average Benzene µg/m^3**
Measured	7.3	10.3	10.5	111	300	1.41
Limit value	40	30	20/402	253	2,0004	5
Applicable from	2010	2001	2010	2010	2005	2010

1 Measured values from Zone D data.
2 Existing/proposed limits
3 $PM_{2.5}$ has a proposed concentration cap rather than a limit value (CEC, 2005).
4 AQS for annual mean CO is guideline from UK Highways Agency (2003) and UK DEFRA (2003). Directive 2000/69/EC Limit Value of 10,000µg/m^3 is for 8-hour mean CO.

On Site Monitoring

I.1.6 MEHL undertakes dust deposition monitoring biannually at four locations in accordance with their current Environmental Protection Agency (EPA) Waste Licence (No. W0129-02).

I.1.7 According to the 2009 Annual Environmental Report (AER, Murphy Environmental Hollywood Ltd.), dust deposition monitoring results were significantly below the licence limit (350 mg/m^2/day) during both monitoring rounds.

I.1.8 Previously, under Waste Licence No. W0129-01, Murphy Environmental were obliged to undertake dust deposition monitoring once per quarter. The overall exceedance rate for all dust deposition monitoring rounds is 4% with a compliance rate of 96% since operations at the site began in 2003.

Evaluation of Air Quality Impacts

Construction Phase - Construction Activities

I.1.9 The bulk of the construction activities will be undertaken during Phase 1 site activities (refer to *EIS Chapter 5, Construction Activities*) and will comprise the following:

- Construct new site entrance with access road at the southern boundary
- Install and commission services, electricity, telecommunications & water
- Initial landscaping works
- Construct new administration building & site management infrastructure
- Construct and commission leachate management collection infrastructure
- Construct and commission leachate holding tank for hazardous cell H1
- Remove and decommission existing site infrastructure
- Construct and commission surface water management infrastructure
- Excavate natural ground from eastern slope for Solidification Plant
- Construct and commission Solidification Plant and Storage Building
- Construct engineered bund between Non Hazardous and Inert Waste cells
- Construct Hazardous Waste Cell H1
- Commence Operation of Hazardous Waste Cell H1

- Remove inert waste from the existing Inert Waste Cell to Inert Waste Cell IN1
- Construct & partially fill Inert Waste Cell IN1 up to 125m OD Malin
- Complete the capping & restoration of Inert Waste Cells C1, C2
- Cap and restore Hazardous Waste Cell H1 at the end of Phase 1/beginning of Phase 2
- Construct Hazardous Waste Cell H2 at the end of Phase 1/beginning of Phase 2
- Operate Inert Waste Cell C5
- Construct Inert Waste Cell IN3 at the end of Phase 1/beginning of Phase 2
- Construct and commission stormwater wetlands treatment area in the north of the site

I.1.10 During Phase 1, the site can be considered of moderate scale as specified in the NRA guidance (2006). This has the potential to result in significant soiling effects within 50m and significant PM_{10} and vegetation effects within 15m of the works.

I.1.11 Two private residential properties adjoin the southern boundary. Refer to *EIS Figure 9.1*. The closest is located approximately 210m from the main construction works associated with the solidification plant and new site management infrastructure. The receptor is also located approximately 284m from the closest hazardous waste cell. The closest inert cell will be located approximately 48m to the west and the closest non hazardous waste cell will be located approximately 85m to the north.

I.1.12 Based on the distance of the closest sensitive receptor to the proposed works no significant PM_{10} or vegetation effects are anticipated following the implementation of standard mitigation measures. However, the construction of inert cell IN1, at approximately 48m from the receptor has the potential to result in significant dust deposition at this receptor following the implementation of standard mitigation measures.

I.1.13 Given the scale of the works during the remaining phases, i.e. excavation of made ground, construction of waste cells and construction of permanent restoration caps and the proximity of these works to the closest sensitive receptor, no significant PM_{10}, vegetation or soiling effects are anticipated with standard mitigation in place.

I.1.14 It is proposed to use Dense Asphaltic Concrete (DAC) for lining of the base and walls of hazardous waste cells. Given the proximity of the closest sensitive receptor to the proposed hazardous waste cells (approximately 284m), no significant air quality impact is envisaged.

Construction Phase - Construction Traffic

I.1.15 During the construction phase, no routes are predicted to achieve a significant increase in traffic volumes.

Operational Phase - Operational Traffic

I.1.16 During the operational phase, no routes are predicted to achieve a significant increase in traffic volumes.

Operational Phase - Odour

I.1.17 The following material will be received at the landfill:

- Inert waste
- Non-biodegradable, solid non-hazardous wastes
- Suitable hazardous wastes

I.1.18 Odours from landfills are typically caused by the decomposition of waste.

I.1.19 The proposed MEHL facility will not accept any biodegradable waste materials. Hence the potential for odour nuisance presented by traditional municipal landfill facilities will not occur at the MEHL facility.

I.1.20 Hydrocarbon contaminated soils may have the potential to release fugitive odorous VOC emissions. Operational control procedures will be implemented to ensure that such wastes are covered or treated as appropriate to prevent fugitive odour emissions.

I.1.21 Inert waste and inert waste handling processes will be as per the established and agreed procedures currently specified under the existing waste licence W0129-02. MEHL have not received any odour complaints in relation to current operations at the site. No significant odour impacts are anticipated as a result of the continuation of these operations at the site.

I.1.22 Non-hazardous wastes will be transported in either enclosed containers or covered vehicles and deposited directly into the waste cell. Non-hazardous waste streams will typically comprise bottom ash and non-hazardous soils and stones. The closest receptor is located approximately 85m from the proposed non-hazardous waste cell. No significant odour impact as a result of the landfilling of non-hazardous waste is anticipated.

I.1.23 Hazardous wastes will either be transported directly to the solidification plant or to the hazardous waste cells according to the waste type and characterisation. Hazardous waste in the form of flue gas treatment residues specified for pre-treatment in the solidification plant will be transported by fully enclosed tankers to the site and will be pumped via an enclosed system into a steel silo, inside an enclosed building. From the silo the residues will be pumped directly into the mixing unit. The residues will then be mixed, bagged, cured and deposited within the cell. There will be no odour potential from the flue gas treatment residues or the solidification process.

I.1.24 Hazardous wastes which do not require pre-treatment in the solidification plant will be transported to the site in covered or fully enclosed containers, in accordance with regulatory requirements. The wastes will then be deposited directly onto the hazardous cell floor. The closest sensitive receptor is located approximately 284m from closest hazardous waste cell therefore no significant odour impact is anticipated.

I.1.25 As both hazardous and non hazardous leachate will be stored in closed concrete tanks, no odour impact from the storage of leachate is likely to occur.

Operational Phase - Fugitive Emissions

VOCs

I.1.26 Fugitive VOC emissions could potentially arise from the handling of contaminated soils on site. Where required by the Waste Acceptance Criteria, contaminated soils may be stored within the hazardous waste cells, the closest of which is located approximately 284m from the closest sensitive receptor.

I.1.27 Given the distance to the closest sensitive receptor and the insignificant amount of VOCs likely to be generated, no significant air quality impact is anticipated as a result of landfilling of contaminated soils.

I.1.28 As it is proposed to accept only wastes that are non-biodegradable, no other landfill gases, e.g. methane will be generated and landfill gas infrastructure is not required.

Heavy Metals

I.1.29 Flue gas treatment residues will be transported to the site using fully enclosed containers. Other approved hazardous wastes will be transported to the site in covered vehicles. The wastes will either be directed to the solidification plant or will be deposited directly into the waste cell.

I.1.30 Where heavy metals are present in FGT residues, they are retained within the solidified wastes and will not cause fugitive emissions. No significant air quality impact from heavy metals is anticipated.

Dust

I.1.31 Fugitive dust emission may arise during the normal day to day activities on site i.e. transportation, handling and processing of waste. The potential for fugitive dust emissions from each of the proposed waste streams is discussed below.

I.1.32 For inert wastes, dust deposition monitoring for the existing facility has demonstrated that monitored levels are generally well below the licensed limit. No significant dust impact is anticipated as a result of the continued acceptance of inert waste on site.

I.1.33 Non-hazardous wastes will be transported in either enclosed containers or covered vehicles and deposited in the non-hazardous cell in accordance with waste placement procedures and as required by a waste licence. Non-hazardous waste streams will typically comprise bottom ash and non-hazardous soils and stones. The closest receptor, R1, is located approximately 85m from the proposed non-hazardous waste cell. The ash has similar properties to those of wet earth/gravel. However, there is potential for dust to impact neighbouring properties if no mitigation is implemented and if the ash is allowed to dry out.

I.1.34 Flue gas treatment (FGT) residues will be disposed of at the facility. These residues are classified as dangerous to the aquatic environment. However they are not classified as toxic to humans. These materials will be transported to the facility in sealed containers and transferred pneumatically, within an enclosed building, to a storage silo provided with a vent filter. After processing to solidify the residue it no longer has the potential to generate fugitive emissions.

I.1.35 Hence no impact on the air quality environment is predicted to result from potential fugitive emissions.

I.1.36 Other hazardous wastes, not intended for the solidification plant will be placed directly in the cell. Given the distance to the closest sensitive receptor (approximately 284m, R1) and the containment measures proposed, no significant impact as a result of fugitive dust is anticipated.

Mitigation Measures

Construction Phase - Construction Activities

I.1.37 The Contractor will be obliged to comply with the dust deposition limits set by the existing EPA Waste Licence.

I.1.38 The Contractor will compile a Dust Minimisation Plan. The mitigation measures detailed below will form part of the Dust Minimisation Plan.

I.1.39 At all times, the procedures put in place will be strictly monitored and assessed. In the event of dust nuisance occurring outside the site boundary, satisfactory procedures will be implemented by the Contractor to rectify the problem.

I.1.40 The Dust Minimisation Plan will be reviewed at regular intervals during the construction phase to ensure the effectiveness of the procedures in place and to maintain the goal of minimisation of dust through the use of best practice and procedures.

I.1.41 The following avoidance, remedial or reductive measures will be implemented as part of the Dust Minimisation Plan:

- In the unlikely event that stockpiled material dries out and has the potential to release dust, the stockpile will be covered entirely by impervious sheeting or sprayed with water.
- Any dust-generating material being removed from site will be transported in covered trucks.
- Exhaust emissions from vehicles operating within the site, including trucks, excavators, diesel generators or other plant equipment, will be minimised by the Contractor; this will include an appropriate regime of planned preventative maintenance for machinery.
- Training will be completed by relevant personnel on how to control dust emissions from construction activities.
- The implementation of the dust mitigation measures will place particular emphasis on areas in proximity to sensitive receptors.

Construction Phase -Construction Traffic

I.1.42 No mitigation measures are required as no negative impacts on air quality are predicted.

Operational Phase - Operational Traffic

I.1.43 No mitigation measures are required as no negative impacts on air quality are predicted.

Operational Phase - Fugitive Emissions

I.1.44 Dust monitoring will continue as per the existing waste licence or any revised waste licence issued by the Environmental Protection Agency. In addition the following mitigation measures will be undertaken:

- Waste cells, particularly hazardous and non-hazardous cells, will be covered daily as necessary in order to minimise fugitive dust emissions.
- Water sprays will be used to ensure that boiler/bottom ash will not dry out and during dry or windy conditions to minimise the potential for dust dispersion. Bottom ash will be quenched in the facilities in which it arises and will be delivered to site damp.
- Water sprays will be used, as required, during dry or windy conditions.
- The implementation of the dust mitigation measures will place particular emphasis on areas in proximity to sensitive receptors.

Operational Phase - Odour Emissions

I.1.45 Routine walkovers of the site will be carried out to ensure that any odour emissions with off-site nuisance potential are identified and measures taken to minimise odour, e.g. covering.

Residual Impacts

Construction Phase

I.1.46 Following the implementation of all mitigation measures outlined above, no significant soiling effects will be experienced at the nearest sensitive receptors.

Operational Phase

I.1.47 The residual impact on air quality as a result of the proposed scheme will not be significant following the implementation of all mitigation measures.

I.2 Assessment of impacts of surface water discharges on the receiving waters

I.2.1 Chapter 15 of the EIS consists of a hydrological impact assessment of the proposed MEHL integrated waste management facility. This chapter provides a description of the existing hydrological environment and a statement of the likely significant hydrological impacts associated with both the construction and operational phases of the proposed scheme. Measures to mitigate the likely significant impacts are outlined, and residual impacts described. Key extracts are provided here in the Waste Licence Application; the full EIS (authored by Arup) accompanies this application.

Baseline Hydrological Environment

Introduction

I.2.2 A stream flows along the northern boundary of the MEHL facility (Refer to *EIS Figure 15.1*). This stream is a tributary of the Ballough Stream. (This tributary is referred to in this document as the “stream which flows along the northern site boundary”) The Ballough Stream is a salmonid river of county significance. The Ballough Stream (sometimes referred to as the Corduff River) flows into the Ballyboghill Stream and forms part of the upper sections of the most northern sub-catchment of the Ballyboghill Streams catchment. The Environmental Protection Agency (EPA) designated codes for the Ballyboghill and Ballough Streams are 08B01 and 08B03 respectively.

I.2.3 The Ballyboghill Stream is the principal freshwater river system that flows into Rogerstown Estuary. This estuary is a protected ecological site designated as a candidate Special Area of Conservation (cSAC) (site code 000208) and a Special Protection Area (SPA) due to its status as a feeding ground for coastal bird populations.

Catchment Character

I.2.4 Ireland is divided into 40 hydrometric areas by the EPA for the purposes of hydrological monitoring. Each hydrometric area comprises a single large river basin, or a group of smaller ones and neighbouring coastal areas. The Ballyboghill Stream and its tributaries are included in Hydrometric Area 08 *Nanny/Devlin Coastal Catchment* and Hydrometric Area 08 is part of the Eastern River Basin District (ERBD). Although Hydrometric Area 08 (HA08) is called “*Nanny/Devlin Coastal Catchment*”, the Ballyboghill Stream Catchment does not form part of the Nanny or Devlin catchments (i.e. it doesn’t flow into either of these catchments). The Ballyboghill Stream is an independent catchment within HA08 (it flows directly into the Rogerstown Estuary). Refer to *EIS Figure 15.1*. Further details on hydrometric areas and catchments can be found on the EPA website.

I.2.5 The Ballyboghill Catchment is approximately 58km^2 in area of which the Ballough Stream sub-catchment comprises 32km^2. The Ballyboghill Catchment exhibits a dendritic drainage pattern in general. The Ballough Stream tributary that runs along the northern boundary of the proposed MEHL facility area has an upstream catchment of approximately 0.7km^2 inclusive of the proposed MEHL facility area (EPA, 2007).

I.2.6 The principal environmental pressures on the hydrological environment in HA08 are considered to be from the agricultural sector, with approximately 91% of the hydrometric area being utilised by this industry. Pasture land comprises approximately 45% of the total area, while 46% is utilised for arable land and crop cultivation including intensive market gardening to supply the Dublin and east coast markets (EPA, 2007).

I.2.7 HA08 does not contain any significant peatlands or managed forests, though there are significant tracts of broadleaf forest and beach/dune systems along the coast.

I.2.8 Other pressures on the hydrological environment consist of population growth (residential and tourists), industrial production and the transportation network.

I.2.9 Environmental pressures on the hydrological environment and consequently aquatic ecology arise through a range of sources. These sources include:

- Diffuse sources such as agriculture
- Point sources such as industry
- Waste disposal
- Recreation and tourism

I.2.10 These sources affect the status of surface water quality throughout this hydrometric area of the ERBD including the Ballyboghill Catchment (ERBDA, 2005). Within the Ballyboghill Catchment, agricultural runoff can be considered to be the dominant cause of poor water quality. The Ballyboghill Catchment features livestock farming and intensive arable and market gardening towards the coastline to the east. There are currently no IPPC or Waste Licensed facilities upstream of the proposed MEHL facility which could have an impact on surface water quality or flow. There are two waste facilities in the catchment area permitted to accept inert soil and stone.

I.2.11 It should be noted that in general, HA08 (which the Ballyboghill Catchment is part of), contains the least well drained soils in the ERBD with 52% of soil either imperfect or poorly drained, and a further 44% only moderately drained. Allied with the increased intensity of arable practices, which generally relies on higher inputs of fertiliser, the situation arises where increased polluting run off might be generated in this catchment.

I.2.12 The stream network adjacent to the proposed MEHL facility is fed by surface water runoff from the catchment as well as from groundwater. During the site visit, local landowners situated adjacent to the proposed MEHL facility indicated that groundwater levels have in the past affected surface water levels in the stream network and that groundwater springs feed the streams. The effect of groundwater on surface water levels is discussed in further detail in the *EIS Chapter 14: Soils, Geology and Hydrogeology.*

Flood Risk

I.2.13 The proposed MEHL facility is located in the north western section of the Ballough Stream catchment in the vicinity of its source. The Ballough Stream catchment is a sub-catchment of the Ballyboghill catchment. The MEHL facility site ranges from 92 to 148m OD and is located at the boundary between the Devlin catchment and the highest point of the Ballyboghill catchment. The proposed MEHL facility is thus located in the vicinity of the catchment divide and as such is not in an area conducive to flood risk. The surrounding topography does not favour retention of surface water on the site and the stream flowing along the northern site boundary does not demonstrate a capacity for significant flows which would overtop the channel and enter adjacent land.

I.2.14 There has been no previous record of flood risk in the vicinity of the proposed MEHL facility according to the OPW flood risk website. The proposed MEHL facility is located at the highest point of the Ballyboghill catchment. There has been one flood incident recorded on the Ballough Stream in 2008 however, the location of the flooding was approximately 5km south east and downstream of the proposed MEHL facility site. This flooding incident occurred during an exceptional rainfall event after a prolonged wet summer which prevented significant ground infiltration of rainfall. In summary, the proposed MEHL facility is not located in an area conducive to flood risk.

I.2.15 There are currently no OPW flow gauges present within the Ballyboghill Catchment or any of its sub-catchments. There was a gauging station on the main Ballyboghill Stream between 1980 and 1999 that fell under the jurisdiction of the EPA. This gauging station recorded nearly twenty years of data for the main channel. The 95% ile flow for the main stream for that period was 0.005 m^3/s with an average annual rainfall for that period of 799 mm / annum.

Surface Water Flow

I.2.16 The stream which flows along the northern site boundary was assessed for its flow in May 2010. In stream flow gauging indicated a flow of 2 l/s. Currently, the landholding area of the site is 54.4 ha, of which approximately 39.8 ha is currently licensed by the EPA as an inert landfill facility. The surface water collected within this licensed area is attenuated through two inline sedimentation ponds with a volume of approximately 600 m^3 and has a controlled discharge to the stream. The lands outside the active landfill drain to the stream via existing open drains along the boundary. Surface water discharged outside the active landfill is not controlled.

Water Quality - Biological Quality

I.2.17 The biological quality of both the Ballyboghill and Ballough Streams are assessed by the EPA. The most recent data arises from their 2005 River Water Quality Status Report. Table **I.2.1** provides the quality status of the Ballyboghill Stream while Table **I.2.2** provides the quality status of the Ballough Stream (EPA, 2007). Refer also to *EIS Figure 15.2* which shows the vulnerability of these streams.

Table I.2.1: Ballyboghill Stream Q-Ratings

Station No.	Station Location	Year				
		1991	1996	1998	2001	2005
1900	Br near Wyanstown	-	2	3	3-4	3
2200	Br at Ballyboghill	3	3	3	3/0	3

I.2.18 According to the 2005 report, the EPA classified the Ballyboghill Stream as having Poor status and that the complete absence of pollution sensitive species in the Ballyboghill Stream indicated that considerable ecological disruption was taking place along its course and that the most likely source of the disruption was due to agricultural runoff (EPA, 2007).

Table I.2.2: Ballough Stream Q-Ratings

Station No.	Station Location	Year				
		1991	1996	1998	2001	2005
1600	Corduff Br	3	3	3	3-4	3

I.2.19 The EPA classified the Ballough Stream in 2005 as poor also with a noted deterioration from the previous assessment. The stream exhibited an unbalanced and restricted faunal distribution which indicates significant water quality impairment. Agriculture is considered to be the source of the poor status as it accounts for 97% of the land use in this catchments area (EPA, 2007).

Water Quality - Physico-chemical Quality

I.2.20 As part of its environmental commitments, MEHL conducts monitoring of surface waters as an integral component of its waste licence requirements (W0129-02). (There is also a requirement under the waste licence for surface water discharge monitoring). Surface waters are monitored at two points (SW1 and SW2) along the stream which flows along the northern site boundary, upstream and downstream of the site. These sample points are illustrated on *EIS Figure 15.1*. Monitoring has been ongoing on a quarterly basis since 2003. The following data indicates the average, maximum and minimum water quality conditions assessed over the past seven years to provide an overview of the existing physico-chemical hydrological conditions. Table **I.2.3** indicates data at SW1 upstream of the site and Table **I.2.4** indicates data at SW2 downstream of the site. Table **I.2.5** indicates data at SW1 for the second quarter of 2010 while Table **I.2.6** indicates data at SW2 for the second quarter of 2010.

Table I.2.3: Summary of Water Quality at SW1 - 2003 - 2009

Parameter	Unit	Average (7 yr)	Minimum Recorded	Maximum Recorded
Chloride	mg/l	40.11	18.000	53.000
Conductivity	mS/cm	0.62	0.250	0.950
Calcium	mg/l	126.17	112.000	136.500
Dissolved Oxygen	mg/l	7.53	5.300	10.160
pH	pH	7.90	7.290	8.450

Parameter	Unit	Average (7 yr)	Minimum Recorded	Maximum Recorded
Ammoniacal Nitrogen	mg/l NH4-N	0.51	<0.20	2.500
Total Suspended Solids	mg/l	53.19	<10.00	284.000
Temperature	°C	9.46	5.600	12.200
Chemical Oxygen Demand	mg/l	19.77	<15.00	31.000
Sodium	mg/l	24.05	11.880	33.900
Magnesium	mg/l	14.92	<0.05	25.000
Manganese	mg/l	0.37	0.002	1.060
Orthophosphate	mg/l	0.22	<0.03	0.720
Sulphate	mg/l	152.03	31.000	299.000
Total Alkalinity	mg/l	205.19	160.000	280.000

Table I.2.4: Summary of Water Quality at SW2 – 2003-2009

Parameter	Unit	Average (7 yr)	Minimum Recorded	Maximum Recorded
Chloride	mg/l	37.36	28.900	47.000
Conductivity	mS/cm	0.87	0.457	3.400
Calcium	mg/l	142.93	134.000	160.000
Dissolved Oxygen	mg/l	8.06	5.300	10.450
pH	pH	7.96	6.910	8.500
Ammoniacal Nitrogen	mg/l NH4-N	0.19	<0.2	0.300
Total Suspended Solids	mg/l	36.44	<10	131.000
Temperature	°C	9.71	5.600	11.500

Parameter	**Unit**	**Average (7 yr)**	**Minimum Recorded**	**Maximum Recorded**
Chemical Oxygen Demand	mg/l	15.02	<15	18.000
Sodium	mg/l	19.48	12.040	32.500
Magnesium	mg/l	14.20	<0.05	19.500
Manganese	mg/l	0.03	0.001	0.123
Orthophosphate	mg/l	0.14	<0.03	0.290
Sulphate	mg/l	170.31	110.000	254.000
Total Alkalinity	mg/l	193.31	130.000	270.000

Water Quality - Surface Water Quality June 2010

Table I.2.5: Summary of Water Quality at SW1 - Q2 2010

Parameter	**Unit**	**Average (7 yr) (2003-2009)**	**Q2 2010**
Chloride	mg/l	40.11	30
Conductivity	mS/cm	0.62	0.86
Calcium	mg/l	126.17	120.7
Dissolved Oxygen	mg/l	7.53	48%
pH	pH	7.90	8.2
Ammoniacal Nitrogen	mg/l NH4-N	0.51	0.06
Total Suspended Solids	mg/l	53.19	18
Temperature	°C	9.46	15.1
Chemical Oxygen Demand	mg/l	19.77	NDP
Sodium	mg/l	24.05	33.2

Parameter	Unit	Average (7 yr) (2003-2009)	Q2 2010
Magnesium	mg/l	14.92	13.6
Manganese	mg/l	0.37	0.009
Orthophosphate	mg/l	0.22	1.31
Sulphate	mg/l	152.03	25.75
Total Alkalinity	mg/l	205.19	NDP

Table I.2.6: Summary of Water Quality at SW2 - Q2 2010

Parameter	Unit	Average (7 yr) (2003-2009)	Q2 2010
Chloride	mg/l	37.36	23.5
Conductivity	mS/cm	0.87	0.82
Calcium	mg/l	142.93	133
Dissolved Oxygen	mg/l	8.06	27%
pH	pH	7.96	8.4
Ammoniacal Nitrogen	mg/l NH4-N	0.19	<0.03
Total Suspended Solids	mg/l	36.44	<10
Temperature	°C	9.71	12.7
Chemical Oxygen Demand	mg/l	15.02	NDP
Sodium	mg/l	19.48	16.5
Magnesium	mg/l	14.20	11
Manganese	mg/l	0.03	0.004

Parameter	Unit	Average (7 yr) (2003-2009)	Q2 2010
Orthophosphate	mg/l	0.14	0.65
Sulphate	mg/l	170.31	8.09
Total Alkalinity	mg/l	193.31	NDP

Morphology

I.2.21 A river's morphology consists of a combination of physical characteristics including catchment drainage patterns, channel shape and size, channel features and sedimentary characteristics.

I.2.22 The stream flowing along the northern site boundary is contained within a small V-shaped river valley that is heavily vegetated. The drainage pattern of the valley exhibits a trellised formation on a small scale, i.e. a relatively straight main channel with tributaries entering at an angle between 70 and 90 degrees. Access to the stream channel itself adjacent to the proposed MEHL facility is difficult due to the density of the vegetation. The stream's morphology is that of a small stream with a sinuous channel that is heavily vegetated on both banks. At the time of the site visit, the stream itself was shallow (less than 30 cm deep at mid channel) with gravels and large clasts forming its bed. The stream does not exhibit extensive in stream vegetative growth. There were no indications of significant erosion or deposition along the stream channel.

I.2.23 The stream water was clear at the time of the site visit indicating low turbidity. Inflowing tributary streams to the main stream were also shallow and clear and exhibited gravel beds with little internal aquatic vegetation.

Aquatic Ecology

I.2.24 The Ballough Stream is classified as a salmonid water by the Regional Fisheries Board and is thus considered ecologically sensitive. Sea trout are endemic to the Ballyboghill Catchment and have been recorded in the Ballyboghill and Ballough stream sections of the catchment. Salmon were recorded in 2007. The stream flowing along the northern site boundary exhibits a dense foliage and woodland along its valley. Vegetation extends into the water of the stream which would provide habitat for amphibians and water borne species. Please refer to *EIS Chapter 13, Flora and Fauna* for greater detail on aquatic ecology.

Functional Value

I.2.25 The Ballough Stream can be classified as having a medium class of functional value based on its current biological and physico-chemical water quality conditions. Its ecological sensitivity as a salmonid water also adds functional value.

Predicted Impacts

Potential Construction Impacts

I.2.26 Chapter 5 Construction Activities describes the construction phase of the proposed development. Mitigation measures are outlined that will be provided to minimise any potential risk to the hydrological environment and consequently aquatic ecology and flood risk during the construction phase of the proposed MEHL facility. The mitigation measures outlined are based on a range of best practice guidance documents and from the consultation process with statutory bodies. Construction activities pose a potential risk to watercourses. In the absence of mitigation measures surface water runoff from construction activities is likely to be contaminated. The main contaminants arising from construction activities can include:

- Silt: elevated silt loading in surface water discharge may result from construction activities. Elevated silt loading leads to long term damage to aquatic ecosystems by clogging the gills of fish and smothering spawning grounds. Chemical contaminants bind to the organic particles attached to silt which can lead to increased bioavailability of these contaminants. Silt also stunts aquatic plant growth, limiting dissolved oxygen supplies and reducing the aquatic ecosystems quality and this is most critical during low flow conditions when the dilution capacity of the receiving watercourse is limited. During high flow or flood condition the receiving watercourse would naturally contain elevated silt loadings. Silt can also contribute to flooding when it deposits, reducing the carrying capacity of the system and potentially causing blockages
- Concrete, bentonite, grout and other cement-based products are highly alkaline and corrosive and can have significant negative effects on surface water quality. Cement-based products generate very fine, highly alkaline silt (pH 11.5) that can physically damage fish by burning their skin and blocking their gills. The alkaline silt can also smother vegetation and the bed of watercourses and can mobilise pollutants such as heavy metals by altering the water’s pH. Concrete and grout pollution is often highly visible.
- Hydrocarbons: accidental spillage from construction plant and storage depots.

- Faecal coliforms: contamination from inadequate containment and treatment of on-site toilet and washing facilities.

I.2.27 Construction activities within and alongside surface waters can also contribute to a deterioration of water quality. In-stream and bankside construction works can alter the bed and bank morphology of a river which can lead to downstream modification of erosion and deposition rates. The potential re-suspension of bottom sediment can also lead to a deterioration of water clarity, increase turbidity and potentially release contaminants that were locked in the sedimentary matrices. In-stream and bankside construction work is not required as part of the proposed development.

Potential Operational Impacts

I.2.28 Potential operational impacts which could arise from the proposed MEHL facility can be categorised as either affecting water quality and subsequently aquatic ecology and the alteration of flooding patterns within the catchments that the proposed MEHL facility is located within.

I.2.29 The quality and flow of surface water downstream and in close proximity to the proposed MEHL facility could potentially be impacted by a number of different sources in the absence of appropriate mitigation measures, these potential sources include:

- Accidental Spillage: spillages arising from accidents involving transportation of hazardous material are potentially the most serious source of contaminants to a watercourse from the hardstanding area of the proposed MEHL facility.
- Hardstanding Runoff: routine runoff from hardstanding associated with vehicular traffic generally contains a variety of contaminants. These arise from the degradation of road surfaces and vehicles, vehicle exhaust combustion by-products, soil erosion and aerial deposition. The primary contaminants known to occur in routine runoff include hydrocarbons, particulate matter and heavy metals.
- Winter Maintenance: applications of salt and grit to maintain safety during icy conditions on the hardstanding areas.
- Leachate: a potential leak of landfill leachate in the event of a puncture of the liner.
- Flood Risk: uncontrolled runoff from the site could lead to downstream flooding.

I.2.30 These potential sources are discussed in greater detail below.

Accidental Spillage

I.2.31 Spillages arising from accidents involving transportation of hazardous material are potentially the most serious source of contaminants to a watercourse from the hardstanding area of the proposed MEHL facility.

I.2.32 Certain wastes to be accepted at the facility are classified as hazardous as they are considered to be very toxic, toxic, harmful or may cause long term harmful effects to the aquatic environment. Refer to *EIS Chapter 7, Human Beings* for further details.

I.2.33 If an accidental spillage of hazardous waste entered the surface water system, this has the potential to have a deleterious effect on the receiving waters quality and could lead to similar downstream affects throughout the wider catchment. Should a spill occur that has the potential to affect the Ballyboghill catchment, the salmonid status of the catchment would be compromised. There would also exist the potential for downstream impacts to the Rogerstown cSAC and SPA.

Road Runoff

I.2.34 Contaminants arising from hardstanding runoff associated with vehicular traffic on site which may have the potential to impact aquatic ecosystems include suspended solids, hydrocarbons and heavy metals (Bibby & Webster-Brown, 2005). The primary hydrocarbons of concern are the petrochemical derived group which includes petrol, fuel oils, lubricating oils and hydraulic fluids. These are generally liquid and water insoluble.

I.2.35 A wide range of heavy metals are known to occur in road runoff, but the primary metals of concern are cadmium (Cd), lead (Pb), copper (Cu) and zinc (Zn). All of these metals are included in SI 272 of 2009 European Communities Environmental Objectives (Surface Waters) Regulations 2009.

I.2.36 Sediments are the dominant mass of pollutants from hardstanding and road runoff (Bruen et al 2006). While most of the sediment load is chemically inert, the increase in turbidity of a watercourse has detrimental impacts on the aquatic system's quality. The sediment load also acts as the primary transport mechanism for contaminants in the water column, contaminants bind to sulphides and organic matter particles that form suspended colloidal particles. Bound together in this fashion contaminants have the potential to become bioavailable.

Winter Maintenance

I.2.37 Salt applications to hardstanding surfaces to mitigate against icy conditions, will result in an increased salinity, pH, conductivity and total dissolved solids concentrations to the receiving aquatic system following application. Increasing the salinity of the watercourse can adversely affect the ecological balance of the aquatic system and increase the bioavailability of chemical contaminants.

Leachate

I.2.38 Leachate produced in the hazardous and non hazardous waste cells will be collected into modular concrete storage tanks prior to use in the solidification process as appropriate or excess leachate will be tankered off site to a suitable wastewater treatment facility. Refer to Chapter 14 Soils, Geology and Hydrogeology for further details on leachate management. While extremely unlikely to occur, there exists the potential for a leachate leak from the proposed MEHL facility arising from a failure of the landfill liner through a puncture. Should such a leak occur, groundwater would be contaminated with leachate which could then subsequently enter surface water systems fed by groundwater. However, the mitigation detailed in *EIS Chapter 4, Proposed Site and Project Description* will ensure that such a leak will not occur.

Flood Risk

I.2.39 The construction of new paved / hardstand areas could result in runoff of surface water. However, attenuation of surface water runoff to control flow entering the adjacent watercourse will be mitigated through the Surface Water Management Plan, which is discussed in *EIS Chapter 4, Proposed Site and Project Description*.

I.2.40 Further detail on the flood risk assessment is located at *EIS Section 15.4.4*.

Impact Assessment

"Do-Nothing"

I.2.41 The "Do-nothing" scenario is the current operation of the facility as an inert landfill under EPA licence to accept 500,000 tonnes per annum. Should the proposed MEHL integrated waste management facility not proceed with construction and operation, the surface water system of the Ballough Stream is not anticipated to be impacted upon under the terms of the existing EPA waste licence for the site and will remain in its current hydrological state.

Construction Impact Assessment

I.2.42 The construction impact of the proposed facility on the stream flowing along the northern site boundary, the Ballough Stream, the Ballyboghill catchment and its ecologically protected areas downstream at the Rogerstown Estuary is expected to be adverse and short-term if mitigation measures are not implemented. However, these impacts are expected to be imperceptible on the basis that the construction mitigation measures outlined will be implemented. Consequently, there are no anticipated negative hydrological impacts to the surface water network as a result of the construction of the proposed MEHL facility.

Operation Impact Assessment

I.2.43 The operational impact of the proposed facility on the stream flowing along the northern site boundary, the Ballough Stream, the Ballyboghill catchment and its ecologically protected areas downstream at the Rogerstown Estuary is expected to be adverse and permanent if mitigation measures are not implemented. However, these impacts are expected to be imperceptible on the basis that the surface water management plan designed for the proposed facility will be implemented.

I.2.44 Consequently, there are no anticipated negative hydrological impacts to the surface water network as a result of the operation of the proposed MEHL facility.

Flood Risk Assessment

I.2.45 In November 2009, the Department of Environment, Heritage and Local Government and the Office of Public works jointly published a Guidance Document for Planning Authorities entitled "*the Planning System and Flood Risk Management*".

I.2.46 The guidelines are issued under Section 28 of the Planning and Development Act 2000 and Planning Authorities and An Bord Pleanála are therefore required to implement these Guidelines in carrying out their functions under the Planning Acts.

I.2.47 The aim of the guidelines is to ensure that flood risk is neither created nor increased by inappropriate development.

I.2.48 The guidelines require the planning system to avoid development in areas at risk of flooding, unless they can be justified on wider sustainability grounds, where the risk can be reduced or managed to an acceptable level.

I.2.49 They require the adoption of a Sequential Approach (to Flood Risk Management) of Avoidance, Reduction, Justification and Mitigation and they require the incorporation of Flood Risk Assessment into the process of making decisions on planning applications and planning appeals.

I.2.50 Fundamental to the guidelines is the introduction of flood risk zoning and the classifications of different types of development having regard to their vulnerability.

I.2.51 In preparing this EIS, an assessment has been undertaken of any potential flood risk arising from the proposed development as outlined below.

Staged Approach to Flood Risk Assessment

I.2.52 Section 2.21 of the guidelines recommends that a staged approach be adopted when considering flood risk.

I.2.53 Stage 1 – Flood Risk Identification should be undertaken to identify whether there may be any flooding or surface water management issues related to the proposed development site that may warrant further investigation.

I.2.54 As demonstrated below, the Stage 1 assessment has identified that there are no significant flooding or surface water management issues associated with the development which would warrant a more detailed assessment and therefore Stage 2 and 3 assessments are not deemed necessary.

I.2.55 Section 2.23 of the guidelines defines Flood Zones as geographical areas within which the likelihood of flooding is in a particular range. There are 3 types of flood zones defined as follows:

- Flood Zone A - Probability of flooding from rivers and the sea is highest (greater than 1% or 1 in 100 for river flooding or 0.5% or 1 in 200 for coastal flooding).
- Flood Zone B - Probability of flooding from rivers and the sea is moderate (between 0.1% or 1 in 1000 year and 1% or 1 in 100 for river flooding and between 0.1% or 1 in 1000 year and 0.5% or 1 in 200 for coastal flooding); and
- Flood Zone C - Probability of flooding from rivers and the sea is low (less than 0.1% or 1 in 1000 for both river and coastal flooding).

I.2.56 Flood Zone C covers all areas of the plan which are not in zones A or B.

I.2.57 The Fingal East Meath Flood Risk Assessment and Management Study (FEM-FRAM) is currently being undertaken by Fingal County Council. The FEM-FRAM project has identified that a stretch of the Ballyboghill River to the south of the proposed site as "high priority water" however, there are no such priority status prescribed to the Ballough Stream. There are currently no flood risk maps available for the Ballyboghill Catchment from the FEM-FRAM project which would have facilitated the direct classification of the site. The classification for the EIS has been inferred based on site visit, topography, location within the catchment and the existing flood risk information from the OPW. The OPW flood risk mapping did not indicate any flooding incidents within a 5km radius of the site. As outlined earlier, the proposed development will be located at the highest point in the Ballyboghill Catchment and the level of the proposed site varies from approximately 92mAOD to 148mAOD and so it is clear that the proposed development site is significantly elevated in relation to adjacent watercourses, even allowing for any potential increase in flood levels which may arise due to the potential impacts of Climate Change.

I.2.58 It is therefore considered that the proposed development site lies within Flood Zone C.

Vulnerability Classification

I.2.59 Table 3.1 of the guidelines outlines the classification of vulnerability of different types of development.

I.2.60 The proposed development would be classified as being 'Less Vulnerable Development' under the guidelines as it would be considered a commercial enterprise.

I.2.61 Table 3.2 of the guidelines contains a matrix of vulnerability versus flood zone to illustrate appropriate development and that required to meet the Justification Test.

I.2.62 As the proposed development is classed as 'Less Vulnerable Development' and is located in 'Flood Zone C', the development is deemed to be appropriate in the context of flood risk and a Justification Test is therefore not required.

Assessment of all potential sources of Flooding

I.2.63 In addition to determining the appropriateness of any development in the context of the potential for fluvial or tidal flooding as detailed above, the guidelines also require that an appropriate assessment be carried out of all potential sources of flooding and that suitable mitigation measures be put in place to cater for any residual flooding risk.

I.2.64 Other sources of flooding would include:

- Groundwater flooding
- Surface water drainage flooding
- Pluvial flooding (direct rainfall) from localised storm water runoff from adjacent ground

I.2.65 Arup have reviewed any records of historic flooding available on the OPW National Flood Hazard Mapping website, www.floodmaps.ie. There is no evidence of historic flooding in the immediate vicinity of the site. Refer to *EIS Chapter 14, Soils, Geology and Hydrogeology* for information regarding groundwater levels on site.

I.2.66 A suitable internal surface water drainage system will be installed to cater for any surface water generated both from rainfall on hard standing areas. It is considered that an appropriately designed internal surface drainage system will adequately deal with any residual localised flood risk.

Mitigation Measures

Construction Phase

I.2.67 Prior to construction, the existing waste licence Environmental Management Plan (EMP) will need to be updated by the Contractor to include the construction practices. The following will be implemented as part of the updated EMP:

- Update the existing waste licence Emergency Response Plan detailing the procedures to be undertaken during the construction phase in the event of a spill of chemical, fuel or hazardous wastes, a fire, or non-compliance incident with any permit or license issues.
- Ensure staff have training in the implementation of the updated Emergency Response Plan and the use of any spill control equipment as necessary for the construction phase.
- Update the existing waste licence method statements for the control, treatment and disposal of potentially contaminated surface water to incorporate the construction phase.

I.2.68 All necessary temporary construction facilities will be incorporated (settlement tanks/ponds/oil/grit interceptors) to ensure that only clean surface water is discharged as per the existing waste licence criteria to the surface watercourses.

I.2.69 In addition, pollution of aquatic systems during the construction phase will be reduced by the implementation of the following best practice on site mitigation measures. Due cognisance will be paid by the Contractor to the following guidance documents for construction work that can potentially impact water:

- Eastern Regional Fisheries Board for use by all Regional Fisheries Boards - Requirements for the Protection of Fisheries Habitat during Construction and Development Works at River Sites
- Central Fisheries Board – Channels and Challenges, The Enhancement of Salmonid Rivers
- CIRIA – Guideline Document C532 Control of Water Pollution from Construction Sites. Guidance for consultants and contactors
- CIRIA – Guideline Document C648 Control of Water Pollution from Linear Construction Projects
- CIRIA – Guideline Document C697 The SUDS Manual
- CIRIA – Guideline Document C624 Development and flood risk - guidance for the construction industry
- CIRIA – Guideline Document C163 The Construction of Bunds for Oil Storage Tanks
- UK Environment Agency – PPG5 Pollution Prevention Guidelines Works and Maintenance in or near Water

I.2.70 Based on these guidance documents the following mitigation measures will be implemented for the proposed MEHL facility's construction phase to protect the Ballyboghill catchment, its associated watercourses and the downstream ecologically protected area of the Rogerstown Estuary cSAC:

- Use of settlement ponds, silt traps and bunds and minimising construction within watercourses. Mobile sedimentation interceptors will be utilised during the construction process to protect water quality. All water generated and collected during the construction phase will pass through the existing settlement ponds on the northern boundary or the proposed detention basin which will be constructed near the proposed administration building.
- Management of excess material stockpiles to prevent siltation of watercourse systems through runoff during rainstorms will be undertaken. This may involve allowing the establishment of vegetation on the exposed soil and surrounding

stockpiles with cut-off ditches to contain runoff. Covering with an impermeable material can also be utilized to prevent rainfall interacting with stockpile material. No material stockpiles will be located near watercourses.

- All watercourses that occur in or adjacent to areas of land that will be used for site compound/storage facilities will be fenced off at a minimum distance of 5m with silt fences. In addition, measures will be implemented to ensure that silt laden or contaminated surface water runoff from the compound does not discharge directly to the watercourse.
- Surface water flowing onto the construction area will be minimised through the provision of berms and diversion channels.
- All chemical and fuel fill points and hoses will be contained within bunded areas as per CIRIA C163.
- Foul drainage from all temporary site offices and construction facilities that are not connected to the sites' waste water treatment facility (e.g. portable toilet facilities that may be required during construction) will be contained and disposed of in an appropriate manner to prevent pollution of rivers and local watercourses in accordance with the relevant statutory regulations.
- Protection measures will be put in place to ensure that all hydrocarbons used during the construction phase are appropriately handled, stored and disposed of.
- Routine monitoring of water quality will be carried out at appropriate locations during construction as per the monitoring requirements of the waste licence.
- The quality of surface water discharge from the site will meet water quality targets specified in the waste licence for the facility.
- A 5m strip will be provided along the stream flowing along the northern site boundary and this will provide a suitable buffer zone.
- There will be no use of persistent herbicides, pesticides or artificial fertilisers in any landscaping or subsequent maintenance within 18m of a watercourse.

I.2.71 For further detail on mitigation measures required to protect ecology please refer to *EIS Chapter 13, Flora and Fauna.*

I.2.72 Concrete waste and wash-down water will be contained and managed on site to prevent pollution of all surface watercourses. The following construction mitigation measures will be utilised to control concrete and cementicious material wash down water interaction with surface water;

- All batching and mixing activities will be located in areas well away from watercourses and drains.
- Surface water drainage around the batching plant will be controlled via the provision of perimeter bunding with runoff diverted to appropriate treatment facilities.
- There will be no hosing into surface water drains of spills of concrete, cement, grout or similar materials.

Operation Phase

I.2.73 It is proposed to manage surface water on site by using a combination of SuDS elements consisting of filter drains and swales, a wetland pond, a detention basin, and rainwater harvesting. This will be in compliance with the objectives and policies of the GDSDS. The filter drain and swale will allow pollutant removal through filtration prior to discharging to the attenuation feature. The proposed wetland treatment system will form an integral part in offsetting both the hydraulic and water quality impacts of the proposed development. The wetland pond will allow for an additional reduction in fine sediments, nutrients and toxicants and maintain the greenfield runoff characteristics (2.64 l/s/ha) by providing a hydrobrake attenuation mechanism for a return period of up to 1 in 100 years. Refer to *EIS Chapter 4, Proposed Site and Project Description* for a full description of the proposed surface water management plan. There will be a new waste licence for the proposed MEHL facility and all conditions in relation to the protection of surface water will be met.

I.2.74 This surface water drainage system will be sized to cater for any potential run-off which may enter the site in the event of surcharging of the existing stream along the northern boundary of the site.

Monitoring

I.2.75 Water quality monitoring shall be implemented as per the monitoring requirements of the waste licence to ensure that construction activities relating to the construction and subsequent operation of the MEHL facility do not have an adverse effect on water quality. Monitoring will identify any weaknesses in the construction phase and enable remedial action to be initiated where necessary.

Residual Impact

I.2.76 As a consequence of compliance with the construction and operational mitigation measures there will be no significant negative effects to nearby surface watercourses or the downstream catchment arising from the proposed MEHL facility. At all times, the MEHL facility will be operated in accordance with the conditions as set out in the waste licence. The project will be in compliance with the principles and objectives of the Eastern River Basin District Management Plan which apply to the study area and will assist in the Water Framework Directive principal objective of achieving "good status" in all waters by 2015.

I.2.77 The proposed development has been assessed in accordance with the requirements of the DEHLG/OPW guidelines on *'The Planning System and Flood Risk Management'* and it has been determined that the proposed development will neither create nor increase flood risk and is therefore deemed appropriate development in the context of flood risk.

I.3 Assessment of impact on receiving sewer

I.3.1 No discharge to sewer is proposed.

I.4 Assessment of impact to groundwater and soils

I.4.1 Chapter 14 of the EIS includes an assessment of the potential impact of the proposed MEHL development on the soils, geology and hydrogeology and where required, mitigating measures are put forward to reduce and/or remove the potential impact of the proposed development. Key extracts are provided here in the Waste Licence Application; the full EIS (authored by Arup) accompanies this application. A full set of appendices is included with the EIS; the following only are appended to this application:

Appendix I.4.1: Borehole Logs

Appendix I.4.2: Quantitative Risk Assessment

Existing Soils and Geology

Landscape and Topography of the Site and Surrounding Area

I.4.2 The broad study area generally incorporates the land from Naul in the northwest to Portrane and the Rogerstown Estuary in the southeast. The local or site-specific area of study incorporates the existing MEHL Facility including the completed cells and the immediate surrounding lands.

I.4.3 The area around the site is generally hilly with elevations falling steeply towards the coast where the area becomes flatter. The site is located on a significant bedrock feature that trends in a WNW-ESE direction. Knockbrack Hill to the north east of the site represents the highest elevation in the surrounding area at 176 mOD.

I.4.4 The MEHL site is on a hill with the natural elevations on the western boundary reaching up to 149 mOD and falling to 90 mOD on the eastern boundary. As the site is a former quarry the topography within the site is varied. A topographic map of the site and the surrounding area is shown in *EIS Figure 14.3*.

I.4.5 The land use in the area surrounding the MEHL site is predominantly agricultural with some low density housing. The majority of these houses are supplied by mains water.

I.4.6 To the east of the site, at Nevitt, Fingal County Council has received planning permission and an EPA licence for a landfill. The location of the Nevitt landfill in relation to the MEHL site is shown on *EIS Figure 14.3*.

Regional Soils and Geology information

Bedrock Geology

I.4.7 A detailed bedrock geology assessment carried out by Tara Prospecting Ltd. (1985) deals with the rocks in the immediate vicinity of the site and is based on their borehole database and local investigations. In summary, their assessment indicated a complex sequence of lithologies in the area, ranging from Namurian and Brigantian shales to Asbian limestones and volcanics to the north. The Namurian shales dominate the eastern part of the area and the Brigantian shales surround these on all sides.

I.4.8 Several lithologies are reported from the area around Hollywood (Geological Survey of Ireland – Geology of Meath, 2001) as shown on *EIS Figure 14.4*. The regional geology of Meath can be divided into Ordovician and Silurian Metasediments and Volcanics, granites and other igneous rocks, sedimentary rocks of Carboniferous age and sedimentary rocks which were deposited during the Permian and Triassic periods

I.4.9 The rocks underlying the area around the site can be described, from youngest to oldest formation, as belonging to the following formations within the Carboniferous Period:

- Walshestown Formation

- Balrickard Formation
- Loughshinny Formation
- Naul Formation
- Lucan Formation

I.4.10 Table **I.4.1** shows approximate ages for each formation.

Table I.4.1: Regional Formations

System	Series	Stage	Formation	Age
Carboniferous	Silesian	Namurian	Walshestown	313 - 326 ma
			Balrickard	
	Dinantian	Visean	Donore	Donore is thought to be situated in both the Visean and Namurian Stages
			Loughshinny	
			Naul	
			Lucan	326 - 345 ma

I.4.11 The Naul Formation is also a Visean age deposit and is similar to the older Lucan formation, but the limestones are paler and less argillaceous and contains less shale. The Lucan Formation, also known locally as Calp limestone is described as dark grey well bedded cherty, graded limestones and calcareous shales.

I.4.12 The next formation shown on the Regional Geology map is the Loughshinny formation. This is a Dinantian deposit from the Visean stage and is described by the GSI as consisting of limestone breccias formed by debris flows and turbidites Younger parts of this formation are made up of well graded limestones interbedded with argillaceous limestones and dark shales.

I.4.13 The Donore Formation underlies the Balrickard Formation. This is thought to be an erosional boundary which was formed during a time when sea levels were fluctuating. Geologically it resembles the Balrickard Formation in some places and the Loughshinny Formation in others due to the changing depositional environment. The changes from one formation to the next is difficult to definitively establish and was not directly observed anywhere on site. As can be seen above, the contact between the Visean/Namurian Stages is thought to occur within the Donore Formation. In addition this formation may not be present throughout the area.

1.4.14 The Balrickard Formation is a feldspathic micaceous sandstone with shale and argillaceous fossiliferous micrite of Pendleian age.

I.4.15 The Walshestown Formation is from the Namurian stage of the Silesian Series of the Carboniferous system. The rocks of this formation are described as black shales with ironstone and subordinate siltstone with rippled fine sandstone bands, calcareous mudstone and biosparite. The Walshestown Formation is described within the GSI Publication "Geology of Meath, Sheet 13" as "predominantly black shales with subordinate siltstones and/or fine sandstone bands with rippled lenses, calcareous mudstone and occasional limestone (biosparite) of Pendleian to Arnsbergian age."

I.4.16 This area is known as the North Dublin Basin. This is a composite basin of combined sedimentary and structural origin. The location of the MEHL site is at the northern margin of this basin. To the north of the site is the Balbriggan Block. This block was bounded by faults and thrown up relative to the nearby basins. The site is located at one of the transitional areas between a block and a basin. This means that the depositional environments affect the nature of the rocks. The muddier, shaley deposits such as the Walshestown Formation, would have been deposited in deeper waters (basins) as opposed to the Loughshinny Formation deposits which appear to be deposited in warm shallow waters (blocks). This would suggest that the Dublin Basin was becoming deeper with time.

I.4.17 From the GSI map of the area (Sheet 13), the Carboniferous rock units (Walshestown, Balrickard, Loughshinny and Naul formations) are folded into a gentle syncline (bowl-shaped fold), whose axis runs roughly WNW-ESE. The Walshestown Formation occupies the centre of the fold, surrounded in sequence by the Balrickard formation, Loughshinny formation and the Naul formation to the south.

I.4.18 The affect of this synclinal structure is to bury the Loughshinny Formation even deeper than would be expected had the rocks in the area not been folded. The Loughshinny Formation is dipping in towards the centre of the syncline, resulting in it becoming deeper as its traced northwards.

I.4.19 Along with the deformation features like the syncline, a number of faults are present in the locality, generally trending N-S or NE-SW. These faults in some cases form contacts between various formations. There are most likely more faults which have not been identified present in the area, as faulting is ubiquitous in Ireland.

Quaternary Geology

I.4.20 The Quaternary (subsoil) strata data is scarce for this area; a map compiled from pre-existing data was produced to accompany an investigation for the location of landfill sites by the Geological Survey of Ireland for Dublin County Council (1979). This provides a guide to the depth and type of Quaternary sediment in the area. The map classifies all the tills as limestone dominated. However, the information presented in the Teagasc Soil Maps presented on the GSI website appears to describe these soils as tills containing Namurian Shales and Sandstones

I.4.21 The ice depositing the tills was most likely extending from the Irish midlands, southwards and eastwards across the area and may contain some far travelled limestone clasts. This till deposit is quite common in this region and is typical of the till dominated by clasts of Namurian lithologies, found in north County Dublin.

Soils

I.4.22 The Gley group of soils cover most of the region in which the MEHL site is located, with the exception of Knockbrack Hill/ Nags Head area and the Palmerstown townland area where the soils are of the Brown Earth Group. A small isolated area of peat occurs around the Bog of the Ring Commons area.

I.4.23 The MEHL site is located in the Knockbrack Hill/ Nags Head area and is therefore characterised by the Brown Earth Group soils. These are a relatively mature soil. They are generally well drained mineral soil. The typical profile is uniform with little or no differentiation into horizons. These soils are not extensively leached or degraded and thus there is little evidence in the soil profile of removal and deposition of iron oxides, humus or clay. The soils of this group are generally good arable soils although sometimes low on nutrients. They have good drainage and structure characteristics with medium textures.

Site Specific Geological information

I.4.24 A detailed site investigation was undertaken as part of the investigative works at MEHL site. The locations of all investigations are shown on *EIS Figure 14.5* and the full factual report is presented in *EIS Appendix A14.3*. Due to the weathered/broken condition of the rocks exposed at the MEHL site intrusive boreholes were drilled and the details of these are presented in Appendix **I.4.1**. The cores obtained demonstrated that these rocks are weathered and broken too.

Results of the Geophysics

I.4.25 A field mapping exercise was undertaken by G. Ll Jones on the MEHL site and a report is presented in *EIS Appendix A14.1*. In this report a major fault was mapped running roughly N-S across the site. A geophysical survey was undertaken to gain further information about this fault and to establish if there were any other unmapped faults present.

I.4.26 A trial geophysical survey was carried out by Apex Geoservices in January 2010 and this was followed by a detailed geophysical survey. The aim of the main survey was to locate any further faults on the site and also to provide information on deep bedrock. The results of the full survey included a series of interim maps along with a number of cross sections.

I.4.27 The report highlighted another bedrock fault trending E-W through the site which intersects the N-S trending fault. It suggested that this fault had a down-throw on the northern side of up to 60m (see *EIS Figure 14.6*).

I.4.28 The results from the intrusive investigations were used by Apex to calibrate the results of the geophysical survey. The results of the full survey are presented in *EIS Appendix A14.2*.

Bedrock Geology

I.4.29 Based on the Jones Report (2009), the Apex Geoservices Geophysics Report (Apex, 2010) and the boreholes carried out during this study a revised geological map has been produced for the site (See *EIS Figure 14.6*). The revised bedrock geological map presented in *EIS Figure 14.6* is founded on significantly more detailed geological information than was available during the production of the GSI 1999 publication.

I.4.30 The principal difference between *EIS Figure 14.6* and the GSI Sheet 13 geological map for the area (*EIS Figure 14.4*) is that the Loughshinny Formation is now confined to the southwestern end of the site with the Donore, Balrickard and Walshestown Formations immediately underlying the greater part of the MEHL site.

I.4.31 The bedrock geology of the site is further influenced by the main North-South trending fault running through the site. The bedrock to the east of this fault appears to have been downthrown by some tens of metres. Folding was observed in the middle of the succession of rock types present on the site but the upper beds are mostly undisturbed.

I.4.32 Overall the geology of the site youngs to the north, starting with the Loughshinny formation passing upwards and eventually into the Walshestown formation.

I.4.33 A schematic cross section for the site is presented in *EIS Figure 14.7*.

I.4.34 A summary table of the information from the boreholes used to amend the geology map is presented in the following table, Table **I.4.2**.

Table I.4.2: Borehole Summary

Borehole ID	Date Drilled	Strata Encountered	Formation/ Description	Depth
BH4A	18/11/2008	Overburden	Clays	0.0 - 4.3
		Bedrock	Loughshinny	4.3 - 12.2
BH5	03/09/1998	Overburden	Clays	0.0 - 6.0
		Bedrock	Walshestown	6.0 - 35.0
BH6	03/09/1998	Overburden	Clays	0.0 - 4.0
		Bedrock	Walshestown	4.0 - 19.5
BH7	07/09/1998	Overburden	Clays	0.0 - 2.0
		Bedrock	Walshestown	2.0 - 26.0
BH8	17/08/2001	Overburden	Clays	0.0 - 3.0
		Bedrock	Walshestown	3.0 - 27.0
BH9	03/08/2001	Overburden	Clays	0.0 - 12.0
		Bedrock	Walshestown	12.0 - 50.0
BH10	04/08/2001	Overburden	Clays	0.0 - 4.0
		Bedrock	Loughshinny	4.0 - 84.0
BH10a	05/03/2007	Overburden	Clays	0.0 - 10.0
		Bedrock	Balrickard/Donore (?)*	10.0 - 21.0
		Bedrock	Loughshinny	21.0 - 68.0
B11a	02/05/2007	Overburden	Clays	0.0 - 2.0

Borehole ID	Date Drilled	Strata Encountered	Formation/ Description	Depth
		Bedrock	Walshestown	2.0 - 30.0
BH12	01/05/2007	Overburden	Clays	0.0 - 5.5
		Bedrock	Walshestown/Balrickard/Donore (?)*	5.5 - 46.0
		Bedrock	Loughshinny	46.0 - 65.0
BH13	15/04/2007	Overburden	Clays	0.0 - 5.5
		Bedrock	Walshestown/Balrickard/Donore (?)*	5.5 - 46.0
		Bedrock	Loughshinny	46.0 - 48.0
BH14	02/03/2007	Overburden	Clays	0.0 - 6.0
		Bedrock	Balrickard/Donore (?)*	6.0 - 30.0
		Bedrock	**Loughshinny**	30.0 - 38.0
BH15	06/04/2010	Overburden	Clays	0.0 - 3.2
		Bedrock	Balrickard (?)*	3.2 -10.0
		Bedrock	Possible Donore (?)*	10.0 - 26.1
		Bedrock	**Loughshinny**	26.1 - 31.9
BH16	12/04/2010	Overburden	Clays	0.0 - 0.8
		Bedrock	Walshestown	0.8 - 60.0
BH17	05/05/2010	Bedrock	Balrickard/Donore (?)*	0.0 -37.0
		Bedrock	**Loughshinny**	37.0 - 54.0
BH18	20/04/2010	Overburden	Clays	0.0 - 0.6
		Bedrock	Balrickard (?)*	0.6 - 5.1
		Bedrock	Donore (?)*	5.1 - 15.2
		Bedrock	**Loughshinny**	15.2 - 21.2
BH19	21/04/2010	Overburden	Clays	0.0 -5.0
		Bedrock	Balrickard (?)*	5.0 - 14.0
		Bedrock	Donore (?)*	14.0 - 18.0
BH20	22/04/2010	Overburden	Clays	0.0 - 7.0
		Bedrock	Walshestown	7.0 - 34.0

Borehole ID	Date Drilled	Strata Encountered	Formation/ Description	Depth
		Bedrock	Balrickard/Donore (?)*	34.0 - 43.0
		Bedrock	**Loughshinny**	43.0 - 48.0

***** (?) – Indicates that the geological strata were not easily identified. Formation named is most likely formation based on location, depth and observed rock types.

I.4.35 The oldest formation observed on site is the Loughshinny Formation. This is Dinantian in age and consists of limestone breccias formed by debris flows and turbidites. Younger parts of this formation are made up of well graded limestones interbedded with argillaceous limestones and dark shales.

I.4.36 The Namurian formations are encountered next and these are composed of shales with argillaceous limestones and sandstones. The oldest Namurian deposit on the site is the Donore Formation. It is thought to form an unconformity between the eroded older units of the Loughshinny Formation and the younger units of the Balrickard Formation. It is of Brigantian to Pendleian in age and is estimated to have a thickness of up to 250m. This formation was difficult to identify from both outcrops and core samples from the underlying and overlying units due it's similarity to both in different areas and the poor quality of much of the core and/or chippings. In BH18 core samples taken at 15 mbgl appeared to be the Loughshinny Formation but palynology proved them to be Namurian in age, indicating were from the Donore Formation.

I.4.37 The next formation encountered is the Balrickard Formation. This was described in the borehole logs as "Moderately strong to moderately weak, thickly laminated to thinly bedded (to structureless where clay-filled), interbedded fine-grained sandstone and mudstone with large amounts of orange/yellow/brown clay infill". It is assumed that the contact between the Walshestown Formation and the Balrickard formation is an erosional contact which follows the topography of the north-western corner of the site.

I.4.38 There is a possibility that the fault which runs roughly East-West which was identified during the geophysics extends further westward and forms the contact between the two formations. It should be noted that the contact was not directly observed anywhere on site.

I.4.39 In the north of the site, where the Walshestown formation is observed, the rocks are described as black shales with ironstone and subordinate siltstone with rippled fine sandstone bands, calcareous mudstone and biosparite. In the borehole logs it is described as "Moderately weak to moderately strong, thinly bedded to thinly laminated, dark grey/black, interbedded fine-grained sandstone and siltstone/mudstone with large amounts of black clay infill".

I.4.40 It should be borne in mind that the overall geological interpretation has been hindered by the weathered and broken nature of the site and the quality of the materials recovered from the boreholes.

Soils

I.4.41 Much of the naturally occurring soils on-site have been stripped and stockpiled during the quarrying operations. Some stockpiling of soils has been carried out for use in the restoration of the quarry, and for lining and capping activities associated with the landfilling activities.

Quaternary Geology

I.4.42 The Quaternary deposits on the site and in the immediate surrounding areas consist of a till. This varies in thickness and texture but is generally less than 5 m thick and has a clay/silt matrix with dispersed pebble clasts. The till contains weathered clasts of Namurian shale and sandstone, with some limestone. Where the till cover is thin it tends to have a coarser texture, being more silty to sandy.

Geological Heritage Areas

I.4.43 Geological Heritage Areas are designated as part of the Irish Geological Heritage Programme as part of a partnership with the Geological Survey of Ireland (GSI) and the Department of Environment, Heritage and Local Government. The aim of the programme is to identify, document and protect the wealth of the geological heritage in Ireland.

I.4.44 The MEHL quarry has been designated a County Geological Site. This designation reflects the exposure in the quarry walls of many of the bedding and structural features characteristic of the geological succession found in the region. Similar exposures are seen along the coast at Loughshinny where the bedrock is also exposed.

Summary of the Geology of the MEHL Site

- An extensive investigation was undertaken at the MEHL site to assess the local geology.

- Four formations have been identified on site. The Loughshinny and part of the Donore Formations are Dinantian in age, while the other part of the Donore Formation, along with the Balrickard and Walshestown Formations are Namurian in age.
- Where they occur within this former quarry, the Quaternary deposits consist of Glacial Tills.
- There is a large WNW-ESE trending syncline which means that the Loughshinny is dipping to the north and therefore becoming deeper in that direction. Furthermore, the Loughshinny appears to have been downthrown significantly by the E-W trending fault so that in the north of the site there is over 60m of Namurian deposits above it. This means that the Loughshinny is overlain by increasing thicknesses of the Donore, Balrickard and Walshestown formations moving northwards across the site.
- A number of faults were located across the site. The main fault appears to run roughly N-S through the site with another two faults running perpendicular to this aligned E-W. These faults may potentially form faulted contacts between Balrickard and Walshestown Formations. The strata in the Loughshinny and the lower parts of the Donore Formations are likely to therefore contain significant faulting and therefore significant permeability.

Description of Groundwater Baseline

Hydrology

I.4.45 A full description of the hydrology of the site and the surrounding area is included in *EIS Chapter 15: Surface Water*. Surface water features in the vicinity of the MEHL site are shown on *EIS Figure 15.1*. A small stream is present along the northern boundary of the site which flows from west to east. This stream is likely to be fed partially by shallow groundwater to the east of the MEHL site where the bedrock is shallow.

Rainfall

I.4.46 The closest weather monitoring station to the site is located at Dublin Airport, approximately 20 km south of the site. Rainfall levels are recorded on a daily basis and the results were used to assist with the analysis of the soakaway and pumping tests and also the interpretation of groundwater levels.

I.4.47 The 30-year average rainfall measured at Dublin airport is 750 mm. Monthly and annual total rainfall for 2003-2010 are presented in *EIS Appendix A14.7* and annual totals are summarised below in Table **I.4.3**.

Table I.4.3: Annual Rainfall and Potential Evapotranspiration (Penman) measured at Dublin Airport

Year	Rainfall (mm/yr)	Potential Evapotranspiration (Penman) (mm/yr)	Effective Rainfall (mm/yr)
2010	-	-	-
2009	920.2	521	399.2
2008	942.3	531	411.3
2007	784.4	531	253.4
2006	740.6	597	143.6
2005	680.3	526	154.3
2004	752.4	563	189.4
2003	643.2	558	85.2

I.4.48 This data shows that since 2005 annual rainfall levels have been increasing and that 2008 and 2009 were particularly wet years. The rainfall data measured in 2010 from January to September show rainfall levels were lower than normal in all months except September.

I.4.49 Monthly potential evapotranspiration (PE) data was collected (Penman method) at Dublin Airport to the south of the MEHL site. This monthly data is presented in *EIS Appendix 14.7* and summarised in Table **I.4.3**. The data shows that the rate of potential evapotranspiration has not changed much since 2003.

I.4.50 Potential or effective rainfall is the amount of rainfall which is available to infiltrate into the ground and which will not evaporate or be taken up by plants. It is determined by subtracting evapotranspiration from rainfall. The annual effective rainfall is also summarised in Table **I.4.3**.

I.4.51 The actual recharge is the measure of how much rainfall can actually be assumed to infiltrate into the ground and recharge the water table. It is based on the potential rainfall but also takes into account rainwater which does not enter the ground but becomes overland flow and enters streams. This occurs when the soil is saturated or has reached its field capacity which is common in Ireland. The Working Group for Groundwater in Ireland have determined that the actual recharge can be set at 95% of the effective rainfall.

I.4.52 This indicates that despite high levels of actual rainfall being measured, the amount of rainfall which may eventually enter groundwater is comparatively low.

Regional Hydrogeology

I.4.53 The site is located within the Eastern River Basin District which covers Dublin and the wider surrounding area as far north as Drogheda as shown in *EIS Figure 14.1*. The geology of the area is composed of different bedrock types and soil deposits which lead to a variety of hydrogeological regimes being present in the area.

I.4.54 The Geological Survey of Ireland has devised a system for classifying the aquifers in Ireland based on the hydrogeological characteristics, size and productivity of the groundwater resource. The three main classifications are Regionally Important Aquifers (RI), Locally Important Aquifers (LI) and Poor Aquifers (P).

I.4.55 Table **I.4.4** summarises the lithologies present on the MEHL site and their GSI aquifer classification. The geology of the MEHL site has been discussed in detail in the section *Site Specific Geological Information* and the work undertaken as part of this assessment has led to the boundaries of the lithologies on site being refined as indicated in *EIS Figure 14.6*. From this the aquifer classification has been refined and is presented in *EIS Figure 14.8*.

Table I.4.4: Summary of the GSI aquifer classification for lithologies present on the MEHL site.

Lithology	Age (Stage)	GSI Aquifer classification
Loughshinny Formation	Visean	Locally Important Aquifer
Donore Formation	Namurian	Poor aquifer
Balrickard Formation	Namurian	Poor aquifer
Walshestown Formation	Namurian	Poor aquifer

1.4.56 Based on the geological information for the area outlined above the hydrogeology of the area can be subdivided into an aquifer unit and an aquitard unit for the purposes of this report.

The Aquifer

I.4.57 The Loughshinny Formation comprises the aquifer in this region. Isolated gravel deposits have been mapped in the region directly above the Loughshinny and these may contribute to the resource of the aquifer.

I.4.58 The aquifer is part of the Lusk – Bog of the Ring Groundwater Body (GWB) as shown on *EIS Figure 14.1*.

I.4.59 The Loughshinny Formation is characterised as being moderately productive bedrock. Well records indicate that there are numerous wells which tap the Loughshinny Formation with yields of over 100m^3/day. These wells are often domestic or Council supplies. Typical specific capacities range from 5 – 150 m^3/day and transmissivities up to 1000 m^2/day have been recorded.

I.4.60 The rocks of the Loughshinny Formation are composed of Calp limestones although they are cleaner and more fractured than the typical Calp limestone seen for example in Dublin. The flow regime in this type of material will be dominated by fracture flow and movement through weathered zones with the majority of the storage being in the fractures. There will be little to no storage and groundwater movement though the matrix of the rock.

I.4.61 Weathered beds of the Donore Formation which were deposited in the same environment as the Loughshinny may also comprise part of the aquifer in places. As outlined in the section *Summary of the Geology of the MEHL Site* the Donore Formation is difficult to distinguish as it is similar to the Loughshinny Formation below it and the Balrickard Formation above it depending on the depositional environment it was formed in at any one location. For this reason parts of it will comprise the aquifer and parts will comprise the aquitard.

I.4.62 The quality of a groundwater source relates to both its productiveness (which includes how often it is renewed) and its chemistry. Testing undertaken on the Loughshinny Formation indicates that it is a productive groundwater resource with a quality suitable for water supply (with local variations).

I.4.63 Based on the NRA guidelines criteria, the aquifer would be given a Medium Importance.

The Aquitard

I.4.64 The aquitard is composed of the formations which were deposited during the Namurian period and is part of the Hynestown GWB (*EIS Figure 14.1*). As stated above the upper part of the Donore Formation is similar to the overlying Namurian strata and therefore is considered to be part of the aquitard. A geological description of these units is provided in the section *Landscape and Topography of the Site and Surrounding Area*.

I.4.65 The area defined as the aquitard is composed of a hill (i.e. it is topographically higher than the surrounding area) and is defined by the extent of Namurian rocks. It is characterised by poorly productive bedrock (except in local zones) and has the GSI classification of Pl (Poor Aquifer, Bedrock which is generally unproductive except in local zones). No detailed hydrogeological investigations have been undertaken in these deposits in this area and the GSI classification is based on the characteristics of the formation elsewhere.

I.4.66 The hydraulic characteristics of the Namurian deposits will vary depending on the lithologies present. Areas of low permeability material such as the siltstones of the Walshestown Formation will allow very little groundwater movement. However weathered or fractured zones in or around the material will allow some groundwater movement through the deposits and may hydraulically connect different lithologies.

I.4.67 Based on the NRA guidelines criteria, the aquitard would be given a Low Importance.

Groundwater Flow Direction

I.4.68 The regional groundwater flow direction is towards the south east. This is influenced by the underlying geological structure which traps water causing it to flow to the south east rather than directly east as would be expected.

Hydrochemistry

I.4.69 Water quality in the Loughshinny Formation is always hard (usually over 250 mg/l, often over 300 mg/l as $CaCO_3$). Generally the quality is good except for in areas where it is locally contaminated.

I.4.70 Groundwater samples are routinely collected at the Bog of the Ring water supply which abstracts water from the Loughshinny Formation. These are presented in monitoring reports and some data is quoted in the Source Protection Zone report for the Bog of the Ring.

I.4.71 The water data from Bog of the Ring is typical of what would be expected from a limestone source. High hardness, alkalinity and Electrical Conductivity (EC) values were observed. Sulphate and chloride values range from 22-82 mg/l and 23-31 mg/l, respectively. Chloride values of this concentration can sometimes indicate organic contamination however in this case they are more likely to be due to the proximity to the coast.

I.4.72 Elevated potassium levels of 0-7 mg/l were observed in the Loughshinny which may indicate organic contamination. However, the Na:K ratio are below the GSI guideline value of 0.3 and as such the elevated potassium levels were attributed to being naturally occurring in the bedrock.

I.4.73 Elevated manganese and iron concentrations were thought to originate from the shaly beds in the limestone.

Groundwater Vulnerability

I.4.74 The vulnerability of a groundwater body is the term used to describe the ease with which the groundwater in the area can be contaminated by human activities. The vulnerability is determined by many factors including the travel time, the quantity of contaminants and the capacity of the deposits overlying the bedrock to attenuate contaminants.

I.4.75 These factors in turn are based on the thickness and permeability of the subsoil deposits, e.g. groundwater in bedrock which has a thick cover of low permeability clay is less vulnerable than the groundwater in bedrock which is exposed at the surface. The criteria for determining groundwater vulnerability, as developed by the GSI, are shown in Table **I.4.5** below. The Extreme vulnerability class is further sub-divided into Extreme (X) – rock near Surface or Karst and Extreme (E) - subsoils <3m thick.

Table I.4.5: GSI Groundwater Vulnerability Mapping Guidelines (DoELG 1999)

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

Notes: (1) N/A = not applicable

(2) Precise permeability values cannot be given at present

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

I.4.76 The GSI groundwater vulnerability maps show different vulnerability ratings in the site and the surrounding area and these are displayed in *EIS Figure 14.9*. The vulnerability classification of the MEHL site is 'Extreme Rock near surface or karst'. This would be expected as the site is a former quarry and the natural overburden has been removed in the area.

I.4.77 However, it should be noted that the GSI criteria does not take the permeability of bedrock into account and the presence of low permeability Namurian material over most of the site is not factored into the vulnerability classification.

Groundwater Resources

GSI Well Records

I.4.78 *EIS Figure 14.10* shows the locations of all wells recorded by the GSI. However, as it is not a requirement for wells to be registered with the GSI the GSI list of wells is not necessarily complete.

Well Survey

I.4.79 A well survey was undertaken to establish if any wells were present in the area which were not identified on the GSI database.

I.4.80 The full details of the well survey are presented in *EIS Appendix A14.9*. The survey was undertaken for residential properties within a 1km radius down-gradient of the site and 0.5 km radius up gradient of the site. Properties which would potentially have larger abstractions such as businesses/agricultural enterprises were audited within 2 km down-gradient of the site and 1 km up-gradient of the site.

I.4.81 The well survey identified only 3 properties in the area which have wells abstracting from groundwater and their locations are shown on *EIS Figure 14.10*. As outlined, groundwater flow is to the south east. This means that two of these abstraction wells are up-gradient of the site and only one is down-gradient. The down-gradient well is used for watering gardens and is not used for a potable water supply. All three locations where wells were noted are also supplied by mains water.

I.4.82 In line with the significance criteria presented in *EIS Appendix Table A14.11.4*, these wells would have a Low importance as they are supplying less than 50 homes.

Bog of the Ring

I.4.83 Fingal County Council have developed a well field in the Loughshinny formation at the Bog of the Ring that supplies up to 4,000 m3/day to Balbriggan and its environs. It is located to the north east of the MEHL site as shown on *EIS Figure 14.10*. The GSI have defined a Source Protection Area (SPA) for this water supply composed of an Inner and Outer Protection Area. The MEHL site is located approximately 1 km outside the Outer Source Protection Area of the abstraction and approximately 3 km from the abstraction locations as shown in *EIS Figure 14.10*.

I.4.84 The GSI have also mapped a groundwater divide to the north east of the MEHL site on the basis of surface water features in that area. This indicates that groundwater from the MEHL site will not flow towards the Bog of the Ring.

I.4.85 Recent monitoring reports have suggested that the supply is in decline "the regional water table is in long term decline and has not reached a steady state at the end of 2005. This is consistent with the ERBD findings that the aquifer is currently at risk from potential over abstraction" (Collins and Herlihy, 2007).

I.4.86 This lowering in groundwater levels is likely due to the limited storage contained within faults, fractures and weathered zones in the Loughshinny Formation as outlined in the section *The Aquifer*. It is generally thought that sands and gravels in the vicinity of the Bog of the Ring wellfield provide significant additional storage.

I.4.87 Based on the NRA Guidelines criteria, the Bog of the Ring abstraction would have a resource valuation of a High Importance as it is supplying more than 1000 homes.

Features dependent on the groundwater regime

Groundwater Dependent Terrestrial Ecosystems (GDTEs)

I.4.88 A full review of ecological features and designated ecological heritage areas in the study area are discussed in detail in *EIS Chapter 13 Flora and Fauna*.

I.4.89 There are two designated areas which could be dependent on groundwater or which may be impacted by changes in the groundwater quality or the groundwater regime of the aquifer. These are the Rogerstown Estuary pNHA[39], SPA[40] and SAC[41] (site codes 000208 and 004015) and the Bog of the Ring pNHA (site code 001024). These features are shown on *EIS Figure 14.11* and their distance from the proposed development is below.

- Rogerstown Estuary: 7.5 km to the southeast
- The Bog of the Ring: 2.3 km to the northeast

I.4.90 However due to the distance of these features and the lack of any direct hydrogeological linkage with the MEHL site they are not be considered further in this assessment.

Surface Water Features

I.4.91 There is a stream to the north of the MEHL site (*EIS Figure 14.11*) which flows from west to east and is likely to be at least partially fed from shallow groundwater. Due to the confining conditions demonstrated by the boreholes adjacent to the stream (BH6 and BH11A) and the presence of the aquifer at a depth of greater than 60 m at this location, potential contamination generated from the site will not enter the stream at this location.

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[39] pNHA: Proposed National Heritage Area
[40] SPA: Special Protection Area
[41] SAC: Special Area of Conservation

I.4.92 There is a tributary of this stream running parallel to the MEHL boundary, approximately 1.5 km from the site. In this area, the bedrock is likely to be hydraulically connected with the stream. This tributary maybe negatively impacted should groundwater become contaminated.

Site Hydrogeology

Introduction

I.4.93 The site work undertaken by Jones (2009) allowed assessment of the principal geological boundary and indicated the presence of a N-S trending fault as outlined in the section *Site Specific Geological Information*. Geophysical surveys were undertaken which identified further faulting on the site trending E-W and intersecting the N-S fault. The faults may influence the hydrogeology of the site by either acting as a conduit for flow or as a barrier to flow.

I.4.94 Many of the monitoring wells and new boreholes drilled on site were positioned in locations to investigate this. This is described in full in Appendix **I.4.1**

I.4.95 The final network of groundwater monitoring boreholes was developed on site as shown in *EIS Figure 14.12*. Extensive investigations were undertaken including:

- New monitoring wells
- New pumping wells
- Hydraulic testing
- Pump test
- Well development
- Groundwater level and quality monitoring

I.4.96 Detailed interpretation and data for these are presented in *EIS Appendices A14.3-A14.12*.

Table I.4.6: Summary Details of Monitoring Wells

Borehole ID	Depth (m)	Response zone lithology	Comments
BH4A	12.2	Loughshinny	Artesian well & topographically lower
BH5	34.9	Namurian	
BH6	19.5	Namurian	Artesian
BH9	19.01	Namurian	
BH10a	67	Loughshinny	
B11a	30	Namurian	Artesian
BH12	65	Loughshinny	
BH13	40	Namurian	
BH14	38	Loughshinny	
BH15a	30	Loughshinny	
BH16	24	Namurian	Weathered/fractured water bearing zone within Walshestown Formation
BH17	54	Loughshinny	Pumping well
BH18	21	Loughshinny	
BH19	18	Namurian	
BH20	43	Namurian/Aquifer	Possibly finishing in the Donore Fm which may be part of the aquifer here

I.4.97 The site is a former working quarry, however as it is located above the water table no dewatering has been undertaken in the past year.

Aquifer Characteristics

I.4.98 Both the aquifer and aquitard are old indurated rocks and therefore are dominated by secondary permeability. The permeability is likely to be related to particular horizons within the formations.

I.4.99 In order to establish vertical and horizontal permeability of the lithologies on the site, permeability testing was undertaken. Details are provided in the following paragraphs.

Infiltration Testing

I.4.100 Infiltration tests were undertaken in trial pits across the base of the excavation to assess the vertical permeability of the deposits.

I.4.101 Full details of the methodology for these tests, the calculations and the interpretation of the results are also included in *EIS Appendix A14.5*. The results of the infiltration tests are summarised below in Table **I.4.7**.

Table I.4.7: Summary of vertical infiltration calculation

Soakaway pit	Time period ending	Infiltration rate (m/s)
TP1	Test 1	4.22E-07
	Test 2	2.82E-08
TP2	Test 1	4.54E-07
	Test 2	1.53E-07
TP3	Test 1	Not conclusive*

* This test was inconclusive as water levels rose in the pit due to rainfall which did not allow calculations to be undertaken. However, it can be taken that this is an indication that the deposit has a low permeability.

I.4.102 These results indicate that the material at the base of the excavation has a low permeability and as such will provide natural protection to the groundwater resources beneath the site.

I.4.103 It should be noted that the calculations had to be modified as the soakaway pits did not drain over a full weekend. This in itself indicates that the material at the base of the excavation has a low permeability or at least a low vertical infiltration rate.

I.4.104 Furthermore, rain fell over the weekend causing TP3, which is located to the north of the site to over-flow as so little water had drained out of it. This indicates that the values may actually be lower than were calculated above.

Variable head testing

I.4.105 Variable head permeability tests were undertaken in many of the boreholes in order to estimate an approximate permeability of the response zone. The full details of these tests including calculations, interpretation and caveats are presented in *EIS Appendix A14.5*. Table **I.4.8** summarises the results obtained from those tests.

Table I.4.8: Summary Results from Variable Head Permeability Testing

Borehole ID	Response zone lithology	Method of Analysis	K (m/sec)	Comments
BH5	Namurian	Bouwer & Rice	5.4 x 10-5	
BH6	Namurian	Bouwer & Rice	5.7 x 10-4	Artesian*
BH8	Namurian	Bouwer & Rice	7 x 10-5	
BH11a	Namurian	Bouwer & Rice	5 x 10-5	Artesian*
BH15a	Loughshinny	Bouwer & Rice	1.04 x 10-6	
BH16	Namurian	Bouwer & Rice	6.95 x 10-6	
BH18	Loughshinny	Bouwer & Rice	-	Drawdown not achieved
BH19	Namurian	Bouwer & Rice	1.10 x 10-6	
BH20	Loughshinny	Bouwer & Rice	-	Drawdown not achieved

* Equations may not be valid for artesian wells

I.4.106 Of the three tests undertaken in the Loughshinny Formation, only one yielded results. This is because the groundwater levels in the other two recovered too quickly to allow a drawdown to be measured. This indicates that the Loughshinny Formation has a moderate to high permeability. The value calculated for BH15a should be treated with caution. A large amount of water was found in this monitoring well and such a small drawdown was achieved that the results may be too low and not reflective of the true permeability of the deposit.

I.4.107 The results of the tests undertaken in boreholes tapping the Namurian strata indicate a lower permeability than the Loughshinny Formation.

I.4.108 The caveats associated with the equations and method of testing as outlined in *EIS Appendix A14.5* should be borne in mind when considering these results.

Packer Tests

I.4.109 Packer tests were developed for use to estimate the amount of grout which would have to be used to block a fracture.

I.4.110 Packer tests were undertaken in the open Geo-bore 'S' holes in BH15, BH16 and BH18 on the MEHL site.

I.4.111 In BH15, two tests were undertaken in an area which cores indicated was very fractured. The area where these tests were taken were between 30 - 31.9 mbgl and 30.5 – 31.5 mbgl at the top of the Loughshinny Formation.

I.4.112 The first test was abandoned as a pressure increase was not observed and indicated that the pressure seal was not functioning correctly. No results could be obtained from the second test as the pressure levels could not be increased. This indicated that the fracture encountered was quite large indicating high permeability.

I.4.113 Two tests were also undertaken in BH16. The first was in a shallow area within the Walshestown Formation between 18 - 21.2 mbgl which was highlighted as having a lot of water flow. The packer tests indicated a permeability value of 2.2 x 10^{-6} m/s.

I.4.114 The second packer test in BH16 was undertaken between 54 - 55 mbgl. This area was still within the Walshestown Formation but was highlighted as being more fractured than previously noted areas. The packer tests indicated a permeability value of 3.29 x 10^{-6} m/s for this fractured area in the Walshestown Formation.

I.4.115 The final packer test was undertaken in BH18 between 18-21.2 mbgl. This area was thought to be in the Loughshinny Formation based on the deposits encountered, however it may have also been the Donore Formation due to difficulties in distinguishing the strata in places.

I.4.116 The packer test yielded a permeability value of 2.2 x 10^{-6} m/s at this location.

I.4.117 The results of all packer tests are summarised in Table **I.4.9**.

Table I.4.9: Summary Results of Packer Testing

BH ID	Depth (mbgl)	Geology	K value (m/s)	Comments
BH15	30 - 31.9	Loughshinny Fm	-	No seal obtained
	30.5 – 31.5	Loughshinny Fm	-	Pressure did not increase indicating highly permeable fracture
BH16	18 - 21.2	Walshestown Fm	2.2 x 10-6	
	54 - 55	Walshestown Fm	3.29 x 10-6	
BH18	18-21.2	Loughshinny Fm	2.22 x 10-6	

Pumping test

I.4.118 A pumping test was undertaken in BH17 in order to estimate the horizontal permeability of the Loughshinny deposit and to assess the hydraulic interactions across the site. The full details of the pumping test including the methodology, data correction, raw data, calculations and interpretation are presented in *EIS Appendix A14.6*.

I.4.119 Step drawdown (& recovery) and constant rate (& recovery) tests were undertaken however data from the observation boreholes could not be used to obtain data on the aquifer characteristics. This is because the presence of faults and partially penetrating wells influenced the groundwater levels in the observation wells during the pumping test and made the data unreliable for these calculations.

I.4.120 The recovery data from BH17 (pumping well) from both the step drawdown and constant rate tests were used to obtain data on the aquifer characteristics. The drawdown data obtained in BH17 during Step 1 of the step drawdown test was also used in the calculations by treating the 60 minutes as a constant rate test.

I.4.121 These calculations indicated that the Loughshinny deposit has a high transmissivity of up to 300 m/d (indicating a permeability of approximately 1.74×10^{-4} m/s if the aquifer is 50 m thick). Specific capacity values of approximately 250 m^3/d/m were also calculated from the data available.

I.4.122 While the observation well data could not be used in the calculations, the data obtained from them was useful for undertaking distance-drawdown analysis of the hydraulic conditions.

I.4.123 The distance-drawdown analysis was used to gain information on the hydrogeological characteristics of the faulting on the site. The analysis demonstrated that the N-S trending fault is hindering the movement of water across it rather than acting as a conduit for flow. However, it is not working as a complete barrier to flow.

I.4.124 The E-W trending fault does not appear to have any influence on the flow in the groundwater beneath the site and it is likely to be bringing the aquifer into contact with permeable horizons within the Namurian.

I.4.125 The shape of a semi-log plot of drawdown versus time coupled with a log-log plot of drawdown versus time can often be a useful indicator of the type of aquifer the pump is abstracting water from. The full details of this are presented in *EIS Appendix A14.6* and are summarised below.

I.4.126 Based on the shapes of the curves in the graphs, the groundwater in the aquifer is confined by the overlying low permeability deposits.

I.4.127 The groundwater in BH19, BH16 and BH5 appear to be tapping a linear weathered area, fault or fracture zone.

I.4.128 The shapes of the curves on the graphs also indicated that the majority of the storage is in fractures. This indicates that although a high permeability value was observed over the length of the pumping test, the aquifer at this location may not be a good long term groundwater resource if the storage is only contained within fractures.

I.4.129 The results of the various hydraulic and well tests indicate that the permeability of the Loughshinny Formation (the aquifer) is moderate being of the order of 10^{-4} / 10^{-5} m/s. The permeability of the more permeable horizons in the Namurian appears to be of the order of 10^{-6} m/s. The permeability of the bulk of the Namurian start appear to be significantly lower and is of the order of 10^{-7} / 10^{-8} m/s.

Groundwater Levels

I.4.130 As part of the current EPA waste licence conditions, groundwater monitoring has been undertaken on the site since 2003. Groundwater levels in the new monitoring boreholes (constructed as part of this investigation in April and May 2010) have been measured since their construction. All records for groundwater levels in new and old boreholes, including hydrographs, are available in *EIS Appendix A14.7*.

I.4.131 Table **I.4.10** summarises the maximum, minimum and average groundwater levels recorded on site for all installations

Table I.4.10: Summary of Groundwater Monitoring Data

Borehole ID	Response zone	Comments	Groundwater level					
			Minimum		Maximum		Average	
			mbgl	mOD	mbgl	mOD	mbgl	mOD
BH4A	Aquifer	Artesian well & topographically lower	-0.70	91.96	-0.70	91.96	-0.70	91.96
BH5	Aquitard		27.08	91.12	14.38	103.80	20.03	98.17
BH6	Aquitard	Artesian	0.17	116.80	-0.31	117.30	-0.30	117.30
BH9	Aquitard		27.54	101.00	20.84	107.72	24.09	104.47
BH10a	Aquifer		48.45	88.39	36.43	100.40	40.70	96.14
B11a	Aquitard	Artesian	4.76	93.41	-0.34	98.51	0.49	97.68
BH12	Aquifer (partially penetrating)		53.85	93.14	46.16	100.83	48.36	98.63
BH13	Aquifer		38.80	108.12	33.50	113.42	35.45	111.47
BH14	Aquifer		32.29	92.56	26.03	98.82	28.04	96.81
BH15a	Aquifer		6.34	99.55	6.02	99.87	6.22	99.66
BH16	Aquitard	Weathered/ fractured water bearing zone within Walshestown Formation	4.44	100.30	3.04	101.70	3.18	101.61

Borehole ID	Response zone	Comments	Groundwater level					
			Minimum		Maximum		Average	
			mbgl	mOD	mbgl	mOD	mbgl	mOD
BH17	Aquifer	Pumping well	5.03	100.38	4.46	100.95	4.68	100.73
BH18	Aquifer (partially penetrating)		10.40	100.10	9.51	100.99	9.70	100.80
BH19	Aquitard		3.42	101.66	2.85	102.23	3.04	102.04
BH20	Aquifer		3.90	100.94	3.45	101.39	3.60	101.24

I.4.132 Graphs of groundwater levels with corresponding rainfall data are plotted in *EIS Appendix A14.7*. These show that groundwater levels have been higher in recent years which corresponds with the country-wide pattern seen due to higher rainfall levels in 2008 and 2009. The hydrographs indicate that recharge/infiltration is slow and relatively low responding to seasonal rainfall rather than individual rainfall events.

I.4.133 *EIS Figure 14.13* shows groundwater levels plotted spatially across the site on 20th May 2010. Groundwater levels recorded in installations in the Loughshinny and in the Namurian deposits are distinguished from each other. This shows that groundwater levels in the Loughshinny are fairly consistent across the whole site demonstrating levels of approximately 100 mOD.

I.4.134 The exception to this is BH4A which is 91.96 mOD, however this borehole is at a lower elevation than the rest of the boreholes and is artesian for that reason. The value quoted as the groundwater level is actually the top of the casing implying the actual level is higher.

I.4.135 There is a large pond in the south eastern corner of the excavation and this probably reflects the water table in this part of the site.

I.4.136 The groundwater levels recorded in the Namurian deposits exhibit more variation across the site. In general they are shallower than the levels recorded in the Loughshinny and the values are more dependent on topography than the values recorded in the Loughshinny indicating separation from the water in the aquifer. The values at the base of the excavation demonstrate the shallowest levels recorded in the Namurian while those outside of the excavation pit demonstrate higher levels. However, it is likely that some of the installations in the Namurian deposits which are demonstrating similar groundwater levels to the Loughshinny are part of the Donore Formation. As outlined previously, it is considered that parts of the Donore Formation are part of the aquifer.

I.4.137 The only pattern which can be seen in the groundwater levels in the Namurian is in BH5, BH16 and BH19 which all demonstrate levels of approximately 101.5 mOD. The distance drawdown analysis grouped these wells together as potentially harnessing the same fracture/weathered zone.

Hydraulic conditions

I.4.138 The water table map presented in *EIS Figure 14.13* shows groundwater in the aquifer flowing to the south east. This is in line with the regional pattern discussed in the section *Regional Hydrogeology*. The hydraulic gradient in the aquifer is approximately 0.02 – 0.04 indicating that the water table has a moderate gradient.

I.4.139 The groundwater velocity beneath the site is the product of the hydraulic conductivity and the hydraulic gradient divided by the effective porosity. The effective porosity is expected to be very low and estimated to be 1-5%. Using the maximum hydraulic conductivity outlined in the section *Aquifer Characteristics* the groundwater velocity would be approximately 1.48×10^{-5} m/s.

I.4.140 The site is located in the upper part of a groundwater catchment. This location, the general absence of large springs in the aquifer, the confined nature of much of the aquifer in the site area and the moderate gradient and velocity indicate that the natural groundwater throughput in the aquifer is relatively low. However, owing to the secondary nature of the permeability in the aquifer, significant volumes of water can be induced to flow under stressed (pumping) conditions.

I.4.141 The hydraulic boundaries of the aquifer in the vicinity of the MEHL site are the confined zone to the north, a groundwater divide to the west, and a small stream and a formation boundary to the south. Down-gradient and to the east the aquifer width narrows and probably discharges to a tributary of the small stream that adjoins the northern boundary of the site.

Hydrochemistry

I.4.142 As part of the current waste licence conditions MEHL has been collecting groundwater quality samples on a quarterly basis and the data from this is presented in *EIS Appendix A14.8*. Groundwater samples were collected from all the monitoring points on site, both the existing and the new ones and the detailed analysis of the water chemistry is discussed in *EIS Appendix A14.8* and summarised below.

I.4.143 The groundwater beneath the site is hard, with concentrations of approximately 200 mg/l $CaCO_3$. This is characteristic of limestone deposits and even higher readings would be realistic.

I.4.144 Elevated concentrations of manganese were detected in all boreholes. This is likely to be due to the shaly deposits present on the site and is in line with the regional data presented.

I.4.145 Elevated spot concentrations of iron and nitrite were found in BH20 and BH18 respectively.

I.4.146 Sulphate concentrations exceeded the Drinking Water Standard in BH10A in the most recent round. In previous monitoring rounds, the values were within guidelines values.

I.4.147 Elevated concentrations of arsenic were found in 4 boreholes, molybdenum and antimony were both found in BH's 5 and 9. It is likely that these metals are naturally occurring.

I.4.148 The potassium:sodium ratio can be used as indicator for organic contamination. The GSI criteria for this is that the ratio must be less than 0.35. BH17 in the centre of the site is the only sample which failed this analysis with a ratio of 1.64 due to the high potassium concentration detected. However, the potassium detected may be naturally occurring.

I.4.149 Ionic balances were used to assess the quality of the data provided by the laboratory.

Vulnerability

I.4.150 Based on the results of the site investigation, it can be stated that between 5-10 m of low permeability material overlie the aquifer over the majority of the site. This is a conservative estimate as it takes account of the shallowest water strikes in the boreholes as opposed to the larger water strikes indicative of the presence of the strata to be taken to be the aquifer.

I.4.151 The aquitard strata on-site act as a low permeability layer and confine/isolate groundwaters within the aquifer from the surface

I.4.152 Following the GSI vulnerability criteria outlined in Table **I.4.5** this would indicate that the majority of the site has a Moderate vulnerability rather than Extreme.

I.4.153 The exception to this is in the southern corner of the excavation where the bedrock is exposed. In this area the vulnerability will still be Extreme.

Site Conceptual Model

I.4.154 A summary of the hydrogeology of the MEHL site is presented here in the form of a site conceptual model. The conceptual model for the site has evolved through the various stages of the project from initial desk study through the final interpretation of site specific data:

- Bedrock beneath this former quarry site can be divided into an aquifer unit, the Loughshinny Formation and the lower part of the overlying Donore Formation and an aquitard unit which consists of the upper part of the Donore Formation and the overlying Balrickard and Walshestown Formations. The aquifer unit is classified by the GSI as a Locally Important Aquifer and the aquitard as a Poor Aquifer.
- The majority of the site is underlain by the aquitard. The limestones of the Loughshinny Formation crop out in the southern part of the MEHL site and dip to the to the north, where they are covered by at least 60 m of aquitard strata in the northern parts of the site.
- There are at least two faults in the central part of the site, a N-S fault which appears to restrict groundwater movement and an E-W fault which does not. The latter appears to bring permeable horizons in the aquitard unit in contact with the aquifer.
- Permeability in the strata beneath the site is predominantly secondary in the form of joints, fractures, weathered/broken zones and faults. Permeability in the aquifer unit is of the order of $10^{-4}/10^{-5}$m/s. In the permeable horizons of the aquitard, permeability is of the order of 10^{-6}m/s and in the remainder of the strata it is of the order of $10^{-7}/10^{-8}$m/s. Storage in all of these strata is low.
- The aquitard strata on-site act as a low permeability layer and confine/isolate groundwaters within the aquifer from the surface. The increasing thickness of these strata reduce the vulnerability to the north.
- The groundwater levels in the aquifer unit are relatively consistent across the site and lie below the floor of the quarry aside from the large pond in the extreme southern part of the site. Groundwater levels in the overlying aquitard strata are more variable, are elevated in relation to those in the underlying aquifer and are artesian in certain horizons. This confirms their position on-site as a confining layer.
- Groundwater flows in a generally south easterly direction from the site at a gradient of 0.02-0.05 and a velocity of approximately 1.48×10^{-5} m/s.

- Groundwater level monitoring indicate that recharge/infiltration is slow and relatively low responding to seasonal rainfall rather than individual rainfall events. This indicates that storage is low in these strata.
- The site is located in the upper part of a groundwater catchment. This location, the general absence of large springs in the aquifer, the confined nature of much of the aquifer in the site area and the moderate gradient and velocity indicate that the natural groundwater throughput in the aquifer is relatively low. However, owing to the secondary nature of the permeability in the aquifer, significant volumes of water can be induced to flow under stressed (pumping) conditions.

I.4.155 Based on the NRA Guidelines criteria, the majority of the site is of Low Importance due to the presence of a Poor aquifer and the southern part is of Medium importance due to the presence of a Locally Important Aquifer.

Description of Proposed Development

I.4.156 The main elements of the proposed MEHL facility will be as follows:

- Cells for the containment of solid non-biodegradable inert, non hazardous and hazardous waste,
- New site entrance and access road at the southern boundary,
- New administration building and site management infrastructure,
- Solidification plant,
- Surface water and foul water management systems,
- Leachate management system.

I.4.157 The proposed site layout is shown on *EIS Figure 4.4*. Refer to the planning application drawings for the details of the buildings and facilities. A description of the main elements of the proposed facility is provided in *EIS Chapter 4, Proposed Site and Project Description* section 4.5.

I.4.158 The different waste types proposed will each pose a different risk to identified aquifer beneath the MEHL site. Hazardous and non-hazardous wastes could potentially impact the groundwater quality with the hazardous posing the highest risk. The inert waste will pose little or no risk to groundwater.

I.4.159 The risk to groundwater from each waste type will be dependent on where the waste will be placed. Based on the assessment undertaken in the section *Regional Hydrogeology* waste located on the south-eastern corner of the excavation is the area with the highest potential risk to groundwater while waste located in the northern part of the site will be afforded the highest level of natural protection.

I.4.160 Faulting was identified on site in the course of this assessment, however the EPA manual on site selection (2006) states that '*It is recommended that there should be no general prohibition of landfill siting on areas with geological faults. Rather, attention should be drawn to them by noting firstly that they are ubiquitous in Irish bedrock, that they often increase the permeability somewhat, and that investigations should take account of their possible presence. Construction of potentially polluting landfills in direct contact with faults should be avoided in situations where investigations show that the fault zone is excessively permeable.*'

I.4.161 The placement of the waste with regard to the distribution of the aquifers on the site is as follows:

- Locally Important Aquifer: Inert waste and non-hazardous waste
- Poor Aquifer: Hazardous waste

I.4.162 Based on the GSI criteria and the redefinition of the aquifer and vulnerability classifications on the site assessment (described in previous sections), the site can be given the following response classifications:

- Northern part of the site where hazardous waste will be placed: $R2^1$
- Southern corner of the site where non-hazardous and inert waste will be placed: $R2^2$

I.4.163 In line with the responses outlined in *EIS Appendix A14.11*, the GSI responses for each of these are follows:

$R2^1$ Acceptable subject to guidance in the EPA Landfill Design Manual or conditions of a waste licence.

- Special attention should be given to checking for the presence of high permeability zones. If such zones are present then the landfill should only be allowed if it can be proven that the risk of leachate movement to these zones is insignificant. Special attention must be given to existing wells down-gradient of the site and to the projected future development of the aquifer.

R2[2] Acceptable subject to guidance outlined in the EPA Landfill Design Manual or conditions of a waste licence.

- Special attention should be given to checking for the presence of high permeability zones. If such zones are present then the landfill should only be allowed if it can be proven that the risk of leachate movement to these zones is insignificant. Special attention must be given to existing wells down-gradient of the site and to the projected future development of the aquifer.
- Groundwater control measures such as cut-off walls or interceptor drains may be necessary to control high water table or the head of leachate may be required to be maintained at a level lower than the water table depending on site conditions.

I.4.164 The impact assessment for the proposed development and the proposed mitigation measures are outlined fully in the sections *Evaluation of Potential Impacts* and *Mitigation Measures*.

Evaluation of Potential Impacts

I.4.165 The discussion of the potential impacts of the proposed integrated waste management facility at the MEHL site have been subdivided into potential impacts to soils and geology; and the potential impacts to hydrogeology. A discussion as to whether these impacts are likely is also presented and if significant impacts are likely then mitigation measures are proposed in the section *Mitigation Measures*. Any residual impacts which remain after the mitigation measures have been developed are discussed in the section *Residual Impacts*.

Potential Impacts to Soils and Geology

I.4.166 The potential effect of the proposal on the existing soils and geology of the site are likely to be minimal as the proposal is to redevelop areas of the MEHL site to accept certain waste streams. These new waste streams will be stored in dedicated, discrete engineered lined cells.

I.4.167 The aspects of the proposed MEHL development which have the potential to impact on the soils and geology of the site are:

- Loss of the Geological Heritage Area - The MEHL quarry is to be back filled as part of its present planning permission and therefore the exposed quarry faces will eventually disappear in a 20 to 30 year period.
- Disposal of Non-Hazardous Bottom Ash - Non-Hazardous bottom ash is to be placed in a dedicated cell for convenient recovery should it prove environmentally viable. This shall reduce the need to extract virgin materials from elsewhere.

Potential Impacts to Groundwater

I.4.168 A confined aquifer underlies the MEHL site with varying degrees of vulnerability as a result of quarrying. The aquifer deposits outcrop to the south of the site and then dip northwards until they are confined by over 60 m of low permeability Namurian deposits in the north of the site.

I.4.169 The potential impacts which could occur from activities at the MEHL site have been identified as:

- Impacts to the hydrogeological regime through the reduction of recharge.
- Contamination of the aquifer and dependent receptors such as wells or the stream to the east of the site.
- Groundwater resources: sterilisation of resource.
- Groundwater flooding

I.4.170 These impacts have the potential to occur both at the construction and operational phases of the site works.

Hydrogeological Regime

I.4.171 Impacts to the hydrogeological regime may occur through the placement of the waste which could potentially both act as a barrier and could also act to reduce the recharge to the aquifer reducing its resource potential.

I.4.172 The landfill will only act as a barrier to flow if the waste were placed significantly below the water table. The piezometric head of the aquifer is currently below the base of the open excavation and details of the design elevations are discussed below.

I.4.173 If the site currently provided a significant amount of recharge to the aquifer, placing impermeable cells over the site in the form of filled landfills would reduce the recharge to the aquifer and potentially reduce its overall resource. The reduction in infiltration could also increase overland flow to streams and potentially increase their flow.

I.4.174 Currently the majority of the site is formed of an open excavation. Infiltration testing undertaken on the base of the excavation showed that the material has a low vertical permeability.

I.4.175 This can be seen on site currently as rainfall ponds in lower areas of the site, before draining to a sump. This water is then discharged through settlement ponds to the stream to the north of the site. Because of this the majority of the site currently contributes little to no recharge to the aquifer.

I.4.176 In the southern corner of the site, the aquifer outcrops and standing water is observed. This pond may provide a small element of recharge to the aquifer, however it is expected that there will be limited connection between it and the aquifer due to the build up of sediment at the base over time. Also, the size of the area of outcrop when compared with the size of the Loughshinny deposit indicates that the recharge that this area would offer is insignificant.

I.4.177 This indicates that placing low permeability engineered waste cells over the site will have no impact on the recharge to the aquifer.

I.4.178 Infilling this area with waste will cause an imperceptible impact on the recharge potential to the groundwater body. For this reason, no mitigation measures will be required for this potential impact.

Contamination of the Aquifer and Groundwater Based Receptors

I.4.179 Contamination of groundwater could potentially arise from the proposed development from a number of sources. This has the potential to impact the quality of groundwater, local wells and the stream 1.5 km to the east of the site.

I.4.180 The impacts are outlined in full in the following sections.

General contamination/accidents

- The groundwater monitoring boreholes in the centre of the site installed as part of this investigation may act as a pathway for any vertical movement of contamination beneath the cells.

- The accidental spillage of potentially polluting materials such lubricant, oil etc could pollute groundwater resources if left unattended.
- Discharge of contaminated water to surface water bodies may eventually enter the aquifer
- The pond on site may potentially be contaminated as it accepts runoff from higher areas and this runoff may be contaminated.

I.4.181 The placement of waste is also a potential impact and this has been outlined further for each waste type.

Quantitative Risk Assessment

I.4.182 As previously outlined, a Quantitative Risk Assessment using the programme LandSim v2.5 was undertaken for the proposed development. Following consultation with the EPA a model was created which simulated the waste in place with no engineered barriers.

I.4.183 It should be noted that this is an over-conservative scenario as there will be a positive gradient upwards beneath the site due to the confining conditions but LandSim cannot take account of this.

I.4.184 Full details of the assessment including justifications for input parameters, detailed results and interpretation are included in the QRA report presented in Appendix **I.4.2**. A summary of the results of the supplementary model with no engineered barriers in place are presented below:

- 'Hazardous substances' and 'non-hazardous substances' (List 1 and List 2 from the Water Framework Directive) present in groundwater beneath the site
- 'Hazardous substances' and 'non-hazardous substances' (List 1 and List 2 from the Water Framework Directive) present in a phantom well receptor placed on the down-gradient boundary of the MEHL site

I.4.185 This is an unrealistic scenario and has been undertaken to highlight the level of protection offered by the liners which will be put in place.

Potential Impact of Inert Waste

- Inert waste is not expected to have a significant impact on groundwater quality due to the Waste Acceptance Criteria associated with it.

- It is proposed to re-grade the existing inert cells and this may disturb or remobilising contaminants within previously deposited fill by reworking the cells. However, all material accepted to the site under the current licence has been tested to ensure that no contaminants exceed the Waste Acceptance Criteria. This indicates that there will be no risk to groundwater from re-grading this material.
- If hazardous or non-hazardous material is accidently allowed to enter the inert cells, this may potentially impact groundwater quality.
- If leachate from the different waste streams were mixed then contaminated leachate may enter the inert cells and cause contamination to groundwater.

Potential Impact of Non-Hazardous Waste

- If non-hazardous waste is placed directly on the aquifer it may potentially contaminate groundwater resources and local receptors (wells and streams).
- If groundwater is contaminated, this may enter the stream 1.5 km to the east of the site with which it has a hydraulic connection.
- Mixing of waste could allow the hazardous materials to enter the wrong cells which may potentially contaminate groundwater.
- If leachate from the hazardous cell is allowed to enter the non-hazardous cell it may cause groundwater contamination.
- If the leachate head is allowed to rise too high it may compromise the competence of the liner and cause leakage which may result in contamination of groundwater.

Potential Impact of Hazardous Waste

- If hazardous waste is placed directly on the aquifer it may potentially contaminate groundwater resources. This could potentially impact groundwater quality at wells abstracting down-gradient of the site.
- If groundwater is contaminated, this may enter the stream 1.5 km to the east of the site with which it has a hydraulic connection.
- If the leachate head is allowed to rise too high it may compromise the competence of the liner and cause leakage which may result in contamination of groundwater.

Groundwater Resources

I.4.186 The impact of the proposed development at the MEHL site on groundwater resources at the MEHL site can beneath the site and the potential for contamination of the groundwater resource. The potential for contamination is covered in detail above and this section will deal solely on the potential impact to the sterilisation of resources.

I.4.187 The proposed development would mean that no groundwater wells can ever be installed on the site. The aquifers on the MEHL site are a Locally Important aquifer and a Poor Aquifer.

I.4.188 The significance of the impact to the aquifers in an unmitigated be considered both in terms of the sterilisation of the groundwater resource scenario in line with the criteria outlined in *EIS Appendix Table A14.11.5* is a Large Adverse impact. This leads to a significance of the impact to the Locally Important aquifer as being a 'Significant impact' and the significance of the impact to the Poor aquifer as being a 'Poor/Moderate impact'.

I.4.189 On the basis of the precautionary principal the presence of a hazardous waste landfill restricts groundwater development for a short distance down gradient. The MEHL land-ownership boundary is approximately 300m down-gradient of the nearest hazardous cell.

I.4.190 A well survey was undertaken to establish the location of down-gradient receptors in the area and only one was identified down-gradient of the site.

I.4.191 Mitigation measures proposed for these potential impacts are outlined below.

Groundwater Flooding

I.4.192 The potential impact from groundwater flooding was highlighted by one consultee as a particular concern. For this reason, the potential for groundwater flooding will be assessed.

- The site is currently an excavated former quarry with an existing EPA waste licence for the landfilling of inert waste.
- The piezometric head of the groundwater is below the base of the excavation, except for in the south eastern corner of the excavation where the excavation is below 100 m and the groundwater within the Loughshinny Formation is unconfined.
- The proposed formation level is above the piezometric level of the groundwater.

I.4.193 For this reason groundwater flooding will not cause an impact on the MEHL site and will not be considered further in this assessment.

Mitigation Measures

Mitigation Measures for Soils And Geology

I.4.194 The mitigation measures include:

- The MEHL quarry is to be back-filled as part of its present planning permission. However, given that the restoration of the MEHL facility will not be complete for some time, geological outcrops shall remain exposed for, at a minimum, the next 20 years. See *EIS Chapter 4, Proposed Site and Project Description* for details of the phasing of these works. Following consultation with the GSI, MEHL has agreed to:
  - provide a viewing platform from which the quarry faces can be viewed in a safe environment
  - To provide an information panel
  - To maintain certain exposures for as long as is practical and
  - To allow for professional and/or student access where the necessary insurances are in place

I.4.195 These proposals were accepted by the Irish Geological Heritage Programme and relevant correspondence are included in *EIS Appendix A1.3*.

- Any Earthworks and excavation of deposited inert wastes will be carried out in a controlled manner in compliance with the waste licence conditions for the site.

Mitigation Measures for Groundwater

I.4.196 The mitigation measures which have been developed are outlined below.

Hydrogeological Regime

I.4.197 As outlined above the only potential impact from the proposed development to the hydrogeological regime arise from the waste acting as a barrier to flow.

I.4.198 In order to ensure that the waste will not act as a barrier to groundwater flow, the following mitigation measures will be put in place:

- The formation level for the site will be set at 102.5 mOD and

- Sumps will be placed in localised areas at a level of 102 mOD

I.4.199 The current base of the excavation is at approximately 105 mOD which indicates that there will be a maximum further excavation of 2.5 m across the site and up to 3 m in places. However, these levels are above the piezometric head of the groundwater in the aquifer and are also above any of the major water strikes encountered in the weathered and faulted areas in the Namurian deposits on the site. This mitigation measure will ensure that the material will not act as a barrier to flow.

Groundwater Contamination

I.4.200 Mitigation measures have been prescribed for the potential impacts which may cause groundwater contamination as outlined above.

General contamination/accidents

- Monitoring boreholes drilled during this investigation which are within the footprint of the cells will be abandoned in line with standards set out in the IGI guidelines. They will be grouted to ensure that they do not allow a preferential pathway for contamination to develop.
- All potentially polluting materials such as lubricant or oil will be stored in bunds to ensure that in the event of an accidental spillage they will not enter groundwater.
- Contaminated water will not be discharged to surface water bodies.
- The water contained within the pond will be tested before disposal and will be appropriately treated and disposed of as required.

Mitigation Measures for Inert Waste

- The inert waste will be placed above the piezometric head of the water table.
- It is proposed to place inert waste on the area of the site where the aquifer outcrops. This area will be backfilled to 102.5 mOD to bring it above the water table
- The inert material will be placed in cells lined with low permeability clay 1 m thick which will be designed in line with EU regulations and EPA guidance.
- The waste streams of inert, hazardous and non-hazardous waste will be kept isolated to ensure that hazardous waste does not enter the inert or non-hazardous cells. Full details of this can be found in *EIS Chapter 4, Proposed Site and Project Description*.

- Separate leachate collection systems will be installed in the different waste cells to ensure that the leachate does not mix and be re-circulated in the wrong cell.
- As part of the waste licence conditions, an Environmental Monitoring Plan will be developed for the site to monitor groundwater.

Mitigation Measures for Non-Hazardous Waste

- Non-hazardous waste cells will be lined with a 2 mm thick HDPE liner and 1 m thick low permeability clay which will be designed in line with EU regulations and EPA guidelines.
- As the non-hazardous material is to be placed in the south of the site where the aquifer is shallower, an additional 1 m of low permeability natural material with a permeability of $6.6x10^{-10}$ m/s will be placed beneath the liner to further enhance the natural protection.
- The waste streams of inert, hazardous and non-hazardous waste will be kept isolated to ensure that hazardous waste does not enter the inert or non-hazardous cells. Full details of this can be found in *EIS Chapter 4, Proposed Site and Project Description*.
- Separate leachate collection systems will be installed in the different waste cells to ensure that the leachate does not mix and be re-circulated in the wrong cell.
- The head of leachate in the cells will be limited to 1m within the non-hazardous cells.
- As part of the waste licence conditions, an Environmental Monitoring Plan will be developed for the site to monitor groundwater.

Mitigation Measures For Hazardous Waste

- Hazardous waste will only be placed on the Poor Aquifer on the site and will not be placed on the Locally Important Aquifer.
- A Dense Asphaltic Concrete (DAC) liner will be constructed for the cells in which hazardous waste is to be placed. The details of the DAC liner are outlined in full in *EIS Chapter 4, Proposed Site and Project Description.* The liner will be designed to meet EU Landfill Directive requirements.
- In order to minimise leachate generation from the flue gas treatment residues, the waste will be solidified before being placed in the cells.
- To further minimise leachate generation, temporary cover options will be employed.

- The head of leachate in the cells will be limited to 1m within the hazardous cells.
- Leachate collected from the hazardous cells will be re-used in the solidification plant further reducing the possibility of surface and groundwater contamination.
- As part of the waste licence conditions, an Environmental Monitoring Plan will be developed for the site to monitor groundwater.
- As outlined in *EIS Chapter 4, Proposed Site and Project Description* the failure of the DAC liner is an unlikely event. However, as the failure of the liner has the potential to cause impacts to groundwater a mitigation measure has been developed for it.
- A leak monitoring and collection system will be provided below the DAC to ensure that leaks will be detected early. This detection system will be placed within the granular stabilisation layer of the liner. Due to the overall composition of the liner, there will be 0.5 m of low permeability clay beneath the leachate detection system to contain the movement of any leak in the DAC.
- Any liquid collected in this detection system will be pumped out of the collection sump and will be tested and disposed of or reused in the solidification plant as appropriate.

Validation of mitigation measures

I.4.201 A Quantitative Risk Assessment using the programme LandSim v2.5 was undertaken for the proposed development. Three scenarios were modelled following consultation with the EPA. The model with no liners in place was presented. This section presents the impact when all liners are in place and functioning correctly and also when one hazardous cell is leaking.

I.4.202 Full details of the assessment including justifications for input parameters, detailed results and interpretation are included in the QRA report presented in Appendix **I.4.2**. The scenario was modelled over a 20,000 year time span to assess any future mobilisation of contaminants.

I.4.203 A summary of the results of the primary model when all the liners are in place and functioning correctly are presented below:

- No ‘hazardous substances’ (List 1) in groundwater beneath the site (and therefore none detected at the phantom receptor well)
- ‘Non-hazardous substances’ (List 2), metals, chloride and sulphate present in groundwater beneath the site after 20,000 years above Drinking Water Standards

- No contaminants detected at the phantom well receptor above Drinking Water Standards
- When a supplementary model simulated failure of the liner in a single hazardous cell, the concentrations of contaminants modelled increased and 'hazardous substances' and 'non-hazardous substances' (List 1 and List 2) were detected in groundwater above Drinking Water Standards.

I.4.204 These results were obtained on the presumption that the mitigation measures outlined below will be put in place. The results highlight the level of protection that the liners offer to groundwater. Specific mitigation measures will be put in place as outlined above to mitigate against liner failure in the hazardous cells.

Groundwater Resources

I.4.205 The provision of suitably lined cells to receive the various waste types coupled with an EPA approved groundwater monitoring programme will ensure that existing or proposed down-gradient wells are suitably protected from contamination.

Residual Impacts

I.4.206 A summary of the impacts to each receptor and the residual impact once mitigation measures have been put in place is outlined in Table **I.4.11**. All residual impacts have a Significance rating of 'Imperceptible'.

I.4.207 The likely significant effects of the project on the soils and geology of the area is considered to be positive, given that the soils will be reused and the MEHL facility will be restored with its former landscape characteristics.

I.4.208 The residual impacts on groundwater are considered to be Imperceptible with the proposed mitigation measures in place.

Table I.4.11: Summary of Predicted Impacts and Mitigation Measures

Constraint		**Impacts and mitigation**					
Name	**Importance**	**Magnitude of Impact**	**Criteria for Impact Assessment**	**Significance of Impact**	**Mitigation Measure**	**Residual Impact**	**Residual significance of impact**
Geology							
Geological Heritage Area	Very High	Large Adverse	Infill of quarry will result in the loss of a number of outcrops of geological interest in the area. Quarry offers an opportunity to view a number of strata in close succession.	Profound	Through correspondence with the GSI an agreement has been reached. MEHL will provide a viewing platform for the site and will allow access once certain conditions as set out in the correspondence in *EIS Appendix A1.3* are met. However it should be noted that the conditions of the planning permission for the quarry require the quarry to be backfilled and restored.	Negligible	Imperceptible
Non-hazardous bottom ash	Low	Minor Beneficial	Disposal of non-hazardous bottom ash into dedicated cells within the landfill.	Imperceptible	None required.	Minor Beneficial	Imperceptible

Constraint		**Impacts and mitigation**					
Name	**Importance**	**Magnitude of Impact**	**Criteria for Impact Assessment**	**Significance of Impact**	**Mitigation Measure**	**Residual Impact**	**Residual significance of impact**
Hydrogeology							
Locally Important aquifer	Medium	Large Adverse	Infilling of waste may cause contamination of groundwater contained in the aquifer	Significant Impact	Employing engineered liners in line with EU legislation. Employ a leak detection system to serve as a warning for contamination. Maintain good site practices	Negligible	Imperceptible
Poor aquifer	Low	Large Adverse	Infilling of waste may cause contamination of groundwater contained in fractures etc	Slight/Moderate impact	Employing engineered liners in line with EU legislation. Employ a leak detection system to serve as a warning for contamination. Maintain good site practices	Negligible	Imperceptible
Wells identified during well survey	Low	Large Adverse	One well is down-gradient of the site and may be impacted by any contamination arising from the site.	Slight/Moderate impact	Employing engineered liners in line with EU legislation. Employ a leak detection system to serve as a warning for contamination. Maintain good site practices	Negligible	Imperceptible

I.5 Ground and/or groundwater contamination

I.5.1 The site is a former quarry and is currently an operational inert landfill site, under EPA licence W0129-02. Waste is placed in lined cells suitable for inert, in compliance with the EPA licence and the Landfill Directive 1999.

I.5.2 There have been no known historical pollution incidents at the site and there is no evidence of contaminated ground or groundwater.

I.6 Noise Impact

1.6.1 Chapter 11 of the EIS presents an assessment of the potential impacts of noise and vibration from the proposed MEHL integrated waste management facility. Key extracts are provided here in the Waste Licence Application; the full EIS (authored by Arup) accompanies this application.

Receiving Environment

I.6.2 The existing MEHL facility is located at Hollywood Great, Nag's Head, Naul Co. Dublin. The surrounding environment in the vicinity of the site is predominately rural with a small number of residential dwellings located in proximity to the site boundary.

I.6.3 The site is bounded to the north, south, east and west by agricultural land and a small number of residential properties. The closest noise sensitive building is a residential property located along the southern boundary, typically at a distance of the order of 0.5 to 1m from the immediate site boundary and a further 30 to 40m from any site operations separated by a buffer zone. The next nearest noise sensitive location is of the order of 36m south of the site boundary.

I.6.4 Environmental noise surveys were conducted in order to quantify the existing noise environment in the vicinity of the existing MEHL facility. The surveys were conducted in general accordance with IS0 1996: 2007 Acoustics – Description, Measurement and Assessment of Environmental Noise. Details of the surveys are set out below.

Measurement Locations

I.6.5 Three measurement locations were selected; each is described in turn below and is shown in *EIS Figure 11.1*.

- Location S01 - This measurement position was located within the front garden of a residential property which borders the southeast of the existing MEHL facility. This property is in the control of MEHL and is unoccupied. The range of noise levels measured at this property is representative of the residential dwellings to the east of this location and immediately south.

- Location S02 - This measurement position was located at the northern end of a laneway to a farm house located to the south west of the facility. This location was chosen to represent sensitive receptors to the west of the existing facility.
- Location S03 - This measurement position was located between two residential properties located to the north west of the existing MEHL facility, representing noise levels at receptors along this boundary of the facility.

Instrumentation

I.6.6 The noise measurements were conducted using a Brüel & Kjær Type 2260 Sound Level Meter. Before and after the survey the measurement apparatus was check calibrated using a Brüel & Kjær Type 4231 Sound Level Calibrator. Please see *EIS Appendix A11.1* for Certificate of Calibration.

Survey Periods

I.6.7 Measurements were conducted over the course of the following survey periods:

- Daytime: 10:36hrs to 11:35hrs on 26 May 2010; and 14:59hrs to 17:00hrs on 27 May 2010
- Night-time: 23:00hrs on 15 June to 01:37hrs on 16 June 2010

I.6.8 The measurement periods were selected in order to provide a typical snapshot of the noise climate at nearby noise sensitive locations, with the primary purpose being to provide a typical range of noise levels that may be encountered during the day and night-time periods. It should be noted, the existing MEHL facility does not operate during night-time periods. Noise levels measured during this period represent noise levels in the absence of the site during night-time hours.

Procedure

I.6.9 Measurements were conducted on a cyclical basis at the locations noted above. Sample periods for the noise measurements were 15 minutes over three hours at each location which is considered suitable to obtain a snap shot of the existing environment for the purpose of the EIS study. The results were noted onto a Survey Record Sheet immediately following each sample, and were also saved to the instrument memory for later analysis. Survey personnel noted the primary noise sources contributing to noise build-up.

Weather

I.6.10 The weather during the daytime survey period was dry with temperatures of approximately 14°C and wind speeds were less than 2m/s.

I.6.11 The weather during the night-time survey period was dry and clear. Temperatures were approximately 6°C and wind speeds were less than 2 m/s.

Measurement Parameters

I.6.12 The noise survey results are presented in terms of the following five parameters:

- L_{Aeq} = the equivalent continuous sound level. It is a type of average and is used to describe a fluctuating noise in terms of a single noise level over the sample period. It is typically used as a descriptor for ambient noise.
- L_{Amax} = the instantaneous maximum sound level measured during the sample period.
- L_{Amin} = the instantaneous minimum sound level measured during the sample period.
- L_{A10} = the sound level that is exceeded for 10% of the sample period. It is typically used as a descriptor for traffic noise.
- L_{A90} = the sound level that is exceeded for 90% of the sample period. It is typically used as a descriptor for background noise.

I.6.13 The "A" suffix denotes the fact that the sound levels have been "A-weighted" in order to account for the non-linear nature of human hearing. All sound levels in this report are expressed in terms of decibels (dB) relative to $2x10^{-5}$ Pa.

Survey Results and Discussion

Location S01

I.6.14 The survey results for Location S01 are summarised in Table **I.6.1** below.

Table I.6.1: Summary of Noise Measurements at Location S01

Measurement Period (Date/Time)			Measured Noise Levels (dB re. $2x10^{-5}$ Pa)				
			L_{Aeq}	L_{Amax}	L_{Amin}	L_{A10}	L_{A90}
Daytime	26/05/10	10:36 – 10:51	57	76	29	57	33
	27/05/10	14:59 – 15:14	57	76	32	55	37
		16:02 – 16:17	58	75	31	59	35
Night-time	15/06/10	23:01 - 23:16	51	76	34	45	37
	16/06/10	23:54 - 00:09	44	68	32	39	35
		00:46 - 01:01	38	66	30	39	34

I.6.15 During the daytime measurement period, the main source of noise was from occasional passing traffic along the local road. Birdsong and leaf rustle formed the background noise environment. No activities from the existing MEHL facility were audible during the survey. Noise levels were in the range 57 to 58dB L_{Aeq} and background noise levels were in the range 33 to 37dB L_{A90}.

I.6.16 During the night-time measurement period, the noise climate was influenced by distant road traffic noise and occasional local road traffic. An aircraft overhead was noted during the first measurement period. The existing MEHL facility was not in operation during the survey period. Noise levels were in the range 38 to 51dB L_{Aeq} and background noise levels were in the range 34 to 37dB L_{A90}.

I.6.17 No source of vibration was observed.

Location S02

I.6.18 The survey results for Location S02 are summarised in Table **I.6.2** below.

Table I.6.2: Summary of noise measurements at Location S02

Measurement Period (Date/Time)			Measured Noise Levels (dB re. 2x10^{-5} Pa)				
			L_{Aeq}	L_{Amax}	L_{Amin}	L_{A10}	L_{A90}
Daytime	26/05/10	10:55 – 11:10	56	77	32	51	36
	27/05/10	15:18 – 15:33	60	83	34	55	37
		16:45 – 17:00	60	81	29	55	33
Night-time	15/06/10	23:19 - 23:34	55	80	32	46	34
	16/06/10	00:12 - 00:27	51	79	30	39	32
		01:04 - 01:19	34	64	27	33	29

I.6.19 During the daytime measurement period, the main source of noise was from intermittent passing traffic along the local road and distant noise from farmyard activities. Birdsong and leaf rustle formed the background noise environment. Occasional aircraft were also noted to be faintly audible. No activities from the existing MEHL facility were audible during the survey. Noise levels were in the range 56 to 60dB L_{Aeq} and background noise levels were in the range 33 to 37dB L_{A90}.

I.6.20 During the night-time measurement period, the noise climate was influenced by distant road traffic noise and occasional local road traffic. A Garda vehicle passed during the first measurement period. No passing traffic was noted during the third measurement. The existing MEHL facility was not in operation during the survey period. Noise levels were in the range 34 to 55dB L_{Aeq} and background noise levels were in the range 29 to 34dB L_{A90}.

I.6.21 No source of vibration was observed.

Location S03

I.6.22 The survey results for Location S03 are summarised in Table **I.6.3** below.

Table I.6.3: Summary of noise measurements at Location S03

Measurement Period (Date/Time)			Measured Noise Levels (dB re. $2x10^{-5}$ Pa)				
			L_{Aeq}	L_{Amax}	L_{Amin}	L_{A10}	L_{A90}
Day-time	26/05/10	11:20 – 11:35	54	80	34	51	37
	27/05/10	15:38 – 15:53	57	80	29	51	33
		16:25 – 16:40	52	84	27	45	31
Night-time	15/06/10	23:37 - 23:52	53	79	34	40	36
	16/06/10	00:29 - 00:44	48	74	30	39	33
		01:22 - 01:37	36	66	28	35	31

I.6.23 During the daytime measurement period, the main source of noise was from passing traffic along the local road. Birdsong and leaf rustle formed the background noise environment. Occasional aircraft were also noted to be faintly audible. No activities from the existing MEHL facility were audible during the survey. Noise levels were in the range 52 to 57dB L_{Aeq} and background noise levels were in the range 31 to 37dB L_{A90}.

I.6.24 During the night-time measurement period, the noise climate was influenced by distant road traffic noise and occasional local road traffic. No passing traffic was noted during the third measurement. The existing MEHL facility was not in operation during the survey period. Noise levels were in the range 36 to 53dB L_{Aeq} and background noise levels were in the range 31 to 36dB L_{A90}.

I.6.25 No source of vibration was observed.

Annual Waste Licence Monitoring

I.6.26 A review of annual noise monitoring between 2008 and 2010 was conducted to assess the range of noise levels typically encountered in the vicinity of the existing MEHL site.

I.6.27 The results for five noise sensitive locations labelled N4 to N8, monitored during the annual surveys for 2008, 2009 and 2010 are summarised below. Refer to *EIS Figure 11.2* for annual monitoring locations.

Table I.6.4: Summary of Noise Monitoring during 2008, 2009 & 2010 Annual Surveys

Location		Daytime LAeq, 30mins			Night-time LAeq, 30mins		
		2010	2009	2008	2010	2009	2008
N4	Located along road; north of the facility	52	55	52	45	41	45
N5	Located along road; west of the facility	58	64	57	52	59	49
N6	Located along road; south-east of the facility	55	57	58	43	46	44
N7	Located along the local road; beyond southern boundary	57	66	63	42	57	52
N8	Located along the local road at southeast corner of the site	62	69	63	48	59	45

I.6.28 The main sources of noise noted during the previous surveys were from road traffic along the local road network, vehicular traffic accessing a nearby permitted waste facility, occasional overhead aircraft noise and leaf rustle. The report concludes that road traffic is the dominant source in the existing environment and the exiting MEHL facility does not contribute to the current noise climate.

Noise and Vibration Characteristics of the Proposed Development

I.6.29 The proposed MEHL integrated waste management facility will comprise the following key elements:

- Construction of new inert, non hazardous and hazardous waste cells.
- Construction of a solidification plant, associated storage building and staff welfare facilities.
- Installation of the necessary leachate, surface water and other associated landfill management infrastructure.

- Construction of the necessary administration, access and ancillary infrastructure to include a new entrance, administration building and two new weighbridges.

I.6.30 It is anticipated that the proposed MEHL facility will be developed over four phases during a 25 year lifespan. Due to the nature of the proposed facility, there is no distinct 'construction' or 'operational' phase as both will continue in tandem within each phase to develop the site over this time period. Further details of the proposed phasing are provide in *EIS Chapter 4, Proposed Site and Project Description.* The existing facility has mobile crushing, screening, grading and conveyor equipment on site. This will be retained as part of the proposed facility's operation.

I.6.31 On review of the proposed MEHL development, the following four activities are considered to be the primary sources of noise:

- Site development and cell operation
- Traffic accessing the facility
- Building services plant
- Additional vehicular traffic on public roads

I.6.32 Each of these activities is discussed in the following sections.

Evaluation of the Noise and Vibration Impacts

Site Development and Cell Operation

Phase 1

I.6.33 During Phase 1 of the proposed MEHL development, there will be an initial construction period where a new entrance and access road, new administration building and solidification plant will be constructed. This initial construction phase is separate to the normal 'construction' and 'operational' phases of the landfill cell development and management. Notwithstanding this, this initial construction work has been assessed against the waste licence limits.

I.6.34 In addition to the initial site works, construction of Hazardous cell 1 (H1) and Inert cell 1 (IN1) will occur during the first two years of Phase 1. A variety of items of plant will be in use, such as excavators, breakers, lifting equipment, dumper trucks, compressors, and generators. There will be vehicular movements to and from the site which will make use of the new site entrance, once constructed.

I.6.35 Table **I.6.5** presents the predicted noise levels assuming combined construction of IN1 and H1 cells in addition to activities associated with road work and building construction. Calculations have been made at the four noise sensitive locations along the north western and southern boundaries. *EIS Figure 11.3* illustrates the location of the assessment positions.

I.6.36 In order to assess a worst case scenario, the calculations assume that all construction plant is operating simultaneously within the various areas of the site. The calculations take account of the vertical screening between the assessment receptor locations and the working areas.

Table I.6.5: Phase 1 Site development and Cell Development Noise Calculations

Description **(Plant Item and BS5228 Reference)**	**Predicted Noise Level dB $L_{Aeq, 1 hr}$**			
	NSL1	**NSL2**	**NSL 3**	**NSL 4**
Road Works and Building Construction	Construction of site entrance, haul road & new buildings			
Pneumatic breaker C.2.11	44	32	35	49
Tracked excavator (loading dump truck) C1-10	42	30	33	47
Articulated dump truck (dumping rubble) C1-11	37	25	28	35
Dozer C.2.10	37	25	28	35
Vibratory Roller C5-24	41	29	32	46
Asphalt Paver & Tipping Lorry C5-31	34	22	25	39
Concrete Mixer Truck C4-27	34	24	27	34
Diesel Generator C4-84	29	19	22	29
Hand Held Circular Saw C4-72	34	24	27	34
Total	*49*	*37*	*40*	*52*

Description	**Predicted Noise Level dB $L_{Aeq, 1 hr}$**			
(Plant Item and BS5228 Reference)	**NSL1**	**NSL2**	**NSL 3**	**NSL 4**
Site Clearance & Cell Construction (per cell)	Combined Inert Cell IN1 & Hazardous Cell H1 Construction			
Pneumatic breaker C.2.11 (1 No.)	30	38	36	41
Tracked excavator (loading dump truck) C1-10 (2 no.)	50	43	40	45
Articulated dump truck (dumping rubble) C1-11 (5 no)	50	38	35	40
Wheeled loader C2-26 (2 no.)	45	38	35	40
Dozer C.2.10 (1 no.)	45	38	35	40
Roller C.2.38* (1 no.)	43	36	33	38
Total	*55*	*47*	*44*	*49*
Mobile Crushing & screening Equipment (C9.14)*	Operation of Crusher and screener adjacent to solidification plant			
Total	*42*	*36*	*42*	*43*
Combined Cell Construction and Screening/Crushing Activities	55	47	46	50
Hazardous Cell Lining	Lining of Hazardous Cell H1			
Asphalt Paver & Tipper Lorry (C5.31) (2 no.)	23	31	19	23
Vibratory Compactor (Asphalt) C.5.29 (2 no.)	34	42	30	34
Roller C.2.38* (2 no.)	30	38	26	30
Total	36	44	32	36

Note: *A noise level of 90dB L_{Aeq} at 10m from both the mobile crusher and screener have been used in the noise calculations.

I.6.37 The indicative calculated noise levels set out in Table **I.6.5** above are within the daytime operational noise limit of 55dB(A) at the closest locations to the works. In the case of the road works and building construction, the calculations assume the plant items are located along the new access road and at the location of the site buildings. In the case of the cell development, the calculated values assume that the plant items listed in the table are operating in each of the cells being developed.

I.6.38 During the normal operation involving filling cells, capping and restoration (typically between years 2012 and 2016), the level of activity within the MEHL facility will be no greater than that associated with the construction phases predicted in Table **I.6.5** and hence are expected to operate within the licence limits.

Phase 2

I.6.39 During Phase 2 of the proposed MEHL development, construction of hazardous cell 2 (H2), non hazardous cell 1 (NH1), inert cell 2 (IN2) and inert cell 3 (IN3) will take place over the first 2 to 3 years. In order to assess a worst case assessment, calculations have been conducted assuming all four cells are developed simultaneously. Spoil crushing and screening may also take place during this Phase and has been included in the noise calculations.

I.6.40 Table **I.6.6** presents the calculated noise levels based on the plant items and cell activity assumed as part of this phase. The same noise sensitive locations as illustrated in *EIS Figure 11.3* have been assessed.

Table I.6.6: Phase 2 Waste Cell Development Noise Calculations

Description **(Plant Item and BS5228 Reference)**	**Predicted Noise Level dB $L_{Aeq,\ 1\ hr}$**			
	NSL1	**NSL2**	**NSL 3**	**NSL4**
Site Clearance & Cell Construction (per cell)	Combined construction of cell H2, NH1, IN2 &IN3			
Pneumatic breaker C.2.11 (1 No.)	45	38	36	41
Tracked excavator (loading dump truck) C1-10 (2 no.)	49	43	40	46
Articulated dump truck (dumping rubble) C1-11 (5 no)	44	38	35	41
Wheeled loader C2-26 (2 no.)	44	38	35	43
Dozer C.2.10 (1 no.)	44	38	35	41
Roller C.2.38* (1 no.)	42	36	33	39
Total	*53*	*47*	*44*	*50*
Hazardous Cell Lining	Lining of Hazardous Cell H2			
Asphalt Paver & Tipper Lorry (C5.31)	23	31	19	23
Vibratory Compactor (Asphalt) C.5.29	34	42	30	34
Roller C.2.38*	30	38	26	30
Total	*37*	*42*	*33*	*34*
Mobile Crushing & screening Equipment (C9.14)*	Operation of Crusher and screener adjacent to solidification plant			
Total	*42*	*36*	*42*	*43*
Combined Cell Construction, Hazardous Lining and Screening/Crushing Activities	54	48	47	51

I.6.41 The indicative calculated noise levels set out in Table **I.6.6** above are within the daytime operational noise limits of 55dB(A) at the closest locations to the works. The calculated values assume that the plant items listed in the table are operating in each of the cells being developed.

I.6.42 During the normal operation involving filling cells, capping and restoration (typically between years 2016 and 2024), the level of activity within the MEHL facility will be no greater than that associated with the construction phases predicted in Table **I.6.6** and hence are expected to operate within the licence limits.

Phase 3

I.6.43 During Phase 3 of the proposed MEHL development, construction of hazardous cell 3 (H3) will take place over the first 3 years. Simultaneous operation of cells NH1, IN1 and IN2 will take place during this phase also. In order to assess a worst case assessment, calculations have been conducted assuming the construction and operational phase of the cells detailed above are conducted simultaneously.

I.6.44 Table **I.6.7** presents the calculated noise levels based on the plant items and cell activity assumed as part of this phase. The same noise sensitive locations as illustrated in *EIS Figure 11.3* have been assessed.

Table I.6.7: Phase 3 Combined Construction and Operational Noise Calculations

Description (Plant Item and BS5228 Reference)	**Predicted Noise Level dB $L_{Aeq, 1 hr}$**			
	NSL1	**NSL2**	**NSL 3**	**NSL 4**
Site Clearance & Cell Construction	Construction of Cell H3			
Pneumatic breaker C.2.11 (1 No.)	35	36	38	42
Tracked excavator (loading dump truck) C1-10 (2 no.)	39	38	39	43
Articulated dump truck (dumping rubble) C1-11 (5 no)	34	36	38	42
Wheeled loader C2-26 (2 no.)	34	36	38	42

Description **(Plant Item and BS5228 Reference)**	**Predicted Noise Level dB $L_{Aeq, 1 hr}$**			
	NSL1	**NSL2**	**NSL 3**	**NSL 4**
Dozer C.2.10 (1 no.)	34	31	28	32
Roller C.2.38* (1 no.)	32	29	26	30
Total	*43*	*43*	*44*	*48*
Hazardous Cell Lining	Lining of Hazardous Cell H3			
Asphalt Paver & Tipper Lorry (C5.31)	28	24	21	26
Vibratory Compactor (Asphalt) C.5.29	39	36	33	37
Roller C.2.38*	35	32	29	33
Total	*41*	*37*	*34*	*39*
Combined Construction and Lining of Hazardous Cells	41	38	35	39
Operational Cells	Operation of Cells NH1, IN1 &IN2			
Dozer (C2.10)	47	34	37	42
Articulated dump truck (dumping rubble) C1-11	47	34	37	42
Tracked excavator (Spreading rubble) C1-13	47	34	37	42
Wheeled loader C2-26	47	34	37	42
Total	53	40	43	48
Combined Construction and Operation	53	42	44	48

I.6.45 The indicative calculated noise levels set out in Table **I.6.7** above are within the daytime operational noise limits of 55dB(A) at the closest locations to the works. The calculated values assume that the plant items listed in the table are operating in each of the cells being developed and during their operational phase.

Phase 4

I.6.46 During Phase 4 of the proposed MEHL development, construction of non hazardous cell 2 (NH2) will take place. Simultaneous operations of cells NH2 and IN1 will take place in addition to the restoration of cells H3 and NH1. In order to assess a worst case assessment, calculations have been conducted assuming the construction and operational phase of the cells detailed above are conducted simultaneously.

I.6.47 Table **I.6.8** presents noise calculations based on the assumptions noted above. The same noise sensitive locations as illustrated in *EIS Figure 11.3* have been assessed.

Table I.6.8: Phase 4 Combined Construction and Operational Noise Calculations

Description (Plant Item and BS5228 Reference)	***Predicted Noise Level dB $L_{Aeq,\ 1\ hr}$***			
	NSL1	***NSL2***	***NSL 3***	***NSL 4***
Site Clearance & Cell Construction (per cell)	*Construction of Cell NH2*			
Pneumatic breaker C.2.11 (1 No.)	*39*	*28*	*30*	*39*
Tracked excavator (loading dump truck) C1-10 (2 no.)	*43*	*32*	*34*	*43*
Articulated dump truck (dumping rubble) C1-11 (5 no)	*38*	*27*	*29*	*38*
Wheeled loader C2-26 (2 no.)	*38*	*27*	*29*	*38*
Dozer C.2.10 (1 no.)	*38*	*27*	*29*	*38*
Roller C.2.38* (1 no.)	*36*	*25*	*27*	*36*
Total	*47*	*36*	*38*	*47*
Operational Cells	*Combined Operation of Cells NH2 &IN1*			
Dozer (C2.10)	*46*	*46*	*36*	*41*

Description (Plant Item and BS5228 Reference)	***Predicted Noise Level dB $L_{Aeq,\ 1\ hr}$***			
	NSL1	***NSL2***	***NSL 3***	***NSL 4***
Articulated dump truck (dumping rubble) C1-11	*46*	*46*	*36*	*41*
Tracked excavator (Spreading rubble) C1-13	*46*	*46*	*36*	*41*
Wheeled loader C2-26	*46*	*46*	*36*	*41*
Total	*52*	*52*	*42*	*47*
Combined Construction and Operation	*54*	*52*	*44*	*51*

I.6.48 The indicative calculated noise levels set out in Table **I.6.8** above are within the daytime operational noise limits of 55dB(A) at the closest locations to the works. The calculated values assume that the plant items listed in the table are operating in each of the cells being developed and during their construction and operational phases.

Traffic Accessing the Facility

I.6.49 The potential noise impact of vehicles entering and exiting the proposed MEHL facility is assessed through consideration of the cumulative noise level associated with a series of individual events. The noise level associated with an event of short duration, such as a vehicle drive-by, may be expressed in terms of its Sound Exposure Level (L_{Ax}). The Sound Exposure Level can be used to calculate the contribution of an event or series of events to the overall noise level in a given period. The appropriate formula is as follows:

$$L_{Aeq,T} = L_{Ax} + 10\log_{10}(N) - 10\log_{10}(T) - 10\log_{10}(r_2/r_1) - Att_{bar}\ \text{dB}$$

Where:

- $L_{Aeq,T}$ is the equivalent continuous sound level over the time period T (s)
- L_{Ax} is the "A-weighted" Sound Exposure Level of the event under consideration (dB)
- N is the number of events over the course of time period T
- r_2 is the distance from the edge of the entrance road to the facade of nearest property, and
- r_1 is the distance from vehicle to the point of original measurement
- Att_{bar} is the attenuation due to screening between the source and receiver

I.6.50 The mean value of Sound Exposure Level for a HGV drive by at low to moderate speeds (i.e. 15 to 50Km/hr) is of the order of 83dB L_{Ax} at a distance of 5m from the edge of the road. The mean value of Sound Exposure Level for a car or light vehicles drive by at low to moderate speeds is of the order of 67dB L_{Ax} at a distance of 5m from the edge of the road. These figures are based on a series of measurements conducted under controlled conditions.

I.6.51 For the purposes of this assessment, traffic accessing the proposed MEHL has been broken into the main construction and operational phases, which will generate differing traffic volumes.

Construction Phase Traffic

I.6.52 The construction works are expected to generate varying traffic volumes for each phase of construction. The peak construction period is 2011 when the earthworks stage will commence. This construction period will occur in advance of the proposed MEHL facility. Therefore, during this period it is assumed that there will be minimal operational traffic due to the existing inert waste facility, as the site footprint will be subject to significant reconfiguration and redevelopment.

I.6.53 At its peak, it is estimated that 240 trips (two-way) per day will be required. It is estimated there will also be 50 trips (two-way) for construction workers. Therefore, 290 trips daily (two-way) are estimated for the peak construction period. Considering a 10-hour day and applying a peak hour factor of 1.5 to take account of construction workers trips during the peak hour periods, 44 trips (two-way) has been assumed.

I.6.54 The proposed MEHL facility will be accessed via a new site entrance and access road along the southern site boundary. In this instance, the nearest residential property is to the south west of the new site entrance (NSL4) at a distance of approximately 120 metres. Refer to *EIS Figure 11.3*.

I.6.55 The predicted daytime noise level at the nearest residential property to the site entrance (NSL4) is 50 dB $L_{Aeq,\ 1hr}$ assuming 40 HGV and 4 light vehicles enter the site over a worst case one hour peak period.

I.6.56 Noise from vehicles driving past properties along the local road has also been considered using the same formulae and truck numbers detailed above. For properties at a distance of 20m from the road edge, the predicted noise level from passing light and heavy vehicles (assuming a total of 44 per hour) is 57dB $L_{Aeq,\ hr}$.

I.6.57 This scenario assumes that all construction traffic entering the site will pass by the assessment location. It should also be noted that this level is of the order of noise levels currently experienced at properties along the local road network in the vicinity of the site, as measured during the baseline surveys.

Operational Phase Traffic

I.6.58 The operational traffic figures include for staff, visitors, cement, acid, waste and leachate disposal. The trips generated during the operation of the MEHL facility are expected to be consistent, with infrequent peaks. It is assumed that daily operations will involve fifteen staff and five visitors, generating 51 car or light two way vehicle trips per day. When the facility is fully operational and all waste types are accepted the average daily HGV trips is estimated at 141 HGV/day.

I.6.59 Noise levels relating to traffic entering the site assuming the normal operation of 141 HGV and 51 light vehicles per day have been predicted at NSL 4. Assuming an average of 25 two-way movements per hour, the predicted noise level at NSL4 is 47dB $L_{Aeq,\ 1\ hr}$.

I.6.60 Noise from vehicles driving past properties along the local road has also been considered using the same formulae and truck numbers detailed above. For properties at a distance of 20m from the road edge, the predicted noise level from passing light and heavy vehicles is 55dB $L_{Aeq,\ 1hr}$.

I.6.61 On a very conservative basis, there may be occasions where hourly traffic flows are higher than those assessed above. For a robust assessment, a peak hour factor of 2 has been assessed also. This would result in 58 two way movements per hour to and from the facility. Noise levels calculated at NSL4 from vehicles entering and existing the site during this worst case scenario is 51dB $L_{Aeq,1\ hr,}$ which is within the noise limits set for the facility.

I.6.62 The predicted noise levels from vehicles driving past properties at a distance of 20m from the local road using the increased operational truck numbers is 58dB $L_{Aeq,\ 1hr}$. This value is marginally above the day-time noise criterion set for the facility however; this scenario assumes that all worst case peak hour traffic entering the facility passes by the assessment locations within one hour. This is considered to be a very worst case scenario. It should also be noted that this predicted noise level is similar to that currently experienced at properties along the local road networks as determined during the baseline noise survey.

Building Services Plant

I.6.63 The proposed MEHL facility includes the provision of an administration building, staff canteen with changing facilities and a solidification plant located along the south-eastern boundary of the facility. A variety of electrical and mechanical plant will be required to service these buildings. Most of this plant will be capable of generating noise to some degree.

I.6.64 The selection and location of plant items will be determined at the detailed design stage of the project. The operation of any installed plant items will be controlled such that the combined cumulative noise level from the facility does not exceed a level of 55dB $L_{Aeq,30mins}$ daytime and 45dB $L_{Aeq,30mins}$ night-time at a distance of 1m from the façade of the nearest noise sensitive locations. Noise from plant items will be broadband in nature and have no tonal or impulsive characteristics.

I.6.65 The closest noise-sensitive property to building services plant is located to the south of the proposed development some 300m from the proposed solidification plant and administration/canteen buildings. At this distance, noise emissions from operational plant items are expected to be insignificant.

Additional Vehicular Traffic on Public Roads

I.6.66 Traffic volumes along the surrounding road network with and without the planned MEHL development for the year 2011 has been assessed and presented in *EIS Chapter 8, Roads and Traffic*. These traffic flow values have been used to determine the predicted change in noise levels adjacent to various roads in the vicinity of the MEHL site with and without the planned development in place. The method for calculating the increase in noise is based upon the procedures within Calculation of Road Traffic Noise (CRTN). Table **I.6.9** below indicate resultant traffic flows and changes in noise levels associated with the MEHL site.

Table I.6.9: Calculated Change In Traffic Noise Levels for 2011

Road	Do Nothing (without planned development) 2011	Do Something (With planned development) 2011	% AADT Increase	Change in noise level
LP01090	1,220	963	-21%	-1.0
LP01080 West of LPO1090	1,780	1,774	0%	0.0
LP01080 East of LPO1090	2,338	2,087	-11%	-0.5
Ballyboghill Rd	344	344	0%	0.0
LPO1090 East of Tooman Rd	2,179	2,218	2%	+0.1
Tooman Rd	509	509	0%	0.0
Rowans Rd (West of M1 BPW)	2,932	2,932	0%	0.0
Rowans Rd (East of M1 BPW)	6,551	6,551	0%	0.0
M1 Overbridge	12,684	12,823	1%	0.0
Rowan Rd (East of Interchange)	19,363	19,402	0%	0.0
R132	10,249	10,288	0%	0.0
R132 Flyover	1,457	1,477	1%	+0.1
M1 North of Interchange	55,781	55,775	0%	0.0
M1 South of interchange	60,694	60,739	0%	0.0

1.6.67 The increase in traffic noise levels in the vicinity of the roads and junctions assessed surrounding the MEHL site is less than 1dB(A). Reference to **Table I.6.9** confirms that this increase is negligible and the resultant impact is imperceptible.

Mitigation Measures

Site Development and Cell Operation

I.6.68 With regard to initial construction activities and those associated with cell development, reference will be made to BS 5228: Part 1 and 2, which provide detailed guidance on the control of noise and vibration from construction activities. In particular, it is proposed that various practices be adopted during the construction and operational works, including:

- Limiting the hours during which site activities likely to create high levels of noise or vibration are permitted;
- All site access roads will be kept even so as to mitigate the potential for vibration from lorries;
- Selection of plant with low inherent potential for generation of noise and/ or vibration;
- Erection of temporary barriers as necessary around noisy processes and items such as generators, heavy mechanical plant or high duty compressors, and;
- Placing of noisy plant machinery as far away from sensitive properties as permitted by site constraints.

I.6.69 It is proposed that vibration from construction activities be limited to the values set out in *EIS Table 11.2*.

Traffic Accessing the Facility

I.6.70 The noise impact assessment has demonstrated that mitigation measures are not required.

Building Services Plant

I.6.71 Noise from plant items on site will be controlled in order to ensure that their operation, when combined with other site activities do not exceed a level of 55dB $L_{Aeq,30mins}$ daytime and 45dB $L_{Aeq,30mins}$ night-time at a distance of 1m from the façade of the nearest noise sensitive locations.

I.6.72 Proven noise control techniques will be employed where necessary to achieve these limits during the detailed design stage of the project. These will typically include:

- Duct mounted attenuators on the atmosphere side of air moving plant;

- Splitter attenuators or acoustic louvres providing free ventilation to internal plant areas;
- Solid barriers screening any external plant.

Additional Vehicular Traffic along Public Roads

I.6.73 The noise impact assessment has demonstrated that mitigation measures are not required.

Residual Impacts

I.6.74 The assessments show that the predicted noise levels at the nearest sensitive locations, due to emissions from the development, are within the sites operational noise limits in all instances.

Site Development and Cell Operation

I.6.75 During the initial construction phase of the project, the impact to noise and vibration is predicted to be within the daytime noise limits values.

I.6.76 During the cell construction phase, the predicted noise levels are within the noise limit values, assuming a worst case scenario of combined cell construction activities. Once, the cells become operational, noise levels from the proposed MEHL facility are expected to remain below the licence noise limits.

Traffic Accessing the Facility

I.6.77 The predicted noise level due to traffic accessing the facility is within the proposed licence limits, therefore the impact is not significant.

Building Services Plant

I.6.78 Proprietary noise and vibration control measures will be employed where necessary, to achieve the recommended criteria at the nearest noise sensitive locations. The resultant noise impact is not significant at the closest noise sensitive locations to the facility.

Additional Vehicular Traffic Along Public Roads

I.6.79 The predicted increase in noise level associated with additional vehicular traffic post-development is imperceptible along the surrounding routes assessed.

I.7 Assessment of Ecological Impacts & Mitigation Measures

1.7.1 Chapter 13 of the EIS describes the existing flora and fauna within the site of the proposed MEHL integrated waste facility, the potential impacts of the proposed development on flora and fauna and proposes measures for the mitigation of these impacts, where appropriate. Key extracts are provided here in the Waste Licence Application; the full EIS (authored by Arup) accompanies this application.

Site Description

General Study Area

1.7.2 The proposed MEHL development site is located 3km south-east of Naul in north County Dublin and 7.5km north-east of Rogerstown Estuary on the east coast. The proposed site (planning/EPA licence boundary area) covers 39.8 hectares. It is a former quarry which operated until 2007 and is now a licensed inert landfill site.

I.7.3 The central 'floor' of the MEHL site includes a number of existing landfill cells containing inert waste. There are two open water bodies where the quarry excavation went below the water table. The walls of the former quarry include exposed rock cliffs, and sloped (benched) walls with unconsolidated overburden. The northern perimeter of the MEHL site is bounded by a stream, which is a tributary of the Ballough Stream, which ultimately discharges to Rogerstown Estuary.

Designated Areas for Nature Conservation

I.7.4 The site is not covered by any conservation designation such as Special Protection Area (SPA), Special Area of Conservation (SAC), Candidate Special Area of Conservation (cSAC), Natural Heritage Area (NHA) and Proposed National Heritage Area (pNHA). There are eight designated conservation areas within 15km as listed in Table **I.7.1** and some of which are shown on *EIS Figure 13.1*.

Table I.7.1: Designated Conservation Areas within 15km of the MEHL Site

Conservation Site Name	Site Code	Conservation status	Distance from MEHL Site
Rogerstown Estuary	000208	cSAC	7.5km east
Rogerstown Estuary	004015	SPA	7.5km east
Bog of the Ring	001204	pNHA	2.5km north-east

Conservation Site Name	Site Code	Conservation status	Distance from MEHL Site
Knock Lake	001203	pNHA	4.2 km north-east
Cromwells Bush Fen	001576	pNHA	8.3km north-west
Skerries Islands	004122	SPA	9.5km east
Malahide Estuary	000205	cSAC	10km south-east
Broadmeadow/Swords Estuary	004025	SPA	10km south-east
River Nanny Estuary and shore	004158	SPA	11.5km north-east

Protected Species of Flora and Fauna

I.7.5 There is a record of one rare protected plant species from the NPWS protected species database within the Ordnance Survey 10km square (O15), in which the MEHL site is located. The plant is red hemp nettle (*Galeopsis angustifolia*), an annual of cultivated or waste ground, which was recorded from 'Cardiff's Bridge' in 1886. There does not appear to be such a location in this 10k square. It may be a misnomer for Corduff Bridge located at grid ref. O 199 523. The species was not found on the MEHL site. The Flora of County Dublin (Doogue et al. 1998) describes this part of the county (which is included in District 1) as having *"the poorest flora of the eight botanical districts of County Dublin"* due to its inland nature and lack of habitat diversity. Quarries create new habitats for plants which colonise the exposed rock and subsoil material over time. Apart from the cliff area, most of the substrate is recently exposed and is only starting to be re-colonised by plants.

Description of Habitats

I.7.6 The habitats are described below and are shown in *EIS Figure 13.2*.

Spoil and Bare Ground

I.7.7 The main habitat on the MEHL site is spoil and unconsolidated material excavated from the former quarry. It includes the glacial overburden material, fragmented limestone rock and shale and a darker clay material excavated from the base of the quarry, which has been deposited on the eastern side of the site. In a few places, this material is beginning to be colonised with plants such as coltsfoot (*Tussilago farfara*), but it is largely unvegetated. For details of the soils and geology of the site, refer to *EIS Chapter 14, Soils, Geology and Hydrogeology.*

Exposed Calcareous Rocks (ER2)

I.7.8 At the southern end of the MEHL site, there is a limestone cliff face, exposed by the former quarrying activities. It is approximately 50m high and 300m long. It is comprised of layers bedded limestone with bands of shale which show folding, characteristic of the Loughshinny formation. For details of the soils and geology of the site, see *EIS Chapter 14, Soils, Geology and Hydrogeology*. The more-or-less vertical cliff face includes ledges with pockets of vegetation. The ledges are used by peregrine falcon as roosting and nest sites. Peregrine falcons hunt in the surrounding area.

Recolonising Bare Ground (ED3)

I.7.9 There are some spoil heaps and areas of exposed rock which have not been disturbed in recent years. These are being colonised with a good diversity of plants typical of calcareous substrates. The main species include: coltsfoot, clovers; (*Trifolium dubium, T. repens*), birds-toot trefoil (*Lotus corniculatus*), vetches (*Vicia sepium and V. sativa*) and a number of other species as listed below in Table **I.7.2**.

Table I.7.2: Lists of Plants Recolonising Quarry Spoil and Exposed Rocky Ground on the MEHL Site

Scientific name	Common name	Scientific name	Common name
Antohoxanthum odoratum	Sweet vernal grass	*Reseda luteola*	Weld
Catapodium rigida	Fern grass	*Sagina procumbens*	Procumbent pearlwort
Centauria nigra	Knapweed	*Scrophularia nodosa*	Common figwort
Chamomilla suaveolens	Pineappleweed	*Senecio jacobea*	ragwort
Cirsium vulgare	Spear thistle	*Senecio vulgaris*	Groundsel
Crepis capillaris	Smooth hawk's beard	*Sonchus asper*	Prickly sow thistle

Scientific name	**Common name**	**Scientific name**	**Common name**
Epilobium brunescens	New Zealand willowherb	*Sonchus oleraceus*	Smooth sow thistle
Holus lanatus	Yorkshire fog	*Trifolium dubium*	Shamrock
Hypochaeris radicata	Cat's ear	*Trifolium repens*	White clover
Lathyrum pratensis	Meadow vetchling	*Ulex europaeus*	Gorse
Lotus uliginosus	Greater bird's –foot trefoil	*Vicia sativa*	Common vetch
Matricaria discoides	Sea mayweed	*Vicia sepium*	Bush vetch
Medicago lupulina	Black medic	*Plantago lanceolata*	Plantain

Eroding Upland Streams (FW1)

I.7.10 The northern boundary of the MEHL site is defined by a watercourse that meanders through a small steeply sloping valley. The stream is up to 2m wide but mostly about 1m wide with a stoney gravely substrate. Water depth is shallow, rarely exceeding 10cms deep. Flow is a swift trickle. The water has a slight turbidity and the stones have a fine film of silt over them. There is no aquatic vegetation. The stream has cut into the bed rock in places. The southern bank of the stream is mostly fringed with mature trees forming a band of mixed broadleaved woodland (WD1). This watercourse is a tributary of the Ballough Stream which has a small but significant population of Atlantic salmon and sea trout (IFI). The stream is fed by groundwater springs as well as surface water flows (Refer to *EIS Chapter 14, Soils, Geology and Hydrogeology* and *EIS Chapter 15, Surface Water*). The Ballough Stream (sometimes referred to as the Corduff River) flows into the Ballyboghill Stream and forms part of the upper sections of the most northern sub-catchment of the Ballyboghill Streams catchment. Ultimately it flows into Rogerstown Estuary 7.5km to the east of the MEHL site.

Mixed Broadleaved Woodland (WD1)/Scrub (WS1)

1.7.11 The southern bank of the watercourse is steeply sloping up towards the northern edge of the MEHL site. It has a woodland cover of Scots pine (*Pinus sylvestris*), oak (*Quercus robur*), sycamore (*Acer pseudoplatanus*), birch (*Betula pubescens*), larch (*Larix decidua),* ash (*Fraxinus excelsior)* and alder (*Alnus glutinosa*). The shrub layer is sparse with elder *(Sambucus nigra*), hawthorn (*Crataegus nigra*) and bramble (*Rubus fruticosus agg.)* The ground flora is quite shaded with abundant ivy (*Hedera helix*) and ferns including; *Dryopteris dilatata, D. filix mas* and Hart's tongue (*Phyllitis scolopendrium*). Other typical woodland ground flora include: herb Robert (*Geranium robertianum*), violet (*Viola riviniana), (Veronica chamaedrys*) and ground ivy (*Glechoma hederacea*). Gorse (Ulex europaeus) is locally frequent at the edge dominating as scrub in places.

Artificial Lakes and Ponds (FL8)

I.7.12 There are two open water bodies on the site, one, at the southern end where the excavation went below the water table and the other in the central part of the site contains standing water from rainfall. There are two smaller attenuation ponds at the northern end of the site. The largest pond near the southern end of the site is approximately 100m x 100m. The smaller pond is ca. 50m in diameter. The edges are quite steep and depth is >5m. There is little fringing vegetation which includes occasional patches of soft rush (*Juncus effusus*), bottle sedge (*Carex rostrata*) horsetail (*Equisetum palustre*) and (*Alopecurus geniculatus*). There was no submerged aquatic vegetation. There were tadpoles in the water.

Mammals

I.7.13 Two hare were observed chasing on site. The Irish hare (*lepus timidus hibernicus*) is protected under the Wildlife Act (1976). The site offers good open spaces for hare and limited foraging due to the sparse vegetation cover. Therefore, hares are unlikely to breed on the site due to the limited cover. Other mammals not seen, but likely to use the site include fox and rabbit. Otters are protected under the Wildlife Act and the EU Habitats Directive. They are found on many Irish watercourses and are likely to occur along the stream on the northern site boundary as it's a tributary of a salmonid watercourse. The woodland edge along the stream would be suitable for badger and other small mammals, including rabbit and hedgehog.

Insects, Reptiles and Amphibians

I.7.14 Butterflies noted on the site include; the Common blue (*Polyommatus icarus*) and Wood white (*Leptidea sinapsis*). The food plants of these butterflies are bird's-foot trefoil and meadow vetchling respectively and are both locally common on the site. Tadpoles were seen in the attenuation ponds. There is potential habitat for the common lizard on the more vegetated parts of the site with exposed rock. Frogs (*Rana temporaria*), newts and lizards (*Lacerta vivipara*) are protected under the Wildlife Act 1976 (Protection of Wild Animals) Regulations, 1980 (S.I. 282 of 1980). Newts (*Triturus vulgaris*) can also be found in ponds where there are no fish predators. No newts were seen during the field survey.

The absence of submerged aquatic vegetation in the ponds makes the habitat less suitable for newts.

Birds

I.7.15 The cliff face, open water and recolonising bare ground, provide habitats for a range of birds. Birds noted on the site are listed in Table **I.7.3.**

Table I.7.3: List of Bird Species Recorded on Site and their Conservation Status**

Common name	Scientific name	Conservation status**	EU Birds Directive
Blackbird	*Tardus merula*	low	-
Black backed gull	*Larus ridibundus*	high	-
Cuckoo	*Cuculus canorus*	medium	-
House martin	*Delichon urbica*	medium	-
Meadow pippit	*Anthus pratensis*	low	-
Peregrine falcon	*Falco peregrinus*	Low,	Listed on Annex I EU Birds Directive
Raven	*Corvus corax*	low	-
Rook	*Corvus frugilegus*	low	-
Sand martin	*Riparia riparia*	medium	-
Swallow	*Hirundo rustica*	medium	-
Wood pigeon	*Columba palumbus*	low	-

** Birdwatch Ireland website
http://www.birdwatchireland.ie/Portals/0/images_large/BoCCI_Redlist.jpg

I.7.16 The conservation status refers to the Birds of Conservation Concern in Ireland as defined by the Royal Society for the Protection of Birds (RSPB) and BirdWatch Ireland so this is their status in Ireland only. Annex I refers to their status in European terms. Peregrine falcon is a species that has a low conservation status in Ireland, however, it is much less common in the rest of Europe and is listed on Annex I of the EU Birds Directive.

Peregrine Falcon

I.7.17 The peregrine falcon is the most important bird species associated with the MEHL site as it is listed on Annex 1 of the EU Birds Directive. A separate report by R and D Avian Ecology (2010) describes in detail the use of the site by peregrine for foraging, roosting and breeding as well as the distribution and occurrence of peregrine falcon within the vicinity and in north county Dublin. Refer to *EIS Appendix A.13.2*. The MEHL site is a known traditional nesting site for peregrine for the past 12 years, with successful breeding up to 2008 and unsuccessful since then although it continues to be a foraging and roosting site.

Site Evaluation

I.7.18 The proposed MEHL integrated waste management facility site is a former limestone and shale quarry now used as an inert landfill. The site is not covered by any conservation designation. The nearest pNHA is Bog of the Ring located 2.5km to the north-east. The nearest cSAC is Rogerstown Estuary, located 7.5km to the east. There is quite a diverse range of habitats on the site including open water bodies, exposed rock cliff face and calcareous spoil heaps. Although most of the site is not vegetated, the areas with re-colonising vegetation have a good diversity of plants and animals.

I.7.19 The watercourse that flows along the northern boundary of the site is a tributary of the Ballough Stream which is a salmonid river of county significance. The bedded limestone cliff face is located at the southern end of the site with bands of shale and the undulating folds are characteristic of the Loughshinny formation. This is of county geological importance and has been designated a Geological Heritage Site by the GSI for the duration of the quarry/landfill site. See *EIS Chapter 14, Soils, Geology and Hydrogeology.* The occurrence of a breeding peregrine falcon on the MEHL site is of county importance, as there are records of only three other breeding sites for peregrine in north county Dublin. Peregrine are also protected under the EU Birds Directive.

I.7.20 Overall, the MEHL site is of county importance due to the presence of peregrine falcon and the exposed limestone cliff face of the former quarry which provides suitable nesting habitat, and the occurrence of a salmonid stream along the site boundary. Also, the open water bodies on the site and the exposed glacial material recolonising with vegetation have potential to significantly expand the local biodiversity over time.

Potential Impacts of the Proposed Development

I.7.21 The existing landfill site has full planning permission to infill the former quarry site and restore it to its original grade and in so doing remove almost all the habitats on the site, including the traditional peregrine falcon nesting and roosting sites on the exposed limestone cliffs. Such a loss of habitats and species would have a significant adverse impact at a county level. The proposed MEHL development is not adding to the loss of habitats and species. The potential impacts of the proposed development on groundwater and surface water are discussed in EIS Chapters 14 and 15 respectively.

Potential Impacts of the Proposed Development on Designated Sites

I.7.22 There will be no direct impacts on any designated areas for conservation, due to the distance (>2.5km) of the nearest designated conservation areas from the MEHL site. The main potential impacts are in relation to contamination of surface or groundwater from the MEHL integrated waste management facility. Bog of the Ring pNHA is a groundwater fed wetland located 2.5km from the proposed development. Refer to *EIS Figure 13.1*. The ecological value of this pNHA has deteriorated considerably since the 1960s due to drainage and eutrophication from the locality (Doogue et. al.1998). Rogerstown Estuary cSAC/SPA is located 7.5km to the east of the proposed development and the watercourse that flows along the northern boundary of the site ultimately discharges into Rogerstown Estuary. Refer to *EIS Figure 13.1*.

I.7.23 The detailed design of the proposed MEHL integrated waste facility will ensure that there are no risks of leakage or contamination from the landfill cells into the groundwater (Refer to *Chapter EIS 14, Soils, Geology and Hydrogeology*). The drainage and surface water management systems proposed for the facility will ensure no likely significant impacts on the adjoining watercourse which is a tributary of the Ballough Stream, which flows into Rogerstown Estuary (Refer to *EIS Chapter 15*, *Surface Water*). Hence, there will be no likely significant adverse impacts on Rogerstown Estuary designated cSAC/SPA or on Bog of the Ring pNHA.

Habitats

I.7.24 Most of the proposed MEHL development site is comprised of quarry spoil and re-colonising bare ground. The loss of this habitat is significant at a local level. The removal/infilling of the limestone quarry at the southern end and hence the removal of the peregrine falcon nest site will be a significant adverse impact at a county level.

Fauna

I.7.25 The infilling of the former quarry and waterbodies will result in the displacement or loss of most of the fauna on the site including amphibians, mammals and birds. This is a significant adverse impact at a local level (higher value). There will be no direct impacts on the watercourse so no mitigation is required for otter.

I.7.26 The traditional peregrine nest site and roosting sites on the limestone cliff face at the southern end of the site will be impacted over time as the development progresses and the cliff face reduces with the licensed infilling of the site with waste. The foraging habitat for the peregrine within the site will also be lost. This is a significant adverse impact at a county level.

I.7.27 It should be remembered that the above impacts were already approved in the planning permission of the existing landfill. No additional impacts on peregrine are expected from the MEHL development.

Aquatic Environment and Fisheries

I.7.28 This watercourse flowing along the northern boundary of the site is a tributary of the Ballough Stream, a salmonid watercourse. The water supply for the stream is mainly from surface water flows and partially fed by groundwater springs (Refer to *EIS Chapter 15, Surface Water*). Any contamination of the surface water could have indirect adverse effects on the salmonid population in the Ballyboghill stream catchment and other species requiring high water quality. This would be a significant adverse impact at a county level. It is essential that only clean and uncontaminated surface water should be discharged from the landfill site to the watercourse at the northern boundary of the site.

I.7.29 Provided the mitigation measures outlined below are implemented and ongoing monitoring is undertaken during operation of the integrated waste management facility, there will be no likely significant adverse impacts on the watercourses.

Mitigation Measures

Mitigation by Avoidance

Designated Areas for Nature Conservation

I.7.30 Provided there is no discharge of contaminated waters from the proposed MEHL facility into the surface water network or seepage of contaminated waters into the groundwater system, there will be no direct or indirect impact on Rogerstown Estuary, which is the nearest designated cSAC and SPA located 7.5km to the east. Neither will there be any significant adverse impacts on Bog of the Ring pNHA.

Protected Species of Flora and Fauna

I.7.31 There are no records from the NPWS database of rare and protected plant species from this site and none were found during the field survey.

I.7.32 Peregrine falcon will be impacted during the construction phase of this project due to disturbance and noise. Alternative natural or artificial ledges will be installed on the south-western side of the limestone cliff face. These will serve as temporary roosting or potential nest sites, as far away from the landfill construction as possible, to minimise the disturbance to peregrine during the construction works. Refer to *EIS Appendix A13.2* for full details.

I.7.33 As tadpoles are present on the site in the existing attenuation ponds and frogs are protected under the wildlife Act, a Licence will be required from the National Parks and Wildlife Service to move them or destroy their breeding habitat. Infilling of the ponds on the site outside the breeding season January-June will avoid having to collect and move the frogs and tadpoles from the site during construction works.

Habitats

I.7.34 Any habitats on the MEHL site which will not be disturbed by the proposed development works will be left as they are, to recolonise naturally. This will increase local biodiversity over time as they become vegetated and provide habitat for a range of fauna also.

I.7.35 A wetland area at the southern end of the site, which includes an open water body fringed with vegetation will be retained within the MEHL site. This will help to increase local biodiversity.

Mitigation During Construction

I.7.36 Best available technology (BAT) mitigation measures will be implemented to ensure protection of the surface water and ground water systems during both construction and operational programmes. These measures are described in detail mainly in *EIS Chapter 14, Soils, Geology and Hydrogeology* and *EIS Chapter 15, Surface Water* of the EIS.

I.7.37 The implementation of a SUDS system (as advocated in the Greater Dublin Strategic Drainage Study) on the site will be part of the proposed development design in the short and long term. The maintenance of any attenuation structures (e.g. de-silting operations) will ensure no release of contaminated water to the surface water network. Class 1 petrol/oil interception, silt and grit trapping and hydro-brake controls will also be implemented during the construction stage.

I.7.38 There will be no development works or any disturbance of existing ground within 10m of the edge of the stream flowing along the northern boundary of the site. This will provide a 10m wide (minimum) riparian corridor or 'leave strip' which is very important to the protection of a local aquatic ecological integrity (and general biological diversity).

I.7.39 The discharge of clean surface waters to the Ballough Stream system and any construction works associated with the proposed development must in no way impact on the passage of salmonids thereby contravening Section 173 of the Fisheries (Consolidation) Act 1959 as amended.

I.7.40 The potentially highly polluting nature of the wastewaters generated at this facility highlights the need for implementation of comprehensive ground and surface water management in order to safeguard the ecological integrity of local ground and surface waters. Under no circumstances will there exist the possibility of contamination of the local surface and ground water system.

I.7.41 Details of the surface water drainage system design and mitigation measures to ensure no significant adverse impacts on the adjoining watercourses are described in *EIS Chapter 15, Surface Water*.

I.7.42 Potential impacts to Groundwater are dealt with in *EIS Chapter 14, Soils, Geology and Hydrogeology*. Design and mitigation measures are described in *EIS Section 14.8.2.2* regarding potential contamination of the groundwater resources and include the design and construction of the landfill cells, including liners. See *EIS Chapter 14, Soils, Geology and Hydrogeology* for full details.

Mitigation During Operation

I.7.43 On-site attenuation ponds will allow for the settlement of fine/particulate materials. Monitoring will be undertaken in accordance with the waste licence of surface water discharges in order to protect the receiving waters which are a tributary of the Ballough Stream.

I.7.44 A proposed wetland system associated with the attenuation ponds will, over time, provide wetland habitat and add to the local habitat and species diversity. Details of the constructed wetland system will be finalised at the detailed design stage in consultation with a suitably qualified wetland ecologist and the Board of Inland Fisheries Ireland.

I.7.45 Potential contamination to groundwater during operation of the landfill will be minimised due to the installation of an impermeable lining system and a leak detection and collection system as described in *EIS Chapter 14, Section 14.8.2.2*. Ongoing monitoring will be required to ensure no contaminating discharges occur to groundwater or surface water. A contingency plan will be in place in case of emergency.

I.7.46 Over time, the peregrine falcon will be displaced from this site. The cliff face will ultimately not be suitable for roosting or nesting sites as the height of the cliff face will diminish with the infilling of the quarry. In the longer term, if monitoring results determine it necessary, the creation of an additional nest site away from the location of the MEHL site within 5km -10km will be investigated in consultation with landowners and the NPWS. This additional site could be located in another quarry or on a man-made structure such as a church/cathedral. Prior to the selection of an alternative nest site location, further monitoring of the peregrine within nearby quarries will be required to better understand their distribution and breeding behaviour. This will help inform the selection of the best locations for alternative peregrine breeding sites. For full details of the proposed peregrine falcon mitigation, refer to *EIS Appendix A13.2*.

Residual Impacts

I.7.47 The existing landfill site has full planning permission to infill the former quarry site and restore it to its original grade and in so doing remove almost all the current habitats on the former quarry site, including the traditional peregrine falcon nesting and roosting sites on the exposed limestone cliffs. Such a loss of habitats and species is a significant adverse impact at a county level.

I.7.48 The construction and operation of the proposed MEHL integrated waste facility will not result in any additional direct loss of habitat in this former quarry site at Hollywood Great. If considered necessary, following monitoring, the creation of an alternative peregrine nest site away from the quarry at a suitable location within 5km of the site will compensate for adverse impacts to this species.

I.7.49 The incorporation of an existing wetland area near the southern boundary of the site into the MEHL site will add to the biodiversity of the site, as well as the constructed wetland area which will provide habitat for a range of wetland species over time.

I.7.50 There will be no residual significant adverse impacts on the local surface watercourses or on the groundwater resource, provided the mitigation measures described in *EIS Chapter 14, Soils, Geology and Hydrogeology* and *EIS 15, Surface Water* are fully implemented and monitored. As a consequence, there will be no significant adverse impact on the Rogerstown Estuary cSAC/SPA located over 7.5km to the east.

Appendix 5: Copy of Article 16 information (extract) submitted to the Agency on 17/10/13

(Figures and Appendices C, D and E are also included. Appendices A, B, F, G and H have been omitted (too voluminous to reproduce in this report). The report is available for inspection in full at epa.ie)

MEHL

MEHL Integrated Waste Management Facility

EPA Waste Licence Application W0129-03. Response to EPA Article 16: Groundwater

Issue 1 | 16 October 2013

This report takes into account the particular instructions and requirements of our client.

It is not intended for and should not be relied upon by any third party and no responsibility is undertaken to any third party.

Job number 326877.30

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1 Introduction

MEHL has planning permission (An Bord Pleanála Ref. 06F.PA0018) to develop an integrated waste management facility which will accept non-biodegradable, solid hazardous and non-hazardous waste streams at their site in Hollywood Great, North County Dublin. The development also requires a waste licence from the Environmental Protection Agency (EPA).

MEHL submitted a Waste Licence Application (W0129-03) to the Environmental Protection Agency (EPA) on 17th December 2010. The EPA responded with a notice in accordance with Article 16(1) of the Waste Management (Licencing) Regulations on the 23rd March 2012. The EPA issued a clarification on the 3rd of May 2012 and further notification on the 11th of July 2012.

This report provides responses to Items 5 – 8 in the Article 16 letter (23rd March 2012) and Items 1 and 3 in the Article 16 notification (11th July 2012).

A separate response for Item 7.2 (a – d) and Item 8.7 was submitted to the EPA on the 18th February 2013: Arup (February 2013) '*Assessment of Hydrogeological Isolation (Bog of the Ring and MEHL Site)*'. Responses to other 'Article 16' requirements were previously submitted by MEHL under separate cover

Other information related to hydrogeology has been submitted to the EPA including:

- An Bord Pleanála Decision and Inspector's Report relating to the proposed facility – submitted by MEHL to EPA on 28th May 2012
- Information provided by the geology/hydrogeology EIS team to An Bord Pleanála Oral Hearing (Ref. 06F.PA0018), March 2011 – submitted by MEHL to EPA on 7th June 2012

This report does not directly respond to the individual items raised in Article 16 clarification from the 3rd of May 2012 as this clarification related to proposed additional ground investigation. The additional ground investigation undertaken is discussed in detail in Chapter 3 and the items raised are addressed within that section as a whole.

2 EPA Questions And Responses

This chapter provides direct responses to the questions raised by the EPA in the notices (issued in accordance with Article 16(1) of the Waste Management (Licencing) Regulations) of the 23rd March 2012 and 11th July 2012. Cross references to other chapters or appendices are provided where required.

The text provided in italics is a direct quote from the EPA notices. Individual responses are provided below.

2.1 Article 16: 23rd March 2012

5. LandSim model

5.1. The Hydrogeological Quantitative Risk Assessment refers to a number of appendices (including Al.1, Al.2, Al.3, A3.l, A3.2, A3.3, A3.4, A4.l, A4.2, A4.3 and A4.4) that do not appear to be included in the application. Please indicate their location in the documentation already submitted or provide a copy of the documents. (It may be appropriate to provide these documents in electronic format).

The appendices A1.1, A1.2, A1.3, A1.4, A1.5, A2.1, A2.2, A2.3, A3.1, A3.2, A3.3, A3.4, A3.5, A4.1, A4.2, A4.3, A4.4 and A4.5 were inadvertently excluded from the original Waste Licence Application (Ref. W0129-03). These appendices are included in **Appendix A** of this report.

These appendices relate to the original Quantitative Risk Assessment (QRA) presented in the Waste Licence Application (WLA). The QRA model has been updated to address the comments received from the EPA in the Article 16 notice of the 23rd March 2012 and as a result of changes to the site conceptual model (CSM). The appendices referred to in the Article 16 notice have been superseded.

The updated QRA is presented in Chapter 5 of this report and the associated appendices for the new models are presented in **Appendix A**.

5.2. Justify whether Landsim is appropriate to use for a site having exposed bedrock, a high water table and a fractured aquifer system directly beneath the proposed landfill development. Although Landsim is considered necessary for evaluating a landfill site generally, the results of the LandSim model should be combined with a more sophisticated numerical groundwater (contaminant transport) model, to consider the regional context and risk or justify why this is not appropriate.

LandSim is the UK Environment Agency approved model for determining potential impacts to groundwater from landfills. It is used extensively in the UK for landfill developments directly overlying fractured chalk and sandstone aquifers and has been deemed to be applicable in those situations. The same applies to the fractured Namurian strata on the MEHL site.

The use of a numerical groundwater (contaminant transport) model was not deemed to be appropriate for the following reasons:

- A wealth of geological and hydrogeological data is available for the MEHL site, however constructing a site specific groundwater (contaminant transport) model would not provide realistic results as the model boundaries would be too close to the site and these would skew any results generated.
- In order to construct and calibrate a groundwater model which provides realistic results a large body of groundwater information in the wider area around the site would be required. Without this information the results would be meaningless as all boundary conditions etc would have to be inferred.
- There are many unmapped faults in the wider region and these are likely to influence groundwater levels and flow patterns on a local scale. Any information that was available in the wider area would have to be treated with caution as local faults may skew the results and this would influence the model results.

5.3. It is stated that a period of 35 years for a management control period is conservative. In section 8.3.4.4 of the Hydrogeological Quantitative Risk Assessment it is stated: "The model assumes that after this period there is no leachate management and leachate head can rise within the cells resulting in greatly increased leakage".

a) Explain how it follows in relation to the claims made for the DAC liner that increased head of leachate will result in increased leakage.

The management control period in LandSim represents the length of time over which a landfill will be maintained by the operator. It assumes that once the management control period is over, the landfill will be ‘abandoned’ and will have no further maintenance undertaken on it (although this is very unrealistic and contrary to EPA aftercare requirements). This has significant implications for the risk assessment model as beyond the specified management period the leachate head level is no longer controlled and is allowed to rise in the model (see answer 5.4 for further information).

The DAC has been simulated in LandSim as a single clay liner (see response to question 5.9 for the justification for this). The engineered properties of the DAC, i.e. total containment of the leachate, cannot be represented in LandSim.

Once the management period ends in LandSim, the leachate level is no longer controlled. As a result of this, it is a default in LandSim that leakage through the ‘clay’ liner will increase as the head level rises. This has no reflection on the DAC, its characteristics or behaviour.

b) Describe the predicted/modelled effect of increasing the maximum leachate head in table 8.5 of the Hydrogeological Quantitative Risk Assessment for non-hazardous and hazardous cells to 2m and 5m.

As outlined in the response to question 5.3 above, the management control period in LandSim represents the length of time over which a landfill will be maintained by the operator. It assumes that once the management control period is over, the landfill will be 'abandoned' and that the leachate head level will be allowed to rise.

The primary model presented in the QRA used a management control period of 35 years which assumes that after 35 years the site will have no further maintenance (this is an unrealistic scenario and contrary to EPA requirements, however it has been modelled as a highly conservative scenario). Once the management control period in the LandSim model finishes, the leachate head level rises until surface breakout occurs (i.e. at the minimum thickness of the waste).

The results of the primary model submitted with the WLA indicated that within 100 years of the landfill starting (and within 65 years of the management control period ending) the leachate levels rose to the surface breakout levels. i.e. beyond the management control period the leachate heads applied in the model ranged from 10.5 – 15.5 m, depending on the specific waste cell).

This means that the results presented in the primary model represent a scenario where a 2 m and 5 m head of leachate are included.

The effects of increasing the maximum head of leachate in the hazardous and non-hazardous cells to 2m and 5m during the 'managed' period of the landfill have been modelled in the updated QRA. It should be noted again that this is an unrealistic scenario and is unlikely to occur as leachate levels will be managed at all times in accordance with closure/aftercare procedures. The drainage system has been specifically designed to maintain a maximum head of 1 m in the landfill cells.

The results are discussed in Chapter 5, presented in **Appendix A** and are summarised as follows:

- Hazardous model: The results from the hazardous cells model and the test versions with a leachate level of 2 m and 5 m are very similar. The main difference is that the leakage levels are higher in the first 35 years (i.e. during the management control period) in the model with the higher leachate head levels than in the model with the lower leachate head levels. Once the management control period finishes the results are the same. This is as expected
- Non-hazardous model: The non-hazardous models which included a higher leachate head level of 5 m and those with the shorter management control period became unstable. The results of these are presented in **Appendix A** but were excluded from the discussion. The models with the longer management control period and leachate heads of up to 2m were stable and their results are discussed below.

5.4. Rainfall and infiltration

a) Demonstrate that the data for Dublin Airport is adequately representative of the site given the different topography and elevation and taking into account the risk of underestimating site specific infiltration rates used in the LandSim model.

b) Justify not applying a further conservative factor to rainfall given these factors.

Data from Dublin Airport was used on the basis that it is the most extensive data set available for the area. While there may be some local variation in the rainfall level due to the elevation, it is unlikely to be far outside the range of values used in the model.

A conservative factor has been built into the infiltration numbers used as no rainfall runoff to the drainage system when the waste cell is open has been included.

A sensitivity analysis was undertaken in the updated QRA model to establish how sensitive the model results are to infiltration. This assessment determined that the models are not sensitive to the infiltration rates.

5.5. On page 59 of the Hydro geological Quantitative Risk Assessment, it is stated that "of those contaminants potentially present in leachate at the site, only cadmium and mercury are classed as hazardous substances." State the source of this finding and explain the apparent rationale behind' the thinking 'that no other hazardous substances will be present in the leachate.

5.6. Provide further information on the assumptions and justification behind selection of the model leachate inventory and initial leachate concentrations. There appears to be no justification/discussion on which potential contaminants have/have not been progressed to risk assessment, only that they are "likely contaminants which may arise in leachate from the hazardous cell". More proposed-waste-streams-specific data should be obtained if possible (from say other similar sites or proposed source sites) to ensure the modelled suite of potential contaminants is comprehensive enough. Bench-scale testing of some of the more significant waste streams proposed may be appropriate to demonstrate that unacceptably high leaching is not going to happen.

5.7 See next box

5.8. Provide greater justification for the use of marker chemicals for certain potential contaminants present within the leachate inventory but excluded from the model simply because of an absence of WAC data. Provide detailed information on the mobility and toxicity similarities between markers and the excluded contaminants they are supposed to represent, under the expected geochemical conditions within the landfill.

We clarify that the statement referred to under question 5.5 should read “of those *modelled* contaminants potentially present in the leachate at the site, only cadmium and mercury are classed as hazardous substances”.

The model leachate inventory is based on those parameters which have EU landfill Waste Acceptance Criteria (WAC) associated with them. The WAC were established pursuant to Article 16 and Annex 2 of the Landfill Directive 1999/31/EC. The purpose of Landfill Directive is to control the operations of landfills “in order to protect, preserve and improve the quality of the environment in the Community”. The WAC were specifically chose to protect the environment having regard to the ecotoxicological properties of the waste and the resulting leachate.

The WAC set:

- limitations on the amount of specified, potentially harmful/hazardous components (in relation to the abovementioned protection criteria),
- limitations on the potential and expected leachability of specified, potentially harmful/hazardous components (in relation to the abovementioned protection criteria).

Other contaminants may be present in the leachate. Modelling these was not undertaken on the basis that the modelled contaminants have a higher mobility and/or toxicity than those not modelled. Consequently, if there is no impact to groundwater from the more toxic and/or mobile contaminants, there will be no impact from those not included in the modelling. Waste-stream specific data for the proposed waste to be accepted has been provided by Patel Tonra and is included in **Appendix B**.

None of these expected contaminants are List 1 or ‘hazardous’ substances under the Water Framework Directive. Cadmium and mercury are ‘hazardous’ substances under the Water Framework Directive indicating they are more toxic than the substances listed above.

The expected concentrations of the contaminants excluded from the modelling are proportionally lower than the modelled concentrations of cadmium and mercury. This indicates that the modelled concentrations of cadmium and mercury are likely to represent a worst case scenario for toxic compounds.

The maximum concentrations were set in the LandSim hazardous models as 3 times the waste acceptance criteria for hazardous waste (set in EU Council Decision 2003/33/EC) as a single value. These concentrations are the maximum amount of any particular contaminant which will be accepted into the landfill (subject to EPA agreement).

They were inputted as a single value (rather than a probability density function) meaning that the model presumes that all waste accepted will be at the maximum concentration which is a very conservative scenario. However, by inputting these maximum values the highest potential risk to groundwater can be assessed.

A comparison of the mobility of the contaminants excluded compared with the most mobile modelled contaminants (chloride and sulphate) is provided in **Table 2.1** below. The partition coefficient (Kd) for chloride and sulphate was set as zero in the model which means these contaminants will not be retarded and are freely mobile.

Table 2.1: Comparison of mobility of contaminants

Contaminant	Kd	Modelled concentration (hazardous waste) mg/l	Comments
Modelled contaminants			
Chloride	0	45000	Very high concentration and freely mobile parameter
Sulphate	0	51000	Very high concentration and freely mobile parameter
Excluded contaminants			
Thallium	1.64 (l/kg)		Mobile parameter but concentrations will not reach those for chloride or sulphate
Vanadium	141 (source 34) ml/g		Low mobility parameter
Cobalt	55.7 (source 32) ml/g		Slightly mobile parameter but concentrations will not reach those for chloride or sulphate
Manganese	50 (source 31) ml/g		Slightly mobile parameter but concentrations will not reach those for chloride or sulphate
Tin	2.1 (l/kg)		Mobile parameter but concentrations will not reach those for chloride or sulphate
Free cyanide	0.996 (l/kg)		Mobile parameter but concentrations will not reach those for chloride or sulphate
Nitrite	0		Freely mobile contaminant but concentrations will not reach those for chloride or sulphate

Chloride and sulphate are the most mobile contaminants modelled and also have the highest leachate concentrations of all the contaminants modelled. Based on the information listed in **Table 2.1** none of the contaminants excluded from the modelling will be as mobile or have concentrations at as high concentrations as chloride and sulphate.

Based on the comparison of mobility, toxicity and potential concentrations, it is considered that based on the waste-stream specific data, that the modelled leachate inventory presents the worst case scenario in terms of risk to groundwater.

5.7. Much of the hazardous waste deposited is not expected to degrade with time and therefore may be expected to act as a constant source of potential leaching in the long term. A declining source term has been used in the model. Provide further information on the rationale behind such a selection and the form of the declining source term used. This includes what kappa values have been used (linked to the rate of predicted contaminant release from the waste).

In order to alleviate the concerns outlined in question 5.7 regarding the use of a declining source for the hazardous waste, a constant source was used instead in the updated QRA modelling. The detailed results of this are presented in Chapter 5 and can be summarised as follows:

- The concentrations of contaminants at the base of the unsaturated zone were observed to slightly increase
- No change was observed in the concentrations detected in groundwater, either at the monitoring well adjacent to the cells or at the phantom monitoring well on the site ownership boundary.

As a constant source is used in the updated QRA modelling, the remainder of the query is not relevant.

5.9. Provide greater justification for the use of a single clay mineral layer to represent the proposed DAC liner system, in particular whether attenuation (adsorption) capacities are appropriate for the DAC system that is designed to act as a structural barrier.

The DAC liner was modelled in LandSim in accordance with the LandSim guidelines which states that DAC can be modelled "by setting thickness and hydraulic conductivity values appropriately".

The DAC liner has been modelled as a single clay barrier the thickness of the DAC sealing layer (0.08m). The use of a double clay barrier in the model was also explored, however it was deemed more conservative to exclude the lower liner from the model.

The DAC liner is composed of two low permeability elements: the 0.08 m thick DAC and a 0.5 m thick secondary clay liner below that. The secondary clay liner (0.5m thick) has not been included in the model. Therefore there is significantly greater sorption/attenuation potential in the liner system than has been modelled.

This balances out the fact that contaminants within the liner will have increased sorption within a clay than within a DAC liner. However, it should be noted, that the DAC liner will be constructed to have such a low permeability as to be effectively impermeable – and therefore the sorption potential is irrelevant.

A version of the model was created with the liner modelled as a double layer system. This modelled two clay liners with a drainage layer in between them as part of the lining system. However, LandSim v 2.5 will not allow the two clay barriers in the liner to have different hydraulic conductivities.

Because of this an adjustment of the hydraulic conductivity and thickness of one of the lining systems was made. As the DAC liner is the dominant liner in the system, it was deemed appropriate to adjust the lower clay liner.

If an adjustment is made to the properties of the lower clay liner in the model, the leakage rates will have to remain the same to ensure that the approach is valid. As the permeability of the lower liner is to be reduced then the thickness will need to be reduced too to maintain the same leakage rate.

LandSim requires that both barriers be assigned the same permeability in the model. In reality, the upper DAC layer will be thinner and have a lower permeability than the clay barrier beneath it. The two liners can be given the same permeability in the model by adjusting the thickness of one to allow the same volume of leakage through.

The leakage through the lower liner within the DAC system can be calculated by following formulas:

$i = ((h+L)/L$ (Equation 1)

$q = ki$ (Equation 2)

where, i = hydraulic gradient

h = leachate head

L = thickness of mineral liner

q = velocity / rate of leakage per unit area

The lower liner within the DAC system has a thickness of 0.5 m (L) and a hydraulic conductivity (k) of 1 x 10-9 m/s. The maximum head of leachate (h) in the hazardous cell will be 1 m. This indicates that the leakage rate will be 3 x 10-9 m/s in line with the calculations below.

$i = ((1+0.5 \text{ m})/0.5 \text{ m}) = 3$

$q = ki = (1 \text{ x } 10\text{-}9 \text{ m/s}) (3) = 3 \text{ x } 10\text{-}9 \text{ m/s}$

This indicates that the thickness will have to be altered to allow the same leakage rate to be maintained if the hydraulic conductivity is reduced to 1 x 10-12 m/s. The formulae used above can be manipulated to allow the thickness to be calculated as shown in Equation 3.

$L = (kH) / (q – k)$ (Equation 3)

The maximum hydraulic conductivity which the DAC will have is 1 x 10-12 m/s based on Attachment D.3 in the Waste Licence Application submitted in December 2010. This value was used to calculate the thickness of the lower liner. If the lower value of 1 x 10-15 m/s was used for this calculation a thicker liner would be achieved which would be less conservative.

Based on Equation 3, the thickness of the lower mineral bed in the DAC when using a hydraulic conductivity value of 1 x 10-12 m/s is 0.000333 m.

$L = [(1 \text{ x } 1012)(1)] / (3 \text{ x } 10\text{-}9 – 1 \text{ x } 1012) = 0.000333 \text{ m}$

The results of the LandSim model indicate that there is no risk to groundwater from the proposed development. However, it is believed that modelling the DAC as a single liner is a worst case scenario as it excludes the additional protection offered by the 0.5 m of clay.

This model is not discussed in Chapter 5, however the model print out and results are presented in **Appendix A**.

5.10. Confirm whether the same vertical saturated pathway was used for all waste phases and cell types modelled relative to the varying pathway properties across the site as a whole, in both south to north, and east to west. Justify not using multiple models to provide a cell specific assessment.

An updated QRA has been prepared and is presented in Chapter 5 of this report. Multiple models have been prepared as part of this updated QRA to account for the varying presence of a vertical saturated pathway across the site. The new models presented in Chapter 5, relative to the vertical pathway are summarised below:

- Hazardous model: cells are located in the north of the site only, a vertical pathway has been included
- Non-hazardous model: located in the south of the site only so no vertical pathway has been included

5.11. Specifically, provide information on the vertical saturated pathway hydraulic conductivity values used within the model

No hydraulic conductivities are inputted in LandSim for the vertical saturated pathway. The only input values required in LandSim for the vertical saturated pathway are: pathway length, the porosity and the dispersivity. This is because the inclusion of a vertical saturated pathway assumes a downward flow through saturated material from the unsaturated zone towards the aquifer.

LandSim calculates the flow rate in the vertical pathway by giving it the same flow rate as the unsaturated zone above it.

A vertical hydraulic conductivity value was inputted for the unsaturated zone and is summarised in Table 2.2.

Table 2.2: Hydraulic conductivity of unsaturated zone

Parameter	Value				Comment
	Distribution	Max	Likely	Min	
Hydraulic conductivity (m/s)	Log triangular	2.82E-08	1.53E-07	4.54E-07	Infiltration testing

These hydraulic conductivities were calculated by undertaken infiltration testing on the site as detailed in **Appendix 14.5** of the EIS.

5.12. Refine the overall modelling exercise on foot of the items above and following any additional site investigations and improvement to the conceptual site model – see ·the following sections of this letter.

As outlined in section 5.1 the modelling has been updated in line with comments received from the EPA (Items 5 - 8) and as a result of changes to the Conceptual Site Model (CSM). The updated QRA report is presented in **Chapter** 5 of this report and the model print outs and results are presented in **Appendix A**.

6. Conceptual Site Model

6.1. Develop further the conceptual site model to encompass the requirements of this notice as a whole. As well as explanatory text, this might result in a series of diagrams including:

a) A plan showing all site investigation to date (including additional investigations conducted as a result of this notice), and topographic detail extending beyond the licence boundary to the limits of the monitoring points;

The Conceptual Site Model (CSM) has been revised based on the additional site investigations. This updated CSM is presented in Chapter 4. The additional diagrams are presented in the figures listed below.

Topographic detail is presented from within the site and beyond the licence boundary in Figures 1 and 2 respectfully. The latter is reproduced from the Ordnance Survey Discovery Series.

- **Figure 1**. All site investigation locations undertaken to date
- **Figure 2**. All site investigation locations undertaken to date on regional topographic map

Details and logs for all historic monitoring wells drilled on the MEHL site are presented in **Appendix C**.

b) A plan showing regional groundwater flow, based on measured water levels and including a more accurate depiction of the groundwater divide between the site and the Bog of the Ring;

The GSI have defined a groundwater divide to the north of the MEHL site. A groundwater divide is a topographical divide in the water table which causes groundwater to flow away from the topographically high area.

The presence of the groundwater divide between the MEHL site and the Bog of the Ring report has been dealt with extensively in the report ‘Hydrogeological Isolation: Bog of the Ring and the MEHL site’ submitted to the EPA on 18th February 2013.

A figure showing the regional groundwater flow, based on measured groundwater levels is presented in **Figure 3**. The regional groundwater level information for this figure was compiled using data gathered for the Fingal landfill project which was collected on the 24th of June 2005.

Figure 4 presents the recorded groundwater levels in the Loughshinny Formation from all the active wells on site.

Groundwater level data was not available for the MEHL site for the 24th of June 2005 which is the date of the data used to create the regional information for **Figure 3**. For this reason only the general groundwater flow contours and flow direction (without quoting specific groundwater levels) from the aquifer beneath the MEHL site, as indicated in **Figure 4,** have been presented on **Figure 3**.

The local groundwater flow pattern observed at the MEHL site shown in **Figure 4** clearly coincides with the regional groundwater level pattern shown in **Figure 3**.

The groundwater divide between the MEHL site and the Bog of the Ring can also clearly be seen in the groundwater flow contours on **Figure 3**.

c) Two separate plans, one showing local groundwater piezometry in the Namurian Formation and one showing it in the Loughshinny Formation;

Groundwater levels collected on 8th July 2013 in all the active wells on the site are presented on the following figures:

- **Figure 4**: Groundwater levels measured in the Loughshinny Formation
- **Figure 5**: Groundwater levels measured in the Namurian strata.
- **Figure 6**: Groundwater contours for both the Visean and Namurian strata

These figures illustrate that:

- Groundwater flow in the Loughshinny Formation is to the southeast in line with the regional groundwater flow pattern
- Groundwater flow within the Namurian formations is mainly driven by topography with some localised variations due to the heterogeneous nature of the Namurian strata.
- Under unstressed conditions, the groundwater within the Namurian deposits and Loughshinny Formation are hydraulically separate

d) A series of cross-sections (e.g. one N-S through the proposed waste cells, and two E-W through the proposed waste cells) that accurately show the geology derived from borehole logs and head gradients derived from monitored water levels in boreholes screened in different strata;

Cross-sections are presented in **Figure 7**. These cross sections were constructed based on information from the borehole logs, down-hole geophysics, palynology, micropaleontology and the pumping tests. In some cases the borehole logs indicate uncertainty regarding which lithology was encountered, palynology, micropaleontology and the down-hole geophysics were used to aid the interpretation.

e) A conceptual site model diagram showing the proposed development superimposed on one or more of the above cross-sections.

A conceptual site model presenting the proposed development, superimposed on the above cross-sections, is shown in **Figure 8**. Please note the design details of the landfill construction have been generalised on the diagram to illustrate their overall geometry e.g. the individual hazardous cells have not been represented, they have been presented as a single hazardous cell.

6.2. More detailed analysis of existing data and information, where available, is required to improve the overall conceptual model for the site. For example:

a) Detailed geological log for Dunne Drilling borehole "5668" drilled in November 2008. From Table 14.3 (p.221) of the EIS it seems this borehole may be BH4A, which is available, and if so, confirm that the "black rock" described by Dunnes is in fact the Loughshinny Formation.

The conceptual model has been updated and is presented in Chapter 4 of this report.

The “black rock” logged in BH4a is the Loughshinny Formation. The log for BH4a is a drillers log. An interpretative log is available for BH4 which was drilled approximately 170 m south west of BH4A (**Appendix C**). The log for BH4 shows 3 m of till overlying limestone bedrock (i.e. the Loughshinny Formation). The proximity of these wells confirms that the “black rock” in BH4a is the Loughshinny formation.

Furthermore, BH4A and BH14 are consistent with the pattern of groundwater levels observed on the site e.g. they are both down gradient of the 100 mOD contour line.

b) Boreholes BH1, BH2 and BH3 were presumably drilled on-site in the past and details about these (location, depth, borehole logs etc.) should be presented.

The logs for for BH4, BH10 and BH11 are presented in **Appendix C**.

c) Appendix A14.4 states that borehole logs are not available for BH4, BH10 and BH11; however the 1999 EIS has a log for BHl0. Review the overall findings of the application with this new information.

Details for BH4, BH10 and BH11 are presented in **Appendix C**. The available logs for all historic boreholes drilled on site are also included in this appendix and their locations have been added to **Figure 1** which presents all explorative holes on site.

These logs confirm the overall findings for the application.

- BH4: located 170 m to the west of BH4A has limestone (Loughshinny Formation) at 3 mbgl, as expected
- BH10: located to the east of BH10A. Limestone (Loughshinny Formation) was encountered at 4 mbgl (131 mOD) indicating limestone is shallower here than in BH10A, where limestone was encountered at 21 mbgl (116 mOD). Across the site the limestone levels vary due to the presence of faulting and the erosional period that occurred during the depositional period between the Visean (Loughshinny) and Namurian deposits.
- BH11 is located underneath the proposed hazardous cell, north east of BH16. The log shows shale to end of hole (50 mbgl) which is consistent with BH16.

d) Figures 14.2, 14.5 and 14.12 show most (not all) of the boreholes and trial pits that have been drilled or excavated on-site: Please provide this information all on one figure. The figure should include topographical detail for the area as a whole (including national grid coordinates), including the area beyond the licence boundary (where off-site monitoring wells and water courses are located).

Figures 1 and 2 show all exploratory holes for the site on site specific topographic and OS mapping. **Figure 2** also presents the watercourses in the wider area.

6.3. Provide separate figures showing the shallow (Namurian) and deeper (Loughshinny) groundwater flow regimes. Also present groundwater flow in a regional context on a detailed figure including site and off-site data, householder/farm wells and the Bog of the Ring water supply wells and trial wells (Figure 12 of the Hydrogeological Quantitative Risk Assessment only shows the local site groundwater flow regime).

The flow regimes are depicted on the following figures:

- **Figure 3:** Regional groundwater flow regime
- **Figure 4**: Groundwater levels measured in the Visean strata (Loughshinny Formation)
- **Figure 5**: Groundwater levels measured in the Namurian strata.
- **Figure 6**: Groundwater flow in both Namurian and Loughshinny formations

The regional groundwater flow has been discussed in detail in the report ‘Hydrogeological Isolation: Bog of the Ring and the MEHL site’ which was submitted to the EPA on the 18th Febuary 2013. The requested figures described in 6.3 are presented in that report in Figures 1, 3, 13, 14 and 17.

7. *Geology, hydrology and hydrogeology*

7.1. Any further analysis of the impact on groundwater should utilise vulnerability and aquifer classifications using GSI guidelines. This refers specifically to the claim that the Namurian bedrock at the site can be interpreted as low permeability subsoil for the purpose of groundwater vulnerability mapping. Bedrock is not subsoil and cannot necessarily be used in this way. Also, it is not clear that the Namurian bedrock has low permeability in the first place. If it is believed that site specific circumstances allow the aquifer to be considered differently, there is need for much more site specific information on the bedrock units beneath the site, as set out in detail in this notice.

The critical issue relating to the vulnerability and aquifer classifications for the site is the protection of groundwater.

The GSI Guidelines are directed at the protection of shallow groundwater as represented by the water table. The GSI Guidelines do not describe the vulnerability conditions relating to confined groundwaters. For example, where a bedrock aquifer is overlain by a bedrock aquitard which in turn is over lain by a thin layer of overburden then the GSI Guidelines would correctly describe the groundwater (as represented by the water table) in the aquitard as being vulnerable to contamination. However, the same description could not be extended to the groundwater within the confined aquifer simply on the basis of the thin overburden cover.

The GSI document "Groundwater Protection Response for Landfills" states that for an R3^2 site landfills are not generally acceptable unless "*There is a minimum consistent thickness of 3 metres of low permeability subsoil*".

The Landfill Directive (1999/31/EC), however, is the current legal basis for the provision of environmental protection from landfills and the GSI document predates this. Therefore, the requirements of the Landfill Directive supersede those of the GSI document.

Annex 1 of the Landfill Directive states that the location of a landfill must take into consideration requirements relating to *inter alia*:

"(b) the existence of groundwater, coastal water or nature protection zones in the area

(c) the geological and hydrogeological conditions in the area"

Section 3 of Annex 1 of the Landfill Directive deals with the protection of soil and water. Section 3.2 states that:

"*The geological barrier is determined by geological and hydrogeological conditions below and in the vicinity of a landfill site providing sufficient attenuation capacity to prevent a potential risk soil and groundwater*"

Minimum thickness and permeability values are provided for the mineral layer to protect soil, groundwater and surface water for the different waste types.

Critically, the Landfill Directive also states:

"*Where the geological barrier does not naturally meet the above conditions it can be completed artificially and reinforced by other means giving equivalent protection. An artificially established geological barrier should be no less than 0.5 m thick*"

The Landfill Directive does not provide minimum requirements for the natural geological and hydrogeological conditions. Rather it states that engineered solutions are acceptable to protect groundwater and soil.

The GSI vulnerability map describes the site as extremely vulnerable as the site is a former quarry. This vulnerability rating relates to groundwater within the shallow bedrock aquiclude formations and reflects the present absence of overburden deposits overlying the aquitard.

The vulnerability of the groundwater within the confined Loughshinny Formation can be assessed by reference to the protection afforded by the overlying aquitard and which, based on site specific data, can be described as Moderate.

There is a minimum of 10 m of, and up to at least 60 m of, moderate to low permeability material present across the northern part of the site. This material is described as "shale". However in many locations it has weathered to a clay. **Plate 1** shows an imprint clearly embedded in the clay material from BH16.

Plate 1. Thumb print in shale (clay) material from BH16

This clay is typical of the "shale" beneath the site and clearly offers protection to the groundwater in the aquifer. In line with GSI guidelines, this can allow the vulnerability to be redefined to Moderate.

Critically, the clay material described as shale would offer protection to groundwater, which is additional to the protection afforded by the engineered landfill liners required under the Landfill Directive.

7.2. Since the bases of the proposed landfill cells are expected to be only 2m above the current water table in places, more consideration of past, current and potential future water levels and abstraction scenarios linked to the Bog of the Ring water supply scheme is required. Illustrate the effect of the abstraction on groundwater piezometry and potential for change in the (yet to be fully characterised) groundwater divide between the site and the Bog of the Ring.

a) For example, this requires analysis of groundwater level data for the MEHL site area prior to commencement of pumping at the Bog of the Ring (water level data is available in the 1999 EIS) as well as in the more recent past.

b) It also requires consideration of the impact of (a) increased abstraction and (b) reduced abstraction (there being evidence of reduced yields) from the active water supply wells possibly leading to groundwater rebound beneath the proposed landfill cells. ·

c) In addition, more regional groundwater level data is required (for example, this might include local domestic well water levels, Bog of the Ring pumping/monitoring/trial well water levels, water level data from the Fingal County Council EIS, or the installation of additional wells to the north of the MEHL site).

d) If insufficient off-site wells are found to exist to define the groundwater divide location, particularly if fault controlled preferential groundwater movement to the north is an important factor, then this should be addressed

The MEHL site falls outside the catchment of, and any hydrogeological influence from, the existing Bog of the Ring abstraction as detailed in the report 'Hydrogeological Isolation: Bog of the Ring and the MEHL site' submitted to the EPA on 18th February 2013.

Consequently, groundwater levels at the MEHL could not have been influenced by the Bog of the Ring abstraction in the past and will not be affected by any future reduction in the output from the Bog of the Ring abstraction as presently configured.

The future of the Bog of the Ring abstraction was discussed at the Tooman - Nevitt landfill oral hearing. Fingal County Council, which manages the abstraction, stated its intention to supply the north of the County from surface water supplies. This abstraction or the aquifer in the area would not be developed further.

The development of the major abstraction from the River Shannon at Lough Derg to serve the Greater Dublin Area is a key element of national water policy. This scheme has recently been confirmed and should, when complete, provide sufficient water to supply the north of Fingal well into the future

In the event that the Bog of the Ring abstraction was extended through the development of additional production wells to the south of the existing well field then it is possible that the MEHL site could then fall within the influence of an extended Bog of the Ring abstraction.

Based on the updated site conceptual model discussed in Chapter 4, during stressed or pumping conditions, groundwater in the Namurian may enter the underlying aquifer via faults. If the site was to fall within the catchment and cone of depression of an abstraction and the landfill liner leaked, contaminants may, having also passed through the clay liner, enter the catchment of the abstraction. For this reason, the faults beneath the site will be grouted prior to development and the design of this will be confirmed during the detailed design stage, prior to commencement of construction.

7.3. Provide data that proves the upward head gradient currently depicted between the Loughshinny Formation and overlying Namurian Formation in Figure 13 ("Schematic Conceptual Model") of the Hydrogeological Quantitative Risk Assessment. The groundwater level data presented in the EIS suggests there may be an upward head gradient in the north-east of the site, but there appears to be a downward head gradient for the majority of the rest of the site, including where the proposed landfill cells are located. The installation and monitoring of well pairs (each one of a pair screened either in Namurian or Loughshinny Formations) in the areas where landfill cells are proposed appears to be the only way to accurately prove the issue of head gradients (see item 8 below).

New monitoring wells were installed on the site in July 2013. The drilling conditions on the site, meant that well pairs could not be constructed in all areas of the site as suggested above. The site investigation is discussed in **Chapter 3** and **Appendices D-H**.

7.4. Illustrate on an appropriate map or drawing the location and course of the stream referred to as being 1.5km to the east of the site and hydraulically connected to the site via groundwater.

Figure 2 presents the surface water features in the region.

The stream referred to is located 1.5 km east of the site and runs north- south, parallel to the site boundary and is presented on **Figure 2**. This stream is hydraulically connected to groundwater in the aquifer and it is likely that groundwater in the Loughshinny Formation discharges at this point.

8. Additional site investigations

In order to improve the landfill site element of the CSM, additional site investigation is expected to be· carried out. It is expected that there should be groundwater monitoring wells within the footprint of each of the proposed landfill cells. Specifically:

8.1. Where both Namurian and Loughshinny bedrock exist, well pairs are needed (comprising one well screened in Namurian and one in the Loughshinny Formations). Where one suitable well already exists the second can be installed close to it (within 5m).

8.2. Such well pairs are expected to be needed within each of four fault blocks created by the N-S fault and E-W fault that transect the site, allowing better assessment of groundwater flow across fault structures and between the Namurian and Loughshinny, and consideration of potential flow along fault zones during pump testing. As the proposed hazardous waste cell is located across all fault blocks and in an area where both formations exist (Narnurian over Loughshinny), this will be the likely main area of focus.

8.3. There is also a need for good well data for the proposed non-hazardous waste cells and new inert cell. In some of the southern area (southwest quadrant) there appears to be insufficient well points, although, as only the Loughshinny is present only single well points are needed. Where it cannot be demonstrated to the EPA's satisfaction that suitable monitoring wells already exist then additional ones are needed.

8.4. Because pump test data may suggest flow along the fault zone (from our review) there is a need to have a well pair at the north end of the proposed hazardous waste cell on the line of the main N-S fault zone.

8.5. As part of preparation for the additional investigation programme consideration should be given to the benefit of undertaking coring of certain boreholes and downhole geophysical logging to maximise understanding of lithology, fracture distribution and orientation, etc.

8.6. A 7-day pump test and associated step test and recovery test should be carried out. (For such a complex site a 2-day test is too short). It is also suggested that the suitability of BH17 as a pump test well should be reconsidered, and a new well (or a packer in BHl7) potentially installed so that the pump test only draws water from the Loughshinny Formation. This will allow better interpretation of the main aquifer zone and the hydraulic connectivity to the overlying Namurian.

Additional site investigation has been undertaken to address points 8.1 – 8.6. This site investigation is discussed in Chapter 3 and details of this are included in **Appendix D-H)**.

8.7. If the further assessment of off-site (down gradient) groundwater levels do not provide conclusive evidence of the location of the groundwater divide between the site and the Bog of the Ring abstraction scheme, then some off-site drilling may be required to address this data gap in the CSM.

The MEHL site falls outside the catchment of, and any hydrogeological influence from, the Bog of the Ring abstraction as detailed in the report ‘Hydrogeological Isolation: Bog of the Ring and the MEHL site’ submitted to the EPA on 18th February 2013. No off-site drilling is required.

2.2 Article 16 Notification: 11th July 2012

1. Formation levels

Condition 3.5.5 of the existing licence (W0129-02) authorises development of landfill cells only above 104.5 mOD. Explain on the rationale for now proposing development above 102.5 mOD with sumps to be placed at 102 mOD. State what circumstances have changed to allow for this new proposal. This question should be addressed in the context of our earlier correspondence dated 23 March 2012 (and in particular item 7.2 therein)

Groundwater levels have risen since the original application in December 2010. This is discussed further in section 3.2. For this reason the formation level has been raised to the level of 104.5 mOD licenced in W0129-02.

Conclusive evidence of the location of a groundwater divide between the site and the Bog of the Ring have been addressed in the report 'Hydrogeological Isolation: Bog of the Ring and the MEHL site' submitted to the EPA on the 18th of February 2013. As such no further discussion of this question in the context of item 7.2 (from the 23rd March 2012) is required.

3. Groundwater trigger levels

3.1 Annex III, section (4)(C), of the Landfill Directive requires that trigger levels be laid down in a licence whenever possible,

- *State what trigger levels are proposed*
- *State what contingency plan will be followed in the event of a trigger level being reached*

3.2 In accordance with the requirements of the European Communities Environmental Objectives (Groundwater) Regulations 2010 and having regard to Guidance on the Authorisation of Discharges to Groundwater, published by the Environmental Protection Agency, provide a technical assessment in relation to the setting of groundwater compliance points and values. Propose the compliance points to be utilised, the corresponding compliance values and the compliance monitoring to be employed.

Questions 3.1 and 3.2 have been answered together as the trigger levels, compliance points and contingency plans are all interrelated.

The proposed compliance monitoring network is shown on **Figure 9**. In accordance with the EPA publication *Guidance on the Authorisation of Discharges to Groundwater* the monitoring network points have been based on the conceptual model for the site:

- The monitoring points have been placed in an outer and inner ring to allow any breaches of trigger levels to be detected before they reach the site boundary. The compliance points are those marked on **Figure 9**.
- All wells will have response zones in both the Namurian strata and the Loughshinny.
- Existing wells on site will be incorporated into the monitoring network, particularly for the up-gradient wells. New down-gradient wells will be installed in the direction of flow (south east) and also the north and east.
- Monitoring wells will be located in known fault zones to ensure that any potential movement of contamination is detected

The locations shown on **Figure 9** are indicative only and the exact locations will be agreed in consultation with the Agency, and with due regard for site conditions, the location of site infrastructure, access to monitoring locations etc. However, any monitoring point that is moved will comply with the requirements listed above.

The trigger levels proposed to be used for this licence are based on the Threshold Values listed in S.I. No. 9 of 2010 European Communities Environmental Objectives (Groundwater) Regulations, 2010. The compliance levels proposed are from S.I. 278 of 2007 European Communities (Drinking Water) (No.2) Regulations 2007. Table 2.3 lists the compliance points and trigger levels proposed for the site.

Table 2.3 Proposed compliance points and trigger levels

Parameter	Trigger level (mg/l)	Compliance value (mg/l)
Barium	*0.525	0.7[2]
Cadmium	0.00375	0.005[1]
Total chromium	0.0375	0.05[1]
Copper	1.5	2[1]
Mercury	0.00075	0.001[1]
Molybdenum	*0.0525	0.07[2]
Nickel	0.015	0.02[1]
Lead	0.01875	0.025[1]
Antimony	*0.00375	0.005[1]
Selenium	*0.0075	0.01[1]
Zinc	*3.75	5[3]
Chloride	187.5	250[1]
Fluoride	*0.75	1[1]
Sulphate	187.5	250[1]

[1] S.I. 278/2007 European Communities (Drinking Water) (No.2) Regulations 2007
[2] WHO Health
[3] UK Drinking Water Standard

*No trigger level is available, so a value of ¾ the compliance value was used

Arsenic and manganese will not be included in the monitoring, as they are naturally elevated in the groundwater of the area.

The contingency plan in the event of a trigger level being reached is laid out below. The following infrastructure will be put in place to allow the contingency plan to be operated effectively:

- A leak detection system will be installed between the DAC and the low permeability clay liner. The presence of the low permeability liner below the leak detection system will ensure that if a leak through the DAC does occur, the contamination cannot enter groundwater immediately.
- Monitoring wells will be installed in an ‘inner’ and ‘outer’ perimeter to allow two levels of protection to be put in place.

The contingency plan has been developed in “layers” to allow any elevated contamination instances to be detected before groundwater is unacceptably impacted:

1. Leak detection system is the first element of the contingency plan. Leachate flow in the leak detection system will be monitored and if higher than normal flows and concentrations are observed the cause will be investigated.
2. The first trigger levels will be set at the ‘inner’ circle of monitoring wells. The use of the threshold values from the Groundwater Regulations as the trigger levels is conservative, as these are three quarters of the corresponding compliance point. This ensures that any potential sustained upward trend in groundwater concentrations will be identified before the compliance values are exceeded.
3. If a breach of the trigger level is detected at the trigger locations, the monitoring frequency will be increased.
4. If the trigger levels are also reached at the compliance points a study will be undertaken to establish if an upward trend, which is not attributed to background contamination can be identified.
5. If a sustained upward trend, which is not attributed to background contamination is identified in both the trigger and compliance wells, an investigation will be undertaken into the competence of the landfill liners
6. While the landfill liners are being investigated, the waste will be covered 24 hours a day. This will prevent further leachate generation during the investigation.
7. In the highly unlikely event of a leak being detected in a cell, no waste will be placed in that cell until the risks have been adequately mitigated.
8. The trigger points will be designed to allow them to be used for pumping of contamination if necessary. If breaches of compliance values are observed and a leak has been identified, a programme of pumping will be undertaken until concentrations reduce to background levels.

3 Additional Site Investigation

3.1 Additional works

A programme of additional site investigation was undertaken on the MEHL site to supplement the information available. These investigations and the reasons they were undertaken are summarised in **Table 3.1**.

Table 3.1 Summary of additional site investigation

Timescale	Work summary	Purpose of work
March 2013	Downhole geophysics on existing wells	Aid the interpretation of the lithologies encountered on site
June 2013	Drilling 7no. new groundwater monitoring wells	Provide additional information on the geology and hydrogeology of the site
	Collection of samples for palynology and micropalaeontology analysis	Aid the interpretation of the lithologies encountered on site
	Downhole geophysics on newly drilled wells	Aid the interpretation of the lithologies encountered on site
July 2013	Groundwater monitoring	Establish current groundwater levels
	7 day pumping test	Provide additional information on the hydrogeological conditions beneath the site

New groundwater monitoring wells were drilled across the site. Details of these are included in **Appendix D**. The groundwater levels recorded across the site are discussed in section 3.2 and data is presented in **Appendix E**.

Two phases of down-hole geophysics were undertaken in December 2012 and July 2013. The factual report for this work is presented in **Appendix F** and the interpretation of the geophysics is presented in section 3.1.1.

Samples were collected from BH24 and BH30 for palynology and micropaleontology analysis to aid in the interpretation of the lithologies encountered. The factual report for this work is saved in **Appendix G** and the interpretation is summarised in section 0.

The pumping test data and interpretation is presented in **Appendix H**.

3.1.1 Downhole Geophysics

The data from the downhole geophysics is presented in **Appendix F** and the results have been summarised in **Table 3.2**.

Table 3.2: Downhole geophysics summary

Location	Monitoring Well and amomaly reference	Approximate depth of anomaly – on the geophysics logs (m bgl)	Comments
BH4a	BH4a-01	1 – end of log	The borehole is located outside of the site boundary by ~250m to the east. There is no detailed interpretation of the geology in this area however both the induction and natural gamma reading suggest there is little variation in the top 8m of the strata logged.
BH11a	BH11a-01	10.5 – 12	Relatively large increase in the natural gamma reading which may be indicative of the 'fractured shale' recorded on the borehole log, especially if the fractures are filled with clay.
	BH11a-02	19 – 23	Reduction in the natural gamma reading which is indicative of an increase in particle size. The borehole log records 'heavily weathered shale from 18m bgl going into to 'sandy shale' at 21m bgl. It is likely that the reduction in the natural gamma output is associated with the sandy shale on the borehole log.
BH15a	BH15a-01	5	The rise in temperature may be indicative of the top of groundwater level.
	BH15a-02	12.5 – 15	Relatively large increase in the natural gamma reading which may be indicative of an increase in clay content.
	BH15a-03	20	The DELC log (assumed change in conductivity) shows a relative increase which may be indicative the boundary between the Balrickard and Donore Formations shown on the borehole logs at 17m bgl.
	BH15a-04	2 – 13	The top portion of the conductivity log is relatively low (typically <75mS/m), whereas the low part of the log records relatively high. This may be indicative of the change between the Balrickard and Donore Formations.
	BH15a-05	15 – 23	
BH17	BH17-01	3	The rise in temperature may be indicative of the top of groundwater level.
	BH17-02	7.5	The DELC log (assumed change in conductivity) shows a relative increase
	BH17-03	15 – 22 and 43 – 51	At these two depth horizons a subtle in conductivity is recorded. Neither of them have a reasonable correlation with the information on the borehole log.
BH18	BH18-01	8	The rise in temperature may be indicative of the top of groundwater level.

Location	**Monitoring Well and amomaly reference**	**Approximate depth of anomaly – on the geophysics logs (m bgl)**	**Comments**
	BH18-02	4 – 10	The natural gamma reading fluctuations observed correlate with the 'interbedded sandstone and mudstone' description provided on the borehole log. The spikes and troughs may be representative of the mudstone and sandstone respectively.
BH19	BH19-01	11 – end of log	BH19 was drilled close to two fault zones. The increase in natural gamma response maybe indicative of material fractured by faulting as observed in the correlation discussed in anomaly BH11a-01.
BH20	BH20-01	10	The DELC log (assumed change in conductivity) shows a relative increase
BH24	BH24-01	11.5 – 13.5	On the natural gamma log, an increase from approximately 80 API units (American Petroleum Institute) to approximately 150 API occurs at the base of the superficial deposits. There is also a notable change in the hydraulic conductivity of the water at this depth.
	BH24-02	31 and 33	Two relatively large readings in the natural gamma log suggesting an increase in the shale / clay content at these depths.
	BH24-03	34 – end of log	The large increase in induced conductivity from ~50mS/m to ~140mS/m, may be indicative of the very soft weathered layer or the iron content causing the iron staining detailed on the logs.
	BH24-04	37 – end of log	The natural gamma log drops to ~80API, there are no other locations on site where this anomaly has been observed however a drop in gamma may indicate the presence of open fractures.
BH25	BH25-01	13.8	Generally over the depth of the borehole there is a steady fluctuation in the natural gamma log which may be indicative of the shale content of the rock. This is discussed in more detail below.
BH26	BH26-01	18.2 – end of log	A relatively large reading in the natural gamma log suggesting an increase in the shale / clay content at these depths. This may be related to the clay filled fractures observed in the borehole logs.
BH27	BH27-01	7 – 8.5	A relatively large reading in the natural gamma log suggesting an increase in the shale / clay content at these depths. This may be related to the heavily weathered rock with large amounts of clay infill observed in the borehole logs.

Location	**Monitoring Well and amomaly reference**	**Approximate depth of anomaly – on the geophysics logs (m bgl)**	**Comments**
	BH27-02	8 – end of log	The induced conductivity increases from ~60mS/m to ~90mS/m. This anomaly may be representative of the increased weathering of the rock and increased amount of infill observed on the borehole logs.
BH28	BH28-01	14.5	The induced conductivity log shows a gradual increase in conductivity (from 50mS/m to 125mS/m) and the profile is less smooth from this depth. This may be indicative of the boundary between the superficial deposits and the underlying rock.
	BH28-02	31 – end of log	The induced conductivity log shows a gradual increase in conductivity (from 50mS/m to 75mS/m) and the profile is less smooth from this depth. This anomaly may be representative of the increased weathering of the rock observed on the borehole logs.
BH29	BH29-01	25 – end of log	The induced conductivity log shows a gradual increase in conductivity (from 25mS/m to 60mS/m) and the profile is less smooth from this depth. This may be indicative of the boundary between the superficial deposits and the underlying rock. The high values may also be representative of the iron staining and increased amount of infill observed on the borehole logs.
BH30	BH30-01	24.5	The induced conductivity log shows a gradual increase in conductivity (from 25mS/m to 50mS/m) and the profile is less smooth from this depth. This may be indicative of the boundary between the superficial deposits and the underlying rock.
	BH30-02	32, 36.3 and 38.7	Three relatively large readings in the natural gamma log suggesting an increase in the shale / clay content at these depths.
	BH30-03	54	The induced conductivity log shows a gradual increase in conductivity (from 50mS/m to 100mS/m). This may be indicative a change in lithology

3.1.2 Paleontological Analysis

The full paleontological analysis is presented in **Appendix G**. Samples were collected from BH30 and BH24 and the results are summarised below:

- BH30: Micropalæontology results from MEHL 30 are late Asbian – Brigantian, consistent with the Loughshinny Formation. The palynology results are in line with these findings, confirming the marine setting for the shales interbedded with limestones. This confirmed that BH30 finished in the Loughshinny Formation
- BH24: There are inherent problems with being definitive with the lithology. The palynology gives broad ranging Visean or younger results, and indicate a strong terrestrial influence. This is in keeping with the younger lithologies of the Donore, Balrickard or Walshestown Formations. Based on the site geology it is likely that this borehole finished in the Walshestown Formation.

3.2 Discussion Of Results

3.2.1 Groundwater Monitoring

As outlined in Chapter 3 groundwater level monitoring was undertaken in all the active wells on the site on the 8th July 2013. This data is presented in **Appendix E**. This data demonstrates that:

- The groundwater levels for the site have been observed to increase since the original application in 2010. The groundwater levels are expected to increase to pre-pumping levels.
- It should be noted that the levels measured in September 2013 were up to 1 m lower than those measured in July 2013. As a worst case scenario, the higher levels recorded have been used as the basis for this discussion.
- The regional groundwater flow direction is to the southeast as shown on **Figure 3**. Groundwater flow contours for the site are presented in **Figures 4 – 6.**
- Over the majority of the site, the Loughshinny Fm and Namurian strata have different flow regimes (e.g. BH29 and BH30), although they appear to be hydraulically connected at some locations (e.g. BH27 and BH18). The vertical gradients and connection between the lithologies are discussed further later in this section.
- The groundwater flow direction in the Loughshinny is clearly to the south east and is in line with the regional groundwater contours (**Figures 4** and **6**).
- The groundwater flow direction in the Namurian is dominated by the topography with local variations due to the inhomogenous nature of the material (**Figures 5** and **6**).

- The site can be divided into 4 quadrants based on the faulting on the site, similarities in the groundwater levels can be observed in each quadrant, in the centre of this site. This may indicate that the faulting is effectively partitioning the groundwater in different areas. However, it may be that the similarities observed are more a function of the lithologies and the distributions of the wells e.g. in the north west of the site, the majority of the wells are screened in the Namurian, while in the southwest of the site, they are primarily in the Loughshinny Fm.
- A vertical upward gradient exists in some areas of the site e.g. the groundwater level recorded in BH30 (Loughshinny Fm) is 1m above that in BH29 (Namurian deposits).
- The ground level recorded in BH12 is consistent with the Loughshinny readings across the rest of the site. However, the groundwater levels in BH13 (122.57 mOD) and BH8 (133.2 mOD) are perched relative to the base of the quarry and the Loughshinny Fm. This is not thought to be indicative of a downward vertical gradient but is more likely a function of the Namurian response zone being located in an isolated fracture or impermeable zone. The 11m head difference between BH13 and BH8 over a relatively short distance (150 m) further corroborates this.
- BH27 (Namurian strata) and BH18 (Loughshinny Fm) would also be expected to show a vertical upward gradient due to their proximity. Groundwater levels recorded in these wells are very similar indicating that they are likely to be hydraulically connected. This may be due to their position close to the east west fault as weathered zones related to this fault may be allowing the connection.
- A vertical downward gradient can also be observed on the site. BH20 and BH26 may be considered a well pair as BH20 is screened across the Namurian strata and the Loughshinny Fm while BH26 is only screened in the Namurian. The groundwater level recorded in BH20 is 0.46 m below the level recorded in BH26 indicating a downward gradient may be present here. It does, however, also illustrate that the Loughshinny and Namurian are hydraulically separate over the majority of the site.

In summary, the groundwater level information indicates that under static conditions the groundwater in the Namurian strata and Loughshinny Formation are hydraulically operate independently of each other.

3.2.2 Faulting

The original conceptual model suggested the site be divided into four quadrants based on the faulting across the site. The recent investigations confirmed the appropriateness of this.

- The geological map of the site shows the main N-S fault and two E-W faults. This was prepared on the basis of geological field mapping and geophysics (original EIS site specific geological map presented in **Figure 10**).
- The E-W fault to the east of the N-S fault was detected by the geophysics which indicated it may have a downthrow of up to 80 m to the north. The geological logs for BH 25, BH18, BH27, BH11 and BH16 show the Loughshinny Formation getting progressively deeper towards the north of the site (shown on **Figure 7**).

- The North-South fault was detected by the geophysics and geological mapping. The movement along this fault is complex as to the south of the east west fault, the eastern block appears to be downthrown however to the north of the E-W fault, the western block appears to be downthrown. This may indicate that the north-south fault is the older faulting while the east-west faulting occurred later.
- **Figure 7** presents cross sections taken across the faults running N-S and E-W. These figures illustrate the influence of faulting on the site geology.

3.2.3 Pumping

A pumping test was conducted in BH17 (the pumping well) at the MEHL site as part of the hydrogeological site investigation in July 2013. The pumping test was split into the following phases:

1. **Constant Rate Test 1** - An abandoned 6-hour constant rate discharge test on Tues, July 9, 2013;
2. A 16.5 hour recovery period between Tues and Wed, July 9 and 10, 2013;
3. **Constant Rate Test 2** - A 7-day constant rate discharge test commenced on Wed, July 10, 2013;
4. **Recovery Test** - A 24-hour recovery test on Wed, July 17, 2013.

Full details of the pumping test and its interpretation are presented in **Appendix H**.

Based on the results of the pumping test it can be determined that under stressed conditions groundwater can move from the Namurian strata into the aquifer along the faults.

4 Updated Conceptual Site Model (CSM)

4.1 Summary Site Conceptual Model

A summary of the hydrogeology of the MEHL site is presented here in the form of a site conceptual model (CSM). This draft updates the previous CSM presented in the EIS and incorporates additional site investigation information gathered in June and July 2013.

The conceptual model for the site has evolved through the various stages of the project from initial desk study through the interpretation of site specific data. Cross sections illustrating the conceptual site model are presented in **Figures 7** and **8** and the model can be summarised as follows:

- From the GSI map of the area (Sheet 13), the Carboniferous rock units (Walshestown, Balrickard, Loughshinny and Naul formations) are folded into a gentle syncline (bowl-shaped fold), whose axis runs roughly WNW-ESE. The Walshestown Formation occupies the centre of the fold, surrounded in sequence by the Balrickard formation, Loughshinny formation and the Naul formation to the south. The site is located on the south west limb of this syncline.
- The effect of this synclinal structure is to bury the Loughshinny Formation even deeper than would be expected had the rocks in the area not been folded. The Loughshinny Formation is dipping in towards the centre of the syncline, resulting in it becoming deeper as its traced northwards.
- Bedrock beneath this former quarry site can be divided into an aquifer unit, the Loughshinny and Donore Formations and an aquitard unit which consists of the overlying Balrickard and Walshestown Formations. The aquifer unit is classified by the GSI as a Locally Important Aquifer and the aquitard as a Poor Aquifer
- The majority of the site is underlain by the aquitard. The limestones of the Loughshinny Formation crop out in the southern part of the MEHL site and dip to the to the north, where they are covered by up to 60 m of aquitard strata in the northern parts of the site.
- The faulting within the site is shown on the site specific geological map presented with the EIS (Figure 10). The understanding of the behaviour of the faulting has been refined with information from site investigation information gathered in 2013 and this is discussed further in this section. The faulting passes through all the rock units found on the MEHL site.
- Permeability in the strata beneath the site is predominantly secondary in the form of joints, fractures, weathered/broken zones and faults. Permeability in the aquifer unit is of the order of 10-4/10-5m/s. In the permeable horizons of the aquitard, permeability is of the order of 10-6m/s and in the remainder of the strata it is of the order of 10-7/10-8m/s. Storage in all of these strata is low.
- The aquitard strata on-site act as a low permeability layer and confine/isolate groundwaters within the aquifer from the surface in some areas of the site. The increasing thickness of these strata reduces the vulnerability to the north.

- The groundwater levels in the aquifer unit are relatively consistent across the site and lie below the floor of the quarry aside from the large pond in the extreme southern part of the site. Groundwater levels in the overlying aquitard strata are more variable and are elevated in relation to those in the underlying aquifer. More permeable fissures are present within the aquitard and these are under artesian pressure.
- Groundwater levels in recent monitoring rounds have been observed to be increasing, indicating that levels may be rebounding following the cessation of dewatering at the quarry. The current design level of the base of the landfill is 102.5 OD while the highest groundwater levels recorded in the base of the landfill are 103.37 mOD. The design base of the landfill has been raised to the original formation level of 104.5 mOD to account for this.
- Groundwater flows in a generally south easterly direction from the site at a gradient of 0.02-0.05 and a velocity of approximately 1.48 x 10-5 m/s.
- The site is located in the upper part of a groundwater catchment. This location, the general absence of large springs in the aquifer, the confined nature of much of the aquifer in the site area and the moderate gradient and velocity indicate that the natural groundwater throughput in the aquifer is relatively low.
- The pumping test indicated that under stressed (pumping) conditions, that groundwater from the Namurian strata can enter the aquifer through the faults on the site. If the site was to fall within the catchment and cone of depression of an abstraction and the landfill liner leaked, contaminants may, having also passed through the clay liner, enter the catchment of the abstraction. Figure 11 presents the conceptual model of this.
- In order to mitigate this risk, the faults beneath the site will be grouted up prior to the development. The design of this will be developed and tested during the detailed design phase of the proposed development.

5 Updated Quantitative Risk Assessment (QRA)

The QRA has been updated in line with additional site investigation information, changes to the conceptual model and questions from the EPA.

5.1 Model Scenarios

Three QRA models were presented in the original WLA. These are outlined below:

- Primary model: This model was constructed based on site specific information for both the landfill design and the hydraulic characteristics of the ground in order to make it as representative of site conditions as possible. All the landfill cells were modelled in the same model.
- Supplementary model 1: Represented the proposed development with a major defect in the liner of one of the hazardous cells.
- Supplementary model 2: Represented the proposed development with no engineered barriers in place.

This report presents a series of updated models and a summary of the changes is listed below:

- The formation level of the landfill cells has been raised to 104.5 mOD. This has also led to a change in the area of the base of the landfill.
- Separate cells have been produced based on the presence or lack of a vertical pathway.
- The unsaturated zone thickness has been reduced to 2 m across the site.
- Representation of the hazardous waste as a constant source rather than a declining source

The EPA requested that the effects of other changes be considered. These include:

- Increasing the leachate head in hazardous and non-hazardous cells to 2 m and 5 m

The management control period has a large influence on the stability of the non-hazardous and inert models as it determines the leachate head on the engineered barrier. For this reason, for the non-hazardous cells, models were constructed with both 35 year and 20,000 year management periods to allow the results of both scenarios to be discussed and compared. It should be noted that the 20,000 year scenario in LandSim represents infinity.

The modelling was not completed for the inert cells as the risk they pose is less than that from the hazardous and non-hazardous cells.

The nomenclature used to discuss the individual models is summarised in **Table 5.1**. All the LandSim inputs (direct model print outs) and outputs (statistical and graphical) are saved in **Appendix A**. The table below lists which sub-appendix the individual models and results are presented in.

Table 5.1: QRA model nomenclature

Model name	Changes incorporated (as compared to original Primary model)	Appendix Reference	
		Model print out	**Model results**
Non-hazardous model V1	• Removes the vertical pathway as the non-hazardous cells will be placed in the south of the site	A1.1	A1.2
Non-hazardous model V2	• Same as V1 model but with a management control period of 20,000 years (infinity)	A2.1	A2.2
Hazardous model	• Includes the vertical pathway on site as the hazardous cells will be placed in the north of the site where the Namurian strata are present • Increase formation level to 104.5 mOD • Represent waste as a constant source	A3.1	A3.2
Supplementary Hazardous model 1	• Increase the leachate head in the hazardous cells to 2m	A4.1	A4.2
Supplementary Hazardous model 2	• Increase the leachate head in the hazardous cells to 5m	A5.1	A5.2
Supplementary Hazardous model 3	• Represent DAC as a double liner (not discussed in this report as the results did not indicate an impact on groundwater)	A6.1	A6.2
Supplementary non-hazardous model V1	• Non hazardous model v1 (management control period of 35 years) • Leachate head of 2m	A7.1	A7.2
Supplementary non-hazardous model V2	• Non hazardous model v1 (management control period of 35 years) • Leachate head of 5m	A8.1	A8.2
Supplementary non-hazardous model V3	• Non hazardous model v2 (management control period of 20,000 years) • Leachate head of 2m	A9.1	A9.2
Supplementary non-hazardous model V4	• Non hazardous model v2 (management control period of 20,000 years) • Leachate head of 5m	A10.1	A10.2
Appendices from original WLA, December 2010		A10	

5.2 Models Construction

The majority of the construction parameters for the models remain the same as the Primary models submitted with the original WLA. For this reason, much of the information provided in that report has not been repeated.

The model input parameters are presented in **Appendix A** as print-outs directly from LandSim.

The non-hazardous models V1 and V2 have all the same input parameters except for the management control period.

5.2.1 Source Term Input Parameters

The source term input parameters include the physical and chemical characteristics of the waste itself, the cell geometry and phasing details and the infiltration rates. These input parameters are discussed in detail in sections 5.2.1.1 to 5.2.1.4. The model print out from LandSim which summarises the input parameters for the primary model are presented in **Appendix A**.

5.2.1.1 Cell Geometry

As outlined above separate models have been constructed for the hazardous, non-hazardous and inert waste streams. The models and the number of cells in each is summarised below:

- Non-hazardous model: 3 cells (NH1a, NH1b and NH2)
- Hazardous model: 6 cells (H1a, H1b, H2a, H2b, H3a and H3b)

Important points to note include:

- For each waste type multiple cells will be constructed to reduce the amount of time that waste remains open to infiltration and to minimise leachate generation. In order to construct a representative model, each of these cells was modelled as an individual cell within the LandSim model.
- On the proposed development many of the cells have been divided in two in order to minimise leachate generation e.g. H1 has been divided into H1a and H1b.
- Each of the proposed cells will have its own sump so they have all been constructed separately in LandSim
- The proposed design for the cells shows them as irregular shapes as shown on Figure 14. In the LandSim model these cells were constructed as squares or rectangles with the area of the top and base maintained at the same size as the irregular shape.
- Where a cell has been divided in two to minimise leachate generation (e.g. H1 into H1a and H1b) the full design details of each individual cell are not available. For this reason it has presumed that the two cells will be identical with the volume of waste expected in cell H1 divided equally between cell H1a and cell H1b.
- The thickness of the waste varies across the site. To account for this variation, the thickness of each cell was entered as a Probabilistic Density Function.
- The thickness of the waste was reduced by 2 m when compared to the original Primary model as the formation level has been raised by 2 m. This has also led to a change in the area of the base of the landfill cell.

The details of the parameters used for the cell geometry are contained within Table 5.2.

Table 5.2: Cell Geometry Input Parameters

Cell number	Base area (ha)	Top area (ha)	Waste thickness			Comments
			Distribution	Min	Max	
Non-hazardous model (both V1 and V2)						
NH1a	0.86	2.24	Uniform	23.5	37.5	Dimensions from site plans and cross sections
NH1b	0.86	2.24	Uniform	23.5	37.5	Dimensions from site plans and cross sections
NH2	0.127	1.1	Uniform	7	16	Dimensions from site plans and cross sections
Hazardous model						
H1a	1.01	1.71	Uniform	8.5	17.5	Amended based on increase in formation level
H1b	1.01	1.71	Uniform	8.5	17.5	Amended based on increase in formation level
H2a	1.4	2.2	Uniform	9.5	24.5	Amended based on increase in formation level
H2b	1.4	2.2	Uniform	9.5	24.5	Amended based on increase in formation level
H3a	1.29	2.55	Uniform	13.5	32.5	Amended based on increase in formation level
H3b	1.29	2.55	Uniform	13.5	32.5	Amended based on increase in formation level

5.2.1.2 Phasing, Management Control Period And Infiltration

The phasing and infiltration values have not been amended for the updated modelling.

The management control period has a large influence on the stability of the models, particularly for the non-hazardous and inert cells due to its influence on the leachate head levels in the cells. It assumes that once the management control period is complete the landfill will be ‘abandoned’ and will have no further maintenance undertaken on it (although this is very unrealistic and contrary to EPA aftercare requirements). This has significant implications for the risk assessment model as beyond the specified management period the leachate level is no longer controlled. The leachate level and, as a result, leakage through the liner will increase.

The management control period for the hazardous cells has been set at 35 years, for the purpose of the model. Due to the instability of the non-hazardous models with a short management control period, two versions of the non-hazardous model have been created. The first has a management control period of 35 years and the second has a management control period of 20,000 years. A comparison of the concentrations of contaminants in groundwater for both models was undertaken to establish the difference between them and assess how much of an influence the instability of the model with the 35 year management period is having on the results.

5.2.1.3 Leachate And Waste Characteristics

The physical characteristics of the waste influence how much leachate may be generated while the chemical characteristics influence the contaminants which may arise. The head at which leachate head is maintained within the system determines how much leachate is allowed to build up within the cell before appropriate removal and disposal.

The head of leachate within the LandSim model was fixed in line with details from the Engineering Planning Report. Within the hazardous and non-hazardous cells the leachate will be allowed to reach a maximum of 1 m above the base of the cell.

As discussed in section 5.2.1.2 the management control period has a large influence on the leachate head levels. The leachate head assigned in the model only applies for the duration of the management control period, once this period ends, the leachate heads are allowed to rise within the model. Leachate head increases to the level where surface breakout occurs, defined by LandSim as the location where waste is thinnest.

The EPA has requested that model scenarios with leachate heads of 2 m and 5 m also be created for the hazardous and non-hazardous cells.

A summary of the models with the varying leachate heads is listed in **Table 5.3**. The management control period has also been listed in the table below due to its relevance to the leachate head.

The maximum head of leachate at which surface breakout occurs is also relevant and is included in **Table 5.3**. This parameter is the minimum thickness of waste in each cells. Once the management control period ends, the leachate head rises to this level and is set at this level for the rest of the simulation period. This indicates that very high leachate heads are present on the lining system once the management control period ends.

Table 5.3: Leachate Head Details Inputted To LandSim

Model name	Leachate head (m)				Control period (years)	Maximum head of leachate when surface breakout occurs (m)	Comment
	Distribution	Min	Likely	Max			
Non-hazardous model V1	Uniform	0.5		1	35	23.5 (NH1a, NH1b) 7 (NH2)	Management control period of 35 years A minimum value of 0.5m was chosen as it is unlikely a head of less than 0.5 m could be maintained. The maximum head value has been set as the maximum head stated in the Engineering Report for Planning (WYG, 2010)
Non-hazardous model V2	Uniform	0.5		1	20,000	23.5 (NH1a, NH1b) 7 (NH2)	Management control period of 20,000 years A minimum value of 0.5m was chosen as it is unlikely a head of less than 0.5 m could be maintained. The maximum head value has been set as the maximum head stated in the Engineering Report for Planning (WYG, 2010)
Supplementary non-hazardous model V1	Single		2 m		35	23.5 (NH1a, NH1b) 7 (NH2)	Management control period of 35 years A minimum value of 0.5m was chosen as it is unlikely a head of less than 0.5 m could be maintained. The maximum head value has been set as the maximum head stated in the Engineering Report for Planning (WYG, 2010)
Supplementary non-hazardous model V2	Single		5 m		35	23.5 (NH1a, NH1b) 7 (NH2)	Management control period of 35 years A minimum value of 0.5m was chosen as it is unlikely a head of less than 0.5 m could be maintained. The maximum head value has been set as the maximum head stated in the Engineering Report for Planning (WYG, 2010)

Model name	**Leachate head (m)**				**Control period (years)**	**Maximum head of leachate when surface breakout occurs (m)**	**Comment**
	Distribution	**Min**	**Likely**	**Max**			
Supplementary non-hazardous model V3	Single		2 m		20,000	23.5 (NH1a, NH1b) 7 (NH2)	Management control period of 20,000 years A minimum value of 0.5m was chosen as it is unlikely a head of less than 0.5 m could be maintained. The maximum head value has been set as the maximum head stated in the Engineering Report for Planning (WYG, 2010)
Supplementary non-hazardous model V4	Single		5 m		20,000	23.5 (NH1a, NH1b) 7 (NH2)	Management control period of 20,000 years A minimum value of 0.5m was chosen as it is unlikely a head of less than 0.5 m could be maintained. The maximum head value has been set as the maximum head stated in the Engineering Report for Planning (WYG, 2010)
Hazardous model	Uniform	0.5		1	35	8.5 (H1a, H1b) 9.5 (H2a, H2b) 13.5 (H3a, H3b)	A minimum value of 0.5m was chosen as it is unlikely a head of less than 0.5 m could be maintained. The maximum head value has been set as the maximum head stated in the Engineering Report for Planning (WYG, 2010)
Supplementary Hazardous model 1	Single		2 m		35	8.5 (H1a, H1b) 9.5 (H2a, H2b) 13.5 (H3a, H3b)	EPA request
Supplementary Hazardous model 2	Single		5 m		35	8.5 (H1a, H1b) 9.5 (H2a, H2b) 13.5 (H3a, H3b)	EPA request

The waste porosity, dry density and field capacity influence the amount of leachate which can be produced from the waste. The parameters used in this model are the same as those used in the previous version.

5.2.1.4 Leachate

As discussed in the response to questions 5.5, 5.6 and 5.8 the leachate inventory is composed of the most likely contaminants to arise from the waste. Waste-stream specific data is provided in **Appendix B** and some of the contaminants listed here have been excluded from the LandSim modelling e.g. thallium, vanadium, cobalt, manganese, tin, free cyanide and nitrite on the basis that they do not have waste acceptance criteria associated with them.

However, as discussed in the responses to questions 5.5, 5.6 and 5.8, the modelled contaminants have a higher mobility and toxicity than those not modelled. Therefore, if there is no impact to groundwater from the more toxic and mobile contaminants, there will be no impact from those not modelled.

Table 8.7: LandSim Leachate Inventory

Contaminant	Concentrations entered into LandSim (mg/l)		
	Inert waste: WAC	Non-hazardous waste: WAC	Hazardous waste: 3 x WAC
Arsenic	0.06	0.3	9
Barium	4	20	180
Cadmium	0.02	0.3	5.1
Total chromium	0.1	2.5	45
Copper	0.6	30	180
Mercury	0.002	0.03	5
Molybdenum	0.2	3.5	30
Nickel	0.12	3	36
Lead	0.15	3	45
Antimony	0.1	0.15	3
Selenium	0.04	0.2	9
Zinc	1.2	15	180
Chloride	460	8500	45000
Fluoride	2.5	40	360
Sulphate	1500	7000	51000

The maximum concentrations were set in the LandSim model as 3 times the Waste Acceptance Criteria (set in EU Council Decision 2003/33/EC) for the relevant waste type as a single value. These concentrations are the maximum amount of any particular contaminant which will be accepted into the landfill.

By inputting the concentration as a single value (rather than a probability density function) it presumes that all waste accepted will be at the maximum concentration which is a very conservative scenario. However, by inputting these maximum values the highest potential risk to groundwater can be assessed.

In the previous model submitted with the WLA, the hazardous waste was modelled as a declining source. In this version, the hazardous waste has been modelled as a constant source. The source of leachate for the non-hazardous and inert models has been set as a 'Declining Source Term' in LandSim which allows the source term concentrations to decrease over time.

The half-lives of each of the contaminants, in the different stages that they move through, has been set at the highest level to effectively simulate zero degradation. The half-lives used for all contaminants at all phases (e.g. within the liner, unsaturated zone, vertical pathway and aquifer) has been set at 1,000,000,000 years. This is a conservative assumption as it does not allow the contaminants to degrade over time.

5.2.2 Pathway Input Parameters

The pathway input parameters are those which define the material which the leachate generated at the source has to move through in order to reach the receptors. The pathways in the proposed development include the drainage system, the engineered barriers and the unsaturated zone.

5.2.2.1 Engineered Barrier

The inputs for the engineered barriers for each of the cells are the same as those provided in the original WLA.

As outlined in the response to question 5.9, the DAC has been modelled as a single clay barrier. This is deemed to be more conservative as it excludes the 0.5 m thick clay barrier which will underlie the DAC layer.

A version of the hazardous model (supplementary hazardous model 3), which models the DAC as a double liner system, has been created. This model and its results are presented in **Appendices A6.1** and **A6.2**.

5.2.2.2 Unsaturated Zone

The unsaturated zone is the ground beneath the site which is above the water table. By inputting this horizon into LandSim V.2.5 it allows the natural protection, which the site offers for the protection of groundwater, to be assessed.

The conceptual model has been updated to reflect the following changes:

- Non-hazardous cells: No saturated vertical pathway will be present between the aquifer and the unsaturated zone. An artificial mineral layer of 1 m thick with a permeability of 6.6 x 10^{-10} m/s will be placed below the cell liner to provide additional protection. This will be used to simulate the unsaturated zone in LandSim and the actual natural protection will not be used. The exclusion of the actual unsaturated zone present will provide additional protection for groundwater.

- Hazardous cells: under conditions observed during the pumping test the aquifer and aquitard are hydraulically connected via the faults. The unsaturated zone thickness has been reduced to 2 m to reflect this.

Based on the conceptual model, changes were made to the unsaturated zone details to ensure that the most conservative scenario is modelled. These changes are summarised below:

- Non-hazardous model: the unsaturated zone was represented using the 1 m thick artificial low permeability (6.6 x 10^{-10} m/s) layer which will be placed below the liner of the cells to simulate the natural protection. The actual unsaturated zone was excluded from the model indicating there will be additional protection for groundwater than is modelled.
- Hazardous Model: the unsaturated zone thickness was reduced to 2 m and the dispersivity was reduced to 0.02 m. The moisture content was changed to a Uniform distribution of 0.1-0.3 due to the uncertainty associated with that parameter. The hydraulic conductivity remained the same as was previously used.
- Vertical Pathway

A ‘vertical pathway’ zone can be inputted into LandSim V2.5. This is appropriate for use in a situation where a saturated low permeability aquitard overlies the aquifer as is the case beneath the MEHL site.

The separate models account for the fact that the vertical pathway is not present in the south of the site where the aquifer outcrops at the surface.

The presence of the vertical zone in the models can be summarised as follows:

- Non-hazardous model: vertical zone not present;
- Hazardous model: vertical zone present.

5.2.2.3 Aquifer

The aquifer parameters have not changed based on the additional work undertaken. The measured background concentrations of each parameter have been included in the aquifer.

5.2.3 Receptors

Concentrations of hazardous substances at the base of the unsaturated zone are assessed in the model.

Concentrations of non-hazardous pollutants are assessed in groundwater at the land ownership boundary, by modelling a phantom monitoring well placed directly down gradient on the land-ownership boundary. The modelled concentrations in groundwater at the land ownership boundary are compared to appropriate drinking water standards.

The distance to the phantom receptor well changes in each model based on the location of the cells in the model relative to the land ownership boundary (except for the hazardous cells where the phantom well is located closer than the land ownership boundary as described above). These distances are summarised below:

- Non-hazardous Model: 110 m;
- Hazardous Model: 270 m.

5.3 Model Results

The results for the main models (Non-Hazardous Model and Hazardous Model) are presented in the following sections including information on the sensitivity analysis for each.

The Supplementary models for the hazardous and non-hazardous cells are also presented in the relevant sections below to allow a comparison of the results.

The models were each run for 1000 iterations. This means that the model re-ran the Monte Carlo simulation 1000 times, each time randomly selecting parameters from those defined. This ensures that the results from the model are not a single selection of results but are results from multiple runs.

Five fixed time slices were chosen for the model runs and these were concentrations after 30 years, 100 years, 300 years, 1000 years and 20,000 years (i.e. infinity).

5.3.1 Hazardous Model And Supplementary Hazardous Models

5.3.1.1 Statistical And Graphical Results

The statistical results from the LandSim models are presented in the following appendices:

- Hazardous Model: A3
- Supplementary Hazardous Model 1: A4
- Supplementary Hazardous Model 2: A5
- Supplementary Hazardous Model 3: A6

LandSim V 2.5 calculates concentrations of each parameter at the set time slices. The 20,000 year time slice represents infinity.

It is accepted best practice to consider the concentrations at the 95th percentile.

The only hazardous substances (as defined by the Water Framework Directive and Groundwater Daughter Directive) with the potential to be present are Cadmium and Mercury and their concentrations at the base of the vertical pathway are summarised in **Table 5.4** for each model.

Table 5.4 Summary 95th percentile concentration of ‘hazardous substances’ at the base of the unsaturated zone and vertical pathway from the hazardous

Parameter	Drinking Water Standard (mg/l)	Cell number	Concentration at the base of the unsaturated zone		Concentration at the base of the vertical pathway	
			95th percentile conc. (mg/l)	Time period after which the concentration is detected (years)	95th percentile conc. (mg/l)	Time period after which the concentration is detected (years)
Hazardous Model						
Cadmium	0.005[1]	H1a	0	NA	0	NA
		H1b	0	NA	0	NA
		H2a	0	NA	0	NA
		H2a	0	NA	0	NA
		H3a	0	NA	0	NA
		H3b	0	NA	0	NA
Mercury	0.001[1]	H1a	0	NA	0	NA
		H1b	0	NA	0	NA
		H2a	0	NA	0	NA
		H2a	0	NA	0	NA
		H3a	0	NA	0	NA
		H3b	0	NA	0	NA
Supplementary Hazardous Model 1						
Cadmium	0.005[1]	H1a	0	NA	0	NA
		H1b	0	NA	0	NA
		H2a	0	NA	0	NA
		H2a	0	NA	0	NA
		H3a	0	NA	0	NA
		H3b	0	NA	0	NA
Mercury	0.001[1]	H1a	0	NA	0	NA
		H1b	0	NA	0	NA
		H2a	0	NA	0	NA
		H2a	0	NA	0	NA
		H3a	0	NA	0	NA
		H3b	0	NA	0	NA

Parameter	**Drinking Water Standard (mg/l)**	**Cell number**	**Concentration at the base of the unsaturated zone**		**Concentration at the base of the vertical pathway**	
			95th percentile conc. (mg/l)	**Time period after which the concentration is detected (years)**	**95th percentile conc. (mg/l)**	**Time period after which the concentration is detected (years)**
Supplementary Hazardous Model 2						
Cadmium	0.005[1]	H1a	0	NA	0	NA
		H1b	0	NA	0	NA
		H2a	0	NA	0	NA
		H2a	0	NA	0	NA
		H3a	0	NA	0	NA
		H3b	0	NA	0	NA
Mercury	0.001[1]	H1a	0	NA	0	NA
		H1b	0	NA	0	NA
		H2a	0	NA	0	NA
		H2a	0	NA	0	NA
		H3a	0	NA	0	NA
		H3b	0	NA	0	NA

[1] S.I. 278/2007 European Communities (Drinking Water) (No.2) Regulations 2007

These results show that after 20,000 years, concentrations of the ‘hazardous substances’ do not exceed Drinking Water Standards for all the models. These results illustrate that groundwater is not at risk from ‘hazardous substances’ from the proposed development.

The modelling included the background concentrations of each parameter measured in groundwater. In the original WLA a separate model was created to illustrate the influence that the background concentrations have on the model results. This illustrated that the background concentrations are the dominant concentrations detected at the phantom receptor well.

Separate models have not been created to determine the influence of the background concentrations for this report. The background concentrations are instead listed in **Table 5.5** to allow their comparison with the results generated. They highlight the extent to which the predicted concentrations are due to background concentrations rather than due to the proposed development.

Table 5.5: Summary 95th percentile concentration of all parameters at the receptor.

Contaminant	Drinking Water Standard (mg/l)	Background concentration (mg/l)			Hazardous Model		Supplementary Hazardous Model 1		Supplementary Hazardous Model 2	
		Min	Likely	Max	95th percentile conc. (mg/l)	Time period after which the concentration is detected (years)	95th percentile conc. (mg/l)	Time period after which the concentration is detected (years)	95th percentile conc. (mg/l)	Time period after which the concentration is detected (years)
Arsenic	0.01[1]	0.00026	0.00503065	0.025	**0.013**	All	**0.014**	All	**0.013**	All
Barium	0.7[2]	0.006	0.02655294	0.06	0.045	All	0.043	All	0.044	All
Cadmium	0.005[1]	0.00003	0.0011075	0.0039	0.0024	All	0.0023	All	0.0024	All
Total chromium	0.05[1]	0.0009	0.0068	0.0237	0.014	All	0.015	All	0.015	All
Copper	2[1]	0.001	0.0027	0.005	0.0044	All	0.0043	All	0.0043	All
Mercury	0.001[1]		0.0005		0.0005	All	0.0005	All	0.0005	All
Molybdenum	0.07[2]	0.0002	0.01048	0.043	0.022	All	0.022	All	0.023	All
Nickel	0.02[1]		0		0	All	0	All	0	All
Lead	0.025[1]	0.001	0.00288889	0.006	0.0051	All	0.0051	All	0.0052	All
Antimony	0.005[1]	0.003	0.0034	0.004	0.0038	All	0.0038	All	0.0038	All
Selenium	0.01[1]	0.0012	0.00248	0.005	0.0042	All	0.0042	All	0.0043	All
Zinc	5[3]	0.002	0.0196875	0.169	0.086	All	0.083	All	0.087	All

Contaminant	Drinking Water Standard (mg/l)	Background concentration (mg/l)			Hazardous Model		Supplementary Hazardous Model 1		Supplementary Hazardous Model 2	
		Min	Likely	Max	95th percentile conc. (mg/l)	Time period after which the concentration is detected (years)	95th percentile conc. (mg/l)	Time period after which the concentration is detected (years)	95th percentile conc. (mg/l)	Time period after which the concentration is detected (years)
Chloride	250[1]	18	32.64	57	50.6 51.5	30,100, 300, 1000 20,000	50.42 51.22	30,100, 300, 1000 20,000	50.15 50.66	30,100, 300, 1000 20,000
Fluoride	1[1]	0.1	0.257	0.4	0.35	30, 100, 300, 1000	0.35	30, 100, 300, 1000	0.35	30, 100, 300, 1000
					0.36	20,000	0.36	20,000	0.36	20,000
Sulphate	250[1]	5.08	49.08	244.77	136 137	30,100, 300, 1000 20,000	153 154	30,100, 300, 1000 20,000	129	30,100,300, 1000 20,000

[1] S.I. 278/2007 European Communities (Drinking Water) (No.2) Regulations 2007
[2] WHO Health
[3] UK Drinking Water Standard

The results presented in **Table 5.5** illustrate that arsenic is the only contaminant to exceed the Drinking Water Standard at the receptor for all of the hazardous models created. This is due to the naturally occurring background concentration of arsenic included in the models. The maximum concentration of arsenic modelled was 0.014 mg/l which is 0.004 mg/l above the drinking water standard.

As outlined in previous sections, a large element of conservatism has been built into the models as they do not account for the second low permeability layer and leak detection layer within the hazardous liner etc.

Furthermore the partition coefficient of arsenic used is relatively low compared to values obtained in a wider literature search. If a higher value for retardation was used the model would not exceed the drinking water standard for arsenic.

These results demonstrate that arsenic concentrations, elevated above background levels will not be present down-gradient.

The models which had higher heads of 2 m and 5 m during the management control period exhibited very similar results to the original model. This is indicative of the low permeability nature of the DAC liner.

5.3.1.2 Sensitivity Analysis

A sensitivity analysis was undertaken to assess the impact that changing certain parameters would have on the model. The model was shown to be sensitive to changes in the parameters outlined below:

- **Management control period:** In LandSim the management control period represents the period leachate heads are controlled. In the model the management control period was set to the length of time which the cells are operational (active filling), i.e. 35 years (from 2003). Beyond this the model assumes the landfill would not be maintained (i.e. leachate removal would cease and leachate levels would rise etc). As expected the results of the model are sensitive to the length of the management control period. A highly conservative approach was undertaken with assigning this parameter and as such the model output is conservative. The management control period of 35 years could reasonably be increased.

- **Aquifer parameters:** The model is sensitive to the aquifer parameters such as the aquifer thickness, porosity, gradient and permeability values. These values influence the amount of dilution which takes place in the aquifer. The values assigned were based on extensive experience in working in the Irish context and as such are reasonable.

- **DAC liner parameters:** the permeability of the DAC liner has a large influence on the results of the model. If the permeability of the liner is increased then the concentrations observed would also increase. However, the second clay liner and leak detection system which is part of the DAC system has not been incorporated into the model indicating that there is a conservative element built in.

- **Retardation:** Contaminants were allowed to be retarded as they moved through each pathway. Conservative contaminant-specific retardation parameters were chosen (the lowest of quoted ranges).

The model was also slightly sensitive to changes in other parameters such as the moisture content of the unsaturated zone. However, the changes did not have a significant influence on the results of the model.

Some parameters were highlighted as uncertain during model parameterisation (e.g. the size of the sump for the internal drainage layer in the DAC, dry density of inert waste). The sensitivity analysis illustrated that the model output was not significantly influenced by these parameters.

The sensitivity analysis indicated that the parameters chosen for the model are the most appropriate and in some cases are highly conservative.

5.3.1.3 Discussion

The results of the modelling indicate that with all the mitigation measures in place, no significant impact will be observed at the receptor.

No ‘hazardous substances’ are observed to enter groundwater beneath the hazardous cells (base of the unsaturated zone).

With respect to ‘hazardous substances’ the concentrations modelled are below Drinking Water Standard and are influenced by background levels.

The leachate head levels during the management control period do not have a significant impact on the results of the modelling for the hazardous cells.

It should be noted that the model can be considered highly conservative for the following reasons:

- The modelling of the hazardous cell liner is conservative as it does not incorporate the second low permeability clay liner and leak detection system built into the DAC system.
- The management control period has been modelled as 35 years, the period of active filling of the cells. The model assumes that after this period there is no leachate management and the leachate head can rise within the cells resulting in greatly increased leakage.
- It will be a requirement of the waste licence that the closure, restoration and aftercare management plan be implemented. Surrender of the licence will only be accepted by the EPA when it has been demonstrated that there will be no risk of significant pollution from the site.
- Conservative input parameters have been used throughout the model and the 95th percentile results have been assessed.

5.3.2 Non-Hazardous Models 1 And 2 And Supplementary Non-Hazardous Models

As outlined in section 5.2.1.2, the management control period has a large influence over the model results as it determines the leachate heads.

The models run with a short management control period generated errors indicating that the leachate head was too high for the underlying barrier to sustain. In order to test the influence that this was having on the resultant concentrations models were constructed using a short (Non-Hazardous Model 1) and long management control period (Non-hazardous Model 2).

The supplementary models assessed the influence of fixing the leachate heads during the management control period.

5.3.2.1 Statistical And Graphical Results

The statistical results from the LandSim models are presented in the following appendices:

- Non-Hazardous Model 1 (35 year management period): A1
- Non-Hazardous Model 2 (20,000 year management period): A2
- Supplementary Non-Hazardous Model 1 (35 year management period, 2 m head of leachate): A7
- Supplementary Non-Hazardous Model 2 (35 year management period, 5 m head of leachate): A8
- Supplementary Non-Hazardous Model 3 (20,000 year management period, 2 m head of leachate): A9
- Supplementary Non-Hazardous Model 4 (20,000 year management period, 5 m head of leachate): A10

The models with higher leachate heads were observed to become unstable (leakage rates from the cells were observed to increase and then decrease). Because of this the results were deemed to be unreliable and have not been discussed below.

It should be noted that these high leachate heads are an unrealistic scenario that will not be allowed to occur.

The stable models are: Non-hazardous model 2 and Supplementary non-hazardous model 3.

LandSim V 2.5 calculates concentrations of each parameter at the set time slices. The 20,000 year time slice represents infinity.

It is accepted best practice to consider the concentrations at the 95th percentile.

The only hazardous substances (as defined by the Water Framework Directive and Groundwater Daughter Directive) with the potential to be present are Cadmium and mercury and their concentrations at the base of the unsaturated zone are summarised in **Table 5.6** for each model.

Table 5.6: Summary 95th percentile concentration of 'hazardous substances' at the base of the unsaturated zone from the non-hazardous cells

Parameter	Drinking Water Standard (mg/l)	Cell number	Concentration at the base of the unsaturated zone	
			95th percentile conc. (mg/l)	Time slice in which the concentration is detected (years)
Non-Hazardous Model 2				
Cadmium	0.005[1]	NH1a	0.00414	20,000
		NH1b	0.0045	20,000
		NH2	0.00058	20,000
Mercury	0.001[1]	NH1a	0	NA
		NH1b	0	NA
		NH2	0	NA
Supplementary Hazardous Model 3				
Cadmium	0.005[1]	NH1a	0.0028	20,000
		NH1b	0.0029	20,000
		NH2	0.001	20,000
Mercury	0.001[1]	NH1a	3.0 x 10^{-13}	20,000
		NH1b	3.7 x 10^{-12}	20,000
		NH2	2.4 x 10^{-11}	20,000

[1] S.I. 278/2007 European Communities (Drinking Water) (No.2) Regulations 2007

These results show that after 20,000 years (infinity) concentrations of the 'hazardous substances' do not exceed Drinking Water Standards for the models.

Exceedences of the drinking water standard for cadmium were observed after 20,000 year (effectively infinite) period of time for the stable models. The exceedences observed were minimal and it should be noted that the results are conservative as they do not include the 'real' unsaturated zone where additional attenuation would occur.

Table 5.7 presents the concentrations of all modelled contaminants at the phantom receptor wells. As outlined in section 5.3.1 separate models were not created to exclude the background concentrations and the results below include the background levels.

Table 5.7: Summary 95th percentile concentration of all parameters at the receptor.

Contaminant	Drinking Water Standard (mg/l)	Background concentration (mg/l)			Non-Hazardous Model 2		Supplementary Non-Hazardous Model 3	
		Min	Likely	Max	95th percentile conc. (mg/l)	Time period after which the concentration is detected (years)	95th percentile conc. (mg/l)	Time period after which the concentration is detected (years)
Arsenic	0.01[1]	0.00026	0.005	0.025	**0.0136**	All	0.013	All
Barium	0.7[2]	0.006	0.027	0.06	0.045 0.046	30, 100, 300, 20,000 1000	0.044 0.049	30, 100, 300,20,000 1000
Cadmium	0.005[1]	0.00003	0.001	0.0039	0.0024	All	0.0023	All
Total chromium	0.05[1]	0.0009	0.007	0.0237	0.0145	All	0.015	All
Copper	2[1]	0.001	0.003	0.005	0.0043 0.0046	30,100,300,1000 20,000	0.0043 0.0049	30,100,300,1000 20,000
Mercury	0.001[1]		0.001		0.0005	All	0.0005	All
Molybdenum	0.07[2]	0.0002	0.01	0.043	0.025	All	0.023	All
Nickel	0.02[1]		0		0 0.000084	30,100,300,1000 20,000	0 0.00007	30,100,300,1000 20,000
Lead	0.025[1]	0.001	0.003	0.006	0.005	All	0.005	All
Antimony	0.005[1]	0.003	0.003	0.004	0.00383	All	0.00384	All
Selenium	0.01[1]	0.0012	0.002	0.005	0.0043	All	0.0043	All
Zinc	5[3]	0.002	0.02	0.169	0.085 0.086	30,100,300,1000 20,000	0.083	All
Chloride	250	18	32.64	57	50.89 51.16 51.62 51.47 50.80	30 100 300 1000 20000	52.14 52.9 53.9 53.58 51.16	30 100 300 1000 20000
Fluoride	1[1]	0.1	0.257	0.4	0.36	All	0.35 0.36 0.37	30,20,000 100,300 1000
Sulphate	250[1]	5.08	49.08	244.77	142 141	30 100, 300, 1000, 20000	143 144 145	30, 100, 20000 300 1000

[1] S.I. 278/2007 European Communities (Drinking Water) (No.2) Regulations 2007

[2] WHO Health

[3] UK Drinking Water Standard

The results presented in **Table 5.7** illustrate that arsenic is the only contaminant to exceed Drinking Water Standards at the receptor.

As outlined above, the exceedence of arsenic is due to the background concentration of arsenic included in the model. The maximum concentration of arsenic modelled was 0.014 mg/l which is 0.004 mg/l above the drinking water standard. These results demonstrate that arsenic concentrations, elevated above background levels, will not be present down-gradient.

As outlined in previous sections, a large element of conservatism has been built into the model as it does not account for the real unsaturated zone which is present on the site.

5.3.2.2 Sensitivity Analysis

A sensitivity analysis was undertaken to assess the impact that changing certain parameters would have on the model. The model was shown to be sensitive to changes in the parameters outlined below:

- **Leachate head**: The leachate heads have a large influence on the model results. When the leachate heads increase to 5 m the model becomes unstable and the results reported are unreliable.
- **Management control period:** As discussed previously models were created for two management control periods, 35 years and 20,000 years. The management control period influences the leachate head and thus the leakage from the cells making the model results sensitive to this input parameter
- **Aquifer parameters:** The model is sensitive to the aquifer parameters such as the aquifer thickness, porosity, gradient and permeability values. These values influence the amount of dilution which takes place in the aquifer. The values assigned were based on extensive experience on working in the Irish context and as such are reasonable.
- **Retardation:** Contaminants were allowed to be retarded as they moved through each pathway. Conservative contaminant-specific retardation parameters were chosen (the lowest of quoted ranges).

The model was also slightly sensitive to changes in other parameters such as the moisture content of the unsaturated zone. However, the changes did not have a significant influence on the results of the model.

The sensitivity analysis indicated that the parameters chosen for the model are the most appropriate and in some cases are highly conservative.

5.3.2.3 Discussion

The results of the modelling indicate that with all the mitigation measures in place, no significant impact will be observed at the down-gradient receptor.

The LandSim models are shown to be highly dependent on the leachate heads. The models become unstable if leachate heads are specified which are too high for the underlying barrier to sustain.

The scenarios where the leachate heads reached 5 m became unstable and the results could not be relied upon. However, it should be reiterated that the leachate heads will not be allowed to reach 5m and the leachate heads will be managed at all times during the operation and aftercare period of the landfill.

The aftercare of the site will be managed and the licence for the site will not be surrendered until the EPA is satisfied that there is no unacceptable risk to the environment from the site.

5.4 Model Discussion And Conclusion

A detailed hydrogeological investigation in 2010 was undertaken on the MEHL site in order to develop a conceptual model for the site using site specific data that describes the groundwater system in the vicinity of the site. Additional investigation was undertaken in 2013 and the CSM was updated based on this.

The LandSim modelling was updated to reflect queries from the EPA and changes in the CSM based on additional information. Separate models were created for the hazardous and non-hazardous cells and were run for a number of scenarios, including varying the leachate heads.

The hazardous cells were amended from the original model to reflect the following changes:

- The formation level of the landfill cells has been raised to 104.5 mOD.
- The unsaturated zone thickness has been reduced to 2 m across the site.
- Representation of the hazardous waste as a constant source rather than a declining source
- Increasing the leachate head in hazardous cells to 2 m and 5 m

A summary of the results of the hazardous models are presented below:

- No 'hazardous substances' (List 1) predicted to be in groundwater beneath the site (and therefore none detected at the phantom receptor well);
- No contaminants at concentrations above Drinking Water Standards predicted to be present at the phantom well receptor.

The results of the LandSim modelling indicate the risk to groundwater quality at wells down gradient of the hazardous cells will be insignificant.

The non-hazardous models were amended from the original models to reflect the following changes:

- The formation level of the landfill cells has been raised to 104.5 mOD. This has also led to a change in the area of the base of the landfill.
- The vertical pathway has been removed from beneath the non-hazardous cells.
- Only the artificial replacement layer beneath the non-hazardous cells have been modelled as the unsaturated zone. The 'real' unsaturated zone was not included in the model allowing an additional element of conservatism to be built into the model
- Increasing the leachate head in hazardous and non-hazardous cells to 2 m and 5 m

- The non-hazardous models were run with management control periods of 35 and 20,000 (infinity) years.

A summary of the results of the non-hazardous model are presented below:

- The models with high leachate heads are unstable and the results unreliable. However, those with those with the predicted lower heads were stable and the results reliable.
- No 'hazardous substances' (List 1) predicted to be in groundwater beneath the site (and therefore none detected at the phantom receptor well);
- 'Non-hazardous pollutants' (List 2), metals, chloride and sulphate predicted to be present in groundwater beneath the site above Drinking Water Standards after 20,000 years;
- No contaminants at concentrations above Drinking Water Standards predicted to be present at the phantom well receptor.

The results of the LandSim modelling indicate the risk to groundwater quality at wells down gradient of the site will be insignificant.

Although the modelling is designed to represent the landfill and surrounding environment it should be noted that these results are considered conservative for the following reasons:

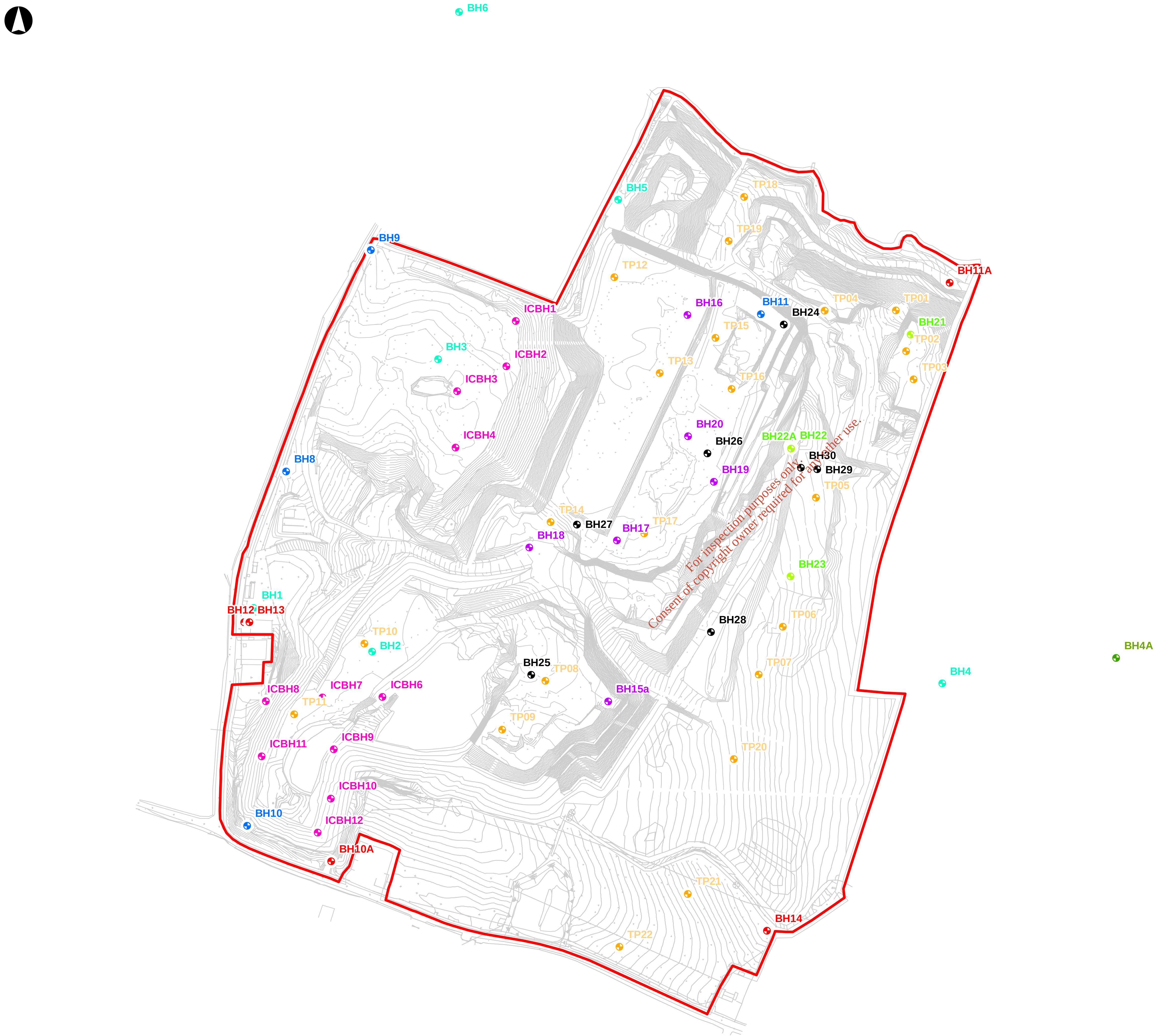
- Lower liner (0.5 m of material with a hydraulic conductivity of $1x10^{-9}$ m/s) within the DAC system has not been modelled.
- The natural unsaturated zone beneath the non-hazardous cells has not been modelled.

A Groundwater and Surface Water Monitoring Plan, incorporating level and quality monitoring, will be a requirement of the waste licence.

A Closure Restoration and Aftercare Management Plan (CRAMP) will be developed and submitted to the Environmental Protection Agency for approval. Following the cessation of operation at the site the CRAMP will be implemented to the satisfaction of the Environmental Protection Agency.

Figures

A3



Legend

- ▭ MEHL Proposed Planning and Waste Licence Boundary
- ● 1989 boreholes
- ● 1998 monitoring wells
- ● 2001 monitoring wells
- ● 2007 monitoring wells
- ● 2008 monitoring well
- ● 2010 monitoring wells
- ● 2010 geotechnical boreholes
- ● 2010 trial pits
- ● 2013 monitoring wells

P1	23-08-13	CB	RL	RL
Issue	Date	By	Chkd	Appd

Metres
0 50 100 200

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**Figure 1.
All site investigations to date
(1989 - 2013)**

Scale at A3
1:3,625

Job No
326877.01

Drawing Status
Final

Drawing No
001

Issue
P1

MXD Location: J:\D6800-D6899\D6877\6_Graphics\30\GIS\WLA 2013\mxd\Site investigation locations.mxd

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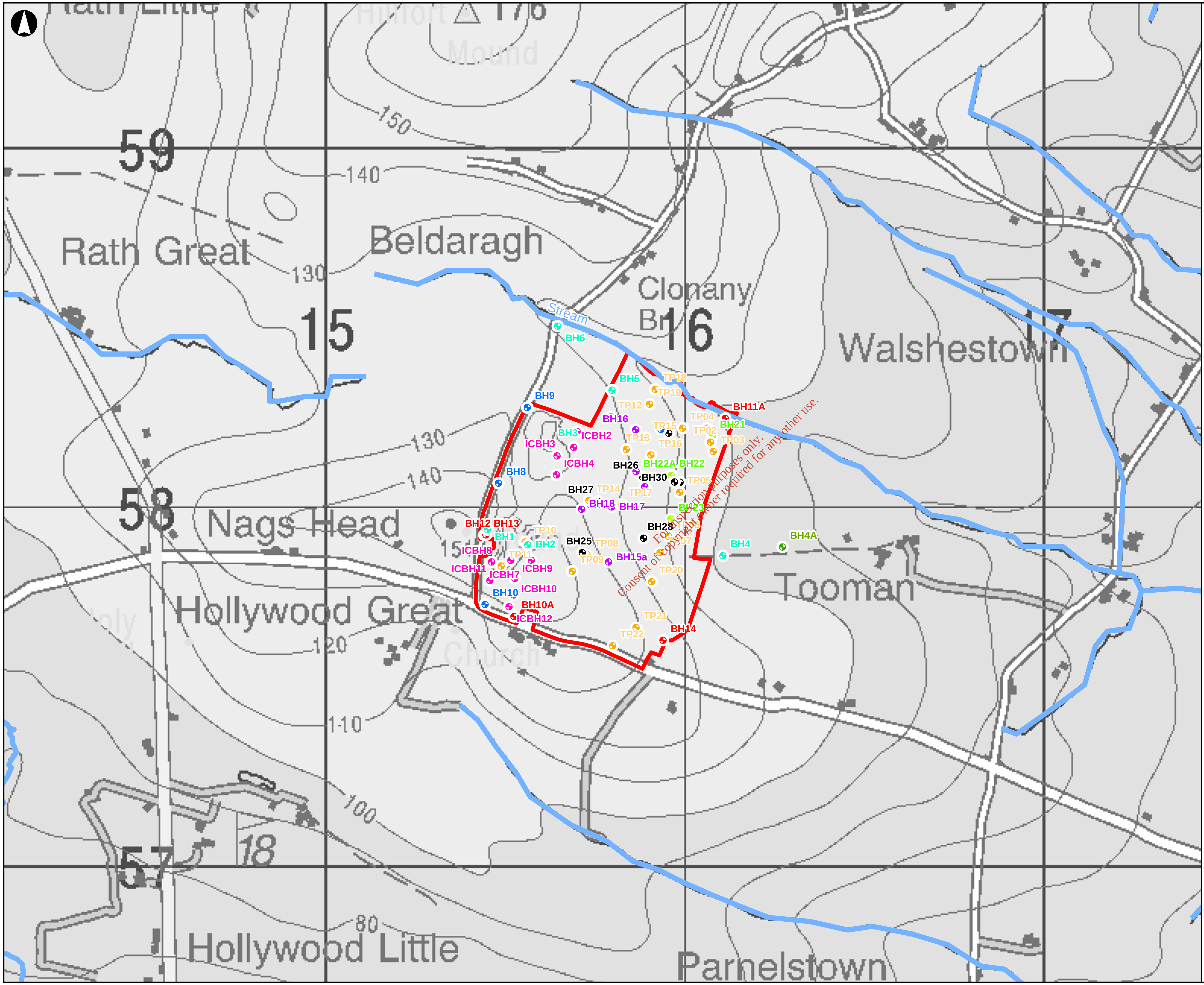

Legend

- 🟥 MEHL Proposed Planning and Waste Licence Boundary
- 🟦 Water courses
- ● 1989 boreholes
- ● 1998 monitoring wells
- ● 2001 monitoring wells
- ● 2007 monitoring wells
- ● 2008 monitoring well
- ● 2010 monitoring wells
- ● 2010 geotechnical boreholes
- ● 2010 trial pits
- ● 2013 monitoring wells

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Issue	Date	By	Chkd	Appd

Metres
0 137.5 275 550

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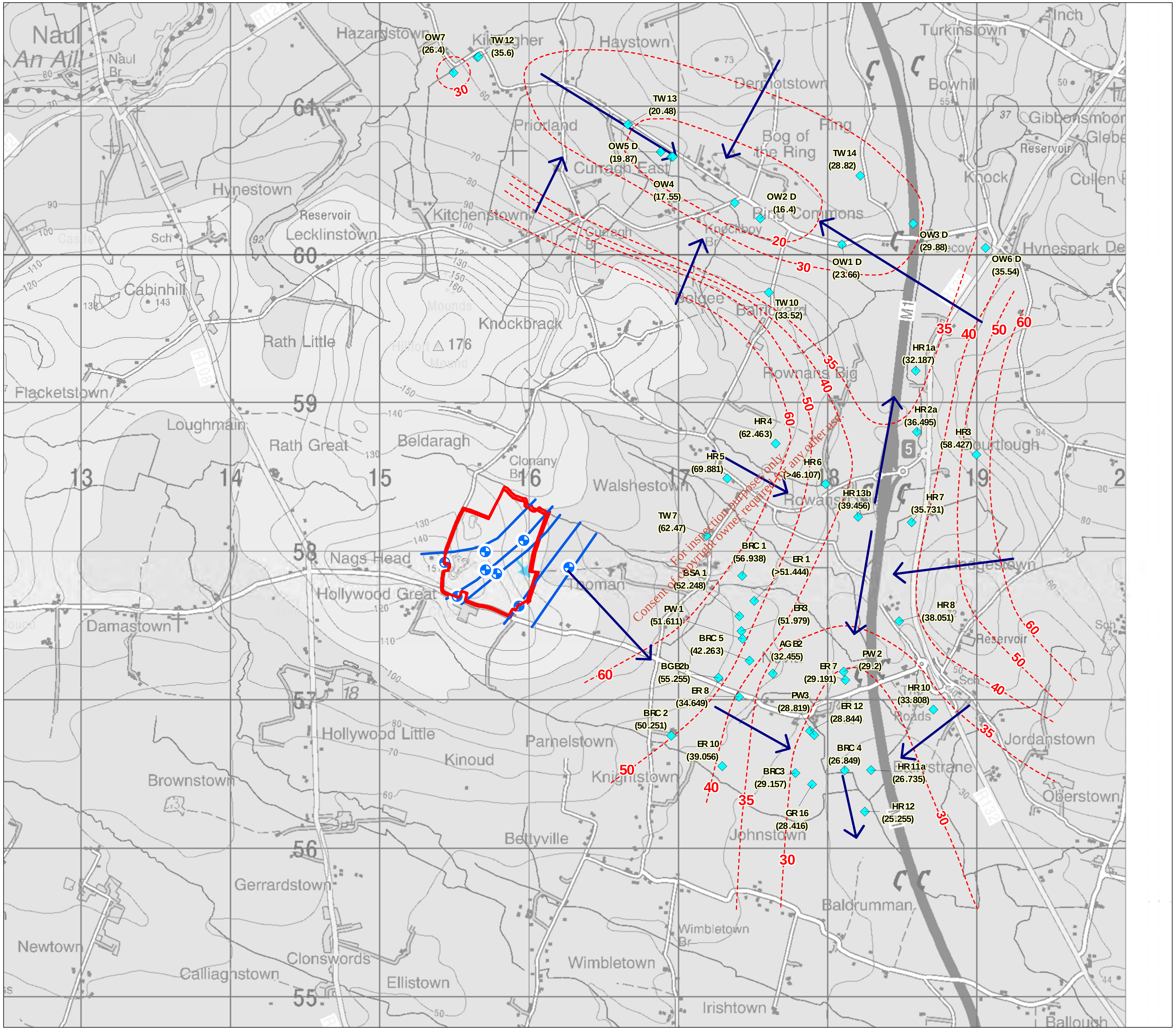
**Figure 2.
All site investigations to date
on regional topographic map**

Scale at A3
1:10,000

Job No **326877.01**	Drawing Status **Final**
Drawing No **002**	Issue **P1**

MXD Location: J:\D6800-D6899\D6877\6_Graphics\30\GIS\WLA 2013\mxd\Figure 2 regional topoSite investigation locations.mxd



0 metres 140

Scale 1:25,00

Ordnance Survey Ireland Licence Number
EN 0004910 © Government of Ireland

Legend

🟥 MEHL Proposed Planning and Waste Licence Boundary

→ Loughshinny Flow Direction

— Loughshinny Approximate Groundwater Level Contours

Legend:
Data from Fingal Landfill,
Groundwater Contours Bedrock 24th June 2005,
Appendix 5.1 (Dwg No. Mi0182)

◆ (51.72) Waterlevel mAOD)

30 Groundwater Contour (mAOD)

→ Groundwater Flow Direction

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MANAHAN PLANNERS
Chartered Town Planning Consultants

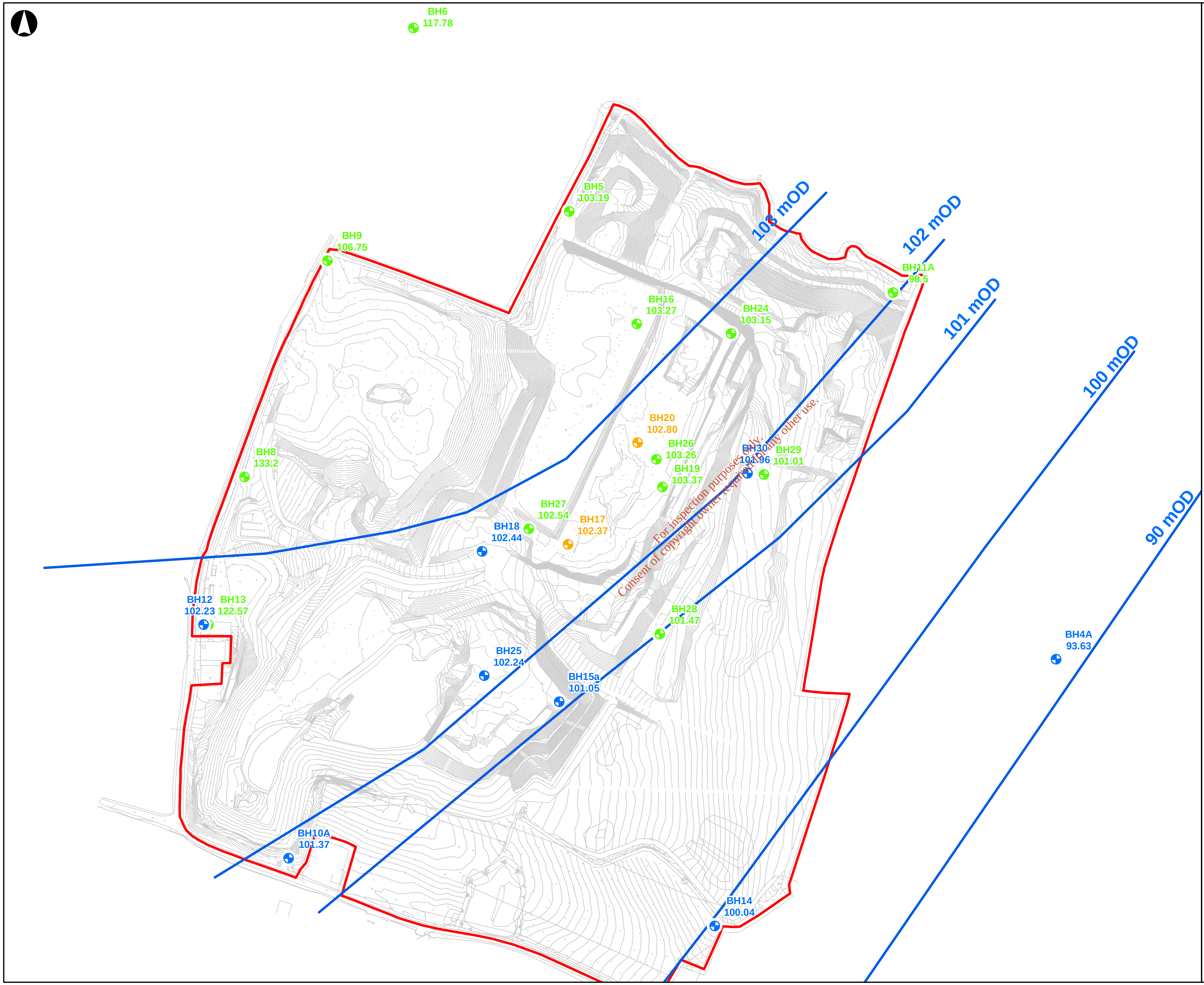
M.E.H.L. HOLLYWOOD
Murphy Environmental Hollywood Ltd

MEHL Integrated
Waste Management Facility
Hollywood Great, Nags Head, Naul, Co Dublin

Regional Groundwater Flow

Figure **3**

A3



Legend

🟥 MEHL Proposed Planning and Waste Licence Boundary

● Monitoring wells in the aquifer (Visean: Loughshinny Fm)

● Monitoring wells in the aquitard (Namurian aged formations)

● Wells screened in aquifer and aquitard

— Loughshinny Fm contours

P1	23-08-13	CB	RL	RL
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Metres
0 45 90 180

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Figure 4.
Groundwater levels and contours: Loughshinny Formation
8th July 2013

Scale at A3
1:3,500

Job No
326877.30

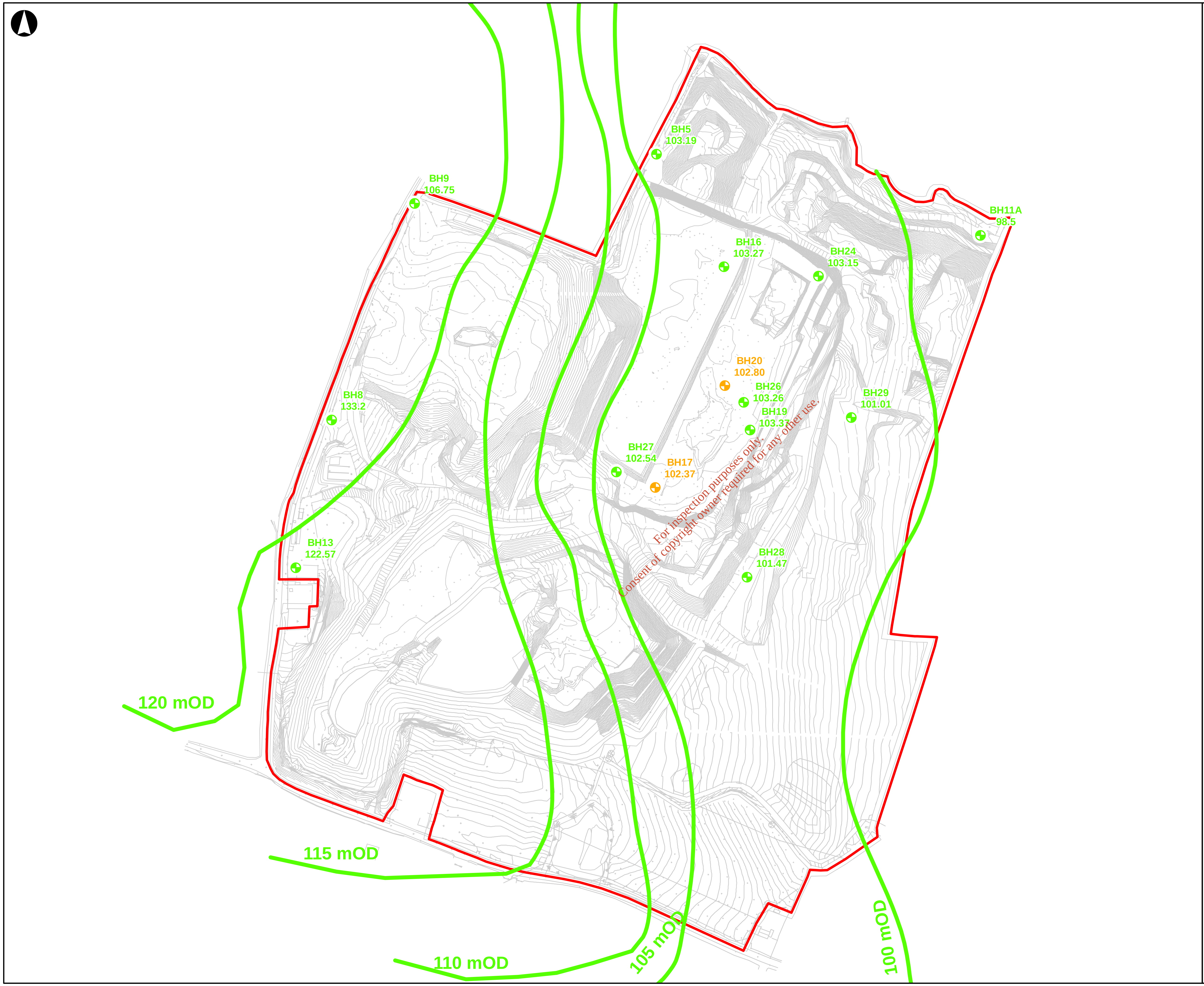
Drawing Status
Final

Drawing No
004

Issue
P1

MXD Location: J:\D6800-D6899\D6877\6_Graphics\30\GIS\WLA 2013\mxd\Loughshinny contours.mxd

A3



Legend

- 🟥 MEHL Proposed Planning and Waste Licence Boundary
- ● Monitoring wells in the aquitard (Namurian aged formations)
- ● Wells screened in aquifer and aquitard
- ━ Namurian groundwater contours

P1	23-08-13	CB	RL	RL
Issue	Date	By	Chkd	Appd

Metres
0 45 90 180

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**Figure 5.
Groundwater levels and contours:
Namurian Formations
8th July 2013**

Scale at A3
1:3,500

Job No: **326877.01**
Drawing Status: **Final**

Drawing No: **005**
Issue: **P1**

MXD Location: J:\D6800-D6899\D6877\6_Graphics\30\GIS\WLA 2013\mxd\Namurian contours.mxd

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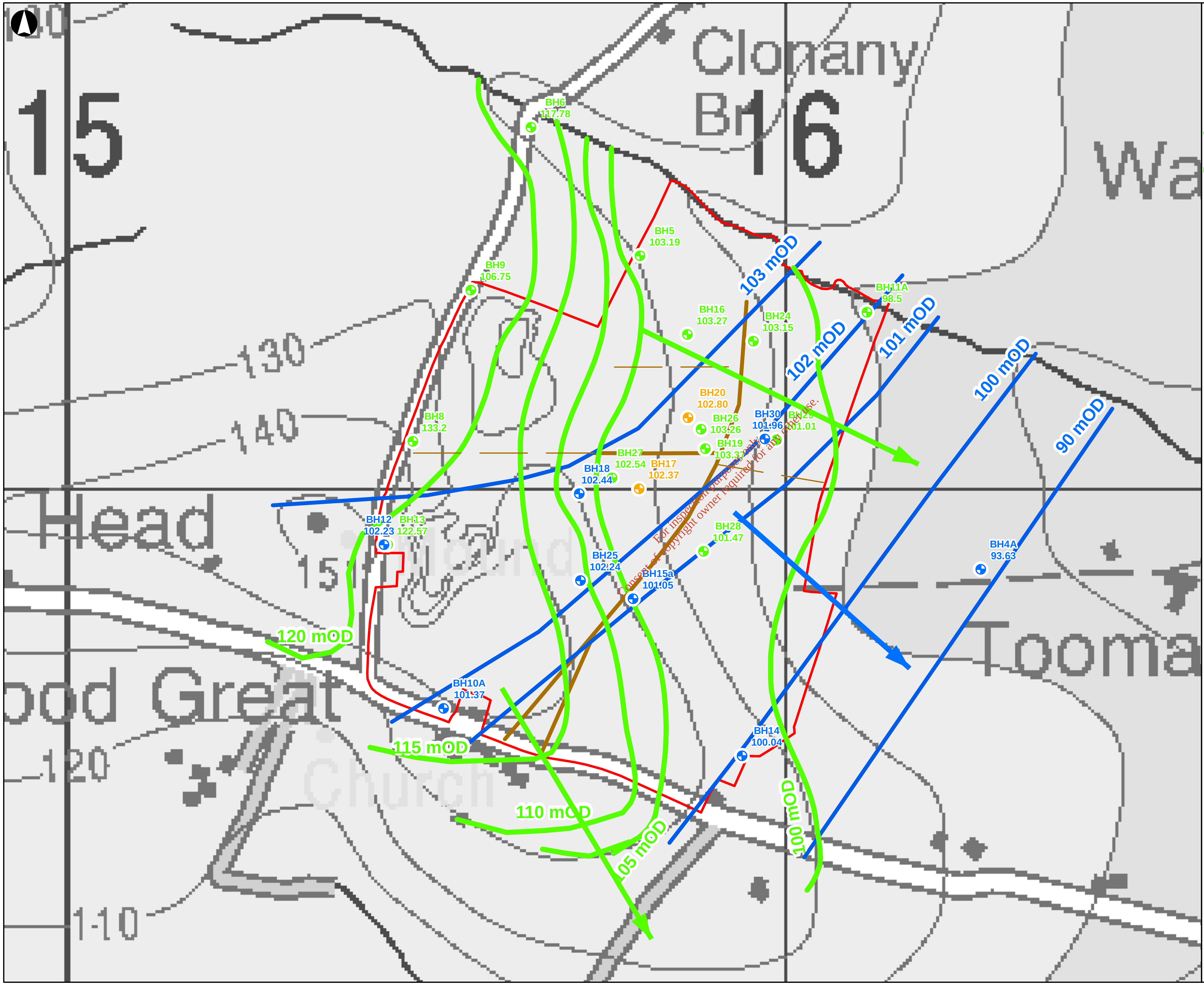

Legend

🟥	MEHL Proposed Planning and Waste Licence Boundary
●	Monitoring wells in the aquifer (Visean: Loughshinny Fm)
●	Monitoring wells in the aquitard (Namurian aged formations)
●	Wells screened in aquifer and aquitard
—	Possible Fault/Fracture
—	Possible faulted boundaries
—	Namurian groundwater contours
—	Loughshinny groundwater contours
→	Namurian groundwater flow direction
→	Loughshinny groundwater flow direction

Issue	Date	By	Chkd	Appd
P1	23-08-13	CB	RL	RL

Metres
0 65 130 260

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Figure 6.
Groundwater levels and contours: Loughshinny and Namurian Formations, 8th July 2013

Scale at A3
1:5,000

Job No	Drawing Status
326877.01	Final

Drawing No	Issue
005	P1

MXD Location: J:\D6800-D6899\D6877\6_Graphics\30\GIS\WLA 2013\mxd\Namurian contours.mxd

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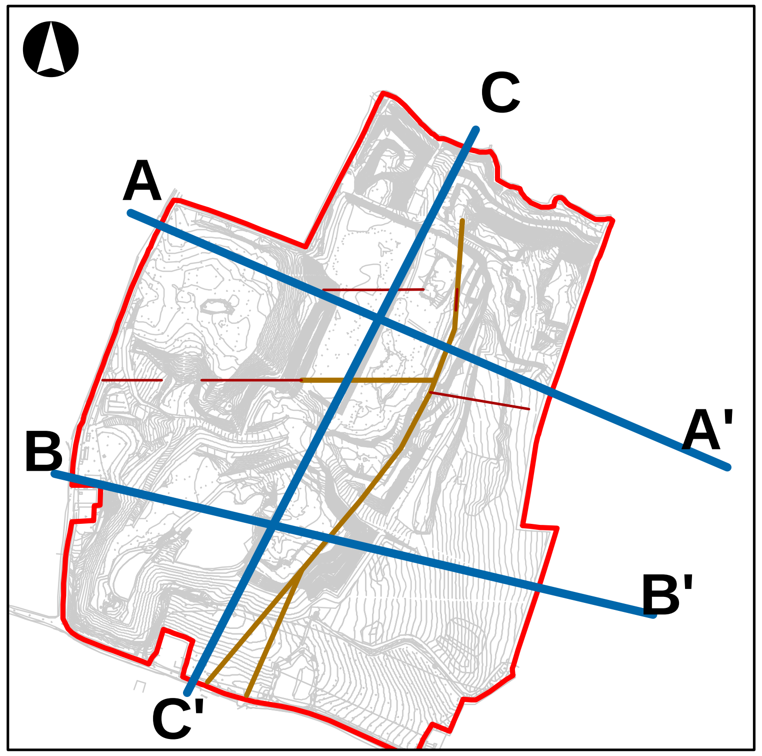

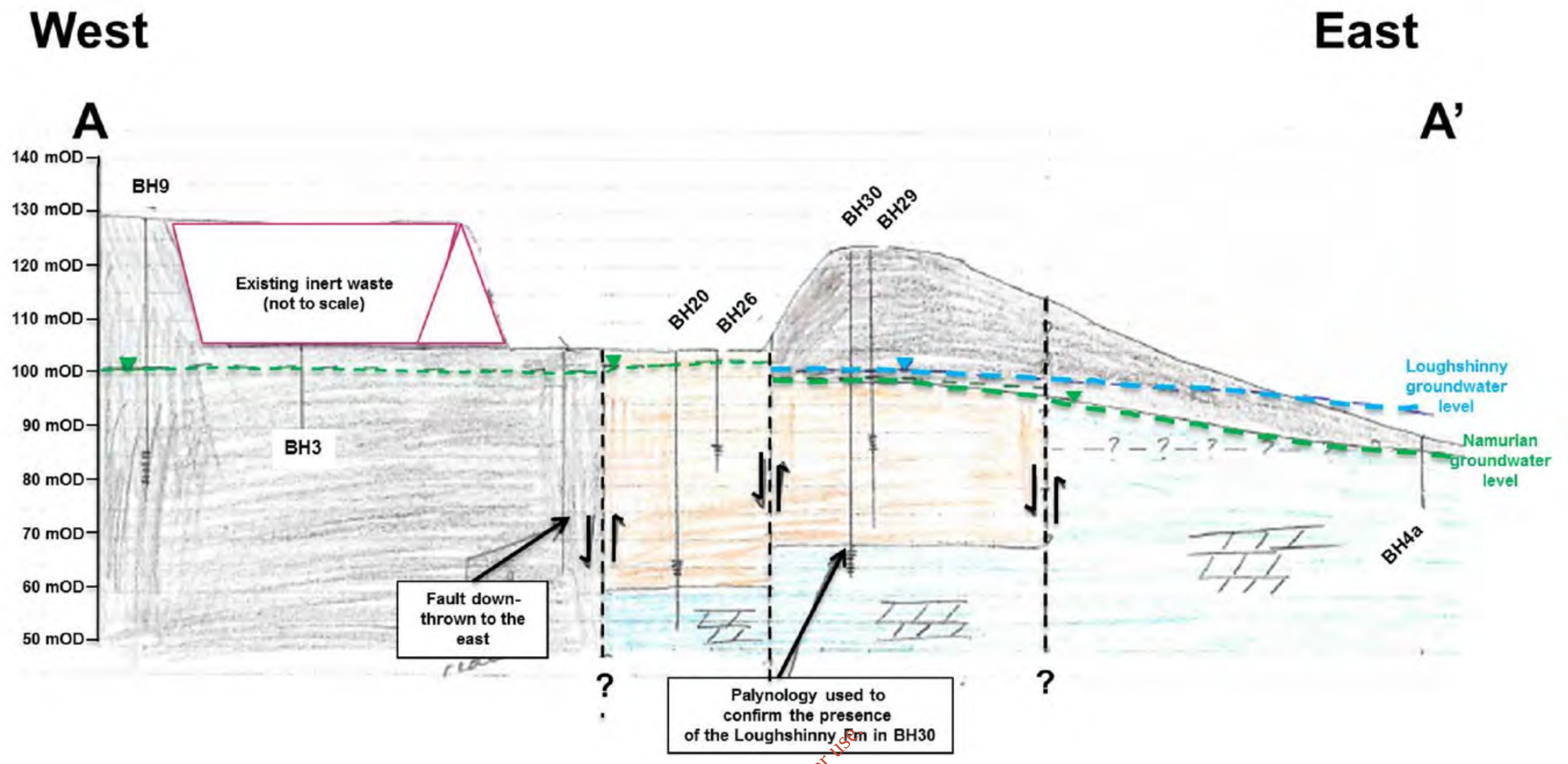

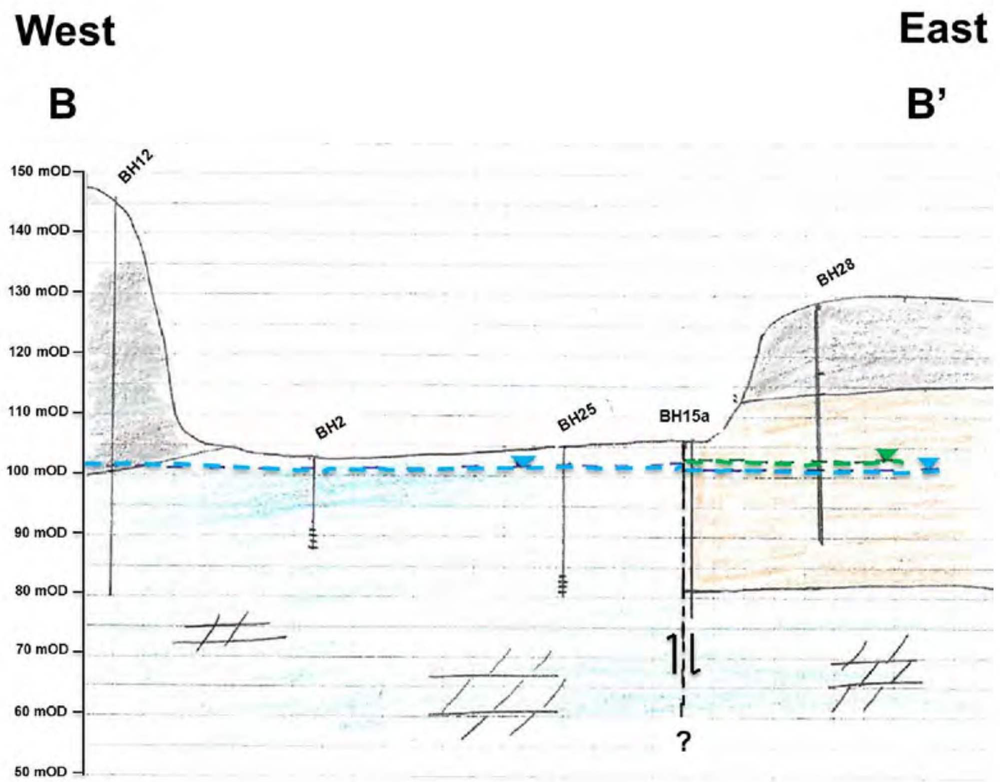

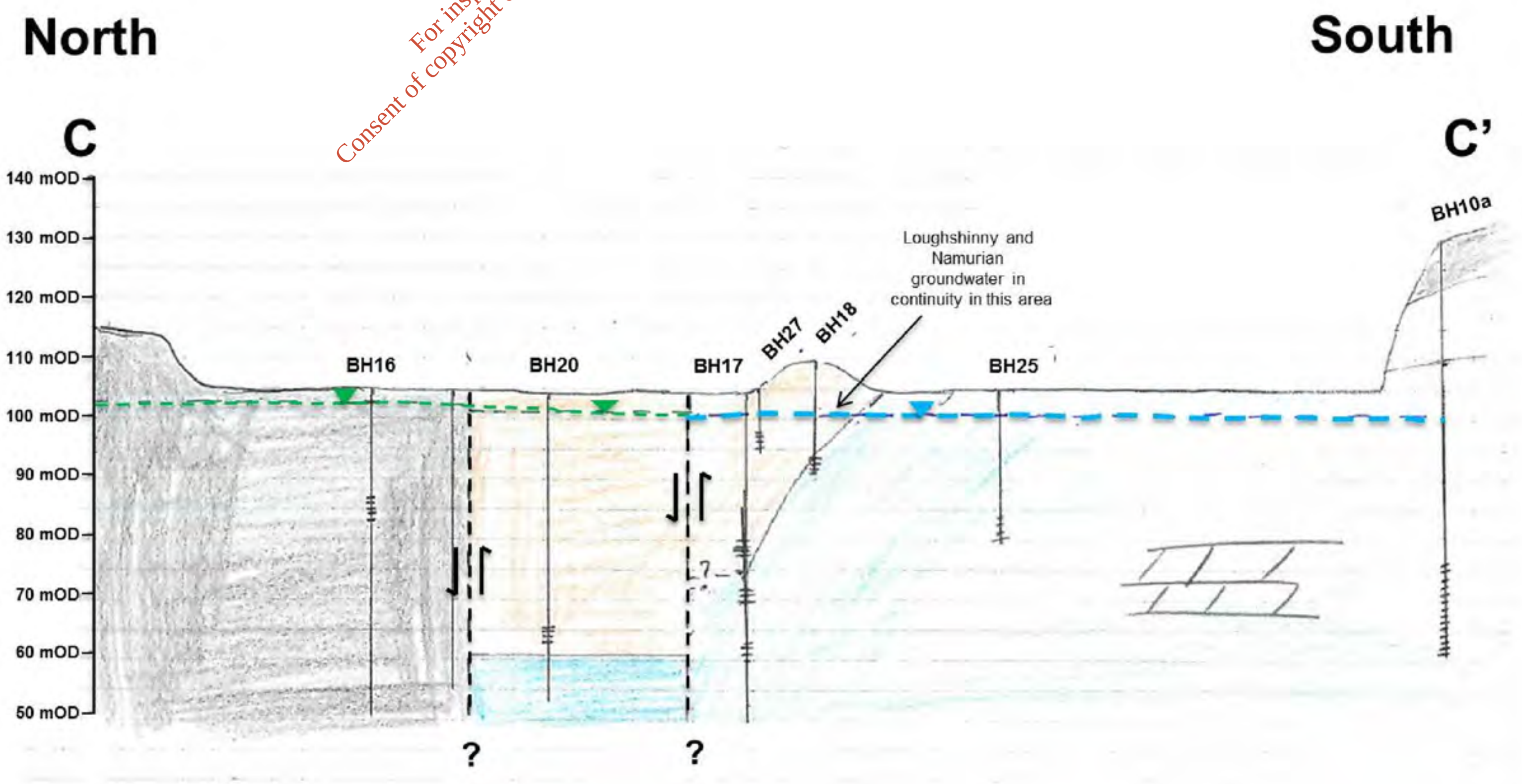

Legend

- 🟥 MEHL Proposed Planning and Waste Licence Boundary
- ━ Possible Fault/Fracture
- ━ PossFaultedContact
- ━ Cross section location

Key:

- ▨ Boulder clay
- ▨ Walshestown Formation
- ☐ Balrickard Formation
- ▨ Loughshinny Formation
- - - Faulting
- - - Namurian groundwater levels
- - - Loughshinny groundwater levels

Cross sections not to scale.
Approximate vertical scale: 1:100
Approximate horizontal scale: 1:3,500

Issue	Date	By	Chkd	Appd
P1	23-08-13	CB	RL	RL

Metres
0 137.5 275 550

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Figure 7.
Geological cross sections

Scale at A3
1:10,000

Job No
326877.30

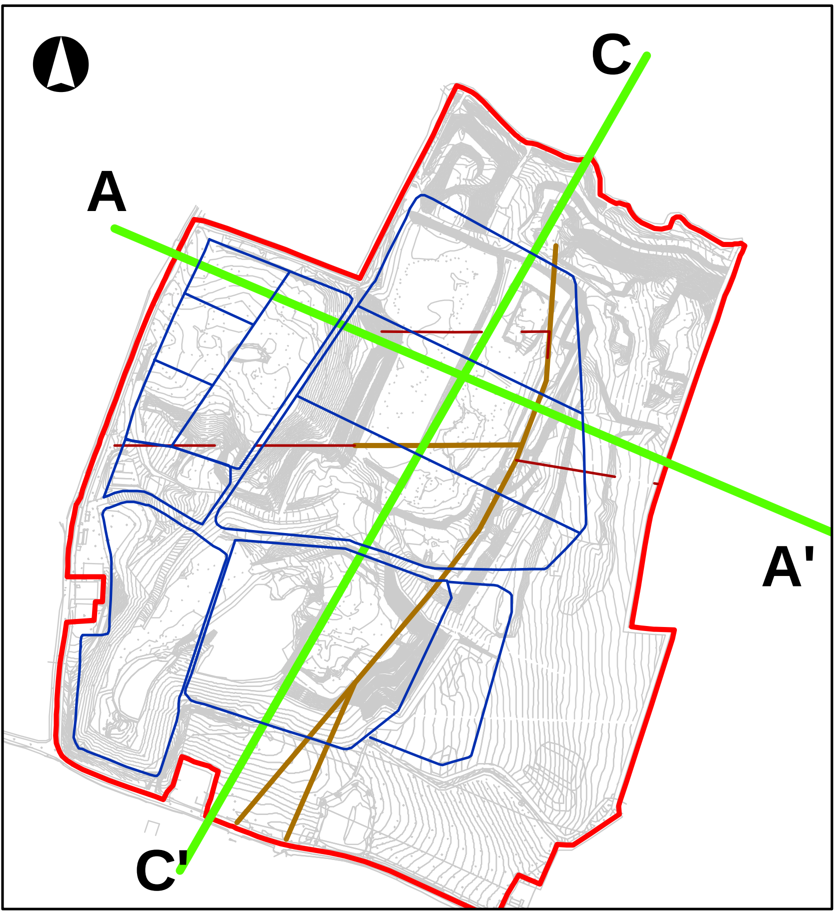
Drawing Status
Final

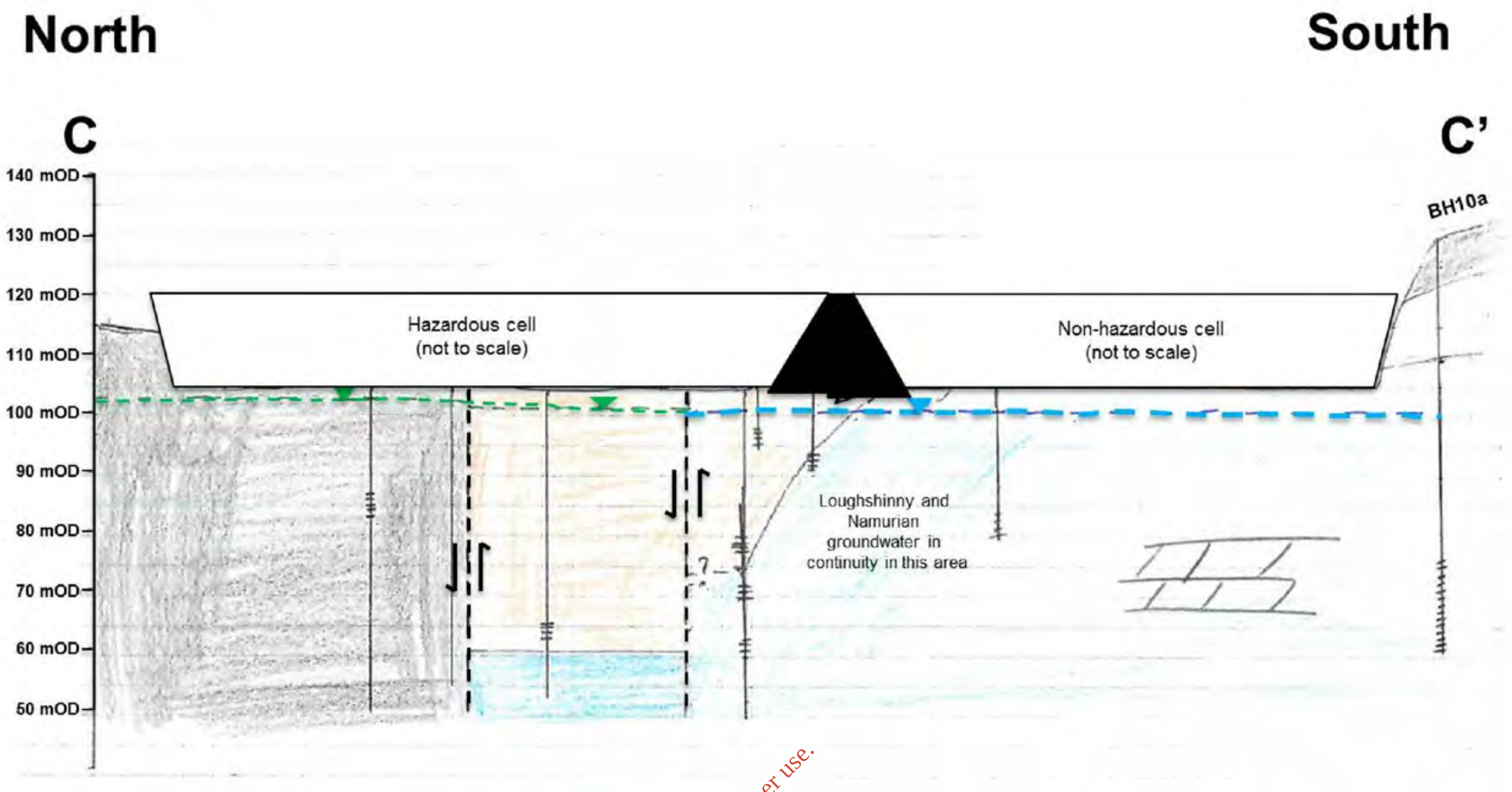
Drawing No
007

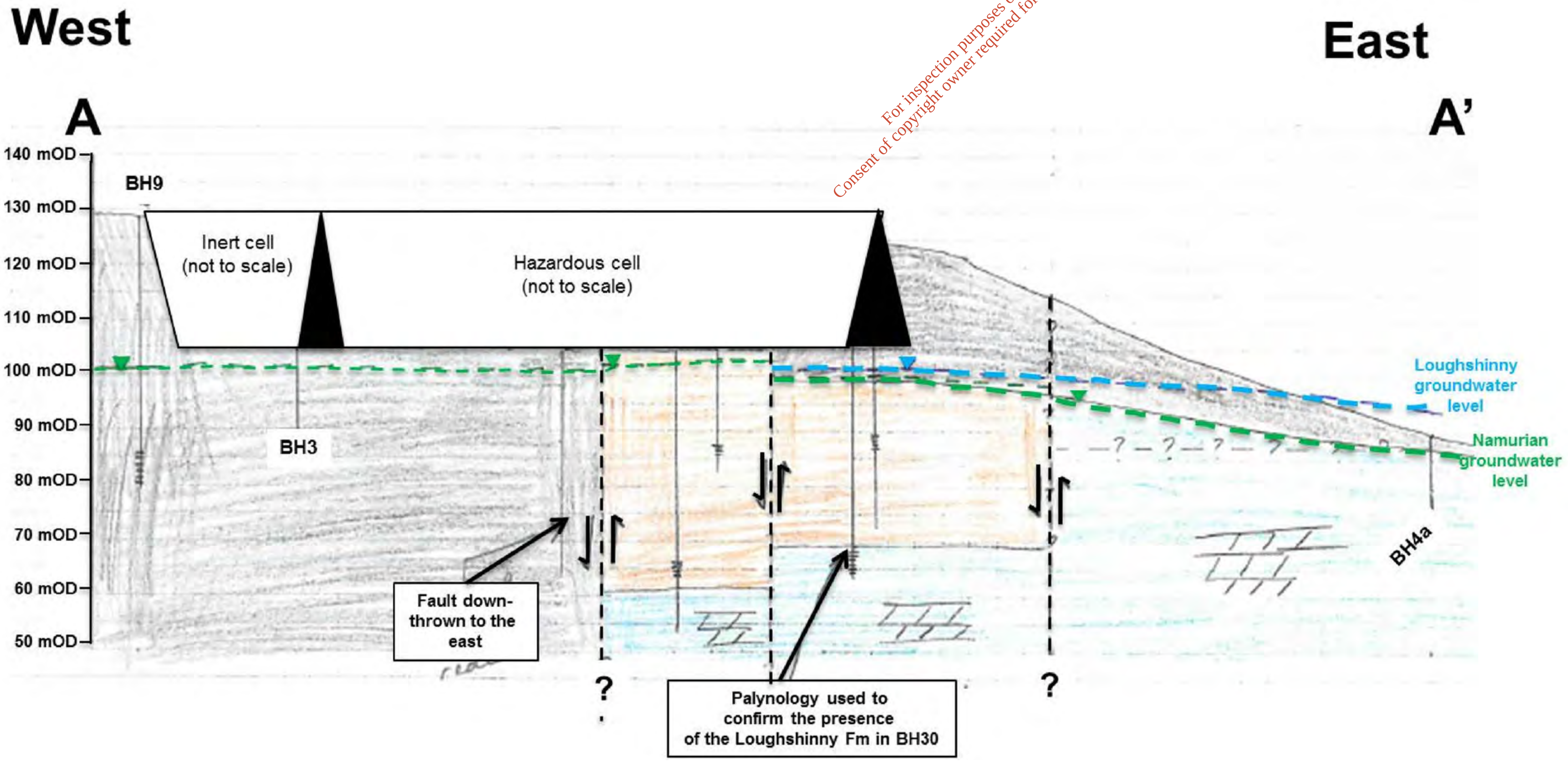
Issue
P1

MXD Location: J:\D6800-D6899\D6877\6_Graphics\30\GIS\WLA 2013\mxd\Figure 7 x sxn locations.mxd

A3







Legend

- 🟥 MEHL Proposed Planning and Waste Licence Boundary
- — Possible Fault/Fracture
- — PossFaultedContact
- — Waste cell layout
- — CSM locations

Key:

- ▨ Boulder clay
- ▨ Walshestown Formation
- ☐ Balrickard Formation
- ▨ Loughshinny Formation
- – – Faulting
- – – Namurian groundwater levels
- – – Loughshinny groundwater levels

Cross sections not to scale.
Approximate vertical scale: 1:100
Approximate horizontal scale: 1:3,500

Issue	Date	By	Chkd	Appd
P1	23-08-13	CB	RL	RL

Metres
0 110 220 440

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Figure 8.
Conceptual site model

Scale at A3
1:8,000

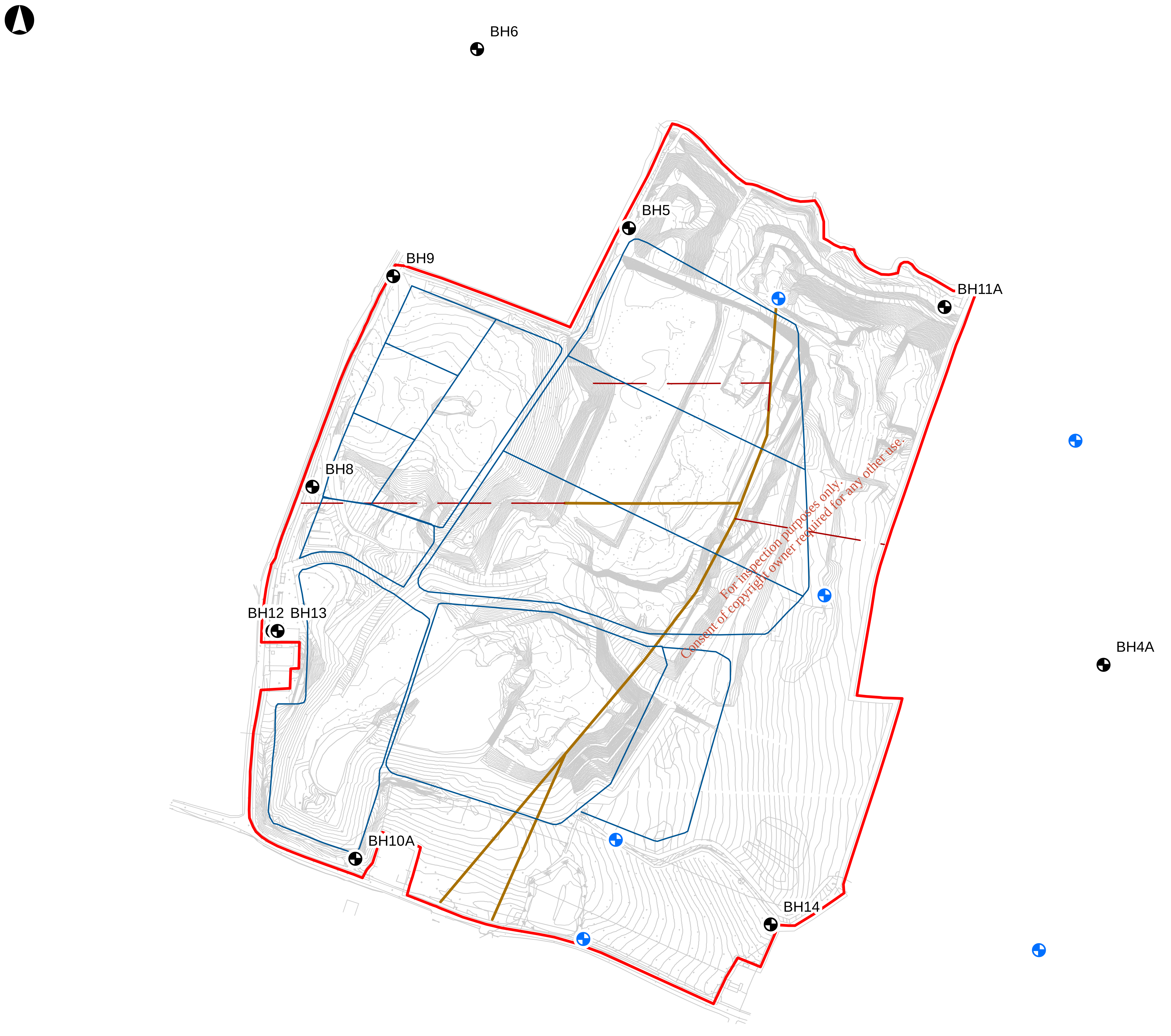
Job No
326877.30

Drawing Status
Final

Drawing No
008

Issue
P1

A3



Legend

🟥	MEHL Proposed Planning and Waste Licence Boundary
—	Waste cell layout
●	Proposed additional monitoring points
●	Existing EPA Licence W0129-02 Monitoring Boreholes
—	Possible Fault/Fracture
—	PossFaultedContact

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P1	23-08-13	CB	RL	RL

Metres
0 55 110 220

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Response to EPA Article 16: Groundwater**

**Figure 9.
Proposed groundwater monitoring locations**

Scale at A3
1:4,000

Job No
326877.01

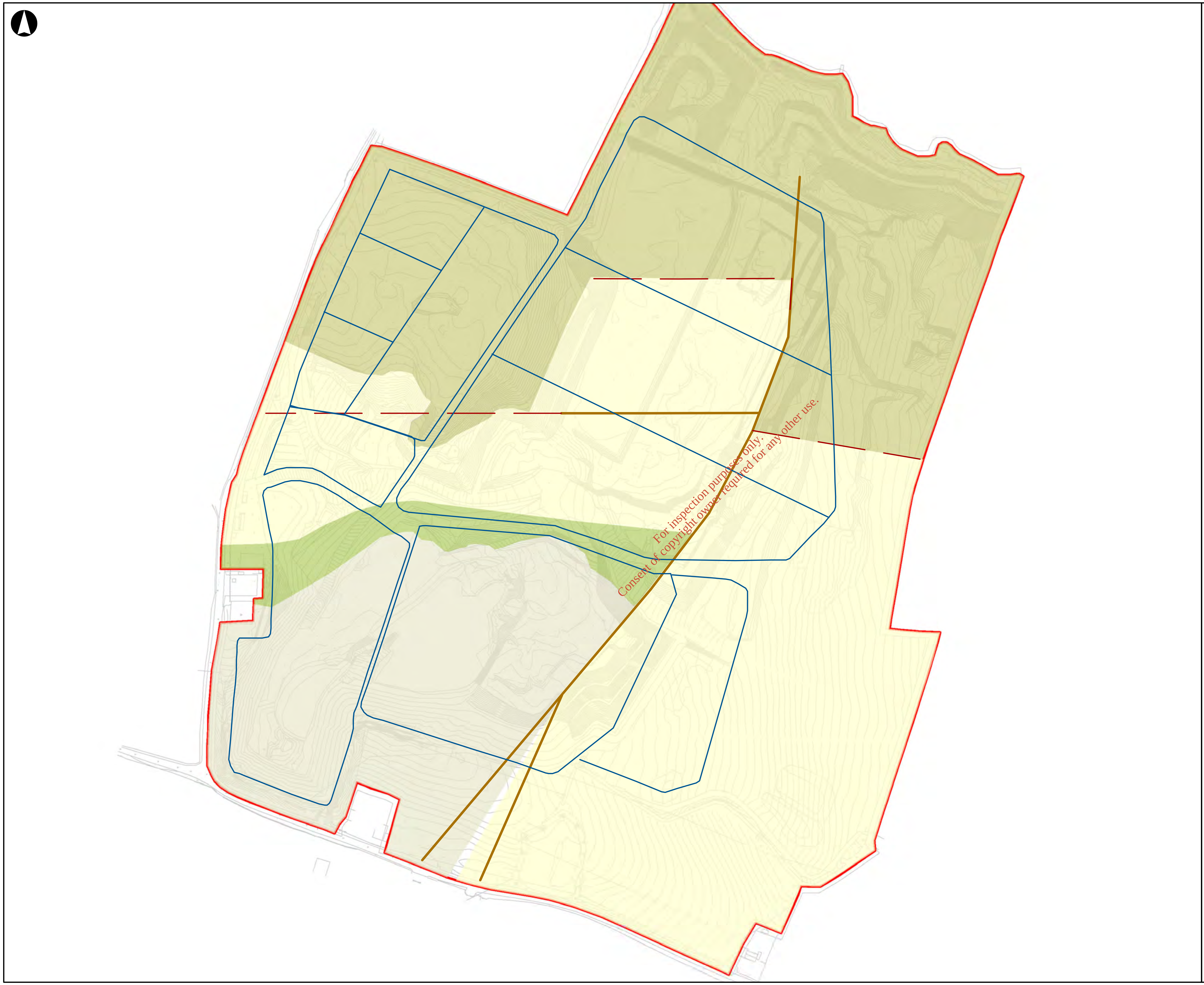
Drawing Status
Final

Drawing No
009

Issue
P1

MXD Location: J:\D6800-D6899\D6877\6_Graphics\30\GIS\WLA 2013\mxd\Figure 9 compliance point locations.mxd

A3



Legend

- 🟥 MEHL Proposed Planning and Waste Licence Boundary
- — Waste cell layout
- — Possible Fault/Fracture
- — PossFaultedContact

Geological formations

- ▨ WL - Walshestown Formation
- ▨ BC - Balrickard Formation
- ▨ DR - Donore Formation
- ▨ LO - Loughshinny Formation

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Metres
0 40 80 160

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**Figure 10.
Site specific geological map**

Scale at A3
1:3,200

Job No
326877.01

Drawing Status
Final

Drawing No
010

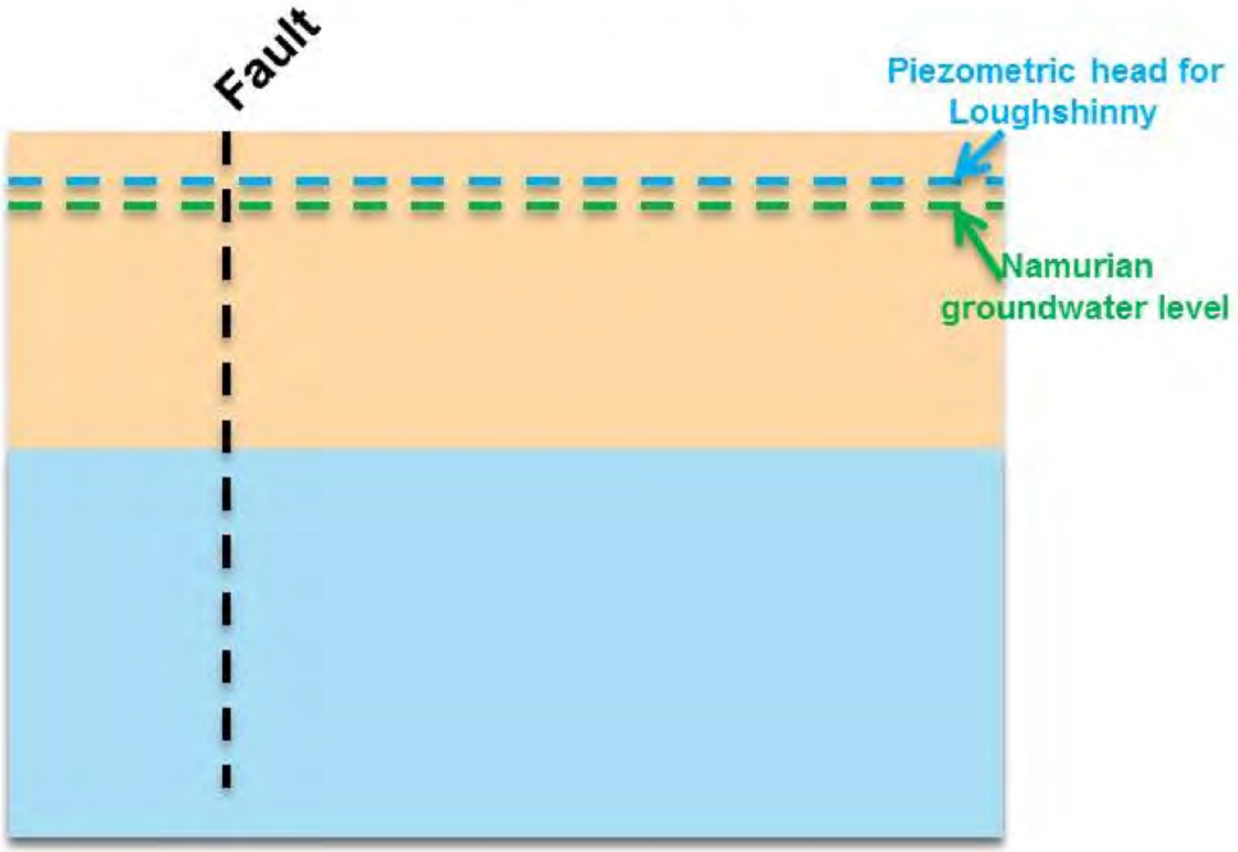
Issue
P1

MXD Location: J:\D6800-D6899\D6877\6_Graphics\30\GIS\WLA 2013\mxd\Figure 10 site specific geology.mxd

A

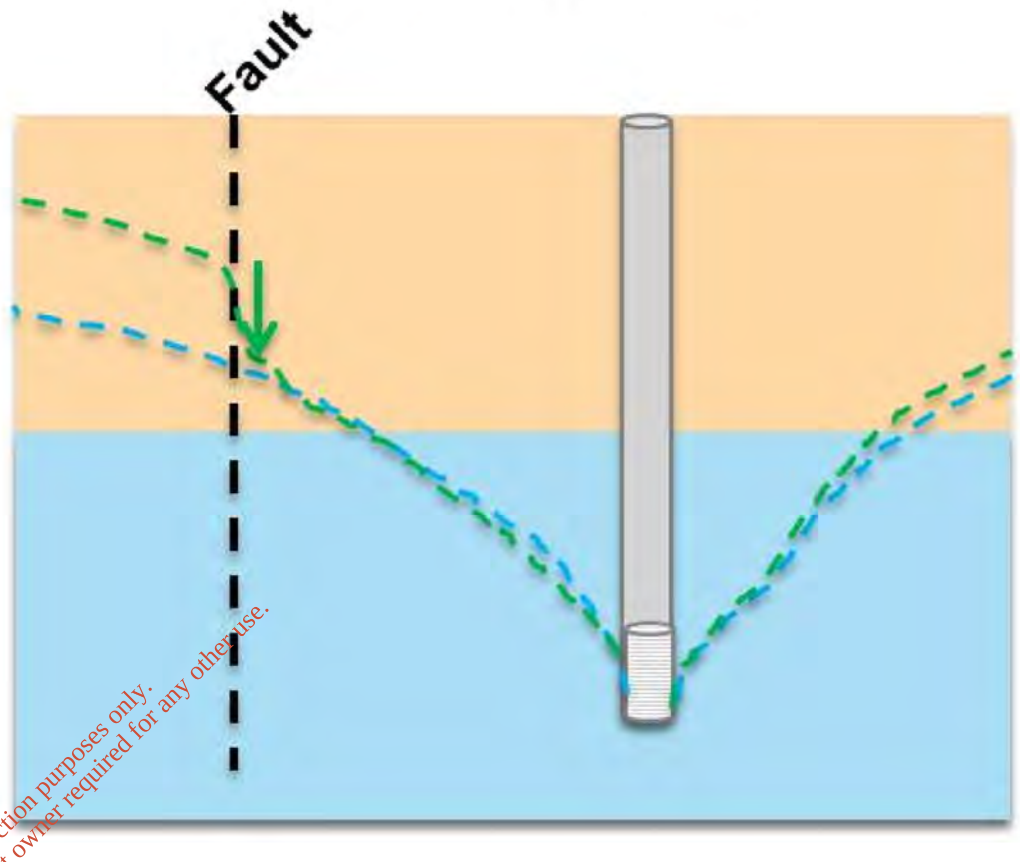
Static scenario

Groundwater in Namurian and Loughshinny are separate



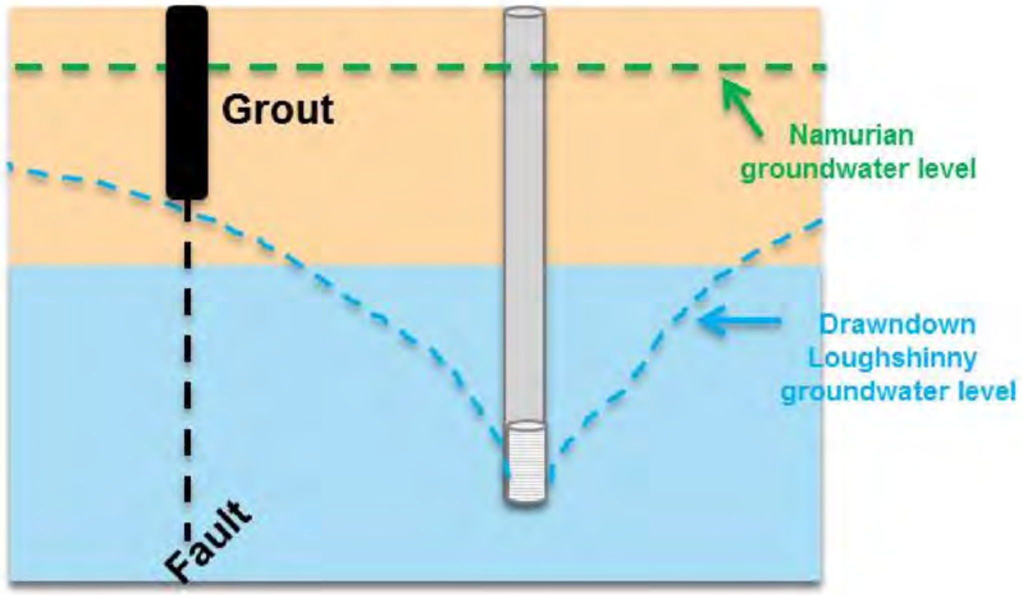
Pumping scenario

Pumping from the Loughshinny causes groundwater in the Namurian to also be drawndown via the faults



Grouting scenario

Grouting of the fault removes the pathway for Namurian water to be drawn down by pumping of the Loughshinny Formation



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P1	23-08-13	CB	RL	RL
Issue	Date	By	Chkd	Appd

Metres
0 137.5 275 550

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**Figure 11.
Conceptual drawing of drawdown in the fault**

Scale at A3

1:10,000

Job No
326877.30

Drawing Status
Final

Drawing No
011

Issue
P1

MXD Location: J:\D6800-D6899\D6877\6_Graphics\30\GIS\WLA 2013\mxd\Figure 10 drawdown.mxd

Appendix C

Historic Borehole Logs

BH ID	EASTING	NORTHING	LOCATION	FINISHED DEPTH	DATE DRILLED	DATE DECOMMISSIONED	REFERENCE/ PURPOSE	LOG AVAILABLE
ICBH1	?[1]	?	Within site – north	34.5m	May 1989	Not known; pre-1998	DeBritt – Quarry investigation for Irish Cement (referenced in EIS 1999)	☒
ICBH2	?	?	Within site – north	34.0m	May 1989	Not known; pre-1998	DeBritt – Quarry investigation for Irish Cement (referenced in EIS 1999)	☒
ICBH3	?	?	Within site – north	32.5m	May 1989	Not known; pre-1998	DeBritt – Quarry investigation for Irish Cement (referenced in EIS 1999)	☒
ICBH4	?	?	Within site – north/centre	38.0m	May 1989	Not known; pre-1998	DeBritt – Quarry investigation for Irish Cement (referenced in EIS 1999)	☒
ICBH6	?	?	Within site – south	22.5m	May 1989	Not known; pre-1998	DeBritt – Quarry investigation for Irish Cement (referenced in EIS 1999)	☒
ICBH7	?	?	Within site – south	10.5m	May 1989	Not known; pre-1998	DeBritt – Quarry investigation for Irish Cement (referenced in EIS 1999)	☒
ICBH8	?	?	Within site – south	6.5m	May 1989	Not known; pre-1998	DeBritt – Quarry investigation for Irish Cement (referenced in EIS 1999)	☒
ICBH9	?	?	Within site – south	29.0m	May 1989	Not known; pre-1998	DeBritt – Quarry investigation for Irish Cement (referenced in EIS 1999)	☒

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[1] Location of IC boreholes shown on Fig. 3.6.2 of EIS 1999

BH ID	EASTING	NORTHING	LOCATION	FINISHED DEPTH	DATE DRILLED	DATE DECOMMISSIONED	REFERENCE/ PURPOSE	LOG AVAILABLE
ICBH10	?	?	Within site – south	32.0m	May 1989	Not known; pre-1998	DeBritt – Quarry investigation for Irish Cement (referenced in EIS 1999)	☒
ICBH11	?	?	Within site – south	4.5m	May 1989	Not known; pre-1998	DeBritt – Quarry investigation for Irish Cement (referenced in EIS 1999)	☒
ICBH12	?	?	Within site – south	6.5m	May 1989	Not known; pre-1998	DeBritt – Quarry investigation for Irish Cement (referenced in EIS 1999)	☒
BH-1	315448	257939	Within site - west	56m	03/09/1998	?	EIS 1999	☑
BH-2	315561	257897	Within site - south	13.9m	16/07/1998	?	EIS 1999	☑
BH-3	315624	258176	Within site – north/centre	10.9m	17/07/1998	?	EIS 1999	☑
BH-4[2]	316105	257867	East of site – ca. 520m	9m	03/09/1998	2009	EIS 1999	☑
BH-4A	316271.2	257891.03	East of site	12.19m	18/11/2008	ACTIVE	To replace BH-4 for ongoing monitoring as a licensed facility.	Drillers' log only
BH-5	315796	258328	Within site – north	35m	03/09/1998	ACTIVE	EIS 1999	☑
BH-6	315644	258506	North of site – ca. 240m	19.5m	03/09/1998	ACTIVE	EIS 1999	☑
BH-7	Not recorded on log	Not recorded on log	Within site - south	41m	07/09/1998	Abandoned 07/09/1998	EIS 1999	☑

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[2] Grid ref. stated as 316115, 257861 on some documents; however grid ref. in table is deemed accurate and is stated on original BH log.

BH ID	EASTING	NORTHING	LOCATION	FINISHED DEPTH	DATE DRILLED	DATE DECOMMISSIONED	REFERENCE/ PURPOSE	LOG AVAILABLE
BH-8	315479	258069	Within site - west	27m	17/08/2001	ACTIVE	W0129-01 Application, Art. 16 (Oct. 2001)	☑
BH-9	315560	258280	Within site – north west	50m	03/08/2001	ACTIVE	W0129-01 Application, Art. 16 (Oct. 2001)	☑
BH-10	315442	257731	Within site – south west	84m	04/08/2001	Q3, 2007	W0129-01 Application, Art. 16 (Oct. 2001)	☑
BH-10A	315522	257697	Within site – south west	68m	05/03/2007	ACTIVE	Application to Review Waste Licence W0129-01 (July 2007)	☑
BH-11[3]	315932	258219	Within site – north east	50m	03/08/2001	Q4, 2007	W0129-01 Application, Art. 16	☑
BH-11A	316112	258249	Within site – north east	30m	02/05/2007	ACTIVE	Application to Review Waste Licence W0129-01 (July 2007)	☑
BH-12	315439	257925	Within site – west	65m	01/05/2007	ACTIVE	Application to Review Waste Licence W0129-01 (July 2007)	☑
BH-13	315444	257925	Within site – west	48m	15/04/2007	ACTIVE	Application to Review Waste Licence W0129-01 (July 2007)	☑
BH-14	315938	257631	Within site – south east	38m	02/03/2007	ACTIVE	Application to Review Waste Licence W0129-01 (July 2007)	☑
BH-15A	315786.3	257849.6	Quarry Floor	30m	16-22/04/2010	ACTIVE	EIS 2010/W0129-03 Application 2010	☑

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[3] Grid ref. stated as 315823, 258182 on some documents; however grid ref. in table is deemed accurate and is stated in WLR Application, July 2007

BH ID	EASTING	NORTHING	LOCATION	FINISHED DEPTH	DATE DRILLED	DATE DECOMMISSIONED	REFERENCE/ PURPOSE	LOG AVAILABLE
BH-16	315861.9	258218.2	Quarry Floor	24m	12-20/04/2010	ACTIVE	EIS 2010/W0129-03 Application 2010	☑
BH-17	315794.7	258003.1	Quarry Floor	54m	05/05/2010	ACTIVE	EIS 2010/W0129-03 Application 2010	☑
BH-18	315711	257996.4	Quarry Floor	21m	20-24/04/2010	ACTIVE	EIS 2010/W0129-03 Application 2010	☑
BH-19	315887.1	258059.1	Quarry Floor	18m	21-22/04/2010	ACTIVE	EIS 2010/W0129-03 Application 2010	☑
BH-20	315862.6	258102.3	Quarry Floor	52m	22-27/04/2010	ACTIVE	EIS 2010/W0129-03 Application 2010	☑
BH-21	316074.94	258199.63	NE corner of site	20m	14/04/2010	Backfilled as part of the SI works	Geotechnical shell and auger borehole for SI No.1 for EIS 2010/W0129-03 Application 2010	☑
BH-22A	315960.83	258090.71	Floor of quarry, in N of site	20.6m	12/04/2010	Backfilled as part of the SI works	Geotechnical shell and auger borehole for SI No.1 for EIS 2010/W0129-03 Application 2010	☑
BH-23	315960.42	257968.59	Floor of quarry; east of site	22.7m	07/04/2010	Backfilled as part of the SI works	Geotechnical shell and auger borehole for SI No.1 for EIS 2010/W0129-03 Application 2010	☑
BH-24	315954.523	258209.452	Floor of quarry, in N of site	48.2m	10-13/06/13	ACTIVE	SI No. 2, W0129-03 Application	☑
BH-25	315713.048	257875.541	Within site – south/centre	26m	21-22/05/2013	ACTIVE	SI No. 2, W0129-03 Application	☑
BH-26	315881.349	258086.043	Within site – north/centre	24m	28/05/2013	ACTIVE	SI No. 2, W0129-03 Application	☑

BH ID	EASTING	NORTHING	LOCATION	FINISHED DEPTH	DATE DRILLED	DATE DECOMMISSIONED	REFERENCE/ PURPOSE	LOG AVAILABLE
BH-27	315756.699	258018.212	Within site - centre	14m	24-26/05/2013	ACTIVE	SI No. 2, W0129-03 Application	☑
BH-28	258018.212	257915.730	Within site – centre/east	40m	22-24/05/2013	ACTIVE	SI No. 2, W0129-03 Application	☑
BH-29	315985.929	258071.197	Within site – north-east	48m	29/05/2013	ACTIVE	SI No. 2, W0129-03 Application	☑
BH-30	315970.402	258072.549	Within site – north-east	61.7m	05/06/2013	ACTIVE	SI No. 2, W0129-03 Application	☑

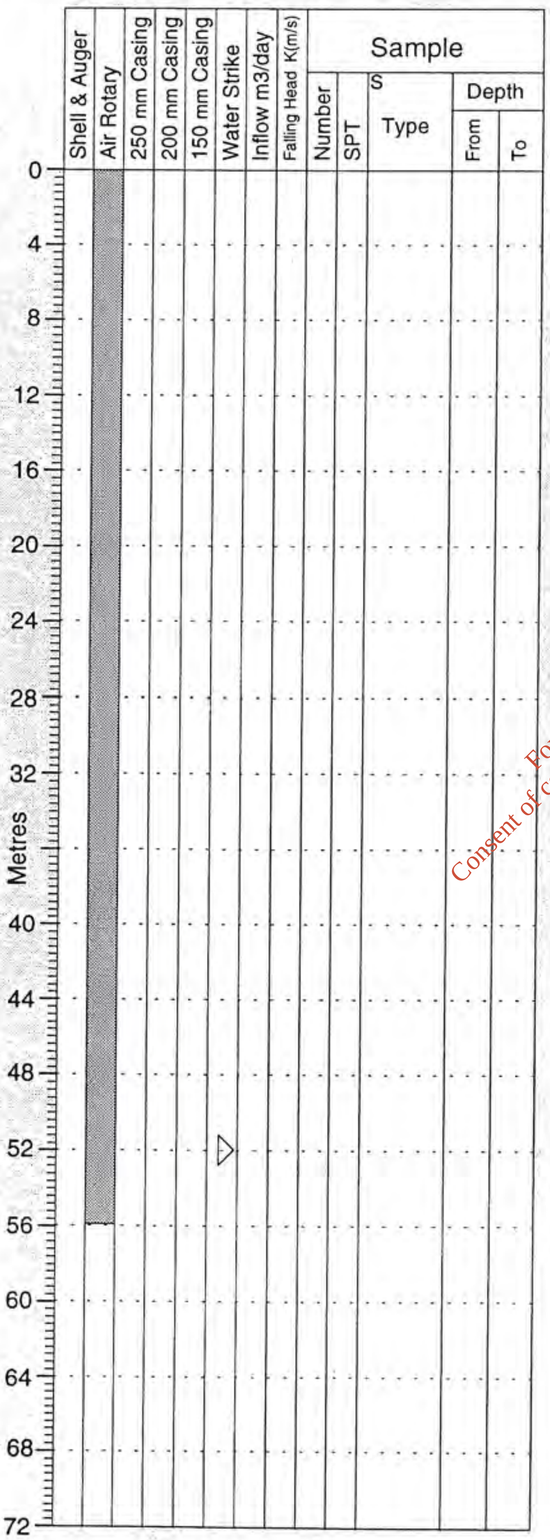
Whilst every effort has been made to ensure the accuracy of this information, the reader is directed to reference the original well logs for definitive data.

Monitoring Well Log

Monitoring Well BH 1

Client : Seamus Murphy.
Location : Hollywood, Co. Dublin
Job No : 1698
Date : 3/9/98
Description : Monitoring Well

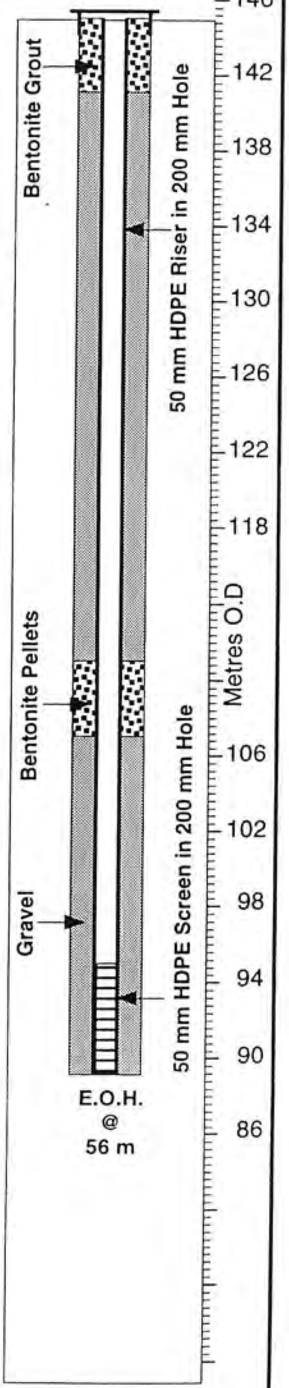
Drilling Company : Glovers Site Investigations Ltd.
Drilling Method : Air Rotary
Drillers Name :
National Grid Co. Ord. : 315448 East 257939 North
Ground Surface Elev. : 145.9 m OD Malin Head
Logged by : Clare Glanville



Drilling Notes and Strata Description

0 - 4 m Light brown silty clayey GRAVEL
4 - 8 m Grey/Brown sand with GRAVEL and Silt
8 - 12 m Orange/Brown Silt and Clay
12 - 20 m Grey/Black Shale Rock Fragments with clay and silt
20 - 36 m Brown/Grey Sandy silt with rock fragments
36 - 42 m Brown Sandy silt with rock fragments (Weathered)
42 - 46 m Grey shale chips with some brown silt
46 - 56 m Black Shale chips with some brown silt

Construction Details



Sample / Test Legend
U - U100 Tubes
SS - Slit Spoon
SPT - Standard Penetration Test

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

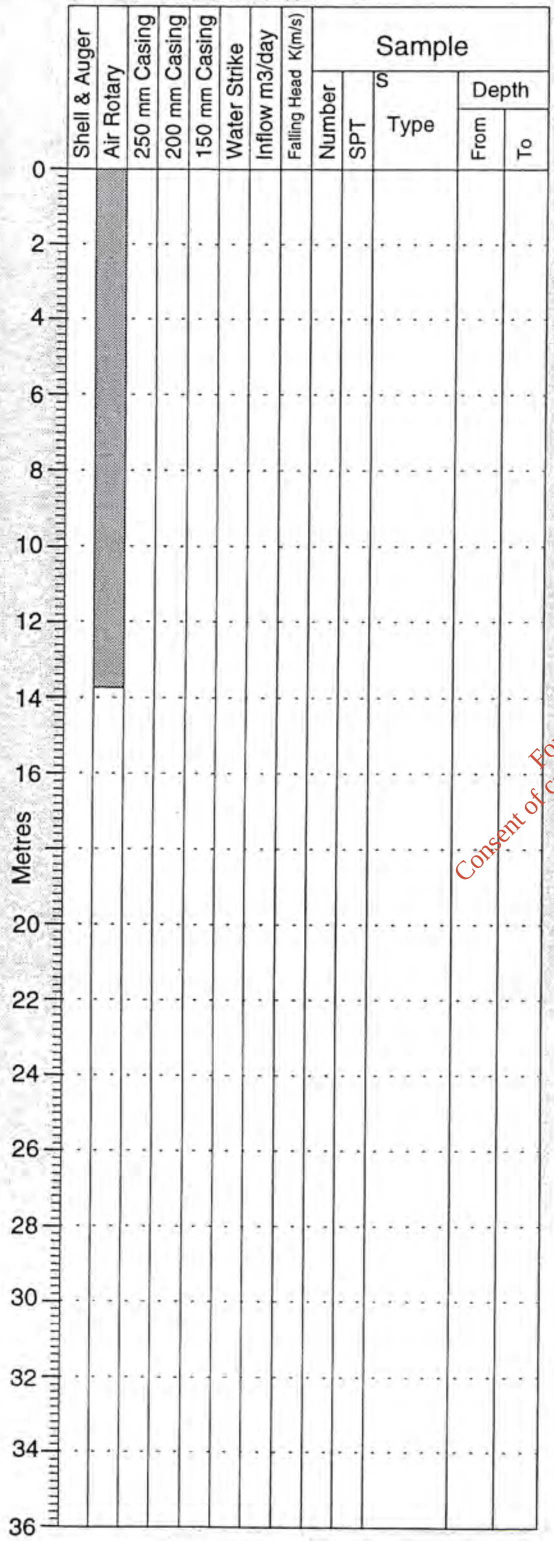
Figure No.

Monitoring Well Log

Monitoring Well BH 2

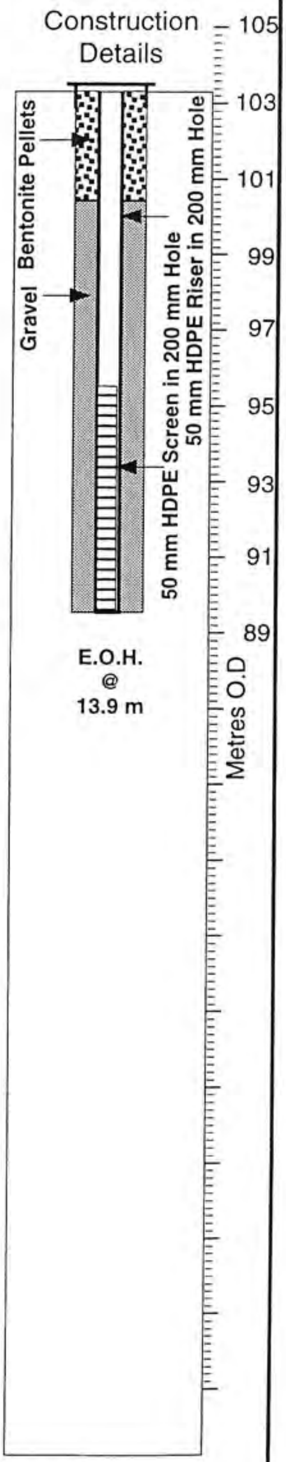
Client : Seamus Murphy.
Location : Hollywood, Co. Dublin
Job No : 1698
Date : 16/7/98
Description : Monitoring Well

Drilling Company : Glovers Site Investigations Ltd.
Drilling Method : Air Rotary
Drillers Name :
National Grid Co. Ord. : 315561 East 257897 North
Ground Surface Elev. : 103.3 m OD Malin Head
Logged by : John Mitchell



Drilling Notes and Strata Description

0-13.9m Limestone BEDROCK



Sample / Test Legend
U - U100 Tubes
SS - Slit Spoon
SPT - Standard Penetration Test

Figure No.

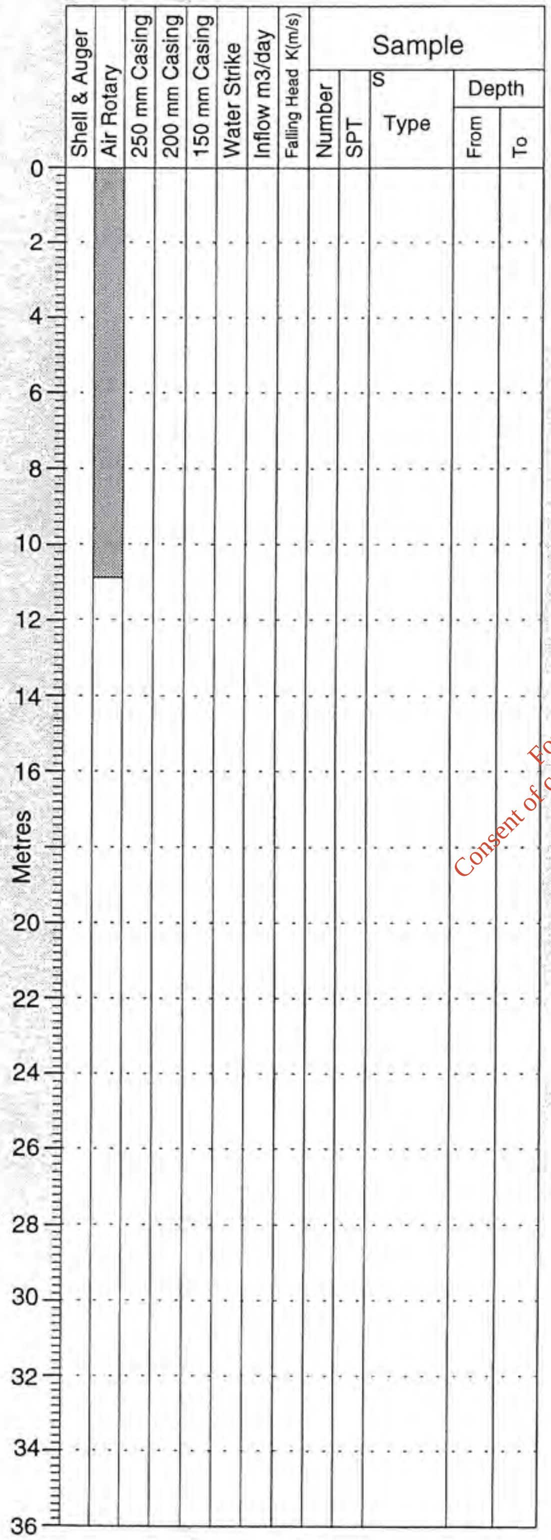
K.T.Cullen & Co. Ltd.
Hydrogeological & Environmental Consultants

Monitoring Well Log

Monitoring Well BH 3

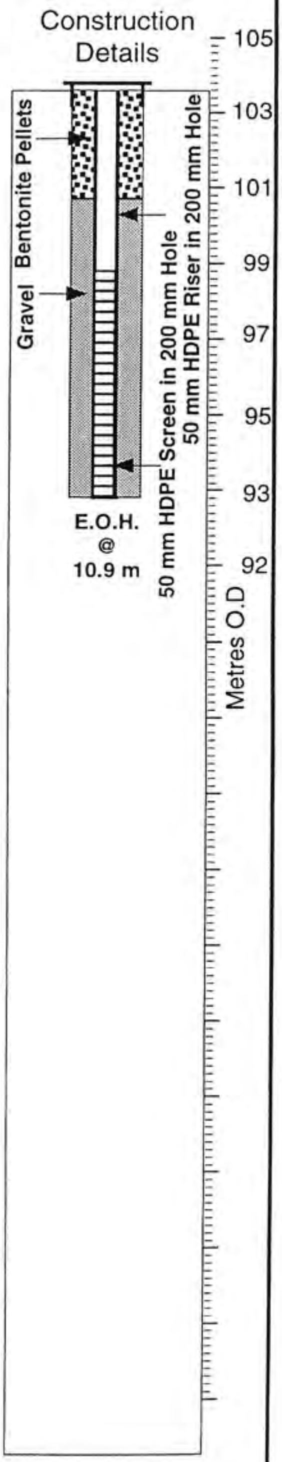
Client : Seamus Murphy.
Location : Hollywood, Co. Dublin
Job No : 1698
Date : 17/7/98
Description : Monitoring Well

Drilling Company : Glovers Site Investigations Ltd.
Drilling Method : Air Rotary
Drillers Name :
National Grid Co. Ord. : 315624 East 258176 North
Ground Surface Elev. : 104.6 m OD Malin Head
Logged by : John Mitchell



Drilling Notes and Strata Description

0-10.9m Shale BEDROCK



Sample / Test Legend
U - U100 Tubes
SS - Slit Spoon
SPT - Standard Penetration Test

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

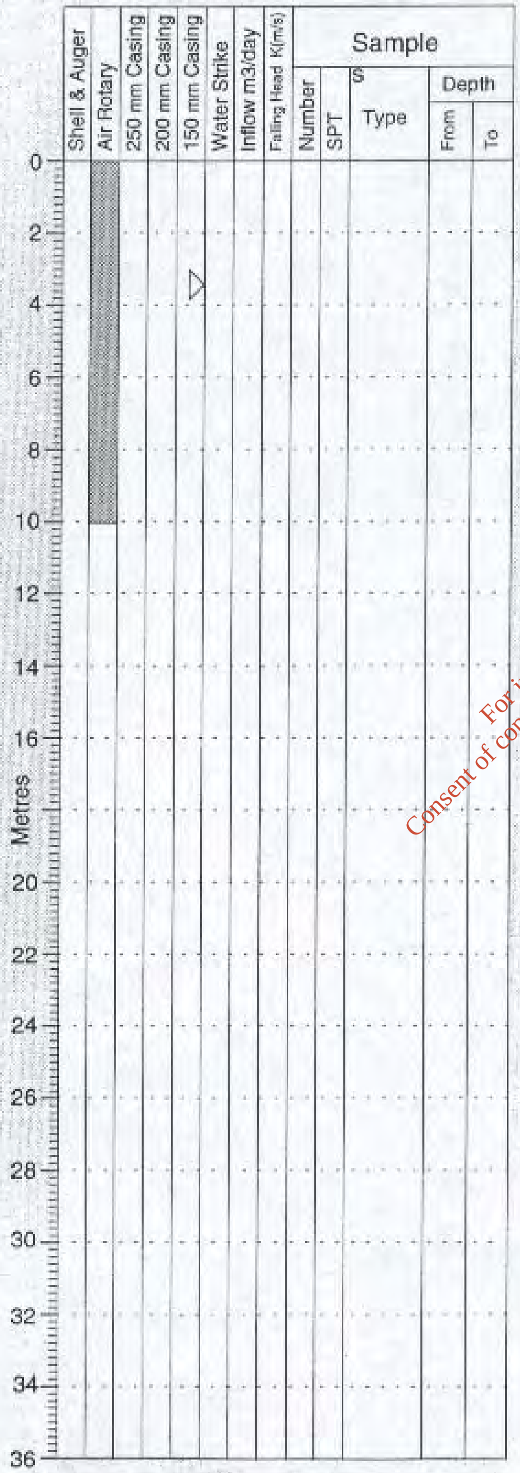
Figure No.

Monitoring Well Log

Monitoring Well BH 4

Client : Seamus Murphy.
Location : Hollywood, Co. Dublin
Job No : 1698
Date : 3/9/98
Description : Monitoring Well

Drilling Company : Glovers Site Investigations Ltd.
Drilling Method : Air Rotary
Drillers Name :
National Grid Co. Ord. : 326044 East 257842 North
Ground Surface Elev. : 96.9 m OD Malin Head
Logged by : Clare Glanville



Drilling Notes and Strata Description

0-3m TILL

3-10m Limestone BEDROCK

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

Sample / Test Legend
U - U100 Tubes
SS - Slit Spoon
SPT - Standard Penetration Test

Figure No.

DUNNES
DRILLING

No: 5668

DRILLERS LOG

WELL DRILLING AND HORIZONTAL DRILLING ENGINEERS
Dublin Road, Dromiskin, Dundalk, Co. Louth.
E-Mail: info@dunnesdrilling.com website: www.dunnesdrilling.com
Tel: +353 42 9372188 Fax: +353 42 9372714

Borehole for: Murphy Environmental Hollywood Ltd
at Hollywood Quarry

8" Monitoring Well

Date	Depth ft	Diam	Conditions
18.11.08	0 - 3	8"	Clay & stones
	3 - 14	8"	Sticky clay
	14 - 17	8"	Grey rock
	17 - 25	8"	Black rock - water at 25ft
	25 - 30	8"	Black rock
	30 - 40	8"	Black rock - water at 35ft

Total depth of well	40ft (12.19m)
Estimated yield	1000 gallons per hour
Depth to rock	14ft (4.27m)
Steel casing installed	17ft (5.18m) of 8" steel casing
PVC casing installed	7m of 2" PVC
Well screen	6m of 2" Screen
Other remarks	Install gravel pack from 40ft to 18ft. 6 bags of bentonite seal from 18ft to 3ft above ground level

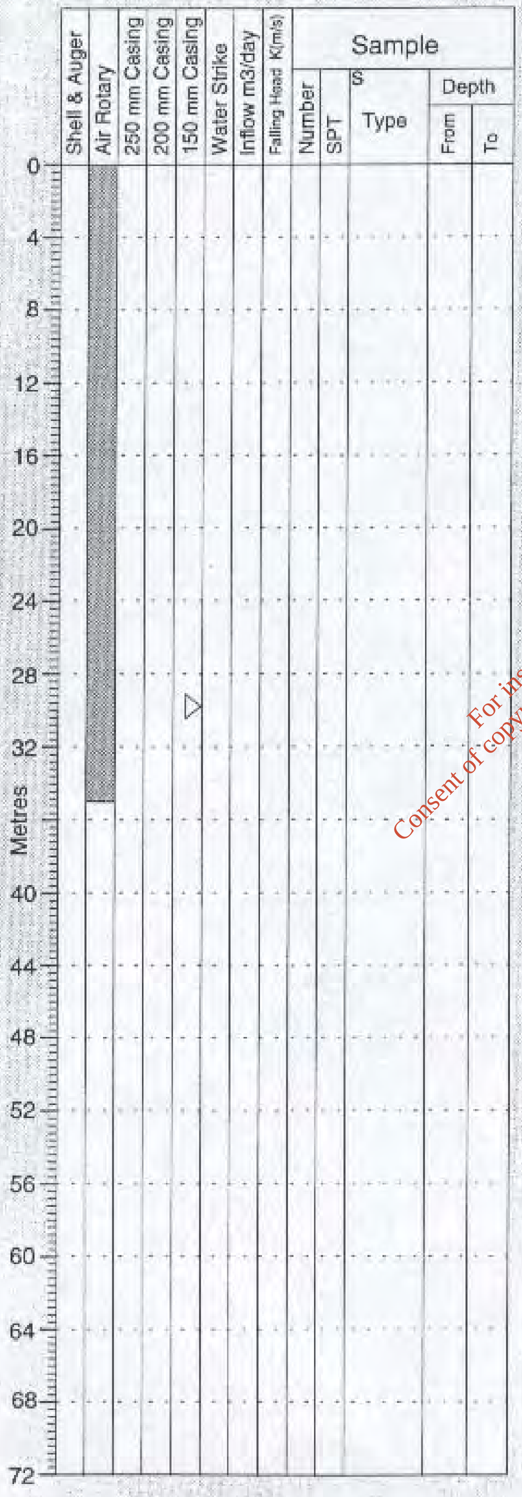
Operator A Hoey

Monitoring Well Log

Monitoring Well BH 5

Client : Seamus Murphy.
Location : Hollywood, Co. Dublin
Job No : 1698
Date : 3/9/98
Description : Monitoring Well

Drilling Company : Glovers Site Investigations Ltd.
Drilling Method : Air Rotary
Drillers Name :
National Grid Co. Ord. : 315796 East 258328 North
Ground Surface Elev. : 118.2 m OD Malin Head
Logged by : Clare Glanville

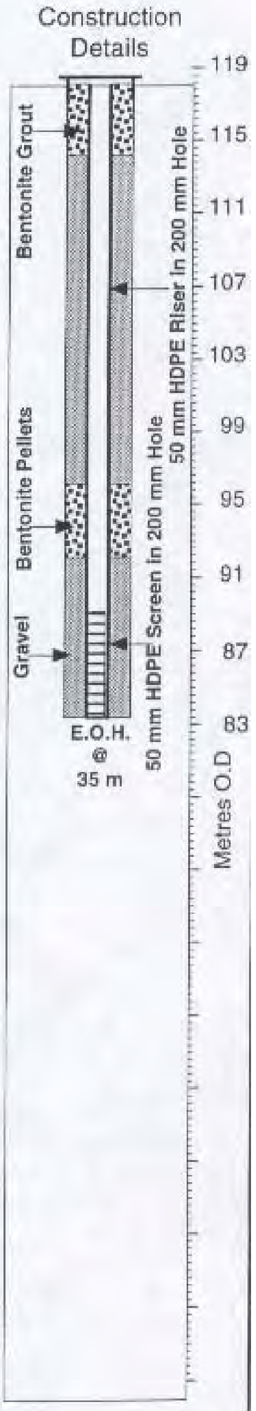


Drilling Notes and Strata Description

0 - 6 m Brown silty clayey matrixed TILL with gravel clasts

6 - 10 m Black Highly Weathered Shale , silty and clayey

10 - 35 m Black Weathered Shale



Sample / Test Legend
U - U100 Tubes
SS - Slit Spoon
SPT - Standard Penetration Test

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

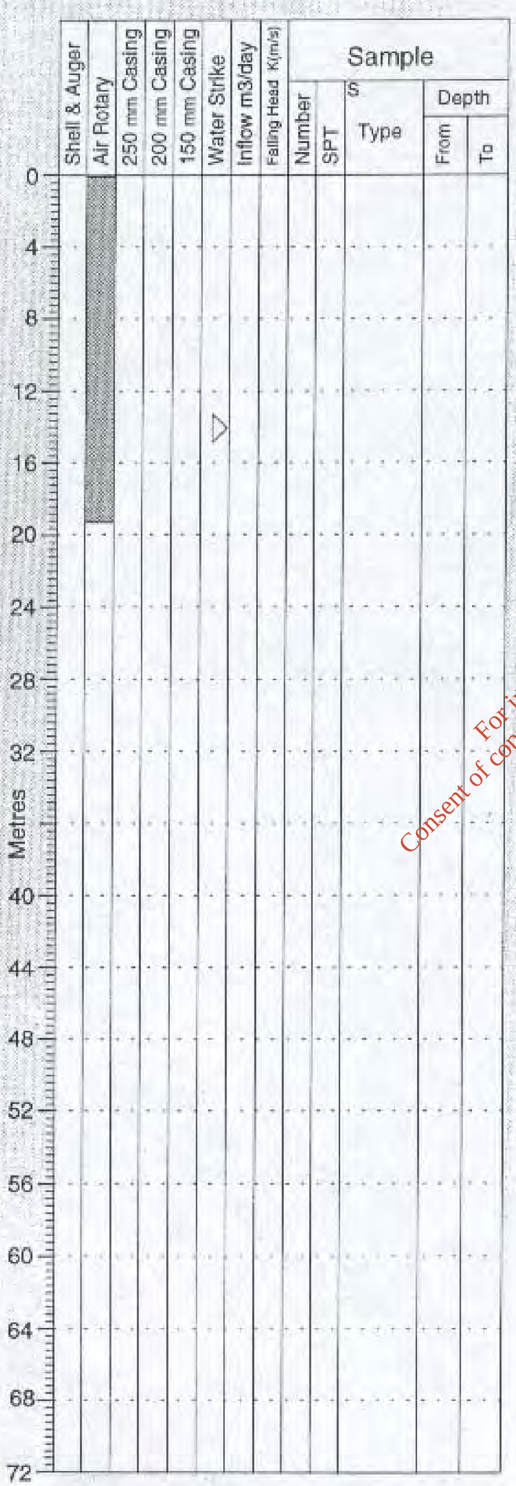
Figure No.

Monitoring Well Log

Monitoring Well BH 6

Client : Seamus Murphy.
Location : Hollywood, Co. Dublin
Job No : 1698
Date : 3/9/98
Description : Monitoring Well

Drilling Company : Glovers Site Investigations Ltd.
Drilling Method : Air Rotary
Drillers Name :
National Grid Co. Ord. : 315644 East 258506 North
Ground Surface Elev. : 117 m OD Malin Head
Logged by : Clare Glanville



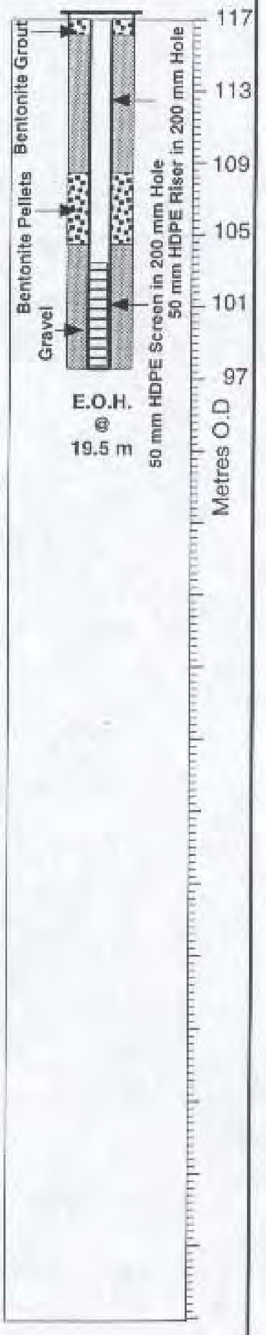
Drilling Notes and Strata Description

0 - 4 m Brown/Grey Clayey TILL

4 - 12 m Black Silty Clay with WEATHERED ROCK

12 - 19.5 m Black Shale BEDROCK

Construction Details



Sample / Test Legend
U - U100 Tubes
SS - Slit Spoon
SPT - Standard Penetration Test

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

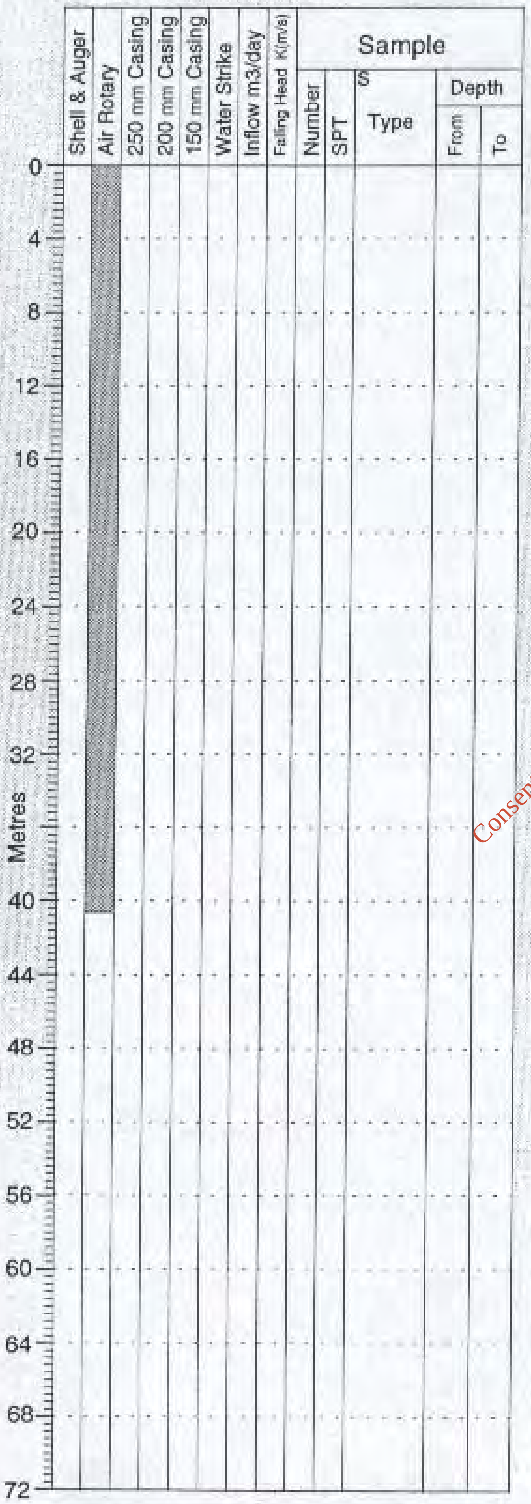
Figure No.

Monitoring Well Log

Monitoring Well BH 7

Client : Seamus Murphy.
Location : Hollywood, Co. Dublin
Job No : 1698
Date : 7/9/98
Description : Monitoring Well

Drilling Company : Glovers Site Investigations Ltd.
Drilling Method : Air Rotary
Drillers Name :
National Grid Co. Ord. : East North
Ground Surface Elev. : 132 m OD Malin Head
Logged by : Clare Glanville



Drilling Notes and Strata Description

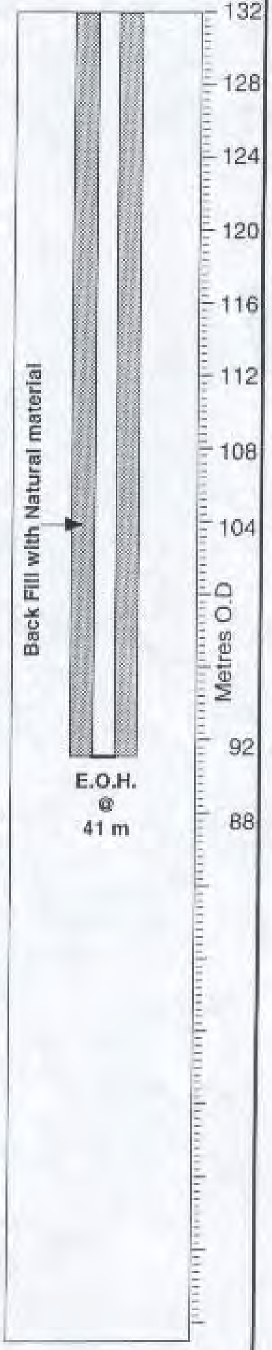
0 - 2 m Brown TILL with a silty to Clayey matrix

2 - 18 m Grey/Brown Silty weathered shale

18- 26 m Grey/Black weathered shale

No Further samples taken -Hole abandoned at 41 m

Construction Details



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

Sample / Test Legend

U - U100 Tubes
SS - Slit Spoon
SPT - Standard Penetration Test

Figure No.

Well Log

Well No. BH8 New
Grid Reference

Project No. 1698
Client Seamus Murphy
Drill Date 17/08/01

Well Type Groundwater Monitoring
Location Hollywood Great Quarry
Geologist F White

SUBSURFACE PROFILE

Description

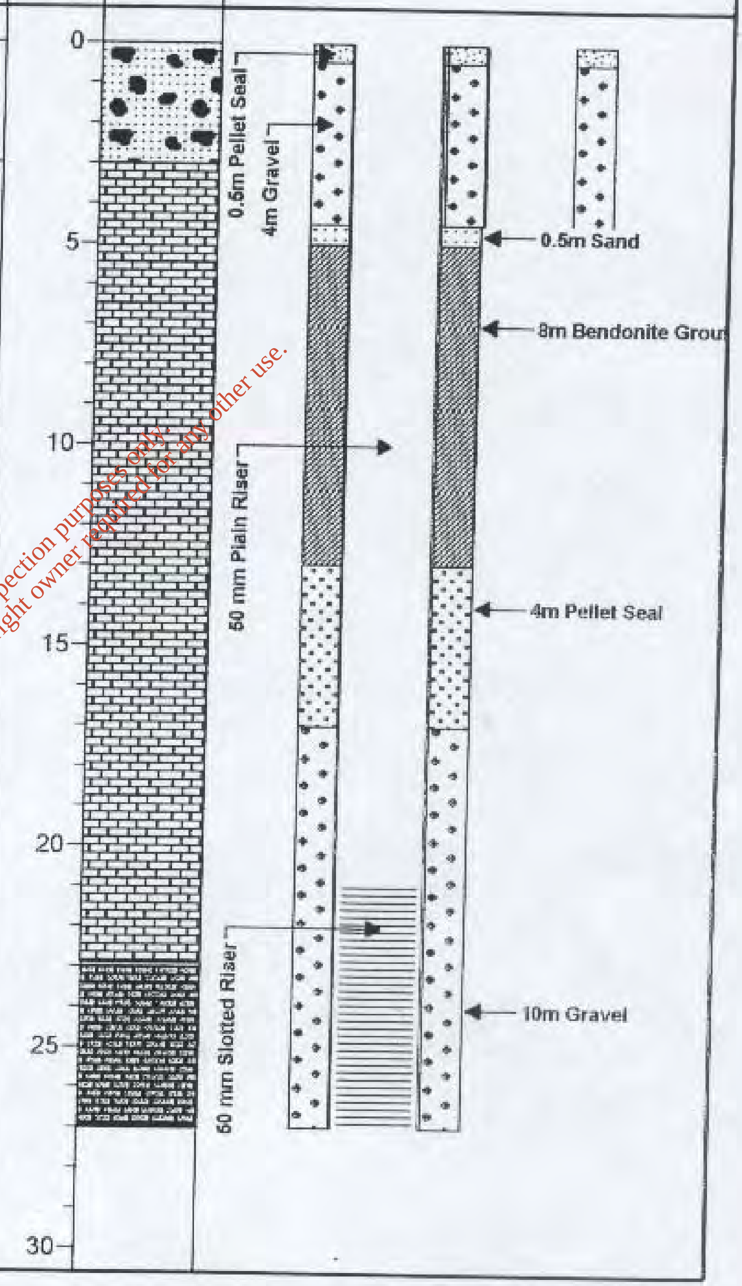
Ground Surface

OVERBURDEN
Overburden BOULDER CLAY

SHALE
Black SHALE bedrock

SHALE
Broken Black SHALE

End of Borehole



K.T.Cullen & Co. Ltd.

Drill Method Air Rotary
Casing Length (m)
Driller Glover Site Investigations

Hole Size (mm)
Ground Level (mOD)
Static Water Level (bgl)

Well Log

Well No. BH9

Grid Reference

Project No. 1698

Client Seamus Murphy

Drill Date 3/8/01

Well Type

Location Hollywood Great

Geologist Ben Whitfield

SUBSURFACE PROFILE

Description

Ground Surface

Colluvium and highly weathered shale
black loamy fine to medium sand
easy drilling; moist

light brown/dark brown gravelly medium clay; moist
Gravel dominantly black shale
Very moist thin layer 10.0 - 10.5
easy to medium drilling

Shale bedrock
black sand to gravel (granulated shale), moist
medium drilling

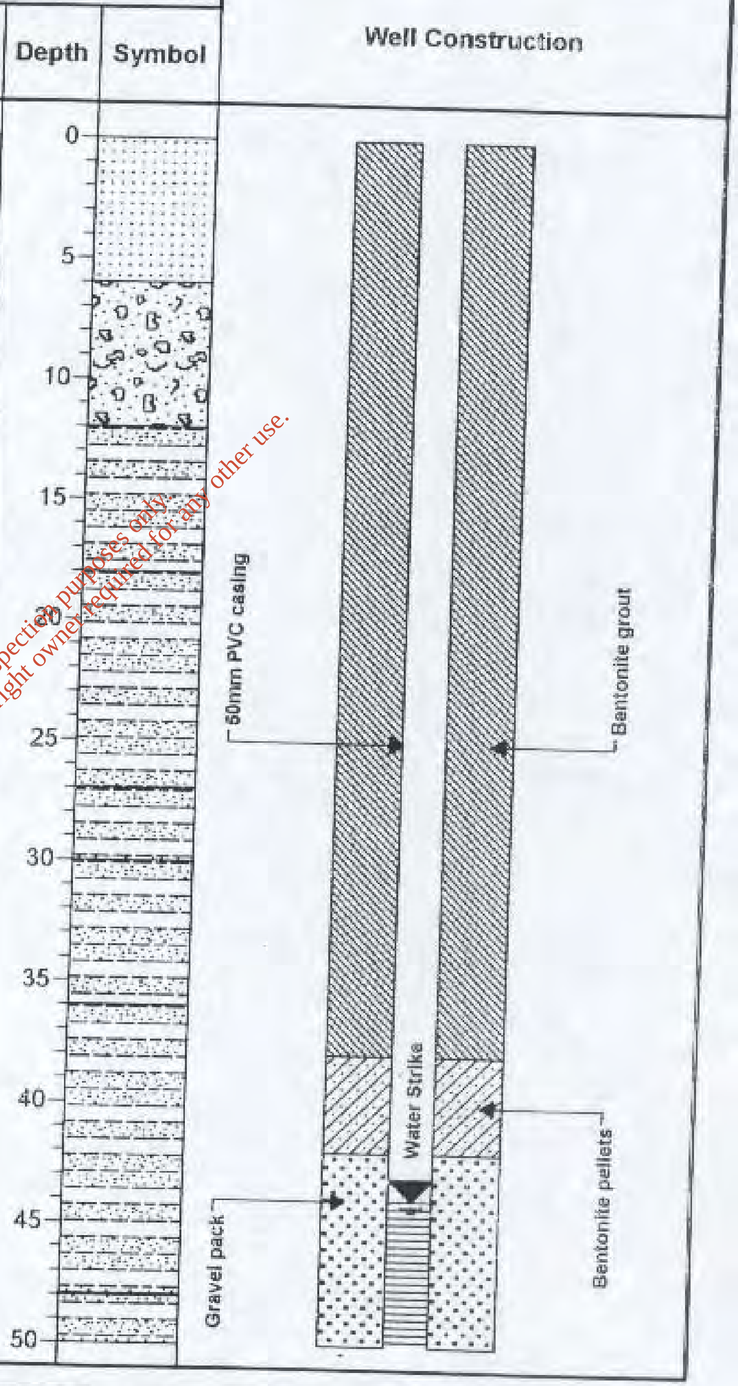
black sand to gravel, as above
gravel sized chips dominant

brown sand to gravel
gravel shale and minor calcareous siltstone
minor clay, moist

black sand to gravel
dominantly shale

black coarse sand to gravel shale chips
very moist@42
very easy drilling 40 - 41m
Water table 44m
Yield 500 gal/hr

End of Borehole



Drill Method Air rotary

Casing Length (m) 50

Driller Glovers Site Investigations

Hole Size (mm) 200

Ground Level (mOD)

Static Water Level (bgl)

T.Cullen & Co. Ltd.

Well Log

Well No. BH10

Grid Reference

Project No. 1698

Client Seamus Murphy

Drill Date 4/8/01

Well Type

Location Hollywood Great

Geologist C Connery

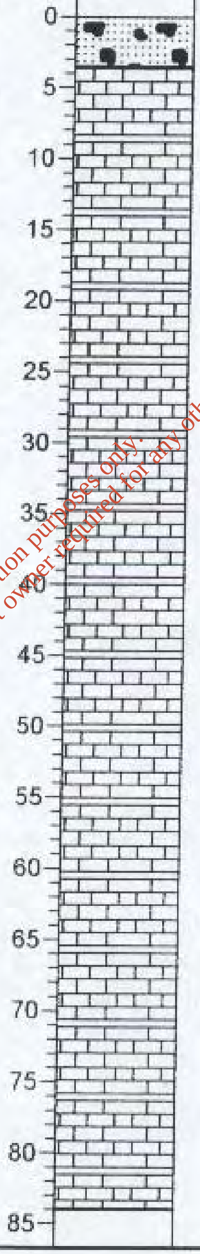
SUBSURFACE PROFILE

Description | **Depth** | **Symbol** | **Well Construction**

Ground Surface

Boulder clay
stiff brown very sandy gravelly clay containing cobbles and boulders

Limestone Bedrock
Limestone



End of Borehole

T.Cullen & Co. Ltd.

Drill Method Air rotary

Casing Length (m) 84

Driller Glovers Site Investigations

Hole Size (mm) 200

Ground Level (mOD)

Static Water Level (bgl)

PROJECT: 07507190035 Murphy's Hollywood

RECORD OF MONITORING WELL BH10A

SHEET 1 OF 1

LOCATION: Murphy's Hollywood

BORING DATE: 5/3/2007

DATUM:

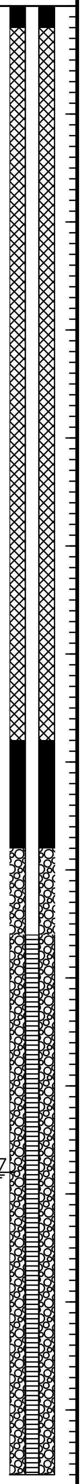
DYNAMIC PENETRATION RESISTANCE, BLOWS/0.3m: 20 40 60 80

SHEAR STRENGTH Cu, kPa: nat V. + Q - ● rem V. ⊕ U - ○ 20 40 60 80

HYDRAULIC CONDUCTIVITY, k, cm/s: 10^{-6} 10^{-5} 10^{-4} 10^{-3}

WATER CONTENT PERCENT: Wp W WI 10 20 30 40

DEPTH SCALE METRES	BORING METHOD	SOIL PROFILE DESCRIPTION	STRATA PLOT	ELEV. DEPTH (m)	GEOTECH NO.	ENV NO.	TYPE	ELEVATION	ADDITIONAL LAB. TESTING	INSTALLATION AND GROUNDWATER OBSERVATIONS
		GROUND SURFACE								Top of Pipe Elev. 137.140
0	Monitoring Borehole Air Rotary	Overburden-brown soil		0.00						Bentonite seal
10		Weathered shale		10.00						
										Riser pipe
21		Limestone		21.00						
										Bentonite Plug
										Riser pipe and gravel pack
										Entry 5/3/07
										Screen and gravel pack
68				68.00						EOH



DEPTH SCALE
1 : 350

Golder Associates

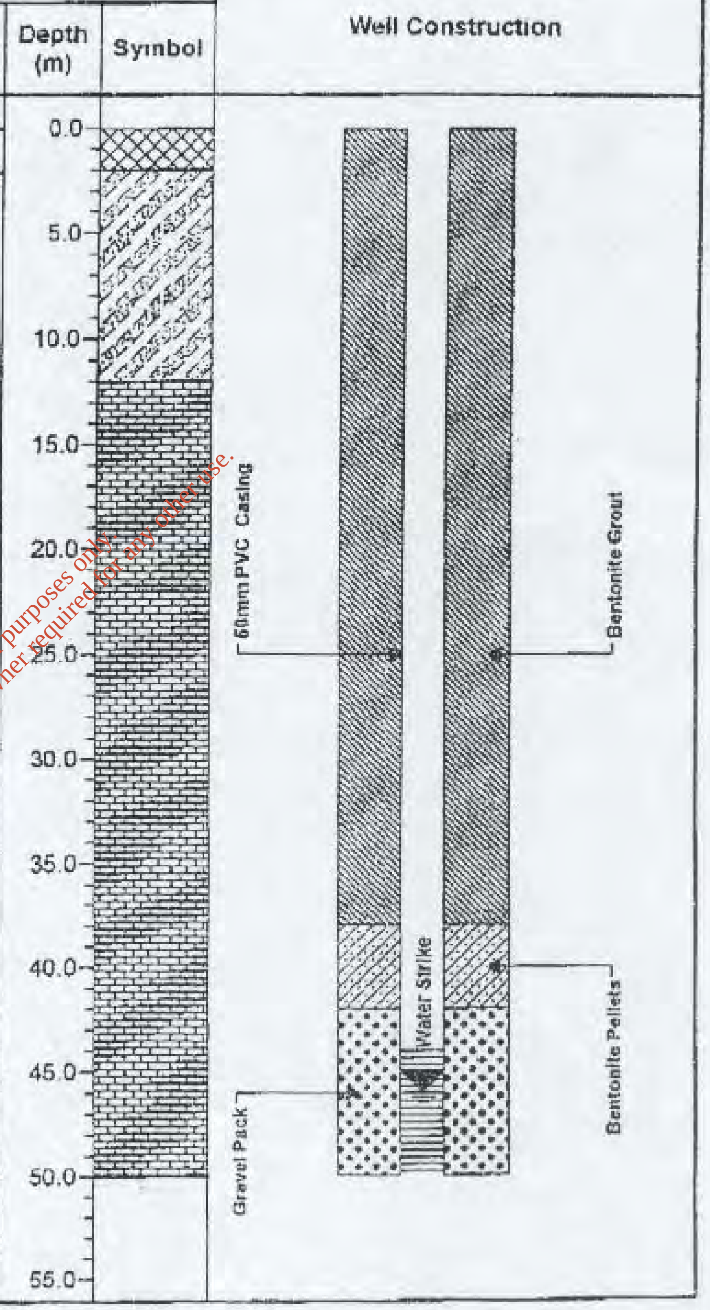
LOGGED: CG
CHECKED: TVM

Well Log

Well No. BH11
Grid Reference
Project No. 1698
Client Seamus Murphy
Drill Date 3/8/01
Well Type
Location Hollywood Great
Geologist Ben Whitfield

SUBSURFACE PROFILE

Description
Ground Surface
Fill Fill
Clay Firm to stiff grey brown sandy gravelly CLAY containing cobbles and boulders
Shale Brown SHALE
Shale Black SHALE



White Young Green

Drill Method Air Rotary
Hole Size (mm) 200
Casing Length (m) 50
TOC (mOD)
Driller Glovers Site Investigations
Static Water Level (bgl)

PROJECT: 07507190035 Murphy's Hollywood

RECORD OF MONITORING WELL BH11A

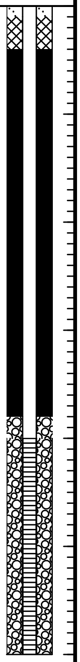
SHEET 1 OF 1

LOCATION: Murphy's Hollywood

BORING DATE: 2/5/07

DATUM:

DEPTH SCALE METRES	BORING METHOD	SOIL PROFILE: DESCRIPTION	STRATA PLOT	ELEV. DEPTH (m)	SAMPLES: GEOTECH NO.	ENV NO.	TYPE	ELEVATION	DYNAMIC PENETRATION RESISTANCE, BLOWS/0.3m (20 40 60 80); SHEAR STRENGTH Cu, kPa nat V. + Q - ● rem V. ⊕ U - ○ (20 40 60 80)	HYDRAULIC CONDUCTIVITY, k, cm/s (10^{-6} 10^{-5} 10^{-4} 10^{-3}); WATER CONTENT PERCENT Wp ⊢—○W—⊣ Wl (10 20 30 40)	ADDITIONAL LAB. TESTING	INSTALLATION AND GROUNDWATER OBSERVATIONS
		GROUND SURFACE										Top of Pipe Elev. 100.01
0	Monitoring Borehole Air Rotary	Overburden/madeground		0.00								Cement Backfill
		Weathered grey shale		2.00								
		Fractured shale		8.00								Bentonite
		Shale		12.00								
		Heavily weathered shale		18.00								Gravel pack
		Grey sandy shale		21.00								Screen and gravel pack
30				30.00								



2 MURPHY HOLLYWOOD.GPJ GLDR_LDN.GDT 5/7/07 DATA INPUT:

DEPTH SCALE
1 : 350

Golder Associates

LOGGED: AS
CHECKED: TVM

PROJECT: 07507190035 Murphy's Hollywood

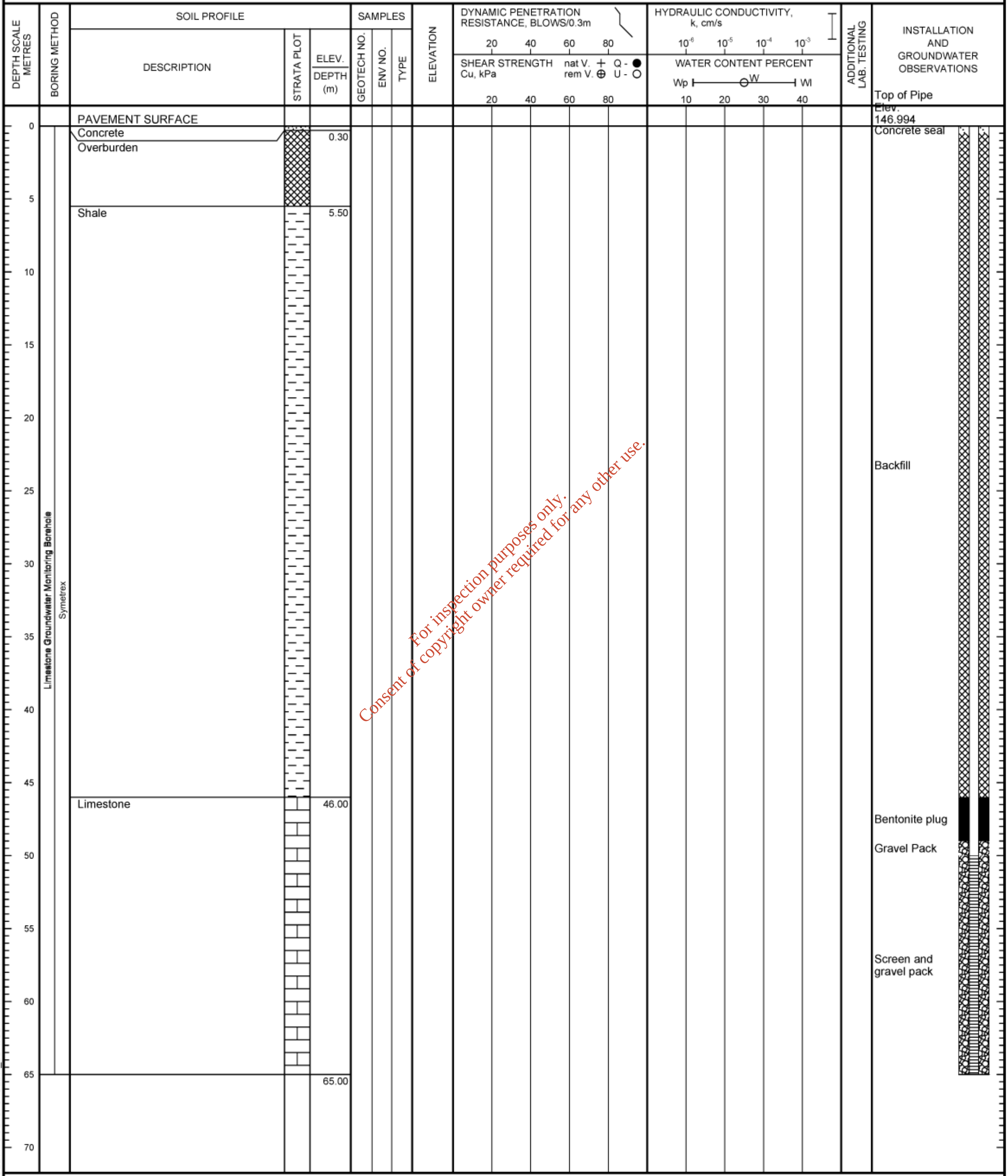
RECORD OF MONITORING WELL BH12

SHEET 1 OF 1

LOCATION: Murphy's Hollywood

BORING DATE: 1/5/07

DATUM:



DESCRIPTION	ELEV. DEPTH (m)
PAVEMENT SURFACE	
Concrete	0.30
Overburden	5.50
Shale	46.00
Limestone	65.00

INSTALLATION AND GROUNDWATER OBSERVATIONS
Top of Pipe Elev. 146.994
Concrete seal
Backfill
Bentonite plug
Gravel Pack
Screen and gravel pack

DEPTH SCALE

1 : 350

Golder Associates

LOGGED: AS

CHECKED: TVM

PROJECT: 07507190035 Murphy's Hollywood

RECORD OF MONITORING WELL BH13

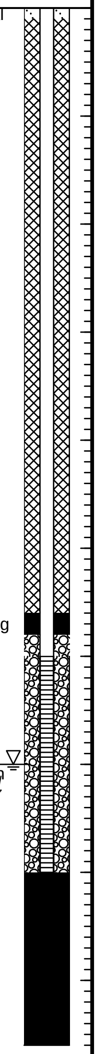
SHEET 1 OF 1

LOCATION: Murphy's Hollywood

BORING DATE: 15/04/07

DATUM:

DEPTH SCALE METRES	BORING METHOD	SOIL PROFILE: DESCRIPTION	STRATA PLOT	ELEV. DEPTH (m)	SAMPLES: GEOTECH NO.	ENV NO.	TYPE	ELEVATION	DYNAMIC PENETRATION RESISTANCE, BLOWS/0.3m 20 40 60 80 / SHEAR STRENGTH Cu, kPa nat V. + Q - ● rem V. ⊕ U - ○ 20 40 60 80	HYDRAULIC CONDUCTIVITY, k, cm/s 10^{-6} 10^{-5} 10^{-4} 10^{-3} / WATER CONTENT PERCENT Wp ⊢—○W—⊣ Wl 10 20 30 40	ADDITIONAL LAB. TESTING	INSTALLATION AND GROUNDWATER OBSERVATIONS
		PAVEMENT SURFACE										Top of Pipe Elev. 146.922
0	Shale Groundwater Monitoring Point Air Rotary	Pavement		0.30								Concrete seal
		Overburden										
5		Shale		5.50								
15												Riser
28												Bentonite Plug
29												Gravel Pack
35												Gravel Pack, 50mm Screen
44												Bentonite Backfill
46		Limestone		46.00								
48				48.00								



DEPTH SCALE
1 : 350

Golder Associates

LOGGED: AS
CHECKED: TVM

2 MURPHY HOLLYWOOD.GPJ GLDR_LDN.GDT 5/7/07 DATA INPUT:

PROJECT: 07507190035 Murphy's Hollywood

RECORD OF MONITORING WELL BH14

SHEET 1 OF 1

LOCATION: Murphy's Hollywood

BORING DATE: 2/3/2007

DATUM:

DEPTH SCALE METRES

BORING METHOD

SOIL PROFILE

DESCRIPTION

STRATA PLOT

ELEV. DEPTH (m)

SAMPLES

GEOTECH NO.

ENV NO.

TYPE

ELEVATION

DYNAMIC PENETRATION RESISTANCE, BLOWS/0.3m

20 40 60 80

SHEAR STRENGTH Cu, kPa nat V. + Q - ● rem V. ⊕ U - ○

20 40 60 80

HYDRAULIC CONDUCTIVITY, k, cm/s

10^{-6} 10^{-5} 10^{-4} 10^{-3}

WATER CONTENT PERCENT

Wp ⊢—○W—⊣ Wl

10 20 30 40

ADDITIONAL LAB. TESTING

INSTALLATION AND GROUNDWATER OBSERVATIONS

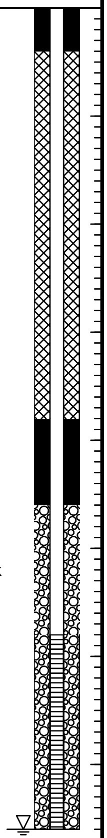
DESCRIPTION	ELEV. DEPTH (m)
GROUND SURFACE	
Topsoil	0.00
Broken weathered shale	6.00
Limestone	30.00
	38.00

Monitoring Well

Air Rotary

Depth scale: 0, 5, 10, 15, 20, 25, 30, 35, 40, 45, 50, 55, 60, 65, 70

Top of Pipe Elev. 125.064



Bentonite

Backfill

Bentonite

Gravel Pack

Screen and gravel pack

EOH

2000 gph est.

DEPTH SCALE

1 : 350

Golder Associates

LOGGED: TVM

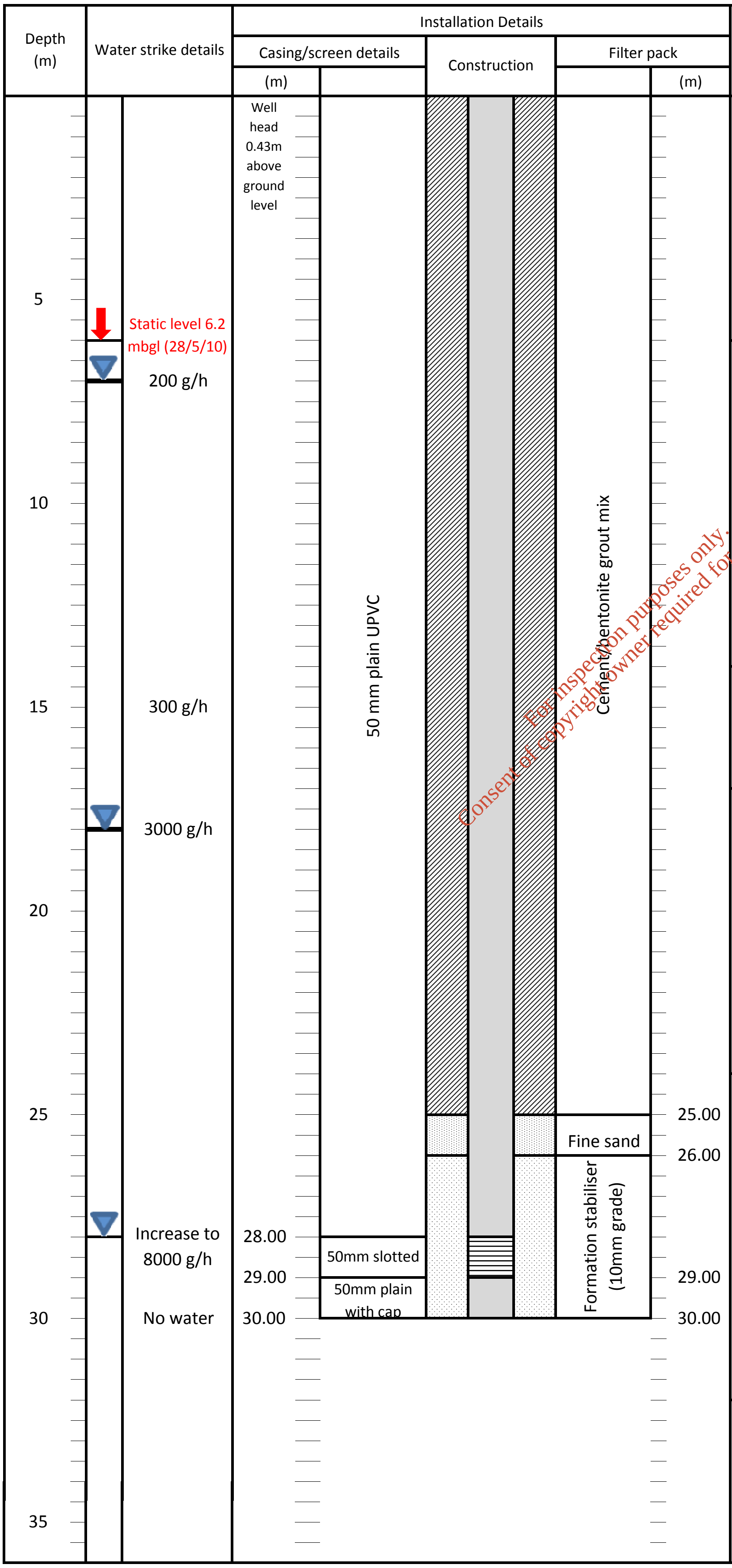
CHECKED: TVM

2 MURPHY HOLLYWOOD.GPJ GLDR_LDN.GDT 5/7/07 DATA INPUT:

ARUP

MONITORING WELL LOG

Project title Integrated Waste Management Facility	Client MEHL	Well No. **BH15a**	Sheet 1 of 1
Date Drilled 16-22/04/2010	Driller Briody & Sons Ltd.	Drill method: Rotary flush	X; 315786.3
Date Logged 16-22/04/2010	Site Engineer/Geologist Sarah Blake	Flush: Air/mist	Y: 257849.6
Comments: Descriptions of chippings from drilling		Borehole diameter: 0.25 m (10") & 0.1m (8")	Z (mOD): 105.89



Lithological description and driller's comments	Elev. (m OD)
Orange-brown, highly weathered, siltstone, mudstone and sandstone (Balrickard Fm.)	99.89
Mid-brown, highly weathered siltstone, mudstone and sandstone (Balrickard Fm.) On completion this section took a significant volume volume of grout 60 mins airlifting at 12m	91.89
Dark brown, highly weathered siltstone, mudstone and sandstone (Balrickard Fm.)	
Large increase in yield at 18m Dark brown, highly weathered siltstone, mudstone and sandstone (very wet) (potentially Donore Fm.) On completion this section took a significant volume volume of grout	86.89 81.89
Dark brown, highly weathered mudstone, sandstone and limestone with calcite veining (Loughshinny Fm.) 45 mins surging and developing well at 24m Drilling after 24m causes the open section of the borehole to collapse. 60 mins surging and developing well at 27m gives 8000 g/h yield 60 mins surging and developing well at 30m. After casing installed to 30m yield dramatically reduced. End of borehole at 30m.	

ARUP

MONITORING WELL LOG

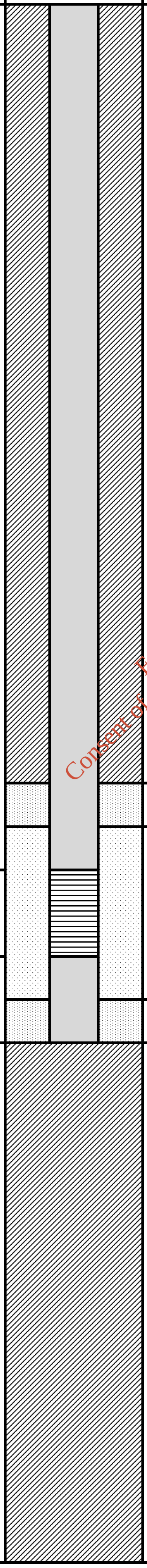
Project title Integrated Waste Management Facility	Client MEHL	Well No. **BH16**	Sheet 1 of 2
Date Drilled 12-20/04/2010	Driller S. Petersen	Drill method: Geobore 'S'	X; 315861.9
Date Logged 20/04/2010	Site Engineer/Geologist D. O'Shea	Flush: Air/Polymer gel	Y: 258218.2
Comments: Descriptions of cores from Geobore 'S' drilling		Borehole diameter 0.2 m (8")	Z (mOD): 104.79

Water strike details: Static water level 3.09 mbgl (28/5/10)

Installation Details

Casing/screen details (m)		Filter pack	(m)
Well head 0.41m above ground level	50 mm plain UPVC	Cement/bentonite grout mix	0.00
20.00	50mm slotted UPVC	Fine sand	18.00
22.00	50mm plain UPVC with cap	Formation stabiliser (10mm grade)	19.00
24.00		Fine sand	23.00
		Cement/bentonite grout mix	24.00
			36.00

Construction

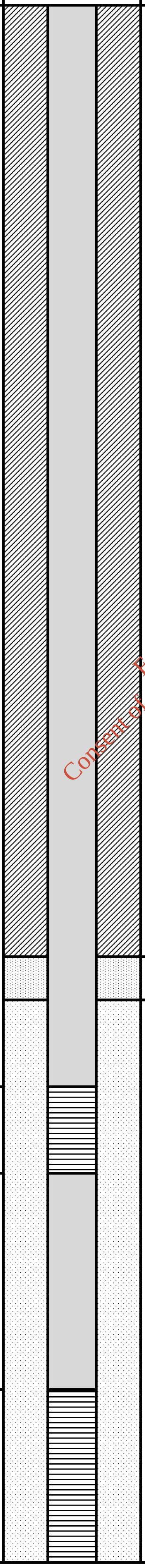


Depth (m)	Lithological description and driller's comments	Elev. (m OD)
	Brown highly weathered, shaley mudstones	104.29
	Black, highly weathered fine-grained mudstone.	
	Dark grey/black, moderately weathered interbedded sandstone and siltstone/mudstone. (Walshestown Fm.)	97.79
10	Orange/brown/black highly weathered, interbedded sandstone and mudstone. Fe-oxide staining. 30% flush loss to fm. between 12.2m and 19.6m	92.79
15	Orange/black/brown/grey, highly weathered interbedded sandstone and mudstone. No recovery from 17.5 to 18m, probably highly weathered rock. 30% flush loss to fm. between 12.2m and 19.6m	89.79
20	Grey/orange/brown, moderately weathered sandstone (Walshestown Fm.) 20% flush losses to fm. between 19.6m and 24.6m	84.79
25	Dark grey/black/brown, interbedded sandstone and mudstone with large amounts of clay infill (Walshestown Fm.)	79.79
30	Dark grey/black, largely fresh mudstone (Walshestown Fm.)	72.79
35		

ARUP

MONITORING WELL LOG

Project title Integrated Waste Management Facility	Client MEHL	Well No. **BH17**	Sheet 1 of 2
Date Drilled 05/05/2010	Driller Briody & Sons Ltd.	Drill method: Rotary flush	X; 315794.7
Date Logged 05/05/2010	Site Engineer/Geologist Catherine Buckley	Flush: Air/mist	Y: 258003.1
Comments: Descriptions of chippings from drilling		Borehole diameter: 0.25 m (10")	Z (mOD): 105.4

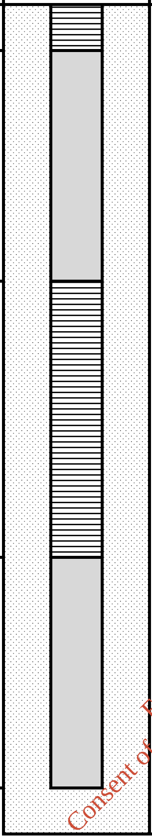


Depth (m)	Water strike details	Installation Details: Casing/screen details (m)	Casing/screen details	Construction	Filter pack	Filter pack (m)	Lithological description and driller's comments	Elev. (m OD)
		Well head 0.29m above ground level	127mm plain UPVC		Cement/bentonite grout mix	0.00	Orange/brown highly weathered siltstone/mudstone/sandstone with Fe-oxide staining. (Poss. Balrickard Fm.) Driller using non-ballistic bit from 0-27m.	
5	Static water level: 4.53 mbgl on 28/05/2010						Black highly weathered siltstone/mudstone/sandstone with slight Fe-oxide staining. (Poss. Balrickard Fm.)	100.4
10							Black, highly weathered shaley siltstone and mudstone. (Poss. Balrickard Fm.)	94.4
15	Strike 15 mbgl, 500 g/h							
20							Fluid losses to fm. from 20m. Added polymer mud.	
					Fine sand	22.00	Black highly weathered siltstone, mudstone and sandstone with slight Fe-oxide staining. (Namurian Deposits)	83.4
	Increase to 5000 g/h				Formation stabiliser (10mm grade)	23.00		
25		25.00	127mm slotted UPVC					
		27.00	127 mm plain UPVC				Large gravel losses to fm. at 27m. Switch to a ballistic drill bit from 28m	
30							Black/grey/brown highly weathered siltstone, mudstone and sandstone. (Poss. Namurian Deposits)	74.4
	Increase to >15000 g/h	32.00	127mm slotted UPVC				Dark brown highly weathered mudstone/sandstone and limestone. (Poss. Loughshinny Fm.)	72.4
35		36.00				36.00	Large mud losses to fm. between 33 and 35m	

ARUP

MONITORING WELL LOG

Project title Integrated Waste Management Facility		Client MEHL	Well No. **BH17**	Sheet 2 of 2
Date Drilled 05/05/2010	Driller Briody & Sons Ltd.	Drill method: Rotary flush	X; 315794.7	
Date Logged 05/05/2010	Site Engineer/Geologist Catherine Buckley	Flush: Air/mist	Y: 258003.1	
Comments: Descriptions of chippings from drilling		Borehole diameter: 0.25 m (10")	Z (mOD): 105.4	



Depth (m)	Water strike details	Installation Details Casing/screen details (m)		Construction	Filter pack	(m)	Lithological description and driller's comments	Elev. (m OD)
36		36.00	50mm slotted			36.00		69.4
		37.00	127 mm plain UPVC		Formation stabiliser (10mm grade)	37.00	Dark brown highly weathered mudstone, sandstone and limestone. (Poss. Loughshinny Fm.) Large mud losses to fm. between 37 and 40m	68.4
						38.00		
40								
		42.00	127mm slotted UPVC					
						43.00		
45								
		48.00	127 mm plain UPVC with end cap			48.00		
50								
		53.00						
						54.00	End of borehole at 54m	
55								
60								
65								
70								

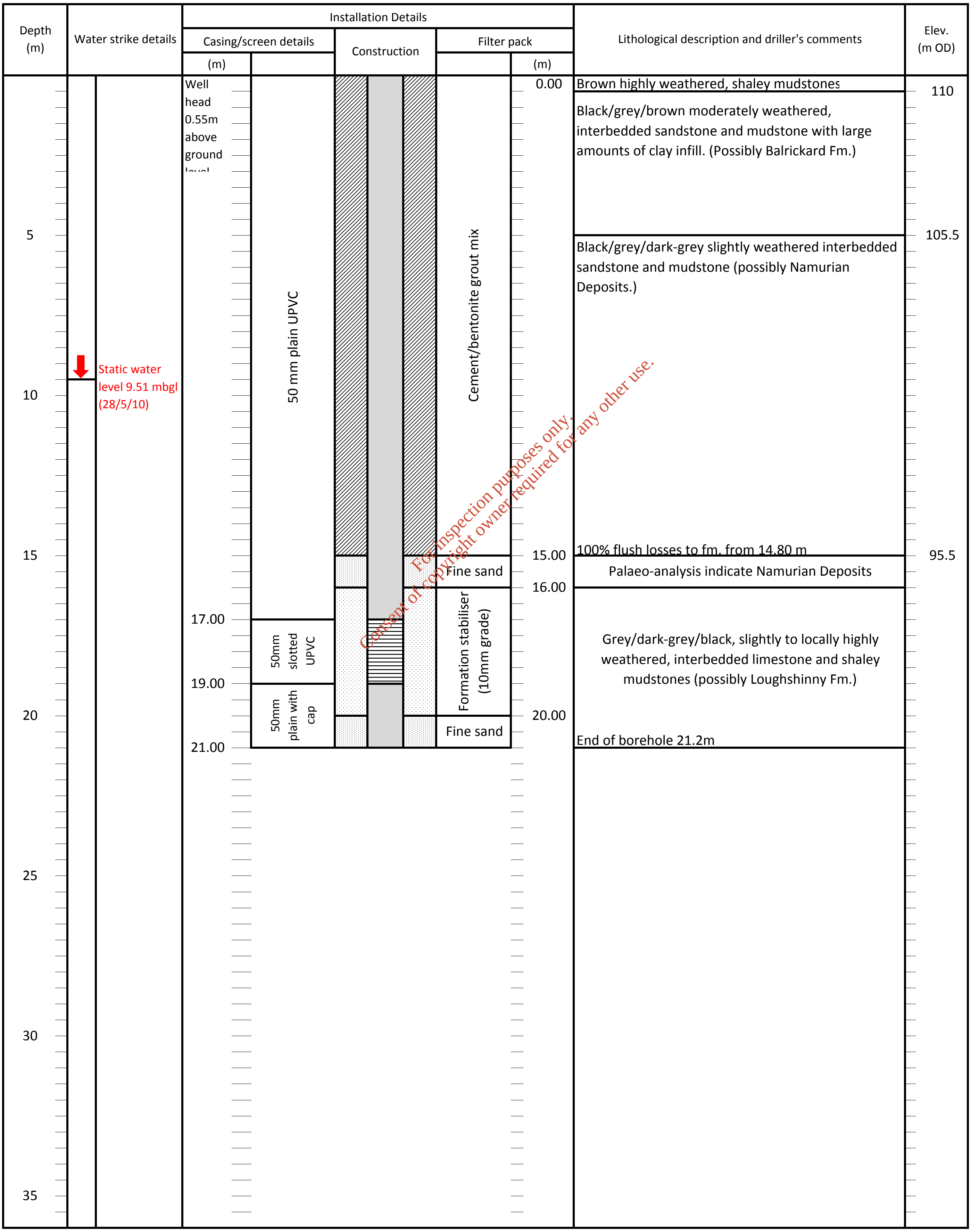
MONITORING WELL LOG

Project title Integrated Waste Management Facility	Client MEHL	Well No. **BH16**	Sheet 2 of 2
Date Drilled 12-20/04/2010	Driller S. Petersen	Drill method: Geobore 'S'	X; 315861.9
Date Logged 20/04/2010	Site Engineer/Geologist D. O'Shea	Flush: Air/Polymer gel	Y: 258218.2
Comments: Descriptions of cores from Geobore 'S' drilling		Borehole diameter: 0.2 m (8")	Z (mOD): 104.79

Depth (m)	Water strike details	Installation Details: Casing/screen details (m)		Construction	Filter pack	(m)	Lithological description and driller's comments	Elev. (m OD)
36				▨	Cement/bentonite grout mix	36.00	Dark grey/black, largely fresh mudstone (Walshestown Fm.)	68.79
40				▨				
45				▨				
				▨			10% flush losses to fm. between 48m and 55.5m	
50				▨				
55				▨				
				▨			Walshestown Fm. possibly grading into the Balrickard Fm. from approx. 58m 12cm limestone layer from 58.07m	46.79
60						60.00	End of borehole at 60m	
65								
70								

MONITORING WELL LOG

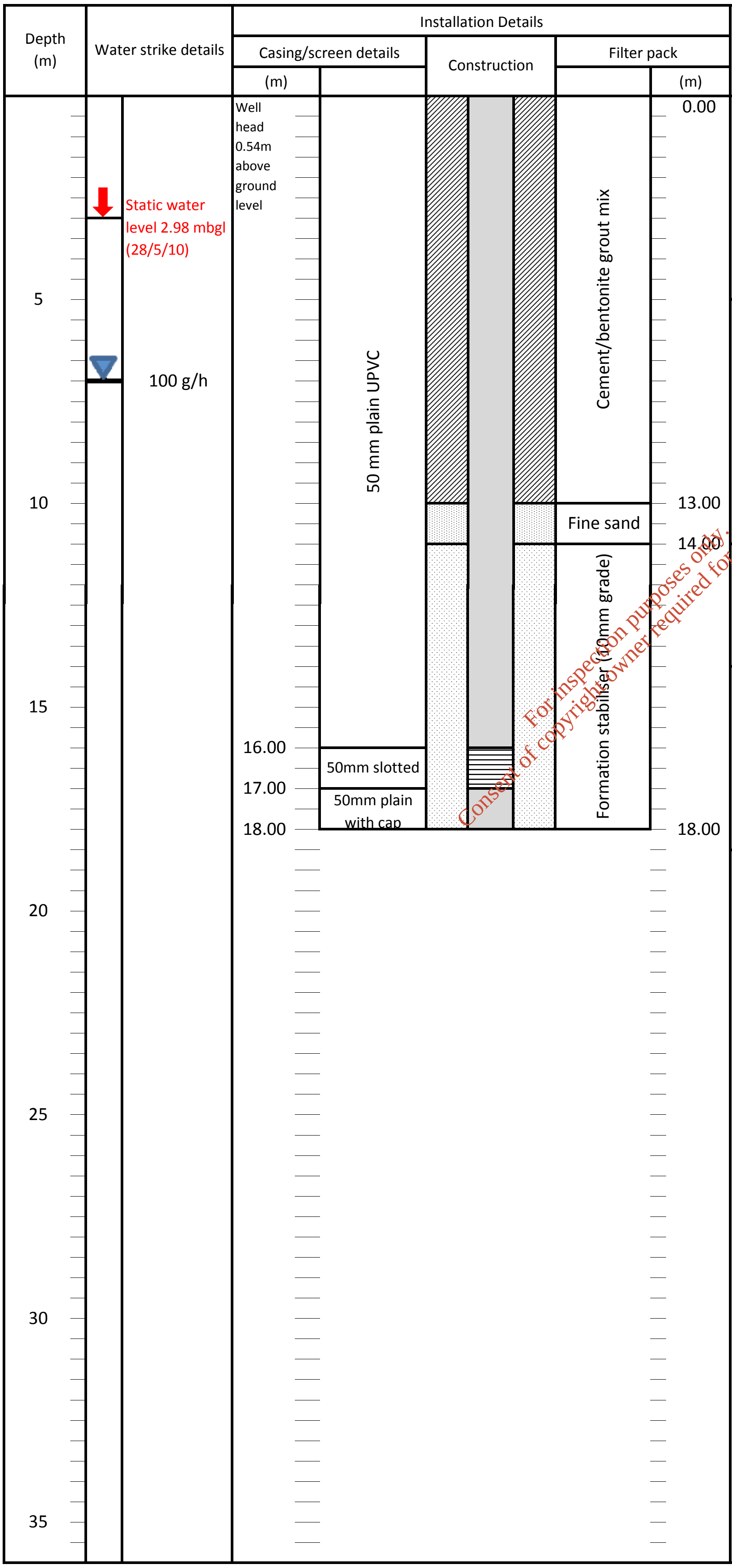
Project title Integrated Waste Management Facility		Client MEHL	Well No. **BH18**	Sheet 1 of 1
Date Drilled 20-24/04/2010	Driller S. Petersen	Drill method: Geobore 'S'	X; 315711	
Date Logged 24/04/2010	Site Engineer/Geologist D. O'Shea	Flush: Air/Polymer gel	Y: 257996.4	
Comments: Descriptions of cores from Geobore 'S' drilling		Borehole diameter: 0.2 m (8")	Z (mOD): 110.5	



Depth (m)	Water strike details	Casing/screen details (m)		Construction	Filter pack	(m)	Lithological description and driller's comments	Elev. (m OD)
		Well head 0.55m above ground level	50 mm plain UPVC		Cement/bentonite grout mix	0.00	Brown highly weathered, shaley mudstones	110
							Black/grey/brown moderately weathered, interbedded sandstone and mudstone with large amounts of clay infill. (Possibly Balrickard Fm.)	
5							Black/grey/dark-grey slightly weathered interbedded sandstone and mudstone (possibly Namurian Deposits.)	105.5
10	Static water level 9.51 mbgl (28/5/10)							
15					Fine sand	15.00	100% flush losses to fm. from 14.80 m	95.5
							Palaeo-analysis indicate Namurian Deposits	
					Formation stabiliser (10mm grade)	16.00	Grey/dark-grey/black, slightly to locally highly weathered, interbedded limestone and shaley mudstones (possibly Loughshinny Fm.)	
		17.00	50mm slotted UPVC					
		19.00	50mm plain with cap					
20					Fine sand	20.00		
		21.00					End of borehole 21.2m	
25								
30								
35								

MONITORING WELL LOG

Project title Integrated Waste Management Facility		Client MEHL	Well No. **BH19**	Sheet 1 of 1
Date Drilled 21-22/04/2010	Driller Briody & Sons Ltd.	Drill method: Rotary flush	X; 315887.1	
Date Logged 21-22/04/2010	Site Engineer/Geologist Sarah Blake	Flush: Air/mist	Y: 258059.1	
Comments: Descriptions based on chippings from drilling		Borehole diameter: 0.25 m (10")	Z (mOD): 105.08	



Lithological description and driller's comments	Elev. (m OD)
No recovery	
Orange-brown, highly weathered siltstone, mudstone and sandstone (Balrickard Fm.) 60 mins surging and well development at 7m	100.08
Dark brown, highly weathered mudstone, sandstone and siltstone (Namurian Deposits.)	94.08
Dark brown, wet, highly weathered siltstone, mudstone and sandstone (Namurian Deposits.) 60 mins surging and well development at 18m End of borehole at 18m	91.08

ARUP

MONITORING WELL LOG

Project title	Client	Well No.	Sheet
Integrated Waste Management Facility	MEHL	**BH20**	1 of 2

Date Drilled	Driller	Drill method:	X;
22-27/04/2010	Briody & Sons Ltd.	Rotary flush	315862.6
Date Logged	**Site Engineer/Geologist**	**Flush:**	**Y:**
22-27/04/2010	Marie Fleming	Air/mist	258102.3

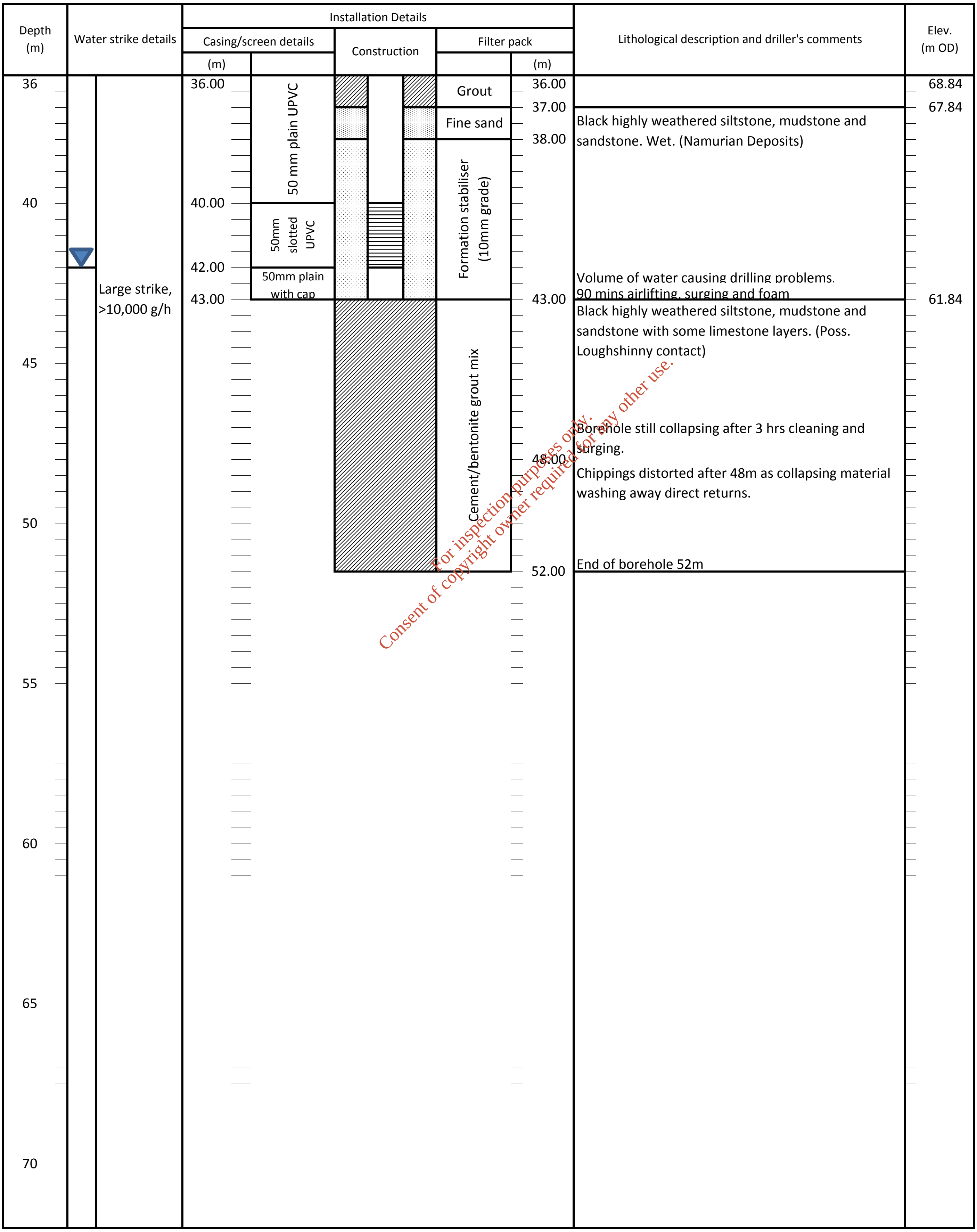
Comments:	Borehole diameter:	Z (mOD):
Descriptions of chippings from drilling	0.25 m (10")	104.84

Depth (m)	Water strike details	Installation Details Casing/screen details (m)	Casing/screen details	Construction	Filter pack	Filter pack (m)	Lithological description and driller's comments	Elev. (m OD)
		Well head 0.45m above ground level				0.00	Grey/black/orange/brown highly weathered siltstone/mudstone. (Poss. Balrickard Fm.)	
	Static water level 3.52 mbgl (28/5/10)							
5							Dark brown/black highly weathered siltstone and mudstone. (Namurian Deposits)	99.84
	Strike 6 mbgl, 100g/h							
							Black, highly weathered siltstone, mudstone and sandstone. (Namurian Deposits)	97.84
10								
15								
	Increase to 500 g/h		50 mm plain UPVC		Cement/bentonite grout mix		Well developed for 30 mins. 500 g/h flow consistent	
20								
25								
30	Increase to 3500 g/h						Significant increase in yield to 3500 g/h. Surging and well development for 60 mins.	
							Black, highly weathered siltstone, mudstone and sandstone. Very wet. (Namurian Deposits)	70.84
35								
		36.00				36.00		

ARUP

MONITORING WELL LOG

Project title Integrated Waste Management Facility	Client MEHL	Well No. **BH20**	Sheet 2 of 2
Date Drilled 22-27/4/2010	Driller Briody & Sons Ltd.	Drill method: Rotary flush	X; 315862.6
Date Logged 22-27/4/2010	Site Engineer/Geologist Marie Fleming	Flush: Air/mist	Y: 258102.3
Comments: Descriptions of chippings from drilling		Borehole diameter: 0.25 m (10")	Z (mOD): 104.84



Black highly weathered siltstone, mudstone and sandstone. Wet. (Namurian Deposits)

Volume of water causing drilling problems. 90 mins airlifting, surging and foam

Black highly weathered siltstone, mudstone and sandstone with some limestone layers. (Poss. Loughshinny contact)

Borehole still collapsing after 3 hrs cleaning and surging.

Chippings distorted after 48m as collapsing material washing away direct returns.

End of borehole 52m

GEOTECHNICAL BORING RECORD

REPORT NUMBER

14695

CONTRACT	MEHL Integrated Waste Management Facility	**BOREHOLE NO.**	**BH21**
		SHEET	Sheet 1 of 2
CO-ORDINATES	316,074.94 E 258,199.63 N	**DATE DRILLED**	14/04/2010
GROUND LEVEL (m AOD)	120.70	**DATE LOGGED**	14/04/2010
RIG TYPE	Dando	**BORED BY**	J.Edwards
BOREHOLE DIAMETER (mm)	200	**PROCESSED BY**	F.C
BOREHOLE DEPTH (m)	20.00		
CLIENT	MEHL	**SPT HAMMER REF. NO.**	
ENGINEER	WYG	**ENERGY RATIO (%)**	

Depth (m)	Description	Legend	Elevation	Depth (m)	Samples: Ref. Number	Samples: Sample Type	Samples: Depth (m)	Samples: Recovery	Field Test Results	Standpipe Details
0	MADE GROUND (Stockpile - Comprised of dark grey sandy gravelly clay)	▨								
					R2005	B	0.50-0.50			
1					R2006	B	1.00-1.00			
					R2007	U	1.00-1.45	50%rec 12 blows		
					R2008	D	1.45-1.60			
2					R2009	B	2.00-2.00			
					R2010	D	2.50-2.50			
3					R2011	U	3.00-3.45	50%rec 9 blows		
					R2012	D	3.45-3.60			
4					R2013	B	4.00-4.00			
					R2014	D	4.50-4.50			
5					R2015	U	5.00-5.45	60%rec 12 blows		
					R2016	D	5.45-5.60			
6					R2017	B	6.00-6.00			
			114.00	6.70	R2018	D	6.50-6.50			
	Light brown sandy gravelly CLAY with some cobbles (occasionally grading to clayey gravel)				R2019	B	6.70-6.70			
7					R2020	U	7.00-7.45	80%rec 29 blows		
					R2021	D	7.45-7.60			
8					R2022	B	8.00-8.00			
					R2023	D	8.50-8.50			
9			111.40	9.30	R2024	U	9.00-9.45	60%rec 42 blows		
	Black/orange sandy very gravelly CLAY with occasional angular cobbles of weathered mudstone / siltstone				R2025	D	9.45-9.60			

HARD STRATA BORING/CHISELLING

From (m)	To (m)	Time (h)	Comments
7.7	7.8	0.75	
11	11.05	0.5	

WATER STRIKE DETAILS

Water Strike	Casing Depth	Sealed At	Rise To	Time (min)	Comments
					No water strike

GROUNDWATER DETAILS

Date	Hole Depth	Casing Depth	Depth to Water	Comments

INSTALLATION DETAILS

Date	Tip Depth	RZ Top	RZ Base	Type

REMARKS Hole located on top of clay stockpile

Sample Legend

D - Small Disturbed (tub)
B - Bulk Disturbed
LB - Large Bulk Disturbed
Env - Environmental Sample (Jar + Vial + Tub)
U - Undisturbed 100mm Diameter Sample
P - Undisturbed Piston Sample
W - Water Sample

GEOTECHNICAL BORING RECORD

REPORT NUMBER 14695

CONTRACT	MEHL Integrated Waste Management Facility	**BOREHOLE NO.**	**BH21**
		SHEET	Sheet 2 of 2
CO-ORDINATES	316,074.94 E 258,199.63 N	**RIG TYPE**	Dando
GROUND LEVEL (m AOD)	120.70	**BOREHOLE DIAMETER (mm)**	200
		BOREHOLE DEPTH (m)	20.00
		DATE DRILLED	14/04/2010
		DATE LOGGED	14/04/2010
CLIENT	MEHL	**SPT HAMMER REF. NO.**	
ENGINEER	WYG	**ENERGY RATIO (%)**	
		BORED BY	J.Edwards
		PROCESSED BY	F.C

Description	Elevation	Depth (m)	Samples Ref. Number	Sample Type	Depth (m)	Recovery	Field Test Results	Standpipe Details
Black/orange sandy very gravelly CLAY with occasional angular cobbles of weathered mudstone / siltstone *(continued)*	110.00	10.70	R2026	B	10.00-10.00			
			R2027	D	10.50-10.50			
Angular cobbly gravel of moderately weathered SILTSTONE/MUDSTONE	109.60	11.10	R2028	B	11.00-11.00			
Black/orange sandy gravelly CLAY with occasional angular cobbles of weathered mudstone / siltstone	108.00	12.70	R2029	D	11.50-11.50			
			R2030	U	12.00-12.45	80%rec 39 blows		
			R2031	D	12.45-12.60			
Dark brown/orange sandy gravelly CLAY with occasional angular cobbles of weathered mudstone / siltstone	102.30	18.40	R2032	B	13.00-13.00			
			R2033	D	13.50-13.50			
			R2034	U	14.00-14.60	0%rec 43 blows		
			R2035	D	14.50-14.50			
			R2036	B	15.00-15.00			
			R2037	D	15.50-15.50			
			R2038	U	16.00-16.45	60%rec 44 blows		
			R2039	D	16.45-16.60			
			R2040	B	17.00-17.00			
			R2041	D	17.50-17.50			
			R2042	U	18.00-18.45	15%rec 72 blows		
Grey brown / green sandy gravelly CLAY with occasional angular cobbles of weathered mudstone / siltstone	101.10	19.60	R2043	D	18.45-18.60			
			R2044	B	19.00-19.00			
			R2045	U	19.40-19.85	100%rec 52 blows		
Very stiff dark grey/grey sandy gravelly CLAY	100.70	20.00	R2046	D	19.85-20.00			

End of Borehole at 20.00m

HARD STRATA BORING/CHISELLING

From (m)	To (m)	Time (h)	Comments
7.7	7.8	0.75	
11	11.05	0.5	

WATER STRIKE DETAILS

Water Strike	Casing Depth	Sealed At	Rise To	Time (min)	Comments
					No water strike

GROUNDWATER DETAILS

Date	Hole Depth	Casing Depth	Depth to Water	Comments

INSTALLATION DETAILS

Date	Tip Depth	RZ Top	RZ Base	Type

REMARKS Hole located on top of clay stockpile

Sample Legend
D - Small Disturbed (tub)
B - Bulk Disturbed
LB - Large Bulk Disturbed
Env - Environmental Sample (Jar + Vial + Tub)
U - Undisturbed 100mm Diameter Sample
P - Undisturbed Piston Sample
W - Water Sample

GEOTECHNICAL BORING RECORD

REPORT NUMBER 14695

CONTRACT	MEHL Integrated Waste Management Facility	**BOREHOLE NO.**	**BH22**
		SHEET	Sheet 1 of 1
CO-ORDINATES	315,961.50 E 258,091.66 N	**RIG TYPE**	Dando
GROUND LEVEL (m AOD)	123.83	**BOREHOLE DIAMETER (mm)**	200
		BOREHOLE DEPTH (m)	5.90
DATE DRILLED	09/04/2010	**DATE LOGGED**	12/04/2010
CLIENT	MEHL	**SPT HAMMER REF. NO.**	
ENGINEER	WYG	**ENERGY RATIO (%)**	
BORED BY	J.Edwards	**PROCESSED BY**	F.C

Depth (m)	Description	Legend	Elevation	Depth (m)	Samples Ref. Number	Sample Type	Depth (m)	Recovery	Field Test Results	Standpipe Details
0	MADE GROUND (Comprised of brown sandy gravelly clay with cobbles)	▨	122.83	1.00	AJ6563	B	0.50-0.95		N = 12 (1, 3, 3, 3, 3, 3)	
1	Firm, dark brown slightly sandy gravelly SILT with angular cobbles of weathered siltstone / mudstone	× o	117.93	5.90	AJ6564	D	1.00-1.00			
					AJ6565	U	1.50-2.10	0%rec		
					AJ6566	D	2.00-2.00			
					AJ6567	D	2.50-2.50			
					AJ6568	B	3.00-3.45		N = 14 (2, 3, 5, 3, 3, 3)	
					AJ6569	D	3.50-3.50			
					AJ6570	U	4.50-4.95	60%rec 19 blows		
					AJ6571	D	4.95-5.10			
					AJ6572	B	5.50-5.50			
					AJ6573	B	5.90-5.90			
6	Obstruction End of Borehole at 5.90 m									

HARD STRATA BORING/CHISELLING

From (m)	To (m)	Time (h)	Comments
2.7	2.75	0.75	
5.1	5.2	0.75	
5.8	5.9	1	

WATER STRIKE DETAILS

Water Strike	Casing Depth	Sealed At	Rise To	Time (min)	Comments
					No water strike

GROUNDWATER DETAILS

Date	Hole Depth	Casing Depth	Depth to Water	Comments

INSTALLATION DETAILS

Date	Tip Depth	RZ Top	RZ Base	Type

REMARKS Obstruction at 5.90m . Moved 1m to BH22A and rebored

Sample Legend
D - Small Disturbed (tub)
B - Bulk Disturbed
LB - Large Bulk Disturbed
Env - Environmental Sample (Jar + Vial + Tub)
U - Undisturbed 100mm Diameter Sample
P - Undisturbed Piston Sample
W - Water Sample

GEOTECHNICAL BORING RECORD

REPORT NUMBER 14695

CONTRACT	MEHL Integrated Waste Management Facility	**BOREHOLE NO.**	**BH22A**
		SHEET	Sheet 1 of 3
CO-ORDINATES	315,960.83 E 258,090.71 N	**RIG TYPE**	Dando
		BOREHOLE DIAMETER (mm)	200
GROUND LEVEL (m AOD)	123.73	**BOREHOLE DEPTH (m)**	20.60
		DATE DRILLED	12/04/2010
		DATE LOGGED	13/04/2010
CLIENT	MEHL	**SPT HAMMER REF. NO.**	
ENGINEER	WYG	**ENERGY RATIO (%)**	
		BORED BY	J.Edwards
		PROCESSED BY	F.C

Depth (m)	Description	Legend	Elevation	Depth (m)	Samples Ref. Number	Sample Type	Depth (m)	Recovery	Field Test Results	Standpipe Details
0	MADE GROUND (Comprised of brown sandy gravelly clay with cobbles)	▩	122.73	1.00						▨
1 2 3 4 5 6	Dark brown sandy very gravelly CLAY with occasional cobbles of weathered mudstone / siltstone	○	117.23	6.50						▨
	Dark brown slightly sandy gravelly CLAY with angular cobbles of weathered siltstone / mudstone.	○	116.63	7.10	AJ6574	D	6.50-6.50			▨
7					AJ6575	B	7.00-7.00			▨
	Firm to stiff, black/orange sandy very gravelly CLAY with occasional angular cobbles of weathered mudstone / siltstone	○			AJ6576	U	7.50-7.95			▨
8					AJ6577 AJ6578	D B	7.95-8.10 8.00-8.00			▨
					AJ6579	D	8.50-8.50			▨
9					AJ6580 AJ6581	D B	9.00-9.45 9.00-9.50		N = 22 (1, 2, 4, 4, 6, 8)	▨

HARD STRATA BORING/CHISELLING

From (m)	To (m)	Time (h)	Comments
2.45	2.5	0.5	
6.25	6.3	0.5	
10.1	10.15	0.5	
11.45	11.5	0.5	
15.3	15.4	1	

WATER STRIKE DETAILS

Water Strike	Casing Depth	Sealed At	Rise To	Time (min)	Comments
					No water strike

GROUNDWATER DETAILS

Date	Hole Depth	Casing Depth	Depth to Water	Comments

INSTALLATION DETAILS

Date	Tip Depth	RZ Top	RZ Base	Type

REMARKS Chiselling also 17.45-17.50=0.5hr / Backfill with bentonite GL - 20.60m

Sample Legend
D - Small Disturbed (tub)
B - Bulk Disturbed
LB - Large Bulk Disturbed
Env - Environmental Sample (Jar + Vial + Tub)
U - Undisturbed 100mm Diameter Sample
P - Undisturbed Piston Sample
W - Water Sample

GEOTECHNICAL BORING RECORD

REPORT NUMBER 14695

CONTRACT	MEHL Integrated Waste Management Facility	**BOREHOLE NO.**	**BH22A**
		SHEET	Sheet 2 of 3
CO-ORDINATES	315,960.83 E 258,090.71 N	**RIG TYPE**	Dando
		BOREHOLE DIAMETER (mm)	200
GROUND LEVEL (m AOD)	123.73	**BOREHOLE DEPTH (m)**	20.60
		DATE DRILLED	12/04/2010
		DATE LOGGED	13/04/2010
CLIENT	MEHL	**SPT HAMMER REF. NO.**	
ENGINEER	WYG	**ENERGY RATIO (%)**	
		BORED BY	J.Edwards
		PROCESSED BY	F.C

Depth (m)	Description	Legend	Elevation	Depth (m)	Samples				Field Test Results	Standpipe Details
					Ref. Number	Sample Type	Depth (m)	Recovery		
10	Firm to stiff, black/orange sandy very gravelly CLAY with occasional angular cobbles of weathered mudstone / siltstone *(continued)*				AJ6582	B	10.00-10.00			
			112.73	11.00	AJ6583	U	10.50-10.95	40%rec 20 blows		
11	Firm to stiff dark brown/orange slightly sandy gravelly SILT with occasional cobbles of weathered mudstone / siltstone.				AJ6584	D	10.95-11.10			
					AJ6585	B	11.00-11.00			
					AJ6586	D	11.50-11.50			
12					AJ6587	D	12.00-12.45		N = 15 (1, 2, 3, 3, 4, 5)	
			110.73	13.00	AJ6588	B	12.00-12.50			
13	Firm to stiff black /orange sandy gravelly CLAYSILT with occasional cobbles of weathered mudstone / siltstone				AJ6589	B	13.00-13.00			
					AJ6590	U	13.50-13.95	50%rec 20 blows		
14					AJ6591	D	13.95-14.10			
					AJ6592	B	14.00-14.00			
					AJ6593	D	14.50-14.50			
15					AJ6594	B	15.00-15.45		N = 50/75 mm (2, 11, 50)	
					AJ6595	D	15.50-15.50			
16										
			106.83	16.90	AJ6596	B	16.50-16.95		N = 23 (3, 4, 6, 5, 5, 7)	
17	Grey/green sandy very gravelly CLAY		106.33	17.40	AJ6597	D	17.00-17.00			
	Very stiff grey/brown/green slightly sandy slightly gravelly CLAY with occasional cobbles of weathered mudstone / siltstone				AJ6598	B	17.50-17.50			
18					AJ6599	B	18.00-18.45		N = 49 (5, 7, 13, 12, 12, 12)	
			105.13	18.60	AJ6600	D	18.50-18.50			
19	Dark grey/green sandy very gravelly CLAY		104.23	19.50	AJ6601	B	19.00-19.00			
	Black dense clayey GRAVEL				AJ6602	U	19.50-19.95	90%rec 67 blows		

HARD STRATA BORING/CHISELLING

From (m)	To (m)	Time (h)	Comments
2.45	2.5	0.5	
6.25	6.3	0.5	
10.1	10.15	0.5	
11.45	11.5	0.5	
15.3	15.4	1	

WATER STRIKE DETAILS

Water Strike	Casing Depth	Sealed At	Rise To	Time (min)	Comments
					No water strike

GROUNDWATER DETAILS

Date	Hole Depth	Casing Depth	Depth to Water	Comments

INSTALLATION DETAILS

Date	Tip Depth	RZ Top	RZ Base	Type

REMARKS Chiselling also 17.45-17.50=0.5hr / Backfill with bentonite GL - 20.60m

Sample Legend
D - Small Disturbed (tub)
B - Bulk Disturbed
LB - Large Bulk Disturbed
Env - Environmental Sample (Jar + Vial + Tub)
U - Undisturbed 100mm Diameter Sample
P - Undisturbed Piston Sample
W - Water Sample

GEOTECHNICAL BORING RECORD

REPORT NUMBER 14695

CONTRACT	MEHL Integrated Waste Management Facility	**BOREHOLE NO.**	**BH22A**
		SHEET	Sheet 3 of 3
CO-ORDINATES	315,960.83 E 258,090.71 N	**RIG TYPE**	Dando
GROUND LEVEL (m AOD)	123.73	**BOREHOLE DIAMETER (mm)**	200
		BOREHOLE DEPTH (m)	20.60
DATE DRILLED	12/04/2010	**DATE LOGGED**	13/04/2010
CLIENT	MEHL	**SPT HAMMER REF. NO.**	
ENGINEER	WYG	**ENERGY RATIO (%)**	
BORED BY	J.Edwards	**PROCESSED BY**	F.C

Depth (m)	Description	Legend	Elevation	Depth (m)	Samples: Ref. Number	Samples: Sample Type	Samples: Depth (m)	Samples: Recovery	Field Test Results	Standpipe Details
20	Black dense clayey GRAVEL *(continued)*		103.13	20.60	AJ6603 AJ6604	D B	19.95-20.10 20.10-20.55		N = 50/225 mm (6, 11, 16, 17, 17)	▨
	End of Borehole at 20.60 m									
21										
22										
23										
24										
25										
26										
27										
28										
29										

HARD STRATA BORING/CHISELLING

From (m)	To (m)	Time (h)	Comments
2.45	2.5	0.5	
6.25	6.3	0.5	
10.1	10.15	0.5	
11.45	11.5	0.5	
15.3	15.4	1	

WATER STRIKE DETAILS

Water Strike	Casing Depth	Sealed At	Rise To	Time (min)	Comments
					No water strike

GROUNDWATER DETAILS

Date	Hole Depth	Casing Depth	Depth to Water	Comments

INSTALLATION DETAILS

Date	Tip Depth	RZ Top	RZ Base	Type

REMARKS Chiselling also 17.45-17.50=0.5hr / Backfill with bentonite GL - 20.60m

Sample Legend

D - Small Disturbed (tub)
B - Bulk Disturbed
LB - Large Bulk Disturbed
Env - Environmental Sample (Jar + Vial + Tub)
U - Undisturbed 100mm Diameter Sample
P - Undisturbed Piston Sample
W - Water Sample

GEOTECHNICAL BORING RECORD

REPORT NUMBER 14695

CONTRACT MEHL Integrated Waste Management Facility

BOREHOLE NO. BH23
SHEET Sheet 1 of 3

CO-ORDINATES 315,960.42 E
257,968.59 N
GROUND LEVEL (m AOD) 125.08

RIG TYPE Dando
BOREHOLE DIAMETER (mm) 200
BOREHOLE DEPTH (m) 22.70

DATE DRILLED 07/04/2010
DATE LOGGED 08/04/2010

CLIENT MEHL
ENGINEER WYG

SPT HAMMER REF. NO.
ENERGY RATIO (%)

BORED BY J.Edwards
PROCESSED BY F.C

Depth (m)	Description	Legend	Elevation	Depth (m)	Samples: Ref. Number	Sample Type	Depth (m)	Recovery	Field Test Results	Standpipe Details
0	Firm to stiff brown sandy gravelly CLAY with occasional cobbles									
					AJ6528	B	0.50-0.50			
1					AJ6529 AJ6530	D B	1.00-1.45 1.00-1.50		N = 15 (1, 2, 5, 4, 3, 3)	
2					AJ6531	U	2.00-2.45	70%rec 50 blows		
					AJ6532	D	2.45-2.60			
3					AJ6533 AJ6534	D B	3.00-3.45 3.00-3.50		N = 18 (2, 4, 4, 3, 5, 6)	
4			120.98	4.10	AJ6535	D	4.00-4.00			
	Dark brown sandy very gravelly CLAY with some cobbles of weathered mudstone / siltstone		120.28	4.80						
5	Firm to stiff dark brown slightly sandy gravelly CLAY with some cobbles and some bands of yellow/brown sand (grading in places to a clayey sandy gravel)				AJ6536 AJ6537	D B	5.00-5.45 5.00-5.50		N = 14 (2, 3, 5, 3, 3, 3)	
6					AJ6538	U	6.00-6.45	80%rec 28 blows		
					AJ6539	D	6.45-6.60			
7					AJ6540 AJ6541	D B	7.00-7.45 7.00-7.50		N = 12 (1, 2, 3, 3, 3, 3)	
8					AJ6542	U	8.00-8.60	0%rec 57 blows		
9					AJ6543	B	9.00-9.45		N = 23 (2, 5, 6, 6, 5, 6)	
			115.08	10.00						

HARD STRATA BORING/CHISELLING

From (m)	To (m)	Time (h)	Comments
2.75	2.8	0.5	
3.85	3.9	0.5	
16.45	16.5	0.5	
20.4	20.5	0.75	
22.6	22.7	1	

WATER STRIKE DETAILS

Water Strike	Casing Depth	Sealed At	Rise To	Time (min)	Comments
					No water strike

GROUNDWATER DETAILS

Date	Hole Depth	Casing Depth	Depth to Water	Comments

INSTALLATION DETAILS

Date	Tip Depth	RZ Top	RZ Base	Type

REMARKS Backfill with bentonite GL - 23.00m

Sample Legend
D - Small Disturbed (tub)
B - Bulk Disturbed
LB - Large Bulk Disturbed
Env - Environmental Sample (Jar + Vial + Tub)
U - Undisturbed 100mm Diameter Sample
P - Undisturbed Piston Sample
W - Water Sample

GEOTECHNICAL BORING RECORD

REPORT NUMBER 14695

CONTRACT	MEHL Integrated Waste Management Facility	**BOREHOLE NO.**	**BH23**
		SHEET	Sheet 2 of 3
CO-ORDINATES	315,960.42 E 257,968.59 N	**DATE DRILLED**	07/04/2010
GROUND LEVEL (m AOD)	125.08	**DATE LOGGED**	08/04/2010
RIG TYPE	Dando	**BORED BY**	J.Edwards
BOREHOLE DIAMETER (mm)	200	**PROCESSED BY**	F.C
BOREHOLE DEPTH (m)	22.70		
CLIENT	MEHL	**SPT HAMMER REF. NO.**	
ENGINEER	WYG	**ENERGY RATIO (%)**	

Depth (m)	Description	Legend	Elevation	Depth (m)	Samples Ref. Number	Sample Type	Depth (m)	Recovery	Field Test Results	Standpipe Details
10	Purplish brown / grey brown sightly sandy gravelly SILT/CLAY				AJ6544	D	10.00-10.00			
11					AJ6545 AJ6546	D B	11.00-11.45 11.00-11.50		N = 12 (1, 2, 4, 3, 2, 3)	
12					AJ6547	B	12.00-12.45		N = 29 (2, 5, 7, 7, 7, 8)	
13					AJ6548	D	13.00-13.00			
14					AJ6549 AJ6550	D B	14.00-14.45 14.00-14.50		N = 13 (1, 3, 3, 4, 3, 3)	
15					AJ6551	D	15.00-15.00			
16					AJ6552 AJ6553	D B	16.00-16.45 16.00-16.50		N = 48/225 mm (2, 2, 16, 16, 16)	
17					AJ6554	B	17.50-17.95		N = 24 (2, 3, 9, 7, 3, 5)	
			107.08	18.00						
18	Grey green very gravelly CLAY				AJ6555	D	18.00-18.00			
			106.58	18.50						
19	Yellow brown clayey GRAVEL / gravelly CLAY		105.68	19.40						
	Medium dense clayey GRAVEL / stiff very gravelly CLAY		105.18	19.90	AJ6556 AJ6557	B U	19.40-19.40 19.50-19.95	80%rec 32 blows		

HARD STRATA BORING/CHISELLING

From (m)	To (m)	Time (h)	Comments
2.75	2.8	0.5	
3.85	3.9	0.5	
16.45	16.5	0.5	
20.4	20.5	0.75	
22.6	22.7	1	

WATER STRIKE DETAILS

Water Strike	Casing Depth	Sealed At	Rise To	Time (min)	Comments
					No water strike

INSTALLATION DETAILS

Date	Tip Depth	RZ Top	RZ Base	Type

GROUNDWATER DETAILS

Date	Hole Depth	Casing Depth	Depth to Water	Comments

REMARKS Backfill with bentonite GL - 23.00m

Sample Legend
D - Small Disturbed (tub)
B - Bulk Disturbed
LB - Large Bulk Disturbed
Env - Environmental Sample (Jar + Vial + Tub)
U - Undisturbed 100mm Diameter Sample
P - Undisturbed Piston Sample
W - Water Sample

GEOTECHNICAL BORING RECORD

REPORT NUMBER 14695

CONTRACT	MEHL Integrated Waste Management Facility	**BOREHOLE NO.**	**BH23**
		SHEET	Sheet 3 of 3
CO-ORDINATES	315,960.42 E 257,968.59 N	**RIG TYPE**	Dando
GROUND LEVEL (m AOD)	125.08	**BOREHOLE DIAMETER (mm)**	200
		BOREHOLE DEPTH (m)	22.70
		DATE DRILLED	07/04/2010
		DATE LOGGED	08/04/2010
CLIENT	MEHL	**SPT HAMMER REF. NO.**	
ENGINEER	WYG	**ENERGY RATIO (%)**	
		BORED BY	J.Edwards
		PROCESSED BY	F.C

Depth (m)	Description	Legend	Elevation	Depth (m)	Samples: Ref. Number	Sample Type	Depth (m)	Recovery	Field Test Results	Standpipe Details
20	Dark grey/ black slightly sandy slightly gravelly CLAY *(continued)*				AJ6558	D	19.95-20.10			
					AJ6559	B	20.50-20.50			
21					AJ6560	U	21.00-21.45	70%rec 61 blows		
					AJ6561	D	21.45-21.60			
22										
			102.38	22.70	AJ6562	B	22.50-22.70			
	End of Borehole at 22.70 m									
23										
24										
25										
26										
27										
28										
29										

HARD STRATA BORING/CHISELLING

From (m)	To (m)	Time (h)	Comments
2.75	2.8	0.5	
3.85	3.9	0.5	
16.45	16.5	0.5	
20.4	20.5	0.75	
22.6	22.7	1	

WATER STRIKE DETAILS

Water Strike	Casing Depth	Sealed At	Rise To	Time (min)	Comments
					No water strike

GROUNDWATER DETAILS

Date	Hole Depth	Casing Depth	Depth to Water	Comments

INSTALLATION DETAILS

Date	Tip Depth	RZ Top	RZ Base	Type

REMARKS Backfill with bentonite GL - 23.00m

Sample Legend
D - Small Disturbed (tub)
B - Bulk Disturbed
LB - Large Bulk Disturbed
Env - Environmental Sample (Jar + Vial + Tub)
U - Undisturbed 100mm Diameter Sample
P - Undisturbed Piston Sample
W - Water Sample

Appendix D

New Monitoring Wells

Appendix D: Monitoring wells

Introduction

Boreholes were drilled on at least five occasions prior to the work undertaken at the MEHL facility in May and June of 2013. As part of the hydrogeological site investigation at MEHL in 2013, seven new boreholes were installed to better define the geology and hydrogeology throughout the site. Four of the new boreholes namely BH24, BH26, BH27 and BH30 were cored using Geobore S technique with a drilling diameter of 146mm. The remaining three boreholes, BH25, BH28 and BH29 were developed by standard open hole drilling with an outer diameter of 120mm.

Both the new and pre-existing installations were utilized in pumping tests of the aquifer to gather groundwater level information throughout the site.

The geological information obtained during the drilling and installation of the new boreholes was used to improve the conceptual model of the complex geology and hydrogeology of the site.

Existing Monitoring Wells

The site has a network of monitoring points along the perimeter which has been expanding since 1998. This monitoring network was installed to fulfill a requirement of the EPA license for the MEHL facility (EPA waste license number W0129-02) and has been detailed in previous reports. The well logs for the newly drilled monitoring boreholes are available in **Appendix D1**. The borehole logs from previous site investigations are presented in **Appendix A** where available. Details of the drilling programmes undertaken to date at the MEHL site are also included in **Appendix C**.

New Monitoring Wells

Figure 1 shows the locations of the new monitoring boreholes as well as the historic monitoring locations. **Table D1** below outlines the rationale behind the selection of the locations. The locations were chosen by taking into account all available geological and hydrogeological information, and constrained by restrictions to site access. There were no changes between the proposed and final locations.

This phase of Site Investigation was designed to address the following:

- EPA Notice under Article 16(1) of the Waste Management (Licensing) Regulations issued on 23 March 2012 (EPA Ref: **W0129-03**);
- Clarification to notice in accordance with Article 16(1) of the Waste Management (Licensing) Regulations issued on 3 May 2012 (EPA Ref: **W0129-03**);

Subsequent meetings and communications with the EPA informed the SI design.

Table D1 Selection of new borehole locations

BH ID	Borehole depth (mbgl)	Response zone (mbgl)	Proposed location	Rationale	Final location	Monitoring installation	Comments
BH24	48.2	44.2-47.2	At the toe end of the proposed hazardous cell (north of the Apex mapped N-S fault)	To be located north of the Apex mapped N-S fault. To be screened with in the Loughshinny Fm only. To establish depth to the Loughshinny Fm in northern area.	As proposed	Yes	Progression of drilling extremely slow, due to the degree of vertical fracturing in the proximity of the S-N trending fault. Borehole terminated in Namurian deposits. Loughshinny Fm not reached.
BH25	26	20-24	In the south-western quadrant (non-hazardous landfill cell)	Further SI data required in south-western quadrant where the Loughshinny Fm is exposed. This is where the non hazardous cell is proposed.	As proposed	Yes	Ponding water located adjacent to this location. Vital to seal shallow part of borehole to avoid hydraulic connectivity with ponding water. Competent limestone encountered
BH26	24	20-23.5	In the vicinity of BH17 (pumping well) in north-western quadrant	Further SI data required in the north-western quadrant. To be screened in the Loughshinny Fm. Depth of Loughshinny Fm not established but estimated to be approx. 60mBGL.	As proposed	Yes	Borehole depth reduced owing to the ground conditions encountered. Borehole screened at a shallower depth than intended in the Namurian deposits.
BH27	14	10-13	Adjacent to BH18	Establish well pair adjacent to BH18 to be screened at the base of the Balrickard Fm where geophysics indicates an increase in shale (approx. 13m - 15m). This will also enable analysis of the vertical hydraulic gradient (if any).	As proposed	Yes	Borehole drilled slightly shallower than originally planned. Terminated in Namurian possibly at interface with Balrickard Fm. Clay infill encountered from 5m to the base of the borehole. Micropaleontology in BH18 (adjacent to BH27) indicated Namurian deposits. BH18 was drilled using the Geobore S method and there is also packer test data available for in this area.
BH28	40	36-39	Western side of Apex mapped fault adjacent to BH15a	To be rotary drilled to circa 40mBGL. To be screened at the base of the Balrickard Fm.	As proposed	Yes	Borehole drilled to and screened at planned depth. No Limestone contact encountered
BH29	58	34-39	Western side of fault adjacent to historic boreholes BH22/22a	EPA suggests well pair with BH30 in this location (adjacent BH22/22a).	As proposed	Yes	Originally intended to drill borehole to 60mBGL but the degree of weathering from ca. 44 – 54m BGL and consequent backfall during construction resulted in the borehole being secured with bentonite at depth to 40m BGL. The borehole was screened in the Namurian deposits only.

BH ID	Borehole depth (mbgl)	Response zone (mbgl)	Proposed location	Rationale	Final location	Monitoring installation	Comments
BH30	61.7	58.7-61.7	Western side of fault adjacent to boreholes BH22/22a	Partially cored hole to circa 60mBGL. To form a pair with BH29.	As proposed	Yes	Limestone was encountered at 55.70m BGL and confirmed with HCl testing. Borehole extended beyond the intended 60m depth to 61.7mBGL to ensure a securely sealed response zone within the Visean deposits.

The new groundwater monitoring installations were drilled by Petersen Drilling Services (PDS) using both an ‘open-hole’ drilling method with an air and water flush and a Geobore ‘S’ drilling method with a polymer gel and water flush. The PDS drill rig was able to change over to the Geobore ‘S’ method from the ‘open-hole’ method during the construction of a single installation, which facilitated the partial coring of certain wells whilst and kept the site investigation costs to a minimum.

The Geobore ‘S’ method employed by PDS uses a double core-barrel system and polymer fluid to produce high quality cores of the subsurface material, which is known to be highly weathered and broken. A log of these cores was made by a representative from Arup. The drill cores were then stored on site in core boxes.

The standard ‘open-hole’ method employed by PDS returned the subsurface material as a slurry of gravel sized chips and mud. These boreholes were sampled and logged on site by the onsite hydrogeologist from Arup. The slurry of gravel sized chips and mud were logged every metre and stored on site in chip boxes.

BH24 and BH26 were drilled to establish the depth below ground level of the Loughshinny and to increase the SI information in the northeastern quadrant of the site.

BH25 was drilled in the south-western quadrant – the site of the proposed new non-hazardous landfill cell- where the Loughshinny is exposed to gain more SI data for this area of the proposed development. It confirmed Visean deposits to surface and is used in hydraulic testing.

BH27, BH28, BH29 and BH30 were drilled to provide well pairs on the either side of the major faults. The intention was to screen BH27 and BH28 in the Balrickard Formation and BH29 and BH30 in the Loughshinny.

The borehole logs contain the standpipe installation details for all the new boreholes drilled at the MEHL site. These are are presented in **Appendix D1.**

Borehole and well logging

A geotechnical borehole log describes the physical properties of the rock types encountered while a hydrogeological well log is a summary of the geology encountered during drilling, the installation details and any water strikes encountered. An interpretative hydrogeological well log was compiled by Arup for each of the new monitoring boreholes installed on site. These logs collate information from the driller’s notes, the site hydrogeologist’s observations, and a lithological interpretation of the subsurface material encountered. These interpretative logs are presented in **Appendix D1**. For the lithological interpretation, in some boreholes it was difficult to distinguish the contacts between the various formations. These have been grouped together as either Namurian (Walshestown, Balrickard, Donore) or Visean (Loughshinny formations). In the 2010 *‘Report on the Geology of the Landfill Site, Hollywood, Naul, Co. Fingal’* by Gareth Jones, it is noted that where the mudstones, shales, siltstones and sandstones are heavily weathered accurate identification is difficult. Thus palynology and micropaleontology was carried out during this investigation to help confirm the various lithologies encountered.

Monitoring Installations

All boreholes on site were grouted by PDS as their equipment includes a grouting plant that can be used to mix grout at the site of each borehole. It was critical that the boreholes were grouted to a high standard as otherwise they may have had the potential to act as pathways for contamination in future. Samples were taken of the grout used for each borehole and these were retained by MEHL for future testing as required.

An initial draft log of the geological profile was compiled on site. Upon completion the monitoring installation detail was designed on site by the site hydrogeologist. In this way, each monitoring installation was tailored to target areas of specific hydrogeological interest. A summary of the monitoring installation configurations from this phase of Site Investigation is laid out in **Table D2** below.

Table D2 Summary of monitoring well installation at the MEHL site in 2013.

Borehole ID	Slotted casing		Plain casing		Gravel pack		Fine sand		Bentonite	
	Depth (mbgl)	Length (m)	Depth (mbgl)	Length (m)	Depth (mbgl)	Length (m)	Depth (mbgl)	Length (m)	Depth (mbgl)	Length (m)
BH24	44.2-47.2	3	0-44.2	44.2	43.2-48.2	5	42.2-43.2	1	41.2-42.2	1
			47.2-48.2	1						
BH25	20-24	4	0-20	20	18-25	7	17-18	1	16-17	1
			24-25	1						
BH26	20-23.5	3.5	0-20	20	19-24	5	18-19	1	17-18	1
			23.5-24	0.5						
BH27	10-13	3	0-10	10	9-14	5	8-9	1	7-8	1
			13-14	1						
BH28	36-39	3	0-36	36	35-40	5	34-35	1	33-34	1
			39-40	1						
BH29	34-39	5	0-34	34	33-40	7	32-33	1	30.5-31.5	1
			39-40	1					40-47.8	7.8
BH30	58.7-61.7	3	0-58.7	58.77	57.7-61.7	4	57.2-57.7	0.5	56.2-57.2	1

The hydrogeological information gathered from each borehole including the bedrock geology, any water strikes, the static water level and the amount of water removed during the development of each monitoring well before sampling for laboratory analysis are summarised below in **Table D3.**

Table D3 Hydrogeological summary for each borehole drilled at the MEHL site in 2013

BH name	Geology		Water strike		Flush losses (Geobore 'S')		Static level (Jul 2013 ave.)
	Depth (mbgl)	Lithology	Depth (mbgl)	Estimated flow (m3/h)	Depth (mbgl)	% loss	Depth (mbgl)
BH24	0-10	Dublin Boulder Clay	9.8	–			3.08
	10-48.2	Possible Walshestown Fm			40.0–48.2	–	
BH25	0-25	Loughshinny Fm	3.6	–			3.08
			7.0	1.02			
			13.0	2.4			
			17.0	2.4			
			26.0	3.0			
BH26	0-24	Namurian Possible Balrickard Fm	4.0	–	16.0–24.0	–	1.97
BH27	0-14	Namurian Possible Balrickard Fm	3.5	–	5.0–14.0	–	4.04
BH28	0-12.5	Made Ground	24.5	–			24.41
	12.5-14.8	Dublin Boulder Clay					
	14.8-40	Namurian Possible Balrickard Fm					
BH29	0-10	Made Ground		–			22.71
	10-24.7	Dublin Boulder Clay	24.5	–			
	24.7-52	Namurian Possible Balrickard Fm	46.0	–	44.0–46.0	Hole collapses	
			58.0	3.6			
BH30	0-10	Made Ground					22.31
	10-24.7	Dublin Boulder Clay	24.5	–			
	24.7-55.7	Namurian Possible Balrickard Fm			40.0–61.7	–	
	55.7-61.7	Visean Possible Loughshinny Fm					

The details of the targeted zones of the new boreholes are presented below in **Table D4.**

Table D4: Hydrogeological summary for each borehole, highlighting targeted zones.

BH ID	Geology		Slotted casing		Gravel pack	
	Depth (mbgl)	Lithology	Depth (mbgl)	Length (m)	Depth (mbgl)	Length (m)
BH24	0-10	Dublin Boulder Clay	44.2-47.2	3	43.2-48.2	5
	10-48.2	Possible Walshestown Fm				
BH25	0-25	Loughshinny Fm	20-24	4	18-25	7
BH26	0-24	Namurian Possible Balrickard Fm	20-23.5	3.5	19-24	5
BH27	0-14	Namurian Possible Balrickard Fm	10-13	3	9-14	5
BH28	0-12.5	Made Ground	36-39	3	35-40	5
	12.5-14.8	Dublin Boulder Clay				
	14.8-40	Namurian Possible Balrickard Fm				
BH29	0-10	Made Ground	34-39	5	33-40	7
	10-24.7	Dublin Boulder Clay				
	24.7-52	Namurian Possible Balrickard Fm				
BH30	0-10	Made Ground	58.7-61.7	3	57.7-61.7	4
	10-24.7	Dublin Boulder Clay				
	24.7-55.7	Namurian Possible Balrickard Fm				
	55.7-61.7	Visean Possible Loughshinny Fm				

Site Notes

The following section contains a detailed summary of the drilling and installation process for each monitoring borehole. This information was collated from a combination of driller's logs and site notes from the supervising hydrogeologist. All monitoring installations were designed by Arup and Eugene Daly Associates. The site hydrogeologist was present for the drilling and development of all boreholes drilled in May and June of 2013. **Table D5** below summarises the response zones of the well screens in each monitoring installation.

Table D5: Summary of details of the well installation undertaken at the MEHL site in 2013.

BHID	Status	Depth to top and bottom of well screen (mbgl)	Geology of response zone	Reason for depth
BH24	New monitoring well	44.2-47.2	Namurian, possible Walshestown Fm.	BH did not reach targeted Loughshinny Fm. Screened at base of bore in Namurian, possibly Walshetown Fm
BH25	New monitoring well	20-24	Loughshinny Fm.	Screened in Loughshinny Fm
BH26	New monitoring well	20-23.5	Namurian, possible Balrickard Fm.	BH did not reach targeted Loughshinny Fm. Screened at base of bore in Balrickard Fm.
BH27	New monitoring well	10-13	Namurian, possible Balrickard Fm.	BH did not reach targeted Loughshinny Fm. for pairing with response zone in BH18. Screened at base of bore in Namurian, possibly Balrickard Fm.
BH28	New monitoring well	36-39	Namurian, possible Balrickard Fm.	BH did not reach targeted Loughshinny Fm. for pairing with response zone in BH15a. Screened at base of bore in Namurian, possibly Balrickard Fm.
BH29	New monitoring well	34-39	Namuran, possible Balrickard Fm.	BH did not reach targeted Loughshinny Fm. for pairing with response zone in BH30. Screened at base of bore in Namurian, possibly Balrickard Fm.
BH30	New monitoring well	58.7-61.7	Loughshinny Fm.	Screened in Loughshinny Fm for pairing with BH29

BH24

BH24 was installed to the north of the Apex mapped N-S fault line targeting the Loughshinny Fm, with a view to establish whether the fracture / faulting system is acting as a barrier or conduit to flow in the bedrock aquifer. It was anticipated that the Loughshinny Fm could be in excess of 75m deep at this location.

The borehole was drilled by PDS between the 10th and 13th June 2013 using a standard open-hole technique with a diameter of 8" OD to 1.5mbgl. The drill bit was then changed to a 6" OD bit and drilled to 40mbgl. The borehole was extended from 40mgbl to 48.2mbgl using the Geobore 'S' drilling system. Cores were extracted for these depths.

The hole was originally intended to be constructed to a depth of 60mbgl however, the hole became very unstable between depths 12-40mbgl and there was a complete collapse within the hole while switching over to the Geobore 'S' drilling system. Consequently, the hole was re-drilled to 40mbgl to carry out the intended coring. The rock was found to be highly fractured and loose taking 9 hours to core a 2m length. The hole was terminated at 48.2mbgl with approximately 80% core recovery between 40 – 48.2mbgl.

The hole was grouted from 0.5 – 41.2mbgl. A bentonite seal was installed between 41.2-42.2mbgl and fine sand from 42.2 to 43.2 with (10mm) pea gravel to 48.2 mbgl. A 3-meter length of 50mm slotted uPVC well screen was installed from 44.2-47.2mbgl. The borehole was fitted with an end cap.

As it became clear that it would not be possible to extend the borehole into the Loughshinny Fm it was decided that the screening depth should target the deepest section of the water bearing zone in the Namurian deposits. The cores from BH24 were photographed and logged by Arup.

The borehole was developed by MEHL using a Grundfos MP1 pump with a nominal output of approximately 15m^3/day on 21st June 2013 for 60 minutes.

BH25

BH25 is an open-hole borehole in the south-western quadrant in the area of the proposed non-hazardous cell. The Loughshinny Fm in this area extends to surface. BH25 was positioned as far away from the N-S Apex mapped fracture / faulting system as possible. In previous site investigations it was noted that there is an area of ponding water which is potentially hydraulically connected to the exposed Loughshinny Fm in this area.

The borehole was drilled by PDS between the 21st and 22nd May 2013 using a standard open-hole technique with a diameter of 8” OD to 1.5mbgl. The drill bit was then changed to a 6” OD bit and drilled to 25mbgl. The borehole collapsed to 3.6mbgl. The casing was then extended to a depth of 3.8mbgl to maintain stability of the borehole. The drill arisings were logged every meter and stored in chip trays.

The first water strike was at 3.6mbgl with the yield gradually increasing with depth. Once the target depth of 25mbgl was reached, the yield was estimated at circa 3m^3/hour. There were some very fractured / weathered layers encountered between depths 15.5-15.7mbgl and 22.6-23.9mbgl which coincided with increases in yield observed during drilling.

HCl testing confirmed the presence of Limestone throughout the entire length of BH25. It is possible that small layer of Donore Fm was encountered at this location, but the method of drilling made interpretation difficult and there are inherent difficulties with distinguishing the Donore Fm anyway.

The hole was grouted from 0.5 – 16mbgl. There were large amounts of grout loss recorded at 3mbgl. A bentonite seal was installed between 16-17mbgl. The aim was to ensure a good seal to prevent any hydraulic connection between screened section of the borehole and the ponding water. Beneath the bentonite a 1m layer of fine sand overlies the (10mm) pea gravel which extended to the base of the borehole. The well was screened from 20-24mbgl with a 4m length of 50mm slotted uPVC pipe. An end cap was fitted. The chippings from BH25 were logged every metre and stored in chip trays.

Once the borehole had been completed as a monitoring well, the well was developed for 60 minutes by airlift.

BH26

BH26 was partially cored and was positioned between boreholes BH19 and BH20. It was originally intended to target the Loughshinny Fm and to establish a well paring with BH20 which is screened in the Namurian. The anticipated depth of the Loughshinny Fm at this location was 60mbgl. This borehole is located in close proximity to the N-S fracture / faulting system. The location of BH26 was selected to provide information on the downthrow on the eastern side of the N-S fault / fracture system.

The borehole was drilled by PDS between the 27th and 29th May 2013 using a standard open-hole technique with a diameter of 8" OD to 1.5mbgl. The drill bit was then changed to a 6" OD bit and drilled to 16mbgl. The Geobore 'S' drilling system was used from 16mgbl to 24mbgl and cores were extracted for these depths. The hole was terminated at 24mbgl not reaching the Loughshinny.

The hole was grouted from 0.5 – 17mbgl. A bentonite seal was installed between 17-18mbgl. A 1m layer of fine sand overlies the (10mm) pea gravel which extended to the base of the borehole. The well was screened from 20-23.5mbgl with a 3.5m length of 50mm slotted uPVC pipe. An end cap was fitted.

The screening depth targeted the base of the Balrickard Fm where an increase in the presence of shales was predicted. The cores from BH26 were photographed and logged by Arup.

BH27

BH27 was partially cored borehole. It was positioned in the south-western quadrant between boreholes BH18 and BH17. It was originally intended to target the base of the Balrickard Fm. and to establish a well pair with BH18 extending to a proposed depth of 25m. BH27 terminated at 14mbgl. It was screened at its base in the Balrickard Fm.

The borehole was drilled by PDS between the 24th and 27th May 2013 using a standard open-hole technique with a diameter of 8" OD to 1.5mbgl. The drill bit was then changed to a 6" OD bit and drilled to 5mbgl. The Geobore 'S' drilling system was used from 5mgbl to 14mbgl and cores were extracted for these depths.

The hole was grouted from 0.5 – 7mbgl as instructed by Arup. A bentonite seal was installed between 7-8mbgl. A 1m layer of fine sand overlies the (10mm) pea gravel which extended to the base of the borehole. The well was screened from 10-13mbgl with a 3m length of 50mm slotted uPVC pipe. An end cap was fitted. The cores from BH27 were photographed and logged by Arup.

BH28

BH28 was constructed to target the Balrickard Fm and groundwater in the south eastern quadrant. Borehole BH28 was constructed between BH15a and BH23. This borehole is situated at the edge of the planned Dense Asphaltic Concrete (DAC) liner and the borehole is designed to form a well paring with BH15a. It was screened in the Balrickard Fm.

The borehole was drilled by PDS between the 22nd and 24th May 2013 using a standard 'hammer down the hole' technique with a diameter of 8" OD to 1.5mbgl. The drill bit was then changed to a 6" OD bit and drilled to 40mbgl. The borehole was cased to 37mbgl due to the highly weathered and unstable nature of the material at this location.

The hole was grouted from 0.5 – 33 mbgl. Heavy grout losses were recorded at approximately 12.5mbgl, potentially at the interface between Made Ground and Dublin Boulder Clay. A bentonite seal was installed between 33-34mbgl. A 1m layer of fine sand overlies the (10mm) pea gravel which extended to the base of the borehole. The well was screened from 36-39mbgl with a 3m length of 50mm slotted uPVC pipe. An end cap was fitted. The drill arisings from BH28 were logged every metre and stored in chip trays.

BH29

BH29 was constructed to establish a well pairing with BH30 in the vicinity of the historic boreholes BH22/BH22a. This borehole was constructed to target the base of the Balrickard Fm where an increase in shales was anticipated while BH30 would target the Loughshinney. This borehole pair were designed to establish the vertical hydraulic gradient (if any) between the underlying Loughshinny Fm and the overlying Namurian Deposits (comprising the Balrickard Fm).

BH29 was drilled by PBS between the 29th May and 4th June 2013 using a standard open-hole drilling method. This borehole was intended to extend to a depth of 60m but terminated at a depth of 58m. Heavy backfall was encountered during drilling from fracture zones located at depths of 44 to 46mbgl and 53 to 54mbgl. The borehole was backfilled to 47.8mbgl due to collapse and sealed with bentonite to 40mbgl. There was substantial bentonite losses at approximately 44-46mbgl owing to cascading during drilling.

Pea gravel was installed from 40mbgl to 32.5mbgl. A 1m layer of fine sand overlies the (10mm) pea gravel. A bentonite seal was installed between 30.5-31.5mbgl. The well was screened from 34-39mbgl with a 5m length of 50mm slotted uPVC pipe. An end cap was fitted. The drill arisings from BH29 were logged every metre and stored in chip trays

The borehole was grouted from 30.5mbgl to 10.9 mbgl. Grout losses were reported at 10.9mbgl, presumed to be at the interface between Made Ground and Dublin Boulder Clay. The annulus of the borehole from 0.5 to 10.9mbgl was filled with arisings.

It was decided that BH29 would become the shallower of the well pairing, targeting the Namurian deposits.

BH30

BH30 was constructed to establish a well pairing with BH29 in the vicinity of the historic boreholes BH22/BH22a. This borehole was constructed to target the Loughshinny Fm and to establish the vertical hydraulic gradient (if any) between the underlying Loughshinny Fm and the overlying Namurian Deposits (comprising the Balrickard Fm).

It was decided to site BH30 a minimum of 5m away from BH29 owing to the weathered / fractured nature of the material encountered at BH29 to avoid any damage to the newly constructed well and attempt to minimize flush losses.

BH30 was drilled by PDS between the 4th and 7th June 2013 using a standard open-hole technique with a diameter of 8” OD to 1.5mbgl. The drill bit was then changed to a 6” OD bit and drilled to 40mbgl. Drilling switched over to the Geobore 'S' system from 40mgbl to 71.7mbgl and cores were extracted for these depths. 100% flush loss occurred at approximately 40mbgl (a flush of water and polymer gel), the flush was potentially lost at a heavily weathered / fractured layer at 40mbgl. A limestone contact was encountered at 55.7mbgl and in order to make a best attempt at ensuring a good screened seal within the Loughshinny Fm, it was decided to continue coring past the intended target depth of 60mbgl to 61.7mbgl.

The annulus of the borehole from 0.5 to 20mbgl was filled with arisings. The hole was grouted from 20 – 56.2mbgl. A bentonite seal was installed between 56.2-57.2mbgl. A 1m layer of fine sand overlies the (10mm) pea gravel which extends to the base of the borehole. The well was screened from 57.7-61.7mbgl with a 3m length of 50mm slotted uPVC pipe. An end cap was fitted. The cores from BH30 were photographed and logged by Arup.

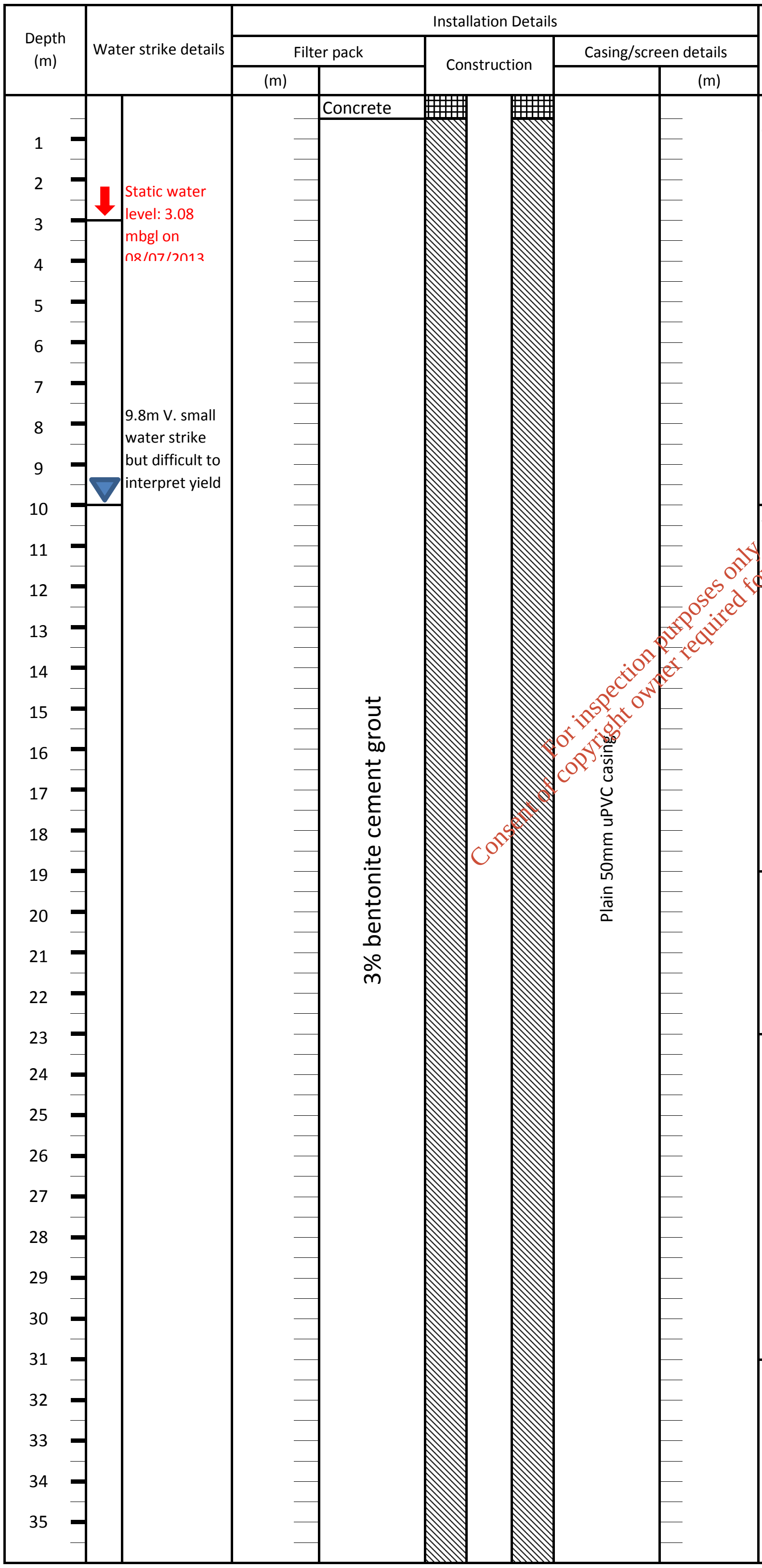
Appendix D1

Well logs

ARUP

MONITORING WELL LOG

Project title Integrated Waste Management Facility	Client MEHL	Well No. **BH24**	Sheet 1 of 2
Date Drilled 10/06/2013 - 13/06/2013 Driller Petersen Drilling Services	Drill method: Air/mist & Geobore 'S'	X; 315954.52	
Date Logged 10/06/2013 - 13/06/2013 Site Engineer/Geologist Lee Chambers	Flush: Air/mist & water/polymer gel	Y: 258209.45	
Comments: Geobore 'S' drilling method between 40-48.2mbgl	Borehole diameter: 146mm (Geobore 'S')	Z (mOD): 106.23	

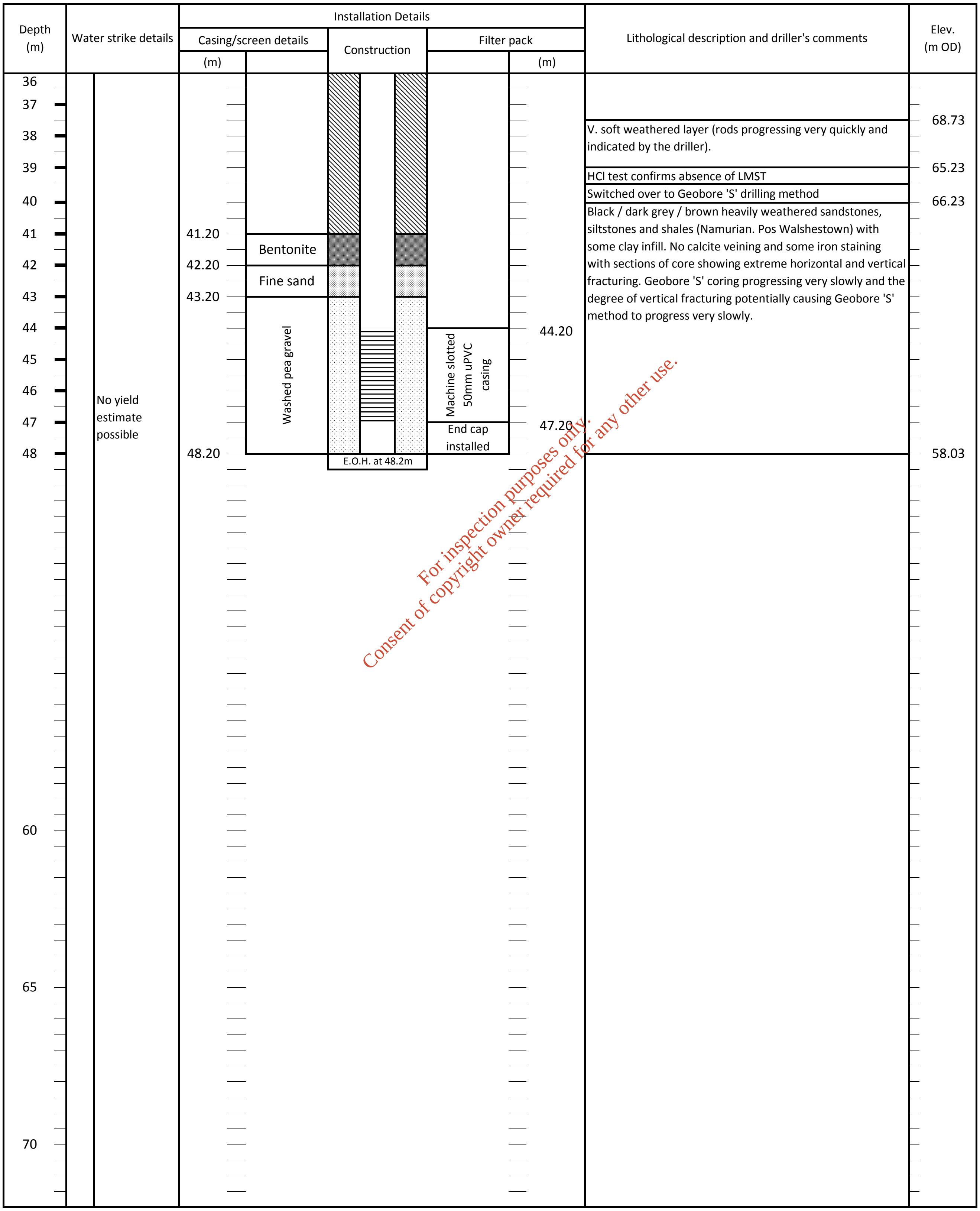


Lithological description and driller's comments	Elev. (m OD)
Black / dark brown sandy gravelly CLAY (Dublin black boulder clay)	
Sand and Gravel layer (possible bed rock contact)	96.43
Black / grey / brown interbedded weathered siltstone, mudstone and shale (Namurian. Possible Walshestown)	94.23
Black / grey / brown interbedded very weathered siltstone, mudstone and shale (Namurian. Possible Walshestown)	87.23
Black / grey / brown interbedded weathered siltstone, mudstone and shale (Namurian. Possible Walshestown)	83.23
Black / grey / brown interbedded very weathered siltstone, mudstone and shale (Namurian. Possible Walshestown)	75.23

ARUP

MONITORING WELL LOG

Project title Integrated Waste Management Facility	Client MEHL	Well No. **BH24**	Sheet 2 of 2
Date Drilled 10/06/2013 - 13/06/	Driller Petersen Drilling Services	Drill method: Air/mist & water/polymer gel	X; 315794.7
Date Logged 10/06/2013 - 13/06/	Site Engineer/Geologist Lee Chambers	Flush: Air/mist	Y: 258003.1
Comments: Geobore 'S' drilling method between 40-48.2mbgl		Borehole diameter: 146mm (Geobore 'S')	Z (mOD): 105.4

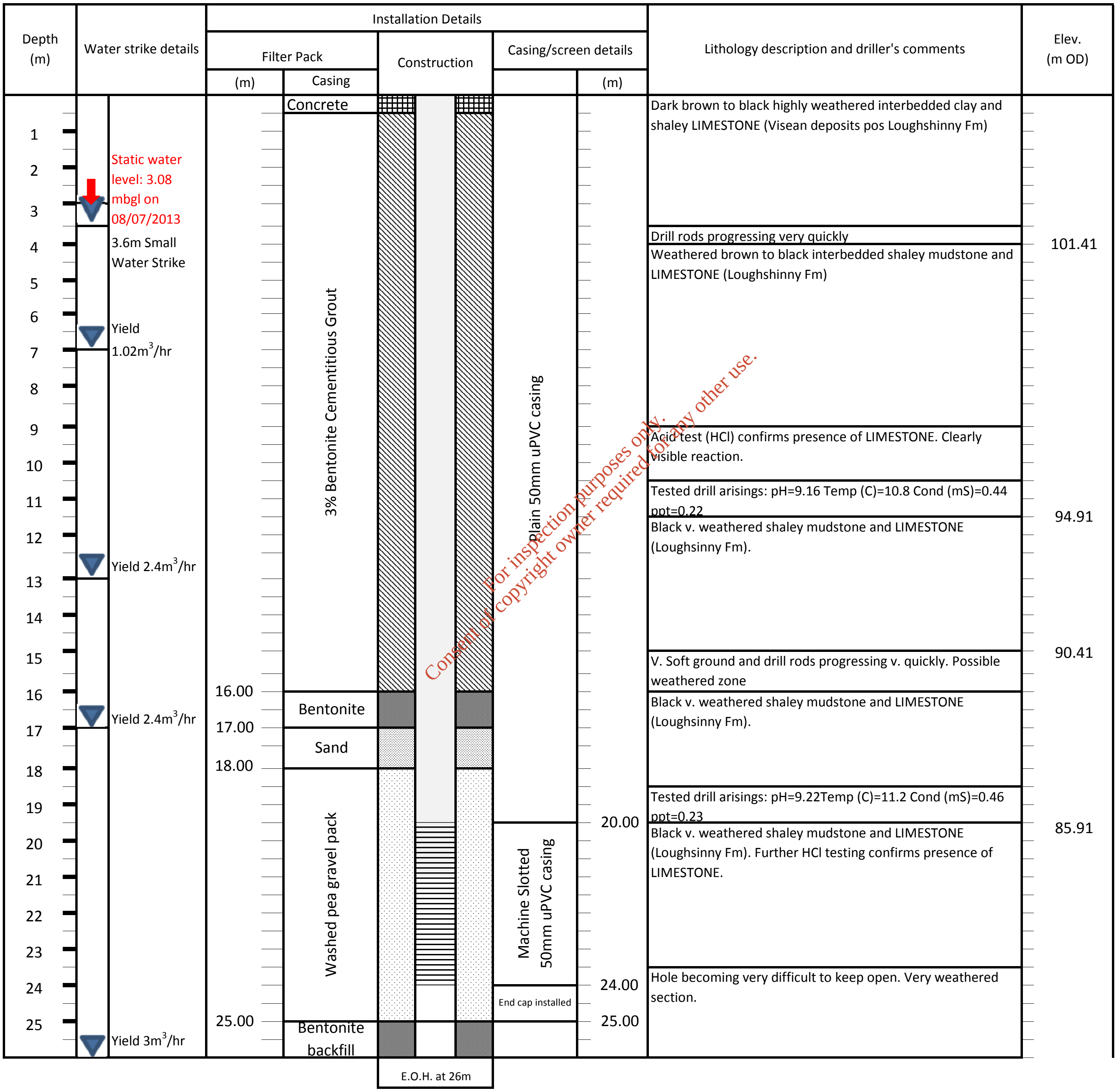


Lithological description and driller's comments	Elev. (m OD)
V. soft weathered layer (rods progressing very quickly and indicated by the driller).	68.73
HCl test confirms absence of LMST	65.23
Switched over to Geobore 'S' drilling method	66.23
Black / dark grey / brown heavily weathered sandstones, siltstones and shales (Namurian. Pos Walshestown) with some clay infill. No calcite veining and some iron staining with sections of core showing extreme horizontal and vertical fracturing. Geobore 'S' coring progressing very slowly and the degree of vertical fracturing potentially causing Geobore 'S' method to progress very slowly.	58.03

ARUP

EXPLORATORY WELL LOG

Project title Integrated waste management facility	Client MEHL	Well No. **BH25**
Date Drilled 21/05/2013 - 22/05/2013	Driller Petersen Drilling Services	Drill method: Super Jaws T117 (Open Hole)	X; 315713.05
Date Logged 21/05/2013 - 22/05/20	Site Engineer/Geologist Lee Chambers	Flush: Air & Water	Y: 257875.54
Comments: Description of chippings from drilling (Loughshinny anticipated)		Hole diameter: 120mm (5")	Z (mOD): 105.41



Static water level: 3.08 mbgl on 08/07/2013

3.6m Small Water Strike

Yield 1.02m^3/hr

Yield 2.4m^3/hr

Yield 2.4m^3/hr

Yield 3m^3/hr

Dark brown to black highly weathered interbedded clay and shaley LIMESTONE (Visean deposits pos Loughshinny Fm)

Drill rods progressing very quickly

Weathered brown to black interbedded shaley mudstone and LIMESTONE (Loughshinny Fm)

Acid test (HCl) confirms presence of LIMESTONE. Clearly visible reaction.

Tested drill arisings: pH=9.16 Temp (C)=10.8 Cond (mS)=0.44 ppt=0.22

Black v. weathered shaley mudstone and LIMESTONE (Loughsinny Fm).

V. Soft ground and drill rods progressing v. quickly. Possible weathered zone

Black v. weathered shaley mudstone and LIMESTONE (Loughsinny Fm).

Tested drill arisings: pH=9.22Temp (C)=11.2 Cond (mS)=0.46 ppt=0.23

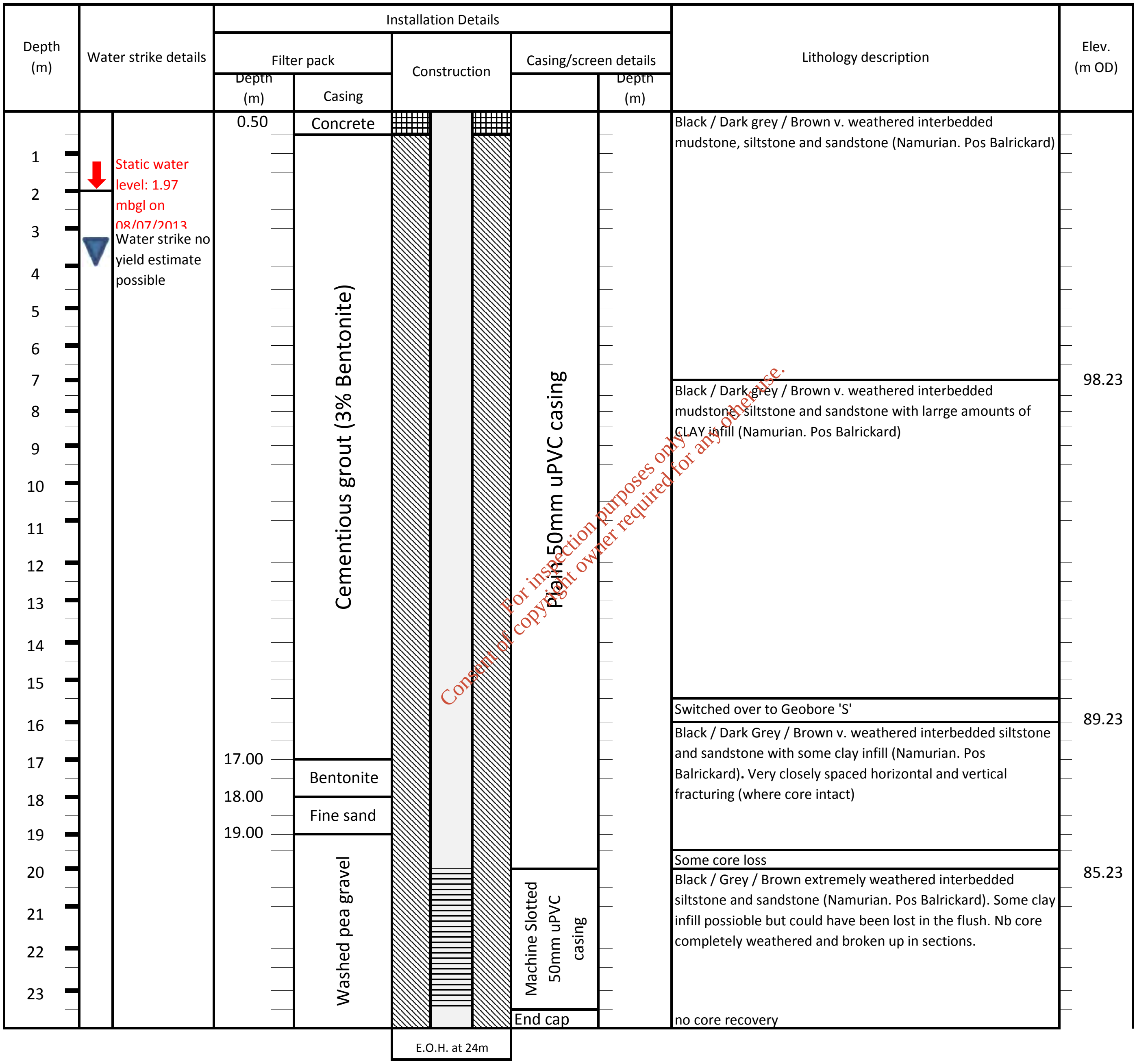
Black v. weathered shaley mudstone and LIMESTONE (Loughsinny Fm). Further HCl testing confirms presence of LIMESTONE.

Hole becoming very difficult to keep open. Very weathered section.

ARUP

EXPLORATORY WELL LOG

Project title Integrated waste management facility		Client MEHL	Well No. **BH26**
Date Drilled 28/05/2013	Driller Petersen Drilling Services	Drill method: "open hole" & Geobore 'S'	X; 315881.35
Date Logged 28/05/2013	Site Engineer/Geologist Lee Chambers	Flush: Air/Water & Water/Polymer Gel	Y: 258086.04
Comments: Geobore 'S' from 16mBGL to 24mBGL		Hole diameter: 146mm	Z (mOD): 105.23



Lithology description	Elev. (m OD)
Black / Dark grey / Brown v. weathered interbedded mudstone, siltstone and sandstone (Namurian. Pos Balrickard)	
Black / Dark grey / Brown v. weathered interbedded mudstone, siltstone and sandstone with larrge amounts of CLAY infill (Namurian. Pos Balrickard)	98.23
Switched over to Geobore 'S'	
Black / Dark Grey / Brown v. weathered interbedded siltstone and sandstone with some clay infill (Namurian. Pos Balrickard). Very closely spaced horizontal and vertical fracturing (where core intact)	89.23
Some core loss	
Black / Grey / Brown extremely weathered interbedded siltstone and sandstone (Namurian. Pos Balrickard). Some clay infill possioble but could have been lost in the flush. Nb core completely weathered and broken up in sections. no core recovery	85.23

ARUP

EXPLORATORY WELL LOG

Project title Integrated waste management facility		Client MEHL	Well No. **BH27**
Date Drilled 24/05/2013 - 26/05/2013	Driller Petersen Drilling Services	Drill method: "open-hole" & Geobore 'S'	X; 315756.7
Date Logged 24/05/2013 - 26/05/2013	Site Engineer/Geologist Lee Chambers	Flush: Water & Polymer Gel	Y: 258018.21
Comments: Geobore 'S' from 5mBGL to 14mBGL		Hole diameter: 146mm	Z (mOD): 106.58

Depth (m): 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13

Water strike details

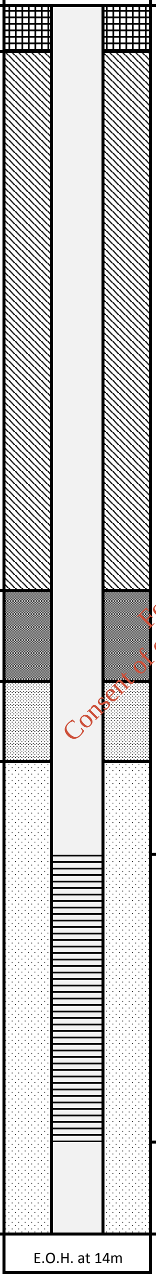
water strike

Static water level: 4.04 mbgl on 08/07/2013

Installation Details

Filter pack (m)	Casing
	Concrete
	3% Bentonite Cementitious Grout
7.00	Bentonite
8.00	Fine sand
9.00	Washed pea gravel pack

Construction

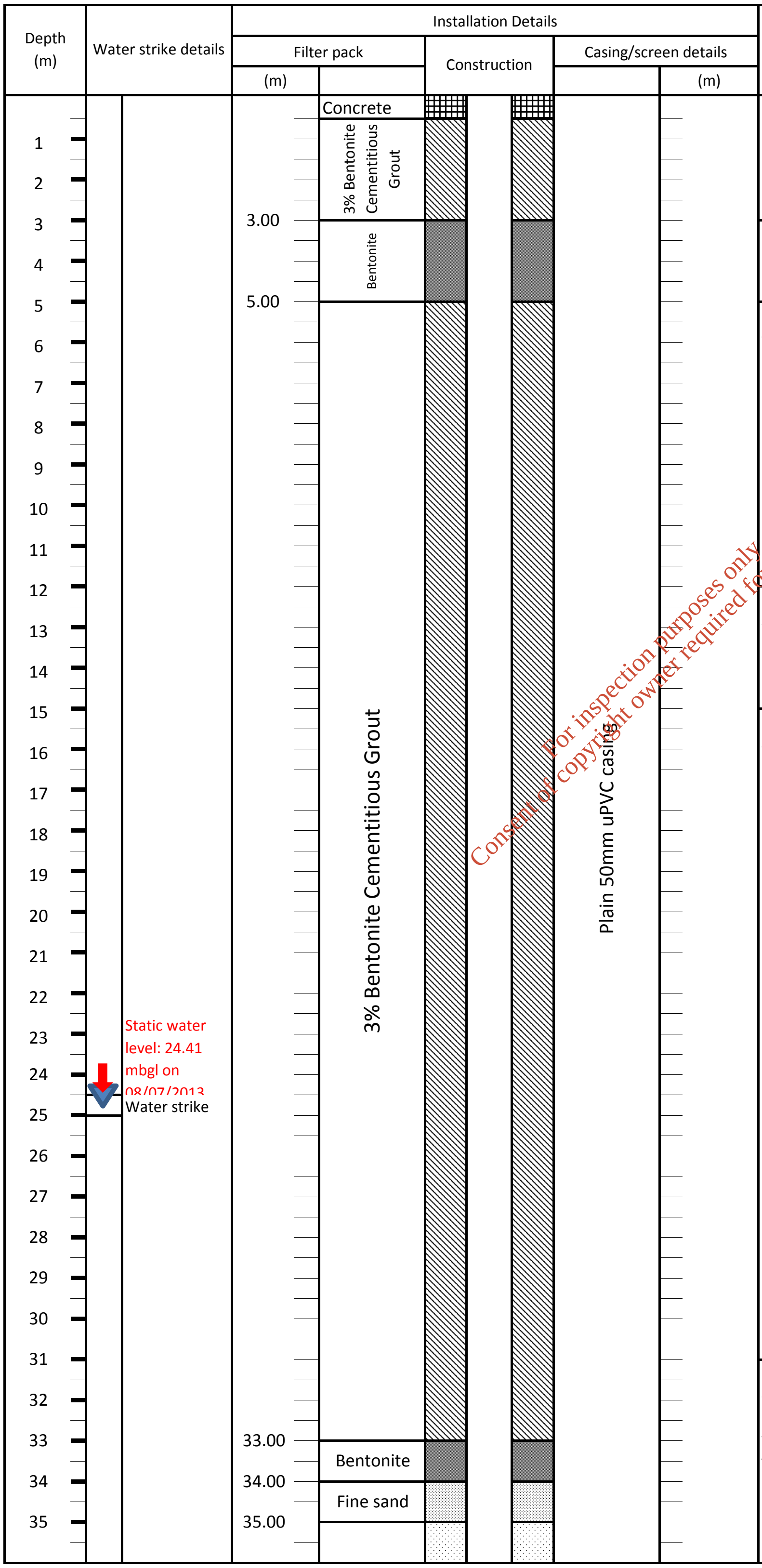


Casing/screen details	(m)
Plain 50mm uPVC casing	10.00
Machine Slotted 50mm uPVC casing	13.00

Lithology description	Elev. (m OD)
Black / Dark grey / Brown v. weathered interbedded mudstone, siltstone and sandstone (Namurian. Pos Balrickard)	
Open hole to 5m. Then changed to Geobore 'S' drilling method.	
Brown / Dark Brown / black moderately weathered interbedded fine grained siltstone and sandstone. Fractures closed with calcite veining and large amounts of clay infill. Some mottling and staining.	101.58
Brown / Dark Brown / black moderately weathered interbedded fine grained siltstone and sandstone. Fractures closed with calcite veining and large amounts of clay infill. Some mottling and staining. HCl test confirms absence of LMST.	100.08
Brown / Dark Brown / black very weathered interbedded siltstone and sandstone with large amounts of clay infill. Some extremely weathered sections and fracturing closed with clay infill. Black clay infill from 8 - 8.75mbgl and finger imprint easy and water retention visible.	98.58
Black / brown v. weathered interbedded mudstone, siltstone and sandstone with large amounts of clay infill.	96.58
Poor core recovery	
Brown to dark grey v. weathered mudstone, siltstone and sandstone with no clay infill. Fractures closed but some extremely weathered sections. Core bcoming very brittle from 11-13.1m and finger indentation not possible.	
Brown / grey extremely weathered siltstone and sandstones with clay infill from 12.5m - 13.1m with some core loss (Namurian pos. base of the Balrickard Fm).	93.58

MONITORING WELL LOG

Project title Integrated Waste Management Facility	Client MEHL	Well No. **BH28**	Sheet 1 of 2
Date Drilled 22/05/2013 - 24/05/2013 Driller Petersen Drilling Services	Drill method: Super Jaws T117 (Open hole)	X; 315884.33	
Date Logged 22/05/2013 - 24/05/2013 Site Engineer/Geologist Lee Chambers	Flush: Air/mist	Y: 257915.73	
Comments:	Borehole diameter: 120mm (5")	Z (mOD): 125.88	



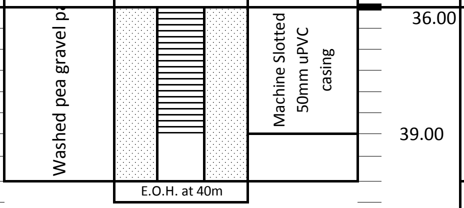
Lithological description and driller's comments	Elev. (m OD)
Brown sandy gravelly CLAY (Made Ground)	
Lost large volumes of grout. Possibly where made ground (fill) meets natural ground (i.e. grout flowing at the base of the made ground). Installed bentonite plug.	122.88
Brown sandy gravelly CLAY (Made Ground). Nb. had to drive casing down to 36m to keep formation open.	120.88
Black to brown stiff sandly gravelly CLAY. Gravel angular to sub angular (Dublin Black Boulder Clay)	123.38
Brown / dark brown / grey weathered shale, siltstone and sandstone with clay infill (Namurian. pos Balrickard Fm)	111.08
Dark brown / grey / black highly weathered shale, siltstones and sandstone with some iron staining (Namurian. Pos Balrickard Fm grading into Donore Fm). Increase in flush washing away less competent material (e.g. clay) and HCl testing confirms absence of Limestone.	94.08

ARUP

MONITORING WELL LOG

Project title Integrated Waste Management Facility	Client MEHL	Well No. **BH28**	Sheet 2 of 2
Date Drilled 10/06/2013 - 13/06/2	Driller Petersen Drilling Services	Drill method: Air/mist & water/polymer gel	X; 315794.7
Date Logged 10/06/2013 - 13/06/2	Site Engineer/Geologist Lee Chambers	Flush: Air/mist	Y: 258003.1
Comments:		Borehole diameter: 146mm (Geobore 'S')	Z (mOD): 105.4

Depth (m)	Water strike details	Installation Details: Casing/screen details (m)	Installation Details: Construction	Installation Details: Filter pack (m)	Lithological description and driller's comments	Elev. (m OD)
				36.00		
37						
38						
39				39.00		
40						



ARUP

MONITORING WELL LOG

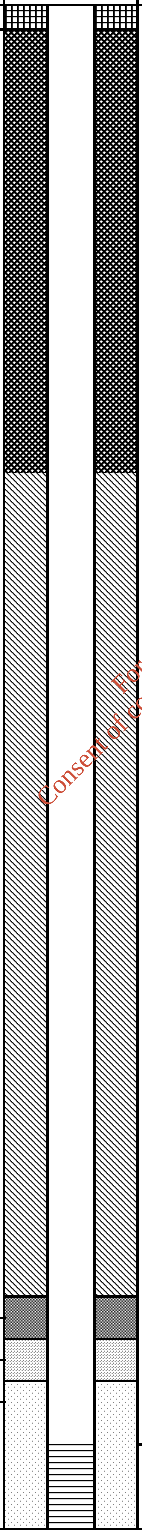
Project title Integrated Waste Management Facility	Client MEHL	Well No. **BH29**	Sheet 1 of 2
Date Drilled 29/05/2013	Driller Petersen Drilling Services	Drill method: Super Jaws T117 (Open Hole)	X; 315985.93
Date Logged 29/05/2013	Site Engineer/Geologist Lee Chambers	Flush: Air/mist	Y: 258071.2
Comments: Hole collapses from 44-46mbgl and 53-54mbgl		Borehole diameter: 120mm (5")	Z (mOD): 123.72

Depth (m): 1–35

Water strike details:
- Static water level: 22.71 mbgl on 08/07/2013
- Water strike (24)

Installation Details

Filter pack (m)	Filter pack
	Concrete
	Backfill with drill arisings
31.00	3% bentonite cement grout
32.00	Bentonite
33.00	Fine Sand



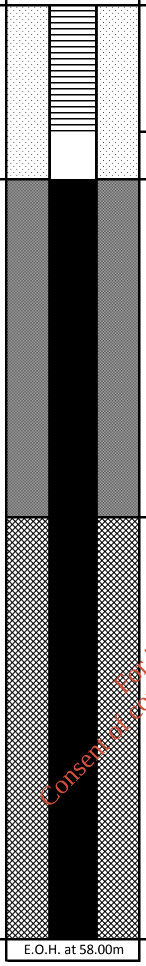
Casing/screen details	(m)
Plain 50mm uPVC casing	34.00

Lithological description and driller's comments	Elev. (m OD)
Orange / Brown sandy gravelly CLAY (Fill). Arisings from quarry.	116.72
Orange / Brown sandy gravelly CLAY (possible brown boulder CLAY). Possible contact with natural ground.	113.72
Black / Grey / Dark Brown sandy gravelly CLAY (Dublin Black Boulder CLAY). Had to fetch doser because clay clogging the hammer and slowing drill progression. Arisings clumping together.	101.22
Black / Grey / Dark Brown sandy gravelly CLAY (Dublin Black Boulder CLAY)	
Competent bedrock encountered at 24.70mBGL	97.72
Grey / Dark Brown / Brown weathered shale, silstone and sandstone with some Fe staining (Namurian. Possible Balrickard)	89.72
Hole very unstable and arisings from depth coming to the surface	

MONITORING WELL LOG

ARUP

Project title Integrated Waste Management Facility	Client MEHL	Well No. **BH29**	Sheet 2 of 2
Date Drilled 29/05/2013	Driller Petersen Drilling Services	Drill method: Super Jaws T117 (Open Hole)	X; 315985.93
Date Logged 29/05/2013	Site Engineer/Geologist Lee Chambers	Flush: Air/mist	Y: 258071.2
Comments: Hole collapses from 44-46mbgl and 53-54mbgl		Borehole diameter: 120mm (5")	Z (mOD): 123.72

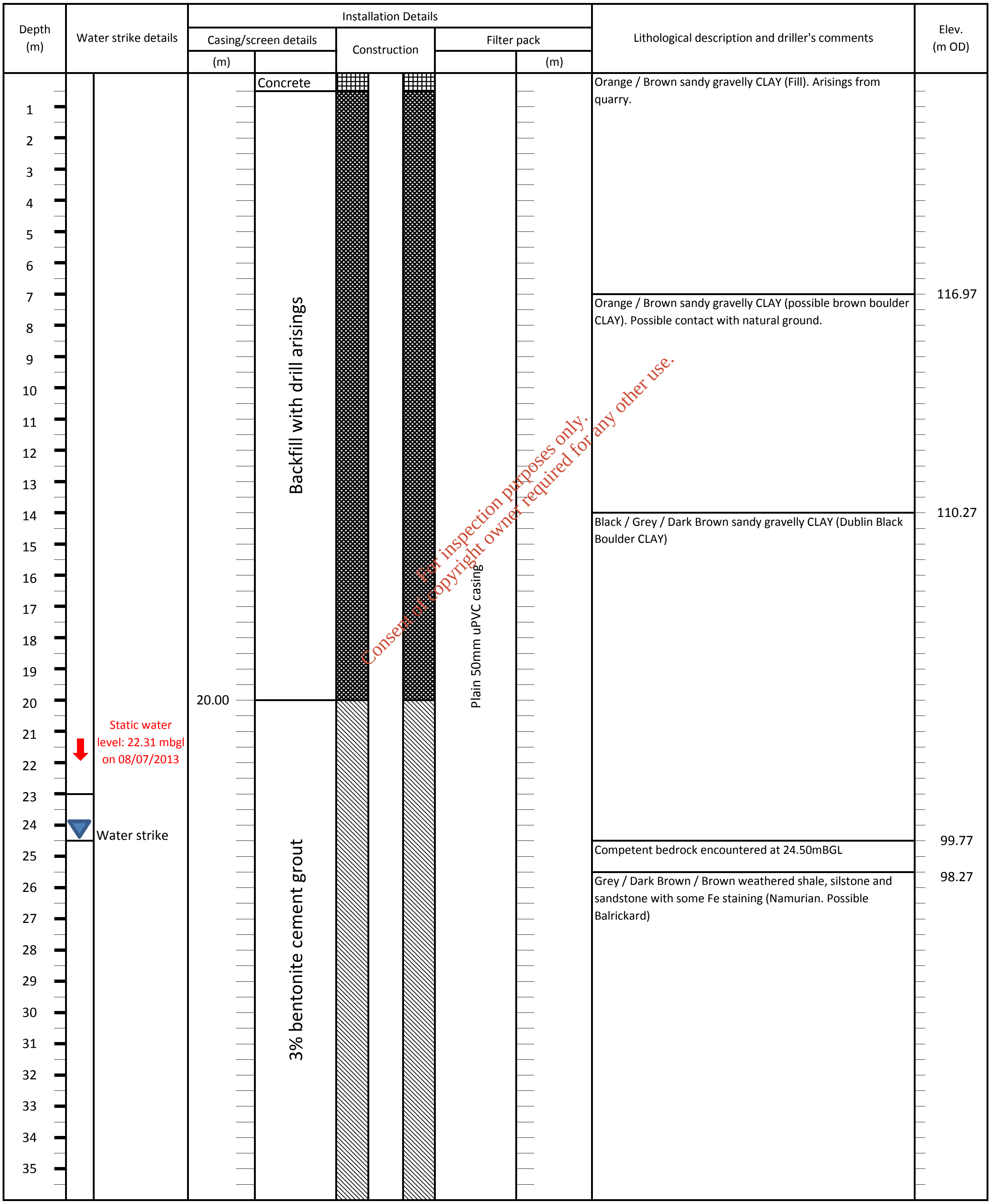


Depth (m)	Water strike details	Casing/screen details (m)	Casing/screen details	Construction	Filter pack	Filter pack (m)	Lithological description and driller's comments	Elev. (m OD)
36			Washed pea gravel		Machine slotted uPVC casing		Grey / Dark Brown / Brown weathered shale, silstone and sandstone with some Fe staining (Namurian. Possible Balrickard)	
39						39.00		
40					Bentonite	40.00		
44							Very fractured and weathered zone. Some heavy losses in benonite.	79.72
45	Increase in yield							
46							Grey / Dark Brown / Brown weathered shale, silstone and sandstone with some Fe staining (Namurian. Possible Balrickard)	77.72
48					Backfall	47.80		
53							Hole very unstable and collapsing in on itself.	70.72
54								69.72
57	Yield estimate of 86.4m^3/day						No LMST indicated by HCl test at end of hole	
58				E.O.H. at 58.00m				65.72

ARUP

MONITORING WELL LOG

Project title: Integrated Waste Management Facility
Client: MEHL
Well No.: **BH30**
Sheet: 1 of 2
Date Drilled: 05/06/2013
Driller: Petersen Drilling Services
Drill method: "open hole" & Geobore 'S'
X;: 315970.4
Date Logged: 05/06/2013
Site Engineer/Geologist: Lee Chambers
Flush: Air/Water & Water/Polyme
Y:: 258072.55
Comments: Geobore 'S' from 40mBGL to 61.7mBGL
Borehole diameter: 146mm (Geobore 'S')
Z (mOD):: 124.27

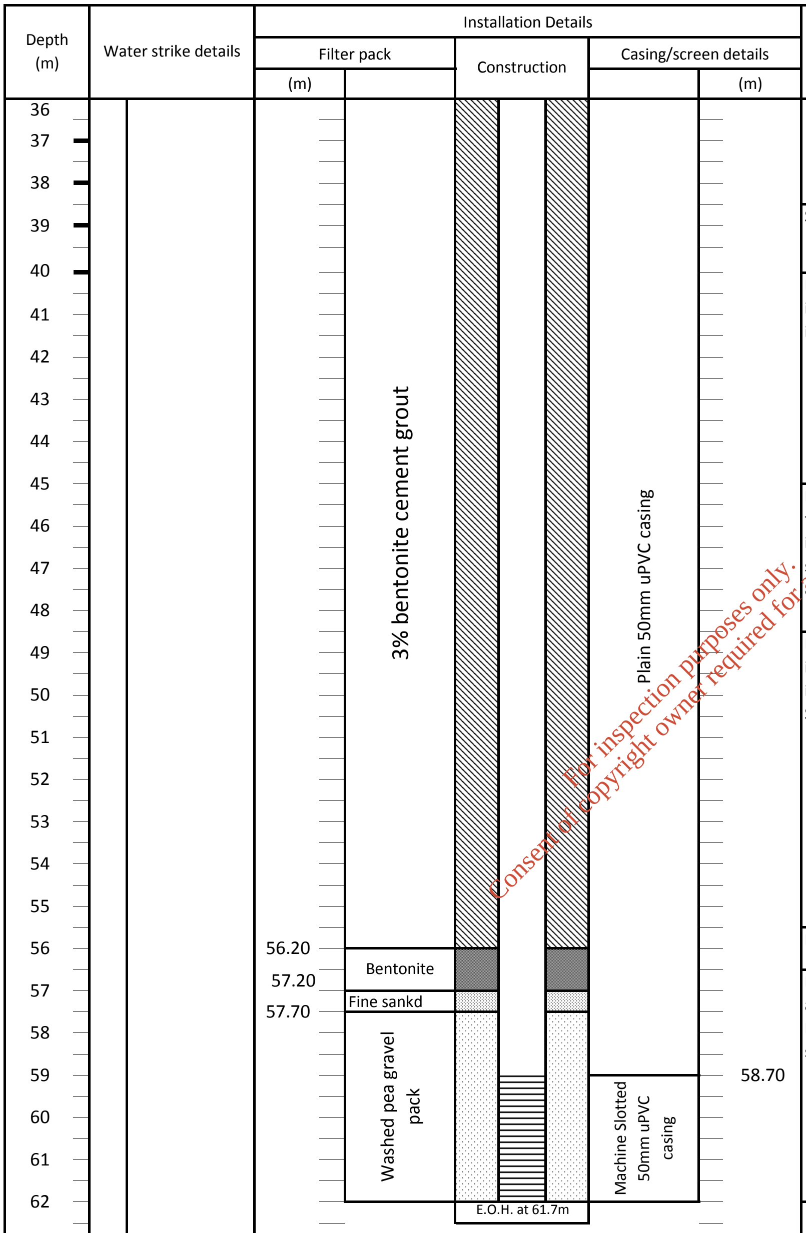


Lithological description and driller's comments	Elev. (m OD)
Orange / Brown sandy gravelly CLAY (Fill). Arisings from quarry.	
Orange / Brown sandy gravelly CLAY (possible brown boulder CLAY). Possible contact with natural ground.	116.97
Black / Grey / Dark Brown sandy gravelly CLAY (Dublin Black Boulder CLAY)	110.27
Competent bedrock encountered at 24.50mBGL	99.77
Grey / Dark Brown / Brown weathered shale, silstone and sandstone with some Fe staining (Namurian. Possible Balrickard)	98.27

ARUP

MONITORING WELL LOG

Project title Integrated Waste Management Facility	Client MEHL	Well No. **BH30**	Sheet 2 of 2
Date Drilled 05/06/2013	Driller Petersen Drilling Services	Drill method: "open hole" & Geobore 'S'	X; 315970.4
Date Logged 05/06/2013	Site Engineer/Geologist Lee Chambers	Flush: Air/Water & Water/Polyme	Y: 258072.55
Comments: Geobore 'S' from 40mBGL to 61.7mBGL		Borehole diameter: 146mm (Geobore 'S')	Z (mOD): 124.27



Lithological description and driller's comments	Elev. (m OD)
Switched over to Geobore 'S' method from 40mbgl	
Black / dark grey / brown weathered and fractured interbedded shale, siltstone and sandstone with some clay infill (Namurian pos Balrickard). Very weathered in sections	84.27
Dark grey to brown weathered and fractured interbedded fine grained siltstone, sandstone and shale with some clay infill (Namurian, possibly Balrickard). V. weathered in sections and some fe staining and shale bands every 20cm approx.	79.07
Black / dark grey / brown weathered and fractured interbedded siltstone sandstone and shale with some clay infill (Namurian. Pos Balrickard grading into Donore Fm). Sections of core very shaley and some Fe staining present.	76.07
HCl indicates LMST contact	68.57
Black / dark grey weathered and fractured interbedded shale and Limestone (Visean. Possible Loughshinny contact or Donore grading into Loughshinny). V. Weathered shale sections and some clay infill with sub horizontal fracturing.	67.57

Appendix E

Groundwater Monitoring

GROUNDWATER LEVELS
HOLLYWOOD LANDFILL (W0129-02)

COMPLETE FIELD DATA FROM WATER SAMPLING SHEET IN TABLE BELOW

BH REF	COMPLETED DEPTH (m)	TOC LEVEL (m OD)	**DEPTH TO WATER (m below top of casing)**															**DEPTH TO WATER (m below top of casing)**									**DEPTH TO WATER (m below top of casing)**										**DEPTH TO WATER (m below top of casing)**										
			2003			**2004**				**2005**				**2006**				**2007**					**2008**				**2009**										**2010**										
			Q3	**Q4**	**Q4**	**Q1**	**Q2**	**Q3**	**Q4**	**Q1**	**Q2**	**Q3**	**Q4**	**Q1**	**Q2**	**Q3**	**Q4**	**Q1**	**Q2**	**Q3**	**Q3**	**Q4**	**Q1**	**Q2**	**Q3**	**Q4**	**Q1**	**Q2**	**Q3**	**Q3**	**Q3**	**Q3**	**Q4**	**Q4**	**Q4**	**Q4**	**Q1**	**Q1**	**Q1**	**Q2**	**Q2**	**Q2**	**Q2**	**Q2**	**Q2**	**Q2**	**Q2**
			23/07/2003	01/10/2003	03/12/2003	10/02/2004	11/05/2004	30/08/2004	09/11/2004	15/03/2005	11/05/2005	19/07/2005	12/10/2005	31/01/2006	05/04/2006	25/07/2006	03/10/2006	31/01/2007	05/04/2007	19/06/2007	09/07/2007	04/10/2007	09/01/2008	02/04/2008	09/07/2008	29/10/2008	09/02/2009	28/04/2009	02/09/2009	03/09/2009	07/09/2009	30/09/2009	17/10/2009	02/11/2009	26/11/2009	16/12/2009	14/01/2010	11/02/2010	11/03/2010	22/04/2010	20/05/2010	21/05/2010	28/05/2010	31/05/2010	01/06/2010	08/06/2010	11/06/2010
BH-4		97.22		0.95	1.37	1.33	2.65	3.21	3.02	3.26	3.44	4.1	4.7	4.33	4.33	4.88	5.3	4.08	4.35		4.52	3.82	3.65	3.2	1.6	0.98																					
BH-4A		91.96																									0	0			0				0			0		0	0	0		0	0		0
BH-4A		95.09																																													
BH-5	34.9	118.72	18.8	19.33	19.74	19.4	20.45	22.36	23.5	24.27	25.21	25.6	25.85	25.77	26.4	26.9	27.6	27.25			24.5	23.1	23.2	21.07	22.05	20.11	19.43	20.52			19.05				17.95			16.3		16.27	17.1	17.11		17.22	17.1		17.56
BH-6	19.5	117.31	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0		0	0	0	0	0	0	0.48	0			0				0			0		0	0	0		0	0		0
BH-6		119.45																																													
BH-8	4.55	136.73	3.37	3.24	3.14	3.28	3.85	3.29	3.35	3.58	3.29	4.3	4.35	3.5	3.2	4.36	3.27	3.35	3.61		3.1	3.21	2.78	2.74	2.78	3	2.8	3.07			2.83				2.78			2.96		2.73	3.59	3.61		3.78	3.59	3.03	3.19
BH-9	49.01	128.81	25.59	26.17	26.44	24.84	25.44	26.59	25.6	24.89	25.4	26.35	27.41	25.94	26.1	26.42	27.79	24.75	25.02		26.52	25.58	25.92	25.76	25.78	23.69	23.4	24.32			23.57				22.79			21.09		21.79	22.39	22.4		22.61	22.39	22.76	22.89
BH-10	68.35	134.1	48.52	49.32	50.14	49.8	50.7	Dry	Dry	Blocked	Dry	52.75	Dry	Dry	Dry	Dry	Dry	Dry	Dry		Dry	Dry																									
BH-10A		137.14																			47.34	48.75	48.35	47.37	47.58	44.72	45.72	43.62			40.4				38.92						37.2	37.19		37.27	37.2	36.73	37.34
BH-11	45.68	120.88	20.81	21.29	21.64	21.44	22.6	25.15	26.8	24.1	24.98	25.35	25.57	28.6	29.1	29.62	30.36	29.94			27.29																										
BH-11A		100.01																			6.6	5.07	4.3	3.86	4.05		1.94	2.29			1.99				1.5			1.6		1.57	1.59	1.6		1.57	1.59		1.59
BH-12		146.99																			53.53	53.55	DRY	51.72	53.85	49.88	49.9	49.55			48.5				47.85			46.39		46.18	46.22	46.24		46.26	46.22	46.3	46.32
BH-13		146.92																			35.57	34.14	34.18	34.11	34.5	33.82	33.9	34.44			34.21				38.8			33.78		34.2	38.46	38.46		38.5	38.46	38.53	38.51
BH-14	38	125.06																			32.5	31.62	31.47	31.4	29.4	28.74	28.95	29.28			28.5				27.3			26.52						26.25		26.24	26.34
BH-15	30	106.29																																						6.45	6.66	6.65	6.63	6.64	6.66		6.77
BH-16	60	105.16																																						2.59	3.45	3.46	3.5	3.52	3.45		3.87
BH-17	54	105.69																																							4.75	4.76	4.82	5.32	4.75		5.28
BH-18	21.2	111.04																																							10.08	10.07	10.06	10.12	10.08		10.95
BH-19	18	105.61																																							3.39	3.4	3.52	3.58	3.39		3.81
BH-20	52	105.28																																							3.9	3.92	3.97	4.03	3.9		4.35
BH-24	48.2	106.23																																													
BH-25	26	105.41																																													
BH-26	24	105.23																																													
BH-27	14	106.58																																													
BH-28	40	125.88																																													
BH-29	48	123.72																																													
BH-30	61.7	124.27																																													
LC1 - Q3 2004*		113.5			Dry	Dry	Dry	9.579	9.05																																						
LC1 - Q2 2005		120.01												17.4																																	
LC1 - Q2 2006		129.81																																													
LC1 - Q3 2006		**133.69**														20.23		21	20.2	20.33	20.26		18.2	17.36	17.36		17.96				18.96				18.84			18.8									
LC2 - Q2 2007		118.3																	11.72		15.37		14.95		11.93																						
LC2 - Q3 2009		**119.5**																																				No access									
LC3 - Q2 2007		114.16																			3.21			9.22	9.22		6.07																				
LC3 - Q3, 2009		**123.9**																																	5.3			6.37									
LC4 -Q3, 2008		106.5																									16.86																				
LC4 -Q3, 2009		124.9																																	21.06			21.38									
LC4 -Q3,2010		131.92																																													
LC4 -Q3, 2010		**133.92**																																													

* Unconfirmed

THE mOD DATA IN TABLE BELOW IS CALCULATED USED EXCEL FORMULAE. THIS DATA IS TO BE REPORTED.

BH REF			**WATER LEVEL (m OD)**															**WATER LEVEL (m OD)**									**WATER LEVEL (m OD)**										**WATER LEVEL (m OD Malin)**										
			Jul-03	Oct-03	Dec-03	Feb-04	May-04	Aug-04	Nov-04	Mar-05	May-05	Jul-05	Oct-05	Jan-06	Apr-06	Jul-06	Oct-06	Jan-07	Apr-07	Jun-07	Jul-07	Oct-07	Jan-08	Apr-08	Jul-08	Oct-08	Feb-09	Apr-09	Sep-09	Sep-09	Sep-09	Sep-09	Oct-09	Nov-09	Nov-09	Dec-09	Jan-10	Feb-10	Mar-10	Apr-10	May-10	May-10	May-10	May-10	Jun-10	Jun-10	Jun-10
BH-4				96.27	95.85	95.89	94.57	94.01	94.2	93.96	93.78	93.12	92.52	92.89	92.89	92.34	91.92	93.14	92.87		92.7	93.4	93.57	94.02	95.62	96.24																					
BH-4A																											91.96	91.96			91.96	91.96	91.96	91.96	91.96	91.96	91.96	91.96		91.96	91.96	91.96		91.96	91.96		91.96
BH-5			99.92	99.39	98.98	99.32	98.27	96.36	95.22	94.45	93.51	93.12	92.87	92.95	92.32	91.82	91.12	91.47			94.22	95.62	95.52	97.65	96.67	98.61	99.29	98.2			99.67	99.71	100.34	99.82	100.77	101.51	102.07	102.42		102.45	101.62	101.61		101.5	101.62		101.16
BH-6			117.31	117.31	117.31	117.31	117.31	117.31	117.31	117.31	117.31	117.31	117.31	117.31	117.31	117.31	117.31	117.31	117.31		117.31	117.31	117.31	117.31	117.31	117.31	116.83	117.31			117.31	117.31	117.31	117.31	117.31	117.31	117.31	117.31		117.31	117.31	117.31		117.31	117.31		117.31
BH-8			133.36	133.49	133.59	133.45	132.88	133.44	133.38	133.15	133.44	132.43	132.38	133.23	133.53	132.37	133.46	133.38	133.12		133.63	133.52	133.95	133.99	133.95	133.73	133.93	133.66			133.9	133.09	133.64	133.87	133.95	133.59	133.79	133.77		134	133.14	133.12		132.95	133.14	133.7	133.54
BH-9			103.22	102.64	102.37	103.97	103.37	102.22	103.21	103.92	103.41	102.46	101.4	102.87	102.71	102.39	101.02	104.06	103.79		102.29	103.23	102.89	103.05	103.03	105.12	105.41	104.49			105.24				106.02			107.72		107.02	106.42	106.41		106.2	106.42	106.05	105.92
BH-10			85.58	84.78	83.96	84.3	83.4					81.35																																			
BH-10A																					89.8	88.39	88.79	89.77	89.56	92.42	91.42	93.52		96.69	96.74	96.99	97.94	97.44	98.22						99.94	99.95		99.87	99.94	100.41	99.8
BH-11			100.07	99.59	99.24	99.44	98.28	95.73	94.08	96.78	95.9	95.53	95.31	92.28	91.78	91.26	90.52	90.94			93.59																										
BH-11A																					93.41	94.94	95.71	96.15	95.96	100.01	98.07	97.72			98.02	98.1	98.4	98.27	98.51			98.41		98.44	98.42	98.41		98.44	98.42		98.42
BH-12																					93.46	93.44		95.27	93.14	97.11	97.09	97.44			98.49	98.62	98.78	97.49	99.14	99.72		100.6		100.81	100.77	100.75		100.73	100.77	100.69	100.67
BH-13																					111.35	112.78	112.74	112.81	112.42	113.1	113.02	112.48			112.71	112.77	112.47	112.33	108.12			113.14		112.72	108.46	108.46		108.42	108.46	108.39	108.41
BH-14																					92.56	93.44	93.59	93.66	95.66	96.32	96.11	95.78			96.56	96.79	97.48	97.01	97.76			98.54						98.81		98.82	98.72
BH-15																																								99.84	99.63	99.64	99.66	99.65	99.63		99.52
BH-16																																								102.57	101.71	101.7	101.66	101.64	101.71		101.29
BH-17																																									100.94	100.93	100.87	100.37	100.94		100.41
BH-18																																									100.96	100.97	100.98	100.92	100.96		100.09
BH-19																																									102.22	102.21	102.09	102.03	102.22		101.8
BH-20																																									101.38	101.36	101.31	101.25	101.38		100.93
BH-24																																															
BH-25																																															
BH-26																																															
BH-27																																															
BH-28																																															
BH-29																																															
BH-30																																															
LC-1								103.92	104.45					102.61		113.46		112.69	113.49	113.36	113.43		115.49	116.33	116.33		115.73				114.73				114.85			114.89									
LC-2																			106.58		102.93		103.35		106.37																						
LC-3																					110.95			104.94	104.94		108.09								118.6			117.53									
LC-4																																			103.84			103.52									
Rock Cell Pond																													96.67	97.03	97.18	97.45	98.42	97.98	98.75	99.19	99.66		100.29								

GROUNDWATER LEVELS
HOLLYWOOD LANDFILL (W0129-02)

COMPLETE FIELD DATA FROM WATER S

BH REF	COMPLETED DEPTH (m)	TOC LEVEL (m OD)	DEPTH TO WATER (m below top of casing)								DEPTH TO WATER (m below top of casing)																		DEPTH TO WATER (m below top of casing)						DEPTH TO WATER (m below top of casing)			
							2011				2012																		2013									
			Q2	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q3	Q3	Q3	Q3	Q3	Q3	Q3	Q3	Q3	Q4	Q4	Q4	Q4	Q4	Q4	Q1	Q2	Q3		Q3	Q4				
			17/06/2010	28/06/2010	27/09/2010	14/12/2010	22/02/2011	27/06/2011	14/09/2011	01/12/2011	22/03/2012	19/06/2012	04/07/2012	11/07/2012	13/07/2012	18/07/2012	20/07/2012	26/07/2012	26-27/07/12	02/08/2012	09/08/2012	29/08/2012	07/09/2012	14/09/2012	16/10/2012	01/11/2012	20/11/2012	11/12/2012	09/04/2013	25-26/06/2013	03/07/2013	08/07/2013	19/09/2013	01/11/2013	MAX	MIN	AVERAGE	MEDIAN
BH-4		97.22																																	5.3	1.0	3.3	**3.5**
BH-4A		91.96	0	0	0	0	0	0	0	0	0	0	0	0		0			0		0									0					0.0	0.0	0.0	**0.0**
BH-4A		95.09																													2.14	1.46	1.55		2.1	1.5	1.7	**1.6**
BH-5	34.9	118.72	17.47	17.52	17.46	16.97	15.97	16.84	17.68	16.98		16.3	16.15	16.09		16.13			15.96		15.91	15.76	15.72	15.73	15.37	15.24	15.28	15.2		15.37		15.53	16.5		27.6	15.2	19.2	**17.5**
BH-6	19.5	117.31	0	0	0	0	0	0	0	0	0	0	0	0		0			0		0									0					0.5	0.0	0.0	**0.0**
BH-6		119.45																													1.63	1.67	1.93		1.9	1.6	1.7	**1.7**
BH-8	4.55	136.73	3.3	3.53	3	2.23	3.2	3.21	3.73	3.11	3.21	2.98	2.95	2.84		2.99		2.87	3.05	2.96	3.1	2.84	3.19	3.18	2.74	3.08	2.89	3.02	3.27	3.24		3.53	3.91		4.4	2.2	3.2	**3.2**
BH-9	49.01	128.81	23.05	23.24	24.22	23.4	21.34	23.54	24.63	24.05	22.7	22.72	22.41	22.13	22.15	22.15		21.79	21.99	21.63	21.8	21.64	21.58	21.55	21.21	20.89	20.93	20.72	19.64	21.81		27.06	23.41		27.8	19.6	23.7	**23.4**
BH-10	68.35	134.1																																	52.8	48.5	50.2	**50.0**
BH-10A		137.14	37.41	37.42	37.55	37.25	36.6	37.04	37.7	37.49			36.61	36.95		36.77					36.73	36.53	36.56	36.54	36.3	36.13	36.12	35.94	35.24	35.7		35.77	36.57		48.8	35.2	38.9	**37.2**
BH-11	45.68	120.88																																	30.4	20.8	25.6	**25.4**
BH-11A		100.01	1.52	1.54	1.53	1.52	1.54	1.6	1.64	1.61	1.61	1.58	1.55	1.55		1.56			1.59	1.47	1.57	1.56	1.55	1.56	1.57	1.54	1.55	1.58	1.55	1.56		1.51	1.55		6.6	1.5	2.0	**1.6**
BH-12		146.99	46.35	46.44	46.64	46.27	45.46	46.17	46.79	46.63	46.16	46.6	46.01	45.93		45.85		45.77		45.72	45.69	45.58	45.54	45.53	45.29	45.12	45.09	44.86	44.08	44.73		44.76	45.55		53.9	44.1	46.9	**46.2**
BH-13		146.92	38.54	36.39	38.14	35.53	34.06	35.22	35.31	34.25	33.41	33.46	33.34	33.1		32.93		32.81		32.39	32.49	32.1	32.04	31.96	31.37	31.06	30.43	29.81	28.55	25.46		24.35	34.67		38.8	24.4	34.0	**34.1**
BH-14	38	125.06	26.25	26.37	26.33	26.97	25.41	26.03	26.56	26.23	25.96		25.18	25.38		25.57		25.41	25.54	25.38	25.47	25.41	25.4	25.42	25.3	25.09	25.13	25	24.44	24.95		25.02	25.65		32.5	24.4	26.7	**26.0**
BH-15	30	106.29		6.77									6.23	6.19		6.1			6.1		6.01	5.9	5.89	5.91	5.72	5.57	5.55			5.19		5.24	5.93		6.8	5.2	6.1	**6.1**
BH-16	60	105.16		4.85									2.56	2.48		2.53		2.29		2.23	2.33	2.17	2.09	2.1						1.83		1.89	2.96		4.9	1.8	2.8	**2.5**
BH-17	54	105.69		5.11									4.17	4.2		4.12		4.04	4.17	3.99	4.09	3.86	3.9	3.95	3.66	3.5	3.45			3.22		3.32	4.16		5.3	3.2	4.2	**4.1**
BH-18	21.2	111.04		10.4									9.38	9.4		9.34	9.37		9.35	9.13	9.3	9.1	9.15	9.2	8.91	8.77	8.72			8.47		8.6	9.39		11.0	8.5	9.4	**9.4**
BH-19	18	105.61		3.96									2.6	2.55		2.47		2.37	2.45	2.32	2.44	2.28	2.21	2.28	1.96	1.82	1.87			2.2		2.24	3.23		4.0	1.8	2.7	**2.5**
BH-20	52	105.28		4.27									3.18	3.18		3.07		2.93		2.87	2.99	2.84	2.8	2.81			2.37			3.29		2.48	3.39		4.4	2.4	3.3	**3.2**
BH-24	48.2	106.23																												2.99		3.08	4.06		4.1	3.0	3.4	**3.1**
BH-25	26	105.41																												3.05		3.17	3.97		4.0	3.1	3.4	**3.2**
BH-26	24	105.23																												1.85		1.97	2.91		2.9	1.9	2.2	**2.0**
BH-27	14	106.58																												3.92		4.04	4.86		4.9	3.9	4.3	**4.0**
BH-28	40	125.88																												24.33		24.41	25.14		25.1	24.3	24.6	**24.4**
BH-29	48	123.72																												22.58		22.71	23.44		23.4	22.6	22.9	**22.7**
BH-30	61.7	124.27																												22.17		22.31	23.03		23.0	22.2	22.5	**22.3**
LC1 - Q3 2004*		113.5																																	9.6	9.1	9.3	**9.3**
LC1 - Q2 2005		120.01																																	17.4	17.4	17.4	**17.4**
LC1 - Q2 2006		129.81																																				
LC1 - Q3 2006		**133.69**			18.8	17.74	17.53	17.62	18.1		16.89																	12.25	12.7						21.0	12.3	18.1	**18.2**
LC2 - Q2 2007		118.3																																	15.4	11.7	13.5	**13.4**
LC2 - Q3 2009		**119.5**			9.74	10.03																													10.0	9.7	9.9	**9.9**
LC3 - Q2 2007		114.16																																	9.2	3.2	6.9	**7.6**
LC3 - Q3, 2009		**123.9**			6.86	5.9	6.09	8.72	9.22		6.79										6.319							6.14	6.32				8.43		9.2	5.3	6.9	**6.3**
LC4 -Q3, 2008		106.5																																	16.9	16.9	16.9	**16.9**
LC4 -Q3, 2009		124.9																																	21.4	21.1	21.2	**21.2**
LC4 -Q3,2010		131.92			24.35	24.42	24.32	24.46	24.49																										24.5	24.3	24.4	**24.4**
LC4 -Q3, 2010		**133.92**									26.65																	17.38	21.44				26.59		26.7	17.4	23.0	**24.0**
* Unconfirmed																																🟧	error in field reading					

THE mOD DATA IN TABLE BELOW IS CA

BH REF			WATER LEVEL (m OD Malin)																										WATER LEVEL (m OD Malin)						WATER LEVEL (m OD Malin)			
			Jun-10	Jun-10	Sep-10	Dec-10	Feb-11	Jun-11	Sep-11	Dec-11	Mar-12	Jun-12	Jul-12	Jul-12	Jul-12	Jul-12	Jul-12	Jul-12	Jul-12	Aug-12	Aug-12	Aug-12	Sep-12	Sep-12	Oct-12	Nov-12	Nov-12	Dec-12	Apr-13	Jun-13	Jul-13		Sep-13	Nov-13	MAX	MIN	AVERAGE	MEDIAN
BH-4																																			96.3	91.9	93.9	**93.7**
BH-4A			91.96	91.96	91.96	91.96	91.96	91.96	91.96	91.96	91.96	91.96	91.96	91.96		91.96			91.96		91.96								91.96	91.96	92.95	93.63	93.54		93.6	92.0	92.1	**92.0**
BH-5			101.25	101.2	101.26	101.75	102.75	101.88	101.04	101.74		102.42	102.57	102.63		102.59			102.76		102.81	102.96	103	102.99	103.35	103.48	103.44	103.52		103.35			102.22		103.5	91.1	99.5	**101.2**
BH-6			117.31	117.31	117.31	117.31	117.31	117.31	117.31	117.31	117.31	117.31	117.31	117.31		117.31			117.31		117.31								117.31	117.31	117.82	117.78	117.52		117.8	116.8	117.3	**117.3**
BH-8			133.43	133.2	133.73	134.5	133.53	133.52	133	133.62	133.52	133.75	133.78	133.89		133.74		133.86	133.68	133.77	133.63	133.89	133.54	133.55	133.99	133.65	133.84	133.71	133.46	133.49		133.2	132.82		134.5	132.4	133.5	**133.5**
BH-9			105.76	105.57	104.59	105.41	107.47	105.27	104.18	104.76	106.11	106.09	106.4	106.68	106.66	106.66		107.02	106.82	107.18	107.01	107.17	107.23	107.26	107.6	107.92	107.88	108.09	109.17	107		101.75	105.4		109.2	101.0	105.1	**105.4**
BH-10																																			85.6	81.4	83.9	**84.1**
BH-10A			99.73	99.72	99.59	99.89	100.54	100.1	99.44	99.65			100.53	100.19		100.37					100.41	100.61	100.58	100.6	100.84	101.01	101.02	101.2	101.9	101.44		101.37	100.57		101.9	88.4	98.1	**99.9**
BH-11																																			100.1	90.5	95.3	**95.5**
BH-11A			98.49	98.47	98.48	98.49	98.47	98.41	98.37	98.4	98.4	98.43	98.46	98.46		98.45			98.42	98.54	98.44	98.45	98.46	98.45	98.44	98.47	98.46	98.43	98.46	98.45		98.5	98.46		100.0	93.4	98.1	**98.4**
BH-12			100.64	100.55	100.35	100.72	101.53	100.82	100.2	100.36	100.83	100.39	100.98	101.06		101.14		101.22		101.27	101.3	101.41	101.45	101.46	101.7	101.87	101.9	102.13	102.91	102.26		102.23	101.44		102.9	93.1	100.0	**100.7**
BH-13			108.38	110.53	108.78	111.39	112.86	111.7	111.61	112.67	113.51	113.46	113.58	113.82		113.99		114.11		114.53	114.43	114.82	114.88	114.96	115.55	115.86	116.49	117.11	118.37	121.46		122.57	112.25		122.6	108.1	112.9	**112.8**
BH-14			98.81	98.69	98.73	98.09	99.65	99.03	98.5	98.83	99.1		99.88	99.68		99.49		99.65	99.52	99.68	99.59	99.65	99.66	99.64	99.76	99.97	99.93	100.06	100.62	100.11		100.04	99.41		100.6	92.6	98.3	**98.8**
BH-15				99.52									100.06	100.1		100.19			100.19		100.28	100.39	100.4	100.38	100.57	100.72	100.74			101.1		101.05	100.36		101.1	99.5	100.2	**100.2**
BH-16				100.31									102.6	102.68		102.63		102.87		102.93	102.83	102.99	103.07	103.06						103.33		103.27	102.2		103.3	100.3	102.4	**102.6**
BH-17				100.58									101.52	101.49		101.57		101.65	101.52	101.7	101.6	101.83	101.79	101.74	102.03	102.19	102.24			102.47		102.37	101.53		102.5	100.4	101.5	**101.6**
BH-18				100.64									101.66	101.64		101.7	101.67		101.69	101.91	101.74	101.94	101.89	101.84	102.13	102.27	102.32			102.57		102.44	101.65		102.6	100.1	101.6	**101.7**
BH-19				101.65									103.01	103.06		103.14		103.24	103.16	103.29	103.17	103.33	103.4	103.33	103.65	103.79	103.74			103.41		103.37	102.38		103.8	101.7	102.9	**103.2**
BH-20				101.01									102.1	102.1		102.21		102.35		102.41	102.29	102.44	102.48	102.47			102.91			101.99		102.8	101.89		102.9	100.9	102.0	**102.1**
BH-24																														103.24		103.15	102.17		103.2	102.2	102.9	**103.2**
BH-25																														102.36		102.24	101.44		102.4	101.4	102.0	**102.2**
BH-26																														103.38		103.26	102.32		103.4	102.3	103.0	**103.3**
BH-27																														102.66		102.54	101.72		102.7	101.7	102.3	**102.5**
BH-28																														101.55		101.47	100.74		101.6	100.7	101.3	**101.5**
BH-29																														101.14		101.01	100.28		101.1	100.3	100.8	**101.0**
BH-30																														102.1		101.96	101.24		102.1	101.2	101.8	**102.0**
LC-1					114.89	115.95	116.16	116.07	115.59		116.8																	121.44	120.99						121.4	102.6	114.1	**114.9**
LC-2					109.76	109.47																													109.8	102.9	106.4	**106.5**
LC-3					117.04	118.00	117.81	115.18	114.68		117.11										117.58							117.76	117.58				115.47		118.6	104.9	114.6	**117.1**
LC-4					107.57	107.5	107.6	107.46	107.43		107.27																	116.54	112.48				107.33		116.5	103.5	108.0	**107.5**
Rock Cell Pond																																			100.3	96.7	98.3	**98.2**

Appendix 6: Copy of *Preliminary ELRA, CRAMP and Financial Provision for Proposed Integrated Waste Management Facility (W0129-03)* (May 2013)

(Submitted to the EPA on 21/05/13 and available for inspection at epa.ie)

MEHL

Preliminary ELRA, CRAMP and Financial Provision for Proposed Integrated Waste Management Facility (W0129-03)

May 2013

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Report Issue Form

IF-11B
Revision: 02 (21st July 2011)

Client Name: MEHL

Client Address: Hollywood Great, Nag's Head, Naul, Co. Dublin

Report Title: Preliminary ELRA, CRAMP and Financial Provision for Proposed Integrated Waste Management Facility (W0129-03)

Project Code: MU0120

Project Manager (Name): Louise O'Donnell

Project Manager (Sign): L O'Donnell

Project Manager (Date): 15th May 2013

Approved by Project Director (Name): Dr. Conor Tonra

Approved by Project Director (Sign):

Approved by Project Director (Date): 15th May 2013

Issue No.	Date	Status
01	15/05/2013	Final version. Issue to Client.

Notes/Comments:

Contents

Appendices

1.0 Introduction

1.1 About this Report

1.1.1 Patel Tonra Ltd., Environmental Solutions was commissioned by MEHL (Murphy Environmental Hollywood Limited) to assess the company's obligations for a proposed integrated waste management facility at Hollywood Great, Nag's Head, Naul, Co. Dublin, in relation to:

- Environmental Liability Risk Assessment (ELRA),
- Closure, Restoration and Aftercare Management Plan (CRAMP), and
- Financial Provision (FP)

1.1.2 The report was commissioned in January 2012 and a draft report was prepared. The EPA requested information relating to CRAMP and ELRA in an 'Article 16' notice in July 2012, as detailed in **Section 1.6**. This report has been updated to reflect the Article 16 notice.

1.1.3 The report is based on information pertaining to the proposed development set out in the planning and waste licence applications, and accompanying EIS. The report should be viewed as preliminary (in the context of a proposed development) and should be reviewed at the post-licensing/operational stage.

1.1.4 The approach adopted herein is based on EPA guidance currently in force[1].

1.1.5 Patel Tonra Ltd., Environmental Solutions prepared the EPA Waste Licence Application for the MEHL integrated waste management facility, and acted as project managers for the planning application and EIS process.

1.2 EPA Licence W0129-02

1.2.1 MEHL holds an EPA licence for the purpose of an inert landfill at Hollywood Great, Nag's Head, Naul, Co. Dublin (EPA Licence W0129-02). The site offers a strategically-located waste disposal facility for inert wastes and mildly contaminated soils.

1.2.2 The facility was first licensed by the EPA (as an inert landfill) in December 2002. The licensee was Murphy Concrete Manufacturing Ltd. Waste acceptance commenced in July 2003, following completion of the necessary infrastructural works.

1.2.3 W0129-02 was issued by the EPA in May 2008 to allow waste acceptance up to 500,000 tonnes per annum and to vary the landfill footprint of the facility (in line with the quarry footprint).

1.2.4 In October 2008, the licence transferred to *Murphy Environmental Hollywood Ltd.* (MEHL), following its establishment as a standalone limited company.

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[1] EPA (2006) *Guidance on Environmental Liability Risk Assessment, Residuals Management Plans and Financial Provision*

1.2.5 Under the terms of W0129-02, the licensee was required to complete and submit to the EPA assessments of (i) 'CRAMP' (Closure, Restoration & Aftercare Management Plan), (ii) ELRA (Environmental Liabilities Risk Assessment) and (iii) FP (Financial Provision). This report was completed in May 2010 (for the licence year 2009) on behalf of MEHL by Patel Tonra Ltd., Environmental Solutions.

1.3 EPA Licence Application W0129-03

1.3.1 MEHL made an application for a waste licence to the EPA in December 2010 to develop an integrated waste management facility within the existing boundaries of its existing facility for the landfilling of non-biodegradable inert, non-hazardous and hazardous wastes, including waste-to-energy residues. The proposed development will allow the former quarry to be restored to a natural landform.

1.3.2 The proposed development involves the construction of: a) specially engineered landfill cells for inert, non-hazardous and hazardous wastes; b) a solidification plant with associated storage tanks and silos; c) a storage building; d) an administration office building; e) new weighbridges; f) car parking; g) an ESB substation/switch room; h) internal haul routes; i) surface water ponds and leachate management facilities; j) a temporary viewing platform for visitors from which the geology of the quarry faces can be viewed, and k) ancillary site works and landscaping. A new facility entrance is also proposed from the County Road LP1080.

1.4 ELRA and CRAMP Requirements

Background

CRAMP = Closure, Restoration & Aftercare Management Plan
ELRA = Environmental Liabilities Risk Assessment
FP = Financial Provision

1.4.1 CRAMP, ELRA and FP are mutually dependent.[2]

1.4.2 Both the IPPC Directive, which was transposed into law under the Protection of The Environment Act of 2003, and the Landfill Directive make reference to the requirements to ensure that closure is adequately addressed. The IPPC Directive states that "the necessary measures are taken upon definitive cessation of activities to avoid any pollution risk and return the site of the operation to a satisfactory state." [3]

CRAMP/ELRA: EPA Guidance

1.4.3 The EPA published *Guidance on Environmental Liability Risk Assessment, Residuals Management Plans and Financial Provision* in 2006. This guidance document presents a systematic approach to the assessment and management of Environmental Liabilities in order to comply with IPPC and Waste Licence conditions for Environmental Risk Assessment (ELRA), Residual Management Planning (RMP) and Financial Provision (FP).

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[2] EPA (2006) *Guidance on Environmental Liability Risk Assessment, Residuals Management Plans and Financial Provision*, Page 8

[3] EPA (2006) *Guidance on Environmental Liability Risk Assessment, Residuals Management Plans and Financial Provision*, Page 17

1.4.4 A systematic step-wise approach is outlined in the EPA guidance document, as follows:

- Step 1: Initial Screening and Operational Risk Assessment
- Step 2: Preparation of a Closure, Restoration and Aftercare Management Plan (CRAMP) for known Liabilities
- Step 3: Environmental Liability Risk Assessment (ELRA) for unknown Liabilities
- Step 4: Identification of Financial Provision (FP) and Instruments

1.4.5 The following ELRA risks must be included at a minimum (if applicable):

- Leaks from above ground and below ground storage tanks
- Spillages from bund
- Leaks from process and effluent bunds
- Leaks from pipes
- Fire and failure/overspill from fire water storage at the facility
- Failures in landfill liner
- Escapes of landfill gas
- Tank overflows
- Mobile tanker spills on site
- Leaks from underground sumps

1.4.6 A closure plan should contain all of the following elements:[4]

Table 1.1: Closure Plan Requirements

Closure Plan Section	Section Contents
Introduction	▪ Facility and Licence Details ▪ Facility Closure Scenarios Covered in the Plan
Site Evaluation	▪ Facility Description & History – planning history EIS ▪ Facility Compliance Status ▪ Facility Processes and Activities ▪ Inventory of Site Buildings, Plant, Raw Materials and Wastes
Closure Considerations	▪ Clean or Non Clean Closure Declaration ▪ Plant or Equipment Decontamination Requirements ▪ Plant Disposal or Recovery ▪ Waste Disposal or Recovery ▪ Soil or Spoil Removal

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[4] EPA (2006) *Guidance on Environmental Liability Risk Assessment, Residuals Management Plans and Financial Provision,* Table 3.2, Page 20

Closure Plan Section	Section Contents
Criteria for Successful Closure	▪ Addressing of Site Environmental Liabilities at Closure
Closure Plan Costing	▪ Decontamination Costs ▪ Plant & Waste Disposal Costs ▪ On-going monitoring ▪ Facility Security and Staffing ▪ Other Costs
Closure Plan Update & Review	▪ Proposed Frequency of Review ▪ Proposed Scope of Review
Closure Plan Implementation	▪ EPA Notification ▪ Local or other Statutory Authority notifications ▪ Test Programme (If Applicable) ▪ Full or Partial Closure considerations
Closure Plan Validation	▪ Closure Validation Audit ▪ Closure Validation Audit Report ▪ Closure Validation Certificate

CRAMP: Waste Licence W0129-02 Requirements

1.4.7 EPA Waste Licence W0129-02 states the following:

10.8 Closure, Restoration & Aftercare Management Plan (CRAMP)

10.8.1 The licensee shall prepare for agreement by the Agency, a fully detailed and costed plan for the closure, restoration and aftercare of the site or part thereof, including details of the final profile.

10.8.2 The plan shall be maintained and reviewed annually and proposed amendments thereto notified to the Agency for agreement as part of the AER. No amendments may be implemented without the prior agreement of the Agency.

10.9 The National Parks and Wildlife Service shall be consulted as part of the preparation of the CRAMP regarding the presence of peregrine falcon nests at the site. The Agency shall be notified of the outcome of this consultation.

10.10 The CRAMP shall include as a minimum, the following:

- *A scope statement for the plan.*
- *The criteria, including those specified in this licence, which define the successful closure and restoration of the facility or part thereof, and which ensure minimum impact to the environment.*
- *A programme to achieve the stated criteria.*
- *Where relevant, a test programme to demonstrate the successful implementation of the plan.*
- *Details of any proposed or required aftercare supervision, monitoring, control, maintenance and reporting requirements for the restored facility.*
- *Details of the costings for the plan and the financial provisions to underwrite those costs.*

10.11 A final validation report to include a certificate of completion for the CRAMP, for all or part of the site as necessary, shall be submitted to the Agency within three months of execution of the plan. The licensee shall carry out such tests, investigations or submit certification, as requested by the Agency, to confirm that there is no continuing risk to the environment.

ELRA: Waste Licence W0129-02 Requirements

1.4.8 W0129-02 states the following in relation to ELRA:

Condition 12: Financial Charges and Provisions

12.2.1 The licensee shall as part of the AER provide an annual statement as to the measures taken or adopted at the site in relation to the prevention of environmental damage, and the financial provisions in place in relation to the underwriting of costs for remedial actions following anticipated events (including closure) or accidents/incidents, as may be associated with the carrying on of the activity.

12.2.2 The licensee shall arrange for the completion, by an independent and appropriately qualified consultant, of a comprehensive and fully costed Environmental Liabilities Risk Assessment (ELRA), which addresses the liabilities from past and present activities. The assessment shall include those liabilities and costs identified in Condition 10 for execution of the CRAMP. A report on this assessment shall be submitted to the Agency for agreement within twelve months of date of grant of this licence. The ELRA shall be reviewed as necessary to reflect any significant change on site, and in any case every three years following initial agreement: review results are to be notified as part of the AER.

12.2.3 As part of the measures identified in Condition 12.2.1, the licensee shall, to the satisfaction of the Agency, make financial provision to cover any liabilities identified in Condition 12.2.2. The amount of indemnity held shall be reviewed and revised as necessary, but at least annually. Proof of renewal or revision of such financial indemnity shall be included in the annual 'statement of measures' report identified in Condition 12.2.1.

12.2.4 Unless otherwise agreed, any revision to that part of the indemnity dealing with restoration and aftercare liabilities (refer Condition 10.8.1) shall be computed using the following formula:

Cost = (ECOST x WPI) + CiCC
Where:
cost = Revised restoration and aftercare cost.
ECOST = Existing restoration and aftercare cost.
WPI = Appropriate Wholesale Price Index [Capital Goods, Building & Construction (i.e. Materials & Wages) Index], as published by the Central Statistics Office, for the year since last closure calculation/revision.
CiCC = Change in compliance costs as a result of change in site conditions, changes in law, regulations, regulatory authority charges, or other significant changes.

1.5 Known and Unknown Liabilities

1.5.1 Environmental liabilities can be subdivided into two main types: known and unknown liabilities. The quantification and costing of these liabilities is conducted separately and different financial instruments are appropriate for each type of liability. **Table 1.2** outlines how these different liabilities are defined, quantified and should be provided for financially.[5]

Table 1.2: Outline of Environmental Liability Assessment

Liability Type	Definition	Quantification Method	Financial Instrument
Known Liability	Planned/anticipated liabilities associated with facility closure, restoration and aftercare management	Closure Restoration Aftercare Management Plan (CRAMP)	Cash based (Cash, Trust, Fund, Escrow, etc)
Unknown Liability	The risk of environmental liabilities occurring due to unexpected events (e.g. leaking chemical storage tank resulting in groundwater contamination)	Environmental Liability Risk Assessment (ELRA)	Risk transfer instruments (insurance, bonds etc) or combinations of these instruments

1.6 Article 16 Requirements

1.6.1 The EPA issued a notice in accordance with Article 16(1) of the Waste Management (Licensing) Regulations on 11th July 2012. Item #5 related to CRAMP, ELRA and financial provision, as follows:

5.1 In accordance with section 53(1) of the Waste Management Acts 1996 to 2011, please furnish particulars in respect of the ability of Murphy Environmental Hollywood Limited to meet the financial commitments or liabilities that will be entered into or incurred in carrying on the proposed activity and provide evidence that Murphy Environmental Hollywood Limited will be in a position to make financial provision that is adequate to discharge these financial commitments. Specifically:

a. Prepare a fully detailed and costed Closure, Restoration and Aftercare Management Plan (CRAMP) for the facility[6], to include as a minimum the following:

- *A scope statement for the plan.*
- *The criteria which define the successful closure and restoration of the facility or part thereof, and which ensure minimum impact to the environment.*
- *A programme to achieve the stated criteria.*
- *Where relevant, a test programme to demonstrate the successful implementation of the plan.*
- *Details of the long-term supervision, monitoring, control, maintenance and reporting requirements for the restored facility.*

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[5] EPA (2006) *Guidance on Environmental Liability Risk Assessment, Residuals Management Plans and Financial Provision*, Page 8

[6] Addressed in **Chapter 3** of this report.

- *Details of the costings for the plan and the financial provisions to underwrite these costs.*

b. Prepare a fully detailed and costed Environmental Liabilities Risk Assessment (ELRA)[7] *which addresses the liabilities and potential liabilities from past and proposed activities, including those liabilities and costs identified in the CRAMP. The assessment should include consideration of potential liabilities as may arise from legal actions alleging the supply of pyrite-containing stone.*[8] *Provide evidence that the assessment was prepared or reviewed, and was found to be complete and accurate, by an independent and appropriate qualified consultant or expert.*[9]

c. Provide a proposal for financial provision to cover any liabilities associated with the operation and identified in the ELRA[10] *(including closure, restoration and aftercare and unanticipated accidents, incidents and liabilities). Provide evidence that Murphy Environmental Hollywood Limited will be in a position to put such financial provision in place in the event that a waste licence is granted and prior to development works commencing.*[11]

The preparation of the CRAMP and ELRA and evaluation of the amount and form of financial provision should have regard to Environmental Protection Agency guidance including Guidance on Environmental Liability Risk Assessment, Residuals Management Plans and Financial Provision (2006).[12]

5.2 Provide information on the mechanism for setting landfill gate fees such that the requirements of section 53A of the Waste Management Acts 1996 to 2011 are met.[13]

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[7] Addressed in Chapter 4 of this report.

[8] Murphy Environmental Hollywood Ltd. has never been involved in the supply of quarry materials; therefore this item is not considered relevant in the context of this report.

[9] This report has been prepared by Patel Tonra Ltd., Environmental Solutions, using the prescribed EPA guidance, and using the methodology detailed in the report.

[10] Addressed in **Chapter 5** of this report.

[11] Subject to agreement by the Agency, Financial Provision arrangements will be put in place, as outlined in **Chapter 5** of this report, which will be legally binding and will demonstrated to the satisfaction of the Agency as being in place prior to the acceptance of waste under the terms of any future Waste Licence W0129-03.

[12] The EPA guidance note, and methodology outlined therein, has been robustly referenced throughout this report.

[13] Addressed in **Section 5.6** of this report.

2.0 Initial Screening and Operational Risk Assessment

2.1 Introduction

2.1.1 This section outlines the initial screening and operational risk assessment outlined in EPA (2006) *Guidance on Environmental Liability Risk Assessment, Residuals Management Plans and Financial Provision*

2.2 Complexity

2.2.1 The proposed integrated waste management facility makes provision for specially engineered landfill for hazardous, non-hazardous and inert wastes. This is deemed to be a 'G5' level of complexity[14].

2.2.2 Operations to which a complexity level of 'G5' is assigned are deemed to be 'Category 3' risk, based on initial screening and operational risk assessment[15].

2.2.3 The relevant steps of CRAMP, ELRA and FP for a Risk Category 3 facility have therefore been followed, in accordance with EPA guidance.

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[14] EPA (2006) *Guidance on Environmental Liability Risk Assessment, Residuals Management Plans and Financial Provision*, Page 11

[15] EPA (2006) *Guidance on Environmental Liability Risk Assessment, Residuals Management Plans and Financial Provision*, Page 12

3.0 CRAMP (Closure, Restoration, Aftercare Management Plan)

3.1 Scoping CRAMP

3.1.1 The proposed MEHL integrated waste facility is classified as Risk Category 3. During the operational lifetime of the landfill, restoration activities will be active on an ongoing and phased basis. The site will be subject to long-term monitoring in its aftercare phase.

3.1.2 Category 3 facilities, in accordance with EPA guidance, require a Closure Plan and a Restoration, Aftercare Management Plan. The requirements of both plans are addressed jointly in the CRAMP report.

3.2 CRAMP Introduction

3.2.1 The outline contents of the Closure Plan and the Restoration and Aftercare Management Plan are detailed in the EPA Guidance Note[16], as follows:

- Introduction
- Site Evaluation
- Restoration and Remediation Proposals
- Closure Considerations
- Criteria for Successful Closure
- CRAMP Update and Review
- CRAMP Implementation and Validation
- Aftercare Management
- CRAMP Costing

3.2.2 The report is prepared for MEHL, Hollywood Great, Nag's Head, Naul, Co. Dublin for a proposed integrated waste management facility. The application for the proposed development is subject to EPA assessment; EPA licence ref. W0129-03.

3.2.3 The Closure Plan is proposed on the basis of full restoration of the landfill site, decommissioning of plant and equipment and aftercare monitoring at the facility.

3.3 Site Evaluation

Facility Description and History

3.3.1 See **Sections 1.2** and **1.3**. A proposed site layout plan is attached as **Figure 1**.

Facility Compliance Status

3.3.2 The facility has a good record of compliance under W0129-02. There is no compliance history under W0129-03 as the application remains at assessment stage.

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[16] EPA (2006) *Guidance on Environmental Liability Risk Assessment, Residuals Management Plans and Financial Provision*, Tables 3.2 and 3.3

3.3.3 In accordance with W0129-02, MEHL is required to conduct regular monitoring to ensure that no environmental impact is occurring as a result of site operations. All monitoring reports are submitted to the EPA, and summaries are publicly available at www.mehl.ie. Monitoring of the following is conducted: noise, dust, surface water, groundwater, leachate and meteorology.

3.3.4 To-date, environmental monitoring results have generally been in compliance with licence and regulatory requirements. There have been exceedances for some metals (e.g. manganese and arsenic), associated with the geology of the site. There is also some indication of background agricultural-type contamination present in the local waters. A full record of all monitoring results is retained on site by MEHL, in the form of a Monitoring Database, which is updated quarterly.

3.3.5 The monitoring programme for the integrated waste management facility will be updated in line with Waste Licence requirements.

3.3.6 MEHL has put in place an Environmental Management System (EMS) at the facility. The EMS is independently certified to ISO14001:2004 (since 2004). The EMS will be updated and extended to include the activities of the integrated waste management facility within its scope.

Facility Processes and Activities

3.3.7 MEHL proposes to develop an integrated waste management facility within the existing boundaries of its existing facility for the landfilling of non-biodegradable inert, non-hazardous and hazardous wastes, including waste-to-energy residues. The proposed development will allow the former quarry to be restored to a natural landform.

3.3.8 The design of the liner and capping systems for each landfill class varies according to international best practice and EPA guidance, and under the EU Landfill Directive 1999. The landfill cells are to be constructed from a minimum formation level of 102.5m within the existing quarried void. Higher ground levels surrounding the quarry void will screen the construction and landfill operations.

3.3.9 The following classes of activity are proposed for the MEHL integrated waste management facility application:

Licensed Waste Disposal Activities, in accordance with the Third Schedule of the Waste Management Acts 1996 to 2010

- **Class 1: Deposit on, in or under land (including landfill):** This activity relates to the deposition of inert material.
- **Class 5: Specially engineered landfill, including placement into lined discrete cells, which are capped and isolated from one another and the environment:** This is the principal activity. It is proposed that the facility will accept a range of non-biodegradable waste streams which fall within the following classes of landfill: landfill for hazardous waste, landfill for non-hazardous waste and landfill for inert waste, as specified under the EU Landfill Directive (1999).
- **Class 7: Physico-chemical treatment not referred to elsewhere in this Schedule which results in final compounds or mixtures which are disposed of by means of any activity referred to in paragraphs 1 to 5 or paragraphs 8 to 10 of this Schedule (including evaporation, drying and calcinations):** This activity relates to the proposed Solidification Plant, which will pre-treat (by means of a solidification process) certain hazardous wastes prior to landfilling.

- **Class 13: Storage prior to submission to any activity referred to in a preceding paragraph of this Schedule, other than temporary storage, pending collection, on the premises where the waste concerned is produced:** This activity includes temporary storage of incoming wastes pending Third Schedule, Class 7 activity; and the storage of unacceptable wastes in a designated area pending their dispatch to appropriate disposal facilities.

Licensed Waste Recovery Activities, in accordance with the Fourth Schedule of the Waste Management Acts 1996-2010

- **Class 3: Recycling or reclamation of metals and metal compounds:** This activity provides for the recovery of metal within wastes delivered to the facility.
- **Class 4: Recycling or reclamation of other inorganic materials:** This activity includes the recovery of inert material for use in site development and site restoration works.
- **Class 13: Storage of waste intended for submission to any activity referred to in a preceding paragraph of this Schedule, other than temporary storage, pending collection, on the premises where such waste is produced**: This activity includes the storage of wastes for recovery purposes at this facility (e.g. stockpiles of soil) and the temporary storage of materials (e.g. metals), pending their dispatch to appropriate off-site recovery facilities.

3.3.10 It is proposed that the principal activity licensed under W0129-02 will remain the same for the purpose of the proposed development, i.e. Class 5, specially engineering landfill. The application proposes engineered landfill disposal capacity for non-biodegradable inert, non-hazardous and hazardous wastes. Third Schedule, Class 7 (physico-chemical treatment) is proposed for the purpose of operation of a solidification plant on site – this is the only additional class of activity proposed, which is not already licensed under W0129-02.

Seveso II Directive

3.3.11 Calculations show that the total inventory of Flue Gas Treatment (FGT) residue (ash) proposed to be accepted/temporarily stored at the MEHL Solidification Plant process is sufficient to qualify as a lower tier site. A notification has been made to the Health & Safety Authority under the European Communities (Control of Major Accidents involving Dangerous Substances) Regulations 2006.

Potential Impact on Natura 2000 Sites

3.3.12 The Environmental Liability Directive (2004/35/CE) considers environmental damage to water, land and "*damage to protected species and natural habitats, which is any damage that has significant adverse effects on reaching or maintaining the favourable conservation status of such habitats or species*".

3.3.13 The EIS for the proposed integrated waste management facility at Hollywood included an Appropriate Assessment (Screening) under the European Communities (Natural Habitats) Regulations, 1997, as well as full Flora & Fauna studies under EIS requirements.

3.3.14 The EIS concludes that there will be no direct impacts on any designated areas for conservation, due to the distance (>2.5km) of the nearest designated conservation areas from the MEHL site.

3.3.15 The EIS notes the loss of habitat for peregrine falcon nesting and roosting; however it is noted that this impact is anticipated under existing operations, and as a direct result of the necessity to infill and restore the quarry. In this context, the loss of habitat has not been included in CRAMP costs.

Site Buildings

3.3.16 Proposed site buildings are as follows:

- Solidification plant
- Storage building
- Administration office building
- ESB substation/switch room

Plant and Infrastructure

3.3.17 Proposed plant/infrastructure items are as follows:

- Specially engineered landfill cells for inert, non-hazardous and hazardous wastes
- Storage tanks and silos (at solidification plant)
- Weighbridges
- Wheelwash
- Car parking
- New facility entrance
- Internal haul routes
- Services and lighting
- Sewage and surface water drainage infrastructure
- Surface water ponds and leachate management facilities
- A temporary viewing platform for visitors from which the geology of the quarry faces can be viewed
- Various vehicles, e.g. loaders, bulldozers, rollers

Raw Materials

3.3.18 It is envisaged that the solidification process will use cement (or replacement binding materials, as appropriate), acid and water. 1 No. cement silo will be provided at the solidification plant, with capacity of 78m^3; equivalent to approximately 117 tonnes. 2 No. bunded acid tanks will be provided at the solidification plant, with capacity of 2 x 30m^3; equivalent to approximately 72 tonnes. Hydrochloric acid (HCl) is the preferred acid type.

3.3.19 It is proposed to install a 7,500 litre diesel tank for site machinery, to be stored in a bunded and roofed storage building. It is proposed to construct this building adjacent to the solidification yard. The existing fuel storage area will be decommissioned when the new fuel storage area has been installed.

Wastes

3.3.20 Waste generation associated with operations of the proposed integrated waste management facility is anticipated to be minimal. General municipal-type waste and recyclables will be generated as a result of office and staff mess facilities.

Small volumes of non-acceptable waste/recyclables may be required to be removed off-site, comprising materials removed from incoming C&D-type waste. Only permitted/licensed waste collectors and facilities, with EPA pre-approval, will be used for removal off-site.

3.3.21 It is proposed that leachate generated on-site will be re-used within the solidification plant, with excess to be removed off-site to an appropriately licensed facility, as required.

3.4 Restoration and Remediation Proposals

3.4.1 The proposed development will effect the restoration of a worked-out quarry in keeping with the surrounding landscape, and in line with pre-quarrying levels. A phased restoration approach is proposed for the MEHL integrated waste management facility, which will allow the site to be restored progressively over the lifetime of the project. As part of the restoration process, as each cell is filled to required restoration levels, capping layers will be applied, in line with requirements for inert, non-hazardous and hazardous cells.

Landfill Cells

3.4.2 It is proposed to construct hazardous (1,735,500 m^3), non-hazardous (1,324,000 m^3) and inert (755,500 m^3) landfill cells; see **Table 3.1**. The hazardous waste cells will be sited in the northern part of the existing quarry. The non-hazardous cell will be located in the southern part of the site and the inert cells to the west (Proposed Site Layout Drawings were included in Waste Licence Application as *PP-WLA-03-01*).

Table 3.1: Proposed Void Capacities

	Cell Ref.	Phase	Void Capacity (m^3)	Subtotal (m^3)
Hazardous	H1	1	327,000	**1,735,500**
	H2	2	652,000	
	H3	3	756,500	
Non-hazardous	NH1	2	1,070,000	**1,324,000**
	NH2	4	254,000	
Inert	IN1	1	853,000	**755,500**
	IN2	2	271,500	
	IN3	3	165,500	
	IN1	-	- 534,500 *	
			TOTAL:	**3,815,000**

* 534,500m^3 to be re-located to IN1 from existing inert waste cells on site

Phasing

3.4.3 The landfill will be constructed in four phases (the preliminary proposed phasing programme for the facility was detailed in Waste Licence Application in *Appendix D.2.2*; Proposed Phasing Layout Drawings were included in Waste Licence Application as *PP-WLA-14-01*; Proposed Site Restoration Drawings were included in Waste Licence Application as *PP-WLA-15-01*).

3.4.4 The actual phasing will depend on the volumes of appropriate waste generated over the lifespan of the project, which is influenced by a number of factors, including waste policy and economic conditions.

3.4.5 The hazardous cells will be constructed and restored over three phases. The construction works will be phased moving from the north to the south of the site. The final restoration of each hazardous cell will commence when filling is completed.

Final Restoration

3.4.6 The final restoration will comprise the demolition and recycling of the administration building, electrical substation, car-parking area, lighting standards and road pavement. During the final restoration, non-hazardous waste cell NH2 and inert waste cell IN1 will be capped and restored.

3.4.7 The maximum restored level will be 148m OD Malin near the existing entrance on the western boundary. Restoration levels will slope from the east and north of the highest point to match the surrounding ground levels and a typical slope of 1 in 10 is anticipated. It is proposed to restore the site to amenity / nature usage.

3.4.8 The position of both surface water drains and hedgerows on site mark the location of inert, non-hazardous and hazardous areas. This will assist with the identification of inert, non-hazardous and hazardous areas on site in addition to site survey records.

3.4.9 The leachate and surface water collection infrastructure will be retained after the final restoration. This infrastructure consists of leachate monitoring wells, leak detection wells, leachate holding tanks and any other monitoring infrastructure in order to meet EPA requirements for aftercare and monitoring.

3.5 Closure Considerations

Clean or Non-Clean Closure

3.5.1 The EPA defines 'clean' and 'non-clean' closure as follows:

- Clean Closure – upon cessation of operations and subsequent decommissioning at the facility, there are no remaining environmental liabilities
- Non-Clean Closure – upon cessation of operations and subsequent decommissioning – there are remaining liabilities, which require a restoration and aftercare management plan

3.5.2 As the proposed activity includes the landfilling of hazardous wastes, upon cessation of operations, there will be remaining liabilities, which require a restoration and aftercare management plan, i.e. the 'non-clean' closure criteria apply.

Plant or Equipment Decontamination Requirements

3.5.3 The items which may be required to be decontaminated (i.e. plant which has been in direct contact with hazardous wastes on-site) upon closure are:

- Silos at the solidification plant (4 No.)
- Acid tanks at the solidification plant (2 No.)
- Mixing unit and hosing at the solidification plan

Plant Disposal or Recovery

3.5.4 Mobile plant will be sold. Fixed plant and buildings will be decommissioned/ demolished and sold for reuse/recovered.

Waste Disposal or Recovery

3.5.5 Strict waste acceptance criteria will be applied during the lifetime of the facility to ensure that only conforming wastes are accepted at the facility.

3.5.6 No significant waste volumes are anticipated upon site closure. Any municipal-type waste will be removed off-site in accordance with legal and regulatory requirements.

Soil or Spoil Removal

3.5.7 It is not anticipated that soil/spoil will be generated at part of site closure activities. There will be no contaminated ground or spoil that requires specialist treatment on cessation of activities at the facility. No residual materials will remain.

3.6 Criteria for Successful Closure

3.6.1 MEHL has established the following criteria for the successful closure of the facility:

- The site has been restored in a manner fitting the surrounding landscape; final capping, grassing and planting has been completed across all areas
- Site buildings and related services and infrastructure have been decommissioned/demolished, as appropriate, and materials have been moved off-site for recovery
- All plant and equipment has been safely decontaminated or decommissioned and removed off-site, as appropriate
- Site security measures are in place
- Leachate and surface water collection infrastructure has been checked and verified and an aftercare maintenance programme agreed
- Monitoring points have been checked and verified and an aftercare monitoring programme agreed
- The Environmental Management System has been actively implemented during the closure period
- All relevant site records, including monitoring data, have been managed appropriately retained in an off-site location
- A Verification Audit / Certification has been independently completed on behalf of the operator and associated report submitted to the Agency
- Financial provision has been updated and agreed with the Agency
- CRAMP has been agreed formally with the Agency
- Other notice parties (e.g. the neighbouring community, the local authority) are informed of CRAMP status

3.7 CRAMP Update and Review

3.7.1 It is proposed that the CRAMP will be reviewed in line with licence requirements (typically once per annum as part of the Annual Environmental Report).

3.7.2 Progress on restoration of cells shall be reported annually as part of the Annual Environmental Report.

3.7.3 CRAMP will be reviewed in the event of a significant amendment to site activities.

3.7.4 Drawdown of financial provision sums will be recorded as per **Section 5.5**.

3.8 CRAMP Implementation and Validation

3.8.1 CRAMP implementation will be on the following basis:

a) CRAMP will be effected on an ongoing basis during the operational lifetime of the landfill, in line with the indicative phasing plan outlined in **Section 3.4**.

b) Closure activities upon cessation of waste activities and facility decommissioning at the facility's end-of-life

c) Implementation of the aftercare management programme

Phased Restoration during Operational Lifetime

3.8.2 MEHL proposes that ongoing/phased CRAMP activities during the operational lifetime of the landfill will be addressed under SEW[17]/CQA[18] processes and procedures, as prescribed by an EPA Waste Licence.

3.8.3 In line with the requirements of W0129-02 (or as may amended by any future Waste Licence), this would mean that restoration of cells/sub-cells would be subject to the following:

- A proposal to restore an area is submitted to the Agency for its agreement at least two months in advance of the intended date of commencement of restoration works.
- Restoration works are supervised by an appropriately qualified person, and that person, or persons, shall be present at all times during which relevant works are being undertaken.
- Following the completion of restoration works, a Construction Quality Assurance validation will be completed. The validation report will include:
  - A description of the works
  - As-built drawings of the works
  - Records and results of all tests carried out
  - Drawings and sections showing the location of all samples and tests carried out
  - Name(s) of contractors/individual(s) responsible for undertaking the restoration works

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[17] SEW = Specified Engineering Works

[18] CQA = Construction Quality Assurance

  - Records of any problems and the remedial works carried out to resolve those problems
  - Any other information requested in writing by the Agency

3.8.4 It is proposed that draw-down of restoration funds (under Financial Provision) is also allayed to the SEW/CQA model, as further discussed in **Section 5.5**.

CRAMP at the facility's end-of-life

3.8.5 Upon cessation of waste activities at the facility, decommissioning and demolition activities will be carried out, as detailed in the previous sections.

3.8.6 An independent verification audit will be completed to verify that all closure criteria have been adequately addressed and the closure phase will be agreed with the Agency. The independent audit will include a soil/groundwater investigation/verification by an appropriately-qualified and experienced hydrogeologist.

3.8.7 It is anticipated that the EPA will conduct its own post-closure audit of the facility also.

Implementation of the aftercare management phase

3.8.8 See **Section 3.9** below.

3.9 Aftercare Management

3.9.1 It is anticipated that future after-use will be for low-impact amenity, nature area, or related uses. The Fingal County Development Plan (2005-2011) states the Council's vision for this area: *"In recognition of the amenity potential of these areas, opportunities to increase public access will be sought".*

3.9.2 The length of the aftercare period will vary from site to site; however, the holder of a landfill waste licence will be responsible for the aftercare of the site up until the date when the Agency accepts the surrender of the waste licence as specified under section 48 of the Waste Management Act, 1996.[19]

3.9.3 Aftercare management of the integrated waste management facility once the lands have been restored, grassed and planted, as appropriate, will include:

- Maintenance of grassland, hedges and planted areas
- Leachate management
- Inspections and surveys of the drains, surface water management and land surface
- Maintenance of infrastructural installations, including pathways, access points and signposting, fencing and security
- Monitoring (detailed in **Section 3.9.7**)

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[19] EPA (1999) Landfill Manual: Landfill Restoration and Aftercare

3.9.4 The following pollution control systems will be maintained and protected during the aftercare period:

- the leachate management system
- the landfill capping system including drainage system
- surface water collection, storage and discharge systems
- groundwater monitoring boreholes
- leachate monitoring wells
- hazardous cell leak detection points
- surface water monitoring points
- any other items required by the Agency

3.9.5 It is proposed that the aftercare programme at MEHL will be focused on a performance-based assessment of site conditions, i.e. using the aftercare monitoring programme to determine any potential facility-related environmental impacts. On the basis of favourable results of the aftercare the monitoring programme, it would be proposed to reduce the monitoring frequencies throughout the aftercare period, in line with after-care control and monitoring procedures specified by the Landfill Directive 1999.

3.9.6 The aftercare programme is proposed on the basis of:

- A five-year active aftercare management period, followed by: -
- A five-year passive aftercare management period, followed by: -
- Additional aftercare management period, as appropriate, depending on results of the performance assessment

3.9.7 Aftercare monitoring requirements will be agreed with the EPA as part of a final closure plan. The monitoring programme will be put forward on the basis of active, passive and additional aftercare phases outlined above. The monitoring programme should prove that no impact is occurring and, on that basis, the monitoring programme will be scaled back throughout the aftercare period. Monitoring will include:

- Meteorological
- Groundwater levels
- Groundwater composition
- Leachate volume
- Leachate composition
- Surface water emissions – volume and composition
- Topographical survey/reading of any settling behaviour of the level of the landfill body

3.9.8 It is proposed that annual meetings would be held between MEHL and all relevant interested parties, such as local community representatives, planning and local authorities, wildlife groups, etc. for 5 years post-closure, as a minimum. Depending on aftercare reporting and consultation with the Agency, this consultation period may be extended.

3.10 CRAMP Costing

3.10.1 The CRAMP has been costed on the basis of 'best estimates' available at the time of writing. Costs items are based on data/extrapolations included in the planning and licensing applications and accompanying EIS. Unit cost rates have been sourced from: (i) direct experience, (ii) published sources, or (iii) EPA information. The costing exercise should be viewed as preliminary (in the context of a proposed development) and should be reviewed at the post-licensing/operational stage.

3.10.2 CRAMP costing estimates[20] are included in **Appendix 1**.

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[20] The 'NaDWaF' report provides a Restoration and Aftercare Cost for a hazardous landfill of €1.5 million. EPA (2010) *Technical and Economic Aspects of developing a National Difficult Waste Facility (NaDWaF)*, Page 14

4.0 Environmental Liabilities Risk Assessment (ELRA)

4.1 Introduction

4.1.1 Environmental liability risk assessment (ELRA) considers the risk of unplanned events occurring during the operation of a facility that could result in unknown liabilities materialising.

4.1.2 As discussed in **Section 2.2**, the proposed MEHL integrated waste management facility (EPA application ref. W0129-03) is classified as a Category 3 facility; therefore the generic approach for Category 3 facilities, as outlined in *Guidance on Environmental Liability Risk Assessment, Residuals Management Plans and Financial Provision* has been followed.

4.1.3 The scope of the ELRA covers environmental risks associated with the proposed integrated waste management facility, which could potentially lead to environmental liability.

4.2 Risk Identification

4.2.1 ELRA risks were identified by Patel Tonra Ltd., Environmental Solutions, based on their detailed understanding of the project elements included in the proposed integrated waste management facility at MEHL. Subsequently, a risk management workshop was held with Patel Tonra Ltd., the General Manager and Facility Manager of MEHL (2nd February 2012).

4.2.2 Risks were identified on a process-based approach, i.e. all proposed activities were examined in relation to potential environmental risks.

4.2 Risk Classification

4.2.1 Risk Classification Tables were applied, as per the EPA ELRA guidance document[21]. 'Occurrence' and 'Severity' were rated for each identified risk. 'Occurrence' is the probability of an event occurring. 'Severity' is the magnitude of impact if the event occurs.

4.3 Assessment of Risks

4.3.1 A Risk Register was prepared, on the basis of the severity and occurrence ratings. The Risk Register is included in **Appendix 2**.

4.3.2 Risks were tabulated in a Risk Matrix, as per **Appendix 3**. The Risk Matrix shows that there are no risks in the red zone requiring priority attention. There are no risks in the yellow/amber zone (these would indicate risks that require mitigation or management action. All risks are located in the light green zone, indicating a need for continuing awareness and monitoring on a regular basis.

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[21] EPA (2006) *Guidance on Environmental Liability Risk Assessment, Residuals Management Plans and Financial Provision*, Page 29

4.4 Risk Prevention/Mitigation

4.4.1 In assigning the 'occurrence' rating, due regard was given to mitigation measures/operational controls outlined in the EIS and Waste Licence Application. 'Severity' was assigned on a worst-case basis.

4.5 Risk Management Programme

4.5.1 Risks/potential environmental impacts have been identified and mitigation measures proposed in the EIS/Waste Licence Application for the proposed integrated waste management facility. A risk management programme will be further explored at the post-licensing stage, and in line with MEHL's Environmental Management System.

4.6 Quantification of Unknown Environmental Liabilities

4.6.1 A preliminary ELRA financial model is included in **Appendix 4**.

4.6.2 The ELRA has been costed on the basis of 'best estimates' available at the time of writing. Costs items are based on data/extrapolations included in the planning and licensing applications and accompanying EIS. Unit cost rates have been sourced from: (i) direct experience, (ii) published sources, or (iii) EPA information. The costing exercise should be viewed as preliminary (in the context of a proposed development) and should be reviewed at the post-licensing/operational stage.

4.6.3 The financial model is based on the application of a median probability and median cost range to each risk, as detailed in the EPA Guidance.

4.7 Review of Risk Assessment

4.7.1 It is proposed that the ELRA will be reviewed and updated in its entirety every 5 years, or sooner, if required.

4.7.2 ELRA will be reviewed in the event of a significant amendment to site activities.

4.7.3 The ELRA status shall be reported annually as part of the Annual Environmental Report.

5.0 Financial Provision (FP)

5.1 Introduction

5.1.1 The main objective of Financial Provision[22] is to ensure that sufficient financial resources are available to cover:

- Known environmental liabilities that will arise at the time of facility closure;
- Known environmental liabilities that are associated with the aftercare and maintenance of the facility until such time as the facility is considered to no longer pose a risk to the environment;
- Unknown environmental liabilities that may occur during the operating life of the facility.

5.1.2 Financial provision encompasses two aspects:

- Quantifying the financial amount of the environmental liabilities (known and unknown)
- Selecting appropriate financial instrument(s) to underwrite the liabilities.

5.2 Calculation of FP

5.2.1 The amount of financial provision required for the proposed MEHL integrated waste management facility (EPA application ref. W0129-03) has been determined using the CRAMP and ELRA assessment protocol outlined in this document.

5.2.2 **Appendix 5** summarises the financial provisions proposed for known and unknown liabilities relating to the proposed development.

5.3 Mechanism for FP

5.3.1 A licence holder is required to make adequate financial provision to cover the known and unknown costs associated with the operation of a facility, any potential liabilities that may arise and the cost of CRAMP during and after the cessation of operations at the facility.

5.3.2 There is a recognised vulnerability in making proper provision for ELRA and CRAMP where funds are held in an account or accounts owned and controlled by the licence holder company. Similarly there is a vulnerability in proposing insurance and or bonds to be acquired by the licence holder company for the purpose of addressing environmental liabilities or CRAMP as these instruments are useful only as long as the licence holder can maintain the premiums and or bond purchase and in the event that this ability was compromised in any way then the provisions themselves become compromised.

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[22] EPA (2006) *Guidance on Environmental Liability Risk Assessment, Residuals Management Plans and Financial Provision*, Page 37

5.3.3 MEHL proposes that provision should be made in a manner that tracks at all times the monetary value of said risks or CRAMP requirements and is retained in a manner which protects these funds from any third party access[23]. The proposed FP model seeks to:

1. Ensure such risks as described above are avoided.
2. Permit the funds to be retained well beyond the lifetime of the facility and/or the licence holder company for the on-going management and aftercare of the facility as long as is deemed appropriate.
3. Ensure that no matter the ultimate fate of the licence holder the money is beyond the reach of any potential creditors.
4. Give the EPA a direct oversight of the management and implementation of the funds over and above any statutory authority.

Proposed FP Model/Vehicle

5.3.4 In the absence of a prescriptive approach by the Agency in relation to the Financial Provision (FP) vehicle, MEHL hereby sets out a proposed approach for consideration and agreement with the Agency. Legal and contractual details will be addressed and implemented prior to the commencement of waste acceptance under any amended Waste Licence W0129-03.

5.3.5 MEHL proposes that a legal instrument is set up to be known as 'H.E.R.A.L.D. Ltd.' (Hollywood Environmental, Restoration and Liabilities Depository Co. Ltd.)[24]. The purpose of 'H.E.R.A.L.D. Ltd.' is to act as a vehicle to receive, retain and where appropriate distribute funds for the purpose of addressing known or as yet unknown liabilities, purchase of insurances and/or bonds and the accumulation of cash funds to address financial requirements identified through the CRAMP and ELRA models [when required] as revised from time to time in accordance with EPA instructions and the conditions of the licence. MEHL proposes that such a vehicle would be managed by nominated parties representing the licence holder and the EPA or such other authority as may be nominated or described as the authority responsible for the control and monitoring of the said licence.

5.3.6 'H.E.R.A.L.D. Ltd.' would receive funds from the licence holder into its hands for the sole and exclusive purpose of discharging costs, fees, premiums and expenses associated with the ELRA and/or CRAMP provisions appropriate to this licence [if granted]. 'H.E.R.A.L.D. Ltd.' would remain impenetrable from the licence holder or other third parties who might otherwise claim a vested interest in the licence holder's assets and seek to secure a lien on said funds on that basis. MEHL would effectively be settling an invoice monthly between itself and the 'vehicle company' for the purchase of financial provision under CRAMP and/or ELRA.

5.3.7 The memorandum and articles of association of 'H.E.R.A.L.D. Ltd.' would be prescriptive and constrain very specifically the purpose of the vehicle such that it could only operate to achieve the objectives set out above. The Memorandum and Articles of association would be constructed in such a manner as to allow for the routine rotation of the Board of Directors with an agreed balance of representation nominated by both the licence holder and the EPA. Suitably qualified persons would be asked to take the places on the Board of Directors to discharge the obligations of the Board which would be described in the licence, all laws relevant to a company under the Companies Acts, the Waste Management Acts and the other Laws of Ireland and the EU as amended from time to time and also in the memorandum and articles of association of 'H.E.R.A.L.D. Ltd.'.

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[23] Parties including the licence holder who might seek to access these funds for purposes other than addressing the ELRA or CRAMP liabilities

[24] Subject to agreement/company registration.

5.3.8 Having considered the alternate options (such as a purpose trust) the proposed approach of establishing a purpose vehicle company, limited by guarantee, is considered to be an effective, efficient and cost-neutral option.

5.4 Draw-down of FP

5.4.1 It shall be agreed that the EPA is the sole consent authority for authorising draw-down of CRAMP funds.

5.4.2 MEHL proposes that drawdown of financial provision sums during the operational lifetime of the landfill will be aligned with SEW[25]/CQA[26] processes and procedures (detailed in **Section 3.8)**, as follows:

- **Proposed restoration works and outline costings** - A proposal to restore an area ('SEW proposal') is submitted to the Agency for its agreement at least two months in advance of the intended date of commencement of restoration works. This is accompanied by an outline costing of the proposed works for the Agency's agreement[27].
- **Restoration works** - Restoration works will be completed and supervised by an appropriately qualified person, and that person, or persons, shall be present at all times during which relevant works are being undertaken.
- **CQA Stage and drawdown of funds** - Following the completion of restoration works, a Construction Quality Assurance validation will be completed and made available for inspection by the Agency. Expenditure validation records for that phase of the restoration works will be made available for inspection by the Agency and it is proposed that a signed agreement will issue from the Agency for drawdown of funds[28].
- **Records of Financial Provision drawdown** – The licensee will maintain a model to note and record details of proposals made to EPA in relation to restoration works, date(s) of EPA approvals and actual draw-down details (dates and amounts).

5.5 S.53(A) Requirements re. setting of Landfill Gate Fees

5.5.1 The Landfill Directive and Section 53(A) of the Waste Management Act, 1996 (as amended) requires that the price charged for disposal of waste in a landfill must not be less than the total costs necessary for the three purposes set out in Section 53(A)(4).[29] These are:

- the costs incurred by the operator in the acquisition or development, or both (as the case may be), of the facility,
- the costs of operating the facility during the relevant period (including the costs of making any financial provision under section 53), and

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[25] SEW = Specified Engineering Works

[26] CQA = Construction Quality Assurance

[27] It is proposed that standardised pro-forma documents be drawn up, which address any appropriate legal requirements.

[28] It is proposed that standardised pro-forma documents be drawn up, which address any appropriate legal requirements.

[29] www.epa.ie (Apr. 2013)

- the estimated costs, during a period of not less than 30 years or such greater period as may be prescribed, of the closure, restoration, remediation or aftercare of the facility.

5.5.2 The licensee will ensure that the long-term aftercare of the facility (*inter alia*) will be considered and will be reflected in the charging structure during the operation of the facility.

5.5.3 MEHL will apply the EPA's bespoke landfill gate fees financial model for determining and reporting to the EPA compliance with Section 53(A).[30] The model will be completed and reported to the Agency prior to the acceptance of waste under any future revised Waste Licence W0129-03, and annually thereafter.

5.5.4 As W0129-03 proposals make provision for the acceptance of waste under three separate classes of landfill (inert, non-hazardous and hazardous), variable gate fees will apply, in line with the costs associated with the management and aftercare of different waste types.

5.5.5 It is noted that charging relates to the period of time from the date of commencement of waste disposal in the landfill to the predicted date of cessation of waste disposal in the landfill; but that costs include acquisition, development, closure, restoration, remediation and aftercare costs.[31] Details and records pertaining to costs, budgets and estimates will be fully documented by MEHL and independently verified, where necessary, in line with business and financial planning and management requirements.

5.5.6 In accordance with the EPA financial model, consideration of revenue and costs will include the following items (for example)[32]:

- Operating costs:
    - Staff
    - Monitoring and control
    - Administrative costs
    - Resources (electricity and fuel)
    - Data management and reporting
- Acquisition and development costs:
    - Land, roads, weighbridge, wheelwash, fencing, buildings, carpark
    - Drainage, interceptors, settlement ponds/lagoons, oil separators
    - Plant, machinery, vehicles
    - Monitoring infrastructure
    - Leachate tanks
    - Services (surface water, foul water, watermain, power)
    - Bunded oil storage
    - Waste quarantine area
    - Traffic management barriers
    - CCTV

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[30] The relevant returns have already been made by MEHL under the requirements of W0129-02.

[31] EPA (2013) S.53(A) Financial Model 2013

[32] EPA (2012) Landfill gate fee workshop (EPA presentation of 1st March 2012)

  - Alarms
  - Spill control equipment
  - Lighting
- Cell construction/development costs
  - Excavation and replacement of soft materials
  - Grading to formation levels
  - Embankments
  - Basal liner system
  - Leachate collection layer
  - Side slope risers
  - Capping costs - incurred & future
  - Leachate costs - incurred & future to close
- Restoration and aftercare costs:
- Leachate cost post closure
- Aftercare
- Monitoring
- Security

Appendix 1: Preliminary CRAMP Costing Estimates

MEHL Proposed Integrated Waste Management Facility
EPA Waste Licence Application W0129-03

Closure Costs (Preliminary Assessment)

#	Item	Estimated Cost (median)
1	Plant removal	€ 5,000
2	Decontamination	€ 23,520
3	Waste Disposal/recovery - Leachate pumping and tankering	€ 1,889,918
4	Demolition/decommissioning	€ 50,689
5	Environmental Monitoring - Aftercare Years 1-5	€ 60,000
5.1	Environmental Monitoring - Aftercare Year 5 onwards	€ 100,000
6	Verification Audit / Certification & Report to EPA	€ 50,000
7	Other items	
7.1	- Capping and drainage: hazardous	€ 2,103,825
7.2	- Capping and drainage: non-hazardous	€ 1,232,400
7.3	- Capping and drainage: inert	€ -
7.4	- Landscaping/planting and grass seed	€ 25,000
7.5	- General ongoing maintenance and aftercare, Aftercare Years 1-5	€ 40,000
7.6	- General ongoing maintenance and aftercare, Aftercare Year 5 onwards	€ 75,000
	Subtotal	€ 5,580,352
	Contingency	€ 558,035
	Total (excl. VAT)	**€ 6,138,387**

Appendix 2: Risk Register

MEHL Proposed Integrated Waste Management Facility
EPA Waste Licence Application W0129-03

Risk Register (Preliminary Assessment)

Risk ID	Activity/Process	Potential Environmental Risk	Potential Environmental Impact	Occurrence Rating [Note d]	Severity Rating [Note e]	Risk Score
W0129-03 Risk#01	Construction activities	Release of polluting substance	Surface water pollution	1	3	3
W0129-03 Risk#02	Construction activities	Release of polluting substance	Groundwater pollution	1	4	4
W0129-03 Risk#03	Construction activities	Release of polluting substance	Soil pollution	1	3	3
W0129-03 Risk#04	Site office/weighbridge	Fuel spillage	Surface water pollution	1	3	3
W0129-03 Risk#05	Site office/weighbridge	Fuel spillage	Groundwater pollution	1	4	4
W0129-03 Risk#06	Site office/weighbridge	Fuel spillage	Soil pollution	1	3	3
W0129-03 Risk#07	Site office/weighbridge	Hazardous waste spillage	Surface water pollution	1	3	3
W0129-03 Risk#08	Site office/weighbridge	Hazardous waste spillage	Groundwater pollution	1	4	4
W0129-03 Risk#09	Site office/weighbridge	Hazardous waste spillage	Soil pollution	1	3	3
W0129-03 Risk#10	Site office/weighbridge	Firewater (office)	Surface water pollution	1	3	3
W0129-03 Risk#11	Site office/weighbridge	Firewater (office)	Groundwater pollution	1	4	4
W0129-03 Risk#12	Site office/weighbridge	Firewater (office)	Soil pollution	1	3	3
W0129-03 Risk#13	Solidification process (pre-treatment, prior to landfilling, for certain hazardous wastes)	Hazardous waste spillage	Surface water pollution	1	3	3
W0129-03 Risk#14	Solidification process (pre-treatment, prior to landfilling, for certain hazardous wastes)	Hazardous waste spillage	Groundwater pollution	1	4	4
W0129-03 Risk#15	Solidification process (pre-treatment, prior to landfilling, for certain hazardous wastes)	Hazardous waste spillage	Soil pollution	1	3	3
W0129-03 Risk#16	Landfill operations: hazardous landfill cells	Failure of cell liner/leachate release	Surface water pollution	1	3	3
W0129-03 Risk#17	Landfill operations: hazardous landfill cells	Failure of cell liner/leachate release	Groundwater pollution	1	4	4
W0129-03 Risk#18	Landfill operations: hazardous landfill cells	Failure of cell liner/leachate release	Soil pollution	1	3	3
W0129-03 Risk#19	Landfill operations: non-hazardous landfill cells	Failure of cell liner/leachate contamination of local waters	Surface water pollution	1	3	3
W0129-03 Risk#20	Landfill operations: non-hazardous landfill cells	Failure of cell liner/leachate contamination of local waters	Groundwater pollution	1	4	4
W0129-03 Risk#21	Landfill operations: non-hazardous landfill cells	Failure of cell liner/leachate contamination of local waters	Soil pollution	1	3	3
W0129-03 Risk#22	Landfill operations: inert landfill cells	Failure of cell liner/leachate contamination of local waters	Surface water pollution	1	3	3
W0129-03 Risk#23	Landfill operations: inert landfill cells	Failure of cell liner/leachate contamination of local waters	Groundwater pollution	1	4	4
W0129-03 Risk#24	Landfill operations: inert landfill cells	Failure of cell liner/leachate contamination of local waters	Soil pollution	1	3	3
W0129-03 Risk#25	Leachate management	Rupture of leachate holding tank	Surface water pollution	1	3	3

MEHL Proposed Integrated Waste Management Facility
EPA Waste Licence Application W0129-03

Risk Register (Preliminary Assessment)

Risk ID	Activity/Process	Potential Environmental Risk	Potential Environmental Impact	Occurrence Rating [Note d]	Severity Rating [Note e]	Risk Score
W0129-03 Risk#26	Leachate management	Rupture of leachate holding tank	Groundwater pollution	1	4	4
W0129-03 Risk#27	Leachate management	Rupture of leachate holding tank	Soil pollution	1	3	3
W0129-03 Risk#28	Surface water management	Uncontrolled release of polluting substance	Surface water pollution	1	3	3
W0129-03 Risk#29	Surface water management	Uncontrolled release of polluting substance	Groundwater pollution	1	4	4
W0129-03 Risk#30	Surface water management	Uncontrolled release of polluting substance	Soil pollution	1	3	3
W0129-03 Risk#31	Wastewater management	Failure of on-site foul treatment	Surface water pollution	1	4	4
W0129-03 Risk#32	Wastewater management	Failure of on-site foul treatment	Groundwater pollution	1	4	4
W0129-03 Risk#33	Wastewater management	Failure of on-site foul treatment	Soil pollution	1	3	3
W0129-03 Risk#34	Fuel storage (located at Solidification Plant)	Tank/Bund failure/ leaks	Surface water pollution	1	3	3
W0129-03 Risk#35	Fuel storage (located at Solidification Plant)	Tank/Bund failure/ leaks	Groundwater pollution	1	4	4
W0129-03 Risk#36	Fuel storage (located at Solidification Plant)	Tank/Bund failure/ leaks	Soil pollution	1	3	3
W0129-03 Risk#37	Garaging and maintenance	Fuel/polluting substance spillage	Surface water pollution	1	3	3
W0129-03 Risk#38	Garaging and maintenance	Fuel/polluting substance spillage	Groundwater pollution	1	4	4
W0129-03 Risk#39	Garaging and maintenance	Fuel/polluting substance spillage	Soil pollution	1	3	3
W0129-03 Risk#40	Acid storage	Tank failure/ spillages/ leaks	Surface water pollution	1	3	3
W0129-03 Risk#41	Acid storage	Tank failure/ spillages/ leaks	Groundwater pollution	1	3	3
W0129-03 Risk#42	Acid storage	Tank failure/ spillages/ leaks	Soil pollution	1	3	3

Note d:

Rating	Category	Description
1	Very Low	Very low chance (0-5%) of hazard occurring in 30 yr period
2	Low	Low chance (5-10%) of hazard occurring in 30 yr period
3	Medium	Medium chance (10-20%) of hazard occurring in 30 yr period
4	High	High chance (20-50%) of hazard occurring in 30 yr period
5	Very High	Greater than 50% chance of hazard occurring in 30 yr period

Note e:

Rating	Category	Description
1	Trivial	No damage or negligible change to the environment
2	Minor	Minor impact/localised or nuisance
3	Moderate	Moderate damage to environment
4	Major	Severe damage to local environment
5	Massive	Massive damage to a large area, irreversible in medium term

Appendix 3: Risk Matrix

MEHL Proposed Integrated Waste Management Facility
EPA Waste Licence Application W0129-03

Risk Matrix (Preliminary Assessment)

			Risk ID (W0129-03 Risk#XY)				
Occurrence	**V. High**	**5**		🟩	🟨	🟥	🟥
	High	**4**		🟩	🟩	🟨	🟥
	Medium	**3**			🟩	🟩	🟨
	Low	**2**				🟩	🟩
	V. Low	**1**			#01, #03, #04, #06, #07, #09, #10, #12, #13, ##15, #16, #18, #19, #21, #22, #24, #25, #27, #28, #30, #33, #34, #36, #27, #39, #40, #41, #41, #42	#02, #05, #08, #11, #14, #17, #20, #23, #26, #29, #31, #32, #35, #38	
			Trivial	**Minor**	**Moderate**	**Major**	**Massive**
			1	**2**	**3**	**4**	**5**
			Severity				

Appendix 4: Preliminary ELRA Financial Model

MEHL Proposed Integrated Waste Management Facility
EPA Waste Licence Application W0129-03

Environmental Liabilities Risk Assessment (ELRA) (Preliminary Assessment)

	A	B	C	D	E	F	G		H	I	J
Risk ID	**Activity/Process**	**Potential Environmental Risk**	**Potential Environmental Impact**	**Likelihood of Occurrence Range (%)** **[Note c]**	**Occurrence Rating** **[Note d]**	**Severity Rating** **[Note e]**	**Cost Range**		**Median Probability** **[Median of D]**	**Median Cost Range** **[Median of G]**	**Most Likely Scenario Cost** **[H x I]**
							Min	**Max**			
W0129-03 Risk#01	Construction activities	Release of polluting substance	Surface water pollution	0-5	1	3	€361	€4,333	2.5%	€ 2,347	€ 59
W0129-03 Risk#02	Construction activities	Release of polluting substance	Groundwater pollution	0-5	1	4	€361	€4,333	2.5%	€ 2,347	€ 59
W0129-03 Risk#03	Construction activities	Release of polluting substance	Soil pollution	0-5	1	3	€3,305	€5,508	2.5%	€ 4,407	€ 110
W0129-03 Risk#04	Site office/weighbridge	Fuel spillage	Surface water pollution	0-5	1	3	€36	€433	2.5%	€ 235	€ 6
W0129-03 Risk#05	Site office/weighbridge	Fuel spillage	Groundwater pollution	0-5	1	4	€36	€433	2.5%	€ 235	€ 6
W0129-03 Risk#06	Site office/weighbridge	Fuel spillage	Soil pollution	0-5	1	3	€330	€551	2.5%	€ 441	€ 11
W0129-03 Risk#07	Site office/weighbridge	Hazardous waste spillage	Surface water pollution	0-5	1	3	€22	€3,305	2.5%	€ 1,663	€ 42
W0129-03 Risk#08	Site office/weighbridge	Hazardous waste spillage	Groundwater pollution	0-5	1	4	€44	€6,610	2.5%	€ 3,327	€ 83
W0129-03 Risk#09	Site office/weighbridge	Hazardous waste spillage	Soil pollution	0-5	1	3	€13,220	€22,033	2.5%	€ 17,626	€ 441
W0129-03 Risk#10	Site office/weighbridge	Firewater (office)	Surface water pollution	0-5	1	3	€1,102	€165,248	2.5%	€ 83,175	€ 2,079
W0129-03 Risk#11	Site office/weighbridge	Firewater (office)	Groundwater pollution	0-5	1	4	€3,608	€43,329	2.5%	€ 23,469	€ 587
W0129-03 Risk#12	Site office/weighbridge	Firewater (office)	Soil pollution	0-5	1	3	€16,525	€27,541	2.5%	€ 22,033	€ 551
W0129-03 Risk#13	Solidification process (pre-treatment, prior to landfilling, for certain hazardous wastes)	Hazardous waste spillage	Surface water pollution	0-5	1	3	€172	€25,779	2.5%	€ 12,975	€ 324
W0129-03 Risk#14	Solidification process (pre-treatment, prior to landfilling, for certain hazardous wastes)	Hazardous waste spillage	Groundwater pollution	0-5	1	4	€344	€51,557	2.5%	€ 25,951	€ 649
W0129-03 Risk#15	Solidification process (pre-treatment, prior to landfilling, for certain hazardous wastes)	Hazardous waste spillage	Soil pollution	0-5	1	3	€103,115	€171,858	2.5%	€ 137,487	€ 3,437
W0129-03 Risk#16	Landfill operations: hazardous landfill cells	Failure of cell liner/leachate release	Surface water pollution	0-5	1	3	€354,577	€16,237,701	2.5%	€ 8,296,139	€ 207,403
W0129-03 Risk#17	Landfill operations: hazardous landfill cells	Failure of cell liner/leachate release	Groundwater pollution	0-5	1	4	€354,577	€16,237,701	2.5%	€ 8,296,139	€ 207,403

MEHL Proposed Integrated Waste Management Facility
EPA Waste Licence Application W0129-03

Environmental Liabilities Risk Assessment (ELRA) (Preliminary Assessment)

	A	B	C	D	E	F	G		H	I	J
Risk ID	**Activity/Process**	**Potential Environmental Risk**	**Potential Environmental Impact**	**Likelihood of Occurrence Range (%)**	**Occurrence Rating**	**Severity Rating**	**Cost Range**		**Median Probability**	**Median Cost Range**	**Most Likely Scenario Cost**
				[Note c]	**[Note d]**	**[Note e]**	**Min**	**Max**	**[Median of D]**	**[Median of G]**	**[H x I]**
W0129-03 Risk#18	Landfill operations: hazardous landfill cells	Failure of cell liner/leachate release	Soil pollution	0-5	1	3	€1,623,770	€2,706,284	2.5%	€ 2,165,027	€ 54,126
W0129-03 Risk#19	Landfill operations: non-hazardous landfill cells	Failure of cell liner/leachate contamination of local waters	Surface water pollution	0-5	1	3	€107,693	€4,931,750	2.5%	€ 2,519,721	€ 62,993
W0129-03 Risk#20	Landfill operations: non-hazardous landfill cells	Failure of cell liner/leachate contamination of local waters	Groundwater pollution	0-5	1	4	€107,693	€4,931,750	2.5%	€ 2,519,721	€ 62,993
W0129-03 Risk#21	Landfill operations: non-hazardous landfill cells	Failure of cell liner/leachate contamination of local waters	Soil pollution	0-5	1	3	€493,175	€821,958	2.5%	€ 657,567	€ 16,439
W0129-03 Risk#22	Landfill operations: inert landfill cells	Failure of cell liner/leachate contamination of local waters	Surface water pollution	0-5	1	3	€48,536	€2,222,671	2.5%	€ 1,135,603	€ 28,390
W0129-03 Risk#23	Landfill operations: inert landfill cells	Failure of cell liner/leachate contamination of local waters	Groundwater pollution	0-5	1	4	€48,536	€2,222,671	2.5%	€ 1,135,603	€ 28,390
W0129-03 Risk#24	Landfill operations: inert landfill cells	Failure of cell liner/leachate contamination of local waters	Soil pollution	0-5	1	3	€222,267	€370,445	2.5%	€ 296,356	€ 7,409
W0129-03 Risk#25	Leachate management	Rupture of leachate holding tank	Surface water pollution	0-5	1	3	€1,801	€82,459	2.5%	€ 42,130	€ 1,053
W0129-03 Risk#26	Leachate management	Rupture of leachate holding tank	Groundwater pollution	0-5	1	4	€3,601	€164,918	2.5%	€ 84,259	€ 2,106
W0129-03 Risk#27	Leachate management	Rupture of leachate holding tank	Soil pollution	0-5	1	3	€329,835	€549,726	2.5%	€ 439,781	€ 10,995
W0129-03 Risk#28	Surface water management	Uncontrolled release of polluting substance	Surface water pollution	0-5	1	3	€329,164	€15,073,941	2.5%	€ 7,701,553	€ 192,539
W0129-03 Risk#29	Surface water management	Uncontrolled release of polluting substance	Groundwater pollution	0-5	1	4	€329,164	€15,073,941	2.5%	€ 7,701,553	€ 192,539
W0129-03 Risk#30	Surface water management	Uncontrolled release of polluting substance	Soil pollution	0-5	1	3	€0	€0	2.5%	€ -	€ -
W0129-03 Risk#31	Wastewater management	Failure of on-site foul treatment	Surface water pollution	0-5	1	4	€108	€4,957	2.5%	€ 2,533	€ 63
W0129-03 Risk#32	Wastewater management	Failure of on-site foul treatment	Groundwater pollution	0-5	1	4	€2,165	€99,149	2.5%	€ 50,657	€ 1,266
W0129-03 Risk#33	Wastewater management	Failure of on-site foul treatment	Soil pollution	0-5	1	3	€19,830	€33,050	2.5%	€ 26,440	€ 661
W0129-03 Risk#34	Fuel storage (located at Solidification Plant)	Tank/Bund failure/ leaks	Surface water pollution	0-5	1	3	€14	€162	2.5%	€ 88	€ 2

MEHL Proposed Integrated Waste Management Facility
EPA Waste Licence Application W0129-03

Environmental Liabilities Risk Assessment (ELRA) (Preliminary Assessment)

	A	B	C	D	E	F	G		H	I	J
Risk ID	**Activity/Process**	**Potential Environmental Risk**	**Potential Environmental Impact**	**Likelihood of Occurrence Range (%)**	**Occurrence Rating**	**Severity Rating**	**Cost Range**		**Median Probability**	**Median Cost Range**	**Most Likely Scenario Cost**
				[Note c]	**[Note d]**	**[Note e]**	**Min**	**Max**	**[Median of D]**	**[Median of G]**	**[H x I]**
W0129-03 Risk#35	Fuel storage (located at Solidification Plant)	Tank/Bund failure/ leaks	Groundwater pollution	0-5	1	4	€27	€325	2.5%	€ 176	€ 4
W0129-03 Risk#36	Fuel storage (located at Solidification Plant)	Tank/Bund failure/ leaks	Soil pollution	0-5	1	3	€2,479	€4,131	2.5%	€ 3,305	€ 83
W0129-03 Risk#37	Garaging and maintenance	Fuel/polluting substance spillage	Surface water pollution	0-5	1	3	€18	€217	2.5%	€ 117	€ 3
W0129-03 Risk#38	Garaging and maintenance	Fuel/polluting substance spillage	Groundwater pollution	0-5	1	4	€36	€433	2.5%	€ 235	€ 6
W0129-03 Risk#39	Garaging and maintenance	Fuel/polluting substance spillage	Soil pollution	0-5	1	3	€3,305	€5,508	2.5%	€ 4,407	€ 110
W0129-03 Risk#40	Acid storage	Tank failure/ spillages/ leaks	Surface water pollution	0-5	1	3	€33	€4,957	2.5%	€ 2,495	€ 62
W0129-03 Risk#41	Acid storage	Tank failure/ spillages/ leaks	Groundwater pollution	0-5	1	3	€66	€9,915	2.5%	€ 4,990	€ 125
W0129-03 Risk#42	Acid storage	Tank failure/ spillages/ leaks	Soil pollution	0-5	1	3	€19,830	€33,050	2.5%	€ 26,440	€ 661
							TOTAL				**€ 1,086,269**

Note d: **Note c:**

Rating	**Category**	**Description**	**Likelihood of Occurrence (%)**
1	Very Low	Very low chance (0-5%) of hazar	0-5
2	Low	Low chance (5-10%) of hazard o	5-10
3	Medium	Medium chance (10-20%) of haz	10-20
4	High	High chance (20-50%) of hazard	20-50
5	Very High	Greater than 50% chance of haza	>50

Note e:

Rating	**Category**	**Description**	**Cost of Remediation**
1	Trivial	No damage or negligible change t	€ A
2	Minor	Minor impact/localised or nuisanc	€ B
3	Moderate	Moderate damage to environmen	€ C
4	Major	Severe damage to local environm	€ D
5	Massive	Massive damage to a large area,	€ E

Appendix 5: Preliminary Financial Provision Calculations

MEHL Proposed Integrated Waste Management Facility
EPA Waste Licence Application W0129-03

Summary Financial Provision (Preliminary Assessment)

Liability Type	Amount	Financial Instrument
Known Liability – Closure, Restoration and Aftercare Management	**€6,138,387**	Cash-based deposit/trust fund/Escrow (accessible by EPA and by MEHL only with EPA consent)
Unknown Liability (ELRA)	**€1,086,269**	Bonds/insurance
TOTAL	**€7,224,656**	

Appendix 7: Copy of Site Layout Drawings (Existing and Proposed)

Extracted from Waste Licence Application, submitted to the Agency on 17/10/10 (available for inspection on epa.ie)

WASTE LICENCE APPLICATION

REPRODUCED IN ACCORDANCE WITH OSI LICENCE NO. EN 0004910

GENERAL NOTES:

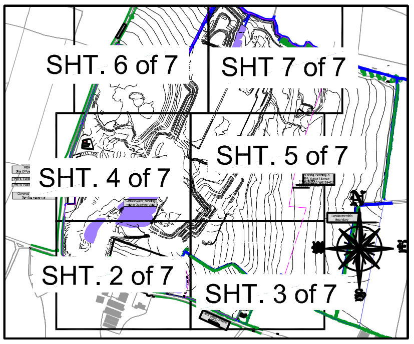
ALL LEVELS RELATE TO MALIN HEAD ORDNANCE DATUM.

ALL LEVELS TO BE CONFIRMED ON SITE BY MAIN CONTRACTOR PRIOR TO COMMENCEMENT.

DRAWING TO BE READ IN CONJUNCTION WITH ALL RELEVANT DRAWINGS.

DO NOT SCALE THIS DRAWING - USE FIGURED DIMENSIONS ONLY.

KEY PLAN :-



LEGEND:-

━━	Existing Landownership Boundary
– – – –	Existing Planning & EPA Waste Licence Boundary
127	Existing Ground Level Contour
+101.84	Existing Spot Level
▨	Existing Surface Water
• V	Existing Public Watermain Sluice Valve
▬ Hyd	Existing Public Watermain Hydrant
• RS	Existing Road Sign
● TP	Existing Telephone Pole
EP	Existing Electrical Pole & Overhead line
······	Existing Electrical Duct & Access Chamber
⋈	Existing Access Gate
─□─□─□─	Existing Fence (Various Types)
═	Existing Masonary Wall
≈≈≈	Existing Hedgerow
✚ BH4A	Monitoring Borehole
○ LC1	Leachate Monitoring Point
● SWD6	Surface Water Discharge Point
● SW1	Surface Water Monitoring Point

01	WASTE LICENCE APPLICATION	10.12.10	4 Projects
ver.	ammendment	date.	issued to.

Prepared For:

Murphy Environmental Hollywood Ltd

Client:

Project: MEHL INTEGRATED WASTE MANAGEMENT FACILITY

Location: HOLLYWOOD GREAT, NAG'S HEAD NAUL, CO. DUBLIN

Title: EXISTING SITE LAYOUT (SHEET 1 OF 7)

Project Name: PP	Drawing No. : 02	File Name: PP_WLA_02_01
Study Name: WLA	Version No. : 01	
Section: _	Date: 10 Dec. 2010	
WYG Job Number: C007831		SCALE: A1(1:2000)/A3(1:4000)
Created By: CF	Reviewed By: JD	Signed Off By: HB

Prepared by:

Old Bridge House,
Strand Street,
Athlone,
Co.Westmeath.

Tel: (090) 6474264.
Fax: (090) 6478422.
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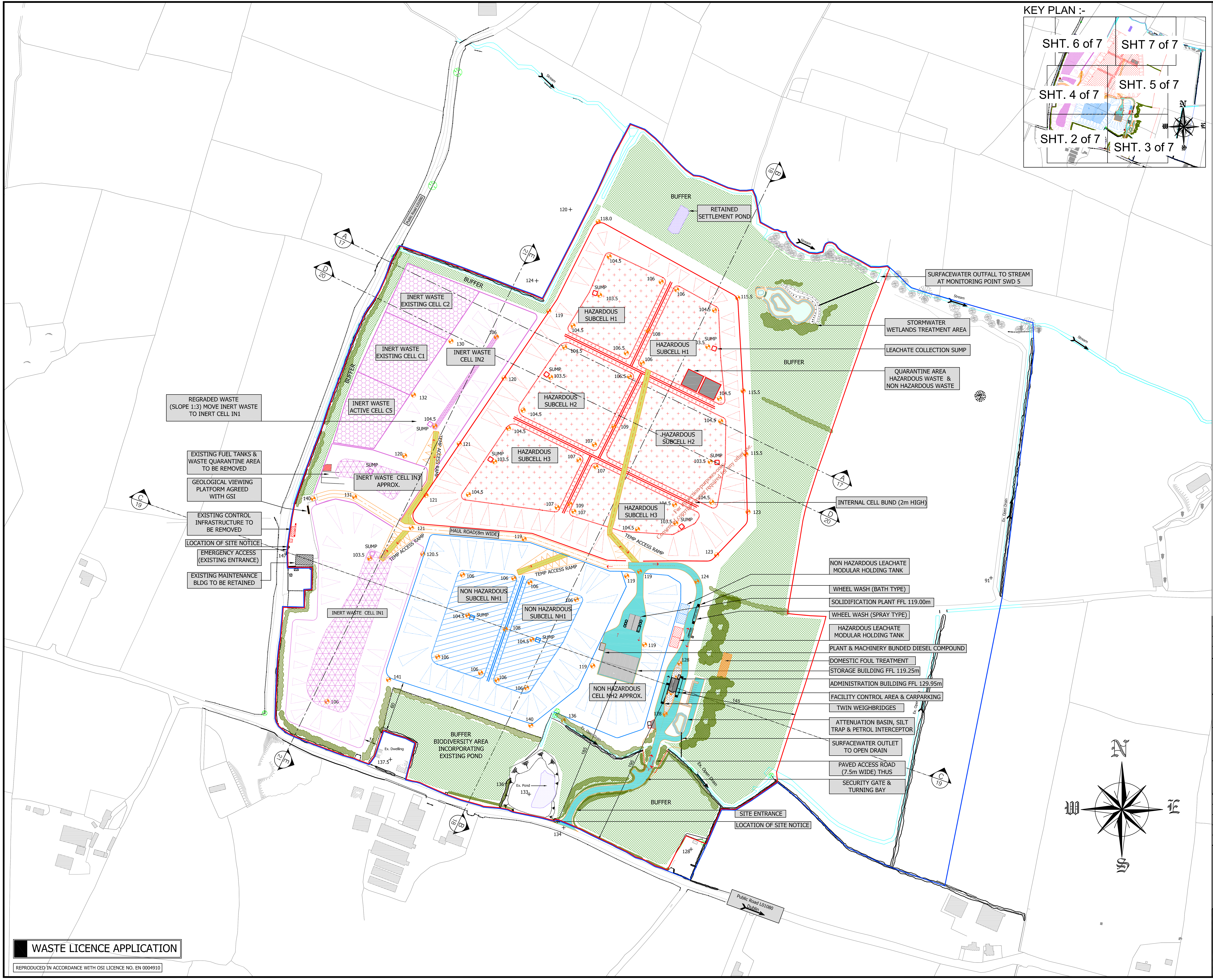
WYG (Engineering) Ireland Ltd.

ARUP patel tonra ltd environmental solutions MANAHAN PLANNERS Chartered Town Planning Consultants



WASTE LICENCE APPLICATION

REPRODUCED IN ACCORDANCE WITH OSI LICENCE NO. EN 0004910

GENERAL NOTES:

ALL LEVELS RELATE TO MALIN HEAD ORDNANCE DATUM.

ALL LEVELS TO BE CONFIRMED ON SITE BY MAIN CONTRACTOR PRIOR TO COMMENCEMENT.

DRAWING TO BE READ IN CONJUNCTION WITH ALL RELEVANT DRAWINGS.

DO NOT SCALE THIS DRAWING - USE FIGURED DIMENSIONS ONLY.

LEGEND:-

▬	Ownership Boundary
▬	Proposed Planning & EPA Waste Licence Boundary
▬	Paved Hardstanding
+ + +	Location for Hazardous Cells
▨	Location for Non-Hazardous Cells
⬡	Existing Inert Cells
▨	Location for Inert Cells
▨	Buffer Zone
←	Traffic flow
TOP ▽▽▽ BOTTOM	Embankment (Slope Direction)
105.5 ⊕	Level / Top of Liner
127	Existing Ground Level Contour
+101.84	Existing Spot Level
⬭	Existing Surface Water
•v	Existing Public Watermain Sluice Valve
▭ Hyd	Existing Public Watermain Hydrant
• RS	Existing Road Sign
● TP	Existing Telephone Pole
● EP	Existing Electrical Pole
Elec MH CL 135.96	Existing Electrical Duct & Access Chamber
⋈	Existing Access Gate
-------	Existing Fence (Various Types)
═	Existing Masonary Wall
⌇⌇⌇	Existing Hedgerow
·······	Leachate Drainage
– – –	Surface Water Drainage

ver.	ammendment	date.	issued to.
02	ARTICLE 16 RESPONSE	14.12.10	MEHL
01	WASTE LICENCE APPLICATION	10.12.10	4 Projects

Prepared For:

Murphy Environmental Hollywood Ltd

Client:

Project: MEHL INTEGRATED WASTE MANAGEMENT FACILITY

Location: HOLLYWOOD GREAT, NAG'S HEAD, NAUL, CO. DUBLIN

Title: PROPOSED SITE LAYOUT (SHEET 1 OF 7)

Project Name: PP	Drawing No. : 03	File Name: PP_WLA_03_02
Study Name: WLA	Version No. : 02	
Section: _	Date: 10 Dec. 2010	
WYG Job Number: C007831		SCALE: A1(1:2000)/A3(1:4000)
Created By: CF	Reviewed By: JD	Signed Off By: HB

Prepared by:

Old Bridge House,
Strand Street,
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Co.Westmeath.

Tel: (090) 6474264.
Fax: (090) 6478422.
E-mail : athlone@wyg.ie

WYG (Engineering) Ireland Ltd.

ARUP
patel tonra ltd environmental solutions
MANAHAN PLANNERS Chartered Town Planning Consultants

Appendix 8: Laboratory Accreditation Details

(For analysis of water samples)

Jones Environmental Laboratory

Information correct at 1st February 2013

Test Method	Code	WATERS	*Please state on C of C whether analysis is required on settled or shaken samples*	ISO 17025 (W)	MDL
015W	BTEX MS	BTEX/MTBE by GC-MS (Benzene 0.5ug/l, Toluene 0.5ug/l, Ethyl Benzene 0.5ug/l, m/p Xylene 1ug/l, o Xylene 1ug/l, MTBE 1ug/l)	BTEX and MTBE by headspace GC-MS, modified USEPA 8260	Y	0.5-1ug/l
015W	BTEX N	As above but including Naphthalene 2ug/l	BTEX and MTBE and Naphthalene by headspace GC-MS, modified USEPA 8260	Y (Naph - No)	0.5-2ug/l
015W	fuel MS	Fuel additives by by GC-MS Benzene (0.5ug/l), Toluene (0.5ug/l), Ethyl Benzene (0.5ug/l), m/p-Xylene (1ug/l), o-Xylene (1ug/l), MTBE (1ug/l), TAME(5ug/l), DIPE(5ug/l), ETBE(5ug/l), Ethanol(100ug/l), TBA(100ug/l)	Fuel additives by headspace GC-MS, modified USEPA 8260	partly	0.5-5ug/l
036W	GRO	GRO (C4-8,8-12,C4-12) by GC-FID	Gasoline Range Organics by GC-FID in the range C4-8 and C8-12.	Y	100ug/l
036W	GRO (low)	GRO (C4-8,8-12,C4-12) by GC-FID	Gasoline Range Organics and BTEX/MTBE by GC-FID in the range C4-8 and C8-12.	N	10ug/l
036/31W	GRO/BTEX FID	GRO and BTEX/MTBE by GC-FID	Gasoline Range Organics and BTEX/MTBE by GC-FID in the range C4-8 and C8-12.	Y	100/5ug/l
031W	BTEX FID	BTEX/MTBE by GC-FID	BTEX and MTBE by headspace GC-FID	Y	5ug/l
005W	EPH	EPH (C8-40) (total or dissolved) by GC-FID including Mineral Oil by calculation if requested	Extractable Petroleum Hydrocarbons by GC-FID. Extraction of as-received sample with hexane/acetone. . Calibrated against diesel and lube oil. Interpretation and carbon banding (10ug/l) included if requested.	Y	10ug/l
005W	OFG	Oil Fats and Grease by GC-FID	Oil Fats and Grease by GC-FID. Following clean-up of sample extract	Y	10ug/l
005W	Min Oil	Mineral Oil Fraction (aliphatics) by GC-FID (C10-C40)	Mineral Oil by GC-FID. Solvent extraction followed by removal of polar and aromatic compounds.	N	10ug/l

036/005W	TPH-CWG	TPH CWG (Aliphatics C5-6,>6-8,>8-10,>10-12,>12-16,>16-21,>21-35) (aromatics >C5-7,>7-8,>8-10,>10-12,>12-16,>16-21,>21-35) inc BTEX/MTBE	C5-10 fractions by Headspace GC-FID(036W). C10-35 fraction extracted with hexane, aliphatic/aromatic splits run by GC-FID (005W).	Y	various
036/005W	TPH-CWG C44	TPH CWG (Aliphatics C5-6,>6-8,>8-10,>10-12,>12-16,>16-21,>21-35) (aromatics >C5-7,>7-8,>8-10,>10-12,>12-16,>16-21,>21-35) inc BTEX/MTBE to C44	C5-10 fractions by Headspace GC-FID(036W). C10-44 fraction extracted with hexane, aliphatic/aromatic splits run by GC-FID (005W).	Y (up to C35)	various
004W	PAH 16 low	PAH 16 by GC-MS (low level)	Polynuclear Aromatic Hydrocarbons by GC-MS. Extraction using solvent. In house method modified USEPA 8270.	N	0.01ug/l
004W	PAH 16	PAH 16 by GC-MS	Polynuclear Aromatic Hydrocarbons by GC-MS. Extraction using solvent. In house method modified USEPA 8270.	Y	0.01-0.018ug/l (see tab)
015W	VOC	VOC target list including BTEX/MTBE by GC-MS	VOC target list by Headspace GC-MS - modified USEPA 8260	Y(53)	1-20ug/l
015W	VOC low	VOC target list including BTEX/MTBE by GC-MS	VOC target list by Headspace GC-MS - modified USEPA 8260	N	1ug/l
014/15W	VOC + TICs	VOC target list including BTEX/MTBE + TICs by GC-MS	VOC target list by Headspace GC-MS - modified USEPA 8260 including up to 10 Tentatively Identified Compounds with >80% match (100ug/l)	Y (TICs N)	1-20/100ug/l
014W	Forensic VOC	VOC scan by GC-MS	Qualitative scan by Headspace GC-MS	N	100ug/l
083W	Acetone	Acetone	Headspace GC-MS	N	50ug/l
016W	SVOC	SVOC target list including PAHs, phenol and chlorinated phenols by GC-MS	SVOC target list by GC-MS - modified USEPA 8270 on DCM extract using liquid/liquid extraction.	Y (42)	0.5-10ug/l
016W	SVOC (ABN)	SVOC target list including PAHs, phenol and chlorinated phenols by GC-MS	SVOC target list by GC-MS - modified USEPA 8270 on DCM extract using liquid/liquid extraction. pH2 and pH11 using combined extract (ABN)	N	10ug/l
016/10W	SVOC + TICs	SVOC target list including PAHs, phenol and chlorinated phenols plus TICs by GC-MS	SVOC target list by GC-MS - modified USEPA 8270 on DCM extract using liquid/liquid extraction. Including up to 10 tentatively Identified compounds with >80% match (100ug/l)	Y (42) (TICs N)	05-10/100ug/l
010W	Forensic SVOC	SVOC scan including Alkylated Naphthalene series (biomarkers) and/or phenols if required	Semi volatile scan by GC-MS on DCM extract	N	NA
086W	PCB 7	PCB 7 congeners	7 congeners (101,118,138,153,180,28,52) by GC-MS	N	0.1ug/l
017W	PCB 12	PCB WHO 12 congeners (dioxin like PCBs)	12 congeners (77,81,105,114,118,123,126,156,157,167,169,189) by GC-MS	N	0.1ug/l
077W	Total PCBs	Total PCBs (aroclor 1254 or 1260)	Total PCBs calibrated against arolclor 1254 or 1260 by ECD	N	0.2ug/l
086W/017W	PCB 7 and 12	PCB 7 congeners and PCB WHO 12 congeners (dioxin like PCBs)	7 congeners (101,118,138,153,180,28,52) and 12 congeners (77,81,105,114,118,123,126,156,157,167,169,189) by GC-MS	N	0.1ug/l

077W	Total PCBs	Total PCBs (aroclor 1254 or 1260)	Total PCBs calibrated against arolclor 1254 or 1260 by GC-MS	N	0.2ug/l
042W	Pest screen	Pesticide Screen by GC-MS	Screening for over 900 compounds using deconvolution software	N	0.1ug/l
042W	Comb pest	Combined pesticide suite (25 OP and OC compounds)	GC-MS (see tab for compound list)	N	0.01ug/l
042W	OCP	Organochlorine pesticides (33 compounds)	GC-MS (see tab for compound list)	N	0.01ug/l
042W	OPP	Organophosphorous pesticides (21 compounds)	GC-MS (see tab for compound list)	N	0.01ug/l
016W	Acid Herbs	Acid Herbicides	GC-MS (see tab for compound list)	N	0.1ug/l
039W	At/Sim	Atrazine and Simazine	GC-MS	N	1ug/l
046W	TBT	Tributyltin, triphenyltin, dibutyltin	GC-MS	N	0.05ug/l
023W	TEL/TML	Tetraethyl Lead, Tetramethyl lead	GC-MS	N	10ug/l
097W	Urons	Linuron, Diuron, Monuron	LCMS	N	0.5ug/l
024W	Glycol	Monoethylene glycol, propylene glycol, diethylene glycol, triethylene glycol	GC-FID	N	1mg/l
040W	VFA	Volatile Fatty Acids - Acetic acid, Propanoic acid, 2-methyl propanoic acid, butanoic acid, 3-methyl butanoic acid, pentanoic acid, 4-methyl pentanoic acid, hexanoic acid, heptanoic acid	GCFID	N	100ug/l
083W	Alc/acet	Ethyl acetate, i-propyl acetate, methyl acetate, n-butyl acetate, n-propyl acetate, ethyl alcohol(ethanol), i-propyl alcohol(IPA), methyl alcohol(methanol), n-butyl alcohol, n-heptyl alcohol, n-hexyl alcohol, n-propyl alcohol, n-pentyl alcohol	GC-MS Headspace	N	500ug/l
083W	Alc/acet ext	As above but including acetone, cyclohexane and THF	GC-MS Headspace	N	50 ug/l
016W	Amine - SV	Cetyl amine, decyldiamine,hexamethylamine diamine, oleylamine, stearylamine, tri-n-butylamine by GCMS	Amines on solvent extract by GC-MS	N	50 ug/l
104W	Amine - HS	Benzyldimethyamine, butylamine, cyclohexamine, ethyldiamine, isopropylamine, octylamine, triethylamine, trimethylamine, tripropylamine by GC-MS headspace	Amines by GC-MS headspace	N	1-10mg/l
103W	Amine - LC	Acrylamide, laurylamine, hydroxyethyl ethylene diamine, myristyl dimethylamine, octyldimethylamine, para phenylene diamine, tetra ethylene pentamine	Amines by LC-MS	N	50ug/l
041W	Hydrazine	Hyrdazine	Colorimetric	N	1ug/l
051W	Form	Formadehyde	Kit	N	0.5mg/l
025W	Diss gases	Dissolved methane, ethane, ethene	GC-FID	N	1ug/l
025W	Diss Meth	Dissolved methane	GC-FID	N	1ug/l
025W	Diss CO2	Dissolved CO2	GC-FID /TCD	N	1ug/l
026W	phenol	Phenol or total monohydric phenols - HPLC	HPLC	Y	0.1mg/l

026W	spec phenol HPLC	Speciated phenols by HPLC - resourcinol, catechol, **phenol**, m/p-cresol, o-cresol, **total cresols, total xylenols**, 1-napthol, 2,3,5-trimethyl phenol, 2-isopropylphenol	HPLC	Y (bold only)	0.01-0.06mg/l
026W	spec phenol HPLC - low	Speciated phenols by HPLC - Resourcinol, Catechol, Phenol, Total Cresols, Total Xylenols, 1-napthol, 2,3,5-trimethyl phenol	HPLC	N	0.5ug/l
016W	Phenols GC-MS	Speciated chlorinated phenols by GCMS - see tab	Phenols by GC-MS	N	0.5ug/l
073W	pH	pH	Determination of pH (Metrohm)	Y	0.01pH units
076W	EC	Electrical Conductivity	Metrohm	Y	2uS/cm
072W	Redox	Redox	Probe - Should be done on-site	N	mV
030W	Metals	As(2.5), Cd(0.5), Cr(1.5), Cu(7), Pb(5), Hg(1), Ni(2), Se(3), Zn(3), B(12), Al(20), Ba(3), Co(2), Fe(20), Mo(2), Mn(2), P(5), Sb (2), V(1.5), Be(0.5), Tl(3)	ICP-OES (Dissolved unless requested otherwise) low level available	Y (not B or Be)	various (ug/l)
030W	Metals low	**Low Level** As(0.9), Cd(0.03), Cr(0.2), Cu(3), Pb(0.4), Hg(0.5), Ni(0.2), Se(1.2), Zn(1.5), B(12), Al(1.5), Ba(1.8), Co(0.1), Fe(4.7), Mo(0.2), Mn(1.5), P(0.7), Sb (2), V(0.6), Be(0.5), Tl(0.9)	ICP-OES (Dissolved unless requested otherwise)	Y (not B or Be)	various (ug/l)
030W	Metals	Single metal	ICP-OES		
030W	Metals	2 -10 metals from above list	ICP-OES		
030W	Metals	11 + metals from above list	ICP-OES		
030W	CLEA short	CLEA Short(excluding B, Cr III and Cr VI) As(2.5), Cd(0.5), Cr(1.5), Cu(7), Pb(5), Hg(1), Ni(2), Se(3), Zn(3), V(1.5), Be(5), Ba(3)	ICPOES	Y (except Be)	various (ug/l)
030W	CLEA short low	**Low Level** CLEA Short (excluding B, Cr III and Cr VI) As(0.9), Cd(0.03), Cr(0.2), Cu(3), Pb(0.4), Hg(0.5), Ni(0.2), Se(1.2), Zn(1.5), V(0.6), Be(5), Ba(1.8)	ICPOES	Y (except Be)	various (ug/l)
030W	CLEA full metals	CLEA Metals Full As(2.5), Cd(0.5), Cr(1.5), Cu(7), Pb(5), Hg(1), Ni(2), Se(3), Zn(3), V(1.5), Be(5), Ba(3), B(12), Cr VI(30), Cr III(30)	ICPOES / Kone analyser	Y (except Be, B, Cr III, Cr VI)	various (ug/l)
030W	CLEA full low	**Low Level** CLEA Metals Full As(0.9), Cd(0.03), Cr(0.2), Cu(3), Pb(0.4), Hg(0.5), Ni(0.2), Se(1.2), Zn(1.5), V(0.6), Be(5), Ba(1.8), B(2), Cr VI(30), Cr III(30)	ICPOES / Kone analyser	Y (except Be, B, Cr III, Cr VI)	various (ug/l)
038W	Hex Cr	Hexavalent Chromium	Kone analyser	N	0.03mg/l
038W	Hex Cr low	Hexavalent Chromium low lovel	Kone analyser	N	0.002mg/l
061W	Hg CVAF	Mercury by CVAF	Mercury by Cold Vapour Atomic Fluorescence	Y	0.01ug/l
030W	Exotics	Exotics Sn(5), Ti(5), Li(5), Bi(5), Sr(5), Zr(5), Te(5)	ICP-OES (€10 single element)	N	various (ug/l)

030W	W	Tungsten (W)	ICP-OES (Dissolved unless requested otherwise)	N	10ug/l
030W	Nb	Niobium (Nb)	ICP-OES (Dissolved unless requested otherwise)	N	10ug/l
030W	Ag	Silver (Ag)	ICP-OES (Dissolved unless requested otherwise)	N	5ug/l
030W	U	Uranium (U)	ICP-OES (Dissolved unless requested otherwise)	N	5ug/l
030W	Pd	Palladium	ICP-OES (Dissolved unless requested otherwise)	N	5ug/l
030W	Earth Metals	Ca(0.2), Mg(0.1), K(0.1), Na(0.1)	ICP-OES (€5 single element)	Y	various (mg/l)
062W	Mn II	Manganese II	Spectrophotometric	N	0.02mg/l
048W	FeII	Iron II (ferrous)	Dr Lange Kit	N	0.02mg/l
048W	FeIII	Iron III (ferric)	Calculation from total iron and ferrous iron	N	0.02mg/l
052W	Silica	Silica	Spectrophotometric	N	0.01mg/l
030W	Tot S	Total Sulphur	ICP-OES	N	0.02mg/l
038W	SO4	Sulphate	Kone analyser	Y	0.05mg/l
038W	Sulphide	Sulphide	Kone analyser	N	10ug/l
079W	CN free	Free cyanide	Flow injection	Y	0.01mg/l
079W	CN tot	Total cyanide	Flow injection	Y	0.01mg/l
079W	CCN	Complex Cyanide	By calculation from total and free cyanide	N	0.01mg/l
038W	Thio	Thiocyanate	Kone analyser	N	0.02mg/l
027W	Br	Bromide	Dionex	N	0.05mg/l
027W	F	Fluoride	Dionex	N	0.3mg/l
038W	Cl	Chloride	Kone analyser	Y	0.3mg/l
066W	Fr Cl	Free chlorine	Kit	N	0.02mg/l
038W	TOxN	Total Oxidised Nitrogen as N	Kone analyser	Y	0.2mg/l
038W	NO3	Nitrate as NO3	Kone analyser	Y	0.2mg/l
038W	NO2	Nitrite as NO2	Kone analyser	Y	0.02mg/l
038W	NO3-N	Nitrate as N	Kone analyser	Y	0.05mg/l
038W	NO2-N	Nitrite as N	Kone analyser	Y	0.006mg/l
038W	Amm N - NH4	Ammonium - total as NH4	Kone analyser	Y	0.03mg/l
038W	Amm N - N	Ammoniacal Nitrogen as N	Kone analyser	Y	0.03mg/l
038W	Amm N - N(low)	Ammoniacal Nitrogen as N	Kone analyser	N	0.01mg/l
038W	Amm N - NH3	Ammoniacal Nitrogen as NH3	Kone analyser	Y	0.03mg/l
053W	Free NH3	Free Ammonia as NH3	Dr Lange Kit	N	0.07mg/l
053W	Free NH4	Free Ammonia as NH4	Dr Lange Kit	N	0.08mg/l
053W	Free N	Free Ammonia as N	Dr Lange Kit	N	0.06mg/l

038W	PO4	Ortho-Phosphate as PO4	Kone analyser	Y	0.06mg/l
038W	PO4 low	Ortho-Phosphate as PO4	Kone analyser	N	0.03mg/l
038W	PO4-P	Ortho-Phosphate as P	Kone analyser	Y	0.03mg/l
075W	Alk	Total Alkalinity as CaCO3	Metrohm	Y	1mg/l
075W	Bi Alk	Bicarbonate Alkalinity	Metrohm	N	1mg/l
075W	Carb Alk	Carbonate Alkalinity	Metrohm	N	1mg/l
075W	P Alk	P Alkalinity	Metrohm	N	1mg/l
030W	bi carb hard	Bicarbonate hardness	ICP-OES	N	1mg/l
030W	tot hard	Total Hardness	ICP-OES (Dissolved)	N	1mg/l
033W	Surf	Anionic surfactants (MBAS)	Spectrophotometric	N	0.2mg/l
034W	Turb	Turbidity	Meter	N	0.1 NTU
035W	Colour	Colour (apparent) unfiltered	Spectrophotometric	N	15 pcu
059W	DO	Dissolved Oxygen- should be analysed within 6 hours	Oxygen Meter	N	1mg/l
064W	Salinity	Salinity	Meter	N	0.1%
020W	TDS	Total Dissolved Solids	Gravimetric - BSEN15216	Y	35mg/l
020W	TS	Total Solids	Gravimetric - BSEN15216	Y	5mg/l
037W	TSS	Total Suspended Solids	Gravimetric - BSEN15216	Y	10mg/l
067W	SS	Settleable Solids	Gravimetric - BSEN15216	N	2mg/l
037W	Res	Residue on Evaporation	Gravimetric - BSEN15216	N	2mg/l
058W	BOD	BOD - should be analysed within 48 hours	5 days ATU (settled unless requested otherwise)	Y	1mg/l
057W	COD	COD	Dr Lange Kit	N	7mg/l
060W	DOC	Dissolved Organic Carbon	Infra Red	Y	2mg/l
060W	TOC	Total Organic Carbon	Infra Red	Y	2mg/l