

National Paediatric Hospital
Development Board

**National Paediatric Hospital
Project**

Feasibility Study for a Potable
Groundwater Supply for the new
children's hospital

237976_Feasibility Study for NPHP

Issue | 31 July 2015

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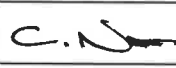
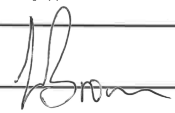
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1 Introduction

Arup are commissioned by the National Paediatric Hospital Development Board (NPHDB) to assess the feasibility for a potable groundwater supply on the site of the proposed new children's hospital at St James's Hospital, Dublin, Ireland. The proposed new children's hospital comprises world-class multi-storey hospital which will bring together the services presently offered for children at three different hospitals in to one location. The new children's hospital will provide both paediatric services for the greater Dublin area and specialist services for the country as a whole.

At the time of preparing this feasibility study for use of groundwater as a potable supply the NPHDB were preparing an application for planning permission for the proposed new children's hospital. Information collected for the purpose of this study will be used to inform the Environmental Impact Statement (EIS). In addition this feasibility study is intended to support the EIS and assesses the impact of the potential potable supply on the wider environment.

The application site comprises the main hospital building (the new children's hospital) located in the western part of the St James's Hospital Campus, a research centre close to the entrance to St James's Hospital and the associated access routes across the St James's Hospital Campus. St James's Hospital is located to the west of Dublin City Centre and to the south of the River Liffey. To the north the new children's hospital is bounded by Mount Brown and to the west by Cameron Square, Brookfield Road and South Circular Road which are all residential streets. To the south the new children's hospital is bounded by the Luas tram line and the east by St James's Hospital. The location of St James Hospital and the new children's hospital within the Dublin area is shown on Drawing 1 and site plan is shown on Drawing 2.

1.1 Objective of the Report

The objective of the study is to assess the feasibility of using the groundwater beneath the proposed new children's hospital as a potable supply and to assess the risk to groundwater receptors from abstraction. To carry out the feasibility study an intrusive site investigation has been carried out comprising the drilling of five monitoring boreholes and two trial supply abstraction boreholes, a downhole geophysical survey and a series of pump tests.

In this study the feasibility of the use of groundwater is assessed in terms of:

1. Ability of any aquifer beneath the site to supply groundwater;
2. Quality of groundwater beneath the site; and
3. An assessment of the likely hydrogeological impacts of abstraction on the surrounds and any nearby groundwater dependant receptors.

As the study will be used in the planning application the report is prepared in general accordance with the Institute of Geologists of Ireland (IGI) guidance for preparing soils, geology and hydrogeology chapters of Environmental Impact Assessments [1]. The drilling and installation of groundwater wells was undertaken in accordance with IGI (2007) guidelines [2] and EPA (2013) advice note [3].

2 Conceptual Site Model

2.1 Site Setting

The site is located in the catchment of the River Camac which is located approximately 60m to the north of the new children's hospital. The River Camac flows in a wide, steep sided valley as it flows north eastwards to the River Liffey. The new children's hospital is located immediately to the south of the base of the Camac valley. The new children's hospital site lies at approximately 20 m Ordnance Datum (OD) and is elevated above the valley, with the exception of the northern part adjacent to base of the Camac valley where the ground level falls to approximately 8 mOD.

In general the site is covered with hospital buildings or hardstanding comprising asphalt covered roads and pavements. A car park in the south of the site is covered by granular material. Low shrubs and trees cover a large area in the north of the site on side of the valley and also smaller patches across the site.

There is only one site within 3km of the new children's hospital recorded on the EPA Envision website [4] which holds an Industrial Emission Licence (IEL) (formerly referred to as IPPC licence) and no Licenced Waste Facilities. The IEL licence is held by Diageo and is located at St James's Gate Brewery, which lies approximately 600 m north-east of the new children's hospital site.

2.2 Site History

Based on the information presented on the historic maps of Dublin [5] prior to 1821 the site of the new children's hospital was largely undeveloped. Between 1821 and 1876 a work house was constructed in the south of the site and small number of buildings were developed in the north of the site on or close to Mount Brown which are likely to comprise residential houses. Between 1925 and 1948 the work house was removed and replaced with a number of buildings associated with St James's Hospital.

On the 1821 map an unnamed watercourse is shown east of the new children's hospital that flows northwards and outfalls to the River Camac to the north east of the new children's hospital. On the 1821 map an arm of the Grand Canal is shown running east to west along the south border of the site in the area currently occupied by the Luas tram line.

2.3 Geology

The geology of the site is taken from the Geological Survey of Ireland (GSI) interactive map [6], available published or publically available information including borehole logs from a number of site investigations carried out in the vicinity of the new children's hospital obtained from the GSI. This publically available or published information has been supplemented with the results of three site investigations carried out at the new children's hospital. A summary of the site investigations reviewed in preparing this study is presented below. The bedrock geology in the vicinity of the new children's hospital is presented in Drawing 3.

Regional Geology

Based on the GSI interactive map the bedrock consists of Dinantian Upper Impure Limestone which is part of the Lucan Formation, colloquially known as Calp Limestone.

The Lucan Formation is described by the GSI [7] as a dark grey to black limestone and shale and consists of a homogenous sequences of dark grey massive limestones, shaley limestones and massive mudstones. Cherts are also common. The bed thickness are generally less than 1m in thickness but can be greater than 2 m thick. The total thickness of the Lucan Formation in the Dublin area is estimated to be up to 800 m [7].

It is conjectured that the Lucan Formation in the Dublin area contains minor synclinal and anticlinal folds with a north east south west strike. Two sets of localised faults are presented on the geological map in the north and north-west of the Dublin area with a north-north-west to south-south-east or east-north-east to west-south-west strike. It is probable that more faults exist but are not observed due to the thickness of the overburden.

The GSI interactive map [6] show the new children's hospital to be underlain by made ground and till. The till is colloquially known as the Dublin Boulder Clay. Glacial and postglacial terrace sands and gravels are also present in a west-east trending buried deep channel, which has cut down into the Dublin Boulder Clay [8] and generally follows the line of the River Liffey. In the vicinity of the new children's hospital the deep channel is located slightly to the south of the River Liffey, indicating that the modern river channel and the buried channel can be offset. Based on a geophysical map showing the depth to bedrock the base of the channel at near Heuston Railway Station, which is approximately 1 km north-east of the site, is likely to be up to 45 m below ground level (mbgl) [8]. Based on the logs available from the GSI in the vicinity of Heuston Railway Station gravel lies at the base of the buried channel and partly on the Lucan Formation.

Summary of the Site Investigation Carried out at Site

In summer 2014 twenty three boreholes were drilled in twenty one locations on the site for the purpose of confirming the depth to bedrock and collecting sample to establish the geotechnical properties of the strata at the site. These boreholes are referred to as the 100 series boreholes and all the borehole numbers are prefixed with the number 1.

The boreholes were drilled by Geobore S and rotary coring methods to collect detailed information on the strata and their depths beneath the proposed new children's hospital. Two boreholes were terminated in the made ground, while the remaining twenty one boreholes were drilled through the made ground, Dublin Boulder Clay and into the Lucan Formation. Seven of the boreholes were completed with water level monitoring standpipes. The standpipes were either screened in the:

- Dublin Boulder Clay;
- The base of the Dublin Boulder Clay and the top of the Lucan Formation; or
- If present, gravel in the Dublin Boulder Clay.

The 100 series borehole logs are included in Appendix A. In addition a series of cross sections prepared based on the results of the site investigation and showing the level of the top of the limestone across the site is presented in Appendix B.

In spring 2015 an additional thirty one boreholes were drilled for the purpose of informing the contamination assessment for the EIS. These boreholes are referred to as the 200 series boreholes and all the borehole numbers are prefixed with the number 2. The 200 series boreholes where all terminated in the made ground or Dublin Boulder Clay. Twenty four boreholes contain groundwater monitoring installations, all of which are screened in:

- The Made Ground;
- The Dublin Boulder Clay; or

- The interface between the Made Ground and the Dublin Boulder Clay.

The 200 series borehole logs are included in Appendix A.

In May and June 2015 five groundwater monitoring (MW01-05) and two trial groundwater supply boreholes (FS01/15 and FS02/15) were drilled by Meehan Drilling as part of joint study between O'Connor Sutton Cronin & Associates Ltd (OCSC) and Arup. The investigation was carried out for the purpose of assessing the feasibility of abstracting the groundwater from the Lucan Formation to use as a potable supply (Arup) and inform an assessment in the EIS of the impacts of dewatering during the construction phase. All seven borehole contain open sections within the Lucan Formation. The site investigation report including the borehole logs for the May and June site investigation is presented in Appendix C.

Locations of the 100 and 200 series boreholes together with those drilled in May and June 2015 are shown on Appendix D. The locations of the boreholes installed only in the Lucan Formation are presented on Drawing 2.

The two trial groundwater supply boreholes locations, FS01/15 and FS02/15, were drilled at the new children's hospital at locations where they would not be covered by the proposed development. The two trial supply boreholes were located at opposite ends of the site to investigate the potential for variable yields across the site. FS01/15 and FS02/15 were drilled using rotary open hole techniques to a depth of 78.5 mbgl and 95 mbgl respectively. Periodically during drilling the borehole was developed by airlifting and the discharge from the development was measured. The intended drill depth was set at 65 mbgl consistent with the depth of the permeable horizons noted by the GSI [9]. However both boreholes were deepened when zones of higher yield (determined by measuring the discharge from borehole development) were encountered at the intended drill depths. Both boreholes were terminated after the recorded blow yields were found to stabilise. The recorded yields measured during periodic well development are presented on the boreholes logs of FS01/15 and FS02/15 in Appendix C.

The construction and installation of FS01/15 and FS02/15 was designed based on the EPA and IGI recommendations for boreholes designed for potable supplies [3] and [2] respectively. The IGI guidelines, EPA advisory note and international standards recommend installation of well grade PVC pump chamber with injected grout seal that prevents shallow groundwater from entering the well and this guidance was incorporated in the design of the test wells. In general boreholes FS01/15 and FS02/15 were drilled at a diameter of 373 mm through the superficial deposits and weathered rock and then 330 mm to 10 m below the base of the weathered bedrock. A plain 280 mm diameter PVC casing was installed with centralisers and grouted into place. After the grout had cured the borehole was advanced in the bedrock at a diameter of approximately 250 mm to 79 mbgl (FS01/15) and 95 mbgl (FS02/15). FS01/15 and FS02/15 were completed below ground level with flush covers. The two wells were sealed with water tight covers. FS01/15 and FS02/15 were drilled at a diameter of 254 mm (10") to facilitate either the installation of a 8" pump or additional casing to allow a 6" pump to be lowered further into the borehole. Importantly, as per IGI, EPA and international guidelines the pump must remain in the chamber housing and this effectively limits the depth that pump testing may draw the water table down to. The design depth of the pump housing is a compromise between ensuring exclusion of shallow water, maximising of the open zone in the well and maintaining enough water above the pump intake. For the new children's hospital site a decision was made to extend 10 m beyond weathered bedrock, which would seal out shallow groundwater and place the base of the pump chamber at approximately 25 mbgl to 30 mbgl based on expected geology.

In addition to the trial supply boreholes five monitoring locations were drilled by rotary open hole methods to 10 m to 13 m below the base of the Dublin Boulder Clay. The monitoring wells were completed with PVC standpipes installed in the Lucan Formation. The open sections of the PVC pipes were installed with a gravel surround to above the level of the open section. Above this the annular space was completed with a thin layer of sand and then grout to ground level. All the monitoring wells were completed at ground level with flush covers. MW01, MW03 and MW05 were completed with 60 mm diameter standpipes. MW02 and MW04 were completed with 140 mm diameter standpipes. A summary of the construction details of the boreholes drilled for this study is presented in Table 1.

Borehole	Grid Reference (ITM)		Ground Level (m OD)	Depth (mbgl)	Depth of screen or open section (mbgl)	Elevation of screen or open section (mOD)	Diameter of screen or open section (mm)	Distance to pumped borehole	
	East	North						FS01	FS02
MW01	713346.61	733344.98	20.51	20	14 to 20	6.51 to 0.51	60	358	80
MW02	713266.62	733350.17	20.76	28	23.1 to 28	-2.34 to -7.24	140	325	22
MW03	713233.30	733525.10	20.52	24	19 to 24	1.52 to -3.48	60	147	201
MW04	713282.59	733622.55	19.35	30	24 to 30	-4.65 to -10.65	140	106	295
MW05	713218.07	733664.96	7.39	18	12 to 18	-4.61 to -10.61	60	32	341
FS01/15	713185.47	733664.42	8.04	79	21 to 79	-12.96 to -61.7	250	-	347
FS02/15	713268.52	733327.47	21.12	95	25.7 to 95	-4.58 to -73.88	250	347	-

Table 1: Summary of the completion of the boreholes drilled in the Lucan Formation for this study.

Note: *Italics* denotes that no screen was installed and the borehole was completed as an open hole.

Site Geology

In the three site investigations which have been carried out at the site the made ground, Dublin Boulder Clay and Lucan Formation have all been proven. Data presented below details all the site investigation available. These data have been used to compile geological cross sections of the site, which are presented as cross-sections in Drawing 4 and 5 of this report. These data are also presented in the EIS (Ref Figure N187-ENV-008 and N187-ENV-009).

In general the made ground consists of hardcore or tarmac over gravel, silt, clay or sandy gravel with occasional pieces of cinders, brick and reinforced concrete. The gravel in the made ground is angular to subrounded fine to medium. The made ground is generally approximately 1 m to 1.5 m thick across the site but has been recorded up to 6 m thick in the east of the site.

Based on the logs the Dublin Boulder Clay comprises of several units. In general it consists of very stiff dark grey to black or brown sandy gravelly clay with occasional cobbles and rare boulders. The sand is fine to coarse. The gravel is subrounded to subangular fine to coarse and cobbles are subrounded to subangular. The boulder clay thickness across the level area above the valley of the Camac is generally around 10 m or greater. In the vicinity of the northern boundary of the proposed new children's hospital the Dublin Boulder Clay is recorded to be 5 m thick.

Occasional gravel or sand and gravel lenses are proven in the Dublin Boulder Clay. These are described generally as dark grey subrounded to subangular fine to coarse gravel.

The thickness of the gravel or sand and gravel varies forms lenses that range from 0.1 m to 5.30 m thick and generally isolated by the surrounding boulder clay. The gravel lenses are more common in the northern part of the site and less common in the southern part of the site.

The total thickness of the superficial deposits and depth to bedrock ranges from between 10.2 mbgl and 19.5 mbgl (10.2 mOD to -0.1 mOD respectively) across the majority of the site. The superficial deposits is thinnest in the north of the site.

Based on the rock cores recovered during the 100 series site investigation the Lucan Formation is recorded as medium to strong and thin to medium bedded dark grey fine to medium grained limestone. The strength of the limestone increases with depth. Calcite veins are occasionally to frequently present. In some borehole the limestone is interbedded with widely spaced, very thin beds of weak dark grey mudstone or brown sandy gravelly clay.

Borehole logs from the 100 series cored boreholes indicate that the top of the Lucan Formation is weathered. On the logs of the 100 series boreholes the weathered zone is approximately 0.8-2.5 m thick. The weathered zone was noted during the drilling of MW01- MW05 and FS01/15 and FS02/15 by a decrease in drilling rate at the base of the weathered zone suggesting that the unweathered rock is relatively softer.

Geophysical surveys were undertaken in FS01/15 and FS02/15 by European Geophysical Services (EGS) following the installation of the PVC casing. The survey included a CCTV survey, calliper, resistivity and gamma logs. The CCTV visual observations of the boreholes show fractures within the boreholes, most of which appear to be very tight to partially open and sub-horizontal in orientation.

Occasional sub-horizontal and sub-vertical calcite veins and pyrite beds are also visible. The CCTV visual inspection of FS02/15 shows a sub-horizontal wide fracture at 36 mbgl approximately 0.2 m in length with an aperture of approximately 0.02 m. This corresponds with a water strike noted during the drilling.

Calliper logs of the boreholes show the width of the boreholes with depth. The logs show a sudden increase in borehole width in FS01 at approximately 37mbgl and 45 mbgl which may indicate a fracture set. It is likely that these fractures are water bearing as this depth correspond with noted water strikes during the borehole drilling.

Gamma logs were taken to confirm the depth of the base of the Dublin Boulder Clay. In FS02 the gamma signal changes at approximately 15 mbgl which corresponds with the change in strata from Dublin Boulder Clay to Lucan Formation recorded during the drilling.

The gamma signal for the Lucan Formation in FS02 is marked by a fluctuating signal of highs and low which probably reflects the shaley and clay mineral rich interbeds. In FS01/15 it is not possible to distinguish between the Lucan Formation and the Dublin Boulder Clay.

The gamma signal is more muted when recorded from within the PVC casing which could suggests a change in strata at the base of the PVC however this is not supported by the observations during drilling and does not reflect the character of the changes in signal seen in FS02/15.

The resistivity log was undertaken to locate any significant changes in lithology or fracture zone in the Lucan Formation.

It is not possible to record the resistivity of the native strata in the PVC hence this method cannot be used to confirm the base of the Dublin Boulder Clay. In general the resistivity signal is seen to increase where the gamma signal decreases. This infers that the higher resistivity strata are low in clay mineral which in the Lucan Formation is likely to comprise the limestone. In general the resistivity signal and the gamma signal demonstrate the highly variable and interbedded nature of the Lucan Formation comprising many medium to thick beds (0.2 m to 2 m) of limestone and mudstone or muddy limestone. No significant areas of reduced resistivity are linked with any significant inflows of groundwater suggesting that any groundwater ingress is in discrete fractures rather than fracture zones.

Geological data provided in borehole logs available on the GSI database have been reviewed to establish the geology in the vicinity of the site, in particular to the north of the site where the River Camac is present. Copies of the logs downloaded from the GSI website are presented in Appendix E.

Based on the information reviewed, the Dublin Boulder Clay is present to a depth of 1mOD in the north of the new children's hospital and has been proven to a depth of at least 5.26 mOD on the opposite side of the valley. Information of the strata beneath the Camac is not available in the immediate vicinity of the site. Boreholes 300 m downstream of the new children's hospital site located close to the banks of the River Camac have proven silt/clay over gravel and then boulder clay beneath the level of the invert of the Camac. The gravel is seen to thicken towards the Liffey (Drawing 4).

Approximately 500 m upstream of the new children's hospital and 25 m north of the River Camac, sandy gravelly silt has been proven to a depth of 8.3 mOD. This is underlain by an unproven thickness of gravel to proven depth of 6.9 mOD. It is unclear what the elevation of the River Camac is in this location. A further 200 m upstream (approximately 700 m upstream of the new children's hospital) gravel has been proven to 8.09 mOD which overlies 5.85 m of clay and boulder clay and bedrock. The bedrock was proven at 2.24 mOD at this location. Based on the information reviewed it is likely that in the vicinity of the new children's hospital the River Camac is underlain by approximately 1m silt or gravel which in turn is underlain >5 m boulder clay to the bedrock of the Lucan Formation.

2.4 Hydrogeology

The principal water bearing units in the vicinity of the new children's hospital are argillaceous limestones of the Lucan Formation.

The GSI have not classified the sands and gravels in the vicinity of the new children's hospital as being either locally or regionally important aquifer [6]. This is likely due to the limited extent of the groundwater body within this subsoil aquifer.

The Lucan Formation is classified by the GSI as a locally important aquifer which is moderately productive only in local zones [6]. This bedrock aquifer is part of the Dublin Urban groundwater body. The GSI note that the aquifer does not contain significant primary porosity with the majority of flow and storage occurring in fractures. It is reported by the GSI [9] that based on packer tests the permeability was seen to reduce by an order of magnitude with every 5 m increase in depth. The GSI report that the majority of flow is in the upper weathered bedrock and is also common within fractures and fissures at depth of up to 50 mbgl [9]. Conduits are also recorded at depth between 30 mbgl to 50 mbgl [9].

Regional groundwater flow in the aquifer is towards Dublin Bay and the Irish Sea in the east [9]. It is also reported by the GSI that flow is also seen towards the River Liffey [9] which suggested that there is a degree of continuity between the groundwater in the Lucan Formation and the River Liffey (Drawing 4).

The GSI consider that based on the dry weather flows in the rivers in the Dublin GWB that the aquifer does not provide large baseflows to the rivers during summer time [9].

Based on the GSI website the effective rainfall in the vicinity of the new children's hospital is 340 mm/year. Recharge to the aquifer can only occur where rainfall can percolate through any subsoil to the aquifer. Due to the significant coverage of hardstanding in the Dublin area opportunities for recharge in the wider areas around the new children's hospital are limited to open spaces such as parks and gardens. However, any water which percolates through the subsoil is likely to be perched on the significant thickness of Dublin Boulder Clay and consequently it is likely that recharge to the Lucan Formation is minimal to insignificant in the area of the new children's hospital. It is considered that this is why the GSI have designated that the recharge coefficient in the immediate area of the new children's hospital as 20%. Based on the GSI [6] the total recharge to the Lucan Formation at the site would be equivalent to approximately 68mm/year. Leaking sewers, storm drains and mains may also contribute to aquifer recharge but again connectivity to the aquifer is minimal due to the low permeability subsoils.

Due to the low permeability cap of the bedrock aquifer at new children's hospital it is considered that recharge to the aquifer is likely to originate beyond the site in areas where the boulder clay thins or is absent. In terms of the regional groundwater gradient the main recharge area for the bedrock aquifer at the site will be to the south west and the region extending through Crumlin (0.5 km distant) and Drimnagh (1 km distant) and extending outwards.

In that part of Dublin the subsoil become significantly thinner [6] and the recharge coefficients higher.

It is reported by the GSI that flow paths within the groundwater body are generally less than 1 km in length in the Dublin area. However this is not considered to occur in the area of the site where the limited amount of recharge across the area of the aquifer. In such areas it is considered that pathways from recharge areas to discharge will be considerably longer.

Based on the geological information reviewed it is considered more likely that the flow paths are generally greater than 1 km and should be considered regional or sub-regional from areas of recharge to discharge.

Based on the GSI, with the exception of a small portion of the south west of the new children's hospital which is designated high, the aquifer vulnerability is classified as moderate beneath the new children's hospital.

Groundwater vulnerability describes the ease at which contamination could infiltrate to groundwater and is a function of the subsoil thickness and its permeability. Although the aquifer vulnerability is classified as moderate across the site it may have a higher vulnerability in the northern part of the site where the overburden is thinner.

Under the requirements of the Water Framework Directive the Dublin Urban groundwater body is classified as having an overall good status for water quality and quantity. However it is classified as 'at risk' of not achieving at least good ecological or good chemical status/potential by 2015.

A search has been undertaken of potential abstraction in the vicinity of the new children's hospital. The search has reviewed the information available on the public register from:

- The GSI website [6];
- The list of abstractions held by the local authority (Dublin City Council); and

- The 2010 EIS for the Dart Underground [10].

The locations of the abstractions located in the vicinity of the site are shown on Drawing 4 and a summary of the use and abstraction rate (where known) for the borehole located within 3 km of the new children's hospital is presented in Table 2.

Borehole Name	Easting (ITM) ¹	Northing (ITM) ¹	Use	Abstraction rate (m ³ /day)	Distance from the new children's hospital
2923SEW010	715676	732077	Domestic	109.1	2685
2923SEW007	711127	731927	Industrial	261.8	2460
2923SEW008	711127	731927	Industrial	436	2460
2923SEW009	711127	731927	Industrial	381	2460
2923SEW012	715876	735076	Unknown	163.6	2930
2923SEW035	711627	731827	Unknown	n/a	2080
2923SEW039	713576	730907	Industrial	45	2360
2923SEW040	713546	730847	Industrial	818	2410
2923SEW013	715326	734326	Unknown	114.5	2070
2329SEW031	711926	731627	Industrial	109	1880
2923SEW015	714676	734776	Industrial	393	1550
Leo Laboratories Ltd.	713258	730962	Not stated	189.27	2340
St. Mary's Laundry	714482	734937	Not stated	3.79	1730
St. James Gate	714049.1	734251.2	Industrial - Process water	100 - 250	940
Pearse College	713953	732245	Not stated	0.05	1230
Serenity Community Garden	714912	735744	Not stated	0.015	2630
Ushers Quay	714616	734184	Ground source heating system	Not known	1400

Table 2: Summary of the abstractions located with 3 km radius of the new children's hospital.

Notes 1: The location of the groundwater abstraction area approximate and some may only be accurate to 500 m.

The closest abstraction to the site is the Cooperage Well located at the St. James's Gate Brewery approximately 940 m north east of the new children's hospital. It is understood from Diageo who operate the brewery that the well is located within the Export Warehouse and was constructed over three phases between 1880 and 1903. In 1880 a 3.05 m diameter open well was dug to 17.07 m below ground level (bgl). In 1902 a 292 mm diameter tube was driven into the base of the well to increase yield. In 1903 a 762 mm diameter tube was driven to a depth of 35.36 mbgl where it met refusal then a borehole with a diameter of 660 mm was then drilled in the base of the well to a depth of 56.99 mbgl. It is understood that the well installed in gravels up to 24 mbgl and then in the upper part of the Lucan Formation.

Diageo state that well has been in operation since 1880 with the exception of a period between 2005 and 2012 when operation was ceased.

Abstraction rates of between 62.5 m³/hr and 312.5 m³/hr have been recorded. During operation sustainable yields of 190 m³/hr were sustained over 6 to 8 consecutive months. In December 2014 the well was abstracting 100 m³/day with plans to increase this rate to 280 m³/day over the following 12 months.

It is reported by Diageo that the water is abstracted and treated for high alkalinity through pre-filtering, reverse osmosis and pH correction, prior to use. The abstracted water is currently being used as process water for the Diageo brewery but is not used in the brewing process.

No Special Areas of Conservation (SAC's), Special Protection Areas (SAC's) or Natural Heritage Areas are located which comprise groundwater dependent habitats have been identified within 5 km of the site.

Two wells which are located on the St James's Gate brewery site are designated by the National Parks and Heritage Service as County Geological Sites (CGS) under the hydrogeology theme. Although these wells do not have the level of protection as National Heritage Areas they should be considered during the planning process.

Site Hydrogeology

Based on the results of the site investigation the Lucan Formation is water bearing.

During the May/June site investigation groundwater monitoring facilities were installed in the Lucan Formation. The details of the completion of the boreholes drilling in the Lucan formation is presented in Table 1.

During the 200 series site investigation five samples described as grey gravelly sandy silty clay were taken at different depths from two boreholes (BH222 and BH223A) and analysed for permeability. The results of the testing range between 5.0×10^{-11} m/s and 4.1×10^{-10} m/s. Falling and rising head tests were also carried out during the 100 and 200 series site investigations in sixteen boreholes. Of these it is considered that only six can be relied as tests carried out in monitoring installations with screened sections only in the Dublin Boulder Clay. A total of ten tests were carried out in the six holes. Of these three did not achieve 37% recovery as specified under BS 5930:1999 +A2:2010 [11] and another three which did achieve the 37% recovery were all less than 1×10^{-7} m/s, which marks the reliable lower limit for variable head tests [11 & 12]. The permeability results from the remaining four tests ranged from 1.7×10^{-7} m/s to 7.6×10^{-6} m/s, with a geometric mean of 1.0×10^{-6} m/s. Although generally the results of the rising and falling head tests suggest that the Dublin Boulder Clay has a low permeability they are not as low as the laboratory results. The variability in the results between the laboratory tests and the rising and falling head test may reflect the differences in the vertical hydraulic conductivity (laboratory tests) and horizontal hydraulic conductivity (rising and falling head tests). It is considered that the results of the tests confirm that the Dublin Boulder Clay comprises an aquitard where it is present as a single continuous unit. The results of the laboratory testing and rising and falling head tests in the Dublin Boulder Clay are presented in Appendix E.

During the EGS geophysical borehole fluid logging of the flow rate in the borehole, temperature and electrical conductivity were recorded in FS01/15 and FS02/15 during static and pumped conditions.

During pumped conditions the pump was installed in the PVC casing. The results of the EGS geophysical logging are presented in Appendix F.

In general during the pumped conditions flow into the borehole (recorded as positive) is recorded between the base of the PVC casing and approximately 45 mbgl (-37.0 mOD) in FS01/15 and 86 mbgl (-65.9 mOD) in FS02/15. The presence of groundwater ingress in these areas is reflected to a small degree by alteration in the electrical conductivity and temperature logs recorded during pumping compared to the static conditions. The recorded flows rates are greatest at approximately the 13 m below the base of the PVC in FS01/15 between -12.9 mOD and -26.1 mOD and approximately 20 m below the base of the casing in FS02/15 between -3.4 mOD and -22.9 mOD. Based on the interpretation of the geophysical logs provided by European Geophysical Services (EGS) it is noted that flow intervals were recorded at -15.16 mOD, -18.76 mOD, -25.16 mOD and -39.46 mOD in FS01/15 and -4.38 mOD, -11.88 mOD, -23.88b mOD, -39.48 mOD and -48.08 mOD in FS02/15. Based on the results of the geophysical fluid logging the flow into the borehole appears to be generally diffuse and along numerous fractures rather than discrete zones.

Groundwater level monitoring of the Lucan Formation has been carried out at the site during June 2015 using both manual measurement and automated water level recording devices which have been recording water levels at 30 minute intervals. A hydrograph showing the water levels recorded in the Lucan Formation during June is presented in Drawing 5.

A summary of the groundwater level monitoring collected between the 4th and 17th of June 2015 prior to the pump tests across the new children's hospital is presented in Table 3. The results of a number of pump tests are shown on the hydrographs. The pump tests and their results are discussed in a later section.

Date		MW-1	MW-2	MW-3	MW-4	MW-5	FS-01	FS-02
04/06/2015	mbgl	4.38	3.05	N/A	12.64	0.1	0.5	3.75
	mhtoc	4.32	3.44	N/A	12.62	0.05	0.6	4.2
	mOD	16.16	17.71	N/A	6.85	7.30	7.75	17.87
12/06/2015	mbgl	3.94	N/A	4.67	12.25	Artesian	Inaccessible	3.69
	mhtoc	3.91	N/A	4.65	12.22	Artesian	Inaccessible	4.16
	mOD	16.57	N/A	15.85	7.11	Artesian	Inaccessible	17.93
17/06/2015	mbgl	3.93	3.07	4.67	12.29	Artesian	Inaccessible	N/A
	mhtoc	3.96	3.46	4.65	12.27	Artesian	Inaccessible	N/A
	mOD	16.52	17.69	15.85	7.06	Artesian	Inaccessible	N/A

Table 3: Water level monitoring prior to pumping tests

Based on the manual monitoring water levels recorded prior to pumping, the Lucan Formation has a water table range from approximately 6.85 mOD in the northern part of the site to approximately 17.93 mOD in the southern part of the site. These levels of groundwater are above the top of the Lucan Formation and indicate that the Lucan Formation is confined beneath the new children's hospital by the Dublin Boulder Clay. At MW5 in the northern part of the site intermittent artesian conditions have been observed.

The typical groundwater levels recorded across the site are presented on Drawing 6 together with the interpolated groundwater contours. Based on the water levels recorded in the groundwater monitoring boreholes it is apparent that the water level in the centre and south of the site (monitored by MW01, MW02, MW03 and FS02/15) is elevated approximately 10 m higher than groundwater levels in the north of the site (monitored by MW04, MW05 and FS01/15).

This difference indicates that there is a relatively sharp steepening of the hydraulic gradient across the northern part of the site, which may be an indicator of a change in aquifer characteristics between the north and south of the site.

These groundwater level data also indicate that the water table in the bedrock aquifer is elevated significantly above elevation of the River Camac and given the thickness of boulder clay underlying the River Camac then the hydrogeological setting indicates that the Lucan Formation under the River Camac is confined. In addition, the apparent groundwater flow towards the River Liffey, and not towards the River Camac, further indicates that connectivity between aquifer and River Camac in the vicinity of the new children's hospital is unlikely and that groundwater from the new children's hospital site does not support baseflow in the River Camac. On this basis all groundwater flow through the bedrock aquifer below the site is considered to discharge to the River Liffey or Dublin Bay. It is likely that this groundwater would contribute to baseflow of the River Liffey down gradient from Heuston Railway Station.

2.5 Hydrology

The new children's hospital is located in the catchment of the River Camac (also known as the Cammock) which flows generally to the east in the vicinity of the new children's hospital. At its closest point the Camac is located approximately 60 m to the north of the new children's hospital.

The River Camac was viewed from two locations up and down stream of the site and was seen to be in an engineered concrete lined channel approximately 5-10 m wide with vertical concrete banks. Photographs of the River Camac together with a map showing the locations where the photographs were taken is presented on Drawing 9. At the locations that the River Camac was viewed the flow was observed to be approximately 0.1 m to 0.3 m deep and was flowing steadily. The river was viewed on the 3rd July 2015 following a relatively dry period.

Dublin City Council monitor water level in the River Camac at Lady's Lane, Kilmainham approximately 350 m upstream of the new children's hospital (Drawing 4). Drawing 10 shows the water level in the River Camac between July 2014 and June 2015.

The water levels recorded at Lady's Lane indicate a flashy river that responds quickly to rainfall suggesting that there is considerable amount of low permeability ground cover in the catchment. In addition water levels do not subside quickly after cessation of rainfall suggesting that the river receives a component of baseflow. Although the extremely low water levels recorded around June 2014 and May 2015 suggest that the source of this baseflow has a limited storage which can become depleted within a few weeks. Based on the site observations and the hydrograph it is considered that in the vicinity of the site the Camac is not tidal.

Approximately 600 m north east of the new children's hospital the River Camac enters a covered channel for approximately 250 m and outfalls to the River Liffey at a location approximately 850 m to the north east of the new children's hospital in the vicinity of Heuston Railway Station.

The Grand Canal is located approximately 400 m from the new children's hospital at its closest point. The Grand Canal runs from the River Shannon at Balinasloe, Co Offaly to the River Liffey at Grand Canal Dock, Dublin. In the vicinity of the site any flow in the canal is considered to be to the west towards the Grand Canal Dock. The Grand Canal was constructed in approximately 1803 [12]. The canal was made watertight by lining it with 9" to 10" of "puddle clay" (a mixture of clay or loam and sand/gravel and water) [13].

The Grand Canal is unlikely to be in continuity with the groundwater in the Lucan Formation in the vicinity of the new children's hospital.

The River Liffey flows generally from the west to the east approximately 670 m to the north of the new children's hospital at its closest point. At the point where the River Camac enters the Liffey the river is tidal. The River Liffey is tidal up to Islandbridge which is located approximately 1100 m to the north-west of the site.

No evidence is recorded on the information provided of the unnamed water course seen on the 1821 map.

A deep buried sewer runs through the site known as the Drimnagh Sewer. The sewer comprises a combined foul water and as storm water which run in separate channels. The storm water component is known to drain into the River Camac in the vicinity of the new children's hospital. It is possible that the storm water component of the Drimnagh sewer captures water from unnamed water course upstream of the site.

No Special Areas of Conservation (SAC's), Special Protection Areas (SAC's) or Natural Heritage Areas are located within 5 km of the site which comprise groundwater dependent habitats have been identified.

2.6 Conceptual Site Model

Based on the information reviewed a schematic section has been prepared which shows the interaction of the geological, hydrogeological and hydrological regime in the vicinity of the new children's hospital. This is presented on Drawing 4. The line of section for the conceptual site model has been drawn generally in the direction of groundwater flow and through the closest receptors.

The new children's hospital is underlain by a significant thickness of low permeability soils which in turn are underlain by a moderate aquifer with local importance. The site is not located in an area of recharge or discharge. The Camac River, located adjacent to site is considered to be not in continuity with the aquifer beneath the new children's hospital. All groundwater flow below the site is likely to drain to the River Liffey and or Dublin Bay as baseflow. In summary the site is considered to comprise a Type A (passive hydrogeological environment) as defined by the IGI [1].

3 Hydrogeological Testing

3.1 Method and Results

A series of pumping tests were carried out to provide information regarding the hydraulic conditions of the aquifer and inform assessment of the feasibility of a potable groundwater supply for the new children's hospital. The tests are not considered long term enough to inform on the sustainability of the abstraction requirement but the testing aids conceptualisation of the groundwater system and interactions with recharge.

The testing comprised:

- 1 x 3 step test in FS02/15 on 22/6/15;
- 1 x 4 step test in FS01/15 (23/6/15); and

- 1 x constant rate test in FS02/15 between 24/6/15 and 25/6/15.

The testing was undertaken in general accordance with international standard for pumping tests (ISO 14686:2003) [14]. The details of monitoring borehole construction are presented in Table 1.

Pumping was undertaken in FS01/15 and FS02/15 using a submersible 6" Gundfos pump (SP17-8). Flow rate was controlled by a manually adjusted valve. Water from the pump tests carried out in FS01/15 and FS02/15 was discharged to the Storm Water Sewer under a discharge consent. A copy of the discharge consent is presented in Appendix G.

In addition to the pump testing pumping was carried out for short interval in FS01 and FS02 to facilitate the measurement of flow in the borehole during pumped conditions. In general the pumping during geophysics testing comprised less than 2 hours pumping at a rate of less than 2.5 L/s (9 m³/hour). The pumping occurred on the 24 June 2015. Discharge from this smaller scale pumping was allowed to drain to ground in the vicinity of the trial abstraction well. Considering the relatively small amount of water (<2 m³) and the thick cover of low permeability strata over the Lucan Formation this was not considered likely to interfere with the results of the pumping test.

Monitoring

Prior to and during the tests monitoring was carried out in nearby monitoring wells (MW01 to MW05) together with the pumped wells FS01/15 and FS02/15. Manual monitoring commenced on the 4 June 2015 and water level data loggers were installed on the 12 June 2015 to provide background water level information prior to the testing. The monitoring continued throughout the period of testing and was supplemented with manual dip measurements. The water level monitoring carried out during the tests is presented in the hydrograph on Drawing 5.

In addition to monitoring water levels the flow rate was continuously monitored from the rising main during pumping. Results from flow monitoring provided by the contractor for the step tests are presented in Appendix H.

Step Tests

Step tests were carried out in the both FS01/15 and FS02/15 to inform the design of the constant rate test to be carried out. The step pumping tests in FS01/15 and FS02/15 were undertaken by pumped continuously with the abstraction rate increasing incrementally with each step. To accommodate the pump tests within the necessary working hours on site each step lasted 60 minutes. Pumping did not cease during the step test, preventing recovery of the water level until the test was complete.

The pumping rates for the step test were selected by the supervising hydrogeologist based on the capacity of the pump and the drawdown recorded during the test. The first steps were carried out at the lowest rate allowable with the 6" pump considering the lift required to discharge the water to the storm water sewer. It was noted that during the first steps, which were pumped at a lower rate, the pump rate did not remain as stable as the higher rates. The discharge rates during each step and maximum drawdown are presented in Table 4 below.

The results of the step tests of FS01/15 and FS02/15 are presented in Drawings 10 and 11 as water level against log time. During the step test in FS02/15 the level of drawdown reached the maximum allowable drawdown and the test had to be cut short after the end of the third step.

Borehole	Step (time in mins)	Flow rate (Q) (m ³ /hour)	Maximum drawdown (S _{max}) (m)	Specific capacity Q/s (hour/m ²)
FS01/15	1 (60)	7.55	9.15	0.825
	2 (120)	8.08	11.15	0.725
	3 (180)	10.10	15.50	0.652
	4 (240)	10.80	17.68	0.611
FS02/15	1 (60)	9.57	7.56	1.266
	2 (120)	11.64	11.47	1.015
	3 (180)	12.77	14.21	0.899

Table 4: Summary of the results of the step tests

Constant Rate Test

Of the two trial abstraction wells FS01 is located in the more sensitive location in relation to residential properties hence the NPHDB requested that the constant rate test be carried out in FS02/15 where more screening is provided to mitigate against any noise from the generator during the test.

Based on the results of the step test the discharge rate for the constant rate test in FS02/15 was selected as 10.5 m³/hour. This was selected based on an estimation of demand and estimated maximum drawdown. With the pump hung at the base of the PVC the maximum allowable drawdown for the constant rate test in FS02/15 was 18.5 m.

During the test the flow rate was continually monitored and a total cumulative volume discharged was recorded. The test was terminated at approximately 23.5 hours due to the maximum drawdown being achieved. At the point of completing the tests a total volume of 237 m³ had been abstracted which equates to approximately 10.1 m³/hour.

Daily total rainfall recorded in mm has been obtained from Met Éireann for the period of groundwater level monitoring prior to and during the constant rate test. The rainfall is presented on the hydrograph (Drawing 7). Generally during the period of monitoring and the pump test comprises a relatively dry period. Following the 24 hour constant rate test and during the recovery stage 1.8mm of rain was recorded however considering the generally warm weather which was noted during that period and the lack of rain it is likely that there was a significant moisture deficit which would have prevented any significant recharge.

The results of the water level monitoring in the pumped borehole and monitoring boreholes are presented on the hydrograph in Drawing 7.

In addition the results of the constant rate pumping test and the recovery are presented on Drawings 13 and 14 respectively. For both the pumping and recovery phase the drawings are presented on Drawing a as log time against drawdown and on Drawing b as log time against log drawdown. The results of the change in drawdown as a result of the pumping test recorded in the monitoring boreholes and FS02/15 is presented in Drawing 15 as log time against drawdown. An electronic file presenting the compensated water levels recorded during the tests can be provided on request.

Aquifer properties calculated from the results of the pump test are presented in Table 5.

Method of analysis	Borehole used	Transmissivity (m ² /day)	Storage coefficient	Comments / Reference
Cooper-Jacob	FS02	6.1	-	[15]
Theis (recovery)	FS02	7.0	-	[16]
Logans approximation	FS02	15.8	-	Indicative as maximum drawdown was not realised
Thiem	MW01	4.4	0.00027	[16]
Thiem	MW02	8.9	0.00229	[16]
Thiem	MW03	8.0	0.00008	[16]

Table 5: Summary of the aquifer properties based on the results of the constant rate test at FS02/15.

The aquifer property results for transmissivity all generally agree with an average value of about 6.8 m²/day, which falls generally within the range of the expected values based on the GSI groundwater body description.

The values for the storage coefficient are generally within the expected range for a confined aquifer. It is noted that the values for storage are highly variable dependent on the borehole selected for interpretation. Considering that the storage is only in fractures this variation is likely to reflect the spatial variations of the fractures in the rock and capacity of the rock to relax as the pore pressure in the rock is reduced.

Water Quality Monitoring

During the step test in FS01/15 and the constant rate test water samples were tested for the general indicator parameters pH, electrical conductivity (EC) and temperature together with comments based on visual and olfactory observations. The sample where collected from a sample port attached to the discharge pipe. The results of the monitoring from FS01/15 and FS02/15 are presented below in Tables 6 and 7 respectively.

Date	Time	Temp (°C)	EC (µScm ⁻¹)	pH	Description / notes
23/06/2015	12:00	13.5	983	7.13	Slightly cloudy, grey & rotten egg smell
	12:32	13.2	976	7.43	Very slightly cloudy, grey & rotten egg smell
	12:55	13.1	982	7.50	Clear, colourless & rotten egg smell
	13:35	13.4	860	7.51	Clear, colourless & rotten egg smell
	14:15	13.7	1001	7.43	Clear, colourless & rotten egg smell
	14:35	13.9	993	7.47	Clear, colourless & rotten egg smell. Sampled (FS01_T1).
	15:30	14.4	1002	7.32	Clear, colourless & slight rotten egg smell
	15:45	14.0	860	7.34	Clear, colourless & slight rotten egg smell

Table 6: Results of the indicator parameter monitoring FS01/15

Date	Time	Temp (°C)	EC (µScm ⁻¹)	pH	Description
24/06/2015	13:05	13.9	855	7.21	Clear, colourless & odourless
	17:07	13.9	826	7.41	Clear, colourless & odourless
	17:47	13.9	826	7.41	Clear, colourless & odourless
	20:47	13.0	810	7.48	Clear, colourless & odourless
	23:47	12.8	789	7.32	Clear, colourless & odourless
25/06/2015	02:47	12.8	779	7.26	Clear, colourless & odourless
	05:47	12.9	781	7.26	Clear, colourless & odourless
	08:47	12.7	787	7.26	Clear, colourless & odourless
25/06/2015	12:35:00	14.0	808	7.35	Clear, colourless & odourless
25/06/2015	10:32:00	13.1	796	7.42	Clear, colourless & odourless. Sampled (FS02_T2).
25/06/2015	11:00:00	13.5	779	7.35	Clear, colourless & odourless. Sampled (FS03_T2).

Table 7: Results of the indicator parameter monitoring FS02/15

Based on the monitoring of indicator parameters during the pumping tests it is noted that all the parameters monitored remained generally stable. Groundwater monitored in both FS01/15 and FS02/15 have typically similar pH and temperature values. However the EC is seen to be approximately 150µScm⁻¹ higher in the FS01/15.

In addition to the general indicator parameter monitoring samples were taken during the step and constant rate tests for laboratory analysis for the suite of determinands necessary to determine if the ground water is suitable for human consumption. Samples FS01/15_T1 and FS02/15_T1 were collected by Arup from FS01/15, and FS02/15 during the third step (between 2-3hours after the start of pumping). Sample FS02/15_T2 was taken during the constant rate test in FS02/15 at 21 hours after the start of the test.

For the purpose of quality control (QC) a second samples from FS02/15 at 21 hours was sampled and analysed for the same parameters as FS02/15. The sample was labelled as FS03/15_T2. A summary of the result of the analysis compared with the drinking water quality standards are presented in Table 8. The laboratory results are presented in Appendix I.

	FS01 22/6/15 16:10	FS02 23/06/15 14:35	FS02 25/06/15 10:32	FS02 (QC) 25/06/15 11:00	Drinking water quality standards (DWS)	Units
Aluminium	153	58	10	5.5	200	µg/l
Antimony	11.3	0.904	0.398	0.406	5	µg/l
Arsenic	4.92	1.13	1	0.96	10	µg/l
Boron	168	85.7	82.9	82.2	1000	µg/l
Cadmium	0.168	0.086	0.012	0.011	5	µg/l
Chromium	2.31	2.47	3.12	3.15	50	µg/l
Copper	0.0174	0.0222	0.0009	0.001	2	µg/l
Iron	216	291	225	230	200	µg/l
Lead	3.75	4.35	0.55	0.6	10	µg/l
Manganese	41	58.2	62.4	64.4	50	µg/l

	FS01 22/6/15 16:10	FS02 23/06/15 14:35	FS02 25/06/15 10:32	FS02 (QC) 25/06/15 11:00	Drinking water quality standards (DWS)	Units
Mercury	<0.02	<0.02	<0.05	<0.05	1	µg/l
Nickel	1.59	1.29	0.79	0.86	20	µg/l
Selenium	5.49	1.76	0.98	0.92	10	µg/l
Sodium	39.1	26.2	25.3	25.6	200	mg/l
Benzo(a)pyrene	<0.32	<0.32	<0.32	<0.32	0.01	µg/l
Indeno(123cd)pyrene	<0.88	<0.88	<0.88	<0.88	0.1Sum	µg/l
Benzo(ghi)perylene	<0.41	<0.41	<0.41	<0.41		
Benzo(b)fluoranthene	<0.31	<0.31	<0.31	<0.31		
Benzo(k)fluoranthene	<0.41	<0.41	<0.41	<0.41		
Volatile organic carbons	ND	ND	ND	ND	-	µg/l
Pesticides (organophosphorus and organochlorine)	ND	ND	ND	ND	0.1 individual / 0.5 total	µg/l
Acrylamide	0.014	<0.005	<0.005	<0.005	0.1	µg/l
Fluoride	0.97	0.68	0.67	0.71	800	mg/l
Sulphate	178	76.1	69.2	69.1	250	mg/l
Chloride	51.3	38.4	37.8	37.8	250	mg/l
Nitrate	<0.37	<0.37	<0.37	<0.37	50	mg/l
Nitrite	<0.009	<0.009	<0.009	<0.009	0.5	mg/l
Cyanide	<0.5	<0.5	<0.5	<0.5	50	mg/l
Ammonium	0.41	0.158	0.151	0.152	0.3	mg/l
Bromate	<0.1	<0.1	<0.1	N/S	10	mg/l
Tritium	<5.0	<5.0	<5.0	N/S	100	Bq/l
Total organic carbon	0.57	0.52	0.55	0.51	-	mg/l
Total coliforms	0	0	0	0	0	CFU/100ml
Enterococci	0	0	0	0	0	CFU/100ml
Escherichia Coli	0	0	0	0	0	CFU/100ml
Clostridium perfringens	1	0	0	5	0	CFU/100ml
pH	7.28	7.26	7.37	7.39	>6.5 and <9.5	pH units

	FS01 22/6/15 16:10	FS02 23/06/15 14:35	FS02 25/06/15 10:32	FS02 (QC) 25/06/15 11:00	Drinking water quality standards (DWS)	Units
Electrical conductivity	897	724	699	700	2500	µS/cm
Turbidity	5.01	2.05	2.56	2.31	-	NTU

Table 8: Summary of the laboratory results compared with the drinking water quality standard

Notes

BOLD Denotes an exceedance of the DWS

ND None of the individual determinands in the suite were recorded above their respective detection limits

N/S Not tested for in the QC sample

Based on the results of the comparison presented in Table 8 the groundwater quality beneath the new children's hospital is considered to be typically good with only minor exceedances for iron and manganese. Exceedances for antimony and ammonium are noted in the one sample from FS01/15. This may represent poorer quality of water in the north of the site.

3.2 Discussion

The results from the step and constant rate test confirmed that the Lucan Formation responds to pumping along the lines of a traditional confined aquifer. Water levels fell rapidly in the earlier times during the testing but the rate that they decreased diminished during the test. This reflects the expansion of the cone of depression. The cone of depression continues to expand until enough water drains into the zone of contribution to balance the volume being abstracted.

During the constant rate test in FS02/15 equilibrium was not achieved. However based on the log time against log drawdown chart (Drawing 13a) the rate of decrease is shown to reduce with time.

The final pumping level and sustainable yield from a well located in a low storage and fracture controlled aquifer will depend on the depth and relative contribution of the fractures encountered by the well. This can be determined with further testing over an extended period of weeks with associated monitoring of water levels in the aquifer and the recording of rainfall events.

As stated in 3.1 the duration of the constant rate test is not sufficient to assess the sustainability of the supply. This should be assessed by further testing over a longer period of time and monitoring of the aquifer water levels and rainfall.

The well was designed to IGI (2007) and EPA (2013) guidelines, which recommend PVC casing extend below the weathered zone and the pump remains protected in the casing. For this design the PVC casing was extended by 10 m below the weathered bedrock to ensure prevent shallow inflows into the well but that enough of the well remained open to maximise on inflows, where they occur. Although extending the casing deeper into the aquifer would allow greater drawdown it is likely to reduce inflows and therefore equate to reduced yield. The well design is considered to be suitable as an abstraction well.

During pumping in FS02/15 water levels in the north of the site were seen to respond but with significantly less drawdown than those monitoring wells in the south.

On this basis although it is clear there is connectivity across the site there are differences in the groundwater between north and south of the site. The most significant difference being the natural 10m drop in water level to the north of the site. There is also a change in water quality to the north where EC is 15% higher.

4 Feasibility Assessment

Based on the results of the assessment the Lucan Formation beneath the site comprises a moderately productive aquifer. There are differences in the aquifer characteristics between abstraction wells drilled in the north and south of the site and these primarily show the water table to naturally be significantly lower south of the site

4.1 Ability of any Aquifer beneath the Site to Supply Groundwater

The pump test has confirmed that it is possible to abstract a moderate volume of water from the Lucan Formation beneath the new children's hospital which could provide the volumes required. However, the ability of the aquifer to supply the necessary volumes of water sustainably could be not assessed based on the results of this feasibility study and should be confirmed by longer term studies and longer periods of testing.

Based on the data presented and considering the guidelines of the EPA and IGI if the required rate of abstraction can be demonstrated to be sustainable a single well will not be sufficient to provide the potable water demand for new children's hospital and it is likely that a number of abstraction wells would be required. Simultaneous pumping from more than one well in an aquifer is likely lead to interaction of drawdown in the aquifer. The most appropriate configuration and number of additional wells will be confirmed based on further testing.

The current well design with the pump positioned in the well PVC casing for protection meets IGI (2007) and EPA (2013) guidelines. Based on the testing completed to date no changes to the standard well design are proposed for additional wells. The current design is considered to meet guidelines but also maximise on the open section of the well, whilst providing protection to the pump.

4.2 Quality of Groundwater beneath the Site

Based on the results of this study with the exception of the exceedences for iron and manganese the quality of the groundwater in both FS01/15 and FS02/15 has been shown to be good. In the sample from FS01 antimony and ammoniacal nitrogen are present at concentrations which marginally exceed the drinking water standards. Clostridium perfringens was detected in the quality control sample which confirms that although uncommon there is a groundwater presence. Measurement of EC shows higher values in the north of the site. This difference over a relatively short distance is unusual and may be due to tidal brackish water in the River Liffey and merits further monitoring and assessment.

The most likely source of local recharge is to the south west and distant from the site beneath the largely residential areas. There are no known licenced landfills or site operating under an IEL are present to the south west of the site.

However wherever an aquifer is open for recharge is it also potentially susceptible to pollution. Longer term water quality monitoring will need to be assessed prior to designing any final abstraction at the new children's hospital and during its operation to confirm sustainability beyond the tests of this feasibility assessment.

Treatment of the groundwater will be necessary to reduce the iron and manganese. In addition it is considered that a suitable disinfection system should be incorporated to remove any occasional bacteria seen in the groundwater.

Long term monitoring of the abstracted groundwater will be need to implemented as part of the management of the system to provide assurance that the water quality meets the necessary standards. Any monitoring will need to be compliant with the requirements of the DWS.

An assessment of the likely impacts on the surrounds any nearby groundwater dependant receptors

To support this feasibility study an assessment has been undertaken of the impacts of the abstraction on the surrounding hydrogeological features in the vicinity of the site. The assessment approach has been prepared in accordance with Table 2 of the IGI guidelines [1] for the activity "lowering groundwater levels by pumping or drainage" and Type A (passive hydrogeological environments). Consistent with the approach outlined in Table 2 of the IGI guidelines this assessment comprises a simple quantitative assessment. The impact assessment is qualitative and not based on results of the pump test.

4.3 An Assessment of the Likely Hydrogeological Impacts of Abstraction on the Surrounds and any nearby Groundwater Dependant Receptors

The Proposed Development

For the purpose of designing an abstraction system the findings of this feasibility assessment should be considered indicative. Further long term testing is required to assess sustainability, which should comprise a 10 day pump test from each abstraction well individually and collectively.

The new children's hospital has an estimated water requirement of 500 m³/day to 600 m³/day. For the purpose of this assessment it is conservatively assumed that that the supply comprises a number of boreholes which are operated with a combined abstraction rate of 550m³/day.

Potential Receptors

Abstracting groundwater at the rate required to supply the new children's hospital has the potential to drawdown groundwater levels below and in the vicinity of the new children's hospital. Lowering groundwater levels has the potential to impact groundwater dependant features in the vicinity of the site. In addition altering groundwater levels can modify groundwater flow paths and can have a physical impact on the water bearing strata and pressures within them.

For the purpose of preparing this study a search has been undertaken which has highlighted the following water sensitive receptors in the vicinity of the site:

- A number of groundwater abstractions;

- River Camac;
- River Liffey; and
- The Grand Canal.

Assessment of the Importance of the Receptors

The closest recorded groundwater abstraction to the site is the abstraction at St James Gate Brewery located 800 m from the site. This is also the receptor with the greatest recorded abstraction rate within 3 km of the site which gives it the highest importance ranking of the abstractions in the vicinity of the site. The position of the abstraction is shown on the conceptual site model (CSM) (Drawing 4). This abstraction has the potential to yield very high volumes of water as it draws water from the gravels beneath the River Liffey together with the Lucan Formation. Based on the characterisation of the Lucan Formation in this report it is considered that the gravels rather than the Lucan Formation is the main source for the St James's Gate well. Based on the Annex C of the IGI guidelines the closest groundwater abstraction receptor is considered to be of medium importance.

None of the three water courses in the vicinity of the new children's hospital have been designated as being ecologically important. Based on the CSM the River River Liffey is likely to be the receiving waters of groundwater from the Lucan Formation. There is likely to be a degree of continuity and interaction between groundwater in the Lucan Formation and the River Liffey. As such, the Lucan Formation in the vicinity of the River Liffey may be at risk of potential water quality impacts. The River Camac and the Grand Canal are not considered likely to be in continuity with the groundwater in the Lucan Formation. Based on the IGI guidance conservatively the Liffey is considered to be a highly important hydrogeological feature and the River Camac and Grand Canal are considered to be of medium importance.

Assessment of the Significance of the Environmental Impacts

It has been demonstrated in the conceptual site model that based on the information reviewed the two closest receptors (the River Camac and the Grand Canal) are not likely to be in continuity or have very limited continuity with the groundwater in the Lucan Formation. Therefore any impacts on water levels in these features will be negligible.

St James's Gate brewery draw on groundwater is a composite groundwater from the bedrock and gravels that the well is open to. Furthermore at this location the gravel aquifer is considered to be in continuity with the Liffey. Considering the significant volumes of water abstracted from the well and the moderate capability of the Lucan Formation to yield groundwater it is likely that the abstraction mostly sources its groundwater from the River Liffey via the gravel aquifer. Consequently any potential decrease in water supplied to the well from the Lucan Formation are likely to be significantly buffered by the water sourced from the gravels.

In the vicinity of the site the River Liffey is assumed to be in continuity with the gravel aquifer and thence the Lucan Formation. Consequently drawing down the water level in the Lucan Formation has the potential to impact on the baseflow to the River Liffey. Considering the distance to the river any drawdown in the Lucan Formation in the vicinity of the Liffey as a consequence of the proposed abstraction at the new children's hospital is likely to be small. In addition as the baseflow component from the Lucan Formation in the vicinity of the site is likely to be small [9] any decrease in flow in the River Liffey as a consequence of the proposed abstraction is likely to be negligible.

The risk of settlement causing damage to property are generally only considered to be significant where the water bearing strata are unconsolidated and susceptible to large changes in volume with water content, such as peat or where karstic features can become dewatered. None of these circumstances were highlighted in the immediate vicinity of the site where the drawdown will be more significant.

Silts, clays and sand and gravels within the subsoil at the site are considered to be well consolidated at not at significant risk of settlement. There are recent sediments in the river valleys, such as the Camac, that are not consolidated. However, those deposits in the Camac are considered to be perched on low permeability boulder clay above the bedrock aquifer. Consequently it is considered that the risk of settlement from the proposed abstraction having a perceptible effect on structures in the vicinity of the new children's hospital is insignificant.

5 Summary and Conclusions

A feasibility study has been undertaken on behalf of the National Paediatric Hospital Development Board to assess the ability to use a groundwater supply at the proposed National Paediatric Hospital, Dublin. For the purpose of carrying out the study a site investigation has been carried out which include pump testing of trial groundwater supply boreholes. The trial groundwater supply boreholes were designed based on the guidance of the Environmental Protection Agency (EPA) guidance.

The study assessed:

1. Ability of any aquifer beneath the site to supply groundwater;
2. Quality of groundwater beneath the site; and
3. An assessment of the likely hydrogeological impacts of abstraction on the surrounds and any nearby groundwater dependant receptors.

The study was assessed against the results of the site work and the conceptual site model (CSM). The CSM and site work highlighted that site is located on a confined moderate bedrock aquifer. Groundwater flow and storage in the aquifer is in fractures. Based on the results of the assessment the aquifer beneath the new children's hospital is considered to comprise a moderate aquifer which has potential to be exploited for groundwater supply. The water quality has been found to be of good quality but requiring treatment for iron and manganese as well as disinfection. The assessment has shown that the abstraction is unlikely to have a perceptible impact on any nearby groundwater receptors in the vicinity of the site.

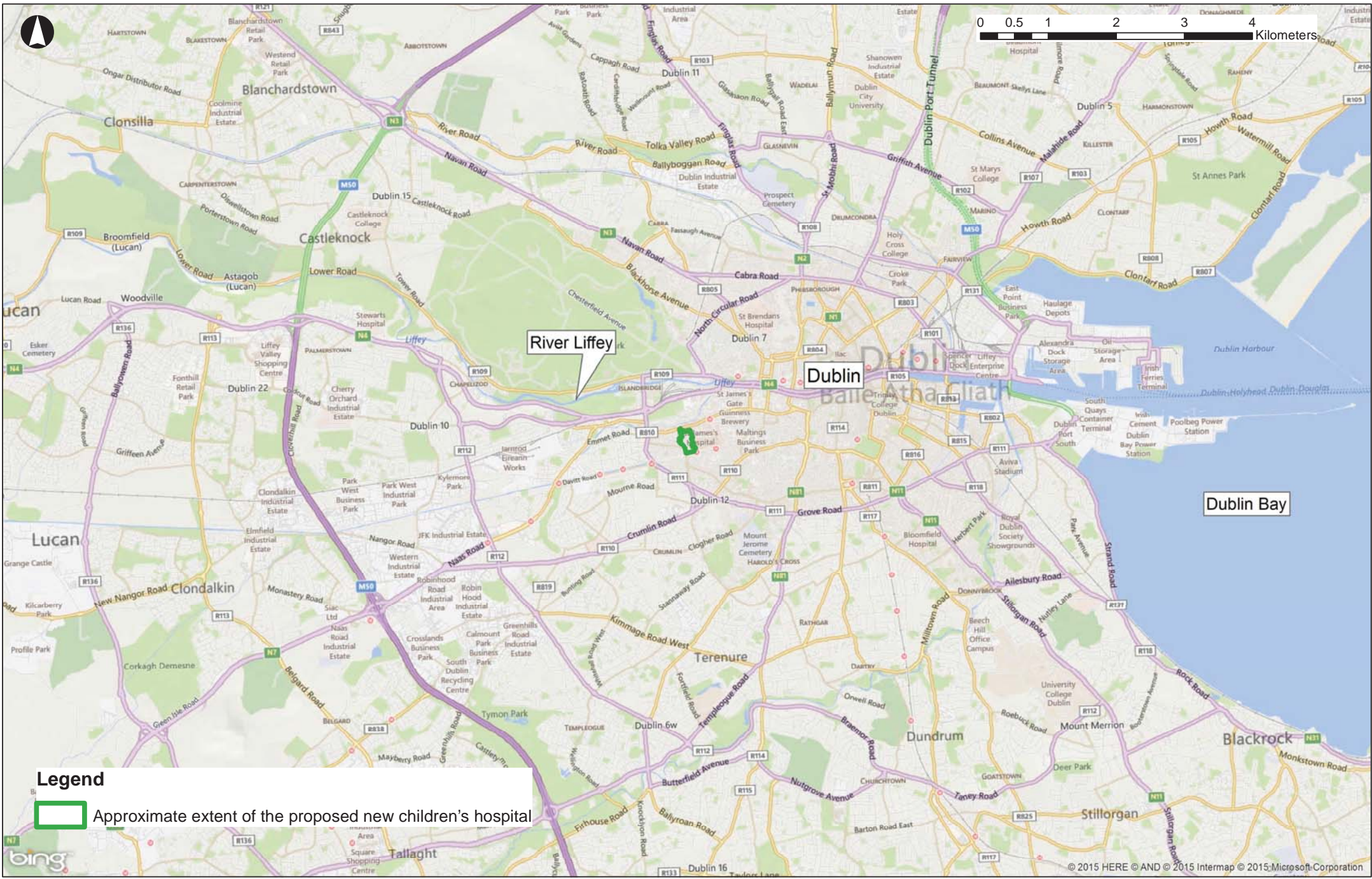
This feasibility report is an initial assessment on abstraction from bedrock aquifer. The data indicates that a number of wells would be required to provide the demand. It is recommended that these wells are located in the south of the site. Subject to further testing to confirm sustainability abstraction well FS02/15 has the potential to be part of an abstraction scheme. The well design of FS02/15 conforms to IGI and EPA guidelines.

Any final system should also be subject to longer term testing to assess the long term impacts on water levels in the aquifer and on the sustainability of the quantity and quality of the abstracted water.


6 References

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- [3] EPA, 2013. EPA Drinking Water Advice Note N0.14. Borehole Construction and Wellhead Protection.
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- [16] Kruseman, G. P. and de Ridder, N. A., 1994. Analysis and evaluation of pumping test data, International Institute for Land Reclamation and Improvement: Amsterdam.

Drawings



Legend

 Approximate extent of the proposed new children's hospital

ARUP

50 Ringsend Road
Dublin 4
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Client
**National Paediatric Hospital
Development Board**
Job Title
**St James Hospital -
new children's hospital**

Job No 237976-00	Drawing Status Issue
Drawing No Drawing 1	Scale 1:50,000
	Issue P1

Site Location



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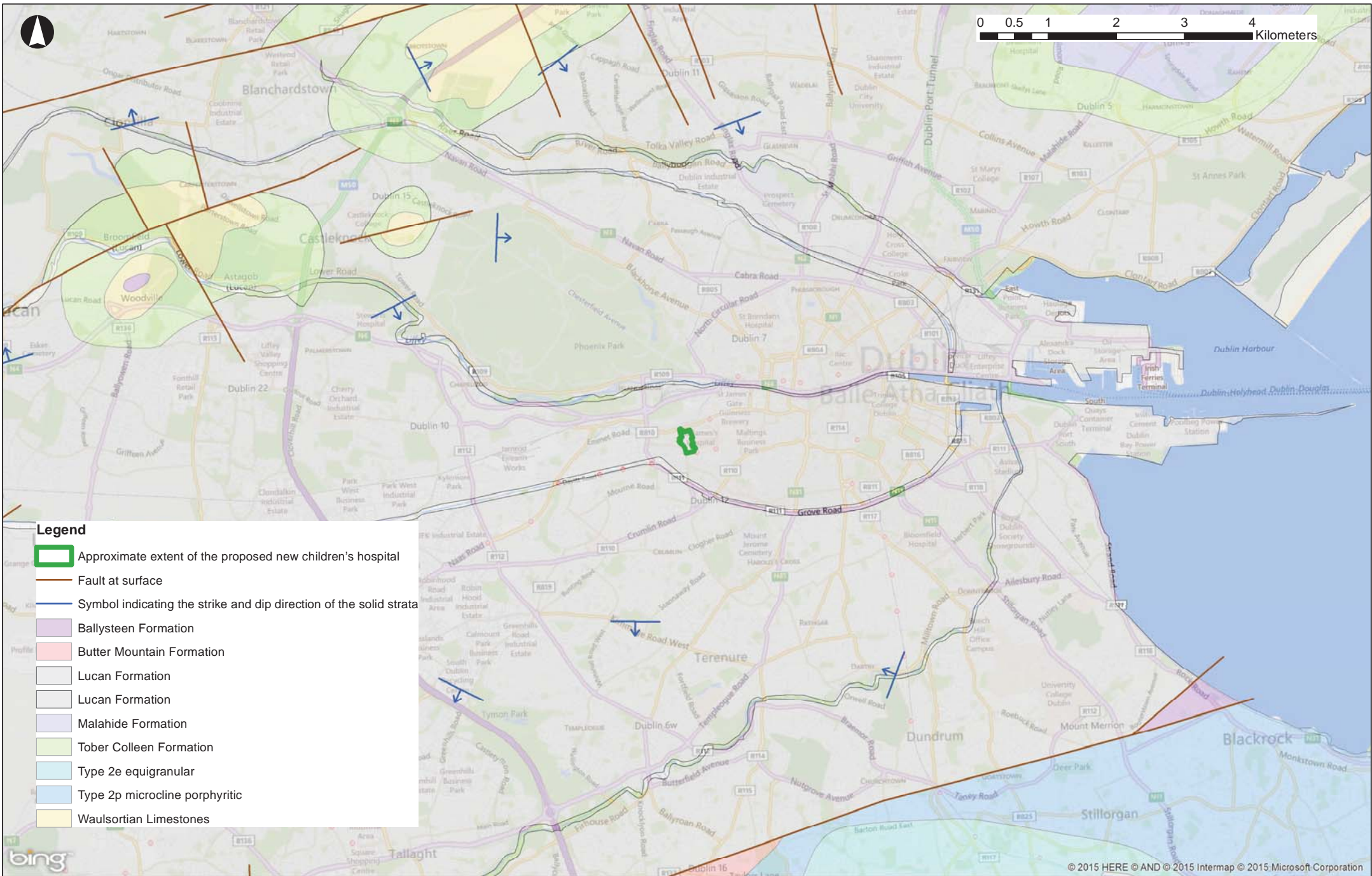
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Drawing 2

Drawing Status
Issue

Scale
1:2,000

Issue
P1

Site Plan



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Drawing No

Drawing 3

Drawing Status

Issue

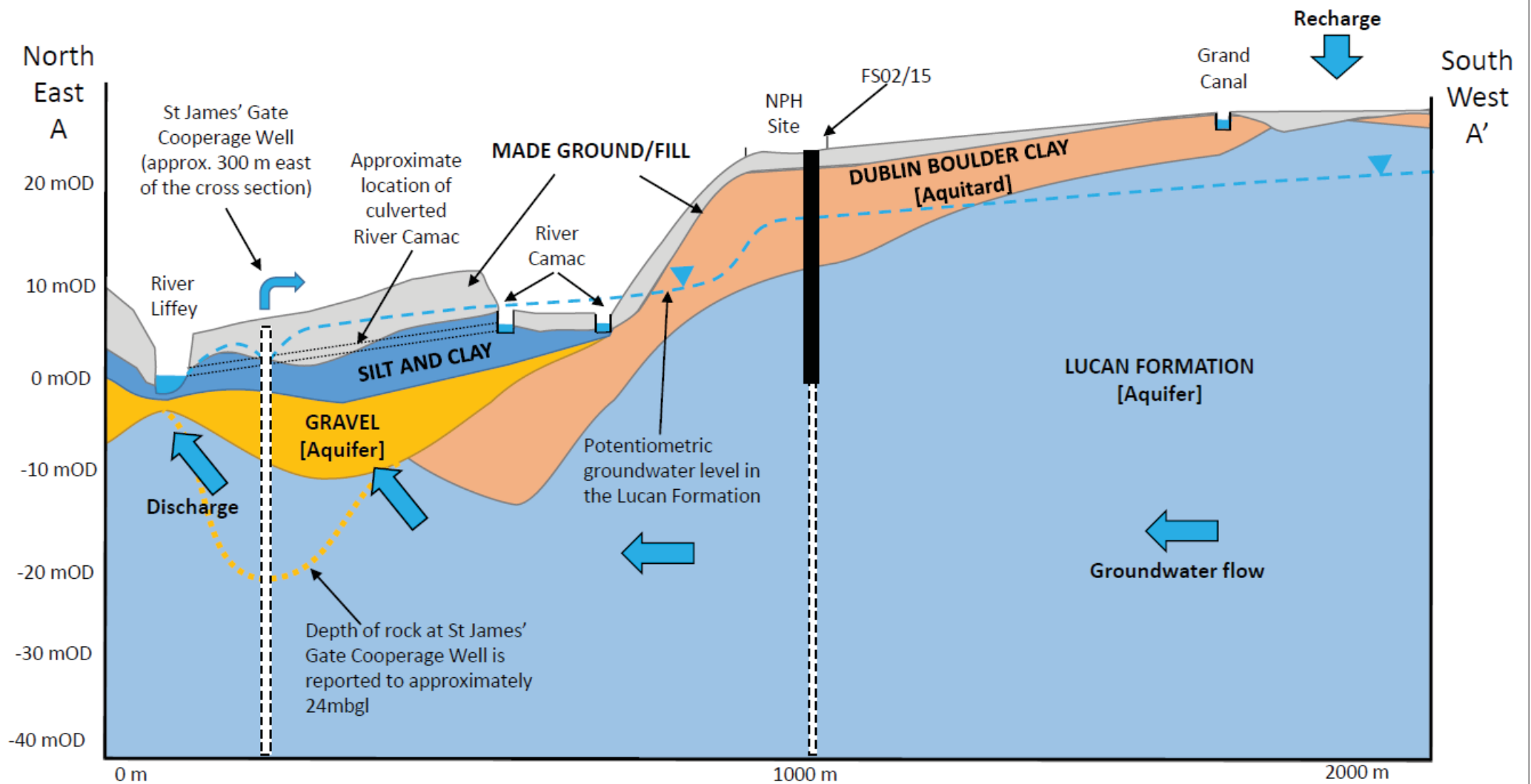
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P1

Bedrock Geology



Legend:

	23/7/2015	AO	CN	LB
Issue	Date	By	Chkd	Appd

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Job Title

National Paediatric Hospital
Project

Client

National Paediatric Hospital
Development Board

Conceptual site
model based on
schematic cross
section

Scale at A3 Not to scale

Discipline

Job No

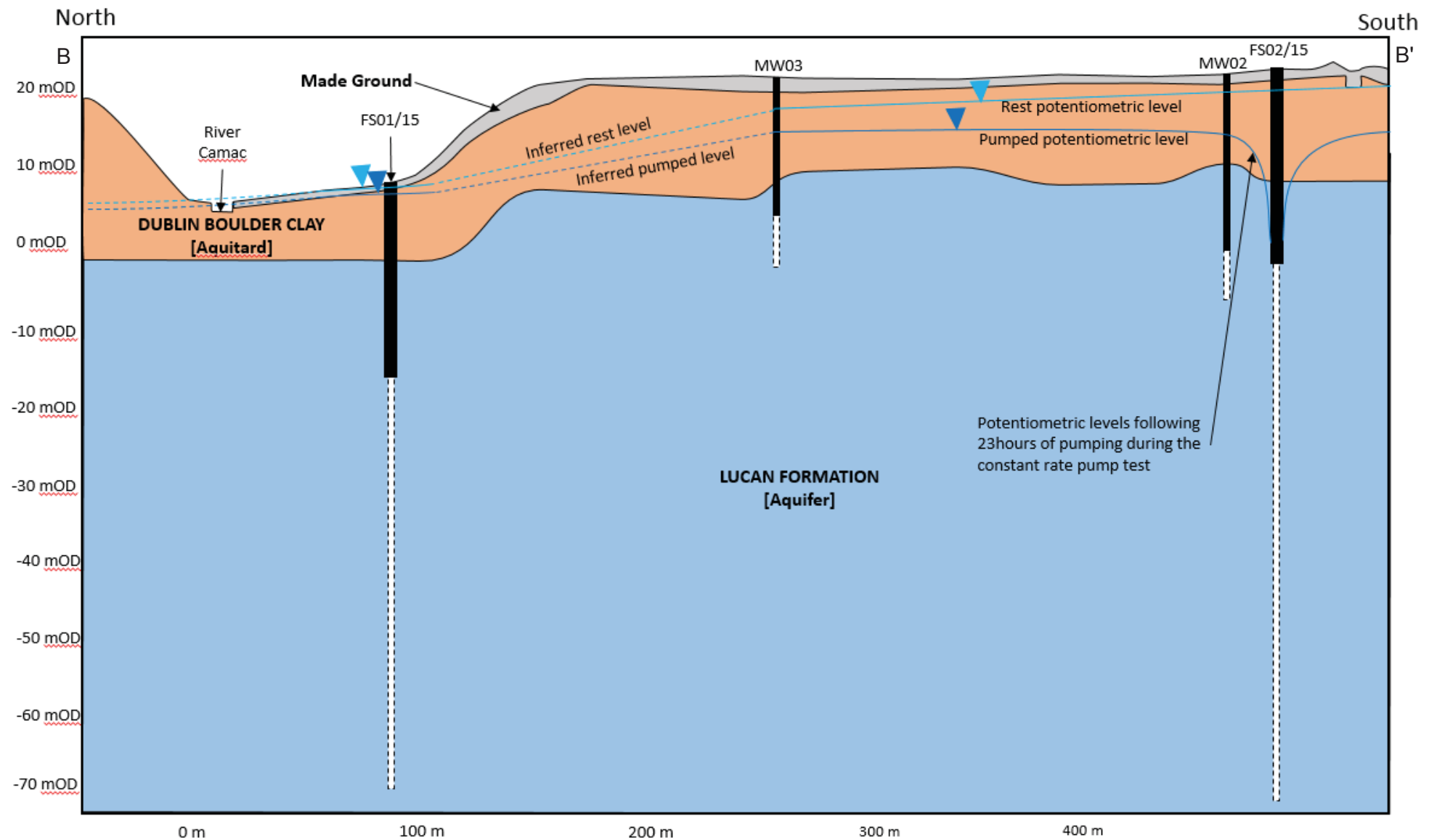
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Drawing Status

Issue

Drawing No

Drawing 4



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	23/7/2015	AO	CN	LB
Issue	Date	By	Chkd	Appd

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Job Title

National Paediatric Hospital
Project

Client

National Paediatric Hospital
Development Board

Hydrogeological
cross section

Scale at A3 Not to scale

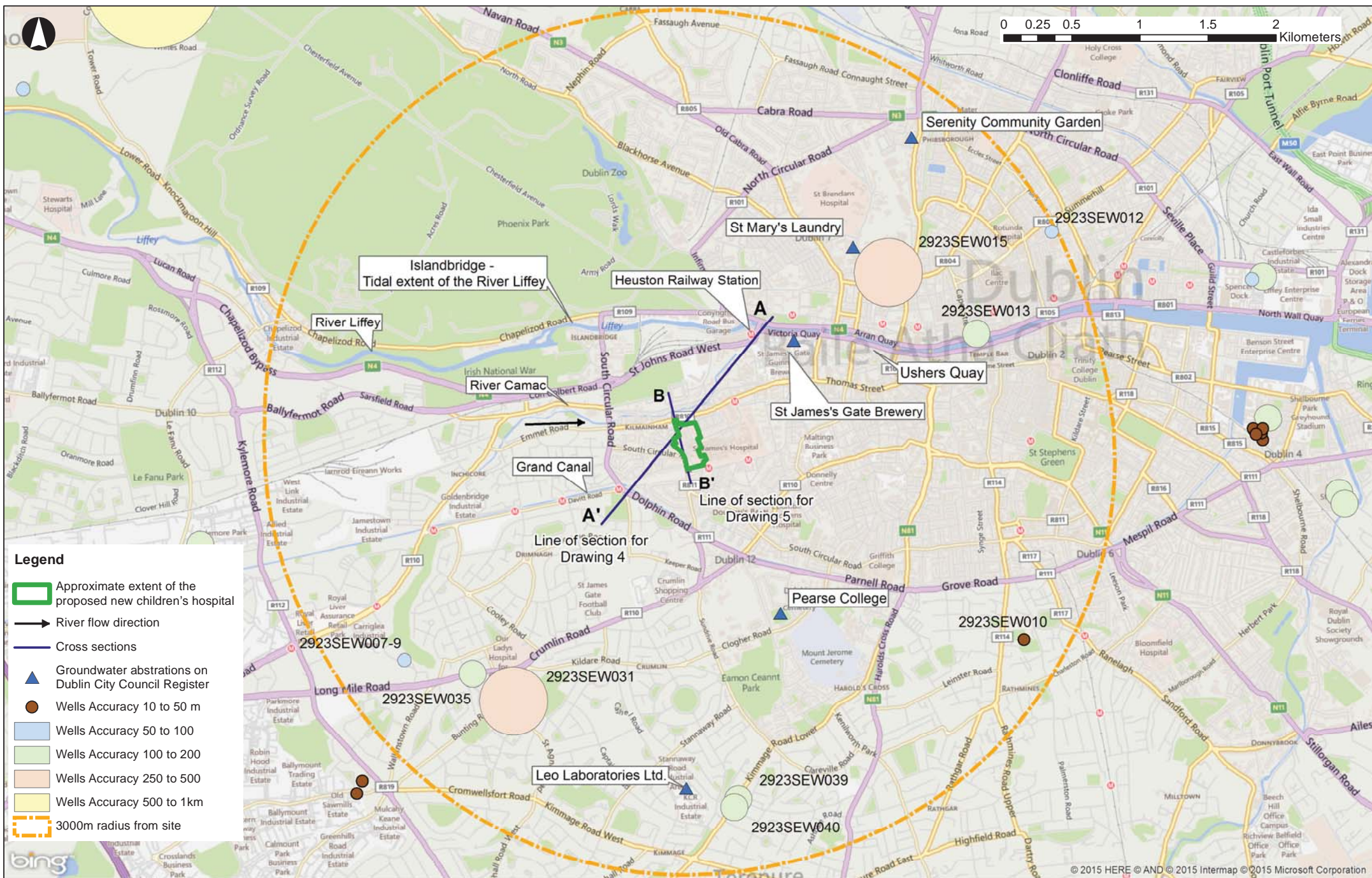
Discipline

Job No
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Drawing Status
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Drawing No

Drawing 5



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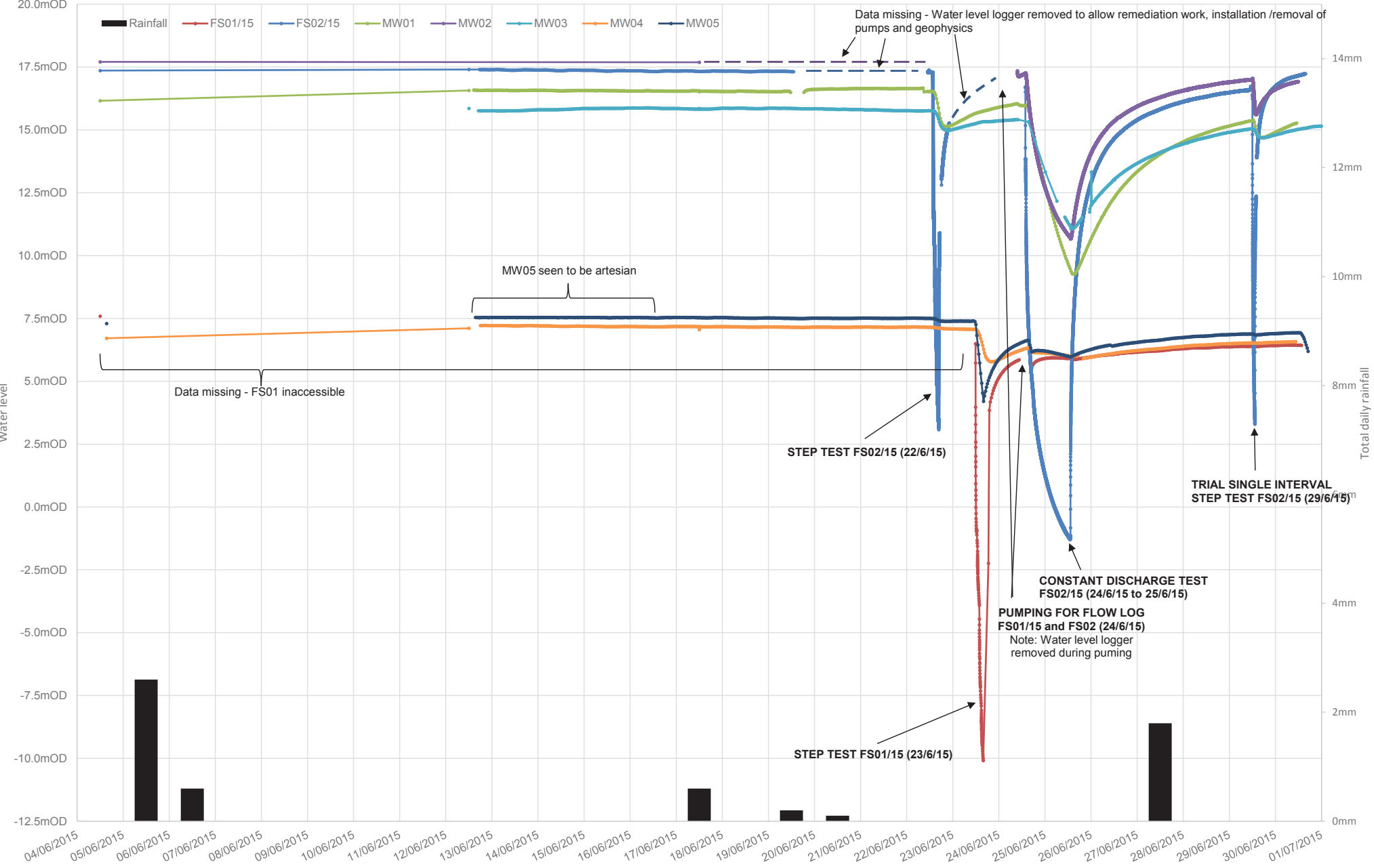
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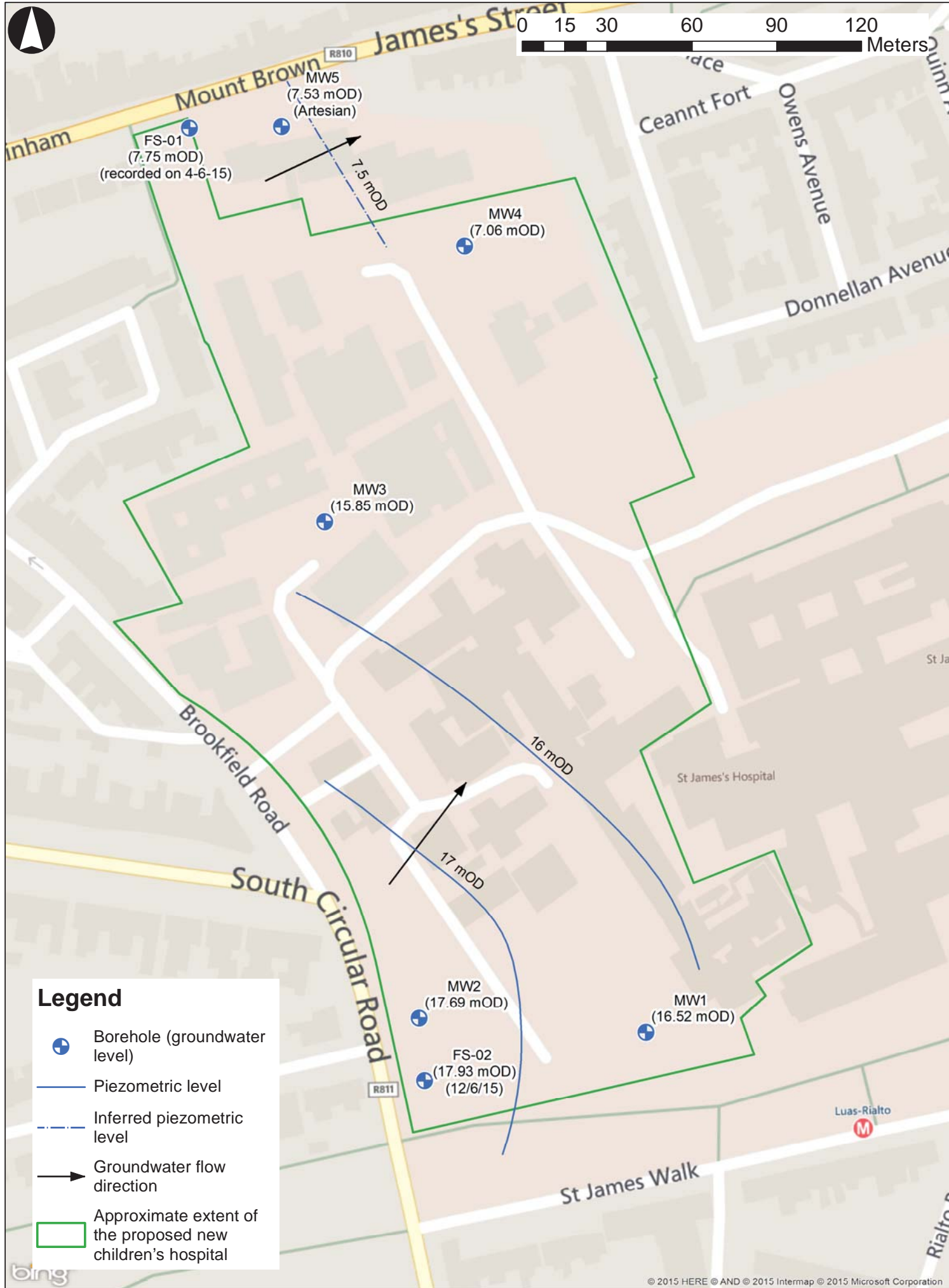
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**National Paediatric Hospital
Development Board**
Job Title
**St James Hospital -
new children's hospital**

Job No 237976-00	Drawing Status Issue
Drawing No Drawing 6	Scale 1:25,000
	Issue P1

**Water dependant features in
the vicinity of the new
children's hospital**

Drawing 7 Hydrograph showing water levels monitored in the Lucan Formation between 4 June 2015 and 1 July





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Job No
237976-00

Drawing No
Drawing 8

Drawing Status
Issue

Scale
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Issue
P1

**Piezometric level map
pre-pumping 17/6/2015**

Drawing 9: Photographs of the River Camac



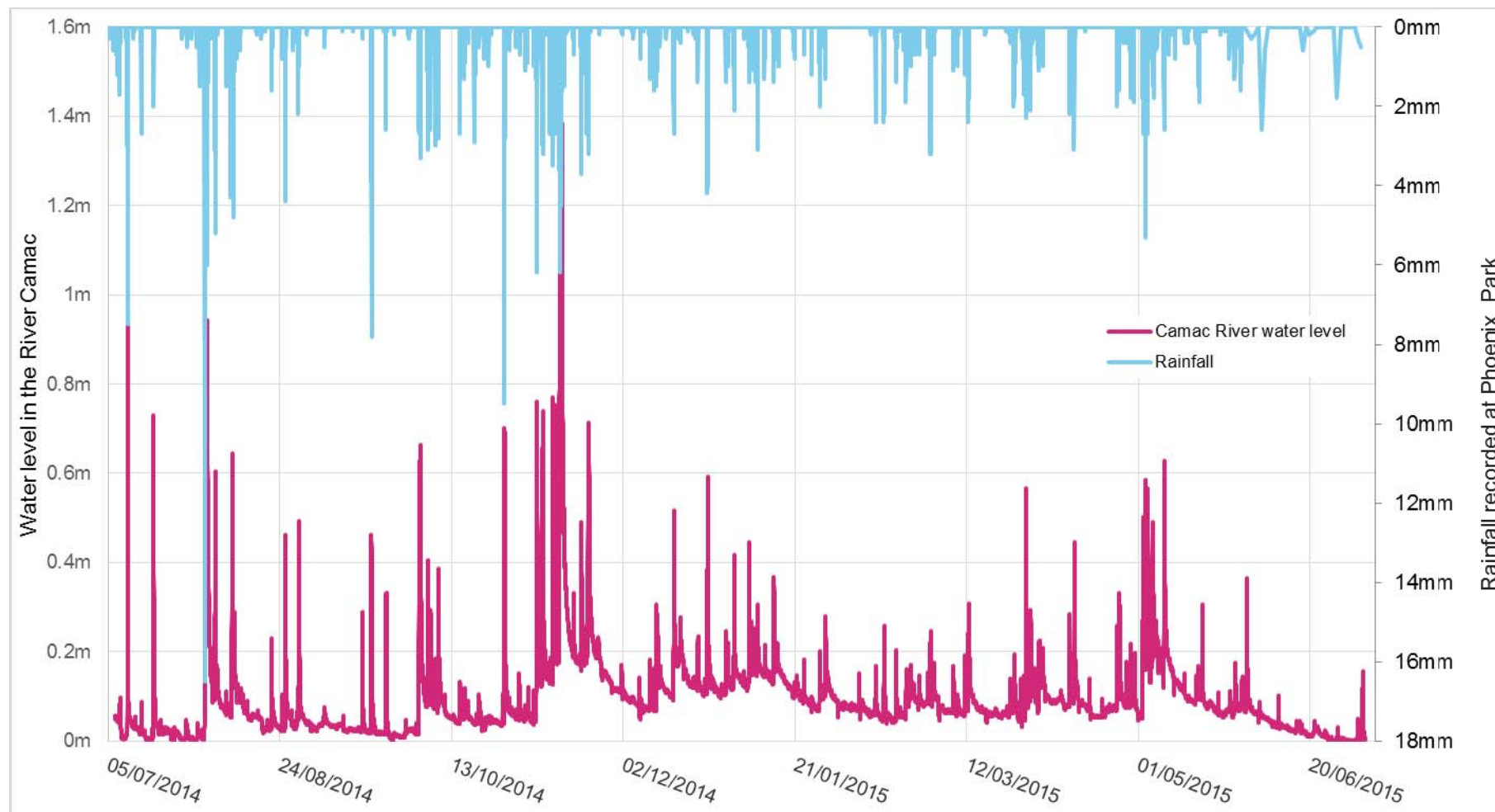
Plate 1: River Camac viewed from Bow Lane Bridge (looking upstream)



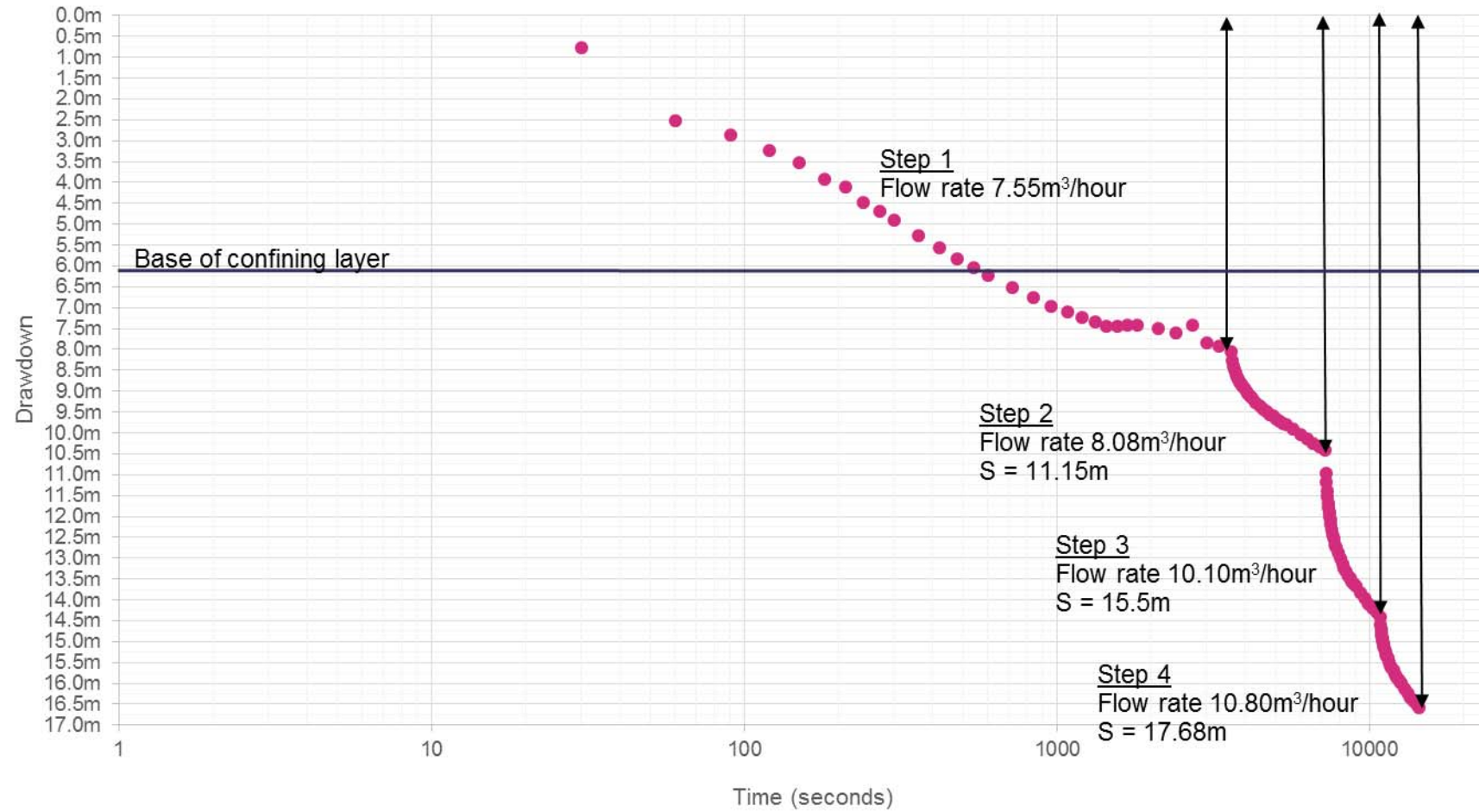
Plate 2: River Camac viewed from Rowerstown Lane Bridge (looking upstream)



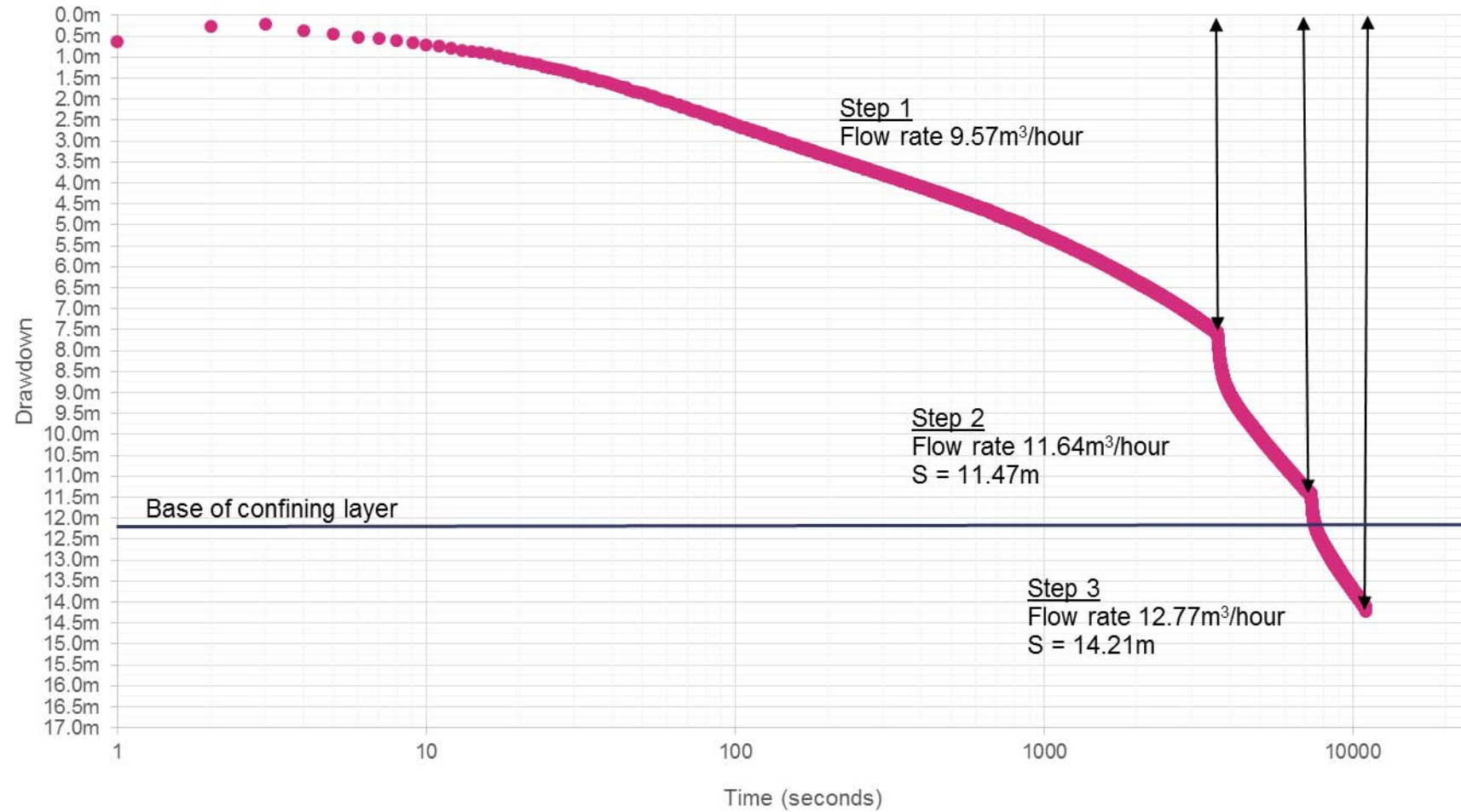
Drawing 10: Hydrograph for the River Camac recorded at Lady's Lane between June 2014 and July 2015



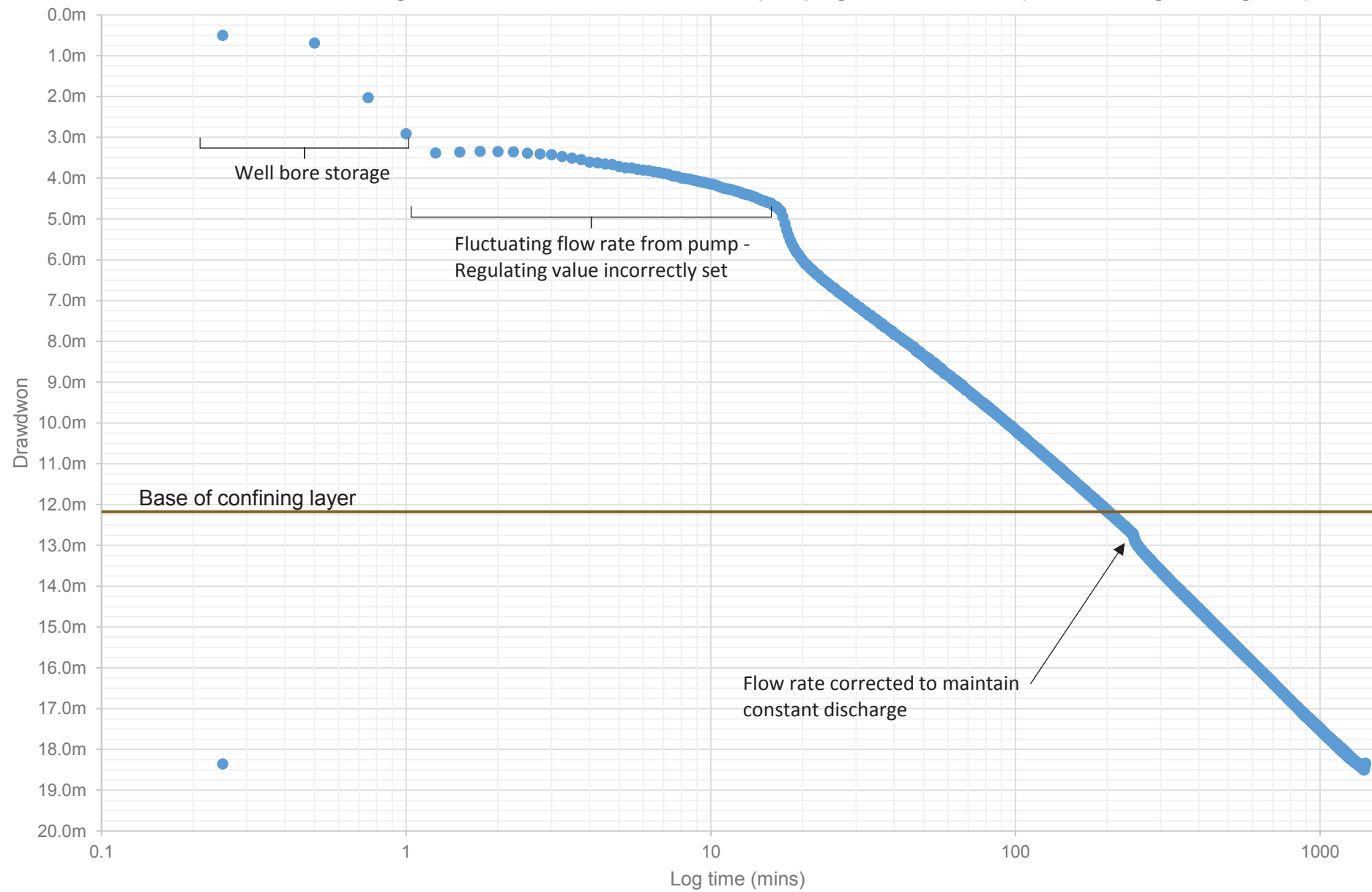
Drawing 11: Results of the step test in FS01/15



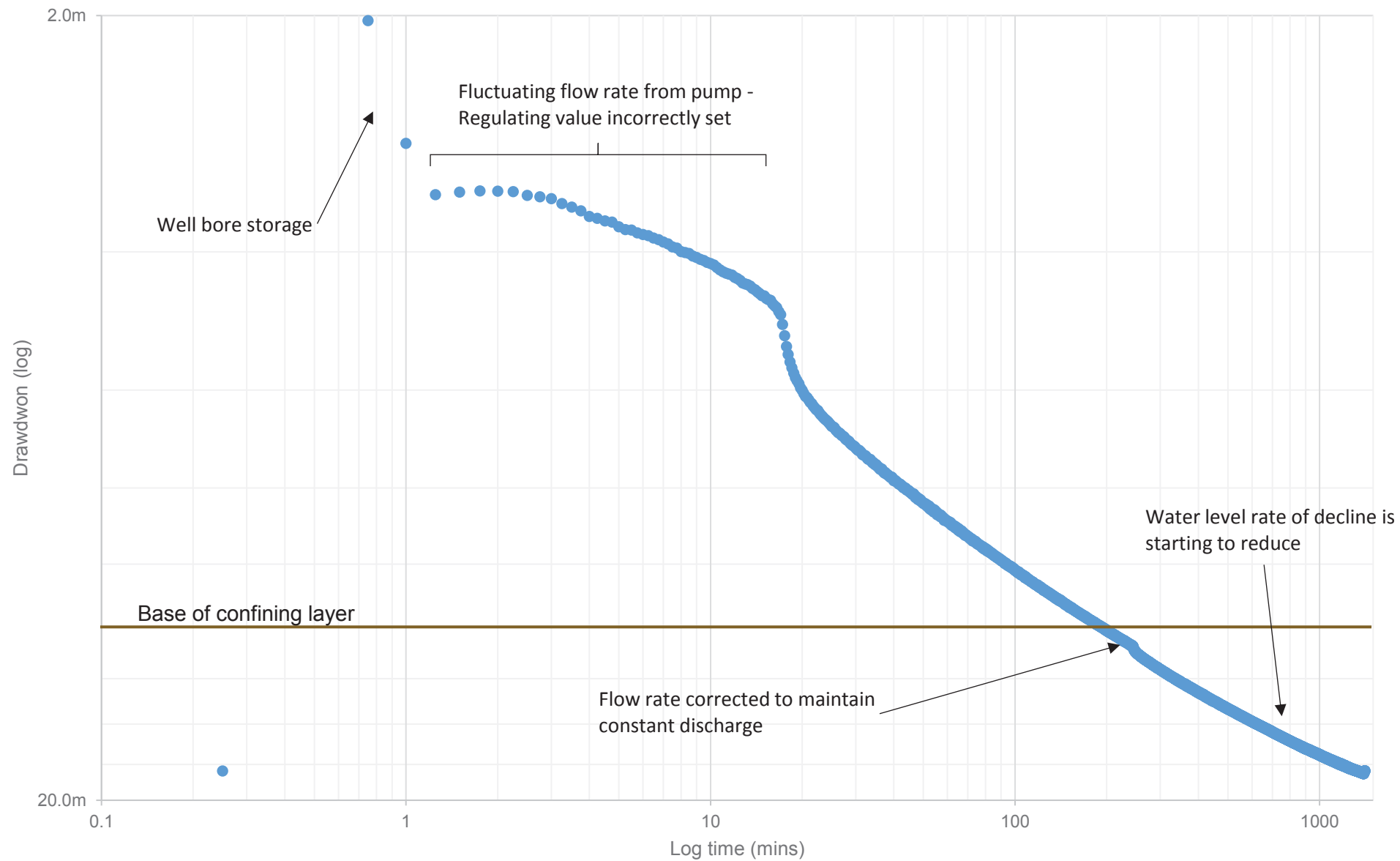
Drawing 12: Results of the step test in FS02/15



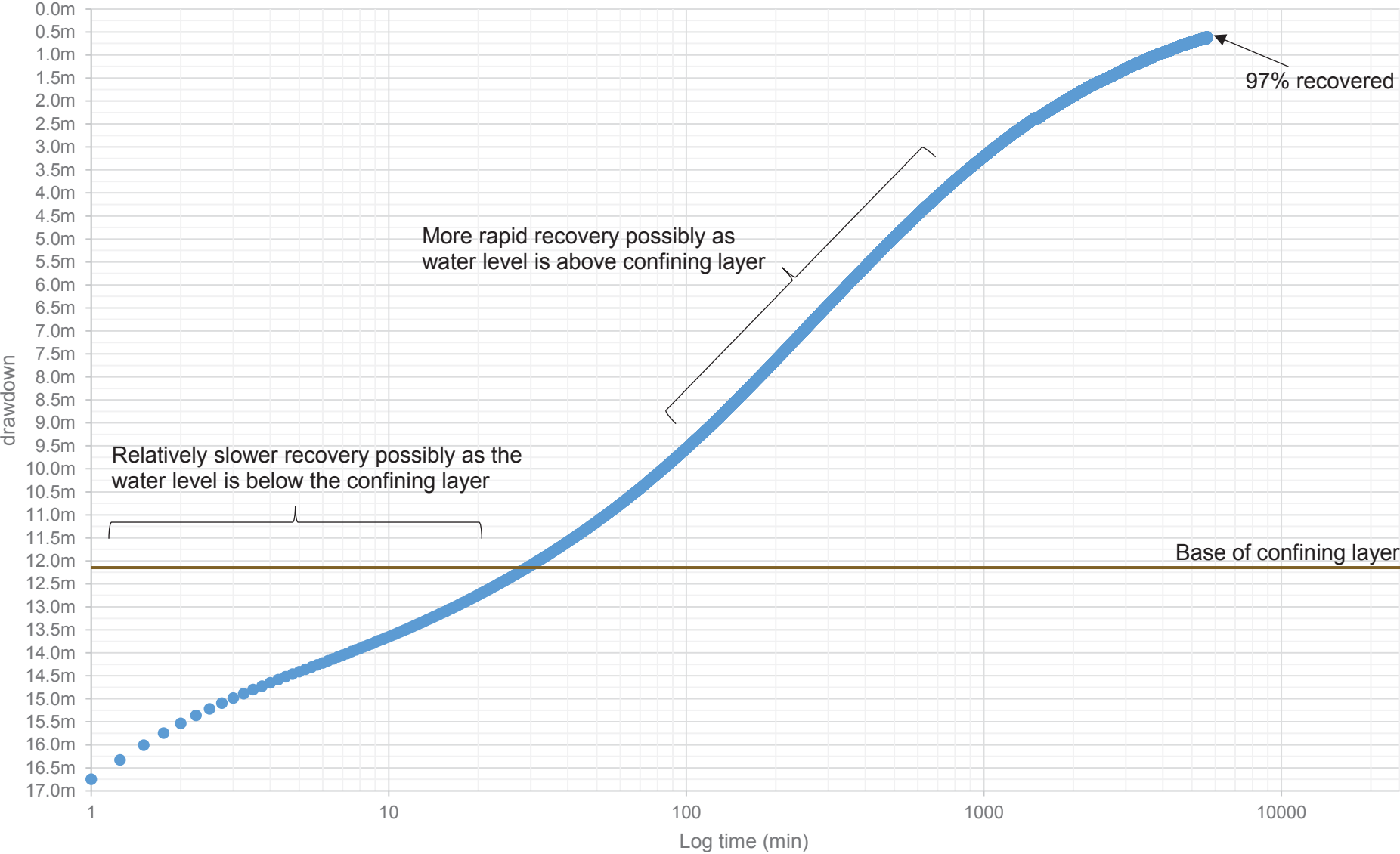
Drawing 13a: Results of the constant rate pumping test in FS02/15 (drawdown against log time)



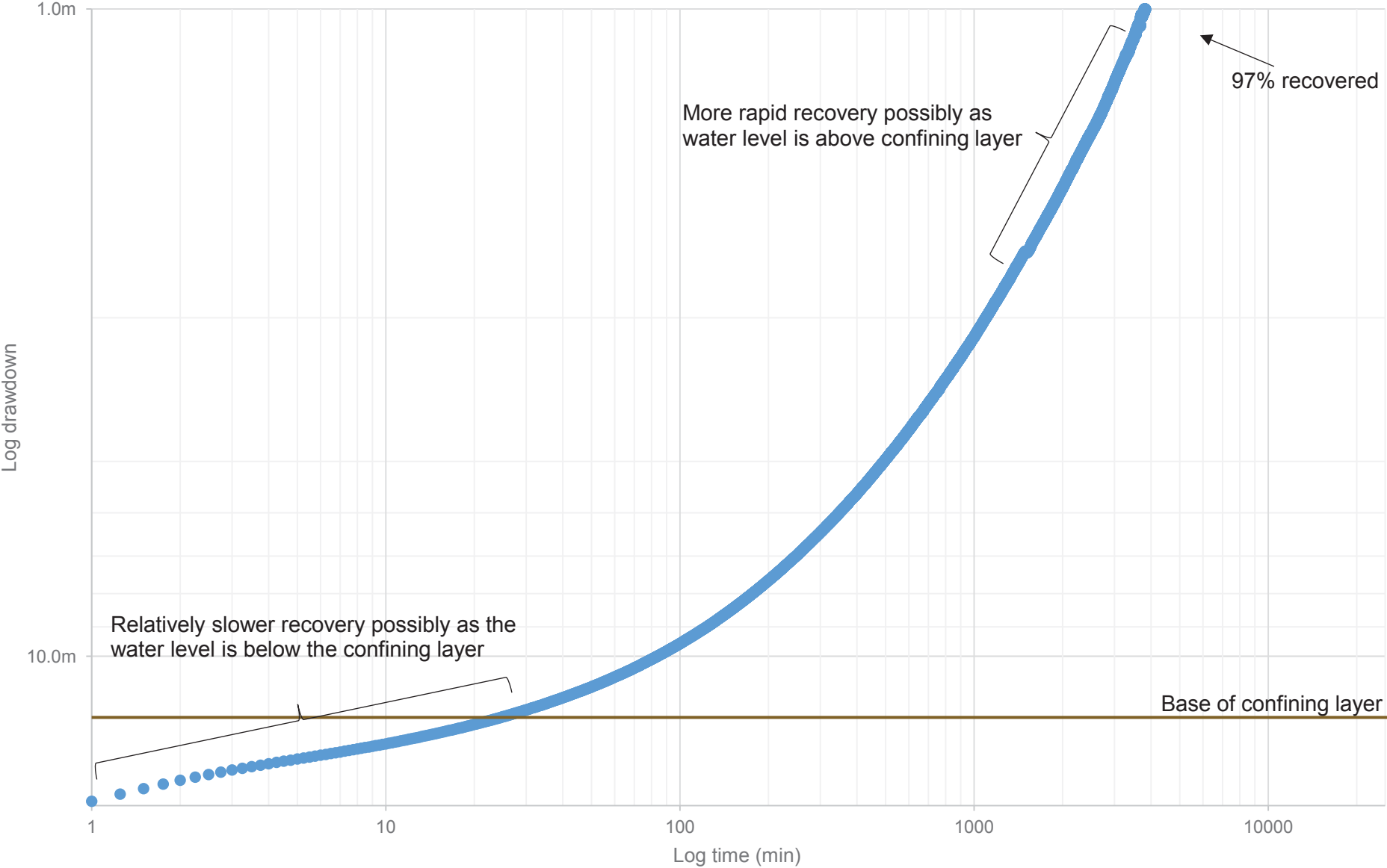
Drawing 13b: Results of the constant rate pumping test in FS02/15 (log drawdown against log time)



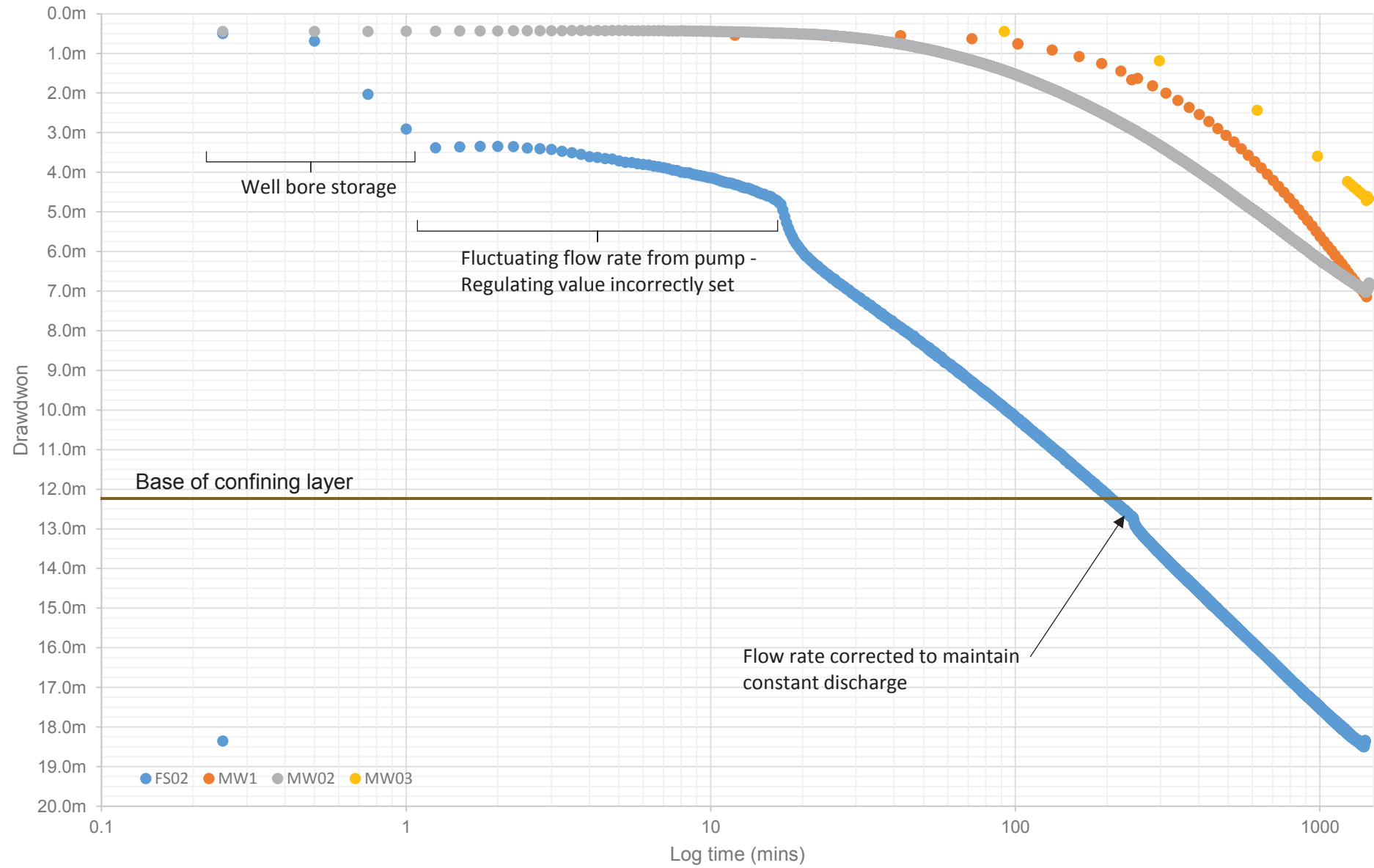
Drawing 14a: Results of the recovery following the constant rate pumping test in FS02/15 (drawdown against log time)



Drawing 14b: Results of the recovery following the constant rate pumping test in FS02/15
(log drawdown against log time)



Drawing 15: Change in drawdown in the monitoring wells as a result of the pumping test in FS02/15

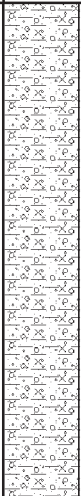
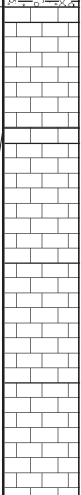
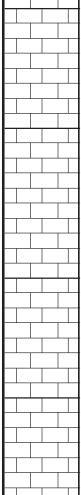



Appendix A

100 and 200 Series Borehole Logs

Causeway Geotech Ltd				Project No: 14-240	Project Name: National Paediatric Hospital, Dublin - Ground Investigation Contract	Borehole No. BH101					
Method and Equipment: Hand dug 0.00-1.20m Percussion boring 1.20-4.50m Dando 2000 Rotary coring 4.50-25.00m Comacchio 450				Co-ords: 713280.2mE 733345.8mN		Client: National Paediatric Hospital		Sheet 1 of 3			
						Engineer: Roughan & O'Donovan		Scale: 1:50			
				Ground Level: 20.88mOD		Dates: 25/06/2014 - 07/07/2014		Driller: DE/GT			
								Logger: DOM/MG			
Depth (m)	Sample / Test	Casing Depth (m)	Water Depth (m)	Field Records	Level	Depth (Thickness)	Stratum Description	Legend & Water Strikes	Backfill Installs		
0.50	B ES				20.78	0.10	MADE GROUND: Tarmac				
0.50					20.48	0.40	MADE GROUND: Hardcore Fill				
1.50	B U ES	1.50	dry	450mm Recovery	19.38	1.50	MADE GROUND: Soft to firm brown gravelly CLAY with occasional pieces of cinders. Gravel is angular fine to medium				
1.50-1.95											
2.00	SPT D B D	2.00	dry	N=10 N=10 (2,2,2,3,3)							
2.00											
2.00											
2.00											
3.80	B U	4.00	dry	450mm Recovery	17.68	3.20	BOULDER				
4.00-4.45											
4.50							Very stiff dark grey to black sandy gravelly CLAY. Sand is fine to coarse. Gravel is angular fine to medium UUT at 4.00m: indicates "high strength" At 4.50m - 6.00m: no recovery - description based on flush returns				
	0	0	0								
6.00							Very stiff to hard dark brownish and light grey sandy gravelly CLAY with occasional cobbles and rare boulders. Sand is fine to coarse. Gravel is subrounded to subangular fine to coarse. Cobbles and boulders are subrounded to subangular				
	100	0	0								
7.50											
	100	0	0								
9.00											
	100	0	0								
	TCR	SCR	RQD	FI							
Remarks: SPT's carried out using SPT hammers: DA08 to 4.50m and SPT1 used to 25.0m					Chiseling: From (m) to (m) time (hh:mm) 3.20 3.80 00:30		Water Strikes: Struck (m) rising to (m) time (min) 3.80 3.60 15		Last Revised: 14/11/2014 www.causewaygeotech.com (c) Causeway Geotech Ltd		
					Core Barrel: SK6L		Casing: to (m) dia. (mm) 4.00 200 25.00 146				
					Flush type: Water/Polymer						

Continued next sheet

Causeway Geotech Ltd					Project No: 14-240	Project Name: National Paediatric Hospital, Dublin - Ground Investigation Contract	Borehole No. BH101		
Method and Equipment: Hand dug 0.00-1.20m Percussion boring 1.20-4.50m Dando 2000 Rotary coring 4.50-25.00m Comacchio 450					Co-ords: 713280.2mE 733345.8mN		Client: National Paediatric Hospital Sheet 2 of 3		
							Engineer: Roughan & O'Donovan Scale: 1:50		
					Ground Level: 20.88mOD		Dates: 25/06/2014 - 07/07/2014 Driller: DE/GT		
							Logger: DOM/MG		
Depth (m)	TCR	SCR	RQD	FI	Field Records	Level Depth (Thickness)	Stratum Description	Legend & Backfill Water Strikes Installs	
10.50							Very stiff to hard dark brownish and light grey sandy gravelly CLAY with occasional cobbles and rare boulders. Sand is fine to coarse. Gravel is subrounded to subangular fine to coarse. Cobbles and boulders are subrounded to subangular From 10.50m - 12.00m: becomes light grey in colour		
	100	0	0						
12.00							Medium strong to strong thin to medium bedded dark grey fine to medium grained clastic LIMESTONE. Partially weathered, locally distinctly weathered to destructured with loss of strength and structure adjacent to fractures with weathering to a residual clay Discontinuity Set 1: bedding planes, close to medium spaced, 10-20 degrees, planar, rough, completely weathered to infill of residual clay (sandy gravelly clay <15-20mm thick)		
	100	9	0						
13.50					13.30	7.58 13.30 (0.80)	Strong, locally very strong, thinly to medium bedded dark grey fine to medium grained LIMESTONE with rare calcite veins. Partially weathered, locally distinctly weathered adjacent to bedding planes with loss of strength and structure Discontinuity Set 1: bedding planes, close to medium spaced, sub-horizontal, planar, rough, open and clean with grey staining to locally closed and infilled with calcite Discontinuity Set 2: joints, probably close to medium spaced, 60-70 degrees, planar to curved, rough, open and stained dark grey to occasionally lined with sandy clay		
	100	85	74	5		6.78 14.10			
15.00					15.75				
	100	93	54						
16.50									
	100	85	26						
18.00									
	100	97	45	11					
19.60						(10.90)			
	TCR	SCR	RQD	FI			Continued next sheet		
Remarks: SPT's carried out using SPT hammers: DA08 to 4.50m and SPT1 used to 25.0m							Chiseling: From (m) to (m) time (hh:mm)	Water Strikes: Struck (m) rising to (m) time (min)	Last Revised: 14/11/2014
							Core Barrel: SK6L Flush type: Water/Polymer	Casing: to (m) dia. (mm) 4.00 200 25.00 146	
							 www.causewaygeotech.com (c) Causeway Geotech Ltd		

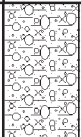
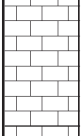
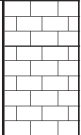
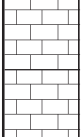
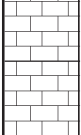
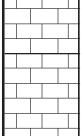

Causeway Geotech Ltd					Project No: 14-240		Project Name: National Paediatric Hospital, Dublin - Ground Investigation Contract			Borehole No. BH101	
Method and Equipment: Hand dug 0.00-1.20m Percussion boring 1.20-4.50m Dando 2000 Rotary coring 4.50-25.00m Comacchio 450					Co-ords: 713280.2mE 733345.8mN		Client: National Paediatric Hospital			Sheet 3 of 3	
							Engineer: Roughan & O'Donovan			Scale: 1:50	
					Ground Level: 20.88mOD		Dates: 25/06/2014 - 07/07/2014			Driller: DE/GT	
										Logger: DOM/MG	
Depth (m)	TCR	SCR	RQD	FI	Field Records	Level Depth (Thickness)	Stratum Description			Legend & Water Strikes	Backfill Installs
21.20	100	99	79		21.20 21.60 21.90		Strong, locally very strong, thinly to medium bedded dark grey fine to medium grained LIMESTONE with rare calcite veins. Partially weathered, locally distinctly weathered adjacent to bedding planes with loss of strength and structure Discontinuity Set 1: bedding planes, close to medium spaced, sub-horizontal, planar, rough, open and clean with grey staining to locally closed and infilled with calcite Discontinuity Set 2: joints, probably close to medium spaced, 60-70 degrees, planar to curved, rough, open and stained dark grey to occasionally lined with sandy clay At 21.00m - 21.20m: drilling induced fracturing At 21.60m - 21.90m: non-intact				
				4							
				NI							
22.70	100	81	74		21.90						
24.20	100	100	88	4	25.00	-4.12 25.00	End of Borehole at 25.00 m				
	100	100	80								
Remarks: SPT's carried out using SPT hammers: DA08 to 4.50m and SPT1 used to 25.0m					Chiseling: From (m) to (m) time (hh:mm)		Water Strikes: Struck (m) rising to (m) time (min)		Last Revised: 14/11/2014		
					Core Barrel: SK6L Flush type: Water/Polymer		Casing: to (m) dia. (mm) 4.00 200 25.00 146		 www.causewaygeotech.com (c) Causeway Geotech Ltd		

Causeway Geotech Ltd					Project No: 14-240	Project Name: National Paediatric Hospital, Dublin - Ground Investigation Contract	Borehole No. BH102		
Method and Equipment: Hand dug 0.00-1.20m Percussion boring 1.20-5.00m Rotary coring 5.00-25.00m Comacchio 450					Co-ords: 713351.6mE 733347.8mN		Client: National Paediatric Hospital	Sheet 1 of 3	
							Engineer: Roughan & O'Donovan	Scale: 1:50	
					Ground Level: 20.41mOD		Dates: 23/06/2014 - 11/07/2014	Driller: DE/GT	
									Logger: JC/MG
Depth (m)	Sample / Test		Casing Depth (m)	Water Depth (m)	Field Records	Level Depth (Thickness)	Stratum Description	Legend & Water Strikes	Backfill Installs
0.50	B		1.20	dry	450mm Recovery	20.21 0.20	MADE GROUND: Grey brown slightly sandy GRAVEL (Hardcore Fill)		
0.50	ES					(1.00)	MADE GROUND: Soft brown sandy gravelly SILT with cinders, brick and stone. Sand is fine to coarse. Gravel is subangular to subrounded fine to coarse		
1.20	B		2.00	dry	N=5 N=5 (1,1,1,1,1,2)	19.21 1.20	Soft brown sandy gravelly CLAY. Sand is fine to coarse. Gravel is angular fine to medium		
1.20-1.70	U								
1.50	ES								
1.70	D		3.20	dry	450mm Recovery	17.21 3.20	Stiff to very stiff grey and black sandy gravelly CLAY. Sand is fine to coarse. Gravel is angular fine to medium		
2.00	SPT								
2.00	B								
3.20	B		4.50	dry	50/75mm 75mm (25,50)	15.41 5.00	Very stiff dark brownish black sandy gravelly CLAY with occasional cobbles and rare boulders. Sand is fine to coarse. Gravel is subrounded to subangular fine to coarse of limestone. Cobbles are subrounded to subangular		
3.20-3.70	U								
3.70	D								
4.00	B		N/A			(1.80)	From 5.00m - 9.50m: becomes brown in colour		
4.50	SPT								
4.50	D								
5.00	B		100	0	0	(5.25)			
5.00									
6.50									
6.50	100		0	0	0				
8.00									
8.00	100								
9.50			0	0	0				
	100								
	TCR	SCR	RQD	FI	Continued next sheet				
Remarks: SPT's carried out using SPT hammers: DA08 used to 5.00m and SPT1 to 25.0m. Standpipe installed.					Chiseling: From (m) to (m) time (hh:mm)		Water Strikes: Struck (m) rising to (m) time (min) No Groundwater Encountered		Last Revised: 14/11/2014 www.causewaygeotech.com (c) Causeway Geotech Ltd
					Core Barrel: SK6L		Casing: to (m) dia. (mm) 5.00 200 25.00 146		
					Flush type: Water/Polymer				

Causeway Geotech Ltd					Project No: 14-240		Project Name: National Paediatric Hospital, Dublin - Ground Investigation Contract		Borehole No. BH102				
Method and Equipment: Hand dug 0.00-1.20m Percussion boring 1.20-5.00m Rotary coring 5.00-25.00m Comacchio 450					Co-ords: 713351.6mE 733347.8mN		Client: National Paediatric Hospital		Sheet 2 of 3				
							Engineer: Roughan & O'Donovan		Scale: 1:50				
					Ground Level: 20.41mOD		Dates: 23/06/2014 - 11/07/2014		Driller: DE/GT				
								Logger: JC/MG					
Depth (m)	TCR	SCR	RQD	FI	Field Records	Level Depth (Thickness)		Stratum Description		Legend & Water Strikes	Backfill/Installs		
11.00	100	48	27	7	10.25	10.16	10.25	Very stiff dark brownish black sandy gravelly CLAY with occasional cobbles and rare boulders. Sand is fine to coarse. Gravel is subrounded to subangular fine to coarse of limestone. Cobbles are subrounded to subangular					
12.50	95	67	15	9	11.45			Medium strong to strong thinly to medium bedded dark grey fine to medium grained LIMESTONE interbedded with medium to widely spaced very thin beds of destructured, extremely to very weak dark grey mudstone. Occasional calcite veining occurs					
14.00	100	94	65	10	13.80			Discontinuity Set 1: bedding planes, close to medium spaced, sub-horizontal, planar, smooth, open and stained dark grey to frequently lined with brown clay. Evidence of destructuring with increased fracturing and loss of strength around flanks					
15.50	100	96	75	12	15.50			Discontinuity Set 2: joints, close to medium spaced, 60-75 degrees, planar, typically smooth, closed and infilled with calcite generally 3-5mm thick					
17.00	100	91	55	6	17.00								
18.50	100	100	86			(14.75)							
	TCR	SCR	RQD	FI				Continued next sheet					
Remarks: SPT's carried out using SPT hammers: DA08 used to 5.00m and SPT1 to 25.0m. Standpipe installed.						Chiseling: From (m) to (m) time (hh:mm)		Water Strikes: Struck (m) rising to (m) time (min) No Groundwater Encountered		Last Revised: 14/11/2014			
Core Barrel: SK6L Flush type: Water/Polymer						Casing: to (m) dia. (mm) 5.00 200 25.00 146				www.causewaygeotech.com (c) Causeway Geotech Ltd			


Causeway Geotech Ltd					Project No: 14-240		Project Name: National Paediatric Hospital, Dublin - Ground Investigation Contract		Borehole No. BH102		
Method and Equipment: Hand dug 0.00-1.20m Percussion boring 1.20-5.00m Rotary coring 5.00-25.00m Comacchio 450					Co-ords: 713351.6mE 733347.8mN		Client: National Paediatric Hospital		Sheet 3 of 3		
							Engineer: Roughan & O'Donovan		Scale: 1:50		
					Ground Level: 20.41mOD		Dates: 23/06/2014 - 11/07/2014		Driller: DE/GT		
									Logger: JC/MG		
Depth (m)	TCR	SCR	RQD	FI	Field Records	Level	Depth (Thickness)	Stratum Description		Legend & Water Strikes	Backfill/Installs
20.00					20.00			Medium strong to strong thinly to medium bedded dark grey fine to medium grained LIMESTONE interbedded with medium to widely spaced very thin beds of destructured, extremely to very weak dark grey mudstone. Occasional calcite veining occurs Discontinuity Set 1: bedding planes, close to medium spaced, sub-horizontal, planar, smooth, open and stained dark grey to frequently lined with brown clay. Evidence of destructuring with increased fracturing and loss of strength around flanks Discontinuity Set 2: joints, close to medium spaced, 60-75 degrees, planar, typically smooth, closed and infilled with calcite generally 3-5mm thick			
21.50	100	97	78								
	100	100	90	5							
23.00											
	100	100	100								
24.50											
	100	100	100								
					25.00	-4.59	25.00	End of Borehole at 25.00 m			

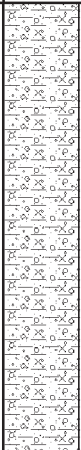
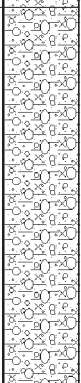
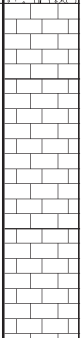

Causeway Geotech Ltd					Project No. 14-240	Project Name: National Paediatric Hospital, Dublin - Ground Investigation Contract	Borehole No. BH103				
Method and Equipment: Hand dug 0.00-1.20m Percussion boring 1.20-4.15m Dando 2000 Rotary drilling 4.15-5.00m Rotary coring 5.00-25.00m Comacchio 450					Co-ords: 713323.8mE 733370.4mN		Client: National Paediatric Hospital		Sheet 1 of 3		
							Engineer: Roughan & O'Donovan		Scale: 1:50		
					Ground Level: 20.43mOD		Dates: 25/06/2014 - 17/07/2014		Driller: DE/GT		
									Logger: DOM/MG		
Depth (m)	Sample / Test	Casing Depth (m)	Water Depth (m)	Field Records	Level	Depth (Thickness)	Stratum Description	Legend & Water Strikes	Backfill/Installs		
0.50 0.50	B ES				20.33	0.10	MADE GROUND: Tarmac				
					20.13	0.30	MADE GROUND: Hardcore Fill				
					(0.50)		MADE GROUND: Firm brown sandy SILT with occasional gravel sized pieces of cinders and brick. Sand is fine to coarse				
					19.63	0.80	Soft to firm brown gravelly CLAY. Gravel is angular fine to medium				
1.20 1.20-1.65 1.50 1.50	B U D ES	1.20	dry	450mm Recovery							
					(1.80)						
2.00 2.00 2.00	SPT B D	2.00	dry	N=11 N=11 (2,2,3,2,3,3)					1		
					17.83	2.60	Firm brown sandy gravelly CLAY. Sand is fine to coarse. Gravel is angular fine to medium				
3.00 3.00-3.45	B U	3.00	dry	450mm Recovery	17.53	2.90	Stiff dark grey to black sandy gravelly CLAY. Sand is fine to coarse. Gravel is angular fine to medium		1		
3.50	D				(1.20)						
4.00 4.00	SPT D	4.00	dry	50/50mm 50mm (25,50)							
					16.33	4.10	BOULDER				
					16.28	4.15	Stiff to very stiff light brownish grey to dark grey brown sandy gravelly CLAY with occasional cobbles. Sand is fine to coarse. Gravel is subangular to subrounded fine to coarse. Cobbles are subrounded to subangular From 5.00m - 11.00m: becomes light grey brown in colour				
5.00											
	100	0	0								
6.50 6.50	SPT		dry	N=97 N=97 (6,10,19,20,27,31)							
	100	0	0								
8.00 8.00	SPT		dry	N=86 N=86 (5,9,16,18,24,28)							
					(8.15)						
	100	0	0	N/A							
9.50 9.50	SPT		dry	N=94 N=94 (7,9,14,21,28,31)							
	TCR	SCR	RQD	FI							
Remarks: SPT's carried out using SPT hammers: DA08 to 4.15m & SPT1 to 25.0m. Double standpipe installed.					Continued next sheet						
					Chiseling: From (m) 4.10 to (m) 4.15 time (hh:mm) 01:00			Water Strikes: Struck (m) 2.90 rising to (m) 2.00 time (min) 15		Last Revised: 14/11/2014	
					Core Barrel: SK6L Flush type: Water/Polymer			Casing: to (m) 4.10 dia. (mm) 200 5.00 196 25.00 146			
										 www.causewaygeotech.com (c) Causeway Geotech Ltd	

Causeway Geotech Ltd					Project No: 14-240	Project Name: National Paediatric Hospital, Dublin - Ground Investigation Contract	Borehole No. BH103	
Method and Equipment: Hand dug 0.00-1.20m Percussion boring 1.20-4.15m Dando 2000 Rotary drilling 4.15-5.00m Rotary coring 5.00-25.00m Comacchio 450					Co-ords: 713323.8mE 733370.4mN		Client: National Paediatric Hospital	Sheet 2 of 3
					Ground Level: 20.43mOD		Engineer: Roughan & O'Donovan	Scale: 1:50
							Dates: 25/06/2014 - 17/07/2014	Driller: DE/GT
								Logger: DOM/MG
Depth (m)	TCR	SCR	RQD	FI	Field Records	Level Depth (Thickness)	Stratum Description	Legend & Backfill Water Strikes Installs
11.00	100	0	0				Stiff to very stiff light brownish grey to dark grey brown sandy gravelly CLAY with occasional cobbles. Sand is fine to coarse. Gravel is subangular to subrounded fine to coarse. Cobbles are subrounded to subangular	
11.00	SPT			dry	N=92 N=92 (8,10,15,20,27,30)		From 11.00m - 12.50m: becomes dark grey/brown in colour	
	100	11	0					
12.50					12.30	8.13 12.30	Extremely weak very thinly bedded brownish grey muddy to fine grained LIMESTONE. Distinctly weathered to destructured with heavy brown penetrative staining and loss of strength and structure (locally non-intact or removal from liner)	
	100	34	0	NI		(1.70)		
14.00					14.00	6.43 14.00	Medium strong to strong thinly to medium, locally very thinly bedded dark grey fine grained LIMESTONE with occasional calcite veining. Partially weathered with some grey staining along fracture surfaces	
	100	100	77				Discontinuity Set 1: bedding planes, close to medium spaced, 10-20 degrees, planar, rough to smooth, typically open and stained grey and brown	
15.50							Discontinuity Set 2: joints, very closely spaced, 30-40 degrees, planar, rough, open and typically stained dark greyish brown	
	100	82	71	7			Discontinuity Set 3: joints, probably close to medium spaced, 60-70 degrees, planar to stepped, rough, open and lined with gravelly clay, locally infilled with calcite generally <2-4mm thick	
17.00								
	100	100	66					
18.50					18.50			
	100	100	83					
				6		(11.00)		
	TCR	SCR	RQD	FI				
Remarks: SPT's carried out using SPT hammers: DA08 to 4.15m & SPT1 to 25.0m. Double standpipe installed.					Chiseling:		Water Strikes:	Last Revised: 14/11/2014  <small>www.causewaygeotech.com (c) Causeway Geotech Ltd</small>
					From (m) to (m) time (hh:mm)		Struck (m) rising to (m) time (min)	
					Core Barrel: SK6L		Casing:	
					Flush type: Water/Polymer		to (m) dia. (mm) 4.10 200 5.00 196 25.00 146	






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Causeway Geotech Ltd					Project No: 14-240	Project Name: National Paediatric Hospital, Dublin - Ground Investigation Contract	Borehole No. BH104	
Method and Equipment: Hand dug 0.00-1.20m Percussion boring 1.20-3.30m Dando 2000 Rotary coring 3.30-25.00m Comacchio 450					Co-ords: 713266.1mE 733374.4mN		Client: National Paediatric Hospital	Sheet 1 of 3
					Ground Level: 20.58mOD		Engineer: Roughan & O'Donovan	Scale: 1:50
							Dates: 26/06/2014 - 02/07/2014	Driller: DE/GT
								Logger: DOM/MG
Depth (m)	Sample / Test		Casing Depth (m)	Water Depth (m)	Field Records	Level Depth (Thickness)	Stratum Description	Legend & Backfill Water Strikes Installs
0.50	ES					20.45 0.13 20.24 0.34 (0.71)	BITMAC CONCRETE Possible MADE GROUND: Soft dark brown and black organic slightly sandy gravelly silty CLAY. Sand is fine to medium. Gravel is rounded to subrounded fine to medium	
1.20 1.20-1.65 1.50 1.70	B U ES D		2.00	dry	N=14 N=14 (2,3,3,4,3,4)	19.53 1.05 19.38 1.20 (0.60)	Possible MADE GROUND: Very soft to soft light brown very gravelly sandy silty CLAY. Sand is fine to coarse	
2.00 2.00 2.00	SPT B D			dry		18.78 1.80 (0.80)	Firm to stiff dark brown sandy gravelly CLAY. Sand is fine to coarse. Gravel is angular fine to medium	
3.00 3.00 3.00 3.30	SPT B D		3.00	dry	50/75mm 75mm (25,50)	17.98 2.60 (0.70)	Firm brown sandy gravelly CLAY. Sand is fine to coarse. Gravel is angular fine to medium	
	100	0	0				Very stiff grey and black sandy gravelly CLAY. Sand is fine to coarse. Gravel is angular fine to medium	
4.90	100	0	0				At 4.90m - 6.30m: UUT indicates extremely high strength	
6.30	100	0	0					
7.90	100	0	0					
9.40	100	0	0	N/A				
9.90	TCR	SCR	RQD	FI				
Remarks: SPT's carried out using SPT hammers: DA08 to 3.30m and SPT1 to 25.0m					Chiseling: From to time (m) (m) (hh:mm)		Water Strikes: Struck rising to time (m) (m) (min) No Groundwater Encountered	Last Revised: 14/11/2014
					Core Barrel: SK6L Flush type: Water/Polymer		Casing: to (m) dia. (mm) 3.00 200 25.00 146	 www.causewaygeotech.com (c) Causeway Geotech Ltd

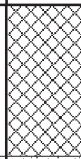

Causeway Geotech Ltd					Project No: 14-240	Project Name: National Paediatric Hospital, Dublin - Ground Investigation Contract		Borehole No. BH104				
Method and Equipment: Hand dug 0.00-1.20m Percussion boring 1.20-3.30m Dando 2000 Rotary coring 3.30-25.00m Comacchio 450					Co-ords: 713266.1mE 733374.4mN		Client: National Paediatric Hospital		Sheet 2 of 3			
							Engineer: Roughan & O'Donovan		Scale: 1:50			
					Ground Level: 20.58mOD		Dates: 26/06/2014 - 02/07/2014		Driller: DE/GT			
									Logger: DOM/MG			
Depth (m)	TCR	SCR	RQD	FI	Field Records	Level	Depth (Thickness)	Stratum Description		Legend & Water Strikes	Backfill Installs	
11.40	100	0	0			7.58	13.00	Very stiff to hard dark brownish grey sandy gravelly CLAY with low cobble content. Sand is fine to coarse. Gravel is subrounded to subangular fine to coarse. Cobbles are subrounded to subangular				
	100	0	0									
13.00	100	0	0									
	100	0	0									
14.50	100	30	30	4	15.50	(2.50)	15.50	Very stiff dark grey sandy very gravelly CLAY with high cobble and boulder content. Sand is fine to coarse. Gravel is angular to subangular fine to coarse4				
	100	0	0									
16.00	100	95	95									
	100	76	59									
17.50	100	93	82	9				Medium strong to strong thin to medium bedded dark grey fine to medium grained LIMESTONE with occasional calcite veining. Partially weathered with grey and brown surface staining along joint surfaces				
	100	95	95									
19.00	100	93	82					Discontinuity Set 1: bedding planes, close to medium spaced, 10-15 degrees, planar, smooth to rough, clean to stained dark grey, occasionally slightly polished				
	100	93	82									
									Discontinuity Set 2: joints, occasionally occurring, probably closely spaced, sub-vertical to 70 degrees, planar to curved, rough, open and stained dark grey to occasionally lined with calcite			
									At 17.70m - 18.00m: highly fractured (non-intact)			
									Continued next sheet			
Remarks: SPT's carried out using SPT hammers: DA08 to 3.30m and SPT1 to 25.0m					Chiseling:		Water Strikes:		Last Revised: 14/11/2014			
					From (m) to (m) time (hh:mm)		Struck (m) rising to (m) time (min)					
					Core Barrel: SK6L Flush type: Water/Polymer		No Groundwater Encountered					
							Casing:					
							to (m) dia. (mm)		www.causewaygeotech.com (c) Causeway Geotech Ltd			
							3.00 200 25.00 146					

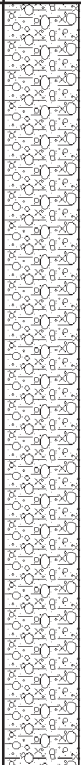
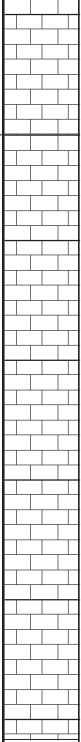

Causeway Geotech Ltd					Project No 14-240		Project Name: National Paediatric Hospital, Dublin - Ground Investigation Contract		Borehole No. BH104		
Method and Equipment: Hand dug 0.00-1.20m Percussion boring 1.20-3.30m Dando 2000 Rotary coring 3.30-25.00m Comacchio 450					Co-ords: 713266.1mE 733374.4mN		Client: National Paediatric Hospital		Sheet 3 of 3		
							Engineer: Roughan & O'Donovan		Scale: 1:50		
					Ground Level: 20.58mOD		Dates: 26/06/2014 - 02/07/2014		Driller: DE/GT		
Logger: DOM/MG											
Depth (m)	TCR	SCR	RQD	FI	Field Records	Level	Depth (Thickness)	Stratum Description		Legend & Water Strikes	Backfill Installs
20.50					20.50	(9.50)		Medium strong to strong thin to medium bedded dark grey fine to medium grained LIMESTONE with occasional calcite veining. Partially weathered with grey and brown surface staining along joint surfaces Discontinuity Set 1: bedding planes, close to medium spaced, 10-15 degrees, planar, smooth to rough, clean to stained dark grey, occasionally slightly polished Discontinuity Set 2: joints, occasionally occurring, probably closely spaced, sub-vertical to 70 degrees, planar to curved, rough, open and stained dark grey to occasionally lined with calcite			
	100	98	75								
22.00											
	100	98	84	7							
23.50											
	100	100	89								
					25.00	-4.42	25.00	End of Borehole at 25.00 m			

Causeway Geotech Ltd					Project No 14-240	Project Name: National Paediatric Hospital, Dublin - Ground Investigation Contract	Borehole No. BH105				
Method and Equipment: Hand dug 0.00-1.20m Percussion boring 1.20-3.50m Dando 2000 Rotary drilling 3.50-5.00m Rotary coring 5.00-25.00m Comacchio 450					Co-ords: 713321.6mE 733348.8mN		Client: National Paediatric Hospital		Sheet 1 of 3		
							Engineer: Roughan & O'Donovan		Scale: 1:50		
					Ground Level: 20.46mOD		Dates: 25/06/2014 - 23/07/2014		Driller: DE/GT		
									Logger: DOM/MG		
Depth (m)	Sample / Test		Casing Depth (m)	Water Depth (m)	Field Records	Level	Depth (Thickness)	Stratum Description	Legend & Water Strikes	Backfill Installs	
0.50 0.50	B ES		1.20	dry	450mm Recovery		20.36 0.10	MADE GROUND: Tarmac			
							20.16 0.30	MADE GROUND: Hardcore Fill			
1.20 1.20-1.65 1.50 1.70	B U ES D						19.06 1.40	MADE GROUND: Firm brown sandy gravelly SILT with occasional cinders and low cobble content. Sand is fine to coarse. Gravel is subangular to subrounded fine to coarse			
2.00 2.00 2.00	SPT B D						(1.10)				
			2.00	dry	N=11 N=11 (2,2,3,2,3,3)		(1.30)	Firm brown sandy gravelly CLAY. Sand is fine to coarse. Gravel is subrounded to angular fine to medium			
3.00 3.00-3.45 3.50	B U D		3.00	dry	450mm Recovery		17.76 2.70	Stiff grey and black sandy gravelly CLAY. Sand is fine to coarse. Gravel is subrounded to angular fine to medium			
							(2.30)				
4.50 5.00	SPT		4.50	dry	N=68 N=68 (15,10,15,20,18,15)		15.46 5.00	Very stiff dark brownish grey sandy gravelly CLAY with low cobble content. Sand is fine to coarse. Gravel is subrounded to subangular fine to coarse. Cobbles are subrounded to subangular			
	100	0	0								
6.60 6.60	SPT		6.60	dry	N=70 N=70 (16,12,13,18,20,19)						
	100	0	0	N/A			(5.80)				
8.10 8.10	SPT		7.50	dry	N=54 N=54 (13,20,14,12,14,14)			At 8.10m: UUT indicates extremely high strength			
	100	0	0								
9.70 9.70	SPT		9.70	dry	9.70 N=70 N=70 (18,15,20,20,12,18)						
	TCR	SCR	RQD	FI							
Remarks: SPT's carried out using SPT hammers: DA08 3.50m and SPT1 used to 25.0m.							Chiseling: From (m) to (m) time (hh:mm)		Water Strikes: Struck (m) rising to (m) time (min) 3.00 3.00 15		Last Revised: 14/11/2014
							Core Barrel: SK6L Flush type: Water/Polymer		Casing: to (m) dia. (mm) 3.50 200 5.00 196 25.00 146		
									 www.causewaygeotech.com (c) Causeway Geotech Ltd		

Causeway Geotech Ltd					Project No: 14-240	Project Name: National Paediatric Hospital, Dublin - Ground Investigation Contract	Borehole No. BH105			
Method and Equipment: Hand dug 0.00-1.20m Percussion boring 1.20-3.50m Dando 2000 Rotary drilling 3.50-5.00m Rotary coring 5.00-25.00m Comacchio 450					Co-ords: 713321.6mE 733348.8mN	Client: National Paediatric Hospital	Sheet 2 of 3			
						Engineer: Roughan & O'Donovan	Scale: 1:50			
					Ground Level: 20.46mOD	Dates: 25/06/2014 - 23/07/2014	Driller: DE/GT			
							Logger: DOM/MG			
Depth (m)	TCR	SCR	RQD	FI	Field Records	Level Depth (Thickness)	Stratum Description	Legend & Backfill Water Strikes Installs		
11.10	100	29	29	4		9.66 10.80	Very stiff dark brownish grey sandy gravelly CLAY with low cobble content. Sand is fine to coarse. Gravel is subrounded to subangular fine to coarse. Cobbles are subrounded to subangular At 10.72m - 10.78m: cobble sized calcite inclusion			
						(1.90)	Medium strong thin to medium bedded dark grey speckled black clastic muddy to fine grained LIMESTONE with occasional calcite veining. Partially to distinctly weathered with some grey and brown staining along discontinuity surfaces Discontinuity Set 1: bedding planes, medium to widely spaced, sub-horizontal, planar, rough to smooth, typically closed, locally open and stained grey			
12.70	100	100	95		12.70	7.76 12.70	Discontinuity Set 2: joints, probably close to medium spaced, 40-55 degrees, planar, rough, open and stained grey to lined with calcite Medium strong to strong thin to medium bedded dark blueish grey fine to medium grained LIMESTONE with frequent calcite veining. Partially weathered with some grey staining along bedding planes Discontinuity Set 1: bedding, close to medium spaced, 10-15 degrees, planar smooth, clean to stained dark grey along surfaces, locally infilled with calcite (<10mm thick) Discontinuity Set 2: joints, 60-70 degrees, planar to curved, closed with calcite infill <5-10mm thick, locally open and lined with calcite			
						(3.00)				
14.20	100	100	89	8	14.20					
15.70	100	100	100	3	15.70	4.76 15.70	Weak to medium strong very thinly to thinly bedded dark grey muddy LIMESTONE interbedded with grey fine to medium grained LIMESTONE. Distinctly weathered adjacent to bedding planes with some infill of residual mudstone (gravelly clay) and heavy brown penetrative staining Discontinuity Set 1: bedding, very close to closely spaced, 10-20 degrees, planar smooth, stained grey and brown, very rarely infilled with calcite Discontinuity Set 2: joints, medium spaced, 50-60 degrees, planar to curved, smooth, stained grey, occasionally destructured around flanks with some clay smearing			
						(1.60)				
17.20	100	100	94		17.30	3.16 17.30				
18.80	100	100	97	5		(2.70)	Weak to medium strong, locally very strong, medium to thickly bedded grey fine to medium grained LIMESTONE with frequent calcite veining interbedded with very thin beds of weak dark grey MUDSTONE. Partially weathered to distinctly weathered adjacent to the mudstone beds with loss of strength and heavy grey penetrative staining Full description as Sheet 3			
					Continued next sheet					
Remarks: SPT's carried out using SPT hammers: DA08 3.50m and SPT1 used to 25.0m.						Chiseling: From (m) to (m) time (hh:mm)		Water Strikes: Struck (m) rising to (m) time (min)		Last Revised: 14/11/2014 <small>www.causewaygeotech.com (c) Causeway Geotech Ltd</small>
						Core Barrel: SK6L		Casing: to (m) dia. (mm)		
						Flush type: Water/Polymer		3.50 200 5.00 196 25.00 146		


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Causeway Geotech Ltd					Project No 14-240	Project Name: National Paediatric Hospital, Dublin - Ground Investigation Contract	Borehole No. BH106				
Method and Equipment: Hand dug 0.00-1.20m Percussion boring 1.20-5.30m Rotary coring 5.30-25.00m Beretta T41					Co-ords: 713305.9mE 733415.2mN		Client: National Paediatric Hospital		Sheet 1 of 3		
							Engineer: Roughan & O'Donovan		Scale: 1:50		
					Ground Level: 20.32mOD		Dates: 23/06/2014 - 08/08/2014		Driller: DE/SS		
									Logger: JC/MG		
Depth (m)	Sample / Test		Casing Depth (m)	Water Depth (m)	Field Records	Level	Depth (Thickness)	Stratum Description	Legend & Water Strikes	Backfill Installs	
0.50 0.50	B ES						(1.00)	MADE GROUND: sandy subrounded fine GRAVEL (TOPSOIL)			
1.20 1.20-1.70 1.50 1.70	B U ES D		1.20	dry	450mm Recovery	19.32	1.00	Soft brown sandy gravelly CLAY. Sand is fine to coarse. Gravel is angular fine to medium			
2.00 2.00 2.00	SPT B D		2.00	dry	N=7 N=7 (1,2,1,2,2,2)		(1.60)				
3.00 3.00-3.50 3.50	B U D		3.00	dry	450mm Recovery	17.72	2.60	Stiff to very stiff grey and black sandy gravelly CLAY. Sand is fine to coarse. Gravel is subrounded fine to medium			
4.00 4.00 4.00	SPT B D		4.00	dry	50/75mm 75mm (25,50)		(2.60)				
5.00 5.00 5.00 5.20 5.50	B D 100 SPT	0	5.20	dry	50/75mm 75mm (25,50)	15.12	5.20	From 5.00m - 7.00m: becomes brownish grey in colour			
							15.02	5.30			BOULDER
	100	0	0					Stiff to very stiff brownish grey to dark brown and black sandy gravelly CLAY with low cobble and boulder content. Sand is fine to coarse. Gravel is subrounded to subangular fine to coarse. Cobbles and boulders are subrounded to subangular			
7.00 7.00	SPT	0	7.00	dry	N=67 N=67 (5,10,10,15,19,23)			From 7.00m - 15.10m: becomes dark brown and black in colour			
8.50 8.50	SPT	0	8.50	dry	N=72 N=72 (5,9,12,16,20,24)						
	100	0	0								
	TCR	SCR	RQD	FI							
Remarks: SPT's carried out using SPT hammers: CC4 to 5.30m and SPT2 to 25.00m.					Continued next sheet						
					Chiseling: From (m) to (m) time (hh:mm) 5.20 5.30 01:00			Water Strikes: Struck (m) rising to (m) time (min) No Groundwater Encountered		Last Revised: 14/11/2014	
					Core Barrel: SK6L Flush type: Water-Polymer			Casing: to (m) dia. (mm) 5.20 200 5.50 196 25.00 146			
										 www.causewaygeotech.com (c) Causeway Geotech Ltd	

Causeway Geotech Ltd					Project No: 14-240	Project Name: National Paediatric Hospital, Dublin - Ground Investigation Contract			Borehole No. BH106	
Method and Equipment: Hand dug 0.00-1.20m Percussion boring 1.20-5.30m Rotary coring 5.30-25.00m Beretta T41					Co-ords: 713305.9mE 733415.2mN		Client: National Paediatric Hospital			Sheet 2 of 3
							Engineer: Roughan & O'Donovan			Scale: 1:50
					Ground Level: 20.32mOD		Dates: 23/06/2014 - 08/08/2014			Driller: DE/SS
										Logger: JC/MG
Depth (m)	TCR	SCR	RQD	FI	Field Records	Level	Depth (Thickness)	Stratum Description		Legend & Backfill Water Strikes Installs
10.00 10.00	SPT		10.00	N/A	N=73 N=73 (5,9,13,17,20,23)		(9.80)	Stiff to very stiff brownish grey to dark brown and black sandy gravelly CLAY with low cobble and boulder content. Sand is fine to coarse. Gravel is subrounded to subangular fine to coarse. Cobbles and boulders are subrounded to subangular		
11.50 11.50	SPT		11.50	dry	50/150mm 150mm (25,45,5)					
13.00 13.00	SPT		13.00	dry	N=75 N=75 (5,11,11,18,22,24)					
14.50 14.50	SPT		14.50	dry	50/150mm 150mm (25,35,15)					
	100	0	0							
	100	0	0							
	100	0	0							
	100	49	22	10	15.10	5.22	15.10	Weak highly fractured, probably thickly laminated to very thinly bedded dark greyish brown fine grained LIMESTONE. Destructured		
16.00					16.00	4.32	16.00	Medium strong to strong, locally weak very thinly to medium bedded dark grey fine grained LIMESTONE interbedded with widely spaced, very thin beds of weak dark grey MUDSTONE. Distinctly weathered with loss of strength and structure along discontinuity surfaces. Some grey penetrative staining occurring adjacent to laminae of mudstone		
17.50								Discontinuity Set 1: bedding very close to medium spaced, sub-horizontal, planar, smooth to rough, typically closed, where open stained dark grey		
19.00								Discontinuity Set 2: joints, probably closely spaced, rarely occurring, 40-50 degrees, stepped, rough, open and stained grey and brown, locally closed and infilled with calcite		
	100	96	79							
	100	100	65							
	100	100	92							
	TCR	SCR	RQD	FI						
Remarks: SPT's carried out using SPT hammers: CC4 to 5.30m and SPT2 to 25.00m.					Chiseling: From (m) to (m) time (hh:mm)		Water Strikes: Struck (m) rising to (m) time (min) No Groundwater Encountered		Last Revised: 14/11/2014	
					Core Barrel: SK6L		Casing: to (m) dia. (mm)		 www.causewaygeotech.com (c) Causeway Geotech Ltd	
					Flush type: Water-Polymer		5.20 200 5.50 196 25.00 146			












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Causeway Geotech Ltd					Project No: 14-240	Project Name: National Paediatric Hospital, Dublin - Ground Investigation Contract	Borehole No. BH107		
Method and Equipment: Hand dug 0.00-1.20m Percussion boring 1.20-5.30m Dando 2000 Rotary drilling 5.30-6.60m Rotary coring 6.60-20.00m Comacchio 450					Co-ords: 713250.2mE 733409.2mN	Client: National Paediatric Hospital	Sheet 1 of 2		
					Ground Level: 20.75mOD	Engineer: Roughan & O'Donovan	Scale: 1:50		
						Dates: 26/06/2014 - 23/07/2014	Driller: DE/GT		
Depth (m)	Sample / Test	Casing Depth (m)	Water Depth (m)	Field Records	Level	Depth (Thickness)	Stratum Description	Legend & Water Strikes	Backfill Installs
0.50	ES				20.67	0.08	BITMAC		
					20.50	0.25	MADE GROUND: Hardcore		
					(0.65)		MADE GROUND: Firm dark brown sandy gravelly silty CLAY with fragments of cinder and brick. Sand is fine to medium. Gravel is rounded to subrounded fine to coarse		
1.20	SPT	1.20	dry	N=6	19.85	0.90			
1.20	B			N=6 (1,1,1,1,2,2)	19.55	1.20	MADE GROUND: Soft light brown mottled dark brown sandy gravelly silty CLAY with fragments of cinder and brick. Sand is fine to coarse. Gravel is rounded to subrounded fine to medium		
1.20	D				(1.20)				
1.50	ES								
2.00	SPT	2.00	dry	N=13			Soft to firm brown gravelly CLAY. Gravel is angular fine to medium		
				N=13 (2,2,2,3,4,4)	18.35	2.40	Firm brown sandy gravelly CLAY. Sand is fine to coarse. Gravel is angular fine to medium		
3.00	B	3.00	dry	450mm Recovery	18.05	2.70	Very stiff grey sandy gravelly CLAY. Sand is fine to coarse. Gravel is angular fine to medium		
3.00-3.45	U								
3.50	D								
4.00	SPT	4.00	dry	50/75mm					
4.00	B			75mm (10,15,50)	(2.60)				
4.00	D								
5.00		5.00	dry	50/50mm					
5.00	SPT			50mm (25,50)	15.45	5.30	Very stiff brownish grey to dark brown and black sandy gravelly CLAY with low cobble content. Sand is fine to coarse. Gravel is subrounded to subangular fine to coarse. Cobbles are subrounded to subangular		
5.00	B						From 5.30m - 11.40m: becomes dark brown in colour		
5.00	D								
	100	0	0						
6.60			dry	N=70					
6.60	SPT			N=70 (10,15,18,14,20,18)					
	100	0	0						
8.20			dry	N=62					
8.20	SPT			N=62 (11,12,12,15,15,20)					
	100	0	0						
9.80			dry	N=81					
9.80	SPT			N=81 (15,20,18,26,19,18)					
	TCR	SCR	RQD	FI					
Remarks: SPT's carried out using SPT hammers: DA08 to 5.30m and SPT1 to 20.0m					Chiseling: From (m) to (m) time (hh:mm)		Water Strikes: Struck (m) rising to (m) time (min) No Groundwater Encountered	Last Revised: 14/11/2014  www.causewaygeotech.com (c) Causeway Geotech Ltd	
					Core Barrel: SK6L		Casing: to (m) dia. (mm) 5.00 200 6.60 196 20.00 146		
					Flush type: Water/Polymer				

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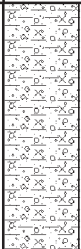

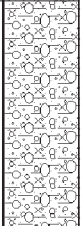



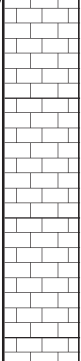

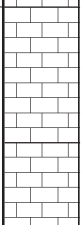










Causeway Geotech Ltd					Project No: 14-240	Project Name: National Paediatric Hospital, Dublin - Ground Investigation Contract	Borehole No. BH107						
Method and Equipment: Hand dug 0.00-1.20m Percussion boring 1.20-5.30m Dando 2000 Rotary drilling 5.30-6.60m Rotary coring 6.60-20.00m Comacchio 450					Co-ords: 713250.2mE 733409.2mN	Client: National Paediatric Hospital	Sheet 2 of 2						
						Engineer: Roughan & O'Donovan	Scale: 1:50						
					Ground Level: 20.75mOD	Dates: 26/06/2014 - 23/07/2014	Driller: DE/GT						
							Logger: DOM/MG						
Depth (m)	TCR	SCR	RQD	FI	Field Records	Level Depth (Thickness)	Stratum Description	Legend & Backfill Water Strikes Installs					
11.40	100	0	0	N/A		(10.40)	Very stiff brownish grey to dark brown and black sandy gravelly CLAY with low cobble content. Sand is fine to coarse. Gravel is subrounded to subangular fine to coarse. Cobbles are subrounded to subangular						
11.40	SPT			dry	N=64 N=64 (14,14,16,12,18,18)		From 11.40m - 12.90m: becomes dark brown in colour						
	100	0	0										
12.90	SPT			dry	N=75 N=75 (20,18,22,15,18,20)		From 12.90m: becoming dark brown and black and with high cobble content						
12.90	100	0	0										
14.40	SPT			dry	99/150mm 150mm (20,20,21,28,50)								
14.40	100	13	0										
15.90					15.70	5.05 15.70	Weak to medium strong thickly bedded dark grey fine grained LIMESTONE with widely spaced very thin beds of very stiff dark brown sandy gravelly CLAY (Destructured Limestone)						
	100	100	100	NI		(1.50)	Discontinuity Set 1: joints, close to medium spaced, 50-60 degrees, planar to curved, closed and tight, infilled with calcite <2-3mm thick						
17.40					17.20	3.55 17.20	Medium strong to strong, locally weak, dark grey thin to thickly bedded fine grained LIMESTONE with occasional calcite veining. Partially weathered with some grey staining along discontinuity surfaces						
	100	100	78	6		(2.80)	Discontinuity Set 1: bedding very close to medium spaced, sub-horizontal, planar, smooth to rough, typically closed where open stained dark grey						
18.90							Discontinuity Set 2: joints, probably closely spaced, rarely occurring, 40-50 degrees, stepped, rough, open and stained grey and brown, locally closed and infilled with calcite						
	100	100	66										
	TCR	SCR	RQD	FI	End of Borehole at 20.00 m								
Remarks: SPT's carried out using SPT hammers: DA08 to 5.30m and SPT1 to 20.0m						Chiseling: From (m) to (m) time (hh:mm)		Water Strikes: Struck (m) rising to (m) time (min) No Groundwater Encountered					
						Core Barrel: SK6L Flush type: Water/Polymer			Casing: to (m) dia. (mm) 5.00 200 6.60 196 20.00 146				
												Last Revised: 14/11/2014	
												 www.causewaygeotech.com (c) Causeway Geotech Ltd	

Causeway Geotech Ltd					Project No: 14-240	Project Name: National Paediatric Hospital, Dublin - Ground Investigation Contract	Borehole No. BH108				
Method and Equipment: Hand dug 0.00-1.20m Percussion boring 1.20-4.60m Dando 2000 Rotary drilling 4.60-5.00m Symmetrix Drilling Rotary coring 5.00-25.20m Geobor S					Co-ords: 713344.0mE 733461.8mN		Client: National Paediatric Hospital		Sheet 1 of 3		
							Engineer: Roughan & O'Donovan		Scale: 1:50		
					Ground Level: 20.01mOD		Dates: 02/07/2014 - 09/07/2014		Driller: DE/SS		
Depth (m)	Sample / Test		Casing Depth (m)	Water Depth (m)	Field Records	Level	Depth (Thickness)	Stratum Description		Legend & Water Strikes	Backfill/Installs
0.50	B		1.20	dry	450mm Recovery	19.98	0.03	MADE GROUND: Tarmac			
0.50	ES					19.61	0.40	CONCRETE			
1.00	D					19.01	1.00	MADE GROUND: Soft brown gravelly CLAY. Gravel is angular fine to medium			
1.20-1.65	U							Soft light brown sandy SILT. Sand is fine to coarse			
1.20	B							Stiff brown and grey sandy gravelly CLAY. Sand is fine to coarse. Gravel is angular fine to medium			
1.50	ES										
1.70	D		2.00	dry	N=22 N=22 (2,3,3,5,6,8)	(1.70)					
2.00	SPT										
2.00	B										
2.00	D										
3.00	B						3.00	dry			450mm Recovery
3.00-3.45	U										
3.50	D										
4.00	SPT		4.00	dry	50/75mm 75mm (25,50)	(2.10)					
4.00	B										
4.00	D										
4.50	SPT		4.50	dry	50/75mm 75mm (25,50)	15.01	5.00	Very stiff to hard dark brownish grey sandy gravelly CLAY with occasional cobbles. Sand is fine to coarse. Gravel is subangular to subrounded fine to coarse. Cobbles are subangular to subrounded			
4.50	B										
4.50	D										
5.00	100	0	0								
5.70	100	0	0								
7.20	100	0	0								
8.70	100	0	0								
	TCR	SCR	RQD	FI	Continued next sheet						
Remarks: SPT's carried out using SPT hammers: DA08 to 4.60m and SPT2 to 25.20m Borehole backfilled on completion.						Chiseling: From (m) to (m) time (hh:mm)		Water Strikes: Struck (m) rising to (m) time (min) No Groundwater Encountered		Last Revised: 14/11/2014	
						Core Barrel: SK6L		Casing: to (m) dia. (mm) 4.60 200 25.20 146		 www.causewaygeotech.com (c) Causeway Geotech Ltd	
						Flush type: Water-Polymer					

Causeway Geotech Ltd					Project No: 14-240		Project Name: National Paediatric Hospital, Dublin - Ground Investigation Contract		Borehole No. BH108				
Method and Equipment: Hand dug 0.00-1.20m Percussion boring 1.20-4.60m Dando 2000 Rotary drilling 4.60-5.00m Symmetrix Drilling Rotary coring 5.00-25.20m Geobor S					Co-ords: 713344.0mE 733461.8mN		Client: National Paediatric Hospital		Sheet 2 of 3				
							Engineer: Roughan & O'Donovan		Scale: 1:50				
					Ground Level: 20.01mOD		Dates: 02/07/2014 - 09/07/2014		Driller: DE/SS				
													Logger: DOM/MG
Depth (m)	TCR	SCR	RQD	FI	Field Records	Level Depth (Thickness)		Stratum Description		Legend & Water Strikes	Backfill Installs		
10.20				N/A			(10.50)	Very stiff to hard dark brownish grey sandy gravelly CLAY with occasional cobbles. Sand is fine to coarse. Gravel is subangular to subrounded fine to coarse. Cobbles are subangular to subrounded					
	100	0	0										
11.70													
	100	0	0										
13.20													
	100	0	0										
14.70													
	100	23	23		15.50	4.51	15.50	Medium strong to strong very thinly to medium bedded dark grey fine grained LIMESTONE with occasional medium spaced very thin beds of very weak dark grey MUDSTONE and rare calcite veining. Distinctly weathered along bedding surfaces with heavy brown staining and occasional loss of strength and structure. Mudstone is locally destructured to residual clay Discontinuity Set 1: bedding very close to medium spaced, sub-horizontal, planar, smooth to rough, typically closed, where open stained dark grey Discontinuity Set 2: joints, probably closely spaced, rarely occurring, 40-50 degrees, stepped, rough, open and stained grey and brown, locally closed and infilled with calcite					
				NI	15.85								
16.20													
	100	100	100	4									
17.70					18.00								
	100	100	84										
19.20													
				7									
	100	89	71										
	TCR	SCR	RQD	FI									
Remarks: SPT's carried out using SPT hammers: DA08 to 4.60m and SPT2 to 25.20m Borehole backfilled on completion.								Continued next sheet					
								Chiseling: From (m) to (m) time (hh:mm)		Water Strikes: Struck (m) rising to (m) time (min) No Groundwater Encountered		Last Revised: 14/11/2014	
								Core Barrel: SK6L Flush type: Water-Polymer		Casing: to (m) dia. (mm) 4.60 200 25.20 146		 www.causewaygeotech.com (c) Causeway Geotech Ltd	

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Causeway Geotech Ltd					Project No: 14-240	Project Name: National Paediatric Hospital, Dublin - Ground Investigation Contract			Borehole No. BH109			
Method and Equipment: Hand dug 0.00-1.20m Percussion boring 1.20-5.00m Dando 2000 Rotary coring 5.00-25.20m Beretta T41					Co-ords: 713315.2mE 733476.8mN		Client: National Paediatric Hospital			Sheet 1 of 3		
							Engineer: Roughan & O'Donovan			Scale: 1:50		
					Ground Level: 19.99mOD		Dates: 27/06/2014 - 16/07/2014			Driller: DE/SS		
										Logger: DOM/MG		
Depth (m)	Sample / Test		Casing Depth (m)	Water Depth (m)	Field Records	Level Depth (Thickness)		Stratum Description		Legend & Backfill		
0.50	B		1.20	dry	450mm Recovery	19.89	0.10	CONCRETE				
0.50	ES					19.79	0.20	MADE GROUND: Hardcore Fill				
1.20	B		2.00	dry	N=10 N=10 (1,2,2,3,2,3)	19.59	0.40	MADE GROUND: Soft brown sandy CLAY with occasional cobbles, fragments of brick and cinder fill. Sand is fine to coarse		1		
1.20-1.65	U					19.09	0.90	Soft light brown gravelly CLAY. Gravel is subangular to subrounded fine to medium				
1.50	ES					Soft to firm brown sandy gravelly CLAY. Sand is fine to coarse. Gravel is subangular to subrounded fine to medium						
1.70	D		4.00	dry	50/20mm 20mm (25,50)	(1.60)	(3.30)					
2.00	SPT							At 4.40m - 5.00m: boulder				
2.00	B											
2.00	D											
3.00	B		3.00	dry	450mm Recovery							
3.00-3.45	U											
3.60	D		5.00	dry	50/15mm 15mm (25,50)							
4.00	SPT											
4.00	B											
4.00	D											
5.00	SPT		0	0								
5.00	B											
5.00	D		0	0								
5.70												
7.20	100		0	0								
7.20												
7.20	SPT		0	0								
7.20												
8.70	100		0	0								
8.70												
8.70	SPT		0	0								
8.70												
	60		0	0	N/A							
	TCR	SCR	RQD	FI								
Remarks: SPT's carried out using SPT hammers: DA08 to 5.00m and SPT2 to 25.20m.. Standpipe piezometer installed.						Chiseling: From (m) to (m) time (hh:mm) 4.90 5.00 01:00			Water Strikes: Struck (m) rising to (m) time (min) 1.20 1.00 15			Last Revised: 14/11/2014 www.causewaygeotech.com (c) Causeway Geotech Ltd
						Core Barrel: SK6L			Casing: to (m) dia. (mm) 5.00 200			
						Flush type: Air-Water						

Causeway Geotech Ltd					Project No: 14-240	Project Name: National Paediatric Hospital, Dublin - Ground Investigation Contract	Borehole No. BH109		
Method and Equipment: Hand dug 0.00-1.20m Percussion boring 1.20-5.00m Dando 2000 Rotary coring 5.00-25.20m Beretta T41					Co-ords: 713315.2mE 733476.8mN	Client: National Paediatric Hospital	Sheet 2 of 3		
						Engineer: Roughan & O'Donovan	Scale: 1:50		
					Ground Level: 19.99mOD	Dates: 27/06/2014 - 16/07/2014	Driller: DE/SS		
							Logger: DOM/MG		
Depth (m)	TCR	SCR	RQD	FI	Field Records	Level Depth (Thickness)	Stratum Description	Legend & Backfill Water Strikes Installs	
10.20 10.20	SPT			dry	N=77 N=77 (5,8,14,20,23,20)		Very stiff dark brownish grey sandy gravelly CLAY with occasional cobbles. Sand is fine to coarse. Gravel is subangular to subrounded fine to coarse. Cobbles are subangular to subrounded		
11.70 11.70	SPT			dry	N=69 N=69 (6,11,12,15,18,24)	8.29 11.70 (1.50)	Stiff to very stiff dark brownish grey sandy gravelly CLAY with occasional boulders. Sand is fine to coarse. Gravel is subangular to subrounded fine to coarse. Boulders are subangular to subrounded		
13.20					13.65	6.79 13.20 (0.45)	Stiff to very stiff dark brownish grey sandy gravelly CLAY with occasional cobbles. Sand is fine to coarse. Gravel is subangular to subrounded fine to coarse. Cobbles are subangular to subrounded		
14.70 14.70	SPT			dry NI	50/40mm 40mm (25,50)	6.34 13.65 (2.55)	Medium strong, locally very weak to weak, very thinly to medium bedded dark grey fine grained LIMESTONE with occasional calcite veins. Distinctly weathered to destructured - largely recovered as highly fractured and non-intact where removed from core liner		
16.20	100	90	67		16.20	3.79 16.20	Medium strong to strong very thinly to thinly bedded dark grey fine to medium grained LIMESTONE with occasional calcite veining. Partially weathered to distinctly weathered along discontinuity surfaces with heavy grey and brown staining		
17.70	100	96	75	12			Discontinuity Set 1: bedding planes, very close to closely spaced, 10-15 degrees, planar rough (occasionally smooth), open (locally by drilling), clean to stained dark grey and brown, occasionally lined with calcite		
19.20					19.50		Discontinuity Set 2: joints, very closely spaced, 70-80 degrees, planar to curved, closed and infilled with calcite to locally open and stained dark grey		
	100	54	54	NI					
	TCR	SCR	RQD	FI					
Remarks: SPT's carried out using SPT hammers: DA08 to 5.00m and SPT2 to 25.20m.. Standpipe piezometer installed.					Chiseling: From (m) to (m) time (hh:mm)		Water Strikes: Struck (m) rising to (m) time (min)	Last Revised: 14/11/2014	
					Core Barrel: SK6L		Casing: to (m) dia. (mm)		
					Flush type: Air-Water		5.00 200	 www.causewaygeotech.com (c) Causeway Geotech Ltd	

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Causeway Geotech Ltd					Project No: 14-240	Project Name: National Paediatric Hospital, Dublin - Ground Investigation Contract	Borehole No. BH110
Method and Equipment: Hand dug 0.00-1.20m Percussion boring 1.20-4.30m Dando 2000 Rotary coring 4.30-25.00m Beretta T41					Co-ords: 713257.9mE 733453.7mN	Client: National Paediatric Hospital	Sheet 1 of 3
						Engineer: Roughan & O'Donovan	Scale: 1:50
					Ground Level: 20.19mOD	Dates: 26/06/2014 - 07/07/2014	Driller: DE/SS
							Logger: DOM/MG
Depth (m)	Sample / Test	Casing Depth (m)	Water Depth (m)	Field Records	Level Depth (Thickness)	Stratum Description	Legend & Backfill Water Strikes Installs
0.50 0.50	B ES				20.09 0.10 20.04 0.15 (0.35)	MADE GROUND: Gravel Fill	
					19.69 0.50 (0.40)	MADE GROUND: Soft grey brown sandy CLAY. Sand is fine to coarse	
						MADE GROUND: Hardcore Fill	
1.20 1.20-1.65 1.50 1.70	B U ES D	1.20	dry	450mm Recovery	19.29 0.90 (0.70)	MADE GROUND: Soft grey sandy gravelly silty CLAY. Sand is fine to coarse. Gravel is angular fine to medium	
2.00 2.00 2.00	SPT B D	2.00	dry	N=11 N=11 (2,1,2,2,3,4)	18.59 1.60	Soft brown sandy gravelly CLAY. Sand is fine to coarse. Gravel is angular fine to medium	
					(1.89)	Firm brown sandy gravelly CLAY. Sand is fine to coarse. Gravel is subangular to subrounded fine to coarse	
3.50 3.50-3.95	B U	3.50	dry	450mm Recovery	16.70 3.49	Very stiff grey and black sandy gravelly CLAY. Sand is fine to coarse. Gravel is angular fine to medium	
4.00 4.00	SPT D	4.00	dry	50/75mm 75mm (25,50)		At 4.20m - 4.30m: boulder encountered	
4.50					(2.01)	At 4.50m - 5.50m: No recovery - description based on flush return	
5.50					14.69 5.50	Very stiff light brownish grey to brown sandy gravelly CLAY with occasional cobbles. Sand is fine to coarse. Gravel is subrounded to subangular fine to coarse. Cobbles are subrounded to subangular	
6.30						At 5.50m - 6.30m: AZCL	
7.00						From 6.50m - 10.00m: becomes light grey and brown in colour	
8.50					(7.50)		
	TCR	SCR	RQD	FI			
Remarks: SPT's carried out using SPT hammers: DA08 to 4.30m and SPT2 to 25.00m.						Chiseling: From (m) to (m) time (hh:mm) 4.20 4.30 01:00	Water Strikes: Struck (m) rising to (m) time (min) 0.15 0.15 20
						Core Barrel: SK6L Flush type: Water & Polymer	Casing: to (m) dia. (mm) 4.20 200 25.00 146
						Last Revised: 14/11/2014	
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Continued next sheet

Causeway Geotech Ltd					Project No: 14-240	Project Name: National Paediatric Hospital, Dublin - Ground Investigation Contract	Borehole No. BH110			
Method and Equipment: Hand dug 0.00-1.20m Percussion boring 1.20-4.30m Dando 2000 Rotary coring 4.30-25.00m Beretta T41					Co-ords: 713257.9mE 733453.7mN		Client: National Paediatric Hospital Sheet 2 of 3			
							Engineer: Roughan & O'Donovan Scale: 1:50			
					Ground Level: 20.19mOD		Dates: 26/06/2014 - 07/07/2014 Driller: DE/SS			
							Logger: DOM/MG			
Depth (m)	TCR	SCR	RQD	FI	Field Records	Level Depth (Thickness)	Stratum Description	Legend & Backfill Water Strikes Installs		
10.00	100	0	0				Very stiff light brownish grey to brown sandy gravelly CLAY with occasional cobbles. Sand is fine to coarse. Gravel is subrounded to subangular fine to coarse. Cobbles are subrounded to subangular From 10.00m - 13.00m: becomes more brown in colour			
11.50	100	0	0							
13.00	100	100	93		13.00	7.19 13.00	Strong, locally weak to medium strong, medium to thickly bedded dark grey fine grained LIMESTONE with frequent calcite veining. Partially weathered with some grey surface staining, locally distinctly weathered with some increased fracturing Discontinuity Set 1: bedding planes, medium to thickly spaced, sub-horizontal, planar rough, typically closed and infilled with calcite <5mm thick, locally open and distinctly weathered along flanks with some loss of strength to clayey gravel Discontinuity Set 2: joints, closely spaced, 60-70 degrees, planar to curved, closed with calcite infill, <7-10mm thick, locally open and stained dark grey At 16.40m - 17.50m: highly fractured			
14.50	100	97	97	4						
16.00	100	100	85	6	16.40					
17.50	100	100	100		17.50					
19.00	100	100	100	3		(12.00)				
	TCR	SCR	RQD	FI			Continued next sheet			
Remarks: SPT's carried out using SPT hammers: DA08 to 4.30m and SPT2 to 25.00m.							Chiseling: From (m) to (m) time (hh:mm)	Water Strikes: Struck (m) rising to (m) time (min)	Last Revised: 14/11/2014 www.causewaygeotech.com (c) Causeway Geotech Ltd	
							Core Barrel: SK6L	Casing: to (m) dia. (mm) 4.20 200 25.00 146		
							Flush type: Water & Polymer			




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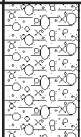

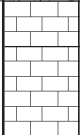

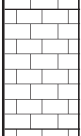

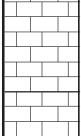

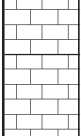

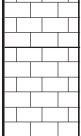


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Causeway Geotech Ltd					Project No. 14-240	Project Name: National Paediatric Hospital, Dublin - Ground Investigation Contract	Borehole No. BH111B						
Method and Equipment: Hand dug 0.00-1.20m Percussion boring 1.20-3.50m Dando 2000 Rotary drilling 3.50-5.00m Symmetrix Drilling Rotary coring 5.00-25.00m Comacchio 450					Co-ords: 713323.8mE 733506.8mN		Client: National Paediatric Hospital		Sheet 1 of 3				
							Engineer: Roughan & O'Donovan		Scale: 1:50				
					Ground Level: 19.89mOD		Dates: 02/07/2014 - 07/08/2014		Driller: DE/GT				
									Logger: DOM/MG				
Depth (m)	Sample / Test		Casing Depth (m)	Water Depth (m)	Field Records	Level	Depth (Thickness)	Stratum Description	Legend & Water Strikes	Backfill/Installs			
0.50	B		1.20	dry	450mm Recovery	19.85	0.04	MADE GROUND: Tarmac		1			
0.50	ES					19.59	0.30	CONCRETE					
1.20	B	U				18.59	1.30	Firm to stiff dark grey brown sandy gravelly silty CLAY. Sand is fine to coarse. Gravel is angular fine to medium					
1.20-1.65	ES												
1.50	D	18.29	1.60	Soft brown sandy gravelly CLAY/SILT. Sand is fine to coarse. Gravel is subrounded fine to coarse									
2.00	SPT	B	2.00	dry	N=8 N=8 (1,1,2,2,2,2)	(1.30)							
2.00	D												
2.00													
3.00	B	U	3.00	dry	450mm Recovery	16.99	2.90	Very stiff dark grey and black sandy gravelly CLAY. Sand is fine to coarse. Gravel is angular fine to medium					
3.00-3.45						(0.60)							
3.50	D					16.39	3.50	Very stiff dark brownish grey sandy gravelly CLAY with many cobbles and occasional boulders. Sand is fine to coarse. Gravel is subrounded to subangular fine to coarse. Cobbles and boulders are subrounded to subangular					
5.00													
	100	0	0										
6.60	SPT		6.60	dry	N=61 N=61 (6,8,12,10,19,20)			From 6.60m - 8.20m: becomes dark grey brown in colour					
6.60		100				0	0						
8.20													
	100	0	0				(10.80)						
9.80			9.80	N/A dry	N=61 N=61 (5,10,9,12,19,21)								
9.80	SPT												
	TCR	SCR	RQD	FI									
Remarks: SPT's carried out using SPT hammers: DA08 to 3.50m and SPT1 to 25.00m.					Continued next sheet					Last Revised: 14/11/2014			
					Chiseling: From (m) to (m) time (hh:mm)							Water Strikes: Struck (m) rising to (m) time (min)	
					Core Barrel: SK6L Flush type: Water-Polymer							Casing: to (m) dia. (mm) 3.50 200 5.00 196 25.00 146	
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Causeway Geotech Ltd					Project No: 14-240		Project Name: National Paediatric Hospital, Dublin - Ground Investigation Contract		Borehole No. BH111B			
Method and Equipment: Hand dug 0.00-1.20m Percussion boring 1.20-3.50m Dando 2000 Rotary drilling 3.50-5.00m Symmetrix Drilling Rotary coring 5.00-25.00m Comacchio 450					Co-ords: 713323.8mE 733506.8mN		Client: National Paediatric Hospital		Sheet 2 of 3			
							Engineer: Roughan & O'Donovan		Scale: 1:50			
					Ground Level: 19.89mOD		Dates: 02/07/2014 - 07/08/2014		Driller: DE/GT			
Depth (m)	TCR	SCR	RQD	FI	Field Records	Level	Depth (Thickness)	Stratum Description		Legend & Water Strikes	Backfill Installs	
11.30	100	0	0	dry	N=74 N=74 (6,10,12,18,20,24)			Very stiff dark brownish grey sandy gravelly CLAY with many cobbles and occasional boulders. Sand is fine to coarse. Gravel is subrounded to subangular fine to coarse. Cobbles and boulders are subrounded to subangular				
	100	0	0									
12.80	SPT											
12.80	100	0	0									
14.30				10	14.30	5.59	14.30	Very weak to weak, very thinly to thinly bedded dark grey MUDSTONE. Distinctly weathered with loss of structure around flanks of discontinuities and heavy brown staining throughout. Locally destructured to a residual clay Discontinuity Set 1: bedding, very close to closely spaced, 10-20 degrees, planar, smooth, closed to locally open with dark grey staining and some clay lining				
15.80	100	100	65									
17.30	100	100	92	6	16.80	3.09	16.80	Medium strong (locally weak), medium bedded grey fine to medium grained LIMESTONE with many calcite veins. Partially weathered with some grey and orange surface staining along discontinuity surfaces Discontinuity Set 1: bedding planes, medium spaced, sub-horizontal, planar to occasionally stepped, rough, open and clean, typically some increased fracturing around flanks, dark grey staining occurs				
	18.80	100	92								47	
18.80	100	95	59		18.35	1.54	18.35	Discontinuity Set 2: joints, very close to closely spaced, 70-80 degrees, curved, closed and infilled with calcite up to 10mm thickness, occasionally open and lined with calcite with heavy grey staining LIMESTONE (Full description as Sheet 3)				
	100	95	59									
	TCR	SCR	RQD	FI	Continued next sheet							
Remarks: SPT's carried out using SPT hammers: DA08 to 3.50m and SPT1 to 25.00m.							Chiseling: From (m) to (m) time (hh:mm)		Water Strikes: Struck (m) rising to (m) time (min)		Last Revised: 14/11/2014	
							Core Barrel: SK6L		Casing: to (m) dia. (mm)		 www.causewaygeotech.com (c) Causeway Geotech Ltd	
							Flush type: Water-Polymer		3.50 200 5.00 196 25.00 146			

Causeway Geotech Ltd					Project No: 14-240		Project Name: National Paediatric Hospital, Dublin - Ground Investigation Contract		Borehole No. BH111B			
Method and Equipment: Hand dug 0.00-1.20m Percussion boring 1.20-3.50m Dando 2000 Rotary drilling 3.50-5.00m Symmetrix Drilling Rotary coring 5.00-25.00m Comacchio 450					Co-ords: 713323.8mE 733506.8mN		Client: National Paediatric Hospital		Sheet 3 of 3			
							Engineer: Roughan & O'Donovan		Scale: 1:50			
					Ground Level: 19.89mOD		Dates: 02/07/2014 - 07/08/2014		Driller: DE/GT			
									Logger: DOM/MG			
Depth (m)		TCR	SCR	RQD	FI	Field Records	Level	Depth (Thickness)	Stratum Description		Legend & Water Strikes	Backfill/Installs
20.30						8	-0.11	20.00	Medium strong to strong, locally weak where weathered, thin to medium bedded dark grey muddy to fine grained LIMESTONE. Partially weathered with some disintegration adjacent to discontinuity surfaces Discontinuity Set 1: bedding, close to medium spaced, sub-horizontal, planar smooth, open and clean with some grey surface staining and occasional clay lining Discontinuity Set 2: joints, 45-60 degrees, close to medium spaced, planar to curved, open and lined with calcite, some orange staining			
21.80		100	100	65								
23.30		100	98	67								
		100	100	82		25.00	-5.11	25.00	End of Borehole at 25.00 m			
		TCR	SCR	RQD	FI							
Remarks: SPT's carried out using SPT hammers: DA08 to 3.50m and SPT1 to 25.00m.							Chiseling: From (m) to (m) time (hh:mm)		Water Strikes: Struck (m) rising to (m) time (min)		Last Revised: 14/11/2014	
							Core Barrel: SK6L Flush type: Water-Polymer		Casing: to (m) dia. (mm) 3.50 200 5.00 196 25.00 146		 www.causewaygeotech.com (c) Causeway Geotech Ltd	

Causeway Geotech Ltd					Project No 14-240	Project Name: National Paediatric Hospital, Dublin - Ground Investigation Contract	Borehole No. BH112					
Method and Equipment: Hand dug 0.00-1.20m Percussion boring 1.20-5.60m Dando 2000 Rotary drilling 5.60-6.80m Symmetrix Drilling Rotary coring 6.80-20.30m Beretta T41					Co-ords: 713262.5mE 733514.8mN		Client: National Paediatric Hospital			Sheet 1 of 3		
							Engineer: Roughan & O'Donovan			Scale: 1:50		
					Ground Level: 20.48mOD		Dates: 26/06/2014 - 01/08/2014			Driller: DE/SS		
										Logger: DOM/DB		
Depth (m)	Sample / Test		Casing Depth (m)	Water Depth (m)	Field Records	Level Depth (Thickness)		Stratum Description		Legend & Water Strikes	Backfill Installs	
0.50	ES					20.40	0.08	Bitmac				
						20.13	0.35	MADE GROUND: Hardcore				
						19.83	0.65	MADE GROUND: Firm dark brown slightly sandy organic clayey SILT with very low brick and cinder fragment content. Sand is fine to medium				
						(0.55)						
1.20 1.20-1.65 1.50 1.70	B U ES D		1.20	dry	450mm Recovery	19.28	1.20	Possible MADE GROUND: Firm brown mottled dark brown slightly sandy silty CLAY. Sand is fine to medium				
								Soft brown gravelly CLAY. Gravel is angular fine to medium				
2.00 2.00 2.00	SPT B D		2.00	dry	N=7 N=7 (1,2,1,2,2,2)	(1.70)						
3.00 3.00-3.45 3.50	B U D		3.00	dry	450mm Recovery	17.58	2.90	Very stiff dark grey to black sandy gravelly CLAY. Sand is fine to coarse. Gravel is angular fine to medium				
4.00 4.00 4.00	SPT B D		4.00	dry	50/75mm 75mm (25,50)	(3.40)						
5.00 5.00 5.00	SPT B D		5.00	dry	50/75mm 75mm (25,50)							
6.30 6.80	100 0 0					14.18	6.30	Stiff to very stiff black and grey brown sandy gravelly silty CLAY with occasional cobbles and boulders. Sand is fine to coarse. Gravel is subrounded to subangular fine to coarse. Cobbles and boulders are subangular to subrounded From 6.30m - 14.30m: becomes brown in colour				
8.30 8.30	SPT 100 0 0		8.30	dry	N=71 N=71 (5,9,15,14,20,22)							
9.80 9.80	SPT TCR SCR RQD FI		9.80	dry	N=73 N=73 (5,7,11,18,21,23)							
Remarks: SPT's carried out using SPT hammers: DA08 to 5.60m and SPT2 to 20.30m. Standpipe piezometer installed.						Continued next sheet						
						Chiseling: From (m) to (m) time (hh:mm)			Water Strikes: Struck (m) rising to (m) time (min)			Last Revised: 14/11/2014
						Core Barrel: SK6L Flush type: Water-Polymer			Casing: to (m) dia. (mm)			
									 www.causewaygeotech.com (c) Causeway Geotech Ltd			


Causeway Geotech Ltd					Project No: 14-240		Project Name: National Paediatric Hospital, Dublin - Ground Investigation Contract			Borehole No. BH112					
Method and Equipment: Hand dug 0.00-1.20m Percussion boring 1.20-5.60m Dando 2000 Rotary drilling 5.60-6.80m Symmetrix Drilling Rotary coring 6.80-20.30m Beretta T41					Co-ords: 713262.5mE 733514.8mN		Client: National Paediatric Hospital			Sheet 2 of 3					
							Engineer: Roughan & O'Donovan			Scale: 1:50					
					Ground Level: 20.48mOD		Dates: 26/06/2014 - 01/08/2014			Driller: DE/SS					
													Logger: DOM/DB		
Depth (m)	TCR	SCR	RQD	FI	Field Records	Level	Depth (Thickness)	Stratum Description			Legend & Water Strikes	Backfill Installs			
11.30	100	0	0	N/A			(8.00)	Stiff to very stiff black and grey brown sandy gravelly silty CLAY with occasional cobbles and boulders. Sand is fine to coarse. Gravel is subrounded to subangular fine to coarse. Cobbles and boulders are subangular to subrounded							
11.30	SPT			dry	N=79 N=79 (7,10,15,15,24,25)										
12.80	100	0	0					Medium strong thinly bedded dark grey fine grained LIMESTONE with occasional widely spaced very thin beds of extremely weak dark brownish grey MUDSTONE. Distinctly weathered with heavy dark grey and brown staining along joint surfaces and mudstone beds are occasionally destructured to residual clay							
12.80	SPT			dry	N=71 N=71 (5,8,12,15,20,24)										
14.30	100	94	82	5	14.30 50/100mm 100mm (25,35,15)	6.18	14.30	Discontinuity Set 1: bedding, closely spaced, sub-horizontal to 20 degrees, planar, smooth, open and clean with grey staining to occasionally lined with gravelly clay (destructured mudstone), rarely lined with calcite							
14.30	SPT			dry											
15.80	100	100	53		15.80			Discontinuity Set 2: joints, rarely occurring, sub-vertical, curved, rough, lined with calcite							
15.80															
17.30	100	93	48	7			(6.00)								
17.30															
18.80	100	85	17	9	18.80										
18.80															
	TCR	SCR	RQD	FI											
Remarks: SPT's carried out using SPT hammers: DA08 to 5.60m and SPT2 to 20.30m. Standpipe piezometer installed.							Continued next sheet								
							Chiseling: From (m) to (m) time (hh:mm)			Water Strikes: Struck (m) rising to (m) time (min)			Last Revised: 14/11/2014		
							Core Barrel: SK6L			Casing: to (m) dia. (mm)			 www.causewaygeotech.com (c) Causeway Geotech Ltd		
							Flush type: Water-Polymer			5.50 200 6.30 196 20.30 146					

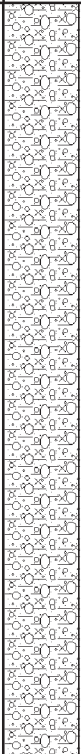
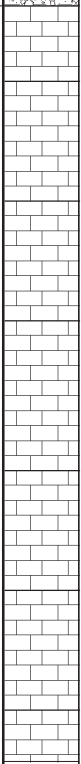

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Causeway Geotech Ltd					Project No: 14-240	Project Name: National Paediatric Hospital, Dublin - Ground Investigation Contract	Borehole No. BH113			
Method and Equipment: Hand dug 0.00-1.20m Rotary drilling 1.20-5.00m Symmetrix Drilling Rotary coring 5.00-25.00m Comacchio 450					Co-ords: 713222.8mE 733513.6mN		Client: National Paediatric Hospital		Sheet 1 of 3	
							Engineer: Roughan & O'Donovan		Scale: 1:50	
					Ground Level: 20.41mOD		Dates: 16/07/2014		Driller: GT	
									Logger: MG	
Depth (m)	Sample / Test		Casing Depth (m)	Water Depth (m)	Field Records	Level Depth (Thickness)	Stratum Description		Legend & Water Strikes	Backfill Installs
1.50	SPT		1.50	dry	N=27 N=27 (5,5,6,5,8,8)	(2.20)	MADE GROUND: Firm brown sandy gravelly SILT with occasional cinders and occasional cobbles. Sand is fine to coarse. Gravel is subangular to subrounded fine to coarse			
3.00	SPT		3.00	dry	N=31 N=31 (6,6,7,8,9,7)	18.21 2.20	Very stiff to hard dark brownish grey sandy gravelly silty CLAY with occasional cobbles. Sand is fine to coarse. Gravel is subrounded to subangular fine to coarse. Cobbles are subrounded to subangular			
4.50	SPT		4.50	dry	N=54 N=54 (10,10,15,14,12,13)					
5.00							At 5.00m - 6.00m and 8.20m - 9.70m: Unconsolidated undrained triaxial tests indicate extremely high strength			
	100	0	0							
6.60										
6.60	SPT		6.60	dry	N=71 N=71 (12,14,18,20,18,15)					
	100	0	0							
8.20										
8.20	SPT		8.20	dry	N=62 N=62 (14,20,18,18,14,12)	(11.70)				
	100	0	0							
9.70				N/A						
9.70	SPT		9.70	dry	N=71 N=71 (14,18,15,18,20,18)					
	TCR	SCR	RQD	FI			Continued next sheet			
Remarks: SPT's carried out using SPT hammer SPT1.							Water Strikes: Struck (m) rising to (m) time (min) No Groundwater Encountered		Last Revised: 14/11/2014	
							Core Barrel: SK6L Flush type: Water & Polymer		Casing: to (m) dia. (mm) 5.00 200 25.00 146	

Causeway Geotech Ltd					Project No: 14-240		Project Name: National Paediatric Hospital, Dublin - Ground Investigation Contract		Borehole No. BH113		
Method and Equipment: Hand dug 0.00-1.20m Rotary drilling 1.20-5.00m Symmetrix Drilling Rotary coring 5.00-25.00m Comacchio 450					Co-ords: 713222.8mE 733513.6mN		Client: National Paediatric Hospital		Sheet 2 of 3		
							Engineer: Roughan & O'Donovan		Scale: 1:50		
					Ground Level: 20.41mOD		Dates: 16/07/2014		Driller: GT		
									Logger: MG		
Depth (m)	TCR	SCR	RQD	FI	Field Records	Level	Depth (Thickness)	Stratum Description		Legend & Water Strikes	Backfill Installs
11.30 11.30	100	0	0		dry N=67 N=67 (19,20,19,20,10,18)			Very stiff to hard dark brownish grey sandy gravelly silty CLAY with occasional cobbles. Sand is fine to coarse. Gravel is subrounded to subangular fine to coarse. Cobbles are subrounded to subangular			
	SPT										
12.80 12.80	100	0	0		dry N=68 N=68 (14,10,15,18,15,20)						
	SPT										
14.30 14.30	100	22	0		dry N=72 N=72 (15,20,15,18,21,18)	6.51	13.90	Medium strong, locally weak, thinly bedded, dark grey muddy LIMESTONE with occasional thin beds of clastic LIMESTONE. Distinctly weathered with increased fracturing adjacent to discontinuities, heavy brown staining also occurs along with clay lined bedding planes			
	SPT										
15.90	100	93	69	5	13.90	(2.15)		Discontinuity Set 1: bedding, closely spaced, sub-horizontal, planar smooth, open and stained grey brown with clay lining to occasionally infilled with calcite			
				18	15.30						
17.30	100	97	89		16.05	4.36	16.05	Discontinuity Set 2: joints, closely spaced, 40-50 degrees, planar smooth, open and lined with gravelly clay, occasionally infilled with calcite <3mm thick, some loss of structure around flanks			
18.90	100	100	100	6		(4.55)		Discontinuity Set 3: joints, sub-vertical, probably closely spaced, planar to curved, rough, closed and tight with calcite infill			
	100	100	98					Medium strong to strong medium bedded dark grey fine to medium grained LIMESTONE with frequent calcite veining. Partially weathered with some surface staining to locally distinctly weathered with some loss of strength and structure adjacent to bedding planes			
								Discontinuity Set 1: bedding medium to locally widely spaced, sub-horizontal to 20 degrees, planar, rough, clean to lined with calcite, occasionally completely infilled with calcite <10-15mm thick			
								Discontinuity Set 2: joints, 50-60 degrees, closely spaced, planar to curved, closed with calcite infill to open and lined with calcite			
								Discontinuity Set 3: joints, randomly			
								Continued next sheet			
Remarks: SPT's carried out using SPT hammer SPT1.								Water Strikes: Struck (m) rising to (m) time (min) No Groundwater Encountered		Last Revised: 14/11/2014	
								Core Barrel: SK6L Flush type: Water & Polymer		Casing: to (m) dia. (mm) 5.00 200 25.00 146	

Causeway Geotech Ltd						Project No: 14-240		Project Name: National Paediatric Hospital, Dublin - Ground Investigation Contract		Borehole No. BH113	
Method and Equipment: Hand dug 0.00-1.20m Rotary drilling 1.20-5.00m Symmetrix Drilling Rotary coring 5.00-25.00m Comacchio 450						Co-ords: 713222.8mE 733513.6mN		Client: National Paediatric Hospital		Sheet 3 of 3	
								Engineer: Roughan & O'Donovan		Scale: 1:50	
						Ground Level: 20.41mOD		Dates: 16/07/2014		Driller: GT	
Depth (m)		TCR	SCR	RQD	FI	Field Records	Level Depth (Thickness)	Stratum Description		Legend & Water Strikes	Backfill Installs
20.40						20.60	-0.19 20.60	orientated, extremely closely spaced, stepped and curved, closed with calcite infill (veining - evidence of faulting) Detail 17.50m - 18.50m : At 17.50m - 18.50m: intensive randomly orientated calcite veining occurs			
21.90		100	100	100			(4.40)	Medium strong to strong, locally weak, medium to thickly bedded grey fine to medium grained LIMESTONE with occasional calcite veining. Partially weathered with some orangey brown surface staining along discontinuity surfaces Discontinuity Set 1: bedding planes, medium to widely spaced (locally closely spaced), sub-horizontal, planar, smooth, clean with some orange and grey surface staining, very occasionally lined with calcite Discontinuity Set 2: joints, 45-60 degrees, close to medium spaced, planar to curved, open, lined with calcite and stained orangey grey and brown along surfaces At 20.90m - 21.15m: very thin beds of extremely weak destructured brown Mudstone/muddy Limestone occur (residual weathering) At 23.85m - 23.95m: highly fractured zone of very weak muddy Limestone			
23.50		100	98	91	5			At 24.60m - 25.00m: sub-vertical joint infilled with calcite <5mm thick			
25.00							-4.59 25.00	End of Borehole at 25.00 m			
Remarks:		SPT's carried out using SPT hammer SPT1.					Water Strikes: Struck rising to time (m) (min) No Groundwater Encountered		Last Revised: 14/11/2014		
Core Barrel:		SK6L					Casing:				
Flush type:		Water & Polymer					to (m) dia. (mm) 5.00 200 25.00 146		www.causewaygeotech.com (c) Causeway Geotech Ltd		

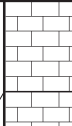
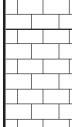






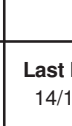


Causeway Geotech Ltd					Project No. 14-240	Project Name: National Paediatric Hospital, Dublin - Ground Investigation Contract		Borehole No. BH114					
Method and Equipment: Hand dug 0.00-1.20m Percussion boring 1.20-3.50m Rotary drilling 3.50-5.00m Symmetrix Drilling Rotary coring 5.00-25.00m Comacchio 450					Co-ords: 713320.5mE 733558.6mN		Client: National Paediatric Hospital		Sheet 1 of 3				
							Engineer: Roughan & O'Donovan		Scale: 1:50				
					Ground Level: 19.56mOD		Dates: 23/06/2014 - 05/08/2014		Driller: CCGT				
									Logger: JC/MG				
Depth (m)	Sample / Test	Casing Depth (m)	Water Depth (m)	Field Records	Level	Depth (Thickness)	Stratum Description		Legend & Water Strikes	Backfill/Installs			
0.30-0.50	B				19.48	0.08	MADE GROUND: Bitmac						
0.40	ES				19.26	0.30	MADE GROUND: Brown sandy fine to coarse GRAVEL (Hardcore Fill)						
0.65-1.00	B				19.06	0.50							
1.00	ES				18.91	0.65	MADE GROUND: Brown sandy subangular to subrounded fine to coarse GRAVEL with ash and red brick. Sand is fine to coarse						
1.20-1.65	U	1.20	dry	55 Blows 450mm Recovery			CONCRETE SLAB						
1.70	SPT	1.70	dry	N=12			Soft to firm brown sandy gravelly CLAY. Sand is fine to coarse. Gravel is subangular to subrounded fine to coarse						
1.70	D			N=12 (2,1,3,3,3,3)									
1.70-2.00	B	2.00	dry		17.56	2.00	Very stiff black sandy gravelly CLAY with low cobble content. Sand is fine to coarse. Gravel is subangular to subrounded fine to coarse. Cobbles are subangular to subrounded						
2.00-3.00	B			85 Blows									
2.00-2.45	U			450mm Recovery									
2.50	D												
3.00	SPT	3.00	dry	N=37									
3.00	D			N=37 (3,4,5,9,10,13)									
5.00					16.06	3.50	Very stiff dark brownish black sandy gravelly CLAY with occasional cobbles. Sand is fine to coarse. Gravel is subangular to subrounded fine to coarse. Cobbles are subrounded to subangular						
							From 5.00m - 8.10m: becomes dark brown and black						
	100	0	0										
6.60													
6.60	SPT	6.60	dry	N=63									
				N=63 (7,9,10,12,19,22)									
	100	0	0										
8.10													
	100	0	0										
9.60													
9.60	SPT	9.60	dry	N=72									
				N=72 (6,10,12,17,20,23)									
	TCR	SCR	RQD	FI									
Remarks: SPT's carried out using SPT hammers: CC4 to 3.50m and SPT1 to 25.00m.					Continued next sheet			Chiseling: From (m) to (m) time (hh:mm)		Water Strikes: Struck (m) rising to (m) time (min) No Groundwater Encountered		Last Revised: 14/11/2014	
								Core Barrel: SK6L		Casing: to (m) dia. (mm)		 www.causewaygeotech.com (c) Causeway Geotech Ltd	
								Flush type: Water-Polymer		3.50 200 5.00 196 25.00 146			

Causeway Geotech Ltd					Project No: 14-240	Project Name: National Paediatric Hospital, Dublin - Ground Investigation Contract	Borehole No. BH114	
Method and Equipment: Hand dug 0.00-1.20m Percussion boring 1.20-3.50m Rotary drilling 3.50-5.00m Symmetrix Drilling Rotary coring 5.00-25.00m Comacchio 450					Co-ords: 713320.5mE 733558.6mN	Client: National Paediatric Hospital	Sheet 2 of 3	
						Engineer: Roughan & O'Donovan	Scale: 1:50	
					Ground Level: 19.56mOD	Dates: 23/06/2014 - 05/08/2014	Driller: CCGT	
								Logger: JC/MG
Depth (m)	TCR	SCR	RQD	FI	Field Records	Level Depth (Thickness)	Stratum Description	Legend & Backfill Water Strikes Installs
11.10	100	0	0	N/A	N=68 N=68 (6,8,12,14,19,23)	4.56 15.00	Very stiff dark brownish black sandy gravelly CLAY with occasional cobbles. Sand is fine to coarse. Gravel is subangular to subrounded fine to coarse. Cobbles are subrounded to subangular	
12.60								
12.60	SPT		12.60	dry				
	100	0	0					
14.10								
	100	5	0		15.00		Medium strong thinly bedded dark grey fine grained LIMESTONE with occasional widely spaced very thin beds of extremely weak dark brownish grey MUDSTONE. Distinctly weathered with heavy dark grey and brown staining along joint surfaces and mudstone beds are occasionally destructured to residual clay Discontinuity Set 1: bedding, closely spaced, sub-horizontal to 20 degrees, planar, smooth, open and clean with grey staining to occasionally lined with gravelly clay (destructured mudstone), rarely lined with calcite Discontinuity Set 2: joints, rarely occurring, sub-vertical, curved, rough, lined with calcite	
15.60				NI	15.60			
	100	90	73	4	16.70			
17.10								
	100	81	58	8				
18.70								
	100	86	75		19.80			
	TCR	SCR	RQD	FI				
Remarks: SPT's carried out using SPT hammers: CC4 to 3.50m and SPT1 to 25.00m.							Continued next sheet	
							Chiseling: From to time (m) (m) (hh:mm)	Water Strikes: Struck rising to time (m) (m) (min) No Groundwater Encountered
							Core Barrel: SK6L Flush type: Water-Polymer	Casing: to (m) dia. (mm) 3.50 200 5.00 196 25.00 146
							Last Revised: 14/11/2014  <small>www.causewaygeotech.com (c) Causeway Geotech Ltd</small>	

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Causeway Geotech Ltd					Project No: 14-240	Project Name: National Paediatric Hospital, Dublin - Ground Investigation Contract	Borehole No. BH115		
Method and Equipment: Hand dug 0.00-1.20m Percussion boring 1.20-4.70m Rotary drilling 4.70-5.00m Symmetrix Drilling Rotary coring 5.00-25.10m Berette T41					Co-ords: 713235.3mE 733541.1mN		Client: National Paediatric Hospital		Sheet 1 of 3
							Engineer: Roughan & O'Donovan		Scale: 1:50
					Ground Level: 20.66mOD		Dates: 30/06/2014 - 06/08/2014		Driller: DE/SS
Depth (m)	Sample / Test	Casing Depth (m)	Water Depth (m)	Field Records	Level	Depth (Thickness)	Stratum Description	Legend & Water Strikes	Backfill Installs
0.50	B	1.20	dry	450mm Recovery	20.56	0.10	MADE GROUND: Tarmac		
0.50	ES				20.46	0.20	MADE GROUND: Hardcore Fill		
					20.36	0.30	MADE GROUND: Angular Cobbles		
					(0.60)		MADE GROUND: Soft brown sandy gravelly SILT. Sand is fine to coarse. Gravel is subrounded to subangular fine to coarse		
1.20	B	1.20	dry	450mm Recovery	19.76	0.90	Brown sandy silty subrounded fine to coarse GRAVEL. Sand is fine to coarse		
1.20-1.65	U				(0.50)		Firm brown sandy gravelly CLAY. Sand is fine to coarse. Gravel is subrounded fine to medium		
1.50	ES				19.26	1.40	BOULDER		
1.70	D				(0.50)		Very stiff grey and black sandy gravelly CLAY. Sand is fine to coarse. Gravel is angular fine to medium		
2.00	B	2.40	dry	N=74 N=74 (7,11,14,17,21,22)	18.76	1.90			
					(0.40)				
					18.36	2.30			
2.40	SPT	2.40	dry	N=74 N=74 (7,11,14,17,21,22)					
2.40	B								
2.40	D								
3.50	B	3.50	dry	450mm Recovery					
3.50-3.95	U								
4.00	D	4.50	dry	85/150mm 150mm (12,12,35,50)					
4.50	SPT	4.50	dry	85/150mm 150mm (12,12,35,50)					
4.50	B								
4.50	D								
5.00		100	0	0					
5.60		100	0	0					
7.10	SPT	7.10	dry	N=61 N=61 (5,8,11,11,18,21)					
7.10									
8.60	SPT	8.60	dry	N=75 N=75 (6,10,12,18,21,24)					
8.60									
	TCR	SCR	RQD	FI	Continued next sheet				
Remarks: SPT's carried out using SPT hammers: CC4 to 4.70m and SPT2 to 25.10m.					Chiseling: From (m) to (m) time (hh:mm)		Water Strikes: Struck (m) rising to (m) time (min) No Groundwater Encountered		Last Revised: 14/11/2014 www.causewaygeotech.com (c) Causeway Geotech Ltd
					Core Barrel: SK6L		Casing: to (m) dia. (mm)		
					Flush type: Water-Polymer		4.70 200 5.00 196 25.10 146		

Causeway Geotech Ltd					Project No: 14-240	Project Name: National Paediatric Hospital, Dublin - Ground Investigation Contract	Borehole No. BH115	
Method and Equipment: Hand dug 0.00-1.20m Percussion boring 1.20-4.70m Rotary drilling 4.70-5.00m Symmetrix Drilling Rotary coring 5.00-25.10m Berette T41					Co-ords: 713235.3mE 733541.1mN		Client: National Paediatric Hospital Sheet 2 of 3	
							Engineer: Roughan & O'Donovan Scale: 1:50	
					Ground Level: 20.66mOD		Dates: 30/06/2014 - 06/08/2014 Driller: DE/SS	
							Logger: DOMMG	
Depth (m)	TCR	SCR	RQD	FI	Field Records	Level Depth (Thickness)	Stratum Description	Legend & Backfill
10.10 10.10	SPT		10.10	dry	N=76 N=76 (5,9,11,18,22,25)	(12.80)	Very stiff light brownish grey to brown/black sandy gravelly CLAY with occasional cobbles. Sand is fine to coarse. Gravel is subrounded to subangular fine to coarse. Cobbles are subangular to subrounded	
11.60 11.60	SPT		11.60	dry	N=57 N=57 (5,9,9,13,15,20)			
13.10 13.10	SPT		13.10	dry	N=66 N=66 (5,8,11,15,19,21)			
14.60 14.60	SPT		14.60	dry	N=74 N=74 (5,9,13,17,20,24)			
16.10 16.10	SPT		16.10	dry	N=64 N=64 (4,8,11,16,16,21)	3.16 17.50	From 14.60m: with many cobbles and occasional boulders	
17.60					17.50			
19.10								
	100	0	0					
	100	0	0					
	100	5	0					
	100	85	69					
	100	48	9					
	TCR	SCR	RQD	FI				
Remarks: SPT's carried out using SPT hammers: CC4 to 4.70m and SPT2 to 25.10m.					Chiseling: From (m) to (m) time (hh:mm)		Water Strikes: Struck (m) rising to (m) time (min) No Groundwater Encountered	Last Revised: 14/11/2014
					Core Barrel: SK6L		Casing: to (m) dia. (mm)	 www.causewaygeotech.com (c) Causeway Geotech Ltd
					Flush type: Water-Polymer		4.70 200 5.00 196 25.10 146	



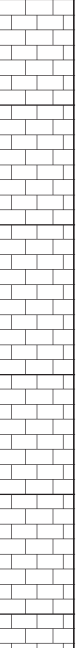


Causeway Geotech Ltd					Project No: 14-240		Project Name: National Paediatric Hospital, Dublin - Ground Investigation Contract		Borehole No. BH115			
Method and Equipment: Hand dug 0.00-1.20m Percussion boring 1.20-4.70m Rotary drilling 4.70-5.00m Symmetrix Drilling Rotary coring 5.00-25.10m Berette T41					Co-ords: 713235.3mE 733541.1mN		Client: National Paediatric Hospital		Sheet 3 of 3			
							Engineer: Roughan & O'Donovan		Scale: 1:50			
					Ground Level: 20.66mOD		Dates: 30/06/2014 - 06/08/2014		Driller: DE/SS			
									Logger: DOMMG			
Depth (m)	TCR	SCR	RQD	FI	Field Records	Level Depth (Thickness)		Stratum Description		Legend & Water Strikes	Backfill/Installs	
20.60					20.60	0.06	20.60	Discontinuity Set 2: joints, randomly orientated, extremely to very closely spaced, stepped and rough, locally infilled with calcite to open and lined with clay (residual mudstone/muddy limestone)				
	100	94	85	Medium strong thinly to medium bedded dark grey fine to medium grained LIMESTONE with rare calcite veining. Partially weathered with some grey surface staining along discontinuity planes								
	22.10							7	(4.50)			Discontinuity Set 1: bedding planes, sub-horizontal, close to medium spaced, planar, smooth, typically open and clean with some dark grey staining, very occasionally closed and infilled with calcite (<3-4mm thick)
100		100	65	Discontinuity Set 2: joints, locally occurring as very closely spaced, sub-vertical to 70 degrees, planar to curved, closed with calcite infill <2-3mm thick								
23.60					25.10	-4.44	25.10					
	100	100	100									
								End of Borehole at 25.10 m				
												
												
												
												
												
												
												
Remarks: SPT's carried out using SPT hammers: CC4 to 4.70m and SPT2 to 25.10m.							Chiseling: From (m) to (m) time (hh:mm)		Water Strikes: Struck (m) rising to (m) time (min)		Last Revised: 14/11/2014	
									No Groundwater Encountered			
							Core Barrel: SK6L Flush type: Water-Polymer		Casing: to (m) dia. (mm) 4.70 200 5.00 196 25.10 146			
									www.causewaygeotech.com (c) Causeway Geotech Ltd			

Causeway Geotech Ltd				Project No: 14-240	Project Name: National Paediatric Hospital, Dublin - Ground Investigation Contract	Borehole No. BH116			
Method and Equipment: Hand dug 0.00-1.20m Percussion boring 1.20-3.90m Rotary drilling 3.90-5.00m Symmetrix Drilling Rotary coring 5.00-25.00m Comacchio 450				Co-ords: 713314.4mE 733589.7mN		Client: National Paediatric Hospital			
						Engineer: Roughan & O'Donovan			
				Ground Level: 19.38mOD		Dates: 23/06/2014 - 29/07/2014		Sheet 1 of 3	
								Scale: 1:50	
						Driller: DE/GT			
						Logger: JC/MG			
Depth (m)	Sample / Test	Casing Depth (m)	Water Depth (m)	Field Records	Level	Depth (Thickness)	Stratum Description	Legend & Water Strikes	Backfill Installs
0.50	B				19.30	0.08	MADE GROUND: Bitmac		
0.50	ES				(0.42)		MADE GROUND: Brown sandy GRAVEL (Hardcore Fill)		
1.20	B	1.20	dry	12 Blows 450mm Recovery	18.88	0.50	Firm to stiff brown sandy gravelly CLAY. Sand is fine to coarse. Gravel is subangular to subrounded fine to medium		
1.20-1.80	U				(1.10)				
1.50	ES								
1.60	B				17.78	1.60	Very stiff brown sandy gravelly SILT. Sand is fine to coarse. Gravel is subrounded fine to medium		
1.80	D								
2.00	SPT	2.00	dry	N=33 N=33 (2,3,5,6,8,14)					
2.50	B				(1.85)				
3.00	B	3.00	dry	150 Blows 450mm Recovery	15.93	3.45	Very stiff grey and black sandy gravelly CLAY with low cobble content. Sand is fine to coarse. Gravel is subangular to subrounded fine to coarse. Cobbles are subangular to subrounded		
3.00-3.50	U				(0.45)				
3.50	D				15.48	3.90	Very stiff dark brownish grey sandy gravelly CLAY with low cobble content. Sand is fine to coarse. Gravel is subangular to subrounded fine to coarse. Cobbles are subangular to subrounded		
3.60	B	3.70	dry	50/95mm 95mm (15,11,25,25)					
3.70	SPT	3.90	dry	50/5mm 5mm (0,25,50)					
3.90	SPT								
3.90	D								
5.00									
	100	0	0						
6.00									
6.00	SPT	6.00	dry	N=72 N=72 (9,13,17,16,19,20)					
	100	0	0						
8.20									
	100	0	0						
9.70									
9.70	SPT	9.70	dry	N=93 N=93 (10,15,18,24,26,25)					
	TCR	SCR	RQD	FI					
Remarks: SPT's carried out using SPT hammers: DA08 to 3.90m and SPT1 to 25.00m.					Chiseling: From (m) to (m) time (hh:mm) 3.80 3.90 01:00		Water Strikes: Struck (m) rising to (m) time (min) No Groundwater Encountered		
					Core Barrel: SK6L		Casing: to (m) dia. (mm) 3.80 200 5.00 196 25.00 146		
					Flush type: Water/Polymer				
					Continued next sheet				
							Last Revised: 14/11/2014		
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Causeway Geotech Ltd					Project No: 14-240		Project Name: National Paediatric Hospital, Dublin - Ground Investigation Contract		Borehole No. BH116				
Method and Equipment: Hand dug 0.00-1.20m Percussion boring 1.20-3.90m Rotary drilling 3.90-5.00m Symmetrix Drilling Rotary coring 5.00-25.00m Comacchio 450					Co-ords: 713314.4mE 733589.7mN		Client: National Paediatric Hospital		Sheet 2 of 3				
							Engineer: Roughan & O'Donovan		Scale: 1:50				
					Ground Level: 19.38mOD		Dates: 23/06/2014 - 29/07/2014		Driller: DE/GT				
													Logger: JC/MG
Depth (m)	TCR	SCR	RQD	FI	Field Records	Level	Depth (Thickness)	Stratum Description		Legend & Backfill	Water Strikes	Installs	
11.20	100	0	0	N/A				Very stiff dark brownish grey sandy gravelly CLAY with low cobble content. Sand is fine to coarse. Gravel is subangular to subrounded fine to coarse. Cobbles are subangular to subrounded					
12.80													
12.80	SPT		12.80	dry	N=78 N=78 (19,20,20,22,16,20)								
14.20	100	0	0										
15.70													
15.70	SPT		15.70	dry	15.70 N=78 N=78 (20,18,22,16,18,22)	3.68	15.70						
17.20	100	89	89	5			(1.60)	Weak thinly to medium bedded pale grey stained brown fine grained LIMESTONE. Distinctly weathered with heavy grey and brown penetrative staining throughout and loss of strength adjacent to fracture planes Discontinuity Set 1: bedding, close to medium spaced, 10-20 degrees, planar, rough, open and stained brown to locally infilled with clayey gravel (destructured limestone) Discontinuity Set 2: joints, medium to widely spaced, 60-70 degrees, planar to stepped, rough, open and infilled with calcite or brown sandy gravelly clay					
18.80													
18.80	100	95	57		17.30		2.08	17.30	Medium strong to strong thin to medium bedded dark grey fine grained LIMESTONE with frequent calcite veining. Partially weathered, occasionally distinctly weathered with heavy dark grey staining penetrating along fracture surfaces Discontinuity Set 1: bedding, close to medium spaced, sub-horizontal, planar, rough, open and stained dark grey to closed and infilled with calcite <10-15mm thick Discontinuity Set 2: joints, close to				
	100	100	96	6									
	TCR	SCR	RQD	FI									
Remarks: SPT's carried out using SPT hammers: DA08 to 3.90m and SPT1 to 25.00m.								Chiseling: From to time (m) (m) (hh:mm)		Water Strikes: Struck (m) rising to (m) time (min) No Groundwater Encountered		Last Revised: 14/11/2014	
								Core Barrel: SK6L		Casing: to (m) dia. (mm)		 www.causewaygeotech.com (c) Causeway Geotech Ltd	
								Flush type: Water/Polymer		3.80 200 5.00 196 25.00 146			

[illegible]

Causeway Geotech Ltd					Project No: 14-240	Project Name: National Paediatric Hospital, Dublin - Ground Investigation Contract			Borehole No. BH117	
Method and Equipment: Hand dug 0.00-1.20m Percussion boring 1.20-6.70m Dando 2000 Rotary drilling 6.70-7.50m Rotary coring 7.50-25.10m Beretta T41					Co-ords: 713237.9mE 733604.2mN		Client: National Paediatric Hospital			Sheet 1 of 3
							Engineer: Roughan & O'Donovan			Scale: 1:50
					Ground Level: 20.24mOD		Dates: 30/06/2014 - 30/07/2014			Driller: DE/SS
										Logger: DOMMG
Depth (m)	Sample / Test	Casing Depth (m)	Water Depth (m)	Field Records	Level	Depth (Thickness)	Stratum Description		Legend & Water Strikes	Backfill Installs
					20.16	0.08	MADE GROUND: Bitmac			
					(0.37)		MADE GROUND: Hardcore			
					19.79	0.45	MADE GROUND: Brown silty sandy angular to subangular fine to medium GRAVEL with occasional gravel sized pieces of brick. Sand is fine to coarse			
					(0.75)					
1.20 1.20-1.65 1.50 1.65-1.80	B U ES D	1.20	dry	450mm Recovery	19.04	1.20	Soft to firm brown sandy gravelly CLAY. Sand is fine to coarse. Gravel is angular fine to medium			
2.00 2.00 2.00	SPT B D	2.00	dry	N=11 N=11 (2,2,3,2,3,3)		(2.50)				
3.40 3.40-3.85	B U	3.40	dry	450mm Recovery						
3.85	D									
4.50 4.50 4.50	SPT B D	4.50	dry	81/150mm 150mm (10,14,31,50)	16.54	3.70	Very stiff grey and black sandy gravelly CLAY. Sand is fine to coarse. Gravel is angular fine to medium			
5.50 5.50 5.50	SPT B D	5.50	dry	75/150mm 150mm (17,8,25,50)		(2.90)				
6.50 6.50 6.50	SPT B D	6.50	dry	50/75mm 75mm (25,50)	13.64	6.60	BOULDER			
					13.54	6.70				
7.05 7.50	SPT	7.05	dry	N=69 N=69 (5,7,11,14,20,24)			Stiff to very stiff dark brownish grey sandy gravelly CLAY with low cobble content. Sand is fine to coarse. Gravel is subrounded to subangular fine to coarse. Cobbles are subrounded to subangular			
8.15	100	0	0			(2.35)				
	100	0	0							
9.05 9.05	SPT	9.05	dry	N=71 N=71 (5,7,11,16,20,24)	11.19	9.05	Dark grey subrounded to subangular coarse GRAVEL			
	65	0	0			(0.95)				
	TCR	SCR	RQD	FI	Continued next sheet					
Remarks: SPT's carried out using SPT hammers: DA08 to 6.70m and SPT2 to 25.10m. Standpipe and standpipe piezometer installed.					Chiseling: From (m) to (m) time (hh:mm) 6.60 6.70 01:00		Water Strikes: Struck (m) rising to (m) time (min) No Groundwater Encountered		Last Revised: 14/11/2014 www.causewaygeotech.com (c) Causeway Geotech Ltd	
					Core Barrel: SK6L Flush type: Air/Water		Casing: to (m) dia. (mm) 6.50 200 7.50 196 25.00 146			

Causeway Geotech Ltd					Project No: 14-240		Project Name: National Paediatric Hospital, Dublin - Ground Investigation Contract		Borehole No. BH117										
Method and Equipment: Hand dug 0.00-1.20m Percussion boring 1.20-6.70m Dando 2000 Rotary drilling 6.70-7.50m Rotary coring 7.50-25.10m Beretta T41					Co-ords: 713237.9mE 733604.2mN		Client: National Paediatric Hospital		Sheet 2 of 3										
							Engineer: Roughan & O'Donovan		Scale: 1:50										
					Ground Level: 20.24mOD		Dates: 30/06/2014 - 30/07/2014		Driller: DE/SS										
									Logger: DOMMG										
Depth (m)	TCR	SCR	RQD	FI	Field Records	Level Depth (Thickness)		Stratum Description		Legend & Water Strikes	Backfill Installs								
10.00		100	0	0		10.24	10.00	Stiff to very stiff dark brownish grey sandy gravelly CLAY with low cobble content. Sand is fine to coarse. Gravel is subrounded to subangular fine to coarse. Cobbles are subrounded to subangular											
11.10																			
11.10	SPT		11.10	dry	N=60 N=60 (4,10,8,12,18,22)														
		100	0	0															
12.60								Medium strong, laminated dark grey LIMESTONE, broken up into cobble and boulder sized pieces supported by extremely weak structureless dark grey MUDSTONE. Weathering: destructured limestone, probably karstified and mixed with mud - partially reworked											
12.60	SPT		12.60	dry	N=65 N=65 (5,9,11,11,19,24)	(5.70)													
		100	0	0															
14.20																			
14.20	SPT		14.20	dry	50/20mm 20mm (25,50)			Continued next sheet											
		100	0	0															
15.70						4.54	15.70												
		100	0	0	8														
								Continued next sheet											
17.20					16.90														
					17.20														
17.20								Continued next sheet											
		100	20	0															
18.70					10														
		100	40	15				Continued next sheet											
	TCR	SCR	RQD	FI															
Remarks: SPT's carried out using SPT hammers: DA08 to 6.70m and SPT2 to 25.10m. Standpipe and standpipe piezometer installed.						Chiseling:		Water Strikes:		Last Revised: 14/11/2014									
						From (m)		to (m)				time (hh:mm)		Struck (m)		rising to (m)		time (min)	
						Core Barrel:		Casing:		 www.causewaygeotech.com (c) Causeway Geotech Ltd									
						SK6L		to (m)				dia. (mm)							
						Flush type:		6.50				200							
						Air/Water		7.50				196							
						25.00		146											

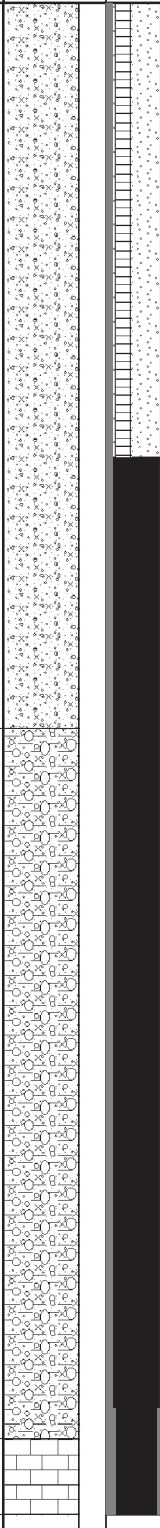

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Causeway Geotech Ltd					Project No: 14-240	Project Name: National Paediatric Hospital, Dublin - Ground Investigation Contract	Borehole No. BH118				
Method and Equipment: Hand dug 0.00-1.20m Percussion boring 1.20-5.50m Rotary drilling 5.50-6.00m Rotary coring 6.00-25.00m Beretta T41					Co-ords: 713193.5mE 733600.4mN	Client: National Paediatric Hospital	Sheet 2 of 3				
						Engineer: Roughan & O'Donovan	Scale: 1:50				
					Ground Level: 20.31mOD	Dates: 01/07/2014 - 21/07/2014	Driller: DE/SS				
							Logger: DOM/MG				
Depth (m)	TCR	SCR	RQD	FI	Field Records	Level Depth (Thickness)	Stratum Description	Legend & Backfill Water Strikes Installs			
11.20	100	0	0	N/A	dry N=48 N=48 (14,9,9,8,12,19)	(9.70)	Very stiff dark brownish grey to brown/black sandy gravelly CLAY with low cobble content. Sand is fine to coarse. Gravel is subrounded to subangular fine to coarse. Cobbles are subrounded to subangular				
11.20	SPT										
12.70	100	0	0		dry N=62 N=62 (4,8,12,12,18,20)						
12.70	SPT										
14.20	100	0	0		dry 50/0mm 0mm (35,15,50)						
14.20	SPT										
15.70	100	0	0		15.70	4.61	Medium strong to strong thin to medium bedded dark grey fine grained LIMESTONE with frequent calcite veining. Partially weathered, occasionally distinctly weathered with heavy dark grey staining penetrating along fracture surfaces Discontinuity Set 1: bedding, close to medium spaced, sub-horizontal, planar, rough, open and stained dark grey to closed and infilled with calcite <10-15mm thick Discontinuity Set 2: joints, close to medium spaced (locally very close), 60-70 degrees, curved, closed and infilled with calcite, locally open and stained dark greyish brown				
	100	94	80	3	16.90						
17.20				NI	17.70						
	100	60	22								
18.70				8							
	100	87	65								
	TCR	SCR	RQD	FI							
Remarks: SPT's carried out using SPT hammers: DA08 to 5.50m and SPT2 to 25.00m.							Chiseling: From (m) to (m) time (hh:mm)		Water Strikes: Struck (m) rising to (m) time (min) No Groundwater Encountered		Last Revised: 14/11/2014
							Core Barrel: SK6L		Casing: to (m) dia. (mm)		
							Flush type: Water/Polymer		5.00 200 6.00 196 25.00 146		 www.causewaygeotech.com (c) Causeway Geotech Ltd

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Causeway Geotech Ltd					Project No. 14-240	Project Name: National Paediatric Hospital, Dublin - Ground Investigation Contract	Borehole No. BH119				
Method and Equipment: Hand dug 0.00-1.20m Percussion boring 1.20-5.00m Rotary coring 5.00-27.50m Comacchio 450					Co-ords: 713302.5mE 733629.3mN		Client: National Paediatric Hospital		Sheet 1 of 3		
							Engineer: Roughan & O'Donovan		Scale: 1:50		
					Ground Level: 19.41mOD		Dates: 23/06/2014 - 31/07/2014		Driller: DE/GT		
									Logger: JC/DB		
Depth (m)	Sample / Test		Casing Depth (m)	Water Depth (m)	Field Records	Level	Depth (Thickness)	Stratum Description	Legend & Water Strikes	Backfill/Installs	
0.50	ES					19.31	0.10	MADE GROUND: Bitmac			
0.50	B						(0.90)	MADE GROUND: Brown and grey silty sandy fine to coarse GRAVEL (Hardcore Fill)			
1.20	SPT		1.20	dry	N=17	18.41	1.00	MADE GROUND: Medium dense brown subrounded fine to medium GRAVEL with low cobble content and pieces of concrete. Cobbles are subangular to subrounded			
1.20	B				N=17 (3,3,4,4,4,5)	18.31	1.10				
1.20	D										
1.50	ES										
2.00	SPT		2.00	dry	N=9			Possible MADE GROUND: Medium dense brown silty fine to coarse SAND and subrounded fine to medium GRAVEL			
2.00	B				N=9 (1,2,2,2,3,2)		(2.50)				
2.00	D										
3.00	SPT		3.00	dry	N=9						
3.00	B				N=9 (2,2,2,2,2,3)						
3.00	D										
3.60	B					15.81	3.60	Firm to stiff brown sandy gravelly CLAY. Sand is fine to coarse. Gravel is subrounded fine to medium			
4.00-4.50	U		4.00	dry	450mm Recovery		(1.00)				
4.50	D					14.81	4.60	Stiff grey and black sandy gravelly CLAY. Sand is fine to coarse. Gravel is angular fine to medium			
5.00							(0.40)				
5.00	SPT		5.00	dry	N=87	14.41	5.00	Very stiff dark brown and black becoming grey sandy gravelly CLAY with low cobble and boulder content. Sand is fine to coarse. Gravel is subrounded to subangular fine to coarse. Cobbles and boulders are subrounded to subangular From 5.00m - 6.60m: becomes dark brown and black in colour			
5.00	B				N=87 (4,7,10,13,14,50)						
5.00	D										
	100	0	0								
6.60								From 6.60m - 8.20m: becomes grey in colour			
	100	0	0				(4.50)				
8.20	SPT		8.20	dry	N=46						
8.20					N=46 (10,10,10,12,11,13)						
	100	0	0								
9.80						9.91	9.50	Dense brown and black clayey sandy subrounded to subangular fine to coarse			
	TCR	SCR	RQD	FI							
Remarks: SPT's carried out using SPT hammers: DA08 to 5.00m and SPT1 to 27.50m.. Standpipe and standpipe piezometer installed.						Continued next sheet					
						Chiseling: From (m) to (m) time (hh:mm)		Water Strikes: Struck (m) rising to (m) time (min) No Groundwater Encountered		Last Revised: 14/11/2014	
						Core Barrel: SK6L		Casing: to (m) dia. (mm) 5.00 200 19.30 196 25.00 146			
						Flush type: Water-Polymer					
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Causeway Geotech Ltd					Project No: 14-240		Project Name: National Paediatric Hospital, Dublin - Ground Investigation Contract		Borehole No. BH119			
Method and Equipment: Hand dug 0.00-1.20m Percussion boring 1.20-5.00m Rotary coring 5.00-27.50m Comacchio 450					Co-ords: 713302.5mE 733629.3mN		Client: National Paediatric Hospital		Sheet 2 of 3			
							Engineer: Roughan & O'Donovan		Scale: 1:50			
					Ground Level: 19.41mOD		Dates: 23/06/2014 - 31/07/2014		Driller: DE/GT			
Depth (m)	TCR	SCR	RQD	FI	Field Records	Level	Depth (Thickness)	Stratum Description		Legend & Water Strikes	Backfill Installs	
11.30 11.30	100	0	0					GRAVEL with low cobble content. Sand is fine to coarse. Cobbles are subrounded to subangular				
	SPT(c)				N=44 N=44 (10,11,10,14,9,11)							
12.30	90	0	0				(5.30)					
					N/A							
13.80 13.80	100	0	0									
	SPT(c)				N=60 N=60 (14,15,14,16,15,15)							
14.80	100	0	0				4.61 14.80	Stiff to very stiff greyish brown and black sandy gravelly silty CLAY with occasional cobbles and boulders. Sand is fine to coarse. Gravel is subrounded to subangular fine to coarse. Cobbles and boulders are subrounded to subangular				
16.30 16.30	100	0	0									
	SPT				N=66 N=66 (18,18,15,16,15,20)							
17.80	100	0	0				(4.70)					
19.30												
					19.50		-0.09 19.50	LIMESTONE				
							(0.50)					
	TCR	SCR	RQD	FI				Continued next sheet				
Remarks: SPT's carried out using SPT hammers: DA08 to 5.00m and SPT1 to 27.50m.. Standpipe and standpipe piezometer installed.							Chiseling: From (m) to (m) time (hh:mm)		Water Strikes: Struck (m) rising to (m) time (min) No Groundwater Encountered		Last Revised: 14/11/2014	
							Core Barrel: SK6L		Casing: to (m) dia. (mm)			
							Flush type: Water-Polymer		5.00 200 19.30 196 25.00 146			



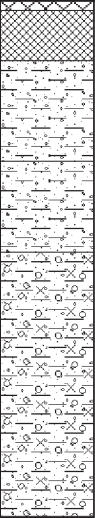

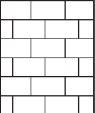
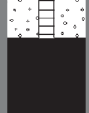
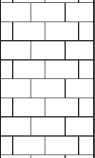

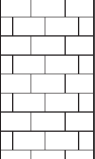

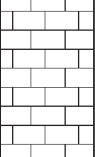


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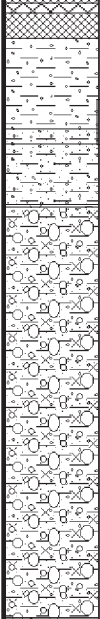



















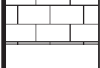





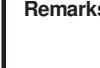






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Causeway Geotech Ltd					Project No: 14-240	Project Name: National Paediatric Hospital, Dublin - Ground Investigation Contract	Borehole No. BH121			
Method and Equipment: Hand dug 0.00-1.20m Percussion boring 1.20-6.30m Dando 2000 Rotary drilling 6.30-6.40m Beretta T41 Rotary coring 6.40-25.00m Beretta T41					Co-ords: 713190.3mE 733616.4mN		Client: National Paediatric Hospital		Sheet 1 of 3	
							Engineer: Roughan & O'Donovan		Scale: 1:50	
					Ground Level: 19.35mOD		Dates: 02/07/2014 - 25/07/2014		Driller: DE/SS	
									Logger: DOM/MG	
Depth (m)	Sample / Test		Casing Depth (m)	Water Depth (m)	Field Records	Level Depth (Thickness)	Stratum Description		Legend & Water Strikes	Backfill Installs
0.50 0.50	B ES						MADE GROUND: Firm grey sandy gravelly SILT. Sand is fine to coarse. Gravel is angular fine to medium			
1.20 1.20-1.65 1.50 1.70	B U ES D		1.20	dry	450mm Recovery	(2.80)				
2.00 2.00 2.00	SPT B D		2.00	dry	N=9 N=9 (1,1,3,2,2,2)					
3.00 3.00-3.45	B U		3.00	dry	450mm Recovery	16.55 2.80 (0.60)	Soft to firm brown sandy gravelly CLAY. Sand is fine to coarse. Gravel is subrounded to subangular fine to medium			
3.50	D					15.95 3.40	Stiff brown sandy gravelly CLAY. Sand is fine to coarse. Gravel is angular fine to medium			
4.00 4.00 4.00	SPT B D		4.00	dry	N=18 N=18 (2,3,3,5,4,6)	(1.30)				
5.00 5.00-5.45	B U		5.00	dry	450mm Recovery	14.65 4.70	Very stiff light greyish brown and black sandy gravelly CLAY with occasional cobbles. Sand is fine to coarse. Gravel is angular fine to medium. Cobbles are angular			
5.50	D									
6.00 6.00	SPT D		6.00	dry	87/150mm 150mm (25,37,50)					
6.40	100	0	0	dry	N=66 N=66 (5,11,10,15,19,22)	(10.40)	From 6.40m - 11.50m: becomes light greyish brown in colour			
7.00	100	0	0							
8.50 8.50	SPT									
	100	0	0							
	TCR	SCR	RQD	FI	Continued next sheet					
Remarks: SPT's carried out using SPT hammers: CC4 to 6.30m and SPT2 to 25.00m.. Standpipe piezometer installed.						Chiseling: From to time (m) (m) (hh:mm)		Water Strikes: Struck rising to time (m) (m) (min) No Groundwater Encountered		Last Revised: 14/11/2014
						Core Barrel: SK6L		Casing: to (m) dia. (mm) 6.30 200 6.40 196 25.00 146		
						Flush type: Air-Water				
								www.causewaygeotech.com (c) Causeway Geotech Ltd		

Causeway Geotech Ltd					Project No: 14-240		Project Name: National Paediatric Hospital, Dublin - Ground Investigation Contract			Borehole No. BH121			
Method and Equipment: Hand dug 0.00-1.20m Percussion boring 1.20-6.30m Dando 2000 Rotary drilling 6.30-6.40m Beretta T41 Rotary coring 6.40-25.00m Beretta T41					Co-ords: 713190.3mE 733616.4mN		Client: National Paediatric Hospital			Sheet 2 of 3			
							Engineer: Roughan & O'Donovan			Scale: 1:50			
					Ground Level: 19.35mOD		Dates: 02/07/2014 - 25/07/2014			Driller: DE/SS			
												Logger: DOM/MG	
Depth (m)	TCR	SCR	RQD	FI	Field Records	Level	Depth (Thickness)	Stratum Description			Legend & Water Strikes	Backfill Installs	
10.00								Very stiff light greyish brown and black sandy gravelly CLAY with occasional cobbles. Sand is fine to coarse. Gravel is angular fine to medium. Cobbles are angular					
11.50	100	0	0	N/A									
11.50	SPT			dry	N=75 N=75 (5,9,13,17,22,23)								
	100	0	0										
13.00								Medium strong to strong thinly to medium bedded dark grey fine grained LIMESTONE with occasional widely spaced very thin beds of weak dark grey MUDSTONE. Typically partially weathered, locally distinctly weathered around bedding planes with heavy staining, loss of strength and structure Discontinuity Set 1: bedding, very close to widely spaced, sub-horizontal, planar, rough, open and lined with calcite or infilled with gravelly clay (destructured Mudstone) Discontinuity Set 2: rarely occurring, joints, 60-75 degrees, curved, closed and infilled with calcite (<2-4mm thick)					
13.00	SPT			dry	N=69 N=69 (7,7,10,18,21,20)								
	100	0	0										
14.50													
14.50	SPT			dry	N=66 N=66 (5,9,9,14,20,23)			Continued next sheet					
	100	60	41		15.10	4.25	15.10						
16.00				9									
	100	92	53										
17.50								Continued next sheet					
	100	85	79		17.50								
19.00				7									
	100	72	38										
	TCR	SCR	RQD	FI									
Remarks: SPT's carried out using SPT hammers: CC4 to 6.30m and SPT2 to 25.00m.. Standpipe piezometer installed.								Chiseling: From (m) to (m) time (hh:mm)		Water Strikes: Struck (m) rising to (m) time (min) No Groundwater Encountered		Last Revised: 14/11/2014	
								Core Barrel: SK6L		Casing: to (m) dia. (mm) 6.30 200 6.40 196 25.00 146		 www.causewaygeotech.com (c) Causeway Geotech Ltd	
								Flush type: Air-Water					

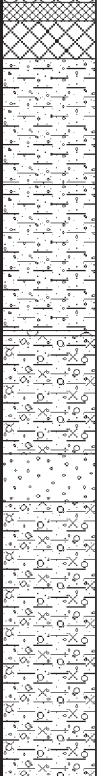

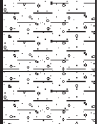
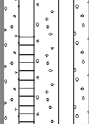
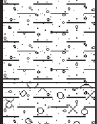

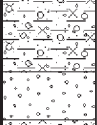



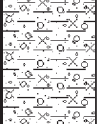

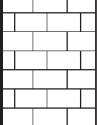

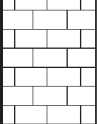

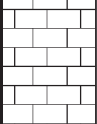

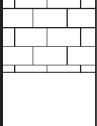



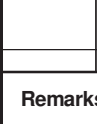
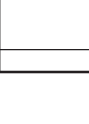





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Causeway Geotech Ltd					Project No. 14-240		Project Name: National Paediatric Hospital, Dublin - Ground Investigation Contract					Borehole No. BH102									
Installation Type: SP102 - Standpipe to 11.00m (50mm dia)					Co-ords: 713351.6mE 733347.8mN		Client: National Paediatric Hospital					Sheet 1 of 1									
							Engineer: Roughan & O'Donovan					Scale: 1:150									
Cover Type: Flush cover fitted.					Ground Level: 20.41mOD		Date of installation: 11/07/2014					Driller: DE/GT									
												Logger: JC/MG									
Legend & Water Strikes		Backfill/Installs	Level (mOD)	Depth (m)	Description	Groundwater Strikes During Drilling															
			16.41	4.00	Bentonite	Date	Time	Strike Number	Depth Struck (m)	Rise Details		Further Details			Casing Depth (m)	Depth Sealed (m)					
						No Groundwater Encountered															
			9.41	11.00	Gravel filter	Groundwater Observations During Drilling															
						Date	Start of Shift					End of Shift									
							Time	Depth Hole (m)	Casing Depth (m)	Water Depth (m)	Water Level (mOD)	Time	Depth Hole (m)	Casing Depth (m)	Water Depth (m)	Water Level BH102					
			9.41	11.00	Gravel filter	Groundwater Monitoring Results					Gas Monitoring Results										
						Install I.D.	Date	Time	Water Depth (m)	Water Level (mOD)	Install I.D.	Date	Time	Oxygen (%)	Carbon Dioxide (%)	Methane (%)	Carbon Monoxide (ppm)	Hydrogen Sulphide (ppm)	Atmospheric Pressure (mB)	Gas Flow (l/hour)	LEL
			9.41	11.00	Gravel filter	SP102	30/07/14		1.71	18.70											
						SP102	06/08/14		0.98	19.43											
						SP102	03/11/14		1.24	19.17											
			-2.59	23.00	Bentonite																
Remarks:												Last Revised: 14/11/2014									
												 www.causewaygeotech.com (c) Causeway Geotech Ltd									

Causeway Geotech Ltd				Project No. 14-240		Project Name: National Paediatric Hospital, Dublin - Ground Investigation Contract				Borehole No. BH103									
Installation Type: SP103-1 - Standpipe to 4.50m (50mm dia) SP103-2 - SP Piezometer to 9.00m (19mm dia)				Co-ords: 713323.8mE 733370.4mN		Client: National Paediatric Hospital				Sheet 1 of 1									
						Engineer: Roughan & O'Donovan				Scale: 1:150									
Cover Type:				Ground Level: 20.43mOD		Date of installation: 17/07/2014				Driller: DE/GT									
										Logger: DOM/MG									
Legend & Water Strikes		Backfill/Installs	Level (mOD)	Depth (m)	Description	Groundwater Strikes During Drilling													
						Date	Time	Strike Number	Depth Struck (m)	Rise Details		Further Details		Casing Depth (m)	Depth Sealed (m)				
			17.43	3.00	Grout	25/06/14	0000	1	2.90	rising to 2.00m after 15min		Water Strike		2.90	-				
			15.93	4.50	Gravel filter														
			12.43	8.00	Grout	Groundwater Observations During Drilling													
						Start of Shift					End of Shift								
			10.93	9.50	Sand filter	Date	Time	Depth Hole (m)	Casing Depth (m)	Water Depth (m)	Water Level (mOD)	Time	Depth Hole (m)	Casing Depth (m)	Water Depth (m)	Water Level BH103			
						Groundwater Monitoring Results					Gas Monitoring Results								
						Install I.D.	Date	Time	Water Depth (m)	Water Level (mOD)	Install I.D.	Date	Time	Oxygen (%)	Carbon Dioxide (%)	Methane (%)	Carbon Monoxide (ppm)	Hydrogen Sulphide (ppm)	Atmospheric Pressure (mB)
					Bentonite	SP103-1	06/08/14		0.85	19.58									
						SP103-1	03/11/14		1.31	19.12									
						SP103-2	30/07/14		1.04	19.39									
						SP103-2	06/08/14		0.91	19.52									
						SP103-2	03/11/14		0.53	19.90									
																			
			-4.57	25.00															
																			
																			
																			
																			
																			
																			
Remarks:														Last Revised: 14/11/2014					
																			
														www.causewaygeotech.com (c) Causeway Geotech Ltd					


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Causeway Geotech Ltd				Project No. 14-240		Project Name: National Paediatric Hospital, Dublin - Ground Investigation Contract				Borehole No. BH117															
Installation Type: SP117 - Standpipe to 5.00m (50mm dia) SP117-1 - SP Piezometer to 10.00m (19mm dia)				Co-ords: 713237.9mE 733604.2mN		Client: National Paediatric Hospital				Sheet 1 of 1															
						Engineer: Roughan & O'Donovan				Scale: 1:150															
Cover Type: Flush cover fitted.				Ground Level: 20.24mOD		Date of installation: 30/07/2014				Driller: DE/SS															
										Logger: DOMMG															
Legend & Water Strikes		Backfill/Installs		Level (mOD)		Depth (m)		Description		Groundwater Strikes During Drilling															
				19.74		0.50		Bentonite		Date	Time	Strike Number	Depth Struck (m)	Rise Details	Further Details	Casing Depth (m)	Depth Sealed (m)								
										No Groundwater Encountered															
				15.24		5.00		Gravel filter		Groundwater Observations During Drilling															
				11.24		9.00		Bentonite		Start of Shift						End of Shift									
				10.24		10.00		Sand filter		Date	Time	Depth Hole (m)	Casing Depth (m)	Water Depth (m)	Water Level (mOD)	Time	Depth Hole (m)	Casing Depth (m)	Water Depth (m)	Water Level BH117					
										Groundwater Monitoring Results					Gas Monitoring Results										
										Install I.D.	Date	Time	Water Depth (m)	Water Level (mOD)	Install I.D.	Date	Time	Oxygen (%)	Carbon Dioxide (%)	Methane (%)	Carbon Monoxide (ppm)	Hydrogen Sulphide (ppm)	Atmospheric Pressure (mB)	Gas Flow (l/hour)	LEL
										SP117	03/11/14		2.58	17.66											
										SP117-1	06/08/14		1.58	18.66											
										SP117-1	03/11/14		0.85	19.39											
										Bentonite															
																									
																									
																									
																									
Remarks:																Last Revised: 14/11/2014									
																 www.causewaygeotech.com (c) Causeway Geotech Ltd									

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Causeway Geotech Ltd						Project no. 15-250	Project Name: Additional Investigation at St James' Hospital, Dublin	Borehole No. BH201												
Method: 0.00 1.20 Inspection Pit 1.20 1.90 Dynamic Sampling 1.90 8.30 Symmetrix						Co-ords: 313385.42mE	Client: National Paediatric Hospital Development Board	Sheet 1 of 1												
Plant: Hand Tools+Comacchio 205						233317.97mN	Client's Representative: O'Connor Sutton Cronin Consulting Engineers	Scale: 1:50												
						Ground Level: 20.56MOD	Dates: 14/04/2015	Crew: JC												
								Logged By: MM												
Depth (m)	TCR	SCR	RQD	FI	Field Records	Level & Depth	Stratum Description	Legend & Water Strikes	Backfill Installs											
0.50	ES					(0.06) 0.06 (0.29) 0.35 (0.15) 0.50 20.06	TARMAC MADE GROUND - Slightly clayey sandy GRAVEL. Sand is fine to coarse. Gravel is subangular to subrounded fine to coarse of sandstone MADE GROUND - Dark grey soft to firm gravelly CLAY. Gravel is subangular to subrounded fine to coarse MADE GROUND - Slightly sandy gravelly CLAY with frequent bricks and brick fragments. Sand is fine to coarse. Gravel is subangular to subrounded fine to coarse.													
1.00	ES					(0.70) 19.36 1.20 (0.10) 1.30 19.26	Firm brown sandy CLAY. Sand is fine to coarse. Stiff brown slightly sandy slightly gravelly CLAY. Sand is fine to coarse. Gravel is subangular to subrounded fine to coarse.													
						(1.40)														
						17.86 2.70	Dark grey slightly sandy gravelly CLAY. Sand is fine to coarse. Gravel is subangular to subrounded fine to coarse.													
						(1.50)														
						16.36 4.20	Grey very clayey GRAVEL. Gravel is subangular to subrounded fine to coarse.													
						(3.10)														
						13.26 7.30	Grey sandy gravelly CLAY. Sand is fine to coarse. Gravel is subangular to subrounded fine to coarse													
						(1.00)														
						12.26 8.30	End of core at 8.30 m													
Remarks Level at top of standpipe: 20.47mOD							Core Barrel: Flush Type: Water Added: <table border="1"> <tr> <th>From (m)</th> <th>To (m)</th> </tr> <tr> <td></td> <td></td> </tr> </table>		From (m)	To (m)			Water Strikes: <table border="1"> <tr> <th>Struck (m)</th> <th>Rose to (m)</th> <th>Time (min)</th> </tr> <tr> <td>4.20</td> <td>4.20</td> <td>10</td> </tr> </table>	Struck (m)	Rose to (m)	Time (min)	4.20	4.20	10	 www.causewaygeotech.com © Causeway Geotech Ltd
From (m)	To (m)																			
Struck (m)	Rose to (m)	Time (min)																		
4.20	4.20	10																		

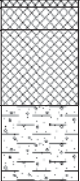

Causeway Geotech Ltd						Project no. 15-250	Project Name: Additional Investigation at St James' Hospital, Dublin	Borehole No. BH202											
Method: 2.80 6.50 Symmetrix 0.00 0.40 Hand Dug 0.40 2.80 Dynamic Sampling						Co-ords: 313367.73mE	Client: National Paediatric Hospital Development Board		Sheet 1 of 1										
						233356.47mN	Client's Representative: O'Connor Sutton Cronin Consulting Engineers		Scale: 1:50										
Plant: Comacchio 205+Hand Tools						Ground Level: 20.61MOD	Dates: 02/04/2015		Crew: JC										
									Logged By: MM										
Depth (m)	TCR	SCR	RQD	FI	Field Records	Level & Depth	Stratum Description	Legend & Water Strikes	Backfill Installs										
0.50	ES					(0.07)	TARMAC												
						20.54 (0.28)	0.07			MADE GROUND - Hardcore fill dark grey SAND and GRAVEL. Sand is fine to coarse. Gravel is subangular fine to medium.									
						20.26	0.35			MADE GROUND - Light brown slightly clayey SAND and GRAVEL. Sand is fine to coarse. Gravel is subangular to subrounded fine to coarse of sandstone.									
						(0.35)	19.91			0.70	MADE GROUND - Greyish brown slightly gravelly CLAY. Gravel is subangular to subrounded fine to coarse.								
						(0.30)	19.61			1.00	Light brown soft slightly gravelly CLAY. Gravel is subangular to subrounded fine to coarse.								
						(0.50)	19.11			1.50	Brown sandy slightly gravelly CLAY with small pockets of fine gravel. Sand is fine to coarse. Gravel is subangular to subrounded fine to coarse								
						(1.00)	18.11			2.50	Slightly silty gravelly fine to coarse SAND. Sand is fine to coarse. Gravel is subangular to subrounded fine to coarse								
						(0.10)	18.01			2.60	Brown sandy slightly gravelly CLAY with small pockets of fine gravel. Sand is fine to coarse. Gravel is subangular to subrounded fine to coarse								
						(0.20)	17.81			2.80	Dark grey sandy gravelly CLAY. Sand is fine to coarse. Gravel is subangular to subrounded fine to coarse								
						(3.70)													
						14.11	6.50	End of core at 6.50 m											
Remarks Level at top of standpipe: 20.53mOD							Core Barrel:		Water Strikes: <table border="1"> <tr> <th>Struck (m)</th> <th>Rose to (m)</th> <th>Time (min)</th> </tr> <tr> <td>2.00</td> <td>2.5</td> <td>10</td> </tr> <tr> <td>2.50</td> <td>2.5</td> <td>10</td> </tr> </table>		Struck (m)	Rose to (m)	Time (min)	2.00	2.5	10	2.50	2.5	10
							Struck (m)	Rose to (m)	Time (min)										
							2.00	2.5	10										
							2.50	2.5	10										
Flush Type:																			
Water Added:		Casing:																	
From (m)	To (m)	To (m)	Diameter (mm)																
		6.50	150																
									www.causewaygeotech.com © Causeway Geotech Ltd										

Causeway Geotech Ltd						Project no. 15-250	Project Name: Additional Investigation at St James' Hospital, Dublin	Borehole No. BH203										
Method: 1.20 2.60 Dynamic Sampling 0.00 1.20 Hand Dug						Co-ords: 313386.80mE	Client: National Paediatric Hospital Development Board	Sheet 1 of 1										
Plant: Comacchio 205+Hand Tools						233374.42mN	Client's Representative: O'Connor Sutton Cronin Consulting Engineers	Scale: 1:50										
						Ground Level: 20.34MOD	Dates: 30/03/2015	Crew: JC										
								Logged By: MM										
Depth (m)	TCR	SCR	RQD	FI	Field Records	Level & Depth	Stratum Description	Legend & Water Strikes	Backfill Installs									
0.50	ES					(0.06) 0.06	TARMAC											
						(0.08) 0.16	MADE GROUND - Hardcore Fill, dark grey SAND/GRAVEL											
						(0.18) 0.22	MADE GROUND - Gravel fill road surface.											
1.00	ES					(0.73) 0.22	MADE GROUND - Grey very clayey sandy GRAVEL with pieces of concrete, brick and ceramics.											
						19.39 0.95	Firm brown slightly sandy slightly gravelly CLAY. Sand is fine to coarse. Gravel is subangular to subrounded fine to coarse.											
2.00	ES					(0.75) 1.70	Stiff brown slightly sandy slightly gravelly CLAY. Sand is fine to coarse. Gravel is subangular to subrounded fine to coarse.											
						18.64 2.00	Subrounded COBBLES											
						(0.30) 2.25	Stiff brown slightly gravelly CLAY. Gravel is subangular to subrounded fine to medium.											
						18.34 2.50	Stiff dark grey slightly sandy gravelly CLAY. Sand is fine to coarse. Gravel is subangular to subrounded fine to coarse.											
						(0.25) 2.60	Gravel is subangular to subrounded fine to coarse.											
							End of core at 2.60 m											
Remarks Level at top of standpipe: 20.22mOD							Core Barrel:		Water Strikes:									
							Flush Type:		<table border="1"> <tr> <th>Struck (m)</th> <th>Rose to (m)</th> <th>Time (min)</th> </tr> <tr> <td>0.80</td> <td>0.80</td> <td>10</td> </tr> </table>		Struck (m)	Rose to (m)	Time (min)	0.80	0.80	10		
Struck (m)	Rose to (m)	Time (min)																
0.80	0.80	10																
							Water Added:		Casing:									
							<table border="1"> <tr> <th>From (m)</th> <th>To (m)</th> </tr> <tr> <td></td> <td></td> </tr> </table>		From (m)	To (m)			<table border="1"> <tr> <th>To (m)</th> <th>Diameter (mm)</th> </tr> <tr> <td>2.60</td> <td>150</td> </tr> </table>		To (m)	Diameter (mm)	2.60	150
From (m)	To (m)																	
To (m)	Diameter (mm)																	
2.60	150																	
www.causewaygeotech.com © Causeway Geotech Ltd																		

Causeway Geotech Ltd						Project no. 15-250		Project Name: Additional Investigation at St James' Hospital, Dublin		Borehole No. BH204							
Method: 1.20 2.90 Dynamic Sampling 0.00 1.20 Hand Dug						Co-ords: 313335.31mE 233372.15mN		Client: National Paediatric Hospital Development Board		Sheet 1 of 1							
								Client's Representative: O'Connor Sutton Cronin Consulting Engineers		Scale: 1:50							
Plant: Comacchio 205+Hand Tools						Ground Level: 20.75MOD		Dates: 30/03/2015		Crew: JC							
										Logged By: MM							
Depth (m)		TCR	SCR	RQD	FI	Field Records	Level & Depth		Stratum Description		Legend & Water Strikes	Backfill Installs					
0.50		ES					(0.20) 20.55 0.20		MADE GROUND - Gravel fill								
							(1.00)		MADE GROUND - Soft to firm dark brown gravelly CLAY. Gravel is subangular to subrounded fine to coarse.								
1.00		ES					19.55 1.20		Firm brown sandy CLAY with cobbles. Sand is fine to coarse. Cobbles are subangular to subrounded.								
1.50		ES					(0.50) 19.05 1.70		Firm brown sandy gravelly CLAY. Sand is fine to coarse. Gravel is subangular to subrounded fine to coarse.								
							(0.30) 18.75 2.00		Very stiff dark grey slightly sandy gravelly CLAY. Sand is fine to coarse. Gravel is subangular to subrounded fine to coarse.								
2.50		ES					(0.70) 18.05 2.70		Very stiff black slightly sandy gravelly CLAY with occasional cobbles. Sand is fine to coarse. Gravel is subangular to subrounded fine to coarse.								
							(0.20) 17.85 2.90		coarse.								
									End of core at 2.90 m								
Remarks Level at top of standpipe: 20.70mOD													Core Barrel: Flush Type:		Water Strikes: Struck (m) Rose to (m) Time (min) 2.00 2.0 10		
													Water Added: From (m) To (m)		Casing: To (m) Diameter (mm) 2.90 150		

Causeway Geotech Ltd						Project no. 15-250	Project Name: Additional Investigation at St James' Hospital, Dublin	Borehole No. BH205			
Method: 1.20 3.00 Dynamic Sampling 0.00 1.20 Hand Dug						Co-ords: 313322.27mE 233380.51mN	Client: National Paediatric Hospital Development Board		Sheet 1 of 1		
							Client's Representative: O'Connor Sutton Cronin Consulting Engineers		Scale: 1:50		
Plant: Comacchio 205+Hand Tools						Ground Level: 20.77MOD	Dates: 31/03/2015		Crew: JC		
									Logged By: MM		
Depth (m)	TCR	SCR	RQD	FI	Field Records	Level & Depth	Stratum Description	Legend & Water Strikes	Backfill Installs		
0.50	ES					20.72 0.05 (0.65)	BITMAC MADE GROUND - Roadbase fill				
1.00	ES					20.07 0.70 (0.70)	MADE GROUND - Brown sandy clayey GRAVEL. Sand is fine to coarse. Gravel is subangular to subrounded fine to coarse.				
1.50	ES					19.37 1.40 (1.10)	Firm brown CLAY with cobbles. Cobbles are subangular to subrounded.				
2.70	ES					18.27 2.50 (0.50)	Very stiff dark brown sandy gravelly CLAY. Sand is fine to coarse. Gravel is subangular to subrounded fine to coarse.				
						17.77 3.00	----- End of core at 3.00 m				
Remarks Level at top of standpipe: 20.66mOD							Core Barrel:		 www.causewaygeotech.com © Causeway Geotech Ltd		
							Flush Type:			Water Strikes: Struck (m) Rose to (m) Time (min) 2.35 2.35 10	
							Water Added:			Casing:	
							From (m)	To (m)		To (m)	Diameter (mm)
										3.00	150



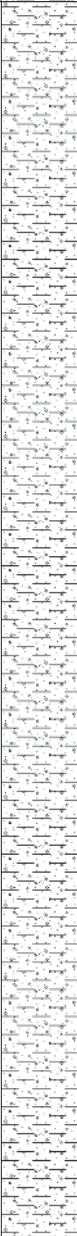


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












Causeway Geotech Ltd						Project no. 15-250	Project Name: Additional Investigation at St James' Hospital, Dublin	Borehole No. BH207				
Method: 0.00 1.20 Hand Dug						Co-ords: 313374.99mE 233417.50mN		Client: National Paediatric Hospital Development Board		Sheet 1 of 1		
								Client's Representative: O'Connor Sutton Cronin Consulting Engineers		Scale: 1:50		
Plant: Hand Tools						Ground Level: 19.98MOD		Dates: 08/04/2015		Crew: JC		
										Logged By: JC		
Depth (m)	TCR	SCR	RQD	FI	Field Records	Level & Depth	Stratum Description		Legend & Water Strikes	Backfill Installs		
0.50	ES					<div>(0.05)</div> <div>(0.98) 0.05</div> <div>19.78 0.20</div> <div>(0.50)</div>	<div>TARMAC</div> <div>MADE GROUND (hardcore): Grey sandy GRAVEL.</div> <div>MADE GROUND (fill): Dark brown slightly sandy CLAY with occasional cobbles and fragments of brick.</div>					
1.00	ES					<div>19.28 0.70</div> <div>(0.50)</div> <div>18.78 1.20</div>	<div>Soft to firm light brown slightly sandy gravelly CLAY.</div> <div>----- End of core at 1.20 m</div>					
Remarks Inspection pit only.							Core Barrel:		Water Strikes:			
							Flush Type:		Struck (m)	Rose to (m)		Time (min)
							Water Added:		Casing:			
							From (m)	To (m)	To (m)	Diameter (mm)		

Causeway Geotech Ltd						Project no. 15-250		Project Name: Additional Investigation at St James' Hospital, Dublin		Borehole No. BH208													
Method: <div>0.00 1.20 Hand Dug 1.20 2.00 Dynamic Sampling 2.00 3.50 Symmetrix</div>						Co-ords: 313400.81mE 233448.07mN		Client: National Paediatric Hospital Development Board		Sheet 1 of 1													
								Client's Representative: O'Connor Sutton Cronin Consulting Engineers		Scale: 1:50													
Plant: Hand Tools+Comacchio 205						Ground Level: 19.86MOD		Dates: 13/04/2015		Crew: JC													
										Logged By: MM													
Depth (m)		TCR	SCR	RQD	FI	Field Records	Level & Depth		Stratum Description		Legend & Water Strikes	Backfill Installs											
							(0.20) 19.66 0.20		CONCRETE														
							(0.50) 19.16 0.70		MADE GROUND - Sandy gravel fill. Sand is fine to coarse. Gravel is subangular to subrounded fine to coarse														
							(0.60) 18.56 1.30		Firm brown slightly gravelly CLAY. Gravel is subangular to subrounded fine to coarse														
							(1.40) 17.16 2.70		Stiff brown slightly gravelly CLAY. Gravel is subangular to subrounded fine to coarse.														
							(0.80) 16.36 3.50		Very stiff black slightly sandy gravelly CLAY. Sand is fine to coarse. Gravel is subangular to subrounded fine to coarse.														
									----- End of core at 3.50 m														
Remarks Level at top of standpipe: 19.86mOD													Core Barrel:		Water Strikes: <table><tr><td>Struck (m)</td><td>Rose to (m)</td><td>Time (min)</td></tr><tr><td>1.80</td><td>1.80</td><td>10</td></tr></table>		Struck (m)	Rose to (m)	Time (min)	1.80	1.80	10	
Struck (m)	Rose to (m)	Time (min)																					
1.80	1.80	10																					
													Flush Type:										
						Water Added: <table><tr><td>From (m)</td><td>To (m)</td></tr><tr><td></td><td></td></tr></table>		From (m)	To (m)			Casing: <table><tr><td>To (m)</td><td>Diameter (mm)</td></tr><tr><td>3.50</td><td>150</td></tr></table>		To (m)	Diameter (mm)	3.50	150						
From (m)	To (m)																						
To (m)	Diameter (mm)																						
3.50	150																						
													www.causewaygeotech.com © Causeway Geotech Ltd										
















Causeway Geotech Ltd						Project no. 15-250	Project Name: Additional Investigation at St James' Hospital, Dublin	Borehole No. BH209									
Method: 0.00 1.20 Hand Dug 1.20 3.50 Dynamic Sampling						Co-ords: 313295.38mE	Client: National Paediatric Hospital Development Board	Sheet 1 of 1									
Plant: Hand Tools+Comacchio 205						233449.35mN	Client's Representative: O'Connor Sutton Cronin Consulting Engineers	Scale: 1:50									
						Ground Level: 20.52MOD	Dates: 15/04/2015	Crew: JC									
								Logged By: MM									
Depth (m)	TCR	SCR	RQD	FI	Field Records	Level & Depth	Stratum Description	Legend & Water Strikes	Backfill Installs								
0.50	ES					0.05 0.05	TARMAC										
						20.27 0.25	MADE GROUND -Dark grey sandy GRAVEL. Sand is fine to coarse. Gravel is subangular to subrounded fine to coarse										
1.00	ES					19.62 0.90	Firm grey very sandy slightly gravelly CLAY. Sand is fine to coarse. Gravel is subangular to subrounded fine to coarse.										
						19.22 1.30	Stiff brown slightly gravelly CLAY. Gravel is subangular to subrounded fine to coarse.										
1.50	ES					18.52 2.00	Firm brown very gravelly CLAY										
						18.32 2.20	Soft to firm brown slightly gravelly CLAY.										
						17.92 2.60	Dark grey very silty SAND										
						17.62 2.90	Stiff dark grey sandy slightly gravelly CLAY. Sand is fine to coarse. Gravel is subangular to subrounded fine to coarse.										
						17.02 3.50	End of core at 3.50 m										
Remarks Level at top of standpipe: 20.40mOD Borehole collapsed to 2.90m							Core Barrel:	Water Strikes: <table border="1"> <tr> <th>Struck (m)</th> <th>Rose to (m)</th> <th>Time (min)</th> </tr> <tr> <td></td> <td></td> <td></td> </tr> </table>		Struck (m)	Rose to (m)	Time (min)					
Struck (m)	Rose to (m)	Time (min)															
							Flush Type:										
							Water Added: <table border="1"> <tr> <th>From (m)</th> <th>To (m)</th> </tr> <tr> <td></td> <td></td> </tr> </table>	From (m)	To (m)			Casing: <table border="1"> <tr> <th>To (m)</th> <th>Diameter (mm)</th> </tr> <tr> <td>3.50</td> <td>150</td> </tr> </table>		To (m)	Diameter (mm)	3.50	150
From (m)	To (m)																
To (m)	Diameter (mm)																
3.50	150																
							 <small>www.causewaygeotech.com © Causeway Geotech Ltd</small>										

Causeway Geotech Ltd						Project no. 15-250	Project Name: Additional Investigation at St James' Hospital, Dublin	Borehole No. BH210			
Method: 0.00 1.20 Hand Dug 1.20 2.80 Dynamic Sampling 2.80 5.00 Symmetrix						Co-ords: 313268.01mE	Client: National Paediatric Hospital Development Board	Sheet 1 of 1			
						233482.75mN	Client's Representative: O'Connor Sutton Cronin Consulting Engineers	Scale: 1:50			
Plant: Hand Tools+Comacchio 205						Ground Level: 20.66MOD	Dates: 12/04/2015	Crew: JC			
								Logged By: MM			
Depth (m)	TCR	SCR	RQD	FI	Field Records	Level & Depth	Stratum Description	Legend & Water Strikes	Backfill Installs		
0.50	ES					(0.07) 20.59 0.07 (0.28) 20.31 0.35	TARMAC Surface MADE GROUND - Angular GRAVEL of limestone and sandstone.				
						(0.85)	MADE GROUND - Dark brown slightly sandy slightly gravelly CLAY with many rootlets. Sand is fine to coarse. Gravel is subangular to subrounded fine to coarse.				
1.00	ES					19.46 1.20	Brown slightly gravelly stiff CLAY. Gravel is subangular to subrounded fine to coarse.				
						(1.60)					
						17.86 2.80	Stiff black slightly gravelly CLAY. Gravel is subangular to subrounded.				
						(2.20)					
						15.66 5.00	End of core at 5.00 m				
Remarks Level at top of standpipe: 20.54mOD							Core Barrel:		Water Strikes:		
							Flush Type:		Struck (m)	Rose to (m)	Time (min)
							Water Added:		Casing:		
From (m)	To (m)	To (m)	Diameter (mm)								
		5.00	150								
									www.causewaygeotech.com © Causeway Geotech Ltd		

Causeway Geotech Ltd						Project no. 15-250	Project Name: Additional Investigation at St James' Hospital, Dublin	Borehole No. BH211			
Method: 0.00 1.20 Hand Dug 1.20 10.00 Symmetrix						Co-ords: 313313.21mE 233504.16mN	Client: National Paediatric Hospital Development Board	Sheet 1 of 1			
							Client's Representative: O'Connor Sutton Cronin Consulting Engineers	Scale: 1:50			
Plant: Hand Tools+Comacchio 405						Ground Level: 20.57MOD	Dates: 11/04/2015	Crew: SJ			
							Logged By: MG				
Depth (m)	TCR	SCR	RQD	FI	Field Records	Level & Depth	Stratum Description	Legend & Water Strikes	Backfill Installs		
0.50	ES					(0.05) 0.05 (0.20) 0.25 (0.45)	TARMAC MADE GROUND - Hardcore Fill MADE GROUND - Dark grey CLAY.				
						19.87 0.70 (0.30) 19.57 1.00 (0.80)	MADE GROUND - Light brown CLAY Light brown silty CLAY.				
1.00	ES					18.77 1.80 (8.20)	Dark grey sandy gravelly CLAY. Sand is fine to coarse. Gravel is subangular to subrounded fine to coarse				
						10.57 10.00	----- End of core at 10.00 m -----				
Remarks Level at top of standpipe: 20.47mOD Vibrating wire piezometer installed.							Core Barrel:		Water Strikes:		
							Flush Type:		Struck (m)	Rose to (m)	Time (min)
							Water Added:		Casing:		
From (m)	To (m)	To (m)	Diameter (mm)								
											
							www.causewaygeotech.com © Causeway Geotech Ltd				

Causeway Geotech Ltd						Project no. 15-250		Project Name:		Additional Investigation at St James' Hospital, Dublin			Borehole No. BH212		
Method: 0.00 1.20 Hand Dug 1.20 2.20 Dynamic Sampling 2.20 3.50 Symmetrix						Co-ords: 313413.12mE 233539.64mN		Client:		National Paediatric Hospital Development Board			Sheet 1 of 1		
								Client's Representative:		O'Connor Sutton Cronin Consulting Engineers			Scale: 1:50		
Plant: Hand Tools+Comacchio 205						Ground Level: 19.45MOD		Dates:		02/04/2015			Crew: JC		
													Logged By: MG		
Depth (m)		TCR	SCR	RQD	FI	Field Records		Level & Depth		Stratum Description			Legend & Water Strikes		Backfill Installs
0.50		ES					(0.07) 19.38 0.07		TARMAC						
							(0.23) 19.15 0.30		MADE GROUND - Hardcore fill SAND and GRAVEL						
							(0.20) 18.95 0.50		MADE GROUND -Slightly silty SAND and GRAVEL with frequent brick and concrete fragments.						
							Soft light grey mottled dark grey soft silty gravelly CLAY. Gravel is subangular to subrounded fine to coarse								
1.00		ES					(0.80)		Soft light grey mottled dark grey soft very gravelly CLAY. Gravel is subangular to subrounded fine to coarse						
							(0.90) 18.15 1.30								
							(0.90) 18.05 1.40		Stiff grey becoming brown slightly gravelly CLAY. Gravel is subangular to subrounded fine to coarse						
							(0.60)								
							(0.70) 17.45 2.00		Brown very silty SAND and GRAVEL. Sand is fine to coarse. Gravel is subangular to subrounded fine to coarse.						
							(0.70) 17.35 2.10								
							(0.90)		Stiff brown slightly gravelly CLAY. Gravel is subangular to subrounded fine to coarse						
							16.45 3.00		Very stiff dark grey sandy gravelly CLAY. Sand is fine to coarse. Gravel is subangular to subrounded fine to coarse						
							(0.50)								
		15.95 3.50		----- End of core at 3.50 m											
Remarks															
Level at top of standpipe: 19.41mOD															
Slight water seepage from 0.5-0.9m															
Core Barrel:															
Water Strikes:															
Struck (m) Rose to (m) Time (min)															
Flush Type:															
Water Added:															
From (m) To (m) To (m) Diameter (mm)															
3.50 150															
															
www.causewaygeotech.com © Causeway Geotech Ltd															

Causeway Geotech Ltd						Project no. 15-250	Project Name: Additional Investigation at St James' Hospital, Dublin	Borehole No. BH213			
Method: 1.70 3.50 Symmetrix 0.00 1.20 Hand Dug 1.20 1.70 Dynamic Sampling						Co-ords: 313362.10mE	Client: National Paediatric Hospital Development Board		Sheet 1 of 1		
						233581.36mN	Client's Representative: O'Connor Sutton Cronin Consulting Engineers		Scale: 1:50		
Plant: Comacchio 205+Hand Tools						Ground Level: 19.42MOD	Dates: 02/04/2015		Crew: JC		
								Logged By: MM			
Depth (m)	TCR	SCR	RQD	FI	Field Records	Level & Depth	Stratum Description	Legend & Water Strikes	Backfill Installs		
0.50	ES					(0.20) 19.22 0.20 (0.30) 18.92 0.50	TOPSOIL Dark brown slightly sandy CLAY with roots. Sand is fine to coarse. Brown sandy slightly silty gravelly CLAY. Sand is fine to coarse. Gravel is subangular fine to medium.				
1.00	ES				(0.60) (0.70) 18.32 1.10 (0.10) 18.22 1.20 (0.50) 17.72 1.70	Firm brown mottled grey slightly sandy slightly gravelly CLAY. Sand is fine to coarse. Gravel is subangular to subrounded fine to coarse. Stiff dark brown slightly sandy slightly gravelly CLAY. Sand is fine to coarse. Gravel is subangular to subrounded fine to coarse. Stiff black slightly sandy slightly gravelly CLAY. Sand is fine to coarse. Gravel is subangular to subrounded fine to coarse.					
						(1.20) 16.52 2.90 (0.60) 15.92 3.50	Stiff dark grey slightly gravelly CLAY. Gravel is subangular to subrounded fine to coarse. End of core at 3.50 m				
Remarks Level at top of standpipe: 19.24mOD							Core Barrel:		Water Strikes:		
							Flush Type:		Struck (m)	Rose to (m)	Time (min)
							Water Added:		Casing:		
							From (m)	To (m)	To (m)	Diameter (mm)	
		3.50	150								
									www.causewaygeotech.com © Causeway Geotech Ltd		

Causeway Geotech Ltd						Project no. 15-250	Project Name: Additional Investigation at St James' Hospital, Dublin	Borehole No. BH214			
Method: 0.00 1.20 Inspection Pit 1.20 2.70 Dynamic Sampling 2.70 7.00 Symmetrix						Co-ords: 313278.46mE	Client: National Paediatric Hospital Development Board		Sheet 1 of 1		
						233542.91mN	Client's Representative: O'Connor Sutton Cronin Consulting Engineers		Scale: 1:50		
Plant: Hand Tools+Comacchio 205						Ground Level: 20.44MOD	Dates: 03/04/2015		Crew: JC		
								Logged By: MM			
Depth (m)	TCR	SCR	RQD	FI	Field Records	Level & Depth	Stratum Description	Legend & Water Strikes	Backfill Installs		
						(1.00)	MADE GROUND: Firm dark grey slightly sandy slightly gravelly CLAY. Sand is fine to coarse. Gravel is subangular to subrounded, fine to coarse.				
						19.44 1.00	Grey fine to coarse slightly silty SAND.				
						(0.30) 19.14 1.30	Stiff brown slightly gravelly CLAY. Gravel is fine to coarse, subangular.				
						(0.70)					
						18.44 2.00	Stiff black slightly sandy slightly gravelly CLAY. Sand is fine to coarse. Gravel is fine to coarse, subangular.				
						(5.00)					
						13.44 7.00	End of core at 7.00 m				
Remarks Level at top of standpipe: 20.15mOD							Core Barrel:		Water Strikes:		
							Flush Type:		Struck (m)	Rose to (m)	Time (min)
							Water Added:		Casing:		
							From (m)	To (m)	To (m)	Diameter (mm)	
		7.00	150								



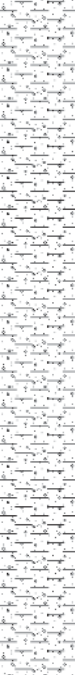

Causeway Geotech Ltd						Project no. 15-250	Project Name: Additional Investigation at St James' Hospital, Dublin	Borehole No. BH215			
Method: 0.00 0.50 Hand Dug 0.50 2.90 Dynamic Sampling 2.90 8.00 Symmetrix						Co-ords: 313281.86mE		Client: National Paediatric Hospital Development Board	Sheet 1 of 1		
						233581.43mN		Client's Representative: O'Connor Sutton Cronin Consulting Engineers	Scale: 1:50		
Plant: Hand Tools+Comacchio 205						Ground Level: 20.26MOD	Dates: 03/04/2015	Crew: JC	Logged By: MM		
Depth (m)	TCR	SCR	RQD	FI	Field Records	Level & Depth	Stratum Description	Legend & Water Strikes	Backfill Installs		
0.50	ES					(0.30) 19.96 0.30	MADE GROUND -Sandy gravelly COBBLES.				
						(0.70)	MADE GROUND - Brown clayey sandy GRAVEL. Gravel is subrounded to subangular fine to coarse.				
1.20	ES					19.26 1.00 (0.50)	MADE GROUND - Dark brown gravelly CLAY with roots and cobbles. Gravel is subangular to subrounded fine to coarse. Cobbles are subangular to subrounded				
1.50	ES					18.76 1.50	Stiff brown slightly gravelly CLAY. Sand is fine to coarse. Gravel is subangular to subrounded fine to coarse. (Drillers description)				
						(2.80)					
						15.96 4.30 (2.30)	Stiff black slightly sandy gravelly CLAY. Sand is fine to coarse. Gravel is subangular to subrounded fine to coarse.				
						13.66 6.60 (0.80)	Slightly sandy GRAVEL. Sand is fine to coarse. Gravel is subangular to subrounded fine to coarse.				
						12.86 7.40 (0.60)	Stiff dark grey slightly sandy gravelly CLAY. Sand is fine to coarse. Gravel is subangular to subrounded fine to coarse.				
						12.26 8.00	----- End of core at 8.00 m				
Remarks Level at top of standpipe: 20.15mOD Continuous water strikes from 6.5-7.5m							Core Barrel:		Water Strikes:		
							Flush Type:		Struck (m)	Rose to (m)	Time (min)
							Water Added:		Casing:		
							From (m)	To (m)	To (m)	Diameter (mm)	
		8.00	150								










Causeway Geotech Ltd						Project no. 15-250	Project Name: Additional Investigation at St James' Hospital, Dublin	Borehole No. BH216			
Method: 0.00 1.20 Hand Dug 1.20 2.70 Dynamic Sampling 2.70 6.80 Symmetrix						Co-ords: 313429.95mE		Client: National Paediatric Hospital Development Board	Sheet 1 of 1		
						233312.23mN		Client's Representative: O'Connor Sutton Cronin Consulting Engineers	Scale: 1:50		
Plant: Hand Tools+Comacchio 205						Ground Level: 20.49MOD	Dates: 02/04/2015		Crew: JC		
									Logged By: MM		
Depth (m)	TCR	SCR	RQD	FI	Field Records	Level & Depth	Stratum Description	Legend & Water Strikes	Backfill Installs		
0.50	ES					(0.50) 19.99 0.50	MADE GROUND - Grey brown SAND and GRAVEL with occasional pieces of plastic				
1.00	ES					(0.50) 19.49 1.00	MADE GROUND - Brown sandy slightly gravelly CLAY. Sand is fine to coarse. Gravel is subangular to subrounded fine to coarse.				
						(0.20) 19.29 1.20	MADE GROUND - Black Ash				
						(0.40) 18.89 1.60	Brown firm slightly gravelly CLAY. Gravel is subangular to subrounded fine to coarse.				
						(0.40) 18.49 2.00	Stiff brown slightly gravelly CLAY. Gravel is subangular to subrounded fine to coarse.				
2.00	ES					(0.40) 18.49 2.00	Soft to firm brown sandy gravelly CLAY. Gravel is subangular to subrounded fine to coarse.				
						(0.40) 18.09 2.40	Stiff dark grey very sandy CLAY. Gravel is subangular to subrounded fine to coarse.				
						(0.20) 17.99 2.50	Stiff dark grey CLAY.				
						(0.20) 17.79 2.70	Stiff dark grey gravelly CLAY. Gravel is subangular to subrounded fine to coarse.				
						(4.10)					
						13.69 6.80	End of core at 6.80 m				
Remarks Level at top of standpipe: 17.24mOD							Core Barrel:		Water Strikes:		
							Flush Type:		Struck (m)	Rose to (m)	Time (min)
							Water Added:		Casing:		
From (m)	To (m)	To (m)	Diameter (mm)								
		6.50	150								

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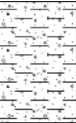
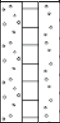

Causeway Geotech Ltd						Project no. 15-250	Project Name: Additional Investigation at St James' Hospital, Dublin	Borehole No. BH217			
Method: 0.00 1.20 Hand Dug 1.20 2.90 Dynamic Sampling 2.90 6.50 Symmetrix						Co-ords: 313342.18mE	Client: National Paediatric Hospital Development Board		Sheet 1 of 1		
						233299.53mN	Client's Representative: O'Connor Sutton Cronin Consulting Engineers		Scale: 1:50		
Plant: Hand Tools+Comacchio 205						Ground Level: 21.15MOD	Dates: 31/03/2015		Crew: JC		
								Logged By: MM			
Depth (m)	TCR	SCR	RQD	FI	Field Records	Level & Depth	Stratum Description	Legend & Water Strikes	Backfill Installs		
0.50	ES					(0.20) 20.95 0.20	MADE GROUND - Gravel fill				
1.00	ES					(1.30)	MADE GROUND- Soft dark brown peaty CLAY with organic fibres.				
1.80	ES					19.65 1.50	Brown soft silty slightly gravelly CLAY. Gravel is subangular to subrounded fine to coarse.				
						(0.70) 18.95 2.20	Firm brown CLAY with cobbles. Cobbles are subangular to subrounded.				
						(0.70) 18.25 2.90	Brown silty CLAY with cobbles. Cobbles are subangular to subrounded.				
						(0.60) 17.65 3.50	Very stiff dark grey slightly sandy gravelly CLAY.				
						(3.00)					
						14.65 6.50	----- End of core at 6.50 m -----				
Remarks Level at top of standpipe: 21.15mOD							Core Barrel:		Water Strikes:		
							Flush Type:		Struck (m)	Rose to (m)	Time (min)
									2.90	2.90	10
							Water Added:		Casing:		
							From (m)	To (m)	To (m)	Diameter (mm)	
		6.50	150								
									www.causewaygeotech.com © Causeway Geotech Ltd		




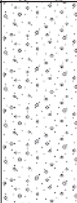
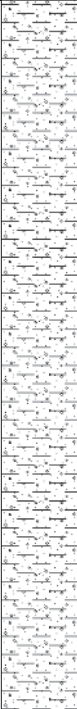

Causeway Geotech Ltd						Project no. 15-250	Project Name: Additional Investigation at St James' Hospital, Dublin	Borehole No. BH217A			
Method: 2.00 3.00 Symmetrix 0.00 2.00 Dynamic Sampling						Co-ords: 313344.78mE 233298.70mN		Client: National Paediatric Hospital Development Board	Sheet 1 of 1		
								Client's Representative: O'Connor Sutton Cronin Consulting Engineers	Scale: 1:50		
Plant: Comacchio 205						Ground Level: 21.18MOD		Dates: 01/04/2015	Crew: JC		
								Logged By: MM			
Depth (m)	TCR	SCR	RQD	FI	Field Records	Level & Depth	Stratum Description	Legend & Water Strikes	Backfill Installs		
0.50	ES					(0.20) 20.98 0.20	MADE GROUND - Dark grey clayey angular to subangular medium to coarse GRAVEL.				
						(0.60)	MADE GROUND - Dark grey gravelly CLAY with pieces of ceramics and occasional rootlets. Gravel is subangular to subrounded fine to coarse.				
						20.38 0.80	MADE GROUND - Firm dark brown grey slightly gravelly peaty CLAY with pieces of timber and rootlets.				
						(1.40)					
2.50	ES					18.98 2.20	Firm to stiff light brown grey slightly gravelly CLAY with occasional cobbles. Gravel is subangular to subrounded fine to coarse. Cobbles are subangular to subrounded.				
						(0.40) 18.58 2.60	Stiff light grey brown sandy slightly gravelly CLAY. Sand is fine to coarse. Gravel is subangular to subrounded fine to coarse.				
						(0.40)					
						18.18 3.00	----- End of core at 3.00 m -----				
Remarks Level at top of standpipe: 21.02mOD							Core Barrel:		Water Strikes:		
							Flush Type:		Struck (m)	Rose to (m)	Time (min)
									2.00	2.0	10
							Water Added:		Casing:		
							From (m)	To (m)	To (m)	Diameter (mm)	
		3.00	150								

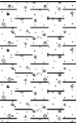


Causeway Geotech Ltd						Project no. 15-250	Project Name: Additional Investigation at St James' Hospital, Dublin	Borehole No. BH218		
Method: 0.00 1.20 Hand Dug 1.20 7.20 Symmetrix						Co-ords: 313330.07mE 233379.74mN	Client: National Paediatric Hospital Development Board		Sheet 1 of 1	
							Client's Representative: O'Connor Sutton Cronin Consulting Engineers		Scale: 1:50	
Plant: Hand Tools+Comacchio 205						Ground Level: 20.79MOD	Dates: 31/03/2015		Crew: JC	
									Logged By: MM	
Depth (m)	TCR	SCR	RQD	FI	Field Records	Level & Depth	Stratum Description	Legend & Water Strikes	Backfill Installs	
0.50	ES					(1.30)	MADE GROUND - Dark brown sandy gravelly CLAY. Sand is fine to coarse. Gravel is subangular to subrounded fine to coarse.			
1.00	ES					19.49 1.30 (1.40)	Firm to stiff brown gravelly CLAY. Gravel is subangular to subrounded fine to coarse.			
						18.09 2.70 (4.50)	Very stiff dark brown sandy gravelly CLAY. Sand is fine to coarse. Gravel is subangular to subrounded fine to coarse.			
						13.59 7.20	----- End of core at 7.20 m			
Remarks Level at top of standpipe: 20.70mOD							Core Barrel:			
							Flush Type:			Water Strikes: Struck (m) Rose to (m) Time (min)
							Water Added:			Casing:
							From (m)	To (m)		To (m)
		7.20	150							

Causeway Geotech Ltd						Project no. 15-250	Project Name: Additional Investigation at St James' Hospital, Dublin	Borehole No. BH219			
Method: 0.00 1.20 Hand Dug 1.20 2.65 Symmetrix 2.65 11.00 Open Hole Drilling						Co-ords: 313396.65mE	Client: National Paediatric Hospital Development Board	Sheet 1 of 2			
						233461.52mN	Client's Representative: O'Connor Sutton Cronin Consulting Engineers	Scale: 1:50			
Plant: Hand Tools+Comacchio 405						Ground Level: 19.99MOD	Dates: 11/04/2015	Crew: SJ+			
						Logged By: MG					
Depth (m)	TCR	SCR	RQD	FI	Field Records	Level & Depth	Stratum Description	Legend & Water Strikes	Backfill Installs		
0.50	ES					(0.35) 19.64 0.35	CONCRETE				
						(0.25) 19.39 0.60	MADE GROUND - Hardcore Fill				
1.00	ES					(0.40) 18.99 1.00	MADE GROUND - Soft to firm dark brown CLAY				
							Soft to firm light brown CLAY				
						(1.50)					
						17.49 2.50	Dark brown sandy gravelly CLAY. Sand is fine to coarse. Gravel is subangular to subrounded fine to coarse.				
						(7.30)					
						10.19 9.80 (0.20) 9.99 10.00	Clayey subangular to subrounded fine to coarse GRAVEL.				
							Dark grey sandy gravelly CLAY. Sand is fine to coarse. Gravel is				
							Continued on next sheet				
Remarks Level at top of standpipe: 19.93mOD							Core Barrel:		Water Strikes:		
							Flush Type:		Struck (m)	Rose to (m)	Time (min)
									9.80	9.80	10
Water Added:		Casing:									
From (m)	To (m)	To (m)	Diameter (mm)								
											

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Causeway Geotech Ltd						Project no. 15-250		Project Name: Additional Investigation at St James' Hospital, Dublin		Borehole No. BH219	
Method: 0.00 1.20 Hand Dug 1.20 2.65 Symmetrix 2.65 11.00 Open Hole Drilling						Co-ords: 313396.65mE 233461.52mN		Client: National Paediatric Hospital Development Board		Sheet 2 of 2	
								Client's Representative: O'Connor Sutton Cronin Consulting Engineers		Scale: 1:50	
Plant: Hand Tools+Comacchio 405						Ground Level: 19.99MOD		Dates: 11/04/2015		Crew: SJ+	
										Logged By: MG	
Depth (m)	TCR	SCR	RQD	FI	Field Records	Level & Depth	Stratum Description			Legend & Water Strikes	Backfill Installs
						(1.00) 8.99 11.00	subangular to subrounded fine to coarse. ----- End of core at 11.00 m				
Remarks Level at top of standpipe: 19.93mOD							Core Barrel:		Water Strikes:		
							Flush Type:		Struck (m) Rose to (m) Time (min)		
									9.80 9.80 10		
							Water Added:		Casing:		
							From (m) To (m)		To (m) Diameter (mm)		
											
										www.causewaygeotech.com © Causeway Geotech Ltd	


Causeway Geotech Ltd						Project no. 15-250	Project Name: Additional Investigation at St James' Hospital, Dublin	Borehole No. BH220			
Method: 0.00 1.20 Hand Dug 1.20 11.00 Symmetrix						Co-ords: 313404.10mE	Client: National Paediatric Hospital Development Board	Sheet 1 of 2			
Plant: Hand Tools+Comacchio 405						233560.60mN	Client's Representative: O'Connor Sutton Cronin Consulting Engineers	Scale: 1:50			
						Ground Level: 19.48MOD	Dates: 14/04/2015	Crew: SJ			
								Logged By: MG			
Depth (m)	TCR	SCR	RQD	FI	Field Records	Level & Depth	Stratum Description	Legend & Water Strikes	Backfill Installs		
0.50	ES					(0.10) 19.38 0.10	TARMAC - Drillers description. MADE GROUND - Drillers description.				
1.00	ES					(0.60) 18.78 0.70	Dark brown gravelly CLAY with cobbles. Gravel is subangular to subrounded fine to medium. Cobbles are subangular to subrounded. - Drillers description.				
						(0.50) 18.28 1.20	Dark brown CLAY with cobbles. Cobbles are subangular to subrounded. - Drillers description.				
						(2.90)					
						15.38 4.10	Brown sandy GRAVEL. Gravel is subangular to subrounded fine to medium. - Drillers description.				
						(1.40)					
						13.98 5.50	Sandy gravelly CLAY. Sand is fine to coarse. Gravel is subangular to subrounded fine to coarse. - Drillers description.				
						(5.50)					
Continued on next sheet											
Remarks Level at top of standpipe: 19.39mOD Vibrating wire piezometer installed.							Core Barrel:		Water Strikes:		
							Flush Type:		Struck (m)	Rose to (m)	Time (min)
							Water Added:		Casing:		
							From (m)	To (m)	To (m)	Diameter (mm)	
							5.60	200			
											
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Causeway Geotech Ltd						Project no. 15-250	Project Name: Additional Investigation at St James' Hospital, Dublin	Borehole No. BH220				
Method: 0.00 1.20 Hand Dug 1.20 11.00 Symmetrix						Co-ords: 313404.10mE 233560.60mN		Client: National Paediatric Hospital Development Board		Sheet 2 of 2		
								Client's Representative: O'Connor Sutton Cronin Consulting Engineers		Scale: 1:50		
Plant: Hand Tools+Comacchio 405						Ground Level: 19.48MOD		Dates: 14/04/2015		Crew: SJ		
										Logged By: MG		
Depth (m)	TCR	SCR	RQD	FI	Field Records	Level & Depth	Stratum Description			Legend & Water Strikes	Backfill Installs	
						8.48 11.00	----- End of core at 11.00 m -----					
Remarks Level at top of standpipe: 19.39mOD Vibrating wire piezometer installed.							Core Barrel:		Water Strikes:			
							Flush Type:		Struck (m)	Rose to (m)		Time (min)
							Water Added:		Casing:			
							From (m)	To (m)	To (m)	Diameter (mm)		
		5.60	200									
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Causeway Geotech Ltd						Project no. 15-250	Project Name: Additional Investigation at St James' Hospital, Dublin	Borehole No. BH221			
Method: 0.00 1.20 Hand Dug 1.20 2.00 Dynamic Sampling						Co-ords: 313387.51mE 233589.73mN	Client: National Paediatric Hospital Development Board		Sheet 1 of 1		
							Client's Representative: O'Connor Sutton Cronin Consulting Engineers		Scale: 1:50		
Plant: Hand Tools+Comacchio 205						Ground Level: 19.26MOD	Dates: 08/04/2015		Crew: JC		
									Logged By: MM		
Depth (m)	TCR	SCR	RQD	FI	Field Records	Level & Depth	Stratum Description	Legend & Water Strikes	Backfill Installs		
0.50	ES					19.03 0.07	TARMAC				
						19.16 0.10	CONCRETE				
1.00	ES					18.66 0.60	MADE GROUND (hardcore fill): Greyish brown fine to coarse angular GRAVEL with occasional cobbles and fragments of brick.				
						18.06 1.20	MADE GROUND (fill): Brown clayey fine to coarse subangular GRAVEL with occasional cobbles and fragments of brick.				
2.00	ES					17.26 2.00	Stiff brown slightly sandy slightly gravelly CLAY with occasional cobbles. Sand is fine to coarse. Gravel is fine to coarse, subangular.				
							End of core at 2.00 m				
Remarks Level at top of standpipe: 19.12mOD Standpipe installed with gas bung and flush cover. Refusal met at 2.0m							Core Barrel:		Water Strikes:		
							Flush Type:		Struck (m)	Rose to (m)	Time (min)
							Water Added:		Casing:		
							From (m)	To (m)	To (m)	Diameter (mm)	

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Causeway Geotech Ltd					Project no. 15-250	Project Name: Additional Investigation at St James' Hospital, Dublin	Borehole No. BH222				
Method: 0.00 1.20 Hand Dug 1.20 3.50 Symmetrix 3.50 16.20 Rotary Coring					Co-ords: 313386.84mE 233608.14mN	Client: National Paediatric Hospital Development Board		Sheet 2 of 2			
						Client's Representative: O'Connor Sutton Cronin Consulting Engineers		Scale: 1:50			
Plant: Hand Tools+Comacchio 405					Ground Level: 19.34MOD	Dates: 09/04/2015		Crew: SJ			
								Logged By: MFG			
Depth (m)	TCR	SCR	RQD	FI	Field Records	Level & Depth	Stratum Description	Legend & Water Strikes	Backfill Installs		
11.70 - 13.20	40	0	0			(3.80)					
	27	0	0								
13.20 - 14.70	C					6.24 13.10	Stiff to very stiff brown, becoming greyish brown downhole, slightly sandy slightly gravelly CLAY with occasional cobbles of limestone. Sand is fine to coarse. Gravel is fine to coarse, subangular, predominantly of limestone.				
13.20 - 14.70	100	0	0								
14.70 - 16.20	C					(3.10)					
14.70 - 16.20	87	0	0								
						3.14 16.20	----- End of core at 16.20 m				
Remarks Level at top of standpipe: 19.28mOD							Core Barrel:		Water Strikes:		
							Flush Type:		Struck (m)	Rose to (m)	Time (min)
							Water Added:		Casing:		
							From (m)	To (m)	To (m)	Diameter (mm)	

Causeway Geotech Ltd						Project no. 15-250	Project Name: Additional Investigation at St James' Hospital, Dublin	Borehole No. BH223			
Method: 0.00 1.20 Hand Dug 1.20 4.50 Symmetrix						Co-ords: 313328.05mE 233594.50mN	Client: National Paediatric Hospital Development Board	Sheet 1 of 1			
							Client's Representative: O'Connor Sutton Cronin Consulting Engineers	Scale: 1:50			
Plant: Hand Tools+Comacchio 405						Ground Level: 19.57MOD	Dates: 13/04/2015	Crew: SJ			
							Logged By: MG				
Depth (m)	TCR	SCR	RQD	FI	Field Records	Level & Depth	Stratum Description	Legend & Water Strikes	Backfill Installs		
1.00	ES					(0.20)	TARMAC				
						(0.90) 0.20	MADE GROUND - Silty sandy gravelly fill				
						(1.20) 0.30	CONCRETE				
						(1.90) 0.50	MADE GROUND - Silty sand gravelly fill				
						(3.90)					
						(4.40) 4.40	CONCRETE				
						15.07 4.50	End of core at 4.50 m				
Remarks Met obstruction at 4.4m. Hole was abandoned and backfilled. BH225 was drilled instead.							Core Barrel:		Water Strikes:		
							Flush Type:		Struck (m)	Rose to (m)	Time (min)
							Water Added:		Casing:		
							From (m)	To (m)	To (m)	Diameter (mm)	
											
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




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Causeway Geotech Ltd						Project no. 15-250	Project Name: Additional Investigation at St James' Hospital, Dublin	Borehole No. BH223A			
Method: 5.40 13.90 Rotary Coring 0.00 1.20 Hand Dug 1.20 5.40 Symmetrix						Co-ords: 313333.46mE	Client: National Paediatric Hospital Development Board	Sheet 2 of 2			
						233595.79mN	Client's Representative: O'Connor Sutton Cronin Consulting Engineers	Scale: 1:50			
Plant: Comacchio 405+Hand Tools						Ground Level: 19.15MOD	Dates: 13/04/2015 - 14/04/2015	Crew: SJ			
								Logged By: MFG			
Depth (m)	TCR	SCR	RQD	FI	Field Records	Level & Depth	Stratum Description	Legend & Water Strikes	Backfill Installs		
10.90 - 12.40						(1.95)	GRAVEL, predominantly of dark grey limestone, with frequent cobbles of limestone from 10.0-10.9m. Sand is fine to coarse.				
	100	0	0			7.20 11.95 (0.30)	Firm brown sandy slightly gravelly CLAY. Sand is fine to coarse. Gravel is fine to coarse, subangular.				
12.40 - 13.90 12.40 - 13.90	C					6.90 12.25	Very stiff brownish dark grey slightly sandy gravelly CLAY. Sand is fine to coarse. Gravel is fine to coarse, subangular, predominantly of dark grey limestone.				
	100	0	0			(1.65)					
						5.25 13.90	----- End of core at 13.90 m				
Remarks Level at top of standpipe: 19.00mOD Vibrating wire piezometer installed.							Core Barrel:		Water Strikes:		
							Flush Type:		Struck (m)	Rose to (m)	Time (min)
							Water Added:		Casing:		
							From (m)	To (m)	To (m)	Diameter (mm)	
		5.40	200								
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Causeway Geotech Ltd						Project no. 15-250	Project Name: Additional Investigation at St James' Hospital, Dublin	Borehole No. BH224				
Method: 0.00 1.20 Hand Dug 1.20 7.00 Symmetrix						Co-ords: 313250.36mE 233634.71mN		Client: National Paediatric Hospital Development Board		Sheet 1 of 1		
								Client's Representative: O'Connor Sutton Cronin Consulting Engineers		Scale: 1:50		
Plant: Hand Tools+Comacchio 205						Ground Level: 8.75MOD		Dates: 14/04/2015		Crew: JC		
										Logged By: MM		
Depth (m)	TCR	SCR	RQD	FI	Field Records	Level & Depth	Stratum Description		Legend & Water Strikes	Backfill Installs		
0.50	ES					0.20 0.20	TOPSOIL					
						8.55 0.20	MADE GROUND - Sandy clayey Fill					
						(1.30)						
						7.25 1.50	Stiff brown slightly sandy gravelly CLAY. Sand is fine to coarse. Gravel is subangular to subrounded fine to coarse.					
1.00	ES					(0.50)	Stiff sandy gravelly CLAY with boulders. Sand is fine to coarse. Gravel is subangular to subrounded fine to coarse.					
1.50	ES					(0.40)	Stiff dark brown slightly sandy slightly gravelly CLAY with regular boulders. Sand is fine to coarse. Gravel is fine to coarse, subangular.					
2.00	SPT (S)				0 (4,7/0 for 0mm)	6.75 2.00						
5.50	SPT (S)				39 (8,10/39 for 225mm)	6.35 2.40						
						(4.60)						
						1.75 7.00	End of core at 7.00 m					
Remarks							Core Barrel:		Water Strikes:			
							Flush Type:		Struck (m)	Rose to (m)		Time (min)
							Water Added:		Casing:			
							From (m)	To (m)	To (m)	Diameter (mm)		
									7.00	150		


Causeway Geotech Ltd						Project no. 15-250	Project Name: Additional Investigation at St James' Hospital, Dublin	Borehole No. BH225				
Method: 0.00 1.20 Hand Dug 1.20 4.10 Symmetrix 4.10 12.00 Open Hole Drilling						Co-ords: 313345.96mE	Client: National Paediatric Hospital Development Board		Sheet 1 of 2			
						233606.76mN	Client's Representative: O'Connor Sutton Cronin Consulting Engineers		Scale: 1:50			
Plant: Hand Tools+Comacchio 405						Ground Level: 17.24MOD	Dates: 14/04/2015		Crew: SJ			
								Logged By: MG				
Depth (m)	TCR	SCR	RQD	FI	Field Records	Level & Depth	Stratum Description		Legend & Water Strikes	Backfill Installs		
0.50	ES					0.20 0.20	TARMAC					
1.00	ES					1.00	MADE GROUND - Sandy gravelly CLAY fill. Sand is fine to medium. Gravel is subangular to subrounded fine to coarse.					
						1.20 1.20	Sandy gravelly CLAY. Sand is fine to medium. Gravel is subangular to subrounded fine to coarse.					
						2.10						
						3.30 3.30	Dark grey sandy gravelly CLAY. Sand is fine to coarse. Gravel is subangular to subrounded fine to coarse.					
4.10	SPT (S)				64 (10,11/64 for 150mm)							
5.60	SPT (S)				39 (8,10/39 for 100mm)	4.70						
7.10	SPT (S)				50 (10 for 75mm/50 for 75mm)							
						8.00 8.00	Brown sandy gravelly CLAY. Sand is fine to coarse. Gravel is subangular to subrounded fine to coarse.					
8.60	SPT (S)				50 (25 for 75mm/50 for 237mm)	2.50						
10.10	SPT (S)				33 (6,8/33 for 150mm)							
							Continued on next sheet					
Remarks Level at top of standpipe: 20.49mOD							Core Barrel:		Water Strikes:			
							Flush Type:		Struck (m)	Rose to (m)		Time (min)
		Water Added:		Casing:								
		From (m)	To (m)	To (m)	Diameter (mm)							

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Causeway Geotech Ltd						Project no. 15-250		Project Name: Additional Investigation at St James' Hospital, Dublin		Borehole No. BH226			
Method: 0.00 1.20 Hand Dug 1.20 1.70 Dynamic Sampling 1.70 7.00 Symmetrix						Co-ords: 313371.27mE 233321.59mN		Client: National Paediatric Hospital Development Board		Sheet 1 of 1			
								Client's Representative: O'Connor Sutton Cronin Consulting Engineers		Scale: 1:50			
Plant: Hand Tools+Comacchio 205						Ground Level: 20.62MOD		Dates: 16/04/2015		Crew: JC			
										Logged By: MM			
Depth (m)		TCR	SCR	RQD	FI	Field Records	Level & Depth		Stratum Description		Legend & Water Strikes	Backfill Installs	
0.50		ES					20.55 0.07 (1.03)		TARMAC MADE GROUND (hardcore fill): Grey sandy fine to coarse angular GRAVEL.				
1.00		ES					19.52 1.10 (0.60)		Stiff brown slightly sandy slightly gravelly CLAY. Sand is fine to coarse. Gravel is fine to coarse, subangular.				
1.20		ES					18.92 1.70 (5.30)		Dark brown slightly sandy gravelly CLAY with occasional cobbles. Sand is fine to coarse. Gravel is fine to coarse, subangular.				
							13.62 7.00		End of core at 7.00 m				
Remarks								Core Barrel:		Water Strikes:			
Level at top of standpipe: 20.45mOD								Flush Type:		Struck (m) Rose to (m) Time (min)			
Vibrating wire piezometer installed.													
								Water Added:		Casing:			
								From (m) To (m)		To (m) Diameter (mm)			
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Causeway Geotech Ltd						Project no. 15-250	Project Name: Additional Investigation at St James' Hospital, Dublin	Borehole No. BH231									
Method: 0.00 1.20 Hand Dug 1.20 3.30 Dynamic Sampling 3.30 6.50 Symmetrix						Co-ords: 313591.08mE	Client: National Paediatric Hospital Development Board	Sheet 1 of 1									
Plant: Hand Tools+Comacchio 205						233731.81mN	Client's Representative: O'Connor Sutton Cronin Consulting Engineers	Scale: 1:50									
						Ground Level: 20.04MOD	Dates: 12/04/2015	Crew: JC									
								Logged By: MM									
Depth (m)	TCR	SCR	RQD	FI	Field Records	Level & Depth	Stratum Description	Legend & Water Strikes	Backfill Installs								
0.50	ES					19.99 0.05 (0.05)	TARMAC MADE GROUND - Firm sandy gravelly CLAY with frequent brick fragments. (Drillers description)										
1.00	ES					(1.15)											
						18.84 1.20 (0.10)	MADE GROUND - COBBLES										
						18.74 1.30 (0.20)	MADE GROUND - Thick black ash material.										
						18.54 1.50	MADE GROUND - Soft to firm sandy CLAY with brick fragments. Sand is fine to coarse. Gravel is subangular to subrounded fine to coarse.										
2.00	ES					(0.50) 18.04 2.00	Firm brown gravelly slightly sandy CLAY. Gravel is subangular to subrounded.										
3.00	ES					(2.60)											
5.50	SPT (S)				N=69 (4,9/13,18,16,22)	(1.90) 15.44 4.60	Black stiff sandy gravelly CLAY. Sand is fine to coarse. Gravel is subangular to subrounded fine to coarse.										
						13.54 6.50	----- End of core at 6.50 m										
Remarks Level at top of standpipe: 19.96mOD Borehole previously numbered as "BH231"							Core Barrel:	Water Strikes: <table border="1"> <tr> <th>Struck (m)</th> <th>Rose to (m)</th> <th>Time (min)</th> </tr> <tr> <td></td> <td></td> <td></td> </tr> </table>		Struck (m)	Rose to (m)	Time (min)					
Struck (m)	Rose to (m)	Time (min)															
							Flush Type:										
							Water Added: <table border="1"> <tr> <th>From (m)</th> <th>To (m)</th> </tr> <tr> <td></td> <td></td> </tr> </table>	From (m)	To (m)			Casing: <table border="1"> <tr> <th>To (m)</th> <th>Diameter (mm)</th> </tr> <tr> <td>6.50</td> <td>150</td> </tr> </table>		To (m)	Diameter (mm)	6.50	150
From (m)	To (m)																
To (m)	Diameter (mm)																
6.50	150																
							 <small>www.causewaygeotech.com © Causeway Geotech Ltd</small>										

Causeway Geotech Ltd						Project no. 15-250	Project Name: Additional Investigation at St James' Hospital, Dublin	Borehole No. BH232				
Method: 0.70 1.50 Symmetrix 1.50 2.70 Dynamic Sampling 2.70 7.50 Symmetrix						Co-ords: 313615.64mE 233739.47mN		Client: National Paediatric Hospital Development Board	Sheet 1 of 1			
								Client's Representative: O'Connor Sutton Cronin Consulting Engineers	Scale: 1:50			
Plant: Comacchio 205						Ground Level: 20.25MOD		Dates: 12/04/2015	Crew: JC			
								Logged By: DOM				
Depth (m)	TCR	SCR	RQD	FI	Field Records	Level & Depth	Stratum Description		Legend & Water Strikes	Backfill Installs		
0.50	ES					(0.15) 20.10 0.15 (0.55)	TARMAC MADE GROUND - SAND and GRAVEL					
						19.55 0.70 (1.30)	MADE GROUND - Very hard yellowish brown brick and stone (possible parts of old building).					
2.00	ES					18.25 2.00 (1.00)	Fine brown slightly sandy slightly gravelly CLAY. Sand is fine to coarse. Gravel is subangular to subrounded fine to coarse.					
						17.25 3.00 (0.20)	Stiff brown slightly sandy slightly gravelly CLAY. Sand is fine to coarse. Gravel is subangular to subrounded fine to coarse.					
						17.05 3.20 (0.50)	Very stiff slightly sandy slightly gravelly CLAY. Sand is fine to coarse. Gravel is subangular to subrounded fine to coarse.					
						16.55 3.70	Sandy gravelly CLAY. Sand is fine to coarse. Gravel is subangular to subrounded fine to coarse.					
						(3.80) 12.75 7.50	End of core at 7.50 m					
Remarks Level at top of standpipe: 20.17mOD Borehole previously numbered as "BH232" Hand dug inspection pit to 0.7m.							Core Barrel:		Water Strikes:		 www.causewaygeotech.com © Causeway Geotech Ltd	
							Flush Type:		Struck (m)	Rose to (m)		Time (min)
							Water Added:		Casing:			
							From (m)	To (m)	To (m)	Diameter (mm)		

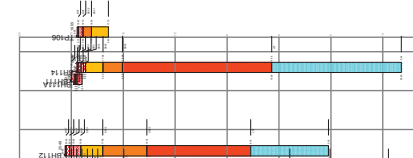
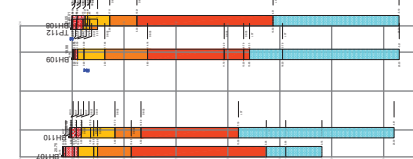
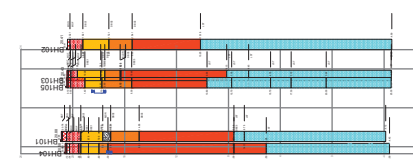
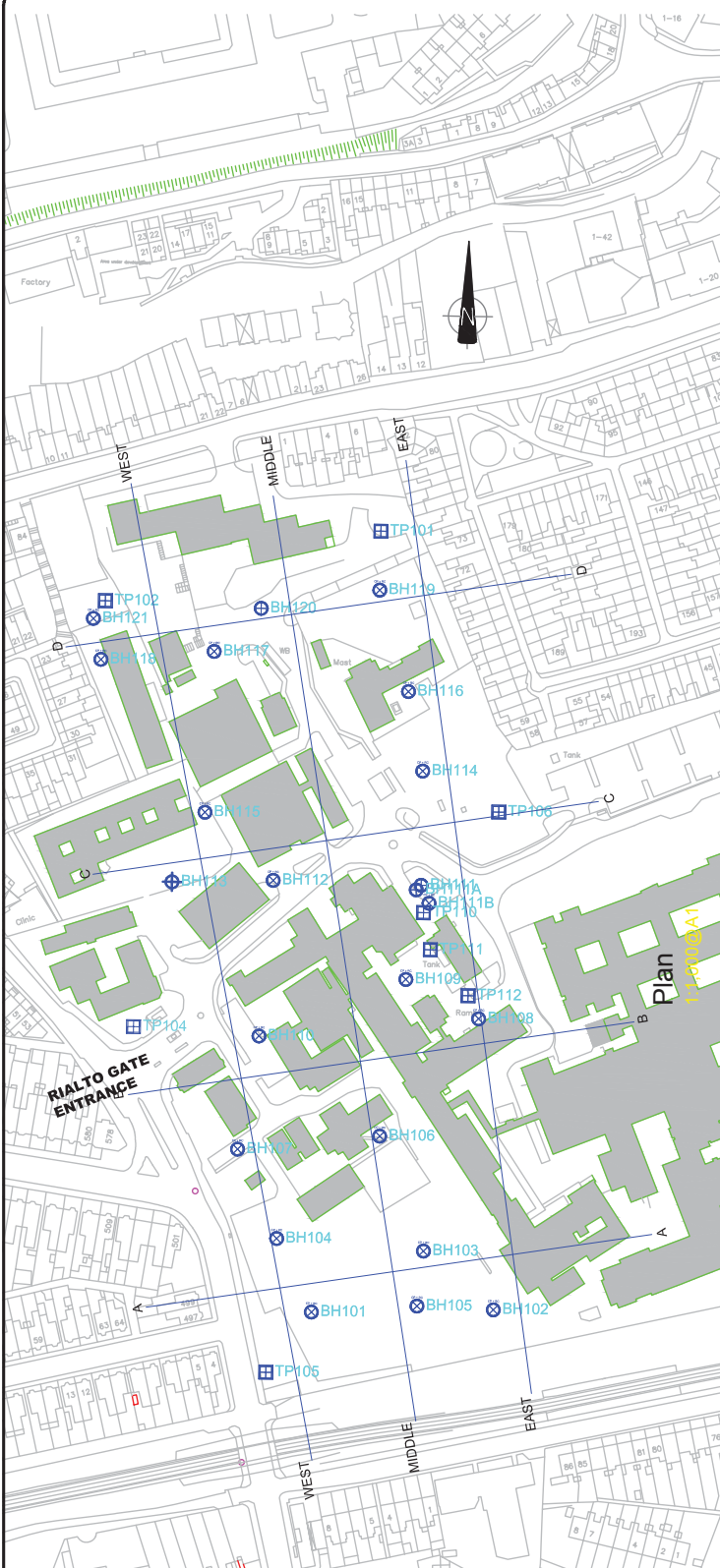
Causeway Geotech Ltd						Project no. 15-250	Project Name: Additional Investigation at St James' Hospital, Dublin	Borehole No. BH234				
Method: 0.00 1.20 Hand Dug 3.70 6.70 Symmetrix 1.20 3.70 Dynamic Sampling						Co-ords: 313631.52mE		Client: National Paediatric Hospital Development Board	Sheet 1 of 1			
						233706.30mN		Client's Representative: O'Connor Sutton Cronin Consulting Engineers	Scale: 1:50			
Plant: Hand Tools+Comacchio 205						Ground Level: 20.66MOD		Dates: 12/04/2015	Crew: JC			
									Logged By: MM			
Depth (m)	TCR	SCR	RQD	FI	Field Records	Level & Depth	Stratum Description		Legend & Water Strikes	Backfill Installs		
0.50 - 1.20	ES					(0.20) 0.20	TOPSOIL					
						(0.30) 0.50	MADE GROUND - Firm brown CLAY with roots.. (Drillers description)					
4.00	SPT (S)				N=71 (7,12/15,18,19,19)	16.96 3.70	MADE GROUND - Grey gravelly sandy fill with cobbles. Sand is fine to coarse. Gravel is subangular to subrounded fine to coarse. Cobbles are subangular to subrounded.					
5.50	SPT (S)				N=72 (6,15/15,17,19,21)	(3.20)						
						13.96 6.70	Very stiff dark grey slightly sandy gravelly CLAY. Sand is fine to coarse.					
							End of core at 6.70 m					
Remarks Level at top of standpipe: 20.59mOD Borehole previously numbered as "BH234"							Core Barrel:		Water Strikes:			
							Flush Type:		Struck (m)	Rose to (m)	Time (min)	
									5.50	5.50	10	
							Water Added:		Casing:			
							From (m)	To (m)	To (m)	Diameter (mm)		
		6.70	200									
												
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Appendix B

Geological Cross Sections
Prepared by Roughan & O
Donovan

SOIL/ROCK STRATA

- TOPSOIL
- TS
- MADE GROUND
- MADE GROUND FINE GRAINED
- MADE GROUND GRANULAR
- MADE GROUND TARMAC
- DUBLIN BOULDER CLAY
- DUBLIN BOULDER CLAY
- DUBLIN BOULDER CLAY
- GRAVELS
- CALP LIMESTONE
- LST
- TRIAL PIT
- BOREHOLE
- WATERSTRIKE

TPBH

Roughan & O'Donovan
Consulting Engineers
Civil, Structural, Transportation, Environmental

Project Title: NATIONAL PAEDIATRIC HOSPITAL AT ST. JAMES'S HOSPITAL CAMPUS
PROJECT GROUND INVESTIGATION

Client: Arena House, Arena Road, Sanoyford, Dublin 18.
Tel : +353 1 294 0800
Fax : +353 1 294 0820
e-mail : info@rod.ie
Website : www.rod.ie

Drawn: PP Scale: AS SHOWN Date: NOV '14 Drawing No: 14.137
Checked: PK Approved: SNG Status: PRELIMINARY
Designed: PP

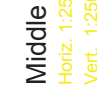
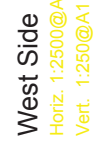
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Revision: No. Date By Date
A. REPORT REVISED DRAFT SHEET 2 2010.15 PK SHAD
B. PRELIMINARY APPROVAL 2010.15 PK SHAD
C. TENDER CONSTRUCTION 2010.15 PK SHAD


Project No: 12500@A1
Drawing Title: GEOLOGICAL PROFILE LAYOUT SHEET 2 OF 2
Revision: No. Date By Date
A. REPORT REVISED DRAFT SHEET 2 2010.15 PK SHAD
B. PRELIMINARY APPROVAL 2010.15 PK SHAD
C. TENDER CONSTRUCTION 2010.15 PK SHAD

Project No: 12500@A1
Drawing Title: GEOLOGICAL PROFILE LAYOUT SHEET 2 OF 2
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B. PRELIMINARY APPROVAL 2010.15 PK SHAD
C. TENDER CONSTRUCTION 2010.15 PK SHAD

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	TOPSOIL	TS
	MADE GROUND	
	MADE GROUND FINE GRAINED	MGF
	MADE GROUND GRANULAR	MGG
	MADE GROUND TARMAC	MGT
	DUBLIN BOULDER CLAY	DBC1
	DUBLIN BOULDER CLAY	DBC2
	DUBLIN BOULDER CLAY	DBC3
	GRAVELS	GRAVEL
	CALP LIMESTONE	LST



 Roughan & O'Donovan Consulting Engineers Civil · Structural · Transportation · Environmental										Project Title NATIONAL PAEDIATRIC HOSPITAL PROJECT GROUND INVESTIGATION									
Address: Arena Road, Sandford, Dublin 18. Tel : +353 1 294 0800 Fax : +353 1 294 0820 E-mail: info@rodo.ie Website: www.rodo.ie										Drawing Title GEOLOGICAL PROFILE LAYOUT SHEET 1 OF 2									
Revision Description Date By Check Approved Drawn Date By Check Approved										Revision Description Date By Check Approved Drawn Date By Check Approved									
PRELIMINARY APPROVAL COMMENTS CONSTRUCTION										PRELIMINARY APPROVAL COMMENTS CONSTRUCTION									
Drawn: PJP Checked: PK Approved: SMG Scale: 1:1 Date: 14/12/17 Drawing No.: GEO - 001 Rev: A										Drawn: PJP Checked: PK Approved: SMG Scale: 1:1 Date: 14/12/17 Drawing No.: GEO - 001 Rev: A									








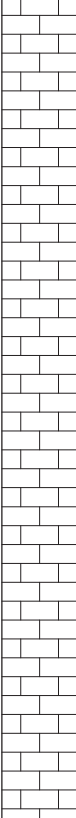
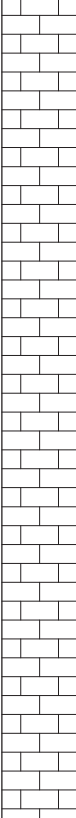
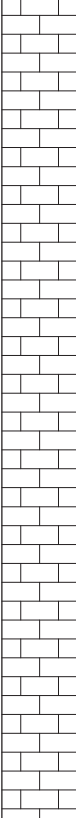
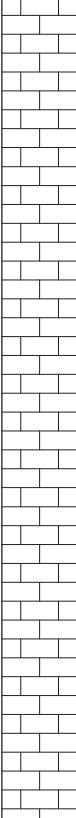
Do not SCALE USE FIGURED DIMENSIONS ONLY
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Appendix C

2015 Borehole Logs Prepared by
Meehans Drilling

BOREHOLE LOG

Project National Paediatric Hospital, St James' Hospital Campus, Dublin				BOREHOLE No FS01/15	
Job No W812	Date 17-05-15 29-05-15	Top of Standpipe (mAOD) 8.19	Co-Ordinates () E 713,185.47 N 733,664.42		
Contractor Meehan Drilling				Sheet 1 of 1	

SAMPLES & TESTS			STRATA				Geology	Instrument/Backfill	
Depth	Type No	Test Result	Water	Ground Level 8.04 (mAOD)	Legend	Depth (Thickness)			DESCRIPTIONG
				6.04		2.00	MADEGROUND/ FILL, brown silty gravelly clay with fragments of brick.		
				1.04		(5.00) 7.00	Dark brown sandy gravelly CLAY with a smell of sulphur. [PROBABLE DUBLIN BOUNDER CLAY]		
				-2.96		11.00	Weathered LIMESTONE. Recovered as dark grey LIMESTONE. Driller noted rate of drilling was relatively fast and is likely to be weathered (PROBABLE WEATHERED LUCAN FORMATION). Recovered as dark grey medium strong to strong LIMESTONE with sand sized pyrite crystals. Frequent white calcite chippings suggest calcite veins are present (LUCAN FORMATION).		
45.00	P	350m3/d	  			(68.00)	@46-49m Drill rate progressed at a faster rate. May indicate fractures or softer rock.		
65.00	P	420m3/d							
72.00	P	480m3/d					@78-79m Drill rate progressed at a faster rate. May indicate fractures or softer rock.		
78.00	P	370m3/d		-70.96		79.00			

Boring Progress and Water Observations						Chiselling			Water Added		GENERAL REMARKS
Date	Time	Depth	Depth	Casing Dia. mm	Water Dpt	From	To	Hours	From	To	
17-05-15	17.00	21.00	21.00		27						Location: Bottom of hill on side of Mt Brown road, beside energy centre - Development 2.5 hrs - Drilled open hole @ 373mm between 0mbgl and 13.3mbgl, 330mm between 13.3mbgl and 21mbgl and 250mm between 21mbgl and 79mbgl - Ground level only relevant for time of drilling.
27-05-15	14.00	13.30	13.30		37						
29-05-15	17.00	79.00	79.00		45						

All dimensions in metres Scale 1:625	Client OCSC/Arup for 'NPHDB'	Method/ Plant Used Rotary DTHH with Simultaneous Casing System	Logged By A Orr
---	---------------------------------	---	--------------------

Test type no 'P' refers to drillers estimate following airlift

AGS3 UK BH DUB 2.GPJ GINT STD AGS3.1.GDT 7/7/15

BOREHOLE LOG

Project National Paediatric Hospital, St James' Hospital Campus, Dublin				BOREHOLE No FS02/15	
Job No W812	Date 15-05-15 20-05-15	Top of Standpipe (mAOD) 21.52	Co-Ordinates () E 713,268.52 N 733,327.47		
Contractor Meehan Drilling				Sheet 1 of 1	

SAMPLES & TESTS			STRATA				Geology	Instrument/Backfill
Depth	Type No	Test Result	Water	Ground level 21.12 (mAOD)	Legend (Thickness)	DESCRIPTION		
				19.82		1.30	FILL/ MADEGROUND [Recovered as dark grey very gravelly CLAY] [PROBABLE DUBLIN BOUNDER CLAY]	
						(11.70)		
				8.12		13.00	Dark brown sandy gravelly CLAY with a smell of sulphur [PROBABLE DUBLIN BOUNDER CLAY]	
				5.12		16.00	Recovered as dark grey medium strong to strong LIMESTONE with sand sized pyrite crystals. Frequent white calcite chippings suggest calcite veins are present [PROBABLE LUCAN FORMATION]	
							47 - 48 mbgl Drilling rate decreased. May indicate harder rock [LUCAN FORMATION].	
45.00	P	300m3/d				(79.00)		
65.00	P	340m3/d						
73.00	P	370m3/d						
85.00	P	550m3/d						
90.00	P	530m3/d						
95.00	P	470m3/d		-73.88		95.00		






Boring Progress and Water Observations						Chiselling			Water Added		GENERAL REMARKS
Date	Time	Depth	Casing Depth	Casing Dia. mm	Water Dpt	From	To	Hours	From	To	
15-05-15	14.00	7.00									Location: South corner of south car park - Development 2.5hours - Drilled open hole @ 373mm between 0mbgl and 7mbgl, 330mm between 7mbgl and 25.7mbgl and 250mm between 25.7mbgl and 95mbgl
15-05-15	17.00	7.25									
16-05-15	17.00	25.70									
19-05-15	17.45	80.40			39						
20-05-15	11.30	95.00									
All dimensions in metres Scale 1:625			Client OCSC/Arup for 'NPHDB'			Method/ Plant Used Rotary DTHH with Simultaneous Casing System			Logged By A Orr		

AGS3 UK BH DUB 2.GPJ GINT STD AGS3.1.GDT 7/7/15

Test type no 'P' refers to drillers estimate following airlift

BOREHOLE LOG







Project National Paediatric Hospital, St James' Hospital Campus, Dublin				BOREHOLE No MW01	
Job No W812	Date 11-05-15 12-05-15	Ground Level (m) 20.51	Co-Ordinates () E 713,346.61 N 733,344.98		
Contractor Meehan Drilling				Sheet 1 of 1	

SAMPLES & TESTS			STRATA					Geology	Instrument/ Backfill
Depth	Type No	Test Result	Water	Reduced Level	Legend	Depth (Thickness)	DESCRIPTION		
				19.11		1.40	MADEGROUND/ FILL, brown silty gravelly clay with minor fragments of brick, metal, char.		
						(8.60)	Dark brown to black CLAY with gravels and boulders. [DUBLIN BOULDER CLAY]		
				10.51		10.00	Dark grey LIMESTONE. [PROBABLE LUCAN FORMATION]		
						(10.00)			
				0.51		20.00			

Boring Progress and Water Observations						Chiselling			Water Added		GENERAL REMARKS
Date	Time	Depth	Depth	Casing Dia. mm	Water Dpt	From	To	Hours	From	To	
11-05-15	00.00	11.00	11.00								Location: Car park - 11m of steel casing retracted - No water strikes - 6.5m gravel, 2 buckets sand - Drilled @155mm - Cement grout from 13mbgl to surface
12-05-15	00.00	20.00	20.00								
All dimensions in metres Scale 1:625		Client		OCSC/Arup for 'NPHDB'		Method/ Plant Used		Rotary DTHH with Simultaneous Casing System			

BOREHOLE LOG







Project National Paediatric Hospital, St James' Hospital Campus, Dublin				BOREHOLE No MW02	
Job No W812	Date 21-05-15 21-05-15	Ground Level (m) 20.76	Co-Ordinates () E 713,266.62 N 733,350.17	Sheet 1 of 1	
Contractor Meehan Drilling					

SAMPLES & TESTS			STRATA					Geology	Instrument/ Backfill
Depth	Type No	Test Result	Water	Reduced Level	Legend	Depth (Thickness)	DESCRIPTION		
			1	17.76		3.00	MADE Fill, brown silty gravelly clay with minor fragments of brick.		
				14.76		6.00	Brown to black firm CLAY with gravels and boulders. [DUBLIN BOULDER CLAY]		
				8.76		(6.00) 12.00	Dark grey very gravelly sandy CLAY. [DUBLIN BOULDER CLAY]		
				5.76		15.00	Possible top of weathered BEDROCK.		
			2	-0.24		(6.00) 21.00	Weathered or very soft or shaley ROCK. Poor drilling returns. [PROBABLE WEATHERED LUCAN FORMATION]		
				-7.24		(7.00) 28.00	Competent dark grey LIMESTONE. [LUCAN FORMATION].		

Boring Progress and Water Observations						Chiselling			Water Added		GENERAL REMARKS
Date	Time	Depth	Depth	Casing Dia. mm	Water Dpt	From	To	Hours	From	To	
21-05-15	12.00	16.70	16.70		22						
21-05-15	18.00	28.00	28.00		26						Location: South corner of south car park - 16.7m of Steel Casing Retracted - Estimated Yield 7.4m3/hr
All dimensions in metres Scale 1:625			Client OCSC/Arup for 'NPHDB'			Method/ Plant Used Rotary DTHH with Simultaneous Casing System			Logged By COH/ ATA		

BOREHOLE LOG

Project National Paediatric Hospital, St James' Hospital Campus, Dublin				BOREHOLE No MW04	
Job No W812	Date 03-06-15 03-06-15	Ground Level (m) 19.35	Co-Ordinates () E 713,282.59 N 733,622.55		
Contractor Meehan Drilling				Sheet 1 of 1	

SAMPLES & TESTS			STRATA					Geology	Instrument/ Backfill
Depth	Type No	Test Result	Water	Reduced Level	Legend	Depth (Thickness)	DESCRIPTION		
				17.35		2.00	MADE Fill, brown silty gravelly clay with minor fragments of concrete.		
						(15.00)	Very sandy, very gravelly CLAY with cobbles. Poor returns. Gravel is subrounded. Sand is fine to coarse. Possibly low clay content in places with high gravel and cobble content. [PROBABLE DUBLIN BOULDER FORMATION]		
				2.35		17.00			
				-0.65		20.00	Weathered ROCK. [PROBABLE DUBLIN BOULDER FORMATION]		
						(10.00)	Dark grey muddy LIMESTONE. [PROBABLE DUBLIN BOULDER FORMATION]		
				-10.65		30.00			

Boring Progress and Water Observations						Chiselling			Water Added		GENERAL REMARKS
Date	Time	Depth	Depth	Casing Dia. mm	Water Dpt	From	To	Hours	From	To	
06-03-15	10.00	16.70	16.70		22						
06-03-15	15.00	18.00	18.00								
06-03-15	18.00	30.00	30.00								
All dimensions in metres Scale 1:625			Client OCSC/Arup for 'NPHDB'			Method/ Plant Used Rotary DTHH with Simultaneous Casing System			Logged By COH/ ATA		

BOREHOLE LOG

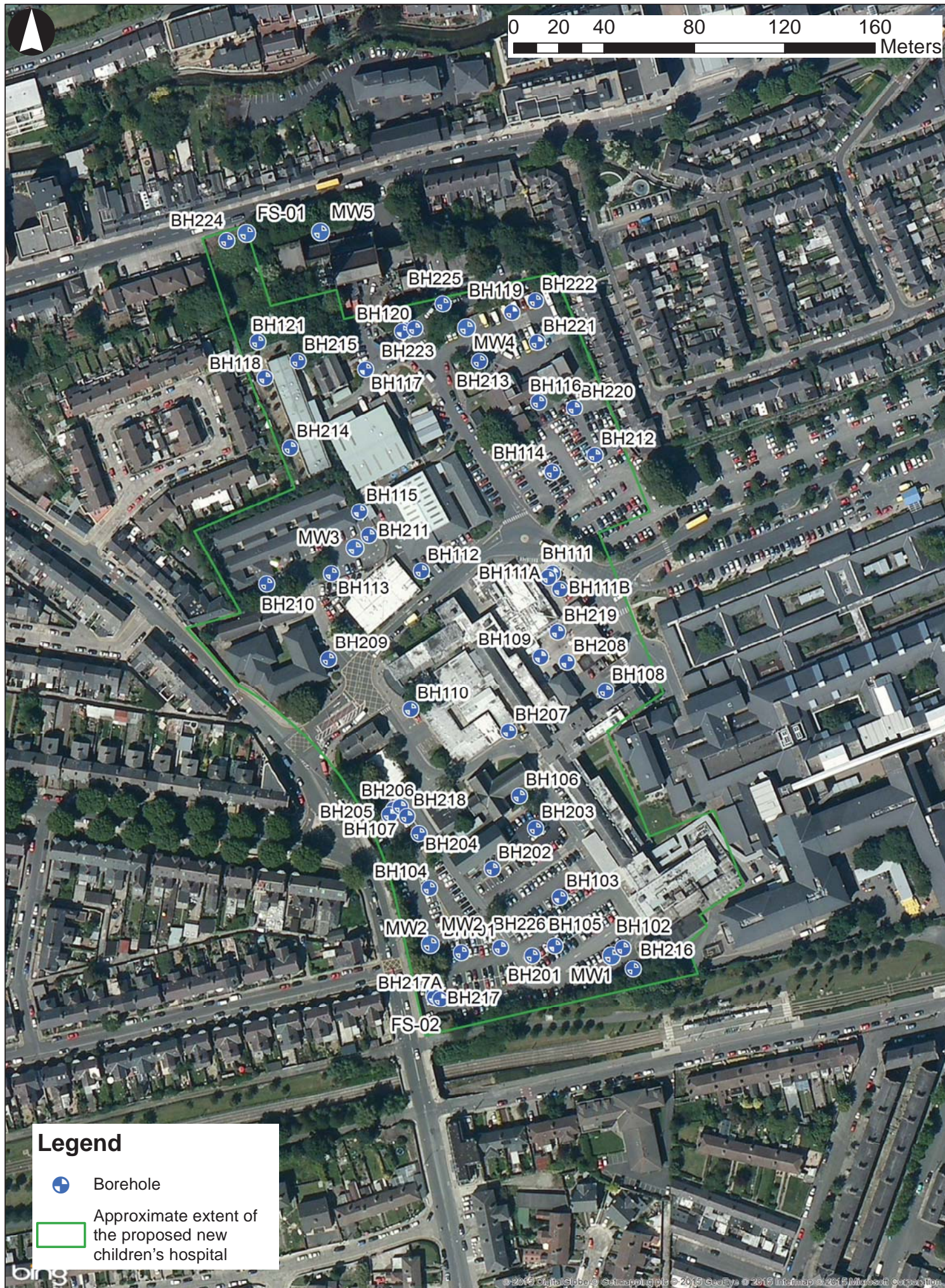
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Job No W812	Date 13-05-15 13-05-15	Ground Level (m) 7.39	Co-Ordinates () E 713,218.07 N 733,664.96		
Contractor Meehan Drilling				Sheet 1 of 1	

SAMPLES & TESTS			STRATA					Geology	Instrument/ Backfill
Depth	Type No	Test Result	Water	Reduced Level	Legend	Depth (Thickness)	DESCRIPTION		
				6.99		0.40	MADE Tarmac.		
				1.39		(5.60)	Dark brown very gravelly CLAY.		
				0.39		6.00	[PROBABLE DUBLIN BOULDER CLAY]		
				-0.61		7.00	Possible GRAVELS with poor drill returns.		
						8.00	Weathered ROCK.		
						(10.00)	[PROBABLE WEATHERED LUCAN FORMATION]		
				-10.61		18.00	Dark grey LIMESTONE. [LUCAN FORMATION]		

Boring Progress and Water Observations						Chiselling			Water Added		GENERAL REMARKS
Date	Time	Depth	Depth	Casing Dia. mm	Water Dpt	From	To	Hours	From	To	
13-05-15	14.00	11.00	11.00								
13-05-15	17.00	18.00	18.00		14.5						Location: front of Energy Centre - 11m of steel casing retracted - Estimated Yield 0.2m ³ /hr - 6.5m of gravel, 2 buckets sand
All dimensions in metres Scale 1:625			Client OCSC/Arup for 'NPHDB'			Method/ Plant Use RotaryDTTH with Simultaneous Casing System			Logged By COH/ ATA		

Appendix D

Borehole Location Plan



Legend



Borehole



Approximate extent of
the proposed new
children's hospital

ARUP

50 Ringsend Road
Dublin 4
Tel +353 (0)1 233 4455 Fax +353 (0)1 668 3169
www.arup.com

Client
**National Paediatric Hospital
Development Board**

Job Title
**St James Hospital -
new children's hospital**

Job No
237976-00

Drawing No
Appendix C

Drawing Status
Draft

Scale
1:1,500

Issue
P1

Borehole location plan

Appendix E

Laboratory Results and Results
of Rising and Falling Head Tests
in the Dublin Boulder Clay

VARIABLE HEAD PERMEABILITY TEST (STANDPIPE PIEZOMETER)

CONTRACT: National Paediatric Hospital, Dublin BOREHOLE No.: BH103 TEST No.: 1
DATE: 7-Aug-14

TYPE OF TEST: **FALLING** HEAD

Diameter of standpipe (d): 50 (mm)
Height of TOP of standpipe above ground level: 0.00 (m) (use -ve values if BELOW g.l.)
Depth to centre of piezo. tip below ground level (m): NA (m)
Depth to top of filter below ground level (m): 3.00 (m)
Depth to bottom of filter below ground level (m): 4.50 (m)
Diameter of filter (D): 196 (mm)
Standing ground water level SWL (mbgl): 0.85 (m) on: 7-Aug-14

DATUM: All depths to water level measured from top of casing.

i.e. SWL 0.85 m below datum.

TIME ELAPSED (mins)	WATER LEVEL* (m)	HEAD H (m)	HEAD RATIO H/Ho
0	0	0.85	1.0000
0.5	0.2	0.65	0.7647
1	0.22	0.63	0.7412
1.5	0.25	0.6	0.7059
2	0.28	0.57	0.6706
2.5	0.315	0.535	0.6294
3	0.33	0.52	0.6118
3.5	0.36	0.49	0.5765
4	0.39	0.46	0.5412
4.5	0.405	0.445	0.5235
5	0.42	0.43	0.5059
6	0.455	0.395	0.4647
7	0.485	0.365	0.4294
8	0.515	0.335	0.3941
9	0.54	0.31	0.3647
10	0.56	0.29	0.3412
12	0.6	0.25	0.2941
14	0.63	0.22	0.2588
16	0.65	0.2	0.2353
20	0.68	0.17	0.2000
25	0.72	0.13	0.1529
30	0.75	0.1	0.1176
35	0.78	0.07	0.0824
40	0.8	0.05	0.0588
45	0.82	0.03	0.0353
50	0.84	0.01	0.0118
55	0.85	0	0.0000

CALCULATION OF PERMEABILITY OF SOIL:

Employing Hvorslev formula: $k = A/FT$

where:

k is the permeability of soil

A is the cross-section area of standpipe

F is the intake factor (see below)

T is the basic time lag factor as defined

in Figure 8 of (2010) BS 5930:1999+A2:2010

Values of intake factors (F/D) for various cylindrical intake zones of length to diameter ratio (L/D) are given in Figures 6&7 of (2010) BS 5930:1999+A2:2010; also Dunn and Razouki formula:

$$F/D = 2.32 \cdot \pi \cdot (L/D) / \log_e[1.1 \cdot (L/D) + \{1 + 1.1 \cdot (L/D)^2\}^{0.5}]$$

$$L/D \text{ ratio} = 7.65 \quad \text{thus } F/D = 19.89$$

$$\text{i.e. } F = 3.90 \text{ (m)}$$

$$\text{and } A = 0.00196 \text{ (m}^2\text{)}$$

$$\text{and } T = 10.23 \text{ mins}$$

(see graph of log H/Ho v Time.)

$$\text{hence, } 8.2\text{E-07 m/s}$$

$$\text{i.e., } k = \underline{8.2 \times 10^{-7}} \text{ m/s}$$

VARIABLE HEAD PERMEABILITY TEST (STANDPIPE PIEZOMETER)

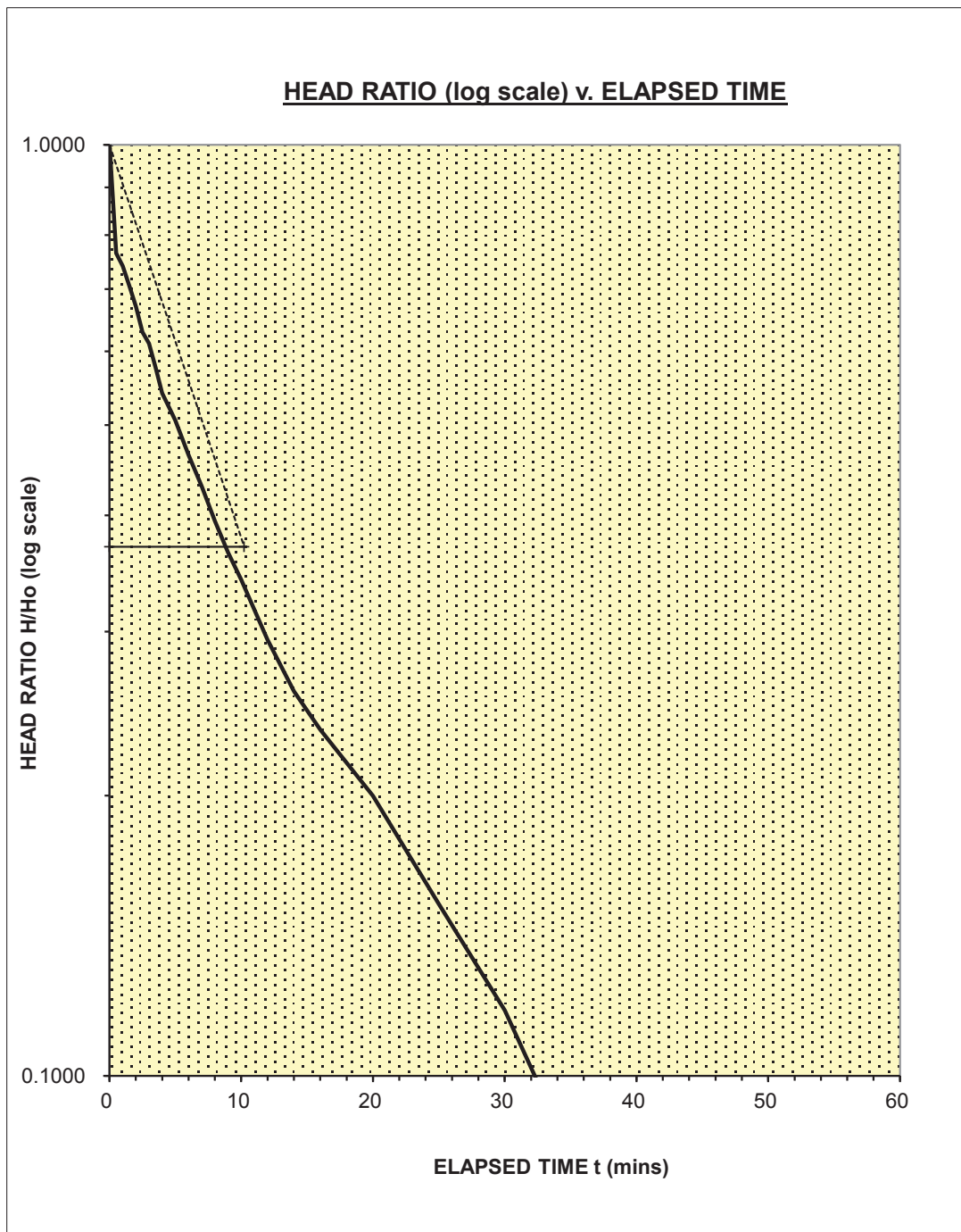
TYPE OF TEST: *FALLING* HEAD

CONTRACT: National Paediatric Hospital Project

BOREHOLE No.: BH103

TEST #: 1

DATE: 7-Aug-14



Basic Time Lag Factor $T =$

10.23 minutes

VARIABLE HEAD PERMEABILITY TEST (STANDPIPE PIEZOMETER)

CONTRACT: National Paediatric Hospital, Dublin BOREHOLE No.: BH103 TEST No.: 1
 DATE: 4-Aug-14

TYPE OF TEST: **FALLING** HEAD

Diameter of standpipe (d): 19 (mm)
 Height of TOP of standpipe above ground level: 0.00 (m) (use -ve values if BELOW g.l.)
 Depth to centre of piezo. tip below ground level (m): 9 (m)
 Depth to top of filter below ground level (m): 8.00 (m)
 Depth to bottom of filter below ground level (m): 9.50 (m)
 Diameter of filter (D): 146 (mm)
 Standing ground water level SWL (mbgl): 0.91 (m) on: 4-Aug-14

DATUM: All depths to water level measured from top of casing.

i.e. SWL 0.91 m below datum.

TIME ELAPSED (mins)	WATER LEVEL* (m)	HEAD H (m)	HEAD RATIO H/Ho
0	0	0.91	1.0000
0.5	0.11	0.8	0.8791
1	0.112	0.798	0.8769
1.5	0.112	0.798	0.8769
2	0.112	0.798	0.8769
2.5	0.112	0.798	0.8769
3	0.112	0.798	0.8769
4	0.112	0.798	0.8769
5	0.112	0.798	0.8769
8	0.113	0.797	0.8758
10	0.114	0.796	0.8747
12	0.115	0.795	0.8736
15	0.117	0.793	0.8714
18	0.118	0.792	0.8703
20	0.119	0.791	0.8692
25	0.12	0.79	0.8681
30	0.122	0.788	0.8659
35	0.122	0.788	0.8659
40	0.123	0.787	0.8648
45	0.123	0.787	0.8648
50	0.124	0.786	0.8637
55	0.125	0.785	0.8626
60	0.125	0.785	0.8626

CALCULATION OF PERMEABILITY OF SOIL:

Employing Hvorslev formula: $k = A/FT$

where:

k is the permeability of soil

A is the cross-section area of standpipe

F is the intake factor (see below)

T is the basic time lag factor as defined

in Figure 8 of (2010) BS 5930:1999+A2:2010

Values of intake factors (F/D) for various cylindrical intake zones of length to diameter ratio (L/D) are given in Figures 6&7 of (2010) BS 5930:1999+A2:2010; also Dunn and Razouki formula:

$$F/D = 2.32 \cdot \pi \cdot (L/D) / \log_e[1.1 \cdot (L/D) + \{1 + 1.1 \cdot (L/D)^2\}^{0.5}]$$

$$L/D \text{ ratio} = 10.27 \quad \text{thus } F/D = 24.18$$

$$\text{i.e. } F = 3.53 \text{ (m)}$$

$$\text{and } A = 0.00028 \text{ (m}^2\text{)}$$

$$\text{and } T = 1266.3 \text{ mins}$$

(see graph of log H/Ho v Time.)

$$\text{hence, } 1.1\text{E-09 m/s}$$

$$\text{i.e., } k = \underline{1.1 \times 10^{-9}} \text{ m/s}$$

VARIABLE HEAD PERMEABILITY TEST (STANDPIPE PIEZOMETER)

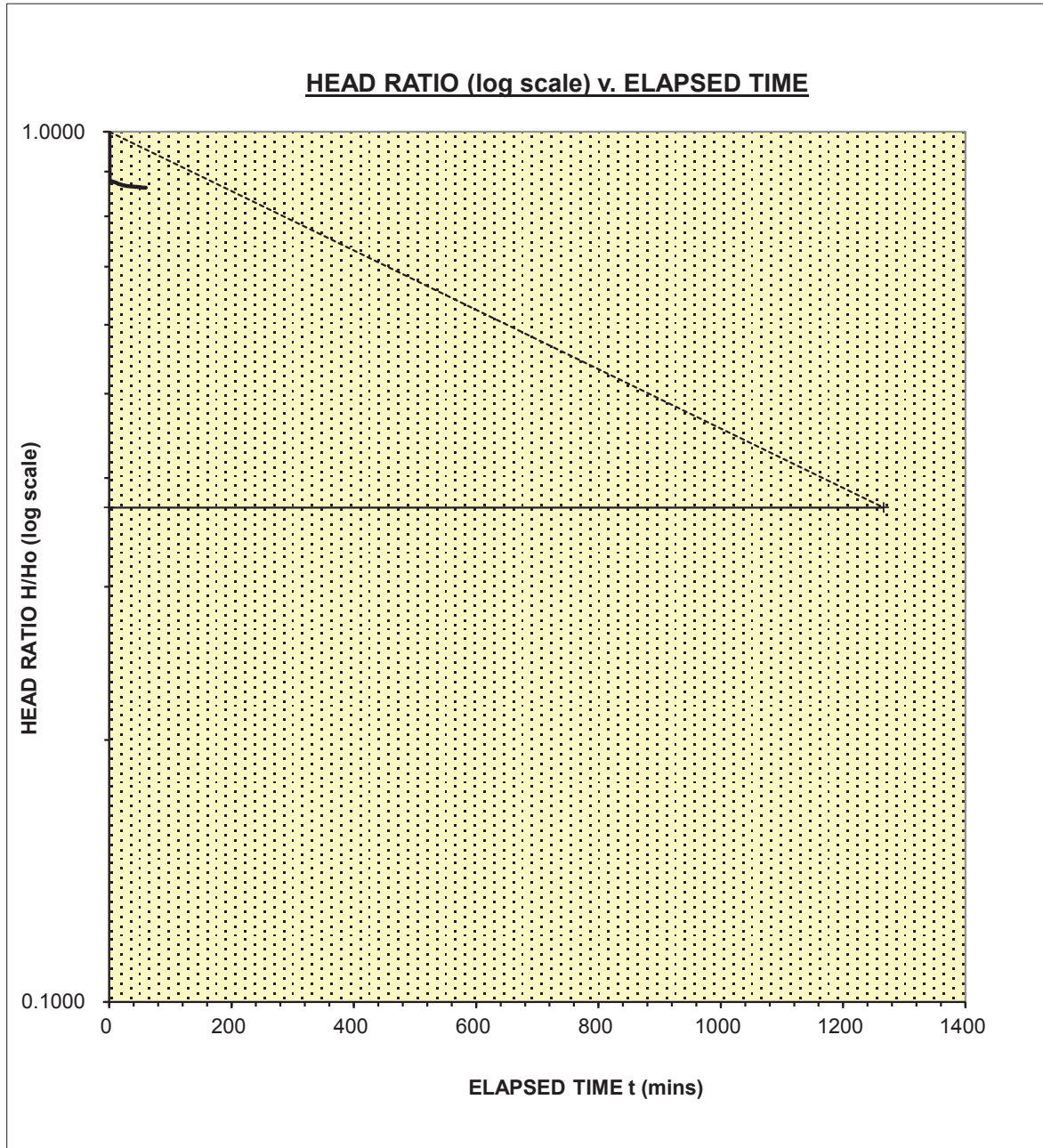
TYPE OF TEST: *FALLING* HEAD

CONTRACT: National Paediatric Hospital Project

BOREHOLE No.: BH103

TEST #: 1

DATE: 4-Aug-14



Basic Time Lag Factor $T =$

1266.3 minutes

VARIABLE HEAD PERMEABILITY TEST (STANDPIPE PIEZOMETER)

CONTRACT St James Hospital, Dublin

BOREHOLE No.: BH212

TEST No.: 1

DATE: 7-May-15

TYPE OF TEST: **FALLING** HEAD

Diameter of standpipe (d): 50 (mm)
 Height of TOP of standpipe above ground level: 0.00 (m) (use -ve values if BELOW g.l.)
 Depth to centre of piezo. tip below ground level (m) NA (m)
 Depth to top of filter below ground level (m): 1.50 (m)
 Depth to bottom of filter below ground level (m): 3.50 (m)
 Diameter of filter (D): 146 (mm)
 Standing ground water level SWL (mbgl): 3.1 (m) on: 7-May-15

DATUM: All depths to water level measured from top of casing.

i.e. SWL 3.10 m below datum.

TIME ELAPSED (mins)	WATER LEVEL* (m)	HEAD H (m)	HEAD RATIO H/Ho
0	0.1	3	1.0000
0.5	0.105	2.995	0.9983
1	0.11	2.99	0.9967
1.5	0.115	2.985	0.9950
2	0.12	2.98	0.9933
2.5	0.125	2.975	0.9917
3	0.13	2.97	0.9900
3.5	0.135	2.965	0.9883
4	0.14	2.96	0.9867
4.5	0.145	2.955	0.9850
5	0.15	2.95	0.9833
10	0.18	2.92	0.9733
15	0.2	2.9	0.9667
20	0.27	2.83	0.9433
140	0.53	2.57	0.8567
300	0.58	2.52	0.8400
960	0.63	2.47	0.8233
1080	0.67	2.43	0.8100
6720	1.04	2.06	0.6867

CALCULATION OF PERMEABILITY OF SOIL:

Employing Hvorslev formula: $k = A/FT$

where:

k is the permeability of soil

A is the cross-section area of standpipe

F is the intake factor (see below)

T is the basic time lag factor as defined

in Figure 8 of (2010) BS 5930:1999+A2:2010

Values of intake factors (F/D) for various cylindrical intake zones of length to diameter ratio (L/D) are given in Figures 6&7 of (2010) BS 5930:1999+A2:2010; also Dunn and Razouki formula:

$$F/D = 2.32 \cdot \pi \cdot (L/D) / \log_e[1.1 \cdot (L/D) + \{1 + 1.1 \cdot (L/D)^2\}^{0.5}]$$

$$L/D \text{ ratio} = 13.70 \quad \text{thus } F/D = 29.51$$

$$\text{i.e. } F = 4.31 \text{ (m)}$$

$$\text{and } A = 0.00196 \text{ (m}^2\text{)}$$

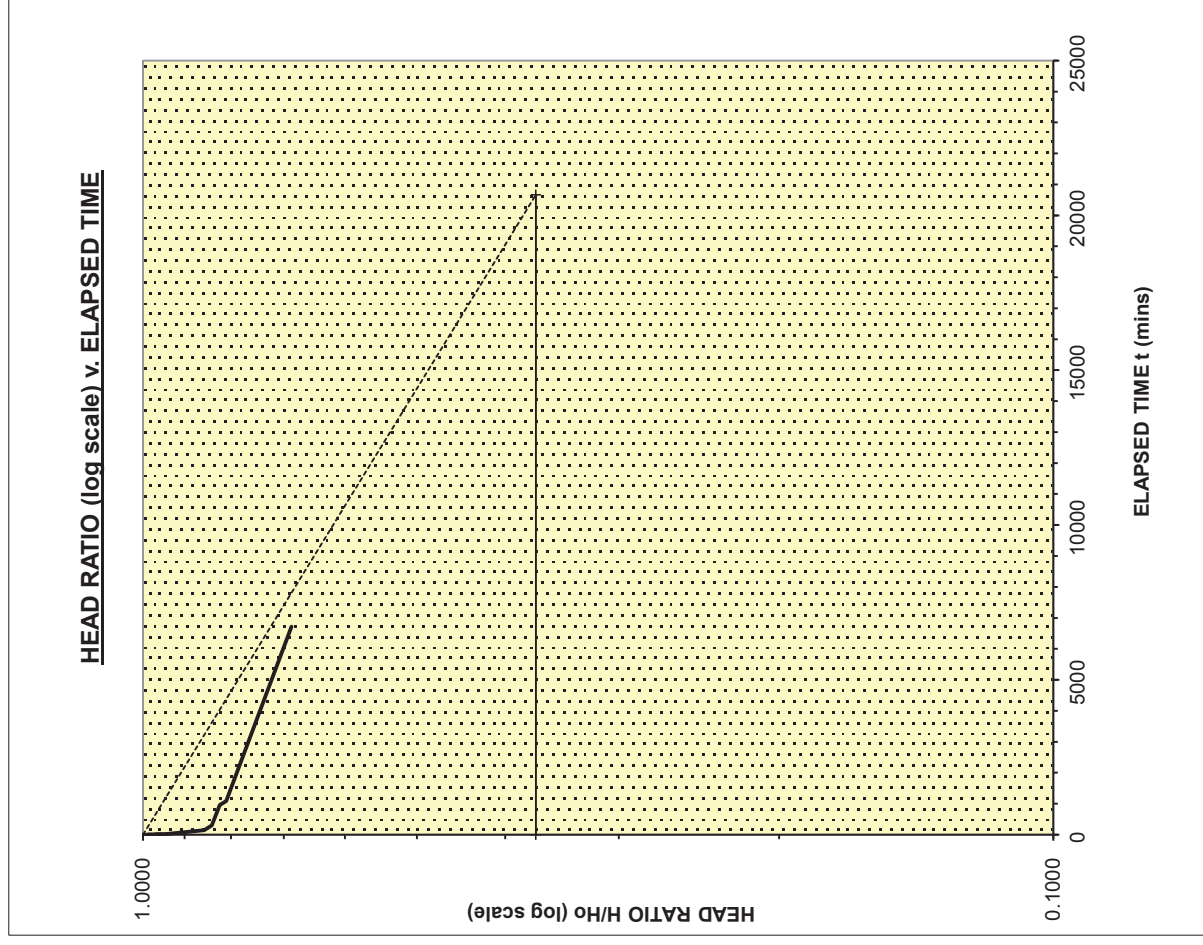
$$\text{and } T = 20665 \text{ mins}$$

(see graph of log H/Ho v Time.)

$$\text{hence, } k = 3.7 \times 10^{-10} \text{ m/s}$$

$$\text{i.e., } k = \underline{3.7 \times 10^{-10}} \text{ m/s}$$

GRAPH



VARIABLE HEAD PERMEABILITY TEST (STANDPIPE PIEZOMETER)

CONTRACT St James Hospital, Dublin

BOREHOLE No.: BH216

TEST No.: 1

DATE: 7-May-15

TYPE OF TEST: **FALLING** HEAD

Diameter of standpipe (d): 50 (mm)
Height of TOP of standpipe above ground level: 0.00 (m) (use -ve values if BELOW g.l.)
Depth to centre of piezo. tip below ground level (m) NA (m)
Depth to top of filter below ground level (m): 5.00 (m)
Depth to bottom of filter below ground level (m): 6.80 (m)
Diameter of filter (D): 146 (mm)
Standing ground water level SWL (mbgl): 1.43 (m) on: 7-May-15

DATUM: All depths to water level measured from top of casing.

i.e. SWL

1.43 m below datum.

TIME ELAPSED (mins)	WATER LEVEL* (m)	HEAD H (m)	HEAD RATIO H/Ho
0	0.38	1.05	1.0000
0.5	0.45	0.98	0.9333
1	0.48	0.95	0.9048
1.5	0.51	0.92	0.8762
2	0.54	0.89	0.8476
2.5	0.56	0.87	0.8286
3	0.58	0.85	0.8095
3.5	0.6	0.83	0.7905
4	0.61	0.82	0.7810
4.5	0.63	0.8	0.7619
5	0.64	0.79	0.7524
6	0.67	0.76	0.7238
7	0.69	0.74	0.7048
8	0.71	0.72	0.6857
9	0.73	0.7	0.6667
10	0.76	0.67	0.6381
15	0.85	0.58	0.5524
20	0.93	0.5	0.4762
30	1.04	0.39	0.3714
45	1.16	0.27	0.2571
60	1.23	0.2	0.1905
300	1.42	0.01	0.0095

CALCULATION OF PERMEABILITY OF SOIL:

Employing Hvorslev formula: $k = A/FT$

where:

k is the permeability of soil

A is the cross-section area of standpipe

F is the intake factor (see below)

T is the basic time lag factor as defined

in Figure 8 of (2010) BS 5930:1999+A2:2010

Values of intake factors (F/D) for various cylindrical intake zones of length to diameter ratio (L/D) are given in Figures 6&7 of (2010) BS 5930:1999+A2:2010; also Dunn and Razouki formula:

$$F/D = 2.32 \cdot \pi \cdot (L/D) / \log_e[1.1 \cdot (L/D) + \{1 + 1.1 \cdot (L/D)^2\}^{0.5}]$$

$$L/D \text{ ratio} = 12.33 \quad \text{thus } F/D = 27.41$$

$$\text{i.e. } F = 4.00 \text{ (m)}$$

$$\text{and } A = 0.00196 \text{ (m}^2\text{)}$$

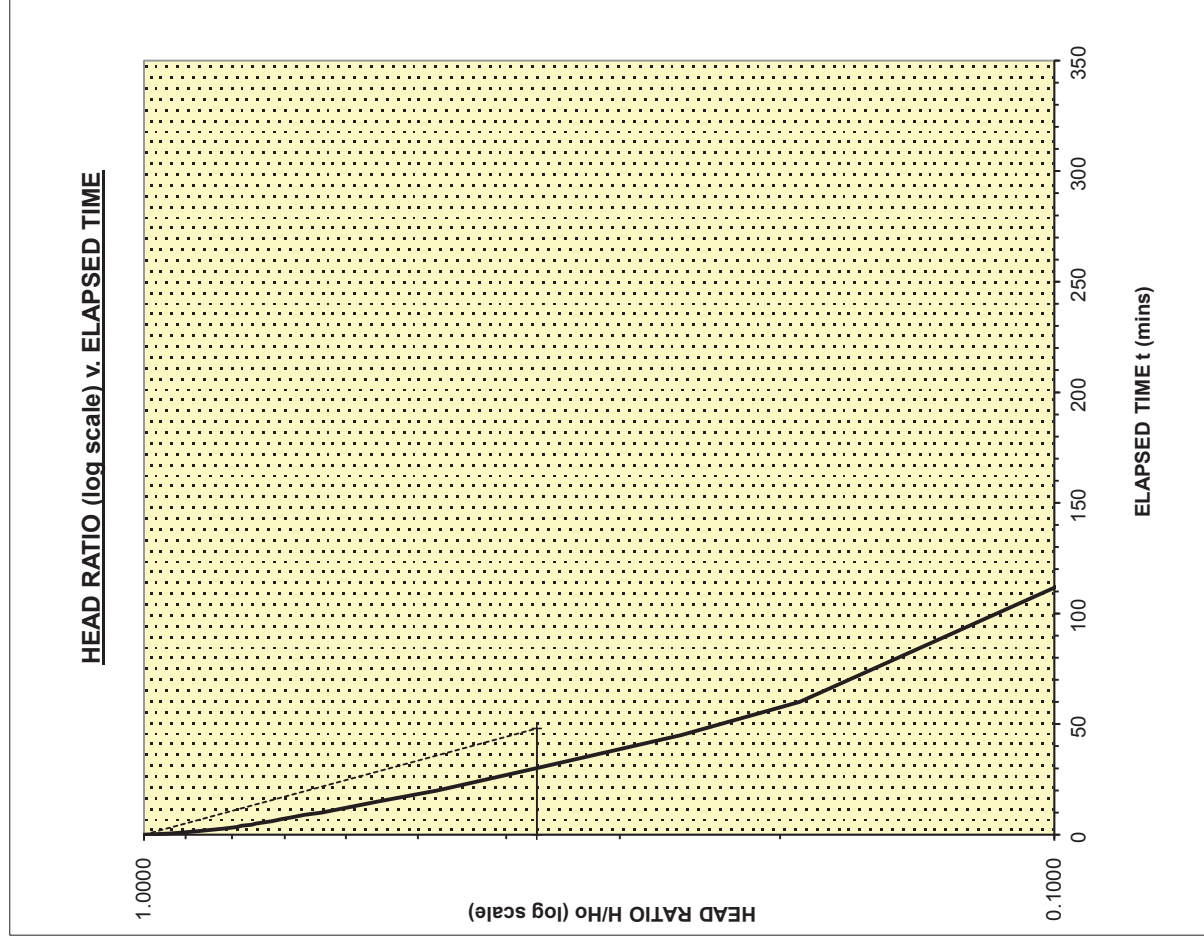
$$\text{and } T = 48 \text{ mins}$$

(see graph of $\log H/H_o$ v Time.)

$$\text{hence, } 1.7\text{E-}07 \text{ m/s}$$

$$\text{i.e., } k = \underline{1.7 \times 10^{-7}} \text{ m/s}$$

GRAPH



VARIABLE HEAD PERMEABILITY TEST (STANDPIPE PIEZOMETER)

CONTRACT St James Hospital, Dublin

BOREHOLE No.: BH216

TEST No.: 1

DATE: 7-May-15

TYPE OF TEST: **Rising** HEAD

Diameter of standpipe (d): 50 (mm)
Height of TOP of standpipe above ground level: 0.00 (m) (use -ve values if BELOW g.l.)
Depth to centre of piezo. tip below ground level (m): NA (m)
Depth to top of filter below ground level (m): 5.00 (m)
Depth to bottom of filter below ground level (m): 6.80 (m)
Diameter of filter (D): 146 (mm)
Standing ground water level SWL (mbgl): 1.43 (m) on: 7-May-15

DATUM: All depths to water level measured from top of casing.

i.e. SWL 1.43 m below datum.

TIME ELAPSED (mins)	WATER LEVEL* (m)	HEAD H (m)	HEAD RATIO H/Ho
0	2.47	1.04	1.0000
0.5	2.44	1.01	0.9712
1	2.41	0.98	0.9423
1.5	2.39	0.96	0.9231
2	2.37	0.94	0.9038
2.5	2.35	0.92	0.8846
3	2.34	0.91	0.8750
3.5	2.33	0.9	0.8654
4	2.31	0.88	0.8462
4.5	2.29	0.86	0.8269
5	2.28	0.85	0.8173
6	2.24	0.81	0.7788
7	2.21	0.78	0.7500
8	2.19	0.76	0.7308
9	2.16	0.73	0.7019
10	2.14	0.71	0.6827
15	2.02	0.59	0.5673
20	1.95	0.52	0.5000
30	1.81	0.38	0.3654
120	1.46	0.03	0.0288

CALCULATION OF PERMEABILITY OF SOIL:

Employing Hvorslev formula: $k = A/FT$

where:

k is the permeability of soil

A is the cross-section area of standpipe

F is the intake factor (see below)

T is the basic time lag factor as defined

in Figure 8 of (2010) BS 5930:1999+A2:2010

Values of intake factors (F/D) for various cylindrical intake zones of length to diameter ratio (L/D) are given in Figures 6&7 of (2010) BS 5930:1999+A2:2010; also Dunn and Razouki formula:

$$F/D = 2.32 \cdot \pi \cdot (L/D) / \log_e[1.1 \cdot (L/D) + \{1 + 1.1 \cdot (L/D)^2\}^{0.5}]$$

L/D ratio = 12.33 thus F/D = 27.41

i.e. F = 4.00 (m)

and A = 0.00196 (m²)

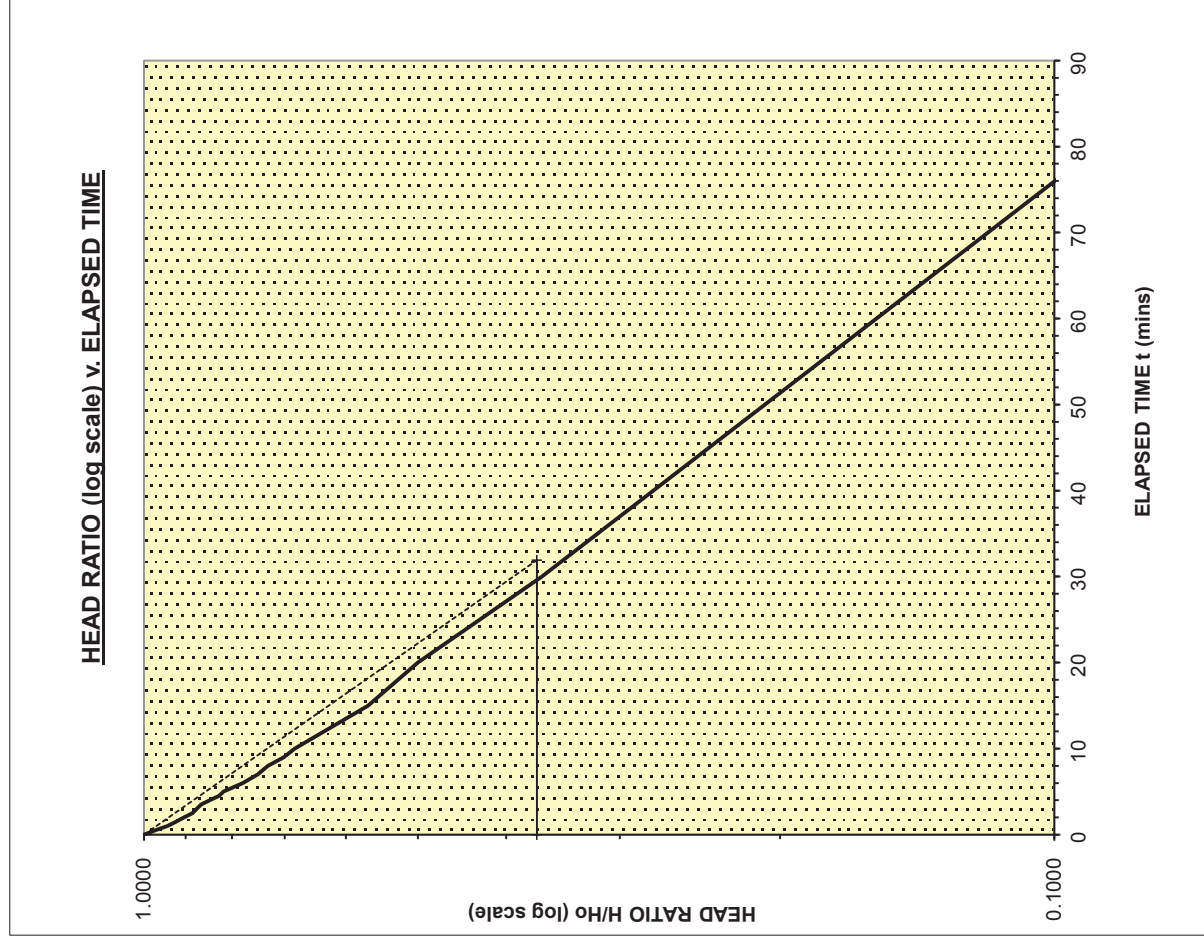
and T = 32 mins

(see graph of log H/Ho v Time.)

hence, **2.6E-07 m/s**

i.e., $k = \underline{2.6 \times 10^{-7}} \text{ m/s}$

GRAPH



VARIABLE HEAD PERMEABILITY TEST (STANDPIPE PIEZOMETER)

CONTRACT St James Hospital, Dublin

BOREHOLE No.: BH217

TEST No.: 1

DATE: 6-May-15

TYPE OF TEST: **FALLING** HEAD

Diameter of standpipe (d): 50 (mm)
 Height of TOP of standpipe above ground level: 0.00 (m) (use -ve values if BELOW g.l.)
 Depth to centre of piezo. tip below ground level (m) NA (m)
 Depth to top of filter below ground level (m): 5.50 (m)
 Depth to bottom of filter below ground level (m): 6.50 (m)
 Diameter of filter (D): 146 (mm)
 Standing ground water level SWL (mbgl): 1.74 (m) on: 6-May-15

DATUM: All depths to water level measured from top of casing.

i.e. SWL 1.74 m below datum.

TIME ELAPSED (mins)	WATER LEVEL* (m)	HEAD H (m)	HEAD RATIO H/Ho
0	0.73	1.01	1.0000
0.5	0.75	0.99	0.9802
1	0.75	0.99	0.9802
1.5	0.75	0.99	0.9802
2	0.75	0.99	0.9802
2.5	0.75	0.99	0.9802
3	0.75	0.99	0.9802
3.5	0.76	0.98	0.9703
4	0.76	0.98	0.9703
4.5	0.76	0.98	0.9703
5	0.76	0.98	0.9703
6	0.77	0.97	0.9604
7	0.77	0.97	0.9604
8	0.77	0.97	0.9604
9	0.78	0.96	0.9505
10	0.78	0.96	0.9505
15	0.79	0.95	0.9406
20	0.8	0.94	0.9307
30	0.81	0.93	0.9208
60	0.86	0.88	0.8713
510	1.1	0.64	0.6337
840	1.22	0.52	0.5149
990	1.23	0.51	0.5050

CALCULATION OF PERMEABILITY OF SOIL:

Employing Hvorslev formula: $k = A/FT$

where:

k is the permeability of soil

A is the cross-section area of standpipe

F is the intake factor (see below)

T is the basic time lag factor as defined

in Figure 8 of (2010) BS 5930:1999+A2:2010

Values of intake factors (F/D) for various cylindrical intake zones of length to diameter ratio (L/D) are given in Figures 6&7 of (2010) BS 5930:1999+A2:2010; also Dunn and Razouki formula:

$$F/D = 2.32 \cdot \pi \cdot (L/D) / \log_e[1.1 \cdot (L/D) + \{1 + 1.1 \cdot (L/D)^2\}^{0.5}]$$

$$L/D \text{ ratio} = 6.85 \quad \text{thus } F/D = 18.53$$

$$\text{i.e. } F = 2.71 \text{ (m)}$$

$$\text{and } A = 0.00196 \text{ (m}^2\text{)}$$

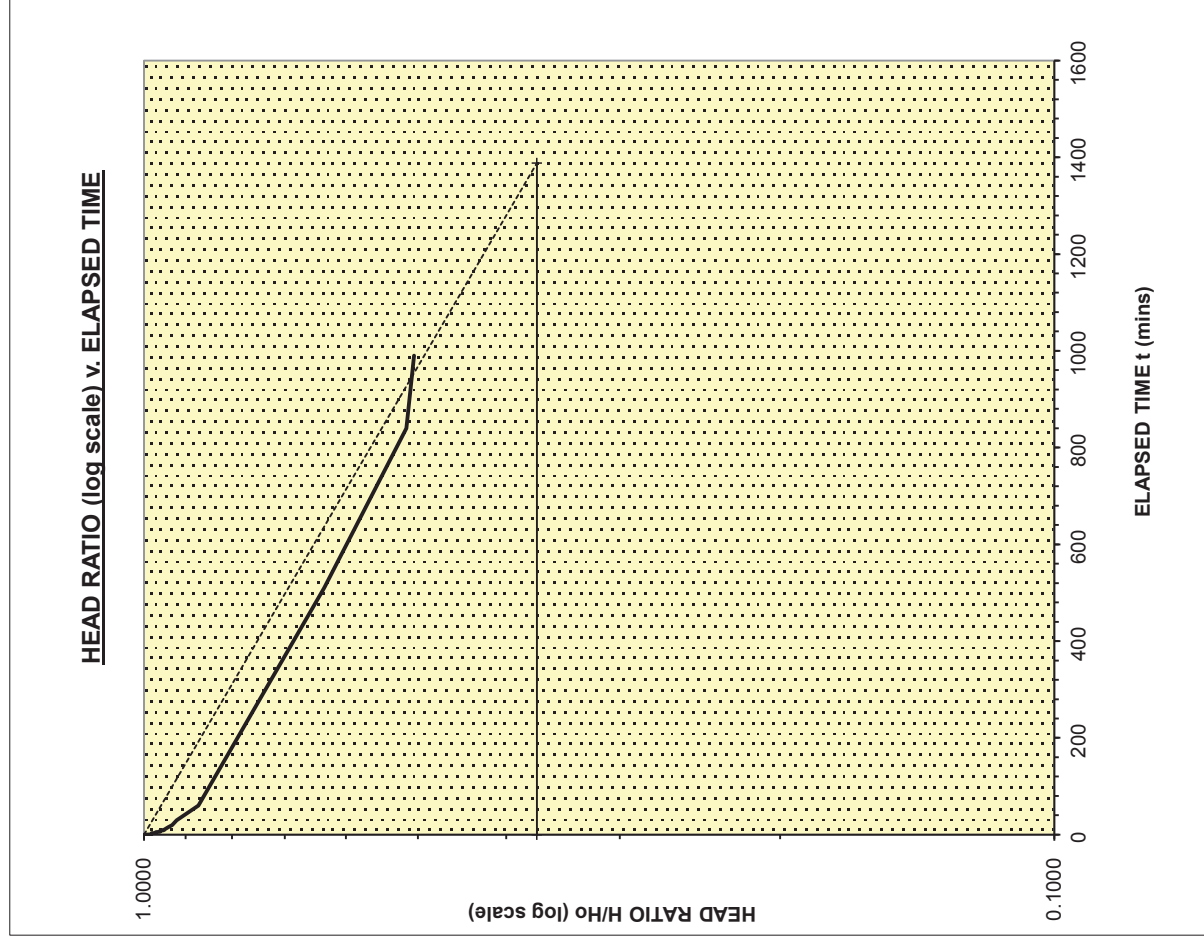
$$\text{and } T = 1388 \text{ mins}$$

(see graph of log H/Ho v Time.)

$$\text{hence, } 8.7\text{E-09 m/s}$$

$$\text{i.e., } k = \underline{8.7 \times 10^{-9}} \text{ m/s}$$

GRAPH



VARIABLE HEAD PERMEABILITY TEST (STANDPIPE PIEZOMETER)

CONTRACT St James Hospital, Dublin

BOREHOLE No.: BH217

TEST No.: 1

DATE: 7-May-15

TYPE OF TEST: **Rising** HEAD

Diameter of standpipe (d): 50 (mm)
Height of TOP of standpipe above ground level: 0.00 (m) (use -ve values if BELOW g.l.)
Depth to centre of piezo. tip below ground level (m): NA (m)
Depth to top of filter below ground level (m): 5.50 (m)
Depth to bottom of filter below ground level (m): 6.50 (m)
Diameter of filter (D): 146 (mm)
Standing ground water level SWL (mbgl): 1.23 (m) on: 7-May-15

DATUM: All depths to water level measured from top of casing.

i.e. SWL 1.23 m below datum.

TIME ELAPSED (mins)	WATER LEVEL* (m)	HEAD H (m)	HEAD RATIO H/Ho
0	2.24	1.01	1.0000
0.5	2.24	1.01	1.0000
1	2.24	1.01	1.0000
1.5	2.24	1.01	1.0000
2	2.24	1.01	1.0000
1.5	2.24	1.01	1.0000
3	2.24	1.01	1.0000
3.5	2.24	1.01	1.0000
45	2.06	0.83	0.8218
90	1.93	0.7	0.6931
180	1.71	0.48	0.4752
300	1.54	0.31	0.3069

CALCULATION OF PERMEABILITY OF SOIL:

Employing Hvorslev formula: $k = A/FT$

where:

k is the permeability of soil

A is the cross-section area of standpipe

F is the intake factor (see below)

T is the basic time lag factor as defined

in Figure 8 of (2010) BS 5930:1999+A2:2010

Values of intake factors (F/D) for various cylindrical intake zones of length to diameter ratio (L/D) are given in Figures 6&7 of (2010) BS 5930:1999+A2:2010; also Dunn and Razouki formula:

$$F/D = 2.32 \cdot \pi \cdot (L/D) / \log_e[1.1 \cdot (L/D) + \{1 + 1.1 \cdot (L/D)^2\}^{0.5}]$$

$$L/D \text{ ratio} = 6.85 \quad \text{thus } F/D = 18.53$$

$$\text{i.e. } F = 2.71 \text{ (m)}$$

$$\text{and } A = 0.00196 \text{ (m}^2\text{)}$$

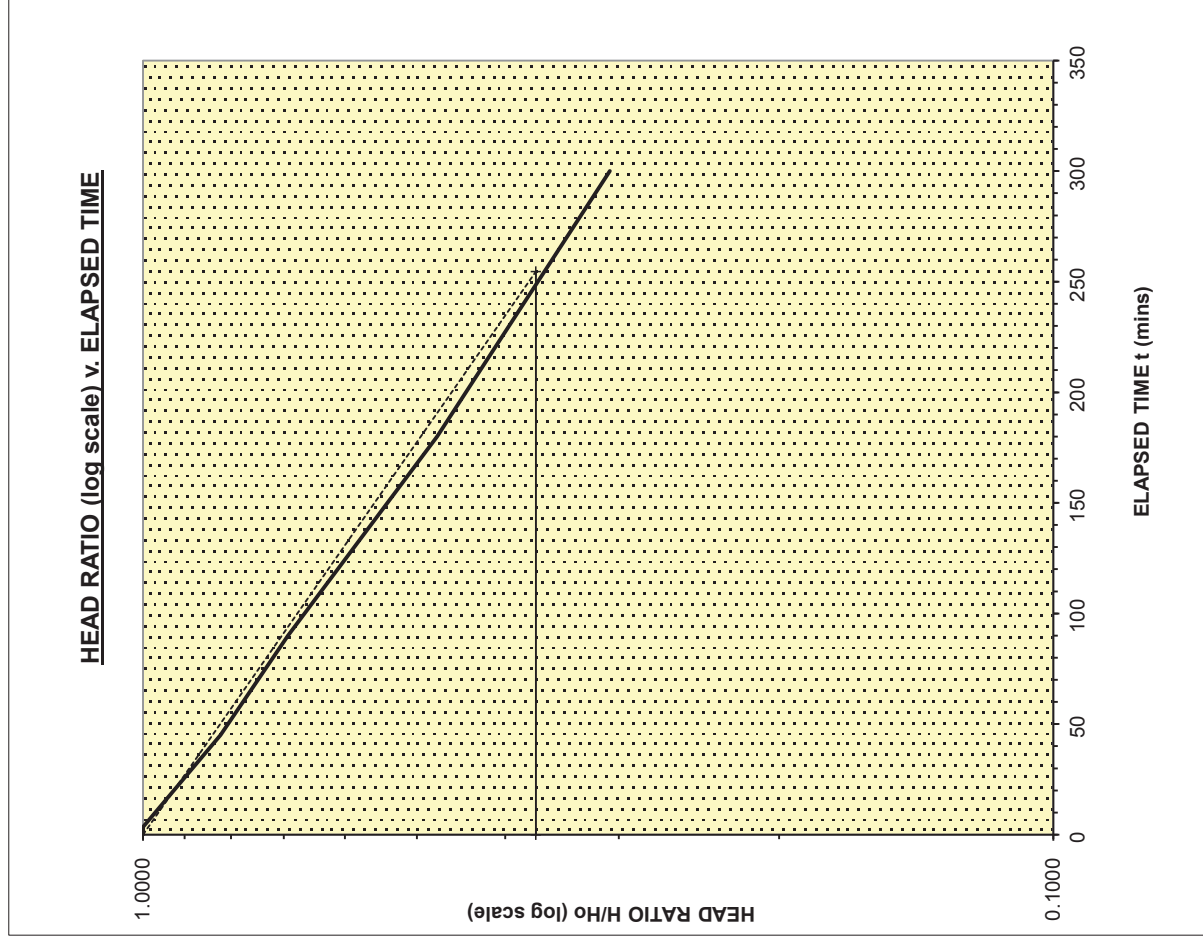
$$\text{and } T = 255 \text{ mins}$$

(see graph of log H/Ho v Time.)

$$\text{hence, } 4.7\text{E-08} \text{ m/s}$$

$$\text{i.e., } k = \underline{4.7 \times 10^{-8}} \text{ m/s}$$

GRAPH



VARIABLE HEAD PERMEABILITY TEST (STANDPIPE PIEZOMETER)

CONTRACT St James Hospital, Dublin

BOREHOLE No.: BH218

TEST No.: 1

DATE: 8-May-15

TYPE OF TEST: **FALLING** HEAD

Diameter of standpipe (d): 50 (mm)
Height of TOP of standpipe above ground level: 0.00 (m) (use -ve values if BELOW g.l.)
Depth to centre of piezo. tip below ground level (m): NA (m)
Depth to top of filter below ground level (m): 6.00 (m)
Depth to bottom of filter below ground level (m): 7.50 (m)
Diameter of filter (D): 146 (mm)
Standing ground water level SWL (mbgl): 5.45 (m) on: 8-May-15

DATUM: All depths to water level measured from top of casing.

i.e. SWL

5.45 m below datum.

TIME ELAPSED (mins)	WATER LEVEL* (m)	HEAD H (m)	HEAD RATIO H/Ho
0	0.1	5.35	1.0000
0.5	0.1	5.35	1.0000
1	0.1	5.35	1.0000
1.5	0.1	5.35	1.0000
2	0.1	5.35	1.0000
3	0.1	5.35	1.0000
4	0.1	5.35	1.0000
5	0.1	5.35	1.0000
5820	0.85	4.6	0.8598

Datalogger malfunctioned during test

CALCULATION OF PERMEABILITY OF SOIL:

Employing Hvorslev formula: $k = A/FT$

where:

k is the permeability of soil

A is the cross-section area of standpipe

F is the intake factor (see below)

T is the basic time lag factor as defined

in Figure 8 of (2010) BS 5930:1999+A2:2010

Values of intake factors (F/D) for various cylindrical intake zones of length to diameter ratio (L/D) are given in Figures 6&7 of (2010) BS 5930:1999+A2:2010; also Dunn and Razouki formula:

$$F/D = 2.32 \cdot \pi \cdot (L/D) / \log_e[1.1 \cdot (L/D) + \{1 + 1.1 \cdot (L/D)^2\}^{0.5}]$$

$$L/D \text{ ratio} = 10.27 \quad \text{thus } F/D = 24.18$$

$$\text{i.e. } F = 3.53 \text{ (m)}$$

$$\text{and } A = 0.00196 \text{ (m}^2\text{)}$$

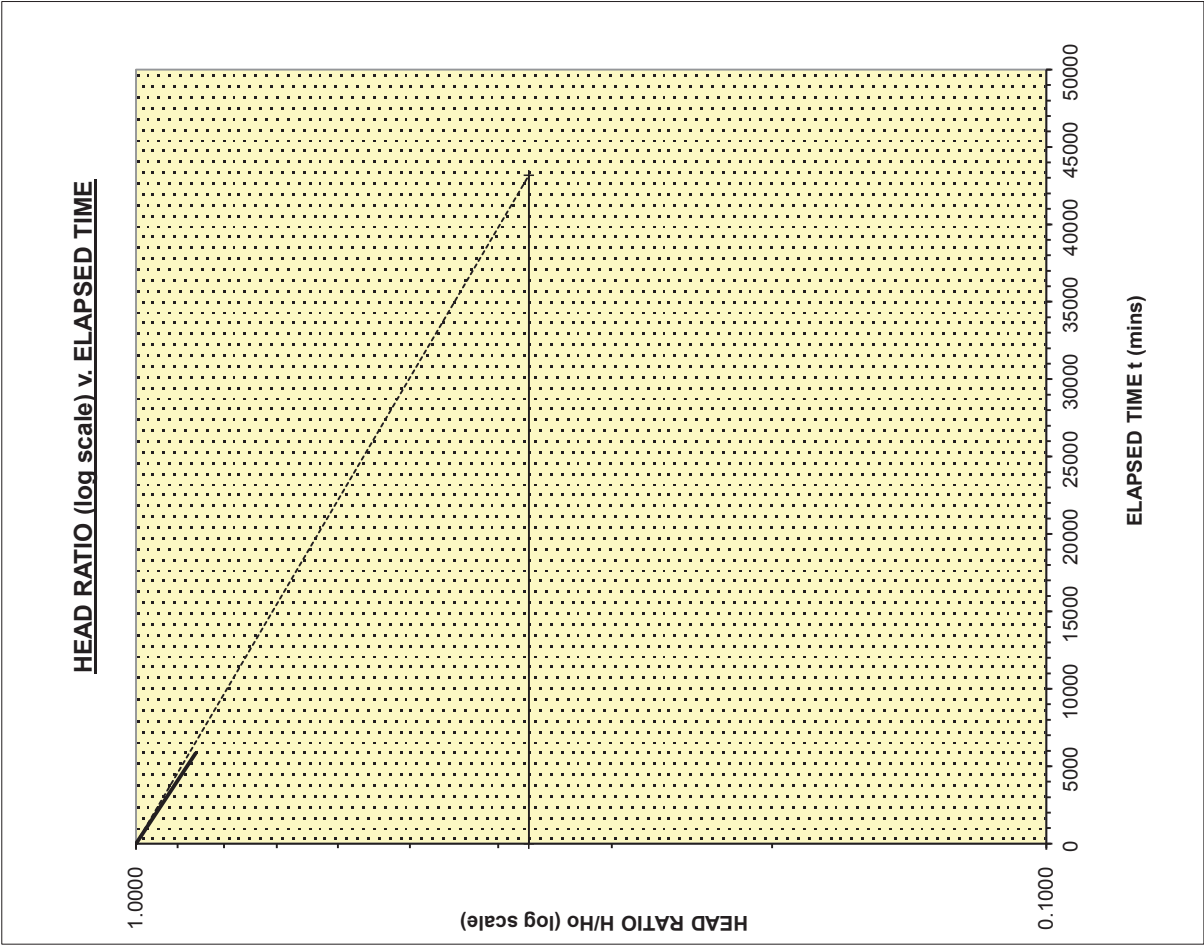
$$\text{and } T = 43182 \text{ mins}$$

(see graph of log H/Ho v Time.)

$$\text{hence, } 2.1\text{E-}10 \text{ m/s}$$

$$\text{i.e., } k = \underline{2.1 \times 10^{-10}} \text{ m/s}$$

*Estimated from graph;
not enough datapoints to
be reliable k value*



VARIABLE HEAD PERMEABILITY TEST (STANDPIPE PIEZOMETER)

CONTRACT St James Hospital, Dublin

BOREHOLE No.: BH225

TEST No.: 1

DATE: 7-May-15

TYPE OF TEST: **FALLING** HEAD

Diameter of standpipe (d): 50 (mm)
Height of TOP of standpipe above ground level: 0.00 (m) (use -ve values if BELOW g.l.)
Depth to centre of piezo. tip below ground level (m): NA (m)
Depth to top of filter below ground level (m): 8.00 (m)
Depth to bottom of filter below ground level (m): 10.50 (m)
Diameter of filter (D): 146 (mm)
Standing ground water level SWL (mbgl): 10.44 (m) on: 7-May-15

DATUM: All depths to water level measured from top of casing.

i.e. SWL 10.44 m below datum.

TIME ELAPSED (mins)	WATER LEVEL* (m)	HEAD H (m)	HEAD RATIO H/Ho
0	2.8	7.64	1.0000
0.5	3.2	7.24	0.9476
1	6	4.44	0.5812
1.5	7.3	3.14	0.4110
2	8.15	2.29	0.2997
2.5	8.75	1.69	0.2212
3	9.17	1.27	0.1662
3.5	9.55	0.89	0.1165
4	9.85	0.59	0.0772
4.5	10.02	0.42	0.0550
5	10.15	0.29	0.0380
6	10.24	0.2	0.0262
7	10.3	0.14	0.0183
8	10.32	0.12	0.0157
9	10.34	0.1	0.0131
10	10.35	0.09	0.0118
15	10.36	0.08	0.0105
20	10.36	0.08	0.0105
25	10.36	0.08	0.0105

CALCULATION OF PERMEABILITY OF SOIL:

Employing Hvorslev formula: $k = A/FT$

where:

k is the permeability of soil

A is the cross-section area of standpipe

F is the intake factor (see below)

T is the basic time lag factor as defined

in Figure 8 of (2010) BS 5930:1999+A2:2010

Values of intake factors (F/D) for various cylindrical intake zones of length to diameter ratio (L/D) are given in Figures 6&7 of (2010) BS 5930:1999+A2:2010; also Dunn and Razouki formula:

$$F/D = 2.32 \cdot \pi \cdot (L/D) / \log_e[1.1 \cdot (L/D) + \{1 + 1.1 \cdot (L/D)^2\}^{0.5}]$$

$$L/D \text{ ratio} = 17.12 \quad \text{thus } F/D = 34.61$$

$$\text{i.e. } F = 5.05 \text{ (m)}$$

$$\text{and } A = 0.00196 \text{ (m}^2\text{)}$$

$$\text{and } T = 0.85 \text{ mins}$$

(see graph of log H/Ho v Time.)

$$\text{hence, } 7.6E-06 \text{ m/s}$$

$$\text{i.e., } k = \underline{7.6 \times 10^{-6}} \text{ m/s}$$

VARIABLE HEAD PERMEABILITY TEST (STANDPIPE PIEZOMETER)

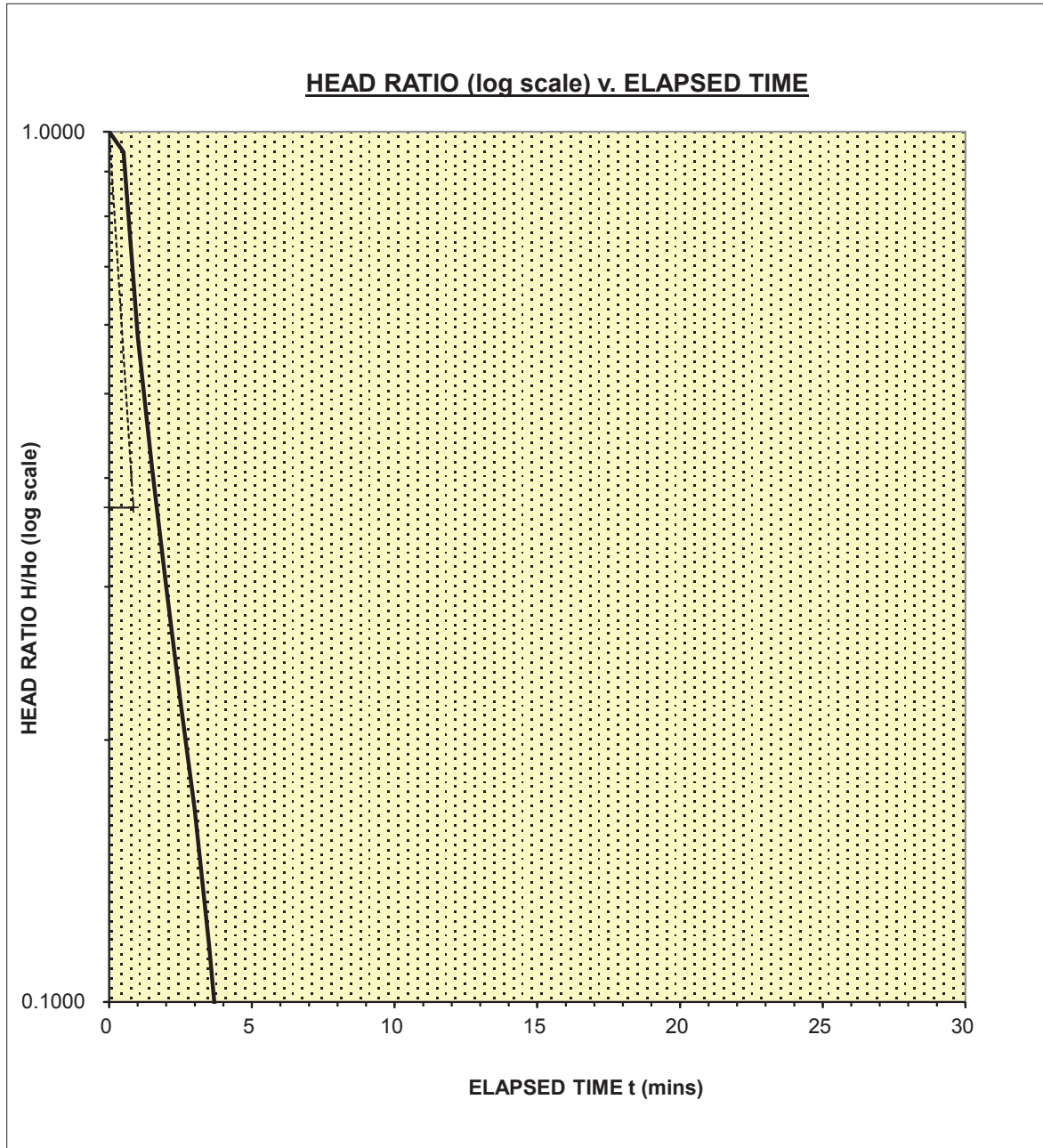
TYPE OF TEST: *FALLING* HEAD

CONTRACT: St James Hospital, Dublin

BOREHOLE No.: BH225

TEST #: 1

DATE: 7-May-15



Basic Time Lag Factor $T =$

1 minutes

VARIABLE HEAD PERMEABILITY TEST (STANDPIPE PIEZOMETER)

CONTRACT St James Hospital, Dublin

BOREHOLE No.: BH225

TEST No.: 2

DATE: 7-May-15

TYPE OF TEST: **FALLING** HEAD

Diameter of standpipe (d): 50 (mm)
Height of TOP of standpipe above ground level: 0.00 (m) (use -ve values if BELOW g.l.)
Depth to centre of piezo. tip below ground level (m): NA (m)
Depth to top of filter below ground level (m): 8.00 (m)
Depth to bottom of filter below ground level (m): 10.50 (m)
Diameter of filter (D): 146 (mm)
Standing ground water level SWL (mbgl): 10.36 (m) on: 7-May-15

DATUM: All depths to water level measured from top of casing.

i.e. SWL 10.36 m below datum.

TIME ELAPSED (mins)	WATER LEVEL* (m)	HEAD H (m)	HEAD RATIO H/Ho
0	0.5	9.86	1.0000
0.5	1.4	8.96	0.9087
1	3.5	6.86	0.6957
1.5	5.5	4.86	0.4929
2	6.27	4.09	0.4148
3	7.82	2.54	0.2576
3.5	8.38	1.98	0.2008
4	8.9	1.46	0.1481
4.5	9.33	1.03	0.1045
5	9.57	0.79	0.0801
6	10.05	0.31	0.0314
7	10.25	0.11	0.0112
8	10.28	0.08	0.0081
9	10.31	0.05	0.0051
10	10.32	0.04	0.0041
15	10.36	0	0.0000
20	10.36	0	0.0000

CALCULATION OF PERMEABILITY OF SOIL:

Employing Hvorslev formula: $k = A/FT$

where:

k is the permeability of soil

A is the cross-section area of standpipe

F is the intake factor (see below)

T is the basic time lag factor as defined

in Figure 8 of (2010) BS 5930:1999+A2:2010

Values of intake factors (F/D) for various cylindrical intake zones of length to diameter ratio (L/D) are given in Figures 6&7 of (2010) BS 5930:1999+A2:2010; also Dunn and Razouki formula:

$$F/D = 2.32 \cdot \pi \cdot (L/D) / \log_e[1.1 \cdot (L/D) + \{1 + 1.1 \cdot (L/D)^2\}^{0.5}]$$

$$L/D \text{ ratio} = 17.12 \quad \text{thus } F/D = 34.61$$

$$\text{i.e. } F = 5.05 \text{ (m)}$$

$$\text{and } A = 0.00196 \text{ (m}^2\text{)}$$

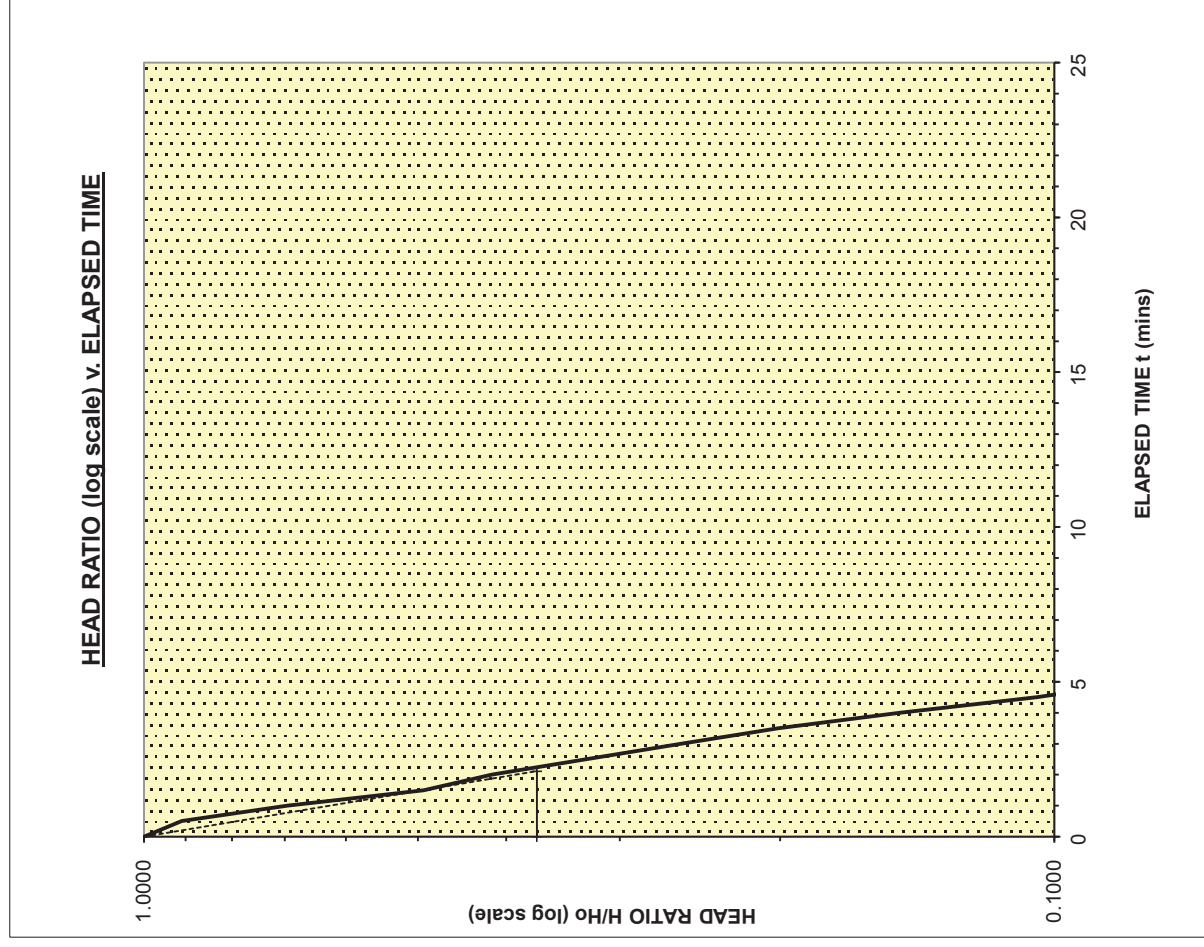
$$\text{and } T = 2 \text{ mins}$$

(see graph of log H/Ho v Time.)

$$\text{hence, } 3.1\text{E-06} \text{ m/s}$$

$$\text{i.e., } k = \underline{3.1 \times 10^{-6}} \text{ m/s}$$

GRAPH



Date	28-May-15		
Client	CW	Sample Height mm	100
Test	Constant Head	Sample Diameter mm	101
	Permeability		
Site	St James Hospital	Sample Volume cm ³	801
Sample Reference	BH222	Initial Wet Mass g	1917
Area/Cell	NA	Final Wet Mass g	1965
S.no	NA	Dry Mass g	1780
Sampling Method	Core	Bulk Density Mg/m ³	2394
Depth m	15.5	Dry Density Mg/m ³	2223
		Initial Water Content %	7.7
		Final Water Content %	10.4

Soil type Grey Gravelly sandy silty CLAY

Saturation Stage

Initial B Value	<0.5
Back Pore Water Pressure During Saturation kPa	500
Cell Pressure kPa	520
Final B Value	0.95
Duration days	6

Consolidation Stage

Cell pressure kPa	550
Back Pore Water Pressure kPa	500
Duration of Consolidation days	1

Permeability Stage

Temperature C°	20
Cell Pressure kPa	550
Pore Water Pressure (Top) kPa	500
Pore Water Pressure (Bottom) kPa	520
Average Effective Stress kPa	40
Head Difference kPa	20
Head Loss kPa	2
Net Head difference m	1.83
Sample Height m	0.100
Hydraulic Gradient i	18.43
Flow Rate cm ³ /min	0.0021
Area of the Sample cm ²	79.4
Permeability m/s	2.4E-10
Duration of permeability stage days	5

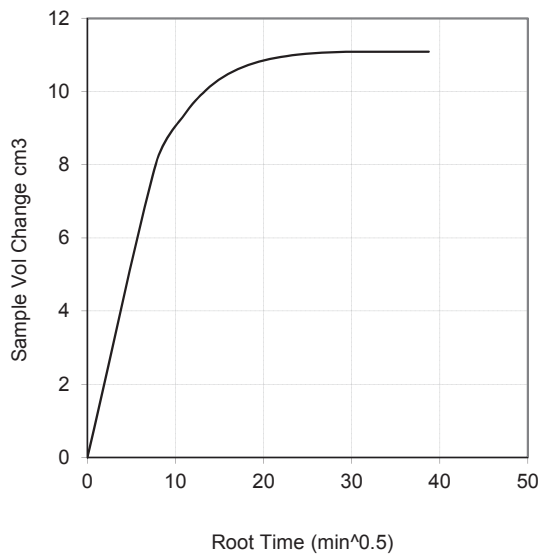


Figure 1 Volume change vs root time

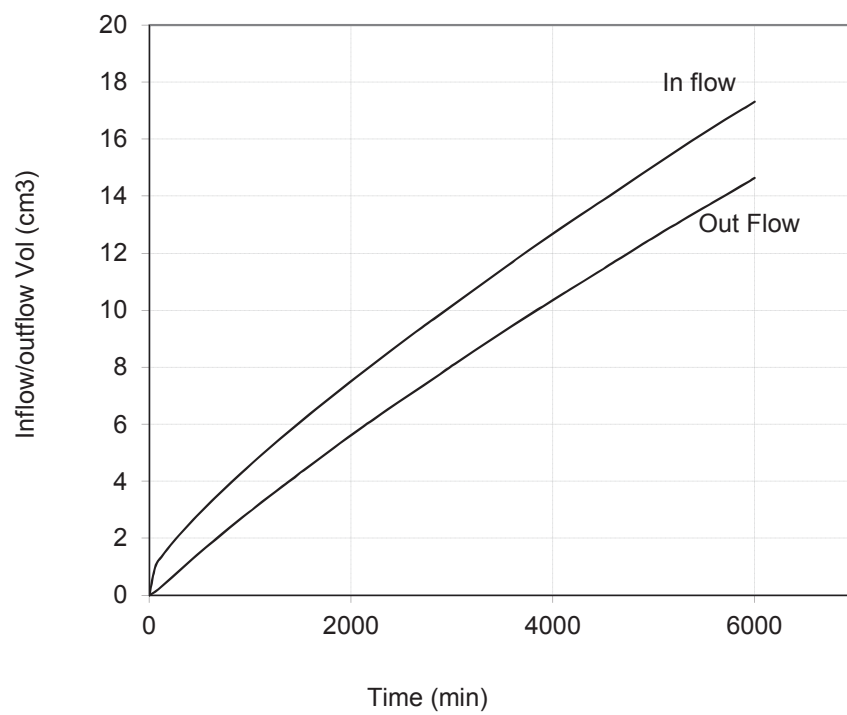


Figure 2 In Flow and out flow against time

Date	28-May-15		
Client	CW	Sample Height mm	100
Test	Constant Head	Sample Diameter mm	101
	Permeability		
Site	St James Hospital	Sample Volume cm ³	801
Sample Reference	BH223A	Initial Wet Mass g	2030
Area/Cell	NA	Final Wet Mass g	2035
S.no	NA	Dry Mass g	1873
Sampling Method	Core	Bulk Density Mg/m ³	2535
Depth m	5.5	Dry Density Mg/m ³	2339
		Initial Water Content %	8.4
		Final Water Content %	8.6

Soil type Grey Gravelly sandy silty CLAY

Saturation Stage

Initial B Value	<0.5
Back Pore Water Pressure During Saturation kPa	500
Cell Pressure kPa	520
Final B Value	0.95
Duration days	6

Consolidation Stage

Cell pressure kPa	553
Back Pore Water Pressure kPa	500
Duration of Consolidation days	1

Permeability Stage

Temperature C°	20
Cell Pressure kPa	553
Pore Water Pressure (Top) kPa	500
Pore Water Pressure (Bottom) kPa	520
Average Effective Stress kPa	43
Head Difference kPa	20
Head Loss kPa	2
Net Head difference m	1.83
Sample Height m	0.100
Hydraulic Gradient i	18.37
Flow Rate cm ³ /min	0.00044
Area of the Sample cm ²	79.9
Permeability m/s	5.0E-11
Duration of permeability stage days	5

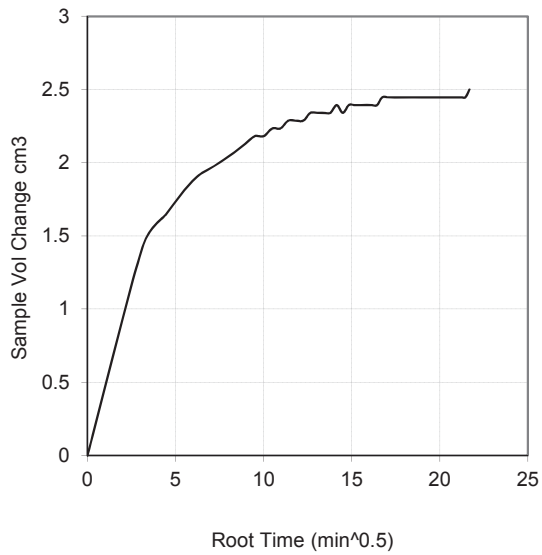


Figure 1 Volume change vs root time

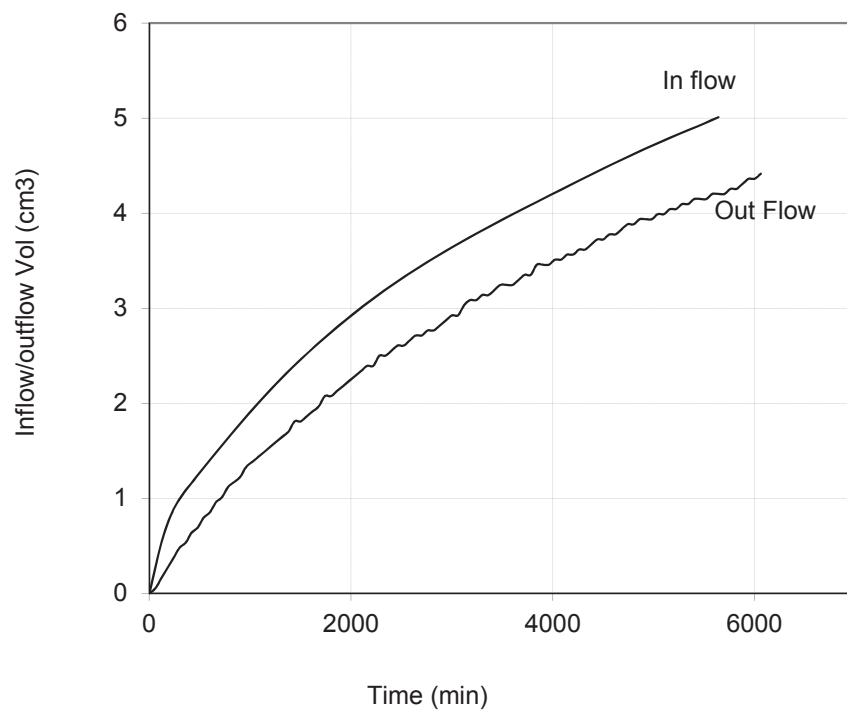


Figure 2 In Flow and out flow against time

Date	28-May-15		
Client	CW	Sample Height mm	100
Test	Constant Head	Sample Diameter mm	101
	Permeability		
Site	St James Hospital	Sample Volume cm ³	801
Sample Reference	BH223A	Initial Wet Mass g	2069
Area/Cell	NA	Final Wet Mass g	2073
S.no	NA	Dry Mass g	1950
Sampling Method	Core	Bulk Density Mg/m ³	2584
Depth m	8	Dry Density Mg/m ³	2435
		Initial Water Content %	6.1
		Final Water Content %	6.3

Soil type Grey Gravelly sandy silty CLAY

Saturation Stage

Initial B Value	<0.5
Back Pore Water Pressure During Saturation kPa	500
Cell Pressure kPa	520
Final B Value	0.95
Duration days	6

Consolidation Stage

Cell pressure kPa	550
Back Pore Water Pressure kPa	500
Duration of Consolidation days	1

Permeability Stage

Temperature C°	20
Cell Pressure kPa	550
Pore Water Pressure (Top) kPa	500
Pore Water Pressure (Bottom) kPa	520
Average Effective Stress kPa	40
Head Difference kPa	20
Head Loss kPa	2
Net Head difference m	1.83
Sample Height m	0.100
Hydraulic Gradient i	18.43
Flow Rate cm ³ /min	0.0036
Area of the Sample cm ²	79.4
Permeability m/s	4.1E-10
Duration of permeability stage days	5

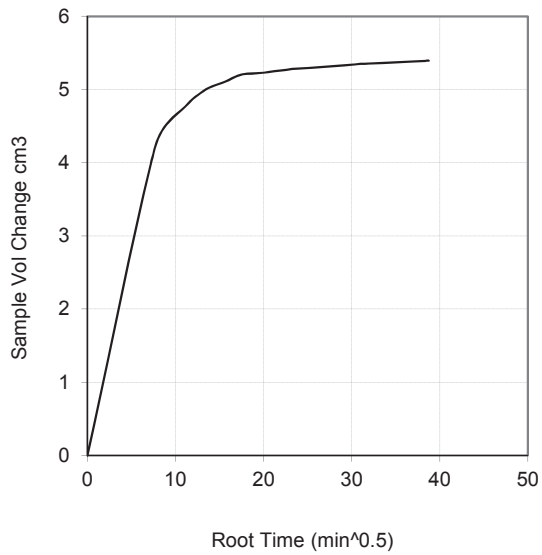


Figure 1 Volume change vs root time

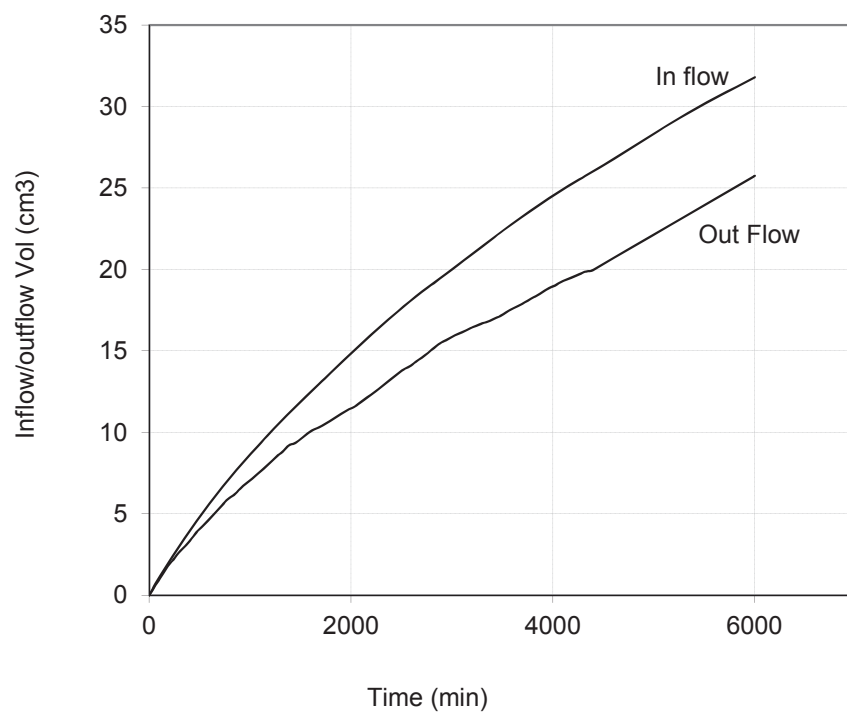


Figure 2 In Flow and out flow against time

Date	28-May-15		
Client	CW	Sample Height mm	100
Test	Constant Head	Sample Diameter mm	101
	Permeability		
Site	St James Hospital	Sample Volume cm ³	801
Sample Reference	BH223A	Initial Wet Mass g	1987
Area/Cell	NA	Final Wet Mass g	1988
S.no	NA	Dry Mass g	1802
Sampling Method	Core	Bulk Density Mg/m ³	2481
Depth m	12.4	Dry Density Mg/m ³	2250
		Initial Water Content %	10.3
		Final Water Content %	10.3

Soil type Grey Gravelly sandy silty CLAY

Saturation Stage

Initial B Value	<0.5
Back Pore Water Pressure During Saturation kPa	500
Cell Pressure kPa	520
Final B Value	0.95
Duration days	6

Consolidation Stage

Cell pressure kPa	602
Back Pore Water Pressure kPa	547
Duration of Consolidation days	1

Permeability Stage

Temperature C°	20
Cell Pressure kPa	602
Pore Water Pressure (Top) kPa	547
Pore Water Pressure (Bottom) kPa	567
Average Effective Stress kPa	45
Head Difference kPa	20
Head Loss kPa	2
Net Head difference m	1.83
Sample Height m	0.100
Hydraulic Gradient i	18.39
Flow Rate cm ³ /min	0.0017
Area of the Sample cm ²	79.7
Permeability m/s	1.9E-10
Duration of permeability stage days	5

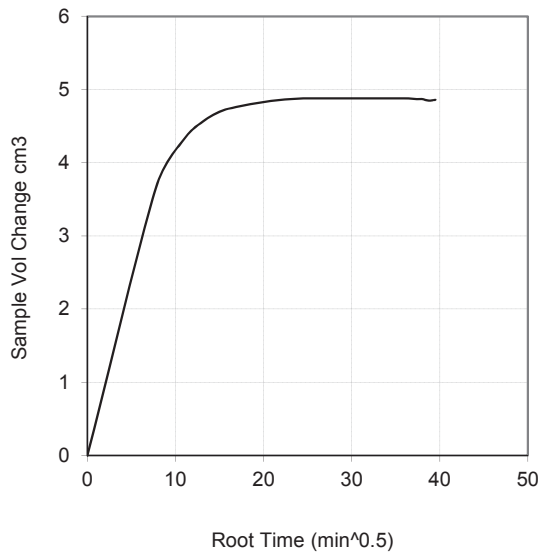


Figure 1 Volume change vs root time

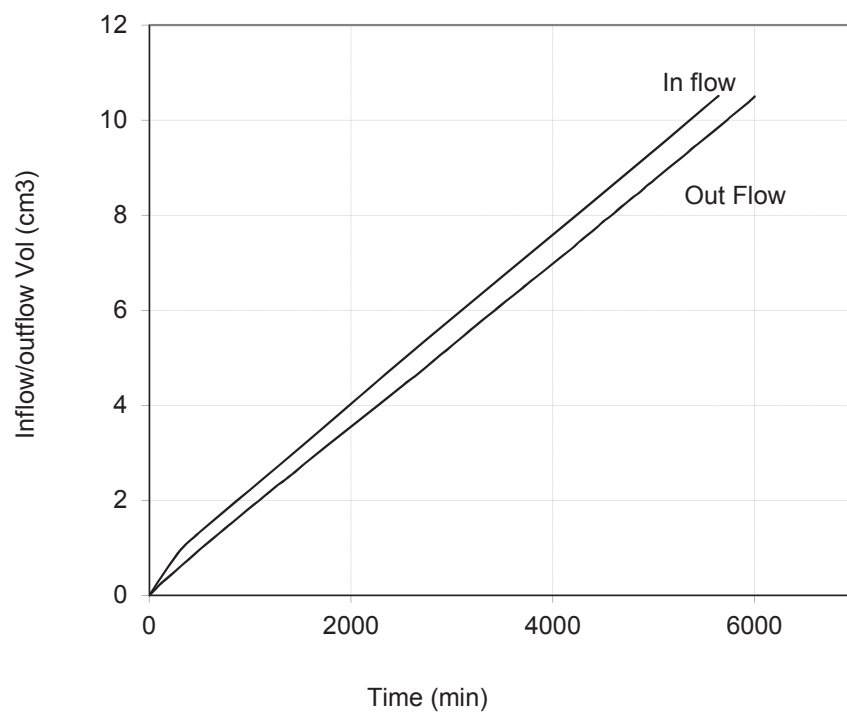


Figure 2 In Flow and out flow against time

Date	28-May-15		
Client	CW	Sample Height mm	100
Test	Constant Head	Sample Diameter mm	101
	Permeability		
Site	St James Hospital	Sample Volume cm ³	801
Sample Reference	BH222	Initial Wet Mass g	1960
Area/Cell	NA	Final Wet Mass g	1987
S.no	NA	Dry Mass g	1815
Sampling Method	Core	Bulk Density Mg/m ³	2448
Depth m	13.4	Dry Density Mg/m ³	2267
		Initial Water Content %	8.0
		Final Water Content %	9.5

Soil type Grey Gravelly sandy silty CLAY

Saturation Stage

Initial B Value	<0.5
Back Pore Water Pressure During Saturation kPa	500
Cell Pressure kPa	520
Final B Value	0.95
Duration days	6

Consolidation Stage

Cell pressure kPa	550
Back Pore Water Pressure kPa	500
Duration of Consolidation days	1

Permeability Stage

Temperature C°	20
Cell Pressure kPa	550
Pore Water Pressure (Top) kPa	500
Pore Water Pressure (Bottom) kPa	520
Average Effective Stress kPa	40
Head Difference kPa	20
Head Loss kPa	2
Net Head difference m	1.83
Sample Height m	0.100
Hydraulic Gradient i	18.43
Flow Rate cm ³ /min	0.0021
Area of the Sample cm ²	79.4
Permeability m/s	2.4E-10
Duration of permeability stage days	5

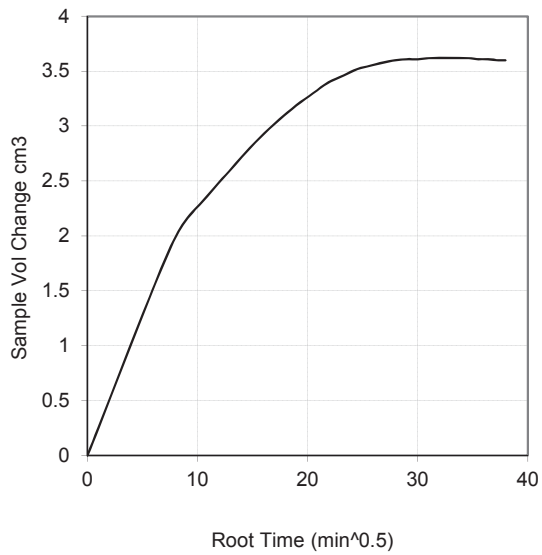


Figure 1 Volume change vs root time

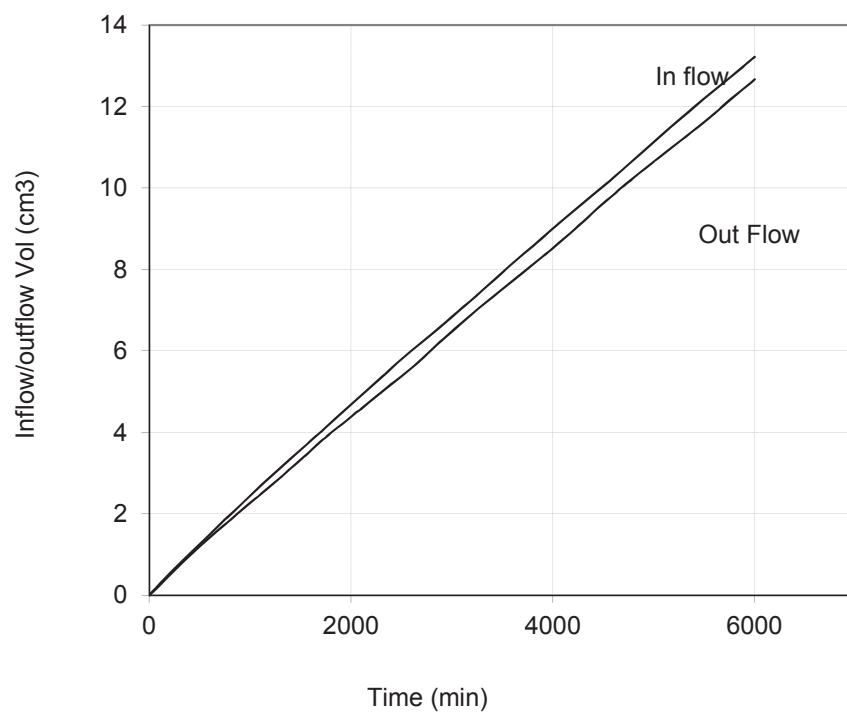


Figure 2 In Flow and out flow against time

Appendix F

Geophysical Logging Report
Prepared by European
Geophysical Surveys LTD



EUROPEAN GEOPHYSICAL SERVICES

REPORT ON THE VIDEO SURVEY

AND

GEOPHYSICAL LOGGING

OF

**BOREHOLE FS01/15
At ST JAMES'S HOSPITAL,
DUBLIN**



Prepared For:

MEEHAN DRILLING

JUNE 2015/MEEH1503_ rpt/IRL

	Name	Date
Logged by:	Rhys Powell	24.6.15
Report by:	Rhys Powell	29.6.15
Checked by:	Kim Beesley	3.07.15

European Geophysical Services Ltd

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4. BOREHOLE LOGGING CONSTRAINTS.....	6
5. RESULTS	7
6. CONCLUSIONS	8

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Figure 3.1	Location map showing St. James's Hospital and FS01/15 highlighted by red circle. © Ordnance Survey 2005
Figure 3.2	Aerial image showing borehole FS01/15 location © Google 2012.

Figure 5.1	Composite Geophysical Log
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Figure 5.2	Images from the video recording
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1.0 INTRODUCTION

At the request of Meehan Drilling Ltd., a video survey and geophysical logging were carried out in borehole FS01/15 at St. James's Hospital, Dublin, Ireland

The aim of the survey was to check the physical condition of the borehole, its construction and some associated hydrogeological parameters.

The work was carried out by European Geophysical Services on the 24th of June 2015.

The following logs were run:

Start Time	End Time	Log / Tool		From (m)	To (m)
10.55	12.30	Borehole Video Camera	GVDTV	0.8	78.7
12.40	13.00	Static Fluid Temperature & Conductivity	GVTCME	2.5	78.8
13.00	13.30	Natural Gamma & Caliper	GVGAM/ CAL	78.5	2.5
13.45	14.10	Focused Resistivity	GVFE	78.7	2.2
14.15	14.55	Static Impeller Flowmeter	GVIFM	19.1	78.0
15.30	16.00	Pumped Impeller Flowmeter	GVIFM	19.5	78.0
16.15		Pumped Fluid Temperature & Conductivity	GVTCME	19.5	78.0

2.0 THE GEOPHYSICAL LOGGING METHODS

The Equipment and Field Procedure

A fully digital logging system with a 600m capacity motorised winch mounted in a 4x4 van was used.

All logging data was recorded digitally for reprocessing and archiving purposes.

With the exception of the fluid logs, all logs were run from the bottom of the boreholes upward.

The video camera survey was carried out first to avoid the disturbance of the fluid by geophysical logs which may affect water clarity.

Borehole Video Camera (DTV)

This borehole camera offers a twin view set up allowing the operator to switch between either a forward or side view camera. The side view camera has an infinite 360° rotation

The results of the survey were recorded on DVD along with the date, borehole identity and depth information.

Fluid Temperature (T)

There is a natural geothermal gradient of increasing temperature with depth. This gradient varies with the thermal conductivity of the geological formation and is modified by water flowing in, out or vertically through the borehole.

This log is used to determine flow patterns within the borehole and to identify flow zones.

Differential logs are produced over a one metre spacing, these are an interpretative aid to detect gradient changes.

Fluid Conductivity (EC or EC25)

The electrical conductivity (EC) of the water is related to its salinity and dissolved solids and is therefore a measure of the quality of the borehole water. The shape of the log trace can indicate zones of inflow.

Using data from the temperature log the electrical conductivity is corrected to 25°C (EC25).

This log is used to identify different zones of water quality.

Differential logs are produced over a one metre spacing, these are an interpretative aid to detect gradient changes.

2.0 THE GEOPHYSICAL LOGGING METHODS

Impeller Flowmeter (FV)

This log is used to determine any flow pattern within the borehole and identify flow zones. The tool uses an impeller and is normally run at a constant logging speed against the anticipated flow for the best response. The data is corrected for logging speed and a fluid velocity (FV) log is produced in mm/s. Where practicable the log may be run in conjunction with a temporary and easily removable pumping system.

Caliper (Cal)

This tool measures the mean diameter of the borehole. It is used to check the integrity of the borehole lining, and where the borehole is unlined to identify zones of washout, breakout or fissures.

Natural Gamma (Gam)

The tool measures the naturally occurring gamma radiation found in rocks and sediments. It is mainly used to detect the clays that contain potassium K^{40} , though the U^{238} and the Th^{232} series of elements present in certain rocks also emit gamma radiation.

The higher the concentration of these clay minerals the greater the responses on the natural gamma log.

Focused Resistivity Log (Deep and Shallow)

The Focused Resistivity tool uses Guard Electrodes to focus the current into the formation. This gives excellent vertical resolution and good penetration, especially in highly conductive borehole fluids where a Normal Resistivity Sonde would not be as effective.

The tool has two electrode spacing's to allow a deep and shallow depth of investigation.

The response of this log is a function of porosity, type of formation / mineralogy and its pore water quality. These logs aid in the identification of strata and quality of the pore water.

3.0 BOREHOLE DETAILS

**St. James's Hospital Borehole
FS01/15**

Irish Grid Ref: O 13235 33641

Lat/Long: 53.341109 -6.3004452

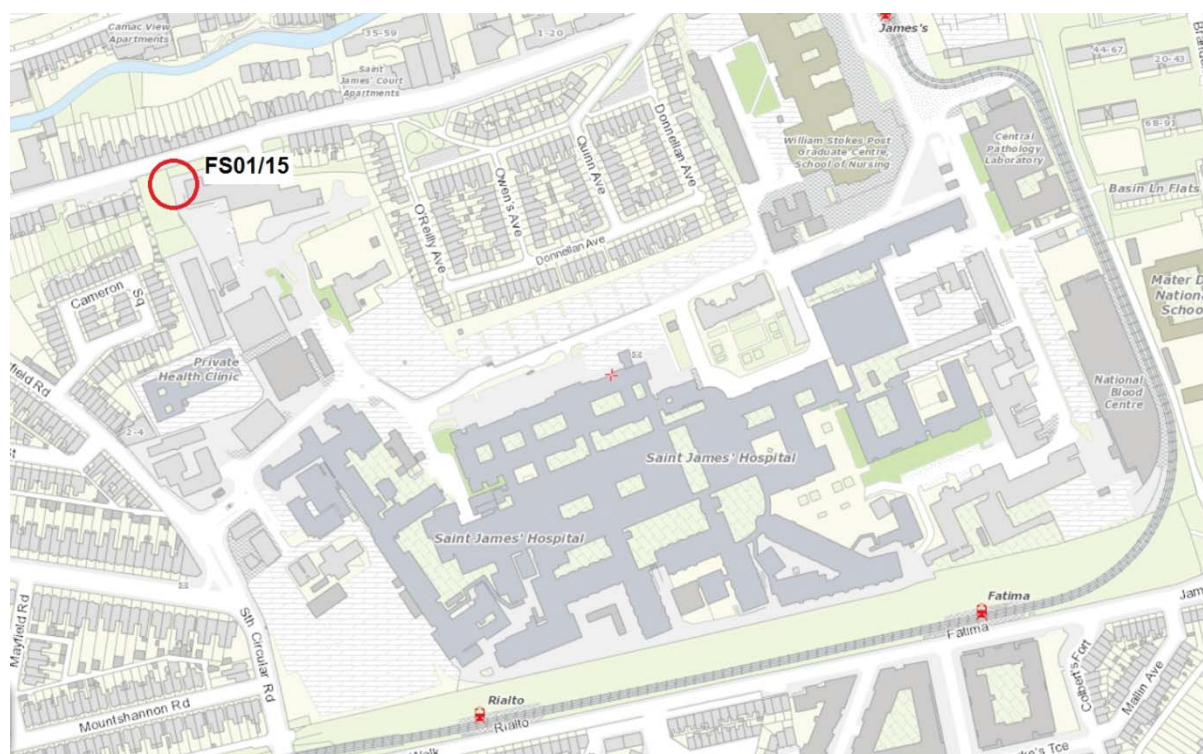


Figure 3.1 Location map showing St. James's Hospital and FS01/15 highlighted by red circle. © Ordnance Survey of Ireland 2015

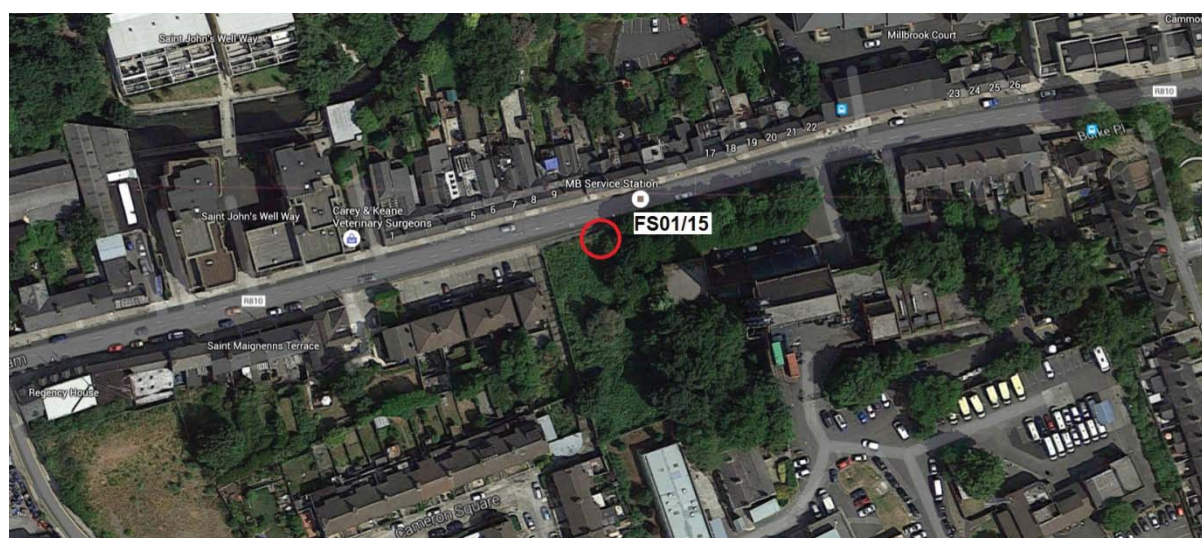


Figure 3.2 Aerial image showing St. James's Hospital and FS01/15 location. © Google 2015.

3.0 BOREHOLE DETAILS

Datum:	Ground Level	Date Logged:	24.06.15
Drilled Depth:	79m	Logged Depth:	78.8m
Plain Plastic Lining:	257mm i.d.	0 – 20.8m	

Water level:	2.2m (RWL)	Logged by:	Rhys Powell
Pump:	4" Pump installed for pumped fluid logging		
Pump Intake Level:	17m		
Pump Diameter:	4"		
Rising Main Diameter:	25mm		
Rising Main Type:	Plastic		

4.0 BOREHOLE LOGGING CONSTRAINTS

- Static logs were carried out first, before a temporary pump was installed to carry out pumped fluid logs
- Visibility was extremely poor from ~40m
- Access restrictions - none
- Time constraints - none
- Construction – Plastic casing 10m into rock
- Borehole appeared to be off-vertical – tools catching wall on down logs
- The flowmeter on several runs caught up on the diameter reduction at 58.4m

5.0 RESULTS

5.1 Presentation of Results

A composite geophysical log with some CCTV observations is shown in Figure 5.1.

5.2 Photographs

Photographs of key features have been taken from the DVD recording and are shown as Figure 5.2.

5.3 Discussion of Results

The static and pumped fluid logs have been overlain in order to highlight the effects of pumping. Gradient changes in the temperature log around 23.2, 26.8, 33.2 and 47.5m under pumping were considered to be indicative of flow points. Under pumping there were also responses around 23.2 and 33.2m on the flowmeter (FV) log.

The formation penetrated by the borehole was a series of interbedded clay and limestone bands. Clay was indicated by the higher natural gamma values coincident with lower resistivity values and limestone by the lower natural gamma values and the higher resistivity values.

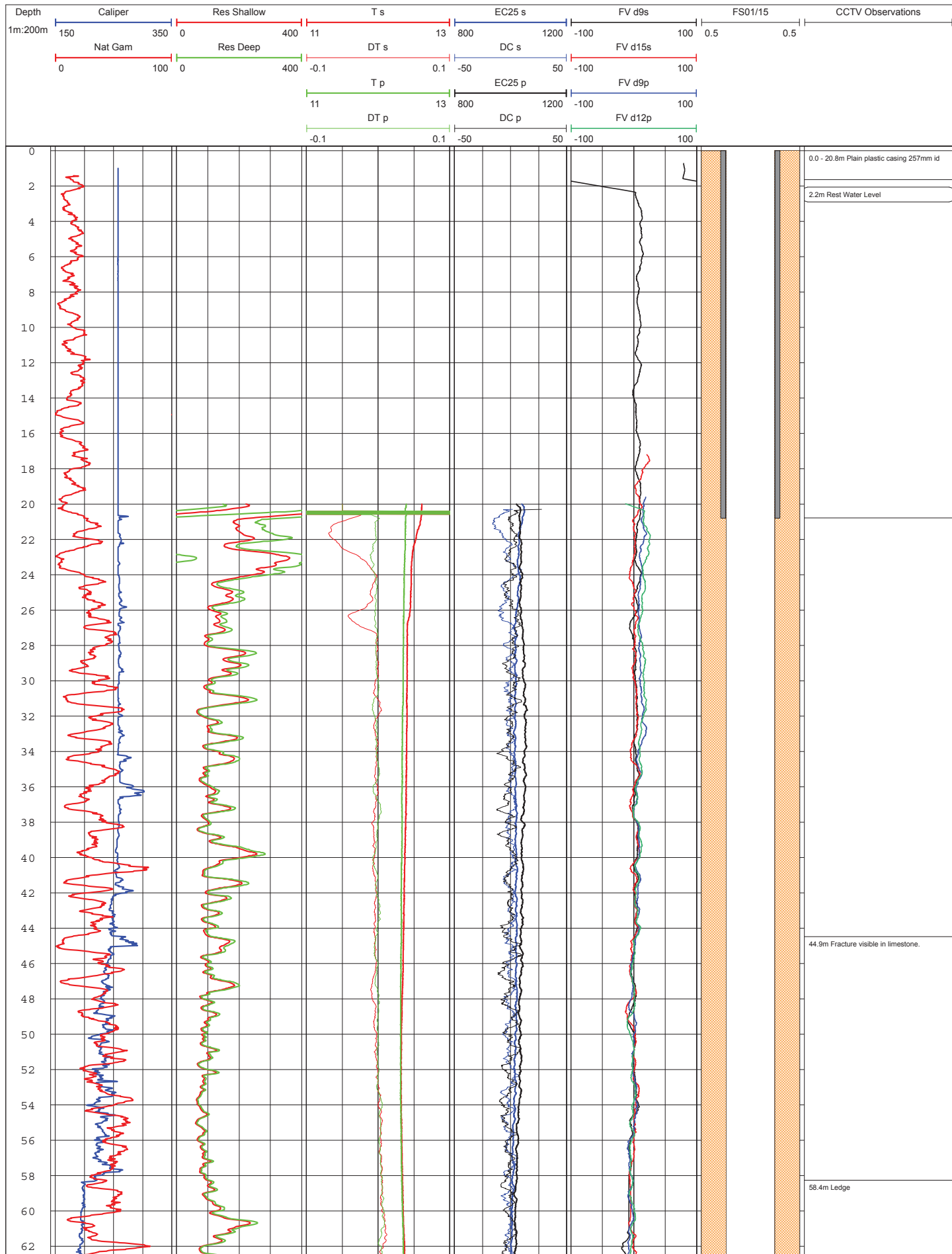
The caliper indicated a rougher borehole wall between 45 and 58.4m below which the diameter reduced. Areas of break out / fracturing within the limestone were the likely cause of the increased diameters seen on the caliper log around 34.4, 36.3 and 44.9m (see cctv also).



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www.europeangeophysical.com

Figure: 5.1 Composite Geophysical Log

CLIENT:	Meehan Drilling	DATE:	24.6.15
SITE:	St. James' Hospital	PROJECT:	MEEH1503
WELL id:	FS01/15	Logging Datum:	Ground Level
		ref:	St James FS01_15 composite.wcl
KEY	Cal: Caliper mm, Gam: Natural Gamma api, T: Temperature °C, EC25: Electrical Conductivity $\mu\text{S/cm}$ @25°C, DT&DC: Differential Logs, 0.4m NR: Res: Resistivity Ohm.m, 1.6m NR: 1.6m Normal Resistivity Ohm.m, PR: Point Resistance Ohms, SP: Spontaneous Potential mV, LSD: Long Spaced Density g/cm^3 , HRD: High Resolution Density g/cm^3 , BRD: Bed Resolution Density g/cm^3 , Dnc: Density - compensated and borehole corrected g/cm^3 , Vp: P Wave Velocity m/s, Amp: P Wave Amplitude %, TT: Transit Time (sonic) μs , FV: Fluid Velocity mm/s, CCL: Casing Collar Locator mV, pH: Acidity, ORP: Redox Potential mV, DO: Dissolved Oxygen % saturation, N, Nitrate as mg/l -N, r: repeat run, u: up run, d: down run, p: pumped, s: static.		



5.0 RESULTS

PHOTOGRAPHS FROM THE CCTV SURVEY

FS01/15

Date: 24.6.15

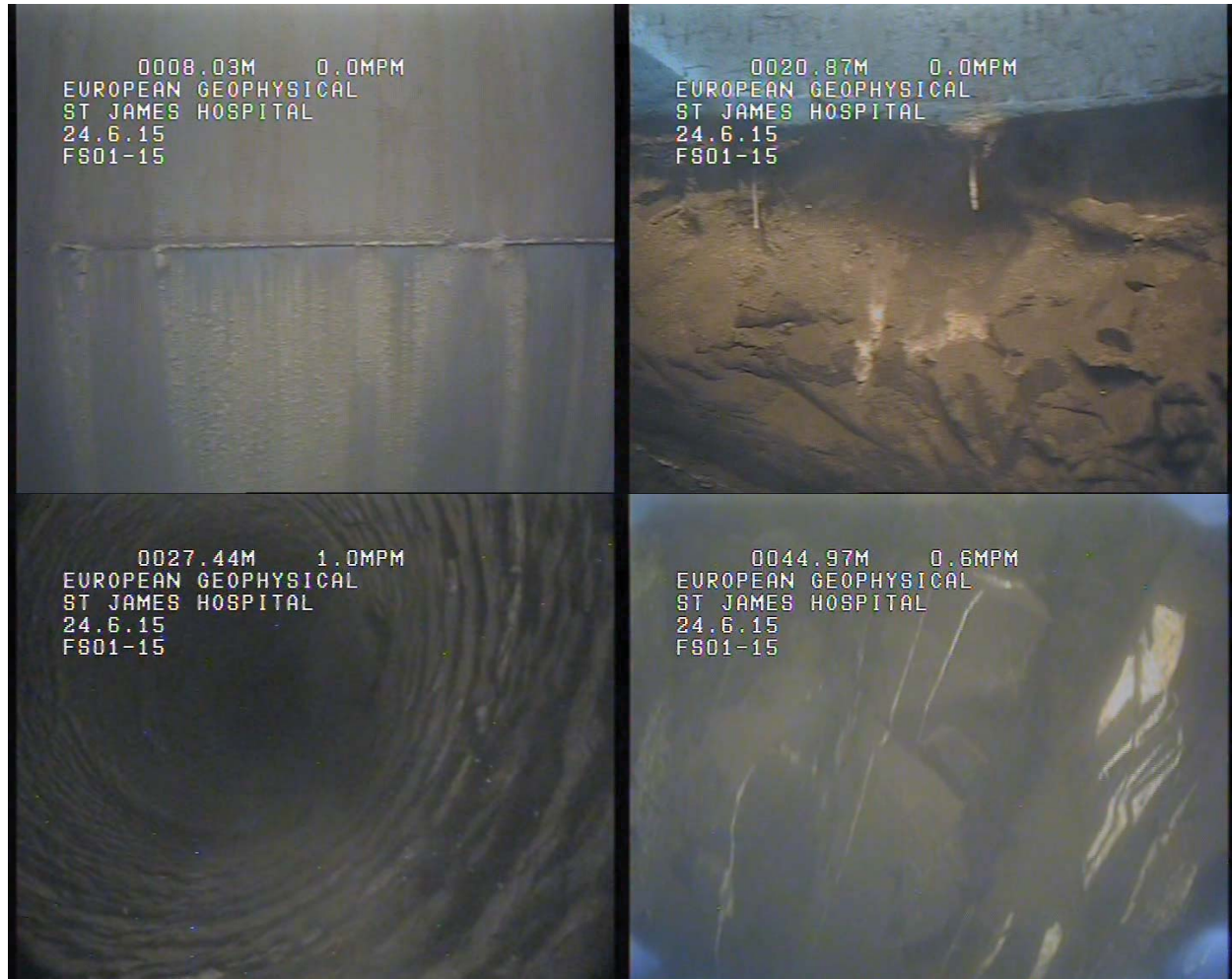


Figure 5.2

8.0m	Join in plain lining
20.8m	Base of lining
27.4m	Typical forward view of open hole
44.9m	View of fractured/veined limestone

6.0 CONCLUSIONS

- 6.1** The final visible depth of the borehole was 78.8m. Visibility was poor throughout the borehole, but was particularly bad below ~40m.
- 6.2** The well was lined with 257mm i.d. plain plastic lining between 0 – 20.8m.
- 6.3** The rest water level was 2.2m.
- 6.4** The formation comprised predominantly limestone, with frequent thin horizons of clay-rich material.
- 6.5** Flow intervals were likely around 23.2, 26.8, 33.2 and 47.5m.
- 6.6** Water quality in terms of electrical conductivity was around 1000 μ S/cm throughout the borehole under static and pumping conditions.



EUROPEAN GEOPHYSICAL SERVICES

REPORT ON THE VIDEO SURVEY

AND

GEOPHYSICAL LOGGING

OF

**BOREHOLE FS02/15
At ST JAMES'S HOSPITAL,
DUBLIN**



Prepared For:

MEEHAN DRILLING

JUNE 2015/MEEH1503_ rpt/IRL

	Name	Date
Logged by:	Rhys Powell	24.6.15
Report by:	Rhys Powell	29.6.15
Checked by:	Kim Beesley	3.7.15

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Figure 3.1	Location map showing St. James's Hospital and FS02/15 highlighted by red circle. © Ordnance Survey 2005
Figure 3.2	Aerial image showing borehole FS02/15 location © Google 2012.

Figure 5.1	Composite Geophysical Log
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Figures 5.2	Images from the video recording
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1.0 INTRODUCTION

At the request of Meehan Drilling Ltd. , a video survey and geophysical logging were carried out in borehole FS02/15 at St. James's Hospital, Dublin, Ireland

The aim of the survey was to check the physical condition of the borehole, its construction and some associated hydrogeological parameters.

The work was carried out by European Geophysical Services on the 23rd/24th of June 2015.

The following logs were run:

Start Time	End Time	Log / Tool		From (m)	To (m)
13.45	15.15	Borehole Video Camera	GVDTV	0.6	94.8
15.25	15.45	Static Fluid Temperature & Conductivity	GVTCME	2.3	95.0
15.50	16.25	Natural Gamma & Caliper	GVGAM/ CAL	95.1	2.3
16.30	17.00	Focused Resistivity	GVFE	95.1	2.0
17.05	17.45	Static Impeller Flowmeter	GVIFM	20	94.5
8.55	9.30	Pumped Impeller Flowmeter	GVIFM	20	94
9.45	10.20	Pumped Fluid Temperature & Conductivity	GVTCME	19.3	94

2.0 THE GEOPHYSICAL LOGGING METHODS

The Equipment and Field Procedure

A fully digital logging system with a 600m capacity motorised winch mounted in a 4x4 van was used.

All logging data was recorded digitally for reprocessing and archiving purposes.

With the exception of the fluid logs, all logs were run from the bottom of the boreholes upward.

The video camera survey was carried out first to avoid the disturbance of the fluid by geophysical logs which may affect water clarity.

Borehole Video Camera (DTV)

This borehole camera offers a twin view set up allowing the operator to switch between either a forward or side view camera. The side view camera has an infinite 360° rotation

The results of the survey were recorded on DVD along with the date, borehole identity and depth information.

Fluid Temperature (T)

There is a natural geothermal gradient of increasing temperature with depth. This gradient varies with the thermal conductivity of the geological formation and is modified by water flowing in, out or vertically through the borehole.

This log is used to determine flow patterns within the borehole and to identify flow zones.

Differential logs are produced over a one metre spacing, these are an interpretative aid to detect gradient changes.

Fluid Conductivity (EC or EC25)

The electrical conductivity (EC) of the water is related to its salinity and dissolved solids and is therefore a measure of the quality of the borehole water. The shape of the log trace can indicate zones of inflow.

Using data from the temperature log the electrical conductivity is corrected to 25°C (EC25).

This log is used to identify different zones of water quality.

Differential logs are produced over a one metre spacing, these are an interpretative aid to detect gradient changes.

2.0 THE GEOPHYSICAL LOGGING METHODS

Impeller Flowmeter (FV)

This log is used to determine any flow pattern within the borehole and identify flow zones. The tool uses an impeller and is normally run at a constant logging speed against the anticipated flow for the best response. The data is corrected for logging speed and a fluid velocity (FV) log is produced. Where practicable the log may be run in conjunction with a temporary and easily removable pumping system.

Caliper (Cal)

This tool measures the mean diameter of the borehole. It is used to check the integrity of the borehole lining, and where the borehole is unlined to identify zones of washout, breakout or fissures.

Natural Gamma (Gam)

The tool measures the naturally occurring gamma radiation found in rocks and sediments. It is mainly used to detect the clays that contain potassium K^{40} , though the U^{238} and the Th^{232} series of elements present in certain rocks also emit gamma radiation.

The higher the concentration of these clay minerals the greater the responses on the natural gamma log.

Focused Resistivity Log (Deep and Shallow)

The Focused Resistivity tool uses Guard Electrodes to focus the current into the formation. This gives excellent vertical resolution and good penetration, especially in highly conductive borehole fluids where a Normal Resistivity Sonde would not be as effective.

The tool has two electrode spacing's to allow a deep and shallow depth of investigation.

The response of this log is a function of porosity, type of formation / mineralogy and its pore water quality. These logs aid in the identification of strata and quality of the pore water.

3.0 BOREHOLE DETAILS

**St. James's Hospital Borehole
FS02/15**

Irish Grid Ref: O 13327 33300

Lat/Long: 53.338020 -6.2991963

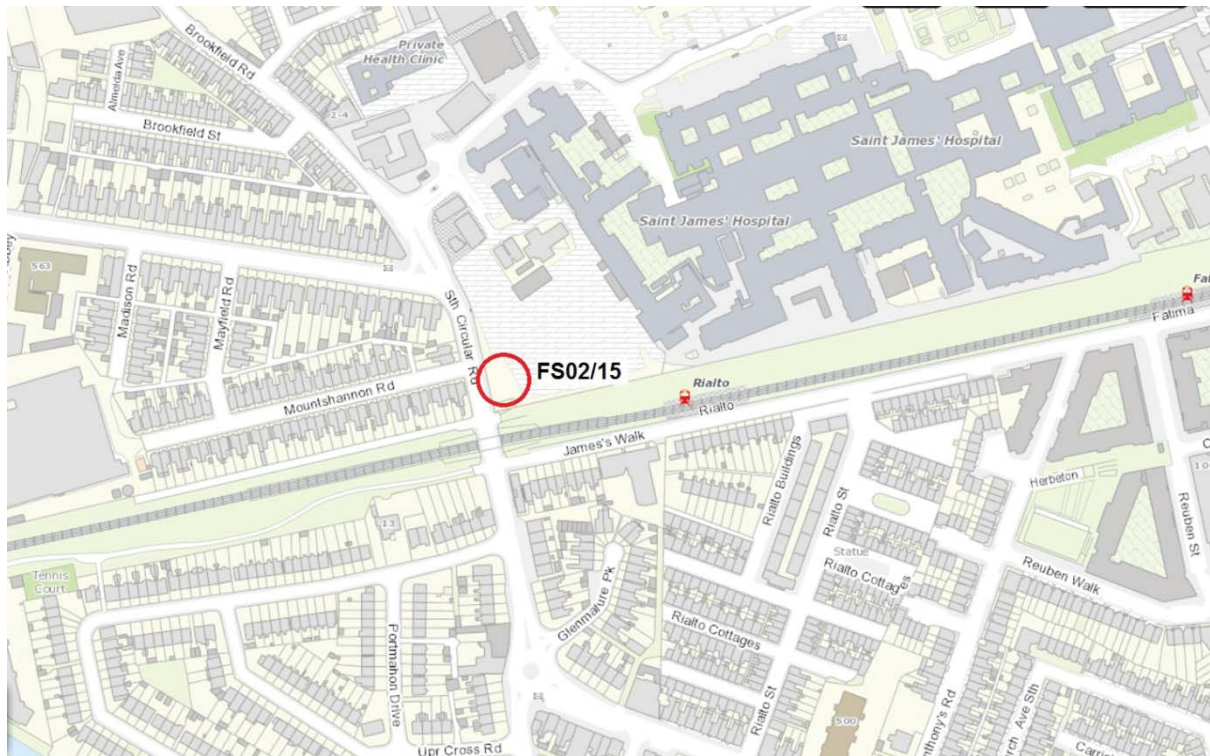


Figure 3.1 Location map showing St. James's Hospital and FS02/15 highlighted by red circle. © Ordnance Survey of Ireland 2015



Figure 3.2 Aerial image showing St. James's Hospital and FS02/15 location. © Google 2015.

3.0 BOREHOLE DETAILS

Datum:	Ground Level	Date Logged:	23.06.15
Drilled Depth:	95m	Logged Depth:	95m
Plain Plastic Lining:	257mm i.d.	0 – 24.5m	

Water level:	4.4m (RWL)	Logged by:	Rhys Powell
Pump:	Temporary pump installed to run pumped fluid logs		
Pump Intake Level:	17m		
Pump Diameter:	4"		
Rising Main Diameter:	25mm		
Rising Main Type:	Plastic		

4.0 BOREHOLE LOGGING CONSTRAINTS

- Static logs were carried out first, before a temporary pump was installed to carry out pumped fluid logs
 - Access restrictions - none
 - Time constraints – none
 - Debris in borehole – plastic stabilizers observed on water level and at ~23m.
 - Construction – Plastic casing ~10m into rock
 - Borehole appeared to be off-vertical – tools catching wall on down logs
 - The flowmeter on several runs caught up on the diameter reductions at 56.2 and 75.7m
-

5.0 RESULTS

5.1 Presentation of Results

A composite geophysical log with CCTV observations is shown in Figure 5.1.

5.2 Photographs

Photographs of key features have been taken from the DVD recording and are shown as Figure 5.2

5.3 Discussion of Results

The static and pumped fluid logs have been overlain in order to highlight the effects of pumping. Gradient changes in the temperature log around 25.5, 33, 45, 60.6 and 69.2m under pumping were considered to be indicative of flow points. Under pumping there were also responses around 45 and 60.6m on the flowmeter (FV) log.

The electrical conductivity of the water was identical below 36.6m under both static and pumped conditions at $880\mu\text{S}/\text{cm}$. Above 36.6m the pumped values were higher than the static values.

The formation penetrated by the borehole was a mainly series of interbedded clay and limestone bands. Clay mineralized formation was indicated by the higher natural gamma values coincident with lower resistivity values and limestone by the lower natural gamma values and the higher resistivity values.

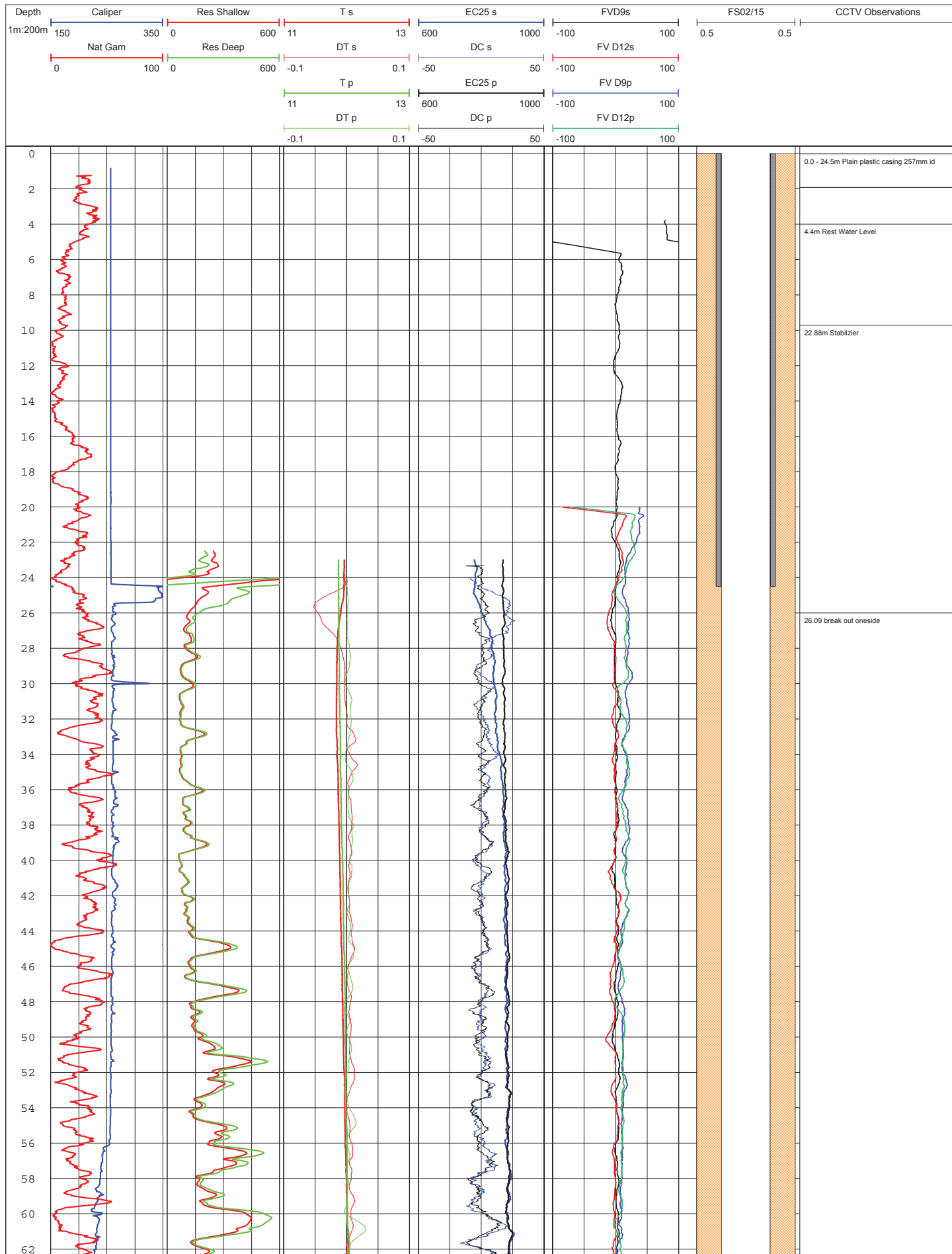
Areas of break out / fracturing within the limestone were the likely cause of the increased diameters seen on the caliper log around 30 and 60m.

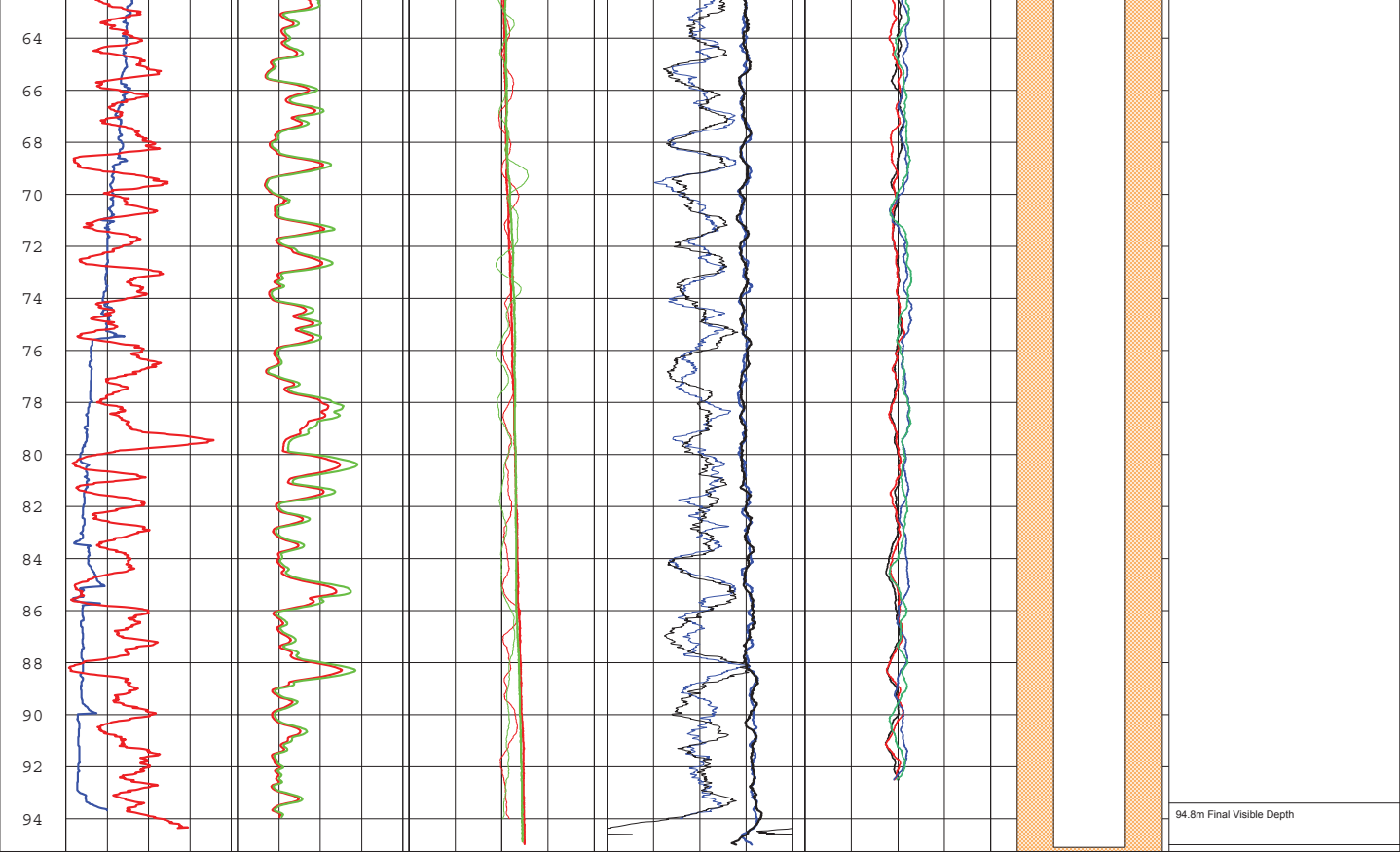


EUROPEAN GEOPHYSICAL SERVICES LTD
22 The Stables, Sansaw Business Park, Hadnall,
Shrewsbury, Shropshire, SY4 4AS
T:01939 210710 F:01939 210532
E:europageophys@europageophysical.com
www.europageophysical.com

Figure: 5.1: Composite Geophysical Log

CLIENT:	Meehan Drilling	DATE:	23.6.15
SITE:	St. James' Hospital	PROJECT:	MEEH1503
WELL id:	FS02/15	Logging Datum:	Ground Level
		ref:	St James FS02_15 composite.wcl
KEY	Cal: Caliper mm, Gam: Natural Gamma api, T: Temperature °C, EC25: Electrical Conductivity µS/cm @25°C, DT&DC: Differential Logs, Res: Resistivity Ohm.m, 1.5m NR: 1.5m Normal Resistivity Ohm.m, PR: Point Resistance Ohms, SP: Spontaneous Potential mV, LSD: Long Spaced Density g/cm³, HRD: High Resolution Density g/cm³, BRD: Bed Resolution Density g/cm³, Dnc: Density - compensated and borehole corrected g/cm³, Vp: P Wave Velocity m/s, Amp: P Wave Amplitude %, TT: Transit Time (sonic) µs, FV: Fluid Velocity mm/s, CCL: Casing Collar Locator mV, pH: Acidity, ORP: Redox Potential mV, DO: Dissolved Oxygen % saturation, N, Nitrate as mg/l -N, r: repeat run, u: up run, d: down run, p: pumped, s: static.		





5.0 RESULTS

PHOTOGRAPHS FROM THE CCTV SURVEY

FS02/15

Date: 23.06.15

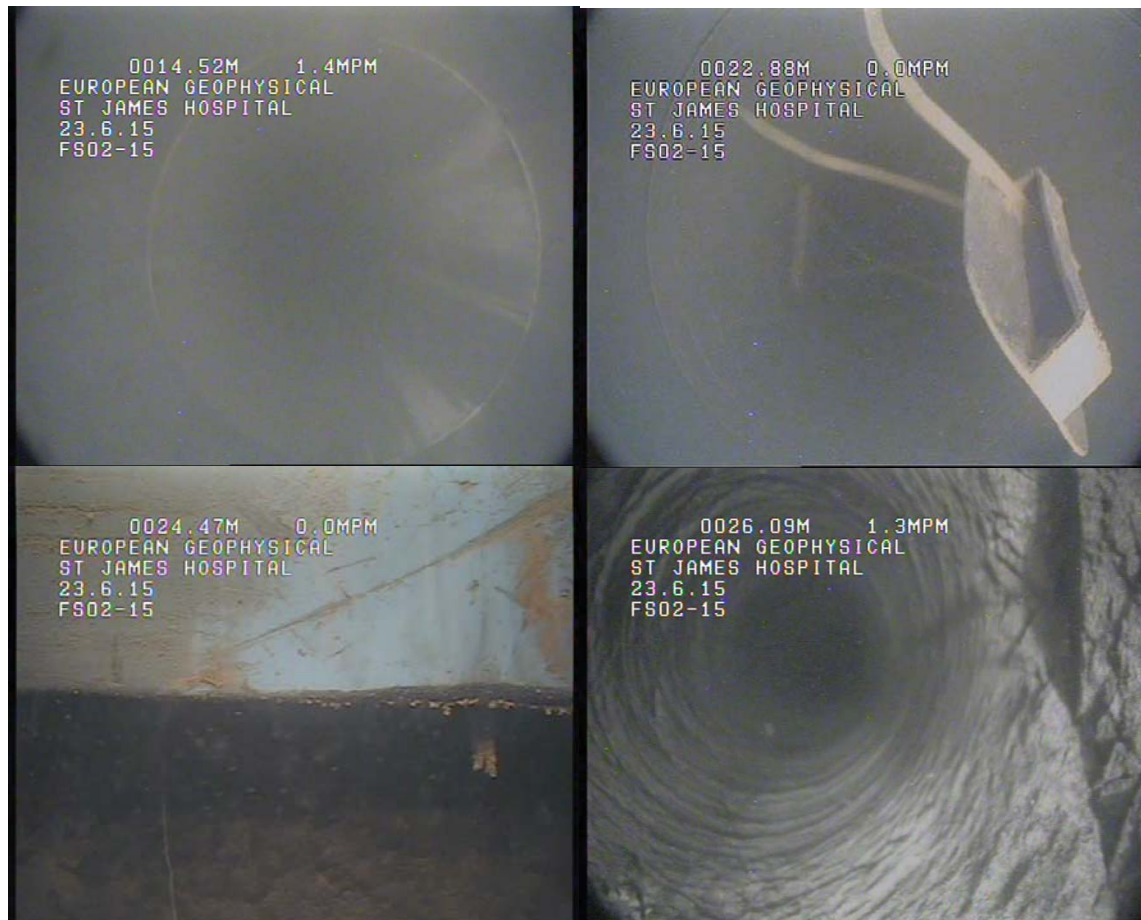


Figure 5.2

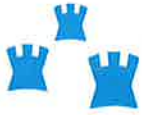
- | | |
|--------|---------------------------|
| 14.52m | Join in plain PVC lining. |
| 22.88m | Stabilizer. |
| 24.47m | Base of plain lining |
| 26.09m | Break out to one side. |

6.0 CONCLUSIONS

- 6.1** The final visible depth of the borehole was 94.8m. Geophysical logs reached 95m.
 - 6.2** The well was lined with 257mm i.d. plain plastic lining between 0 – 24.5m.
 - 6.3** The rest water level was 4.4m.
 - 6.4** The formation comprised predominantly limestone with frequent thin horizons with increased clay content between.
 - 6.5** Flow intervals were noted at around 25.5, 33, 45, 60.6 and 69.2m.
 - 6.6** Water quality in terms of electrical conductivity was of the range 780 - 900 $\mu\text{S}/\text{cm}$ (@25°C, with lowest values around 25m under static conditions).
-

Appendix G

Discharge Consent Issued by
Dublin City Council



LOCAL GOVERNMENT (WATER POLLUTION) ACTS, 1977 & 1990

SANITARY AUTHORITY: DUBLIN CITY COUNCIL

LICENCE NUMBER (Reg. Ref.):

PCLS/01/15

Dublin City Council, Sanitary Authority, in exercise of the powers conferred on it by the Local Government (Water Pollution) Acts, 1977 & 1990 hereby **grants the under mentioned Licensee, a licence (PCLS/01/15), subject to the conditions stated overleaf**, to discharge trade effluent from the under mentioned premises to the sewer detailed below:

LICENSEE:

**Meehan Drilling Limited
Castlecourt
Castlebellingham
Dundalk
Co. Louth**

PREMISES:

**St. James's Hospital
James's Street
Dublin 8**

ACTIVITY:

Pumping Test

SEWER:

Surface Water Sewer traversing the hospital

NATURE OF DISCHARGE:

Groundwater

Signed:


Executive Manager (Engineering)

Dated:

this 19 day of June 2015

CONDITIONS

Point 1 (ROD002)

1. A record or log book of cleaning, maintenance and performance of settling tanks shall be made and kept available for inspection at all times by officials of Dublin City Council on demand.
2. The trade effluent discharged shall be of the same nature and composition as described and conditioned in this licence.
3. No substance shall be present in the trade effluent in such concentration as would constitute a danger to personnel working in the sewer or to the sewer fabric, or would interfere with the operation of downstream handling facilities.
4. In the event of an accidental discharge, spillage or deposit of any polluting matter which enters or is likely to enter any waters or a sewer, the person responsible shall notify the City Council as soon as practicable afterwards (Section 14, Local Government (Water Pollution) Act, 1977).
5. The Licensee shall provide and maintain such inspection chambers as are required for the purpose of taking samples of trade effluent.
6. The Licensee shall keep records in such form as required, of the volume, rate of discharge, nature and composition of the trade effluent discharged into the sewer.
7. The Licensee shall permit authorised persons to inspect, examine or test, at all reasonable times, any works or apparatus installed in connection with the trade effluent, and to take samples of the trade effluent.
8. The temperature of the trade effluent shall not exceed 25 degrees C, or ambient temperature whichever is highest.
9. The pH shall lie in the range 6.0 to 9.0
10. Over any 24-hour period the mean concentration of suspended solids in the trade effluent shall not exceed 20 mg/litre and the maximum concentration of suspended solids shall not exceed 30 mg/litre. The total quantity of suspended solids discharged in this period shall not exceed 43.5 Kgs.
11. The concentration of mineral oils in the effluent shall not exceed 10 mg/l. The total quantity of mineral oils discharged per day shall not exceed 22 Kgs.
12. Materials classifiable as Hazardous Waste under the Waste Management Act 1996, shall not be discharged to the surface water sewer.
13. Non-trade effluent waste water (including fire water, hydrocarbon product seepages and accidental spillage's arising on the site) shall not be discharged to the sewer without the prior authorisation of the Drainage division of Dublin City Council.


14. The effluent discharged shall not contain petroleum hydrocarbons or organic solvents (including chlorinated organic solvents) which would give rise to flammable or explosive vapours.
15. The effluent shall be screened prior to discharge to waters to remove gross solids
16. The Licensee shall monitor the discharge of trade effluent to ensure compliance with the conditions of this licence. A flow meter shall be installed on the discharge line and the volumes discharged to the sewer shall be forwarded to Dublin City Council on an hourly basis.
17. The discharge of trade effluent shall not exceed **7 litres per second**.
18. Charges as approved by the Sanitary Authority will be applied as appropriate.

Point 2 (ROD003)

1. A record or log book of cleaning, maintenance and performance of settling tanks shall be made and kept available for inspection at all times by officials of Dublin City Council on demand.
2. The trade effluent discharged shall be of the same nature and composition as described and conditioned in this licence.
3. No substance shall be present in the trade effluent in such concentration as would constitute a danger to personnel working in the sewer or to the sewer fabric, or would interfere with the operation of downstream handling facilities.
4. In the event of an accidental discharge, spillage or deposit of any polluting matter which enters or is likely to enter any waters or a sewer, the person responsible shall notify the City Council as soon as practicable afterwards (Section 14, Local Government (Water Pollution) Act, 1977).
5. The Licensee shall provide and maintain such inspection chambers as are required for the purpose of taking samples of trade effluent.
6. The Licensee shall keep records in such form as required, of the volume, rate of discharge, nature and composition of the trade effluent discharged into the sewer.
7. The Licensee shall permit authorised persons to inspect, examine or test, at all reasonable times, any works or apparatus installed in connection with the trade effluent, and to take samples of the trade effluent.
8. The temperature of the trade effluent shall not exceed 25 degrees C, or ambient temperature whichever is highest.
9. The pH shall lie in the range 6.0 to 9.0
10. Over any 24-hour period the mean concentration of suspended solids in the trade effluent shall not exceed 20 mg/litre and the maximum concentration of suspended solids shall not exceed 30 mg/litre. The total quantity of suspended solids discharged in this period shall not exceed 43.5 Kgs.
11. The concentration of mineral oils in the effluent shall not exceed 10 mg/l. The total quantity of mineral oils discharged per day shall not exceed 22 Kgs.
12. Materials classifiable as Hazardous Waste under the Waste Management Act 1996, shall not be discharged to the surface water sewer.
13. Non-trade effluent waste water (including fire water, hydrocarbon product seepages and accidental spillage's arising on the site) shall not be discharged to the sewer without the prior authorisation of the Drainage division of Dublin City Council.
14. The effluent discharged shall not contain petroleum hydrocarbons or organic solvents (including chlorinated organic solvents) which would give rise to flammable or explosive vapours.

15. The effluent shall be screened prior to discharge to waters to remove gross solids
16. The Licensee shall monitor the discharge of trade effluent to ensure compliance with the conditions of this licence.. A flow meter shall be installed on the discharge line and the volumes discharged to the sewer shall be forwarded to Dublin City Council on an hourly basis.
17. The discharge of trade effluent shall not exceed **7 litres per second**.
- 18..Charges as approved by the Sanitary Authority will be applied at appropriate intervals.

Signed:



Executive Manager (Engineering)

Dated:

this 19 day of June 2015

Drainage Division
Dublin City Council
Civic Offices
Fishamble Street
Dublin 8

Tel 2222155

DUBLIN CITY COUNCIL

**LOCAL GOVERNMENT (WATER POLLUTION) ACTS, 1977 & 1990
AND
LOCAL GOVERNMENT (WATER POLLUTION) REGULATIONS 1978 & 1992**

**Application for a Licence / Licence Review to discharge
Trade Effluent or Other Matter to a Sewer**

Notes on completion of the application:

1. The application should be completed in accordance with the above mentioned Acts and regulations.
2. The application should be accompanied by :
 - (a) A site location map, in **duplicate**, to a suitable scale showing premises, public roadways, and all points of discharge to the public sewers.
 - (b) A site drainage plan, in **triplicate**, to a scale of 1:100 (or other appropriate scale), and such other particulars as are necessary to describe the premises, works, apparatus or plant from which the effluent is to be discharged. The site drainage plan shall clearly indicate all drainage on site and shall be **colour coded**.
 - (c) An application fee of €380.00 (three hundred and eighty euros).
3. Completed applications should be sent to:

**The Senior Engineer
Drainage Division
Dublin City Council
Civic Offices
Dublin 8
Tel 2222155 Fax 2222300**

1. Name and address of Applicant: Mr Jeff Meehan, Meehan Driling Limited, Castlecourt, Castlebellingham, Dundalk, Co. Louth. Tel. No. 0863341401
2. Name and address of the Premises: St James's Hospital, James's Street, Dublin 8 (a site location map is presented in Annex A).
3. Number of employees at premises: N/A
4. Date of commencement of discharge: _____
5. Description of the process or activity: A series of pumping tests will be undertaken by abstracting groundwater from beneath St James Hospital.
6. Point of discharge to sewer: Point 1 (ROD002) and Point 2 (ROD003) shown on the Dublin City Council site drainage plan dated 12 June 2015 and the Figure entitled proposed survey location prepared by Roughan & O'Donovan dated September 2013 presetned in Annex B.
7. Size and type of discharge pipe: 100ml flexible hose.
8. Location of sampling point: As per point 6 above.
9. Average Volume see Table 1 in Annex C.
10. Maximum Volume see Table 1 in Annex C.
11. Maximum rate of discharge see Table 1 in Annex C.
12. Method of flow measurement: Flow meter
13. Period or periods of discharge during day: See Table 1 in Annex C.
14. Number of days worked per annum: N/A
15. Particulars of effluent treatment: N/A

16. Characteristics of the Trade Effluent or other Matter

Complete for all applicable characteristics giving ranges where available. Concentrations to be expressed in mg / litre.

Characteristic	Prior to Treatment	As Discharged
Temperature (°C)	_____	_____12.5°C_____
pH	_____	_____7.6_____
Colour (degree Hazen)	_____	Clear and colourless_____
B.O.D.	_____	_____
C.O.D.	_____	_____
Suspended Solids	_____	_____30mg/l_____
Settleable Solids (ml/litre)	_____	_____
Dissolved Solids	_____	_____(EC 0.75 mS/cm)_____
Ammonia (as N)	_____	(Ammoniacal N 0.55mg/l)
Nitrates (as N)	_____	_____<0.05mg/l_____
Phosphorous (as P)	_____	_____
Sulphates (as SO ₄)	_____	_____98.77mg/l_____
Chlorides (as Cl)	_____	_____47.9mg/l_____
Phenols (as C ₆ H ₅ OH)	_____	_____
Detergents (as Methylene Blue Active Substances)	_____	_____
Oils, fats and grease	_____	_____
Metals (Specify each)	_____	___ See attached Annex D
Organohalogen compounds (specify)_____	_____	___ See attached Annex D
Organophosphorous compounds (specify) _____	_____	___ See attached Annex D
Organotin compounds (specify) _____	_____	_____
Mineral oils or Hydrocarbons of Petroleum origin	_____	Total Petroleum Hydrocarbons - CWG <10µg/l
Other toxic substances (specify) _____	_____	___ See attached Annex D

Other relevant characteristics

SIGNED: _____

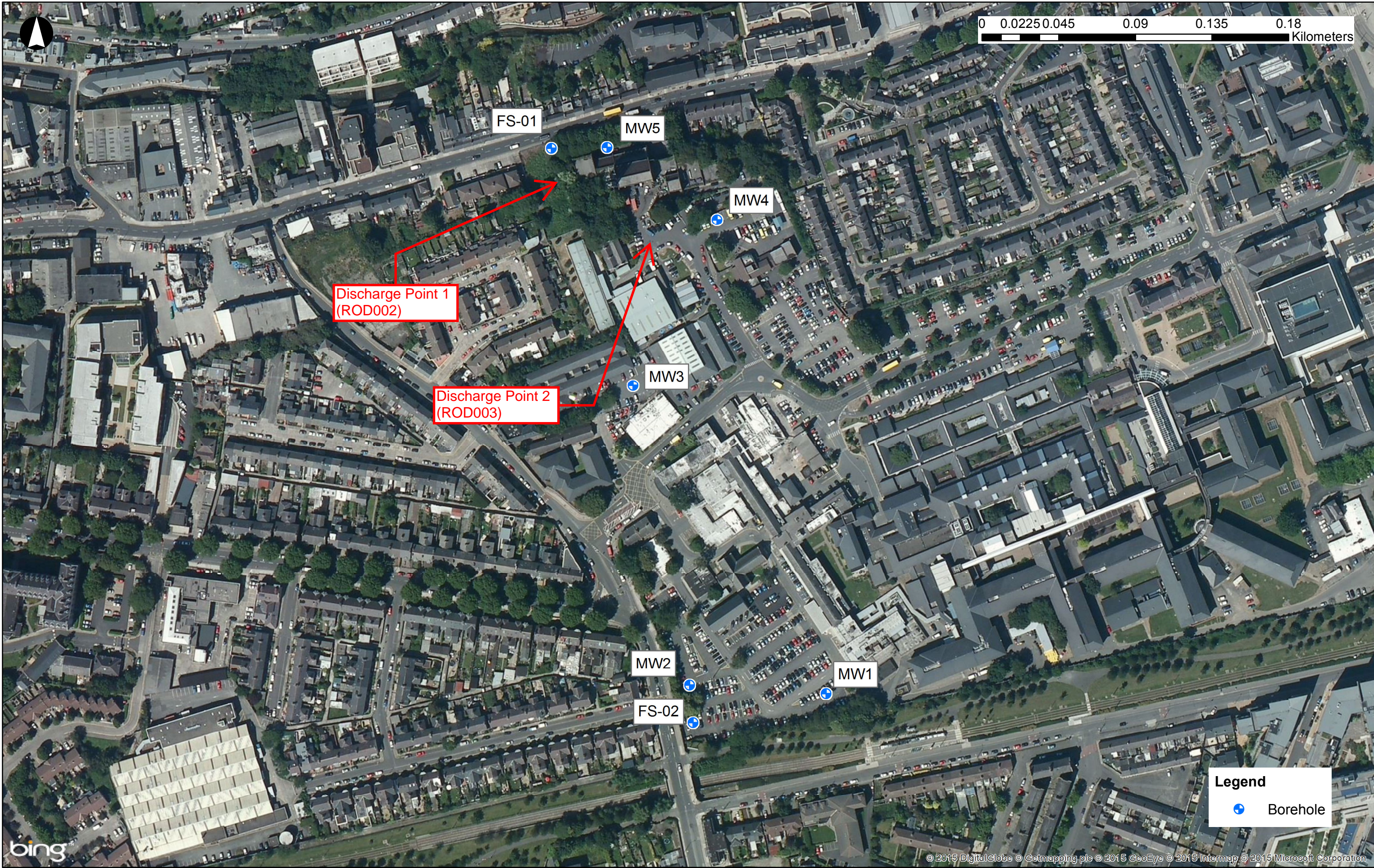
DATE: _____

For Office Use

REGISTER / FILE REF: _____

DATE RECEIVED: _____

ANNEX A
SITE LOCATION PLAN



bing

© 2015 DigitalGlobe © Getmapping plc © 2015 GeoEye © 2015 Intermap © 2015 Microsoft Corporation

ARUP

50 Ringsend Road
Dublin 4
Tel +353 (0)1 233 4455 Fax +353 (0)1 668 3169
www.arup.com

Client
**National Paediatric Hospital
Development Board**
Job Title
**St James Hospital -
National Childrens Hospital**

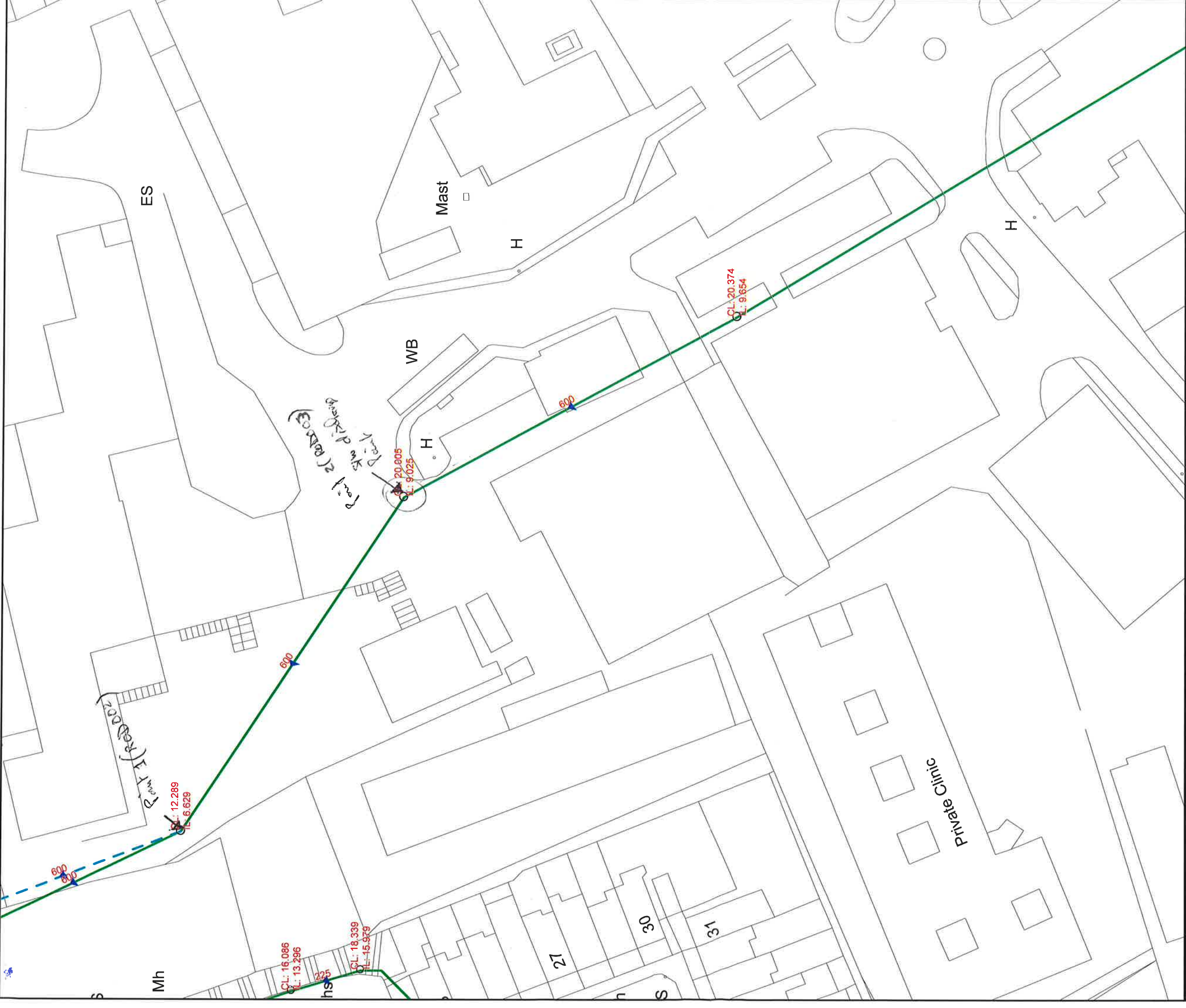
Job No	Drawing Status	
237976-52	Information	
Drawing No	Scale	Issue
	1:2,000	P1

Borehole Location Map

ANNEX B

SITE DRAINAGE PLANS

**DUBLIN CITY COUNCIL SITE DRAINAGE PLAN DATED 12 JUNE 2015 AND THE
FIGURE ENTITLED PROPOSED SURVEY LOCATION PREPARED BY ROUGHAN
& O'DONOVAN DATED SEPTEMBER 2013**



LEGEND

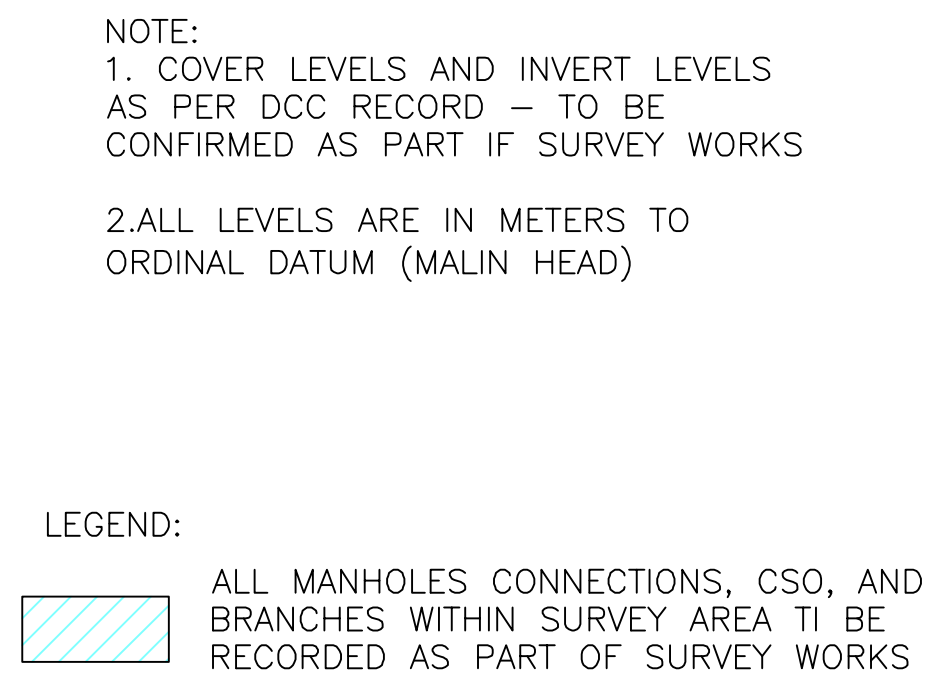
Trunk Sewer	Combined Sewer	Surface Water Sewer	Foul Sewer	Overflow	Pumping

gully	catch pit	cover	alarm	overflow	pumping station	junction	other nodes	hatch box	outfall	high point	vent column	catchpit	cascade	unknown feature	flap valve	rodding eye	inverted siphon

Scale: 1: 500
Date: 12 Jun 2015

PLEASE NOTE:

- INFORMATION SUPPLIED FROM CORPORATION RECORD SHEETS IS GIVEN WITHOUT PREJUDICE.
- ACCURACY MUST ALWAYS BE VERIFIED ON SITE.
- MANHOLES MAY BE OPENED ONLY BY CORPORATION PERSONNEL.
- TO COPY OR FURNISH SURVEY SHEETS UNLESS LICENCED IS A BREACH OF COPYRIGHT.



ANNEX C

ESTIMATED FLOW RATES, DURATION OF TESTING AND THE VOLUMES TO DISCHARGE FOR THE PROPOSED PUMP TESTS AT ST JAMES'S HOSPITAL

Table 1
Estimated flow rates, duration of testing and the volumes to discharge for the proposed pump tests at St James's Hospital

Test number	Diameter of borehole	Flow rate	Duration of test	Maximum potential volume	Discharge location¹
1	254mm	Starts at 3.6L/s and increases incrementally by 1.1L/s up to 7L/s every 100 min	6hours 40min	130,000L	Point 1 (ROD003)
2	254mm	Starts at 3.6L/s and increases incrementally by 1.1L/s up to 7L/s every 100 min	6hours 40min	130,000L	Point 2 (ROD002)
3	254mm	2.5L/s	1hour	9000L	Point 2 (ROD002)
4	254mm	Not specified however the rate will be less than 7L/s	72hours	1,800,000L	Point 2 (ROD002)

Note

All values are approximate

¹ The discharge locations are shown on the figures presented in Annex A.

ANNEX D

EXTRACTS OF THE LABORATORY CERTIFICATE PRESENTING THE RESULTS OF PRELIMINARY WATER QUALITY SAMPLING

Client Name: Arup
Reference: NCH187
Location: NCH
Contact: Christopher Newton
JE Job No.: 15/7885

Report : Liquid

Liquids/products: V=40ml vial, G=glass bottle, P=plastic bottle
H=H₂SO₄, Z=ZnAc, N=NaOH, HN=HNO₃

J E Sample No.	1-13										Please see attached notes for all abbreviations and acronyms		
Sample ID	FS02												
Depth	5.0												
COC No / misc													
Containers	V H H N N P G B C												
Sample Date	26/05/2015												
Sample Type	Ground Water												
Batch Number	1										LOD/LOR	Units	Method No.
Date of Receipt	28/05/2015												
Dissolved Aluminium #	<20										<20	ug/l	TM30/PM14
Dissolved Antimony #	6										<2	ug/l	TM30/PM14
Dissolved Arsenic #	<2.5										<2.5	ug/l	TM30/PM14
Dissolved Boron	29										<12	ug/l	TM30/PM14
Dissolved Cadmium #	<0.5										<0.5	ug/l	TM30/PM14
Dissolved Calcium #	13.8										<0.2	mg/l	TM30/PM14
Total Dissolved Chromium #	21.7										<1.5	ug/l	TM30/PM14
Dissolved Copper #	<7										<7	ug/l	TM30/PM14
Total Dissolved Iron #	<20										<20	ug/l	TM30/PM14
Dissolved Lead #	<5										<5	ug/l	TM30/PM14
Dissolved Magnesium #	4.0										<0.1	mg/l	TM30/PM14
Dissolved Manganese #	<2										<2	ug/l	TM30/PM14
Dissolved Mercury #	<1										<1	ug/l	TM30/PM14
Dissolved Nickel #	<2										<2	ug/l	TM30/PM14
Dissolved Potassium #	90.4										<0.1	mg/l	TM30/PM14
Dissolved Selenium #	<3										<3	ug/l	TM30/PM14
Dissolved Sodium #	58.9										<0.1	mg/l	TM30/PM14
Dissolved Zinc #	<3										<3	ug/l	TM30/PM14
PAH MS													
Naphthalene	0.02										<0.01	ug/l	TM4/PM30
Acenaphthylene	0.01										<0.01	ug/l	TM4/PM30
Acenaphthene	<0.01										<0.01	ug/l	TM4/PM30
Fluorene	<0.01										<0.01	ug/l	TM4/PM30
Phenanthrene	0.01										<0.01	ug/l	TM4/PM30
Anthracene	<0.01										<0.01	ug/l	TM4/PM30
Fluoranthene	<0.01										<0.01	ug/l	TM4/PM30
Pyrene	<0.01										<0.01	ug/l	TM4/PM30
Benzo(a)anthracene	0.01										<0.01	ug/l	TM4/PM30
Chrysene	0.01										<0.01	ug/l	TM4/PM30
Benzo(bk)fluoranthene	<0.01										<0.01	ug/l	TM4/PM30
Benzo(a)pyrene	<0.01										<0.01	ug/l	TM4/PM30
Indeno(123cd)pyrene	<0.01										<0.01	ug/l	TM4/PM30
Dibenzo(ah)anthracene	<0.01										<0.01	ug/l	TM4/PM30
Benzo(ghi)perylene	<0.01										<0.01	ug/l	TM4/PM30
PAH 16 Total	<0.1										<0.1	ug/l	TM4/PM30
Benzo(b)fluoranthene	<0.01										<0.01	ug/l	TM4/PM30
Benzo(k)fluoranthene	<0.01										<0.01	ug/l	TM4/PM30
PAH Surrogate % Recovery	71										<0	%	TM4/PM30
VOC TICs	ND											None	TM15/PM10
Epichlorohydrin	<100										<100	ug/l	TM15/PM10
Methyl Tertiary Butyl Ether #	<0.1										<0.1	ug/l	TM15/PM10
Benzene #	<0.5										<0.5	ug/l	TM15/PM10
Toluene #	<0.5										<0.5	ug/l	TM15/PM10

Report : Liquid

Liquids/products: V=40ml vial, G=glass bottle, P=plastic bottle
H=H₂SO₄, Z=ZnAc, N=NaOH, HN=HN0₃

Please see attached notes for all abbreviations and acronyms

QF-PM 3.1.3 v11

Please include all sections of this report if it is reproduced

All solid results are expressed on a dry weight basis unless stated otherwise.

5 of

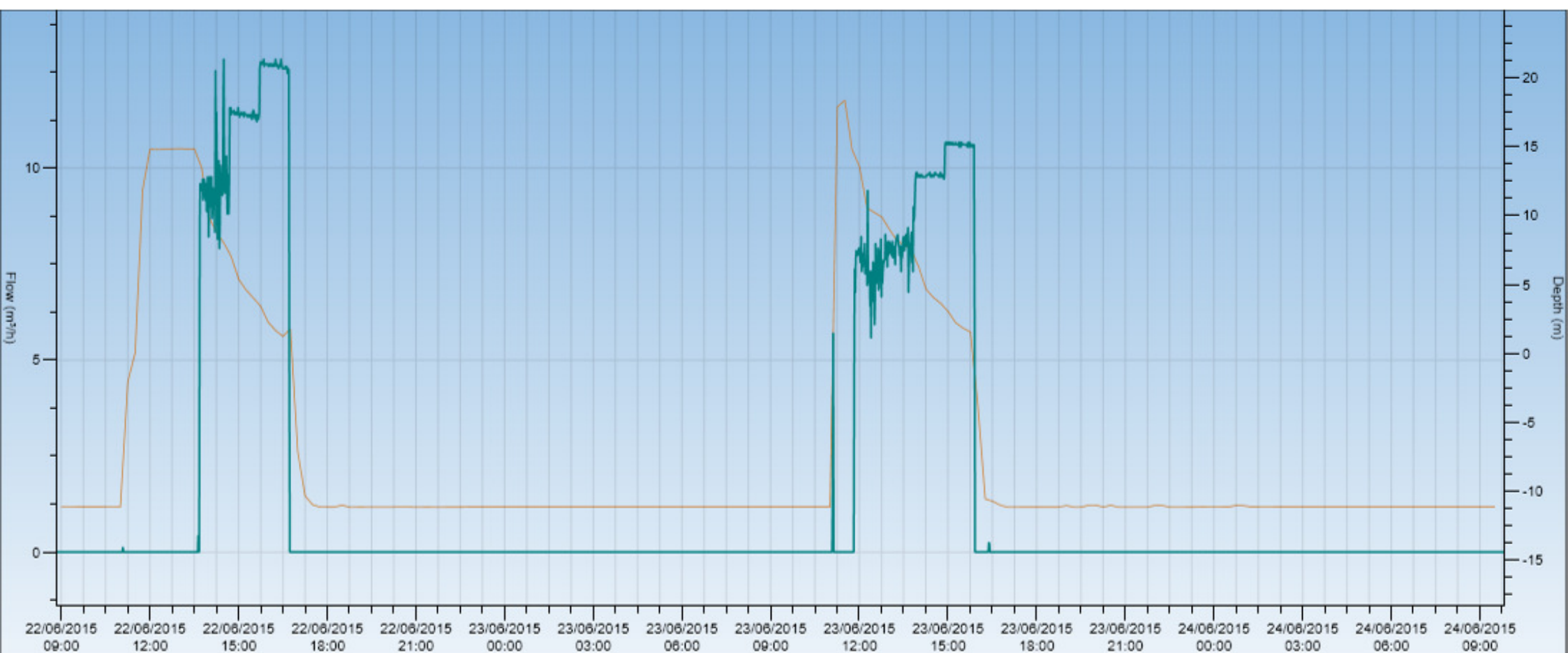
Client Name: Arup
Reference: NCH187
Location: NCH
Contact: Christopher Newton
JE Job No.: 15/7885

VOC Report : Liquid

J E Sample No.	1-13										Please see attached notes for all abbreviations and acronyms		
Sample ID	FS02												
Depth	5.0												
COC No / misc													
Containers	V H H N N P G B C												
Sample Date	26/05/2015												
Sample Type	Ground Water												
Batch Number	1										LOD/LOR	Units	Method No.
Date of Receipt	28/05/2015												
VOC MS													
Dichlorodifluoromethane	<2										<2	ug/l	TM15/PM10
Methyl Tertiary Butyl Ether #	<0.1										<0.1	ug/l	TM15/PM10
Chloromethane #	<3										<3	ug/l	TM15/PM10
Vinyl Chloride #	<0.1										<0.1	ug/l	TM15/PM10
Bromomethane	<1										<1	ug/l	TM15/PM10
Chloroethane #	<3										<3	ug/l	TM15/PM10
Trichlorofluoromethane #	<3										<3	ug/l	TM15/PM10
1,1-Dichloroethene (1,1 DCE) #	<3										<3	ug/l	TM15/PM10
Dichloromethane (DCM) #	<3										<3	ug/l	TM15/PM10
trans-1-2-Dichloroethene #	<3										<3	ug/l	TM15/PM10
1,1-Dichloroethane #	<3										<3	ug/l	TM15/PM10
cis-1-2-Dichloroethene #	<3										<3	ug/l	TM15/PM10
2,2-Dichloropropane	<1										<1	ug/l	TM15/PM10
Bromochloromethane #	<2										<2	ug/l	TM15/PM10
Chloroform #	<2										<2	ug/l	TM15/PM10
1,1,1-Trichloroethane #	<2										<2	ug/l	TM15/PM10
1,1-Dichloropropene #	<3										<3	ug/l	TM15/PM10
Carbon tetrachloride #	<2										<2	ug/l	TM15/PM10
1,2-Dichloroethane #	<2										<2	ug/l	TM15/PM10
Benzene #	<0.5										<0.5	ug/l	TM15/PM10
Trichloroethene (TCE) #	<3										<3	ug/l	TM15/PM10
1,2-Dichloropropane #	<2										<2	ug/l	TM15/PM10
Dibromomethane #	<3										<3	ug/l	TM15/PM10
Bromodichloromethane #	<2										<2	ug/l	TM15/PM10
cis-1-3-Dichloropropene	<2										<2	ug/l	TM15/PM10
Toluene #	<0.5										<0.5	ug/l	TM15/PM10
trans-1-3-Dichloropropene	<2										<2	ug/l	TM15/PM10
1,1,2-Trichloroethane #	<2										<2	ug/l	TM15/PM10
Tetrachloroethene (PCE) #	<3										<3	ug/l	TM15/PM10
1,3-Dichloropropane #	<2										<2	ug/l	TM15/PM10
Dibromochloromethane #	<2										<2	ug/l	TM15/PM10
1,2-Dibromoethane #	<2										<2	ug/l	TM15/PM10
Chlorobenzene #	<2										<2	ug/l	TM15/PM10
1,1,1,2-Tetrachloroethane #	<2										<2	ug/l	TM15/PM10
Ethylbenzene #	<0.5										<0.5	ug/l	TM15/PM10
p/m-Xylene #	<1										<1	ug/l	TM15/PM10
o-Xylene #	<0.5										<0.5	ug/l	TM15/PM10
Styrene	<2										<2	ug/l	TM15/PM10
Bromoform #	<2										<2	ug/l	TM15/PM10
Isopropylbenzene #	<3										<3	ug/l	TM15/PM10
1,1,2,2-Tetrachloroethane	<4										<4	ug/l	TM15/PM10
Bromobenzene #	<2										<2	ug/l	TM15/PM10
1,2,3-Trichloropropane #	<3										<3	ug/l	TM15/PM10
Propylbenzene #	<3										<3	ug/l	TM15/PM10
2-Chlorotoluene #	<3										<3	ug/l	TM15/PM10
1,3,5-Trimethylbenzene #	<3										<3	ug/l	TM15/PM10
4-Chlorotoluene #	<3										<3	ug/l	TM15/PM10
tert-Butylbenzene #	<3										<3	ug/l	TM15/PM10
1,2,4-Trimethylbenzene #	<3										<3	ug/l	TM15/PM10
sec-Butylbenzene #	<3										<3	ug/l	TM15/PM10
4-Isopropyltoluene #	<3										<3	ug/l	TM15/PM10
1,3-Dichlorobenzene #	<3										<3	ug/l	TM15/PM10
1,4-Dichlorobenzene #	<3										<3	ug/l	TM15/PM10
n-Butylbenzene #	<3										<3	ug/l	TM15/PM10
1,2-Dichlorobenzene #	<3										<3	ug/l	TM15/PM10
1,2-Dibromo-3-chloropropane	<2										<2	ug/l	TM15/PM10
1,2,4-Trichlorobenzene	<3										<3	ug/l	TM15/PM10
Hexachlorobutadiene	<3										<3	ug/l	TM15/PM10
1,2,3-Trichlorobenzene	<3										<3	ug/l	TM15/PM10
Surrogate Recovery Toluene D8	98										<0	%	TM15/PM10
Surrogate Recovery 4-Bromofluorobenzene	95										<0	%	TM15/PM10

Appendix H

Flow Monitoring during the Step Pump Testing



Name	Units	Min	Max	Total	
St James - 15 Minute Average Depth A1	m	-11.188 m	18.427 m		
St James - 1 Minute Average Flow D1a	m³/h	0 m³/h	12.84 m³/h	70.631	m³ ▾

Appendix I

Laboratory Results for the Abstracted Groundwater

ALS Environmental Ltd
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Mr O'Hora
Meehan Drilling Ltd
Collonbeg Farm
Collon Louth

28 July 2015

Test Report: COV/1196256/2015

Dear Mr O'Hora

Analysis of your sample(s) submitted on 23 June 2015 is now complete and we have pleasure in enclosing the appropriate test report(s).


An invoice for the analysis carried out will be sent under separate cover.

Should you have any queries regarding this report(s) or any part of our service, please contact Customer Services on +44 (0)24 7642 1213 who will be happy to discuss your requirements.

If you would like to arrange any further analysis, please contact Customer Services. To arrange container delivery or sample collection, please call the Couriers Department directly on 024 7685 6562.

Thank you for using ALS Environmental Ltd and we look forward to receiving your next samples.

Yours Sincerely,

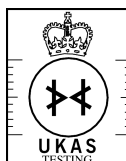
Signed: 

Name: P. Patel

Title: Inorganic Team Leader



Report Summary



1314
0897
4409



**Mr Cian O'Hora
Meehan Drilling Ltd
Collonbeg Farm
Collon
Louth**

Date of Issue: **28 July 2015**

Report Number: **COV/1196256/2015**

Issue **6**

Job Description: NCH Drinking Water & GW Testing

Number of Samples
included in this report **2**

Job Received: **23 June 2015**

Number of Test Results
included in this report **408**

Analysis Commenced: **24 June 2015**

Signed:

Name: **P. Patel**

Date: **28 July 2015**

Title: **Inorganic Team Leader**

ALS Environmental Ltd was not responsible for sampling unless otherwise stated. Sampling is not covered by our UKAS accreditation.

Information on the methods of analysis and performance characteristics are available on request.

Opinions and interpretations expressed herein are outside the scope of UKAS accreditation. The results relate only to the items tested.

Tests marked 'Not UKAS Accredited' in this Report/Certificate are not included in the UKAS Accreditation Schedule for our laboratory.

This communication has been sent to you by ALS Environmental Ltd. Registered in England and Wales. Registration No. 02148934. Registered Office: ALS Environmental Limited, Torrington Avenue, Coventry, CV4 9GU.

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Certificate of Analysis



Report Number: **COV/1196256/2015**

Issue **6**

Laboratory Number: **14666078**

Sample **1** of **2**

Sample Source: **Meehan Drilling Ltd**

Sample Point Description:

Sample Description: **FS02_T1**

Sample Matrix: **Ground Water**

Sample Date/Time: **23 June 2015**

Sample Received: **23 June 2015**

Analysis Complete: **28 July 2015**

Test Description	Result	Units	Analysis Date	Accreditation	Method
Toluene	<0.03	ug/l	26/06/2015	N Wak	WPC28
Tert-amyl-methyl-ether	<0.05	ug/l	26/06/2015	N Wak	WPC28
1,2-Dibromoethane	<0.09	ug/l	26/06/2015	N Wak	WPC28
2,3,6-Trichlorobenzoic Acid	<0.007	ug/l	06/07/2015	Y Wak	WPC45
2,4,5-T	<0.002	ug/l	06/07/2015	Y Wak	WPC45
2,4,5-TP (Fenoprop)	<0.005	ug/l	06/07/2015	Y Wak	WPC45
2,4-D	<0.006	ug/l	06/07/2015	Y Wak	WPC45
2,4-DB	<0.007	ug/l	06/07/2015	Y Wak	WPC45
2,4-DP (Dichloroprop)	<0.005	ug/l	06/07/2015	Y Wak	WPC45
Bentazone	<0.002	ug/l	06/07/2015	Y Wak	WPC45
Bromoxynil	<0.003	ug/l	06/07/2015	Y Wak	WPC45
Clopyralid	<0.020	ug/l	06/07/2015	Y Wak	WPC45
Dicamba	<0.015	ug/l	06/07/2015	Y Wak	WPC45
Ioxynil	<0.002	ug/l	06/07/2015	Y Wak	WPC45
MCPA	<0.005	ug/l	06/07/2015	Y Wak	WPC45
MCPB	<0.004	ug/l	06/07/2015	Y Wak	WPC45
MCPP (Mecoprop)	<0.004	ug/l	06/07/2015	Y Wak	WPC45
Pentachlorophenol	<0.002	ug/l	06/07/2015	Y Wak	WPC45
Triclopyr	<0.006	ug/l	06/07/2015	Y Wak	WPC45
Benazolin	<0.008	ug/l	06/07/2015	Y Wak	WPC45
Fluroxypyr	<0.006	ug/l	06/07/2015	Y Wak	WPC45
Imazapyr	<0.009	ug/l	06/07/2015	Y Wak	WPC45
Asulam	<0.003	ug/l	06/07/2015	Y Wak	WPC45
Aldicarb	<0.001	ug/l	29/06/2015	Y Wak	WPC46
Ametryn	<0.001	ug/l	29/06/2015	Y Wak	WPC46
Azinphos-methyl	<0.003	ug/l	29/06/2015	Y Wak	WPC46
Carbendazim	<0.001	ug/l	29/06/2015	Y Wak	WPC46
Chlorfenvinphos	<0.004	ug/l	29/06/2015	Y Wak	WPC46
Demeton-S-Methyl	<0.002	ug/l	29/06/2015	Y Wak	WPC46
Dichlorvos	<0.004	ug/l	29/06/2015	Y Wak	WPC46
Dimethoate	<0.003	ug/l	29/06/2015	Y Wak	WPC46
Disulphoton	<0.003	ug/l	01/07/2015	Y Wak	WPC46

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Certificate of Analysis



Report Number: **COV/1196256/2015**

Laboratory Number: **14666078**

Issue **6**

Sample **1** of **2**

Sample Source: **Meehan Drilling Ltd**

Sample Point Description:

Sample Description: **FS02_T1**

Sample Matrix: **Ground Water**

Sample Date/Time: **23 June 2015**

Sample Received: **23 June 2015**

Analysis Complete: **28 July 2015**

Test Description	Result	Units	Analysis Date	Accreditation	Method
Ethofumesate	<0.009	ug/l	01/07/2015	Y Wak	WPC46
Fenpropidin	<0.002	ug/l	01/07/2015	Y Wak	WPC46
Fenpropimorph	<0.002	ug/l	01/07/2015	Y Wak	WPC46
Fonofos	<0.004	ug/l	29/06/2015	Y Wak	WPC46
Heptenophos	<0.005	ug/l	29/06/2015	Y Wak	WPC46
Malathion	<0.003	ug/l	29/06/2015	Y Wak	WPC46
Metamitron	<0.004	ug/l	29/06/2015	Y Wak	WPC46
Methabenzthiazuron	<0.002	ug/l	29/06/2015	Y Wak	WPC46
Methiocarb	<0.004	ug/l	29/06/2015	Y Wak	WPC46
Mevinphos	<0.003	ug/l	29/06/2015	Y Wak	WPC46
Phosalone	<0.003	ug/l	03/07/2015	Y Wak	WPC46
Pirimicarb	<0.002	ug/l	29/06/2015	Y Wak	WPC46
Pirimiphos-methyl	<0.002	ug/l	29/06/2015	Y Wak	WPC46
124-Trichlorobenzene	<0.001	ug/l	07/07/2015	Y Wak	WPC50
Aldrin	<0.002	ug/l	07/07/2015	Y Wak	WPC50
Alpha-Chlordane	<0.002	ug/l	07/07/2015	Y Wak	WPC50
Alpha-Endosulphan	<0.002	ug/l	07/07/2015	Y Wak	WPC50
Alpha-HCH	<0.001	ug/l	07/07/2015	Y Wak	WPC50
Beta-Endosulphan	<0.002	ug/l	07/07/2015	Y Wak	WPC50
Beta-HCH	<0.001	ug/l	07/07/2015	Y Wak	WPC50
Carbophenothion	<0.001	ug/l	07/07/2015	Y Wak	WPC50
Chlorothalonil	<0.001	ug/l	07/07/2015	Y Wak	WPC50
cis-Heptachlor Epoxide	<0.002	ug/l	07/07/2015	Y Wak	WPC50
cis-Permethrin	<0.002	ug/l	07/07/2015	Y Wak	WPC50
Cyfluthrin	<0.001	ug/l	07/07/2015	Y Wak	WPC50
Cypermethrin	<0.001	ug/l	07/07/2015	Y Wak	WPC50
Delta-HCH	<0.003	ug/l	07/07/2015	Y Wak	WPC50
Deltamethrin	<0.003	ug/l	07/07/2015	Y Wak	WPC50
Dichlobenil	<0.002	ug/l	17/07/2015	Y Wak	WPC50
Dieldrin	<0.002	ug/l	07/07/2015	Y Wak	WPC50
Endrin	<0.002	ug/l	07/07/2015	Y Wak	WPC50
Fenitrothion	<0.002	ug/l	07/07/2015	Y Wak	WPC50
Fenvalerate	<0.001	ug/l	07/07/2015	Y Wak	WPC50

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Certificate of Analysis



Report Number: **COV/1196256/2015**

Laboratory Number: **14666078**

Issue **6**

Sample **1** of **2**

Sample Source: **Meehan Drilling Ltd**

Sample Point Description:

Sample Description: **FS02_T1**

Sample Matrix: **Ground Water**

Sample Date/Time: **23 June 2015**

Sample Received: **23 June 2015**

Analysis Complete: **28 July 2015**

Test Description	Result	Units	Analysis Date	Accreditation	Method
Gamma-HCH	<0.001	ug/l	07/07/2015	Y Wak	WPC50
Heptachlor	<0.001	ug/l	07/07/2015	Y Wak	WPC50
Hexachlorobenzene	<0.001	ug/l	07/07/2015	Y Wak	WPC50
Hexachlorobutadiene	<0.002	ug/l	07/07/2015	Y Wak	WPC50
Isodrin	<0.001	ug/l	07/07/2015	Y Wak	WPC50
Methoxychlor	<0.003	ug/l	07/07/2015	Y Wak	WPC50
op-DDE	<0.002	ug/l	07/07/2015	Y Wak	WPC50
op-DDT	<0.002	ug/l	07/07/2015	Y Wak	WPC50
op-TDE	<0.001	ug/l	07/07/2015	Y Wak	WPC50
PCB28	<0.001	ug/l	07/07/2015	Y Wak	WPC50
PCB52	<0.001	ug/l	07/07/2015	Y Wak	WPC50
PCB101	<0.001	ug/l	07/07/2015	Y Wak	WPC50
PCB118	<0.001	ug/l	07/07/2015	Y Wak	WPC50
PCB138	<0.002	ug/l	07/07/2015	Y Wak	WPC50
PCB153	<0.001	ug/l	07/07/2015	Y Wak	WPC50
PCB180	<0.002	ug/l	07/07/2015	Y Wak	WPC50
Phorate	<0.001	ug/l	07/07/2015	Y Wak	WPC50
pp-DDE	<0.001	ug/l	07/07/2015	Y Wak	WPC50
pp-DDT	<0.001	ug/l	07/07/2015	Y Wak	WPC50
pp-TDE	<0.001	ug/l	07/07/2015	Y Wak	WPC50
Tecnazene	<0.001	ug/l	07/07/2015	Y Wak	WPC50
trans-Heptachlor Epoxide	<0.001	ug/l	07/07/2015	Y Wak	WPC50
trans-Permethrin	<0.001	ug/l	07/07/2015	Y Wak	WPC50
Trifluralin	<0.001	ug/l	07/07/2015	Y Wak	WPC50
Prometryn	<0.002	ug/l	29/06/2015	Y Wak	WPC46
Propazine	<0.002	ug/l	29/06/2015	Y Wak	WPC46
Propetamphos	<0.003	ug/l	29/06/2015	Y Wak	WPC46
Terbutryn	<0.002	ug/l	29/06/2015	Y Wak	WPC46
Triadimefon	<0.002	ug/l	29/06/2015	Y Wak	WPC46
Triazophos	<0.003	ug/l	29/06/2015	Y Wak	WPC46
Parathion-ethyl	<0.004	ug/l	29/06/2015	Y Wak	WPC46
Xylene, Total	0.0	ug/l	26/06/2015	N Wak	WPC28
Acrylamide	<0.005	ug/l	26/06/2015	Y Wak	WPC53

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Report Number: **COV/1196256/2015**

Laboratory Number: **14666078**

Issue **6**

Sample **1** of **2**

Sample Source: **Meehan Drilling Ltd**

Sample Point Description:

Sample Description: **FS02_T1**

Sample Matrix: **Ground Water**

Sample Date/Time: **23 June 2015**

Sample Received: **23 June 2015**

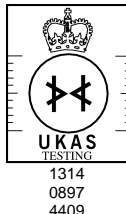
Analysis Complete: **28 July 2015**

Test Description	Result	Units	Analysis Date	Accreditation	Method
PAH Total ug/l	0	ug/l	03/07/2015	N Wak	WPC27
Sulphur, Total as SO4	76.1	mg/l	25/06/2015	Y Wak	WPC12
EPTC	<0.006	ug/l	29/06/2015	Y Wak	WPC43
Boron, Total as B	85.7	ug/l	26/06/2015	Y Wak	WPC12
Boscalid	<0.004	ug/l	29/06/2015	Y Wak	WPC43
Metoxuron	<0.002	ug/l	29/06/2015	Y Wak	WPC43
Tebuconazole	<0.002	ug/l	29/06/2015	Y Wak	WPC43
Enterococci	0	cfu/100ml	29/06/2015	N S	SUBCON
Total Coliforms	0	cfu/100ml	29/06/2015	N S	SUBCON
E-Coli	0	cfu/100ml	29/06/2015	N S	SUBCON
Clostridium Perfringens	0	cfu/100ml	29/06/2015	N S	SUBCON
Tritium	<5.0	Bq/l	08/07/2015	Y S	SUBCON
Aluminium, Total as Al	58.6	ug/l	26/06/2015	Y Wak	WPC12
Iron, Total as Fe	291	ug/l	26/06/2015	Y Wak	WPC12
Antimony, Total as Sb	0.9040	ug/l	25/06/2015	Y Wak	WPC15
Arsenic, Total as As	1.13	ug/l	25/06/2015	Y Wak	WPC15
Boron, Total as B	0.086	mg/l	26/06/2015	N Wak	WPC12
Manganese, Total as Mn	58.2	ug/l	26/06/2015	Y Wak	WPC12
Cadmium, Total as Cd	0.032	ug/l	25/06/2015	Y Wak	WPC15
Chromium, Total as Cr	2.47	ug/l	25/06/2015	Y Wak	WPC15
Sodium, Total as Na	26.2	mg/l	26/06/2015	Y Wak	WPC12
Copper, Total as Cu	0.0222	mg/l	25/06/2015	N Wak	WPC15
Lead, Total as Pb	4.35	ug/l	25/06/2015	Y Wak	WPC15
Nickel, Total as Ni	1.29	ug/l	25/06/2015	Y Wak	WPC15
Selenium, Total as Se	1.76	ug/l	25/06/2015	Y Wak	WPC15
Hydrogen ion (pH)	7.26	pH units	24/06/2015	Y Wak	WPC8/WPC40
Conductivity	724	uS/cm	24/06/2015	Y Wak	WPC7/WPC40
Turbidity	2.05	NTU	24/06/2015	Y Wak	WPC6/WPC40
Total organic carbon	0.52	mg/l	26/06/2015	Y Wak	WPC24
Ammonium ammonia+ammonium ion	0.158	mg/l	26/06/2015	Y Wak	WPC10
Nitrite as NO2	<0.009	mg/l	26/06/2015	Y Wak	WPC10
Nitrate as NO3	<0.37	mg/l	28/06/2015	Y Wak	CALC
Chloride as Cl	38.4	mg/l	26/06/2015	Y Wak	WPC10

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Certificate of Analysis



Report Number: **COV/1196256/2015**

Laboratory Number: **14666078**

Issue **6**

Sample **1** of **2**

Sample Source: **Meehan Drilling Ltd**

Sample Point Description:

Sample Description: **FS02_T1**

Sample Matrix: **Ground Water**

Sample Date/Time: **23 June 2015**

Sample Received: **23 June 2015**

Analysis Complete: **28 July 2015**

Test Description	Result	Units	Analysis Date	Accreditation	Method
Total Oxidised Nitrogen as NO3	<0.37	mg/l	28/06/2015	Y Wak	WPC10
Bromate as BrO3	<0.1	ug/l	26/06/2015	Y Wak	WPC42/WPC5
Cyanide, Total as CN	<0.5	ug/l	26/06/2015	Y Wak	WPC19
Fluoride, Total as F	0.68	mg/l	29/06/2015	Y Wak	WPC20
Mercury, Total as Hg	<0.02	ug/l	26/06/2015	Y Wak	WPC21
Chlorodibromomethane	<0.09	ug/l	26/06/2015	Y Wak	WPC28
Bromodichloromethane	<0.06	ug/l	26/06/2015	Y Wak	WPC28
Tetrachloroethene	<0.05	ug/l	26/06/2015	Y Wak	WPC28
Tetrachloromethane	<0.02	ug/l	26/06/2015	Y Wak	WPC28
Bromoform	<0.15	ug/l	26/06/2015	Y Wak	WPC28
1,1,1-Trichloroethane	<0.04	ug/l	26/06/2015	Y Wak	WPC28
Trichloroethene	<0.05	ug/l	26/06/2015	Y Wak	WPC28
Chloroform	<0.30	ug/l	26/06/2015	Y Wak	WPC28
1,2-Dichloroethane	<0.07	ug/l	26/06/2015	Y Wak	WPC28
Benzene	<0.02	ug/l	26/06/2015	Y Wak	WPC28
Ethylbenzene	<0.03	ug/l	26/06/2015	Y Wak	WPC28
m&p-Xylene	<0.05	ug/l	26/06/2015	Y Wak	WPC28
o-Xylene	<0.04	ug/l	26/06/2015	Y Wak	WPC28
MTBE	<0.06	ug/l	26/06/2015	Y Wak	WPC28
THM, Total	0.00	ug/l	26/06/2015	N Wak	WPC28
Tetra and Trichloroethene	0.00	ug/l	26/06/2015	N Wak	WPC28
Benzo(b)fluoranthene	<0.31	ng/l	03/07/2015	Y Wak	WPC27
Benzo(k)fluoranthene	<0.41	ng/l	03/07/2015	Y Wak	WPC27
Benzo(ghi)perylene	<0.41	ng/l	03/07/2015	Y Wak	WPC27
Benzo(a)pyrene	<0.32	ng/l	03/07/2015	Y Wak	WPC27
Fluoranthene	<1.15	ng/l	03/07/2015	Y Wak	WPC27
Indeno(1,2,3cd)pyrene	<0.88	ng/l	03/07/2015	Y Wak	WPC27
Total PAHs 4 Constituents	0	ug/l	03/07/2015	Y Wak	WPC27
Atrazine	<0.002	ug/l	29/06/2015	Y Wak	WPC43
Cyanazine	<0.002	ug/l	29/06/2015	Y Wak	WPC43
Simazine	<0.003	ug/l	29/06/2015	Y Wak	WPC43
Trietazine	<0.003	ug/l	29/06/2015	Y Wak	WPC43
Carbetamide	<0.002	ug/l	29/06/2015	Y Wak	WPC43

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Report Number: **COV/1196256/2015**

Laboratory Number: **14666078**

Issue **6**

Sample **1** of **2**

Sample Source: **Meehan Drilling Ltd**

Sample Point Description:

Sample Description: **FS02_T1**

Sample Matrix: **Ground Water**

Sample Date/Time: **23 June 2015**

Sample Received: **23 June 2015**

Analysis Complete: **28 July 2015**

Test Description	Result	Units	Analysis Date	Accreditation	Method
Chlortoluron	<0.002	ug/l	29/06/2015	Y Wak	WPC43
Diuron	<0.003	ug/l	29/06/2015	Y Wak	WPC43
Isoproturon	<0.002	ug/l	29/06/2015	Y Wak	WPC43
Linuron	<0.003	ug/l	29/06/2015	Y Wak	WPC43
Monuron	<0.002	ug/l	29/06/2015	Y Wak	WPC43
Chlorpropham	<0.003	ug/l	29/06/2015	Y Wak	WPC43
Diazinon	<0.001	ug/l	29/06/2015	Y Wak	WPC43
Chlorpyrifos Ethyl	<0.003	ug/l	29/06/2015	Y Wak	WPC43
Propham	<0.003	ug/l	29/06/2015	Y Wak	WPC43
Prosulfocarb	<0.002	ug/l	29/06/2015	Y Wak	WPC43
Clomazone	<0.003	ug/l	29/06/2015	Y Wak	WPC43
Difenconazole	<0.002	ug/l	29/06/2015	Y Wak	WPC43
Flufenacet	<0.002	ug/l	29/06/2015	Y Wak	WPC43
Flurtamone	<0.002	ug/l	29/06/2015	Y Wak	WPC43
Quinmerac	<0.002	ug/l	29/06/2015	Y Wak	WPC43
Oxadixyl	<0.003	ug/l	29/06/2015	Y Wak	WPC43
Epoxiconazole	<0.002	ug/l	29/06/2015	Y Wak	WPC43
Cyproconazole	<0.002	ug/l	29/06/2015	Y Wak	WPC43
Flusilazole	<0.002	ug/l	29/06/2015	Y Wak	WPC43
Chlorpyrifos Methyl	<0.008	ug/l	29/06/2015	Y Wak	WPC43
Carbaryl	<0.002	ug/l	29/06/2015	Y Wak	WPC43
Chloridazon	<0.003	ug/l	29/06/2015	Y Wak	WPC43
Metalaxyl	<0.002	ug/l	29/06/2015	Y Wak	WPC43
Kresoxim-Methyl	<0.007	ug/l	01/07/2015	Y Wak	WPC43
Triallate	<0.003	ug/l	29/06/2015	Y Wak	WPC43
Diflufenican	<0.002	ug/l	29/06/2015	Y Wak	WPC43
Bromacil	<0.003	ug/l	29/06/2015	Y Wak	WPC43
Flutriafol	<0.002	ug/l	29/06/2015	Y Wak	WPC43
Metazachlor	<0.002	ug/l	29/06/2015	Y Wak	WPC43
Pendimethalin	<0.002	ug/l	29/06/2015	Y Wak	WPC43
Propachlor	<0.002	ug/l	29/06/2015	Y Wak	WPC43
Propiconazole	<0.002	ug/l	29/06/2015	Y Wak	WPC43
Propyzamide	<0.002	ug/l	29/06/2015	Y Wak	WPC43

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Laboratory Number: **14666078**

Issue **6**

Sample **1** of **2**

Sample Source: **Meehan Drilling Ltd**

Sample Point Description:

Sample Description: **FS02_T1**

Sample Matrix: **Ground Water**

Sample Date/Time: **23 June 2015**

Sample Received: **23 June 2015**

Analysis Complete: **28 July 2015**

Test Description	Result	Units	Analysis Date	Accreditation	Method
Chlorbufam	<0.005	ug/l	01/07/2015	Y Wak	WPC43
VOC	Y	ug/l	02/07/2015	N Cov	GEO32
Vinyl Chloride	<0.5	ug/l	02/07/2015	Y Cov	GEO32
Dibromofluoromethane	100.1	%Recovery	02/07/2015	N Cov	GEO32
Toluene-d8	99.3	%Recovery	02/07/2015	N Cov	GEO32
4-Bromofluorobenzene	84.7	%Recovery	02/07/2015	N Cov	GEO32
Epichlorohydrin	<0.1	ug/l	29/06/2015	N Cov	GEO52

Analyst Comments for 14666078:

{/*}L.O.D raised for dichlobenil as sample was repeated on dilution due to a drift failure{*/}

Accreditation Codes: Y = UKAS / ISO17025 Accredited, N = Not UKAS / ISO17025 Accredited, M = MCERTS.

Analysed at: Cov = Coventry(CV4 9GU), Run = Runcorn(WA7 1SL), S = Subcontracted, Trb = Subcontracted to Trowbridge(BA14 0XD), Wak = Wakefield(WF5 9TG).

For Microbiological determinands 0 or ND=Not Detected, For Legionella ND=Not Detected in volume of sample filtered. The LOD for the Legionella analysis will increase where the volume analysed is <1000g (1g is approximately equivalent to 1ml for sample volume analysed).

I/S=Insufficient sample For soil/sludge samples: AR=As received, DW=Dry weight.

Signed:

Name: **P. Patel**

Date: **28 July 2015**

Title: **Inorganic Team Leader**

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Report Number: **COV/1196256/2015**

Issue **6**

Laboratory Number: **14666079**

Sample **2** of **2**

Sample Source: **Meehan Drilling Ltd**

Sample Point Description:

Sample Description: **FS01_T1**

Sample Matrix: **Ground Water**

Sample Date/Time: **23 June 2015**

Sample Received: **23 June 2015**

Analysis Complete: **28 July 2015**

Test Description	Result	Units	Analysis Date	Accreditation	Method
Toluene	<0.03	ug/l	26/06/2015	N Wak	WPC28
Tert-amyl-methyl-ether	<0.05	ug/l	26/06/2015	N Wak	WPC28
1,2-Dibromoethane	<0.09	ug/l	26/06/2015	N Wak	WPC28
2,3,6-Trichlorobenzoic Acid	<0.007	ug/l	06/07/2015	Y Wak	WPC45
2,4,5-T	<0.002	ug/l	06/07/2015	Y Wak	WPC45
2,4,5-TP (Fenoprop)	<0.005	ug/l	06/07/2015	Y Wak	WPC45
2,4-D	<0.006	ug/l	06/07/2015	Y Wak	WPC45
2,4-DB	<0.007	ug/l	06/07/2015	Y Wak	WPC45
2,4-DP (Dichloroprop)	<0.005	ug/l	06/07/2015	Y Wak	WPC45
Bentazone	<0.002	ug/l	06/07/2015	Y Wak	WPC45
Bromoxynil	<0.003	ug/l	06/07/2015	Y Wak	WPC45
Clopyralid	<0.020	ug/l	06/07/2015	Y Wak	WPC45
Dicamba	<0.015	ug/l	06/07/2015	Y Wak	WPC45
Ioxynil	<0.002	ug/l	06/07/2015	Y Wak	WPC45
MCPA	<0.005	ug/l	06/07/2015	Y Wak	WPC45
MCPB	<0.004	ug/l	06/07/2015	Y Wak	WPC45
MCPB (Mecoprop)	<0.004	ug/l	06/07/2015	Y Wak	WPC45
Pentachlorophenol	<0.002	ug/l	06/07/2015	Y Wak	WPC45
Triclopyr	<0.006	ug/l	06/07/2015	Y Wak	WPC45
Benazolin	<0.008	ug/l	06/07/2015	Y Wak	WPC45
Fluroxypyr	<0.006	ug/l	06/07/2015	Y Wak	WPC45
Imazapyr	<0.009	ug/l	06/07/2015	Y Wak	WPC45
Asulam	<0.003	ug/l	06/07/2015	Y Wak	WPC45
Aldicarb	<0.001	ug/l	29/06/2015	Y Wak	WPC46
Ametryn	<0.001	ug/l	29/06/2015	Y Wak	WPC46
Azinphos-methyl	<0.003	ug/l	29/06/2015	Y Wak	WPC46
Carbendazim	<0.001	ug/l	29/06/2015	Y Wak	WPC46
Chlorfenvinphos	<0.004	ug/l	29/06/2015	Y Wak	WPC46
Demeton-S-Methyl	<0.002	ug/l	29/06/2015	Y Wak	WPC46
Dichlorvos	<0.004	ug/l	29/06/2015	Y Wak	WPC46
Dimethoate	<0.003	ug/l	29/06/2015	Y Wak	WPC46
Disulphoton	<0.003	ug/l	01/07/2015	Y Wak	WPC46

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Report Number: **COV/1196256/2015**

Laboratory Number: **14666079**

Issue **6**

Sample **2** of **2**

Sample Source: **Meehan Drilling Ltd**

Sample Point Description:

Sample Description: **FS01_T1**

Sample Matrix: **Ground Water**

Sample Date/Time: **23 June 2015**

Sample Received: **23 June 2015**

Analysis Complete: **28 July 2015**

Test Description	Result	Units	Analysis Date	Accreditation	Method
Ethofumesate	<0.009	ug/l	01/07/2015	Y Wak	WPC46
Fenpropidin	<0.002	ug/l	01/07/2015	Y Wak	WPC46
Fenpropimorph	<0.002	ug/l	01/07/2015	Y Wak	WPC46
Fonofos	<0.004	ug/l	29/06/2015	Y Wak	WPC46
Heptenophos	<0.005	ug/l	29/06/2015	Y Wak	WPC46
Malathion	<0.003	ug/l	29/06/2015	Y Wak	WPC46
Metamitron	<0.004	ug/l	29/06/2015	Y Wak	WPC46
Methabenzthiazuron	<0.002	ug/l	29/06/2015	Y Wak	WPC46
Methiocarb	<0.004	ug/l	29/06/2015	Y Wak	WPC46
Mevinphos	<0.003	ug/l	29/06/2015	Y Wak	WPC46
Phosalone	<0.003	ug/l	03/07/2015	Y Wak	WPC46
Pirimicarb	<0.002	ug/l	29/06/2015	Y Wak	WPC46
Pirimiphos-methyl	<0.002	ug/l	29/06/2015	Y Wak	WPC46
124-Trichlorobenzene	<0.005	ug/l	20/07/2015	Y Wak	WPC50
Aldrin	<0.005	ug/l	20/07/2015	Y Wak	WPC50
Alpha-Chlordane	<0.005	ug/l	20/07/2015	Y Wak	WPC50
Alpha-Endosulphan	<0.010	ug/l	20/07/2015	Y Wak	WPC50
Alpha-HCH	<0.005	ug/l	20/07/2015	Y Wak	WPC50
Beta-Endosulphan	<0.010	ug/l	20/07/2015	Y Wak	WPC50
Beta-HCH	<0.005	ug/l	20/07/2015	Y Wak	WPC50
Carbophenothion	<0.010	ug/l	20/07/2015	Y Wak	WPC50
Chlorothalonil	<0.010	ug/l	20/07/2015	Y Wak	WPC50
cis-Heptachlor Epoxide	<0.005	ug/l	20/07/2015	Y Wak	WPC50
cis-Permethrin	<0.010	ug/l	20/07/2015	Y Wak	WPC50
Cyfluthrin	<0.005	ug/l	20/07/2015	Y Wak	WPC50
Cypermethrin	<0.005	ug/l	20/07/2015	Y Wak	WPC50
Delta-HCH	<0.005	ug/l	20/07/2015	Y Wak	WPC50
Deltamethrin	<0.010	ug/l	20/07/2015	Y Wak	WPC50
Dichlobenil	<0.005	ug/l	20/07/2015	Y Wak	WPC50
Dieldrin	<0.005	ug/l	20/07/2015	Y Wak	WPC50
Endrin	<0.010	ug/l	20/07/2015	Y Wak	WPC50
Fenitrothion	<0.005	ug/l	20/07/2015	Y Wak	WPC50
Fenvalerate	<0.005	ug/l	20/07/2015	Y Wak	WPC50

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Issue **6**

Sample **2** of **2**

Sample Source: **Meehan Drilling Ltd**

Sample Point Description:

Sample Description: **FS01_T1**

Sample Matrix: **Ground Water**

Sample Date/Time: **23 June 2015**

Sample Received: **23 June 2015**

Analysis Complete: **28 July 2015**

Test Description	Result	Units	Analysis Date	Accreditation	Method
Gamma-HCH	<0.005	ug/l	20/07/2015	Y Wak	WPC50
Heptachlor	<0.005	ug/l	20/07/2015	Y Wak	WPC50
Hexachlorobenzene	<0.005	ug/l	20/07/2015	Y Wak	WPC50
Hexachlorobutadiene	<0.005	ug/l	28/07/2015	Y Wak	WPC50
Isodrin	<0.005	ug/l	20/07/2015	Y Wak	WPC50
Methoxychlor	<0.005	ug/l	20/07/2015	Y Wak	WPC50
op-DDE	<0.005	ug/l	20/07/2015	Y Wak	WPC50
op-DDT	<0.005	ug/l	20/07/2015	Y Wak	WPC50
op-TDE	<0.005	ug/l	20/07/2015	Y Wak	WPC50
PCB28	<0.005	ug/l	20/07/2015	Y Wak	WPC50
PCB52	<0.005	ug/l	20/07/2015	Y Wak	WPC50
PCB101	<0.005	ug/l	20/07/2015	Y Wak	WPC50
PCB118	<0.005	ug/l	20/07/2015	Y Wak	WPC50
PCB138	<0.005	ug/l	20/07/2015	Y Wak	WPC50
PCB153	<0.005	ug/l	20/07/2015	Y Wak	WPC50
PCB180	<0.005	ug/l	20/07/2015	Y Wak	WPC50
Phorate	<0.005	ug/l	20/07/2015	Y Wak	WPC50
pp-DDE	<0.005	ug/l	20/07/2015	Y Wak	WPC50
pp-DDT	<0.005	ug/l	20/07/2015	Y Wak	WPC50
pp-TDE	<0.005	ug/l	20/07/2015	Y Wak	WPC50
Tecnazene	<0.005	ug/l	20/07/2015	Y Wak	WPC50
trans-Heptachlor Epoxide	<0.005	ug/l	20/07/2015	Y Wak	WPC50
trans-Permethrin	<0.010	ug/l	20/07/2015	Y Wak	WPC50
Trifluralin	<0.005	ug/l	20/07/2015	Y Wak	WPC50
Prometryn	<0.002	ug/l	29/06/2015	Y Wak	WPC46
Propazine	<0.002	ug/l	29/06/2015	Y Wak	WPC46
Propetamphos	<0.003	ug/l	29/06/2015	Y Wak	WPC46
Terbutryn	<0.002	ug/l	29/06/2015	Y Wak	WPC46
Triadimefon	<0.002	ug/l	29/06/2015	Y Wak	WPC46
Triazophos	<0.003	ug/l	29/06/2015	Y Wak	WPC46
Parathion-ethyl	<0.004	ug/l	29/06/2015	Y Wak	WPC46
Xylene, Total	0.0	ug/l	26/06/2015	N Wak	WPC28
Acrylamide	0.014	ug/l	26/06/2015	Y Wak	WPC53

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Report Number: **COV/1196256/2015**

Laboratory Number: **14666079**

Issue **6**

Sample **2** of **2**

Sample Source: **Meehan Drilling Ltd**

Sample Point Description:

Sample Description: **FS01_T1**

Sample Matrix: **Ground Water**

Sample Date/Time: **23 June 2015**

Sample Received: **23 June 2015**

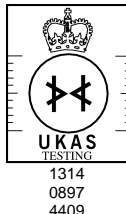
Analysis Complete: **28 July 2015**

Test Description	Result	Units	Analysis Date	Accreditation	Method
PAH Total ug/l	0	ug/l	03/07/2015	N Wak	WPC27
Sulphur, Total as SO4	178	mg/l	25/06/2015	Y Wak	WPC12
EPTC	<0.006	ug/l	29/06/2015	Y Wak	WPC43
Boron, Total as B	168	ug/l	26/06/2015	Y Wak	WPC12
Boscalid	<0.004	ug/l	29/06/2015	Y Wak	WPC43
Metoxuron	<0.002	ug/l	29/06/2015	Y Wak	WPC43
Tebuconazole	<0.002	ug/l	29/06/2015	Y Wak	WPC43
Enterococci	0	cfu/100ml	29/06/2015	N S	SUBCON
Total Coliforms	0	cfu/100ml	29/06/2015	N S	SUBCON
E-Coli	0	cfu/100ml	29/06/2015	N S	SUBCON
Clostridium Perfringens	1	cfu/100ml	29/06/2015	N S	SUBCON
Tritium	<5.0	Bq/l	08/07/2015	Y S	SUBCON
Aluminium, Total as Al	153	ug/l	26/06/2015	Y Wak	WPC12
Iron, Total as Fe	216	ug/l	26/06/2015	Y Wak	WPC12
Antimony, Total as Sb	11.3	ug/l	26/06/2015	Y Wak	WPC15
Arsenic, Total as As	4.92	ug/l	25/06/2015	Y Wak	WPC15
Boron, Total as B	0.168	mg/l	26/06/2015	N Wak	WPC12
Manganese, Total as Mn	41.0	ug/l	26/06/2015	Y Wak	WPC12
Cadmium, Total as Cd	0.167	ug/l	25/06/2015	Y Wak	WPC15
Chromium, Total as Cr	2.31	ug/l	25/06/2015	Y Wak	WPC15
Sodium, Total as Na	39.1	mg/l	26/06/2015	Y Wak	WPC12
Copper, Total as Cu	0.0174	mg/l	25/06/2015	N Wak	WPC15
Lead, Total as Pb	3.75	ug/l	25/06/2015	Y Wak	WPC15
Nickel, Total as Ni	1.59	ug/l	25/06/2015	Y Wak	WPC15
Selenium, Total as Se	5.49	ug/l	25/06/2015	Y Wak	WPC15
Hydrogen ion (pH)	7.28	pH units	24/06/2015	Y Wak	WPC8/WPC40
Conductivity	897	uS/cm	24/06/2015	Y Wak	WPC7/WPC40
Turbidity	5.01	NTU	24/06/2015	Y Wak	WPC6/WPC40
Total organic carbon	0.57	mg/l	26/06/2015	Y Wak	WPC24
Ammonium ammonia+ammonium ion	0.410	mg/l	26/06/2015	Y Wak	WPC10
Nitrite as NO2	<0.009	mg/l	26/06/2015	Y Wak	WPC10
Nitrate as NO3	<0.37	mg/l	28/06/2015	Y Wak	CALC
Chloride as Cl	51.3	mg/l	26/06/2015	Y Wak	WPC10

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Issue **6**

Sample **2** of **2**

Sample Source: **Meehan Drilling Ltd**

Sample Point Description:

Sample Description: **FS01_T1**

Sample Matrix: **Ground Water**

Sample Date/Time: **23 June 2015**

Sample Received: **23 June 2015**

Analysis Complete: **28 July 2015**

Test Description	Result	Units	Analysis Date	Accreditation	Method
Total Oxidised Nitrogen as NO3	<0.37	mg/l	28/06/2015	Y Wak	WPC10
Bromate as BrO3	<0.1	ug/l	26/06/2015	Y Wak	WPC42/WPC5
Cyanide, Total as CN	<0.5	ug/l	26/06/2015	Y Wak	WPC19
Fluoride, Total as F	0.97	mg/l	29/06/2015	Y Wak	WPC20
Mercury, Total as Hg	<0.02	ug/l	26/06/2015	Y Wak	WPC21
Chlorodibromomethane	<0.09	ug/l	26/06/2015	Y Wak	WPC28
Bromodichloromethane	<0.06	ug/l	26/06/2015	Y Wak	WPC28
Tetrachloroethene	<0.05	ug/l	26/06/2015	Y Wak	WPC28
Tetrachloromethane	<0.02	ug/l	26/06/2015	Y Wak	WPC28
Bromoform	<0.15	ug/l	26/06/2015	Y Wak	WPC28
1,1,1-Trichloroethane	<0.04	ug/l	26/06/2015	Y Wak	WPC28
Trichloroethene	<0.05	ug/l	26/06/2015	Y Wak	WPC28
Chloroform	<0.30	ug/l	26/06/2015	Y Wak	WPC28
1,2-Dichloroethane	<0.07	ug/l	26/06/2015	Y Wak	WPC28
Benzene	<0.02	ug/l	26/06/2015	Y Wak	WPC28
Ethylbenzene	<0.03	ug/l	26/06/2015	Y Wak	WPC28
m&p-Xylene	<0.05	ug/l	26/06/2015	Y Wak	WPC28
o-Xylene	<0.04	ug/l	26/06/2015	Y Wak	WPC28
MTBE	<0.06	ug/l	26/06/2015	Y Wak	WPC28
THM, Total	0.00	ug/l	26/06/2015	N Wak	WPC28
Tetra and Trichloroethene	0.00	ug/l	26/06/2015	N Wak	WPC28
Benzo(b)fluoranthene	<0.31	ng/l	03/07/2015	Y Wak	WPC27
Benzo(k)fluoranthene	<0.41	ng/l	03/07/2015	Y Wak	WPC27
Benzo(ghi)perylene	<0.41	ng/l	03/07/2015	Y Wak	WPC27
Benzo(a)pyrene	<0.32	ng/l	03/07/2015	Y Wak	WPC27
Fluoranthene	<1.15	ng/l	03/07/2015	Y Wak	WPC27
Indeno(1,2,3cd)pyrene	<0.88	ng/l	03/07/2015	Y Wak	WPC27
Total PAHs 4 Constituents	0	ug/l	03/07/2015	Y Wak	WPC27
Atrazine	<0.002	ug/l	29/06/2015	Y Wak	WPC43
Cyanazine	<0.002	ug/l	29/06/2015	Y Wak	WPC43
Simazine	<0.003	ug/l	29/06/2015	Y Wak	WPC43
Trietazine	<0.003	ug/l	29/06/2015	Y Wak	WPC43
Carbetamide	<0.002	ug/l	29/06/2015	Y Wak	WPC43

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Certificate of Analysis



Report Number: **COV/1196256/2015**

Laboratory Number: **14666079**

Issue **6**

Sample **2** of **2**

Sample Source: **Meehan Drilling Ltd**

Sample Point Description:

Sample Description: **FS01_T1**

Sample Matrix: **Ground Water**

Sample Date/Time: **23 June 2015**

Sample Received: **23 June 2015**

Analysis Complete: **28 July 2015**

Test Description	Result	Units	Analysis Date	Accreditation	Method
Chlortoluron	<0.002	ug/l	29/06/2015	Y Wak	WPC43
Diuron	<0.003	ug/l	29/06/2015	Y Wak	WPC43
Isoproturon	<0.002	ug/l	29/06/2015	Y Wak	WPC43
Linuron	<0.003	ug/l	29/06/2015	Y Wak	WPC43
Monuron	<0.002	ug/l	29/06/2015	Y Wak	WPC43
Chlorpropham	<0.003	ug/l	29/06/2015	Y Wak	WPC43
Diazinon	<0.001	ug/l	29/06/2015	Y Wak	WPC43
Chlorpyrifos Ethyl	<0.003	ug/l	29/06/2015	Y Wak	WPC43
Propham	<0.003	ug/l	29/06/2015	Y Wak	WPC43
Prosulfocarb	<0.002	ug/l	29/06/2015	Y Wak	WPC43
Clomazone	<0.003	ug/l	29/06/2015	Y Wak	WPC43
Difenconazole	<0.002	ug/l	29/06/2015	Y Wak	WPC43
Flufenacet	<0.002	ug/l	29/06/2015	Y Wak	WPC43
Flurtamone	<0.002	ug/l	29/06/2015	Y Wak	WPC43
Quinmerac	<0.002	ug/l	29/06/2015	Y Wak	WPC43
Oxadixyl	<0.003	ug/l	29/06/2015	Y Wak	WPC43
Epoxiconazole	<0.002	ug/l	29/06/2015	Y Wak	WPC43
Cyproconazole	<0.002	ug/l	29/06/2015	Y Wak	WPC43
Flusilazole	<0.002	ug/l	29/06/2015	Y Wak	WPC43
Chlorpyrifos Methyl	<0.008	ug/l	29/06/2015	Y Wak	WPC43
Carbaryl	<0.002	ug/l	29/06/2015	Y Wak	WPC43
Chloridazon	<0.003	ug/l	29/06/2015	Y Wak	WPC43
Metalaxyl	<0.002	ug/l	29/06/2015	Y Wak	WPC43
Kresoxim-Methyl	<0.007	ug/l	01/07/2015	Y Wak	WPC43
Triallate	<0.003	ug/l	29/06/2015	Y Wak	WPC43
Diflufenican	<0.002	ug/l	29/06/2015	Y Wak	WPC43
Bromacil	<0.003	ug/l	29/06/2015	Y Wak	WPC43
Flutriafol	<0.002	ug/l	29/06/2015	Y Wak	WPC43
Metazachlor	<0.002	ug/l	29/06/2015	Y Wak	WPC43
Pendimethalin	<0.002	ug/l	29/06/2015	Y Wak	WPC43
Propachlor	<0.002	ug/l	29/06/2015	Y Wak	WPC43
Propiconazole	<0.002	ug/l	29/06/2015	Y Wak	WPC43
Propyzamide	<0.002	ug/l	29/06/2015	Y Wak	WPC43

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Report Number: **COV/1196256/2015**

Laboratory Number: **14666079**

Issue **6**

Sample **2** of **2**

Sample Source: **Meehan Drilling Ltd**

Sample Point Description:

Sample Description: **FS01_T1**

Sample Matrix: **Ground Water**

Sample Date/Time: **23 June 2015**

Sample Received: **23 June 2015**

Analysis Complete: **28 July 2015**

Test Description	Result	Units	Analysis Date	Accreditation	Method
Chlorbufam	<0.005	ug/l	01/07/2015	Y Wak	WPC43
VOC	Y	ug/l	02/07/2015	N Cov	GEO32
Vinyl Chloride	<0.5	ug/l	02/07/2015	Y Cov	GEO32
Dibromofluoromethane	99.8	%Recovery	02/07/2015	N Cov	GEO32
Toluene-d8	99.5	%Recovery	02/07/2015	N Cov	GEO32
4-Bromofluorobenzene	95.9	%Recovery	02/07/2015	N Cov	GEO32
Epichlorohydrin	<0.1	ug/l	29/06/2015	N Cov	GEO52

Analyst Comments for 14666079:

{/*}Non-Polar analysis - L.O.D raised (x5) due to sample being carried out on dilution following a surrogate failure{/*}

Accreditation Codes: Y = UKAS / ISO17025 Accredited, N = Not UKAS / ISO17025 Accredited, M = MCERTS.

Analysed at: Cov = Coventry(CV4 9GU), Run = Runcorn(WA7 1SL), S = Subcontracted, Trb = Subcontracted to Trowbridge(BA14 0XD), Wak = Wakefield(WF5 9TG).

For Microbiological determinands 0 or ND=Not Detected, For Legionella ND=Not Detected in volume of sample filtered. The LOD for the Legionella analysis will increase where the volume analysed is <1000g (1g is approximately equivalent to 1ml for sample volume analysed).

I/S=Insufficient sample For soil/sludge samples: AR=As received, DW=Dry weight.

Signed:

Name: **P. Patel**

Date: **28 July 2015**

Title: **Inorganic Team Leader**

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ANALYST COMMENTS FOR REPORT

COV/1196256/2015

Issue 6

Date of Issue: 28 July 2015

Sample No	Analysis Comments
14666078	{/*}L.O.D raised for dichlobenil as sample was repeated on dilution due to a drift failure{*/}
14666079	{/*}Non-Polar analysis - L.O.D raised (x5) due to sample being carried out on dilution following a surrogate failure{*/}

Signed:



Name: **P. Patel**

Date: **28 July 2015**


Title: **Inorganic Team Leader**

DETERMINAND COMMENTS FOR REPORT COV/1196256/2015

ISSUE 6

Date of Issue : 28 July 2015

Sample No	Description	Determinand	Comments

Signed: 	Name: P. Patel	Date: 28 July 2015
	Title: Inorganic Team Leader	

ALS Environmental Ltd
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Mr O'Hora
Meehan Drilling Ltd
Collonbeg Farm
Collon Louth

14 July 2015

Test Report: COV/1196902/2015

Dear Mr O'Hora

Analysis of your sample(s) submitted on 25 June 2015 is now complete and we have pleasure in enclosing the appropriate test report(s).

An invoice for the analysis carried out will be sent under separate cover.

Should you have any queries regarding this report(s) or any part of our service, please contact Customer Services on +44 (0)24 7642 1213 who will be happy to discuss your requirements.

If you would like to arrange any further analysis, please contact Customer Services. To arrange container delivery or sample collection, please call the Couriers Department directly on 024 7685 6562.

Thank you for using ALS Environmental Ltd and we look forward to receiving your next samples.

Yours Sincerely,

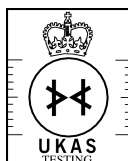
Signed: 

Name: J. Thompson

Title: Operations Manager



Report Summary



1314
0897
4409



**Mr Cian O'Hora
Meehan Drilling Ltd
Collonbeg Farm
Collon
Louth**

Date of Issue: **14 July 2015**

Report Number: **COV/1196902/2015**

Issue **2**

Job Description: NCH Drinking Water & GW Testing

Number of Samples
included in this report **2**

Job Received: **25 June 2015**

Number of Test Results
included in this report **407**

Analysis Commenced: **26 June 2015**

Signed: 

Name: **J. Thompson**

Date: **14 July 2015**

Title: **Operations Manager**

ALS Environmental Ltd was not responsible for sampling unless otherwise stated. Sampling is not covered by our UKAS accreditation.

Information on the methods of analysis and performance characteristics are available on request.

Opinions and interpretations expressed herein are outside the scope of UKAS accreditation. The results relate only to the items tested.

Tests marked 'Not UKAS Accredited' in this Report/Certificate are not included in the UKAS Accreditation Schedule for our laboratory.

This communication has been sent to you by ALS Environmental Ltd. Registered in England and Wales. Registration No. 02148934. Registered Office: ALS Environmental Limited, Torrington Avenue, Coventry, CV4 9GU.

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Certificate of Analysis



Report Number: **COV/1196902/2015**

Issue **2**

Laboratory Number: **14670036**

Sample **1** of **2**

Sample Source: **Meehan Drilling Ltd**

Sample Point Description:

Sample Description: **FS02-T2**

Sample Matrix: **Drinking Water**

Sample Date/Time: **25 June 2015**

Sample Received: **25 June 2015**

Analysis Complete: **14 July 2015**

Test Description	Result	Units	Analysis Date	Accreditation	Method
Toluene	<0.03	ug/l	30/06/2015	N Wak	WPC28
Tert-amyl-methyl-ether	<0.05	ug/l	30/06/2015	N Wak	WPC28
1,2-Dibromoethane	<0.09	ug/l	30/06/2015	N Wak	WPC28
2,3,6-Trichlorobenzoic Acid	<0.007	ug/l	06/07/2015	Y Wak	WPC45
2,4,5-T	<0.002	ug/l	06/07/2015	Y Wak	WPC45
2,4,5-TP (Fenoprop)	<0.005	ug/l	06/07/2015	Y Wak	WPC45
2,4-D	<0.006	ug/l	06/07/2015	Y Wak	WPC45
2,4-DB	<0.007	ug/l	06/07/2015	Y Wak	WPC45
2,4-DP (Dichloroprop)	<0.005	ug/l	06/07/2015	Y Wak	WPC45
Bentazone	<0.002	ug/l	06/07/2015	Y Wak	WPC45
Bromoxynil	<0.003	ug/l	06/07/2015	Y Wak	WPC45
Clopyralid	<0.020	ug/l	06/07/2015	Y Wak	WPC45
Dicamba	<0.015	ug/l	06/07/2015	Y Wak	WPC45
Ioxynil	<0.002	ug/l	06/07/2015	Y Wak	WPC45
MCPA	<0.005	ug/l	06/07/2015	Y Wak	WPC45
MCPB	<0.004	ug/l	06/07/2015	Y Wak	WPC45
MCPP (Mecoprop)	<0.002	ug/l	06/07/2015	Y Wak	WPC45
Pentachlorophenol	<0.002	ug/l	06/07/2015	Y Wak	WPC45
Triclopyr	<0.006	ug/l	06/07/2015	Y Wak	WPC45
Benazolin	<0.008	ug/l	06/07/2015	Y Wak	WPC45
Fluroxypyr	<0.006	ug/l	06/07/2015	Y Wak	WPC45
Imazapyr	<0.009	ug/l	06/07/2015	Y Wak	WPC45
Asulam	<0.003	ug/l	06/07/2015	Y Wak	WPC45
Aldicarb	<0.002	ug/l	29/06/2015	Y Wak	WPC46
Ametryn	<0.002	ug/l	29/06/2015	Y Wak	WPC46
Azinphos-methyl	<0.002	ug/l	29/06/2015	Y Wak	WPC46
Carbendazim	<0.001	ug/l	29/06/2015	Y Wak	WPC46
Chlorfenvinphos	<0.004	ug/l	29/06/2015	Y Wak	WPC46
Demeton-S-Methyl	<0.002	ug/l	29/06/2015	Y Wak	WPC46
Dichlorvos	<0.003	ug/l	29/06/2015	Y Wak	WPC46
Dimethoate	<0.003	ug/l	29/06/2015	Y Wak	WPC46
Disulphoton	<0.003	ug/l	29/06/2015	Y Wak	WPC46

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Certificate of Analysis



Report Number: **COV/1196902/2015**

Laboratory Number: **14670036**

Issue **2**

Sample **1** of **2**

Sample Source: **Meehan Drilling Ltd**

Sample Point Description:

Sample Description: **FS02-T2**

Sample Matrix: **Drinking Water**

Sample Date/Time: **25 June 2015**

Sample Received: **25 June 2015**

Analysis Complete: **14 July 2015**

Test Description	Result	Units	Analysis Date	Accreditation	Method
Ethofumesate	<0.009	ug/l	29/06/2015	Y Wak	WPC46
Fenpropidin	<0.002	ug/l	29/06/2015	Y Wak	WPC46
Fenpropimorph	<0.002	ug/l	29/06/2015	Y Wak	WPC46
Fonofos	<0.003	ug/l	29/06/2015	Y Wak	WPC46
Heptenophos	<0.003	ug/l	29/06/2015	Y Wak	WPC46
Malathion	<0.002	ug/l	29/06/2015	Y Wak	WPC46
Metamitron	<0.003	ug/l	29/06/2015	Y Wak	WPC46
Methabenzthiazuron	<0.002	ug/l	29/06/2015	Y Wak	WPC46
Methiocarb	<0.003	ug/l	29/06/2015	Y Wak	WPC46
Mevinphos	<0.002	ug/l	29/06/2015	Y Wak	WPC46
Phosalone	<0.003	ug/l	29/06/2015	Y Wak	WPC46
Pirimicarb	<0.002	ug/l	29/06/2015	Y Wak	WPC46
Pirimiphos-methyl	<0.002	ug/l	29/06/2015	Y Wak	WPC46
124-Trichlorobenzene	<0.001	ug/l	14/07/2015	Y Wak	WPC50
Aldrin	<0.002	ug/l	14/07/2015	Y Wak	WPC50
Alpha-Chlordane	<0.002	ug/l	14/07/2015	Y Wak	WPC50
Alpha-Endosulphan	<0.002	ug/l	14/07/2015	Y Wak	WPC50
Alpha-HCH	<0.001	ug/l	14/07/2015	Y Wak	WPC50
Beta-Endosulphan	<0.002	ug/l	14/07/2015	Y Wak	WPC50
Beta-HCH	<0.001	ug/l	14/07/2015	Y Wak	WPC50
Carbophenothion	<0.001	ug/l	14/07/2015	Y Wak	WPC50
Chlorothalonil	<0.001	ug/l	14/07/2015	Y Wak	WPC50
cis-Heptachlor Epoxide	<0.002	ug/l	14/07/2015	Y Wak	WPC50
cis-Permethrin	<0.002	ug/l	14/07/2015	Y Wak	WPC50
Cyfluthrin	<0.001	ug/l	14/07/2015	Y Wak	WPC50
Cypermethrin	<0.001	ug/l	14/07/2015	Y Wak	WPC50
Delta-HCH	<0.003	ug/l	14/07/2015	Y Wak	WPC50
Deltamethrin	<0.003	ug/l	14/07/2015	Y Wak	WPC50
Dichlobenil	<0.001	ug/l	14/07/2015	Y Wak	WPC50
Dieldrin	<0.002	ug/l	14/07/2015	Y Wak	WPC50
Endrin	<0.002	ug/l	14/07/2015	Y Wak	WPC50
Fenitrothion	<0.002	ug/l	14/07/2015	Y Wak	WPC50
Fenvalerate	<0.001	ug/l	14/07/2015	Y Wak	WPC50

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Report Number: **COV/1196902/2015**

Issue **2**

Laboratory Number: **14670036**

Sample **1** of **2**

Sample Source: **Meehan Drilling Ltd**

Sample Point Description:

Sample Description: **FS02-T2**

Sample Matrix: **Drinking Water**

Sample Date/Time: **25 June 2015**

Sample Received: **25 June 2015**

Analysis Complete: **14 July 2015**

Test Description	Result	Units	Analysis Date	Accreditation	Method
Gamma-HCH	<0.001	ug/l	14/07/2015	Y Wak	WPC50
Heptachlor	<0.001	ug/l	14/07/2015	Y Wak	WPC50
Hexachlorobenzene	<0.001	ug/l	14/07/2015	Y Wak	WPC50
Hexachlorobutadiene	<0.002	ug/l	14/07/2015	Y Wak	WPC50
Isodrin	<0.001	ug/l	14/07/2015	Y Wak	WPC50
Methoxychlor	<0.003	ug/l	14/07/2015	Y Wak	WPC50
op-DDE	<0.002	ug/l	14/07/2015	Y Wak	WPC50
op-DDT	<0.002	ug/l	14/07/2015	Y Wak	WPC50
op-TDE	<0.001	ug/l	14/07/2015	Y Wak	WPC50
PCB28	<0.001	ug/l	14/07/2015	Y Wak	WPC50
PCB52	<0.001	ug/l	14/07/2015	Y Wak	WPC50
PCB101	<0.001	ug/l	14/07/2015	Y Wak	WPC50
PCB118	<0.001	ug/l	14/07/2015	Y Wak	WPC50
PCB138	<0.002	ug/l	14/07/2015	Y Wak	WPC50
PCB153	<0.001	ug/l	14/07/2015	Y Wak	WPC50
PCB180	<0.002	ug/l	14/07/2015	Y Wak	WPC50
Phorate	<0.001	ug/l	14/07/2015	Y Wak	WPC50
pp-DDE	<0.001	ug/l	14/07/2015	Y Wak	WPC50
pp-DDT	<0.001	ug/l	14/07/2015	Y Wak	WPC50
pp-TDE	<0.001	ug/l	14/07/2015	Y Wak	WPC50
Tecnazene	<0.001	ug/l	14/07/2015	Y Wak	WPC50
trans-Heptachlor Epoxide	<0.001	ug/l	14/07/2015	Y Wak	WPC50
trans-Permethrin	<0.001	ug/l	14/07/2015	Y Wak	WPC50
Trifluralin	<0.001	ug/l	14/07/2015	Y Wak	WPC50
Prometryn	<0.001	ug/l	29/06/2015	Y Wak	WPC46
Propazine	<0.002	ug/l	29/06/2015	Y Wak	WPC46
Propetamphos	<0.002	ug/l	29/06/2015	Y Wak	WPC46
Terbutryn	<0.001	ug/l	29/06/2015	Y Wak	WPC46
Triadimefon	<0.001	ug/l	29/06/2015	Y Wak	WPC46
Triazophos	<0.003	ug/l	29/06/2015	Y Wak	WPC46
Parathion-ethyl	<0.005	ug/l	29/06/2015	Y Wak	WPC46
Xylene, Total	0.0	ug/l	30/06/2015	N Wak	WPC28
Acrylamide	<0.005	ug/l	02/07/2015	Y Wak	WPC53

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Report Number: **COV/1196902/2015**

Issue **2**

Laboratory Number: **14670036**

Sample **1** of **2**

Sample Source: **Meehan Drilling Ltd**

Sample Point Description:

Sample Description: **FS02-T2**

Sample Matrix: **Drinking Water**

Sample Date/Time: **25 June 2015**

Sample Received: **25 June 2015**

Analysis Complete: **14 July 2015**

Test Description	Result	Units	Analysis Date	Accreditation	Method
PAH Total ug/l	0	ug/l	06/07/2015	N Wak	WPC27
Sulphur, Total as SO4	69.2	mg/l	27/06/2015	Y Wak	WPC12
EPTC	<0.006	ug/l	02/07/2015	Y Wak	WPC43
Boron, Total as B	82.9	ug/l	27/06/2015	Y Wak	WPC12
Boscalid	<0.004	ug/l	02/07/2015	Y Wak	WPC43
Metoxuron	<0.002	ug/l	04/07/2015	Y Wak	WPC43
Tebuconazole	<0.002	ug/l	02/07/2015	Y Wak	WPC43
Enterococci	0	cfu/100ml	29/06/2015	Y S	SUBCON
Total Coliforms	0	cfu/100ml	29/06/2015	Y S	SUBCON
E-Coli	0	cfu/100ml	29/06/2015	Y S	SUBCON
Clostridium Perfringens	0	cfu/100ml	29/06/2015	Y S	SUBCON
Tritium	<5.0	Bq/l	08/07/2015	Y S	SUBCON
Aluminium, Total as Al	10.0	ug/l	27/06/2015	Y Wak	WPC12
Iron, Total as Fe	225	ug/l	27/06/2015	Y Wak	WPC12
Antimony, Total as Sb	0.3980	ug/l	27/06/2015	Y Wak	WPC15
Arsenic, Total as As	1.00	ug/l	27/06/2015	Y Wak	WPC15
Boron, Total as B	0.083	mg/l	27/06/2015	N Wak	WPC12
Manganese, Total as Mn	62.4	ug/l	27/06/2015	Y Wak	WPC12
Cadmium, Total as Cd	0.012	ug/l	27/06/2015	Y Wak	WPC15
Chromium, Total as Cr	3.12	ug/l	27/06/2015	Y Wak	WPC15
Sodium, Total as Na	25.3	mg/l	27/06/2015	Y Wak	WPC12
Copper, Total as Cu	0.0009	mg/l	27/06/2015	N Wak	WPC15
Lead, Total as Pb	0.55	ug/l	27/06/2015	Y Wak	WPC15
Nickel, Total as Ni	0.79	ug/l	27/06/2015	Y Wak	WPC15
Selenium, Total as Se	0.98	ug/l	27/06/2015	Y Wak	WPC15
Hydrogen ion (pH)	7.37	pH units	27/06/2015	Y Wak	WPC8/WPC40
Conductivity	699	uS/cm	27/06/2015	Y Wak	WPC7/WPC40
Turbidity	2.56	NTU	27/06/2015	Y Wak	WPC6/WPC40
Total organic carbon	0.55	mg/l	30/06/2015	Y Wak	WPC24
Ammonium ammonia+ammonium ion	0.151	mg/l	27/06/2015	Y Wak	WPC10
Nitrite as NO2	<0.009	mg/l	27/06/2015	Y Wak	WPC10
Nitrate as NO3	<0.37	mg/l	29/06/2015	Y Wak	CALC
Chloride as Cl	37.8	mg/l	27/06/2015	Y Wak	WPC10

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Report Number: **COV/1196902/2015**

Laboratory Number: **14670036**

Issue **2**

Sample **1** of **2**

Sample Source: **Meehan Drilling Ltd**

Sample Point Description:

Sample Description: **FS02-T2**

Sample Matrix: **Drinking Water**

Sample Date/Time: **25 June 2015**

Sample Received: **25 June 2015**

Analysis Complete: **14 July 2015**

Test Description	Result	Units	Analysis Date	Accreditation	Method
Total Oxidised Nitrogen as NO3	<0.37	mg/l	29/06/2015	Y Wak	WPC10
Bromate as BrO3	<0.1	ug/l	29/06/2015	Y Wak	WPC42/WPC5
Cyanide, Total as CN	<0.5	ug/l	02/07/2015	Y Wak	WPC19
Fluoride, Total as F	0.67	mg/l	01/07/2015	Y Wak	WPC20
Mercury, Total as Hg	<0.05	ug/l	01/07/2015	Y Wak	WPC21
Chlorodibromomethane	<0.09	ug/l	30/06/2015	Y Wak	WPC28
Bromodichloromethane	<0.06	ug/l	30/06/2015	Y Wak	WPC28
Tetrachloroethene	<0.05	ug/l	30/06/2015	Y Wak	WPC28
Tetrachloromethane	<0.02	ug/l	30/06/2015	Y Wak	WPC28
Bromoform	<0.15	ug/l	30/06/2015	Y Wak	WPC28
1,1,1-Trichloroethane	<0.04	ug/l	30/06/2015	Y Wak	WPC28
Trichloroethene	<0.05	ug/l	30/06/2015	Y Wak	WPC28
Chloroform	<0.30	ug/l	30/06/2015	Y Wak	WPC28
1,2-Dichloroethane	<0.07	ug/l	30/06/2015	Y Wak	WPC28
Benzene	<0.02	ug/l	30/06/2015	Y Wak	WPC28
Ethylbenzene	<0.03	ug/l	30/06/2015	Y Wak	WPC28
m&p-Xylene	<0.05	ug/l	30/06/2015	Y Wak	WPC28
o-Xylene	<0.04	ug/l	30/06/2015	Y Wak	WPC28
MTBE	<0.06	ug/l	30/06/2015	Y Wak	WPC28
THM, Total	0.00	ug/l	30/06/2015	N Wak	WPC28
Tetra and Trichloroethene	0.00	ug/l	30/06/2015	N Wak	WPC28
Benzo(b)fluoranthene	<0.31	ng/l	06/07/2015	Y Wak	WPC27
Benzo(k)fluoranthene	<0.41	ng/l	06/07/2015	Y Wak	WPC27
Benzo(ghi)perylene	<0.41	ng/l	06/07/2015	Y Wak	WPC27
Benzo(a)pyrene	<0.32	ng/l	06/07/2015	Y Wak	WPC27
Fluoranthene	<1.15	ng/l	06/07/2015	Y Wak	WPC27
Indeno(1,2,3cd)pyrene	<0.88	ng/l	06/07/2015	Y Wak	WPC27
Total PAHs 4 Constituents	0	ug/l	06/07/2015	Y Wak	WPC27
Atrazine	<0.002	ug/l	02/07/2015	Y Wak	WPC43
Cyanazine	<0.002	ug/l	02/07/2015	Y Wak	WPC43
Simazine	<0.003	ug/l	02/07/2015	Y Wak	WPC43
Trietazine	<0.003	ug/l	02/07/2015	Y Wak	WPC43
Carbetamide	<0.002	ug/l	02/07/2015	Y Wak	WPC43

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Report Number: **COV/1196902/2015**

Laboratory Number: **14670036**

Issue **2**

Sample **1** of **2**

Sample Source: **Meehan Drilling Ltd**

Sample Point Description:

Sample Description: **FS02-T2**

Sample Matrix: **Drinking Water**

Sample Date/Time: **25 June 2015**

Sample Received: **25 June 2015**

Analysis Complete: **14 July 2015**

Test Description	Result	Units	Analysis Date	Accreditation	Method
Chlortoluron	<0.002	ug/l	02/07/2015	Y Wak	WPC43
Diuron	<0.003	ug/l	02/07/2015	Y Wak	WPC43
Isoproturon	<0.002	ug/l	04/07/2015	Y Wak	WPC43
Linuron	<0.007	ug/l	04/07/2015	Y Wak	WPC43
Monuron	<0.002	ug/l	02/07/2015	Y Wak	WPC43
Chlorpropham	<0.003	ug/l	02/07/2015	Y Wak	WPC43
Diazinon	<0.001	ug/l	02/07/2015	Y Wak	WPC43
Chlorpyrifos Ethyl	<0.003	ug/l	02/07/2015	Y Wak	WPC43
Propham	<0.003	ug/l	02/07/2015	Y Wak	WPC43
Prosulfocarb	<0.002	ug/l	02/07/2015	Y Wak	WPC43
Clomazone	<0.003	ug/l	02/07/2015	Y Wak	WPC43
Difenconazole	<0.002	ug/l	04/07/2015	Y Wak	WPC43
Flufenacet	<0.002	ug/l	02/07/2015	Y Wak	WPC43
Flurtamone	<0.002	ug/l	02/07/2015	Y Wak	WPC43
Quinmerac	<0.002	ug/l	02/07/2015	Y Wak	WPC43
Oxadixyl	<0.003	ug/l	02/07/2015	Y Wak	WPC43
Epoxiconazole	<0.002	ug/l	02/07/2015	Y Wak	WPC43
Cyproconazole	<0.002	ug/l	02/07/2015	Y Wak	WPC43
Flusilazole	<0.002	ug/l	04/07/2015	Y Wak	WPC43
Chlorpyrifos Methyl	<0.008	ug/l	02/07/2015	Y Wak	WPC43
Carbaryl	<0.002	ug/l	02/07/2015	Y Wak	WPC43
Chloridazon	<0.003	ug/l	04/07/2015	Y Wak	WPC43
Metalaxyl	<0.002	ug/l	02/07/2015	Y Wak	WPC43
Kresoxim-Methyl	<0.007	ug/l	02/07/2015	Y Wak	WPC43
Triallate	<0.004	ug/l	04/07/2015	Y Wak	WPC43
Diflufenican	<0.002	ug/l	02/07/2015	Y Wak	WPC43
Bromacil	<0.003	ug/l	02/07/2015	Y Wak	WPC43
Flutriafol	<0.002	ug/l	04/07/2015	Y Wak	WPC43
Metazachlor	<0.002	ug/l	02/07/2015	Y Wak	WPC43
Pendimethalin	<0.003	ug/l	04/07/2015	Y Wak	WPC43
Propachlor	<0.002	ug/l	02/07/2015	Y Wak	WPC43
Propiconazole	<0.002	ug/l	02/07/2015	Y Wak	WPC43
Propyzamide	<0.002	ug/l	02/07/2015	Y Wak	WPC43

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Report Number: **COV/1196902/2015**

Laboratory Number: **14670036**

Issue **2**

Sample **1** of **2**

Sample Source: **Meehan Drilling Ltd**

Sample Point Description:

Sample Description: **FS02-T2**

Sample Matrix: **Drinking Water**

Sample Date/Time: **25 June 2015**

Sample Received: **25 June 2015**

Analysis Complete: **14 July 2015**

Test Description	Result	Units	Analysis Date	Accreditation	Method
Chlorbufam	<0.005	ug/l	02/07/2015	Y Wak	WPC43
VOC	Y	ug/l	04/07/2015	N Cov	GEO32
Vinyl Chloride	<0.5	ug/l	04/07/2015	N Cov	GEO32
Dibromofluoromethane	96.1	%Recovery	04/07/2015	N Cov	GEO32
Toluene-d8	99.9	%Recovery	04/07/2015	N Cov	GEO32
4-Bromofluorobenzene	92.9	%Recovery	04/07/2015	N Cov	GEO32
Epichlorohydrin	<0.1	ug/l	29/06/2015	N Cov	GEO52

Analyst Comments for 14670036:

No Analyst Comment

Accreditation Codes: Y = UKAS / ISO17025 Accredited, N = Not UKAS / ISO17025 Accredited, M = MCERTS.

Analysed at: Cov = Coventry(CV4 9GU), Run = Runcorn(WA7 1SL), S = Subcontracted, Trb = Subcontracted to Trowbridge(BA14 0XD), Wak = Wakefield(WF5 9TG).

For Microbiological determinands 0 or ND=Not Detected, For Legionella ND=Not Detected in volume of sample filtered. The LOD for the Legionella analysis will increase where the volume analysed is <1000g (1g is approximately equivalent to 1ml for sample volume analysed).

I/S=Insufficient sample For soil/sludge samples: AR=As received, DW=Dry weight.

Signed:

Name: **J. Thompson**

Date: **14 July 2015**

Title: **Operations Manager**

ALS Environmental Ltd

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Report Number: **COV/1196902/2015**

Issue **2**

Laboratory Number: **14670037**

Sample **2** of **2**

Sample Source: **Meehan Drilling Ltd**

Sample Point Description:

Sample Description: **FS03-T2**

Sample Matrix: **Drinking Water**

Sample Date/Time: **25 June 2015**

Sample Received: **25 June 2015**

Analysis Complete: **14 July 2015**

Test Description	Result	Units	Analysis Date	Accreditation	Method
Toluene	<0.03	ug/l	30/06/2015	N Wak	WPC28
Tert-amyl-methyl-ether	<0.05	ug/l	30/06/2015	N Wak	WPC28
1,2-Dibromoethane	<0.09	ug/l	30/06/2015	N Wak	WPC28
2,3,6-Trichlorobenzoic Acid	<0.018	ug/l	06/07/2015	Y Wak	WPC45
2,4,5-T	<0.012	ug/l	06/07/2015	Y Wak	WPC45
2,4,5-TP (Fenoprop)	<0.008	ug/l	06/07/2015	Y Wak	WPC45
2,4-D	<0.006	ug/l	06/07/2015	Y Wak	WPC45
2,4-DB	<0.012	ug/l	06/07/2015	Y Wak	WPC45
2,4-DP (Dichloroprop)	<0.012	ug/l	06/07/2015	Y Wak	WPC45
Bentazone	<0.004	ug/l	06/07/2015	Y Wak	WPC45
Bromoxynil	<0.006	ug/l	06/07/2015	Y Wak	WPC45
Clopyralid	<0.022	ug/l	06/07/2015	Y Wak	WPC45
Dicamba	<0.016	ug/l	06/07/2015	Y Wak	WPC45
Ioxynil	<0.008	ug/l	06/07/2015	Y Wak	WPC45
MCPA	<0.010	ug/l	06/07/2015	Y Wak	WPC45
MCPB	<0.008	ug/l	06/07/2015	Y Wak	WPC45
MCPP (Mecoprop)	<0.004	ug/l	06/07/2015	Y Wak	WPC45
Pentachlorophenol	<0.010	ug/l	06/07/2015	Y Wak	WPC45
Triclopyr	<0.014	ug/l	06/07/2015	Y Wak	WPC45
Benazolin	<0.022	ug/l	06/07/2015	Y Wak	WPC45
Fluroxypyr	<0.018	ug/l	06/07/2015	Y Wak	WPC45
Imazapyr	<0.018	ug/l	06/07/2015	Y Wak	WPC45
Asulam	<0.008	ug/l	06/07/2015	Y Wak	WPC45
Aldicarb	<0.002	ug/l	29/06/2015	Y Wak	WPC46
Ametryn	<0.002	ug/l	29/06/2015	Y Wak	WPC46
Azinphos-methyl	<0.002	ug/l	29/06/2015	Y Wak	WPC46
Carbendazim	<0.001	ug/l	29/06/2015	Y Wak	WPC46
Chlorfenvinphos	<0.004	ug/l	29/06/2015	Y Wak	WPC46
Demeton-S-Methyl	<0.002	ug/l	29/06/2015	Y Wak	WPC46
Dichlorvos	<0.003	ug/l	29/06/2015	Y Wak	WPC46
Dimethoate	<0.003	ug/l	29/06/2015	Y Wak	WPC46
Disulphoton	<0.003	ug/l	29/06/2015	Y Wak	WPC46

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Report Number: **COV/1196902/2015**

Laboratory Number: **14670037**

Issue **2**

Sample **2** of **2**

Sample Source: **Meehan Drilling Ltd**

Sample Point Description:

Sample Description: **FS03-T2**

Sample Matrix: **Drinking Water**

Sample Date/Time: **25 June 2015**

Sample Received: **25 June 2015**

Analysis Complete: **14 July 2015**

Test Description	Result	Units	Analysis Date	Accreditation	Method
Ethofumesate	<0.009	ug/l	29/06/2015	Y Wak	WPC46
Fenpropidin	<0.002	ug/l	29/06/2015	Y Wak	WPC46
Fenpropimorph	<0.002	ug/l	29/06/2015	Y Wak	WPC46
Fonofos	<0.003	ug/l	29/06/2015	Y Wak	WPC46
Heptenophos	<0.003	ug/l	29/06/2015	Y Wak	WPC46
Malathion	<0.002	ug/l	29/06/2015	Y Wak	WPC46
Metamitron	<0.003	ug/l	29/06/2015	Y Wak	WPC46
Methabenzthiazuron	<0.002	ug/l	29/06/2015	Y Wak	WPC46
Methiocarb	<0.003	ug/l	29/06/2015	Y Wak	WPC46
Mevinphos	<0.002	ug/l	29/06/2015	Y Wak	WPC46
Phosalone	<0.003	ug/l	29/06/2015	Y Wak	WPC46
Pirimicarb	<0.002	ug/l	29/06/2015	Y Wak	WPC46
Pirimiphos-methyl	<0.002	ug/l	29/06/2015	Y Wak	WPC46
124-Trichlorobenzene	<0.001	ug/l	14/07/2015	Y Wak	WPC50
Aldrin	<0.002	ug/l	14/07/2015	Y Wak	WPC50
Alpha-Chlordane	<0.002	ug/l	14/07/2015	Y Wak	WPC50
Alpha-Endosulphan	<0.002	ug/l	14/07/2015	Y Wak	WPC50
Alpha-HCH	<0.001	ug/l	14/07/2015	Y Wak	WPC50
Beta-Endosulphan	<0.002	ug/l	14/07/2015	Y Wak	WPC50
Beta-HCH	<0.001	ug/l	14/07/2015	Y Wak	WPC50
Carbophenothion	<0.001	ug/l	14/07/2015	Y Wak	WPC50
Chlorothalonil	<0.001	ug/l	14/07/2015	Y Wak	WPC50
cis-Heptachlor Epoxide	<0.002	ug/l	14/07/2015	Y Wak	WPC50
cis-Permethrin	<0.002	ug/l	14/07/2015	Y Wak	WPC50
Cyfluthrin	<0.001	ug/l	14/07/2015	Y Wak	WPC50
Cypermethrin	<0.001	ug/l	14/07/2015	Y Wak	WPC50
Delta-HCH	<0.003	ug/l	14/07/2015	Y Wak	WPC50
Deltamethrin	<0.003	ug/l	14/07/2015	Y Wak	WPC50
Dichlobenil	<0.001	ug/l	14/07/2015	Y Wak	WPC50
Dieldrin	<0.002	ug/l	14/07/2015	Y Wak	WPC50
Endrin	<0.002	ug/l	14/07/2015	Y Wak	WPC50
Fenitrothion	<0.002	ug/l	14/07/2015	Y Wak	WPC50
Fenvalerate	<0.001	ug/l	14/07/2015	Y Wak	WPC50

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Report Number: **COV/1196902/2015**

Laboratory Number: **14670037**

Issue **2**

Sample **2** of **2**

Sample Source: **Meehan Drilling Ltd**

Sample Point Description:

Sample Description: **FS03-T2**

Sample Matrix: **Drinking Water**

Sample Date/Time: **25 June 2015**

Sample Received: **25 June 2015**

Analysis Complete: **14 July 2015**

Test Description	Result	Units	Analysis Date	Accreditation	Method
Gamma-HCH	<0.001	ug/l	14/07/2015	Y Wak	WPC50
Heptachlor	<0.001	ug/l	14/07/2015	Y Wak	WPC50
Hexachlorobenzene	<0.001	ug/l	14/07/2015	Y Wak	WPC50
Hexachlorobutadiene	<0.002	ug/l	14/07/2015	Y Wak	WPC50
Isodrin	<0.001	ug/l	14/07/2015	Y Wak	WPC50
Methoxychlor	<0.003	ug/l	14/07/2015	Y Wak	WPC50
op-DDE	<0.002	ug/l	14/07/2015	Y Wak	WPC50
op-DDT	<0.002	ug/l	14/07/2015	Y Wak	WPC50
op-TDE	<0.001	ug/l	14/07/2015	Y Wak	WPC50
PCB28	<0.001	ug/l	14/07/2015	Y Wak	WPC50
PCB52	<0.001	ug/l	14/07/2015	Y Wak	WPC50
PCB101	<0.001	ug/l	14/07/2015	Y Wak	WPC50
PCB118	<0.001	ug/l	14/07/2015	Y Wak	WPC50
PCB138	<0.002	ug/l	14/07/2015	Y Wak	WPC50
PCB153	<0.001	ug/l	14/07/2015	Y Wak	WPC50
PCB180	<0.002	ug/l	14/07/2015	Y Wak	WPC50
Phorate	<0.001	ug/l	14/07/2015	Y Wak	WPC50
pp-DDE	<0.001	ug/l	14/07/2015	Y Wak	WPC50
pp-DDT	<0.001	ug/l	14/07/2015	Y Wak	WPC50
pp-TDE	<0.001	ug/l	14/07/2015	Y Wak	WPC50
Tecnazene	<0.001	ug/l	14/07/2015	Y Wak	WPC50
trans-Heptachlor Epoxide	<0.001	ug/l	14/07/2015	Y Wak	WPC50
trans-Permethrin	<0.001	ug/l	14/07/2015	Y Wak	WPC50
Trifluralin	<0.001	ug/l	14/07/2015	Y Wak	WPC50
Prometryn	<0.001	ug/l	29/06/2015	Y Wak	WPC46
Propazine	<0.002	ug/l	29/06/2015	Y Wak	WPC46
Propetamphos	<0.002	ug/l	29/06/2015	Y Wak	WPC46
Terbutryn	<0.001	ug/l	29/06/2015	Y Wak	WPC46
Triadimefon	<0.001	ug/l	29/06/2015	Y Wak	WPC46
Triazophos	<0.003	ug/l	29/06/2015	Y Wak	WPC46
Parathion-ethyl	<0.005	ug/l	29/06/2015	Y Wak	WPC46
Xylene, Total	0.0	ug/l	30/06/2015	N Wak	WPC28
Acrylamide	<0.005	ug/l	02/07/2015	Y Wak	WPC53

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Report Number: **COV/1196902/2015**

Laboratory Number: **14670037**

Issue **2**

Sample **2** of **2**

Sample Source: **Meehan Drilling Ltd**

Sample Point Description:

Sample Description: **FS03-T2**

Sample Matrix: **Drinking Water**

Sample Date/Time: **25 June 2015**

Sample Received: **25 June 2015**

Analysis Complete: **14 July 2015**

Test Description	Result	Units	Analysis Date	Accreditation	Method
PAH Total ug/l	0	ug/l	06/07/2015	N Wak	WPC27
Sulphur, Total as SO4	69.1	mg/l	27/06/2015	Y Wak	WPC12
EPTC	<0.006	ug/l	02/07/2015	Y Wak	WPC43
Boron, Total as B	82.2	ug/l	27/06/2015	Y Wak	WPC12
Boscalid	<0.004	ug/l	02/07/2015	Y Wak	WPC43
Metoxuron	<0.002	ug/l	04/07/2015	Y Wak	WPC43
Tebuconazole	<0.002	ug/l	02/07/2015	Y Wak	WPC43
Enterococci	0	cfu/100ml	29/06/2015	Y S	SUBCON
Total Coliforms	0	cfu/100ml	29/06/2015	Y S	SUBCON
E-Coli	0	cfu/100ml	29/06/2015	Y S	SUBCON
Clostridium Perfringens	5	cfu/100ml	29/06/2015	Y S	SUBCON
Aluminium, Total as Al	5.5	ug/l	27/06/2015	Y Wak	WPC12
Iron, Total as Fe	230	ug/l	27/06/2015	Y Wak	WPC12
Antimony, Total as Sb	0.4060	ug/l	27/06/2015	Y Wak	WPC15
Arsenic, Total as As	0.96	ug/l	27/06/2015	Y Wak	WPC15
Boron, Total as B	0.082	mg/l	27/06/2015	N Wak	WPC12
Manganese, Total as Mn	64.4	ug/l	27/06/2015	Y Wak	WPC12
Cadmium, Total as Cd	0.011	ug/l	27/06/2015	Y Wak	WPC15
Chromium, Total as Cr	3.15	ug/l	27/06/2015	Y Wak	WPC15
Sodium, Total as Na	25.6	mg/l	27/06/2015	Y Wak	WPC12
Copper, Total as Cu	0.0010	mg/l	27/06/2015	N Wak	WPC15
Lead, Total as Pb	0.60	ug/l	27/06/2015	Y Wak	WPC15
Nickel, Total as Ni	0.86	ug/l	27/06/2015	Y Wak	WPC15
Selenium, Total as Se	0.92	ug/l	27/06/2015	Y Wak	WPC15
Hydrogen ion (pH)	7.39	pH units	27/06/2015	Y Wak	WPC8/WPC40
Conductivity	700	uS/cm	27/06/2015	Y Wak	WPC7/WPC40
Turbidity	2.31	NTU	27/06/2015	Y Wak	WPC6/WPC40
Total organic carbon	0.51	mg/l	30/06/2015	Y Wak	WPC24
Ammonium ammonia+ammonium ion	0.152	mg/l	27/06/2015	Y Wak	WPC10
Nitrite as NO2	<0.009	mg/l	27/06/2015	Y Wak	WPC10
Nitrate as NO3	<0.37	mg/l	29/06/2015	Y Wak	CALC
Chloride as Cl	37.8	mg/l	27/06/2015	Y Wak	WPC10
Total Oxidised Nitrogen as NO3	<0.37	mg/l	29/06/2015	Y Wak	WPC10

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Report Number: **COV/1196902/2015**

Laboratory Number: **14670037**

Issue **2**

Sample **2** of **2**

Sample Source: **Meehan Drilling Ltd**

Sample Point Description:

Sample Description: **FS03-T2**

Sample Matrix: **Drinking Water**

Sample Date/Time: **25 June 2015**

Sample Received: **25 June 2015**

Analysis Complete: **14 July 2015**

Test Description	Result	Units	Analysis Date	Accreditation	Method
Bromate as BrO ₃	Y	ug/l	29/06/2015	Y Wak	WPC42/WPC5
Cyanide, Total as CN	<0.5	ug/l	02/07/2015	Y Wak	WPC19
Fluoride, Total as F	0.71	mg/l	01/07/2015	Y Wak	WPC20
Mercury, Total as Hg	<0.05	ug/l	01/07/2015	Y Wak	WPC21
Chlorodibromomethane	<0.09	ug/l	30/06/2015	Y Wak	WPC28
Bromodichloromethane	<0.06	ug/l	30/06/2015	Y Wak	WPC28
Tetrachloroethene	<0.05	ug/l	30/06/2015	Y Wak	WPC28
Tetrachloromethane	<0.02	ug/l	30/06/2015	Y Wak	WPC28
Bromoform	<0.15	ug/l	30/06/2015	Y Wak	WPC28
1,1,1-Trichloroethane	<0.04	ug/l	30/06/2015	Y Wak	WPC28
Trichloroethene	<0.05	ug/l	30/06/2015	Y Wak	WPC28
Chloroform	<0.30	ug/l	30/06/2015	Y Wak	WPC28
1,2-Dichloroethane	<0.07	ug/l	30/06/2015	Y Wak	WPC28
Benzene	<0.02	ug/l	30/06/2015	Y Wak	WPC28
Ethylbenzene	<0.03	ug/l	30/06/2015	Y Wak	WPC28
m&p-Xylene	<0.05	ug/l	30/06/2015	Y Wak	WPC28
o-Xylene	<0.04	ug/l	30/06/2015	Y Wak	WPC28
MTBE	<0.06	ug/l	30/06/2015	Y Wak	WPC28
THM, Total	0.00	ug/l	30/06/2015	N Wak	WPC28
Tetra and Trichloroethene	0.00	ug/l	30/06/2015	N Wak	WPC28
Benzo(b)fluoranthene	<0.31	ng/l	06/07/2015	Y Wak	WPC27
Benzo(k)fluoranthene	<0.41	ng/l	06/07/2015	Y Wak	WPC27
Benzo(ghi)perylene	<0.41	ng/l	06/07/2015	Y Wak	WPC27
Benzo(a)pyrene	<0.32	ng/l	06/07/2015	Y Wak	WPC27
Fluoranthene	<1.15	ng/l	06/07/2015	Y Wak	WPC27
Indeno(1,2,3cd)pyrene	<0.88	ng/l	06/07/2015	Y Wak	WPC27
Total PAHs 4 Constituents	0	ug/l	06/07/2015	Y Wak	WPC27
Atrazine	<0.002	ug/l	02/07/2015	Y Wak	WPC43
Cyanazine	<0.002	ug/l	02/07/2015	Y Wak	WPC43
Simazine	<0.003	ug/l	02/07/2015	Y Wak	WPC43
Trietazine	<0.003	ug/l	02/07/2015	Y Wak	WPC43
Carbetamide	<0.002	ug/l	02/07/2015	Y Wak	WPC43
Chlortoluron	<0.002	ug/l	02/07/2015	Y Wak	WPC43

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Certificate of Analysis



Report Number: **COV/1196902/2015**

Laboratory Number: **14670037**

Issue **2**

Sample **2** of **2**

Sample Source: **Meehan Drilling Ltd**

Sample Point Description:

Sample Description: **FS03-T2**

Sample Matrix: **Drinking Water**

Sample Date/Time: **25 June 2015**

Sample Received: **25 June 2015**

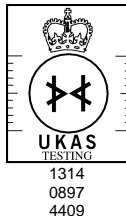
Analysis Complete: **14 July 2015**

Test Description	Result	Units	Analysis Date	Accreditation	Method
Diuron	<0.003	ug/l	02/07/2015	Y Wak	WPC43
Isoproturon	<0.002	ug/l	04/07/2015	Y Wak	WPC43
Linuron	<0.007	ug/l	04/07/2015	Y Wak	WPC43
Monuron	<0.002	ug/l	02/07/2015	Y Wak	WPC43
Chlorpropham	<0.003	ug/l	02/07/2015	Y Wak	WPC43
Diazinon	<0.001	ug/l	02/07/2015	Y Wak	WPC43
Chlorpyrifos Ethyl	<0.003	ug/l	02/07/2015	Y Wak	WPC43
Propham	<0.003	ug/l	02/07/2015	Y Wak	WPC43
Prosulfocarb	<0.002	ug/l	02/07/2015	Y Wak	WPC43
Clomazone	<0.003	ug/l	02/07/2015	Y Wak	WPC43
Difenconazole	<0.002	ug/l	04/07/2015	Y Wak	WPC43
Flufenacet	<0.002	ug/l	02/07/2015	Y Wak	WPC43
Flurtamone	<0.002	ug/l	02/07/2015	Y Wak	WPC43
Quinmerac	<0.002	ug/l	02/07/2015	Y Wak	WPC43
Oxadixyl	<0.003	ug/l	02/07/2015	Y Wak	WPC43
Epoxiconazole	<0.002	ug/l	02/07/2015	Y Wak	WPC43
Cyproconazole	<0.002	ug/l	02/07/2015	Y Wak	WPC43
Flusilazole	<0.002	ug/l	04/07/2015	Y Wak	WPC43
Chlorpyrifos Methyl	<0.008	ug/l	02/07/2015	Y Wak	WPC43
Carbaryl	<0.002	ug/l	02/07/2015	Y Wak	WPC43
Chloridazon	<0.003	ug/l	04/07/2015	Y Wak	WPC43
Metalaxyl	<0.002	ug/l	02/07/2015	Y Wak	WPC43
Kresoxim-Methyl	<0.007	ug/l	02/07/2015	Y Wak	WPC43
Triallate	<0.004	ug/l	04/07/2015	Y Wak	WPC43
Diflufenican	<0.002	ug/l	02/07/2015	Y Wak	WPC43
Bromacil	<0.003	ug/l	02/07/2015	Y Wak	WPC43
Flutriafol	<0.002	ug/l	04/07/2015	Y Wak	WPC43
Metazachlor	<0.002	ug/l	02/07/2015	Y Wak	WPC43
Pendimethalin	<0.003	ug/l	04/07/2015	Y Wak	WPC43
Propachlor	<0.002	ug/l	02/07/2015	Y Wak	WPC43
Propiconazole	<0.002	ug/l	02/07/2015	Y Wak	WPC43
Propyzamide	<0.002	ug/l	02/07/2015	Y Wak	WPC43
Chlorbufam	<0.005	ug/l	02/07/2015	Y Wak	WPC43

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Laboratory Number: **14670037**

Issue **2**

Sample **2** of **2**

Sample Source: **Meehan Drilling Ltd**

Sample Point Description:

Sample Description: **FS03-T2**

Sample Matrix: **Drinking Water**

Sample Date/Time: **25 June 2015**

Sample Received: **25 June 2015**

Analysis Complete: **14 July 2015**

Test Description	Result	Units	Analysis Date	Accreditation	Method
VOC	Y	ug/l	04/07/2015	N Cov	GEO32
Vinyl Chloride	<0.5	ug/l	04/07/2015	N Cov	GEO32
Dibromofluoromethane	96.8	%Recovery	04/07/2015	N Cov	GEO32
Toluene-d8	99.4	%Recovery	04/07/2015	N Cov	GEO32
4-Bromofluorobenzene	86.6	%Recovery	04/07/2015	N Cov	GEO32
Epichlorohydrin	<0.1	ug/l	29/06/2015	N Cov	GEO52

Analyst Comments for 14670037:

{/*}WPC45 Acid herbs - Sample analysed on x2 dilution due to surrogate failure{*/}

Accreditation Codes: Y = UKAS / ISO17025 Accredited, N = Not UKAS / ISO17025 Accredited, M = MCERTS.

Analysed at: Cov = Coventry(CV4 9GU), Run = Runcorn(WA7 1SL), S = Subcontracted, Trb = Subcontracted to Trowbridge(BA14 0XD), Wak = Wakefield(WF5 9TG).

For Microbiological determinands 0 or ND=Not Detected, For Legionella ND=Not Detected in volume of sample filtered. The LOD for the Legionella analysis will increase where the volume analysed is <1000g (1g is approximately equivalent to 1ml for sample volume analysed).

I/S=Insufficient sample For soil/sludge samples: AR=As received, DW=Dry weight.

Signed:

Name: **J. Thompson**

Date: **14 July 2015**

Title: **Operations Manager**

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ANALYST COMMENTS FOR REPORT

COV/1196902/2015

Issue 2

Date of Issue: 14 July 2015

Sample No	Analysis Comments
14670036	
14670037	{/*}WPC45 Acid herbs - Sample analysed on x2 dilution due to surrogate failure{*/}

Signed:



Name: **J. Thompson**

Date: **14 July 2015**

Title: **Operations Manager**

DETERMINAND COMMENTS FOR REPORT COV/1196902/2015

ISSUE 2

Date of Issue : 14 July 2015

Sample No	Description	Determinand	Comments

Signed: 

Name: J. Thompson

Date: 14 July 2015

Title: Operations Manager