



Llwyn Onn WTW: Phase I Contamination Report

August 2010



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LLWYN ONN WATER TREATMENT WORKS: PHASE I CONTAMINATION REPORT**CONTENTS**

1.	BACKGROUND	1
2.	EXISTING ENVIRONMENT	1
2.1	Site Description	1
2.2	Geology and Topography.....	2
2.3	Hydrology and Hydrogeology	3
2.4	Ecology and Nature Conservation	3
2.5	Archaeology and Cultural Heritage	4
3.	SITE HISTORY	5
4.	RISK ASSESSMENT CONTEXT	6
4.1	Potential Contamination Sources.....	6
4.2	Pollutant Linkages.....	8
5.	SUMMARY AND CONCLUSIONS	10
5.1	Summary of Site Details	10
5.2	Conclusions	10
5.3	Recommendations	10

APPENDICES

- Appendix A: Figures
- Appendix B: Photographs
- Appendix C: Borehole and Trial Pit Logs
- Appendix D: Envirocheck Report

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LLWYN ONN WATER TREATMENT WORKS: PHASE I CONTAMINATION REPORT

1. BACKGROUND

This report details the findings of the desktop study undertaken into the Dee Valley Water (DVW) Llwyn Onn Water Treatment Works (WTW) in Wrexham.

The purpose of this report is to assess the potential for contamination to be present at the site and to report the findings of a qualitative risk assessment of potential pollutant linkages and development of a conceptual site model (CSM).

2. EXISTING ENVIRONMENT

A summary of baseline environmental information obtained from the desk study, walkovers and initial consultation is provided below.

2.1 Site Description

The site is currently a drinking water treatment works, grid reference 335770, 348860, located off Cefn Road, to the south east of Wrexham.

Total site area measures 5.32 Ha, however the northern portion (approximately one third of the total area) is currently undeveloped scrubland. The main (developed) portion of the site covers the central and southern areas.

A site walkover was undertaken on the 16th of April 2010. The centre of the site contains a large above ground water reservoir (Photograph 1, Appendix B). This would remain in use as part of the proposed scheme. To the northern side of the reservoir are a site office building, pump-house building (Photograph 2), an electricity substation/ transformer building, an enclosure housing backup generator (with integral diesel tank), chemical house and two long wooden storage sheds (Photograph 3). The generator enclosure is bunded with a low concrete block bund (Photograph 4). There is no evidence of any staining within the bund, and it appears intact (Photograph 5). The wooden sheds contain a variety of tools and equipment. There is a storage area to the west of the wooden sheds that contains mainly empty fibreglass and plastic water tanks, wooden pallets, wooden sleepers and plastic pipes (Photograph 6). There is no evidence of any staining or hazardous materials in this area, and the main storage area and building footprints are located on areas of hard standing. There is also further storage of empty large plastic and fibreglass water tanks to the west of the reservoir in an area overgrown with brambles (Photographs 7 and 8). The chemical house stores Chlorine and Sulphur Dioxide. Other chemicals used within the treatment process include Monosodium Phosphate, Alum and Lime, which are stored in containers located in or near to the treatment building.

To the east of the reservoir is the existing treatment building and south of this are located two concrete wash-water tanks (Photograph 9) and a series of settlement and sludge storage lagoons (Photograph 10). The lagoons are drained and emptied of sludge regularly. Sludge 'cake' is a by product of the water treatment process and is centrifuged and then removed from site on trailers to be used as fertiliser for nearby farmland. There is also a lime silo (attached to treatment building, Photograph 11) and LPG tank located within the east of the site.

A tar macadam access road loops around the site from the site entrance at the north east, around the reservoir and treatment building and back to the entrance.

Within the southwest of the site there is some evidence of material storage adjacent to the haul road, some areas of which have become overgrown with vegetation. The material is

of unknown origin but is thought to be clean fill for pipelines from offsite. It comprises sandy soil material and contains concrete curb stone (Photograph 12).

There is also a telephone mast located within the south west of the site (Photograph 13 and 8).

Between the developed area of the site (central, south and east) and the scrubland (north west) there is a small plantation woodland. This joins into the Mill Wood to the west.

The site is immediately surrounded by agricultural land to the north, east and south, and a woodland area (Mill Wood) to the west and southwest perimeter. The site is located in an elevated position and the surrounding areas slope away from the site perimeter steeply in all directions. The scrubland portion of the site also slopes steeply down towards the north.

There is no evidence of any staining, fly tipping, storage or dumping of hazardous materials, vandalism or indications of plant stress on site.

2.2 Geology and Topography

The site is located in an elevated position, with ground generally sloping away from the site boundaries. The centre, and main operational area, of the site itself is largely level and approximately 71-72m AOD. There is a steep slope to the north and north-west within the north and north-west portion of the site where the woodland and open ground areas are located. The gradient of this slope reduces towards the most north-west corner. The north-west corner of the site is approximately 53m AOD. The site also slopes downwards to the south and south-east within the south and south-east corner where the settlement ponds and centrifuge are located, to approximately 62m AOD at the southern site boundary.

The bedrock geology is Salop Formation sedimentary rock of Early Permian to Westphalian age (Envirocheck Geology 1:10,000 Maps, Appendix D. BGS Map Sheet 121, Wrexham Solid and Drift edition 1:50,000).

The drift/superficial geology is comprised mainly Glaciofluvial Deposits (glacial sand and gravel) and there is an area of Glaciolacustrine Deposits (clay) within the north west corner of the site (BGS Map Sheet 121, Wrexham Solid and Drift edition 1:50,000). There is also an area of Made Ground (undivided) recorded at the site, slightly north of the centre of site (Envirocheck Geology 1:10,000 Maps).

There site is within a Radon affected area (between 5 and 10% of homes are above the radon action level), basic protection measures are necessary in the construction of new buildings (see Envirocheck report, Appendix D).

Historic borehole data (Llwyn Onn WTW Structural Survey, B&V 2007), within the southeast of the site, indicates that the site is underlain by Made Ground comprising sandy gravel with cobbles (noted to contain brick, concrete and a little ash content) to a depth of between 1.15m and 4.5m below ground level. This overlies natural Glaciofluvial Deposits (sands and gravels), comprising fine sand over coarse sand with occasional layers of sandy silt and sandy clay occurring between 3.3m and 10m depth.

A site investigation, gathering geotechnical information within the location of the proposed building, was undertaken by the client in July 2010. Borehole and trial pit logs (presented in Appendix C) show shallow Made Ground, over Glacio Fluvial sands and gravels at depth. Areas of Made Ground contained some construction materials (sands, gravels and cobbles) and in one location (TP1) a broken fibreglass drinking water tank was found at 0.7m depth within the southwest portion of the site. It is noted that trial pits TP5,

TP6 and TP7 were undertaken through an area of above ground soil storage therefore part of the indicated thickness of Made Ground in these trial pit logs is actually including the height of above ground storage of material on site. Thickness of Made Ground was typically around 1m, with a maximum depth of 1.7 noted in TP1 (although 2.1-2.2m noted within TP5-TP7 where this included above ground storage). During the ground investigation, bedrock (mudstone) was found at 29.8m depth in borehole BH3. It is noted that laboratory test results undertaken as part of this site investigation were not available at the time of reporting.

2.3 Hydrology and Hydrogeology

There are no groundwater protection zones present within the area.

Within the locality of the site the drift and bedrock aquifers are classified as 'Secondary A' (Environment Agency website) comprising permeable layers capable of supporting water supplies at a local rather than strategic scale, and in some cases forming an important baseflow for rivers. Secondary A aquifers were formerly classified as 'minor' aquifers.

The Envirocheck report (see Appendix D) indicates that the site is located on a Minor Aquifer (Variably permeable) important for supplying base flow to rivers; and that local soils are of High Leaching Potential (H2) meaning that they have rapid drainage and low attenuation potential (Sheet 16, West Cheshire, 1:100,000).

Historic site investigation data indicates that no groundwater was encountered within any of the four boreholes drilled (maximum depth of 15.45m); however this was undertaken within the summer so groundwater may occur above this level in wetter winter periods. Recent site investigations have drilled to a maximum depth of 30.13m and have not encountered groundwater (refer to Appendix 3).

The Afon Clywedog runs past the site (flowing from north-west to south-east) between 50m to 100m to the west and 130m to the south of the site boundary. The ground slopes down towards the river and Mill Wood is located between the site and the watercourse. Afon Clywedog flows into the River Dee approximately 5.2km east of the site.

A small stream, flowing south west towards the Afon Clywedog, runs within a few metres the north-west corner of the site. This appears to be dry further north of the site, with a field drain running into it near the northern most point of the site.

2.4 Ecology and Nature Conservation

There are no Statutory Nature Conservation Sites within 1km of the site.

There is a single Local Wildlife Site within 1km; Marchwiell Marsh, approximately 995m south of the site.

Mill Wood ancient woodland runs along the western and south western boundaries of the site between the site and the Afon Clywedog.

The River Dee, which is part of the River Dee and Bala Lake Site of Special Scientific Interest (SSSI) and Special Area of Conservation (SAC), is met by Afon Clywedog approximately 5.2km east of the site.

The Council indicate that there are no Tree Preservation Orders (TPOs) at, or within the vicinity of, the site.

2.5 Archaeology and Cultural Heritage

There are no Scheduled Ancient Monuments, historic parks and gardens or historic landscapes affected by the proposed works at the site.

There are no listed buildings on the site, and the site is not within any Conservation Areas.

3. SITE HISTORY

Llwyn Onn reservoir and water treatment works (WTW) was constructed in 1940 to supply water to a munitions factory located on what is now Wrexham Industrial Estate. The site has since undergone a series of modifications to become Dee Valley Water's main water treatment works, supplying the majority of water for Wrexham and a population of approximately 105,000. The existing water treatment works, built in 1997, has a capacity of 48ML/d and treats water from river and upland sources.

Historic maps from Envirocheck are presented in Appendix D. The history of the site and its surround are summarised in the Tables 1 and 2 below.

Table 1: Site History, Summarised from Historic Maps.

Date	Description
Pre 1879 – Pre 1938	No development on site; agricultural land
Pre 1938 – Pre 1964	Reservoir located on site
Pre 1964 – present day	Works (Water Treatment Works) located on site
Pre 1992 – present day	Storage huts / transformer house / pump house / office buildings located on site to north of water reservoir and further settlement lagoons located on site to the south of reservoir.

Table 2: Areas Surrounding the Site, Summarised from Historic Maps.

Date	Direction	Distance (m)	Description
Pre 1873 – present day	W + SW	0	Mill Wood
Pre 1873 – present day	N, E + S	0	Agricultural land
Pre 1873 – present day	SE	140	Old Llwyn Onn (farm house)
Pre 1873 – present day	NE	200	Residential (Twmpath / Holly Corner)
Pre 1873 – Pre 1964	NW	150	Llwyn Onn Mill (flour mill)
Pre 1873 – present day	S	190	Old Quarry (small; no longer labelled)
Pre 1879 – present day	N	400	Llwyn Onn Hall
Pre 1879 – Pre 1990	W	550	Abenbury Forge
Pre 1900 – Pre 1964	W/NW	560	Abenbury Brick Works
Pre 1900 – present day	W	250	Railway line (dismantled Pre 1990)
Pre 1915 – present day	S	740	Sewage Works (later replaced by modern works in the same location)
Pre 1915 – Pre 1954	S/SE	450	Sludge Lagoon (adjacent to river)
Pre 1964 – present day	NW	450	Residential properties (Wrexham)
Pre 1974 – Pre 2000	W/NW	460	Electricity Sub station
Pre 2000 – present day	N/NW	75	Residential properties (Wrexham)

There are no historic or current landfills within 250m of the site (refer to Envirocheck report). There are four historic landfill sites located between 538 to 920m northwest of the site closed between 1971 and 1987. There are also five closed (registered) landfills located between 405 to 916m northwest of the site. None of these are considered to present a significant risk to the proposed development as they all have housing built on and near to them within the last 20 years.

The Council records and Envirocheck report indicate no records of any fuel tanks on or in the vicinity of the site. However there is an existing LPG tank and a standby generator with a self contained bunded diesel fuel tank located within the eastern side of the site as described within Section 2.1.

4. RISK ASSESSMENT CONTEXT

4.1 Potential Contamination Sources

Chemicals used on site within the water treatment process include Chlorine, Sulphur Dioxide, Monosodium Phosphate, Alum and Lime. These chemicals are stored in a safe manner and are safe for use in the treatment of drinking water therefore are unlikely to pose a significant risk. There is no Department of the Environment (DoE) Industry Profile for drinking WTW and the WTW process is not considered to give rise to any particular contaminants of concern.

An electricity sub station / transformer house is located on site (access was not gained into this building during the site walkover). Historic maps show that the substation was constructed between 1979 and 1992, so is unlikely to contain PCBs as the use of PCBs in new equipment was banned in the UK in 1981.

A small volume of diesel is stored on site for use within the backup generator (stored within an above ground tank that is integral to the generator). This is contained within the low bund surrounding the generator enclosure, and no spillages have been recorded on site. Diesel is only used within the self contained generator building and is not used to refuel plant or equipment that would be likely to cause spillages across site.

A number of historic off site sources have been ruled out as potential sources of contamination due to their location, distance and/or down gradient elevation in relation to the site. The historic forge, old quarry, dismantled railway line, historic and current sewage works and historic sludge lagoon are all located down gradient of the site (due to the elevated level of the site) beyond the Afon Clywedog, and therefore are not thought to present any source of contamination that might enter the site. The historic brick works and historic sub station are also down gradient and a considerable distance away (560 and 460m respectively) from the site. The former flour mill and Old Llwyn Onn farm are nearer to the site (150 and 140m respectively) but are still located down gradient of the main site area and are considered to be low risk features that are unlikely to present a source of contamination to the site.

Shallow Made Ground is known to occur in locations across site. The majority of this is likely to be from levelling of the site prior to initial construction of the works, however, the possibility of contaminated material/soil from off site sources of unknown origin cannot be fully eliminated at this stage. Made Ground has been shown to occur to a depth of between 0 – 2.2m below ground level, typically having a depth of approximately 1m in the majority of locations investigated. This potential source is discussed in more detail within Table 3 below.

Table 3: Potential Contamination Sources

Potential Source	Potential Contaminants	Risk of Occurrence
Shallow Made Ground across site	A variety of contaminants could be contained within Made Ground of unknown origin. These could include: Heavy metals, sulphate/sulphide, total petroleum hydrocarbons (TPHs), volatile and semi-volatile compounds (VOCs and sVOCs).	MEDIUM risk of occurrence: Shallow Made Ground is known to occur in locations across site. The majority of this is likely to be from levelling of the site prior to initial construction of the works, however, the possibility of contaminated material/soil from off site sources of unknown origin cannot be fully eliminated at this stage. Borehole and trial pit logs (see Appendix C) have indicated that Made Ground contains some brick, pottery, plastic piping, concrete and fibreglass fragments and some limited areas of filter cake deposits (from the WTW process). These items are considered to have a low potential for causing pollution, but could indicate the presence of other potential contaminants. However, during recent geotechnical site investigations it was noted that there was no visual or olfactory evidence of any petroleum hydrocarbons within the areas of ground investigated, and there is no visual evidence of any organic matter or degradable material that would generate ground gases. Due to the length of time since the site was developed (1938) and the sandy nature of the underlying geology, it is considered likely that the majority of mobile contaminants would have previously been degraded or leached from shallow substrate across site, leaving only strongly bound potential contaminants within the shallow Made Ground across site.

4.2 Pollutant Linkages

Table 4: Potential Source Pathway Receptor Linkages

Source	Potential Contaminants	Pathway	Receptor	Risk
Shallow Made Ground	Heavy metals, sulphate, sulphide, total petroleum hydrocarbons (TPHs), volatile and semi-volatile compounds (VOCs and sVOCs).	Inhalation and ingestion of dust and particulates.	Off site residents *	MEDIUM. There are residential properties located 75m N/NW, 140m SE and 200m NE from the site boundary and livestock are present adjacent to the site boundary. Dust generation is only likely during the construction phase as a large portion of the development area will be covered with hard standing once new treatment works is completed. During construction best practice will be implemented to suppress dust generation therefore it is anticipated that the risk of transfer of contaminated dust to adjacent areas will be short term and will present a medium risk.
		Inhalation and ingestion of dust and particulates.	Off site livestock	
		Direct contact.	On site buildings and services	LOW. Geotechnical investigations included testing for the aggressiveness of the soil/groundwater toward concrete and therefore concrete will be specified appropriately and will therefore not be at risk. Services will be placed in accessible service ducts or above ground and therefore will not be in direct contact with potential contaminants.
		Migration and leaching of contaminants within soil.	Groundwater	LOW. Groundwater is located at considerable depth below the site (>30m BGL). Due to the length of time since the site was developed (1938) and the sandy nature of the underlying geology it is considered likely that the majority of mobile contaminants would have previously been degraded or leached from shallow Made Ground across site. Strongly bound contaminants are unlikely to be subject to significant migration and

Source	Potential Contaminants	Pathway	Receptor	Risk
				leaching. Water infiltration through the soil will also be reduced due to the presence of hard standing in the form of increased building footprint and access roads following construction, further reducing the likelihood of potential contaminants leaching through the soil into groundwater post development.
		Surface water runoff.	Surface water bodies (Afon Clywedog and tributary)	LOW. Due to the length of time since the site was developed (1938) and the sandy nature of the underlying geology, it is considered likely that the majority of mobile contaminants would have previously been degraded or leached from shallow Made Ground across site. The majority of surface water collected on site is drained into a number of soakaways; however water from the existing WTW building is passed through the wash water and settlement lagoons. Strongly bound contaminants are likely to be removed during the settlement or soakaway process, and are therefore highly unlikely to reach the water courses. It is also noted that sludge material from the settlement process is tested before removal from site.

Notes on Table: * Risk to site workers during development is covered by HSE regulation and is not assessed within conceptual model. Construction workers will be wearing appropriate PPE and there will be dust minimisation measures in place to minimise contact with potential contamination. Any potential acute risks will be made known.

All source-pathway-receptor linkages are presented within the Conceptual Site Model shown in Appendix A.

Only those linkages that are considered to be medium or high risk will be considered further.

5. SUMMARY AND CONCLUSIONS

5.1 Summary of Site Details

Site address	Llwyn Onn WTW, Cefn Road, Wrexham.
Size	5.32 Ha.
Current use and condition	Operational drinking water treatment works.
Future use	Drinking water treatment works (new works replace existing).
Current neighbouring uses	Agricultural fields and ancient woodland are located immediately adjacent to site. Residential properties located 75m N/NW, 200m NE and 140m SE of the site.
Site history	The site has been developed as (and remained as) a drinking water treatment works since 1938. Prior to this the site was undeveloped agricultural land.
Geology	Solid geology is Salop Formation sedimentary rock. Drift comprises Glaciofluvial Deposits (glacial sands and gravels) across the majority of the site, with Glaciolacustrine Deposits (clay) within the north west corner. There is some Made Ground indicated north of the site centre (site investigations have shown this to be typically 1m in depth below ground level, where present).
Hydrology	Small stream located within 10m to northwest of the site. Afon Cylwedog runs 50-100m west of site.
Hydrogeology	No groundwater protection zones. Secondary A (minor) aquifers. High leaching potential.
Ecology	Ancient woodland adjacent to W and SW of site.
Previous reports	Site investigations indicate that the Made Ground comprises material considered to have a low potential for pollution, with no visual or olfactory evidence of contamination or of degradable materials.
Other relevant information	No registered/historic fuel tanks present. However, there is a LPG tank and an above ground bunded diesel tank known to be currently located on site.

5.2 Conclusions

The following potential contamination linkages have been identified and assessed to present a medium or high risk to receptors:

- Medium risk to off site residents from the inhalation and ingestion of dust from shallow Made Ground across site (this will only occur during proposed construction works, therefore is of limited duration).
- Medium risk to off site livestock from inhalation and ingestion of dust from shallow Made Ground across site (this will only occur during proposed construction works, therefore is of limited duration).

The linkages are shown within the Conceptual Site Model in Appendix A.

5.3 Recommendations

It is recommended that during the construction phase the contractor should implement dust control measures to minimise dust generation in line with best practice guidance for construction sites.

It is not anticipated that there is a requirement for any further contaminated land site investigations, however test results provided from current site investigations should be utilised to supplement this report. These data should be used as the basis for additional

assessments to determine whether dust is likely to present a risk to off-site receptors. The data should also be used to determine disposal and reuse options.

Any material that is being removed from site for disposal should be tested and assessed appropriately. This may require the collection and assessment of additional samples from stockpiles of excavated soil.

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APPENDICES

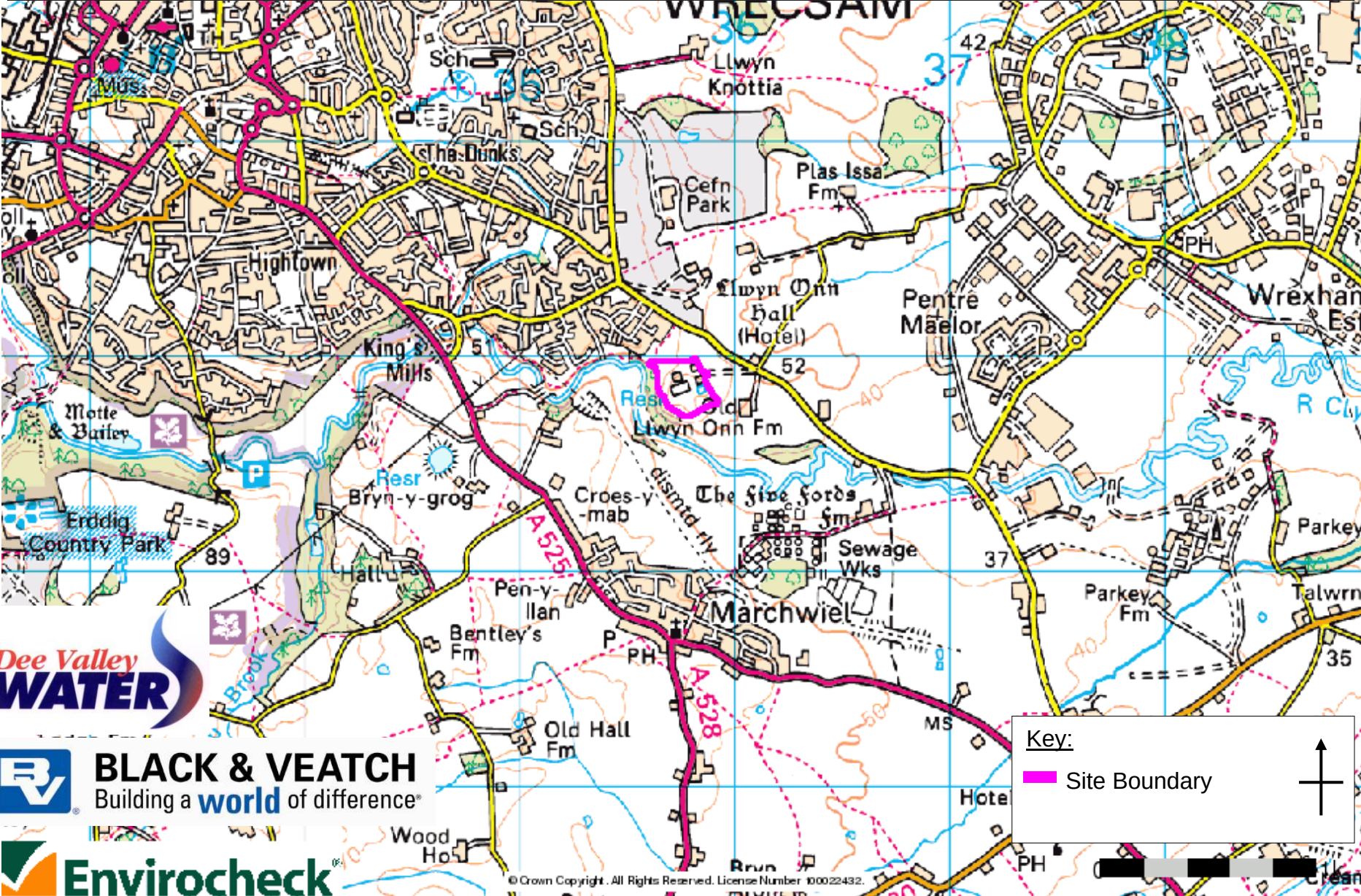
APPENDIX A: FIGURES

- A.1 Figure 1 – Site Location Plan**
- A.2 Figure 2 – Existing Site Layout Plan**
- A.3 Figure 3 – Proposed Site Layout Plan**
- A.4 Figure 4 – Conceptual Site Model**

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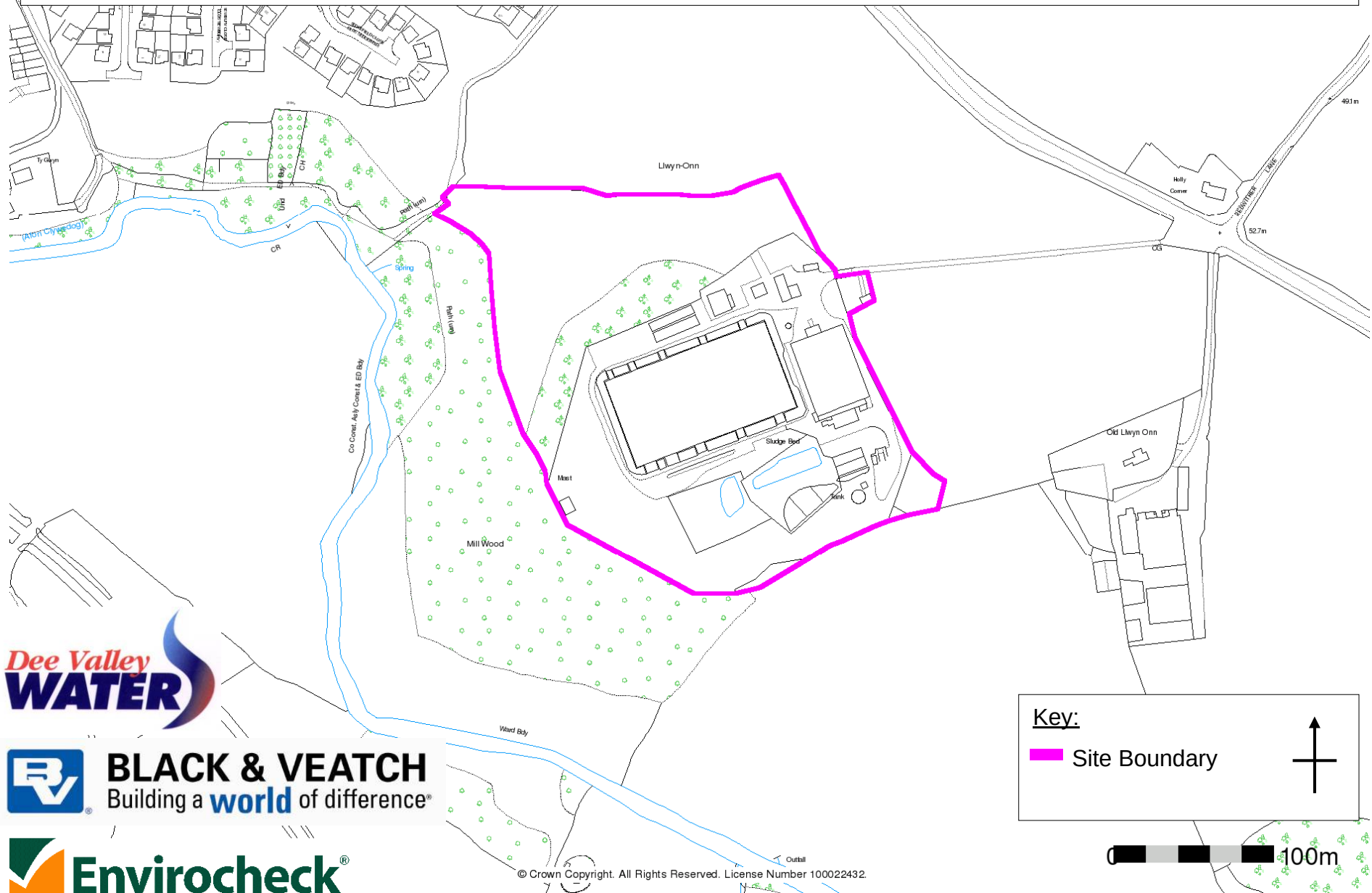
Llwyn Onn WTW - Phase I Contamination Report

Figure 1: Site Location Plan



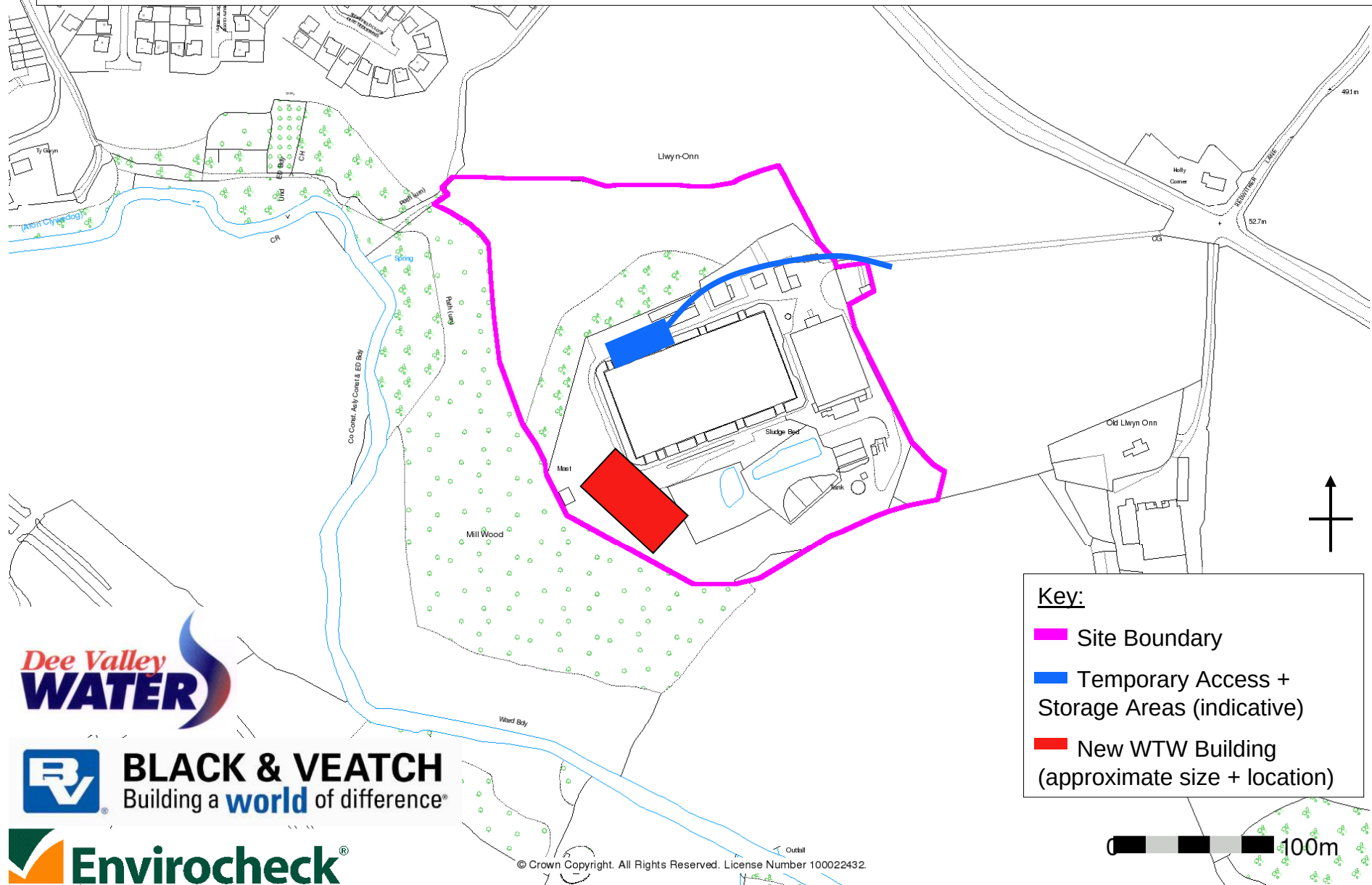
Llwyn Onn WTW - Phase I Contamination Report

Figure 2: Existing Site Layout Plan



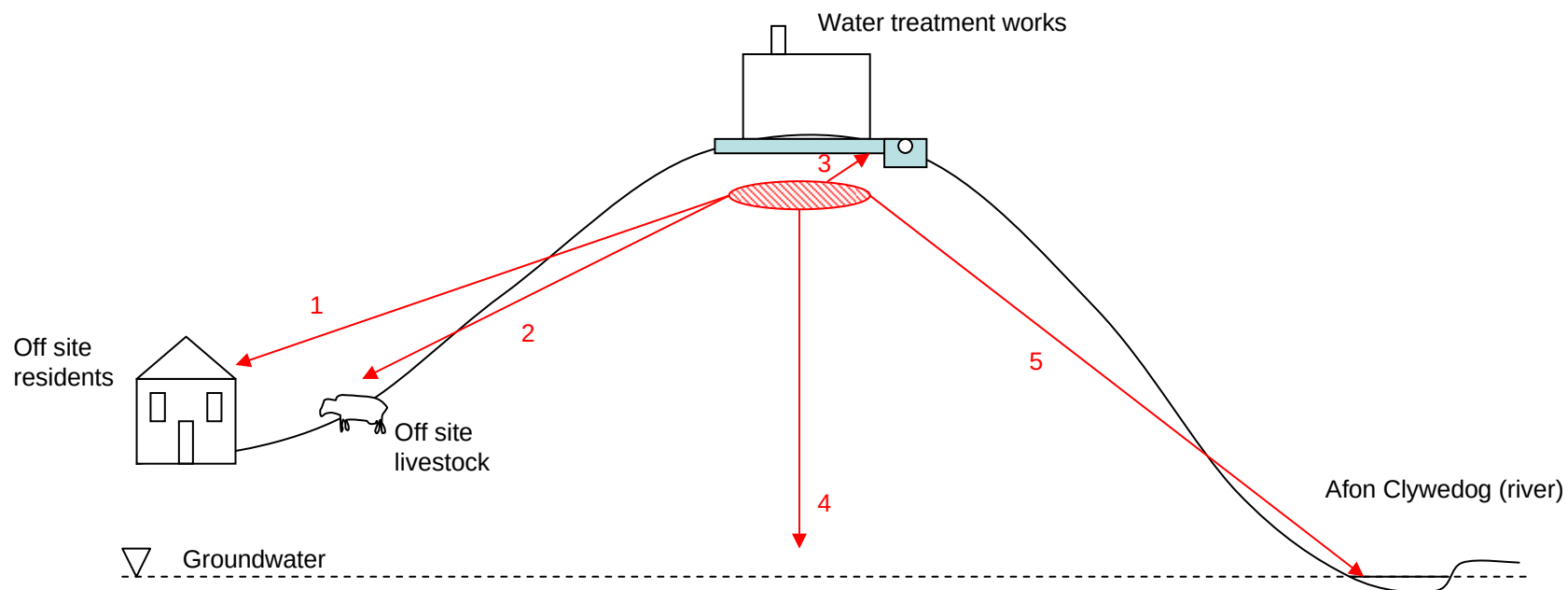
Llwyn Onn WTW - Phase I Contamination Report

Figure 3: Proposed Site Layout Plan



Llwyn Onn WTW - Phase I Contamination Report

Figure 4: Conceptual Site Model



No.	Source	Potential Contaminants	Pathway	Receptor
1	Shallow Made Ground	Heavy metals, sulphate, sulphide, total petroleum hydrocarbons (TPHs) volatile and semi-volatile compounds (VOCs and sVOCs).	Inhalation and ingestion of dust and particulates.	Off site residents.
2			Inhalation and ingestion of dust and particulates.	Off site livestock.
3			Direct contact.	On site buildings and services.
4			Migration and leaching of contaminants within soil.	Groundwater.
5			Surface water runoff.	Surface water bodies.

APPENDIX B: PHOTOGRAPHS

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Photograph 1: View of centre of site looking west from near the entrance gate. Showing access road in centre, raised water reservoir (to left of photograph) and generator compound (right, front) and chemical house (right, back).



Photograph 2: View of pump house looking from water reservoir towards site entrance.



Photograph 3: View of wooden storage sheds located on northern side of water reservoir and access road. Wooden storage sheds are to be removed as part of the development to allow temporary construction access and storage area to be built.



Photograph 4: View of compound housing backup generator within wire enclosure and shallow concrete bund. Electricity sub station / transformer house is located to right of photograph. Chemical house is located to the left of the photograph.



Photograph 5: Close up view of the wire enclosure and low concrete bund housing backup generator. No visible signs of staining near outlet tap.



Photograph 6: View of current storage area to west of wooden storage sheds. The raised grass banks of the water reservoir can be seen in the background of the photo.



Photograph 7: Close up view of empty drinking water tanks stored within the western side of the site. There is a mixture of plastic and fibreglass tanks stored here. Partially overgrown with brambles.



Photograph 8: View of western perimeter of site from water reservoir, showing storage area (wooden pallets, plastic pipes and empty water drinking tanks) and telephone mast.



Photograph 9: Showing wash water tanks within south eastern portion of site.



Photograph 10: Showing 'half moon' shaped settling lagoon within south eastern portion of site.



Photograph 11: Showing lime silo attached to current water treatment building located along the eastern side of the site.



Photograph 12: Showing raised ground level within south western corner of site where there is storage of soil material.

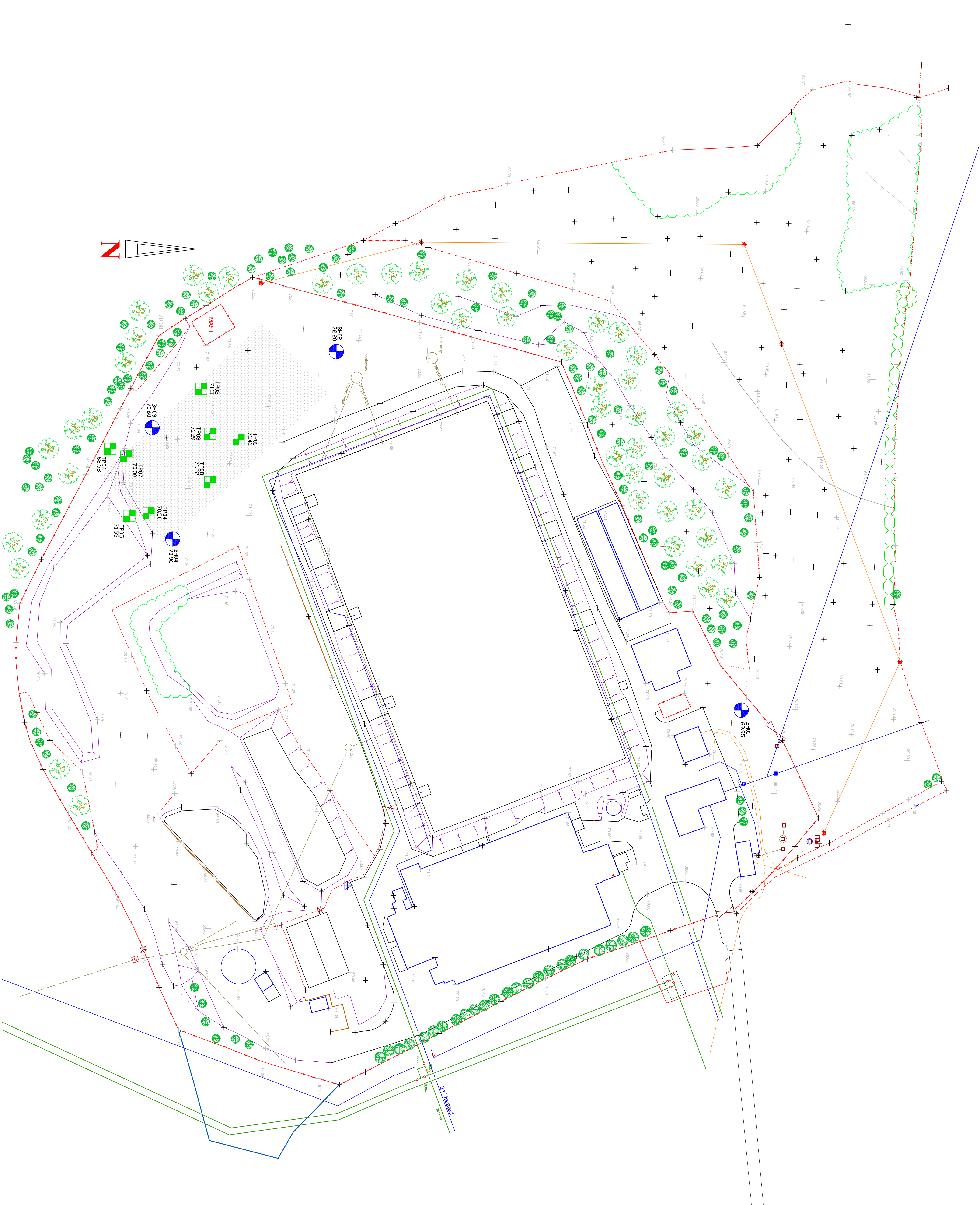


Photograph 13: View of telephone mast located at the western boundary of site.

APPENDIX C: BOREHOLE AND TRIAL PIT LOGS

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	Easting	Northing	Level
BH01	335801.27	348921.73	69.95
BH02	335699.66	348806.92	72.20
BH03	335721.24	348754.70	70.60
BH04	335752.77	348760.54	70.96
TP01	335724.58	348779.23	71.41
TP02	335710.20	348768.67	71.11
TP03	335722.98	348771.13	71.29
TP04	335745.49	348753.70	70.50
TP05	335746.22	348748.29	71.55
TP06	335727.23	348742.83	68.58
TP07	335729.37	348747.40	70.30
TP08	335736.67	348771.16	71.22



BENCH MARK INFORMATION	
BM Attached to OSDB2 grid and level via GPS/GPRS Smartnet system	
geotechnics	
The Geotechnical Centre Riverside Industrial Park, Riverside, Wrexham, Cheshire CH9 8BQ	
Phone: 01244 871117 Fax: 01244 871122 Email: info@geotechnics.co.uk www.geotechnics.co.uk	
Engineer: BLACK AND VEATCH LTD	
Client: DEE VALLEY WATER	
Project: LLWYN ONN WTW, WREXHAM	
Drawing Title: Exploratory Hole Location Plan	
Taken from a drawing supplied by the client	
Scale: 1:500@A1	Date: July 2010
Project No: PNI02275	File Name: Geo-PNI02275-001

DATA SHEET - Symbols and Abbreviations used on Records

Sample Types		Groundwater		Strata, Continued	
B	Bulk disturbed sample	Water Strike		Mudstone	
BLK	Block sample	Depth Water Rose To		Siltstone	
C	Core sample				
D	Small disturbed sample (tub/jar)	Instrumentation			
E	Environmental test sample	Seal		Metamorphic Rock	
ES	Environmental soil sample	Filter		Fine Grained	
EW	Environmental water sample			Medium Grained	
G	Gas sample			Coarse Grained	
L	Liner sample			Igneous Rock	
P	Piston sample (PF - failed P sample)	Seal		Fine Grained	
TW	Thin walled push in sample			Medium Grained	
U	Open Tube - 102mm diameter with blows to take sample. (UF - failed U sample)			Coarse Grained	
UT	Thin wall open drive tube sampler - 102mm diameter with blows to take sample. (UTF - failed UT sample)	Strata			
V	Vial sample	Made Ground Type 1			
W	Water sample	Type 2			
#	Sample Not Recovered				
Insitu Testing / Properties		Topsoil			
S	Standard Penetration Test (SPT)	Cobbles and Boulders			
C	SPT with cone	Gravel			
VN	Strength from Insitu Vane	Sand			
HV	Strength from Hand Vane	Silt			
PP	Strength from Pocket Penetrometer	Clay			
(All other strengths from undrained triaxial testing)		Peat			
w%	Water content	Note: Composite soil types shown by combined symbols			
N	SPT Result	Chalk		Arisings	
-/-	Blows/penetration (mm) after 150mm seating.	Limestone		Bentonite Seal	
.*/- (mm)	Total blows/penetration	Sandstone		Concrete	
()	Extrapolated value	Coal		Fine Gravel Filter	
				General Fill	
Rotary Core			Gravel Filter		
RQD	Rock Quality Designation (% of intact core >100mm)		Grout		
FRACTURE INDEX Fractures/metre			Sand Filter		
FRACTURE SPACING (mm)	Maximum		Tarmacadam		
NI	Non-intact core				
NR	No core recovery (where core recovery is unknown it is assumed to be at the base of the run)				

TRIAL PIT RECORD

Trial Pit

Project LLWYN ONN WTW, WREXHAM

Engineer

BLACK & VEATCH LIMITED

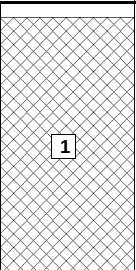
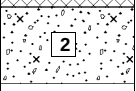
Trial Pit
Project No

TP1
PN102275

Client DEE VALLEY WATER

National Grid
Coordinates 335724.58 E
348779.23 N

Ground Level 71.41 m OD

Samples and Tests				Strata	Scale 1:50		
Depth	Type	Stratum No	Results	Description	Depth	Legend	Level m OD
0.20- 0.50 0.20 0.50	B ES ES			MADE GROUND: Brown silty very gravelly fine to medium sand with occasional cobbles. Gravel is fine to coarse angular to rounded of limestone, mudstone, brick and pottery fragments. At 0.60m: Redundant water piping and plastic cable. Below 0.70m: Many pieces of fibre glass water drums.	G.L.		71.41
1.00- 1.70 1.00 1.00	B D ES						
1.50	ES						
1.70- 2.20 1.70	B ES			Light brown silty very gravelly fine to coarse SAND. Gravel is fine to coarse subangular to subrounded of various lithologies.	1.70		69.71
				End of Excavation	2.20		69.21

Excavation				Groundwater		
Plant JCB 3CX	Width (B) 0.80	Depth Observed	Depth of Pit	Details		
Date 14/07/2010	Length (C) 3.50			None encountered.		
Shoring None.	Date Backfilled 14/07/2010					
Stability Stable during excavation.						

Remarks	ES Sample = 1 x 60ml VOC vials, 1 x 1kg plastic tub and 1 x 258ml amber jars. The Trial Pit was terminated at a depth of 2.20m on the instruction of the Engineer. Spoil containing fibre glass fragments removed not used in backfilling of pit.	Logged by MD
Symbols and abbreviations are explained on the accompanying key sheet.		Figure 1 of 1 09/08/2010
All dimensions are in metres.	Logged in accordance with Amendment 1 published December 2007 to BS5930:1999	

TRIAL PIT RECORD

Trial Pit

Project LLWYN ONN WTW, WREXHAM

Engineer

BLACK & VEATCH LIMITED

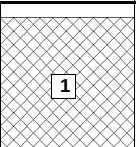
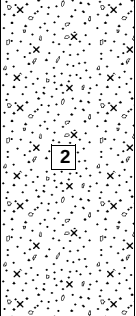
Trial Pit
Project No

TP2
PN102275

Client DEE VALLEY WATER

National Grid
Coordinates 335710.2 E
348768.67 N

Ground Level 71.11 m OD

Samples and Tests				Strata	Scale 1:50		
Depth	Type	Stratum No	Results	Description	Depth	Legend	Level m OD
0.20 0.30- 0.70 0.50	ES B ES			Rough grass over MADE GROUND: Brown silty gravelly to very gravelly fine to medium sand with occasional cobbles. Gravel is fine to coarse subangular to subrounded of various lithologies, brick and pottery fragments.	G.L.		71.11
1.00- 1.50 1.00	B ES			Light brown silty very gravelly fine to coarse SAND. Gravel is fine to medium subangular to rounded of mudstone, sandstone and occasional coal traces.	0.90		70.21
2.00- 2.50 2.00	B D		mc=9.6%	At 2.00m: Becoming gravelly. At 2.10m: Occasional pockets (up to 60mm) of clay.			
3.00	D			End of Excavation	3.00		68.11

Excavation				Groundwater		
Plant	JCB 3CX	Width (B)	0.80	Depth Observed	Depth of Pit	Details
Date	14/07/2010	Length (C)	3.40			
Shoring	None.	Date Backfilled	14/07/2010			None encountered.
Stability	Stable during excavation.					

Remarks	ES Sample = 1 x 60ml VOC vials, 1 x 1kg plastic tub and 1 x 258ml amber jars. The Trial Pit was terminated at a depth of 3.00m on the instruction of the Engineer.					Logged by	MD
Symbols and abbreviations are explained on the accompanying key sheet.						Figure	1 of 1 09/08/2010
All dimensions are in metres.	Logged in accordance with Amendment 1 published December 2007 to BS5930:1999						

TRIAL PIT RECORD

Trial Pit

Project LLWYN ONN WTW, WREXHAM

Engineer

BLACK & VEATCH LIMITED

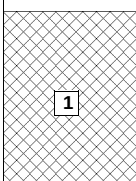
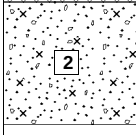
Trial Pit
Project No

TP3
PN102275

Client DEE VALLEY WATER

National Grid
Coordinates 335722.98 E
348771.13 N

Ground Level 71.29 m OD

Samples and Tests				Strata	Scale 1:50		
Depth	Type	Stratum No	Results	Description	Depth	Legend	Level m OD
0.20	ES			MADE GROUND: Brown silty very sandy fine to coarse subangular to rounded gravel of various lithologies, brick and clay pipe fragments.	G.L.		71.29
0.50 - 1.00	B		mc=10%				
0.50	ES						
1.20	ES			Light brown silty gravelly fine to coarse SAND with occasional pockets (up to 60mm) of clay. Gravel is fine to coarse subangular to rounded of various lithologies.	1.20		70.09
1.50 - 2.00	B		mc=8.9%				
1.50	D						
				End of Excavation	2.00		69.29

Excavation				Groundwater		
Plant	JCB 3CX	Width (B)	0.80	Depth Observed	Depth of Pit	Details
Date	14/07/2010	Length (C)	3.40			
Shoring	None.	Date Backfilled	14/07/2010			None encountered.
Stability	Stable during excavation.					

Remarks	ES Sample = 1 x 60ml VOC vials, 1 x 1kg plastic tub and 1 x 258ml amber jars The Trial Pit was terminated at a depth of 2.00m on the instruction of the Engineer.					Logged by MD
Symbols and abbreviations are explained on the accompanying key sheet.						Figure 1 of 1 09/08/2010
All dimensions are in metres.	Logged in accordance with Amendment 1 published December 2007 to BS5930:1999					

TRIAL PIT RECORD

Trial Pit

Project LLWYN ONN WTW, WREXHAM

Engineer

BLACK & VEATCH LIMITED

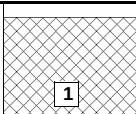
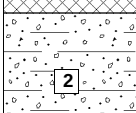
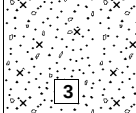
Trial Pit
Project No

TP4
PN102275

Client DEE VALLEY WATER

National Grid
Coordinates 335745.49 E
348753.7 N

Ground Level 70.50 m OD

Samples and Tests				Strata	Scale 1:50		
Depth	Type	Stratum No	Results	Description	Depth	Legend	Level m OD
0.20 0.30- 0.70 0.50	ES B ES		mc=18%	MADE GROUND: Brown mottled orange and black gravelly very silty fine to coarse sand with frequent cobbles. Gravel is fine to coarse angular to subrounded of mudstone, sandstone, brick, concrete and clay pipe fragments.	G.L.		70.50
1.00	ES			Firm brown slightly sandy slightly gravelly CLAY. Gravel is fine to medium subangular to subrounded of mudstone, sandstone and coal traces.	1.00		69.50
1.50- 1.90 1.50	B D			Light brown silty gravelly fine to medium SAND. Gravel is fine to coarse subangular to rounded of various lithologies.	1.90		68.60
2.50- 3.20	B						
3.00	D						
				End of Excavation	3.20		67.30

Excavation				Groundwater		
Plant	JCB 3CX	Width (B)	0.80	Depth Observed	Depth of Pit	Details
Date	14/07/2010	Length (C)	3.40			
Shoring	None.	Date Backfilled	14/07/2010			None encountered.
Stability	Stable during excavation.					

Remarks	ES Sample = 1 x 60ml VOC vials, 1 x 1kg plastic tub and 1 x 258ml amber jars The Trial Pit was terminated at a depth of 3.20m on the instruction of the Engineer.					Logged by MD
Symbols and abbreviations are explained on the accompanying key sheet.						Figure 1 of 1 09/08/2010
All dimensions are in metres.	Logged in accordance with Amendment 1 published December 2007 to BS5930:1999					

TRIAL PIT RECORD

Trial Pit

Project LLWYN ONN WTW, WREXHAM

Engineer

BLACK & VEATCH LIMITED

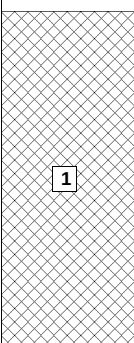
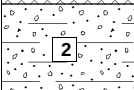
Trial Pit
Project No

TP5
PN102275

Client DEE VALLEY WATER

National Grid
Coordinates 335746.22 E
348748.29 N

Ground Level 71.55 m OD

Samples and Tests				Strata	Scale 1:50		
Depth	Type	Stratum No	Results	Description	Depth	Legend	Level m OD
0.20 0.30- 0.70 0.50	ES B ES			Rough grass over MADE GROUND: Dark reddish brown slightly silty to silty gravelly fine to medium sand with occasional cobbles and pockets (up to 200mm) of laminated filter cake. Gravel is fine to coarse angular to subrounded of various lithologies, brick and clay pipe fragments.	G.L.		71.55
1.00- 1.50 1.00	B ES						
1.60	ES						
2.00- 2.20	B			Firm brown slightly sandy slightly gravelly CLAY. Gravel is fine to medium subangular to subrounded of various lithologies.	2.20		69.35
2.50	ES						
2.80	D			End of Excavation	2.80		68.75

Excavation				Groundwater		
Plant JCB 3CX	Width (B) 0.80	Depth Observed	Depth of Pit	Details		
Date 14/07/2010	Length (C) 3.30					
Shoring None.	Date Backfilled 14/07/2010			None encountered.		
Stability Stable during excavation.						

Remarks	ES Sample = 1 x 60ml VOC vials, 1 x 1kg plastic tub and 1 x 258ml amber jars	Logged by MD
	The Trial Pit was terminated at a depth of 2.80m on the instruction of the Engineer.	Figure 1 of 1
Symbols and abbreviations are explained on the accompanying key sheet.		09/08/2010
All dimensions are in metres.	Logged in accordance with Amendment 1 published December 2007 to BS5930:1999	

TRIAL PIT RECORD

Trial Pit

Project LLWYN ONN WTW, WREXHAM

Engineer

BLACK & VEATCH LIMITED

Trial Pit
Project No

TP6
PN102275

Client DEE VALLEY WATER

National Grid
Coordinates 335727.23 E
348742.83 N

Ground Level 68.58 m OD

Samples and Tests				Strata	Scale 1:50		
Depth	Type	Stratum No	Results	Description	Depth	Legend	Level m OD
0.20	ES			Rough vegetation and saplings over: Brown very clayey very gravelly fine to coarse SAND. Gravel is fine to medium subangular to subrounded of mudstone, sandstone and occasional coal traces.	G.L.		68.58
0.50	ES						
1.00- 2.00 1.00	B ES						
				End of Excavation	2.10		66.48

Excavation				Groundwater		
Plant	JCB 3CX	Width (B)	0.80	Depth Observed	Depth of Pit	Details
Date	14/07/2010	Length (C)	1.80			
Shoring	None.	Date Backfilled	14/07/2010			None encountered.
Stability	Stable during excavation.					

Remarks	ES Sample = 1 x 60ml VOC vials, 1 x 1kg plastic tub and 1 x 258ml amber jars The Trial Pit was terminated at a depth of 2.10m on the instruction of the Engineer.					Logged by MD
Symbols and abbreviations are explained on the accompanying key sheet.						Figure 1 of 1 09/08/2010
All dimensions are in metres.	Logged in accordance with Amendment 1 published December 2007 to BS5930:1999					

TRIAL PIT RECORD

Trial Pit

Project LLWYN ONN WTW, WREXHAM

Engineer

BLACK & VEATCH LIMITED

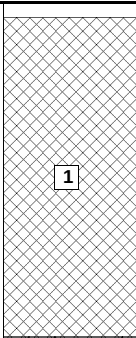
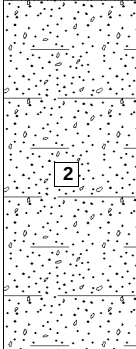
Trial Pit
Project No

TP7
PN102275

Client DEE VALLEY WATER

National Grid
Coordinates 335729.37 E
348747.4 N

Ground Level 70.30 m OD

Samples and Tests				Strata	Scale 1:50		
Depth	Type	Stratum No	Results	Description	Depth	Legend	Level m OD
0.20	ES			MADE GROUND: Brown silty gravelly fine to coarse sand with occasional pockets (up to 200mm) of clay. Gravel is fine to coarse angular to subrounded of mudstone, brick and concrete. At 0.90m: Redundant cable casing.	G.L.		70.30
0.50- 1.00	B						
0.50	ES						
1.00	ES						
1.50- 2.00	B			Light reddish brown clayey gravelly fine to coarse SAND. Gravel is fine to coarse subangular to rounded of various lithologies.			
2.00	ES				2.10		68.20
2.50- 3.00	B						
2.50	ES						
3.50- 4.00	B			Below 4.10m: Becoming light greyish brown and silty.			
3.50	D						
4.10	D			End of Excavation	4.40		65.90

Excavation				Groundwater		
Plant	JCB 3CX	Width (B)	0.80	Depth Observed	Depth of Pit	Details
Date	14/07/2010	Length (C)	3.40			
Shoring	None.	Date Backfilled	14/07/2010			None encountered.
Stability	Stable during excavation.					

Remarks	ES Sample = 1 x 60ml VOC vials, 1 x 1kg plastic tub and 1 x 258ml amber jars. The Trial Pit was terminated at a depth of 4.40m on the instruction of the Engineer.					Logged by MD
Symbols and abbreviations are explained on the accompanying key sheet.						Figure 1 of 1 09/08/2010
All dimensions are in metres.	Logged in accordance with Amendment 1 published December 2007 to BS5930:1999					

TRIAL PIT RECORD

Trial Pit

Project LLWYN ONN WTW, WREXHAM

Engineer

BLACK & VEATCH LIMITED

Trial Pit
Project No

TP8
PN102275

Client DEE VALLEY WATER

National Grid
Coordinates 335736.67 E
348771.16 N

Ground Level 71.22 m OD

Samples and Tests				Strata	Scale 1:50		
Depth	Type	Stratum No	Results	Description	Depth	Legend	Level m OD
0.20 - 0.70	B		mc=17%	MADE GROUND: Grey slightly silty very sandy fine to coarse angular to subrounded gravel of limestone and sandstone (hardcore).	G.L.		71.22
0.20	ES				0.05		71.17
0.30 - 0.70	B			MADE GROUND: Dark brown silty gravelly fine to coarse sand and gravel. Gravel is fine to coarse subangular to rounded of various lithologies.			
0.50	ES						
1.00	ES						
1.50 - 2.00	B			Light yellowish brown slightly gravelly to gravelly silty fine to medium SAND with occasional pockets (up to 60mm) of clay.	1.20		70.02
1.50	ES						
				End of Excavation	2.00		69.22

Excavation				Groundwater		
Plant	JCB 3CX	Width (B)	0.80	Depth Observed	Depth of Pit	Details
Date	14/07/2010	Length (C)	3.60			
Shoring	None.	Date Backfilled	14/07/2010			None encountered.
Stability	Stable during excavation.					

Remarks	ES Sample = 1 x 60ml VOC vials, 1 x 1kg plastic tub and 1 x 258ml amber jars. The Trial Pit was terminated at a depth of 4.40m on the instruction of the Engineer.					Logged by MD
Symbols and abbreviations are explained on the accompanying key sheet.						Figure 1 of 1 09/08/2010
All dimensions are in metres.	Logged in accordance with Amendment 1 published December 2007 to BS5930:1999					

DATA SHEET - Symbols and Abbreviations used on Records

Sample Types	
B	Bulk disturbed sample
BLK	Block sample
C	Core sample
D	Small disturbed sample (tub/jar)
E	Environmental test sample
ES	Environmental soil sample
EW	Environmental water sample
G	Gas sample
L	Liner sample
P	Piston sample (PF - failed P sample)
TW	Thin walled push in sample
U	Open Tube - 102mm diameter with blows to take sample. (UF - failed U sample)
UT	Thin wall open drive tube sampler - 102mm diameter with blows to take sample. (UTF - failed UT sample)
V	Vial sample
W	Water sample
#	Sample Not Recovered
Insitu Testing / Properties	
S	Standard Penetration Test (SPT)
C	SPT with cone
VN	Strength from Insitu Vane
HV	Strength from Hand Vane
PP	Strength from Pocket Penetrometer
(All other strengths from undrained triaxial testing)	
w%	Water content
N	SPT Result
-/-	Blows/penetration (mm) after 150mm seating.
.*./- (mm)	Total blows/penetration
()	Extrapolated value
Rotary Core	
RQD	Rock Quality Designation (% of intact core >100mm)
FRACTURE INDEX Fractures/metre	
FRACTURE SPACING (mm)	Maximum Minimum
NI	Non-intact core
NR	No core recovery
(where core recovery is unknown it is assumed to be at the base of the run)	
Groundwater	
Water Strike	
Depth Water Rose To	
Instrumentation	
Seal	
Filter	
Seal	
Strata	
Made Ground Type 1	
Type 2	
Topsoil	
Cobbles and Boulders	
Gravel	
Sand	
Silt	
Clay	
Peat	
Note: Composite soil types shown by combined symbols	
Chalk	
Limestone	
Sandstone	
Coal	
Strata, Continued	
Mudstone	
Siltstone	
Metamorphic Rock	
Fine Grained	
Medium Grained	
Coarse Grained	
Igneous Rock	
Fine Grained	
Medium Grained	
Coarse Grained	
Backfill Materials	
Arisings	
Bentonite Seal	
Concrete	
Fine Gravel Filter	
General Fill	
Gravel Filter	
Grout	
Sand Filter	
Tarmacadam	

BOREHOLE RECORD - Cable Percussion

Project	LLWYN ONN WTW, WREXHAM	Engineer	BLACK & VEATCH LIMITED	Borehole Project No	BH1 PN102275
Client	DEE VALLEY WATER	National Grid Coordinates	335801.27 E 348921.73 N	Ground Level	69.95 m OD

Sampling			Properties			Strata	Scale 1:50		
Depth	Sample Type	Depth Cased & (to Water)	Strength kPa	w %	SPT	Description	Depth	Legend	Level m OD
0.30- 1.20	B					Grass over TOPSOIL: Brown slightly gravelly silty fine sand with rootlets. Gravel is fine to medium subangular to subrounded of various lithologies. Very loose becoming loose brown slightly gravelly silty fine to medium SAND with pockets of clay (up to 60mm). Gravel is fine to coarse subangular to rounded of various lithologies.	G.L.		69.95
							0.30		69.65
1.20- 1.65 1.20- 1.65	B D	(DRY)			S3				
1.65- 2.20	D								
2.20- 2.65 2.20- 2.65	B D	2.20 (DRY)			S7				
2.65- 3.20	D								
3.20- 3.65 3.20- 3.65	B D	3.20 (DRY)			S6				
3.65- 4.20	D								
4.20- 4.65 4.20- 4.65	B D	4.20 (DRY)			S8				
4.65- 5.20	D								
5.20- 5.65 5.20- 5.65	B D	5.20 (DRY)			S6				
5.65- 6.70	D								
6.70- 7.15 6.70- 7.15	B D	6.20 (DRY)			S5				
7.15- 8.20	D								
8.20- 8.65 8.20- 8.65	B D	7.70 (DRY)			S9				
9.60 9.60-10.05	D D	9.20 (DRY)			S14	At 9.60m: Becoming greyish brown.			

Boring				Progress					Groundwater					
Depth	Hole Dia	Technique	Crew	Depth of Hole	Depth Cased	Depth to Water	Date	Time	Depth Struck	Depth Cased	Rose to	in Mins	Depth Sealed	Remarks on Groundwater
1.20 9.20	0.40 0.15	Inspection Pit Cable Percussion	PB/DA PB/DA	G.L. 10.00	9.20	DRY	21/07/10 21/07/10	08:00 18:00						None encountered.

Remarks  Inspection pit hand excavated to 1.20m depth.
ES Sample = 2 x 60ml VOC vials, 1 x 1kg plastic tub and 2 x 258ml amber jars
Borehole backfilled with bentonite grout on completion.

Symbols and abbreviations are explained on the accompanying key sheet.

All dimensions are in metres.

Logged in accordance with Amendment 1 published December 2007 to BS5930:1999

Logged by MD

Figure 1 of 2
09/08/2010



BOREHOLE RECORD - Cable Percussion

Project **LLWYN ONN WTW, WREXHAM** Engineer **BLACK & VEATCH LIMITED** Borehole Project No **BH1 PN102275**

Client **DEE VALLEY WATER** National Grid Coordinates **335801.27 E 348921.73 N** Ground Level **69.95** m OD

Sampling			Properties			Strata			Scale 1:50		
Depth	Sample Type	Depth Cased & (to Water)	Strength kPa	w %	SPT	Description	Depth	Legend	Level m OD		
						End of Borehole	10.05		59.90		

Boring				Progress					Groundwater					
Depth	Hole Dia	Technique	Crew	Depth of Hole	Depth Cased	Depth to Water	Date	Time	Depth Struck	Depth Cased	Rose to	in Mins	Depth Sealed	Remarks on Groundwater

Remarks 

Symbols and abbreviations are explained on the accompanying key sheet.

All dimensions are in metres.

Logged in accordance with Amendment 1 published December 2007 to BS5930:1999

Logged by **MD**

Figure **2 of 2**
09/08/2010



BOREHOLE RECORD - Cable Percussion

Project **LLWYN ONN WTW, WREXHAM** Engineer **BLACK & VEATCH LIMITED** Borehole Project No **BH2 PN102275**

Client **DEE VALLEY WATER** National Grid Coordinates **335699.66 E 348806.92 N** Ground Level **72.20** m OD

Sampling			Properties			Strata			Scale 1:50		
Depth	Sample Type	Depth Cased & (to Water)	Strength kPa	w %	SPT	Description	Depth	Legend	Level m OD		
0.40- 0.85	B					MADE GROUND: Dark brown silty very gravelly fine to coarse sand. Gravel is fine to medium angular to subrounded of various lithologies and occasional brick fragments.	G.L.		72.20		
0.85- 1.20	B					Light yellowish brown gravelly very silty fine to medium SAND. Gravel is fine to coarse subangular to rounded of various lithologies.	0.40		71.80		
1.00	ES						0.85		71.35		
1.20- 1.65	B	(DRY)			C9	Loose brown silty gravelly fine to medium SAND. Gravel is fine to coarse subrounded to rounded of sandstone and quartz.					
1.65- 2.20	D										
2.20- 2.65	B	1.70 (DRY)			C6		2.50		69.70		
2.65- 3.20	D					Loose becoming medium dense brown slightly gravelly clayey fine to medium SAND. Gravel is fine to coarse subangular to subrounded of various lithologies.					
3.20- 3.65	B	3.20 (DRY)			C5						
3.65- 4.20	D										
4.20- 4.65	B	4.20 (DRY)			S5						
4.20- 4.65						Between 4.65-5.20m: No clay or gravel content.					
4.65- 5.20	D										
5.20- 5.65	D	5.20 (DRY)			S6						
5.65- 6.70	B										
5.65- 6.70	D										
6.70- 7.15	B					At 6.70m: Locally medium dense to dense.					
6.70- 7.15	D	6.20 (6.20)			S30						
7.15- 8.20	D										
8.20- 8.65	B										
8.20- 8.65	D	8.20 (7.00)			S26	Below 8.40m: Occasional clay bands.					
8.65- 9.70	D										
9.70-10.15	D	9.70 (8.70)			S23	Firm to stiff orangish brown slightly sandy slightly gravelly CLAY. Gravel is fine angular to subangular of sandstone and quartz.	9.70		62.50		

Boring				Progress					Groundwater					
Depth	Hole Dia	Technique	Crew	Depth of Hole	Depth Cased	Depth to Water	Date	Time	Depth Struck	Depth Cased	Rose to	in Mins	Depth Sealed	Remarks on Groundwater
1.20	0.40	Inspection Pit	PB/DA	G.L.			12/06/10	08:00						None encountered.
10.15	0.15	Cable Percussion	PB/DA	10.15	9.70	8.70	12/06/10	18:00						

Remarks **INS** Inspection pit hand excavated to 1.20m depth.
BSS Borehole backfilled with bentonite grout on completion.
 ES Sample = 2 x 60ml VOC vials, 1 x 1kg plastic tub and 2 x 258ml amber jars
 Water was added to assist boring between 5.50m and 9.70m.

Logged by **DS**
 Figure **1 of 2**
 09/08/2010

geotechnics

BOREHOLE RECORD - Cable Percussion

Project

LLWYN ONN WTW, WREXHAM

Engineer

BLACK & VEATCH LIMITED

Borehole Project No

BH2
PN102275

Client

DEE VALLEY WATER

National Grid Coordinates

335699.66 E
348806.92 N

Ground Level

72.20 m OD

Sampling			Properties			Strata			Scale 1:50		
Depth	Sample Type	Depth Cased & (to Water)	Strength kPa	w %	SPT	Description	Depth	Legend	Level m OD		
						End of Borehole	10.15		62.05		

Boring				Progress					Groundwater					
Depth	Hole Dia	Technique	Crew	Depth of Hole	Depth Cased	Depth to Water	Date	Time	Depth Struck	Depth Cased	Rose to	in Mins	Depth Sealed	Remarks on Groundwater

BOREHOLE RECORD - Cable Percussion

Project **LLWYN ONN WTW, WREXHAM** Engineer **BLACK & VEATCH LIMITED** Borehole Project No **BH3 PN102275**

Client **DEE VALLEY WATER** National Grid Coordinates **335721.24 E 348754.7 N** Ground Level **70.60** m OD

Sampling			Properties			Strata	Scale 1:50		
Depth	Sample Type	Depth Cased & (to Water)	Strength kPa	w %	SPT	Description	Depth	Legend	Level m OD
0.00- 1.00	B	(DRY)			C2	MADE GROUND: Brown silty gravelly to very gravelly fine to medium sand with occasional cobbles. Gravel is fine to coarse subangular to subrounded of various lithologies, brick and pottery fragments.	G.L.		70.60
1.00- 1.20	B					MADE GROUND: Very loose to loose brown slightly clayey gravelly fine to medium sand. Gravel is fine to medium subangular to subrounded of various lithologies.	1.00		69.60
1.00	ES								
1.20- 1.65	B								
1.65- 2.20	D					Loose to medium dense brown very silty fine to medium SAND. Gravel is fine to medium subangular to rounded of sandstone and quartz.	2.40		68.20
2.00	ES								
2.20- 2.65	B								
2.50	ES								
2.65- 3.20	D								
3.20- 3.65	B								
3.65- 4.20	D								
4.20- 4.65	B								
4.65- 5.20	D								
5.20- 5.65	B								
5.65- 6.70	D								
6.70- 7.15	B	6.20 (DRY)			C10	Between 6.70-7.15m: Locally brown slightly silty very sandy fine to coarse gravel.			
7.15- 8.20	D								
8.20- 8.65	B								
9.00	D	9.00 (DRY)	303	13	C11	Stiff to very stiff laminated brown slightly sandy slightly gravelly laminated CLAY. Gravel is fine to medium subangular to rounded of mudstone, sandstone and quartz. At 9.00m, extremely high strength	9.00		61.60
9.00- 9.45	U85								
9.45-10.50	D								

Boring				Progress					Groundwater					
Depth	Hole Dia	Technique	Crew	Depth of Hole	Depth Cased	Depth to Water	Date	Time	Depth Struck	Depth Cased	Rose to	in Mins	Depth Sealed	Remarks on Groundwater
1.20	0.40	Inspection Pit	PB/DA PB/DA	G.L.			13/07/10	08:00						None encountered.
13.60	0.20	Cable Percussion		9.00	9.00	DRY	13/07/10	18:00						
30.13	0.15	Cable Percussion		G.L.	9.00	DRY	14/07/10	08:00						
				23.80	23.80	DRY	14/07/10	18:00						
				23.80	23.80	DRY	15/07/10	08:00						
				30.13	25.00	DRY	15/07/10	18:00						

Remarks Inspection pit hand excavated to 1.20m depth.
 ES Sample = 2 x 60ml VOC vials, 1 x 1kg plastic tub and 2 x 258ml amber jars
 A 19mm standpipe piezometer was installed to 29.80m with flush lockable protective cover.
 Detail as follows from base of hole: fine gravel filter up to 19.80m, bentonite seal up to 0.50m, concrete up to ground level.

Symbols and abbreviations are explained on the accompanying key sheet.

All dimensions are in metres.

Logged in accordance with Amendment 1 published December 2007 to BS5930:1999

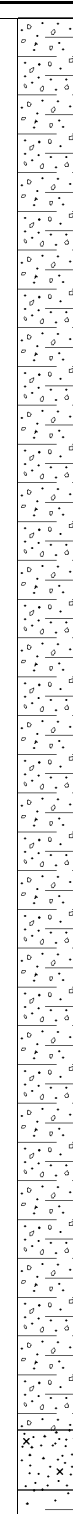
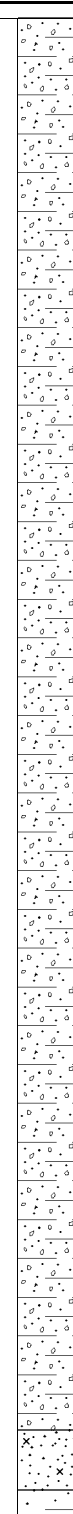
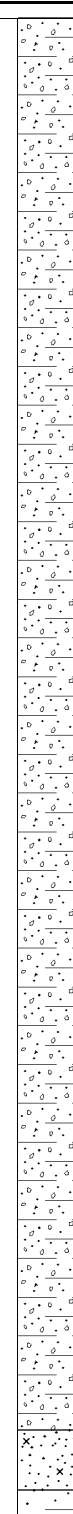
Figure

1 of 4
09/08/2010

BOREHOLE RECORD - Cable Percussion

Project **LLWYN ONN WTW, WREXHAM** Engineer **BLACK & VEATCH LIMITED** Borehole Project No **BH3 PN102275**

Client **DEE VALLEY WATER** National Grid Coordinates **335721.24 E 348754.7 N** Ground Level **70.60** m OD

Sampling			Properties			Strata		Scale 1:50		
Depth	Sample Type	Depth Cased & (to Water)	Strength kPa	w %	SPT	Description	Depth	Legend	Level m OD	
10.50-10.95 10.50-10.95	B D	10.50 (DRY)			S29					
10.95-12.00	D									
12.00-12.45	U90	12.00 (DRY)		14		Between 12.00-12.45m: Locally silt.				
12.45-13.50	D									
13.50-13.94		13.50 (DRY)			S50/ 290	At 13.50m: Cobble				
15.00-15.45 15.00-15.45	B D	15.00 (DRY)			S37					
15.45-16.50	D									
16.50-16.95	U92	16.50 (DRY)								
16.95-18.00	D									
18.00-18.45 18.00-18.45	B D	18.00 (DRY)			S35					
19.30 19.30-19.75	D U78	19.30 (DRY)		19		Grey slightly silty fine to medium SAND.	19.30		51.30	
19.75-20.80	D					Firm to stiff brown slightly sandy CLAY.	19.70		50.90	

Boring				Progress					Groundwater					
Depth	Hole Dia	Technique	Crew	Depth of Hole	Depth Cased	Depth to Water	Date	Time	Depth Struck	Depth Cased	Rose to	in Mins	Depth Sealed	Remarks on Groundwater

BOREHOLE RECORD - Cable Percussion

Project **LLWYN ONN WTW, WREXHAM** Engineer **BLACK & VEATCH LIMITED** Borehole Project No **BH3 PN102275**

Client **DEE VALLEY WATER** National Grid Coordinates **335721.24 E 348754.7 N** Ground Level **70.60** m OD

Sampling			Properties			Strata			Scale 1:50		
Depth	Sample Type	Depth Cased & (to Water)	Strength kPa	w %	SPT	Description	Depth	Legend	Level m OD		
20.80-21.25	B	20.80 (DRY)			S30						
20.80-21.25											
21.25-22.30	D										
22.30-22.75	U72	22.30 (DRY)									
22.75-23.80	D										
23.80-24.25	B	23.80 (DRY)			S37	Very stiff greyish brown slightly sandy slightly gravelly CLAY. Gravel is fine to medium subangular to subrounded of various lithologies.	23.80				46.80
23.80-24.25											
24.25-25.30	D										
25.30-25.75	U90	25.00 (DRY)		14							
25.75-26.80	D										
26.80-27.25	D	25.00 (DRY)			S32						
27.25-28.30	D										
28.30-28.90	B										
28.30-28.90	UF										
29.80		25.00 (DRY)			C50/175	Extremely weak reddish brown MUDSTONE (Recovered as very stiff slightly sandy clay)	29.80				40.80
29.80-30.13	D										

Boring				Progress					Groundwater					
Depth	Hole Dia	Technique	Crew	Depth of Hole	Depth Cased	Depth to Water	Date	Time	Depth Struck	Depth Cased	Rose to	in Mins	Depth Sealed	Remarks on Groundwater

Remarks 

Symbols and abbreviations are explained on the accompanying key sheet.

All dimensions are in metres.

Logged in accordance with Amendment 1 published December 2007 to BS5930:1999

Figure **3 of 4**
09/08/2010



BOREHOLE RECORD - Cable Percussion

Project **LLWYN ONN WTW, WREXHAM** Engineer **BLACK & VEATCH LIMITED** Borehole Project No **BH3 PN102275**

Client **DEE VALLEY WATER** National Grid Coordinates **335721.24 E 348754.7 N** Ground Level **70.60** m OD

Sampling			Properties			Strata			Scale 1:50		
Depth	Sample Type	Depth Cased & (to Water)	Strength kPa	w %	SPT	Description	Depth	Legend	Level m OD		
						End of Borehole	30.13		40.47		

Boring				Progress					Groundwater						
Depth	Hole Dia	Technique	Crew	Depth of Hole	Depth Cased	Depth to Water	Date	Time	Depth Struck	Depth Cased	Rose to	in Mins	Depth Sealed	Remarks on Groundwater	

Remarks 

Symbols and abbreviations are explained on the accompanying key sheet.

All dimensions are in metres.

Logged in accordance with Amendment 1 published December 2007 to BS5930:1999

Figure

4 of 4
09/08/2010



BOREHOLE RECORD - Cable Percussion

Project	LLWYN ONN WTW, WREXHAM	Engineer	BLACK & VEATCH LIMITED	Borehole Project No	BH4 PN102275
Client	DEE VALLEY WATER	National Grid Coordinates	335752.77 E 348760.54 N	Ground Level	70.96 m OD

Sampling			Properties			Strata			Scale 1:50		
Depth	Sample Type	Depth Cased & (to Water)	Strength kPa	w %	SPT	Description	Depth	Legend	Level m OD		
0.45- 1.20	B					MADE GROUND: Grey slightly silty sandy fine to coarse angular to subrounded gravel of limestone and sandstone (hardcore). MADE GROUND: Dark brown silty gravelly fine to medium sand. Gravel is fine to coarse subangular to rounded of various lithologies. Soft brown slightly sandy CLAY with occasional lenses of silt. Below 0.70m: Becoming very gravelly	G.L.		70.96		
1.00	ES						0.25		70.71		
1.20- 1.65	B	(DRY)			S7		0.45		70.51		
1.65- 2.20	D										
2.20- 2.65	U35	2.20 (DRY)		26							
2.80- 3.25	B	2.80 (DRY)			C6	Loose to medium dense dark orangish brown silty gravelly fine to coarse SAND. Gravel is fine to medium subangular to subrounded of mudstone, sandstone and occasional coal traces.	2.80		68.16		
2.80	D										
3.25- 3.80	D										
3.80- 4.25	B	3.80 (DRY)			C9						
4.25- 4.80	D										
4.80- 5.25	B	4.80 (DRY)			C10						
5.25- 6.30	D										
6.30- 6.75	B	6.20 (DRY)			C11						
6.75- 7.80	D										
7.80- 8.25	B	7.70 (DRY)			C7						
8.25- 9.30	D										
9.30- 9.75	B	9.20 (DRY)			C6	Between 9.30-9.75m: Becoming silty very gravelly					
9.75-10.80	D										

Boring				Progress					Groundwater					
Depth	Hole Dia	Technique	Crew	Depth of Hole	Depth Cased	Depth to Water	Date	Time	Depth Struck	Depth Cased	Rose to	in Mins	Depth Sealed	Remarks on Groundwater
1.20	0.40	Inspection Pit		G.L.	12.30		19/07/10	08:00						None encountered.
12.30	0.20	Cable Percussion	PB/DA	12.30	12.30	DRY	19/07/10	18:00						
20.00	0.15	Cable Percussion	PB/DA	12.30	12.30	DRY	20/07/10	08:00						
				20.10	19.70	DRY	20/07/10	18:00						

Remarks  Inspection pit hand excavated to 1.20m depth.
 ES Sample = 2 x 60ml VOC vials, 1 x 1kg plastic tub and 2 x 258ml amber jars
 A 19mm standpipe piezometer was installed to 15.00m with flush lockable protective cover.
 Detail as follows from base of hole: bentonite seal up to 15.00m, fine gravel filter up to 10.00m, bentonite seal up to 0.50m, concrete up to ground level.

Symbols and abbreviations are explained on the accompanying key sheet.

All dimensions are in metres.

Logged in accordance with Amendment 1 published December 2007 to BS5930:1999

Figure

1 of 3

09/08/2010



BOREHOLE RECORD - Cable Percussion

Project **LLWYN ONN WTW, WREXHAM** Engineer **BLACK & VEATCH LIMITED** Borehole Project No **BH4 PN102275**

Client **DEE VALLEY WATER** National Grid Coordinates **335752.77 E 348760.54 N** Ground Level **70.96** m OD

Sampling			Properties			Strata		Scale 1:50		
Depth	Sample Type	Depth Cased & (to Water)	Strength kPa	w %	SPT	Description	Depth	Legend	Level m OD	
10.80-11.25	B	10.60 (DRY)		12	C11		15.40		55.56	
11.25-12.30	D									
12.30-12.75	B	12.30 (DRY)			S9					
12.30-12.75	D									
12.75-13.80	D									
13.80-14.25	B	13.70 (DRY)			S26					
13.80-14.25	D									
14.25-15.30	D									
15.30-15.75	B	15.20 (DRY)			S23					Stiff becoming very stiff laminated reddish brown slightly sandy slightly gravelly CLAY with occasional lenses of fine sand.
15.30-15.75	D									
15.75-16.80	D									
16.80-17.25	U82	16.70 (DRY)								
17.25-18.30	D									
18.30-18.72	B	18.20 (DRY)			S50/198					
18.30-18.65	D									
18.72-19.80	D									
19.80-20.16	D	19.70 (DRY)	S50/210							

Boring				Progress					Groundwater					
Depth	Hole Dia	Technique	Crew	Depth of Hole	Depth Cased	Depth to Water	Date	Time	Depth Struck	Depth Cased	Rose to	in Mins	Depth Sealed	Remarks on Groundwater

Remarks 

Symbols and abbreviations are explained on the accompanying key sheet.

All dimensions are in metres.

Logged in accordance with Amendment 1 published December 2007 to BS5930:1999

Figure

2 of 3
09/08/2010



BOREHOLE RECORD - Cable Percussion

Project **LLWYN ONN WTW, WREXHAM** Engineer **BLACK & VEATCH LIMITED** Borehole Project No **BH4 PN102275**

Client **DEE VALLEY WATER** National Grid Coordinates **335752.77 E 348760.54 N** Ground Level **70.96** m OD

Sampling			Properties			Strata		Scale 1:50		
Depth	Sample Type	Depth Cased & (to Water)	Strength kPa	w %	SPT	Description	Depth	Legend	Level m OD	
						End of Borehole	20.16		50.80	

Boring				Progress					Groundwater					
Depth	Hole Dia	Technique	Crew	Depth of Hole	Depth Cased	Depth to Water	Date	Time	Depth Struck	Depth Cased	Rose to	in Mins	Depth Sealed	Remarks on Groundwater