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Arran Chemicals Limited

Athlone, Co. Roscommon.

Baseline Report 2019

In accordance with Article 22(2) of Directive 2010/75/EU on Industrial Emissions

Report Reference Number: 4750-19-01
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Contents

Executive Summary

This Baseline Report has been prepared for Arran Chemicals Limited (referred to hereinafter as Arran) as part of an application for an Environmental Protection Agency (EPA) Industrial Emissions Licence Review at its facility at Monksland Industrial Estate, Athlone, Co. Roscommon. The activity which is listed in the amended First Schedule of the EPA Act 1992, as amended;

5.16: The production of pharmaceutical products including intermediates (production means the production on an industrial scale by chemical or biological processing)

Baseline reports are required to meet the requirements of Article 22(2) of the Industrial Emissions Directive (2010/75/EU). The objective of the report is to obtain a current status of the site prior to issue or review of Industrial emissions licences. This information will be used to assess the impact of the facility on the local soils and groundwater since the baseline concentrations were established.

The facility is located in Monksland Industrial Estate and is adjacent to several other pharmaceutical facility's including Alexion, Alkermes and Jazz Pharmaceuticals. The site is almost 100% hardstanding with concrete cover. There are no underground storage tanks for raw materials. As part of the existing EPA licence all chemicals are stored in suitably bunded areas and the bund integrity is reviewed every three years. All materials with environmental hazard statements are classified, labelled and packaged in accordance with Regulation 1272/2008.

During routine monitoring of groundwater carried out in August 2018, an increase in concentration of contaminants was detected. The origin of this leak was determined to be an effluent sump onsite. Since then a remedial pumping system has been setup and is being improved based on performance observations. Concentrations of CoPCs since the remedial pumping started are decreasing in the majority of the monitoring wells with some exceptions. The recommendations made in the following corrective action procedures are being implemented including further testing of sumps and drainage network, reducing laboratory limits of detection and continuing assessment of performance.

The licence review application is for the purposes of installing a new air abatement system which in accordance with BAT will be more energy efficient and effective in control of pollution to atmosphere as well as new emission limits to sewer which have been agreed with Irish Water.

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Revision	Purpose/Description	Originated	Checked	Authorised	Date
Additional Notes:					

1. Introduction

The Arran facility at Monksland, Athlone, Co. Roscommon currently operates under EPA licence P0110-02. Arran are in the process of applying for a revised Industrial Emissions Licence as a result of installation of a new emission point, updating the abatement equipment and an increase in emissions.

The requirement for a baseline report comes from European Legislation, specifically the Industrial Emissions Directive (2010/75/EU) or IED which entered into force within the European Union on the 6th January 2011. The Baseline report shall contain the information necessary to determine the state of soil and groundwater contamination so as to make a quantified comparison with the state upon definitive cessation of activities.

The company is currently licensed by the EPA for the following activity:

5.16: The production of pharmaceutical products including intermediates (Production means the production on an industrial scale by chemical or biological processing)

The scope of the report follows the stages set out in the European Guidance concerning baseline reports under Article 22(2) of Directive 2010/75/EU on Industrial Emissions.

Stage1: Identifying the hazardous substances that are currently used, produced or released at the installation.

Stage 2: Identifying the relevant hazardous substances.

Stage 3: Assessment of the site-specific pollution possibility.

Stage 4: Site History.

Stage 5: Environmental setting.

Stage 6: Site characterisation.

Stage 7: Site investigation.

Stage 8: Production of the baseline report.

2. Objectives

The objective of this Baseline Report screen was to determine if the installation would warrant progression from a screen to a full intrusive investigation into potential groundwater and soil contamination on site.

The objectives of this screening report were met by considering the following:

- Identification of the hazardous substances use, produced or released from site;
- Listing, assessing and restricting the hazardous substances to relevant hazardous substances;
- Discarding hazardous substances which are incapable of contaminating soil or groundwater;
- Justifying the decisions to exclude certain hazardous substances;
- Identifying the actual possibility for soil and groundwater contamination of the site;
- Inclusion probability of releases and the consequences of a release;
- Assessment of quantities of hazardous materials stored on site;
- Review the storage arrangements, use and transport procedures around site;
- Procedures, policies and measures adapted to minimise or eliminate possibility of groundwater and soil contamination.

3. Baseline Report Methodology

The installation was assessed in line with Table 1 to identify if activities and operations attributed significant risk to groundwater and soil contamination on site.

Table 1 Baseline Report Screening Assessment

Stage	Activity	Objective
1	Identify which hazardous substances are used, produced or released at the installation and produce a list of these hazardous substances	Determine whether or not hazardous substances are used, produced or released in view of deciding on the need to prepare and submit a baseline report.
2	Identify which of the hazardous substances from Stage 1 are relevant hazardous substances. Discard substances which are incapable of contaminating soil or groundwater. Justify and record the decisions taken to exclude certain hazardous substances	To restrict further consideration to only the relevant hazardous substances in view of deciding on the need to prepare a baseline report

If the site is considered a threat or potentially impacting on the local soil and groundwater quality with substances considered as Hazardous under Article 3 of Regulation (EC) No 1272/2008 of the European Parliament and of the Council of 16 December 2008, the Screening Assessment is extended to a detailed Baseline Report.

Table 2 Baseline Report

Stage	Activity	Objective
3	From each relevant hazardous substance brought forward from Stage 2, identify the actual possibility for soil or groundwater contamination at the site of the installation, including the probability of releases and their consequences, and taking particular account of: • The quantities of each hazardous substance or groups of similar hazardous substances concerned; • How and where hazardous substances are stored, used and to be transported around the installation; • Where they pose a risk to be released; • In the case of existing installations also the measures that have been adapted to ensure that it is impossible in practice that contamination of soil or groundwater takes place.	To identify which of the relevant hazardous substances represent a potential pollution risk at the site based on the likelihood of releases of such substances occurring. For these substances, information must be included in the baseline report.
4	Provide a site history. Consider available data and information: — In relation to the present use of the site, and on emissions of hazardous substances which have occurred and which may give rise to pollution. In particular, consider accidents or incidents, drips or spills from routine operations, changes in operational practice, site surfacing, changes in the hazardous substances used. — Previous uses of the site that may have resulted in the release of hazardous substances, be they the same as those used, produced or released by the existing installation, or different ones. Review of previous investigation reports may assist in compiling this data.	Identify potential sources which may have resulted in the hazardous substances identified in Stage 3 being already present on the site of the installation.

Stage	Activity	Objective
5	Identify the site's environmental setting including: — Topography; — Geology; — Direction of groundwater flow; — Other potential migration pathways such as drains and service channels; — Environmental aspects (e.g. particular habitats, species, protected areas etc.); and — Surrounding land use.	Determine where hazardous substances may go if released and where to look for them. Also identify the environmental media and receptors that are potentially at risk and where there are other activities in the area which release the same hazardous substances and may cause them to migrate onto the site.
6	Use the results of Stages 3 to 5 to describe the site, in particular demonstrating the location, type, extent and quantity of historic pollution and potential future emissions sources noting the strata and groundwater likely to be affected by those emissions – making links between sources of emissions, the pathways by which pollution may move and the receptors likely to be affected.	Identify the location, nature and extent of existing pollution on the site and to determine which strata and groundwater might be affected by such pollution. Compare with potential future emissions to see if areas are coincident.
7	If there is sufficient information to quantify the state of soil and groundwater pollution by relevant hazardous substances on the basis of Stages (1) to (6) then go directly to Stage 8. If insufficient information exists then intrusive investigation of the site will be required in order to gather such information. The details of such investigation should be clarified with the competent authority.	Collect additional information as necessary to allow a quantified assessment of soil and groundwater pollution by relevant hazardous substances.
8	Produce a baseline report for the installation that quantifies the state of soil and groundwater pollution by relevant hazardous substances.	Provide a baseline report in line with the IED.

4. Site Description and Layout

Arran Chemicals was originally founded by Anthony Owens in 1984 at a site in Galway which operated a lab and produced on pilot scale for three years. The operation then moved to Athlone when commercial production commenced. Arran Chemical Company commenced manufacturing on-site in Monksland in 1988. The operation was acquired by the Almac Group in 2015. Almac, whose headquarters are located in Craigavon, Northern Ireland are a contract development and manufacturing organisation that can offer a range of services that can cover the full life cycle of a product from R & D through to commercial-scale manufacture. Arran is a fine chemical company specialising in the manufacture of products for pharmaceutical and health care and other specialised chemical and industrial applications. The current facility employs 100 personnel who operate over a twenty-four-hour shift. Arran's first operated under EPA licence in 1996 and that licence was replaced by the current licence, P0110-02 in 2007. The facility is located in Monksland Industrial Estate, Athlone, Co. Roscommon and is adjacent to other licensed facility's including Alkermes Pharmaceutical and Alexion Pharmaceutical and is 500m east of Jazz Pharmaceuticals. The company is accredited to ISO 14001:2015 and ISO 9001:2015 standards which both demonstrates and defines the commitment of the organisation to quality and environmental standards.

Arran first commenced operation as an R & D and pilot production facility in Galway but relocated to Monksland to facilitate more commercial production. The strategic location of Arran is in line with the Westmeath County Development Plan 2014-2020 which aims to promote and sustain development of high value, knowledge based industrial activities. The three-acre site facilities include range from laboratory and kilo laboratory for process development and prototype manufacture, to pilot plant (with stainless steel, Hastelloy and glass lined vessels of volume up to 1,000 L) and to manufacture plant (with stainless steel, Hastelloy and glass lined vessels of volume up to 8,000 L). A range of filters and centrifuges are available for product isolation and distillation technologies are widely deployed to enhanced product purity and quality. A total of 88 m^3 of manufacturing vessel capacity is available with a potential to produce approximately 1,500 - 2,000 batches of product per calendar quarter.

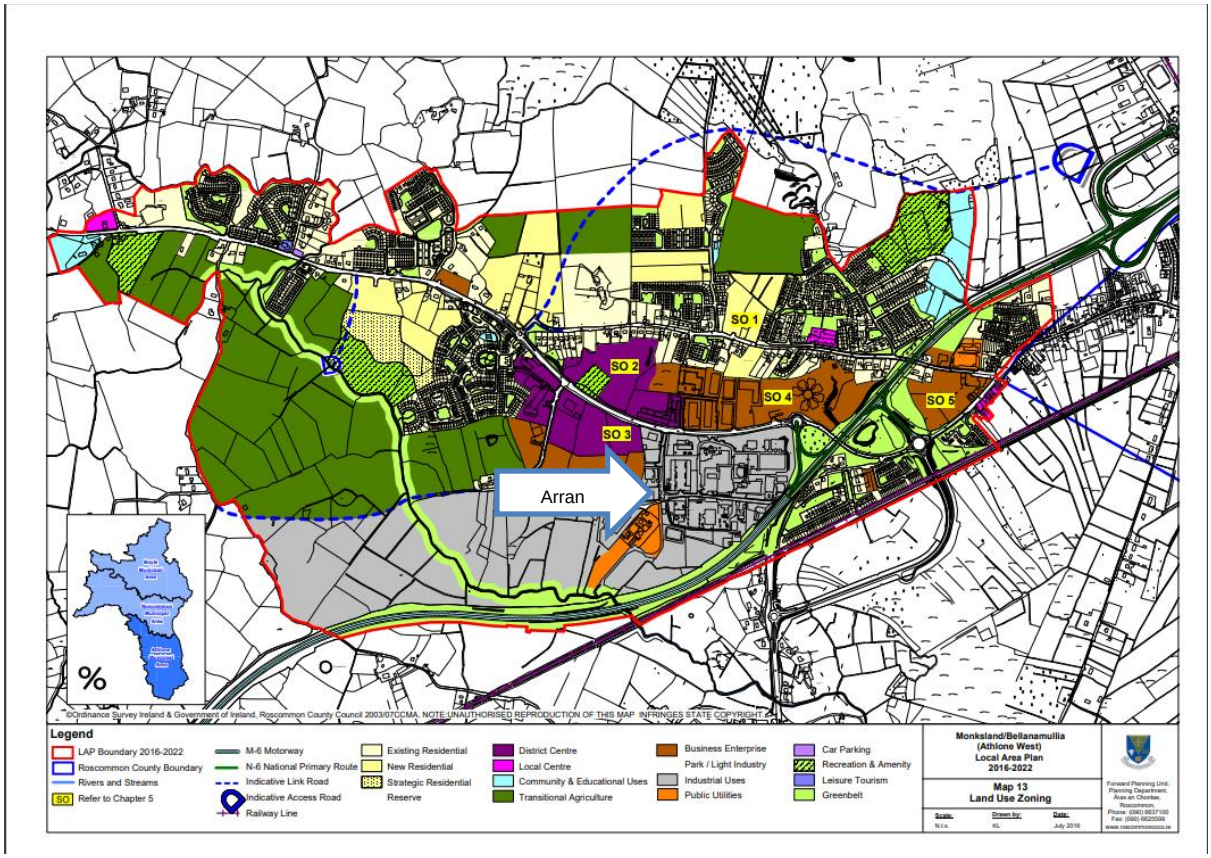


Figure 1: Area Development Plan

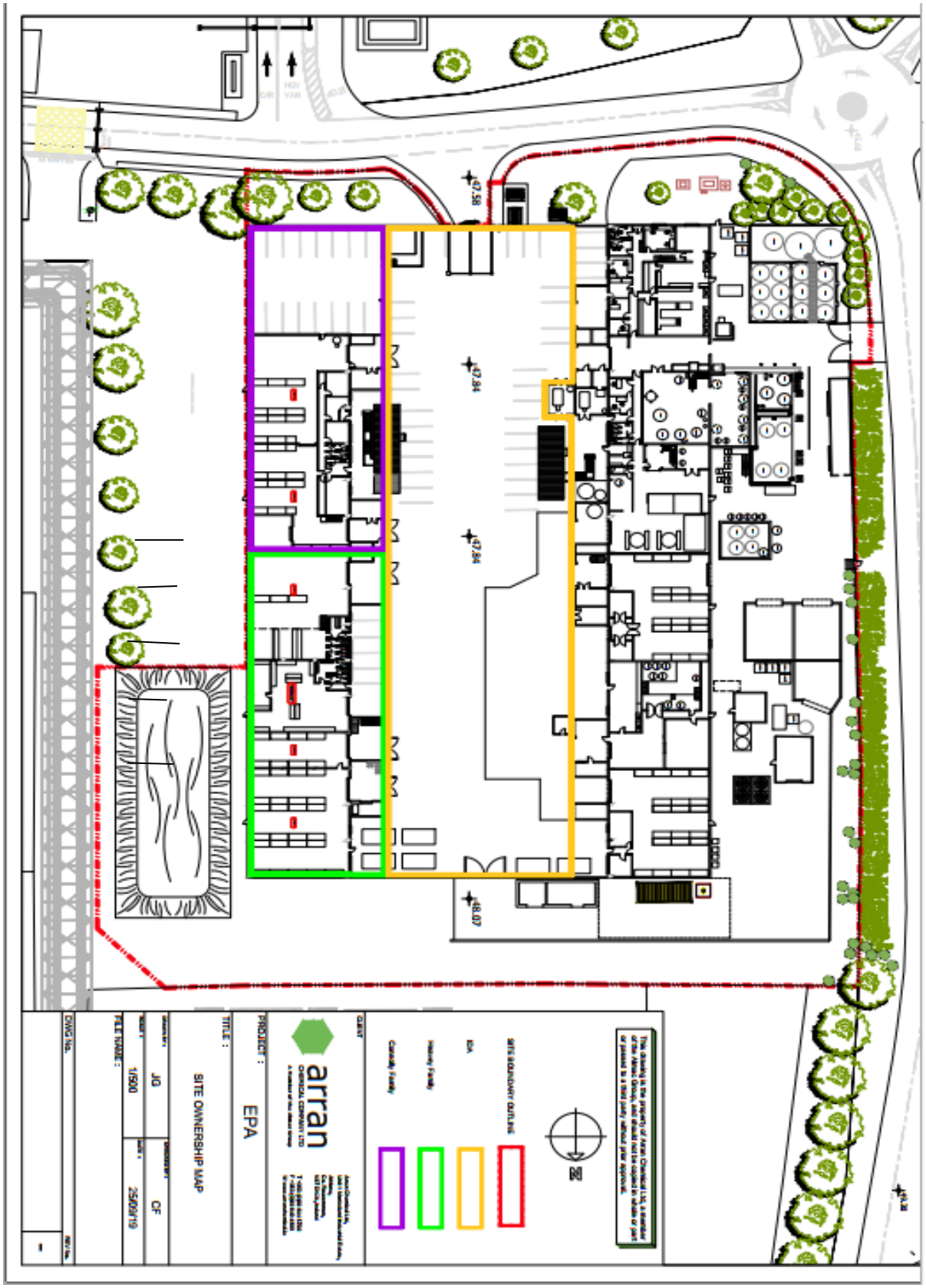


Figure 2; Site Layout & Ownership

Table 3 Inventory of Equipment, Buildings and Plant

Item Name	Item Description
Unit 1	Offices, QC & R+D laboratory and small volume lab chemical storage
Unit 2	Processing Building made up of 14 no. reactors & 3 no. centrifuges
Unit 3	Dryer Area & 3 no. distillation evaporator units & 1 no. centrifuge
Unit 4	Bunded raw material warehouse for solvents and aqueous chemicals
Unit 5	Pilot Plant & TBE laboratory & new Kilo Laboratory
Tray Dryer Building	Tray Dryer
Unit 6	Bunded raw material & in-process material warehouse
Front Unit 6	QC material sampling room.
Front Unit 5-6	Tray Dryer is located in front of Units 5 and 6. The Tray Dryer is incorporated within the operations at the pilot plant.
Unit 7	Dry Product Warehouse (in-process material)
Unit 8	Dry Waste Warehouse
Maintenance	Engineering workshop
Unit 9	Engineering equipment & packaging store
Unit 10	Dry Product & raw material warehouse
Unit 11	Dry Product & Goods outwards storage warehouse
Port cabin (2-storey)	Administration and Meeting rooms in front of Unit 10-11
Port cabin (2-storey)	Site Canteen & Production Locker room in front of Unit 2- 3
Sub Station	Electrical Sub Station
Other	Car park Processing Yard Bunded Tank farms Loading & Unloading Area Emergency Power only generator Refrigerated Container storage (40ft) for dry material Refrigerated Container storage (20ft) x 3 no
Utilities	1.4 Mw gas boiler In front of Unit 2 Backup oil steam Boiler Domestic Heating oil Boiler x 3 Domestic Heating gas Boiler Pilot Plant Chiller New Cooling Water Tower/Tanks New chiller unit
Fuel Storage	4 Diesel tanks 3 x 1,000L 1 x 10,000L
40 Foot Container	Lock Up Container for Metal supplies
Fire Water Retention	700m3 Firewater lagoon
Sumps	Process water control sumps 2, 3 & 5 Front Yard Storm water sump Firewater control sump
Drains	Process Drains Storm Water Drains Firewater Diversion Drains
Equipment	Various including forklifts reactors, feed vessels etc
Storage	Bunded tank farms, bunded warehouses, prefabricated bunds.

5. Stage 1: Identifying the hazardous substances that are currently used, produced or released at the installation.

All materials used, produced and released are included in Appendix 1 of this report. The Safety Data Sheets for the materials were used to compile a list of materials that had relevant hazardous substances such as substances that are known to contribute to contamination of soils and groundwater in the event of an accidental release.

6. Stage 2: Identifying the relevant hazardous substances

As stated in the EC Guidance this stage consists of identifying potential contaminants from the list produced in Stage 1 by considering the composition, physical state, solubility, toxicity, mobility and persistence to determine its potential to cause pollution to soil and groundwater. Hazardous substances can be defined as substances that are toxic and persistent and liable to bio-accumulate. A review of the chemicals that fit this description can be seen in Table 3.

Table 4 Summary of Materials listed as Environmentally Hazardous

	Raw Material name	CAS No.	Ton. Band	Hazard Phrases
1.	1'-Acetonaphthone*	941-98-0	1-10	H302, H412
2.	AIBN (2,2'-Azobis(2-methylpropionitrile)	78-67-1	<1MT	H242, H302, H312, H332, H412
3.	2-Amino-1-butanol*	96-20-8	1-10	H302, H314., H400
4.	(+)-2-Aminobutane	13952-84-6	<1MT	H225, H302, H332, H314, H400
5.	4-Aminophenol	123-30-8	<1MT	H302, H332, H341, H410
6.	Ammonia (Gas)	7664-41-7	<1MT	H221, H280, H314, H331, H410
7.	Ammonia Solution	1336-21-6	1-10	H314, H335, H400
8.	Aniline	62-53-3	<1MT	H301, H311, H317, H318, H330, H341, H351, H372, H400
9.	Benzophenone*	119-61-9	1-10	H373, H411
10.	Benzyl Chloroformate	501-53-1	<1MT	H314, H410
11.	Benzylchloromethyl Ether	3587-60-8	<1MT	H302, H315, H318, H331, H334, H335, H350, H373, H400
12.	BHT	128-37-0	<1MT	H410
13.	Bromine	7726-95-6	<1MT	H330, H314, H400
14.	Bromobenzene	203-623-8	<1MT	H226, H315, H411
15.	1-Bromo-3-chloropropane*	109-70-6	10-100	H302, H331, H341, H335, H412
16.	4-t-Butylbenzaldehyde	939-97-9	<1MT	H302, H334, H410
17.	4-t-Butylcatechol	98-29-3	1-10	H302+H312, H314, H317, H410
18.	4-tert-Butylcyclohexanol*	98-52-2	1-10	H302+H312, H314, H317, H410
19.	t-Butyl Hydroquinone	1948-33-0	<1MT	H302+H312, H315, H319, H400
20.	N-Butyllithium (24%) in Hexane	203-698-7 / 265-151-9	<1MT	H225, H250, H260, H304, H314, H336, H361f, H373, H411, EUH014
21.	3-Chloro-2-methylpropene	563-47-3	<1MT	H225, H302+H332, H314, H317, H411
22.	Chloroacetyl Chloride	201-171-6	<1MT	H301, H311, H314, H331, H372, H400, EUH014

23.	2-Chloroacrylonitrile	920-37-6	<1MT	H225, H300+H310+H330, H314, H334, H350, H400
24.	Cobalt Acetate Tetreahydrate	612-153-6 (200-755-8)	<1MT	H302, H317, H332, H334, H341, H350i, H360F, H410
25.	Copper (I) Chloride	7758-89-6	<1MT	H302, H315, H318, H335, H410
26.	Copper (II) Chloride	7447-39-4	<1MT	H302, H315, H319, H335, H410
27.	Copper (I) Iodide	7681-65-4	<1MT	H302, H315, H317, H318, H335, H410
28.	Cyclohexane	110-82-7	1-10	H225, H304, H315, H336, H400, H410
29.	Dichlorobis(triphenylphosphine) Palladium (II)	13965-03-2	<1MT	H302+H312+H332, H315, H317, H319, H413
30.	Dichloro (p-cymene) RU (II) Dimer	52462-29-0	<1MT	H302, H319, H412
31.	4-Dimethylaminopyridine (DMAP)	1122-58-3	<1MT	H301+H331, H310, H314, H411
32.	Dimethylaluminium Chloride (13%) in Hexane	110-54-3 / 1184-58-3	<1MT	H225, H250, H260, H304, H314, H336, H361, H373, H411, EUH014
33.	N,N-Dimethylaniline	204-493-5	<1MT	H301, H311, H331, H351, H411
34.	2,5-Diphenyl-1,4-benzoquinone	844-51-9	<1MT	H302, H317, H400
35.	Furan	110-00-9	<1MT	H224, H302, H315, H331, H341, H350, H373, H412, EUH019
36.	Heptane	142-82-5	10-100	H225, H304, H315, H336, H400, H410
37.	1-Hexane	110-54-3	<1MT	H225, H304, H315, H335+H336, H361, H373, H411
38.	Hexamethyldisilazane	999-97-3	<1MT	H225, H302, H311, H314, H332, H412
39.	Hexamethyldisiloxane	107-46-0	<1MT	H225, H410
40.	Hexyllithium (33%) in Hexane	21369-64-2 / 64742-49-0	<1MT	H314, H225, H304, H336, H361f, H373, H411, EUH014
41.	Hydrazine Monohydrate	7803-57-8	<1MT	301, 311, 330, 314, 317, 350, 410
42.	Hydroxylamine Sulfate*	10039-54-0	1-10	H290, H302, H312, H315, H319, H317, H351, H373, H400, H412
43.	Iodine	7553-56-2	<1MT	H312, H332, H400
44.	Iodomethane	74-88-4	<1MT	H301, H312, H315, H331, H335, H351
45.	Irgacure 250	344562-80-7	<1MT	H302, H317, H318, H373, H410
46.	Lithium Hexamethyldisilazine (24%) in THF	109-99-9 / 4039-32-1 / 513-35-9	1-10	H341, H351, H225, H314, H302, H335, H412, EUH019
47.	Marlotherm	27776-01-8 / 53585-53-8	<1MT	H304, H315, H413
48.	2-Mercaptoethanol	60-24-2	<1MT	H301+H331, H310, H315, H317, H318, H373, H410
49.	2-Nitropropane	79-46-9	<1MT	226, 302, 331, 341, 350, 412
50.	Octamethylcyclotetrasiloxane	556-67-2	<1MT	H226, H361, H413
51.	Peracetic Acid (40%)*	79-21-0	1-10	242, 271, 290, 301+331, 312, 314, 335, 410
52.	Potassium Cyanide	151-50-8	<1MT	H290, H300, H330, H310, H370, H372, H400, H410

53.	Quizarin	81-64-1	<1MT	H410
54.	Ruthenium (III) Chloride Hydrate	14898-67-0	<1MT	H290, H302, H314, H412
55.	Silver Nitrate	7761-88-8	<1MT	H272, H290, H314, H410
56.	Sodium Chlorite (25%)	7758-19-2	<1MT	H271, H301, H310, H314, H373, H410
57.	Sodium Cyanide	143-33-9	<1MT	H290, H300+H310+H330, H372, H410, EUH032
58.	Sodium Hypochlorite	7681-52-9	1-10	H314, H400
59.	Sodium Nitrite	7632-00-0	<1MT	H272, H301, H400
60.	Tetrabutylammonium Bromide	1643-19-2	<1MT	H315, H319, H412
61.	Toluene	108-88-3	10-100	H225, H304, H315, H336, H361d, H373, H412
62.	Tributylamine	102-82-9	<1MT	H302, H310, H330, H315, H319, H411
63.	(S)-3,5,5-Trimethylpyrrolidin-2-one	14482-00-9	1-10	H402, H412
64.	Zinc Chloride Anhydrous*	7646-85-7	1-10	H314, H335, H302, H410
65.	Zinc Bromide (30%) in THF	109-99-9 7699-45-8	<1MT	H351, H225, H314, H317, H335, H411, EUH019
66.	Zinc Dust	7440-66-6 / 1314-13-2	<1MT	H410
67.	Diesel	Ultra Low Sulphur Diesel	10,000L	H411, H350, H315, H304, H332, H373

Hazardous Waste

There are three main process stages including lab, pilot plant and manufacturing. All of these stages have various volumes of aqueous and solvent waste. All chemicals including waste are stored onsite in bunded areas to minimise the potential for escape to soils or groundwater. A list of these areas is below:

Table 5 Bunded Storage

Bund Identity	Construction Material	Bund Contents
Bund No. 1	Concrete	Tanks - T913, T914, T915, T916, T917, T918
Bund No. 2	Concrete	Tanks - T907, T908, T909, T911, T912
Effluent Tank Bund	Concrete	Effluent Tank A, Effluent Tank B, Tank D
Bund No. 6	Concrete	Chillers & Glycol Tank Bund
Bund No. 7	Concrete	IBC Storage
Bund No. 8	Concrete	Tanks - T903, T904, T922, T923
Acids Bund	Concrete	Drums and IBC's containing acids
Bases Bund	Concrete	Drums and IBC's containing bases
Mobile Bund 1	Prefabricated	Mixed Solvent drums for Lab
Mobile Bund 2	Prefabricated	Acid drums for Effluent
Mobile Bund 3	Prefabricated	Base drums for Effluent
Mobile Bund 4	Prefabricated	Drums and IBC's
Mobile Bund 5	Prefabricated	Drums and IBC's
Mobile Bund 6	Prefabricated	Drums & IBC's

Mobile Bund 7	Prefabricated	DIW drum storage
Mobile Bund 8	Prefabricated	Water treatment storage
Mobile Bund 9	Prefabricated	Lab waste solvent
Mobile Bund 10	Prefabricated	Inside refrigeration unit
Unit 4	Lined Concrete	Bunded warehouse
Unit 6	Lined Concrete	Drums and IBCs in warehouse
U4B1	Double skinned tank	Double bunded Oil Tank
U8B1	Double skinned tank	Double bunded Oil Tank
U10B1	Double skinned tank	Double bunded Oil Tank
U11B1	Double skinned tank	Oil Tank not in use

All bunded areas are monitored in accordance with the conditions laid out in the existing IE licence. Details of this monitoring programme and test conclusions are submitted annually to the Agency as part of the AER. Waste is collected from site on a regular basis by licensed contractors and disposed of in a responsible manner. Total volumes of hazardous waste for the period 2018 are outlined in the table below. This includes laboratory wastes, empty hazardous containers and waste oils. All documentation is retained on site in accordance with legislative requirements and the EMS for the site. Therefore, waste materials are not included in Stage 2.

Table 6 AER Waste 2018

Hazardous	Quantity Tonnes	Description	Contractor
Yes	51.5	Aqueous washing liquids and mother liquors	McQuillan Envirocare
Yes	312.9	Organic Solvents, liquids and mother liquors	Soltec Ireland
Yes	285	Other organic solvents	SAVA Sonderabfall
Yes	599	Organic Solvents, liquids and mother liquors	Tradebe Solvent
Yes	811	Organic Solvents, liquids and mother liquors	Tradebe Fawley
Yes	358	Organic Solvents, liquids and mother liquors	Veolia Env
Yes	85	Other still bottoms and reaction residues	SAVA Sonderabfall
Yes	0.2	Engine, gear and lubricating oils	Safety Kleen Ireland
Yes	30	Packaging containing dangerous substances	Soltec Ireland
Yes	63	Packaging containing residues of dangerous substances	Rilta Env

7. Stage 3: Assessment of the site-specific pollution possibility

For substances brought forward from Stage 2, the possibility of a release of a substance in sufficient quantities to represent a pollution risk, either as a single emission or as a result of accumulation from multiple emissions requires assessment.

The facility is operational 24 hours on a three-shift basis, six days a week, Monday to Saturday. There is a total of 100 employees with c. 12 employees operating during the night shift. Staff rotations are outlined in the table below.

Table 7 Personnel Schedule

Department or Position	Numbers	Shift
Management	5	Day
Administration	5	Day
Manufacturing Supervisors & Operators	35	3 shift cycle
Pilot Plant & kilo	15	2 & 3 shift cycle
R&D Laboratory	5	Day
QC Laboratory	15	2 shift cycle
Environmental & Warehouse	10	2 shift cycle
Engineering & Maintenance	10	Day
Total	100	

Arran Chemicals operate to ISO 14001 environmental management which implements strict procedural controls for the storage, handling and movement of hazardous materials onsite. In addition to these procedures they've implemented spill control and emergency response procedures in the event of an incident. Suitably trained staff are always onsite during each shift in the event of a spill or fire. The ERP and Spill Response Procedures are Appendix 2 & 3 attached to this report.

Procedural controls include:

- All bulk storage facilities are specified in order to be compatible to what is being stored.
- Staff are trained and follow SOPs.
- The processes on site have undergone/will undergo HAZOPs to ensure that the necessary controls are in place in the case of deviations from operating norms. The facility has been designed in order to allow for ease of and safe access for maintenance.
- Emergency Response Procedure training.
- Site-Wide Spill Control Programme.
- Firewater retention protocol.

The design of the facility and storage of chemicals are highlighted on the map below, Figure 3.

Figure 3

Bulk liquid chemical storage takes the form of a tank farm and an open chemical storage area for the IBCs/drums at the rear of Units 1 to 6. The area is covered by reinforced concrete bunding and the gradient is such that liquids are directed towards one of three sumps serving the area. The main sump adjacent to the tank farm has a 3,000L capacity. The sump operates on a high-level switch and pumps to the effluent tank when the level of liquid rises sufficiently. Any surface water from the bunded area or liquid which enters these sumps is pumped via the main sump into the standby effluent tank for balancing and containment. Two effluent tanks run as duty and standby, one filling whilst one discharges to the Monksland Wastewater Treatment facility under permission and limits from Irish Water.

Storage of Dry Materials, packaging stores, engineering equipment and dry product goods outwards are contained in Units 7-11 on the eastern boundary of the facility.

All bunds, sumps and drainage systems have been tested and results submitted to the Agency as part of the AER. These documents can be reviewed in Appendix 4 of this report.

In the event of a major spill or fire at the facility the Emergency Response Procedure is instigated mitigating against the potential for ground contamination. The procedure involved the diversion of surface and foul water drains to the fire water retention pond. There is a new fire detection and alarm system in place across the entire facility. This should ensure a very fast response in the event of a fire decreasing the likelihood of escape of contaminants to surface and foul water drains before the diversion measures can be implemented. In addition, effluent works have been upgraded with a fully automated management system to include pump control and high-level alarms.

Continuous upgrade works, system controls, staff training and procedural controls combined with a revised Emergency Response Procedure and Fire water retention capacity combine to minimise potential risk of contamination to soils and groundwater.

8. Stage 4: Site History

Arran first began operation in Monksland Industrial Estate in 1988. Currently there are three other pharmaceutical facility's adjacent to the site, Alkermes, Alexion and Jazz Pharmaceuticals which are all EPA licensed sites. There is a significant groundwater quality set available for the local area. There have been a number of historical accidental discharges resulting in shallow groundwater contamination which have occurred and reported to the EPA.

- Prior to 1997 a leak in the sewer line which contained Volatile Organic Compounds (VOCs) at Arran.
- A loss of Trichloroethene (TCE) at Alkermes (1993)
- A solvent spill with Tetrachloroethene (PCE) at an undetermined location but resulting in highest concentrations at a borehole installed on the eastern site boundary of Arran Chemicals
- August 2018, Groundwater monitoring at Arran detected an increase in VOC's which was attributed to a leak in a sump within the facility. Remediation measures have been implemented since on an ongoing basis.

A hydrogeological corrective action procedure has been submitted to the EPA by Minerex Environmental on behalf of Arran. The report outlines the response to remediation as well as recommendations including:

a) Testing of sumps and drainage system;
b) Remedial pumping rate increase;
c) Continuous water level monitoring;
d) Water levels in the Monksland Spring;
e) Reduce laboratory limits of detection;
f) Continue assessing performance of remediation system.

A full copy of the investigation is attached in Appendix 5 below. Subsequent to these recommendations Arran have completed extensive testing of sumps and the drainage system. These reports can be viewed in Appendix 4 below.

Investigation of soils is not a requirement of the licence however some soil samples were tested in August 2017. These samples were sent to a UKAS accredited laboratory and results show no contamination at the location tested. The results can be seen in Appendix 6 below.

9. Stage 5: Site Environmental Setting

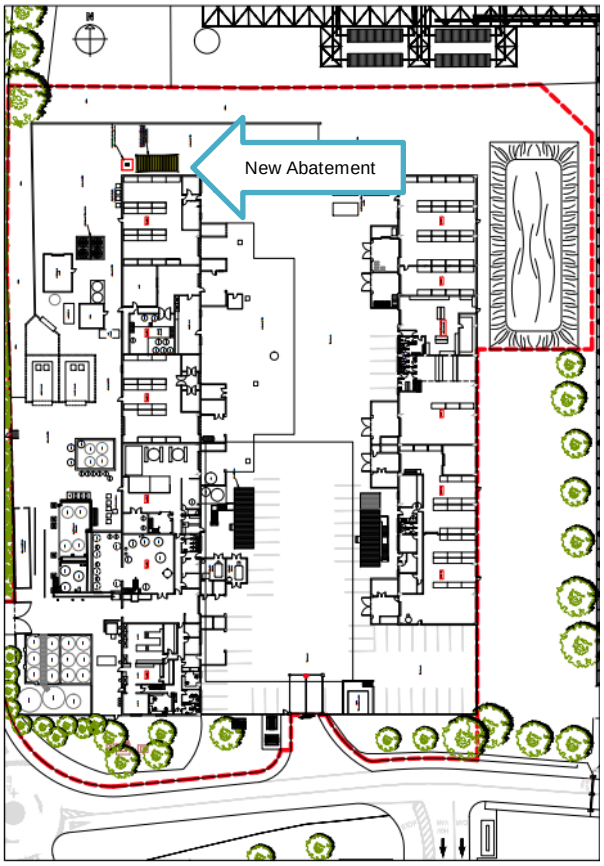
The facility is located in Monksland Industrial Estate, Athlone since 1988 and was granted its first EPA licence in 1996. The location of the facility is a strategic location in accordance with the Westmeath County Development Plan and the Roscommon County Development Plan 2014-2020 which aims to promote and sustain development of high value, knowledge based industrial activities. Roscommon County Council has earmarked Monksland as an area for industry and manufacturing development opportunities, to aid the Country's economic recovery and increase job opportunities in the County[1]. The site is characterised by significant industrial and pharmaceutical developments of varying scale. The M6 motorway runs south and east of the site. The Monksland Wastewater treatment facility is 170, south west of the facility. The new emission abatement equipment and emission point will be located at the back of the site, within the current site boundary.

There is no exposed soil within the confines of the facility and the only grass areas are either side of the entrance outside the boundary of operation. The nearest surface water is the Cross River which is 450m south west of the facility. The only discharge to Local Authority Surface Water drains from Arran is storm water. The proposed new abatement installation is highlighted in Figure 2. The Cross river is classified as status 'Good' to 'Moderate' at separate locations under the Water Framework Directive 2010-2015. Arran holds a Licence from Irish Water with agreed emission to sewer. This licence has been reviewed by Irish Water in light of the IE review and the updated version is included in Appendix 7.

Figure 4: Site Location

[1] http://www.roscommoncoco.ie/en/Services/Planning/Roscommon-County-Council-Planning-Publications/Roscommon-County-Council-Planning-Publications/County_Development_Plan_2014_-_2020/Variations-No-1-Plans/1c%20Chapters%201%20-%204.pdf

Figure 5:



9.1 Topography

The majority of the site is concrete hardstand. The topography of the site slopes in a southerly direction, see Figure 6

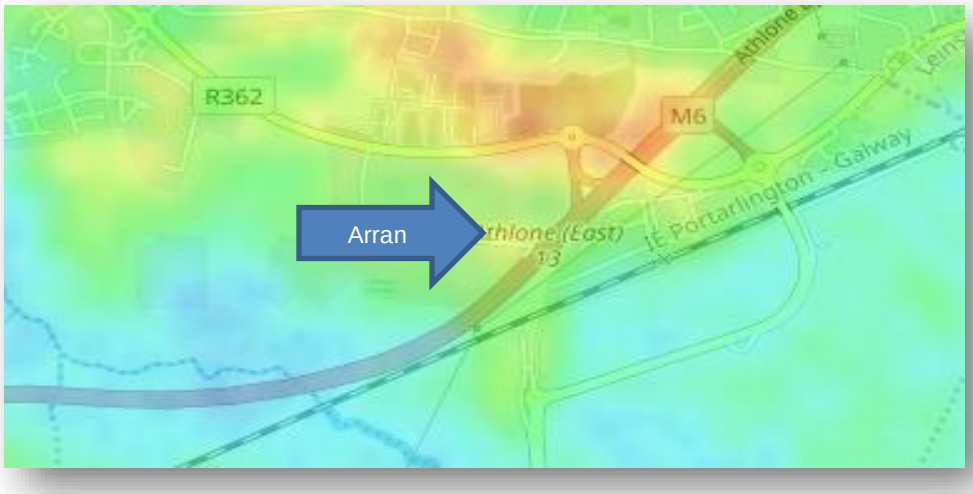


Figure 6 Topography

9.2 Bedrock and Structural Geology

Unit Name	**Waulsortian Limestones 100k – 500k**
Unit Code	WA
Description	Massive unbedded Lime-mudstone
Formation	Waulsortian Limestones
Summary	Dominantly pale-grey, crudely bedded or massive limestone.
System	Carboniferous

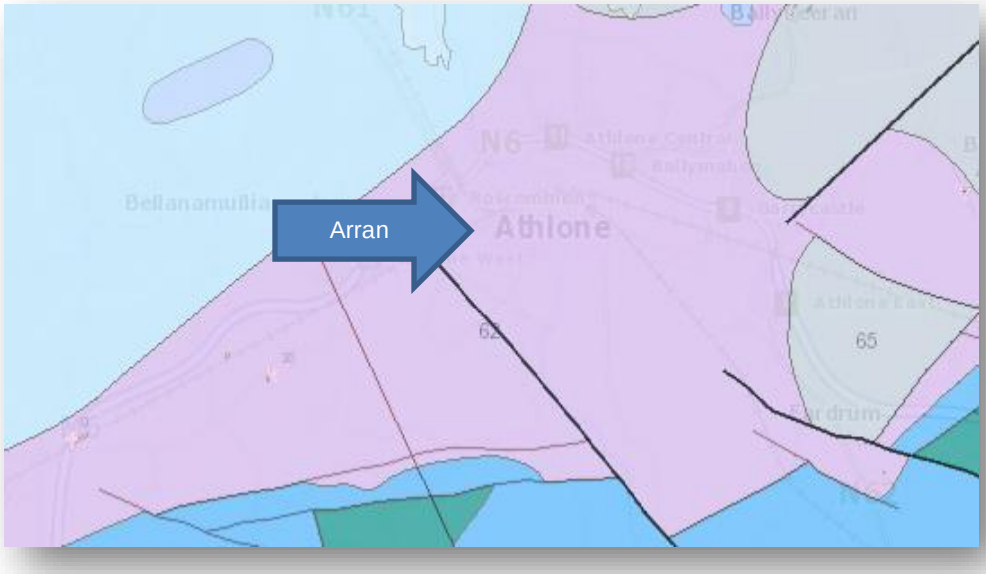


Figure 7 Geology

9.3 Soils and Subsoils

The GSI classify the soils of Monksland Industrial Estate as Urban (Urban) which is substantially modified and has low permeability. The surrounding soils composition are a combination of Mullabane, Burren and Crush all of which are defined as loamy drift over limestone.

The planned installation of the thermal oxidiser will take place inside the facility boundary on an existing hardstand area.

Figure 8 Soils

Table 8 Subsoil Classification

Category	**N.A.**
Description	Man made
Texture	N.A.
Class	N.A.
County	Roscommon/Westmeath

9.4 Hydrogeology

The limestone bedrock underlays made ground with the subsoil permeability classified as moderate. The aquifer is described as a Locally Important Aquifer-Bedrock which is Moderately Productive only in Local Zones. The flow regime is classified as poorly productive bedrock. The site bedrock is primarily Waulsortian Limestones. These consist of pre dominantly pale grey, crudely bedded or massive limestone. Subsoils are classified made ground consisting of man-made soils and other materials with the overlying soil as peaty and poorly drained.

Recharge calculations were developed by the GSI on a regional scale by calculating the effective rainfall (minus evapotranspiration) and then applying a recharge coefficient to indicate the proportion of the effective rainfall that recharges groundwater. Recharge is therefore closely linked to vulnerability. The recharge coefficient for made ground is 20%.

The SAAR (Standard Average Annual Rainfall 2008-2018) recorded at Athlone (Glynwood). (ca. 9km south east of the Arran location), the closet rainfall station to the site with long term SAAR data, is 1046mm annual average rainfall (www.met.ie). The average potential evapotranspiration (PE) at Mount Dillon, north of Athlone has an annual average of 491mm. The actual evapotranspiration (AE) is calculated to be 466 (95% PE). Using the above figures, the effective rainfall (ER) for the area is calculated to be (ER = SAAR – AE) 580mm.

Figure 9 Groundwater Vulnerability

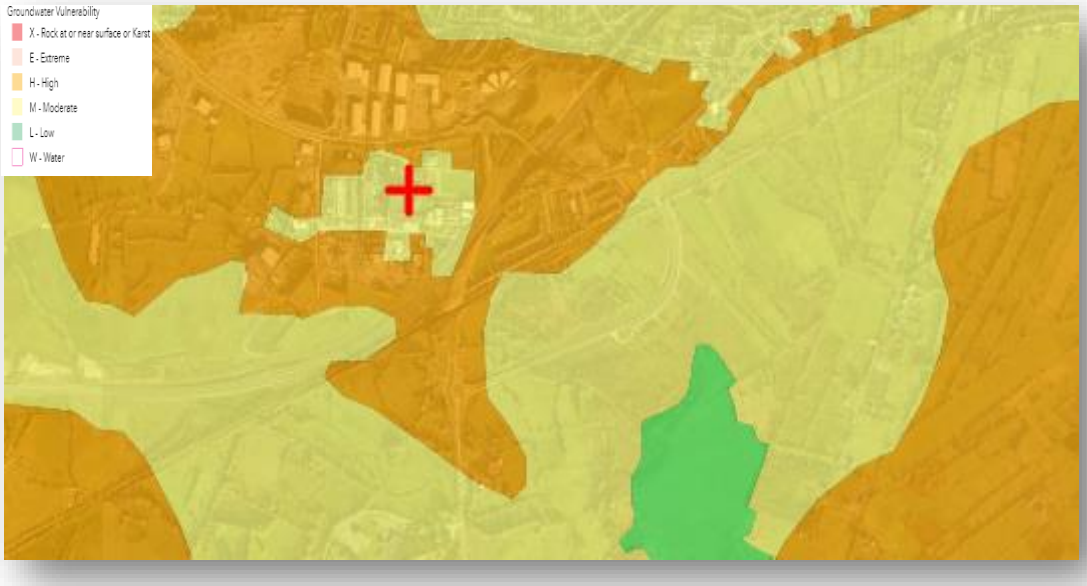
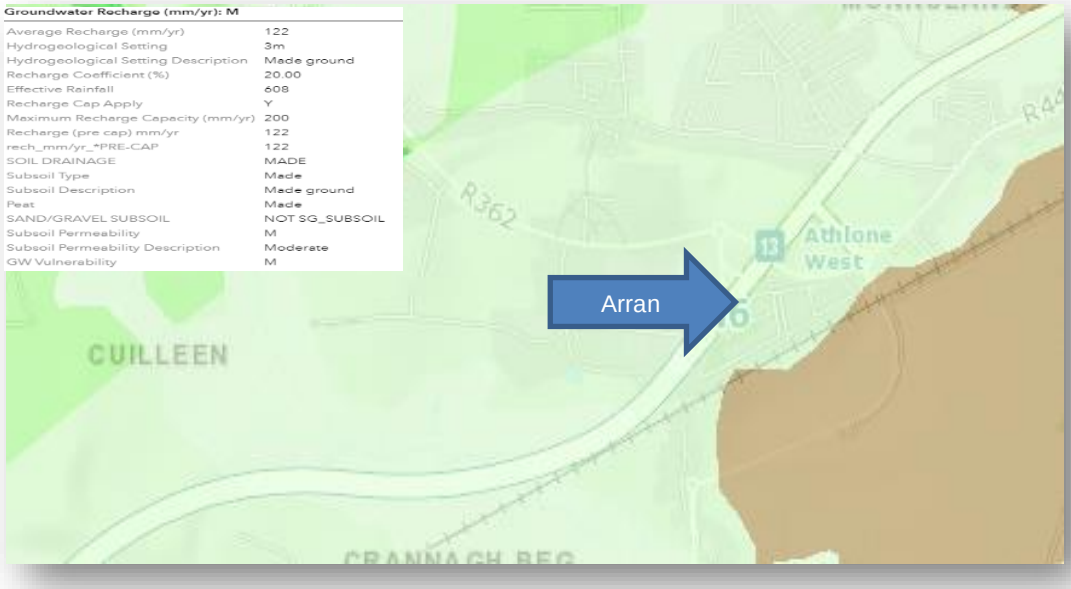


Figure 10 Groundwater Recharge



9.5 Hydrology

The site is located in an industrial estate with the nearest river over 400m south of the site. Surface water quality at the Cross Stream most southerly to the Arran facility is classified as high and changes to moderate beyond the point of the R446 road. The Cross (Roscommon)_040 which connects downstream to the River Shannon (Upper)_120 are both classified 'At Risk' of not attaining their objectives under the Water Framework Directive

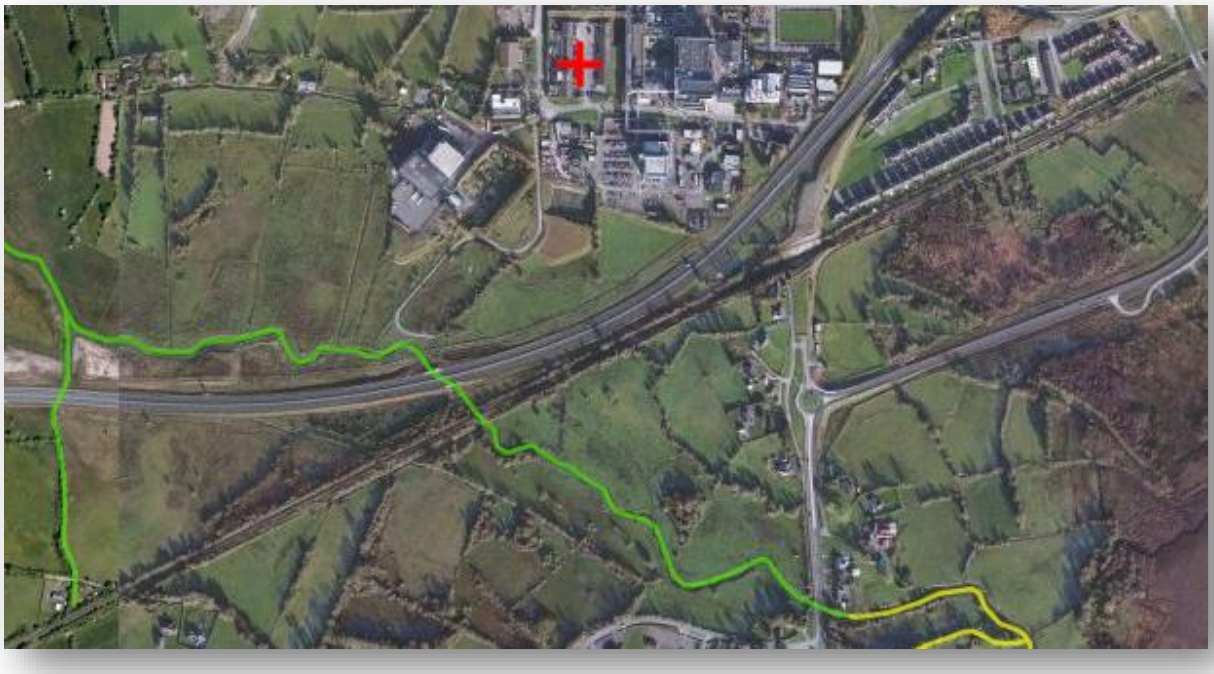


Figure 11 River System

There are no process discharges to surface water from the facility. All storm water is discharged to the Local Authority Surface Water drainage system.

Table 9 River Classification

River Status	2010-2015
European Code	IE_SW_26C100300
Name	Cross (Roscommon)_030
Status	Good
Bio Status	Good
Chemical Status	Good
Dissolved Oxygen Saturation	Pass
General Condition	Pass
Invertebrate Status	Good
Nutrient Conditions	Pass
Supporting Chemistry Conditions	Pass
Projection	At Risk

9.6 Surrounding Land Use

The land use in the surrounding area is predominantly industrial with some agricultural. The site is approximately 2.5km west of Athlone Town Centre. The nearby Monksland Waste Water treatment facility is located 200m south west of the site which was designed with sufficient capacity to service the surrounding area. Irish Water, operators

of the facility have agreed volume discharge, parameters and emission limits for discharge to sewer with Arran Chemicals. Copy of agreement attached Appendix 7.

9.7 Flora and Fauna

The site is not located within or directly adjacent to any designated conservation site. There are 12 Special Areas of Conservation (SACs) and 4 Special Protection Areas (SPA's) located within 15km of the proposed development site.

The River Shannon Callows is a proposed Natural Heritage Area (pNHA) and is addressed under the higher conservation status of SAC. Carrickynaghtan Bog NHA is located c. 2.5km to the south of the site and has no hydrological connectivity and no relevant biological connectivity with the proposed development site and will not be affected. No other conservation areas have the biological or hydrological connectivity with the facility.

10. Stage 6: Site Characterisation

The conceptual site model (CSM) for the site presented in Figure: 7.1 produced by Minerex shows a schematic cross section of the site. It summarises the soil, bedrock and hydrogeology characteristics of the site.

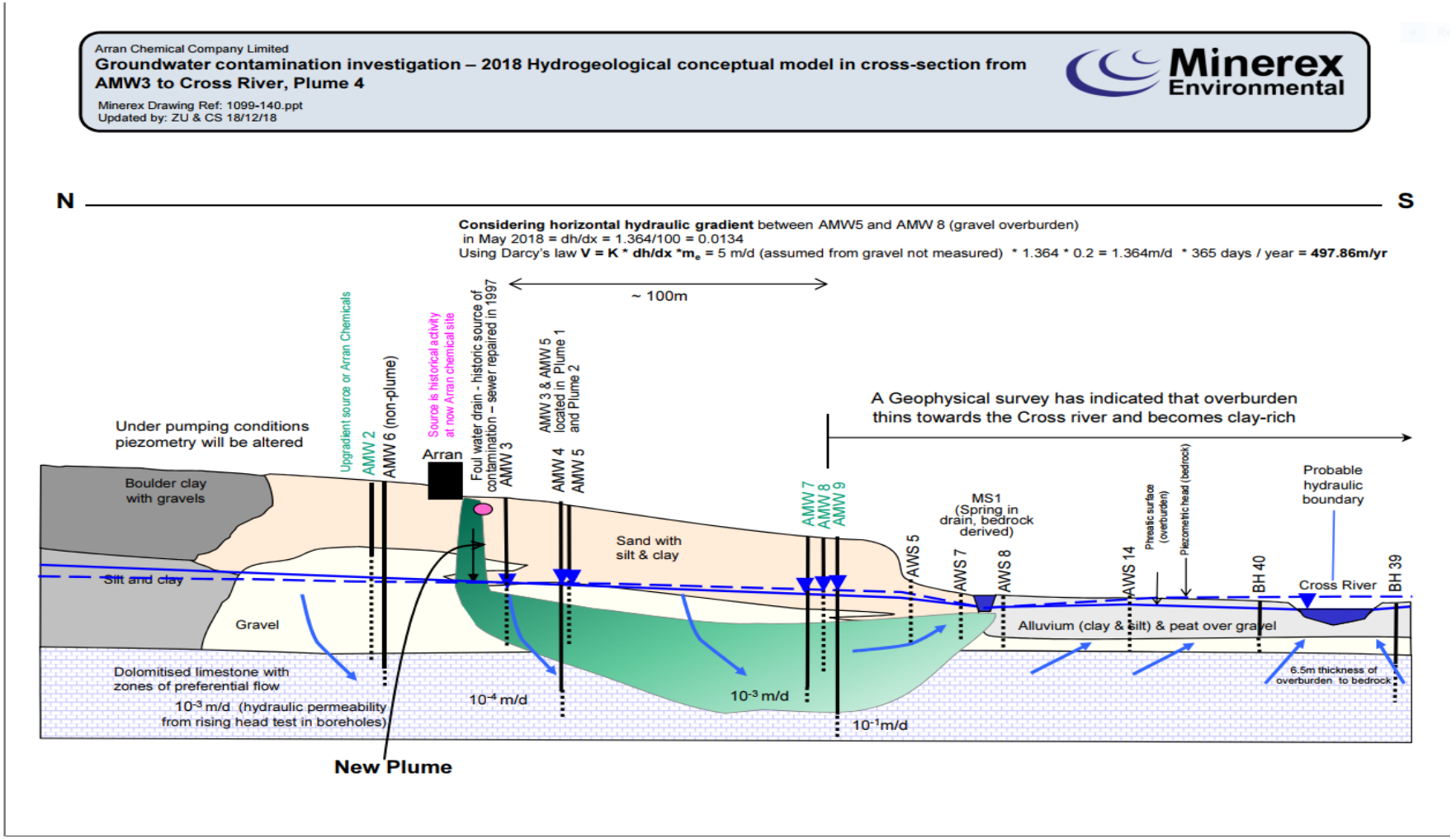


Figure 12 CSM

11. Stage 7: Site Investigation

As outlined in the EC Guidance, if there is sufficient information available from Stages 1-6 to characterise the site both laterally and vertically in terms of pollution of soil and groundwater by relevant hazardous substances, then go directly to stage 8. Based up the following points this step may be taken:

- Significant site investigations have been performed to date providing site specific soil and groundwater monitoring data.
- There is a substantial body of soil and groundwater investigative data submitted by three other adjacent EPA licenced sites.
- The site operated under EPA licence for over 20 years and all bunding, storage and handling of hazardous materials practices have been reviewed by the EPA over this period.

Based on the information provided in the Site Investigation and previous sections it can be concluded that Arran Chemicals will continue to employ Best Available Techniques and implement EPA guidance on the bunding, storage and handling of hazardous materials. In addition to this they will continue to implement monitoring and remediation measures to ensure that the operation of the facility will have no long-term negative impact on the condition of the site.

Stage 8: Baseline Report

The purpose of this stage is to summarise all of the information collated in Stages 1-7. This report has been prepared in accordance with Regulation 9 of the EPA (Industrial Emissions) (Licensing) Regulations, 2013. The EC Guidance on the content of the baseline report as required by Article 22(2) of the Industrial Emissions Directive has been used in the preparation of this report. The EC Guidance identifies key stages to be undertaken and in order in which the baseline report is produced. This baseline report follows these stages.

Stage 1: Identifying the hazardous substances that are currently used, produced or released at the installation.

A complete inventory of raw and ancillary materials, substances, preparations and fuels which is produced by or utilised within the installation boundary is contained within Appendix 1 of this report.

Stage 2: Identifying the relevant hazardous substances

A review of the substances listed in Appendix 1 has been undertaken to identify substances that are potentially hazardous to soils and groundwater, these are included in Table 4 of this report. These are defined as 'relevant hazardous substances'.

Stage 3: Assessment of the site-specific pollution possibility

The quantity and locations of the relevant hazardous identified in Stage 2 were detailed. Assessment of the risk of site-specific pollution from the relevant hazardous substances identified in Stage 2 by considering (1) Storage and usage quantities; (2) Storage and Usage locations; (3) Controls and measures in place to prevent contamination of soils and groundwater; (4) Review of historical environmental records; (5) Review of integrity testing of bunds, process and foul drainage; (6) Site Inspection results; (7) Environmental setting of the site.

Stage 4: Site History

A summary of numerous site investigations which have been carried out on site previously to establish the baselines soils, geology and hydrogeology, hydrology, flora & fauna and land use.

Stage 5: Environmental Setting

The existing environment of the site is analysed using data collect from a desk study. The information has been derived from a number of different sources and provided information on the surrounding topography, geology, hydrogeology, hydrology, flora & fauna and land use.

Stage 6: Site Characterisation

Based on previous site monitoring well drilling works and reports, the Conceptual Site Model for Arran Athlone is shown in Figure: 7.1

Stage 7: Site Investigation

A detailed environmental assessment of the extent of groundwater contamination at the Arran site was undertaken by Minerex Environmental and a Conceptual Site Model was compiled. Based on the model and ongoing groundwater monitoring a corrective action procedure outlining remediation measures for the contamination plume was submitted to the agency. The recommendations that were outlined in this report are also in the process of being implemented including the surveying of all process drains onsite. Copies of these reports are attached in the appendices.

Soil investigations that were carried out did not show any indication of contamination onsite.

List of Appendices:

Appendix 1 – Complete Chemical List

Appendix 2 – Emergency Response Procedure

Appendix 3 – Spill Response Procedure

Appendix 4 – Sump, Drain and Bund Integrity Testing

Appendix 5 – Hydrogeological Corrective Action Procedure

Appendix 6 – Soil Sample Results

Appendix 7 – Irish Water Discharge Agreement

	Raw Material name	CAS No.	Ton. Band	Hazard Phrases
1	1'-Acetonaphthone*	941-98-0	1-10	H302, H412
2	AIBN (2,2'-Azobis(2-methylpropionitrile)	78-67-1	<1MT	H242, H302, H312, H332, H412
3	2-Amino-1-butanol*	96-20-8	1-10	H302, H314., H400
4	(+)-2-Aminobutane	13952-84-6	<1MT	H225, H302, H332, H314, H400
5	4-Aminophenol	123-30-8	<1MT	H302, H332, H341, H410
6	Ammonia (Gas)	7664-41-7	<1MT	221, 280, 314, 331, 410
7	Ammonia Solution	1336-21-6	1-10	H314, H335, H400
8	Aniline	62-53-3	<1MT	H301, H311, H317, H318, H330, H341, H351, H372, H400
9	Benzophenone*	119-61-9	1-10	H373, H411
10	Benzoyl Chloride	98-88-4	<1MT	H302, H331, H315, H318, H350, H335, H373
11	Benzyl Chloroformate	501-53-1	<1MT	H314, H410
12	Benzylchloromethyl Ether	3587-60-8	<1MT	H302, H315, H318, H331, H334, H335, H350, H373, H400
13	BHT	128-37-0	<1MT	H410
14	Bromine	7726-95-6	<1MT	H330, H314, H400
15	Bromobenzene	203-623-8	<1MT	H226, H315, H411
16	1-Bromo-3-chloropropane*	109-70-6	10-100	H302, H331, H341, H335, H412
17	1-Bromopropane	106-94-5	<1MT	H225, H315, H319, H335, H336, H360, H373
18	4-t-Butylbenzaldehyde	939-97-9	<1MT	H302, H334, H410
19	4-t-Butylcatechol	98-29-3	1-10	H302+H312, H314, H317, H410
20	4-tert-Butylcyclohexanol*	98-52-2	1-10	H302+H312, H314, H317, H410
21	t-Butyl Hydroquinone	1948-33-0	<1MT	H302+H312, H315, H319, H400
22	N-Butyllithium (24%) in Hexane	203-698-7 / 265-151-9	<1MT	H225, H250, H260, H304, H314, H336, H361f, H373, H411, EUH014
23	Catechol	120-80-9	1-10	H301, H311, H315, H317, H318, H332, H341, H
24	3-Chloro-2-methylpropene	563-47-3	<1MT	H225, H302+H332, H314, H317, H411
25	Chloroacetyl Chloride	201-171-6	<1MT	H301, H311, H314, H331, H372, H400, EUH014
26	2-Chloroacrylonitrile	920-37-6	<1MT	H225, H300+H310+H330, H314, H334, H350, H400
27	Cobalt Acetate Tetreahydrate	612-153-6 (200-755-8)	<1MT	H302, H317, H332, H334, H341, H350i, H360F, H410
28	Copper (I) Chloride	7758-89-6	<1MT	H302, H315, H318, H335, H410
29	Copper (II) Chloride	7447-39-4	<1MT	H302, H315, H319, H335, H410
30	Copper (I) Iodide	7681-65-4	<1MT	H302, H315, H317, H318, H335, H410
31	Cyclohexane	110-82-7	1-10	H225, H304, H315, H336, H400, H410

32	Dichlorobis(triphenylphosphine) Palladium (II)	13965-03-2	<1MT	H302+H312+H332, H315, H317, H319, H413
33	Dichloro (p-cymene) RU (II) Dimer	52462-29-0	<1MT	H302, H319, H412
34	1,1-Dichloroethene	75-35-4	<1MT	H224, H332, H351
35	N,N-Dimethylacetamide*	127-19-5	<1MT	H312, H332, H360D
36	4-Dimethylaminopyridine (DMAP)	1122-58-3	<1MT	H301+H331, H310, H314, H411
37	Dimethylaluminium Chloride (13%) in Hexane	110-54-3 / 1184-58-3	<1MT	H225, H250, H260, H304, H314, H336, H361, H373, H411, EUH014
38	N,N-Dimethylaniline	204-493-5	<1MT	H301, H311, H331, H351, H411
39	Dimethylformamide (DMF)*	68-12-2	10-100	H226, H312, H319, H332, H360D
40	2,5-Diphenyl-1,4-benzoquinone	844-51-9	<1MT	H302, H317, H400
41	1,4-Dioxane	123-91-1	<1MT	H225+EUH019, H319+EUH066, H351, H335
42	DMPU	230-625-6	<1MT	H302, H318, H361
43	(+)-Epichlorhydyrdin	106-89-8	<1MT	H226, H301, H311, H331, H314, H317, H350
44	Formaldehyde (37%)	50-00-0	1-10	H301, H311, H314, H317, H331, H335, H351, H370
45	Formamide*	75-12-7	1-10	H351, H360D, H373
46	Furan	110-00-9	<1MT	H224, H302, H315, H331, H341, H350, H373, H412, EUH019
47	Heptane	142-82-5	10-100	H225, H304, H315, H336, H400, H410
48	1-Hexane	110-54-3	<1MT	H225, H304, H315, H335+H336, H361, H373, H411
49	Hexamethyldisilazane	999-97-3	<1MT	H225, H302, H311, H314, H332, H412
50	Hexamethyldisiloxane	107-46-0	<1MT	H225, H410
51	Hexyllithium (33%) in Hexane	21369-64-2 / 64742-49-0	<1MT	H314, H225, H304, H336, H361f, H373, H411, EUH014
52	Hydrazine Monohydrate	7803-57-8	<1MT	301, 311, 330, 314, 317, 350, 410
53	Hydroxylamine Sulfate*	10039-54-0	1-10	H290, H302, H312, H315, H319, H317, H351, H373, H400, H412
54	Imidazole	206-019-2	<1MT	H302, H314, H360D
55	Iodine	7553-56-2	<1MT	H312, H332, H400
56	Iodomethane	74-88-4	<1MT	H301, H312, H315, H331, H335, H351
57	Irgacure 250	344562-80-7	<1MT	H302, H317, H318, H373, H410
58	Isopropylmagnesium Chloride (20%) in Tetrahydrofuran	1068-55-9	1-10	H225, EUH014, H260, H314, H335, H351
59	Isopropylmagnesium Chloride (21%) in Tetrahydrofuran	109-99-9 / 1068-55-9	<1MT	H225, EUH014, H260, H314, H335, H351
60	Lithium Hexamethyldisilazine (24%) in THF	109-99-9 / 4039-32-1 / 513-35-9	1-10	H341, H351, H225, H314, H302, H335, H412, EUH019

61	Marlotherm	27776-01-8 / 53585-53-8	<1MT	H304, H315, H413
62	2-Mercaptoethanol	60-24-2	<1MT	H301+H331, H310, H315, H317, H318, H373, H410
63	N-Methyl-2-Pyrrolidone (NMP)	872-50-4	1-10	H315, H319, H335, H360D,
64	2-Nitropropane	79-46-9	<1MT	226, 302, 331, 341, 350, 412
65	Octamethylcyclotetrasiloxane	556-67-2	<1MT	H226, H361, H413
66	Paraformaldehyde*	30525-89-4	1-10	H228, H302+H332, H315, H317, H318, H335, H351
67	Peracetic Acid (40%)*	79-21-0	1-10	242, 271, 290, 301+331, 312, 314, 335, 410
68	Potassium Cyanide	151-50-8	<1MT	H290, H300, H330, H310, H370, H372, H400, H410
69	Quizarin	81-64-1	<1MT	H410
70	Ruthenium (III) Chloride Hydrate	14898-67-0	<1MT	H290, H302, H314, H412
71	Silver Nitrate	7761-88-8	<1MT	H272, H290, H314, H410
72	Sodium Borohydride	16940-66-2	<1MT	H260, H301, H314, H360F, EUH014
73	Sodium Chlorite (25%)	7758-19-2	<1MT	H271, H301, H310, H314, H373, H410
74	Sodium Cyanide	143-33-9	<1MT	H290, H300+H310+H330, H372, H410, EUH032
75	Sodium Hypochlorite	7681-52-9	1-10	H314, H400
76	Sodium Nitrite	7632-00-0	<1MT	H272, H301, H400
77	Tetrabutylammonium Bromide	1643-19-2	<1MT	H315, H319, H412
78	Tetrahydrofuran*	109-99-9	10-100	H225, H302, H319, H335, H351
79	Toluene	108-88-3	10-100	H225, H304, H315, H336, H361d, H373, H412
80	Tributylamine	102-82-9	<1MT	H302, H310, H330, H315, H319, H411
81	(S)-3,5,5-Trimethylpyrrolidin-2-one	14482-00-9	1-10	H402,H412
82	N-Vinyl-2-pyrrolidone	88-12-0	<1MT	H302, H311, H318, H332, H335, H351, H371
83	Zinc Chloride Anhydrous*	7646-85-7	1-10	314, 335, 302, 410
84	Zinc Bromide (30%) in THF	109-99-9 7699-45-8	<1MT	H351, H225, H314, H317, H335, H411, EUH019
85	Zinc Dust	7440-66-6 / 1314-13-2	<1MT	H410
86	Acetic Acid	64-19-7	1-10	H226, H314
87	Acetone	67-64-1	1-10	H225, H319, H336
88	4-Acetomidophenol	103-90-2	1-10	H302, H315, H317, H319
89	Acetonitrile*	75-05-2	10-100	H225, H332, H312, H302, H319
90	D-Alanine Methyl Ester HCl	14316-06-4	1-10	H302, H315, H319, H335
91	(+)-2-Amino-1-butanol*	13054-87-0	1-10	
92	(R)-2-Amino-1-butanol*	5856-63-3	1-10	H302, H314
93	Ammonia Hydroxide*	1336-21-6	1-10	
94	Ammonium Acetate*	631-61-8	10-100	
95	Ammonium Chloride*	12125-02-9	1-10	H302, H319

96	L-Arabinose	5328-37-0	10-100	-
97	Benzaldehyde*	100-52-7	10-100	H302
98	1-Bromo-3-chloro-2-methylpropane*	6974-77-2	10-100	H302, H319
99	3-Bromobenzytrifluoride*	401-78-5	1-10	
100	1-Butanol	71-36-3	1-10	H226, H302, H315, H318, H335, H336
101	2-Butanol	78-92-2	1-10	H226, H319, H335, H336
102	Butyl Acetate*	123-86-4	1-10	H226, H336, EUH066
103	Di-t-Butyl Dicarbonate	24424-99-5	1-10	H226, H228, H330, H315, H317, H319, H335
104	Carbon (Charcoal)*	7440-44-0	1-10	-
105	Carbon Dioxide (Liquid)	124-38-9	1-10	H281
106	Catechol	120-80-9	1-10	H301, H311, H315, H317, H318, H332, H341
107	Celite (Clarcel Flo)*	14808-60-7	1-10	
108	Chloroacetic Acid*	79-11-8	1-10	
109	2-Chlorobenzaldehyde	89-98-5	1-10	H314, H317
110	1-(2-Chloroethyl)pyrrolidine Hydrochloride	7250-67-1	1-10	
111	Cyclohex-2-ene-1R-carboxylicaid	5709-98-8	1-10	H371
112	Cyclohexanol	108-93-0	1-10	302, 315, 319, 332, 335
113	3-Cyclohexene-1-carboxylic Acid	4771-80-6	1-10	H312, H314
114	Cyclohexyl Bromide (Bromocyclohexane)*	108-85-0	1-10	H226, H315, H332, H302, H335
115	Cyclopentyl Bromide*	137-43-9	1-10	H226
116	Danish Weed Spray	64-19-7	1-10	
117	Desicant		1-10	-
118	1,2-Diaminocyclohexane*	694-83-7	1-10	H314, H318, H335, H302, H312, H332
119	cis Enriched 1,2-Diaminocyclohexane	694-83-7	1-10	
120	Dibutylamine*	111-92-2	1-10	H226, H302, H311, H314, H330
121	Dichloromethane (DCM)	75-09-2	1-10	H315, H319, H335, H336, H351, H373
122	Diethyl Malonate	105-53-3	1-10	H319
123	Diethyl Oxalate*	95-92-1	1-10	H302, H319
124	Diethyl Sulfate*	64-67-5	1-10	
125	Dihydroeugenol	2785-87-7	1-10	H315, H317, H318, H335
126	Dimethylamine (60%)*	124-40-3	10-100	H225, H332, H302, H314
127	Ethanol (Denatured)	64-17-5	1-10	H225, H319
128	Ethyl Acetate	141-78-6	10-100	H225, H336, EUH066
129	Ethyl Butyrate*	105-54-4	1-10	H226
130	Ethyl Formate	109-94-4	1-10	H225, H302, H319, H332
131	Ethylene Glycol	107-21-1	1-10	H302, H373
132	Eugenol*	97-53-0	1-10	H302, H315, H317, H319, H334, H335
133	Formaldehyde (37%)	50-00-0	1-10	H301, H311, H314, H317, H331, H335, H351, H370

134	Formamide*	75-12-7	1-10	H351, H360D, H373
135	Formamidine Acetate	3473-63-0	1-10	H315, H317, H319, H335
136	Formic Acid*	64-18-6	1-10	H225, H314
137	D-(+)-Glucose Monohydrate	14431-43-7	1-10	
138	1-Heptane (99%)	142-82-5	10-100	
139	Hexane	64742-49-0	1-10	
140	Hydrobromic Acid (48%)	10035-10-6	1-10	H314, H318, H335
141	Hydrochloric Acid (28%)	7647-01-0	10-100	290, 314, 335
142	Hydrochloric Acid (36%)	7647-01-0	1-10	290, 314, 335
143	Hydrogen Chloride (Gas)	7647-01-0	10-100	H280, H331, H314, EUH071
144	4-Hydroxybenzaldehyde*	123-08-0	1-10	H315, H319, H335
145	4-(4-Hydroxyphenyl)-2-butanone (Raspberry Ketone) (RM)*	5471-51-2	1-10	-
146	Immobead A150	133396-60-8	1-10	-
147	IMS	64-17-5	>100	H225, H371, H332
148	Indene*	95-13-6	1-10	
149	Isopropanol*	67-63-0	10-100	225, 319, 336
150	Isopropylamine	75-31-0	1-10	H224, H319, H315, H311, H331, H301, H335
151	Isopropyl Acetate*	108-21-4	1-10	H225, H319, H336
152	4-Isopropyl Catechol	2138-43-4	1-10	
153	Isopropylmagnesium Chloride (20%) in Tetrahydrofuran	1068-55-9	1-10	H225, EUH014, H260, H314, H335, H351
154	Lithium Aluminium Hydride (10%) in THF	16853-85-3	1-10	H351, H225, H260, H314, H335, EUH019
155	Magnesium Hydroxide	1309-42-8	1-10	-
156	Malonic Acid*	141-82-2	1-10	H302, H318
157	Mandelic Acid	90-64-2	1-10	H318
158	(D)-(-)-Mandelic Acid*	611-71-2	1-10	H318
159	(L)-(+)-Mandelic Acid*	17199-29-0	1-10	-
160	Mannose Syrup	6153-56-6	10-100	-
161	Methacrylic Acid	79-41-4	1-10	H302, H311, H314, H332, H335
162	Methanesulphonyl Chloride	124-63-0	1-10	H301, H311, H330, H314, H318, H317, H335
163	Methanol	67-56-1	10-100	H225, H301, H311, H331, H370
164	4-Methylacetophenone	122-00-9	1-10	H302, H315
165	Methyl Acrylate*	96-33-3	1-10	H319, H315, H312, H331, H302, H317, H225, H335
166	4-Methyl Catechol*	452-86-8	10-100	H315, H319, H335
167	4-Methyl Catechol Diacetic Acid (WMK Diester)	52589-39-6	10-200	
168	Methyl Chloroacetate*	96-34-4	10-100	H226, H301+H331, H315, H318, H335
169	Methyl-t-Butyl Ether (MTBE)	1634-04-4	10-100	H225, H315
170	2-Methyltetrahydrofuran	96-47-9	1-10	H225, H302, H315, H318
171	Nitrogen (Liquid)	7727-37-9	10-100	
172	PEG 300	25322-68-3	1-10	-

173	PEG 400	25322-68-3	1-10	
174	D-Phenylalanine	673-06-3	1-10	-
175	L-Phenylalanine	63-91-2	1-10	-
176	D-Phenylalanine Methyl Ester HCl	13033-84-6	1-10	
177	Phenylglyoxylic Acid Methyl Ether (PGME)*	15206-55-0	1-10	
178	4-Picoline*	108-89-4	1-10	H226, H302, H311, H315, H319, H332, H335
179	Potassium Hydroxide*	1310-58-3	1-10	H290, H302, H314
180	1-Propanol*	71-23-8	1-10	H225, H318, H336
181	Propionaldehyde	123-38-6	1-10	
182	Propylene Glycol	57-55-6	10-100	-
183	L-Pyroglutamic Acid	98-79-3	1-10	H318
184	Pyridine*	110-86-1	1-10	H225, H302, H312, H332
185	Sodium Bicarbonate*	144-55-8	1-10	-
186	Sodium Carbonate*	497-19-8	1-10	H319
187	Sodium Chloroacetate	3926-62-3	10-100	
188	Sodium Chloride	7647-14-5	1-10	-
189	Sodium Ethoxide (Crystals)*	141-52-6	1-10	H228, H251, H314, EUH014
190	Sodium Ethoxide (21%) in Ethanol	141-52-6 / 64-17-5	1-10	H226, H290, H314
191	Sodium Hydroxide	1310-73-2	1-10	H290, H314
192	Sodium Hydroxide (30%)	1310-73-2	>100	
193	Sodium Metabisulphite*	7681-57-4	1-10	H318, H302, EUH031
194	Sodium Methoxide*	124-41-4	10-100	EUH014, 225, 314
195	Sodium Methoxide (30%) in Methanol	124-41-4	10-100	H226, H290, H301, H311, H314, H331, H370
196	Succinic Anhydride*	108-30-5	1-10	H302, H314, H317, H334, H335
197	Sulphuric Acid (50%)*	7664-93-9	10-100	H314
198	Sulphuric Acid (96%)*	7664-93-9	10-100	H290, H314
199	(D)-(-)-Tartaric Acid*	147-71-7	1-10	
200	(L)-(+)-Tartaric Acid*	87-69-4	1-10	H318
201	Tetrahydrofuran*	109-99-9	10-100	H225, H302, H319, H335, H351
202	Thionyl Chloride	7719-09-7	1-10	H302, H331, H314, H318, H335, EUH014, EUH029
203	Toluene (Recovered)	108-88-3	10-100	
204	Triflic Anhydride (Trifluoromethanesulfonic Anhydride)	358-23-6	1-10	EUH014, 302, 314
205	Triethylamine*	121-44-8	10-100	H225, H302, H311, H331, H314, H335
206	Veratraldehyde*	120-14-9	1-10	H302, H315, H319
207	Xylene	1330-20-7	1-10	
208	D-Xylose	58-86-6	1-10	-
209	L-Xylose	609-06-3	1-10	

Emergency Response Procedure

Rev No: 9 Procedure: EP 7

1. PURPOSE

This procedure clearly sets out duties for key personnel in the event of an emergency and makes provision for normal safety requirements and environmental protection. This procedure is designed to provide employees, Supervisors and Management with the training required to deal with emergency situations and drills in an effective coordinated manner.

2. SCOPE

To ensure efficient and effective response to any emergency on the site by defining the actions and responsibilities necessary and the occurrences which warrant such action. The plan is intended to prevent or minimise any damage or danger to employees, the general public, the environment or the plant. This procedure addresses potential emergency situations, drills, and false alarms. This procedure also identifies the roles and responsibilities of key personnel and the arrangements for contact & communications, both in planning for and in managing major emergencies

Likely Emergency situations:

- Large uncontained fire within or outside factory premises or on immediately adjoining property
- Explosion or Ignition of hazardous material
- Significant Toxic Release
- Fatality due to an on-site event
- Significant Off-Site impact
- An incident, other than a chemical spillage, which may be a threat to the environment
- Personal injury, not related to above, following a fall, collision or other incident.
- Break-in by intruders leading to theft, damage or hazardous operating conditions.
- Overfill of a receiving vessel or bund of a hazardous material
- Any scenario likely to result in significant production downtime or product loss or which could adversely affect the company's reputation in any way.

3. RESPONSIBILITIES

The *Emergency controller* will be the Production Supervisor on shift, who will coordinate and supervise action within the plant, in accordance with procedures laid down (SOP 1 Fire Evacuation & SOP 3 Spillage Procedure) and any drills carried out. The *emergency controller* may call for back-up assistance from one of the following; Managing Director, Production Manager, Technical Manager or Environmental Manager. EL-13 is a check list for the Emergency Controller and copies are available in the emergency equipment holding cabinet in unit 1.

The *Assistant controller* will be a designated person on each shift, normally the lead operator, who will be responsible, subject to direction from the *emergency controller*, for evacuation of personnel to assembly points in accordance with

procedures and drills. EL-14 is a checklist for the Assistant Controller and copies are available in the emergency equipment holding cabinet in unit 1.

All Staff members are charged with the responsibility to quickly and effectively assist the Emergency Controller and Assistant controller to deal with the emergency. This will require as a minimum that each employee making the workplace safe before evacuating, to actively assist the evacuation headcount, being alert to requests from the emergency Controller.

4. PROCEDURES

Action Outside Normal Working Hours:

Outside normal working hours, back-up advice is available on call. A list of emergency telephone numbers is available at a number of locations on the premises and an EPA notice board containing all relevant information is located on the front gate.

Key Emergency Points & Supplies:

Main Assembly point: The main assembly point is located at the front of the premises close to the entrance of the courtyard. This assembly point is for all personnel and visitors. The assembly point is divided in to four separate sections, A, B, C and D to simplify roll call duties in an emergency situation. Different groups should assemble at separate points as indicated. Communication on this arrangement is delivered to personnel at induction and subsequent procedure training.

Breathing Apparatus:
The self-contained breathing apparatus is located outside the engineering office in the hallway unit 1 in a marked cabinet. If evacuation of personnel from the danger area using breathing apparatus is required, this will be done by those persons specially trained for this task. A training log of all those trained is maintained at the holding point for SCBA.

SABRE BA Escape Hoods are located on the Condenser Floor for use to evacuate the Production Areas.

Emergency Kit:
The emergency kit is located in the hallway unit 1 in a marked cabinet in a suitably marked container easily accessible to emergency personnel. It contains the items listed in Appendix 3. In addition a defibrillator together with a list of trained personnel and a fully stocked portable first aid kit are located within 2m of the emergency kit.

Emergency file:
Located in 'Athlone Fire Brigade' office, containing list of telephone numbers, copy of Emergency Response Procedure, site drawing showing water supplies and locations and an extract from the Master Substance List.

After every review an updated copy of this procedure is forwarded to the Athlone Fire Brigade Office.

Evacuation Drills:
Drills are carried out at regular intervals to determine the effectiveness of the fire alarm system and evacuation efficiency. Evacuation drills are logged in the Emergency Incident Record EL-24.

Master Substance List: A Master Substance List has been drawn up as part of the REACH Management System. An extract from this list with UN numbers, quantities and storage locations of substances is kept in the Emergency file and in the Emergency Kit.

- **Raw Material SDS – Reception Office**
- **Product SDS – Reception Office**
- **General SDS – Library**
- **Master Substance (REACH) List – Emergency Kit**

Emergency First Aid Kits:
A large portable first aid kit is available at reception. There are fixed large first aid kits located around the site. Lists of trained first aid personnel are posted throughout the site and first aid markers are indicated on employees clocking station card.

Emergency Procedures for On-site incident:

1. Any person noticing a Fire/Smoke/Spillage or any other incident which may be a threat to personnel, the plant or the environment, shall activate the alarm at the nearest break-glass unit and report the fire/incident to their supervisor or department head. Personnel are trained on the correct procedure at site induction/ orientation training.

2. The *Emergency Controller* will determine where the alarm has been activated and assess the severity of the incident. If necessary the *Emergency Controller* should call the emergency services. Two trained persons can be instructed to don the fire tunics in Unit 9 locker room and the BA sets in case they are required to assist in the evacuation of staff or the Emergency Services.

3. The emergency services call will be answered by the main emergency control centre which is located in Dublin. The Arran *Emergency Controller* should give the name and address of Arran, phone no., state the type of incident, e.g. chemical fire or chemical incident and an estimate of the severity.
   The *Emergency Controller* should ensure that he informs them that the Athlone Fire Brigade is required.

   The presence of the Gardai may also be requested when warranted as listed;

- Loss of life (Compulsory)
- Serious life threatening injury has occurred
- Smoke or fumes affecting traffic on local roads,
- Evacuation of neighbouring premises or homes required
- Breaches of security, theft or violence involved

4. **Evacuation Procedure**
On hearing the fire alarm start evacuation process. In so far as is safe to do so, all persons shall make their work safe and any materials at risk of propagating the incident should be removed from the danger area. Machines should be stopped or shut-down as appropriate and power turned off in so far as is practicable in accordance with training and drills.
Evacuate the premises and go directly to the assembly point at the Front Gate. The assembly point is divided in to four separate sections, A, B, C and D to simplify roll call duties in an emergency situation.

5. On hearing the firm alarm, the *Assistant Controller / Receptionist* shall supervise the evacuation of personnel to the assembly point. Three log books (white – visitors sign in log, green - truck drivers sign in log, and blue – staff sign out log), 2 racks of clock cards marked "IN" (are easily removed from the wall) and the emergency kit are taken to the assembly point, by the *Receptionist* during normal business hours and by the *Assistant Controller* outside business hours.

6. All Staff should ensure that they co-operate to ensure the evacuation procedure is carried out efficiently and accurately. Staff are required to remain alert during an evacuation for requests of assistance from the Emergency Controller or Assistant Controller or other instructions.

7. Employees shall be accounted for by means of the clock cards in the "IN" racks less those signed out in the staff sign out book. All visitors and contractors on-site can be identified from the 'Visitors' logbook and drivers from truck-drivers logbook. Any un-accounted for personnel should be communicated to the Fire Chief or *Emergency Controller* immediately.

8. Once the Emergency Service arrives on site the *Fire Brigade Incident Controller* will take charge following an update from the Arran Emergency Controller.

9. **Injured Persons:**
Casualties, whose injuries appear to be such that being moved would worsen their injury, should only be moved if in immediate danger.
Casualties should be removed to a safe area* and given First Aid treatment as appropriate. Medical assistance or the ambulance service should be summoned immediately if there are significant injuries or the scope or extent of injury is not known.
Casualties with minor injuries will be treated on-site by trained First-Aiders, or sent to the Doctor at Athlone Town Surgery.

*NOTE: Fire brigade personnel are trained in rescue techniques and are specially equipped for the lifting and transport of badly injured persons. 'Search and Rescue' is the responsibility of trained Fire brigade personnel.

10. Injured Persons Leaving the site Injured Staff Checklist EL-25
The Incident Controller can use "Injured Persons Record" to record vital information with regard to any staff or visitor/contractor sent to hospital or a Doctor's Medical Surgery. Injured persons should whenever possible or practical be accompanied by another member of staff when sent off site for medical assessment or treatment. This is for practical reasons to provide assistance or support until a family relative or next of kin arrives. The Incident Controller should request another member of staff to accompany them or call Management to provide assistance. If the accompanying person cannot be accompanied in an ambulance, they should follow in a car. The checklist is completed to record the details of when, where and how they can be contacted for updates. Arran Staff Next of Kin contact details are available in a sealed envelope in the Emergency Kit.

11. If necessary, consult the compilation of safety data sheets (kept at Reception) for particular fire fighting procedures or details of protective clothing and make these available to emergency services on their arrival. In storage areas, refer to overall directions for each storage bay or classification.

12. Transport of materials of a hazardous nature from the plant is carried out by 'Hazchem'-trained drivers from an 'Approved Freight Agents' list. Arran Chemical Co. Ltd. co-operates with Local Authorities and Emergency Services in all matters relating to transport of materials to and from the site and this co-operation is extended on a voluntary basis in other cases as applicable.

Environmental considerations:

13. In the case of a spillage or incident that is thought to be a threat to the environment, the following procedures should be adhered to :

Containment:

a. Use all means possible to prevent chemicals or contaminated water from entering the environment. Initial actions should start with containment in the Backyard, Tankfarm tanks, Effluent tanks & bunds.
b. Divert firewater to Fire Water Retention Pond by switching valve at control panel to the right of the main gate towards Reception.
c. If flammable or toxic material is directed towards the FWR pond, consider the likelihood of vapours arising from the pond, and the necessity of foaming the pond itself to minimise atmospheric losses and risk of fire. Contact Alkermes about the situation as may need to extend a safe zone on their site.

A spillage station is located in 'Unit 3' containing materials for use in containing/soaking up contents of such a spillage. Alkermes will have additional spillage supplies if there is a major spillage – Contact Alkermes Security?

Breathing Apparatus & Chemical suits may be required to deal with a spillage using staff trained in their operation. The Chemical Suit is stored in Unit 9 locker room along with three Fire Tunics (S, M &L), Flash Hoods & Fire Gloves

16. Following any spillage or incident, which is thought to be a threat to the environment, a formal notification must be made to the Environmental Protection Agency in accordance with condition 11.1 of the company's IPPC licence No.P0110-02

EF-05, Environmental Incident Notification, should be completed and faxed to the EPA as soon as practicable after the incident. Prior to sending EF-05, the EPA should be contacted by telephone which is manned by an answering machine outside of normal working hours. A message should be left giving details as per EF-05.

Reference: IPCC Licence, Condition 11, Notification, Records and Reports
EF-05 Environmental Incident Notification

Safety and Health

17. Following any incident which is considered to have caused an injury to an employee which is deemed to be immediately reportable, a formal notification must be made to the Health and Safety Authority in accordance with the Safety and Health at Work Act 2005

The HSA should also be contacted by telephone. A message should be left giving full details if outside normal working hours.
A full report should be sent as soon as practicable to the HSA

Reference: Safety, Health and Welfare at Work Act 2005

Stand-Down / All Clear :

When it is clear that the incident has been handled safely and that it is safe to return, the *Emergency Controller* or *Assistant Controller* may give approval for personnel to return to their work stations.
In certain cases it may be necessary to call in the Electrician before the all clear can be given.
The Emergency Controller may organize workgroups to inspect the premises to assess the extent of any damage and check control and containment systems. All plant and equipment should be inspected and tested, if necessary, prior to a startup. If the incident

did not affect any of equipment the Emergency Controller may decide to give the go ahead to resume normal operations.

The *Emergency Controller* should delegate a person to inform the neighbours and the Police, if necessary, that the all clear has been given.

Incident Report

Following an incident an Emergency Incident Report should be completed by the *Emergency Controller* and circulated to Management, who will review the report and determine if Regulatory Authorities need to be contacted. An internal review may be required to determine lessons learnt and corrective & preventative actions.

Training

All employees should be re-trained in the Procedure annually and each time the Procedure is revised.

Review of Emergency Response Procedure:

Carried out at regular intervals and when changes in site arrangements will require procedural change,, working through Production, safety and environmental personnel and in consultation with outside emergency services and other appropriate third parties.

Referenced procedures

SOP1 Fire Procedure
SOP3 Spillage Procedure
SOP70 Fire Water Retention Pond Procedure
EF-05 Environmental Incident Notification
EL-13 Emergency Controller Checklist
EL-14 Assistant Controller Checklist
EL-24 Emergency Incident Record
EL-25 Emergency Incident Injured Persons Record
EP-20 Accident Prevention Procedure
IPPC Licence No. P-0110-02
Safety, Health and Welfare at Work Act 2005
S-05 Incident Report Form

Revision HISTORY

Previous Revision Number	Document Change Request
EP 13 Rev 4	New Procedure format.

Approval

Issued by			
Name	Signature	Department	Date
Denis Dowling		H&S Officer	16 Aug 18
Approved by			
Name	Signature	Department	Date
Cyril Furey		EHS Manager	16 Aug 2018
EHS Approved by			
Name	Signature	Title	Date
Martin McCabe		Site Manager	20 Aug 2018

Emergency Procedure Appendix 1

Emergency Services Contact Phone numbers :

Service	Name / Details	Phone No.
Fire Brigade	**"Ask for Athlone Fire Brigade"**	999 / 112
Ambulance	**Arran Eircode N37 DN24**	999 / 112
Doctor	Dr. John Rice Surgery MIDOC	090 6472595 1850 302 702
Hospital	Portiuncula, Ballinasloe. Midland Hospital, Tullamore.	090 9648200 057 9321501
Garda (Athlone)	090 6492600 / 6492609	999 / 112
Electrician	Frank Dempsey	(087) 2351830
Transformer Failure	Brendan Geoghegan	(087) 6799531
ESB (Day & Night)	Supply Failure / Emergencies	1850 372999
GAS (smell or leak)	For all gas suppliers	1850 20 50 50
EPA OEE Office	Out of hours Answer machine	094 9048400
HSA Offices	Workplace Contact Unit	01 617000

Arran Staff Contact details for Next of Kin in Emergency Kit Bag in Old Reception

Emergency Phone		(086) 2500729
Arran Supervisor's Phone		(086) 0408356
Waste Shipment Contacts		
Veolia Environ Services	24 hour Emergency Service	021- 459331
DEE Environmental	Emergency Service	041-6856900
Indaver	24 hour Emergency Service	01 2804534
Monksland Treatment Plant	Caretaker (Joe O Grady)	(087) 8148922

Arran Staff Contact numbers :

Name		Phone No.
Martin McCabe	Site Manager	086
Peter Cairns	Technical Manager	086
Cyril Furey	E H S Manager	087
Rhona Fitzgerald	Admin Manager	086
Philip Killeen	Plant Engineer	087
Emer Nooney	Process Engineer	085
Shane Naughton	Environmental	086
Karen Fahey	PhD Chemist	087

Emergency Response Plans Spreadsheet

Locations of plans:

- Administration office
- Supervisors Office
- Pilot Plant Office
- Engineering Office
- Warehouse Office
- Environmental Supervisors Office
- Safety Officers Office
- Emergency Plans & Drawings
- Management Offices
    - Martin
    - Cyril
    - Peter
    - Rhona
    - Andrew

Emergency Equipment Type & Location

Respiratory Protective Equipment	
Breathing Apparatus	Old Reception Press
SABRE escape sets	Unit 2 at Electric Panel
	Unit 5 in Bay area
Air Hoods & Filters	PPE Room Unit 3
Full Face Masks & Filters	PPE Room Unit 3
Chemical & Splash Protection	
Tyvek Suits, Gloves	PPE Room Unit 3
	Unit 9 on RHS rack
Chemical Splash Suit	
Wellington Boots	
Emergency Fire Tools	
Hydrant Keys & upstands	Unit 9 entrance
	Unit 2 Side Gate exit
Manhole cover lifting keys	Unit 9 entrance
	Unit 2 Side Gate exit
	Environmental Analyst & Gas terminal
Firefighting Foam Drums & Diffuser attachment	Unit 9 entrance
	Unit 2 Side Gate exit
Fire Suits – Tunic & pull-ups	PPE Room Unit 3
Fire Gloves	PPE Room Unit 3
Flash Hoods	PPE Room Unit 3
First Aid Kits	**Unit 1 Hallway (PORTABLE)**
	Unit 2 Supervisors Office
	Unit 5 Pilot Plant Bay
	Unit 10 Canteen
	Unit 1 QC
	Maintenance Workshop
Defibrillator (AED)	Unit 1 Hallway
Emergency telephone numbers Next of Kin Contact number Torch and batteries Master keys, Locker Keys, Leakstop Putty	Emergency Kit Bag in old reception
Spare Male & Female Clothing & towels bags	Emergency Kit Press in old reception

Emergency Procedure Appendix 3

Emergency Equipment Type & Location

Site drawings: · Water Hydrants · Electrical Isolation Panels & switches · Gas & Diesel supply isolation points · Cylinder storage locations · Firewater Diversion to Retention pond · Fire Extinguishing Equipment · Safety Shower locations · Assembly Point	Emergency Kit Press in old reception
• EP7 Emergency Response Procedure, • EL-13 Emergency Controller Checklist, • EL-14 Assistant Controller Checklist, notebook and pen, • Incident Scenarios? • Sample bottles	Emergency Kit Bag in old reception

Procedure No.	**AHS.002**	**Standard Operating Procedure** **SPILLAGE PROCEDURE**	arran CHEMICAL COMPANY LTD A Member of the Almac Group
Revision No.	**00**		
Pages	**1 of 3**		
Effective Date			

APPROVAL SIGNATURES		JOB TITLE	DATE
Prepared by:	Shane Naughton	Env. Supervisor	30 Sep 2019
Reviewed by:	Cyril Furey	EHS Manager	30 Sep 2019
QA Approved:			

1 PURPOSE AND SCOPE

1.1 This SOP details the process to be followed by Arran personnel when dealing with spillages. The type of spillage either minor or major is outlined in AHS.002 App01.00 and outlines suitable response considerations. This is important in the provision of training on this procedure.

2 RESONSIBILITY

2.1 The activities described in this SOP are the responsibility of Supervisors, Warehouse, Environmental Health & Safety and all operational personnel in labs, pilot plant and production.

3 PROCEDURE

3.1 Determine the spillage situation as defined above at either a Minor or Major spillage, using guidelines in AHS.002 App01.00

3.2 **Raise the alarm with colleagues** before taking any action, avoiding acting alone if at all possible.

3.3 For a MINOR Spillage, that you know the substance involved, can see the extent of the spillage or the rate of expansion, get suitable PPE especially RPE before attempting to stop the spillage or starting to clean it up.

3.4 For a Major Spillage that you have come across, and don't know exactly the chemical risk involved then set up a safety zone safety sign to warn & prevent personnel from entering the area. Alert Supervisor (if necessary, sound fire alarm). Identify the material involved and select suitable PPE especially RPE as per SDS instructions or instructions on container.

3.5 Use all means possible to contain chemical or contaminated water on-site:

(a) Cover drains /gullies with drain blockers if there is a risk of material getting to drains.
(b) If spillage occurs in front yard, ensure valve is closed.
(c) If spillage occurs in back yard, turn off the sump pump to contain the spillage in the sump, until a dedicated tank or IBC can be setup.
(d) If the front yard surface water drains are reached by the spillage and it cannot be stopped activate the Fire water diversion system to direct all flow to the fire water retention pond.

3.6 The CODE 01234* opens the Spillage Station at Unit 3, with bulk quantities of absorbent material. An exclusion area with barrier tape & cones may be required to prevent pedestrian or forklift access during clean-up.

3.7 Lay out absorbent material / matting to contain spillage. Spread absorbent matting/material over the affected area to soak up spillage. Use the correct absorbent mats – White mats are oil only, Grey mats are for all substances and Yellow / Pink mats are specially designed for strong acids or bases or chemicals. The absorbent material must be treated in the same manner as the chemical that was absorbed.

3.8 Transfer wetted absorbent material to the waste drum, seal the lid and label for disposal, indicating contents as it will have to be classified for transport.

3.9 Check area for toxicity/flammability using Gas detector and PPE may be required for this clean-up.

3.10 The Supervisor declares the area safe and writes an incident report.

3.11 The Environmental Protection Agency may need to be informed as soon as is practicable, after the incident has occurred, in consultation with EHS Manager. Refer to EP7 Emergency Response Procedure.

NOTES:

1. Spillage Stations are located in the following areas:
   Unit 3 (Main Spillage Station), Unit 4, Unit 5, Unit 6 and Unit 7.
   Three mobile spill kits are located outside Unit 4 (front) & Base bund & backyard at Oil heater shed.

4.0 APPENDICES

AHS.002 App01.00

5.0 REFERENCES

6.0 REVISION HISTORY

Previous Revision Number	Date of Change Note
SOP.3 Rev. 7	

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BACKGROUND

In the event of a spillage, the main consideration is for human safety and then containment to protect the environment. The initial action taken will depend on the seriousness of the situation e.g. a minor spillage vs major spillage. How they are defined determines the appropriate response.

Minor Spillage:

- Less than $2m^2$ in surface area
- Known source of spillage, found by person working in that area or happens when staff present
- Allows staff assess the risks, the substance involved and access suitable PPE quickly
- Allows fast response by staff to contain / stop spill before vapours or odours become stronger and more serious.
- Extent of spillage present is obvious and not spreading

Major Spillage:

- Greater than $2m^2$ in surface area
- Spillage found by passing staff or in unmanned area of the site
- Source of spillage not obvious immediately
- Vapours & odours potentially strong
- Fast response by staff is inappropriate due to unknown factor above or type of spillage
- Extent of spillage and risks not obvious

Resources for Spillage control on Site:

- Bunded areas
- Isolation valves on pipework
- Sump isolation points
- Effluent tanks
- Absorbent pads & mats
    - White for oil only
    - Grey for all-purpose mats & rolls
    - Yellow for strong fuming acids
- Absorbent rolls
- Drain blocker mats
- Spillage Kit Bins for mobile response x4
- Central Spillage station at entrance to Unit 3
- Fire water Diversion system to prevent excursions to surface water
- Fire alarm system to raise the alarm or seek help & assistance
- SDS for all materials, or hazard information on containers or batch sheets
- Personnel protective equipment
    - Full face mask
    - BA sets
    - Wellingtons

Bund/Pipeline testing template	Lic No:	PO110-02	Year	2018	

Bund testing

dropdown menu click to see options

			Additional information
	Are you required by your licence to undertake integrity testing on bunds and containment structures ? if yes please fill out table B1 below listing all **new bunds and containment structures** on site, **in addition to all bunds which failed** the integrity test-**all bunding structures**		
1	**which failed including mobile bunds must be listed in the table below**	Yes	
2	Please provide integrity testing frequency period	3 years	
3	Does the site maintain a register of bunds, underground pipelines (including stormwater and foul), Tanks, sumps and containers? (containers refers to "Chemstore" type units and mobile bunds)	Yes	
4	How many bunds are on site?	25	
5	How many of these bunds have been tested witin the required test schedule?	24	
6	How many mobile bunds are on site?	13	
7	Are the mobile bunds included in the bund test schedule?	Yes	
8	How many of these mobile bunds have been tested witin the required test schedule?	12	
9	How many sumps on site are included in the integrity test schedule?	5	
10	How many of these sumps are integrity tested within the test schedule?	5	
	Please list any sump integrity failures in table B1		
11	Do all sumps and chambers have high level liquid alarms?	Yes	
12	If yes to Q11 are these failsafe systems included in a maintenance and testing programme?	Yes	

Table B1: Summary details of bund /containment structure integrity test

Bund/Containment structure ID	Type	Specify Other typ	Product containment	Actual capacity	Capacity required*	Type of integrity test	Other test type	Test date	Integrity reports maintained on site?	Results of test	Integrity test failure explanation <50 words	Corrective action taken	Scheduled date for retest	Results of retest(if in current reporting year)
Bund No 1	reinforced concrete		Solvent waste tanks	90	36.5	Hydraulic test		Dec-17	Yes	Pass			Jul-20	
Bund No 2	reinforced concrete		Aqueous waste tanks	117	80	Hydraulic test		Jun-16	Yes	Pass			Jun-19	
Effluent Tank Bund	reinforced concrete		Aqueous waste tanks	90	80	Hydraulic test		Jul-18	Yes	Pass			Jul-21	
Bund No 6	reinforced concrete		Chiller & glycol tanks	6.7	6	Hydraulic test		Dec-17	Yes	Pass			Jul-20	
Bund No 7	reinforced concrete		Aqueous IBC storage	6.6	26	Hydraulic test		Dec-17	Yes	Pass			Jul-20	
Bund No 8	reinforced concrete		Aqueous waste tanks	20	19.5	Hydraulic test		Jun-16	Yes	Pass			Jun-19	
Acid Bund	reinforced concrete		Acid storage	7.4	12	Hydraulic test		Aug-16	Yes	Pass			Aug-19	
Base Bund	reinforced concrete		Base storage	7.4	12	Hydraulic test		Oct-16	Yes	Pass			Oct-19	
Mobile Bund No 1	prefabricated		Unit 11 liquid products	0.5	0.4	Hydraulic test		Aug-16	Yes	Pass			Aug-19	
Mobile Bund No 2	prefabricated		Acid for effluent	0.5	0.4	Hydraulic test		Aug-16	Yes	Pass			Aug-19	
Mobile Bund No 3	prefabricated		Base for effluent	0.5	0.4	Hydraulic test		Aug-16	Yes	Pass			Aug-19	
Mobile Bund No 4	prefabricated		Drums & IBCs	1.2	0.4	Hydraulic test		Aug-16	Yes	Pass			Aug-19	
Mobile Bund No 5	prefabricated		Drums & IBCs	1.2	0.4	Hydraulic test		Aug-16	Yes	Pass			Aug-19	
Mobile Bund No 6	prefabricated		Drums & IBCs	1.1	1	Hydraulic test		Jul-18	Yes	Pass			Jul-21	
Mobile Bund No 7	prefabricated		DIW drum additives	0.25	0.22	Hydraulic test		Jul-18	Yes	Pass			Jul-21	
Mobile Bund No 8	prefabricated		Water treatment storage	0.25	0.22	Hydraulic test		Jul-18	Yes	Pass			Jul-21	
Mobile Bund No 9	prefabricated		Lab solvent drum storage	0.25	0.22	Hydraulic test		Jul-18	Yes	Pass			Jul-21	
Unit 4 Warehouse	reinforced concrete		Raw material warehouse	34.6	33	Hydraulic test		Apr-18	Yes	Fa			Apr-21	
Unit 6 Warehouse	reinforced concrete		Process material warehouse	33.7	33	Hydraulic test		Jun-16	Yes	Pass			Jun-19	
Lab Tray 1	other (Stainless)		Drums	0.5	0.22	Hydraulic test		Jul-18	Yes	Pass			Jul-21	
Lab Tray 2	other (Stainless)		Drums	0.3	0.22	Hydraulic test		Jul-18	Yes	Pass			Jul-21	

* Capacity required should comply with 25% or 110% containment rule as detailed in your licence

			Commentary
	Has integrity testing been carried out in accordance with licence requirements and are all structures		
14	tested in line with BS8007/EPA Guidance?	bunding and storage guidelines	Yes
15	Are channels/transfer systems to remote containment systems tested?		Yes
16	Are channels/transfer systems compliant in both integrity and available volume?		Yes

Bund/Pipeline testing template Lic No: PO110-02 Year 2018

Pipeline/underground structure testing

Are you required by your licence to undertake integrity testing on underground structures e.g. pipelines or sumps etc ? if yes please fill out
1 table 2 below listing all underground structures and pipelines on site **which failed the integrity test**
2 Please provide integrity testing frequency period

Yes	
3 years	

Table B2: Summary details of pipeline/underground structures integrity test

Structure ID	Type system	Material of construction:	Does this structure have Secondary containment?	Type of secondary containment	Type integrity testing	Integrity reports maintained on site?	Results of test	Integrity test failure explanation <50 words	Corrective action taken	Scheduled date for retest	Results of retest(if in current reporting year)
Unit 2 Sump	Process	concrete	No		Hydraulic	Yes	Pass			Sep-19	SELECT
Unit 3 Sump	Process	concrete	No		Hydraulic	Yes	Pass			Jul-21	
Unit 5 Sump	Process	concrete	No		Hydraulic	Yes	Pass			Jul-20	
Front Yard Sump	Process	concrete	No		Hydraulic	Yes	Pass			Jul-20	
Fire Water Retention	Storm	polypropylene	No		Combination	Yes	Pass			May-20	
Fire Water Main Sump	Storm	concrete	No		Hydraulic	Yes	Pass			Dec-20	
Line A (SE-1 Effluent)	Process	polypropylene	Yes	Double walled piping	Air		Pass			Nov-21	
Line B	Process	concrete	Yes	Pipe in channel	Hydraulic	Yes	Pass			Dec-20	
Line C	Process	concrete	Yes	Pipe in channel	Air	Yes	Pass			Jul-19	
Line D	Process	concrete	Yes	Pipe in channel	Air	Yes	Pass			Jul-19	
Line E	Process	polypropylene	Yes	Pipe in channel	Air	Yes	Pass			Jul-19	
Line F	Process	polypropylene	Yes	Pipe in channel	Air	Yes	Pass			Jul-19	
Line G	Storm	polypropylene	Yes	Pipe in channel	Air	Yes	Pass			Dec-20	
Line H	Storm	polypropylene	Yes	Pipe in channel	Air	Yes	Pass			Dec-20	
Line I	Storm	polypropylene	Yes	Pipe in channel	Air	Yes	Pass			Dec-20	
Line J	Storm	polypropylene	Yes	Pipe in channel	Air	Yes	Pass			Dec-20	
Line K	Storm	pvc	No		CCTV	Yes	Pass			Dec-20	
Foul Sewer	Foul	pvc	No		CCTV	Yes	Pass			Dec-20	
Line L	Process	polypropylene	No	Pipe in channel	Air	Yes	Pass			Jul-19	
Line M (New Kilo)	Process	polypropylene	Yes	Double walled piping	Hydraulic	Yes	Pass			Dec-20	

Hydrualic and pneumatic testing of underground drains has been extended replacing the CCTV testing previously carried out. Further works are planned for the drainage system in 2017 as part of plant extension.

Arran Chemicals

Integrity Testing Report

Project Handover & Completion File

Client:	Arran Chemicals
Site:	Arran Chemicals, Athlone, Roscommon
Project Number:	J-008330
Purpose of Project:	Testing of Underground Services
Project Contact:	Cyril Fuery
File Prepared by:	Dwayne Watson

Table of Contents

McBreen Environmental

Project:	Integrity Testing at Arron Chemicals, Athlone
Contact:	Cyril Furey
Client:	Arran Chemicals
Network:	Proicess & Storm Network
Date:	22/08/2019

arran CHEMICAL COMPANY LTD
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U/S MH REF	D/S MH REF	Length (m)	Diameter	Air / Water	Network or Individual Test	Number of Laterals (if Network)	Test Result	Test No	Order No	Test Date	Location
Process											
SE1	COUNCIL SEWER	18	100	Air	Individual	N/A	Pass	54	2	09/08/2019	Arron Chemicals
UNIT 3 SUMP	GULLY AT BB	10	100	Air	Individual	N/A	Pass	54	3	09/08/2019	Arron Chemicals
PP SUMP	KILO LABS	21	100	Air	Individual	N/A	Pass	54	5	09/08/2019	Arron Chemicals
PP SUMP	TBE LABS	11	100	Air	Individual	N/A	Pass	54	6	09/08/2019	Arron Chemicals
GULLY AT BB	SIEVE ROOM	48	150	Air	Individual	N/A	Pass	54	4	09/08/2019	Arron Chemicals
PP SUMP	COOLING WATER GULLY	17	150	Air	Individual	N/A	Pass	54	7	09/08/2019	Arron Chemicals
Storm											
FYS	GULLY J	25	150	Air	Individual	N/A	Pass	55	1	09/08/2019	Arron Chemicals
FYS	GULLY G	22	150	Air	Individual	N/A	Pass	55	2	09/08/2019	Arron Chemicals

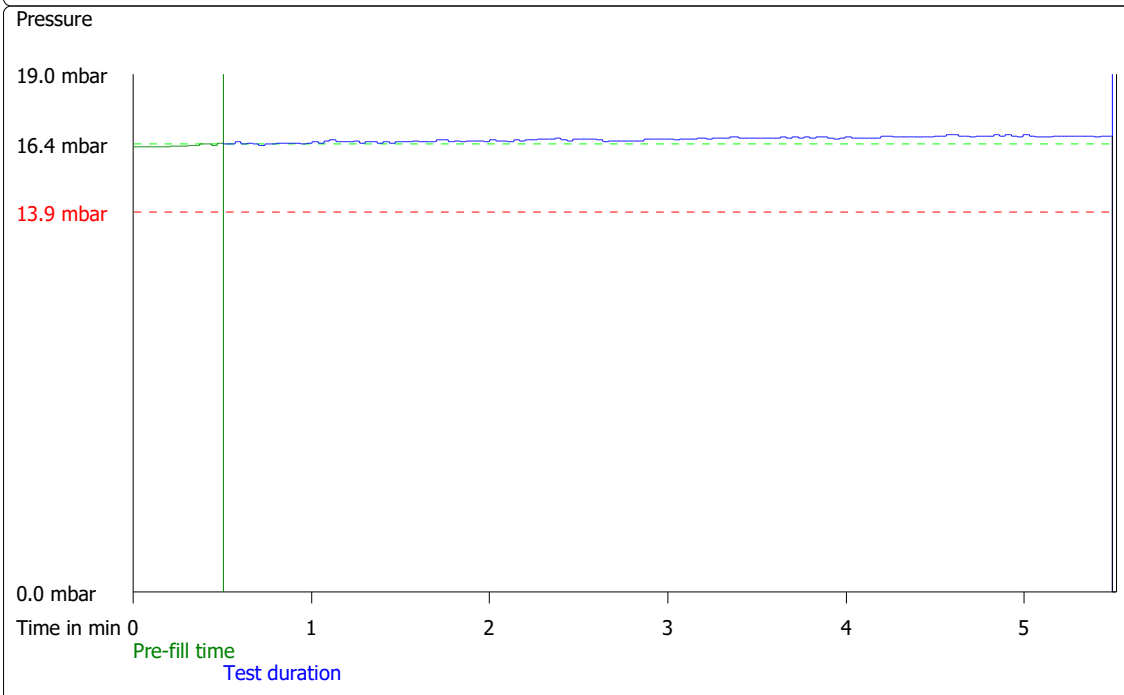
Order no.: 54 Test no.: 2

McBreen Environmental

Lismagratty, Co. Cavan - Cootehill Road - Tel : +353 (0)49 432 6306

Client:
ARRAN CHEMICALS

Pressure test report Pipe - Air/EN 1610



Location	: EFFLUANT DISCHARGE LINE		
Location	: MONKSLAND	Drawing No.	: NONE
Street	: MAIN STREET	Section no.:	: PROCESS
Tester	: NIALL MC CABE	from manhole	: SE 1
Test equipment	: MASTERTEST® SN:170210	to manhole	: COUNCIL SEWER
Order no.	: 54	Length of test section	: 18.0 m
Test date	: 09/08/2019 08:53:28	Pipe profile	: Circle
Test method	: Air/EN 1610	Diameter	: 100 mm
Test category	: Air LA		
Test section	: Pipe	Pipe no.	: SE 1
Material	: High-density polyethylene	Internal protection	: without
Remark	:		
Sensor	: PMC131 -300 - +300 mbar, SN: LC0E4001052	Sensor test	: 25/03/2019
Approval	:		

Test pressure	: 16.4 mbar	Pre-fill time	: 0:31 min
Permiss. pressure loss	: 2.5 mbar	Test duration	: 5:00 min
Act. pressure loss	: 0.0 mbar	Result	: Passed

Testing contractor

Client

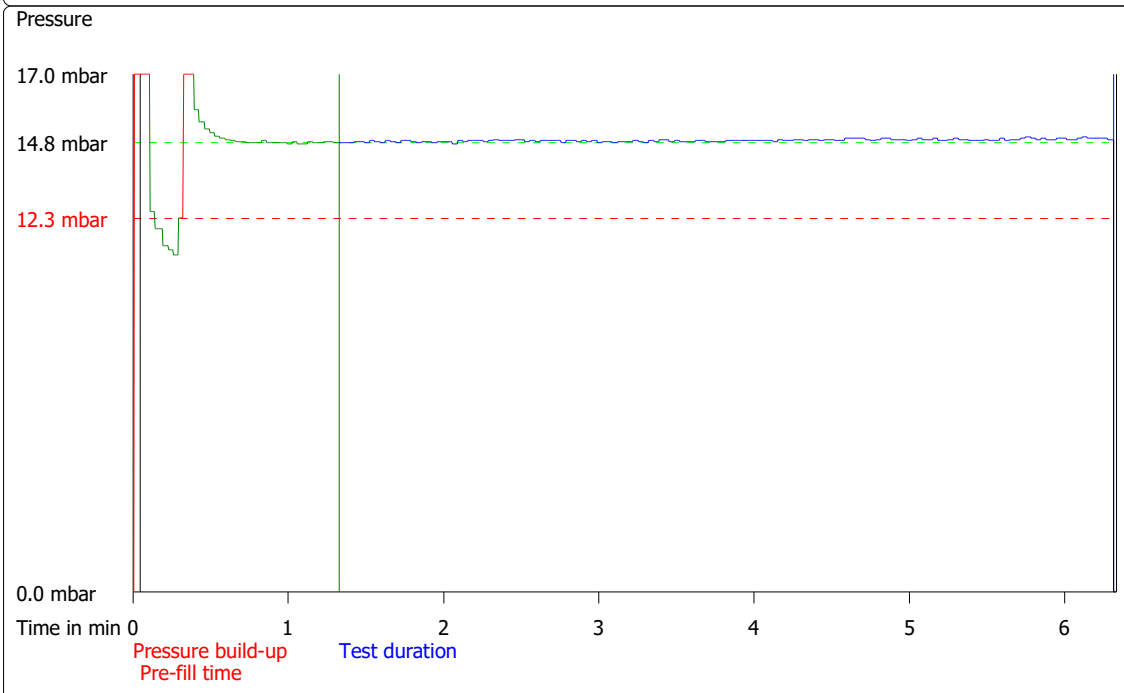
Order no.: 54 Test no.: 3

McBreen Environmental

Lismagratty, Co. Cavan - Cootehill Road - Tel : +353 (0)49 432 6306

Client:
ARRAN CHEMICALS

Pressure test report Pipe - Air/EN 1610



Location	: UNIT 3 BAck yard		
Location	: MONKSLAND	Drawing No.	: NONE
Street	: MAIN STREET	Section no.:	: PROCESS
Tester	: NIALL MC CABE	from manhole	: UNIT 3 SUMP
Test equipment	: MASTERTEST® SN:170210	to manhole	: GULLY AT BB
Order no.	: 54	Length of test section	: 10.0 m
Test date	: 09/08/2019 09:36:49	Pipe profile	: Circle
Test method	: Air/EN 1610	Diameter	: 100 mm
Test category	: Air LA		
Test section	: Pipe	Pipe no.	: UNIT 3 SUMP
Material	: High-density polyethylene	Internal protection	: without
Remark	:		
Sensor	: PMC131 -300 - +300 mbar, SN: LC0E4001052	Sensor test	: 25/03/2019
Approval	:		

Test pressure	: 14.8 mbar	Pre-fill time	: 1:17 min
Permiss. pressure loss	: 2.5 mbar	Test duration	: 5:00 min
Act. pressure loss	: 0.0 mbar	Result	: Passed

Testing contractor

Client

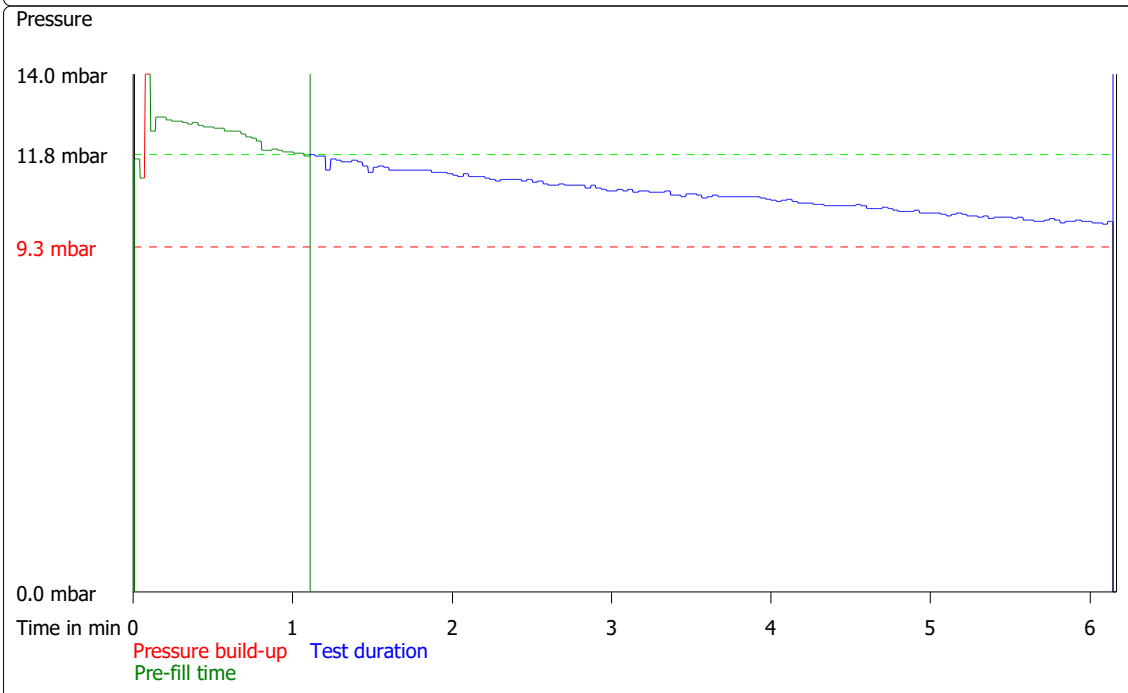
Order no.: 54 Test no.: 4

McBreen Environmental

Lismagratty, Co. Cavan - Cootehill Road - Tel : +353 (0)49 432 6306

Client:
ARRAN CHEMICALS

Pressure test report Pipe - Air/EN 1610



Location	: UNIT 4 BACK YARD		
Location	: MONKSLAND	Drawing No.	: NONE
Street	: MAIN STREET	Section no.:	: PROCESS
Tester	: NIALL MC CABE	from manhole	: BB GULLY
Test equipment	: MASTERTEST® SN:170210	to manhole	: SIEVE ROOM
Order no.	: 54	Length of test section	: 48.0 m
Test date	: 09/08/2019 10:47:52	Pipe profile	: Circle
Test method	: Air/EN 1610	Diameter	: 150 mm
Test category	: Air LA		
Test section	: Pipe	Pipe no.	: BB GULLY
Material	: High-density polyethylene	Internal protection	: without
Remark	:		
Sensor	: PMC131 -300 - +300 mbar, SN: LC0E4001052	Sensor test	: 25/03/2019
Approval	:		

Test pressure	: 11.8 mbar	Pre-fill time	: 1:06 min
Permiss. pressure loss	: 2.5 mbar	Test duration	: 5:03 min
Act. pressure loss	: -1.9 mbar	Result	: Passed

Testing contractor

Client

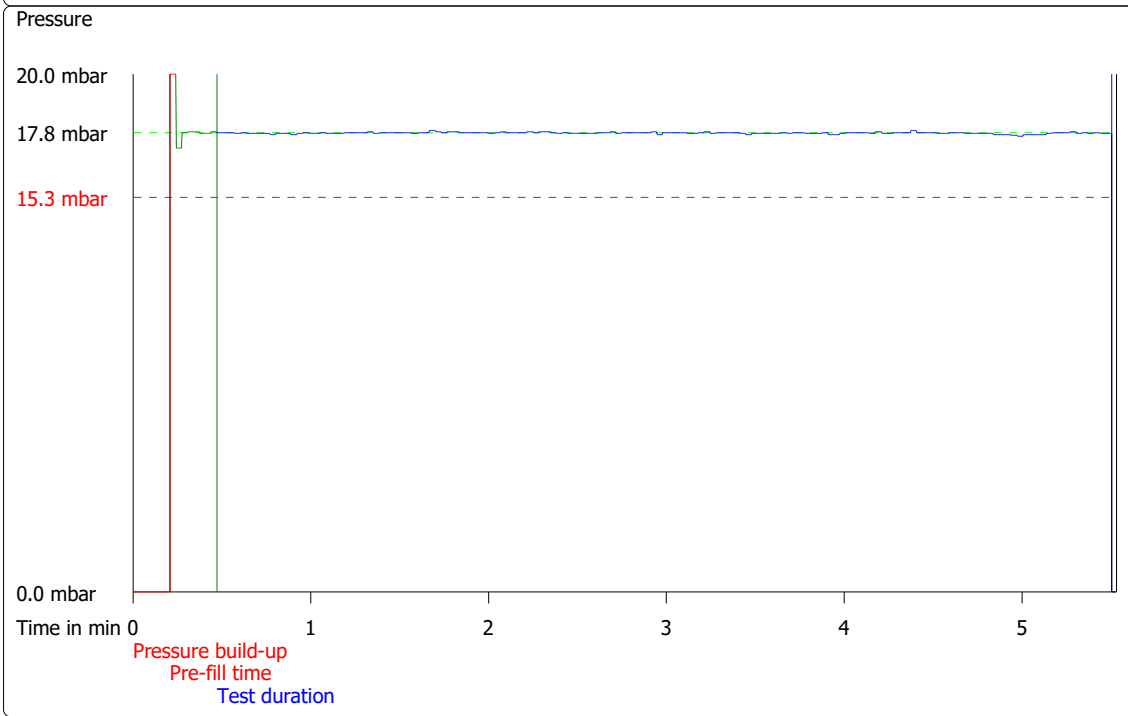
Order no.: 54 Test no.: 5

McBreen Environmental

Lismagratty, Co. Cavan - Cootehill Road - Tel : +353 (0)49 432 6306

Client:
ARRAN CHEMICALS

Pressure test report Pipe - Air/EN 1610



Location	: UNIT 5		
Location	: MONKSLAND	Drawing No.	: NONE
Street	: MAIN STREET	Section no.:	: PROCESS
Tester	: NIALL MC CABE	from manhole	: PP SUMP
Test equipment	: MASTERTEST® SN:170210	to manhole	: KILO LABS
Order no.	: 54	Length of test section	: 21.0 m
Test date	: 09/08/2019 16:28:05	Pipe profile	: Circle
Test method	: Air/EN 1610	Diameter	: 100 mm
Test category	: Air LA		
Test section	: Pipe	Pipe no.	: PP SUMP
Material	: High-density polyethylene	Internal protection	: without
Remark	:		
Sensor	: PMC131 -300 - +300 mbar, SN: LC0E4001052	Sensor test	: 25/03/2019
Approval	:		

Test pressure	: 17.8 mbar	Pre-fill time	: 0:16 min
Permiss. pressure loss	: 2.5 mbar	Test duration	: 5:03 min
Act. pressure loss	: -0.1 mbar	Result	: Passed

Testing contractor

Client

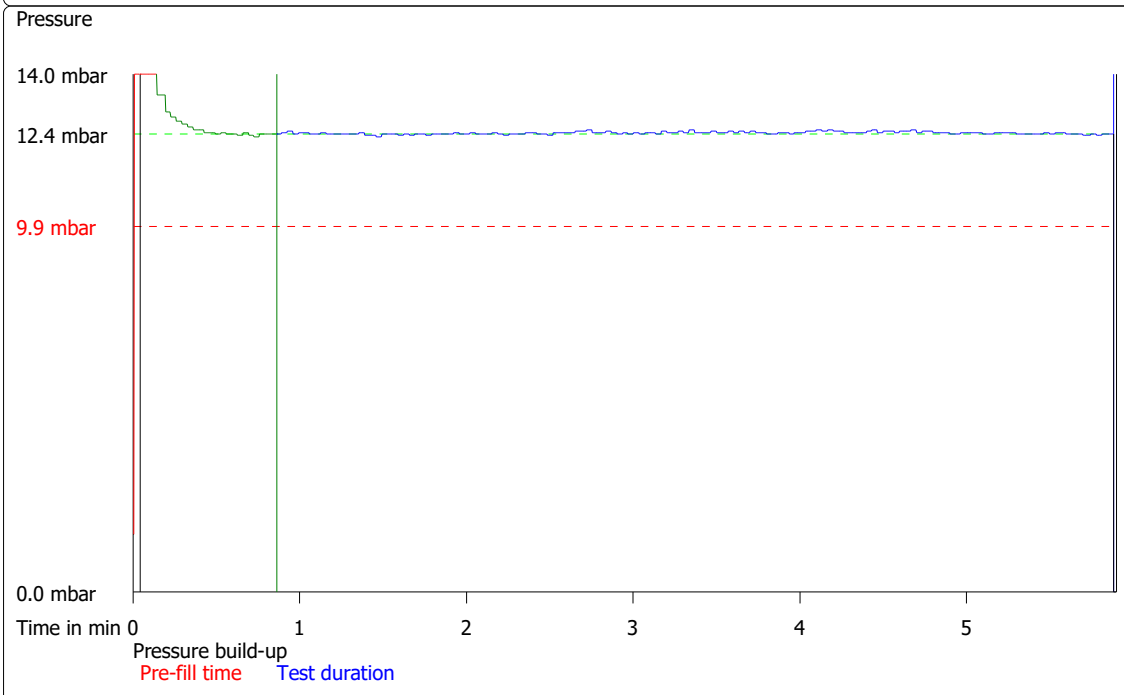
Order no.: 54 Test no.: 6

McBreen Environmental

Lismagratty, Co. Cavan - Cootehill Road - Tel : +353 (0)49 432 6306

Client:
ARRAN CHEMICALS

Pressure test report Pipe - Air/EN 1610



Location	: UNIT 5		
Location	: MONKSLAND	Drawing No.	: NONE
Street	: MAIN STREET	Section no.:	: PROCESS
Tester	: NIALL MC CABE	from manhole	: PP SUMP
Test equipment	: MASTERTEST® SN:170210	to manhole	: TBE LABS
Order no.	: 54	Length of test section	: 11.0 m
Test date	: 09/08/2019 11:56:55	Pipe profile	: Circle
Test method	: Air/EN 1610	Diameter	: 100 mm
Test category	: Air LA		
Test section	: Pipe	Pipe no.	: PP SUMP
Material	: High-density polyethylene	Internal protection	: without
Remark	:		
Sensor	: PMC131 -300 - +300 mbar, SN: LC0E4001052	Sensor test	: 25/03/2019
Approval	:		

Test pressure	: 12.4 mbar	Pre-fill time	: 0:49 min
Permiss. pressure loss	: 2.5 mbar	Test duration	: 5:02 min
Act. pressure loss	: -0.1 mbar	Result	: Passed

Testing contractor

Client

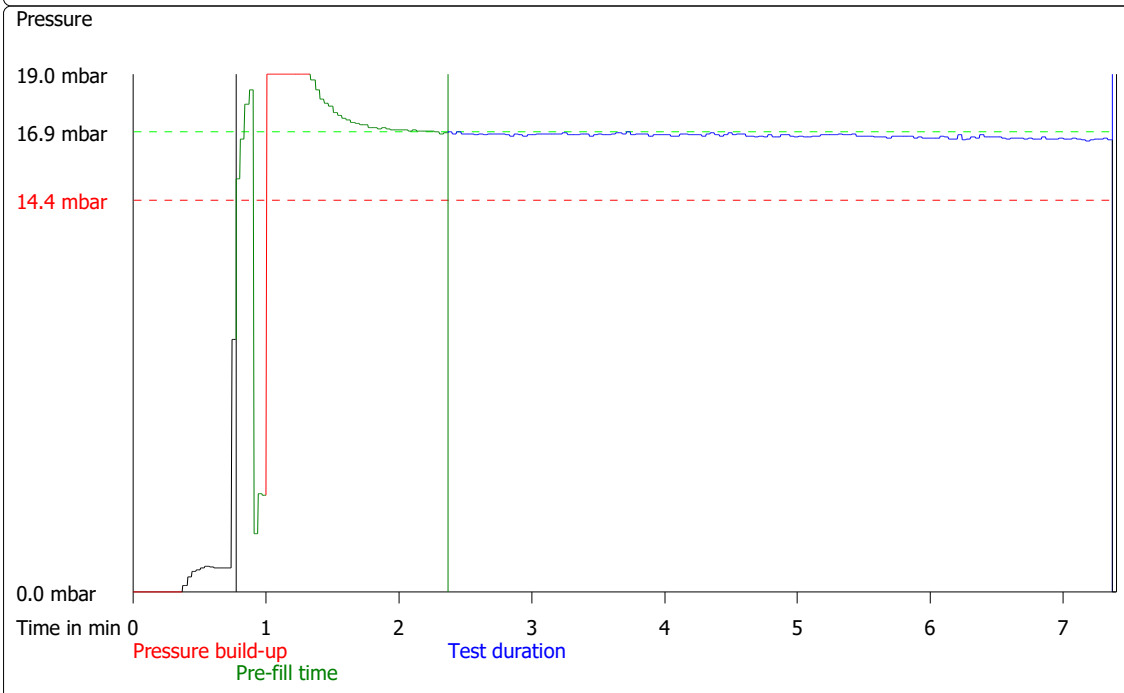
Order no.: 54 Test no.: 7

McBreen Environmental

Lismagratty, Co. Cavan - Cootehill Road - Tel : +353 (0)49 432 6306

Client:
ARRAN CHEMICALS

Pressure test report Pipe - Air/EN 1610



Location	: UNIT 5		
Location	: MONKSLAND	Drawing No.	: NONE
Street	: MAIN STREET	Section no.:	: PROCESS
Tester	: NIALL MC CABE	from manhole	: PP SUMP
Test equipment	: MASTERTEST® SN:170210	to manhole	: COOLING WATER GULLY
Order no.	: 54	Length of test section	: 17.0 m
Test date	: 09/08/2019 12:13:09	Pipe profile	: Circle
Test method	: Air/EN 1610	Diameter	: 150 mm
Test category	: Air LA		
Test section	: Pipe	Pipe no.	: PP SUMP
Material	: High-density polyethylene	Internal protection	: without
Remark	:		
Sensor	: PMC131 -300 - +300 mbar, SN: LC0E4001052	Sensor test	: 25/03/2019
Approval	:		

Test pressure	: 16.9 mbar	Pre-fill time	: 1:36 min
Permiss. pressure loss	: 2.5 mbar	Test duration	: 5:01 min
Act. pressure loss	: -0.3 mbar	Result	: Passed

Testing contractor

Client

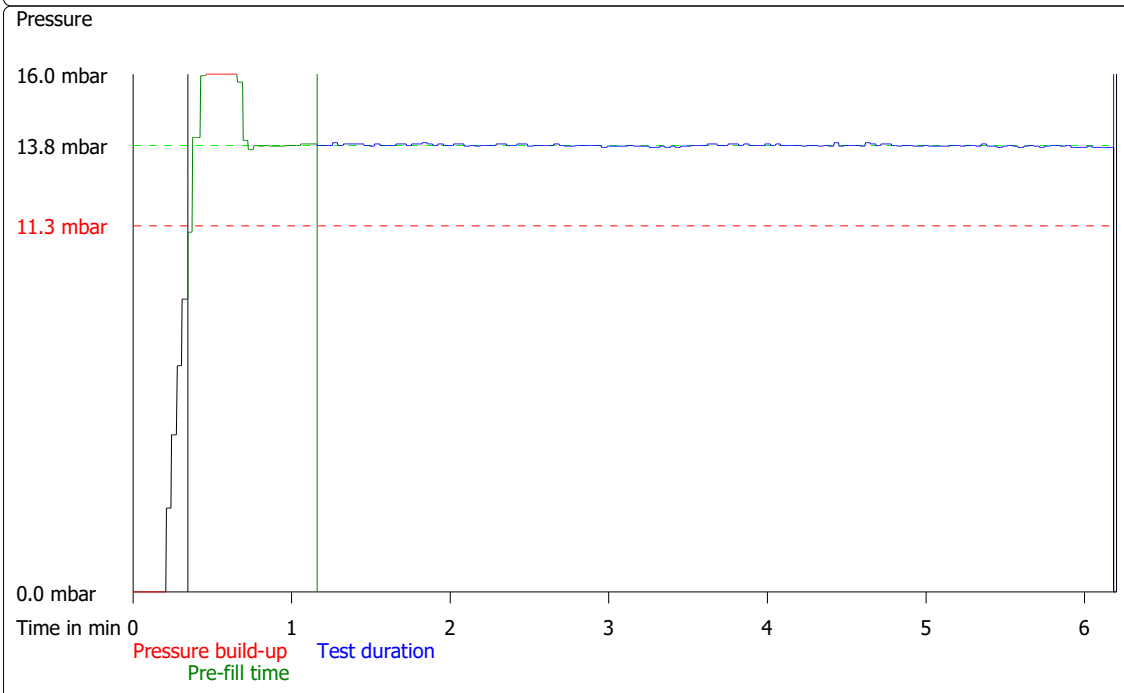
Order no.: 55 Test no.: 1

McBreen Environmental

Lismagratty, Co. Cavan - Cootehill Road - Tel : +353 (0)49 432 6306

Client:
ARRAN CHEMICALS

Pressure test report Pipe - Air/EN 1610



Location	: FYS FRONT YARD		
Location	: MONKSLAND	Drawing No.	: NONE
Street	: MAIN STREET	Section no.:	: STORM
Tester	: NIALL MC CABE	from manhole	: FYS
Test equipment	: MASTERTEST® SN:170210	to manhole	: GULLY J
Order no.	: 55	Length of test section	: 25.0 m
Test date	: 09/08/2019 14:33:17	Pipe profile	: Circle
Test method	: Air/EN 1610	Diameter	: 150 mm
Test category	: Air LA		
Test section	: Pipe	Pipe no.	: FYS
Material	: PVC	Internal protection	: without
Remark	:		
Sensor	: PMC131 -300 - +300 mbar, SN: LC0E4001052	Sensor test	: 25/03/2019
Approval	:		

Test pressure	: 13.8 mbar	Pre-fill time	: 0:49 min
Permiss. pressure loss	: 2.5 mbar	Test duration	: 5:02 min
Act. pressure loss	: -0.2 mbar	Result	: Passed

Testing contractor

Client

Order no.: 55 Test no.: 1

McBreen Environmental

Lismagratty, Co. Cavan - Cootehill Road - Tel : +353 (0)49 432 6306

Pressure test report Pipe - Air/EN 1610

Laterals for this section no.:

No.	Position	Diameter [mm]	Longitude [m]	Remark	Material
1	1	150	11	GULLY I	PVC

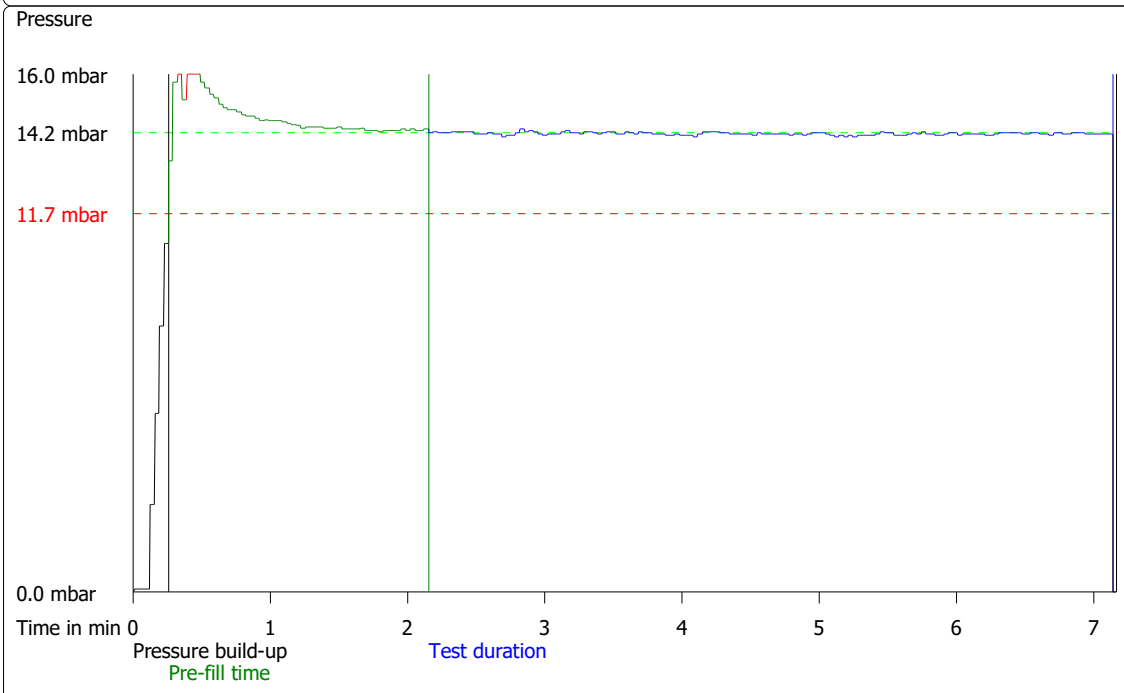
Order no.: 55 Test no.: 2

McBreen Environmental

Lismagratty, Co. Cavan - Cootehill Road - Tel : +353 (0)49 432 6306

Client:
ARRAN CHEMICALS

Pressure test report Pipe - Air/EN 1610



Location	: FYS FRONT YARD		
Location	: MONKSLAND	Drawing No.	: NONE
Street	: MAIN STREET	Section no.:	: STORM
Tester	: NIALL MC CABE	from manhole	: FYS
Test equipment	: MASTERTEST® SN:170210	to manhole	: GULLY G
Order no.	: 55	Length of test section	: 22.0 m
Test date	: 09/08/2019 14:54:17	Pipe profile	: Circle
Test method	: Air/EN 1610	Diameter	: 150 mm
Test category	: Air LA		
Test section	: Pipe	Pipe no.	: FYS
Material	: PVC	Internal protection	: without
Remark	:		
Sensor	: PMC131 -300 - +300 mbar, SN: LC0E4001052	Sensor test	: 25/03/2019
Approval	:		

Test pressure	: 14.2 mbar	Pre-fill time	: 1:54 min
Permiss. pressure loss	: 2.5 mbar	Test duration	: 5:00 min
Act. pressure loss	: -0.3 mbar	Result	: Passed

Testing contractor

Client

Order no.: 55 Test no.: 2

McBreen Environmental

Lismagratty, Co. Cavan - Cootehill Road - Tel : +353 (0)49 432 6306

Pressure test report Pipe - Air/EN 1610

Laterals for this section no.:

No.	Position	Diameter [mm]	Longitude [m]	Remark	Material
1	1	150	10	GULLY H	PVC

LICENCE REFERENCE No.	RISK ASSESSMENT METHODOLOGY STAGE & STEP	REPORT VERSION
P0110-02	Stage 3 Step 2	Rev. 6

Corrective Action Implementation & Verification Report

for the Environmental Protection Agency

(July 2019)

(P0110-02)

Project Title:	Plume 4 Progress Report
Licence No:	P0110-02
Project No:	1099
Contract No:	
Report Ref:	1099-780
Status:	Rev. 6
Client:	Arran Chemical Company
Client Details:	Monksland Industrial Estate, Athlone, Co Roscommon, Ireland
Issued By:	Minerex Environmental Limited Hydrogeological, Environmental and Geophysical Services Taney Hall, Dundrum, Dublin 14, Ireland Dublin 14, Ireland

Document Production/Approval Record

	Name	Signature	Date	Position	% Input
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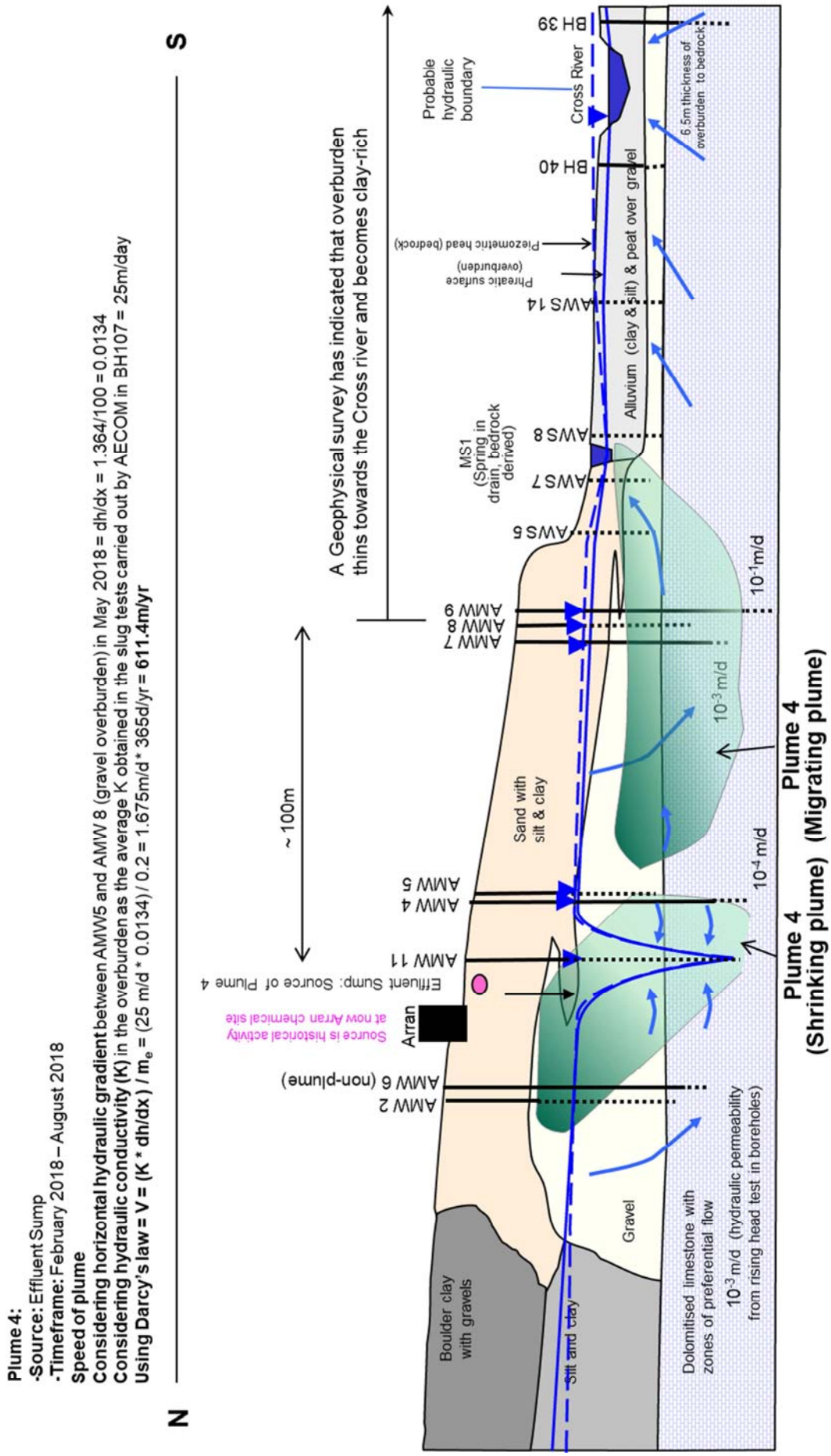
REFERENCES

Ref.1	Report into the recent investigation in relation to monitoring well AMW3 (2015) – (Minerex Doc. Ref. 1099-751)
Ref.2	2018 Hydrogeological Assessment (2019) – (Minerex Doc. Ref. 1099-775)
Ref.3	Reply on EPA comment on AMW 3 chemistry (2015) – (Minerex Doc. Ref. 1099-774)

EXECUTIVE SUMMARY

1. ACCL is a chemical company specialising in the manufacture of products for pharmaceutical and health care, flavour/fragrance, personal care, and other specialised chemical and industrial applications.
2. Historically, back in the 1990s, a leak in the sewage system generated a plume of contaminants (Plume 1) into the ground close to AMW3 monitoring well. Concentration reduced to practically nil by the end of 1998 and remained <2% of the peak concentration until 2010-2013.
3. Over the period 2010-2013, several leaks in the main water supply is understood to have led to water flowing along the top of a clay layer in significant amounts and mobilised residual contamination (which normal rainfall could not achieve) giving as a result new peaks in concentration. By the end of 2015 and up to 2018 the contaminant concentrations where again reducing.
4. During 2018, peaks in the concentration of contaminants were detected after the routine Q3 groundwater monitoring round. The origin of this leak was most likely an effluent sump that had some remedial repairs performed in August of 2018, but the leak was not evident at the time of the inspection.
5. A remedial pumping system has been setup and is being improved based on performance observations. Concentrations of CoPCs since the remedial pumping started are decreasing in the majority of the monitoring wells but some exceptions remain. Based on evidence several possible reasons have been postulated to explain this, namely:
    a) Off-site source of contamination: Mainly supported by the persistence of a number of CoPCs in the groundwater at a higher concentration than in the Effluent.
    b) Unidentified leak in ACCL drainage/effluent system: Mainly supported by the increase of MTBE in AMW6 over time.
    c) Remnant contamination from Plume 4: Under this assumption, remedial pumping has not been running for enough time yet to draw firm conclusions.


Plume 4:
·Source: Effluent Sump
·Timeframe: February 2018 – August 2018
Speed of plume
Considering horizontal hydraulic gradient between AMW5 and AMW 8 (gravel overburden) in May 2018 = dh/dx = 1.364/100 = 0.0134
Considering hydraulic conductivity (K) in the overburden as the average K obtained in the slug tests carried out by AECOM in BH107 = 25m/day
Using Darcy's law = V = (K * dh/dx) / m_e = (25 m/d * 0.0134) / 0.2 = 1.675m/d * 365d/yr = 611.4m/yr
N
S
A Geophysical survey has indicated that overburden thins towards the Cross river and becomes clay-rich
Probable hydraulic boundary
Cross River
BH 39
BH 40
6.5m thickness of overburden to bedrock
Piezometric head (bedrock)
Phreatic surface (overburden)
AWS 14
Alluvium (clay & silt) & peat over gravel
AWS 8
MS1 (Spring in drain, bedrock derived)
AWS 7
AWS 5
AMW 9
AMW 8
AMW 7
~ 100m
Sand with silt & clay
AMW 5
AMW 4
AMW 11
Effluent Sump: Source of Plume 4
Source is historical activity at now Arran chemical site
Arran
AMW 6 (non-plume)
AMW 2
Boulder clay with gravels
Silt and clay
Gravel
Dolomitised limestone with zones of preferential flow
10^{-3} m/d (hydraulic permeability from rising head test in boreholes)
10^{-1}m/d
10^{-3} m/d
10^{-4} m/d
Plume 4 (Migrating plume)
Plume 4 (Shrinking plume)

	EPA Contaminated Land & Groundwater Risk Assessment Methodology	Report Reference	Report Date	Status
	STAGE 1: SITE CHARACTERISATION & ASSESSMENT			
1.1	PRELIMINARY SITE ASSESSMENT			
1.2	DETAILED SITE ASSESSMENT			
1.3	QUANTITATIVE RISK ASSESSMENT			
	STAGE 2: CORRECTIVE ACTION FEASIBILITY & DESIGN			
2.1	OUTLINE CORRECTIVE ACTION STRATEGY			
2.2	FEASIBILITY STUDY & OUTLINE DESIGN			
2.3	DETAILED DESIGN			
2.4	FINAL STRATEGY & IMPLEMENTATION PLAN			
	STAGE 3: CORRECTIVE ACTION IMPLEMENTATION & AFTERCARE			
3.1	ENABLING WORKS			
3.2	CORRECTIVE ACTION IMPLEMENTATION & VERIFICATION	1099-780	11/07/19	Rev.6
3.3	AFTERCARE			

1. INTRODUCTION

1.1. GENERAL INTRODUCTION

Minerex Environmental Limited (MEL) was contracted by Arran Chemicals Co. Limited (ACCL) to generate a report to respond to the EPA.

Zala Uriel (Hydrogeologist at Minerex, 4 years' experience) has been in charge of the writing of this report with the continuous assistance of Cecil Shine (Director at Minerex, 35 years' experience).

1.2. BACKGROUND INFORMATION

ACCL is a chemical company specialising in the manufacture of products for pharmaceutical and health care, flavour/fragrance, personal care, and other specialised chemical and industrial applications.

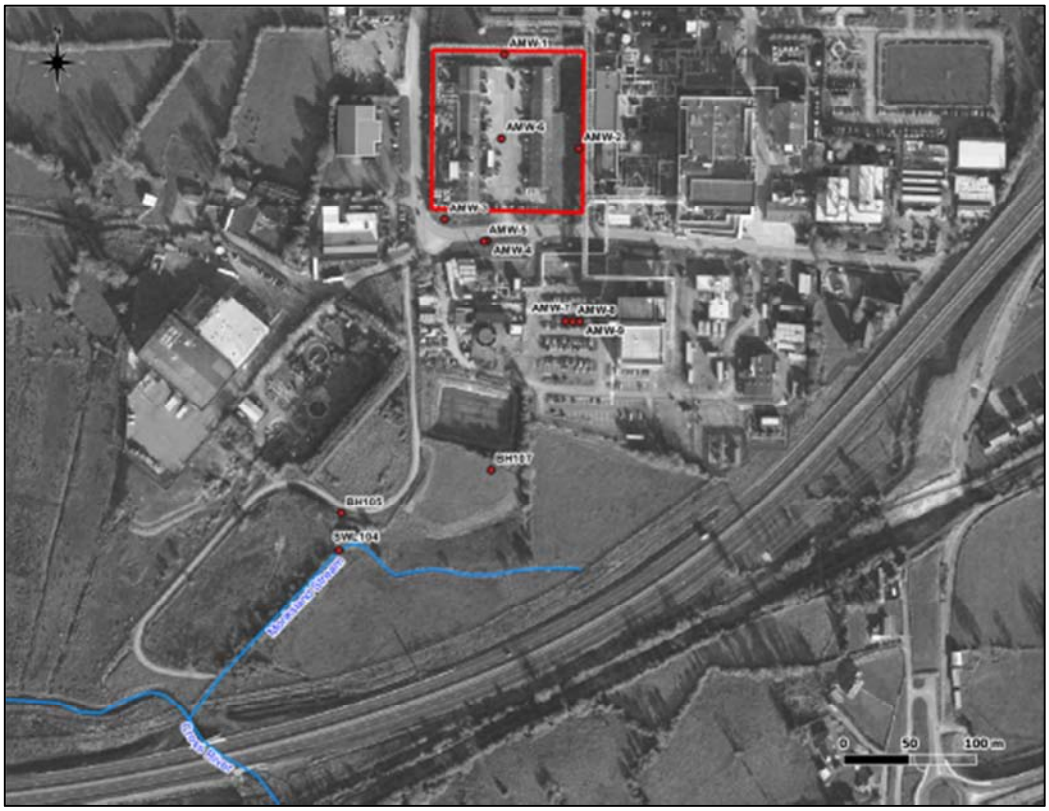
Historically, back in the 1990s, a leak in the effluent system generated a plume of contaminants (plume 1) into the ground close to AMW3 monitoring well. Concentration reduced to practically nil by the end of 1998 and remained <2% of the peak concentration until 2010-2013 (Ref.1).

Over the period 2010-2013, several leaks in the main water supply flowed along the top of the clay layer in significant amounts and mobilised residual contamination (which normal rainfall could not achieve) giving as a result new peaks in concentration. By the end of 2015 and up to 2018 the contaminant concentrations where again reducing.

During 2018, peaks in the concentration of contaminants were detected after the routine Q3 groundwater monitoring round carried out by BnM (Ref.3). Figure 1.1 shows the location of the wells being monitored up to date.

Appendix A shows the borehole logs for the monitoring wells and Appendix B show the wells inventory from Arran and Alkermes (extracted from the 2014 Targeted Site Investigation Reports by URS-AECOM).

Figure 1.1 – Location map.



1.2.1. DETERMINATION OF THE CONTAMINANTS OF POTENTIAL CONCERN (COPCS)

Contaminants of potential concern have been determined to be the chemical compounds present in ACCL effluent before the pumping commenced in November plus MIBK (as MIBK is being detected in moderate concentrations in the groundwater despite not being originally present in ACCL effluent). Table 1.1 below lists the CoPCs and their maximum and average concentrations in the effluent during 2018.

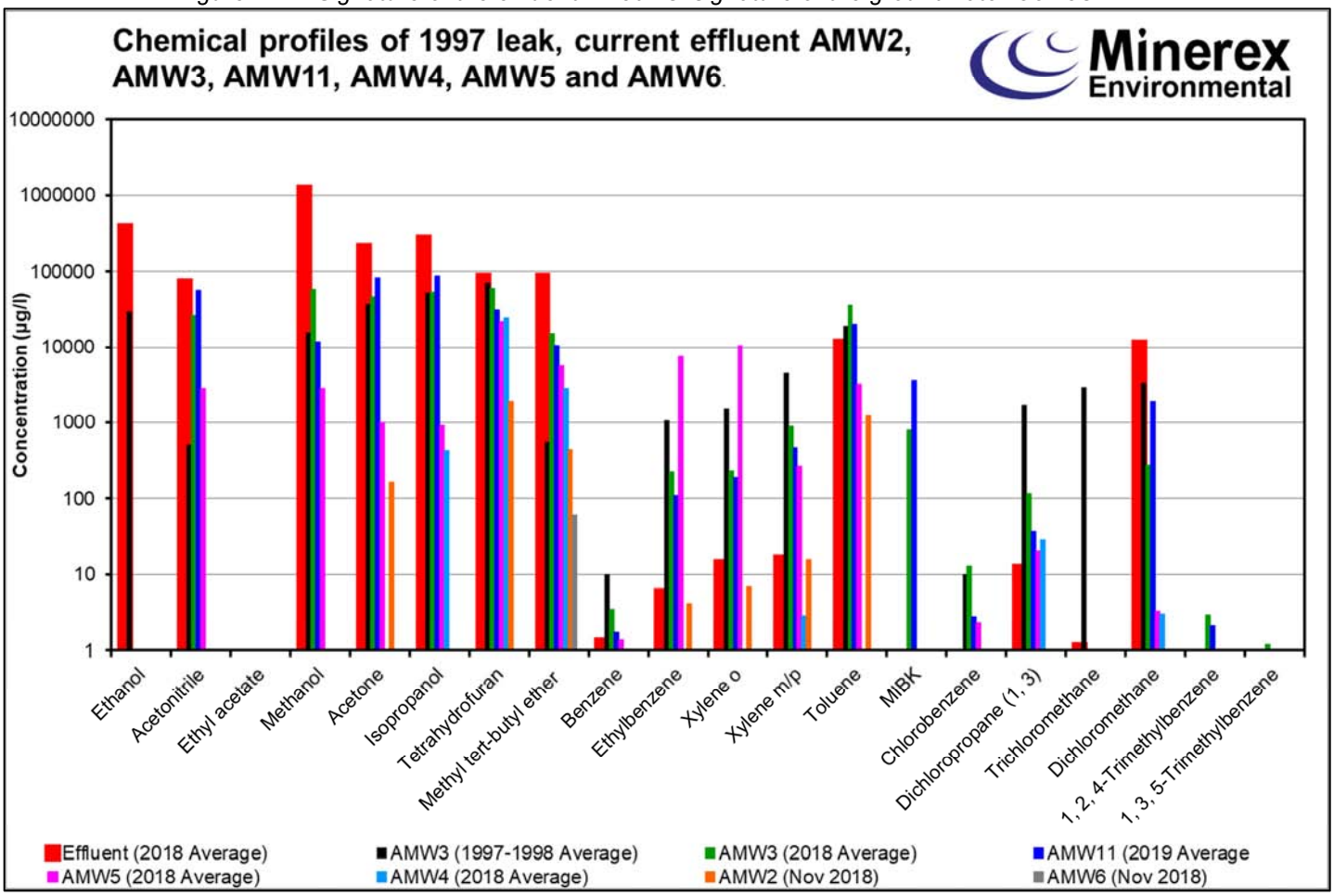
Table 1.1 – CoPCs and their concentration in the effluent (µg/l)

	Chemical Compound	Minimum concentration	Maximum concentration	Average concentration
1	Methanol	1,000	2,144,000	1,121,353
2	Ethanol	104,000	600,000	337,922
3	Isopropanol	79,000	454,000	248,437
4	Acetone	93,000	295,800	188,934
5	THF	50,000	120,390	80,404
6	Acetonitrile	20,000	159,819	78,214
7	MTBE	4,000	184,000	77,120
8	Toluene	3,350	18,300	11,763
9	Dichloromethane	4	46,900	5356
10	m,p-Xylene	1 (LOD)	98	24
11	1,3 dichloropropane	1 (LOD)	96	20
12	o-Xylene	1 (LOD)	58	18
13	Ethylbenzene	1 (LOD)	26	9
14	Chloromethane	1 (LOD)	10	6
15	Bromoform	1 (LOD)	10	3
16	Bromochloromethane	1 (LOD)	15	2
17	Styrene	1 (LOD)	8	2
18	MIBK	100 (LOD)	100 (LOD)	100 (LOD)

1.2.2. DETERMINATION OF THE EFFLUENT SIGNATURE

Figure 1.2 below shows the concentration of CoPCs in the effluent and in the groundwater. It is noted some of the compounds are more elevated in the groundwater than in the effluent.

Figure 1.2 – Signature of the effluent in red vs. signature of the groundwater CoPCs.



ACCL effluent is characterised by having high levels for 9 compounds including Ethanol, Acetonitrile, Methanol, Acetone, Isopropanol, Tetrahydrofuran (THF), Methyl-tert butyl ether (MTBE), Toluene and Dichloromethane (DCM).

1.2.3. PLUME 4 TRAVEL TIME ESTIMATION

A travel time estimation exercise has been carried out to determine if it has been possible for the plume to reach the downstream boreholes (BH107 and BH105, 250m downstream from the Effluent Sump) since the leak started (the earliest in February 2018) (Ref.2).

1. <u>Variables</u>

$v = real\ speed\ of\ groudwater\ (metres/day)$
$q = Darcy\ speed\ of\ groundwater\ (metres/day)$
$K = hydraulic\ conductivity\ /\ permeability\ (metres/day)$
$i = hydraulic\ gradient\ (adimensional)$
$m_e = effective\ porosity\ (adimensional)$
$d = distance\ between\ the\ Effluent\ sump\ and\ BH\ 107\ (metres)$
$t_t = travel\ time\ between\ the\ Effluent\ Sump\ and\ BH107\ (days)$

2. <u>Assumptions:</u>

$K = 25.229\ m/d$
Value for K has been taken from the average hydraulic conductivity obtained by AECOM during the slug tests carried out at BH107. Appendix C shows the results for these tests.

$m_e = 0.2$
Value for effective porosity has been set at 0.2 which is a widely accepted average effective

porosity for fine sands.

$$i = \frac{dh}{dx} = \frac{1.364}{100} = 1.364 * 10^{-2}$$

Value for hydraulic gradient has been calculated from the water level difference (dh) and distance (dx) between AMW5 and AMW8 in May 2018.

$$d = 215\ m$$

3. Travel time calculation:

$$q = K * i$$

$$v = \frac{q}{m_e}$$

$$v = \frac{K * i}{m_e}$$

$$t_t = \frac{d}{v}$$

$$t_t = \frac{d}{(K * i)/m_e}$$

$$t_t = \frac{215}{(25.229 * 0.0134)/\ 0.2}$$

$$\boldsymbol{t_t = 127.19\ d}$$

4. Conclusion

Based on the travel time approximation calculated above, it is likely that Plume 4 has had time to travel from the Effluent Sump to the downgradient boreholes in between February 2018 and November 2018.

1.3. PROJECT OBJECTIVES

The objective of this project is:

1. SOURCE DETERMINATION - Validate the source of the contamination plume that developed during 2018 (Plume 4).
2. INSTALL REMEDIATION SYSTEM - Put in place a remediation system capable of stopping the contaminants migration from ACCL site and reduce the contaminant concentrations in the most affected area (that is the southern limit of ACCL facilities).
3. MONITOR AND MODIFY AS NECESSARY - Monitor the contamination levels downstream where the leak occurred.
4. REPORT – Report on results.

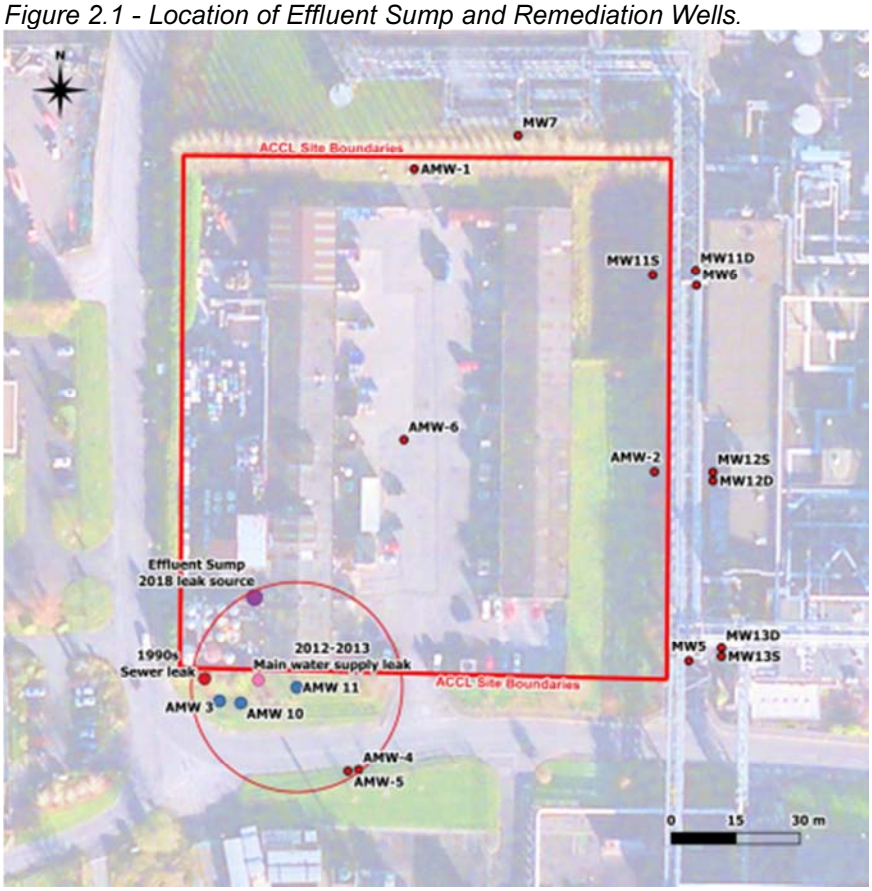
2. SYSTEM PERFORMANCE

The remediation system performance is continuously under review and the optimisation of the system is still ongoing based on monitoring results. The table 3.1 below summarizes the amendments that have been made to the system up to date.

Table 2.1 – Remediation system performance and actions taken to improve performance		
Date	**Action taken**	**Validation/Comments**
20/11/18	**Setup AMW 3 as a remediation well.**	
	- Installation of a WASP-P5 pump. - Installation of telemetric water level logger - Daily Conductivity and COD manual readings until January.	- Constant pumping could not be achieved (low yield, well going dry). - Pump setup with an automatic timer turning pump on and off as required. CONCLUSION - To obtain optimal configuration to maximise pumping rate.
December 2018	**Optimisation of AMW 3 pumping.**	
	- Optimal configuration of timer achieved: Maximum abstraction rate obtained = 3 m3/day.	CONCLUSION - Zone of Influence of remedial action to be increased to guarantee contaminants capture so decided to drill an additional remediation well.
15/01/19	**Drilling of an additional well: AMW10**	
	- Well was drilled to refusal (7 mbGL) with shell and auger (screened in the overburden). - Located within 5 m from AMW 3 and within 25 m from the Effluent Sump.	- AMW 10 yield = 1 l/min approx. - AMW 3 yield = 2 l/min approx. CONCLUSIONS - Pumping continued from AMW 3. Decision made to drill a well which would straddle overburden and bedrock.
20/03/19	**Drilling of an additional well: AMW 11**	
	- Well drilled several metres into rock (15 mbGL) with rotary coring machine. - Located within 19 m from AMW 3 and within 24 m from the Effluent Sump. - Installation of telemetric water level logger and telemetric conductivity logger. - Installation of a Vortex 2GD1 pump ***(first pump)*** (capacity = 0.06 l/s) - Daily Conductivity and COD manual readings.	- AMW 11 yield > 1 l/s. - Pumping at pump capacity: 5.5 m3/day. - Few weeks after it was seen that conductivity was not decreasing as expected, CONCLUSION - To increase the pumping rate by changing the pump.
23/05/19	**Increase AMW 11 pumping capacity.**	
	- Installation of a Grundfos SQ2-55 pump ***(second pump)*** (capacity 1 l/s approx.). - Installation of a telemetric flow meter.	- Due to the IW Discharge Licence volume limitation requirements, pumping rate had to be limited to approximately 0.11 l/s (daily abstraction rate = 10 m^3/day approx.). - Due to the IW Discharge Licence volume limitation requirements, pumping had to cease with heavy rain events. - Conductivity decreases while pumping but rebounds when pumping stops. CONCLUSION - IW discharge licence to be reviewed to allow a higher pumping rate

Figure 2.1 below shows the location of AMW 3, AMW 10, AMW 11 and the Effluent Sump, source of the Plume 4 in 2018.

Figure 2.1 - Location of Effluent Sump and Remediation Wells.



3. MONITORING RESULTS

Monitoring results are presented here in order to validate and support the actions being taken.

3.1. WATER LEVELS

Groundwater level maps have been drawn for the Overburden and The Bedrock based on groundwater level readings taken on the 27/02/19 by AECOM & BNM. These can be seen in figures 3.1 and 3.2 below:

Figure 3.1: Piezometric map for the overburden – 27/02/19

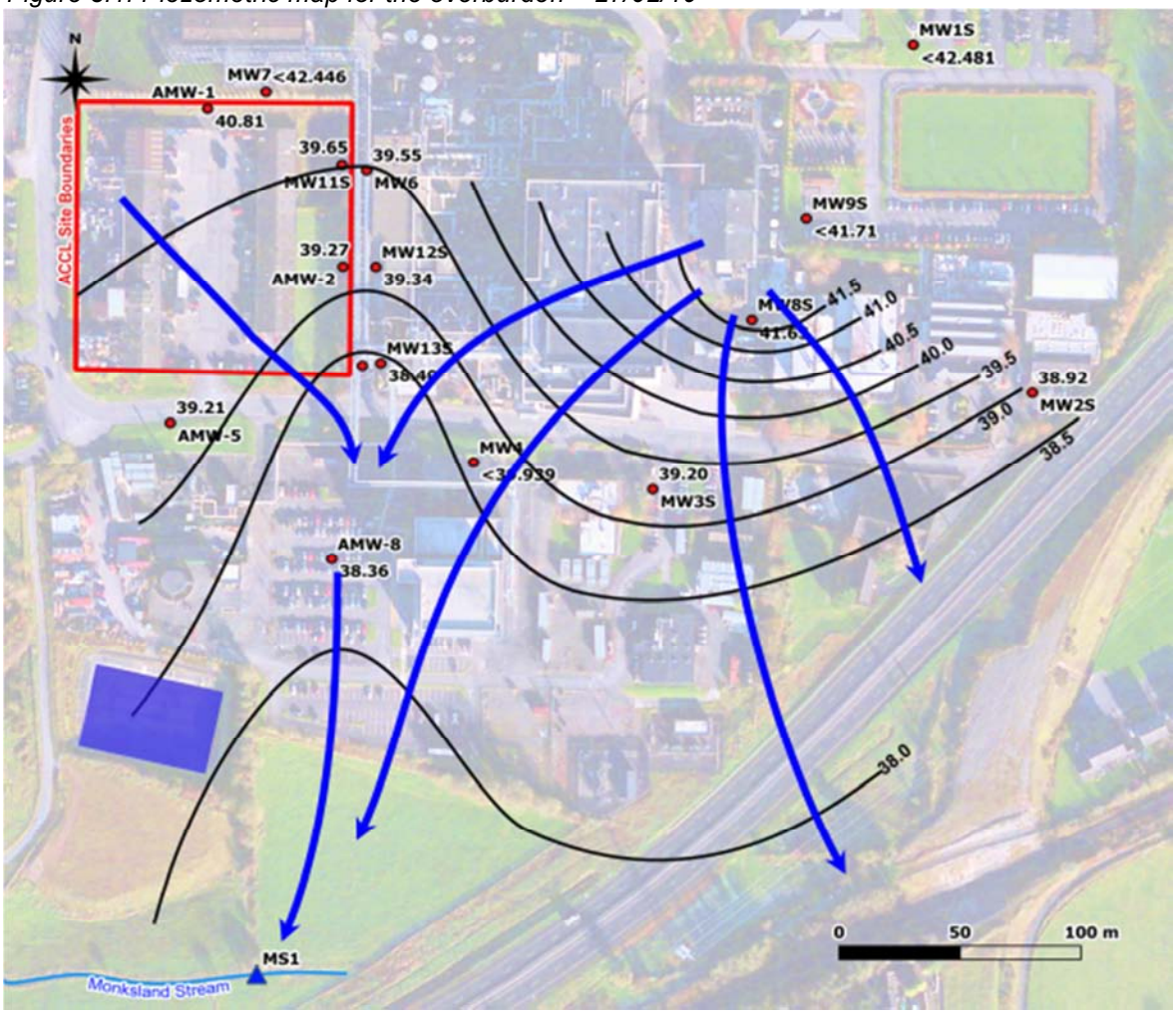
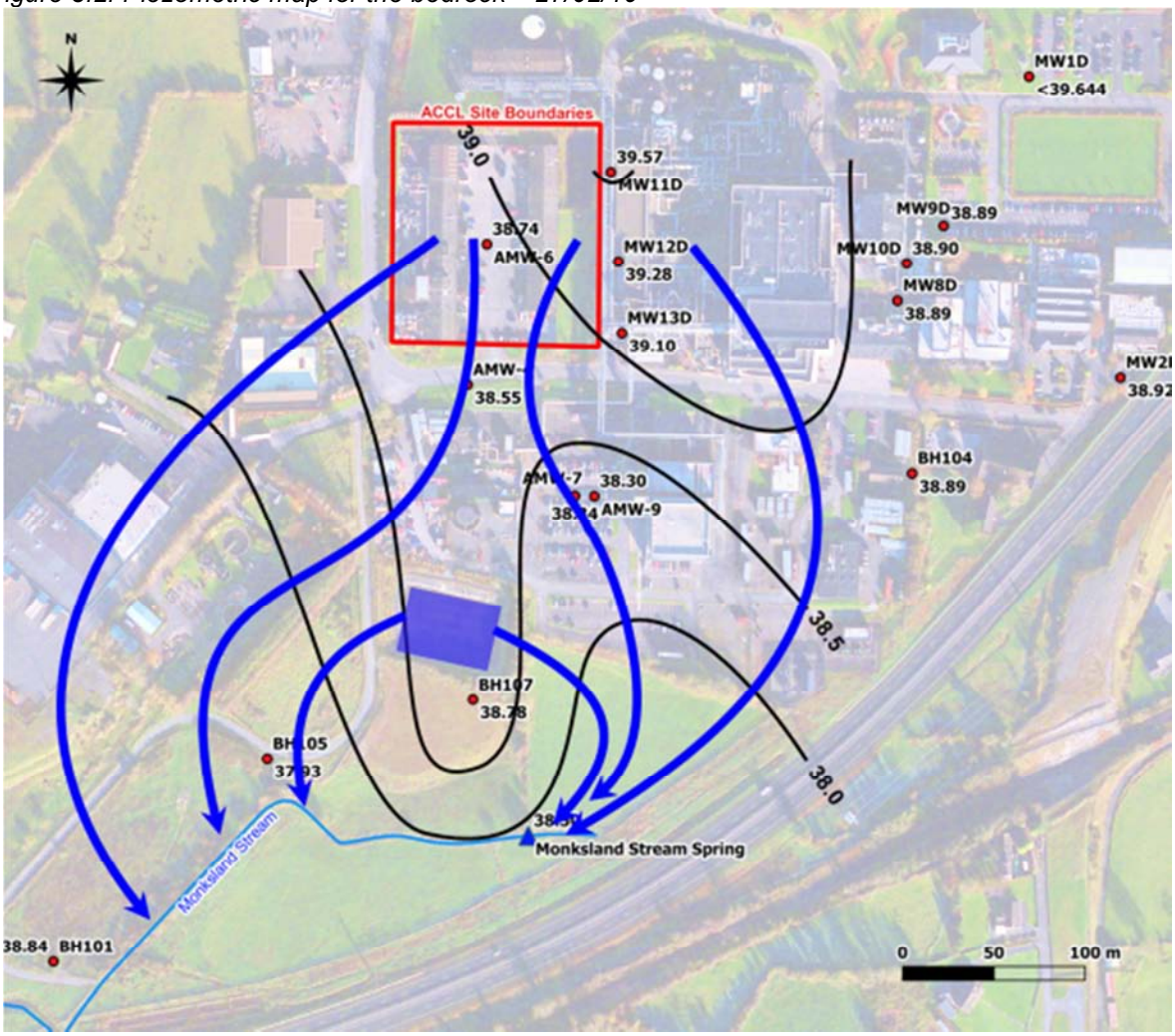


Figure 3.2: Piezometric map for the bedrock – 27/02/19



The firewater water retention pond is 150m to the south from ACCL. Based on piezometry, it is noted that the pond could be leaking water into the Overburden and Bedrock producing a groundwater mound.

The Overburden groundwater flows in a southeast direction within ACCL site. The pathway is likely (to be confirmed after acquiring level data – see recommendations) to connect downstream with the Monksland Stream Spring.

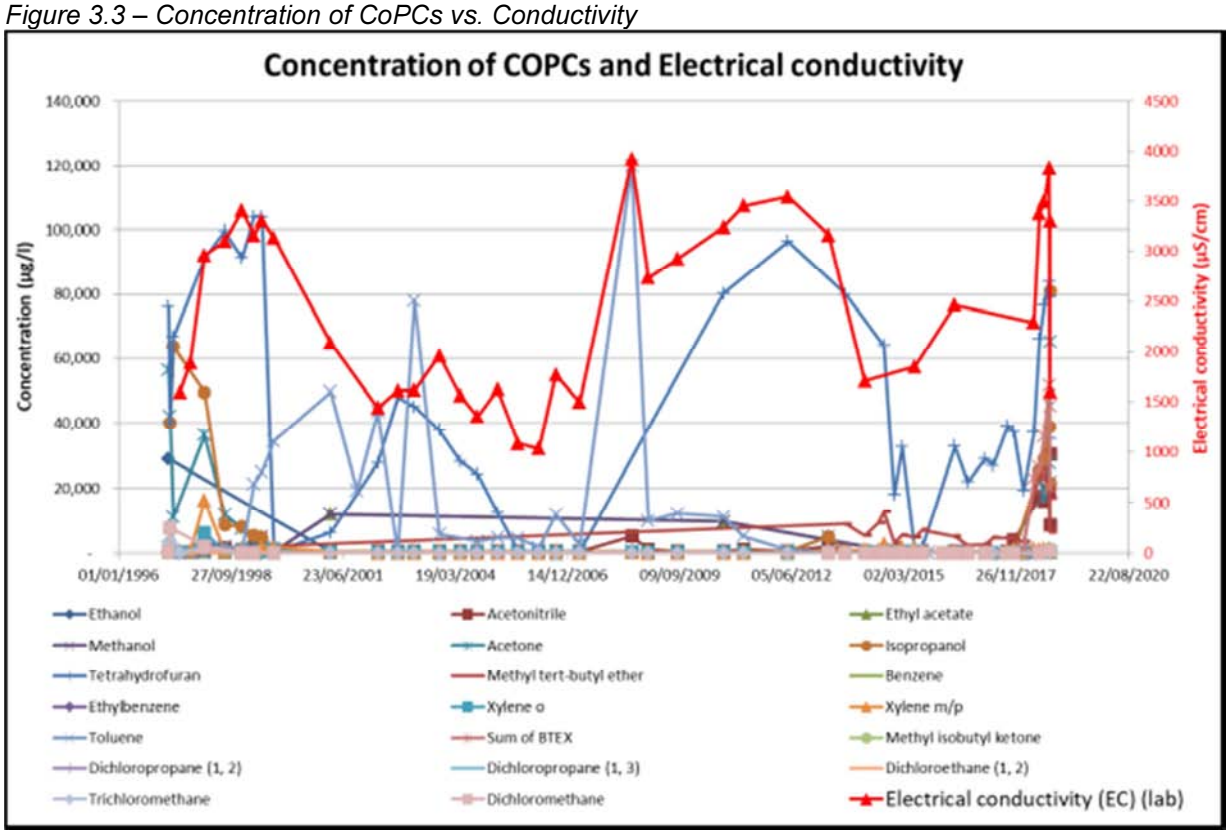
The Bedrock groundwater flows in a south to southwest direction within ACCL site. There are 2 possible pathways for the groundwater downstream the site, one links with the Monksland Stream Spring and the other with the western side of the Monskland Spring.

Water level readings reports from AECOM and BnM can be seen in Appendix D.

3.2. CONDUCTIVITY

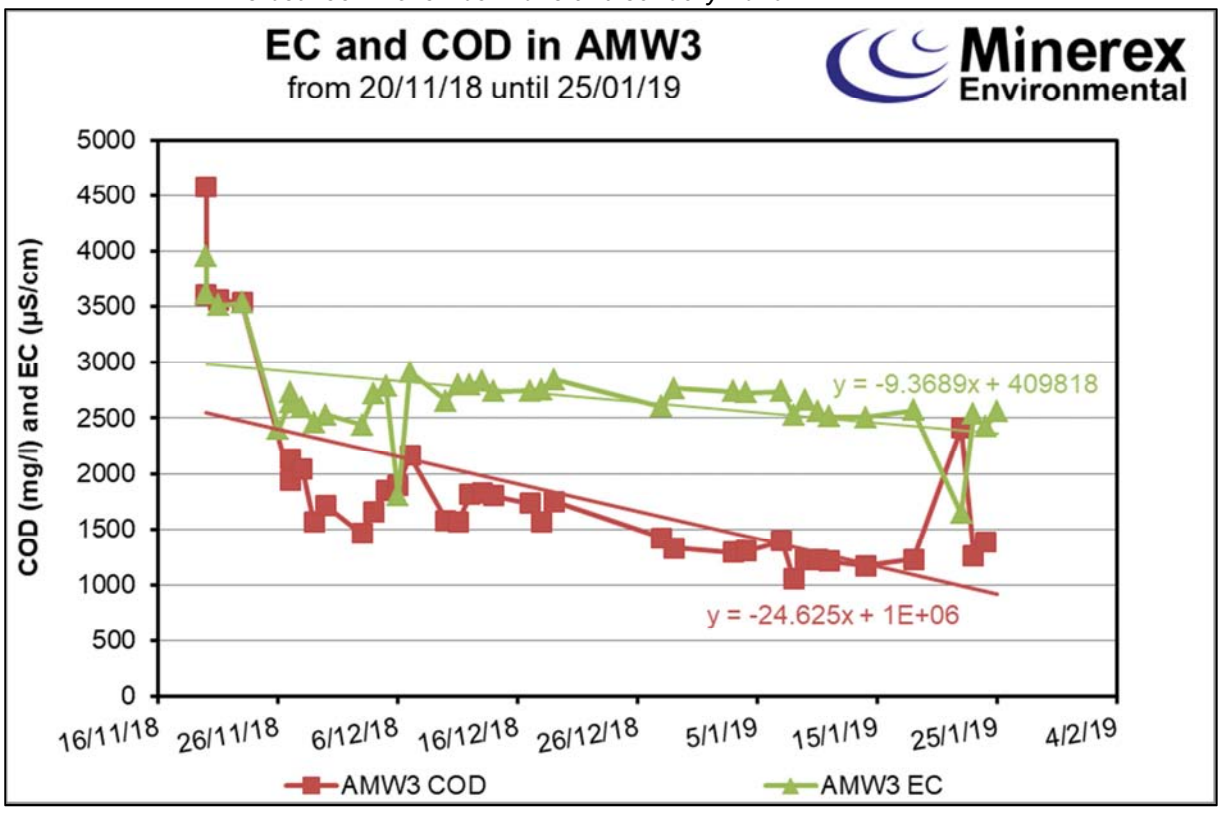
Conductivity values broadly mirrors the CoPCs concentrations as shown in the figure 3.3 below (Ref.3).

Figure 3.3 – Concentration of CoPCs vs. Conductivity



Conductivity and COD have been regularly monitored manually since the pumping at AMW3 started on November 2018. Figure 3.4 below shows the manual conductivity and COD values recorded.

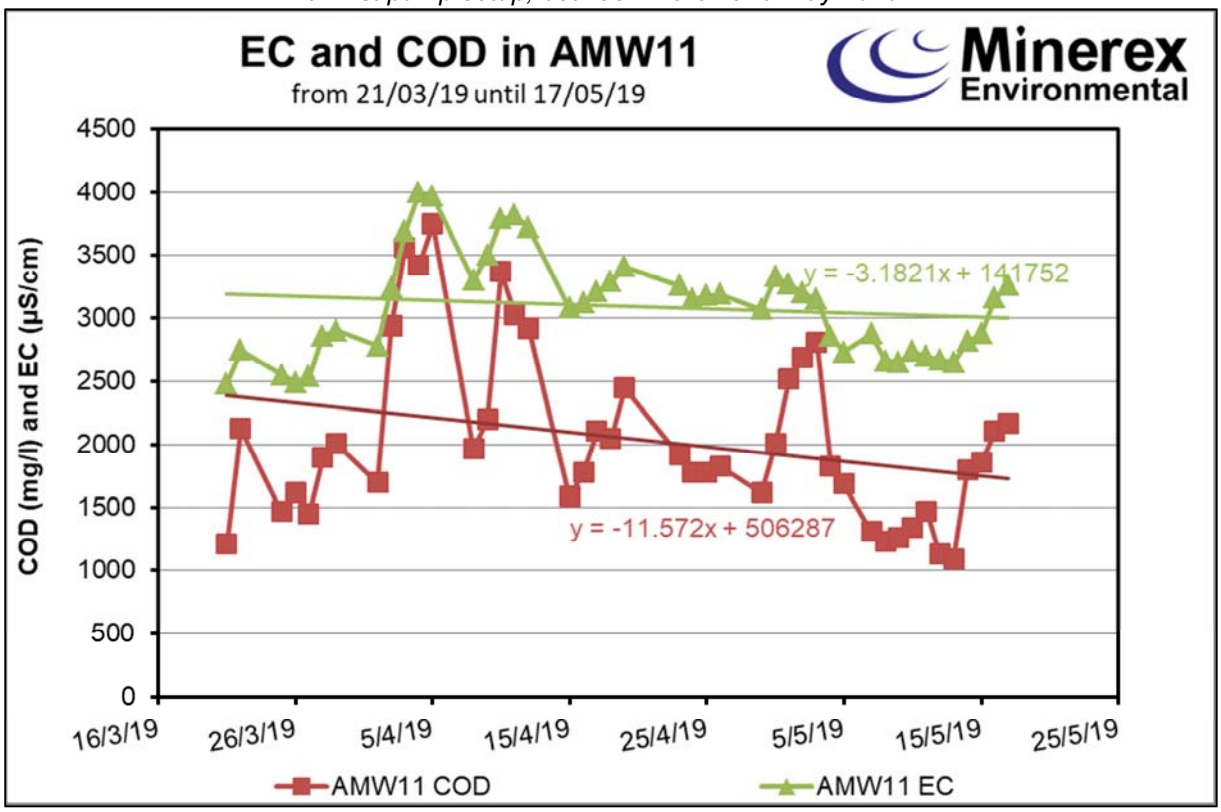
Figure 3.4 – Variation of the conductivity and the COD over time when pumping was occurring at AMW 3 between November 2018 and January 2019.



Conductivity decreased between November 2018 and early December 2019 from approximately 3500 µS/cm to 2500 µS/cm, but remained stable between December and January. Overall conductivity reduction was about 9 µS/day. This decrease rate was not considered adequate to reach the objectives and a plan was put in place to drill an additional well capable of pumping at a higher rate.

Conductivity has been regularly monitored manually since the pumping in AMW11 started with the first pump on the 20/03/19. Figure 3.5 below shows the manual conductivity and COD values obtained.

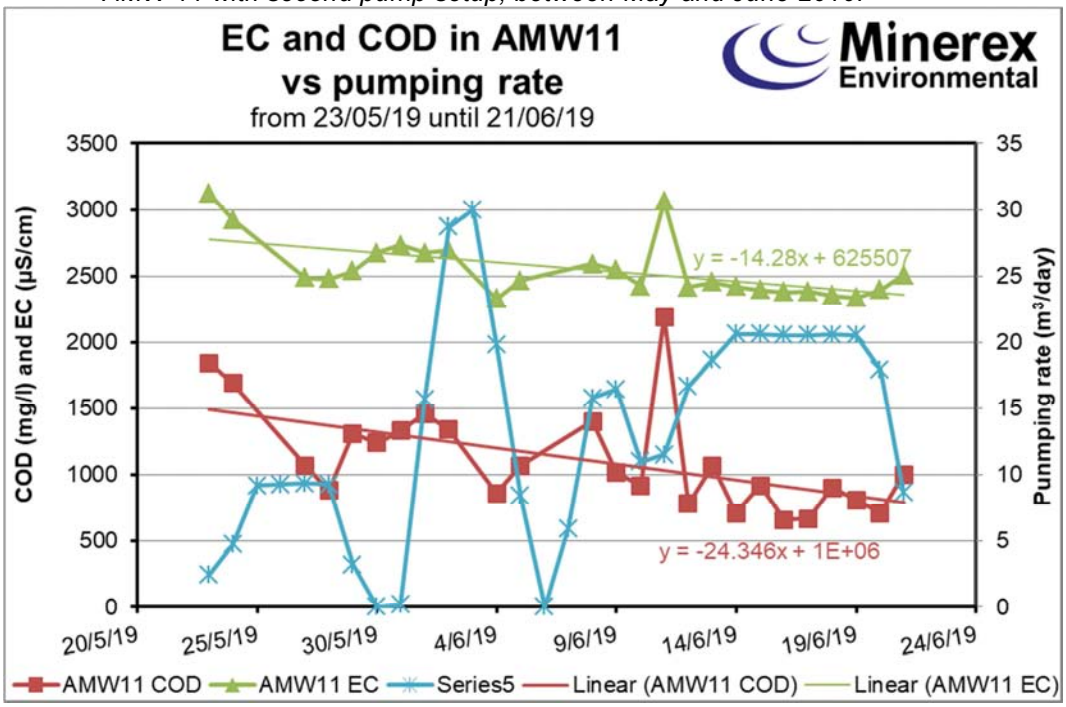
Figure 3.5 – Variation of the conductivity and the COD over time when pumping was occurring at AMW 11 with first pump setup, between March and May 2019.



Conductivity did show a stable trend over the period from the 21/03/19 µS/cm until the 03/05/19. It was considered that the pumping rate was not enough and, in response to that, a plan was put in place to install a more powerful pump to increase the pumping rate.

Conductivity has been regularly monitored manually since the pumping in AMW11 started with the second pump on the 23/03/19. Figure 3.6 below shows the manual conductivity and COD values obtained together with the pumping rate in m^3/day.

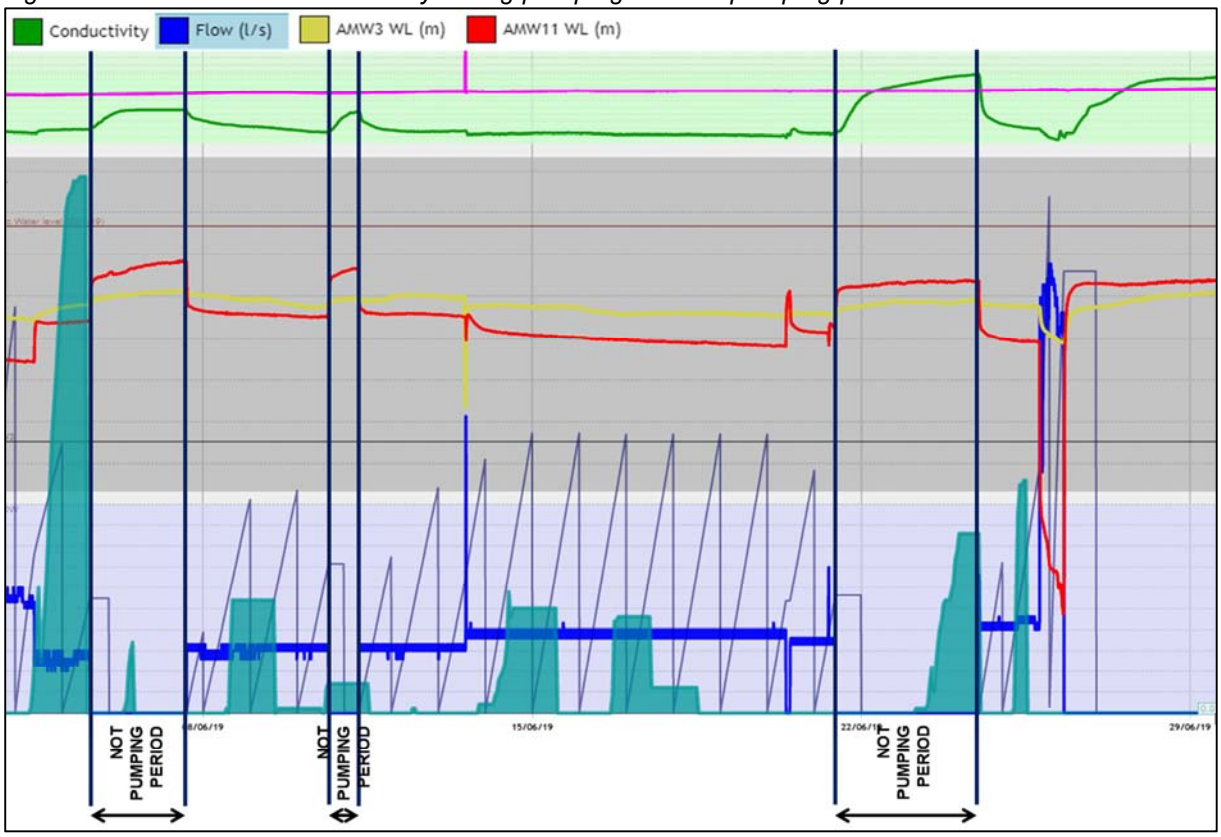
Figure 3.6 – Variation of the conductivity and the COD over time when pumping was occurring at AMW 11 with second pump setup, between May and June 2019.



As it can be observed, conductivity and COD have been progressively decreasing from 3000 µS/cm to 2500 µS/cm and approximately 2000 to 1000 mg/l. It is also noted that when pumping ceases both rebound to values close to those values at beginning of period being considered here.

Figure 3.7 below shows that the conductivity returned to values close to 4000 µS/cm when pumping had to stop due to heavy rains. This is a higher than normal rebound.

Figure 3.7 – Variation of conductivity during pumping and not-pumping periods.

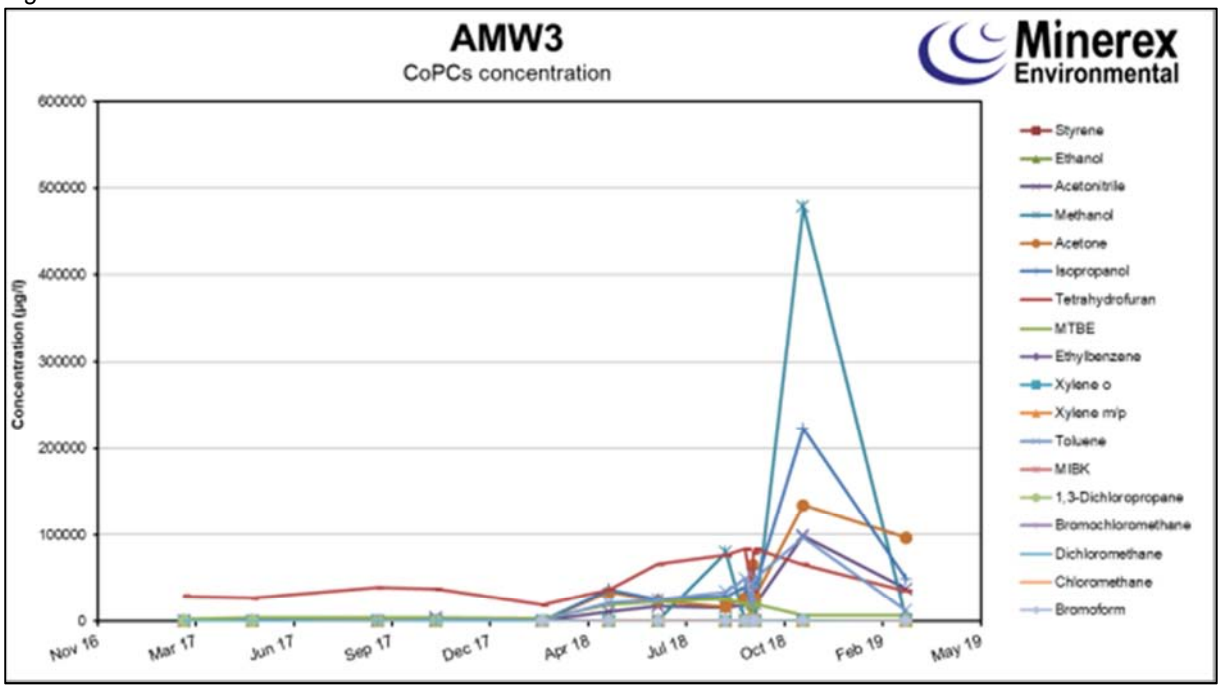


3.3. RESULTS FROM LABORATORY ANALYSIS

Figures 3.8 to 3.21 below show the variation of the CoPCs over time in the monitoring boreholes. Analysis results compared with EQS and laboratory certificates are shown in Appendix E.

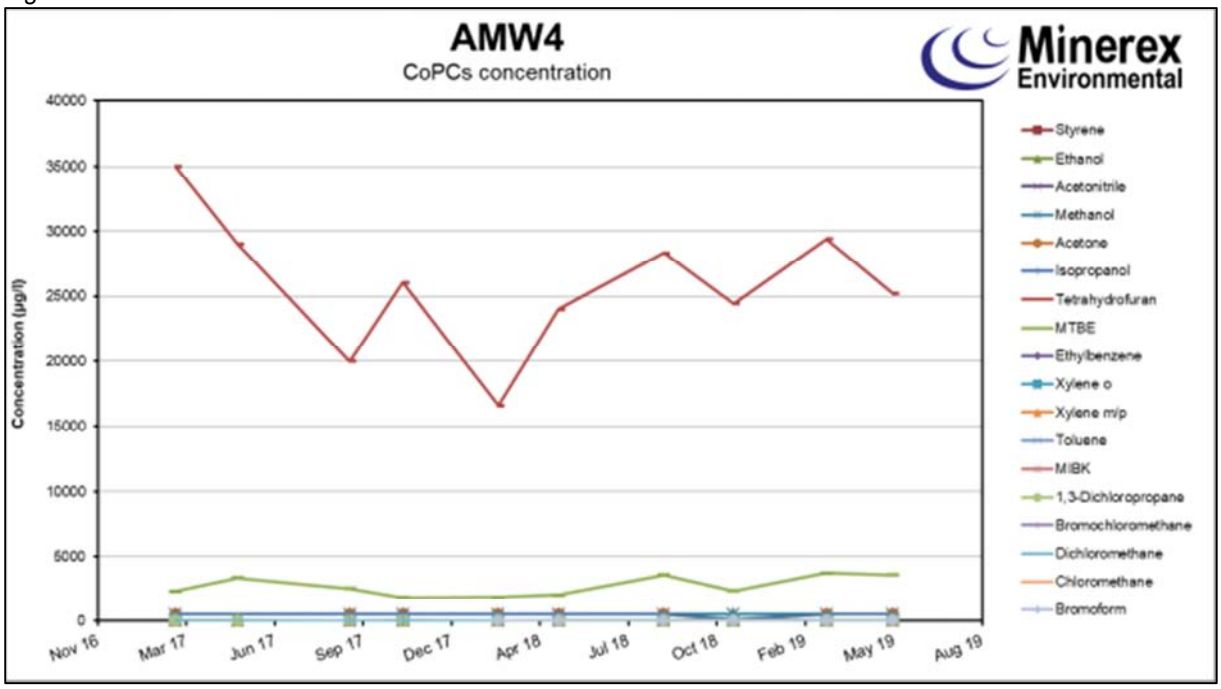
3.3.1. WELLS HISTORICALLY RELATED WITH 1990S PLUME 1 AND IN CLOSE PROXIMITY TO EFFLUENT SUMP, (SOURCE OF A KNOWN LEAK DURING 2018)

Figure 3.8 – AMW3 CoPCs concentrations



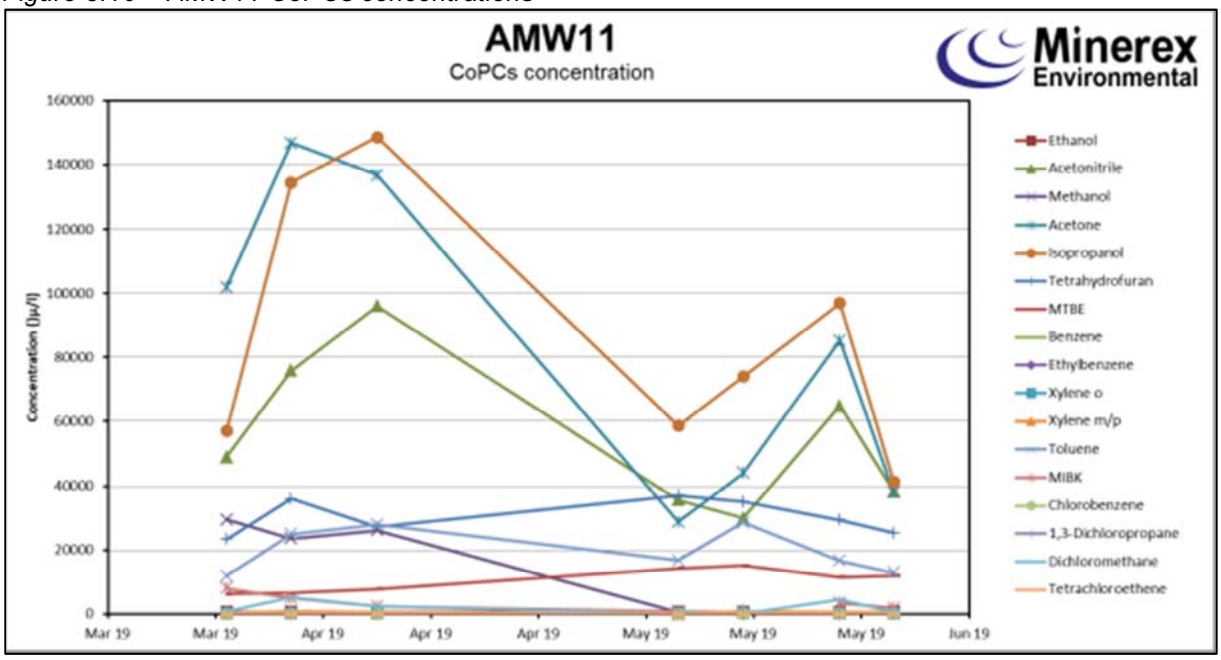
Well AMW3 (depth: 6.9m, screened in the overburden) has shown a downwards trend in all the CoPCs concentrations since the pumping started.

Figure 3.9 – AMW4 CoPCs concentrations



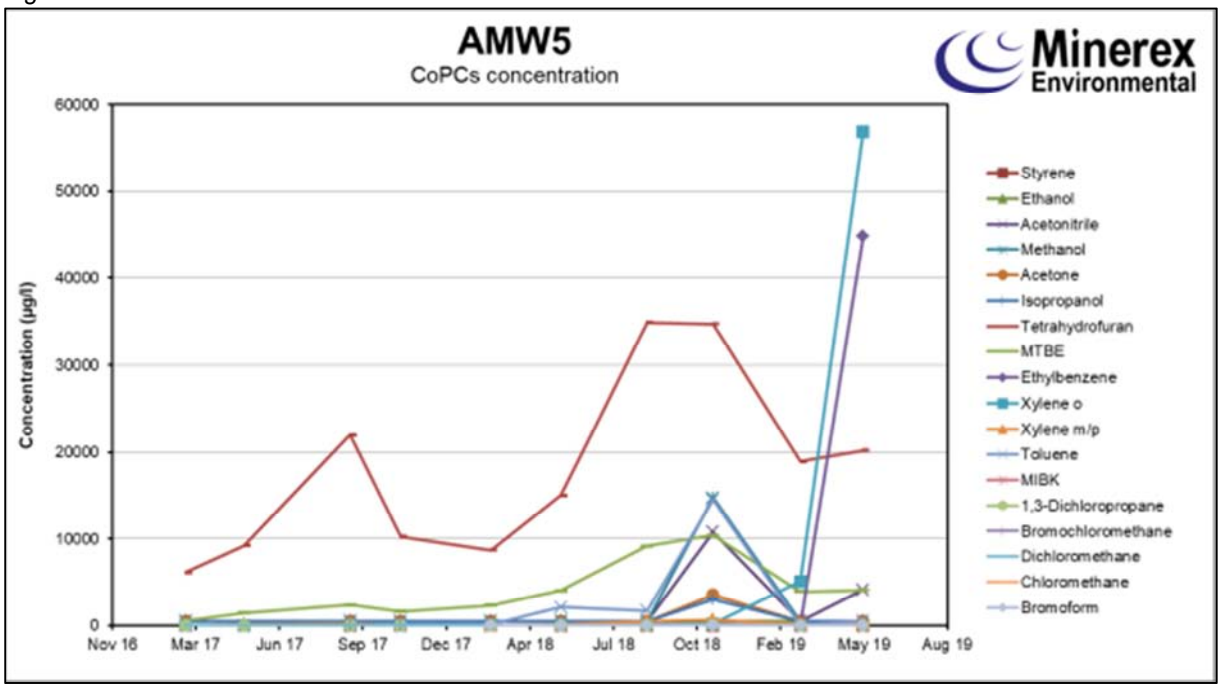
Well AMW4 (depth 18.44m, screened in bedrock) shows a broadly stable CoPCs concentration in the last 2 years. Substances detected during 2018 in this well are THF, MTBE and, at lower concentrations, 1,3-Dichloropropane.

Figure 3.10 – AMW11 CoPCs concentrations



Well AMW11 (depth: 15m, screened in bedrock) has shown a downwards trend in certain CoPCs concentration since the pumping started: Isopropanol, Acetonitrile, Acetone, MIBK and Methanol. Other CoPCs remain stable or are increasing: THF, Toluene, MTBE, Benzene, Ethylbenzene, Xylenes, Chlorobenzene, DCM and 1,3-Dichloropropane.

Figure 3.11 – AMW5 CoPCs concentrations



Well AMW5 (depth: 7.41m, screened in the overburden) shows a generally increasing trend in THF and MTBE concentration over the last 2 years.

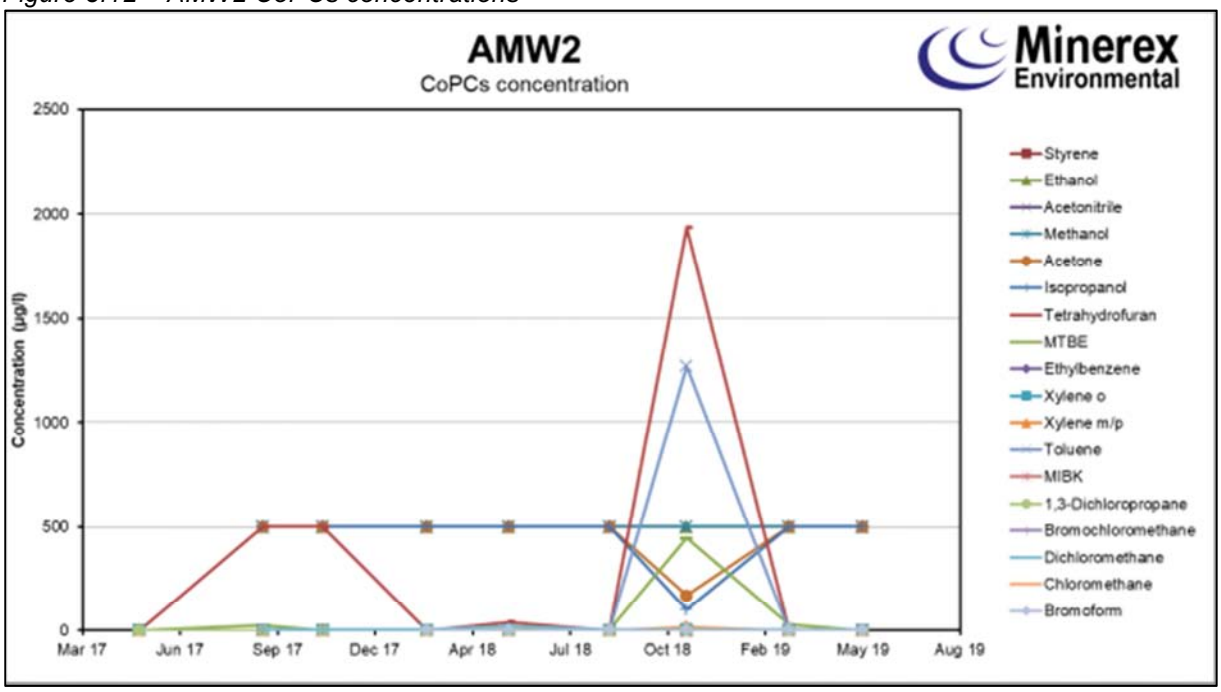
Peaks in the concentrations of THF, Toluene, Methanol, Acetonitrile, MTBE, Acetone and Isopropanol were recorded in November 2018; general trend for these substances over the

next 2 sampling events was decrease.

Peaks in o-Xylene and Ethylbenzene were detected in February and May 2018.

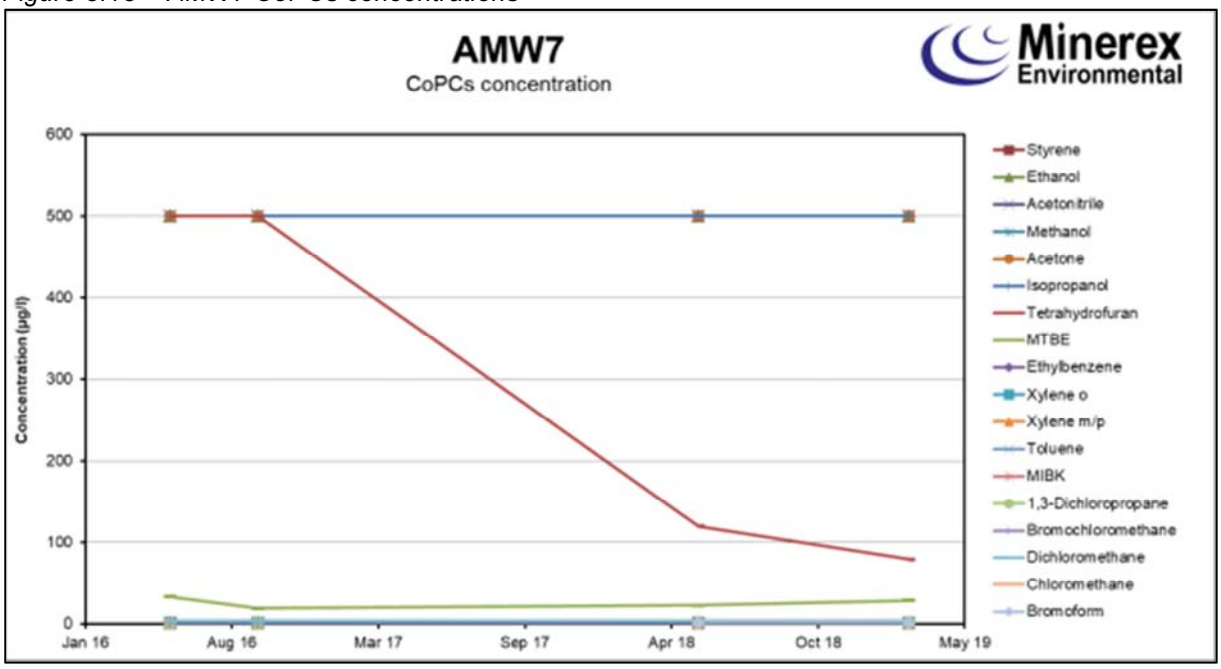
3.3.2. WELLS HISTORICALLY RELATED WITH OFF-SITE PLUME 2

Figure 3.12 – AMW2 CoPCs concentrations



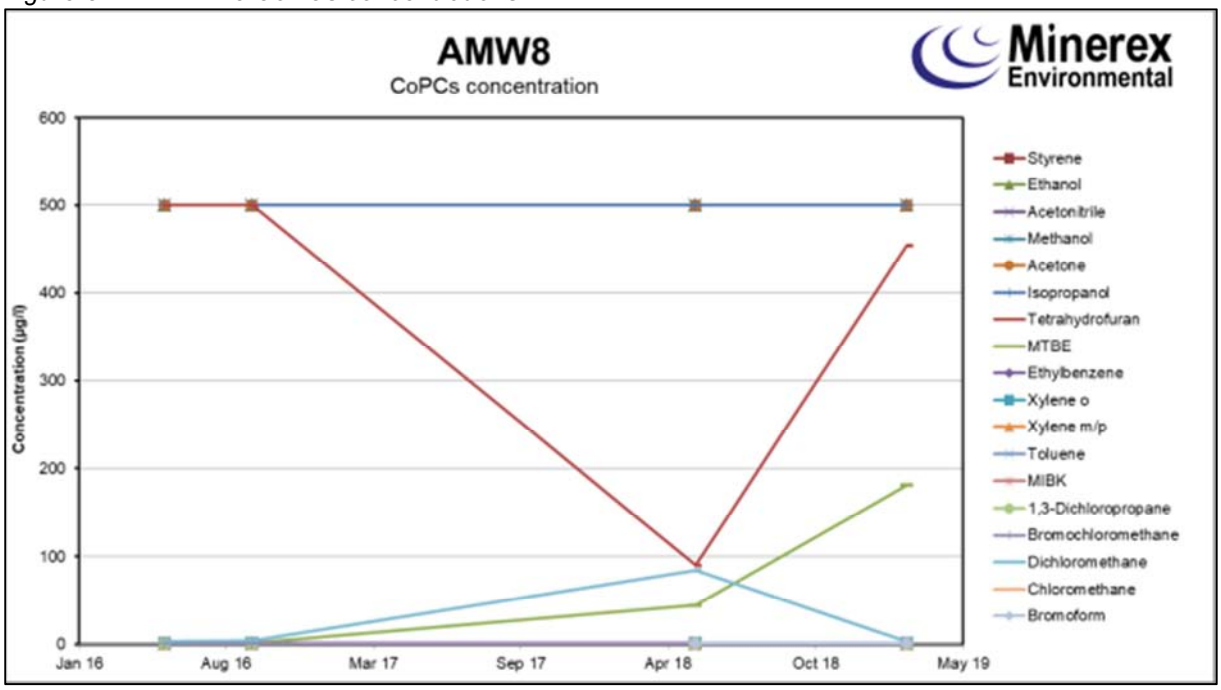
Well AMW2 (depth 7.61m, screened in the overburden) recorded peaks in the concentration of THF, Toluene, MTBE, Acetone and Isopropanol in November 2018. Concentration of these substances has decreased since the pumping started.

Figure 3.13 – AMW7 CoPCs concentrations



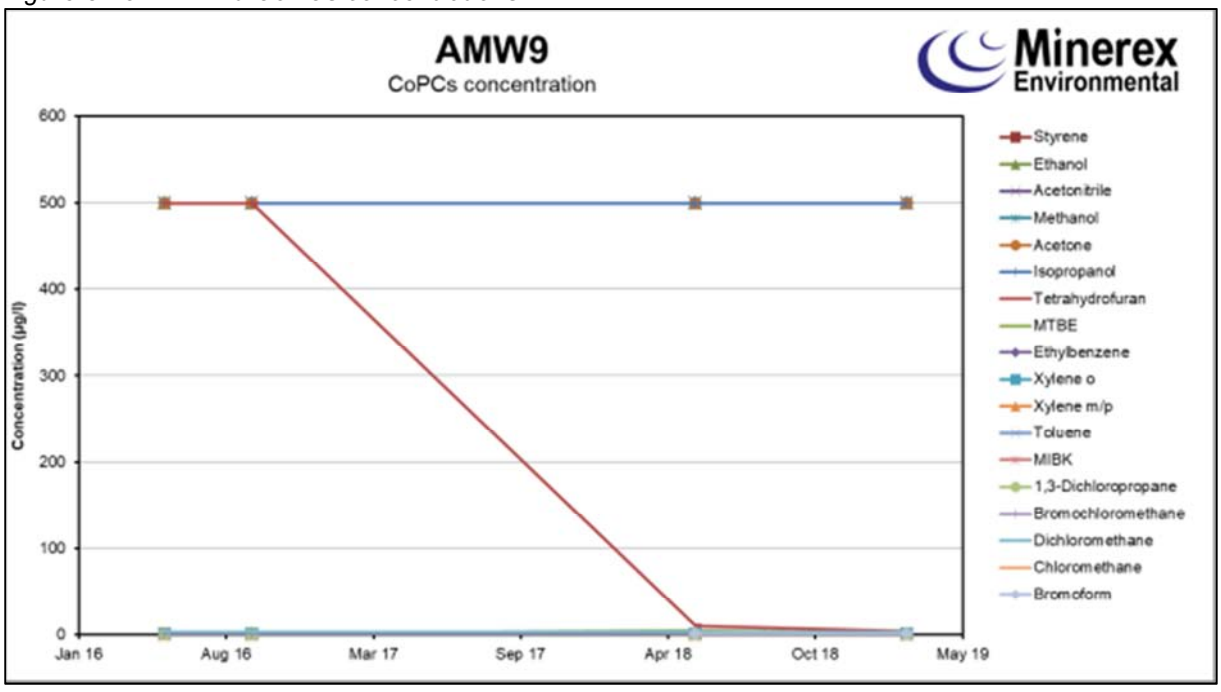
Well AMW7 (depth: 26m, screened in bedrock) shows stable presence of MTBE, THF and, at lower concentrations, 1,3-Dichloropropane since 2015. Concentration of THF has decreased in between May 2018 and February 2019.

Figure 3.14 – AMW8 CoPCs concentrations



Well AMW8 (depth: 11m, screened in the overburden and bedrock) has no record of the presence of contaminants since October 2016, although LOD for several of the substances has been 500 µg/l up to May 2018. In May 2018, DCM was detected but returned to below LOD in February 2019. In May 2018 THF and MTBE were detected and concentration has risen in February 2019.

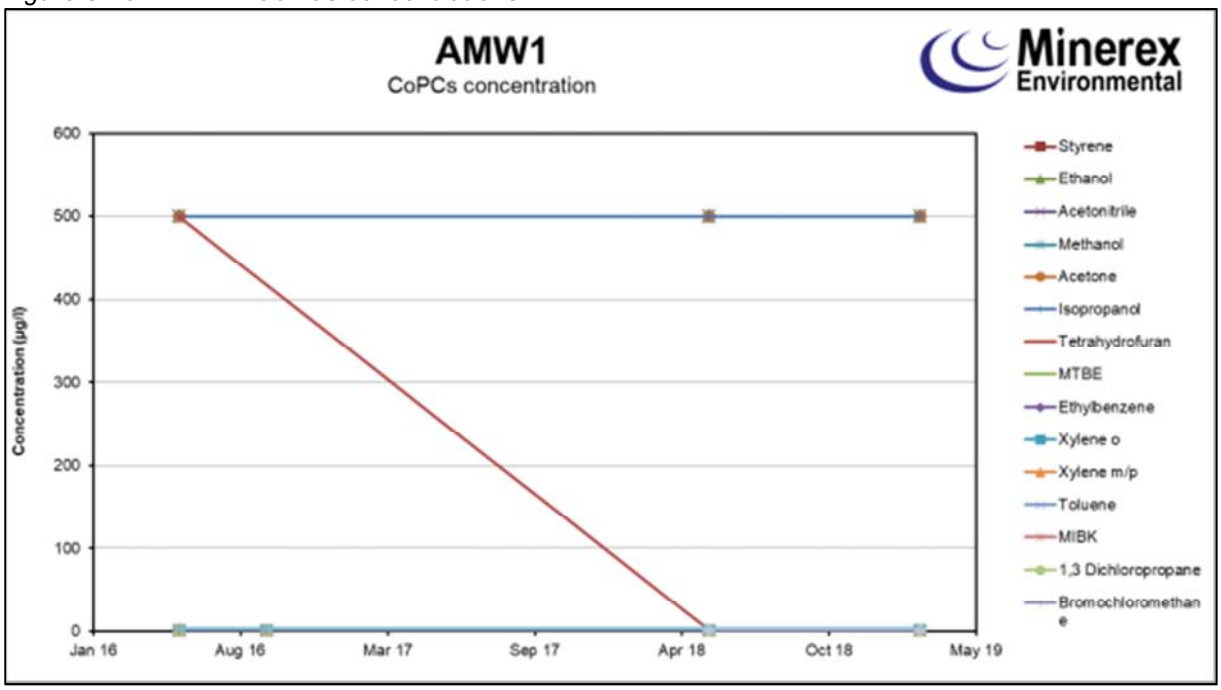
Figure 3.15 – AMW9 CoPCs concentrations



Well AMW9 (depth: >30m, screened in bedrock) has no records of CoPCs presence since October 2016. In May 2018 THF and MTBE were detected and concentration has decreased in February 2019.

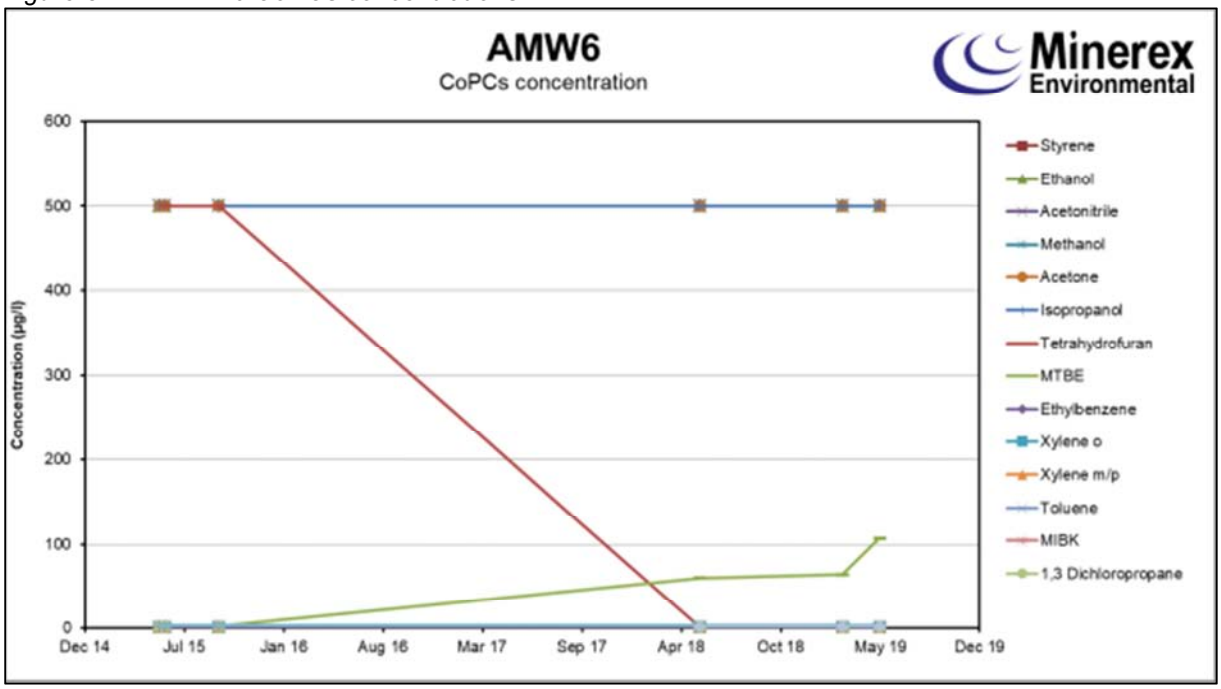
3.3.3. WELLS NOT HISTORICALLY RELATED TO CONTAMINATION PLUMES

Figure 3.16 – AMW1 CoPCs concentrations



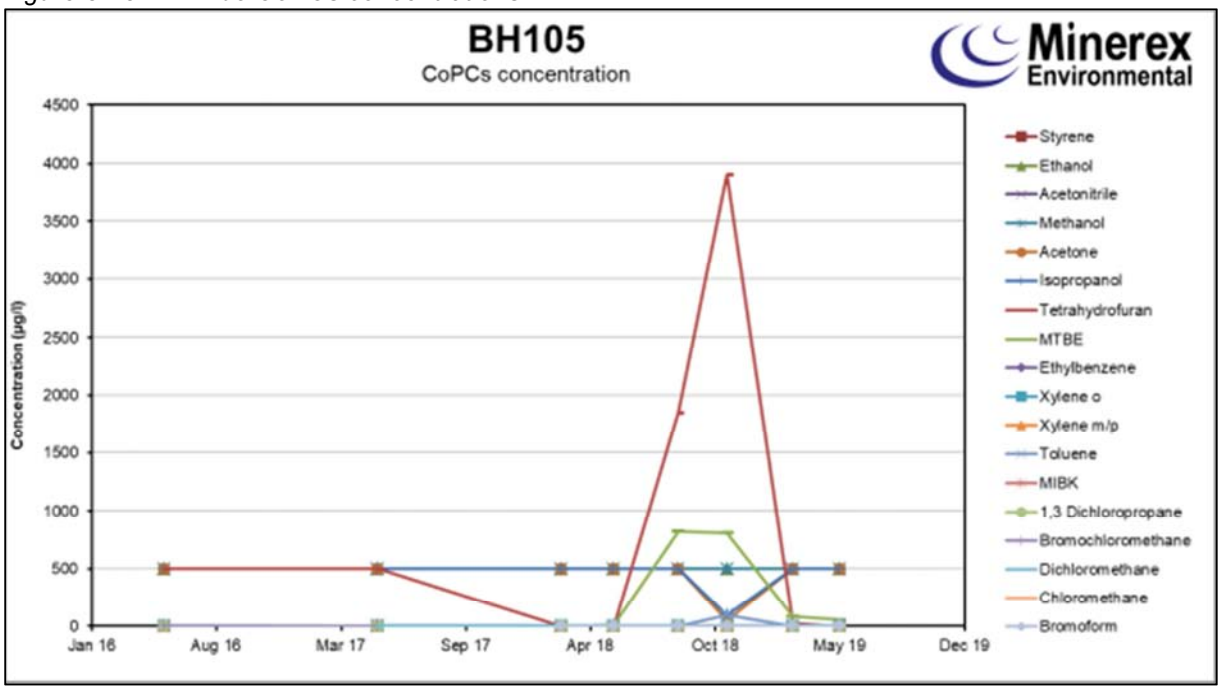
No CoPCs were detected above LOD in AMW1 (depth: 8.20m, screened in the overburden) in the last 2 years.

Figure 3.17 – AMW6 CoPCs concentrations



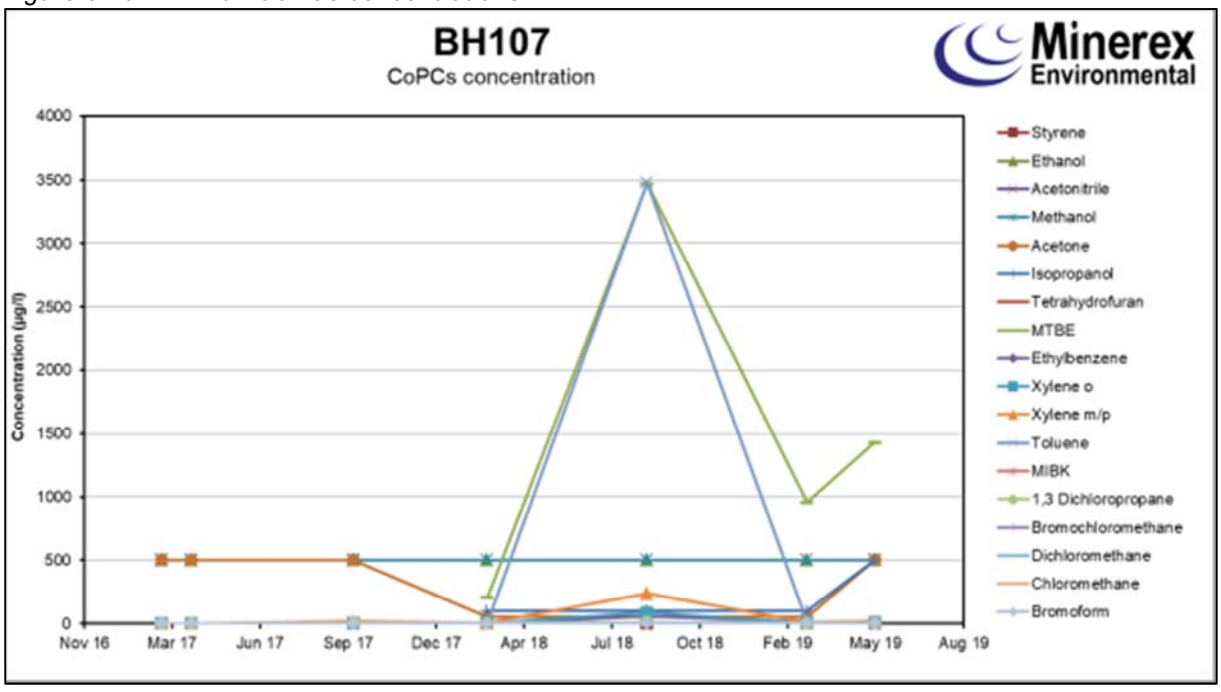
MTBE shows an upward trend in AMW6 (depth 23.73m, screened in bedrock) in the last year, the rest of the CoPCs are below LOD.

Figure 3.18 – BH105 CoPCs concentrations



Well BH105 (depth: 7.78m, screened in bedrock) has no record of the presence of any CoPC between May 2016 and May 2018. THF, MTBE, o-Xylene and 1,3-Dichloropropane were detected in 2018 and peaked in between May and November 2018. Concentrations of all the detected CoPCs have decreased since then and in May 2019 only MTBE was above LOD.

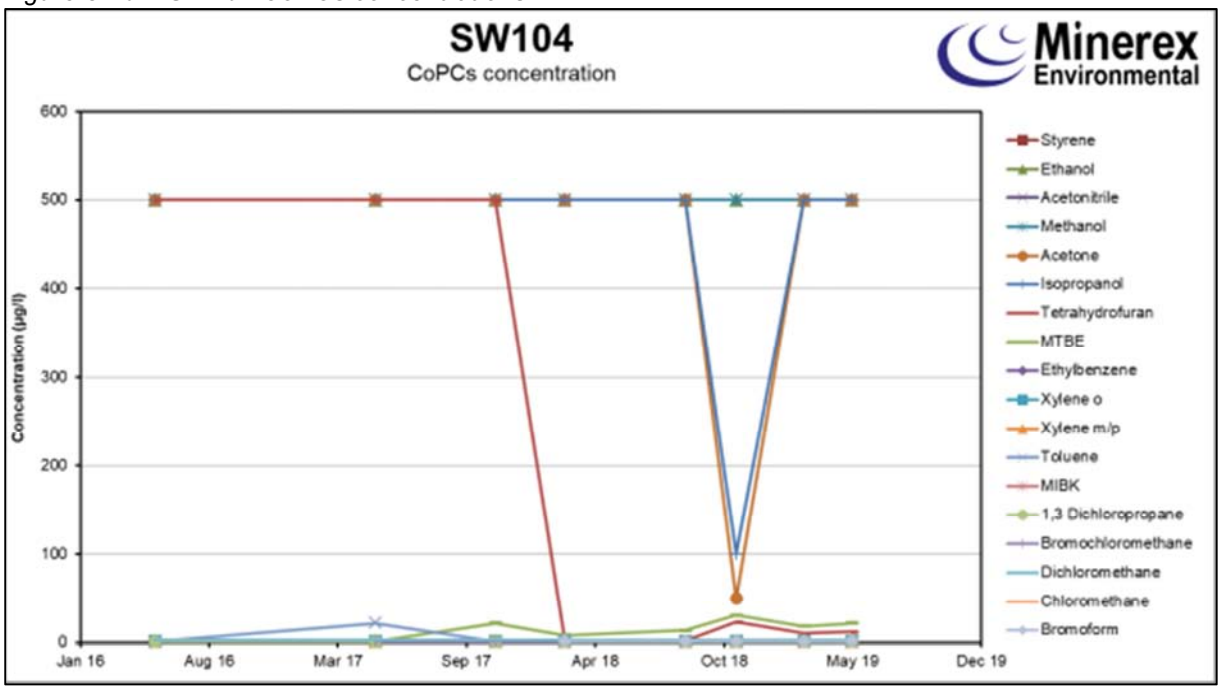
Figure 3.19 – BH107 CoPCs concentrations



BH107 (depth: 7.62m, screened in overburden and weathered bedrock) has no records of presence of any CoPC between October 2011 and March 2017. In October 2017 o-Xylene and m/p-Xylene were detected, MTBE was detected in February 2018 and by August 2018 concentration in CoPCs peaked when MTBE, Ethylbenzene, o-Xylene, m/p-Xylene, Toluene and 1,3-Dichloropropane were detected (THF was analysed for first time on May 2019). Since then concentration in all the CoPCs detected has been decreasing and in May 2019

Ethylbenzene and Toluene were below LOD.

Figure 3.20 – SW104 CoPCs concentrations



SW104 (surface water, Monksland Stream) recorded the presence of MTBE since May 2017 and THF since November 2017. Concentrations peaked in November 2018 and remain stable or are decreasing since then.

3.3.4. EFFLUENT CHEMISTRY:

Figure 3.21 – Effluent CoPCs concentrations

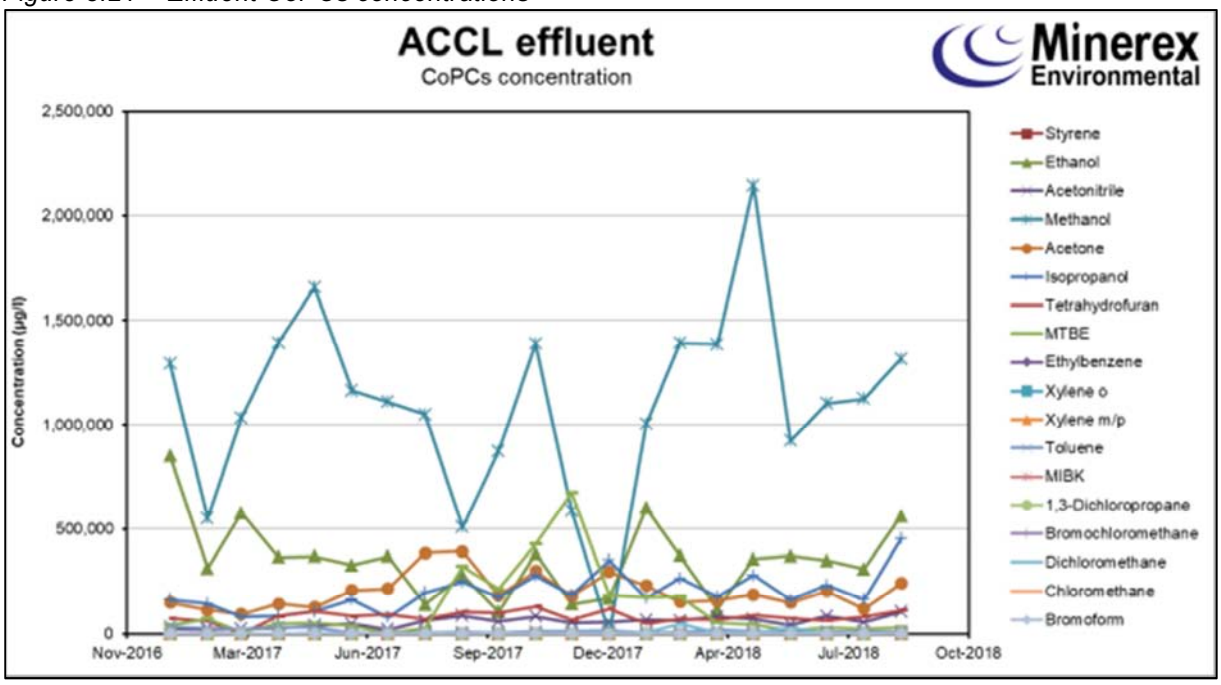


Figure 3.21 above shows the pre-pumping CoPCs concentrations. It is noted that some CoPCs are found in the groundwater at significantly higher concentrations than in the Effluent; this is summarized in the table 3.1.

Table 3.1 – CoPCs with higher concentration in the groundwater than in the Effluent					
Substance	Well	2018-2019 **Maximum** concentration in **well** (µg/l)	2018-2019 **Average** concentration in **well** (µg/l)	2017-2018 **Maximum** concentration in **effluent** (µg/l)	2017-2018 **Average** concentration in **effluent** (µg/l)
Ethylbenzene	AMW 3	357	232	29	10
	AMW 5	44800	7,522		
	AMW 11	175	111		
	BH 107	59	30		
o-Xylene	AMW 3	386	235	75	21
	AMW 5	56900	10,396		
	AMW 11	290	193		
	BH 107	88	44		
m/p-Xylene	AMW 3	1290	890	101	32
	AMW 5	646	269		
	AMW 11	824	467		
	BH 107	237	119		
1,3-Dichloropropane	AMW 3	187	116	58	17
	AMW 5	36	25		
	AMW 11	53	37		
MIBK	AMW 3	1240	805	0.1	0.1
	AMW 11	7990	3523		

Figures 3.22 and 3.23 illustrate the significantly higher content of o-Xylene and Ethylbenzene in AMW 11 and AMW 3 than in the effluent.

Figure 3.22 – Concentration of o-Xylene in the Effluent, in AMW 3 and in AMW 11.

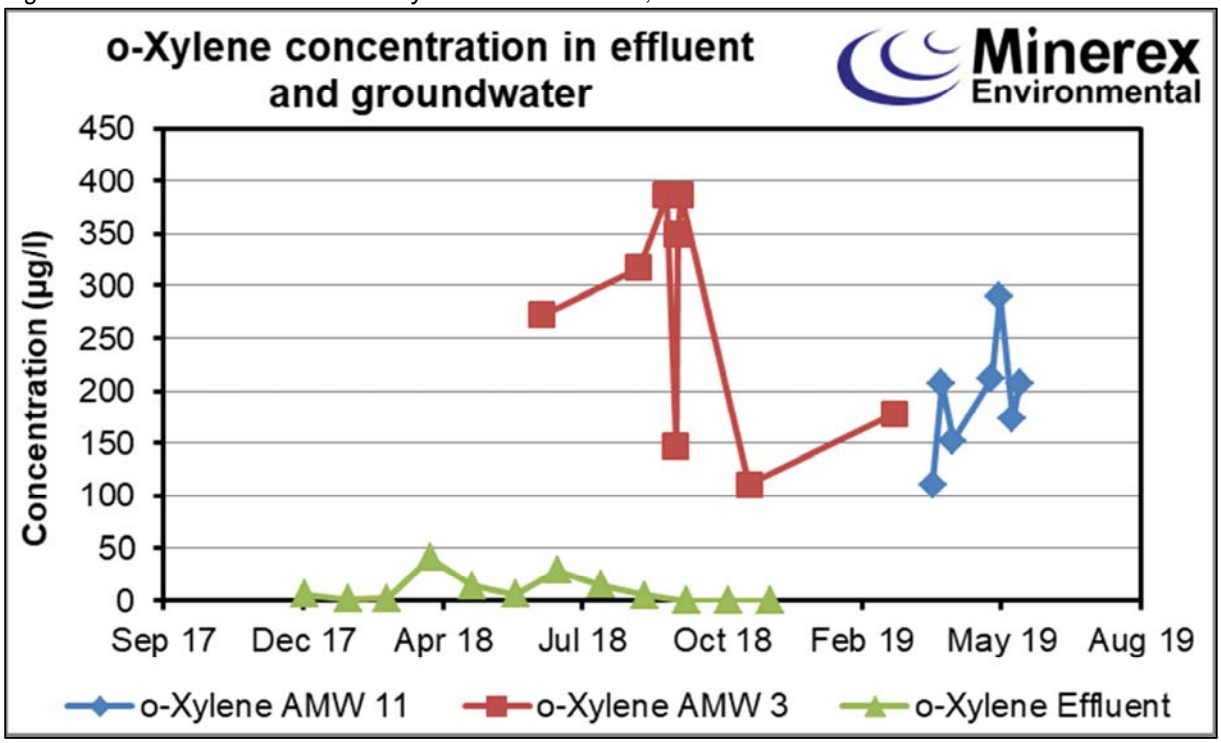
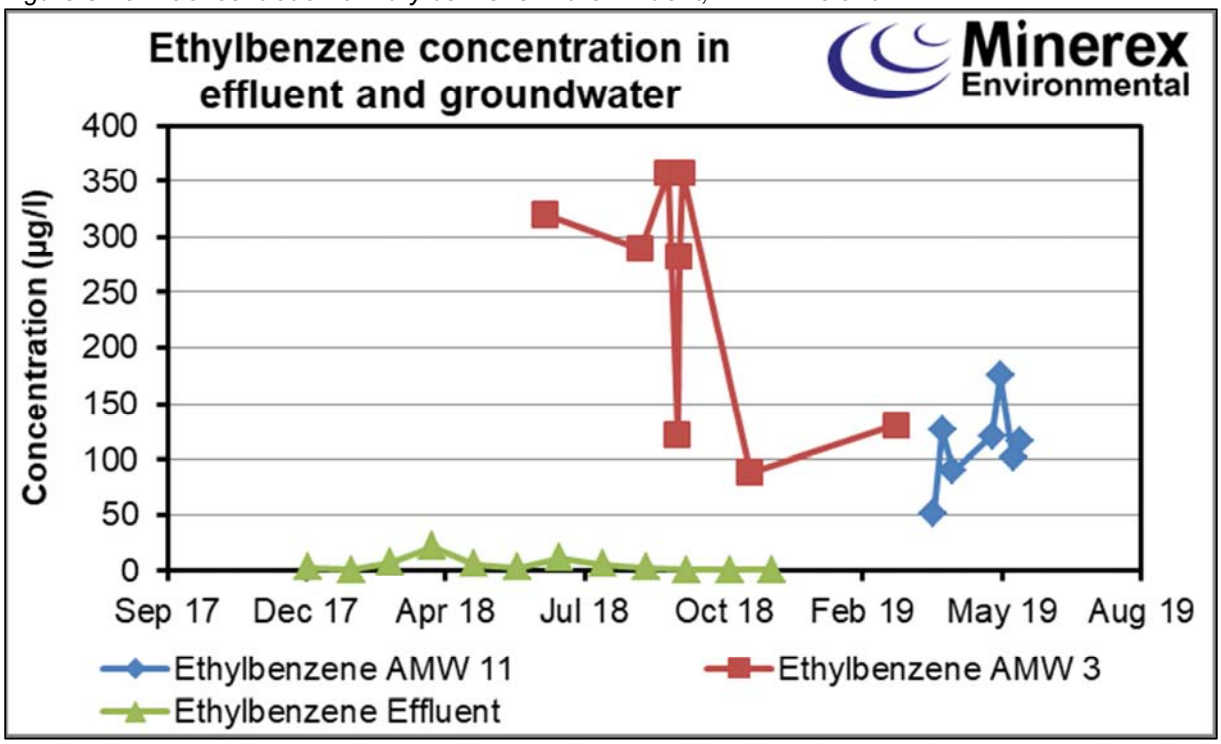
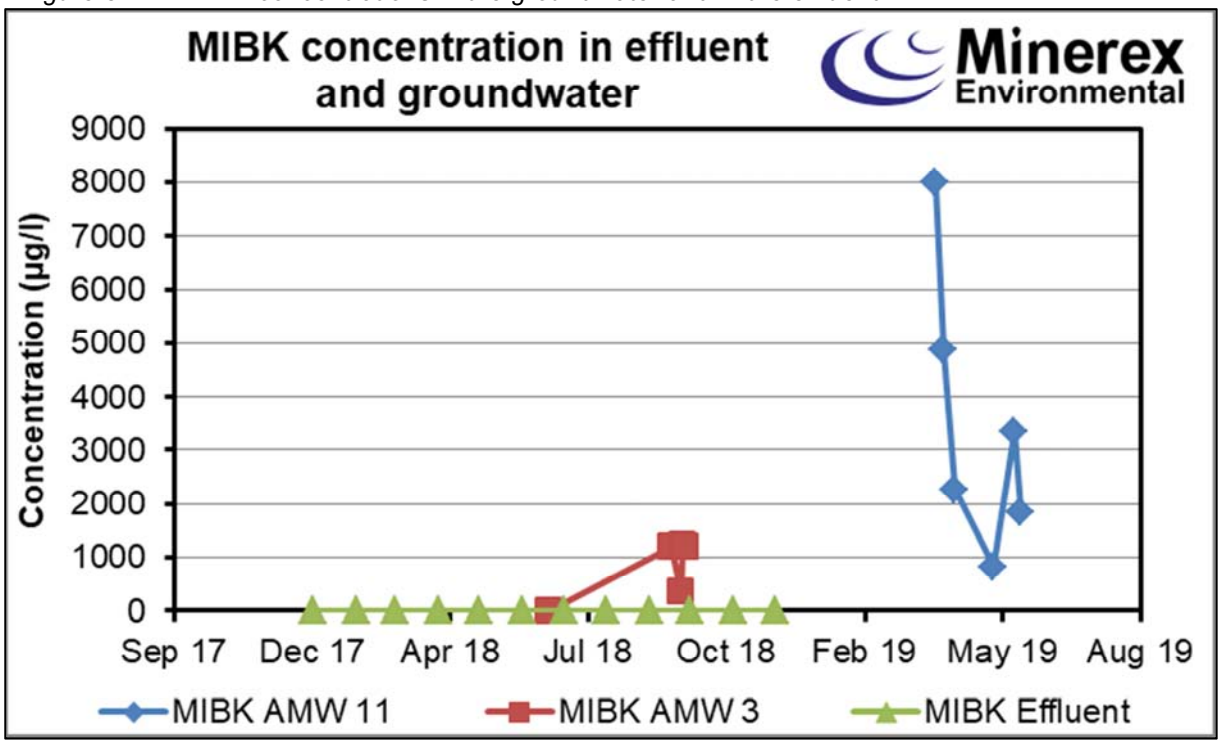


Figure 3.23 – Concentration of Ethylbenzene in the Effluent, in AMW 3 and in AMW 11.



Special attention is paid to MIBK, whose concentration in the effluent is below LOD while it is found at significant concentrations in AMW 3 and AMW 11. Figure 3.24 below illustrates this.

Figure 3.24 – MIBK concentrations in the groundwater and in the effluent.



4. VERIFICATION

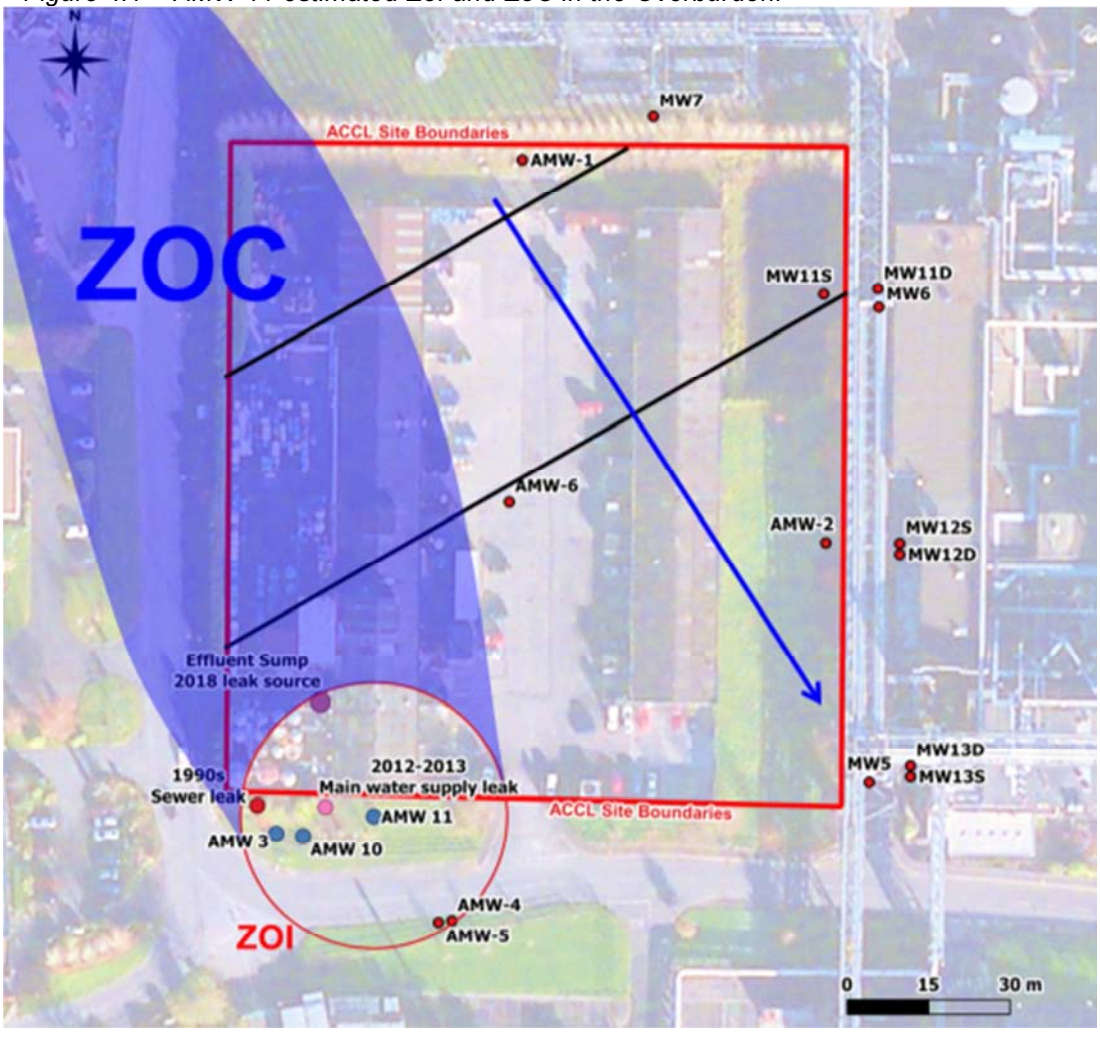
4.1. WELLS LOCATED IN CLOSE PROXIMITY TO ACCL FACILITIES AND THE EFFLUENT SUMP WHERE THE KNOWN 2018 LEAK WAS IDENTIFIED:

The hydrochemistry of the wells located in the area historically related with the plume of contamination occurred in the 1990s and located closer to the area where the known 2018 leak occurred (AMW 3, AMW 4, AMW 5 and AMW 11) show variable trends:

1. AMW3 and AMW11 show a decrease in the concentration of all the CoPCs since the pumping started.
2. AMW4 shows a stable long-term trend in THF (the other CoPCs analysed are below LOD) and any clear variation in this has been detected since the pumping started.
3. In AMW 5, concentrations in most of the contaminants decreased from the November 2018 peak values since pumping started; however THF seems to continue with the long term increase and o-Xylene and Ethylbenzene peaked in May 2019 with concentrations above ACCL effluent concentrations.

AMW11 is capturing groundwater in a radius estimated to be at least 15m from the well as there is influence in AMW3 (Figure 4.1 below) (the influence in AMW4 and 5 is currently unknown, see recommendations), but it is thought that the zone of influence does not cover all the south side of ACCL facilities and therefore, in the event any source of contaminants still exists at ACCL, those could be flowing southwards through the south-eastern side of the site.

Figure 4.1 – AMW 11 estimated ZoI and ZoC in the Overburden.



Based on the decreasing trend in most of the CoPCs in AMW 3 and 5 (overburden), it is thought that AMW11 pumping is capturing most of the contaminants leaked during 2018 in the area close to where the leak occurred. The presence of o-Xylene and Ethylbenzene at concentrations well above the Effluent concentrations points towards an off-site leak and / or historical leak both unrelated with the effluent, i.e. a petrol or diesel spill, MIBK and 1,3-Dichloropropane at the surface or below ground, but this has not been reported up to date.

AMW 4 (bedrock) show long-term stable trends and concentrations which do not seem to have been affected by pumping. Minerex considers 2 possible reasons for that:

1. Zone of Influence of current remedial pumping does not reach AMW4 and contaminants are not attenuating nor diluting over the years.
2. An active source of these contaminants still exists.

4.2. WELLS LOCATED UPSTREAM THE EFFLUENT SUMP AND DOWNSTREAM OR WITHIN THE ACCL SITE.

AMW2 (overburden) is located downstream of ACCL manufacturing and labs area and AMW 6 (bedrock) is located downstream the offices and lab areas but in close proximity to the manufacturing area. Due to exceptionally dry weather conditions last year, these wells were positioned downstream of the Effluent Sump and this was thought to be the reason for the CoPCs rise recorded in the wells. Based on current piezometry, AMW 2 and AMW 6 are now located upstream of the effluent sump where the known 2018 leak (plume 4) occurred. Please see summary below.

1. AMW 2: While the analysis carried out on the sample taken on November 2018 at AMW2 detected the presence of several CoPCs (THF, Toluene, MTBE, Acetone and Isopropanol) in the groundwater, the last analysis carried out on the sample taken on May 2019 shows the concentrations of these are below LOD. It is noted that certain analysis are carried out with an LOD of 500 µg/l which is unacceptably high (see recommendations). Figures 3.9 and 3.14 illustrate this.
2. AMW 6: Analysis carried out on samples taken from AMW6 show the presence of MTBE in the groundwater from August 2018 and the trend is upwards.

It is thought that the natural dilution and dispersion was successful in reducing CoPCs concentrations in AMW2; however the persistence and increasing trend of MTBE in AMW6 points towards either:

1. Zone of Influence of current remedial pumping does not reach AMW 6 and contaminants are not attenuating nor diluting over the years.
2. An active source of these contaminants still exists. It is thought, based on the groundwater piezometry for the bedrock, that such a source would be located in a north-east direction from AMW 6 but due to the proximity of ACCL manufacturing area it is not discarded the MTBE could be sourced on-site.
3. Remnant contamination of Plume 4, from when the wells were located downstream the effluent sump.

4.3. WELLS LOCATED UPSTREAM THE ACCL FACILITIES.

Analysis carried out on samples taken from AMW1 (overburden), located upstream ACCL facilities, show all the CoPCs are below LOD. Figure 3.13 illustrates this.

4.4. OTHER WELLS LOCATED AT THE SOUT FROM ACCL FACILITIES.

4.4.1. AMW 7, AMW 8 AND AMW 9

AMW 7, 8 and 9 are a group of wells located in close proximity to each other and within 85 m

downstream ACCL facilities; while AMW7 and 9 are screened in the Bedrock, AMW8 is screened in the overburden and the bedrock. Please see summary below.

1. AMW 7 and AMW 9 show the presence of THF and MTBE. Concentrations are decreasing in both wells with the exception of MTBE in AMW7, that is following a slowly increasing trend.
2. AMW 8 shows an increasing trend for MTBE and THF since May 2018. DCM presence, detected in May 2018, returned to below LOD by February 2019.

Based on distance and piezometry, it is concluded that the remedial pumping would have no influence on these wells, that is, outside of Zone of Influence (ZoI).

Concentrations in AMW 8 are higher than in AMW 7 and 9. This could be explained by the fact that the source of contaminants is or has been located in the overburden and the migration path towards the bedrock could be AMW 8 itself (as it is screened in both the overburden and the weathered bedrock, effectively connecting hydraulically both layers).

Based on that, the persistence and increasing trend for THF and MTBE is thought to be related to either:

1. Remnants from Plume 4 migrating towards these wells in favour of hydraulic gradient.
2. An active source of THF and MTBE upstream of AMW 8 but the location of a source remains unclear.

4.4.2. BH 105 AND BH 107

BH105 and BH107 are wells located within 250m and 200m downstream ACCL facilities respectively. Both wells recorded a peak in the concentration of certain CoPCs (THF and MTBE in BH105 and MTBE and Toluene in BH107) during 2018 (due to Plume 4, Ref.2). Concentration of the detected CoPCs in BH105 and BH107 have decreased significantly (for BH105, THF was in May 2019 below LOD while MTBE decreased from 826 µg/l in August 2018 to 57.4 in May 2019; for BH107, all CoPCs have at least halved from peak values of 2018). Figures 3.15 and 3.16 illustrate this.

It is thought that this decreasing trend of CoPCs concentration is due to natural influences such as attenuation and dilution, as a result of natural groundwater flow. It is thought that this trend will continue over time until contaminants are completely dissipated.

4.5. MONKSLAND STREAM: SW 104

The presence of MTBE in the Monksland Stream is noted since November 2017 with values between 7 and 30 µg/l approximately and these have remained broadly stable over the sampling events since.

THF has been detected since February 2018 with values between 2 to 15µg/l approximately and have remained broadly stable over the sampling events since.

It is noted that MTBE started to be detected in SW104 in November 2017 and THF in February 2018. It is thought that Plume 4 source was active from February 2018 until August 2018 (Ref.2). Based on that, the persistence and increasing trend for THF and MTBE is thought to be related to either:

1. Remnant contaminants from Plume 4 reaching the stream.
2. Additional source for THF and MTBE exists upstream SW 104 apart from plume 4.
3. Both of the above.

4.6. SUMMARY

1. ZOI AND ZOC OF REMEDIAL WELL:

   It is thought Zone of Influence (ZoI) (area affected by drawdown) of the remedial well currently possesses a radius of 15m approximately (assuming circular shape) and the Zone of Contribution (ZoC) in the overburden is thought to include the ACCL manufacturing area on the western side the site (see figure 4.1). Consideration should be given to extending the ZoI to cover all the south side of ACCL site and avoid any potential contaminant to migrate downstream the site. The entire ACCL site would then be inside the ZoC.

2. REMEDIAL PUMPING EFFICIENCY:

   Concentrations of CoPCs in the wells in close proximity to the source of the known 2018 leak (Plume 4), AMW3 and AMW11, show a decreasing trend for the majority of CoPCs detected since remedial pumping started. Also, most of the wells downstream the remedial well (i.e. BH 105, BH 107, AMW 5) show a decreasing trend in the concentration of CoPCs since the pumping started.

   Therefore it is considered that the pumping is helping to reduce the concentration of contaminants from the ground and blocking the migration of new contaminants that could be sourced at ACCL facilities along most part of the southern limit of the site.

3. POSSIBLE UNIDENTIFIED LEAK WITHIN ACCL:

   The conductivity of groundwater in AMW11 rebounds when pumping has to stop because the eluent volume has been reached during heavy rain events. Also, some of the CoPCs detected in AMW11 do not seem to be reducing in concentration (i.e. THF, Toluene, MTBE, Benzene, Ethylbenzene, Xylenes, Chlorobenzene, DCM and 1,3-Dichloropropane).

   Some CoPCs show an increasing trend in AMW 8 (MTBE and THF), although the source for these remain unclear and it is possible they are migrating off site to the south east.

   Based on that it is thought that an unidentified leak in the ACCL effluent drainage system could exist.

4. POSSIBLE OFF-SITE SOURCE OF CONTAMINATION:

   Concentration of certain CoPCs is, in some of the wells (i.e. AMW 5 and AMW 11 and others), greater than the effluent concentrations.

   MIBK is found in the groundwater but not in the effluent.

   Concentration of certain CoPCs is rising in some of the wells (i.e. AMW 6, AMW 4) that are, based on the piezometry, not downstream of the ACCL manufacturing area.

   Based on that it is suspected that an off-site source of contamination exists or historically existed.

5. LIKELY EXTENT OF PLUME 4

   Based on the decreasing CoPCs concentrations found in most part of the monitoring wells, it is thought that Plume 4 concentration is decreasing with time. However it is understood that the Plume may have extended its area under the influence of groundwater transport: advection, dispersion and diffusion.

5. CONCLUSIONS

1. **RECHARGE OVER 1990S LEAK IS NOT THE CAUSE OF THE CURRENT CONTAMINATION (PLUME 4)** – The simulated rain test carried out in the grass

area close to where the first plume occurred did not increase the conductivity/contaminants concentration in the AMW3 well. Details and results of these tests were included in the 2018 Hydrogeological Report (Ref.2) and the extract from this report concerning the simulated rain test is shown in Appendix F. Rain percolating through the soil and entraining residual contaminants in the groundwater is not likely to be the cause of the peaks in CoPCs experienced during 2018. Rather it is possible, that despite integrity tests to date, rain falling on the urbanised area of the site could be flowing through unidentified leaks in the ACCL drainage system.

2. **EFFLUENT SUMP INTEGRITY TESTING –** The origin of this leak was most likely an effluent sump that had some remedial repairs performed in August of 2018, but the leak was not evident at the time of the inspection, and was fixed at the time. This would explain the increase in the concentrations of CoPCs in the groundwater during 2018. Since then a new stainless steel sump has been installed in April 2019.
3. **REMEDIATION STRATEGY –** A remediation strategy was put in place consisting of pumping water from the ground while monitoring the conductivity, flow rate and water levels continuously, and taking regular samples to determine the water quality variations with time. AMW3 was poorly productive. AMW10 was drilled to refusal and showed poor yield also. AMW11 (primary current remediation well) was drilled several metres into rock and yield is greater than 1 l/s. ACCL has been pumping from it since 23/5/19.
4. **RESPONSE TO REMEDIATION –** The conductivity in the remediation well decreases while pumping is ongoing (approximately 2200µS/cm), but rises to pre-pumping values (over 3000 µS/cm) rapidly after pumping ceases. Therefore it is possible that a still unknown leak exists in the ACCL effluent drainage system. However, concentrations of some of the contaminants in the groundwater (MIBK, Xylenes, Benzene, Ethylbenzene, Chlorobenzene and 1,3-Dichloropropane) are higher in the groundwater than they are in the 2017 and 2018 effluent (MIBK is not present in the effluent) therefore it is possible that an off-site source of CoPCs could also exist.
5. **ZONE OF INFLUENCE –** After several attempts of pumping from different wells and with different pumps, a ZoI (effectively cone of depression) was developed sufficiently large enough in May 2019 to extend to AMW3 and probably the effluent sump, where there was a known leak.
6. **SIZE OF PLUME 4 –** It is thought that Plume 4 covers now a bigger area and CoPCs will be less concentrated as a result of transport (advection, dispersion and diffusion).

6. RECOMMENDATIONS:

1. **TRACER TESTING OF SUMPS AND DRAINAGE SYSTEM -** Other leaks could exist in the ACCL effluent drainage system. Therefore tracer tests are recommended to be carried out in the ACCL drainage system to confirm if any leak still exists.
2. **REMEDIAL PUMPING RATE INCREASE -** It is recommended to increase the pumping rate to the WWTP from the remediation well to allow a bigger ZoI (cone of depression) to develop. The objective is to pump at such a rate to ensure that all of the manufacturing area is within the ZoC. This would prevent the migration southwards of any contaminant sourced at ACCL.
3. **CONTINUOUS WATER LEVEL MONITORING -** It is recommended to install a water level logger in AMW1, 2, 4, 5 & 6 to monitor water level variations and

evaluate the influence that the pumping from the remediation well has on it to further delineate the ZoI and ZoC.

4. **WATER LEVELS IN THE MONKSLAND SPRING -** It is recommended to include Monksland Stream Spring in the monitoring events and take readings of the water levels (hydrochemistry samples are taken by Alkermes for lab analysis). Also it is recommended that the elevation above ordnance datum of the V notch weir is obtained.
5. **REDUCE LABORATORY LIMITS OF DETECTION -** It is recommended that the LODs of the laboratory analyses are always below the EQS (environmental quality standards).
6. **CONTINUE ASSESSING PERFORMANCE OF REMEDIATION SYSTEM –** Make changes to the pumping rate, consider pumping from other wells, installing new sensors and setup and on-site treatment system together with recharging to ground the treated water.

oo0oo

Respectfully submitted

On behalf of **Minerex Environmental**

APPENDIX A

Arran Chemical Company Limited
Groundwater monitoring well installation

Geology & Monitoring Well Design
Well No. AMW 1

Summary Geology

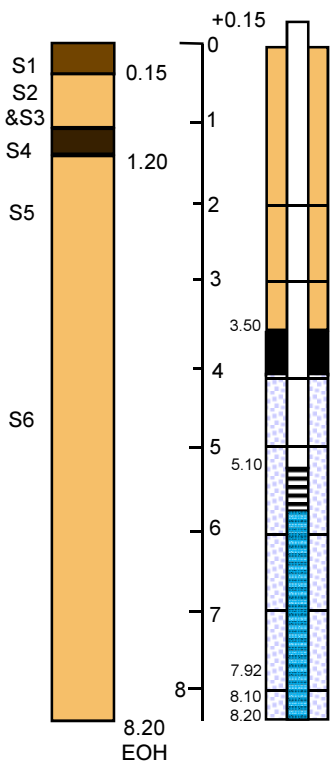
(meters below ground level)

Top soil, dark brown in colour
Sand, fine to med. grained, light to med brown, sorted, occasional rounded lst & sst pebbles and boulders
Clayey silt, dark brown in colour with limestone pebbles & boulders

Sand, fine to medium grained, med brown to grey colour, sorted, occasional lst & sst pebbles and boulders. Sst appear semi-consolidated and highly porous. Refusal at 8.2m

Suction pump used to purge well before installing screen and casing - 30l/minute for 35 minutes - volume removed ~1050l -water still mod. brown with minor sand - dynamic water level 6.6mbgl and static water level 5.95 mbgl - yield of 43m3/day for 0.65m drawdown but only tested over 35 minutes

Monitoring well design



Top of casing (reference) is 45.647maOD (Data from Elan - URS survey 01/09/11)

Well drilled 8" nominal diameter using shell & auger method.

Piezometer nominal 2" diameter, uPVC

Water Level at 5.80m (AHE,SD 15/02/12)

Thickness of sediment AFTER cleaning = 0.00m at base of well which = 8.20mbgl (AHE,SD 15/02/12)

Notes: (AHE,SD 15/02/12)
- Tree roots growing through slots in screen into the well

Legend

- Compacted backfill (geological material which was removed during drilling)
- bentonite pellets (1 bag ~25kg)
- monitoring well casing with centralisers composed of stainless steel and uPVC, positions of joins indicated by dark line
- nominal 5mm, rounded and washed Limestone gravel pack, acquired from local quarry
- S7 Sediment sample number
- monitoring well screen with centralisers and screw cap on base

Arran Chemical Company Limited
Groundwater monitoring well installation

Geology & Monitoring Well Design
Well No. AMW 2

Summary Geology

(meters below ground level)

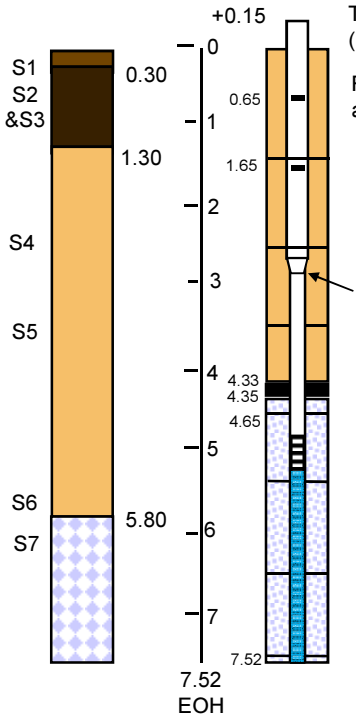
Top soil, dark brown in colour, clayey

Clay, silt & sand lenses, brown at top to grey at bottom

Sands, fine grained, grey to pale yellow in colour, occasional lenses of clay also semi-consolidated & very porous sandstone lenses up to several cm thick

Gravel, 0.1cm to 8cm in diameter, angular to rounded, limestone and sandstone clasts

Monitoring well design



Top of casing (reference) is 45.013maOD (Data from Elan - URS survey 01/09/11)

Reference point (top of casing) is 0.15m above ground level and 47.643maOD

Well drilled 8" nominal diameter using shell & auger method.

Piezometer nominal 2" diameter, uPVC

Piezometer reduced down to 19mm diameter uPVC

Water level at 5.20m (AHE,SD 15/02/12)

Thickness of sediment AFTER cleaning = 0.00m
Base of well = 7.52m
(AHE,SD 15/02/12)

Suction pump used to purge well before installing screen and casing - at least 200g removed via bailer and suction pump, As much sand still making into well at end of purging

Legend

- Compacted backfill (geological material which was removed during drilling)
- bentonite pellets (1 bag ~25kg)
- monitoring well casing with centralisers composed of stainless steel and uPVC, positions of joins indicated by dark line
- nominal 5mm, rounded and washed Limestone gravel pack, acquired from local quarry
- S4 Sediment sample number
- monitoring well screen with centralisers and screw cap on base

Arran Chemical Company Limited
Groundwater monitoring well installation

Geology & Monitoring Well Design
Well No. AMW 3

Summary Geology

(meters below ground level)

Top soil, dark brown in colour, clayey
Clay/silt , pebbly, possibly made ground

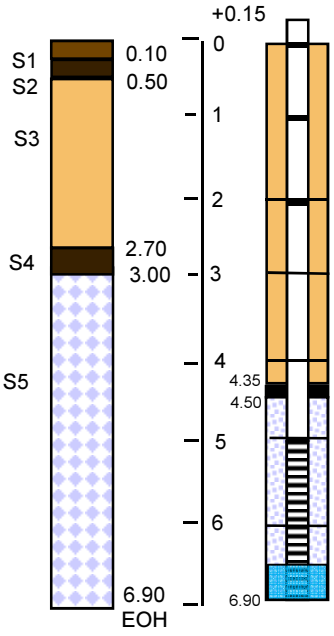
Sand, fine to medium grained, grey to brown in colour, with occasional silt & clay lenses

Clay, with rounded gravels, <4mm in diameter clasts, mostly limestone with occasional sandstone clasts

Gravel, bouldery, limestone clasts 0.20cm to >20cm in diameter, rounded to subangular

On 13/3/97, suction pump used to purge well before installing screen and casing. 15l/minute pumped out for 15 minutes, intake at 6.50mbgl and dynamic water level 6.13 (SWL 5.50mbgl). Yield therefore ~1m3/hr for drawdown of 1m at least over 15 minutes. Water white colour, strong odour and little surface, very little silt at end of purging.

Monitoring well design



Top of casing (reference) is 45.394maOD (Data from Elan - URS survey 01/09/11)

Reference point (top of casing) is 0.15m above ground level and 48.090 maOD

Well drilled 8" nominal diameter using shell & auger method.

Piezometer nominal 2" diameter, uPVC

Water level varies from approx 5 to 6.7mbGL

(CS 9/10/14)

Water level at 6.23 – 0.15 = 6.08mb ground level (ANUA September 2014)

Water level at 6.50m (AHE,SD 15/02/12)
Thickness of sediment AFTER cleaning = 0.00m at base of well which = 6.90mbgl (AHE,SD 15/02/12)

Legend

Compacted backfill (geological material which was removed during drilling)

bentonite pellets (1 bag ~25kg)

monitoring well casing with centralisers composed of stainless steel and uPVC, positions of joins indicated by dark line

nominal 5mm, rounded and washed Limestone gravel pack, acquired from local quarry

S4 Sediment sample number

monitoring well screen with centralisers and screw cap on base

Arran Chemical Company Limited
Groundwater contamination investigation

MEL brief B - Item 3 - Additional groundwater monitoring wells requested by the EPA

AMW4 Geology & Monitoring Well Design

Summary Geology
(meters below ground level)

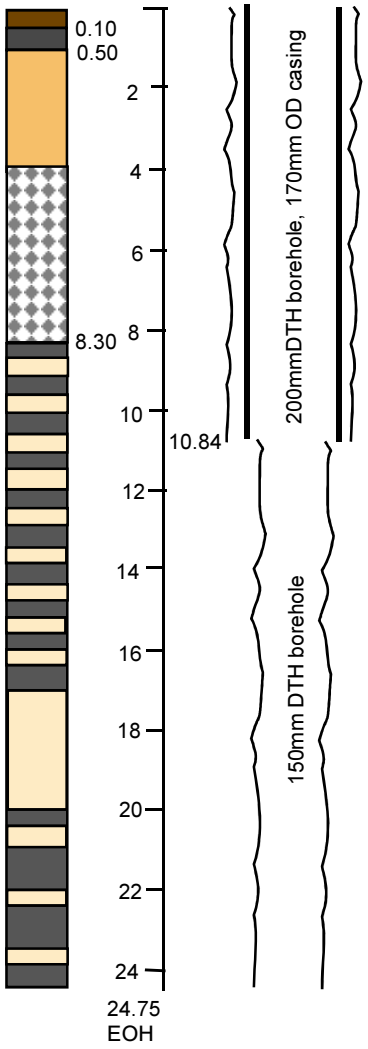
Top soil, dark brown in colour
Aggregate,grey col. made ground

Sand, fine to medium grained, medium brown in colour, rounded cobbles comprise <20% of sample, some clay horizons

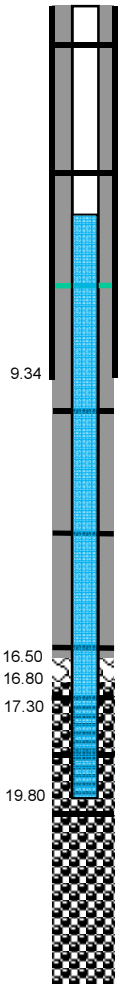
Gravel, with sand, silt, clay and limestone boulders, rounded to subangular, colour dark brown at top and medium grey at base, no clay seen at top of bedrock

Limestone bedrock,bioclastic (crinoids and bryozoa), dark grey and light brown-cream coloured where dolomitised and more weathered. The latter varies from 10-90% of clasts returned and occurs particularly from 17-20m. Weathered clast surfaces common at rockhead.

Well drilling schedule



Monitoring well design



Top of casing (reference) is 44.918maOD (Data from Elan - URS survey 01/09/11)

35mm ID uPVC Piezometer with centralisers every 3m~

1-2mm diameter limestone gravel pack positioned around screen

Water level at 5.17m (AHE,SD 15/02/12)

170mm OD casing had to be grouted into position due to casing withdrawn problem

Pre-purging static water level was 6.23mbgl. During purging of one (1) borehole volume, conductivity was 2100 micro Siemens and when dynamic water level was at 17m, the recovery was 1cm/30 seconds so low groundwater yield. Pie x r2 x h = volume, 1m = 3.14 x 0.075 x 0.075 x 1m = 17l. 17l x0.01m = 0.17l in 30 secs or 0.34l in 1 minute = 489l/day! So bedrock yield (below 10.84m) is much lower that the overburden yield which is several m3/day)

Thickness of sediment AFTER cleaning = 0.00m at base of well which = 19.80mbgl (AHE,SD 15/02/12)

Notes: (AHE,SD 15/02/12)
- End cap may be missing from base of well.

Legend

- OPC cement-bentonite grout
- bentonite pellets (1.5 bags @ ~25kg/bag)
- monitoring well casing with centralisers composed of stainless steel and uPVC
- Nominal1-2mm, rounded and washed limestone gravel pack, acquired from local quarry
- S2 Sediment sample number
- monitoring well screen with centralisers and screw cap at base 1mm slots on screen.

Arran Chemical Company Limited
Groundwater contamination investigation

MEL brief B - Item 3 - Additional groundwater monitoring wells requested by the EPA

AMW5 Geology & Monitoring Well Design

Summary Geology
(meters below ground level)

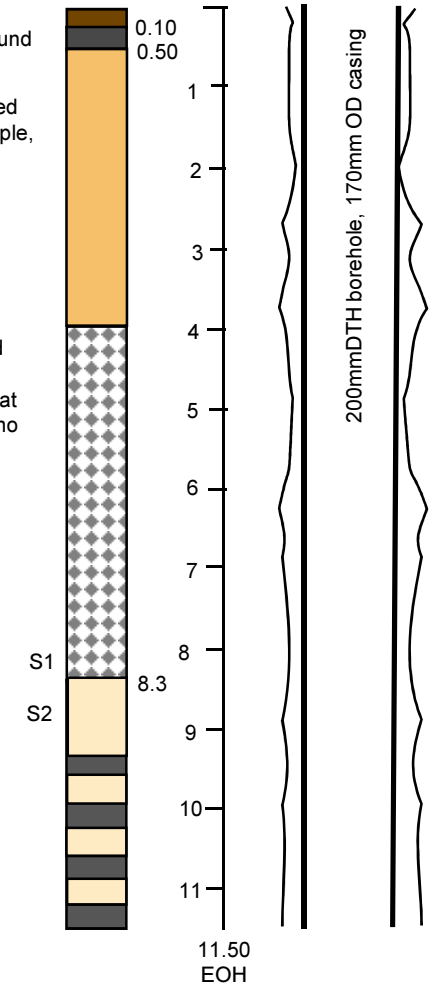
Top soil, dark brown in colour
Aggregate,grey col. made ground

Sand, fine to medium grained, medium brown in colour, rounded cobbles comprise <20% of sample, some clay horizons

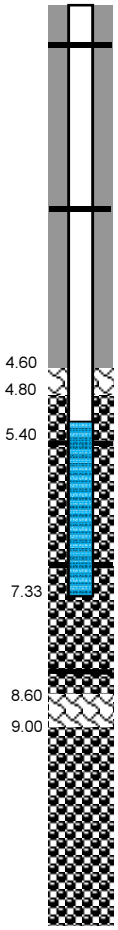
Gravel, with sand, silt, clay and limestone boulders, rounded to subangular, colour dark brown at top and medium grey at base, no clay seen at top of bedrock

Limestone bedrock,bioclastic (crinoids and bryozoa), dark grey and light brown-cream coloured where dolomitised and more weathered. The latter varies from 90-50% of clasts returned and occurs particularly from 8.3-9.3m. Weathered clast surfaces common at rockhead.

Well drilling schedule



Monitoring well design



Top of casing (reference) is 44.933maOD
(Data from Elan - URS survey 01/09/11)

35mm ID uPVC Piezometer with centralisers every 3m~

1-2mm diameter limestone gravel pack positioned at base of hole and around screen. Bentonite seal placed at rockhead.

Water Level at 5.15m (AHE,SD 15/02/12)

Thickness of sediment AFTER cleaning = 0.00m at base of well which = 7.33mbgl (AHE,SD 15/02/12)

Notes: (AHE,SD 15/02/12)
- Gravel pack is present inside well.
- The well casing can move vertically within borehole.
- End cap may be missing from base of well.

Purging for ~30 minutes after installation, removed ~200L (~33 borehole volumes). Water almost clear at end of this period. Conductivity increased from 1400-2100 micro Siemens/cm over purging period. Appears to be sustainable yield of ~10m3/d (2200g/d) for dynamic water level at 7m (~1.5m drawdown).

Legend

- OPC cement-bentonite grout
- bentonite pellets (1.5 bags @ ~25kg/bag)
- monitoring well casing with centralisers composed of stainless steel and uPVC
- Nominal1-2mm, rounded and washed limestone gravel pack, acquired from local quarry
- S2 Sediment sample number
- monitoring well screen with centralisers and screw cap at base. 1mm slots on screen

Arran Chemical Company Limited
Groundwater contamination investigation

MEL brief B - Item 3 - Additional groundwater monitoring wells requested by the EPA

AMW6 Geology & Monitoring Well Design

Summary Geology
(meters below ground level)

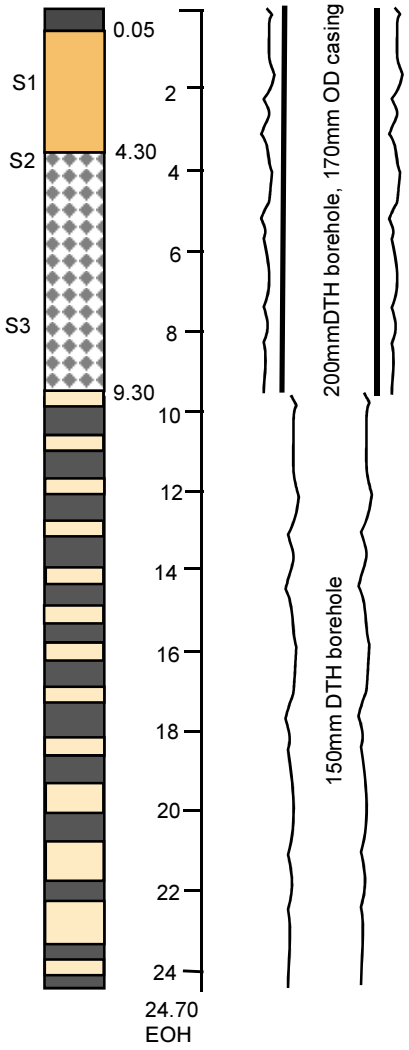
Tarmacadam

Sand, fine to medium grained, medium brown in colour, rounded gravels comprise <10% of sample. Some thin (~1cm thick) silt and clay beds

Gravel, with sand also limestone boulders, rounded to subangular, colour dark brown at top and light grey at base. Minor (cms thick) clay/silt at top of sequence and through out. Grain size increases with depth.

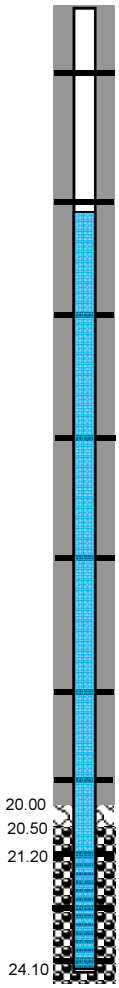
Limestone bedrock, bioclastic (crinoids and bryozoa), dark grey and light brown-cream coloured where dolomitised and more weathered. The latter varies from 10-90% of clasts returned and occurs particularly from 17-20m. Weathered clast surfaces common at rockhead.

Well drilling schedule



Monitoring well design

Top of casing (reference) is 45.061maOD (Data from Elan - URS survey 01/09/11)



51mm ID uPVC Piezometer with centralisers every 3m~

1-2mm diameter limestone gravel pack positioned around screen.

Water Level at 5.25m (AHE,SD 15/02/12)

Conductivity of overburden water during drilling was 825 microSiemens/cm

At end of purging of piezometer conductivity was 849 microSiemens and pH was 7.53. Approximately one borehole volume was removed during purging. When dynamic water level at 19.00, recovery rate was 1cm/18seconds, so low groundwater yield

Thickness of sediment AFTER cleaning = 0.00m at base of well which = 24.10mbgl (AHE,SD 15/02/12)

Legend

- OPC cement-bentonite grout
- bentonite pellets (1.5 bags @ ~25kg/bag)
- monitoring well casing with centralisers composed of stainless steel and uPVC
- Nominal 1-2mm, rounded and washed limestone gravel pack, acquired from local quarry
- S2 Sediment sample number
- monitoring well screen with centralisers and screw cap at base. 1mm slots on screen

Arran Chemical Company Limited
Groundwater contamination investigation

MEL brief B - Item 4 - Groundwater monitoring wells located in Elan Car Park

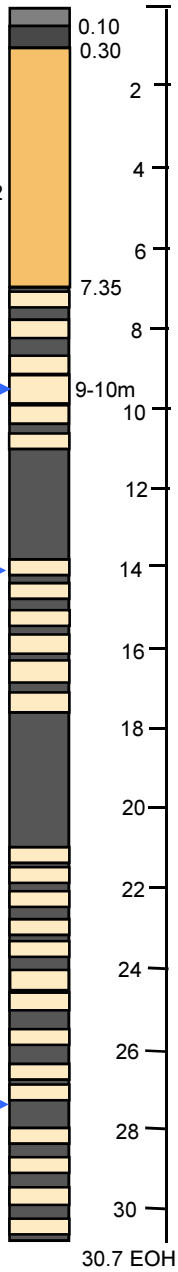
AMW7 Geology & Monitoring Well Design

Summary Geology
(meters below ground level)

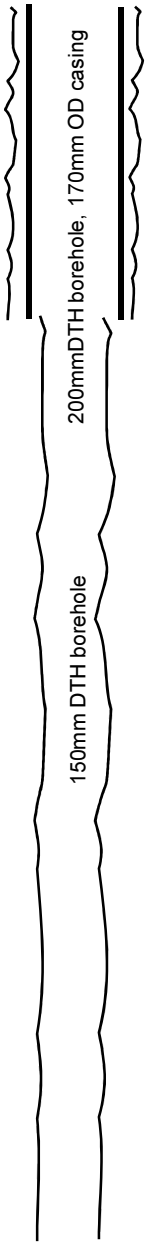
Tarmacadam Aggregate,grey col. made ground

Sand, with silt and clay interbedded. Fine to medium grained, Medium brown in colour, Beds <1cm thick. Sand possible only 50% of sequence. Beach rock occasionally. Cobbles and boulders present at base of sequence.

Limestone bedrock,bioclastic (crinoids and bryozoa), dark grey and light brown-cream coloured where dolomitised and more weathered. Cavities up to 0.15m wide (blue arrow), with water inflows at @ ~9, 14 & 27.4m. Weathered rounded and brecciated fragments returning in water high in suspended solids when cavities encountered.

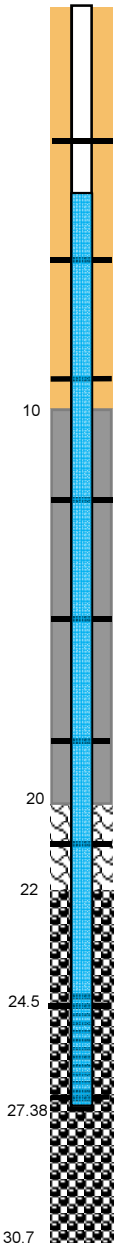


Well drilling schedule



Monitoring well design

Top of casing (reference) is 43.436maOD (Data from Elan - URS survey 01/09/11)



51mm ID uPVC Piezometer with centralisers every 3m~.

1-2mm diameter limestone gravel pack positioned around screen.

Water level at 4.52m (AHE,SD 15/02/12)

Cement-bentonite grout below 10m and ground allowed to collapse above 10m.

Conductivity of water was 860 microS/cm @ 20 degrees celcius after 1 hour airlifting when some suspended solids still in water. Well yield in open hole (~8-30.7m) was ~ 4000g/hr (~432m3/d). Conductivity value is considered average over all the inflow zones.

Post-well completion purging of 1 borehole volume yielded stable conductivity value of 726 microSiemens/cm @ 20 degrees celcius from open hole interval 22 to 30.7m.

Thickness of sediment AFTER cleaning = 0.00m at base of well which = 27.38mbgl (AHE,SD 15/02/12)

Legend

- bentonite pellets (1.5 bags @ ~25kg/bag)
- OPC cement-bentonite grout
- Nominal1-2mm, rounded and washed limestone gravel pack, acquired from local quarry
- Monitoring well casing with centralisers composed of stainless steel and uPVC
- Monitoring well screen with centralisers and screw cap at base 1mm slots on screen.

Arran Chemical Company Limited
Groundwater contamination investigation

MEL brief B - Item 4 - Groundwater monitoring wells located in Elan Car Park

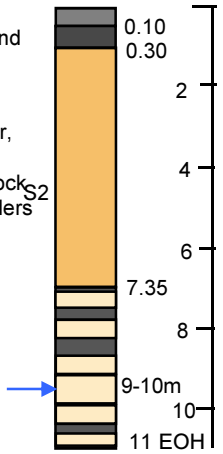
AMW8 Geology & Monitoring Well Design

Summary Geology
(meters below ground level)

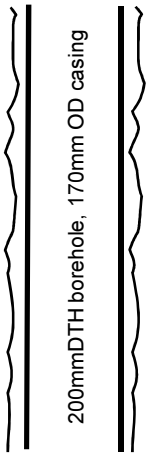
Tarmacadam Aggregate,grey col. made ground

Sand, with silt and clay interbedded. Fine to medium grained, Medium brown in colour, Beds <1cm thick. Sand possible only 50% of sequence. Beach rock occasionally. Cobbles and boulders present at base of sequence.

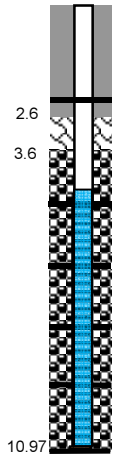
Limestone bedrock,bioclastic (crinoids and bryozoa), dark grey and light brown-cream coloured where dolomitised and more weathered. Cavities up to 0.15m wide (blue arrow), with water inflow at @ ~9m. Weathered rounded and brecciated fragments returning in water high in suspended solids when cavities encountered.



Well drilling schedule



Monitoring well design



Top of casing (reference) is 43.500maOD (Data from Elan - URS survey 01/09/11)

51mm ID uPVC Piezometer with centralisers every 3m~.

1-2mm diameter limestone gravel pack positioned around screen.

Water Level at 4.54m (AHE,SD 15/02/12)

Located 8m south of AMW7 in fourth car parking space.

Post-well completion purging showed a well yield of ~440g/hr (~48m3/d) over interval 3.6-11m.

Thickness of sediment AFTER cleaning = 0.00m at base of well which = 10.97mbgl (AHE,SD 15/02/12)

Post-well completion purging of several borehole volumes to remove suspended solids prior to water sampling yielded stable conductivity value of 936 microSiemens/cm @ 20 degrees celcius from open hole interval 3.6-11m.

Legend

bentonite pellets (1.5 bags @ ~25kg/bag)

OPC cement-bentonite grout

Nominal1-2mm, rounded and washed limestone gravel pack, acquired from local quarry

monitoring well casing with centralisers composed of stainless steel and uPVC

monitoring well screen with centralisers and screw cap at base 1mm slots on screen.

Arran Chemical Company Limited
Groundwater contamination investigation

MEL brief B - Item 5 - Drilling of bedrock well AMW9

AMW9 Geology & Monitoring Well Design

Summary Geology

(meters below ground level)

Tarmacadam
Aggregate, grey col. made ground

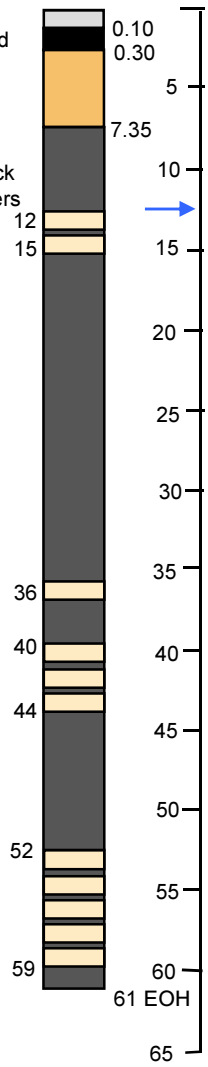
Sand, with silt and clay interbedded. Fine to medium grained, Medium brown in colour, Beds <1cm thick. Sand possible only 50% of sequence. Beach rock occasionally. Cobbles and boulders present at base of sequence.

Limestone bedrock, bioclastic (crinoids and bryozoa), dark grey and light brown-cream coloured where dolomitised and more weathered. Cavities up to 0.15m wide (blue arrow), recorded at only water inflow at ~12.5m. Weathered rounded and brecciated fragments returning in orange-brown coloured airlifted water rich in suspended solids when cavity encountered at ~12.5m.

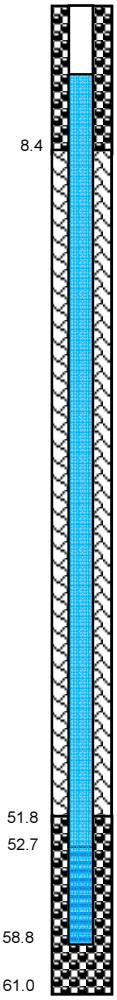
Increased weathering noted from 12-15m, 36m, 40-44m, 52-59m and these zones correspond to orange brown coloured water being airlifted to the surface and an increase in the percentage of dolomitised limestone and calcite in the drill chip logging.

Well drilling schedule

(Drilled by Lenihan Well Drilling)



Monitoring well design



Top of casing (reference) is 43.442maOD (Data from Elan - URS survey 01/09/11)

Water level at 5.45m (AHE,SD 15/02/12)

60mm OD (51mm ID) uPVC Demco piezometer

No centralisers used

1-2mm diameter limestone gravel pack positioned around screen.

Bentonite pellets tremied into position. Gravel pack used in the steel casing.

Yield from a drilled depth of 12.5m was 1782g/hr (194m3/day).

Post-well completion purging of ~16 borehole volumes yielded stable conductivity value of 586 microSiemens/cm @ 20 degrees celcius from open hole interval 51.8 to 61.0m. The water level in AMW9 during purging was 25.66m and a drawdown of 0.17m was observed in AMW7 and 0.02m in AMW8 during the 4.75 hours of purging.

Thickness of sediment AFTER cleaning = 0.00m at base of well which = 58.80mbgl (AHE,SD 15/02/12)

Legend

- Inflow recorded during drilling
- bentonite pellets (1.5 bags @ ~25kg/bag)
- Nominal1-2mm, rounded and washed limestone gravel pack, acquired from local quarry
- Undolomitised reef limestone
- Dolomitised reef limestone associated with increased weathering and the likelihood of increased water makes
- uPVC monitoring well casing
- uPVC monitoring well screen with screw cap at base and 1mm slots on screen.

Borehole/ Trial Pit Design & Completion	Soil (S) / Water (W) / Vapour (V) Sampling					Depth in metres below ground level, also (maODM) & [Thickness]	Geology (graphical log)	INVESTIGATION POINT LOG NUMBER	AMW10					
ELEVATION STILL TO BE DETERMINED	Sample number & interval (mbGL) (Sample 10 kg minimum)	Non-Natural Ground Percentage (see * below)	PID (ppm) Bagged sample (BS); Trial Pit Wall (TPW); Soil Core (SC); BH Arisings (BHA); Trial Pit Clumps (TPC)	Odour strength & description (none, weak, moderate, strong)	Groundwater occurrence (See legend for symbols used for dry, damp and wet)			Client, Project, Location	Arran Chemical Company					
Borehole diameter: → 200mm Screen & Casing ID: → 100 mm Capped : → at top and bottom TOC: 0.2 mbGL	Red line = Single channel sample (from field) Blue line = Composite sample (generated in office or lab) Green line = Grab sample (acquired on site)							Minerex work item						
								Page No.	1 of 2					
								Date & time drilled / formed:	15/01/19					
								Logged by (drawn by) [checked by]:	ZU					
								Drilling / Trial pitting co. & equipment	Shell and auger					
								Minerex Doc. Ref.	1099-186					
								Irish Transverse Mercator (ITM)**						
								Geological description	DOMINANT	NON-DOMINANT	COLOUR	STIFFNESS	LAYER ID, RECOVERY & STONE	NN OR N
		8: <1%		NO					TOPSOIL CLAY	GRAVELS COBBLES	BROWN	SOFT		NN
	SS1			NO		0.5			CLEAN FINE SANDS	CLAY CLUSTERS <1%	LIGHT BROWN	SOFT		NN
				NO		1.0			CLEAN FINE SANDS		BROWN TO GREY	SOFT		N
	SS2			YES Strong Unidentified HC??		1.5			FINE SAND	CLAY CLUSTERS 2%	GREY	SOFT		N
	SS3			YES Strong Unidentified HC??		2.0			SILTY SAND		GREY	SOFT		
	SS4			YES Strong Unidentified HC??		2.5			SANDY GRAVEL	CLAY COBBLES BOULDERS	GREY	SOFT		
						3.0								
						3.5								
						4.0								

* **Non-natural material %s with total % in ( )**

NON-DEGRADABLE % (ND): 1 = **Brick**, 2 = **Concrete**, 3 = **Glass**, 4 = **Ceramic tiles,** 5 = **ACMs** (asbestos containing materials such as roof tiles, piping). 6 = **Blue Bangor slate.**

DEGRADABLE % (D): 7 = **Plastic**, 8 = **Metal**, 9 = **Wood / Organic / Leaves / Twigs / Peat**, 10 = **Ash & Clinker**, 11 = **Charcoal**, 12 = **Tarmacadam**, 13 = **Leather.**

** 1-From hand held GPS, 2-Estimated from goggle maps or 3-Surveyed with theodolite.

Write additional help notes on macropores, mottling etc as space allows

Minerex Environmental

Borehole/ Trial Pit Design & Completion **Reduced levels** Ref. Point = top of uPVC Casing = XX maTBM, Ground level (GL) = XX maTBM	Soil (S) / Water (W) / Vapour (V) Sampling					Depth in metres below ground level, also (maODM) & [Thickness]	Geology (graphical log)	INVESTIGATION POINT LOG NUMBER	AMW10
								Client, Project, Location	Arran Chemical Company
								Minerex work item	
								Page No.	1 of 2
								Date & time drilled / formed:	15/01/19
								Logged by (drawn by) [checked by]:	ZU
								Drilling / Trial pitting co. & equipment	Shell and auger
								Minerex Doc. Ref.	1099-186
								Irish Transverse Mercator (ITM)**	

Sample number & interval (mbGL) *(Sample 10 kg minimum)* **Red line** = Single channel sample (from field) **Blue line** = Composite sample (generated in office or lab) **Green line** = Grab sample (acquired on site)	Non-Natural Ground Percentage (see * below)	PID (ppm) Bagged sample (BS); Trial Pit Wall (TPW); Soil Core (SC); BH Arisings (BHA); Trial Pit Clumps (TPC)	Odour strength & description (none, weak, moderate, strong)	Groundwater occurrence (See legend for symbols used for dry, damp and wet)
SS4				

Geological description

DOMINANT	NON-DOMINANT	COLOUR	STIFFNESS	LAYER ID, RECOVERY & STONE	NN OR N
			VERY STIFF		
EOH – REFUSAL – PROBABLY BEDROCK MET					

4.5
5.0
5.5
6.0
6.5
7.0
7.5
8.0

* **Non-natural material %s with total % in ( )**

NON-DEGRADABLE % (ND): 1 = **Brick**, 2 = **Concrete**, 3 = **Glass**, 4 = **Ceramic tiles,** 5 = **ACMs** (asbestos containing materials such as roof tiles, piping). 6 = **Blue Bangor slate.**

DEGRADABLE % (D): 7 = **Plastic**, 8 = **Metal**, 9 = **Wood / Organic / Leaves / Twigs / Peat**, 10 = **Ash & Clinker**, 11 = **Charcoal**, 12 = **Tarmacadam**, 13 = **Leather.**

**1-From hand held GPS, 2-Estimated from goggle maps or 3-Surveyed with theodolite.

A DOMINANT GEOLOGICAL COMPONENT: Clay, Silt, Sand, Gravel, Cobble, Boulder deposit

B NON-DOMINANT GEOLOGICAL COMPONENT: Clay - Silt - Sand Gravel - Cobble - Boulder

C COLOUR: **- Brown (B)** (LB, MB, DB) **- GREY (G)** (LG, MG, DG) **- Beige (tan) - Olive - Mottled**

D STIFFNESS: VST - V. Soft, ST = Soft, F = Firm, S = Stiff, VS = V. Stiff)

E LAYER ID, RECOVERY & STONE: % recovery, % >10mm stone

F NN or N

F Interpretation

NN = Non-natural ground (fill / made up ground / disturbed natural); N = Natural ground)

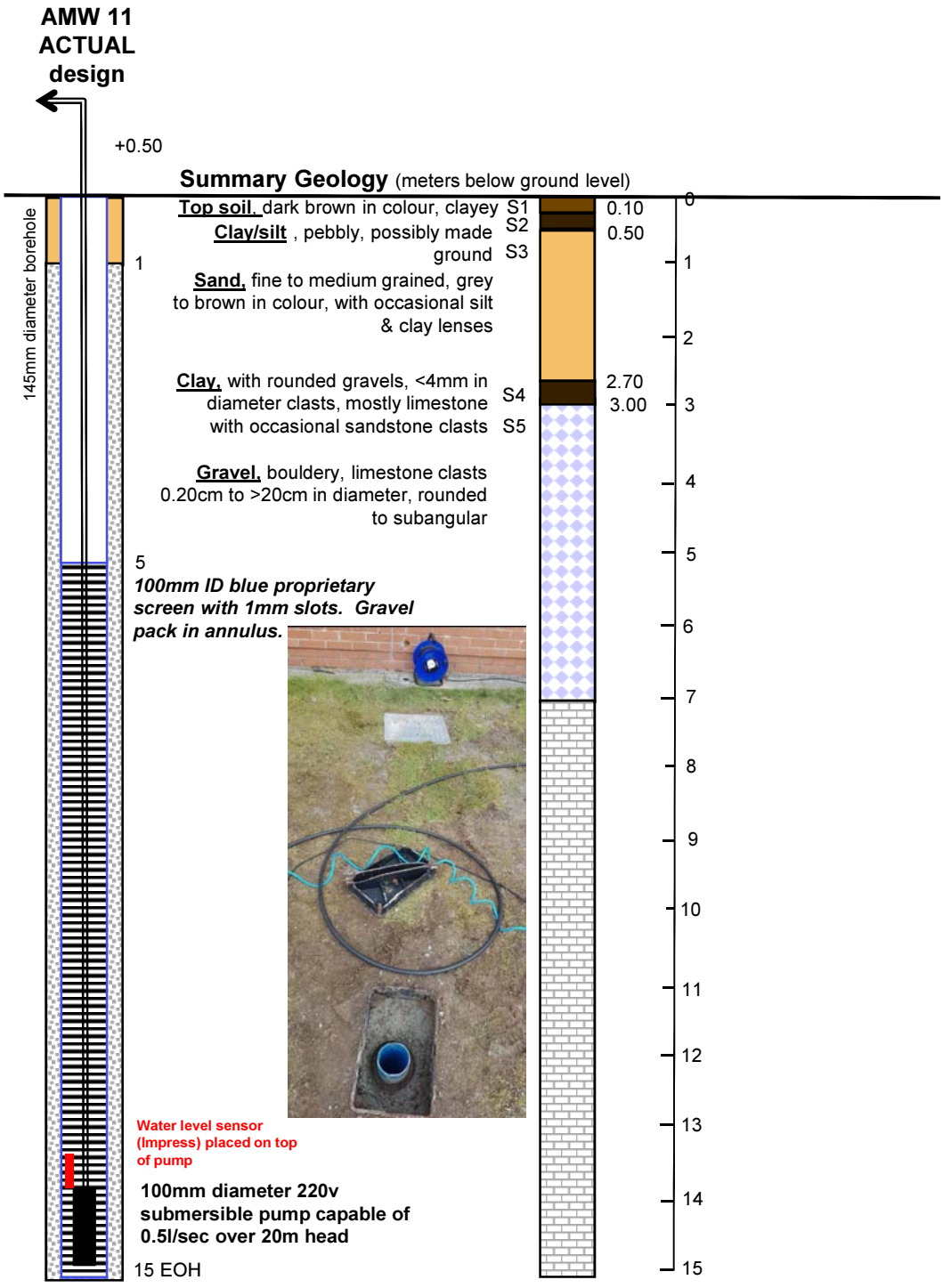
Minerex Environmental

Write additional help notes on macropores, mottling etc as space allows

Arran Chemical Company Limited, Athlone
Groundwater monitoring

Geology & Well Design

AMW 11 pumping wells (close to AMW3)



Legend

- Compacted backfill (geological material which was removed during drilling)
- bentonite pellets (1 bag ~25kg)
- Monitoring well casing with centralisers composed of stainless steel and uPVC, positions of joins indicated by dark line
- nominal 5mm, rounded and washed Limestone gravel pack, acquired from local quarry
- S4 Sediment sample number
- Monitoring well screen with centralisers and screw cap on base

Minerex Environmental

Doc. Ref.: 1099-186 CS & ZU 25/4/19

URS Ireland Ltd.
4th Floor, Iveagh Court,
6-8 Harcourt Road,
Dublin 2, Ireland.
Telephone: 01 4155100
Fax: 01 4155101

Trial Pit Log

Project Name and Site Location	Client	TRIAL PIT No
Elan Greenfield ESA	Elan Pharma Corporation Ltd	**BH105**

Job No	Date	Ground Level (m)	Co-Ordinates ()
49341699	Start Date / End Date 28-01-09		

Contractor	Method / Plant Used	Sheet
Glover Site Investigation	Komachi Rig	1 of 1

Depth BGL	Sample / Test Details	PID (ppm)	Water	STRATA: Legend	Depth (Thickness)	DESCRIPTION	COMMENTS	Instrument / Backfill
0.5	BH105 0.3m	0			(1.00) 1.00	TOPSOIL / Loose silty SAND	NEC	
1.0	BH105 1.0m	0			(1.00) 2.00	Loose brown yellow silty SAND	NEC	
1.5								
2.0	BH105 2.0m VOC & SVOC	0			(1.00) 3.00	Loose caorse brown yellow GRAVEL	NEC	
2.5								
3.0	BH105 3.0m	0			(1.00) 4.00	Soft brown yellow sandy gravelly CLAY	NEC	
3.5								
4.0	BH105 4.0m TPH, Metals, VOC & SVOC	0			4.50	Loose brown yellow angular GRAVEL	NEC	
4.5						Bedrock LIMESTONE	NEC	
5.0								
5.5			1					
6.0					(3.00)			
6.5								
7.0								
7.5					7.50			

Backfill

- Top Cap: 2 pipe group, 1st pipe
- Cement Seal: 2 pipe group, 1 pipe
- Filter Pack: 2 pipe group, 1 pipe
- Bentonite Seal: 2 pipe group, 1 pipe
- Slotted Pipe: 2 pipe group, 1 pipe

Sample Details

- Small disturbed sample

Legend

- Brick
- Silty/Clayey SAND
- GRAVEL
- Gravelly CLAY
- LIMESTONE
- Groundwater Table
- Groundwater Strike

GENERAL REMARKS

50mm Piezometer installed
2mm slot size
NEC: No evidence of contamination

Logged By	Approved By
R Rafferty	CAG

URS ENVIRONMENTAL TRIAL PIT LOG 21/09/07 ELAN LOGS.GPJ AGS3 ALL.GDT 27/4/09

URS Ireland Ltd.
Acorn Business Campus
Mahon Industrial Park
Blackrock
Cork
Phone 021 4536 136/7
Fax 021 4350 666

AIR ROTARY DRILLING LOG

Project Name and Site Location	Client	BOREHOLE No
Alkermes Groundwater Assessment 2011	Alkermes Pharma Ltd.	**BH107**

Job No	Date	Ground Level (m)	Co-Ordinates ()
46403003	Start Date 24-08-11 End Date 24-08-11	43.19	E 200,723.79 N 240,731.30

Contractor	Method / Plant Used	Sheet
JSD	Air Rotary - Beretta T51	1 of 1

Depth BGL	Sample / Test Details	PID (ppm)	Water	STRATA Legend	Depth (Thick-ness)	DESCRIPTION	COMMENTS	Instalation /Backfill
0.5		0.2			(1.70)	MADE GROUND Soft to firm brown gravelly clay with frequent cobbles. Gravel is medium to large.	Dry, NEC	
1.0		0.3						
1.5					1.70			
2.0					(2.60)	Soft red/brown slightly gravelly clayey SAND. Gravel is fine to medium, subangular to subrounded. Sand is fine to coarse.	Dry, NEC	
2.5								
3.0								
3.5								
4.0					4.30			
4.5					(2.90)	Soft grey brown slightly sandy CLAY/SILT. Sand is fine.	Damp at 4.3m. Wet at 5m, NEC	
5.0			▼1					
5.5								
6.0								
6.5								
7.0					7.20			
					7.40	Weathered uniform grey limestone BEDROCK.	Water at 7.2m, NEC	
						EOH @ 7.4m		

WELL INSTALLATION DETAILS

Cement seal riser
Bentonite seal riser
Filter pack riser
Filter pack screen

SAMPLE TYPE DETAILS

LEGEND

Made Ground
Gravelly Clayey Sand
Sandy Silt/Clay
LIMESTONE

Groundwater Table
Water Strike
bgl = Below Ground Level

GENERAL REMARKS

NEC - No Evidence of Contamination
EOH - End of Hole

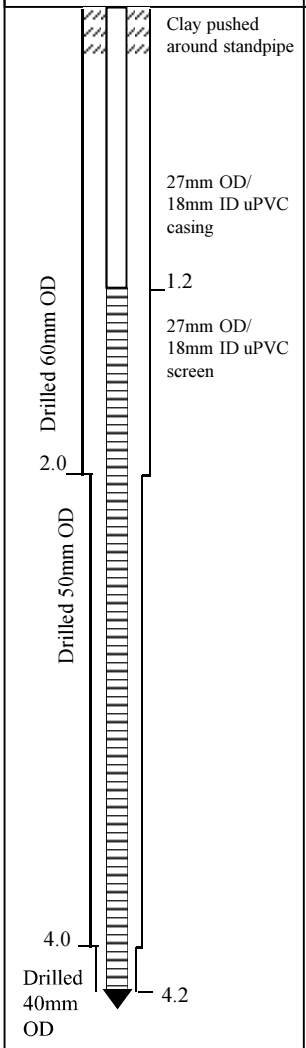
Located in the field to the south east corner of the fire water retention pond. Upright red cover approx 3m from the ditch.

		Logged By	RC	Approved By	EOH

URS CORK ROTARY DRILLING LOG ELAN ATHLONE BH LOGS.GPJ AGS3_ALL.GDT 5/7/12

Appendix D

BH Type & No.	AWS1
Page Number	Page 1 of 1
Total Depth (m)	4.2
Date drilled: Logged by: Date drawn:	09/12/98 E. McCarthy 18/01/99 (EMcC)
Drilling/Excavation Equipment	Percussion Window Sampling
Weather	Dry



Soil/Water/ Vapour Sample No.	Soil/Water/ Vapour Sample Depth Interval	Groundwater occurrence	Depth (m)	Geology - graphical log	Description	Interpretation/ Comments
			0.09		Firm, fresh (some mottling), medium to dark brown, gravelly (angular), clayey **SILT**	Topsoil
		→ 0.32-0.46			Soft, fresh, yellow-brown, slightly gravelly (subrounded to subangular), sandy **SILT** with medium grading	
			0.8		Firm, fresh , medium to dark brown, silty **CLAY** with medium grading	
			1		Firm, fresh to mottled, yellow-brown, slightly gravelly (angular to subangular), sandy, clayey **SILT** with medium grading	
		→ 1.0-1.9	1.88			
			2		Firm, fresh, light grey, poorly graded, silty, fine **SAND**	Transitional contact
			2.8			
			3		Dense/firm, fresh, grey to light brown, very clayey **SILT** with medium plasticity	More clay with depth
					Boulder/Cobble at base, filling diameter of "window", at least 40mm ø	
			3.75		Dense, fresh, yellow-brown, very gravelly (angular) **CLAY** with very low plasticity	Increase in no. & size of micritic limestone fragments with depth
W1			4			
			4.2		4.2 EOH	
			5			

Operation Comments

- The well design involving a phreatic tube was a temporary installation and was withdrawn after the geology was logged, the water levels measured and water samples taken
- The intake for all water sampling was at the base of each tube

Legend

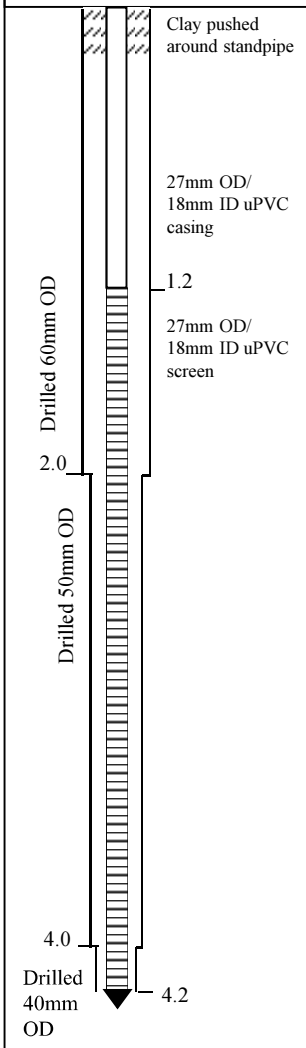
W1	Water sample
G1	Gas sample
S1	Sediment sample
→	Water inflow
▼	Cone tip
■	Push on cap
//////	Back-filled clay acting as seal

Title	**BOREHOLE LOG**
Client	Arran Chemical Company Ltd.
Job Description	Brief B.6 PWS Reconnaissance
Document & Report Ref.	1099d186.ppt & 1099r206.doc

Minerex Environmental Limited

BH Type & No.	AWS2
Page Number	Page 1 of 1
Total Depth (m)	4.2
Date drilled: Logged by: Date drawn:	08/12/98 E. McCarthy 18/01/99 (EMcC)
Drilling/Excavation Equipment	Percussion Window Sampling
Weather	Dry

Temporary Reconnaissance Borehole Design



Soil/Water/ Vapour Sample		Groundwater occurrence	Depth (m)	Geology - graphical log	Description	Interpretation/ Comments
No.	Depth Interval					
			0		Firm, fresh, dark brown, slightly gravelly (sub-rounded), silty **CLAY** with medium to poor grading	Topsoil
			0.29		Very stiff, fresh (occasionally weathered gravel), medium brown, medium to poorly graded, gravelly, sandy **SILT** with very low plasticity	Pro-glacial outwash
			1			
			1.1		Very stiff, fresh to mottled, yellow to light brown, gap graded, gravelly (angular), silty **CLAY** with very low plasticity	Fibrous plant stems visible
		→ 1.63				
			1.88		Very stiff, fresh, grey-brown, poorly graded, silty, very fine **SAND**	Fibrous plants, fining up pattern distinguished
			2			
			2.34		Stiff, fresh to mottled, light brown, poorly graded, silty **CLAY**	
		→	2.5		Firm, fresh , grey-brown, medium to poorly graded silty, fine **SAND**	
			2.78		Firm to soft (with depth), fresh to discoloured, light brown, poorly graded, medium plasticity, clayey **SILT** with interlaminations of **CLAY**	Clay laminations occur from 3.1-3.2m
			3			
			3.3		Firm, fresh, grey-brown, medium to well graded **GRAVEL**	Fining up trend
			3.58		Firm, fresh, grey-brown, medium to well graded, subrounded, sandy, medium to fine **GRAVEL**	Outwash "grit"
			3.85		Firm, fresh, light brown, very gravelly (subangular to angular) **CLAY**	Fining upward Diamicton/Boulder clay
			4			
W1			4.2		4.2 EOH	
			5			

General Head Protection

- The well design involving a phreatic tube was a temporary installation and was withdrawn after the geology was logged, the water levels measured and water samples taken
- The intake for all water sampling was at the base of each tube

Legend

W1	Water sample
G1	Gas sample
S1	Sediment sample
→	Water inflow
▼	Cone tip
■	Push on cap
//////	Back-filled clay acting as seal

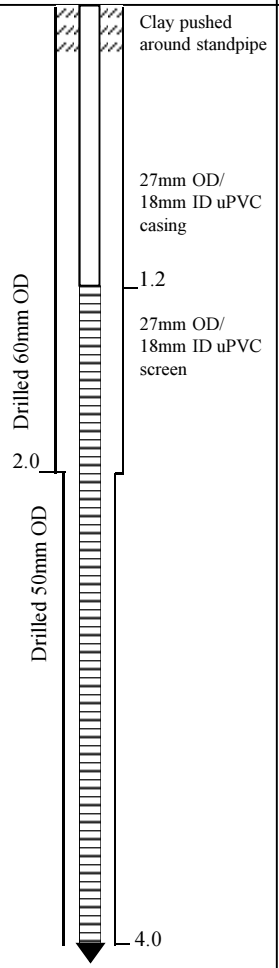
Title	**BOREHOLE LOG**
Client	Arran Chemical Company Ltd.
Job Description	Brief B.6 PWS Reconnaissance
Document & Report Ref.	1099d186.ppt & 1099r206.doc

Minerex Environmental Limited

Appendix D

BH Type & No.	AWS3
Page Number	Page 1 of 1
Total Depth (m)	4.0
Date drilled: Logged by: Date drawn:	09/12/98 E. McCarthy 18/01/99 (EMcC)
Drilling/Excavation Equipment	Percussion Window Sampling
Weather	Dry

Temporary Reconnaissance Borehole Design



Soil/Water/ Vapour Sample No.	Soil/Water/ Vapour Sample Depth Interval	Groundwater occurrence	Depth (m)	Geology - graphical log	Description	Interpretation/ Comments
			0		Soft, discoloured (mottled horizons), medium brown, medium graded, silty **CLAY** with low plasticity	Topsoil
			0.37		Stiff, fresh to discoloured, light brown, clayey, silty **SAND**	
			0.52		Stiff to soft (with depth), discoloured, light grey to intermittently brown-orange, medium graded, slightly gravelly (subrounded), silty **CLAY** with low plasticity. (A minor clayey, silty **SAND** horizon occurs between 1.01-1.09m, while a medium to dark CLAY layer occurs at 1.9-2.0)	Locally known as "dob". Tree roots evident, highly pliable, cohesive
		→ 1.5-1.9	1			
			2			
			2.5			
			2.56		Thinly interbedded silty **SAND** & clayey **SILT**. Increase in sand thickness with depth, average sand ø = 0.45m, while average ø clay = 0.35m, with all variables in between	Fining up trend
		→ 2.8	3			
W1			4		4.0 EOH	
			5			

General Head Protection

- The well design involving a phreatic tube was a temporary installation and was withdrawn after the geology was logged, the water levels measured and water samples taken
- The intake for all water sampling was at the base of each tube

Legend

- W1 Water sample
- G1 Gas sample
- S1 Sediment sample
- → Water inflow
- ▼ Cone tip
- ■ Push on cap
- Back-filled clay acting as seal

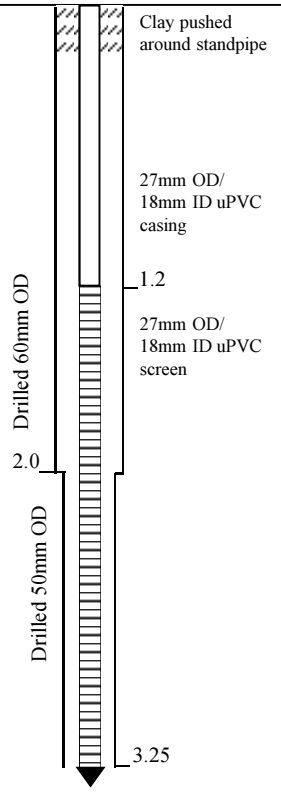
Title	**BOREHOLE LOG**
Client	Arran Chemicals Ltd.
Job Description	Brief B.6 PWS Reconnaissance
Document & Report Ref.	1099d186.ppt & 1099r206.doc

Minerex Environmental Limited

Appendix D

BH Type & No.	AWS4
Page Number	Page 1 of 1
Total Depth (m)	3.25
Date drilled: Logged by: Date drawn:	09/12/98 E. McCarthy 19/01/99 (EMcC)
Drilling/Excavation Equipment	Percussion Window Sampling
Weather	Dry

Temporary Reconnaissance Borehole Design



Soil/Water/ Vapour Sample		Groundwater occurrence	Depth (m)	Geology - graphical log	Description	Interpretation/ Comments
No.	Depth Interval					
			0		Soft to dense/stiff (with depth), discoloured (mottled) to fresh , medium to dark brown, medium graded, silty **CLAY** with low plasticity	Fibrous topsoil
			5.4			
			1		Dense/stiff to firm (with depth) discoloured (mottled), light brown to yellow-brown, medium to poorly graded, silty **CLAY** with thick laminations of fine **SAND** occurring from 1.48m, (average ø = 0.015m)	
			1.48			
			2			Predominance of clay over last metre
		2.82	2.82		Loose, fresh, grey-brown, moderately gravelly (interspersed & subrounded), very silty **CLAY**	
			3			
W1			3.25		3.25 EOH	
			4			
			5			

General Head Protection

- The well design involving a phreatic tube was a temporary installation and was withdrawn after the geology was logged, the water levels measured and water samples taken
- The intake for all water sampling was at the base of each tube

Legend

- W1 Water sample
- G1 Gas sample
- S1 Sediment sample
- → Water inflow
- ▼ Cone tip
- ■ Push on cap
- Back-filled clay acting as seal

Title	**BOREHOLE LOG**
Client	Arran Chemical Company Ltd.
Job Description	Brief B.6 PWS Reconnaissance
Document & Report Ref.	1099d186.ppt & 1099r206.doc

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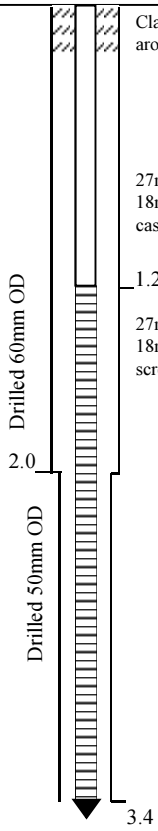
BH Type & No.	AWS5
Page Number	Page 1 of 1
Total Depth (m)	3.4
Date drilled:	09/12/98
Logged by:	E. McCarthy
Date drawn:	19/01/99 (EMcC)
Drilling/Excavation Equipment	Percussion Window Sampling
Weather	Dry

Temporary Reconnaissance Borehole Design



Soil/Water/ Vapour Sample		Groundwater occurrence	Depth (m)	Geology - graphical log	Description	Interpretation/ Comments
No.	Depth Interval					
			0.6		Firm, fresh to discoloured, medium brown, medium graded, silty **CLAY** with low plasticity	Topsoil - lower 0.14m showing signs of leaching
		→ 1.14	1		Very stiff, thickly to very thinly laminated, discoloured, yellow-orange/brown, silty **CLAY**& grey silty **SAND**	Lamination thickness = 0.01-0.03m, more sand with depth
			1.77		Firm, intermixed, discoloured, light grey to brown, well graded, silty, gravelly (angular) **CLAY** with low plasticity	Shattered limestone fragments evident
			2			
			2.34		Soft to loose, intermixed, discoloured, grey to light brown, well graded, silty, clayey **GRAVEL** (very angular)	Boulder clay/diamicton, or possibly rock head
W1			3			
			3.4		3.4 EOH	
			4			
			5			

General Head Protection

- The well design involving a phreatic tube was a temporary installation and was withdrawn after the geology was logged, the water levels measured and water samples taken
- The intake for all water sampling was at the base of each tube

Legend

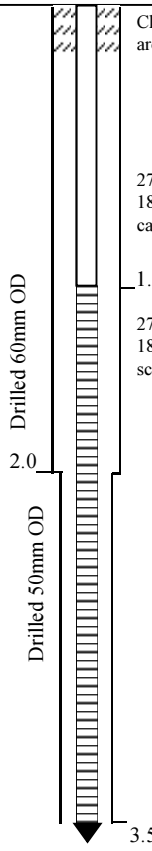
W1	Water sample
G1	Gas sample
S1	Sediment sample
→	Water inflow
▼	Cone tip
■	Push on cap
//////	Back-filled clay acting as seal

Title	**BOREHOLE LOG**
Client	Arran Chemical Company Ltd.
Job Description	Brief B.6 PWS Reconnaissance
Document & Report Ref.	1099d186.ppt & 1099r206.doc

Minerex Environmental Limited

BH Type & No.	AWS6
Page Number	Page 1 of 1
Total Depth (m)	3.5
Date drilled: Logged by: Date drawn:	09/12/98 E. McCarthy 19/01/99 (EMcC)
Drilling/Excavation Equipment	Percussion Window Sampling
Weather	Dry

Temporary Reconnaissance Borehole Design



Soil/Water/ Vapour Sample		Groundwater occurrence	Depth (m)	Geology - graphical log	Description	Interpretation/ Comments
No.	Depth Interval					
			0		Firm, fresh to discoloured, medium to dark brown, medium graded, very silty **CLAY** with low plasticity	Topsoil - roots plentiful
			0.4		Firm to soft, intermixed, discoloured (mottled), light grey to yellow-brown, slightly gravelly (occasional, subangular to subrounded), silty **CLAY**	"Gley" - iron reduction evident
			1			
			1.4		Soft, interbedded, discoloured, light brown **CLAY** & fresh, grey **SILT**, with medium grading & plasticity	~50:50 representation
		→ 1.6	1.73		Soft, fresh, light grey with a hint of brown, slightly gravelly (angular), clayey **SILT**	Transition Gravel content increasing in size and proportion with depth
			2			
			3		Loose, angular to subangular, silty **GRAVEL** with a minor **CLAY** layer (thickness = 0.1-0.15m) at 3.2m	Transition
W1			3.5		3.5 EOH	
			4			
			5			

General Head Protection

- The well design involving a phreatic tube was a temporary installation and was withdrawn after the geology was logged, the water levels measured and water samples taken
- The intake for all water sampling was at the base of each tube

Legend

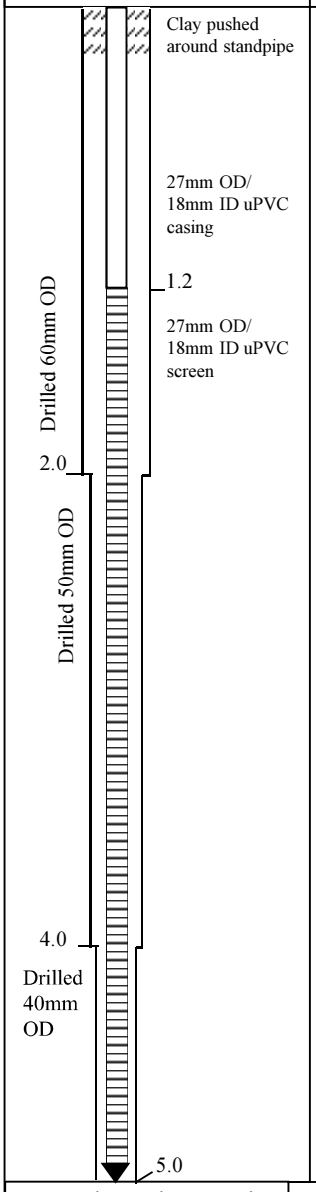
- W1 Water sample
- G1 Gas sample
- S1 Sediment sample
- → Water inflow
- ▼ Cone tip
- ■ Push on cap
- Back-filled clay acting as seal

Title	**BOREHOLE LOG**
Client	Arran Chemical Company Ltd.
Job Description	Brief B.6 PWS Reconnaissance
Document & Report Ref.	1099d186.ppt & 1099r206.doc

Minerex Environmental Limited

BH Type & No.	AWS7
Page Number	Page 1 of 1
Total Depth (m)	5.0
Date drilled: Logged by: Date drawn:	11/12/98 E. McCarthy 19/01/99 (EMcC)
Drilling/Excavation Equipment	Percussion Window Sampling
Weather	Dry

Temporary Reconnaissance Borehole Design



Soil/Water/ Vapour Sample		Groundwater occurrence	Depth (m)	Geology - graphical log	Description	Interpretation/ Comments
No.	Depth Interval					
			0.68		Soft, fresh to discoloured (mottled), medium to dark brown **PEAT**	Acting as topsoil - anaerobic conditions Transitional contact
			1		Firm to soft, grey to brown (with depth), silty **CLAY** with medium plasticity	Very pliable, fibrous ~50:50 representation
			2			
			2.14		Firm, light brown, medium graded, low plasticity, silty **CLAY**	
			3			
		→	3.32		Very fine **SAND** lens/horizon	
			3.47		Loose, grey, angular, sandy, silty/clayey (50:50) **GRAVEL**	Large angular clasts, at least 0.04m ø, fine to medium gravel or "grit" acting as matrix with depth
			4			
W1			5		5.0 EOH	

General Head Protection

- The well design involving a phreatic tube was a temporary installation and was withdrawn after the geology was logged, the water levels measured and water samples taken
- The intake for all water sampling was at the base of each tube

Legend

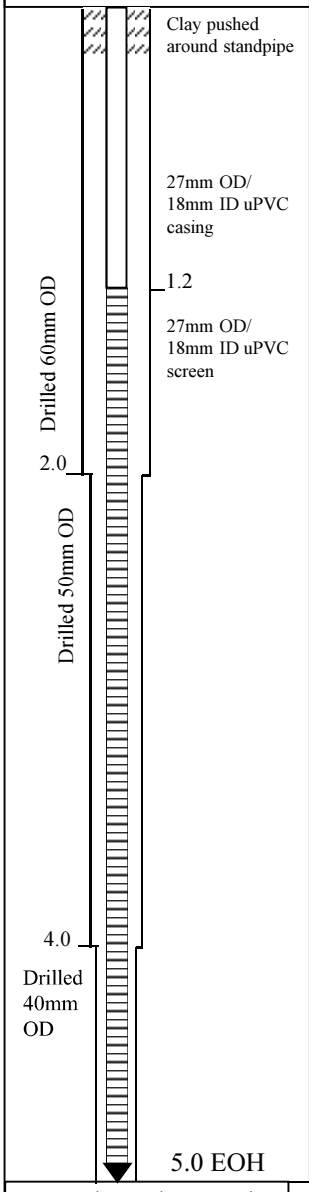
- W1 Water sample
- G1 Gas sample
- S1 Sediment sample
- → Water inflow
- ▼ Cone tip
- ■ Push on cap
- Back-filled clay acting as seal

Title	**BOREHOLE LOG**
Client	Arran Chemical Company Ltd.
Job Description	Brief B.6 PWS Reconnaissance
Document & Report Ref.	1099d186.ppt & 1099r206.doc

Minerex Environmental Limited

BH Type & No.	AWS8
Page Number	Page 1 of 1
Total Depth (m)	5.0
Date drilled: Logged by: Date drawn:	10/12/98 E. McCarthy 19/01/99 (EMcC)
Drilling/Excavation Equipment	Percussion Window Sampling
Weather	Dry

Temporary Reconnaissance Borehole Design



Soil/Water/ Vapour Sample		Groundwater occurrence	Depth (m)	Geology - graphical log	Description	Interpretation/ Comments
No.	Depth Interval					
			0.97		Very soft, homogeneous, fresh to slightly decomposed (with depth), dark brown **PEAT**	Acting as topsoil horizon from 0.3-0.68 = hard & friable
			1		Soft, fresh (weathered roots), grey, poorly graded, very clayey, very fine **SILT** with medium to high plasticity	Very pliable, "Argilla"
			1.8			Transition
			2		Soft, fresh, grey to yellow-grey/brown (with depth), poorly graded **SILT/CLAY** (50:50) with medium plasticity	Coarsening upwards
			3			
			3.17		Soft to firm, fresh, grey, poorly graded, slightly clayey, sandy **SILT** with medium to low plasticity	First distinct sandy, silt lens/horizon
		→	3.46		Interbedded & interlaminated, soft to firm, fresh, grey, very clayey **SILT** & yellow/brown, very silty **CLAY**	Coarsening upwards, silt beds thicken towards the top. More clay at base
			4			
			4.3		Soft to firm, fresh, grey, clayey, gravelly (angular) **SILT**	
W1			4.78		Loose, grey, angular, clayey, silty **GRAVEL**	Boulder clay/ Diamicton
			5			

General Head Protection

- The well design involving a phreatic tube was a temporary installation and was withdrawn after the geology was logged, the water levels measured and water samples taken
- The intake for all water sampling was at the base of each tube

Legend

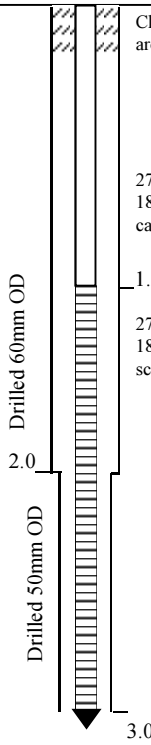
- W1 Water sample
- G1 Gas sample
- S1 Sediment sample
- → Water inflow
- ▼ Cone tip
- ■ Push on cap
- Back-filled clay acting as seal

Title	**BOREHOLE LOG**
Client	Arran Chemical Company Ltd.
Job Description	Brief B.6 PWS Reconnaissance
Document & Report Ref.	1099d186.ppt & 1099r206.doc

Minerex Environmental Limited

BH Type & No.	AWS9
Page Number	Page 1 of 1
Total Depth (m)	3.0
Date drilled: Logged by: Date drawn:	12/01/99 E. McCarthy 19/01/99 (EMcC)
Drilling/Excavation Equipment	Percussion Window Sampling
Weather	Dry

Temporary Reconnaissance Borehole Design



Soil/Water/ Vapour Sample		Groundwater occurrence	Depth (m)	Geology - graphical log	Description	Interpretation/ Comments
No.	Depth Interval					
			0		Soft to firm, fresh (roots), medium to dark brown, poorly graded, damp **PEAT** with low plasticity	Fresh topsoil layer
			0.49		Firm to soft, slightly discoloured (mottled), light grey, damp, very silty **CLAY** with gravel occurring (slightly gravelly, very silty **CLAY**) from 1m, increasing in size with depth (average ø = <0.01m)	Original root structures - orange/brown mottling
			1			
			1.5		Firm to loose, fresh, light grey, well graded, damp to wet, gravelly (angular to subangular), clayey, very sandy **SILT**, with medium plasticity	Gravel contingent increasing in size with depth.
		→			LOSS	Outwash mixture
			2		Firm, fresh, light grey, poorly graded, wet, clayey, silty, very gravelly (angular to subangular), coarse **SAND**	
			2.35		Firm to loose, grey, very sandy, fine to medium **GRAVEL**	
			2.57		Soft, fresh, light brown ("cream"), wet, gravelly (angualar), silty **CLAY**	
W1					LOSS	
			3		3.0 EOH	
			4			
			5			

General Head Protection

- The well design involving a phreatic tube was a temporary installation and was withdrawn after the geology was logged, the water levels measured and water samples taken
- The intake for all water sampling was at the base of each tube

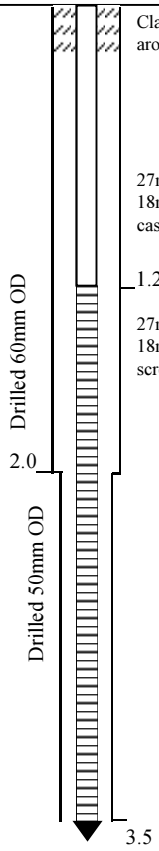
Legend

W1	Water sample
G1	Gas sample
S1	Sediment sample
→	Water inflow
▼	Cone tip
■	Push on cap
//////	Back-filled clay acting as seal

Title	**BOREHOLE LOG**
Client	Arran Chemical Company Ltd.
Job Description	Brief B.6 PWS Reconnaissance
Document & Report Ref.	1099d186.ppt & 1099r206.doc

Minerex Environmental Limited

BH Type & No.	AWS10
Page Number	Page 1 of 1
Total Depth (m)	3.5
Date drilled: Logged by: Date drawn:	10/12/98 E. McCarthy 19/01/99 (EMcC)
Drilling/Excavation Equipment	Percussion Window Sampling
Weather	Dry



Soil/Water/ Vapour Sample No.	Soil/Water/ Vapour Sample Depth Interval	Groundwater occurrence	Depth (m)	Geology - graphical log	Description	Interpretation/ Comments
			0		Very soft, homogeneous, fresh to slightly decomposed (with depth), dark brown, high to medium plasticity **PEAT**	Acting as topsoil horizon
			0.9		Clayey **SILT** lens	Man-made? - drainage
			1		**PEAT**, as above	
					Firm, fresh, grey, very clayey, very fine **SILT** with medium to low plasticity	
			2			
			2.45		Firm, grey, clayey, fine **SILT**	
			2.85		Interbedded clayey **SILT** & silty **CLAY**	
			3			
W1			3.3		Firm, discoloured, yellow/brown, gravelly (angular), silty **CLAY**	From 3.3-3.38 = very coarse sand or very fine gravel (grit), under which 0.12m of clay dominated diamicton
			3.5		3.5 EOH	
			4			
			5			

General Head Protection

- The well design involving a phreatic tube was a temporary installation and was withdrawn after the geology was logged, the water levels measured and water samples taken
- The intake for all water sampling was at the base of each tube

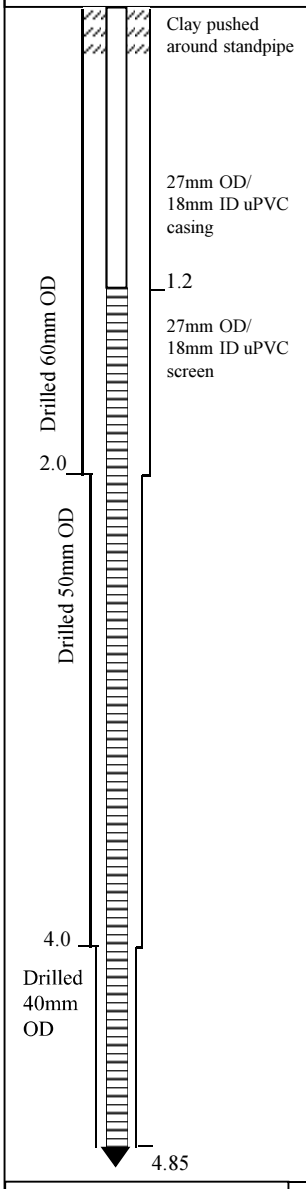
Legend

- W1 Water sample
- G1 Gas sample
- S1 Sediment sample
- Water inflow
- Cone tip
- Push on cap
- Back-filled clay acting as seal

Title	**BOREHOLE LOG**
Client	Arran Chemical Company Ltd.
Job Description	Brief B.6 PWS Reconnaissance
Document & Report Ref.	1099d186.ppt & 1099r206.doc

Minerex Environmental Limited

BH Type & No.	AWS11
Page Number	Page 1 of 1
Total Depth (m)	4.85
Date drilled: Logged by: Date drawn:	10/12/98 E. McCarthy/A. Milner 19/01/99 (EMcC)
Drilling/Excavation Equipment	Percussion Window Sampling
Weather	WET



Temporary Reconnaissance Borehole Design	Soil/Water/ Vapour Sample No.	Soil/Water/ Vapour Sample Depth Interval	Groundwater occurrence	Depth (m)	Geology - graphical log	Description	Interpretation/ Comments
				0.54		Very soft, homogeneous, fresh to slightly decomposed (with depth), dark brown, high to medium plasticity, silty, clayey **PEAT**	More "soily" than before
				1		Firm to soft, interbedded,fresh to discoloured (mottled), grey-brown, sandy, clayey **SILT** & silty **CLAY**, with two silty **SAND** horizons between 1.5-1.6m & 3.5-3.6m	
				2			
				3			
				3.6		Soft, medium brown, silty **CLAY** with medium plasticity	
				4			
				4.2		Firm, light brown, silty, very gravelly (subangular) **CLAY** Gravel component reaching diameter of window ~0.04m	Heterogeneous mixture =Diamicton/ Boulder clay with matrix in silt-clay spectrum
	W1			4.85		4.85 EOH	
				5			

General Head Protection

- The well design involving a phreatic tube was a temporary installation and was withdrawn after the geology was logged, the water levels measured and water samples taken
- The intake for all water sampling was at the base of each tube

Legend

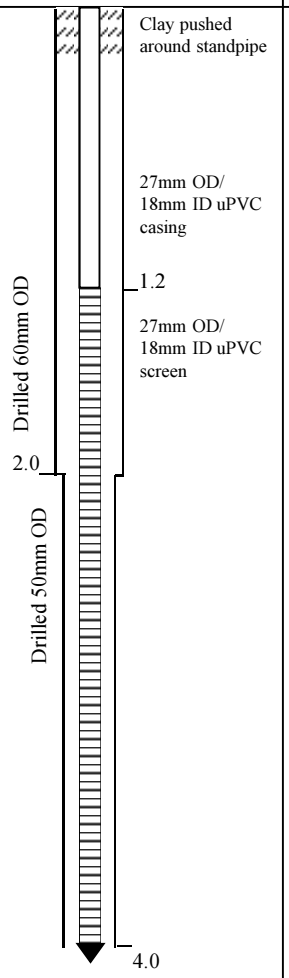
- W1 Water sample
- G1 Gas sample
- S1 Sediment sample
- → Water inflow
- ▼ Cone tip
- ■ Push on cap
- Back-filled clay acting as seal

Title	**BOREHOLE LOG**
Client	Arran Chemical Company Ltd.
Job Description	Brief B.6 PWS Reconnaissance
Document & Report Ref.	1099d186.ppt & 1099r206.doc

Minerex Environmental Limited

BH Type & No.	AWS12
Page Number	Page 1 of 1
Total Depth (m)	4.0
Date drilled:	11/12/98
Logged by:	E. McCarthy/A. Milner
Date drawn:	19/01/99 (EMcC)
Drilling/Excavation Equipment	Percussion Window Sampling
Weather	WET

Temporary Reconnaissance Borehole Design



Soil/Water/ Vapour Sample No.	Soil/Water/ Vapour Sample Depth Interval	Groundwater occurrence	Depth (m)	Geology - graphical log	Description	Interpretation/ Comments
			0		Stiff, discoloured (mottled), medium brown, sandy **SILT**	Topsoil, some root matter
			0.25		Firm, medium brown to grey, low to medium plasticity **CLAY**, with minor **SILT** bands	
			1			
			1.35		Firm, medium brown to grey, low to medium plasticity **SILT**, with minor **CLAY** bands (<0.05m)	
			2		LOSS	
			3		Firm, very gravelly (angular) **CLAY**	
		→	3.3		Firm, well graded,very sandy, angular **GRAVEL**	
			3.5		Well graded, very sandy **GRAVEL**	75-80% large, angular clasts
W1			4		4.0 EOH	
			5			

General Head Protection

- The well design involving a phreatic tube was a temporary installation and was withdrawn after the geology was logged, the water levels measured and water samples taken
- The intake for all water sampling was at the base of each tube

Legend

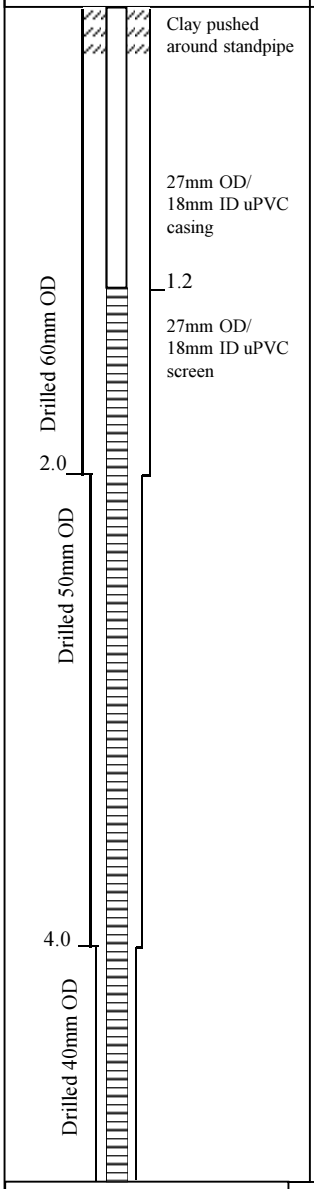
W1	Water sample
G1	Gas sample
S1	Sediment sample
→	Water inflow
▼	Cone tip
■	Push on cap
//////	Back-filled clay acting as seal

Title	**BOREHOLE LOG**
Client	Arran Chemical Company Ltd.
Job Description	Brief B.6 PWS Reconnaissance
Document & Report Ref.	1099d186.ppt & 1099r206.doc

Minerex Environmental Limited

BH Type & No.	AWS13
Page Number	Page 1 of 2
Total Depth (m)	6.04
Date drilled: Logged by: Date drawn:	13/12/98 E. McCarthy/A. Milner 19/01/99 (EMcC)
Drilling/Excavation Equipment	Percussion Window Sampling
Weather	WET

Temporary Reconnaissance Borehole Design



Soil/Water/ Vapour Sample No.	Soil/Water/ Vapour Sample Depth Interval	Groundwater occurrence	Depth (m)	Geology - graphical log	Description	Interpretation/ Comments
			0		Stiff, homogeneous, slightly to moderately decomposed (with depth), dark brown to black, poorly graded, medium plasticity, damp **PEAT**	Colour darkening with depth
			0.82			
			1		Firm, very thinly bedded, fresh, grey, medium to poorly graded, damp to wet, slightly clayey, very silty, fine **SAND**	
		→ 1.8	2			
					LOSS	
			2.5		Same as above i.e. very thinly bedded, fine **SAND**	
			2.68		Transition - interbedded fine **SAND** (above) & **CLAY** (below)	
			2.97			
			3		Stiff to slightly firm, fresh, grey-brown, poorly graded, low plasticity, damp, slightly silty **CLAY**	Impermeable layer
			4			
			5			

General Head Protection

- The well design involving a phreatic tube was a temporary installation and was withdrawn after the geology was logged, the water levels measured and water samples taken
- The intake for all water sampling was at the base of each tube

Legend

- W1 Water sample
- G1 Gas sample
- S1 Sediment sample
- → Water inflow
- ▼ Cone tip
- ■ Push on cap
- Back-filled clay acting as seal

Title	**BOREHOLE LOG**
Client	Arran Chemical Company Ltd.
Job Description	Brief B.6 PWS Reconnaissance
Document & Report Ref.	1099d186.ppt & 1099r206.doc

Minerex Environmental Limited

BH Type & No.	AWS13
Page Number	Page 2 of 2
Total Depth (m)	6.04
Date drilled: Logged by: Date drawn:	13/12/98 E. McCarthy/A. Milner 19/01/99 (EMcC)
Drilling/Excavation Equipment	Percussion Window Sampling
Weather	WET

Temporary Reconnaissance Borehole Design	Soil/Water/ Vapour Sample: No.	Soil/Water/ Vapour Sample: Depth Interval	Groundwater occurrence	Depth (m)	Geology - graphical log	Description	Interpretation/ Comments
Drilled 40mm OD; 27mm OD/ 18mm ID uPVC screen; 6.04	W1			5.54; 5.85; 6; 6.04; 7; 8; 9; 10		Stiff to slightly firm, fresh, grey-brown, poorly graded, low plasticity, damp, slightly silty **CLAY**, with very thinly bedded, brown, silty **SAND** horizons occurring from 5.54m	Continued from page 1
						Brown-grey, gravelly (angular), silty **CLAY**	Boulder clay/rock head at base - stopped drilling
						6.04 EOH	

General Head Protection

- The well design involving a phreatic tube was a temporary installation and was withdrawn after the geology was logged, the water levels measured and water samples taken
- The intake for all water sampling was at the base of each tube

Legend

- W1 Water sample
- G1 Gas sample
- S1 Sediment sample
- → Water inflow
- ▼ Cone tip
- ■ Push on cap
- Back-filled clay acting as seal

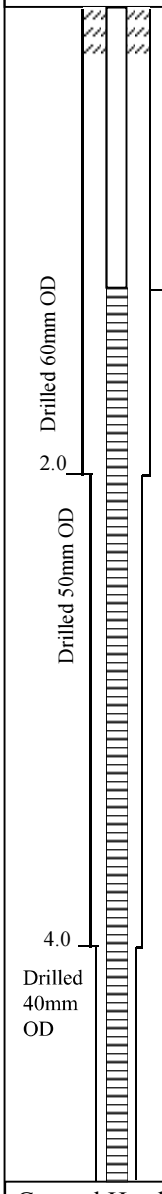
Title	**BOREHOLE LOG**
Client	Arran Chemical Company Ltd.
Job Description	Brief B.6 PWS Reconnaissance
Document & Report Ref.	1099d186.ppt & 1099r206.doc

Minerex Environmental Limited

BH Type & No.	AWS14
Page Number	Page 1 of 2
Total Depth (m)	6.0
Date drilled: Logged by: Date drawn:	13/12/98 E. McCarthy/A. Milner 19/01/99 (EMcC)
Drilling/Excavation Equipment	Percussion Window Sampling
Weather	WET

Temporary Reconnaissance Borehole Design

Soil/Water/ Vapour Sample		Groundwater occurrence	Depth (m)	Geology - graphical log	**Description**	**Interpretation/ Comments**
No.	Depth Interval					
					LOSS	
			0.25		Firm, homogeneous, moderately decomposed, dark brown to black, poorly graded, damp **PEAT** with low plasticity	Colour darkening with depth
			1		Firm, fresh, grey, damp, slightly clayey, very silty, fine **SAND** with minor **CLAY** laminations occurring from ~1.7m	
			1.8		Firm, fresh, grey, slightly sandy, very clayey **SILT** with medium plasticity	Transition
			2		Firm, fresh, grey, poorly graded, medium plasticity, damp, very silty **CLAY**	
			3			
			3.18		Firm, fresh, yellow-brown, poorly graded, medium plasticity, damp, very silty **CLAY**	
			4		Stiff, fresh, yellow-brown, well graded, medium plasticity, damp, gravelly (very angular), very silty **CLAY** with well graded, very sandy **GRAVEL**	Gravel increases with depth Diamicton/Boulder clay
			5			



General Head Protection

- The well design involving a phreatic tube was a temporary installation and was withdrawn after the geology was logged, the water levels measured and water samples taken
- The intake for all water sampling was at the base of each tube

Legend

W1	Water sample
G1	Gas sample
S1	Sediment sample
→	Water inflow
▼	Cone tip
■	Push on cap
//////	Back-filled clay acting as seal

Title	**BOREHOLE LOG**
Client	Arran Chemical Company Ltd.
Job Description	Brief B.6 PWS Reconnaissance
Document & Report Ref.	1099d186.ppt & 1099r206.doc

Minerex Environmental Limited

BH Type & No.	AWS14
Page Number	Page 2 of 2
Total Depth (m)	6.0
Date drilled: Logged by: Date drawn:	13/12/98 E. McCarthy/A. Milner 19/01/99 (EMcC)
Drilling/Excavation Equipment	Percussion Window Sampling
Weather	WET

Temporary Reconnaissance Borehole Design	**Soil/Water/ Vapour Sample** No.	Depth Interval	Groundwater occurrence	Depth (m)	Geology - graphical log	**Description**	**Interpretation/ Comments**
Drilled 40mm OD 27mm OD/ 18mm ID uPVC screen 6.0	W1			6 7 8 9 10		Stiff - loose, fresh, brown-grey, well graded, low plasticity, damp, clayey, silty **GRAVEL** (angular)	Transition from 5m

General Head Protection

- The well design involving a phreatic tube was a temporary installation and was withdrawn after the geology was logged, the water levels measured and water samples taken
- The intake for all water sampling was at the base of each tube

Legend

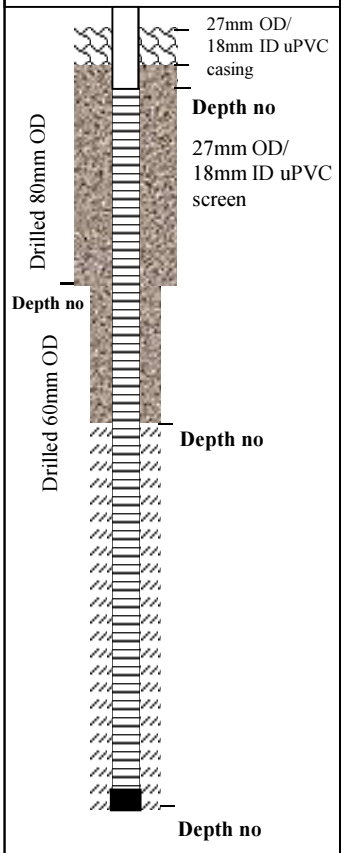
- W1 Water sample
- G1 Gas sample
- S1 Sediment sample
- → Water inflow
- ▼ Cone tip
- ■ Push on cap
- Back-filled clay acting as seal

Title	**BOREHOLE LOG**
Client	Arran Chemical Company Ltd.
Job Description	Brief B.6 PWS Reconnaissance
Document & Report Ref.	1099d186.ppt & 1099r206.doc

Minerex Environmental Limited

Appendix D

Borehole Design & Completion	Soil and Water sample/record			Groundwater occurrence	Depth (m)	Geology - graphical log		
EXAMPLE ONLY	No.	Weight in kgs	Depth Interval				**BH Type & No.**	
							Page Number	Page 1 of 1
							Total Depth (m)	
							Date drilled: Logged by: Date drawn:	07/11/98 (EMcC)
							Drilling/Excavation Equipment	Percussion Window Sampling
							Weather	



SYMBOLS FOR LOGS

Other ID's:

24mm ID/34mm OD uPVC casing 0.9m

24mm ID/34mm OD uPVC screen

BOULDER(S)
(>200mm)

COBBLES
(60 to 200mm)

GRAVEL
(2 to 60 mm)

Coarse **SAND**
(2-0.6mm)

Medium **SAND**
(0.6-0.2mm)

Fine **SAND**
(0.2-0.06mm)

SILT
(0.06 - 0.002mm)

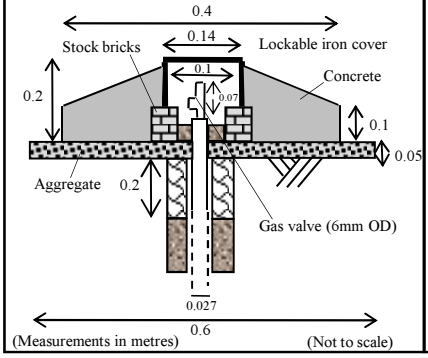
CLAYS
(<0.002mm)

PEAT
(dark brown, black, plant remains evident, distinct H_2Ssmell)

FILL
(i.e plastic, glass, wood, domestic waste etc.)

SAND - general, if without grain size description.

General Head Protection



Legend

W1	Water sample
G1	Gas sample
S1	Sediment sample
→	Water inflow
▼	Cone tip
■	Push on cap
	Gravel pack, nominal 2-5mm in diameter
	Collapsed Formation
	Bentonite pellets

Title	**BOREHOLE LOG**
Client	
Job Description	
Document & Report Ref.	1099d186.ppt & 1099r206

Minerex Environmental Limited

Borehole Design & Completion	Soil and Water sample/record			Groundwater occurrence	Depth (m)	Geology - graphical log	BH Type & No.	
EXAMPLE ONLY	No.	Weight in kgs	Depth Interval				Page Number	Page 1 of 1
							Total Depth (m)	
							Date drilled: Logged by: Date drawn:	07/11/98 (EMcC)
							Drilling/Excavation Equipment	Percussion Window Sampling
							Weather	

LEGEND FOR PERCUSSION WINDOW SAMPLER DRILL LOGS

BOULDER(S)
(>200mm)

COBBLES
(60 to 200mm)

GRAVEL
(Homogeneous larger sized particles from 2 to 60 mm)

EXTRA

FILL
(i.e plastic, glass, wood, domestic waste etc.)

SAND
(Particle sizes: 2 to 0.06mm. Three sub-categories distinguishable to the eye)

C
M
F

Pending framework/matrix component - interpretations made

Diamicton/till
(i.e. poorly sorted heterogeneous 'glacial' deposit - consisting of predominantly angular clasts)

Fluvioglacial
(Better sorted, can show clastconcentration/ imbrication or be interstratified. Constituent clasts/particles show varying degrees/orders of roundness)

SILT
(0.06 - 0.002mm)

Top-soil

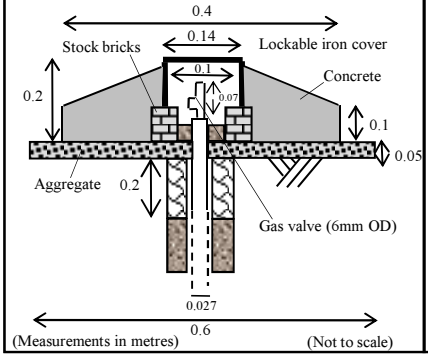
Lacustrine silt
(non- to little-disturbed varved/rhythmic cycles. Mainly dark coloured material)

Alluvial silt
(Levee bank, flood-plain, or deltaic setting)

CLAYS
(<0.002mm)

PEAT
(dark brown, black, plant remains evident, distinct H_2Ssmell)

General Head Protection



Legend

W1	Water sample
G1	Gas sample
S1	Sediment sample
→	Water inflow
▼	Cone tip
■	Push on cap
	Gravel pack, nominal 2-5mm in diameter
	Collapsed Formation
	Bentonite pellets

Title	**BOREHOLE LOG**
Client	
Job Description	
Document & Report Ref.	1099d186.ppt & 1099r206

Minerex Environmental Limited

Drilling Log

Project No. : 632 Date : 06/09/1994

Drilling Location : Adj. B 8 Boring No : MW - 1

Supervisor : Teri Hayes

Drilling Contractor : Glover Site Investigations Ltd.

Drilling Method : Percussion

Site : Elan Corp plc.
Monks land Industrial Est.
Athlone
Co. West Meath

Sample	Depth	Description / Comments etc.
	0 - 0.2	Top Soil
	0.2 - 0.6	Silty gravel. Cobbles up to 15 cm in diameter Moist
	0.6 - 1.5	Boulders with clay matrix Drilling difficult - Chiseling for two hours
	1.5 - 2.0	Clayey gravels, moist
	2.0 - 4.0	Clays, silts and clayey gravels Very Dry and compact, drilling difficult
	4.0 - 6.0	Silt and Clay
	6 - 6.5	Cobbles and boulders with a clay matrix Dry

K.T.Cullen & Co. Ltd.

☑ Complete ☐ Continued

Drilling Log

Project No. 632 Date 6-7/9/1994

Drilling Location S of B2 Boring No : MW - 2

Supervisor : Teri Hayes

Drilling Contractor Glover

Drilling Method Percussion

Site : Elan Corp plc.
Monksland Industrial Estate.
Athlone

Sample	Depth	Description / Comments etc.
	0.0 - 0.3	Sandy Topsoil
	0.5 - 1.3	Light brown silt, dry
	1.3 - 2.0	Boulder -chiselling
	2.0 - 3.0	Clayey silt with pebble
	4.0 - 6.5	Boulder Clay. Cobbles with diameters up to 30 cm, moist
	6.5 - 7.8	Boulder clay with water saturated silt lenses
	7.8 - 8.4	Boulders , drilling impeded

.T.Cullen & Co. Ltd.

☐ Complete ☐ Continued

Drilling Log

Project No. : 632 Date : 8/9/1994

Drilling Location : S of B4 Boring No : MW - 3

Supervisor : Teri Hayes

Drilling Contractor : Glover

Drilling Method : Percussion

Site : Elan Corporation plc.
Monksland Ind. Est.
Athlone

Sample	Depth	Description / Comments etc.
	0.0 - 0.4	Topsoil
	0.4 - 1.6	Light brown intermixed sand and silt, moist
		Clay with silt lenses.
	1.6 - 3.5	Pebbles approx 2 - 5 cm in diameter, moist
	3.5 - 5.2	Boulder Clay with sandy lenses which ae saturated.
	5.2 - 6.4	Boulder Clay with large cobbles
		Cohesive clay, low permeability
		Drilling impeded due to boulders

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

☐ Complete ☐ Continued

Drilling Log

Project No.: 632 Date: 8-9/9/1994

Drilling Location: SW of site Boring No MW-5

Supervisor: Teri Hayes

Drilling Contractor: Glover

Drilling Method: Percussion

Site: MW-5

Elan Corporation plc.

Monksland Industrial Estate

Athlone

Co. Westmeath

Sample	Depth	Description / Comments etc.
	0.0 - 0.7	Fill material
	0.7 - 2.1	Boulder Clay. Cobbles with a diameter of 20 cm approx. Moist, strong flow at 2 metres bls
	2.1 - 5.0	Silt with clay and sand lenses Saturated
	5.0 - 6.3	Boulder Clay and silt, Cobbles approx. 10 cm in diameter.

T.Cullen & Co. Ltd.
Geotechnical & Environmental Consultants

☐ Complete ☐ Continued

Well Construction Log

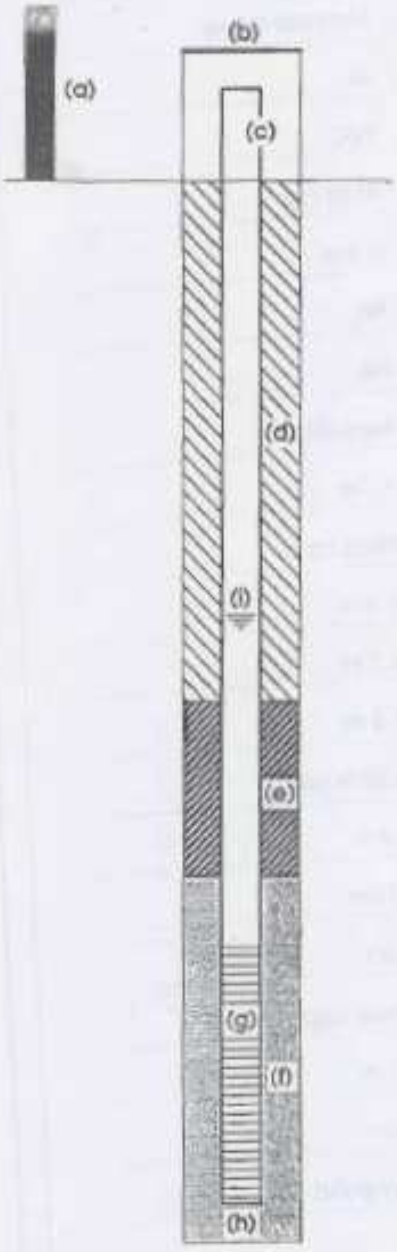
Site : Elan Corporation plc.

Drilling Location : SW of site (on roadway)

Drilling Contractor : Glover

Supervisor : Teri Hayes Observer : ———

Well No. : MW - 1 Date : 5/9/1994 Time : ———



(a) Protection : Manhole Cover

(b) Casing / lockable : no

(c) Well material : PVC

TOC (msl) : 48.64 msl

Stickup : 0.0 m

(d) Grout Type : NA

Grout Length : NA

(e) Seal Type : Bentonite

Seal Length : 1.0 m

(f) Pack Type : Silica Sand

Pack Length : 4.0 m

(g) Screen Length : 3.0 m

(h) Well Depth (bls) : 6.0 m

(i) Water Level :

(j) Boring Depth (bls) : 6.5 m

(k) Borehole Diameter : 20 cm

(l) Well Diameter : 5 cm

(m) Well cap : Screw Cap

(n) Casing Length : 1.5 m

Casing Diameter : 15 cm

(o) Recovery rate : Very good

(p) Cement pad : Yes

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

Well Construction Log

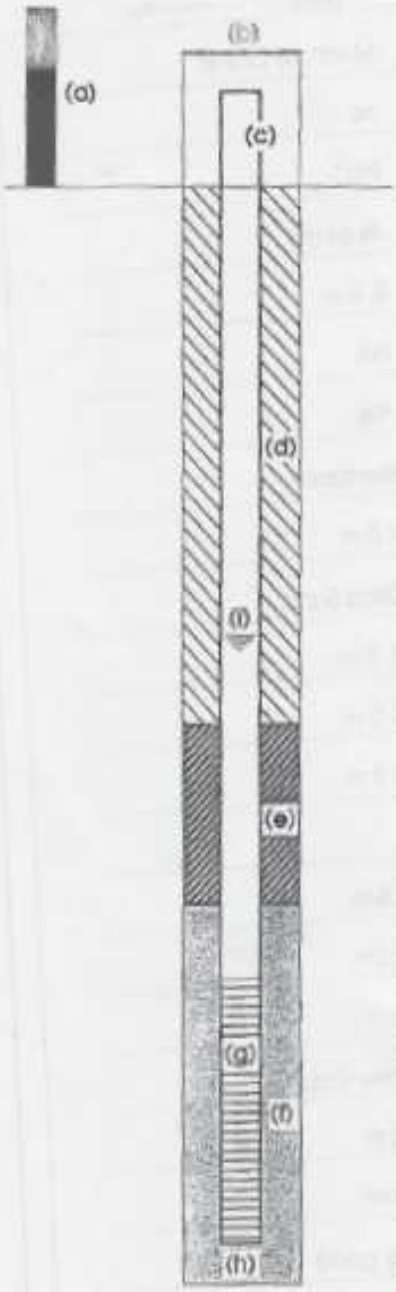
Site : Elan Corporation plc.

Drilling Location : SW of site (on roadway)

Drilling Contractor : Glover

Supervisor : Teri Hayes Observer : ———

Well No. : MW - 2 Date : 6-7/1994 Time : ———



(a) Protection : Manhole Cover

(b) Casing / lockable : no

(c) Well material : PVC

TOC (msl) : 44.89 msl

Stickup : 0.0 m

(d) Grout Type : NA

Grout Length : NA

(e) Seal Type : Bentonite

Seal Length : 1.0 m

(f) Pack Type : Silica Sand

Pack Length : 5.0 m

(g) Screen Length : 4.5 m

(h) Well Depth (bls) : 7.5 m

(i) Water Level : 6.55 m btoc

(j) Boring Depth (bls) : 8.4 m

(k) Borehole Diameter : 20 cm

(l) Well Diameter : 5 cm

(m) Well cap : Screw Cap

(n) Casing Length : 1.5 m

Casing Diameter : 15 cm

(o) Recovery rate : Very good

(p) Cement pad : Yes

T.Cullen & Co. Ltd.

Well Construction Log

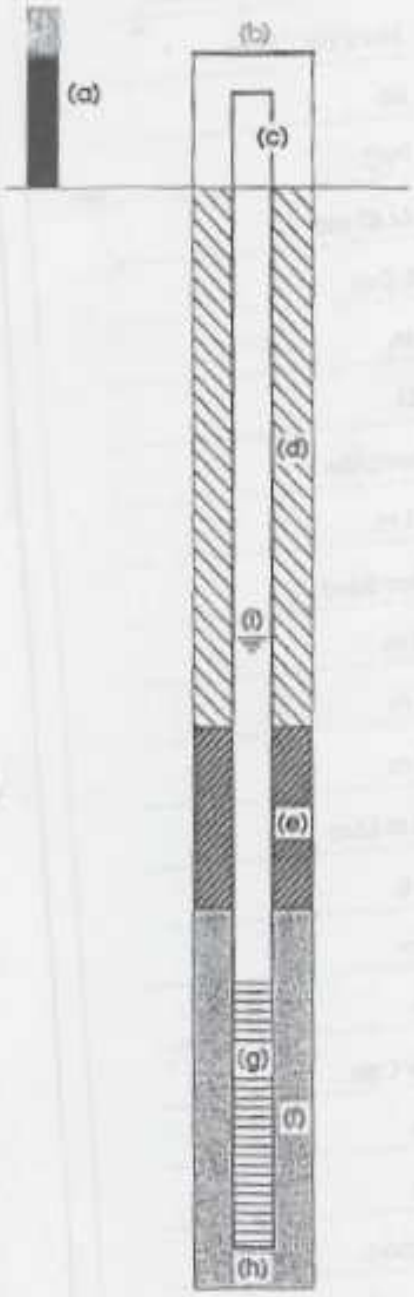
Site : Elan Corporation plc.

Drilling Location : SW of site (on roadway)

Drilling Contractor : Glover

Supervisor : Teri Hayes Observer : ———

Well No. : MW - 3 Date : 8/9/1994 Time : ———



(a) Protection : Manhole Cover

(b) Casing / lockable : no

(c) Well material : PVC

TOC (msl) : 45.165 msl

Stickup : 0.0 m

(d) Grout Type : NA

Grout Length : NA

(e) Seal Type : Bentonite

Seal Length : 1.0 m

(f) Pack Type : Silica Sand

Pack Length : 4.0 m

(g) Screen Length : 3.0 m

(h) Well Depth (bls) : 6.0 m

(i) Water Level : 4.55 m btoc

(j) Boring Depth (bls) : 6.4 m

(k) Borehole Diameter : 20 cm

(l) Well Diameter : 5 cm

(m) Well cap : Screw Cap

(n) Casing Length : 1.5 m

Casing Diameter : 15 cm

(o) Recovery rate : Very good

(p) Cement pad : Yes

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

Well Construction Log

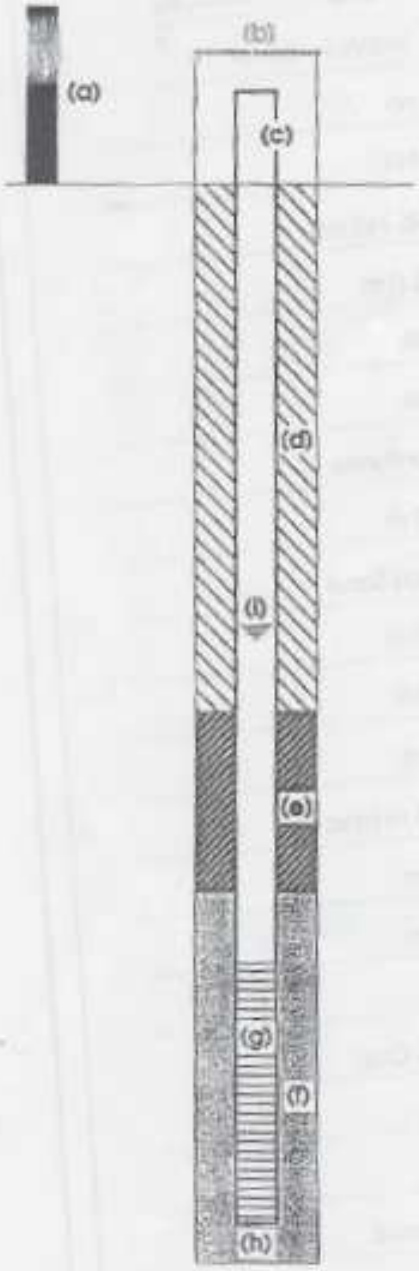
Site : Elan Corporation plc.

Drilling Location : SW of site (on roadway)

Drilling Contractor : Glover

Supervisor : Teri Hayes Observer : ———

Well No. : MW -5 Date : Nov. 18, 1993 Time : ———



(a) Protection : Manhole Cover

(b) Casing / lockable : no

(c) Well material : PVC

TOC (msl) : 44.47 msl

Stickup : 0.0 m

(d) Grout Type : NA

Grout Length : NA

(e) Seal Type : Bentonite

Seal Length : 1.1 m

(f) Pack Type : Silica Sand

Pack Length : 5.0 m

(g) Screen Length : 4.5 m

(h) Well Depth (bls) : 6.3 m

(i) Water Level : 4.75 m btoc

(j) Boring Depth (bls) : 6.5 m

(k) Borehole Diameter : 20 cm

(l) Well Diameter : 5 cm

(m) Well cap : Screw Cap

(n) Casing Length : 1.5 m

Casing Diameter : 15 cm

(o) Recovery rate : Very good

(p) Cement pad : Yes

BORD NA MÓNA

BORD NA MONA ENVIRONMENTAL LIMITED

Log of Borehole: MW-07

Project No: T074

Client: Elan Corporation

Site: Athlone

Location: West side of plant

Date: 05/03/2001

Logged by: Garrett Leech

SUBSURFACE PROFILE				SAMPLE			Well Data	Remarks
Depth	Symbol	Description	Depth/ Elev.	Number	Sample Interval	TOV (ppm)		
1		*..ight Brown Clay*	1				Lockable steel case fitted Bentonite to grout 1m	
2		*Clay/Sand* Light coloured clay with high content (30%) sand content	3				Plain 50mm standpipe	
3								Slotted 50mm PVC standpipe
4		*Sand/Gravel* Dark coloured till with a clay/sand matric containing rounded clasts/cobbles (up to 5cm). Thought to be of glacial origin.	5				Backfilled with washed pea gravel	
5		End of Borehole					After drilling water was sitting at 4.8m	
6								
7								
8								

Drilled By: Glover Site Investigation

Drill Method: Shell & Auger

Drill Date: 05/03/2001

Bord na Móna
Environmental Limited
Main Street
Newbridge
Co. Kildare

Hole Size (mm): 4 inch

Datum (m AOD):

Sheet: 1 of 1

URS Ireland Limited
410/411 Q House,
76 Furze Road, Sandyford,
Dublin 18, Ireland.
Telephone: 01 2933213
Fax: 01 2933201

BOREHOLE LOG

Project Name and Site Location	Client	BOREHOLE No
Alkermes Targeted SI 2014	Alkermes	**MW10d**

Job No	Date	Ground Level (m)	Co-Ordinates ()
47092672	Start Date 08-09-14 End Date 15-09-14		

Contractor	Method / Plant Used	Sheet
AQS / ADP	Disab Vaccum Tanker / Commachio Geo 205	1 of 1

Depth BGL	Sample / Test Details	PID (ppm)	Water	STRATA: Legend	Depth (Thickness)	DESCRIPTION	COMMENTS	Installation / Backfill
0.0					0.10	Reinforced CONCRETE.	NEC	
					0.25	Dense greyish black SAND and GRAVEL. Gravel is fine to coarse and subangular. (FILL)	NEC	
						Medium dense to dense slightly silty slightly gravelly SAND. Gravel is fine to coarse and subangular.	NEC	
						Subrounded cobbles at 2.8 m.		
					(5.25)			
					5.50	Weathered LIMESTONE bedrock.	NEC	
					(2.50)			
					8.00	Competent LIMESTONE bedrock.	NEC	
					(3.00)			
					11.00	EOH @ 11.0 m bgl		

WELL INSTALLATION DETAILS

- Cement seal riser
- Filter pack riser
- Bentonite seal riser
- Filter pack screen
- Hole Collapse

SAMPLE TYPE DETAILS

LEGEND

- Concrete
- Fill (made ground)
- Silty/Clayey Gravelly SAND
- Limestone
- Groundwater Table
- Water Strike

bgl = Below Ground Level

GENERAL REMARKS

NEC - No evidence of Contamination
EOH - End of Hole
m bgl - metres below ground level
Vac Ex to 3.4 m bgl

		Logged By	EJ	Approved By	CF

EXPLORATORY HOLE LOG 21/09/07 BH LOGS GPJ AGS3_ALL.GDT 4/2/15

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BOREHOLE LOG

Project Name and Site Location	Client	BOREHOLE No
Alkermes Targeted SI 2014	Alkermes	**MW11s**

Job No	Date	Ground Level (m)	Co-Ordinates ()
47092672	Start Date 17-09-14 End Date 17-09-14		

Contractor	Method / Plant Used	Sheet
AQS / ADP	Disab Vaccum Tanker / Commachio Geo 205	1 of 1

Depth BGL	Sample / Test Details	PID (ppm)	Water	STRATA: Legend	Depth (Thickness)	DESCRIPTION	COMMENTS	Installation (Backfill)
0.5					0.05	TARMAC	NEC	
1.0					0.30	Very dense grey sandy GRAVEL. Gravel is fine to coarse and angular. (FILL)	NEC	
1.5					(1.50)	Dense brown cobbley gravelly slightly silty SAND. Cobbles are rounded to subrounded. Gravel is fine to coarse and subrounded.	NEC	
2.0					1.80	Loose to medium dense brown gravelly silty SAND. Gravel is fine to coarse and subrounded.	NEC	
2.5								
3.0								
3.5								
4.0								
4.5								
5.0					(6.80)			
5.5								
6.0								
6.5								
7.0								
7.5								
8.0								
8.5					8.60	EOH @ 8.6 m bgl (bedrock)		

WELL INSTALLATION DETAILS

- Cement seal riser
- Filter pack riser
- Bentonite seal riser
- Filter pack screen
- Hole Collapse

SAMPLE TYPE DETAILS

LEGEND

- Tarmac
- Fill (made ground)
- Silty/Clayey Gravelly SAND
- Groundwater Table
- Water Strike

bgl = Below Ground Level

GENERAL REMARKS

NEC - No evidence of Contamination
EOH - End of Hole
m bgl - metres below ground level
Vac Ex to 2.4 m bgl

		Logged By	EJ	Approved By	CF

EXPLORATORY HOLE LOG 2NEW7 BH LOGS GPJ AGS3_ALLGDT 4/2/15

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BOREHOLE LOG

Project Name and Site Location	Client	BOREHOLE No
Alkermes Targeted SI 2014	Alkermes	MW11d

Job No	Date	Ground Level (m)	Co-Ordinates ()
47092672	Start Date 17-09-14 End Date 17-09-14		

Contractor	Method / Plant Used	Sheet
AQS / ADP	Disab Vaccum Tanker / Commachio Geo 205	1 of 1

Depth BGL	Sample / Test Details	PID (ppm)	Water	STRATA: Legend	Depth (Thickness)	DESCRIPTION	COMMENTS	Installation (Backfill)
0.0					0.05	TARMAC	NEC	
					0.30	Very dense grey sandy GRAVEL. Gravel is fine to coarse and angular. (FILL)	NEC	
1.0					(1.50)	Dense brown cobbley gravelly slightly silty SAND. Cobbles are rounded to subrounded. Gravel is fine to coarse and subrounded.	NEC	
					1.80	Loose to medium dense brown gravelly silty SAND. Gravel is fine to coarse and subrounded.	NEC	
5.0			▼		(6.80)			
8.5					8.60	LIMESTONE BEDROCK	NEC	
13.0					(5.40)			
14.0					14.00	EOH @ 14.0 m bgl		

WELL INSTALLATION DETAILS

- Cement seal riser
- Filter pack riser
- Bentonite seal riser
- Filter pack screen
- Hole Collapse

SAMPLE TYPE DETAILS

LEGEND

- Tarmac
- Fill (made ground)
- Silty/Clayey Gravelly SAND
- Limestone
- Groundwater Table
- Water Strike

bgl = Below Ground Level

GENERAL REMARKS

NEC - No evidence of Contamination
EOH - End of Hole
m bgl - metres below ground level
Vac Ex to 2.4 m bgl

Logged By	Approved By
EJ	CF

EXPLORATORY HOLE LOG 21/09/07 BH LOGS GPJ AGS3_ALLGDT 4/2/15

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BOREHOLE LOG

Project Name and Site Location	Client	BOREHOLE No
Alkermes Targeted SI 2014	Alkermes	**MW12s**

Job No	Date	Ground Level (m)	Co-Ordinates ()
47092672	Start Date 22-09-14 End Date 22-09-14		

Contractor	Method / Plant Used	Sheet
AQS / ADP	Disab Vaccum Tanker / Commachio Geo 205	1 of 1

Depth BGL	Sample / Test Details	PID (ppm)	Water	STRATA: Legend	Depth (Thickness)	DESCRIPTION	COMMENTS	Installation Backfill
0.5					0.15	CONCRETE	NEC	
1.0					0.30	Dense brownish grey sandy cobbley GRAVEL. Gravel is fine to coarse and subangular to subrounded. (FILL)	NEC	
1.5						Soft to firm brown very gravelly cobbley slightly silty SAND. Gravel is fine to coarse and subrounded. Cobbles are subrounded to rounded.	NEC	
2.0								
2.5								
3.0						Becoming less gravelly and less cobbley with depth.		
3.5								
4.0								
4.5					(8.10)			
5.0								
5.5								
6.0								
6.5								
7.0								
7.5								
8.0					8.40	EOH @ 8.4 m bgl (bedrock)		

WELL INSTALLATION DETAILS

- Cement seal riser
- Filter pack riser
- Bentonite seal riser
- Filter pack screen
- Hole Collapse

SAMPLE TYPE DETAILS

LEGEND

- Concrete
- Fill (made ground)
- Silty/Clayey Gravelly SAND
- Groundwater Table
- Water Strike

bgl = Below Ground Level

GENERAL REMARKS

NEC - No evidence of Contamination
EOH - End of Hole
m bgl - metres below ground level
Vac Ex to 2.4 m bgl

		Logged By	EJ	Approved By	CF

EXPLORATORY HOLE LOG 21/09/07 BH LOGS.GPJ AGS3_ALLGDT 4/2/15

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BOREHOLE LOG

Project Name and Site Location	Client	BOREHOLE No
Alkermes Targeted SI 2014	Alkermes	**MW12d**

Job No	Date	Ground Level (m)	Co-Ordinates ()
47092672	Start Date 22-09-14 End Date 22-09-14		

Contractor	Method / Plant Used	Sheet
AQS / ADP	Disab Vaccum Tanker / Commachio Geo 205	1 of 1

Depth BGL	Sample / Test Details	PID (ppm)	Water	STRATA: Legend	Depth (Thickness)	DESCRIPTION	COMMENTS	Installations (Backfill)
0.5					0.15	CONCRETE	NEC	
1.0					0.30	Dense brownish grey sandy cobbley GRAVEL. Gravel is fine to coarse and subangular to subrounded. (FILL)	NEC	
1.5						Soft to firm brown very gravelly cobbley slightly silty SAND. Gravel is fine to coarse and subrounded. Cobbles are subrounded to rounded.	NEC	
2.0								
2.5						Becoming less gravelly and less cobbleY with depth.		
3.0								
3.5								
4.0								
4.5					(8.10)			
5.0								
5.5								
6.0								
6.5								
7.0								
7.5								
8.0					8.40			
8.5						LIMESTONE BEDROCK		
9.0								
9.5								
10.0					(3.60)			
10.5								
11.0								
11.5								
12.0					12.00			
						EOH @ 12.0 m bgl		

WELL INSTALLATION DETAILS

- Cement seal riser
- Filter pack riser
- Bentonite seal riser
- Filter pack screen

SAMPLE TYPE DETAILS

LEGEND

- Concrete
- Fill (made ground)
- Silty/Clayey Gravelly SAND
- Limestone
- Groundwater Table
- Water Strike

bgl = Below Ground Level

GENERAL REMARKS

NEC - No evidence of Contamination
EOH - End of Hole
m bgl - metres below ground level
Vac Ex to 2.4 m bgl

		Logged By	EJ	Approved By	CF

EXPLORATORY HOLE LOG 21/09/07 BH LOGS GPJ AGSI_ALL.GDT 4/2/15

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URS

BOREHOLE LOG

Project Name and Site Location	Client	BOREHOLE No
Alkermes Targeted SI 2014	Alkermes	MW13s

Job No	Date	Ground Level (m)	Co-Ordinates ()
47092672	Start Date 10-09-14 End Date 18-09-14		

Contractor	Method / Plant Used	Sheet
AQS / ADP	Disab Vaccum Tanker / Commachio Geo 205	1 of 1

Depth BGL	Sample / Test Details	PID (ppm)	Water	STRATA: Legend	Depth (Thickness)	DESCRIPTION	COMMENTS	Installation (Backfill)
0.5					0.05	TARMAC	NEC	
1.0					0.35	Dense grey brown sandy GRAVEL. Gravel is fine to coarse and subangular. (FILL)	NEC	
1.5						Medium dense to dense brown very cobbley very gravelly silty SAND with occasional boulders. Cobbles are rounded to subrounded. Gravel fine to coarse and subrounded.	NEC	
2.0								
2.5								
3.0								
3.5								
4.0					(7.65)			
4.5								
5.0								
5.5								
6.0								
6.5								
7.0								
7.5								
8.0					8.00	EOH @ 8.0 m bgl (bedrock)		

WELL INSTALLATION DETAILS

- Cement seal riser
- Filter pack riser
- Bentonite seal riser
- Filter pack screen
- Hole Collapse

SAMPLE TYPE DETAILS

LEGEND

- Tarmac
- Fill (made ground)
- Silty/Clayey Gravelly SAND
- Groundwater Table
- Water Strike

bgl = Below Ground Level

GENERAL REMARKS

NEC - No evidence of Contamination
EOH - End of Hole
m bgl - metres below ground level
Vac Ex to 2.4 m bgl

		Logged By	EJ	Approved By	CF

EXPLORATORY HOLE LOG 21/05/07 BH LOGS GPJ AGS3 ALLGDT 4/2/15

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BOREHOLE LOG

Project Name and Site Location	Client	BOREHOLE No
Alkermes Targeted SI 2014	Alkermes	MW13d

Job No	Date	Ground Level (m)	Co-Ordinates ()
47092672	Start Date 10-09-14 End Date 18-09-14		

Contractor	Method / Plant Used	Sheet
AQS / ADP	Disab Vaccum Tanker / Commachio Geo 205	1 of 1

Depth BGL	Sample / Test Details	PID (ppm)	Water	STRATA: Legend	Depth (Thickness)	DESCRIPTION	COMMENTS	Installation / Backfill
0.0					0.05	TARMAC	NEC	
					0.35	Dense grey brown sandy GRAVEL. Gravel is fine to coarse and subangular. (FILL)	NEC	
						Medium dense to dense brown very cobbley very gravelly silty SAND with occasional boulders. Cobbles are rounded to subrounded. Gravel fine to coarse and subrounded.	NEC	
					(7.65)			
					8.00	LIMESTONE BEDROCK	NEC	
					(4.40)			
					12.40	EOH @ 12.4 m bgl		

WELL INSTALLATION DETAILS

- Cement seal riser
- Filter pack riser
- Bentonite seal riser
- Filter pack screen
- Hole Collapse

SAMPLE TYPE DETAILS

LEGEND

- Tarmac
- Fill (made ground)
- Silty/Clayey Gravelly SAND
- Limestone
- Groundwater Table
- Water Strike

bgl = Below Ground Level

GENERAL REMARKS

NEC - No evidence of Contamination
EOH - End of Hole
m bgl - metres below ground level
Vac Ex to 2.4 m bgl

		Logged By	EJ	Approved By	CF

EXPLORATORY HOLE LOG 21/05/07 BH LOGS.GPJ AGS3_ALL.GDT 4/2/15

APPENDIX B

Table 1 - Summary of Drilling and Well Installations at APIL and Arran Chemicals, Monksland, Athlone

Location	Site	Function/Status	Installation Date	Ground Elevation	Top of Well Casing Elevation			Grid Co-Ordinates[4]		Overburden		Weathered Bedrock		Depth to Competent Bedrock	Total Depth Drilled		Reported Depth Installed	Total Depth Gauged[5]	Top of Screen Section	Base of Screen Section	Screened Unit	Siltation
				m OD	m OD[1]	m OD[2]	m OD[3]	Easting (m)	Northing (m)	Thickness m	Description	Depth m bgl	Description	m bgl	m bgl	Justification	m bgl	m bct	m bct	m bct		m
MW1S	Alkermes Pharma International Ltd.	Monitoring well	1994	48.738	48.640	-	48.661	201025.672	241073.108	>6.50	Clayey gravel with cobbles and boulders	Not proven	-	Not proven	6.50	Target depth	6.00	6.27	3.00	6.00	Overburden	-
MW1D		Monitoring well	Pre 2000	48.802	-	48.372	48.774	201028.494	241072.901	-	-	-	-	-	-	-	9.53	9.34	-	-	Probably Bedrock	0.19
MW2		Monitoring well, decommissioned	1994	44.800	44.900	44.630	-	-	-	>8.4	Boulder clay	Not proven	-	Not proven	8.40	Target depth	7.50	5.36	3.00	7.50	Overburden	2.14
MW2S		Replacement monitoring well	2011	44.815	-	-	44.698	201074.928	240917.178	>8.5	Made ground on sandy clay/silt followed by sandy gravel/gravelly sand.	Not proven	-	Not proven	8.50	Target depth	8.50	8.27	3.50	8.50	Overburden	0.23
MW2D		Monitoring well	2011	44.808	-	-	44.675	201078.603	240907.842	9.80	Made ground on sandy clay/silt followed by sandy gravel.	-	-	9.80	15.00	Target depth	15.00	14.93	11.93	14.93	Limestone bedrock	0.07
MW3		Monitoring well, replaced	1994	44.920	45.165	44.897	-	-	-	>6.4	Boulder clay	Not proven	-	Not proven	6.40	Refusal (on boulders)	6.00	-	3.00	6.00	Overburden	-
		Replacement monitoring well	Sep/Nov-2003	45.960	-	44.897[6]	45.809	200917.954	240873.815	-	-	-	-	-	-	-	-	8.31	-	-	Probably Overburden	-
MW3D		Monitoring well	Pre May-2003	45.953	-	-	45.798	200918.026	240875.375	-	-	-	-	-	-	-	-	18.46	-	-	Probably Bedrock	-
MW4		Monitoring well	1994	44.257	45.250	44.982 and 44.897	44.289	200843.801	240885.840	>7.7	Boulder clay	Not proven	-	Not proven	7.70	Refusal (on boulders)	7.70	6.95	Not recorded, but reported to be 3 m in length		Overburden	0.75
MW5		Monitoring well	1994	44.423	44.475	44.207, 44.417 and 44.447[6]	44.356	200797.804	240929.544	>6.3	Boulder clay	Not proven	-	Not proven	at least 6.00	Target depth	6.30	7.98	1.80	6.30	Overburden	-
MW6		Monitoring well	Pre 2000	46.097	-	-	45.987	200799.589	241017.173	-	-	-	-	-	-	-	-	8.62	-	-	Probably Overburden	-
MW7		Monitoring well	Pre 2000	46.890	-	-	46.616	200758.004	241052.290	-	-	-	-	-	-	-	-	3.77	-	-	Probably Overburden	-
MW8S		Monitoring well	2012	-	-	-	45.500	200958.933	240949.684	4.00	Light brown sand	4.00	-	-	4.00	Target depth	4.00	3.96	0.96	3.96	Overburden	0.04
MW8D		Monitoring well	2012	-	-	-	45.580	200956.408	240950.167	4.20	Light brown sand	4.20	Fine, angular greyish black limestone	8.50	11.10	Target depth	10.93	10.93	7.93	10.93	Limestone bedrock	0.00
MW9S		Monitoring well	2012	-	-	-	46.650	200981.432	240995.240	5.00	Light brown sandy silt	5.00	-	-	5.00	Target depth	5.00	4.94	1.00	5.00	Overburden	0.06
MW9D		Monitoring well	2012	-	-	-	46.580	200981.691	240991.095	6.50	Light brown sandy gravelly silt	6.50	Fine, angular dark grey limestone	11.20	14.50	Target depth	14.50	14.47	11.47	14.47	Limestone bedrock	0.03
MW10D		Monitoring well	2014	-	-	-	46.566	200961.450	240970.587	5.50	Brown gravelly silty sand	5.50	Weathered, fractured limestone	8.00	11.00	Target depth	10.20	10.00	8.20	10.00	Limestone bedrock	0.20
MW11S		Monitoring well	2014	-	-	-	45.923	200798.414	241019.596	8.60	Brown gravelly silty sand	8.60	-	-	8.60	Target depth	8.30	7.50	6.60	7.50		0.80
MW11D		Monitoring well	2014	-	-	-	46.039	200799.414	241020.597	8.60	Brown gravelly silty sand	8.60	-	-	14.00	Target depth	13.50	13.40	10.50	13.40	Limestone bedrock	0.10
MW12S		Monitoring well	2014	-	-	-	45.377	200803.415	240973.587	8.40	Brown gravelly silty sand	8.40	-	-	8.40	Target depth	8.10	7.41	6.10	7.41		0.69
MW12D		Monitoring well	2014	-	-	-	45.235	200803.415	240971.586	8.40	Brown gravelly silty sand	8.40	-	-	12.00	Target depth	12.00	11.41	9.00	11.41	Limestone bedrock	0.59
MW13S		Monitoring well	2014	-	-	-	44.360	200805.416	240930.577	8.00	Brown gravelly silty sand	8.00	-	-	8.00	Target depth	7.80	6.53	5.80	6.53		1.27
MW13D		Monitoring well	2014	-	-	-	44.384	200805.416	240932.578	8.00	Brown gravelly silty sand	8.00	-	-	12.40	Target depth	12.00	11.69	9.00	11.69	Limestone bedrock	0.31
BH101		Monitoring well	2009	37.629	-	-	39.072	200493.886	240587.523	8.00	Peat on alternating soft clay and loose sand	8.00	Loose, angular limestone gravel	Not proven	12.00	Refusal	12.00	6.62	9.00	12.00	Angular limestone gravel (weathered bedrock)	5.39
BH102		Borehole	2009	-	NR			-	-	>4.00	Peat on dense sand, soft clay, and terminating in dense, angular gravel	Not proven	-	Not proven	4.00	Target depth	Not installed as a monitoring well					
BH103		Borehole	2009	-	NR			-	-	>3.00	Peat on dense sand, dense gravel, and terminating in soft clay	Not proven	-	Not proven	3.00	Target depth	Not installed as a monitoring well					

Table 1 - Summary of Drilling and Well Installations at APIL and Arran Chemicals, Monksland, Athlone

Location	Site	Function/Status	Installation Date	Ground Elevation	Top of Well Casing Elevation			Grid Co-Ordinates[4]		Overburden		Weathered Bedrock		Depth to Competent Bedrock	Total Depth Drilled		Reported Depth Installed	Total Depth Gauged[5]	Top of Screen Section	Base of Screen Section	Screened Unit	Siltation
				m OD	m OD[1]	m OD[2]	m OD[3]	Easting (m)	Northing (m)	Thickness m	Description	Depth m bgl	Description	m bgl	m bgl	Justification	m bgl	m bct	m bct	m bct		m
BH104		Monitoring well	2009	45.624	-	-	46.121	200964.444	240855.119	8.50	Peat on dense sand at first then loose sand	Absent	-	8.50	10.00	Target depth	10.00	8.78	8.25	10.00	Limestone bedrock	1.23
BH105		Monitoring well	2009	40.544	-	-	40.510	200611.090	240698.741	4.00	Loose sand on gravel and gravelly clay.	4.00	Loose angular gravel	4.50	7.50	Target depth	7.50	7.74	5.00	7.50	Limestone bedrock	-
BH106		Monitoring well	2009	43.927	-	-	44.422	200845.221	240750.810	6.00	Sand on gravel, peat, stiff silt and soft clay.	6.00	Loose angular gravel	6.50	8.50	Target depth	8.50	7.01	6.00	8.50	Weathered and competent limestone bedrock	1.49
BH107		Monitoring well	2011	43.194	NR		43.397	200723.793	240731.299	7.20	Made ground on slightly gravelly, clayey sand, followed by sandy clay/silt.	7.20	Weathered, fractured limestone	Not proven	7.40	Target depth	7.40	7.64	4.64	7.64	Sandy/clay silt and top of weatehred limestone bedrock	-
DP01		Dynamic probe	2008	-	NR			-	-	5.40	-	-	-	5.40	5.40	Refusal	Not installed as a monitoring well					
DP02		Dynamic probe	2008	-	NR			-	-	7.40	-	-	-	6.40	7.40	Refusal	Not installed as a monitoring well					
DP03		Dynamic probe	2008	-	NR			-	-	6.30	-	-	-	7.40	6.30	Refusal	Not installed as a monitoring well					
DP04		Dynamic probe	2008	-	NR			-	-	6.90	-	-	-	8.40	6.90	Refusal	Not installed as a monitoring well					
PW1/WW1		Abstraction well	Jan-1995	51.772	-	52.085	52.227	200812.450	241106.695	-	-	-	-	-	-	-	33.00	-	-	-	Probably Bedrock	-
PW2		Abstraction well	-	51.572	-	-	51.857	200807.575	241105.119	-	-	-	-	-	-	-	-	-	-	-	Probably Bedrock	-
PW3		Abstraction well, not operational	1999[6]	49.218	-	-	49.379	201047.529	241116.007	10.00[6]	8 m of clay and 2 m of coarse gravel	-	-	10.00[6]	92.00[6]	-	92.00[6]	-	-	-	Probably Bedrock	-
PW4		Abstraction well	-	46.699	-	-	47.010	201105.937	240988.236	-	-	-	-	-	-	-	-	-	-	-	Probably Bedrock	-
PW5		Abstraction well	-	47.044	-	-	-	201108.667	240993.670	-	-	-	-	-	-	-	-	-	-	-	Probably Bedrock	-
TW1		Trial well	Pre Apr-1997	-	-	52.302	-	-	-	-	-	-	-	-	-	-	-	-	-	-	Probably Bedrock	-
TW2		Trial well	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	Probably Bedrock	-
AMW1	Arran Chemicals	Monitoring well	Pre Mar-1997	45.809	-	45.972	45.647	200733.834	241044.373	-	-	-	-	-	8.20[6]	-	8.10[5]	7.92	4.00[6]	8.20[6,7]	Overburden, sand	0.28
AMW2		Monitoring well	Pre Mar-1997	44.971	-	44.965	45.013	200789.793	240973.693	-	-	-	-	-	7.65[6]	-	7.65[5]	7.59	4.35[6]	7.65[6]	Overburden, sand	0.06
AMW3		Monitoring well	Pre Mar-1997	45.395	-	45.412	45.394	200688.696	240920.339	-	-	-	-	-	7.00[6]	-	7.00[5]	6.97	4.50[6]	7.00[6]	Overburden, sand and gravel	0.03
AMW4		Monitoring well	Pre Jul-1997	44.991	-	45.074	44.918	200720.834	240903.980	8.30[6]	Sand and gravel	-	-	8.30[6]	24.75[6]	-	20.30[6]	18.74	16.80[6]	24.75[6,7]	Bedrock	9.01
AMW5		Monitoring well	Pre Jul-1997	44.994	-	45.034	44.933	200718.370	240903.659	8.30[6]	Sand and gravel	-	-	-	11.50[6]	-	8.40[5]	7.20	4.80[6]	8.60[6,7]	Overburden, sand and gravel	1.40
AMW6		Monitoring well	Pre Jul-1997	45.059	-	45.103	45.061	200731.423	240981.142	9.30[6]	Sand and gravel	-	-	9.30[6]	24.70[6]	-	24.20[6]	23.72	20.50[6]	24.70[6,7]	Bedrock	0.98
AMW7		Monitoring well	Pre Oct-1997	43.866	-	43.970	43.436	200779.649	240842.962	7.35[6]	Sand	-	-	7.35[6]	30.70[6]	-	27.50[6]	27.00	22.00[6]	30.70[6,7]	Bedrock	3.70
AMW8		Monitoring well	Pre Oct-1997	43.971	-	44.040	43.500	200785.182	240842.698	7.35[6]	Sand	-	-	7.35[6]	11.00[6]	-	11.00[6]	11.01	3.60[6]	11.00[6]	Overburden and bedrock	-
AMW9		Monitoring well	Pre Jan-1999	43.945	-	44.150	43.442	200790.292	240842.758	7.35[6]	Sand	-	-	7.35[6]	60.96[6]	-	58.80[6]	>30	51.80[6]	60.96[6,7]	Bedrock	-

Notes:

-: Indicates data not available.

NR: Not relevant.

Grey font indicates well decommissioned and no longer in existence, or superceded data.

1: Top of well casing elevation reported by KT Cullen (1994), Environmental Site Assessment Phase II, report reference #632-Dec 1994.

2: Top of well casing elevation reported by Minerex Environmental Ltd. (2004), Arran Chemical Company Ltd. 2004 Review of Hydrochemistry and Plume Migration, report reference 1099-342 (Final).

3: Top of well casing elevation as measured realtive to Ordnance Datum (Malin Head), ins surveys condcuted in 2011 and 2012.

4: Grid co-ordinates as measured relative to Irish National Grid Reference, 01 September 2011.

5: Total depth as guaged on 01 September 2011.

6: Reported by Minerex Environmental Ltd. (2011), Arran Chemical Company Ltd. 2011 Review of Hydrochemistry and Plume Migration, repcrt reference 1099-558 (Final).

7: Base of screen section is reported to be deeper than the reported depth of well installation.

APPENDIX C

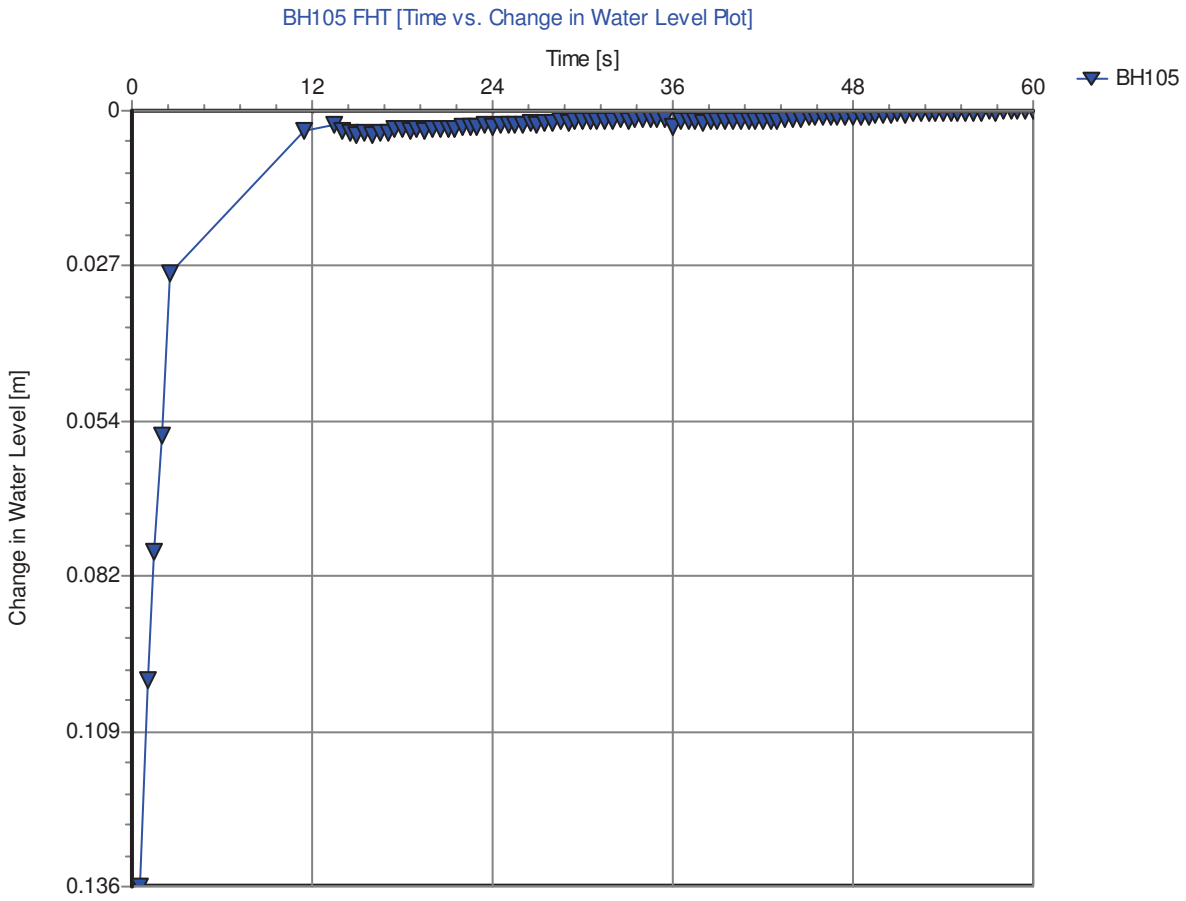
URS Scott Wilson
Acorn Business Campus
Mahon Ind. Pk., Blackrock, Cork
Phone 00353(0)21 4536137

Slug Test Analysis Report

Project: Elan SI 2011

Number: 46403003

Client: Elan Pharma Ltd



Slug Test: **BH105 FHT**

Analysis Method: **Time vs. Change in Water Level Plot**

Analysis Results:

Test parameters:				
	Test Well:	BH105	Aquifer Thickness:	10 [m]
	Casing radius:	0.025 [m]		
	Screen length:	2.5 [m]		
	Boring radius:	0.075 [m]		

Comments: Well construction details known, water level is within screen section. Well is not fully penetrating.

Evaluated by: EO H

Evaluation Date: 9/9/2011

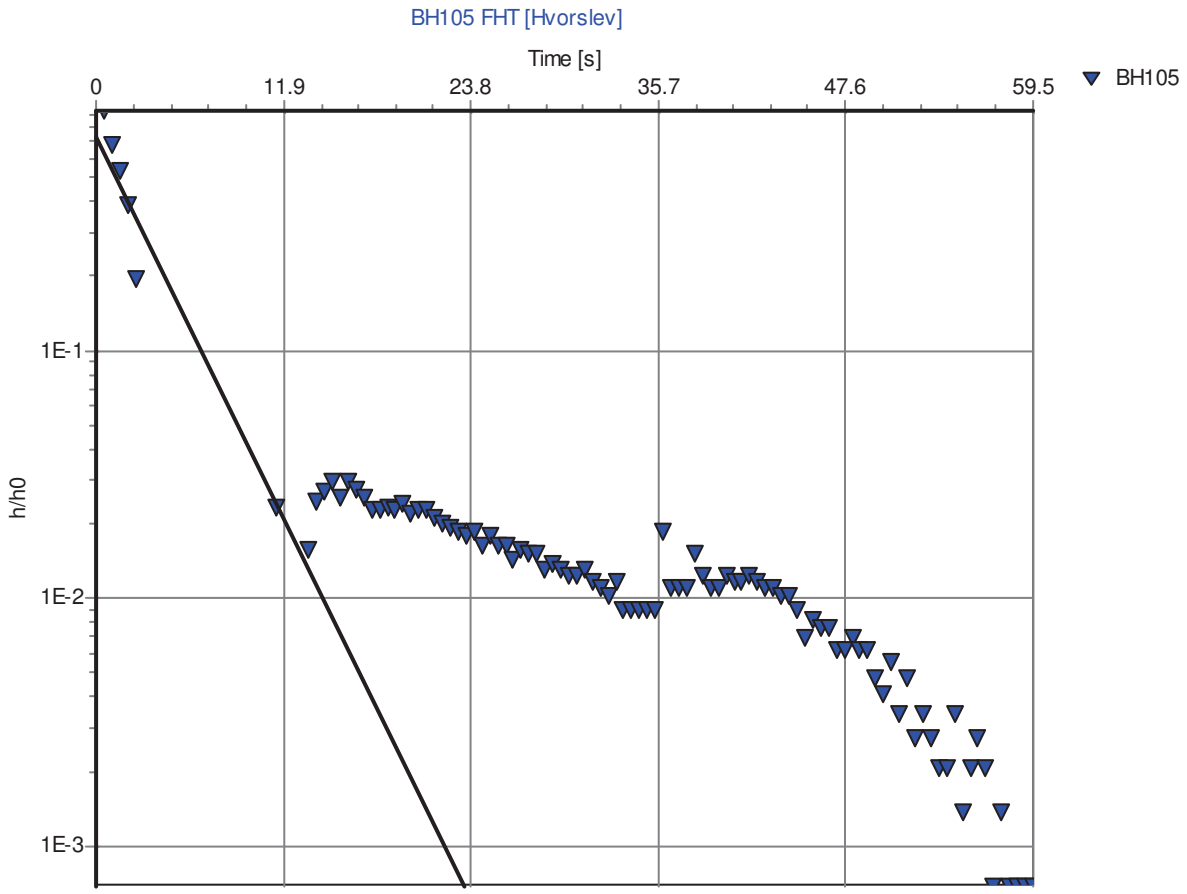
URS Scott Wilson
Acorn Business Campus
Mahon Ind. Pk., Blackrock, Cork
Phone 00353(0)21 4536137

Slug Test Analysis Report

Project: Elan SI 2011

Number: 46403003

Client: Elan Pharma Ltd



Slug Test: **BH105 FHT**

Analysis Method: **Hvorslev**

Analysis Results:

Conductivity: 1.31E-4 [m/s]

Test parameters:

Test Well:	BH105	Aquifer Thickness:	10 [m]
Casing radius:	0.025 [m]		
Screen length:	2.5 [m]		
Boring radius:	0.075 [m]		

Comments: Well construction details known, water level is above top of screen section.

Evaluated by: EO H

Evaluation Date: 9/9/2011

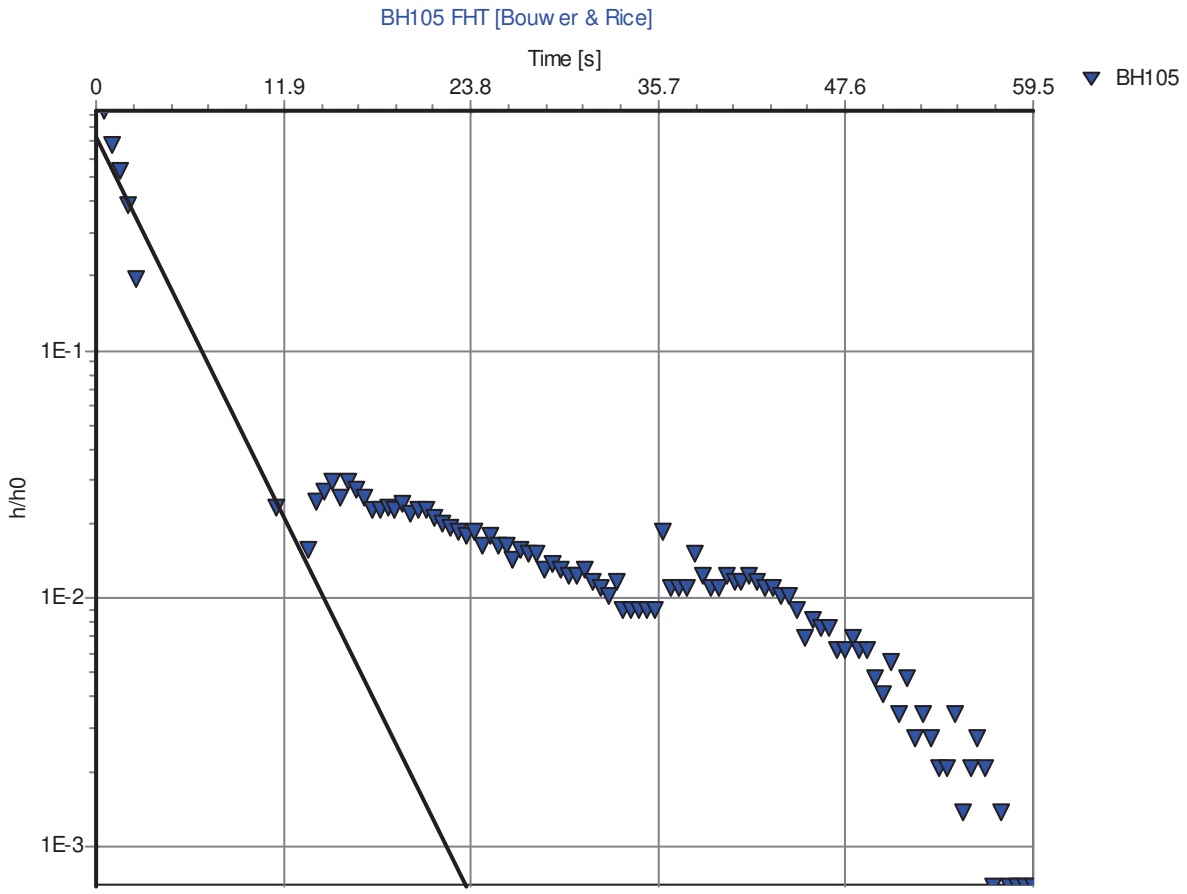
URS Scott Wilson
Acorn Business Campus
Mahon Ind. Pk., Blackrock, Cork
Phone 00353(0)21 4536137

Slug Test Analysis Report

Project: Elan SI 2011

Number: 46403003

Client: Elan Pharma Ltd



Slug Test: **BH105 FHT**

Analysis Method: **Bouwer & Rice**

Analysis Results:

Conductivity: 9.78E-5 [m/s]

Test parameters:

Test Well:	BH105	Aquifer Thickness:	10 [m]
Casing radius:	0.025 [m]	Gravel Pack Porosity (%)	25
Screen length:	2.5 [m]		
Boring radius:	0.075 [m]		
r(eff):	0.043 [m]		

Comments: Well construction details known, water level is above top of screen section. Well is not fully penetrating.

Evaluated by: EO H

Evaluation Date: 9/9/2011

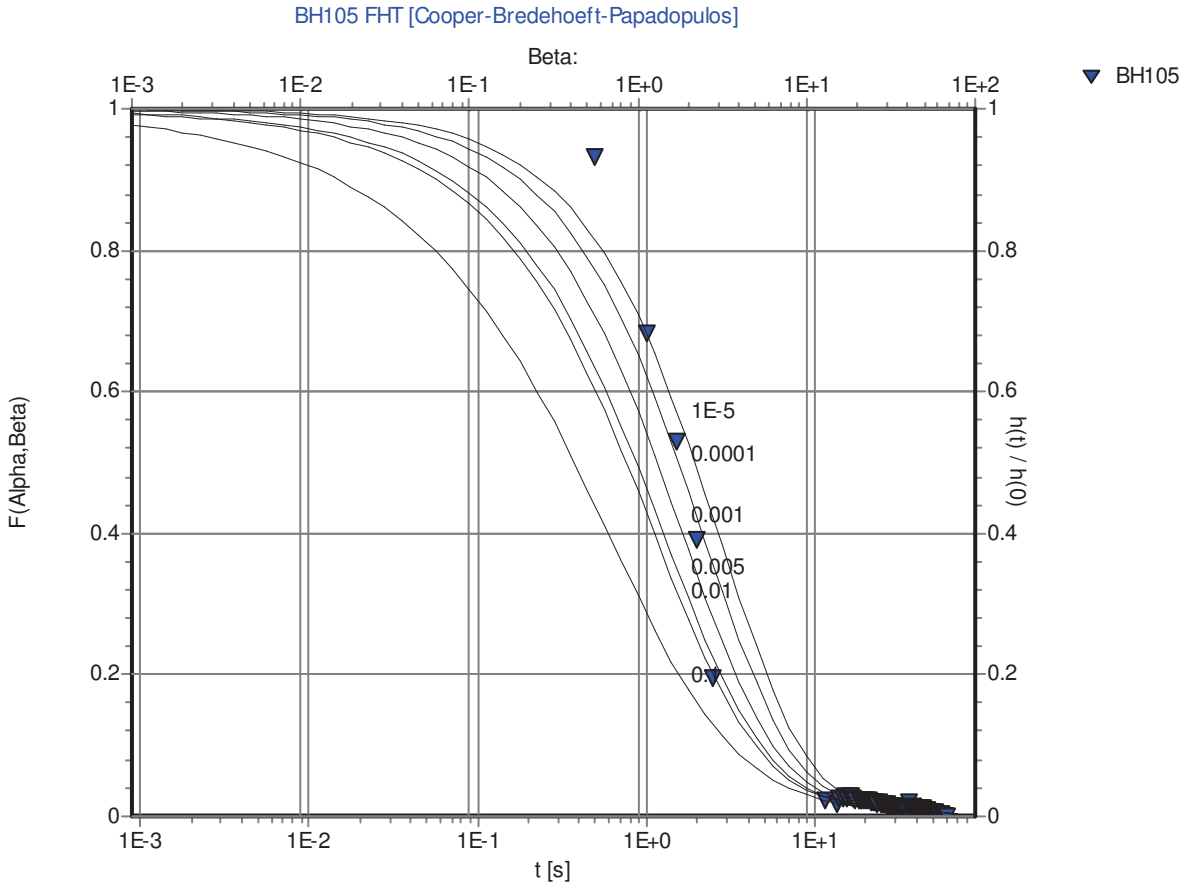
URS Scott Wilson
Acorn Business Campus
Mahon Ind. Pk., Blackrock, Cork
Phone 00353(0)21 4536137

Slug Test Analysis Report

Project: Elan SI 2011

Number: 46403003

Client: Elan Pharma Ltd



Slug Test: **BH105 FHT**

Analysis Method: **Cooper-Bredehoeft-Papadopulos**

Analysis Results:	Transmissivity:	7.01E-4 [m²/s]	Conductivity:	7.01E-5 [m/s]
	Storativity:	5.00E-3		
Test parameters:	Test Well:	BH105	Aquifer Thickness:	10 [m]
	Casing radius:	0.025 [m]	Alpha:	0.005
	Screen length:	2.5 [m]		
	Boring radius:	0.075 [m]		
	r(c):	0.025 [m]		

Comments:

Evaluated by: EO H

Evaluation Date: 9/9/2011

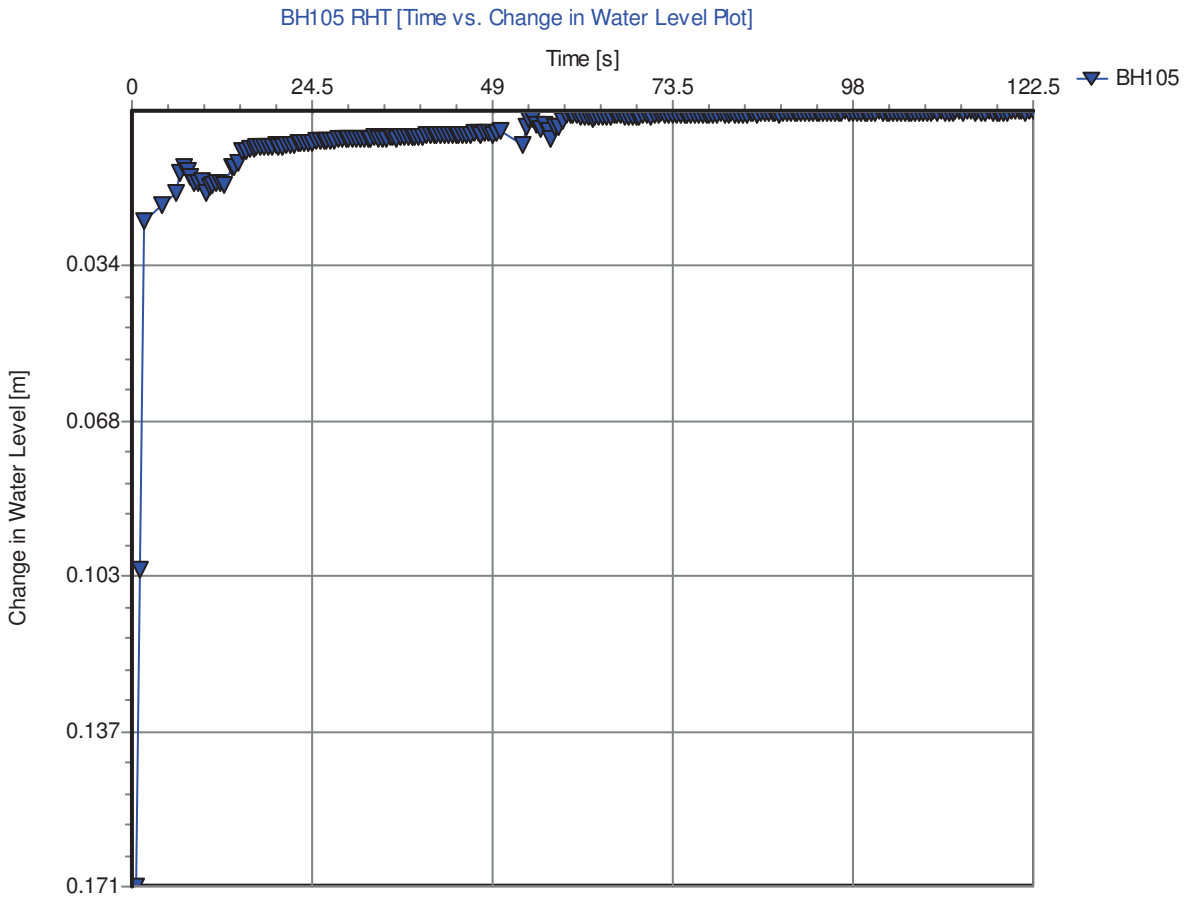
URS Scott Wilson
Acorn Business Campus
Mahon Ind. Pk., Blackrock, Cork
Phone 00353(0)21 4536137

Slug Test Analysis Report

Project: Elan SI 2011

Number: 46403003

Client: Elan Pharma Ltd



Slug Test: **BH105 RHT**

Analysis Method: **Time vs. Change in Water Level Plot**

Analysis Results:

Test parameters:				
	Test Well:	BH105	Aquifer Thickness:	10 [m]
	Casing radius:	0.025 [m]		
	Screen length:	2.5 [m]		
	Boring radius:	0.075 [m]		

Comments: Well construction details known, water level is within screen section. Well is not fully penetrating.

Evaluated by: EO H

Evaluation Date: 9/9/2011

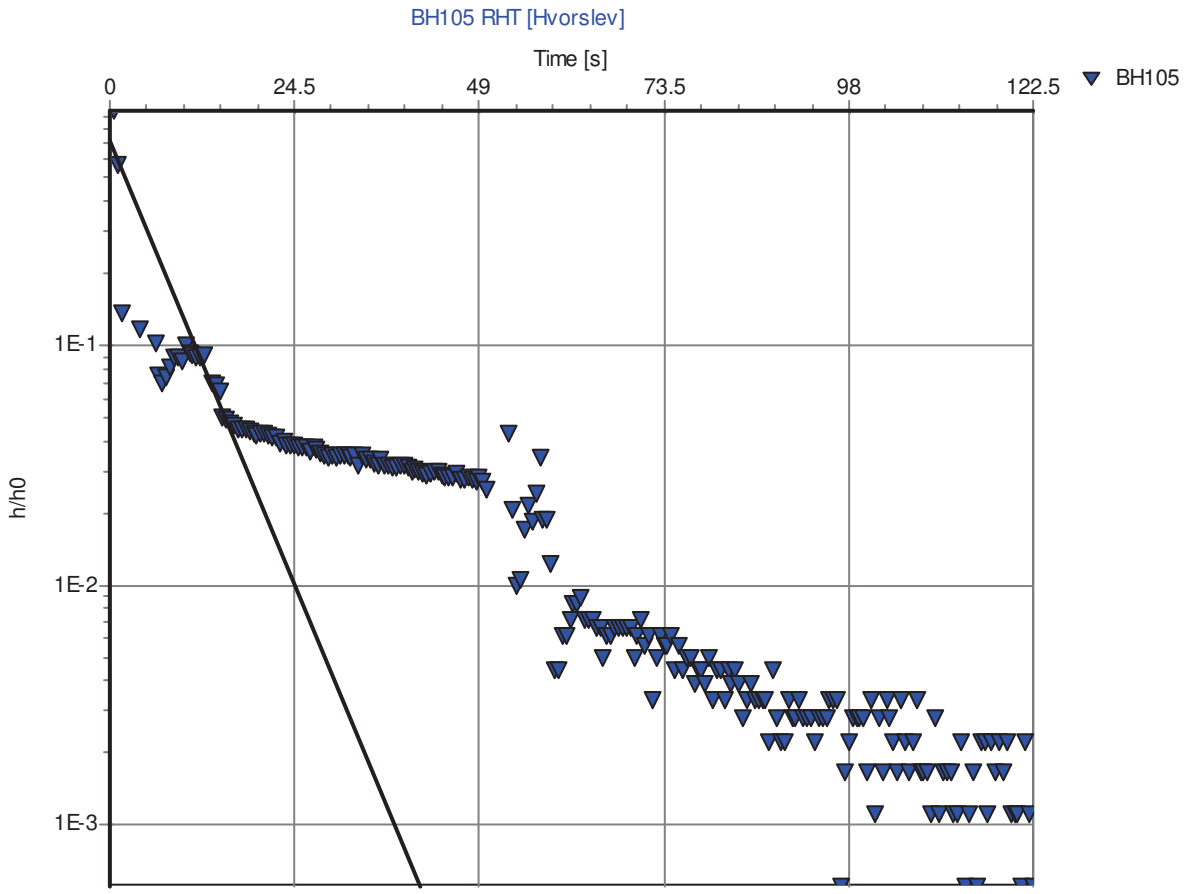
URS Scott Wilson
Acorn Business Campus
Mahon Ind. Pk., Blackrock, Cork
Phone 00353(0)21 4536137

Slug Test Analysis Report

Project: Elan SI 2011

Number: 46403003

Client: Elan Pharma Ltd



Slug Test: **BH105 RHT**

Analysis Method: **Hvorslev**

Analysis Results:

Conductivity: 7.67E-5 [m/s]

Test parameters:

Test Well:	BH105	Aquifer Thickness:	10 [m]
Casing radius:	0.025 [m]		
Screen length:	2.5 [m]		
Boring radius:	0.075 [m]		

Comments: Well construction details known, water level is above top of screen section.

Evaluated by: EO H

Evaluation Date: 9/9/2011

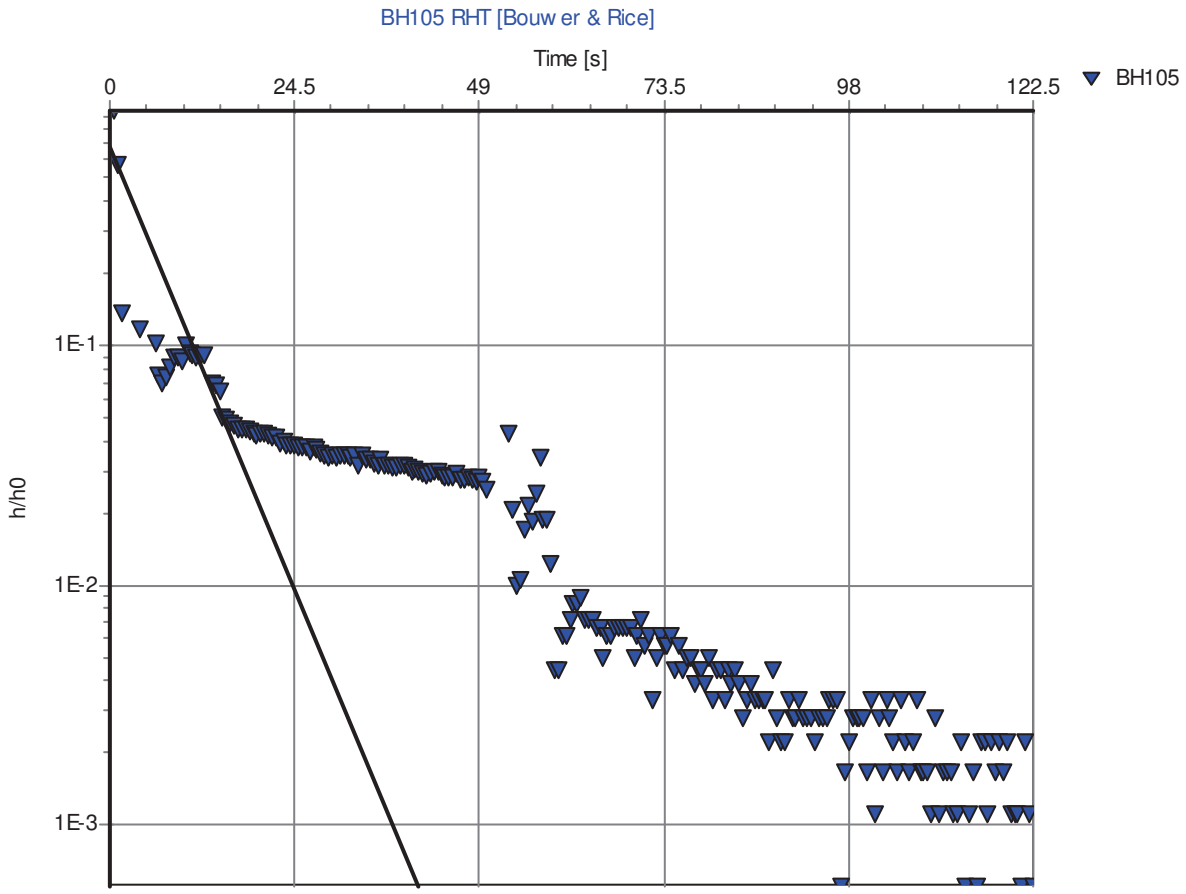
URS Scott Wilson
Acorn Business Campus
Mahon Ind. Pk., Blackrock, Cork
Phone 00353(0)21 4536137

Slug Test Analysis Report

Project: Elan SI 2011

Number: 46403003

Client: Elan Pharma Ltd



Slug Test: **BH105 RHT**

Analysis Method: **Bouwer & Rice**

Analysis Results:

Conductivity: 5.69E-5 [m/s]

Test parameters:

Test Well:	BH105	Aquifer Thickness:	10 [m]
Casing radius:	0.025 [m]	Gravel Pack Porosity (%)	25
Screen length:	2.5 [m]		
Boring radius:	0.075 [m]		
r(eff):	0.043 [m]		

Comments: Well construction details known, water level is above top of screen section. Well is not fully penetrating.

Evaluated by: EO H

Evaluation Date: 9/9/2011

URS Scott Wilson
Acorn Business Campus
Mahon Ind. Pk., Blackrock, Cork
Phone 00353(0)21 4536137

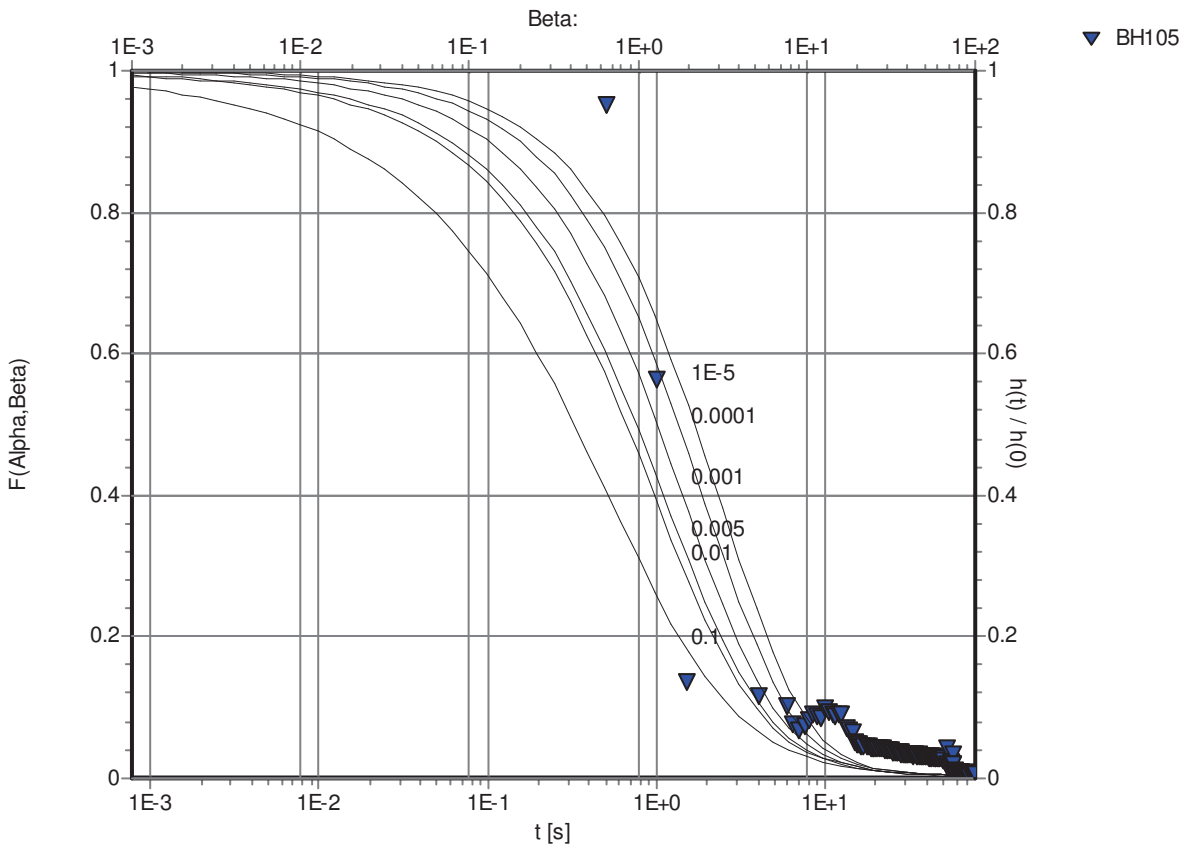
Slug Test Analysis Report

Project: Elan SI 2011

Number: 46403003

Client: Elan Pharma Ltd

BH105 RHT [Cooper-Bredehoeft-Papadopulos]



Slug Test: **BH105 RHT**

Analysis Method: **Cooper-Bredehoeft-Papadopulos**

Analysis Results:	Transmissivity:	8.05E-4 [m²/s]	Conductivity:	8.05E-5 [m/s]
	Storativity:	5.00E-3		
Test parameters:	Test Well:	BH105	Aquifer Thickness:	10 [m]
	Casing radius:	0.025 [m]	Alpha:	0.005
	Screen length:	2.5 [m]		
	Boring radius:	0.075 [m]		
	r(c):	0.025 [m]		

Comments:

Evaluated by: EO H

Evaluation Date: 9/9/2011

URS Scott Wilson
Acorn Business Campus
Mahon Ind. Pk., Blackrock, Cork
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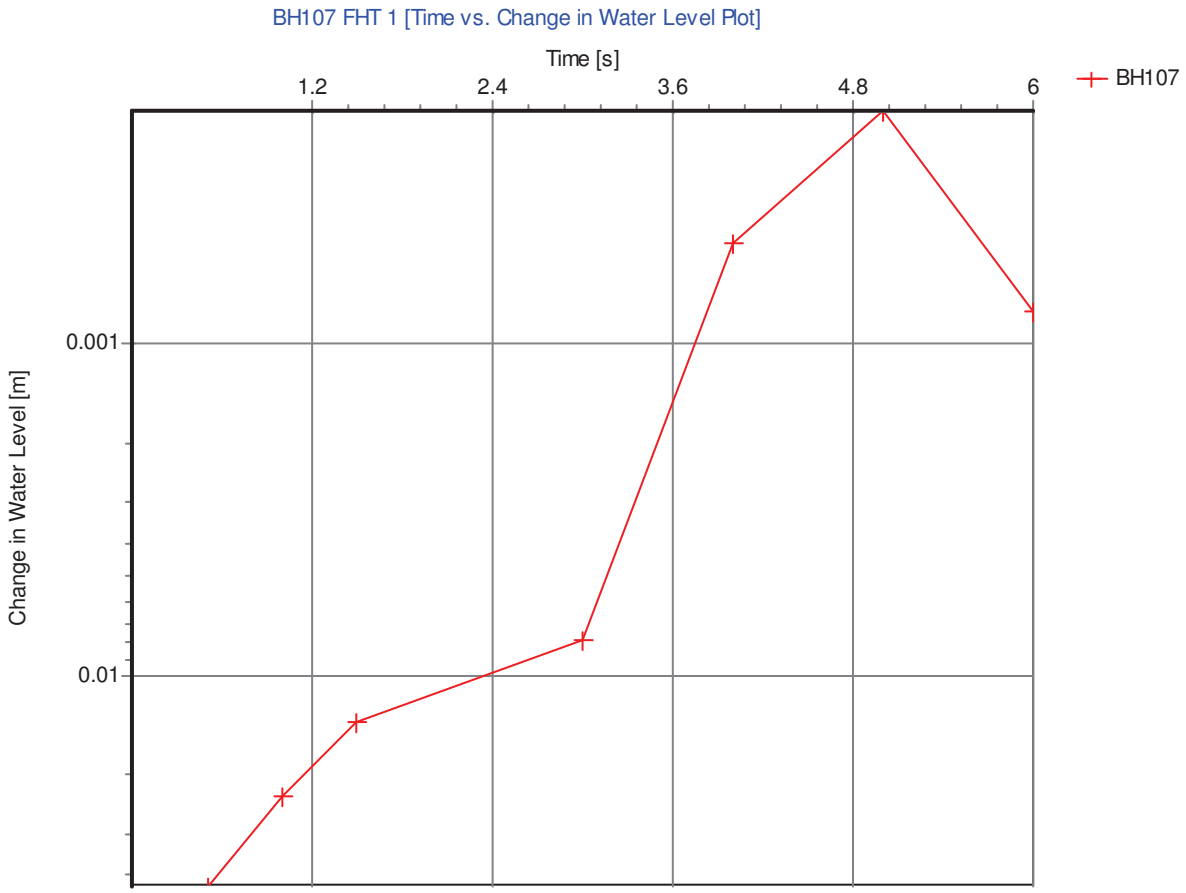
Slug Test Analysis Report

Project: Elan SI 2011

Number: 46403003

Client: Elan Pharma Ltd



Slug Test: **BH107 FHT 1**

Analysis Method: **Time vs. Change in Water Level Plot**

Analysis Results:

Test parameters:				
	Test Well:	BH107	Aquifer Thickness:	3.09 [m]
	Casing radius:	0.025 [m]		
	Screen length:	3 [m]		
	Boring radius:	0.075 [m]		

Comments: Well construction details known, water level remains above the top of screen section.

Evaluated by: EO H

Evaluation Date: 9/9/2011

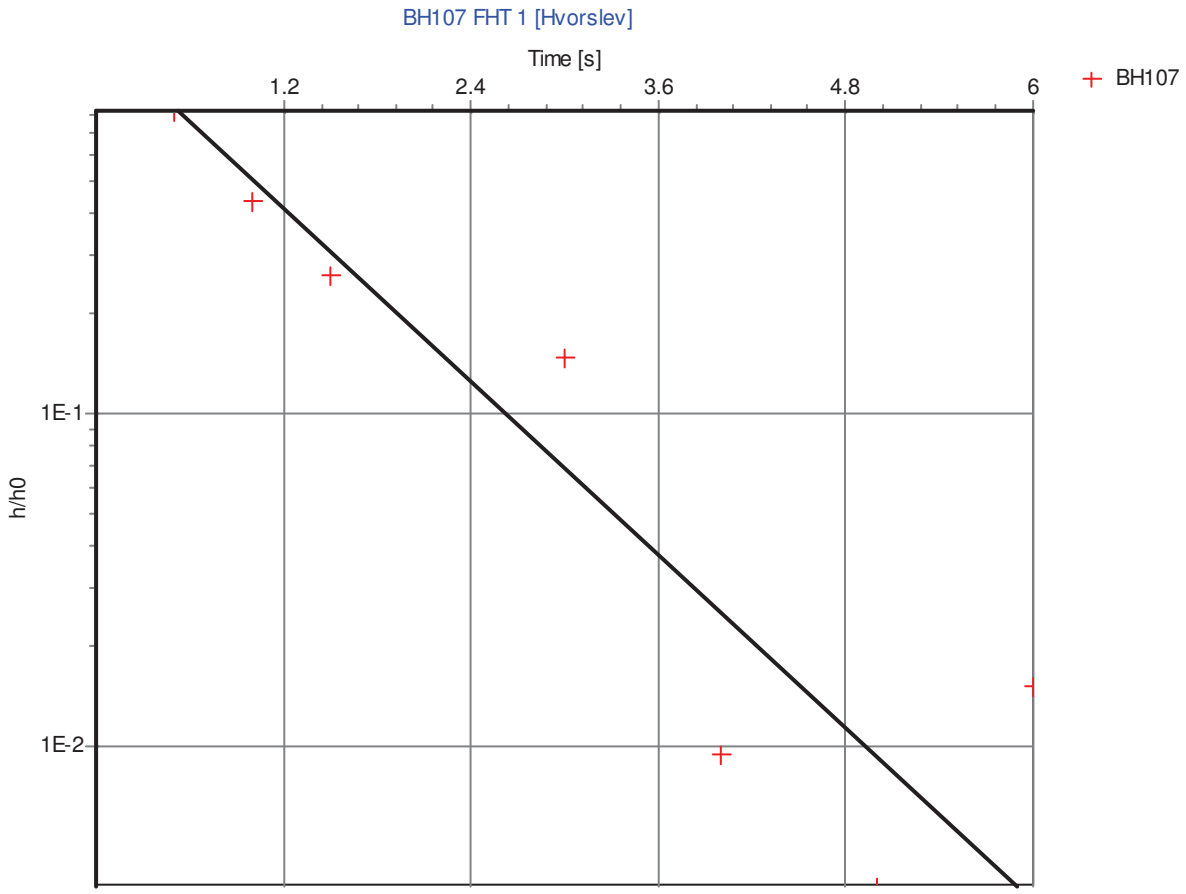
URS Scott Wilson
Acorn Business Campus
Mahon Ind. Pk., Blackrock, Cork
Phone 00353(0)21 4536137

Slug Test Analysis Report

Project: Elan SI 2011

Number: 46403003

Client: Elan Pharma Ltd



Slug Test: **BH107 FHT 1**

Analysis Method: **Hvorslev**

Analysis Results:

Conductivity: 3.87E-4 [m/s]

Test parameters:

Test Well:	BH107	Aquifer Thickness:	3.09 [m]
Casing radius:	0.025 [m]		
Screen length:	3 [m]		
Boring radius:	0.075 [m]		

Comments: Well construction details known, water level remains above the top of screen section.

Evaluated by: EO H

Evaluation Date: 9/9/2011

URS Scott Wilson
Acorn Business Campus
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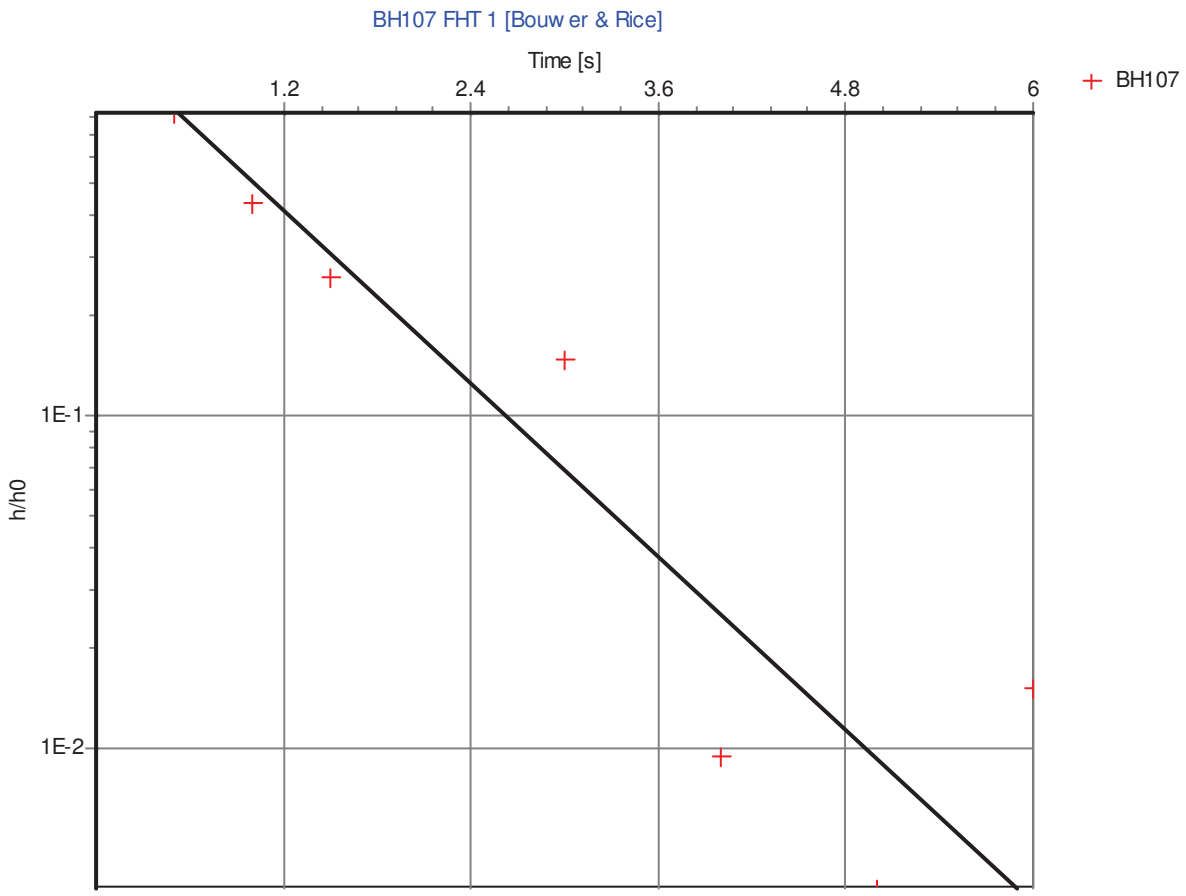
Slug Test Analysis Report

Project: Elan SI 2011

Number: 46403003

Client: Elan Pharma Ltd



Slug Test: **BH107 FHT 1**

Analysis Method: **Bouwer & Rice**

Analysis Results:

Conductivity: 2.97E-4 [m/s]

Test parameters:

Test Well:	BH107	Aquifer Thickness:	3.09 [m]
Casing radius:	0.025 [m]	Gravel Pack Porosity (%)	25
Screen length:	3 [m]		
Boring radius:	0.075 [m]		
r(eff):	0.043 [m]		

Comments: Well construction details known, water level remains above the top of screen section. Fully penetrating well.

Evaluated by: EO H

Evaluation Date: 9/9/2011

URS Scott Wilson
Acorn Business Campus
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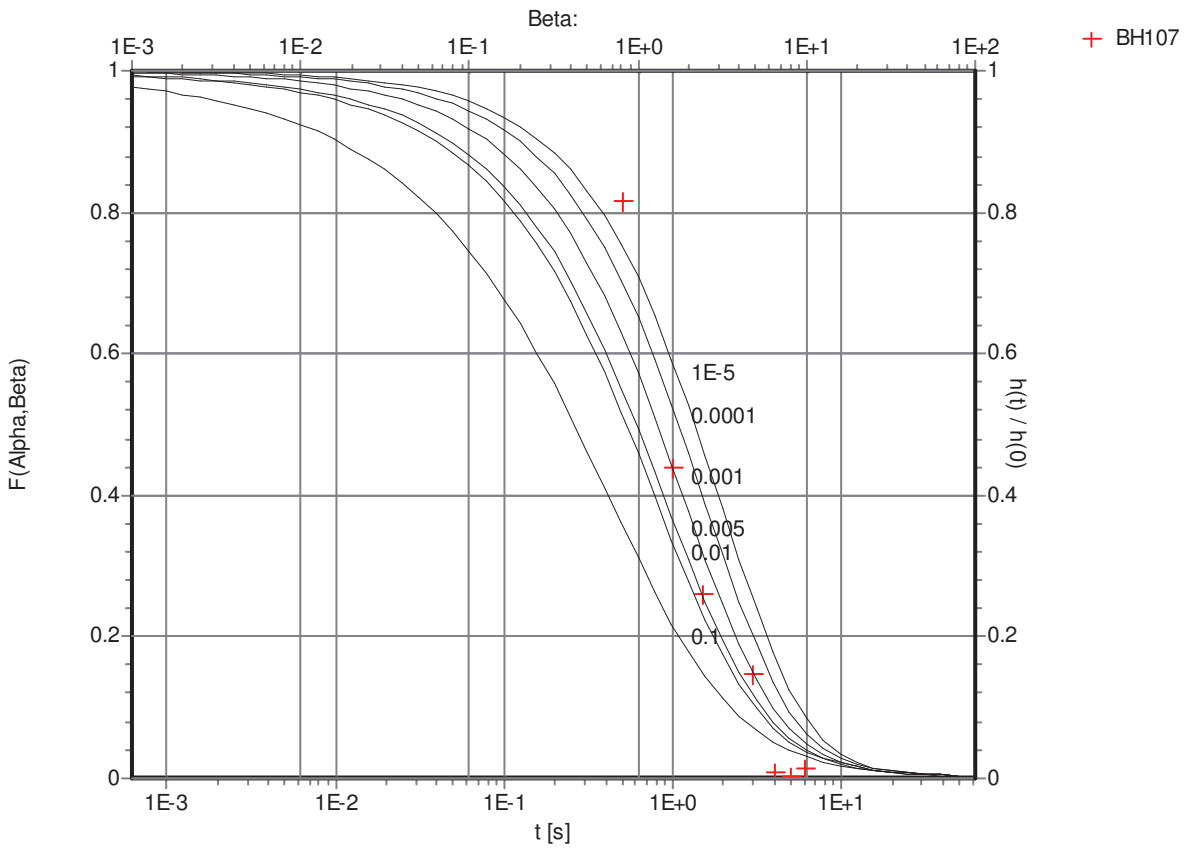
Slug Test Analysis Report

Project: Elan SI 2011

Number: 46403003

Client: Elan Pharma Ltd

BH107 FHT 1 [Cooper-Bredehoeft-Papadopulos]



Slug Test: **BH107 FHT 1**

Analysis Method: **Cooper-Bredehoeft-Papadopulos**

Analysis Results:	Transmissivity:	1.01E-3 [m²/s]	Conductivity:	3.26E-4 [m/s]
	Storativity:	5.00E-3		
Test parameters:	Test Well:	BH107	Aquifer Thickness:	3.09 [m]
	Casing radius:	0.025 [m]	Alpha:	0.005
	Screen length:	3 [m]		
	Boring radius:	0.075 [m]		
	r(c):	0.025 [m]		

Comments:

Evaluated by: EO H

Evaluation Date: 9/9/2011

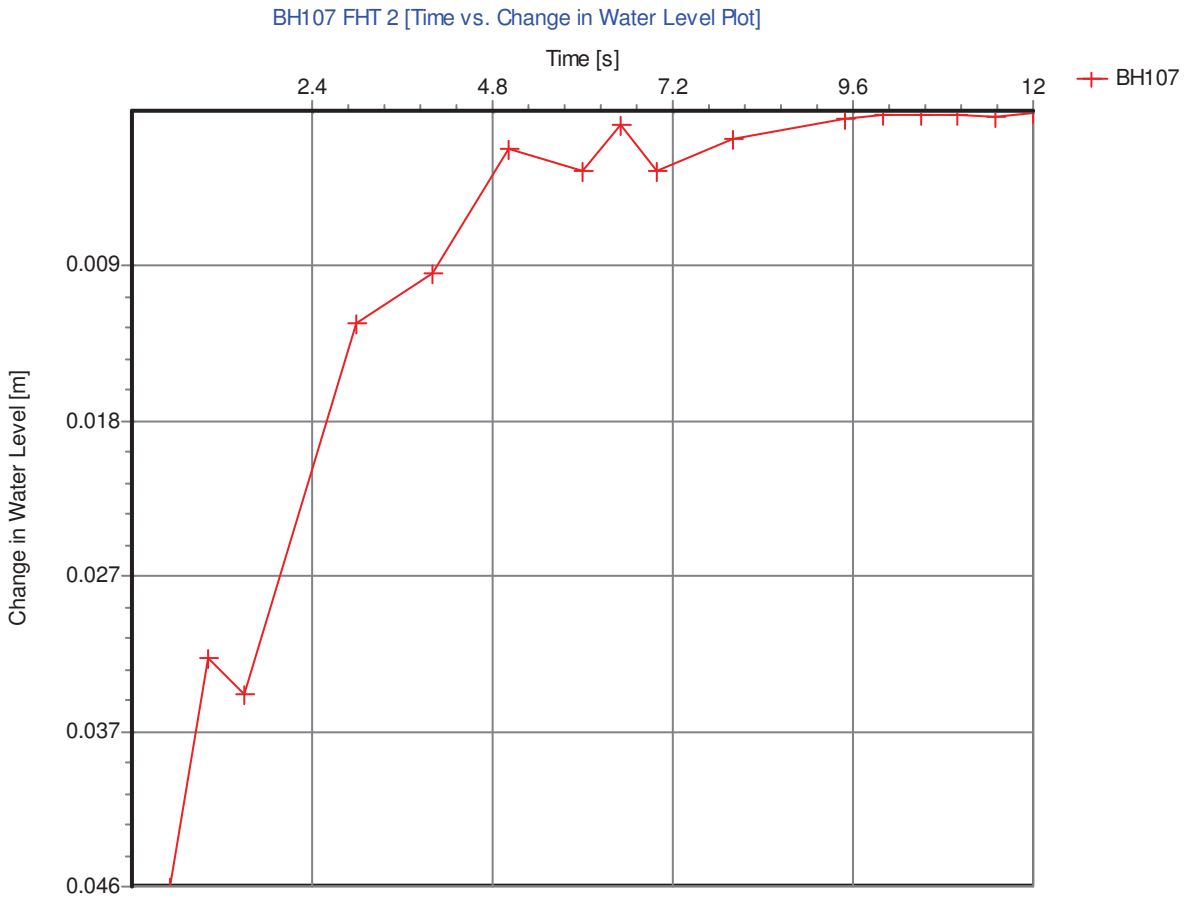
URS Scott Wilson
Acorn Business Campus
Mahon Ind. Pk., Blackrock, Cork
Phone 00353(0)21 4536137

Slug Test Analysis Report

Project: Elan SI 2011

Number: 46403003

Client: Elan Pharma Ltd



Slug Test: **BH107 FHT 2**

Analysis Method: **Time vs. Change in Water Level Plot**

Analysis Results:

Test parameters:				
	Test Well:	BH107	Aquifer Thickness:	3.09 [m]
	Casing radius:	0.025 [m]		
	Screen length:	3 [m]		
	Boring radius:	0.075 [m]		

Comments: Well construction details known, water level remains above the top of screen section.

Evaluated by: EO H

Evaluation Date: 9/9/2011

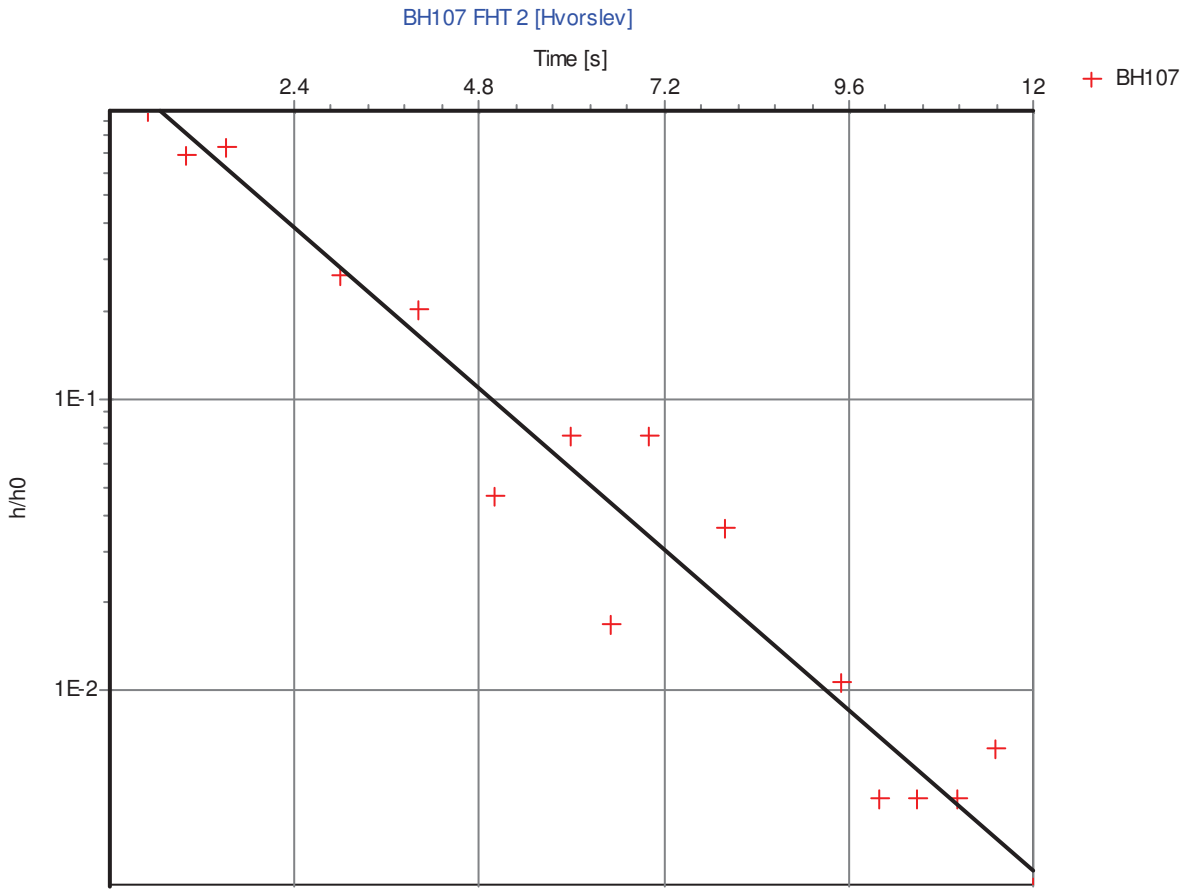
URS Scott Wilson
Acorn Business Campus
Mahon Ind. Pk., Blackrock, Cork
Phone 00353(0)21 4536137

Slug Test Analysis Report

Project: Elan SI 2011

Number: 46403003

Client: Elan Pharma Ltd



Slug Test: **BH107 FHT 2**

Analysis Method: **Hvorslev**

Analysis Results:

Conductivity: 2.04E-4 [m/s]

Test parameters:

Test Well:	BH107	Aquifer Thickness:	3.09 [m]
Casing radius:	0.025 [m]		
Screen length:	3 [m]		
Boring radius:	0.075 [m]		

Comments: Well construction details known, water level remains above the top of screen section.

Evaluated by: EO H

Evaluation Date: 9/9/2011

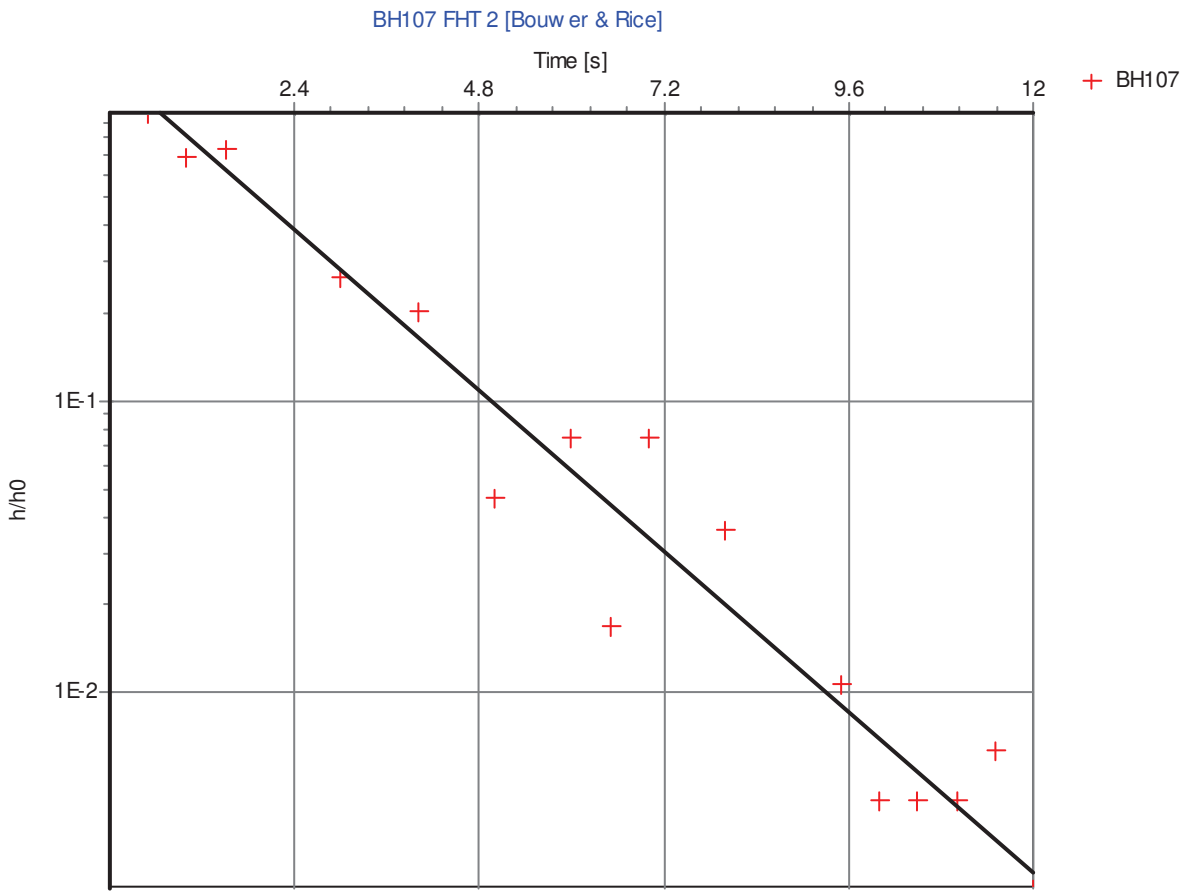
URS Scott Wilson
Acorn Business Campus
Mahon Ind. Pk., Blackrock, Cork
Phone 00353(0)21 4536137

Slug Test Analysis Report

Project: Elan SI 2011

Number: 46403003

Client: Elan Pharma Ltd



Slug Test: **BH107 FHT 2**

Analysis Method: **Bouwer & Rice**

Analysis Results:

Conductivity: 1.57E-4 [m/s]

Test parameters:

Test Well:	BH107	Aquifer Thickness:	3.09 [m]
Casing radius:	0.025 [m]	Gravel Pack Porosity (%)	25
Screen length:	3 [m]		
Boring radius:	0.075 [m]		
r(eff):	0.043 [m]		

Comments: Well construction details known, water level remains above the top of screen section. Fully penetrating well.

Evaluated by: EO H

Evaluation Date: 9/9/2011

URS Scott Wilson
Acorn Business Campus
Mahon Ind. Pk., Blackrock, Cork
Phone 00353(0)21 4536137

Slug Test Analysis Report

Project: Elan SI 2011

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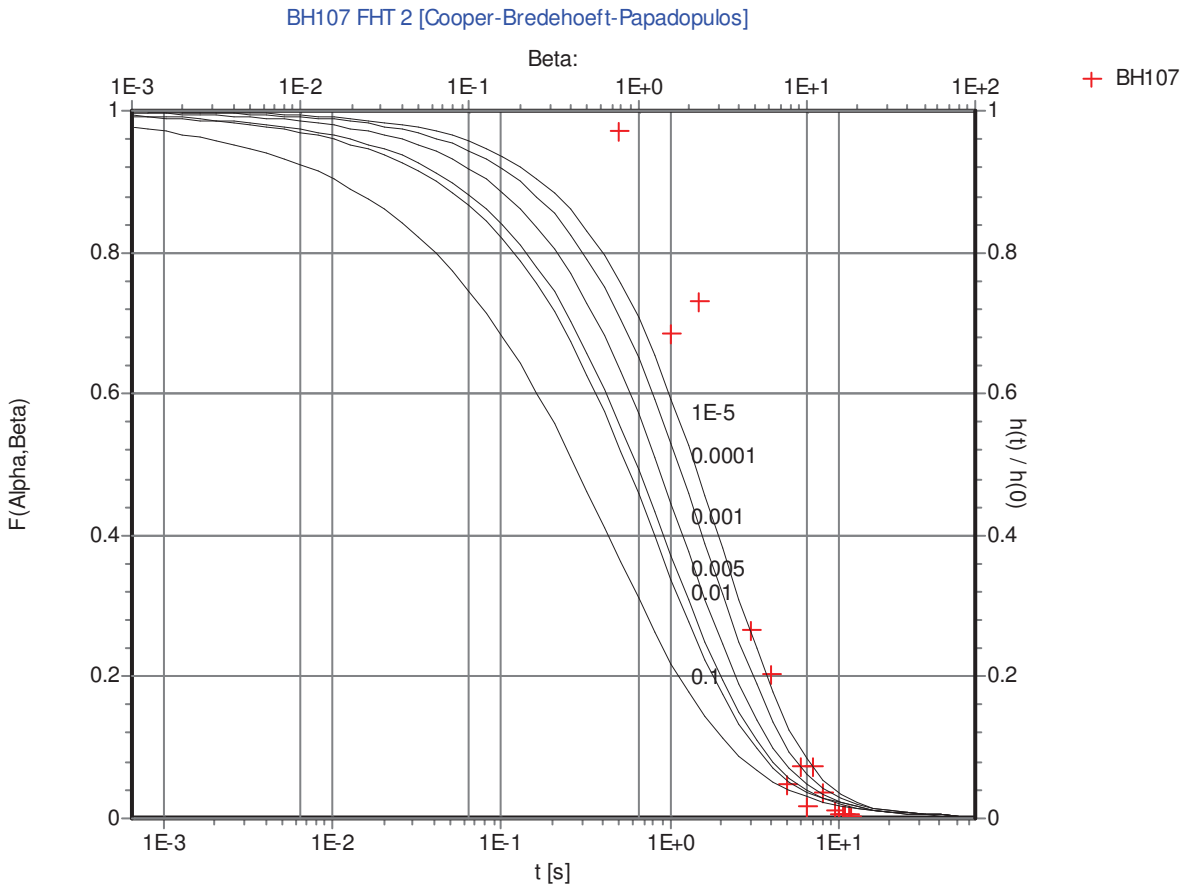
Client: Elan Pharma Ltd



Slug Test: **BH107 FHT 2**

Analysis Method: **Cooper-Bredehoeft-Papadopulos**

Analysis Results:	Transmissivity:	9.68E-4 [m²/s]	Conductivity:	3.13E-4 [m/s]
	Storativity:	5.00E-3		
Test parameters:	Test Well:	BH107	Aquifer Thickness:	3.09 [m]
	Casing radius:	0.025 [m]	Alpha:	0.005
	Screen length:	3 [m]		
	Boring radius:	0.075 [m]		
	r(c):	0.025 [m]		

Comments:

Evaluated by: EO H

Evaluation Date: 9/9/2011

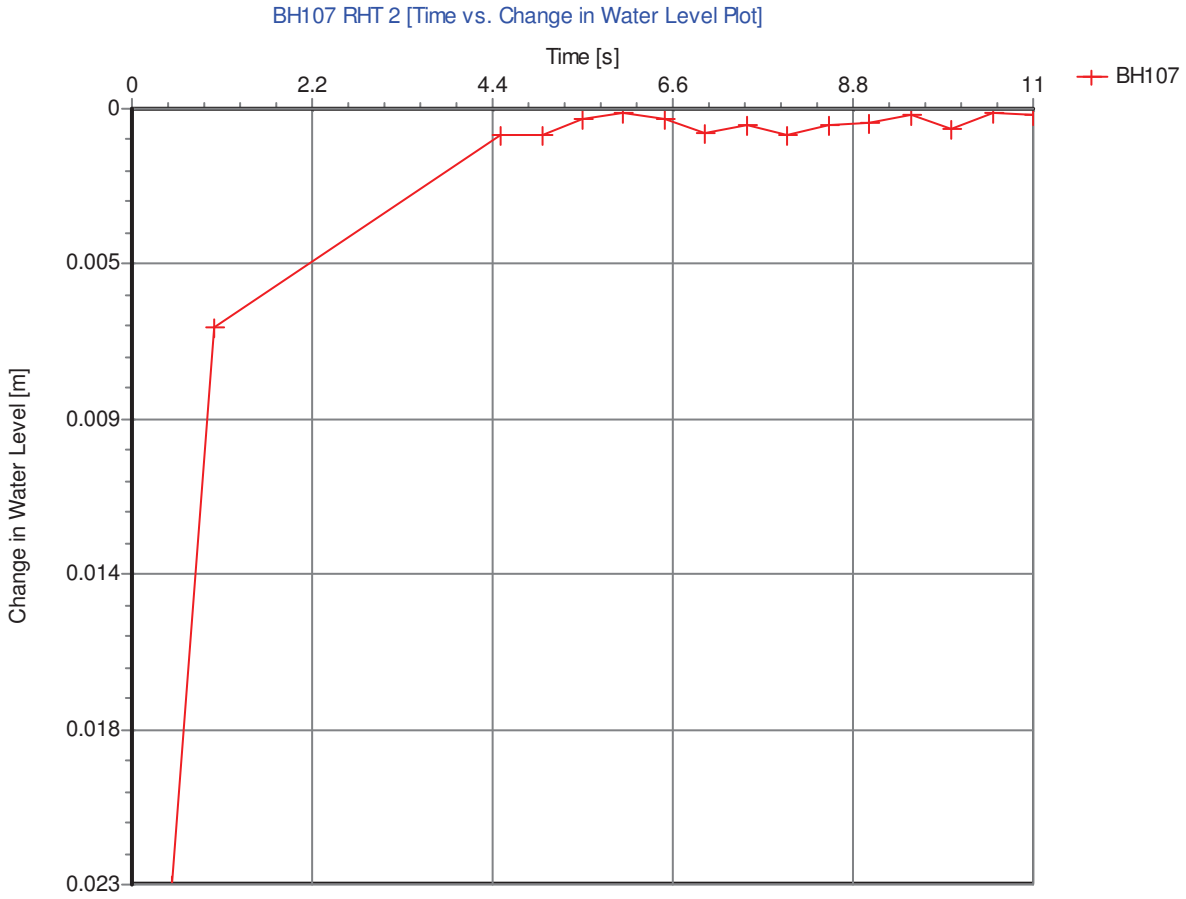
URS Scott Wilson
Acorn Business Campus
Mahon Ind. Pk., Blackrock, Cork
Phone 00353(0)21 4536137

Slug Test Analysis Report

Project: Elan SI 2011

Number: 46403003

Client: Elan Pharma Ltd



Slug Test: **BH107 RHT 2**

Analysis Method: **Time vs. Change in Water Level Plot**

Analysis Results:

Test parameters:				
	Test Well:	BH107	Aquifer Thickness:	3.09 [m]
	Casing radius:	0.025 [m]		
	Screen length:	3 [m]		
	Boring radius:	0.075 [m]		

Comments: Well construction details known, water level remains above the top of screen section.

Evaluated by: EO H

Evaluation Date: 9/9/2011

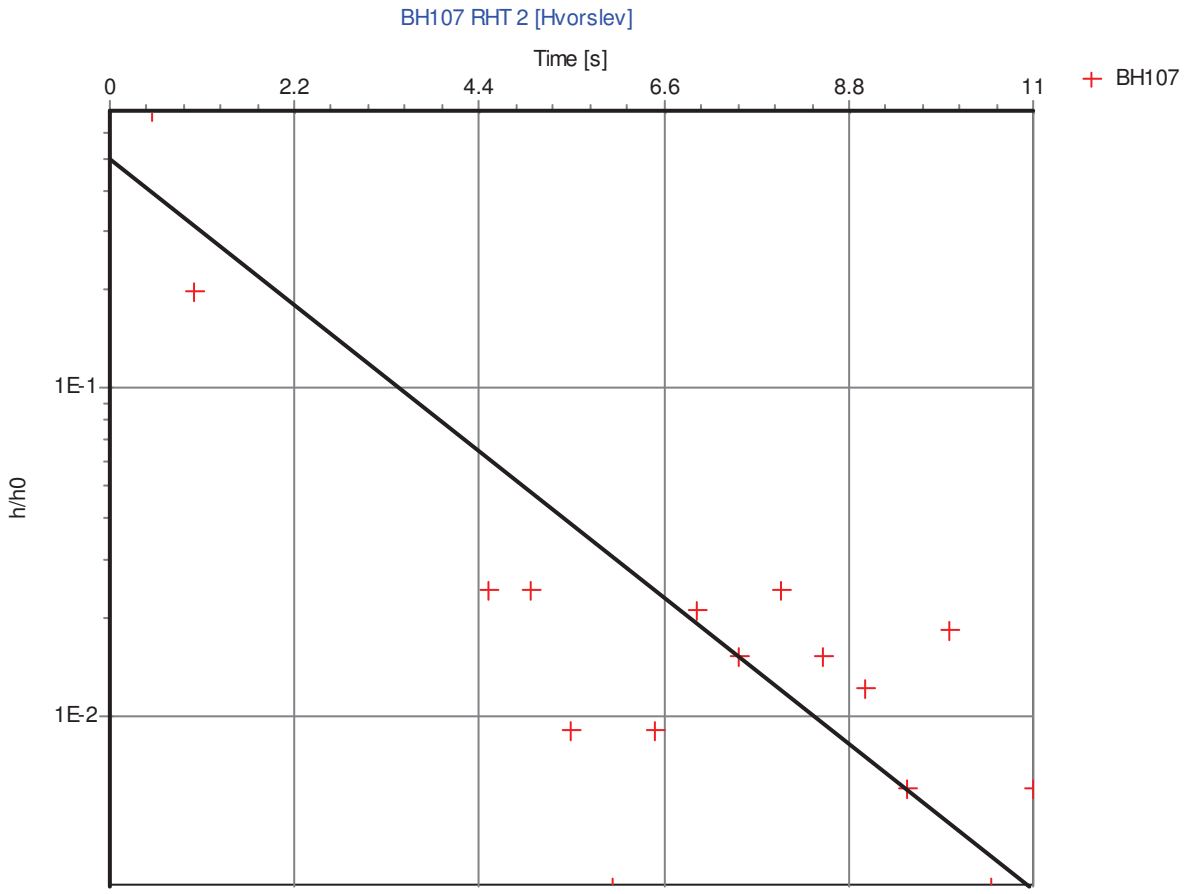
URS Scott Wilson
Acorn Business Campus
Mahon Ind. Pk., Blackrock, Cork
Phone 00353(0)21 4536137

Slug Test Analysis Report

Project: Elan SI 2011

Number: 46403003

Client: Elan Pharma Ltd



Slug Test: **BH107 RHT 2**

Analysis Method: **Hvorslev**

Analysis Results:

Conductivity: 1.80E-4 [m/s]

Test parameters:

Test Well:	BH107	Aquifer Thickness:	3.09 [m]
Casing radius:	0.025 [m]		
Screen length:	3 [m]		
Boring radius:	0.075 [m]		

Comments:

Evaluated by: EO H

Evaluation Date: 9/9/2011

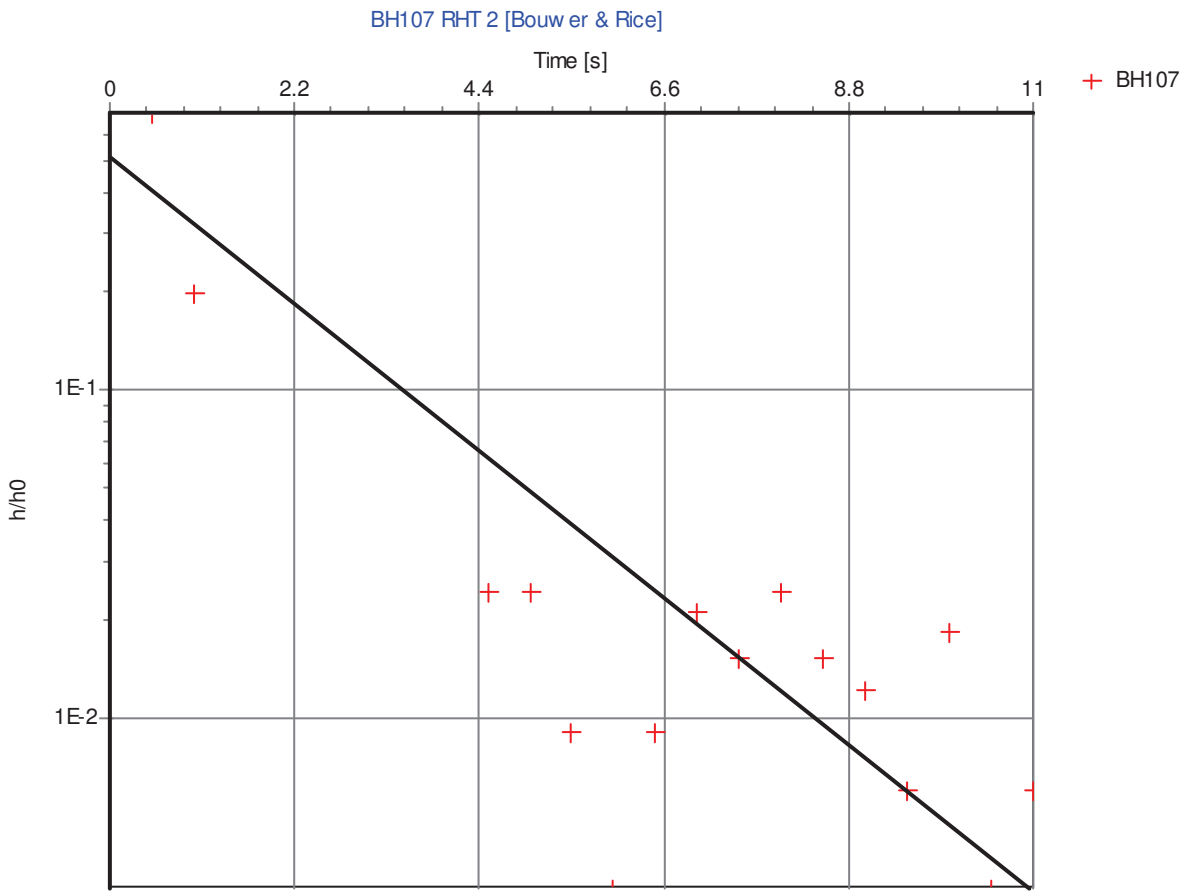
URS Scott Wilson
Acorn Business Campus
Mahon Ind. Pk., Blackrock, Cork
Phone 00353(0)21 4536137

Slug Test Analysis Report

Project: Elan SI 2011

Number: 46403003

Client: Elan Pharma Ltd



Slug Test: **BH107 RHT 2**

Analysis Method: **Bouwer & Rice**

Analysis Results:

Conductivity: 1.39E-4 [m/s]

Test parameters:

Test Well:	BH107	Aquifer Thickness:	3.09 [m]
Casing radius:	0.025 [m]	Gravel Pack Porosity (%)	25
Screen length:	3 [m]		
Boring radius:	0.075 [m]		
r(eff):	0.043 [m]		

Comments: Well construction details known, water level remains above the top of screen section. Fully penetrating well.

Evaluated by: EO H

Evaluation Date: 9/9/2011

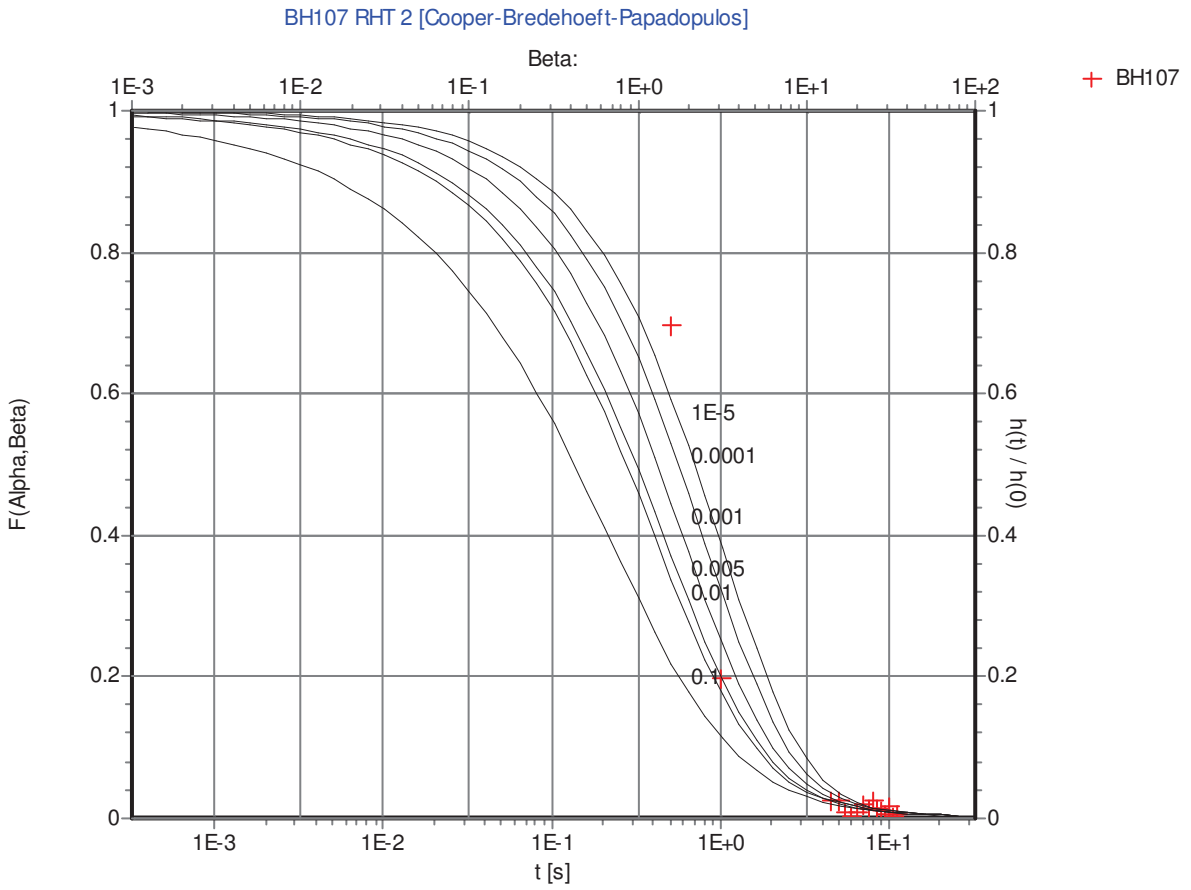
URS Scott Wilson
Acorn Business Campus
Mahon Ind. Pk., Blackrock, Cork
Phone 00353(0)21 4536137

Slug Test Analysis Report

Project: Elan SI 2011

Number: 46403003

Client: Elan Pharma Ltd



Slug Test: **BH107 RHT 2**

Analysis Method: **Cooper-Bredehoeft-Papadopulos**

Analysis Results:	Transmissivity:	1.93E-3 [m²/s]	Conductivity:	6.25E-4 [m/s]
	Storativity:	5.00E-3		
Test parameters:	Test Well:	BH107	Aquifer Thickness:	3.09 [m]
	Casing radius:	0.025 [m]	Alpha:	0.005
	Screen length:	3 [m]		
	Boring radius:	0.075 [m]		
	r(c):	0.025 [m]		

Comments:

Evaluated by: EO H

Evaluation Date: 9/9/2011

APPENDIX D

SAMPLING D	AMW1		AMW2		AMW3		AMW4		AMW5		AMW6		AMW7		AMW8	
	Overburden		Overburden		Overburden		Bedrock		Overburden		Bedrock		Bedrock		Overburden	
Date of WL measurement	AMW1 mbtc	From **01/09/11** using URS maODM AMW1 maOD Malin	AMW2 mbtc	From **1/9/11** using URS maODM (1099-655) URS Well Survey maOD Malin	AMW3 mbtc	From **1/9/11** using URS maODM (1099-655) URS Well Survey maOD Malin	AMW4 mbtc	From **1/9/11** using URS maODM (1099-655) URS Well Survey maOD Malin	AMW5 mbtc	From **1/9/11** using URS maODM (1099-655) URS Well Survey maOD Malin	AMW6 mbtc	From **1/9/11** using URS maODM (1099-655) URS Well Survey maOD Malin	AMW7 mbtc	From **1/9/11** using URS maODM (1099-655) URS Well Survey maOD Malin	AMW8 mbtc	From **1/9/11** using URS maODM (1099-655) URS Well Survey maOD Malin
04/02/2016			4.470	40.543	5.050	40.344							4.320	39.116	4.160	39.340
26/05/2016	5.930	39.717	5.160	39.853	5.700	39.694	6.220	38.698	5.410	39.523	6.260	38.801	4.760	38.676	4.680	38.820
22/09/2016	6.400	39.247	5.470	39.543	5.960	39.434	6.440	38.478	5.630	39.303	6.350	38.711	4.660	38.776	4.540	38.960
03/05/2017			5.640	39.373	6.050	39.344	6.630	38.288	5.760	39.173	6.350	38.711	4.660	38.776	4.540	38.960
06/09/2017			5.660	39.353	6.150	39.244	6.620	38.298	5.770	39.163						
09/11/2017			5.430	39.583	5.670	39.724	6.480	38.438	5.640	39.293						
27/02/2018	5.140	40.507	4.700	40.313	5.050	40.344	5.800	39.118	5.050	39.883	5.150	39.911	5.010	38.426	4.520	38.980
17/05/2018	5.800	39.847	5.200	39.813	5.460	39.934	6.010	38.908	5.140	39.793	6.020	39.041	5.250	38.186	4.930	38.570
28/08/2018			5.810	39.203	5.880	39.514	7.710	37.208	5.590	39.343						
15/11/2018			5.980	39.033	5.990	39.404	6.370	38.548	5.730	39.203						
15/11/2018	6.130	39.517	5.150	39.863			5.610	39.308	5.710	39.223	5.540	39.521	5.180	38.256	5.180	38.320
27/02/2019	4.840	40.807	5.740	39.273			6.370	38.548	5.720	39.213	6.320	38.741	5.100	38.336	5.140	38.360

SAMPLING D	AMW9		MW1a (d)	MW1 (s)	MW2 (s)		MW2 (d)		MW3S		MW4	MW5		MW6		MW7
	Bedrock		**Probably Lin**	**Overburden**	**Overburden**		**Overburden**		**Overburden**		**Overburden**	**Overburden**		**Probably Overburden**		**Probably Ov**
		From **1/9/11** using URS maODM (1099-655)				From **1/9/11** using URS maODM (1099-655)		From **1/9/11** using URS maODM (1099-655)		From **1/9/11** using URS maODM (1099-655)			From **1/9/11** using URS maODM (1099-655)		From **1/9/11** using URS maODM (1099-655)	
Date of WL measurement	AMW9 mbtc	URS Well Survey maOD Malin	MW1a (D-Deep) mbtc	MW1 (S-shallow) mbtc	MW2 mbtc	URS Well Survey TOC maOD Malin	MW2 mbtc	URS Well Survey TOC maOD Malin	MW3 mbtc	URS Well Survey TOC maOD Malin	MW4 mbtc	MW5 mbtc	URS Well Survey TOC maOD Malin	MW6 mbtc	URS Well Survey TOC maOD Malin	MW7 mbtc
04/02/2016	4.560	38.882														
26/05/2016	4.680	38.762														
22/09/2016	5.140	38.302														
03/05/2017	5.140	38.302														
06/09/2017																
09/11/2017																
27/02/2018	6.050	37.392														
17/05/2018	4.240	39.202														
28/08/2018																
15/11/2018																
15/11/2018	6.400	37.042														
27/02/2019	5.140	38.302	Dry	Dry	5.782	**38.916**	5.755	**38.920**	6.611	**39.198**	Dry	4.967	39.389	6.442	39.545	Dry

SAMPLING D	BH101		BH104		BH105		BH107		MW8S		MW8D		MW9S	MW9D	
	Limestone Bedrock		Limestone Bedrock		Limestone Bedrock		Overburden		URS Data 29/01/15 (CG)		URS Data 29/01/15 (CG)		URS Data 29/01/1	URS Data 29/01/15 (CG)	
		From **1/9/11** using URS maODM (1099-655)		From **1/9/11** using URS maODM (1099-655)		From **1/9/11** using URS maODM (1099-655)		From **1/9/11** using URS maODM (1099-655)	SWL (m bTOC)	TOC maOD Malin	SWL (m bTOC)	TOC maOD Malin	SWL (m bTOC)	SWL (m bTOC)	TOC maOD Malin
										45.500		45.580			46.580
Date of WL measurement	BH101 mbtc	URS Well Survey TOC maOD Malin	BH104 mbtc	URS Well Survey TOC maOD Malin	BH105 mbtc	URS Well Survey TOC maOD Malin	BH107 mbtc	URS Well Survey TOC maOD Malin							
04/02/2016															
26/05/2016					4.760	**35.750**									
22/09/2016															
03/05/2017															
06/09/2017					2.400	**38.110**									
09/11/2017					2.620	**37.890**									
27/02/2018					2.280	**38.230**									
17/05/2018					2.470	**38.040**									
28/08/2018					2.710	**37.800**									
15/11/2018					2.740	**37.770**									
15/11/2018					2.640	**37.870**	4.820	38.577							
27/02/2019	0.235	38.837	7.232	**38.889**	2.580	**37.930**	4.621	38.776	3.871	41.629	6.692	38.888	Dry	7.693	38.887

SAMPLING D	MW10D		MW11S		MW11D		MW12S				MW13S		MW13D	
	URS Data 29/01/15 (CG)		URS Data 29/01/15 (CG)		URS Data 29/01/15 (CG)								URS Data 29/01/15 (CG)	
Date of WL measurement	SWL (m bTOC)	TOC maOD Malin 46.566	SWL (m bTOC)	TOC maOD Malin 45.923	SWL (m bTOC)	TOC maOD Malin 46.039	SWL (m bTOC)	TOC maOD Malin 45.377	SWL (m bTOC)	TOC maOD Malin 45.235	SWL (m bTOC)	TOC maOD Malin 44.360	SWL (m bTOC)	TOC maOD Malin 44.384
04/02/2016														
26/05/2016														
22/09/2016														
03/05/2017														
06/09/2017														
09/11/2017														
27/02/2018														
17/05/2018														
28/08/2018														
15/11/2018														
15/11/2018														
27/02/2019	7.666	38.900	6.270	39.653	6.471	39.568	6.037	39.340	5.952	39.283	5.958	38.402	5.282	39.102

APPENDIX E

Substances & categorisation		S.I. No. 366 of 2016	Dutch 2009 Levels		AMW3												
					2016			2017				2018				1st Baseline Sampling Event	
Substance analysed (also known as)	Units	Overall threshold Values Range (from Column test 1 to column	Target Levels (optimum)	Intervention (action)	05/02/2016	26/05/2016	22/09/2016	22/02/2017	03/05/2017	07/09/2017	06/11/2017	22/02/2018	27/02/2018	01/05/2018	17/05/2018	20/06/2018	28/08/2018
Styrene	µg/l		6.00	300		1	1			1	1	1		1		1	1
Ethanol	µg/l					500	500	500		500	500	500		500		500	500
Acetonitrile	µg/l					500	500	500		500	3,900	500		11000		17359	16000
Ethyl acetate	µg/l																
Chloroethane	µg/l					1	1			1	1	1		1		1	1
Methanol	µg/l					500	500	500		500	500	500		500		500	79670
Acetone	µg/l					500	500	500		500	500	500		34000		23969	17000
Isopropanol	µg/l					500	500	500		500	500	500		37000		25591	29000
Tetrahydrofuran	µg/l		0.50	300		32,900	22,000	29,000	27,000	39,000	37,320	19200		37000		65996	76653
MTBE	µg/l	10.00				5,160	2,340	2,690	4,620	4,650	4,360	3410		19000		22900	26000
Benzene	µg/l	0.75				4	1	3	2	2	4	1.55		4.41		5.41	3.91
Ethylbenzene	µg/l		4.00	150		128	1	85	90	169	247	83.1		299		320	289
Xylene o	µg/l		0.20	70		1	6	3	13	101	147	18.9		190		273	317
Xylene m/p	µg/l		0.20	70		46	156	265	328	804	924	316		1180		1070	1160
Toluene	µg/l	525.00	7.00	1000		316	1	14	18	16	1,920	706		21400		25000	34500
Sum of BTEX	µg/l		0.20	70												26500	
MIBK	µg/l		7.00	1000												2	
Chlorobenzene	µg/l					12	1		8	10.2	14.1	5.94		18.4		19.93	16.8
Bromobenzene	µg/l					1	1			1	1.31	1		1.98		2.24	1.74
1,2-Dichloropropane	µg/l		0.80	80		1	1	1		1	1	1		1		1	1
2,2-Dichloropropane	µg/l		0.01	20								1		1		1	1
1,3-Dichloropropane	µg/l		0.80	80		107	39	95	68	89	116	37.1		122		129	116
1,2,3-Trichloropropane	µg/l		0.01	20								1		1		1	1
Bromochloromethane	µg/l				1	1	1			1	1	1		1		1	1
1,1,1-Trichloroethane	µg/l		0.01	300	1	1	1			1	1	1		1		1	1
1,1,2-Trichloroethane	µg/l		0.01	20								1		1		1	1
1,1-Dichloroethane	µg/l		7.00	900	1	1	1			1	1	1		1		1	1
1,2-Dichloroethane	µg/l	2.25	7.00	400		3	1	2		1	2	1		2.86		1	1
Dissolved ethane	mg/l																
Trichloromethane (Chloroform)	µg/l		6.00	400	1	1	1		1			1		1		1	1
Dichloromethane	µg/l	15.00	0.01	1000	3	1	3	3		3	3	3		306		25.9	280
Dichlorodifluoromethane	µg/l		0.01	20								1		1		1	1
Dissolved methane	mg/l					1											
Tetrachloroethene	µg/l	7.50	0.01	40	0.05	1	1		1	1	1	1		1		1	1
Trichloroethene	µg/l	7.50	24.00	500		1	1			1	1	1		1		1	1
1,1-Dichloroethene	µg/l		0.01	10		1	1			1	1	1		1		1	1
cis-1,2-Dichloroethene	µg/l	0.38	0.01	20		1	1		1	1	1	1		1		1	1
Chloromethane	µg/l		0.01	20								1		1		1	1
2-Chlorotoluene	µg/l		0.01	20								1		1		1	1
4-Chlorotoluene	µg/l		0.01	20								1		1		1	1
trans-1,2-Dichloroethene	µg/l	0.38	0.01	20								1		1.71		1.43	1
Trichlorofluoromethane	µg/l		0.01	20								1		1		1	1
Dibromomethane	µg/l		0.01	20								1		1		1	1
1,2-Dibromoethane	µg/l		0.01	20								1		1		1	1
1,1,1,2-Tetrachloroethane	µg/l		0.01	20								1		1		1	1
1,1,2,2-Tetrachloroethane	µg/l																
Bromodichloromethane	µg/l		0.01	20								1		1		1	1
Dibromochloromethane	µg/l		0.01	20								1		1		1	1
1,2-Dibromo-3-chloropropane	µg/l		0.01	20								1		1		1	1
Carbon Tetrachloride	µg/l		0.01	20								1		1		1	1
4-Isopropyltoluene	µg/l		0.01	20								1		1		1	1
Bromomethane	µg/l		0.01	20								1		1		1	1
sec-Butylbenzene	µg/l		0.01	20								1		1		1	1
tert-Butylbenzene	µg/l		0.01	20								1		1		1	1
n-Butylbenzene	µg/l		0.01	20								1		1		1	1
1,2,3-Trichlorobenzene	µg/l		0.01	20								1		1		1	1
1,2,4-Trichlorobenzene	µg/l		0.01	20								1		1		1	1
Bromoform	µg/l		0.01	20								1		1		1	1
Hexachlorobutadiene	µg/l		0.01	20								1		1		1	1
Naphthalene	µg/l		0.01	20								1		1		1	1
Chloroethene	µg/l	0.375	0.01	5		1	1					1		1		1	1
1, 2, 4-Trimethylbenzene	µg/l									1	1	1		1.48		1.2	2.82
1, 3, 5-Trimethylbenzene	µg/l					1				1	1	1		1		1	1.11
cis-1, 3-Dichloropropene	µg/l					1				1	1	1		1		1	1
trans-1, 3-Dichloropropene	µg/l		0.01	20								1		1		1	1
1,1-Dichloropropene	µg/l		0.01	20								1		1		1	1
1, 2-Dichlorobenzene	µg/l					1				1	1	1		1		1	1
1, 3-Dichlorobenzene	µg/l		0.01	20								1		1		1	1
1, 4-Dichlorobenzene	µg/l		0.01	20								1		1		1	1
n-Propylbenzene	µg/l		0.01	20								1		1		1	1
Isopropylbenzene	µg/l					1				1	1.85	1		1.76		1.89	1.88
Aluminium	µg/l	150.00				11								10			
Ammonia	mg/l	0.065 - 0.175				11								10			
Antimony	µg/l					4								1			
Arsenic	µg/l	7.50				14								15.8			
Barium	µg/l					276								419			
Beryllium	µg/l					2								0.1			
Boron	µg/l	750.00												46			
Cadmium	µg/l	3.75				2								0.08			
Calcium	mg/l					496								180			
Chemical Oxygen demand	µg/l																
Chloride	mg/l	24-187.50				409								452			
Chromium	µg/l	37.50				2								1			
Cobalt	µg/l					2								1.03			
Copper	µg/l	1500.00				2								0.3			
Electrical conductivity (EC) (field)	µS/cm @	800 - 1875 @25°C							2164	2320	2240		1273		2290		3490
Electrical conductivity (EC) (lab)	µS/cm @	800 - 1875 @25°C				2464								2377		3370	
Hydrogen ion concentration (field)	pH units								7.20	7.23	7.54		7.64		7.19	7.3	7.29
Hydrogen ion concentration (lab)	pH units					7								7.3			
Iron	mg/l					0.1								1.62			
Lead	µg/l	7.50				2								0.2			
Manganese	µg/l					698								425			
Magnesium	mg/l					39								37			
Mercury	µg/l	0.75				1								0.01			
Nickel	µg/l	15.00				5								4.02			
Nitrate Nitrogen	mg/l	37.50				0								0.045			
Phosphate	mg/l													0.16			
Potassium	mg/l					13								7.58			
Redox Potential (eH)	mV								-102.0	-91.5	-102.7		-128.1		-107.9		-127.3
Selenium	µg/l					132								1			
Silver	µg/l					2								0.5			
Sodium	mg/l	150				580								333			
Sulphate	mg/l	187.50				2								0.5			
Tin	µg/l					2								1			
Total alkalinity	mg/l					584								782			
Zinc	µg/l	75.00				14								57.9			

Value Above S.I. No. 366 of 2016	VALUE
Value above Dutch 2009 circular Target levels	VALUE
Value above Dutch 2009 circular Intervention levels	VALUE

Substances & categorisation		S.I. No. 366 of 2016	Dutch 2009 Levels		AMW3					AMW4								
					2nd Baseline Sampling Event	1st post sprinkling sampling event	2nd post sprinkling sampling event		2019	2016		2017				2018		
Substance analysed (also known as)	Units	Overall threshold Values Range (from Column test 1 to column	Target Levels (optimum)	Intervention (action)	17/09/2018	24/09/2018	25/09/2018	15/11/2018	28/02/2019	26/05/2016	22/09/2016	22/02/2017	03/05/2017	07/09/2017	06/11/2017	22/02/2018	27/02/2018	01/05/2018
Styrene	µg/l		6.00	300	1	1	1	1	1	1	1			1	1	1		1
Ethanol	µg/l				500	500	500	500	500	500	500	500		500	500	500		500
Acetonitrile	µg/l				19500	8690	30500	99145	37255	500	500	500		500	500	500		500
Ethyl acetate	µg/l							100	500									
Chloroethane	µg/l				4.93			1	1	1	1			1	1	1		1
Methanol	µg/l				500	500	500	478342	500	500	500	500		500	500	500		500
Acetone	µg/l				27700	21700	65400	134615	96895	500	500	500		500	500	500		500
Isopropanol	µg/l				38900	21500	61000	222821	48930	500	500	500		500	500	500		500
Tetrahydrofuran	µg/l		0.50	300	83900	35200	79200	65766	34989	26600	36000	35000	29000	20000	26032	16600		24000
MTBE	µg/l	10.00			20100	6360	17200	6960	6980	2700	2200	2330	3330	2530	1810	1850		2010
Benzene	µg/l	0.75			5.11	1.55	4.07	2.21	1.92	1	1	1	1	1	1	1		1.25
Ethylbenzene	µg/l		4.00	150	357	122	282	88.4	131	1	1	1	4.72	1	1	1		1
Xylene o	µg/l		0.20	70	386	148	350	111	178	1	1	1		1	1	1		1
Xylene m/p	µg/l		0.20	70	1290	487	1070	410	635	1	2	1	25.6	1	1.11	2.41		10.9
Toluene	µg/l	525.00	7.00	1000	49700	19400	43500	97400	12400	1	1	1	1.81	1	1	1		1
Sum of BTEX	µg/l		0.20	70	51700	20200	45200											
MIBK	µg/l		7.00	1000	1210	363	1240											
Chlorobenzene	µg/l				20.5	5.5	13.5	3.71	5.35	1	1		2.36	1	1	1		1.08
Bromobenzene	µg/l				2.16	1	1.53	1	1	1	1			1	1	1		1
1,2-Dichloropropane	µg/l		0.80	80	1	1	1	1	1	1	1	1		1	1	1		1
2,2-Dichloropropane	µg/l		0.01	20	1	1	1	1	1							1		1
1,3-Dichloropropane	µg/l		0.80	80	156	56.1	152	187	56.3	24.4	26.6	28.5	32	27.7	29.1	16.6		33.5
1,2,3-Trichloropropane	µg/l		0.01	20	1	1	1	1	1							1		1
Bromochloromethane	µg/l				1	1	1	1	1	1	1			1	1	1		1
1,1,1-Trichloroethane	µg/l		0.01	300	1	1	1	1	1	1	1			1	1	1		1
1,1,2-Trichloroethane	µg/l		0.01	20	1	1	1	1	1							1		1
1,1-Dichloroethane	µg/l		7.00	900	1	1	1	1	1	1	1			1	1	1		1
1,2-Dichloroethane	µg/l	2.25	7.00	400	1.87		2.1	1	1	1	1	1.46		1.39	1.56	1		1.77
Dissolved ethane	mg/l																	
Trichloromethane (Chloroform)	µg/l		6.00	400	1	1.02	1	1	1.27	1.00	1.00		1.00			1		1
Dichloromethane	µg/l	15.00	0.01	1000	726			180	3	1	3	3		3	3	3		3
Dichlorodifluoromethane	µg/l		0.01	20	1	1	1	1	1							1		1
Dissolved methane	mg/l									1.00								
Tetrachloroethene	µg/l	7.50	0.01	40	1	1	1	1.23	1	1.00	1.00		1.00	1	1	1		1
Trichloroethene	µg/l	7.50	24.00	500	1	1	1	1	1	1.00	1.00			1	1	1		1
1,1-Dichloroethene	µg/l		0.01	10	1			1	1	1	1			1	1	1		1
cis-1,2-Dichloroethene	µg/l	0.38	0.01	20	1	1	1	1	1	1	1		1.00	1	1	1		1
Chloromethane	µg/l		0.01	20	1	537	1150	1	1							1		1
2-Chlorotoluene	µg/l		0.01	20	1	1	1	1	1							1		1
4-Chlorotoluene	µg/l		0.01	20	1	1	1	1	1							1		1
trans-1,2-Dichloroethene	µg/l	0.38	0.01	20	2.59	1	2.34	1.39	3.07							1		1
Trichlorofluoromethane	µg/l		0.01	20	1			1	1							1		1
Dibromomethane	µg/l		0.01	20	1	1	1	1	1							1		1
1,2-Dibromoethane	µg/l		0.01	20	1	1	1	1	1							1		1
1,1,1,2-Tetrachloroethane	µg/l		0.01	20	1	1	1	1								1		1
1,1,2,2-Tetrachloroethane	µg/l								1									
Bromodichloromethane	µg/l		0.01	20	1	1	1	1	1							1		1
Dibromochloromethane	µg/l		0.01	20	1	1	1	1	1							1		1
1,2-Dibromo-3-chloropropane	µg/l		0.01	20	1	1	1	1	1							1		1
Carbon Tetrachloride	µg/l		0.01	20	1	1	1	1	1							1		1
4-Isopropyltoluene	µg/l		0.01	20	1	1	1	1	1							1		1
Bromomethane	µg/l		0.01	20	1			1	1							1		1
sec-Butylbenzene	µg/l		0.01	20	1	1	1	1	1							1		1
tert-Butylbenzene	µg/l		0.01	20	1	1	1	1	1							1		1
n-Butylbenzene	µg/l		0.01	20	1	1	1	1	1							1		1
1,2,3-Trichlorobenzene	µg/l		0.01	20	1	1	1	1	1							1		1
1,2,4-Trichlorobenzene	µg/l		0.01	20	1	1	1	1	1							1		1
Bromoform	µg/l		0.01	20	1	1	1	1	1							1		1
Hexachlorobutadiene	µg/l		0.01	20	1	1	1	1	1							1		1
Naphthalene	µg/l		0.01	20	1	1	1	1	1							1		1
Chloroethene	µg/l	0.375	0.01	5	1			1	1	1	1					1		1
1, 2, 4-Trimethylbenzene	µg/l				4.18	1.73	5.75	5.48	1.32	1				1	1	1		1
1, 3, 5-Trimethylbenzene	µg/l				1.44	1	1.41	1.45	1	1				1	1	1		1
cis-1, 3-Dichloropropene	µg/l				1	1	1	1	1	1				1	1	1		1
trans-1, 3-Dichloropropene	µg/l		0.01	20	1	1	1	1	1							1		1
1,1-Dichloropropene	µg/l		0.01	20	1	1	1	1	1							1		1
1, 2-Dichlorobenzene	µg/l				1	1	1	1	1	1				1	1	1		1
1, 3-Dichlorobenzene	µg/l		0.01	20	1	1	1	1	1							1		1
1, 4-Dichlorobenzene	µg/l		0.01	20	1	1	1	1	1							1		1
n-Propylbenzene	µg/l		0.01	20	1	1	1	1	1							1		1
Isopropylbenzene	µg/l				2.74	1	2.21	1	1	1				1	1	1		1
Aluminium	µg/l	150.00							10	13								10
Ammonia	mg/l	0.065 - 0.175							2.6									3.4
Antimony	µg/l								1	4								1
Arsenic	µg/l	7.50							26.3	6								4.26
Barium	µg/l								302	695								502
Beryllium	µg/l								0.1	2								0.1
Boron	µg/l	750.00							44.5									24.2
Cadmium	µg/l	3.75							0.08	2								0.08
Calcium	mg/l								219	50								58.9
Chemical Oxygen demand	µg/l								1167									
Chloride	mg/l	24-187.50							495	312								270
Chromium	µg/l	37.50							1	2								1
Cobalt	µg/l								1	3								0.626
Copper	µg/l	1500.00							0.3	2								0.3
Electrical conductivity (EC) (field)	µS/cm @	800 - 1875 @25°C						2970					1616	1418	1582		1227	1504
Electrical conductivity (EC) (lab)	µS/cm @	800 - 1875 @25°C			3830	1602	3300		2787	312								1425
Hydrogen ion concentration (field)	pH units				6.9			6.85					7.46	7.57	7.88		7.59	7.63
Hydrogen ion concentration (lab)	pH units						6.8		6.7	7								8
Iron	mg/l								17.8	0.1								0.019
Lead	µg/l	7.50							0.2	2								0.2
Manganese	µg/l								739	2295								481
Magnesium	mg/l								17.2	28								17.8
Mercury	µg/l	0.75							0.129	1								0.01
Nickel	µg/l	15.00							2.2	27								5.31
Nitrate Nitrogen	mg/l	37.50							0.05	0								0.045
Phosphate	mg/l								0.16									0.16
Potassium	mg/l								17.4	14								7.46
Redox Potential (eH)	mV							-84.7				-109.8	-109.8	-61.3	93.2		-82	-119.5
Selenium	µg/l								1	495								1
Silver	µg/l								0.5	2								0.5
Sodium	mg/l	150							334	574								251
Sulphate	mg/l	187.50							2.2	2								0.94
Tin	µg/l								1	2								1
Total alkalinity	mg/l								845	348								391
Zinc	µg/l	75.00							2.93	52								36.9

Value Above S.I. No. 366 of 2016	VALUE
Value above Dutch 2009 circular Target levels	VALUE
Value above Dutch 2009 circular Intervention levels	VALUE

Substances & categorisation		S.I. No. 366 of 2016	Dutch 2009 Levels		AMW4					AMW5									
										2016		2017				2018			
Substance analysed (also known as) Minerex Environmental	Units	Overall threshold Values Range (from Column test 1 to column	Target Levels (optimum)	Intervention (action)	17/05/2018	28/08/2018	15/11/2018	28/02/2019	14/05/2019	26/05/2016	12/10/2016	22/02/2017	03/05/2017	07/09/2017	06/11/2017	22/02/2018	27/02/2018	17/05/2018
Styrene	µg/l		6.00	300		1	1	1	1	1	1			1	1	1		1
Ethanol	µg/l					500	500	500	500	500	500	500		500	500	500		500
Acetonitrile	µg/l					500	500	500	500	500	500	500		500	500	500		500
Ethyl acetate	µg/l						100	500										
Chloroethane	µg/l					1	1	1	1		1			1	1	1		1
Methanol	µg/l					500	500	500	500	500	500	500		500	500	500		500
Acetone	µg/l					500	500	500	500	500	500	500		500	500	500		500
Isopropanol	µg/l					500	100	500	500	500	500	500		500	500	500		500
Tetrahydrofuran	µg/l		0.50	300		28299	24443	29378	25230	7900		6100	9200	22000	10280	8700		15000
MTBE	µg/l	10.00				3570	2340	3720	3580	710	269	590	1460	2380	1610	2320		4010
Benzene	µg/l	0.75				1	1	1	1	1	1		1	1	1	1		1.39
Ethylbenzene	µg/l		4.00	150		1	1	1	1	1	1	30.3	62.4	1.8	1	13		42
Xylene o	µg/l		0.20	70		1	1	1	1	1	1	18.8	24.5	47.6	25	7.62		55.1
Xylene m/p	µg/l		0.20	70		1	1	1	1	1	1	74.4	130	170	50.7	18.5		147
Toluene	µg/l	525.00	7.00	1000		1	1	1	1	1	1	40.5	3.88	1	140	97.8		2090
Sum of BTEX	µg/l		0.20	70														
MIBK	µg/l		7.00	1000														
Chlorobenzene	µg/l					1	1	1	1	1	1		3.02	1	1.18	1.13		2.08
Bromobenzene	µg/l					1	1	1	1	1	1			1	1	1		1
1,2-Dichloropropane	µg/l		0.80	80		1	1	1	1	1	1	1		1	1	1		1
2,2-Dichloropropane	µg/l		0.01	20		1	1	1	1							1		1
1,3-Dichloropropane	µg/l		0.80	80		34.7	28.8	28.7	32.6	1	6.5	15.7	22.9	25.3	13.1	12		20.9
1,2,3-Trichloropropane	µg/l		0.01	20		1	1	1	1							1		1
Bromochloromethane	µg/l					1	1	1	1	1	1			1	1	1		1
1,1,1-Trichloroethane	µg/l		0.01	300		1	1	1	1	1	1			1	1	1		1
1,1,2-Trichloroethane	µg/l		0.01	20		1	1	1	1							1		1
1,1-Dichloroethane	µg/l		7.00	900		1	1	1	1	1	1			1	1	1		1
1,2-Dichloroethane	µg/l	2.25	7.00	400		1	1.34	1	1.58	1	1	1		1	1	1		1
Dissolved ethane	mg/l																	
Trichloromethane (Chloroform)	µg/l		6.00	400		1	1	1	1	1	1.00		1			1		1
Dichloromethane	µg/l	15.00	0.01	1000		3	3	3	3	3	3	3		3	3	3		3.5
Dichlorodifluoromethane	µg/l		0.01	20		1	1	1	1							1		1
Dissolved methane	mg/l																	
Tetrachloroethene	µg/l	7.50	0.01	40		1	1	1	1	1	1.00		1	1	1	1		1
Trichloroethene	µg/l	7.50	24.00	500		1	1	1	1	1.78	1.43			1	1	1.1		1.84
1,1-Dichloroethene	µg/l		0.01	10		1	1	1	1	1	1			1	1	1		1
cis-1,2-Dichloroethene	µg/l	0.38	0.01	20		1	1	1	1	1	1.28		1.73	1	1.72	1.11		4.64
Chloromethane	µg/l		0.01	20		1	1	1	1							1		1
2-Chlorotoluene	µg/l		0.01	20		1	1	1	1							1		1
4-Chlorotoluene	µg/l		0.01	20		1	1	1	1							1		1
trans-1,2-Dichloroethene	µg/l	0.38	0.01	20		1	1	1	1							1		1
Trichlorofluoromethane	µg/l		0.01	20		1	1	1	1							1		1
Dibromomethane	µg/l		0.01	20		1	1	1	1							1		1
1,2-Dibromoethane	µg/l		0.01	20		1	1	1	1							1		1
1,1,1,2-Tetrachloroethane	µg/l		0.01	20		1	1									1		1
1,1,2,2-Tetrachloroethane	µg/l							1	1									
Bromodichloromethane	µg/l		0.01	20		1	1	1	1							1		1
Dibromochloromethane	µg/l		0.01	20		1	1	1	1							1		1
1,2-Dibromo-3-chloropropane	µg/l		0.01	20		1	1	1	1							1		1
Carbon Tetrachloride	µg/l		0.01	20		1	1	1	1							1		1
4-Isopropyltoluene	µg/l		0.01	20		1	1	1	1							1		1
Bromomethane	µg/l		0.01	20		1	1	1	1							1		1
sec-Butylbenzene	µg/l		0.01	20		1	1	1	1							1		1
tert-Butylbenzene	µg/l		0.01	20		1	1	1	1							1		1
n-Butylbenzene	µg/l		0.01	20		1	1	1	1							1		1
1,2,3-Trichlorobenzene	µg/l		0.01	20		1	1	1	1							1		1
1,2,4-Trichlorobenzene	µg/l		0.01	20		1	1	1	1							1		1
Bromoform	µg/l		0.01	20		1	1	1	1							1		1
Hexachlorobutadiene	µg/l		0.01	20		1	1	1	1							1		1
Naphthalene	µg/l		0.01	20		1	1	1	1							1		1
Chloroethene	µg/l	0.375	0.01	5		1	1	1	1	1	1					1		1.47
1, 2, 4-Trimethylbenzene	µg/l					1	1	1	1	1				1	1	1		1
1, 3, 5-Trimethylbenzene	µg/l					1	1	1	1	1				1	1	1		1
cis-1, 3-Dichloropropene	µg/l					1	1	1	1	1				1	1	1		1
trans-1, 3-Dichloropropene	µg/l		0.01	20		1	1	1	1							1		1
1,1-Dichloropropene	µg/l		0.01	20		1	1	1	1							1		1
1, 2-Dichlorobenzene	µg/l					1	1	1	1	1				1	1	1		1
1, 3-Dichlorobenzene	µg/l		0.01	20		1	1	1	1							1		1
1, 4-Dichlorobenzene	µg/l		0.01	20		1	1	1	1							1		1
n-Propylbenzene	µg/l		0.01	20		1	1	1	1							1		1
Isopropylbenzene	µg/l					1	1	1	1	1				1	1	1		1
Aluminium	µg/l	150.00						10		57								10
Ammonia	mg/l	0.065 - 0.175						4.4		4								1.5
Antimony	µg/l							1		2								1
Arsenic	µg/l	7.50						4.77		2								10.3
Barium	µg/l							417		238								269
Beryllium	µg/l							0.1		2								0.1
Boron	µg/l	750.00						13.2										40.8
Cadmium	µg/l	3.75						0.08		2								0.08
Calcium	mg/l							70.9		501								164
Chemical Oxygen demand	µg/l							158										
Chloride	mg/l	24-187.50						297		132								196
Chromium	µg/l	37.50						1		2								1
Cobalt	µg/l							0.761		2								0.77
Copper	µg/l	1500.00						0.3		2								0.3
Electrical conductivity (EC) (field)	µS/cm @	800 - 1875 @25°C			1504	1406	1083						1224	1503	1462		1025	1264
Electrical conductivity (EC) (lab)	µS/cm @	800 - 1875 @25°C						1749		1199								1397
Hydrogen ion concentration (field)	pH units				7.63	8.16	7.73						7.34	7.28	7.89		7.47	7.4
Hydrogen ion concentration (lab)	pH units							7.3		7								7.4
Iron	mg/l							0.019		0								0.474
Lead	µg/l	7.50						0.2		2								0.2
Manganese	µg/l							630		947								629
Magnesium	mg/l							19		26								20.5
Mercury	µg/l	0.75						0.01		1								0.01
Nickel	µg/l	15.00						4.15		2								1.43
Nitrate Nitrogen	mg/l	37.50						0.05		0								0.05
Phosphate	mg/l							0.16										0.16
Potassium	mg/l							4.56		13								6.51
Redox Potential (eH)	mV				-119.5	-113.6	-102.6						-95.4	-99.7	-110.4		-114.9	-125.6
Selenium	µg/l							1		34								1
Silver	µg/l							0.5		2								0.5
Sodium	mg/l	150						249		226								143
Sulphate	mg/l	187.50						0.98		3								0.5
Tin	µg/l							1		2								1
Total alkalinity	mg/l							460		379								456
Zinc	µg/l	75.00						3.86		39								37.5

Value Above S.I. No. 366 of 2016	VALUE
Value above Dutch 2009 circular Target levels	VALUE
Value above Dutch 2009 circular Intervention levels	VALUE

Substances & categorisation		S.I. No. 366 of 2016	Dutch 2009 Levels		AMW5				AMW11							AMW11	Effluent		
								2019	2019								2017		
Substance analysed (also known as)	Units	Overall threshold Values Range (from Column test 1 to column	Target Levels (optimum)	Intervention (action)	28/08/2018	15/11/2018	28/02/2019	14/05/2019	27/03/2019	02/04/2019	10/04/2019	08/05/2019	14/05/2019	23/05/2019	28/05/2019		Jan-2017	Feb-2017	Mar-2017
Styrene	µg/l		6.00	300	1	1	1	1					1				1	18	13
Ethanol	µg/l				500	500	500	500	500	500	500	500	500	500	500		849000	312000	577000
Acetonitrile	µg/l				500	10770	500	4100	48977	75840	96021	35686	30000	64768	38272		22000	21000	24000
Ethyl acetate	µg/l					100	500												
Chloroethane	µg/l				1	1	1	1					1				2.000	1.000	1.000
Methanol	µg/l				500	14756	500	500	29449	23572	26098	500	500	500	500		1290000	551000	1035000
Acetone	µg/l				500	3556	500	500	102045	146875	136864	28742	44000	85294	38020		149000	113000	93000
Isopropanol	µg/l				500	3001	500	500	56999	134524	148763	58611	74000	97014	41318		164000	144000	80000
Tetrahydrofuran	µg/l		0.50	300	34865	34674	18935	20196	23329	35946	27204	37038	35060	29342	25282		73000	60000	
MTBE	µg/l	10.00			9180	10400	3880	4070	6220	6500	7740	14300	15100	11500	11900		42800	70900	9100
Benzene	µg/l	0.75			1.67	2.28	1	1	1	2.92	1.81	0.5	2.32	1.7	1.89		1	1	1
Ethylbenzene	µg/l		4.00	150	119	160	1	44800	51.4	126	89.5	121	175	101	116		20	9	24
Xylene o	µg/l		0.20	70	146	187	5080	56900	111	207	152	212	290	173	207		46	1	40
Xylene m/p	µg/l		0.20	70	508	646	120	178	325	629	430	0.5	824	486	578		64	27	76
Toluene	µg/l	525.00	7.00	1000	1700	14500	1	550	11800	24900	27900	16700	28500	16600	12900		35000	26700	22000
Sum of BTEX	µg/l		0.20	70															
MIBK	µg/l		7.00	1000					7990	4870	2270	831		3350	1830				
Chlorobenzene	µg/l				3.47	4.51	1	1.59	1.46	3.12	1	3.53	4.53	2.48	3.38		1	1	1
Bromobenzene	µg/l				1	1	1	1					1				1	1	1
1,2-Dichloropropane	µg/l		0.80	80	1	1	1	1					1				1	1	1
2,2-Dichloropropane	µg/l		0.01	20	1	1	1	1					1				1	1	1
1,3-Dichloropropane	µg/l		0.80	80	31.5	36.4	11.6	13.6	40.3	53.2	52.2	38.4	31.8	22	25.1		58	10	13
1,2,3-Trichloropropane	µg/l		0.01	20	1	1	1	1					1				1	1	1
Bromochloromethane	µg/l				1	1	1	1					1				1	1	1
1,1,1-Trichloroethane	µg/l		0.01	300	1	1	1	1					1				1	1	1
1,1,2-Trichloroethane	µg/l		0.01	20	1	1	1	1					1				1	1	1
1,1-Dichloroethane	µg/l		7.00	900	1	1	1	1					1				1	1	1
1,2-Dichloroethane	µg/l	2.25	7.00	400	1	1	1	1					1				1	1	1
Dissolved ethane	mg/l																		
Trichloromethane (Chloroform)	µg/l		6.00	400	1	1	1	1					1				1	1	1
Dichloromethane	µg/l	15.00	0.01	1000	3	4.37	3	3	725	5100	2290	99.8	99.9	4410	529		1040	1620	1110
Dichlorodifluoromethane	µg/l		0.01	20	1	1	1	1					1						
Dissolved methane	mg/l																		
Tetrachloroethene	µg/l	7.50	0.01	40	1	1	1	1	1	1	1	1	1	1	1		1	1	1
Trichloroethene	µg/l	7.50	24.00	500	1	1	1	1					1				1	1	1
1,1-Dichloroethene	µg/l		0.01	10	1	1	1	1					1				1	1	1
cis-1,2-Dichloroethene	µg/l	0.38	0.01	20	1	1	1	1					1				1	1	1
Chloromethane	µg/l		0.01	20	1	1	1	1					1				4	4	5
2-Chlorotoluene	µg/l		0.01	20	1	1	1	1					1				1	1	1
4-Chlorotoluene	µg/l		0.01	20	1	1	1	1					1				1	1	1
trans-1,2-Dichloroethene	µg/l	0.38	0.01	20	1	1	1	1					4.09				1	1	1
Trichlorofluoromethane	µg/l		0.01	20	1	1	1	1					1						
Dibromomethane	µg/l		0.01	20	1	1	1	1					1						
1,2-Dibromoethane	µg/l		0.01	20	1	1	1	1					1				1	1	1
1,1,1,2-Tetrachloroethane	µg/l		0.01	20	1	1											1	1	1
1,1,2,2-Tetrachloroethane	µg/l						1	1					1						
Bromodichloromethane	µg/l		0.01	20	1	1	1	1					1						
Dibromochloromethane	µg/l		0.01	20	1	1	1	1					1						
1,2-Dibromo-3-chloropropane	µg/l		0.01	20	1	1	1	1					1				1	1	1
Carbon Tetrachloride	µg/l		0.01	20	1	1	1	1					1				1	1	1
4-Isopropyltoluene	µg/l		0.01	20	1	1	1	1					1				1	1	1
Bromomethane	µg/l		0.01	20	1	1	1	1					1						
sec-Butylbenzene	µg/l		0.01	20	1	1	1	1					1				1	1	1
tert-Butylbenzene	µg/l		0.01	20	1	1	1	1					1				1	1	1
n-Butylbenzene	µg/l		0.01	20	1	1	1	1					1				1	1	1
1,2,3-Trichlorobenzene	µg/l		0.01	20	1	1	1	1					1						
1,2,4-Trichlorobenzene	µg/l		0.01	20	1	1	1	1					1						
Bromoform	µg/l		0.01	20	1	1	1	1					1				1	1	1
Hexachlorobutadiene	µg/l		0.01	20	1	1	1	1					1				1	1	1
Naphthalene	µg/l		0.01	20	1	1	1	1					1				1	1	1
Chloroethene	µg/l	0.375	0.01	5	1	1	1	1					1				1	1	1
1, 2, 4-Trimethylbenzene	µg/l				1	1.2	1	1					2.13				1	1	1
1, 3, 5-Trimethylbenzene	µg/l				1	1	1	1					1				1	1	1
cis-1, 3-Dichloropropene	µg/l				1	1	1	1					1				1	1	1
trans-1, 3-Dichloropropene	µg/l		0.01	20	1	1	1	1					1				1	1	1
1,1-Dichloropropene	µg/l		0.01	20	1	1	1	1					1				1	1	1
1, 2-Dichlorobenzene	µg/l				1	1	1	1					1				1	1	1
1, 3-Dichlorobenzene	µg/l		0.01	20	1	1	1	1					1						
1, 4-Dichlorobenzene	µg/l		0.01	20	1	1	1	1					1				1	1	1
n-Propylbenzene	µg/l		0.01	20	1	1	1	1					1				1	1	1
Isopropylbenzene	µg/l				1	1.24	1	1					1.6				1	1	1
Aluminium	µg/l	150.00					10												
Ammonia	mg/l	0.065 - 0.175					2												
Antimony	µg/l						1												
Arsenic	µg/l	7.50					16.1												
Barium	µg/l						83												
Beryllium	µg/l						0.1												
Boron	µg/l	750.00					61												
Cadmium	µg/l	3.75					0.08												
Calcium	mg/l						138												
Chemical Oxygen demand	µg/l						120												
Chloride	mg/l	24-187.50					201												
Chromium	µg/l	37.50					1												
Cobalt	µg/l						1.43												
Copper	µg/l	1500.00					0.3												
Electrical conductivity (EC) (field)	µS/cm @	800 - 1875 @25°C			1332	1341													
Electrical conductivity (EC) (lab)	µS/cm @	800 - 1875 @25°C					1520												
Hydrogen ion concentration (field)	pH units				7.62	7.29													
Hydrogen ion concentration (lab)	pH units						7.2												
Iron	mg/l						0.208												
Lead	µg/l	7.50					0.2												
Manganese	µg/l						342												
Magnesium	mg/l						15.3												
Mercury	µg/l	0.75					0.01												
Nickel	µg/l	15.00					2.66												
Nitrate Nitrogen	mg/l	37.50					0.05												
Phosphate	mg/l						0.16												
Potassium	mg/l						5.33												
Redox Potential (eH)	mV				-137.2	-118.1													
Selenium	µg/l						1												
Silver	µg/l						0.5												
Sodium	mg/l	150					171												
Sulphate	mg/l	187.50					2												
Tin	µg/l						2.59												
Total alkalinity	mg/l						559												
Zinc	µg/l	75.00					1.71												

Value Above S.I. No. 366 of 2016	VALUE
Value above Dutch 2009 circular Target levels	VALUE
Value above Dutch 2009 circular Intervention levels	VALUE

Substances & categorisation		S.I. No. 366 of 2016	Dutch 2009 Levels		Effluent													
														2018				
Substance analysed (also known as) Minerex Environmental	Units	Overall threshold Values Range (from Column test 1 to column	Target Levels (optimum)	Intervention (action)	Apr-2017	May-2017	Jun-2017	Jul-2017	Aug-2017	Sep-2017	Oct-2017	Nov-2017	Dec-2017	Jan-2018	Feb-2018	Mar-2018	Apr-2018	May-2018
Styrene	µg/l		6.00	300	14	10	6	5	1	4	8	1	11	1	1	8	1	1
Ethanol	µg/l				366000	369000	327000	369000	140000	281000	104000	382000	141000	169000	600000	373000	117000	356000
Acetonitrile	µg/l				27000	38000	47000	20000	62000	86000	59000	82000	53900	57000	66000	63000	80000	70000
Ethyl acetate	µg/l																	
Chloroethane	µg/l				1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	3.000	1.000	1.000	1.000	1.000	1.000
Methanol	µg/l				1391000	1658000	1163000	1111000	1050000	509000	874000	1385000	588000	1000	1004000	1389000	1384000	2144000
Acetone	µg/l				144000	127000	207000	215000	386000	393000	182000	299000	179000	296000	230000	152000	158000	187000
Isopropanol	µg/l				86000	107000	164000	79000	197000	247000	174000	277000	183000	351000	170000	264000	176000	279000
Tetrahydrofuran	µg/l		0.50	300	84000	106000	84000	91000	69000	104000	99000	130000	66000	120000	50000	72000	68000	88000
MTBE	µg/l	10.00			49000	51000	39000	4000	27000	322000	213000	428000	674000	184000	175000	178000	54000	46000
Benzene	µg/l	0.75			8	11	13	9	1	1	1	1	1	1	1	4	1	1
Ethylbenzene	µg/l		4.00	150	17	1	1	7	29	1	1	28	18	3	1	7	22	6
Xylene o	µg/l		0.20	70	23	5	3	25	75	9	4	58	40	6	1	2	41	14
Xylene m/p	µg/l		0.20	70	41	6	4	41	101	10	5	87	65	10	4	2	67	21
Toluene	µg/l	525.00	7.00	1000	28500	30000	6300	4910	3350	6350	4000	11500	12000	14300	5780	8150	17700	10800
Sum of BTEX	µg/l		0.20	70														
MIBK	µg/l		7.00	1000										0.1	0.1	0.1	0.1	0.1
Chlorobenzene	µg/l				1	1	1	1	1	1	1	1	1	1	1	1	1	1
Bromobenzene	µg/l				1	1	1	1	1	1	1	1	1	1	1	1	1	1
1,2-Dichloropropane	µg/l		0.80	80	1	1	1	1	1	1	1	1	1	1	1	1	1	1
2,2-Dichloropropane	µg/l		0.01	20	1	1	1	1	1	1	1	1	1	1	1	1	1	1
1,3-Dichloropropane	µg/l		0.80	80	37	7	56	15	18	10	3	1	26	4	6	1	24	9
1,2,3-Trichloropropane	µg/l		0.01	20	1	1	1	1	1	1	1	1	1	1	1	1	1	1
Bromochloromethane	µg/l				1	1	1	1	1	1	1	1	1	15	1	1	1	1
1,1,1-Trichloroethane	µg/l		0.01	300	1	1	1	1	1	1	1	1	1	1	1	1	1	1
1,1,2-Trichloroethane	µg/l		0.01	20	1	1	1	1	1	1	1	1	1	1	1	1	1	1
1,1-Dichloroethane	µg/l		7.00	900	1	1	1	1	1	1	1	1	1	1	1	1	1	1
1,2-Dichloroethane	µg/l	2.25	7.00	400	1	1	1	1	1	1	1	1	1	1	1	1	1	1
Dissolved ethane	mg/l																	
Trichloromethane (Chloroform)	µg/l		6.00	400	1	1	1	1	10	1	1	1	1	1	1	1	1	1
Dichloromethane	µg/l	15.00	0.01	1000	1400	2680	1800	749	1350	896	319	2330	1090	3210	3120	46900	5050	2940
Dichlorodifluoromethane	µg/l		0.01	20														
Dissolved methane	mg/l																	
Tetrachloroethene	µg/l	7.50	0.01	40	1	1	1	1	1	1	1	1	1	1	1	1	1	1
Trichloroethene	µg/l	7.50	24.00	500	1	1	1	1	1	1	1	1	1	1	1	1	1	1
1,1-Dichloroethene	µg/l		0.01	10	1	1	1	1	1	1	1	1	1	1	2	1	1	1
cis-1,2-Dichloroethene	µg/l	0.38	0.01	20	1	1	1	1	1	1	1	1	1	1	1	1	1	1
Chloromethane	µg/l		0.01	20	1	3	5	1	3	5	2	1	1	8	10	5	2	1
2-Chlorotoluene	µg/l		0.01	20	1	1	1	1	1	1	1	1	1	3	1	1	1	1
4-Chlorotoluene	µg/l		0.01	20	1	1	1	1	1	1	1	1	1	1	1	1	1	1
trans-1,2-Dichloroethene	µg/l	0.38	0.01	20	1	1	1	1	1	1	1	1	1	1	1	1	1	1
Trichlorofluoromethane	µg/l		0.01	20														
Dibromomethane	µg/l		0.01	20														
1,2-Dibromoethane	µg/l		0.01	20	1	1	1	1	1	1	1	1	1	1	1	1	1	1
1,1,1,2-Tetrachloroethane	µg/l		0.01	20	1	1	1	1	1	1	1	1	1	1	1	1	1	1
1,1,2,2-Tetrachloroethane	µg/l																	
Bromodichloromethane	µg/l		0.01	20														
Dibromochloromethane	µg/l		0.01	20														
1,2-Dibromo-3-chloropropane	µg/l		0.01	20	1	1	1	1	1	1	1	1	1	1	1	1	1	1
Carbon Tetrachloride	µg/l		0.01	20	1	1	1	1	1	1	1	1	1	1	1	1	1	1
4-Isopropyltoluene	µg/l		0.01	20	1	1	1	1	1	1	1	1	1	1	1	1	1	1
Bromomethane	µg/l		0.01	20														
sec-Butylbenzene	µg/l		0.01	20	1	1	1	1	1	1	1	1	1	1	1	1	1	1
tert-Butylbenzene	µg/l		0.01	20	1	1	1	1	1	1	1	1	1	1	1	1	1	1
n-Butylbenzene	µg/l		0.01	20	1	1	1	1	1	1	1	1	1	1	1	1	1	1
1,2,3-Trichlorobenzene	µg/l		0.01	20														
1,2,4-Trichlorobenzene	µg/l		0.01	20														
Bromoform	µg/l		0.01	20	1	1	1	1	1	1	1	4	5	10	4	4	1	1
Hexachlorobutadiene	µg/l		0.01	20	1	1	1	1	1	1	1	1	1	1	1	1	1	1
Naphthalene	µg/l		0.01	20	1	1	1	1	1	1	1	1	1	1	1	1	1	1
Chloroethene	µg/l	0.375	0.01	5	1	1	1	1	1	1	1	1	1	1	1	1	1	1
1, 2, 4-Trimethylbenzene	µg/l				1	1	1	1	1	1	1	1	1	1	1	1	1	1
1, 3, 5-Trimethylbenzene	µg/l				1	1	1	1	1	1	1	1	1	1	1	1	1	1
cis-1, 3-Dichloropropene	µg/l				1	1	1	1	1	1	1	1	1	1	1	1	1	1
trans-1, 3-Dichloropropene	µg/l		0.01	20	1	1	1	1	1	1	1	1	1	1	1	1	1	1
1,1-Dichloropropene	µg/l		0.01	20	1	1	1	1	1	1	1	1	1	1	1	1	1	1
1, 2-Dichlorobenzene	µg/l				1	1	1	1	1	1	1	1	1	1	1	1	1	1
1, 3-Dichlorobenzene	µg/l		0.01	20														
1, 4-Dichlorobenzene	µg/l		0.01	20	1	1	1	1	1	1	1	1	1	1	1	1	1	1
n-Propylbenzene	µg/l		0.01	20	1	1	1	1	1	1	1	1	1	1	1	1	1	1
Isopropylbenzene	µg/l				1	1	1	1	1	1	1	1	1	1	1	1	1	1
Aluminium	µg/l	150.00																
Ammonia	mg/l	0.065 - 0.175																
Antimony	µg/l																	
Arsenic	µg/l	7.50																
Barium	µg/l																	
Beryllium	µg/l																	
Boron	µg/l	750.00																
Cadmium	µg/l	3.75																
Calcium	mg/l																	
Chemical Oxygen demand	µg/l																	
Chloride	mg/l	24-187.50																
Chromium	µg/l	37.50																
Cobalt	µg/l																	
Copper	µg/l	1500.00																
Electrical conductivity (EC) (field)	µS/cm @	800 - 1875 @25°C																
Electrical conductivity (EC) (lab)	µS/cm @	800 - 1875 @25°C																
Hydrogen ion concentration (field)	pH units																	
Hydrogen ion concentration (lab)	pH units																	
Iron	mg/l																	
Lead	µg/l	7.50																
Manganese	µg/l																	
Magnesium	mg/l																	
Mercury	µg/l	0.75																
Nickel	µg/l	15.00																
Nitrate Nitrogen	mg/l	37.50																
Phosphate	mg/l																	
Potassium	mg/l																	
Redox Potential (eH)	mV																	
Selenium	µg/l																	
Silver	µg/l																	
Sodium	mg/l	150																
Sulphate	mg/l	187.50																
Tin	µg/l																	
Total alkalinity	mg/l																	
Zinc	µg/l	75.00																

Value Above S.I. No. 366 of 2016	VALUE
Value above Dutch 2009 circular Target levels	VALUE
Value above Dutch 2009 circular Intervention levels	VALUE

Substances & categorisation		S.I. No. 366 of 2016	Dutch 2009 Levels		Effluent AMW2													
												2016			2017			2018
Substance analysed (also known as) Minerex Environmental	Units	Overall threshold Values Range (from Column test 1 to column	Target Levels (optimum)	Intervention (action)	Jun-2018	Jul-2018	Aug-2018	Sep-2018	Oct-2018	Nov-2018	Dec-2018	01/02/2016	26/05/2016	22/09/2016	03/05/2017	07/09/2017	07/11/2017	22/02/2018
Styrene	µg/l		6.00	300	1	1	1	1	1	1	1		1	1		1	1	1
Ethanol	µg/l				370000	349000	308000	561000					500	500		500	500	500
Acetonitrile	µg/l				43000	84000	55000	104000					500	500		500	500	500
Ethyl acetate	µg/l																	
Chloroethane	µg/l				1.000	1.000	1.000	1.000	1.000	1.000	1.000		1	1		1	1	1
Methanol	µg/l				924000	1103000	1125000	1314000					500	500		500	500	500
Acetone	µg/l				149000	203000	119000	240000					500	500		500	500	500
Isopropanol	µg/l				162000	232000	164000	454000					500	500		500	500	500
Tetrahydrofuran	µg/l		0.50	300	73000	65000	82000	111000							1	500	500	1
MTBE	µg/l	10.00			16000	29000	23000	31000					1	1	1	24.6	1	1
Benzene	µg/l	0.75			1	1	1	1	1	1	1		1		1	1	1	1
Ethylbenzene	µg/l		4.00	150	3	12	6	3	1	1	1		1	1	1	1	1	1
Xylene o	µg/l		0.20	70	6	29	15	5					1	1	1	1	1	1
Xylene m/p	µg/l		0.20	70	1	4	20	11					1	1	1	1	1	1
Toluene	µg/l	525.00	7.00	1000	12800	8330	12100	9370					1	1	1	1	1	1
Sum of BTEX	µg/l		0.20	70														
MIBK	µg/l		7.00	1000	0.1	0.1	0.1	0.1	0.1	0.1	0.1							
Chlorobenzene	µg/l				1	1	1	1	1	1	1							1
Bromobenzene	µg/l				1	1	1	1	1	1	1							1
1,2-Dichloropropane	µg/l		0.80	80	1	1	1	1	1	1	1					1	1	1
2,2-Dichloropropane	µg/l		0.01	20	1	1	1	1	1	1	1							1
1,3-Dichloropropane	µg/l		0.80	80	9	4	28	19					1	1	1	1	1	1
1,2,3-Trichloropropane	µg/l		0.01	20	1	1	1	1	1	1	1							1
Bromochloromethane	µg/l				1	1	1	1	1	1	1		1	1		1	1	1
1,1,1-Trichloroethane	µg/l		0.01	300	1	1	1	1	1	1	1		1	1		1	1	1
1,1,2-Trichloroethane	µg/l		0.01	20	1	1	1	1	1	1	1							1
1,1-Dichloroethane	µg/l		7.00	900	1	1	1	1	1	1	1		3	3		1	1	1
1,2-Dichloroethane	µg/l	2.25	7.00	400	1	1	1	1	1	1	1		1	1		1	1	1
Dissolved ethane	mg/l																	
Trichloromethane (Chloroform)	µg/l		6.00	400	1	2	1	1	1	1	1		1.00	1.00				1
Dichloromethane	µg/l	15.00	0.01	1000	28800	4	4010	2060					3	3		4.07	3.00	3
Dichlorodifluoromethane	µg/l		0.01	20														1
Dissolved methane	mg/l																	
Tetrachloroethene	µg/l	7.50	0.01	40	1	1	1	1	1	1	1	513	869	229	81.8	99.6	98.2	519
Trichloroethene	µg/l	7.50	24.00	500	1	1	1	1	1	1	1		1.00	1.00		1	1	1
1,1-Dichloroethene	µg/l		0.01	10	1	1	1	1	1	1	1		1.00	1.00		1	1	1
cis-1,2-Dichloroethene	µg/l	0.38	0.01	20	1	1	1	1	1	1	1		1.00	1.00		1	1	1
Chloromethane	µg/l		0.01	20	4	8	1	8	1	1	1							1
2-Chlorotoluene	µg/l		0.01	20	1	1	1	1	1	1	1							1
4-Chlorotoluene	µg/l		0.01	20	1	1	1	1	1	1	1							1
trans-1,2-Dichloroethene	µg/l	0.38	0.01	20	1	1	1	1	1	1	1							1
Trichlorofluoromethane	µg/l		0.01	20														1
Dibromomethane	µg/l		0.01	20														1
1,2-Dibromoethane	µg/l		0.01	20	1	1	1	1	1	1	1							1
1,1,1,2-Tetrachloroethane	µg/l		0.01	20	1	1	1	1	1	1	1							1
1,1,2,2-Tetrachloroethane	µg/l																	
Bromodichloromethane	µg/l		0.01	20														1
Dibromochloromethane	µg/l		0.01	20														1
1,2-Dibromo-3-chloropropane	µg/l		0.01	20	1	1	1	1	1	1	1							1
Carbon Tetrachloride	µg/l		0.01	20	1	1	1	1	1	1	1							1
4-Isopropyltoluene	µg/l		0.01	20	1	1	1	1	1	1	1							1
Bromomethane	µg/l		0.01	20														1
sec-Butylbenzene	µg/l		0.01	20	1	1	1	1	1	1	1							1
tert-Butylbenzene	µg/l		0.01	20	1	1	1	1	1	1	1							1
n-Butylbenzene	µg/l		0.01	20	1	1	1	1	1	1	1							1
1,2,3-Trichlorobenzene	µg/l		0.01	20														1
1,2,4-Trichlorobenzene	µg/l		0.01	20														1
Bromoform	µg/l		0.01	20	1	1	1	2	1	1	1							1
Hexachlorobutadiene	µg/l		0.01	20	1	1	1	1	1	1	1							1
Naphthalene	µg/l		0.01	20	1	1	1	1	1	1	1							1
Chloroethene	µg/l	0.375	0.01	5	1	1	1	1	1	1	1		1.00	1.00				1
1, 2, 4-Trimethylbenzene	µg/l				1	1	1	1	1	1	1							1
1, 3, 5-Trimethylbenzene	µg/l				1	1	1	1	1	1	1							1
cis-1, 3-Dichloropropene	µg/l				1	1	1	1	1	1	1							1
trans-1, 3-Dichloropropene	µg/l		0.01	20	1	1	1	1	1	1	1							1
1,1-Dichloropropene	µg/l		0.01	20	1	1	1	1	1	1	1							1
1, 2-Dichlorobenzene	µg/l				1	1	1	1	1	1	1							1
1, 3-Dichlorobenzene	µg/l		0.01	20														1
1, 4-Dichlorobenzene	µg/l		0.01	20	1	1	1	1	1	1	1							1
n-Propylbenzene	µg/l		0.01	20	1	1	1	1	1	1	1							1
Isopropylbenzene	µg/l				1	1	1	1	1	1	1							1
Aluminium	µg/l	150.00											11.0					
Ammonia	mg/l	0.065 - 0.175											0.0					
Antimony	µg/l												2.0					
Arsenic	µg/l	7.50											2.0					
Barium	µg/l												37.0					
Beryllium	µg/l												2.0					
Boron	µg/l	750.00																
Cadmium	µg/l	3.75											2.0					
Calcium	mg/l												296.0					
Chemical Oxygen demand	µg/l																	
Chloride	mg/l	24-187.50											37.0					
Chromium	µg/l	37.50											3.0					
Cobalt	µg/l												2.0					
Copper	µg/l	1500.00											2.0					
Electrical conductivity (EC) (field)	µS/cm @	800 - 1875 @25°C													889	857	946	
Electrical conductivity (EC) (lab)	µS/cm @	800 - 1875 @25°C											708.0					
Hydrogen ion concentration (field)	pH units														7.58	7.71	7.22	
Hydrogen ion concentration (lab)	pH units												7.3					
Iron	mg/l												0.1					
Lead	µg/l	7.50											2.0					
Manganese	µg/l												2.0					
Magnesium	mg/l												14.0					
Mercury	µg/l	0.75											1.0					
Nickel	µg/l	15.00											2.0					
Nitrate Nitrogen	mg/l	37.50											1.2					
Phosphate	mg/l																	
Potassium	mg/l												3.7					
Redox Potential (eH)	mV														17.7	48.1	24.5	
Selenium	µg/l												17.0					
Silver	µg/l												2.0					
Sodium	mg/l	150											38.0					
Sulphate	mg/l	187.50											7.0					
Tin	µg/l												9.0					
Total alkalinity	mg/l												243.0					
Zinc	µg/l	75.00											18.0					

Value Above S.I. No. 366 of 2016	VALUE
Value above Dutch 2009 circular Target levels	VALUE
Value above Dutch 2009 circular Intervention levels	VALUE

Substances & categorisation		S.I. No. 366 of 2016	Dutch 2009 Levels		AMW2					AMW7			AMW7	AMW8			AMW8
									2019	2016		2018	2019	2016	2016	2018	2019
Substance analysed (also known as)	Units	Overall threshold Values Range (from Column test 1 to column	Target Levels (optimum)	Intervention (action)	27/02/2018	17/05/2018	28/08/2018	15/11/2018	28/02/2019	14/05/2019	26/05/2016	22/09/2016	17/05/2018	28/02/2019	26/05/2016	22/09/2016	17/05/2018	28/02/2019
Styrene	µg/l		6.00	300		1	1	1	1	1	1	1	1	1	1	1	1	1
Ethanol	µg/l					500	500	500	500	500	500	500	500	500	500	500	500	500
Acetonitrile	µg/l					500	500	500	500	500	500	500	500	500	500	500	500	500
Ethyl acetate	µg/l							100	500					500				500
Chloroethane	µg/l					1	1	1	1	1	1	1	1	1	1	1	1	1
Methanol	µg/l					500	500	500	500	500	500	500	500	500	500	500	500	500
Acetone	µg/l					500	500	170	500	500	500	500	500	500	500	500	500	500
Isopropanol	µg/l					500	500	100	500	500	500	500	500	500	500	500	500	500
Tetrahydrofuran	µg/l		0.50	300		41	1	1935	0.066	1	500	500	120	79	500	500	90	454
MTBE	µg/l	10.00				2.62	4.91	446	27.4	1.39	33	19	22.3	28.2	2	1	44.2	181
Benzene	µg/l	0.75				1	1	1	1	1			1	1			1	1
Ethylbenzene	µg/l		4.00	150		1	1	4.17	1	1	1	1	1	1	1	1	1	1
Xylene o	µg/l		0.20	70		1	1	6.87	1	1	1	1	1	1	1	1	1	1
Xylene m/p	µg/l		0.20	70		1	1	15.7	1	1	1	1	1	1	1	1	1	1
Toluene	µg/l	525.00	7.00	1000		1	1	1270	1	1	1	1	1	1	1	1	1	1
Sum of BTEX	µg/l		0.20	70														
MIBK	µg/l		7.00	1000														
Chlorobenzene	µg/l					1	1	1	1	1			1	1			1	1
Bromobenzene	µg/l					1	1	1	1	1			1	1			1	1
1,2-Dichloropropane	µg/l		0.80	80		1	1	1	1	1	1	2	1	1	1	1	1	1
2,2-Dichloropropane	µg/l		0.01	20		1	1	1	1	1			1	1			1	1
1,3-Dichloropropane	µg/l		0.80	80		1	1	1.01	1	1	1	2	1.67	1.9	1	1	1	1
1,2,3-Trichloropropane	µg/l		0.01	20		1	1	1	1	1			1	1			1	1
Bromochloromethane	µg/l					1	1	1	1	1	1	1	1	1	1	1	1	1
1,1,1-Trichloroethane	µg/l		0.01	300		1	1	1	1	1	1	1	1	1	1	1	1	1
1,1,2-Trichloroethane	µg/l		0.01	20		1	1	1	1	1			1	1			1	1
1,1-Dichloroethane	µg/l		7.00	900		1	1	1	1	1	4	5	5.31	3.73	1	1	1	1
1,2-Dichloroethane	µg/l	2.25	7.00	400		1	1	1	1	1	1	1	1.34	1	1	1	1	1
Dissolved ethane	mg/l																	
Trichloromethane (Chloroform)	µg/l		6.00	400		1	1	1	1	1	1.00	1.00	1	1	2.33	2.23	1.96	1
Dichloromethane	µg/l	15.00	0.01	1000		21.3	3	3	3	3	3	3	3	3	3	4	84.1	3
Dichlorodifluoromethane	µg/l		0.01	20		1	1	1	1	1			1	1			1	1
Dissolved methane	mg/l																	
Tetrachloroethene	µg/l	7.50	0.01	40		780	291	109	108	1	60	21	55.2	34.5	218	254	120	34.5
Trichloroethene	µg/l	7.50	24.00	500		1	1	1	13.2	1	3.9	3.3	6.53	5.18	1	1	3.64	3.23
1,1-Dichloroethene	µg/l		0.01	10		1	1	1	1	1	1	1	1.25	1	1	1	1	1
cis-1,2-Dichloroethene	µg/l	0.38	0.01	20		1	1	1	1.5	1	32.70	89.50	92.2	55.8	8	3.98	13	58.8
Chloromethane	µg/l		0.01	20		1	1	1	1	1			1	1			1	1
2-Chlorotoluene	µg/l		0.01	20		1	1	1	1	1			1	1			1	1
4-Chlorotoluene	µg/l		0.01	20		1	1	1	1	1			1	1			1	1
trans-1,2-Dichloroethene	µg/l	0.38	0.01	20		1	1	1	1	1			1	1			1	1
Trichlorofluoromethane	µg/l		0.01	20		1	1	1	1	1			1	1			1	1
Dibromomethane	µg/l		0.01	20		1	1	1	1	1			1	1			1	1
1,2-Dibromoethane	µg/l		0.01	20		1	1	1	1	1			1	1			1	1
1,1,1,2-Tetrachloroethane	µg/l		0.01	20		1	1	1					1				1	
1,1,2,2-Tetrachloroethane	µg/l								1	1				1				1
Bromodichloromethane	µg/l		0.01	20		1	1	1	1	1			1	1			1	1
Dibromochloromethane	µg/l		0.01	20		1	1	1	1	1			1	1			1	1
1,2-Dibromo-3-chloropropane	µg/l		0.01	20		1	1	1	1	1			1	1			1	1
Carbon Tetrachloride	µg/l		0.01	20		1	1	1	1	1			1	1			1	1
4-Isopropyltoluene	µg/l		0.01	20		1	1	1	1	1			1	1			1	1
Bromomethane	µg/l		0.01	20		1	1	1	1	1			1	1			1	1
sec-Butylbenzene	µg/l		0.01	20		1	1	1	1	1			1	1			1	1
tert-Butylbenzene	µg/l		0.01	20		1	1	1	1	1			1	1			1	1
n-Butylbenzene	µg/l		0.01	20		1	1	1	1	1			1	1			1	1
1,2,3-Trichlorobenzene	µg/l		0.01	20		1	1	1	1	1			1	1			1	1
1,2,4-Trichlorobenzene	µg/l		0.01	20		1	1	1	1	1			1	1			1	1
Bromoform	µg/l		0.01	20		1	1	1	1	1			1	1			1	1
Hexachlorobutadiene	µg/l		0.01	20		1	1	1	1	1			1	1			1	1
Naphthalene	µg/l		0.01	20		1	1	1	1	1			1	1			1	1
Chloroethene	µg/l	0.375	0.01	5		1	1	1	1	1	1	2	1	1	1	1	1	1
1, 2, 4-Trimethylbenzene	µg/l					1	1	1	1	1			1	1			1	1
1, 3, 5-Trimethylbenzene	µg/l					1	1	1	1	1			1	1			1	1
cis-1, 3-Dichloropropene	µg/l					1	1	1	1	1			1	1			1	1
trans-1, 3-Dichloropropene	µg/l		0.01	20		1	1	1	1	1			1	1			1	1
1,1-Dichloropropene	µg/l		0.01	20		1	1	1	1	1			1	1			1	1
1, 2-Dichlorobenzene	µg/l					1	1	1	1	1			1	1			1	1
1, 3-Dichlorobenzene	µg/l		0.01	20		1	1	1	1	1			1	1			1	1
1, 4-Dichlorobenzene	µg/l		0.01	20		1	1	1	1	1			1	1			1	1
n-Propylbenzene	µg/l		0.01	20		1	1	1	1	1			1	1			1	1
Isopropylbenzene	µg/l					1	1	1	1	1			1	1			1	1
Aluminium	µg/l	150.00				10			10		4.0		10	10	9.0		10	10
Ammonia	mg/l	0.065 - 0.175				0.02			0.08		0.1		0.02	0.05	0.0		0.02	0.48
Antimony	µg/l					1			1		2.0		1	1	2.0		1	1
Arsenic	µg/l	7.50				0.5			0.624		3.0		1.67	2.19	2.0		0.5	1.59
Barium	µg/l					170			21.3		213.0		179	75.8	70.0		156	47.5
Beryllium	µg/l					0.1			0.1		2.0		0.1	0.1	2.0		0.1	0.1
Boron	µg/l	750.00				21.5			10				12.8	10			16.8	10
Cadmium	µg/l	3.75				0.08			0.08		2.0		0.08	0.08	2.0		0.08	0.08
Calcium	mg/l					99.8			60.6		501.0		100	105	1504.0		109	95.1
Chemical Oxygen demand	µg/l								10					10				66
Chloride	mg/l	24-187.50				99			121		56.0		42	53	36.0		45	100
Chromium	µg/l	37.50				1.5			1		2.0		1	1	2.0		1	1
Cobalt	µg/l					0.5			0.948		5.0		2.8	2.77	2.0		0.5	1.5
Copper	µg/l	1500.00				0.3			0.3		2.0		0.3	0.3	2.0		0.3	0.513
Electrical conductivity (EC) (field)	µS/cm @	800 - 1875 @25°C			811	855	866	700			792		761				777	
Electrical conductivity (EC) (lab)	µS/cm @	800 - 1875 @25°C				852			922				704	774	775.0		717.5	873
Hydrogen ion concentration (field)	pH units				8.1	7.6	7.6	7.75					7.36				7.38	
Hydrogen ion concentration (lab)	pH units					7.7			7.5		7.2		7.5	7.3	7.2		7.5	7.6
Iron	mg/l					0.019			0.019		0.1		0.019	0.0472	0.1		0.019	0.019
Lead	µg/l	7.50				0.2			0.2		2.0		0.2	0.2	2.0		0.2	0.2
Manganese	µg/l					5.2			132		2678.0		779	976	13.0		193	885
Magnesium	mg/l					9.06			7.66		33.0		18	18.1	24.0		12.8	12.5
Mercury	µg/l	0.75				0.01			0.01		1.0		0.01	0.01	1.0		0.01	0.01
Nickel	µg/l	15.00				0.4			3.47		12.0		7.31	5.67	3.0		1.21	11.5
Nitrate Nitrogen	mg/l	37.50				1.4			0.26		0.3		0.13	0.05	2.7		2	0.05
Phosphate	mg/l					0.16			0.16				0.16	0.16			0.16	0.16
Potassium	mg/l					2.05			2.28		2.6		1.03	1.04	5.7		2.25	2.69
Redox Potential (eH)	mV				-10.2	21.1	125.9	-76.9					-48.5				-2.6	
Selenium	µg/l					1			1.52		17.0		1	1	68.0		1	1
Silver	µg/l					0.5			0.5		2.0		0.5	0.5	2.0		0.5	0.5
Sodium	mg/l	150				79			127		69.0		35.6	37.2	79.0		39.1	75.2
Sulphate	mg/l	187.50				13			15		11.0		16	15	14.0		15	14
Tin	µg/l					1			1		2.0		1	1	2.0		1	1
Total alkalinity	mg/l					288			264		281.0		307	328	299.0		301	324
Zinc	µg/l	75.00				23.4			3.71		27.0		23.5	3.04	52.0		20.5	2.7

Value Above S.I. No. 366 of 2016	VALUE
Value above Dutch 2009 circular Target levels	VALUE
Value above Dutch 2009 circular Intervention levels	VALUE

Substances & categorisation		S.I. No. 366 of 2016	Dutch 2009 Levels		AMW9			AMW9	AMW1			AMW1		AMW6		AMW6	SW1	SW2	SW2
					2016		2018	2019	2016			2018	2019	2018	2019		2018	2019	
Substance analysed (also known as) Minerex Environmental	Units	Overall threshold Values Range (from Column test 1 to column	Target Levels (optimum)	Intervention (action)	26/05/2016	22/09/2016	17/05/2018	28/02/2019	26/05/2016	22/09/2016		17/05/2018	28/02/2019	17/05/2018	28/02/2019	10/05/2019	17/05/2018	26/02/2019	10/05/2019
Styrene	µg/l		6.00	300	1	1	1	1	1			1	1	1	1	1	1	2	1
Ethanol	µg/l				500	500	500	500	500			500	500	500	500	500	500	500	500
Acetonitrile	µg/l				500	500	500	500	500			500	500	500	500	500	500		500
Ethyl acetate	µg/l							500					500		500			100	
Chloroethane	µg/l				1	1	1	1	1			1	1	1	1	1	1	3	1
Methanol	µg/l				500	500	500	500	500			500	500	500	500	500	500	500	500
Acetone	µg/l				500	500	500	500	500			500	500	500	500	500	500	500	500
Isopropanol	µg/l				500	500	500	500	500			500	500	500	500	500	500	100	500
Tetrahydrofuran	µg/l		0.50	300	500	500	10	4	500			1	1	1	1	1	20		1
MTBE	µg/l	10.00			2	1	4.52	1.62	1	1		1	1	60.1	63.8	107	9.28	26	5.8
Benzene	µg/l	0.75					1	1	1			1	1	1	1	1	1	0.5	1
Ethylbenzene	µg/l		4.00	150	1	1	1	1	1	1		1	1	1	1	1	1	1	1
Xylene o	µg/l		0.20	70	1		1	1	1	1		1	1	1	1	1	1	1	1
Xylene m/p	µg/l		0.20	70	1	1	1	1	1	1		1	1	1	1	1	1	2	1
Toluene	µg/l	525.00	7.00	1000	1	1	1	1	1	1		1	1	1	1	1	1	5	1
Sum of BTEX	µg/l		0.20	70															
MIBK	µg/l		7.00	1000															
Chlorobenzene	µg/l						1	1				1	1	1	1	1	1	2	1
Bromobenzene	µg/l						1	1				1	1	1	1	1	1	2	1
1,2-Dichloropropane	µg/l		0.80	80	1	1	1	1	1	1		1	1	1	1	1	1	2	1
2,2-Dichloropropane	µg/l		0.01	20			1	1				1	1	1	1	1	1	1	1
1,3-Dichloropropane	µg/l		0.80	80	1	1	1	1	1	1		1	1	1	1	1	1	2	1
1,2,3-Trichloropropane	µg/l		0.01	20			1	1				1	1	1	1	1	1	3	1
Bromochloromethane	µg/l				1	1	1	1	1	1		1	1	1	1	1	1	2	1
1,1,1-Trichloroethane	µg/l		0.01	300	1	1	1	1	1	1		1	1	1	1	1	1	2	1
1,1,2-Trichloroethane	µg/l		0.01	20			1	1				1	1	1	1	1	1	2	1
1,1-Dichloroethane	µg/l		7.00	900	1	1	1.23	1	1	1		1	1	1	1	1	1	3	1
1,2-Dichloroethane	µg/l	2.25	7.00	400			1	1	1	1		1	1	1	1	1	1	2	1
Dissolved ethane	mg/l																		
Trichloromethane (Chloroform)	µg/l		6.00	400	1	1	1	1	3.73	4.2		3.14	3.08	1	1	1	1	2	1
Dichloromethane	µg/l	15.00	0.01	1000	3	3	3	3	3	3		3	3	3	3	3	6.89	5	3
Dichlorodifluoromethane	µg/l		0.01	20			1	1				1	1	1	1	1	1	2	1
Dissolved methane	mg/l																		
Tetrachloroethene	µg/l	7.50	0.01	40	28	5	81.3	37.9	1	1		1	1	1	1	1	21	3	1.46
Trichloroethene	µg/l	7.50	24.00	500	3.0	1.0	5.4	2.14	1	1		1	1	1	1	1	2.23	3	1
1,1-Dichloroethene	µg/l		0.01	10	1	1	1	1	1	1		1	1	1	1	1	1	3	1
cis-1,2-Dichloroethene	µg/l	0.38	0.01	20	1.10	1.00	3.28	1.58	1	1		1	1	1	1	1	2.4	3	2.27
Chloromethane	µg/l		0.01	20			1	1				1	1	1	1	1	1	3	1
2-Chlorotoluene	µg/l		0.01	20			1	1				1	1	1	1	1	1	3	1
4-Chlorotoluene	µg/l		0.01	20			1	1				1	1	1	1	1	1	3	1
trans-1,2-Dichloroethene	µg/l	0.38	0.01	20			1	1				1	1	1	1	1	1	3	1
Trichlorofluoromethane	µg/l		0.01	20			1	1				1	1	1	1	1	1	3	1
Dibromomethane	µg/l		0.01	20			1	1				1	1	1	1	1	1	3	1
1,2-Dibromoethane	µg/l		0.01	20			1	1				1	1	1	1	1	1	2	1
1,1,1,2-Tetrachloroethane	µg/l		0.01	20			1					1		1			1	2	
1,1,2,2-Tetrachloroethane	µg/l							1					1		1	1		4	1
Bromodichloromethane	µg/l		0.01	20			1	1				1	1	1	1	1	1	2	1
Dibromochloromethane	µg/l		0.01	20			1	1				1	1	1	1	1	1	2	1
1,2-Dibromo-3-chloropropane	µg/l		0.01	20			1	1				1	1	1	1	1	1	2	1
Carbon Tetrachloride	µg/l		0.01	20			1	1				1	1	1	1	1	1	2	1
4-Isopropyltoluene	µg/l		0.01	20			1	1				1	1	1	1	1	1	3	1
Bromomethane	µg/l		0.01	20			1	1				1	1	1	1	1	1	1	1
sec-Butylbenzene	µg/l		0.01	20			1	1				1	1	1	1	1	1	3	1
tert-Butylbenzene	µg/l		0.01	20			1	1				1	1	1	1	1	1	3	1
n-Butylbenzene	µg/l		0.01	20			1	1				1	1	1	1	1	1	3	1
1,2,3-Trichlorobenzene	µg/l		0.01	20			1	1				1	1	1	1	1	1	3	1
1,2,4-Trichlorobenzene	µg/l		0.01	20			1	1				1	1	1	1	1	1	3	1
Bromoform	µg/l		0.01	20			1	1				1	1	1	1	1	1	2	1
Hexachlorobutadiene	µg/l		0.01	20			1	1				1	1	1	1	1	1	3	1
Naphthalene	µg/l		0.01	20			1	1				1	1	1	1	1	1	2	1
Chloroethene	µg/l	0.375	0.01	5	1	1	1	1		1		1	1	1	1	1	1	0.1	1
1, 2, 4-Trimethylbenzene	µg/l						1	1				1	1	1	1	1	1	3	1
1, 3, 5-Trimethylbenzene	µg/l						1	1				1	1	1	1	1	1	3	1
cis-1, 3-Dichloropropene	µg/l						1	1				1	1	1	1	1	1	2	1
trans-1, 3-Dichloropropene	µg/l		0.01	20			1	1				1	1	1	1	1	1	2	1
1,1-Dichloropropene	µg/l		0.01	20			1	1				1	1	1	1	1	1	3	1
1, 2-Dichlorobenzene	µg/l						1	1				1	1	1	1	1	1	3	1
1, 3-Dichlorobenzene	µg/l		0.01	20			1	1				1	1	1	1	1	1	3	1
1, 4-Dichlorobenzene	µg/l		0.01	20			1	1				1	1	1	1	1	1	3	1
n-Propylbenzene	µg/l		0.01	20			1	1				1	1	1	1	1	1	3	1
Isopropylbenzene	µg/l						1	1				1	1	1	1	1	1	3	1
Aluminium	µg/l	150.00			20.0		27.5	10	6			10	10	10	10		15.7		
Ammonia	mg/l	0.065 - 0.175			0.0		0.02	0.02	0			0.02	0.02	0.02	0.02		0.02		
Antimony	µg/l				2.0		1	1	6			1	1	1	1		4		
Arsenic	µg/l	7.50			5.0		0.5	0.5	5			0.5	0.5	0.5	0.5		2		
Barium	µg/l				20.0		138	12.4	43			167	40.5	141	16.5		45.4		
Beryllium	µg/l				2.0		0.1	0.1	2			0.1	0.1	0.1	0.1		1		
Boron	µg/l	750.00					10	10				30	10	18.9	10		333		
Cadmium	µg/l	3.75			2.0		0.08	0.08	2			0.08	0.08	0.08	0.08		0.5		
Calcium	mg/l				50.0		44.4	42.5	292			102	105	95.2	100		121		
Chemical Oxygen demand	µg/l							10					18		41				
Chloride	mg/l	24-187.50			11.0		110	102	53			69	70	40	43		85		
Chromium	µg/l	37.50			2.0		1	1	2			1	1	1	1		3		
Cobalt	µg/l				2.0		0.5	0.5	2			0.5	0.591	0.5	0.5		0.5		
Copper	µg/l	1500.00			3.0		0.801	0.717	2			0.3	0.3	1.82	0.677		1		
Electrical conductivity (EC) (field)	µS/cm @	800 - 1875 @25°C					574		967			1097		798				898	
Electrical conductivity (EC) (lab)	µS/cm @	800 - 1875 @25°C			265.0		600	626				982	1066	723	792		798		
Hydrogen ion concentration (field)	pH units						7.88					7.33		7.51				7.3	
Hydrogen ion concentration (lab)	pH units				7.7		7.8	7.7	7.2			7.5	7.2	7.6	7.4		7.6		
Iron	mg/l				0.1		0.019	0.019	0			0.019	0.019	0.019	0.019		0.0304		
Lead	µg/l	7.50			2.0		0.2	0.2	2			0.2	0.27	0.2	0.2		28.9		
Manganese	µg/l				2.0		4.13	8.94	4			60.4	55.8	8.97	5.42		17.8		
Magnesium	mg/l				48.0		4.31	2.98	16.0			11.1	11.4	25.3	24.6		13		
Mercury	µg/l	0.75			1.0		0.01	0.01	1			0.01	0.01	0.01	0.01		0.02		
Nickel	µg/l	15.00			2.0		0.5	0.4	2			0.98	3.1	0.4	1.02		2.16		
Nitrate Nitrogen	mg/l	37.50			0.7		0.52	0.05				1.3	0.28	1.6	0.17		1.3		
Phosphate	mg/l						0.16	0.16				0.16	0.16	0.16	0.16		0.16		
Potassium	mg/l				2.3		1.43	0.662	2.6			1.97	2.48	1.49	1.45		2.8		
Redox Potential (eH)	mV						-15.2					213		39.3				162	
Selenium	µg/l				34.0		1	1	17			1	1.13	1	1		1		
Silver	µg/l				2.0		0.5	0.5	2			0.5	0.5	0.5	0.5		1		
Sodium	mg/l	150			16.0		74.7	80.3	159			112	124	42.1	38.7		67.2		
Sulphate	mg/l	187.50			5.1		7.1	5.6	22			30	35	22	24		18		
Tin	µg/l				2.0		1	1	5			1	1	1	1		3		
Total alkalinity	mg/l				100.0		165	129	350			407	423	297	330		316		
Zinc	µg/l	75.00			45.0		16.1	5.43	14			22.2	4.39	26.2	7.36		5		

Value Above S.I. No. 366 of 2016	VALUE
Value above Dutch 2009 circular Target levels	VALUE
Value above Dutch 2009 circular Intervention levels	VALUE

Substances & categorisation		S.I. No. 366 of 2016	Dutch 2009 Levels		SW3	MS1	MW2D	MW3D	MW8D	MW9D	MW10D	MW11S	MW11D	MW12S	MW12D	MW13S
					2019	2019	2019	2019	2019	2019	2019	2019	2019	2019	2019	2019
Substance analysed (also known as)	Units	Overall threshold Values Range (from Column test 1 to column	Target Levels (optimum)	Intervention (action)	10/05/2019	26/02/2019	26/02/2019	26/02/2019	27/02/2019	26/02/2019	27/02/2019	27/02/2019	27/02/2019	27/02/2019	27/02/2019	27/02/2019
Styrene	µg/l		6.00	300	1	2	2	2	2	2	2	2	2	2	2	2
Ethanol	µg/l				500	500	500	500	500	500	500	500	500	500	500	500
Acetonitrile	µg/l				500											
Ethyl acetate	µg/l					100	100	100	100	100	100	100	100	100	100	100
Chloroethane	µg/l				1	3	3	3	3	3	3	3	3	3	3	3
Methanol	µg/l				500	500	500	500	500	500	500	500	500	500	500	500
Acetone	µg/l				500	50	50	50	50	50	50	50	50	50	50	50
Isopropanol	µg/l				500	100	100	100	100	100	100	100	100	100	100	100
Tetrahydrofuran	µg/l		0.50	300	1											
MTBE	µg/l	10.00			1	0.2	0.1	0.1	0.1	0.4	0.1	0.1	0.1	18	61	0.1
Benzene	µg/l	0.75			1	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5
Ethylbenzene	µg/l		4.00	150	1	1	1	1	1	1	1	1	1	1	1	1
Xylene o	µg/l		0.20	70	1	1	1	1	1	1	1	1	1	1	1	1
Xylene m/p	µg/l		0.20	70	1	2	2	2	2	2	2	2	2	2	2	2
Toluene	µg/l	525.00	7.00	1000	1	5	5	5	5	5	5	5	5	5	5	5
Sum of BTEX	µg/l		0.20	70												
MIBK	µg/l		7.00	1000												
Chlorobenzene	µg/l				1	2	2	2	2	2	2	2	2	2	2	2
Bromobenzene	µg/l				1	2	2	2	2	2	2	2	2	2	2	2
1,2-Dichloropropane	µg/l		0.80	80	1	2	2	2	2	2	2	2	2	2	2	2
2,2-Dichloropropane	µg/l		0.01	20	1	1	1	1	1	1	1	1	1	1	1	1
1,3-Dichloropropane	µg/l		0.80	80	1	2	2	2	2	2	2	2	2	2	2	2
1,2,3-Trichloropropane	µg/l		0.01	20	1	3	3	3	3	3	3	3	3	3	3	3
Bromochloromethane	µg/l				1	2	2	2	2	2	2	2	2	2	2	2
1,1,1-Trichloroethane	µg/l		0.01	300	1	2	2	2	2	2	2	2	2	2	2	2
1,1,2-Trichloroethane	µg/l		0.01	20	1	2	2	2	2	2	2	2	2	2	2	2
1,1-Dichloroethane	µg/l		7.00	900	1	3	3	3	3	3	3	3	3	3	3	3
1,2-Dichloroethane	µg/l	2.25	7.00	400	1	2	2	2	2	2	2	2	2	2	2	2
Dissolved ethane	mg/l															
Trichloromethane (Chloroform)	µg/l		6.00	400	1	2	2	2	11	2	2	2	2	2	2	7
Dichloromethane	µg/l	15.00	0.01	1000	3	5	5	5	5	5	5	5	5	5	5	5
Dichlorodifluoromethane	µg/l		0.01	20	1	2	2	2	2	2	2	2	2	2	2	2
Dissolved methane	mg/l															
Tetrachloroethene	µg/l	7.50	0.01	40	1	3	3	3	3	3	3	3	3	93	21	3
Trichloroethene	µg/l	7.50	24.00	500	1	3	3	7	3	3	6	3	3	7	18	3
1,1-Dichloroethene	µg/l		0.01	10	1	3	3	3	3	3	3	3	3	3	3	3
cis-1,2-Dichloroethene	µg/l	0.38	0.01	20	1	3	3	62	3	3	6	3	3	3	3	3
Chloromethane	µg/l		0.01	20	1	3	3	3	3	3	3	3	3	3	3	3
2-Chlorotoluene	µg/l		0.01	20	1	3	3	3	3	3	3	3	3	3	3	3
4-Chlorotoluene	µg/l		0.01	20	1	3	3	3	3	3	3	3	3	3	3	3
trans-1,2-Dichloroethene	µg/l	0.38	0.01	20	1	3	3	3	3	3	3	3	3	3	3	3
Trichlorofluoromethane	µg/l		0.01	20	1	3	3	3	3	3	3	3	3	3	3	3
Dibromomethane	µg/l		0.01	20	1	3	3	3	3	3	3	3	3	3	3	3
1,2-Dibromoethane	µg/l		0.01	20	1	2	2	2	2	2	2	2	2	2	2	2
1,1,1,2-Tetrachloroethane	µg/l		0.01	20		2	2	2	2	2	2	2	2	2	2	2
1,1,2,2-Tetrachloroethane	µg/l				1	4	4	4	4	4	4	4	4	4	4	4
Bromodichloromethane	µg/l		0.01	20	1	2	2	2	2	2	2	2	2	2	2	2
Dibromochloromethane	µg/l		0.01	20	1	2	2	2	2	2	2	2	2	2	2	2
1,2-Dibromo-3-chloropropane	µg/l		0.01	20	1	2	2	2	2	2	2	2	2	2	2	2
Carbon Tetrachloride	µg/l		0.01	20	1	2	2	2	2	2	2	2	2	2	2	2
4-Isopropyltoluene	µg/l		0.01	20	1	3	3	3	3	3	3	3	3	3	3	3
Bromomethane	µg/l		0.01	20	1	1	1	1	1	1	1	1	1	1	1	1
sec-Butylbenzene	µg/l		0.01	20	1	3	3	3	3	3	3	3	3	3	3	3
tert-Butylbenzene	µg/l		0.01	20	1	3	3	3	3	3	3	3	3	3	3	3
n-Butylbenzene	µg/l		0.01	20	1	3	3	3	3	3	3	3	3	3	3	3
1,2,3-Trichlorobenzene	µg/l		0.01	20	1	3	3	3	3	3	3	3	3	3	3	3
1,2,4-Trichlorobenzene	µg/l		0.01	20	1	3	3	3	3	3	3	3	3	3	3	3
Bromoform	µg/l		0.01	20	1	2	2	2	2	2	2	2	2	2	2	2
Hexachlorobutadiene	µg/l		0.01	20	1	3	3	3	3	3	3	3	3	3	3	3
Naphthalene	µg/l		0.01	20	1	2	2	2	2	2	2	2	2	2	2	2
Chloroethene	µg/l	0.375	0.01	5	1	0.1	0.1	22	0.1	0.1	0.4	0.1	0.1	0.1	0.1	0.1
1, 2, 4-Trimethylbenzene	µg/l				1	3	3	3	3	3	3	3	3	3	3	3
1, 3, 5-Trimethylbenzene	µg/l				1	3	3	3	3	3	3	3	3	3	3	3
cis-1, 3-Dichloropropene	µg/l				1	2	2	2	2	2	2	2	2	2	2	2
trans-1, 3-Dichloropropene	µg/l		0.01	20	1	2	2	2	2	2	2	2	2	2	2	2
1,1-Dichloropropene	µg/l		0.01	20	1	3	3	3	3	3	3	3	3	3	3	3
1, 2-Dichlorobenzene	µg/l				1	3	3	3	3	3	3	3	3	3	3	3
1, 3-Dichlorobenzene	µg/l		0.01	20	1	3	3	3	3	3	3	3	3	3	3	3
1, 4-Dichlorobenzene	µg/l		0.01	20	1	3	3	3	3	3	3	3	3	3	3	3
n-Propylbenzene	µg/l		0.01	20	1	3	3	3	3	3	3	3	3	3	3	3
Isopropylbenzene	µg/l				1	3	3	3	3	3	3	3	3	3	3	3
Aluminium	µg/l	150.00														
Ammonia	mg/l	0.065 - 0.175														
Antimony	µg/l															
Arsenic	µg/l	7.50														
Barium	µg/l															
Beryllium	µg/l															
Boron	µg/l	750.00														
Cadmium	µg/l	3.75														
Calcium	mg/l															
Chemical Oxygen demand	µg/l															
Chloride	mg/l	24-187.50														
Chromium	µg/l	37.50														
Cobalt	µg/l															
Copper	µg/l	1500.00														
Electrical conductivity (EC) (field)	µS/cm @	800 - 1875 @25°C				534	1202	736	1338	514	909	1022	1045	8	744	578
Electrical conductivity (EC) (lab)	µS/cm @	800 - 1875 @25°C														
Hydrogen ion concentration (field)	pH units					7.3	7.1	7.2	7.3	7.5	7.1	7.8	7.5	7.7	7.1	7.3
Hydrogen ion concentration (lab)	pH units															
Iron	mg/l															
Lead	µg/l	7.50														
Manganese	µg/l															
Magnesium	mg/l															
Mercury	µg/l	0.75														
Nickel	µg/l	15.00														
Nitrate Nitrogen	mg/l	37.50														
Phosphate	mg/l															
Potassium	mg/l															
Redox Potential (eH)	mV					108	19	-9	43	24	35	25	29	32	-46	38
Selenium	µg/l															
Silver	µg/l															
Sodium	mg/l	150														
Sulphate	mg/l	187.50														
Tin	µg/l															
Total alkalinity	mg/l															
Zinc	µg/l	75.00														

Value Above S.I. No. 366 of 2016	VALUE
Value above Dutch 2009 circular Target levels	VALUE
Value above Dutch 2009 circular Intervention levels	VALUE

Substances & categorisation		S.I. No. 366 of 2016	Dutch 2009 Levels		MW13D	WW1/TW1	WW5	BH101	BH104	BH105						
					2019	2019	2019	2019	2019	2016	2017		2018			2019
Substance analysed (also known as)	Units	Overall threshold Values Range (from Column test 1 to column	Target Levels (optimum)	Intervention (action)	27/02/2019	27/02/2019	27/02/2019	26/02/2019	26/02/2019	26/05/2016	03/05/2017	03/05/2017	22/02/2018	17/05/2018	28/08/2018	15/11/2018	28/02/2019
Styrene	µg/l		6.00	300	2	2	2	2	2	1	1	1	1	1	1	1	1
Ethanol	µg/l				500	500	500	500	500	500	500	500	500	500	500	500	500
Acetonitrile	µg/l									500	500	500	500	500	500	500	500
Ethyl acetate	µg/l				100	100	100	100	100		500	500				100	500
Chloroethane	µg/l				3	3	3	3	3	1	1	1	1	1	1	1	1
Methanol	µg/l				500	500	500	500	500	500	500	500	500	500	500	500	500
Acetone	µg/l				50	50	50	50	50	500	500	500	500	500	500	50	500
Isopropanol	µg/l				100	100	100	100	100	500	500	500	500	500	500	100	500
Tetrahydrofuran	µg/l		0.50	300						500	500	500	1	1	1849	3907	22
MTBE	µg/l	10.00			22	0.1	0.1	0.3	0.1	1	1	1	1	11.8	826	811	85.3
Benzene	µg/l	0.75			0.5	0.5	0.5	0.5	0.5		1	1	1	1	1	1	1
Ethylbenzene	µg/l		4.00	150	1	1	1	1	1	1	1	1	1	1	1	1	1
Xylene o	µg/l		0.20	70	1	1	1	1	1	1	1	1	1	1	1.02	1	1
Xylene m/p	µg/l		0.20	70	2	2	2	2	2	1	1	1	1	1	1	1	1
Toluene	µg/l	525.00	7.00	1000	5	5	5	5	5	1	1	1	1	1	1	100	1
Sum of BTEX	µg/l		0.20	70													
MIBK	µg/l		7.00	1000													
Chlorobenzene	µg/l				2	2	2	2	2				1	1	1	1	1
Bromobenzene	µg/l				2	2	2	2	2				1	1	1	1	1
1,2-Dichloropropane	µg/l		0.80	80	2	2	2	2	2	1	1	1	1	1	1	1	1
2,2-Dichloropropane	µg/l		0.01	20	1	1	1	1	1				1	1	1	1	1
1,3-Dichloropropane	µg/l		0.80	80	2	2	2	2	2	1	1	1	1	1	1.74	2.26	1
1,2,3-Trichloropropane	µg/l		0.01	20	3	3	3	3	3				1	1	1	1	1
Bromochloromethane	µg/l				2	2	2	2	2	3	1	1	1	1	1	1	1
1,1,1-Trichloroethane	µg/l		0.01	300	2	2	2	2	2	1	1	1	1	1	1	1	1
1,1,2-Trichloroethane	µg/l		0.01	20	2	2	2	2	2				1	1	1	1	1
1,1-Dichloroethane	µg/l		7.00	900	3	3	3	3	3		1	1	1	1	1	1	1
1,2-Dichloroethane	µg/l	2.25	7.00	400	2	2	2	2	2	1	1	1	1	1	1	1	1
Dissolved ethane	mg/l																
Trichloromethane (Chloroform)	µg/l		6.00	400	2	2	2	2	2	1	1	1	1	1	1	1	1
Dichloromethane	µg/l	15.00	0.01	1000	5	5	5	5	5		3	3	3	3	3	3	3
Dichlorodifluoromethane	µg/l		0.01	20	2	2	2	2	2				1	1	1	1	1
Dissolved methane	mg/l																
Tetrachloroethene	µg/l	7.50	0.01	40	15	3	3	3	3	1.83	1.3	1.3	1	1.1	1.35	1	1.09
Trichloroethene	µg/l	7.50	24.00	500	3	3	3	3	3	1	1	1	1	1	1	1	1
1,1-Dichloroethene	µg/l		0.01	10	3	3	3	3	3	1	1	1	1	1	1	1	1
cis-1,2-Dichloroethene	µg/l	0.38	0.01	20	18	3	3	3	3	1	1	1	1	1	1.95	1.09	1
Chloromethane	µg/l		0.01	20	3	3	3	3	3				1	1	1	1	1
2-Chlorotoluene	µg/l		0.01	20	3	3	3	3	3				1	1	1	1	1
4-Chlorotoluene	µg/l		0.01	20	3	3	3	3	3				1	1	1	1	1
trans-1,2-Dichloroethene	µg/l	0.38	0.01	20	3	3	3	3	3				1	1	1	1	1
Trichlorofluoromethane	µg/l		0.01	20	3	3	3	3	3				1	1	1	1	1
Dibromomethane	µg/l		0.01	20	3	3	3	3	3				1	1	1	1	1
1,2-Dibromoethane	µg/l		0.01	20	2	2	2	2	2				1	1	1	1	1
1,1,1,2-Tetrachloroethane	µg/l		0.01	20	2	2	2	2	2				1	1	1	1	
1,1,2,2-Tetrachloroethane	µg/l				4	4	4	4	4								1
Bromodichloromethane	µg/l		0.01	20	2	2	2	2	2				1	1	1	1	1
Dibromochloromethane	µg/l		0.01	20	2	2	2	2	2				1	1	1	1	1
1,2-Dibromo-3-chloropropane	µg/l		0.01	20	2	2	2	2	2				1	1	1	1	1
Carbon Tetrachloride	µg/l		0.01	20	2	2	2	2	2				1	1	1	1	1
4-Isopropyltoluene	µg/l		0.01	20	3	3	3	3	3				1	1	1	1	1
Bromomethane	µg/l		0.01	20	1	1	1	1	1				1	1	1	1	1
sec-Butylbenzene	µg/l		0.01	20	3	3	3	3	3				1	1	1	1	1
tert-Butylbenzene	µg/l		0.01	20	3	3	3	3	3				1	1	1	1	1
n-Butylbenzene	µg/l		0.01	20	3	3	3	3	3				1	1	1	1	1
1,2,3-Trichlorobenzene	µg/l		0.01	20	3	3	3	3	3				1	1	1	1	1
1,2,4-Trichlorobenzene	µg/l		0.01	20	3	3	3	3	3				1	1	1	1	1
Bromoform	µg/l		0.01	20	2	2	2	2	2				1	1	1	1	1
Hexachlorobutadiene	µg/l		0.01	20	3	3	3	3	3				1	1	1	1	1
Naphthalene	µg/l		0.01	20	2	2	2	2	2				1	1	1	1	1
Chloroethene	µg/l	0.375	0.01	5	1.5	0.1	0.1	0.1	0.1	1			1	1	1	1	1
1, 2, 4-Trimethylbenzene	µg/l				3	3	3	3	3				1	1	1	1	1
1, 3, 5-Trimethylbenzene	µg/l				3	3	3	3	3				1	1	1	1	1
cis-1, 3-Dichloropropene	µg/l				2	2	2	2	2				1	1	1	1	1
trans-1, 3-Dichloropropene	µg/l		0.01	20	2	2	2	2	2				1	1	1	1	1
1,1-Dichloropropene	µg/l		0.01	20	3	3	3	3	3				1	1	1	1	1
1, 2-Dichlorobenzene	µg/l				3	3	3	3	3				1	1	1	1	1
1, 3-Dichlorobenzene	µg/l		0.01	20	3	3	3	3	3				1	1	1	1	1
1, 4-Dichlorobenzene	µg/l		0.01	20	3	3	3	3	3				1	1	1	1	1
n-Propylbenzene	µg/l		0.01	20	3	3	3	3	3				1	1	1	1	1
Isopropylbenzene	µg/l				3	3	3	3	3				1	1	1	1	1
Aluminium	µg/l	150.00												10			10
Ammonia	mg/l	0.065 - 0.175												0.02			0.1
Antimony	µg/l													1			1
Arsenic	µg/l	7.50												0.5			0.5
Barium	µg/l													285			46.4
Beryllium	µg/l													0.1			0.1
Boron	µg/l	750.00												22.2			10
Cadmium	µg/l	3.75												0.08			0.08
Calcium	mg/l													121			117
Chemical Oxygen demand	µg/l																10
Chloride	mg/l	24-187.50												33			45
Chromium	µg/l	37.50												1			1
Cobalt	µg/l													0.5			2.17
Copper	µg/l	1500.00												0.407			0.884
Electrical conductivity (EC) (field)	µS/cm @	800 - 1875 @25°C			669	667	967	644	810		711	702		762	793	716	
Electrical conductivity (EC) (lab)	µS/cm @	800 - 1875 @25°C												702			716
Hydrogen ion concentration (field)	pH units				7.4	7.7	7.3	6.7	7.1		7.28	7.18		7.46	7.73	7.38	
Hydrogen ion concentration (lab)	pH units													7.6			7.2
Iron	mg/l													0.019			0.019
Lead	µg/l	7.50												0.2			0.2
Manganese	µg/l													26.1			759
Magnesium	mg/l													10.4			9.92
Mercury	µg/l	0.75												0.01			0.01
Nickel	µg/l	15.00												1.72			13.1
Nitrate Nitrogen	mg/l	37.50												1.5			0.53
Phosphate	mg/l													0.16			0.16
Potassium	mg/l													1.61			1.46
Redox Potential (eH)	mV				52	37	39	235	-15		61.0	192.3		21.4	32.9	-52.3	
Selenium	µg/l													1			1
Silver	µg/l													0.5			0.5
Sodium	mg/l	150												22.7			26.8
Sulphate	mg/l	187.50												15			9.7
Tin	µg/l													1			1
Total alkalinity	mg/l													316			320
Zinc	µg/l	75.00												59.1			3.69

Value Above S.I. No. 366 of 2016	VALUE
Value above Dutch 2009 circular Target levels	VALUE
Value above Dutch 2009 circular Intervention levels	VALUE

Substances & categorisation		S.I. No. 366 of 2016	Dutch 2009 Levels		BH105	BH107								BH107	SW104			
						2016	2017				2018	2019			2016	2017		2018
Substance analysed (also known as)	Units	Overall threshold Values Range (from Column test 1 to column	Target Levels (optimum)	Intervention (action)	10/05/2019	27/05/2016	01/09/2016	22/02/2017	28/03/2017	28/09/2017	27/02/2018	28/08/2018	26/02/2019	10/05/2019	26/05/2016	03/05/2017	06/11/2017	22/02/2018
Styrene	µg/l		6.00	300	1	1	1	1	1	2	2	2	2	1	1	1	1	1
Ethanol	µg/l				500	500	500	500	500	500	500	500	500	500	500	500	500	500
Acetonitrile	µg/l				500	500	500	500	500	500				500	500	500	500	500
Ethyl acetate	µg/l										100	100	100			500	500	
Chloroethane	µg/l				1	1	1	1	1	1	3	3	3	1	1	1	1	1
Methanol	µg/l				500	500	500	500	500	500	500	500	500	500	500	500	500	500
Acetone	µg/l				500	500	500	500	500	500	50	50	50	500	500	500	500	500
Isopropanol	µg/l				500						100	100	100	500	500	500	500	500
Tetrahydrofuran	µg/l		0.50	300	1									6.612	500	500	500	15
MTBE	µg/l	10.00			57.4						204	3468	959	1430	1	1	21.6	7.82
Benzene	µg/l	0.75			1	0.5	0.5	0.5	0.5	0.5	0.5	0.8	0.5	1		1	1	1
Ethylbenzene	µg/l		4.00	150	1	1	1	1	1	1	1	59	10	1	1	1	1	1
Xylene o	µg/l		0.20	70	1	1	1	1	1	3	1	88	1	4.84	1	1	1	1
Xylene m/p	µg/l		0.20	70	1			1	1	14	2	237	10	15	1	1	1	1
Toluene	µg/l	525.00	7.00	1000	1	1	1	1	1	5	5	3477	8	1	1	21.6	1	1
Sum of BTEX	µg/l		0.20	70														
MIBK	µg/l		7.00	1000														
Chlorobenzene	µg/l				1	1	1	1	1	1	2	2	2	1				1
Bromobenzene	µg/l				1	1	1	1	1	1	2	2	2	1				1
1,2-Dichloropropane	µg/l		0.80	80	1	1	1	1	1	1	2	2	2	1	1	1	1	1
2,2-Dichloropropane	µg/l		0.01	20	1	1	1	1	1	1	1	1	1	1				1
1,3-Dichloropropane	µg/l		0.80	80	1	1	1	1	1	5.72	2	12	2	4.64	1	1	1	1
1,2,3-Trichloropropane	µg/l		0.01	20	1	1	1	1	1	1	3	3	3	1				1
Bromochloromethane	µg/l				1	1	1	1	1	1	2	2	2	1		1	1	1
1,1,1-Trichloroethane	µg/l		0.01	300	1	1	1	1	1	1	2	2	2	1	1	1	1	1
1,1,2-Trichloroethane	µg/l		0.01	20	1	1	1	1	1	1	2	2	2	1				1
1,1-Dichloroethane	µg/l		7.00	900	1	1	1	1	1	1	3	3	3	1		1	1	1
1,2-Dichloroethane	µg/l	2.25	7.00	400	1	1	1	1	1	1	2	2	2	1	1	1	1	1
Dissolved ethane	mg/l																	
Trichloromethane (Chloroform)	µg/l		6.00	400	1	1	1	1	1	1	2	2	2	1	1.44	1	1	1
Dichloromethane	µg/l	15.00	0.01	1000	3						5	5	5	3	3	3	3	3
Dichlorodifluoromethane	µg/l		0.01	20	1	1	1	1	1	1	2	2	2	1				1
Dissolved methane	mg/l																	
Tetrachloroethene	µg/l	7.50	0.01	40	1	1.38	7.22	1.4	2.12	3.17	3	3	3	1	50.7	21.7	21.7	13.5
Trichloroethene	µg/l	7.50	24.00	500	1	1	1	1	1	1	3	3	3	1	1.09	1	1	1
1,1-Dichloroethene	µg/l		0.01	10	1	1	1	1	1	1	3	3	3	1	1	1	1	1
cis-1,2-Dichloroethene	µg/l	0.38	0.01	20	1	1	1	1	1	1	3	3.0	3	1	2	1	1	1.97
Chloromethane	µg/l		0.01	20	1	1	1	1	1	1	3	3	3	1				1
2-Chlorotoluene	µg/l		0.01	20	1	1	1	1	1	1	3	3	3	1				1
4-Chlorotoluene	µg/l		0.01	20	1	1	1	1	1	1	3	3	3	1				1
trans-1,2-Dichloroethene	µg/l	0.38	0.01	20	1	1	1	1	1	1	3	3	3	1				1
Trichlorofluoromethane	µg/l		0.01	20	1	1	1	1	1	1	3	3	3	1				1
Dibromomethane	µg/l		0.01	20	1	1	1	1	1	1	3	3	3	1				1
1,2-Dibromoethane	µg/l		0.01	20	1	1	1	1	1	1	2	2	2	1				1
1,1,1,2-Tetrachloroethane	µg/l		0.01	20		1	1	1	1	1	2	2	2					1
1,1,2,2-Tetrachloroethane	µg/l				1								4	1				
Bromodichloromethane	µg/l		0.01	20	1	1	1	1	1	1	2	2	2	1				1
Dibromochloromethane	µg/l		0.01	20	1	1	1	1	1	1	2	2	2	1				1
1,2-Dibromo-3-chloropropane	µg/l		0.01	20	1						2	2	2	1				1
Carbon Tetrachloride	µg/l		0.01	20	1	1	1	1	1	1	2	2	2	1				1
4-Isopropyltoluene	µg/l		0.01	20	1						3	3	3	1				1
Bromomethane	µg/l		0.01	20	1	1	1	1	1	1	1	1	1	1				1
sec-Butylbenzene	µg/l		0.01	20	1	1	1	1	1	1	3	3	3	1				1
tert-Butylbenzene	µg/l		0.01	20	1	1	1	1	1	1	3	3	3	1				1
n-Butylbenzene	µg/l		0.01	20	1	1	1	1	1	1	3	3	3	1				1
1,2,3-Trichlorobenzene	µg/l		0.01	20	1	1	1	1	1	1	3	3	3	1				1
1,2,4-Trichlorobenzene	µg/l		0.01	20	1	1	1	1	1	1	3	3	3	1				1
Bromoform	µg/l		0.01	20	1	1	1	1	1	1	2	2	2	1				1
Hexachlorobutadiene	µg/l		0.01	20	1	1	1	1	1	1	3	3	3	1				1
Naphthalene	µg/l		0.01	20	1	1	1	1	1	1	2	2	2	1				1
Chloroethene	µg/l	0.375	0.01	5	1	1	1	1	1	1	0.1	2.1	0.7	1	1			1
1, 2, 4-Trimethylbenzene	µg/l				1	1	1	1	1	1	3	3	3	1				1
1, 3, 5-Trimethylbenzene	µg/l				1	1	1	1	1	1	3	3	3	1				1
cis-1, 3-Dichloropropene	µg/l				1	1	1	1	1	1	2	2	2	1				1
trans-1, 3-Dichloropropene	µg/l		0.01	20	1	1	1	1	1	1	2	2	2	1				1
1,1-Dichloropropene	µg/l		0.01	20	1	1	1	1	1	1	3	3	3	1				1
1, 2-Dichlorobenzene	µg/l				1	1	1	1	1	1	3	3	3	1				1
1, 3-Dichlorobenzene	µg/l		0.01	20	1	1	1	1	1	1	3	3	3	1				1
1, 4-Dichlorobenzene	µg/l		0.01	20	1	1	1	1	1	1	3	3	3	1				1
n-Propylbenzene	µg/l		0.01	20	1	1	1	1	1	1	3	3	3	1				1
Isopropylbenzene	µg/l				1	1	1	1	1	1	3	3	3	1				1
Aluminium	µg/l	150.00																
Ammonia	mg/l	0.065 - 0.175							0.28									
Antimony	µg/l																	
Arsenic	µg/l	7.50																
Barium	µg/l																	
Beryllium	µg/l																	
Boron	µg/l	750.00																
Cadmium	µg/l	3.75																
Calcium	mg/l								128									
Chemical Oxygen demand	µg/l								20									
Chloride	mg/l	24-187.50							41									
Chromium	µg/l	37.50																
Cobalt	µg/l																	
Copper	µg/l	1500.00																
Electrical conductivity (EC) (field)	µS/cm @	800 - 1875 @25°C											927				856	
Electrical conductivity (EC) (lab)	µS/cm @	800 - 1875 @25°C							820									
Hydrogen ion concentration (field)	pH units												6.9				7.90	
Hydrogen ion concentration (lab)	pH units								7.2									
Iron	mg/l																	
Lead	µg/l	7.50																
Manganese	µg/l																	
Magnesium	mg/l								11.2									
Mercury	µg/l	0.75																
Nickel	µg/l	15.00																
Nitrate Nitrogen	mg/l	37.50							1									
Phosphate	mg/l								0.01									
Potassium	mg/l								2									
Redox Potential (eH)	mV												-73				140.9	
Selenium	µg/l																	
Silver	µg/l																	
Sodium	mg/l	150							28.6									
Sulphate	mg/l	187.50							17									
Tin	µg/l																	
Total alkalinity	mg/l																	
Zinc	µg/l	75.00																

Value Above S.I. No. 366 of 2016	VALUE
Value above Dutch 2009 circular Target levels	VALUE
Value above Dutch 2009 circular Intervention levels	VALUE

Substances & categorisation		S.I. No. 366 of 2016	Dutch 2009 Levels		SW104			
							2019	
Substance analysed (also known as)	Units	Overall threshold Values Range (from Column test 1 to column	Target Levels (optimum)	Intervention (action)	28/08/2018	15/11/2018	28/02/2019	10/05/2019
Styrene	µg/l		6.00	300	1	1	1	1
Ethanol	µg/l				500	500	500	500
Acetonitrile	µg/l				500	500	500	500
Ethyl acetate	µg/l					100	500	
Chloroethane	µg/l				1	1	1	1
Methanol	µg/l				500	500	500	500
Acetone	µg/l				500	50	500	500
Isopropanol	µg/l				500	100	500	500
Tetrahydrofuran	µg/l		0.50	300	2	23	10	12
MTBE	µg/l	10.00			13.6	30.5	18.2	21.5
Benzene	µg/l	0.75			1	1	1	1
Ethylbenzene	µg/l		4.00	150	1	1	1	1
Xylene o	µg/l		0.20	70	1	1	1	1
Xylene m/p	µg/l		0.20	70	1	1	1	1
Toluene	µg/l	525.00	7.00	1000	1	1	1	1
Sum of BTEX	µg/l		0.20	70				
MIBK	µg/l		7.00	1000				
Chlorobenzene	µg/l				1	1	1	1
Bromobenzene	µg/l				1	1	1	1
1,2-Dichloropropane	µg/l		0.80	80	1	1	1	1
2,2-Dichloropropane	µg/l		0.01	20	1	1	1	1
1,3-Dichloropropane	µg/l		0.80	80	1	1	1	1
1,2,3-Trichloropropane	µg/l		0.01	20	1	1	1	1
Bromochloromethane	µg/l				1	1	1	1
1,1,1-Trichloroethane	µg/l		0.01	300	1	1	1	1
1,1,2-Trichloroethane	µg/l		0.01	20	1	1	1	1
1,1-Dichloroethane	µg/l		7.00	900	1	1	1	1
1,2-Dichloroethane	µg/l	2.25	7.00	400	1	1	1	1
Dissolved ethane	mg/l							
Trichloromethane (Chloroform)	µg/l		6.00	400	1	1	1	1
Dichloromethane	µg/l	15.00	0.01	1000	3	3	3	3
Dichlorodifluoromethane	µg/l		0.01	20	1	1	1	1
Dissolved methane	mg/l							
Tetrachloroethene	µg/l	7.50	0.01	40	13	3.41	2.47	6.43
Trichloroethene	µg/l	7.50	24.00	500	1.05	1	1	2.26
1,1-Dichloroethene	µg/l		0.01	10	1	1	1	1
cis-1,2-Dichloroethene	µg/l	0.38	0.01	20	3.33	1.53	5.95	10
Chloromethane	µg/l		0.01	20	1	1	1	1
2-Chlorotoluene	µg/l		0.01	20	1	1	1	1
4-Chlorotoluene	µg/l		0.01	20	1	1	1	1
trans-1,2-Dichloroethene	µg/l	0.38	0.01	20	1	1	1	1
Trichlorofluoromethane	µg/l		0.01	20	1	1	1	1
Dibromomethane	µg/l		0.01	20	1	1	1	1
1,2-Dibromoethane	µg/l		0.01	20	1	1	1	1
1,1,1,2-Tetrachloroethane	µg/l		0.01	20	1	1		
1,1,2,2-Tetrachloroethane	µg/l						1	1
Bromodichloromethane	µg/l		0.01	20	1	1	1	1
Dibromochloromethane	µg/l		0.01	20	1	1	1	1
1,2-Dibromo-3-chloropropane	µg/l		0.01	20	1	1	1	1
Carbon Tetrachloride	µg/l		0.01	20	1	1	1	1
4-Isopropyltoluene	µg/l		0.01	20	1	1	1	1
Bromomethane	µg/l		0.01	20	1	1	1	1
sec-Butylbenzene	µg/l		0.01	20	1	1	1	1
tert-Butylbenzene	µg/l		0.01	20	1	1	1	1
n-Butylbenzene	µg/l		0.01	20	1	1	1	1
1,2,3-Trichlorobenzene	µg/l		0.01	20	1	1	1	1
1,2,4-Trichlorobenzene	µg/l		0.01	20	1	1	1	1
Bromoform	µg/l		0.01	20	1	1	1	1
Hexachlorobutadiene	µg/l		0.01	20	1	1	1	1
Naphthalene	µg/l		0.01	20	1	1	1	1
Chloroethene	µg/l	0.375	0.01	5	1	1	1	1
1, 2, 4-Trimethylbenzene	µg/l				1	1	1	1
1, 3, 5-Trimethylbenzene	µg/l				1	1	1	1
cis-1, 3-Dichloropropene	µg/l				1	1	1	1
trans-1, 3-Dichloropropene	µg/l		0.01	20	1	1	1	1
1,1-Dichloropropene	µg/l		0.01	20	1	1	1	1
1, 2-Dichlorobenzene	µg/l				1	1	1	1
1, 3-Dichlorobenzene	µg/l		0.01	20	1	1	1	1
1, 4-Dichlorobenzene	µg/l		0.01	20	1	1	1	1
n-Propylbenzene	µg/l		0.01	20	1	1	1	1
Isopropylbenzene	µg/l				1	1	1	1
Aluminium	µg/l	150.00					10	
Ammonia	mg/l	0.065 - 0.175					0.06	
Antimony	µg/l						1	
Arsenic	µg/l	7.50					0.904	
Barium	µg/l						35	
Beryllium	µg/l						0.1	
Boron	µg/l	750.00					10	
Cadmium	µg/l	3.75					0.08	
Calcium	mg/l						90.4	
Chemical Oxygen demand	µg/l						10	
Chloride	mg/l	24-187.50					205	
Chromium	µg/l	37.50					1	
Cobalt	µg/l						0.5	
Copper	µg/l	1500.00					0.3	
Electrical conductivity (EC) (field)	µS/cm @	800 - 1875 @25°C			1290	905		
Electrical conductivity (EC) (lab)	µS/cm @	800 - 1875 @25°C					1210	
Hydrogen ion concentration (field)	pH units				8.15	7.82		
Hydrogen ion concentration (lab)	pH units						7.8	
Iron	mg/l						0.019	
Lead	µg/l	7.50					0.2	
Manganese	µg/l						35.5	
Magnesium	mg/l						10.7	
Mercury	µg/l	0.75					0.01	
Nickel	µg/l	15.00					2.33	
Nitrate Nitrogen	mg/l	37.50					0.2	
Phosphate	mg/l						0.16	
Potassium	mg/l						2.9	
Redox Potential (eH)	mV				50.5	38.8		
Selenium	µg/l						1	
Silver	µg/l						0.5	
Sodium	mg/l	150					147	
Sulphate	mg/l	187.50					21	
Tin	µg/l						1	
Total alkalinity	mg/l						325	
Zinc	µg/l	75.00					2.57	

Value Above S.I. No. 366 of 2016	VALUE
Value above Dutch 2009 circular Target levels	VALUE
Value above Dutch 2009 circular Intervention levels	VALUE

APPENDIX F

5. Effect of rainfall events investigation (EPA question C)

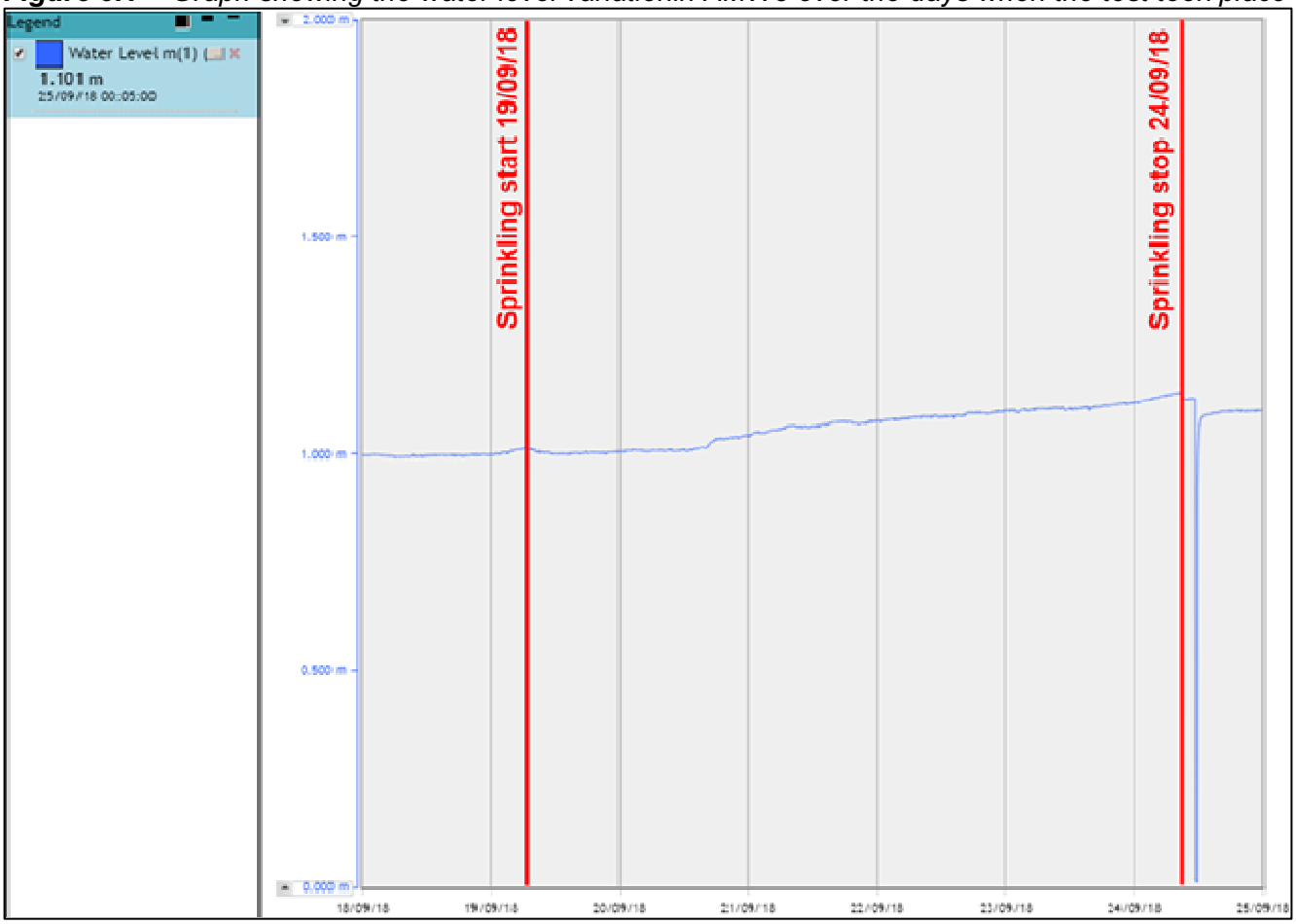
Since the leakage of the water main back in 2010, it has been hypothesized that the peaks in the concentration of several substances found in AMW3 since the leak was fixed were due to remobilisation of substances stored in the soil above the phreatic surface by heavy rainfall events.

To validate this hypothesis a test has been carried out by simulating a heavy rainfall event by means of sprinklers in the affected area, near AMW3, where 2 baseline samples were taken prior to the simulated rain event and 2 samples were taken after the simulated rainfall event concluded. Baseline sample was taken on the 17/09/18, before the test started

The rainfall simulation consisted in 3no. sprinklers evenly distributed over the grass area beside the location were the original 1997 leak occurred. The sprinklers were distributing water 24h a day for 6 days, from the 18/09/18 until the 24/09/18. The total volume sprinkled to simulate heavy rain events over 6 days was 363m^3 approximately (0.7 l/s), which, over the 400m^2 area, is equivalent to a 150mm/day rainfall.

The decision to stop the sprinkling and proceed with the sampling was decided based on the water level response in AMW3 to overcome the soil moisture deficit, evident countywide during the long dry period this summer. A telemetric water level logger was installed in the well and the water level was recorded in a continuous basis (every 15 minutes a reading was taken) and accessible online. When the water level in AMW3 showed a response (rising water level), the sprinkling was stopped and the first post-sprinkling groundwater sample was taken on the next working day in AMW3 **(figure 5.1).**

Figure 5.1 *– Graph showing the water level variationin AMW3 over the days when the test took place*



The graphs in the figures below show the chemical trends of THF, MTBE and Toluene over this period of time:

Figure 5.2 *– Chemical trends of THF during the rainfall test event.*

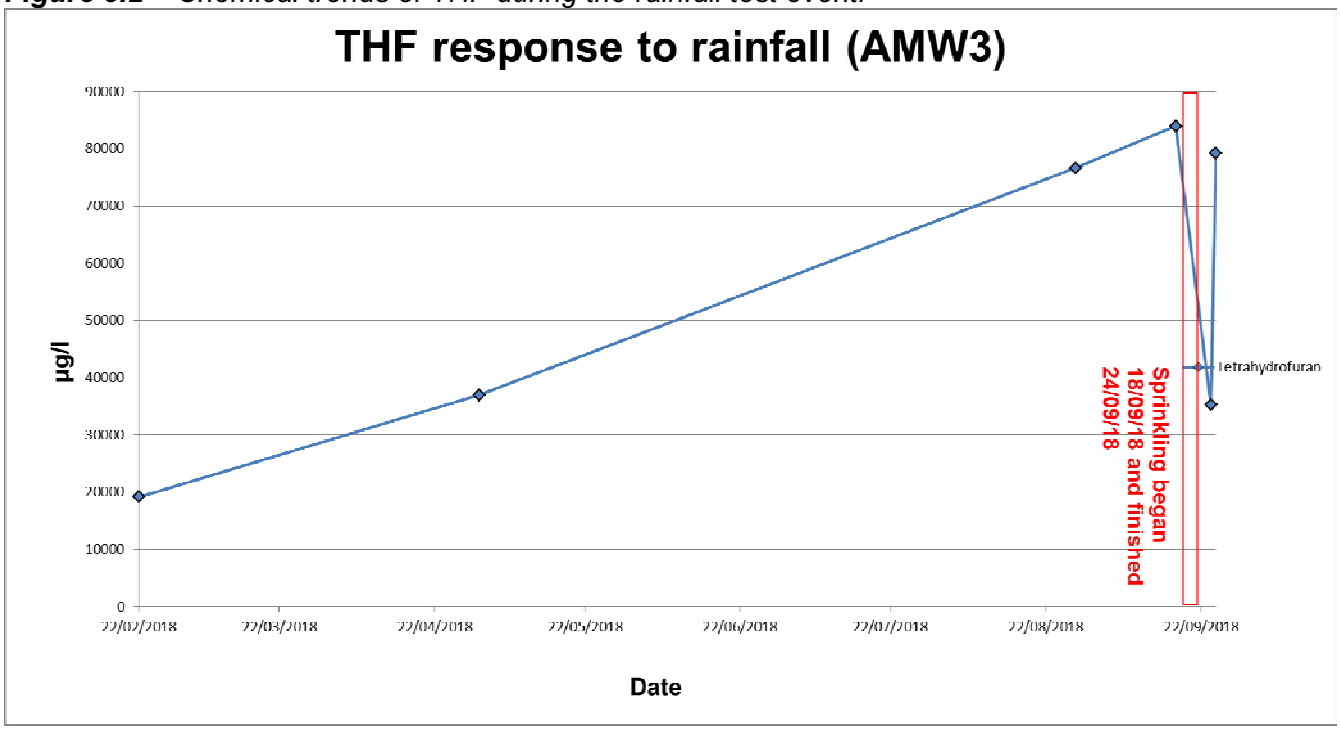


Figure 5.3 *– Chemical trends of MTBE during the rainfall test event.*

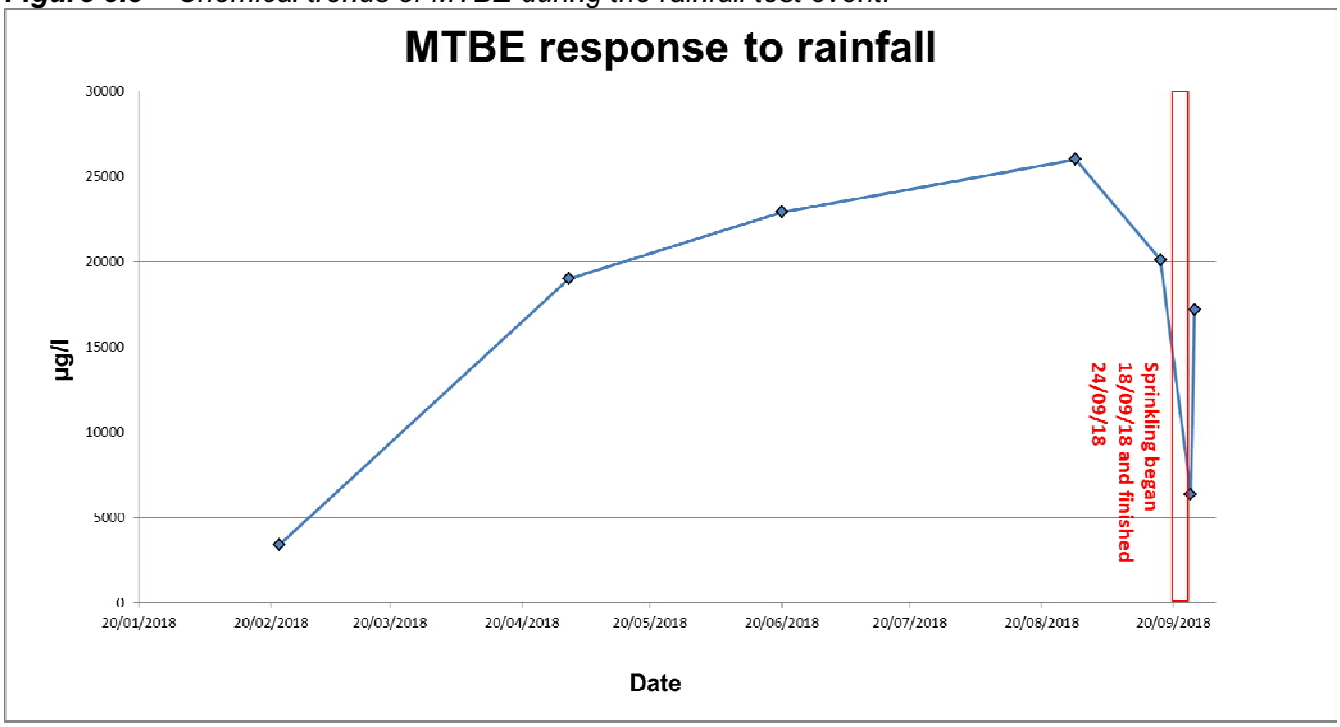
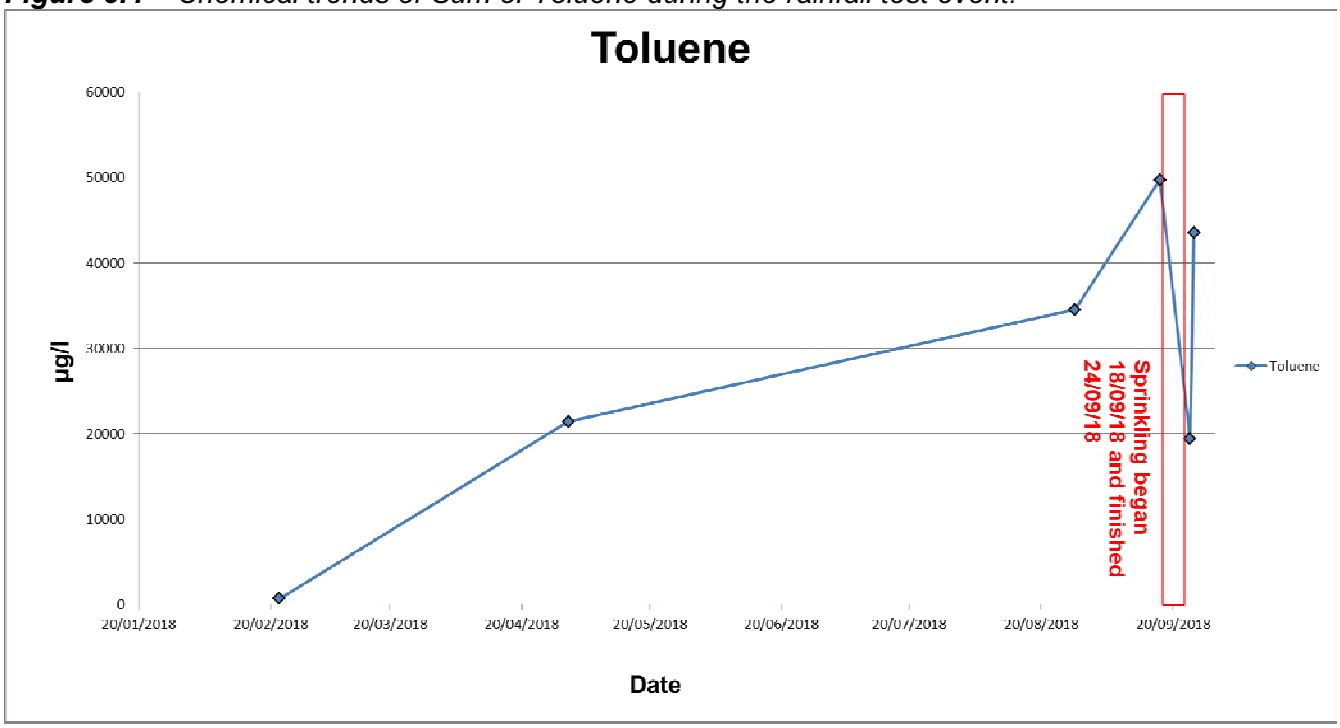


Figure 5.4 *– Chemical trends of Sum of Toluene during the rainfall test event.*



As shown in the graphs the simulated heavy rainfall event caused a dilution of the concentrations rather than an increase as it was suggested by the hypothesis.
However, interpretation is not possible given the events that were happening in the background, i.e. ongoing leaking instead of contaminants trapped in the soil.

Chemtest
The right chemistry to deliver results
Chemtest Ltd.
Depot Road
Newmarket
CB8 0AL
Tel: 01638 606070
Email: info@chemtest.co.uk

UKAS TESTING
2183

Final Report

Report No.:	17-20149-1
Initial Date of Issue:	11-Aug-2017
Client	Minerex Environmental Limited
Client Address:	Taney Hall Eglinton Terrace Dundrum Ireland
Contact(s):	Sven Klinkenbergh Jen Caleno Michael Owens
Project	Arran Chemical Company, Athlone, Co. Roscommon

Quotation No.:		**Date Received:**	02-Aug-2017
Order No.:		**Date Instructed:**	07-Aug-2017
No. of Samples:	4		
Turnaround (Wkdays):	5	**Results Due:**	11-Aug-2017
Date Approved:	11-Aug-2017		

Approved By:

Details: Robert Monk, Technical Development Chemist

Chemtest
The right chemistry to deliver results

Results - Soil

Project: Arran Chemical Company, Athlone, Co. Roscommon

Client: Minerex Environmental Limited			**Chemtest Job No.:**		17-20149	17-20149	17-20149	17-20149
Quotation No.:			**Chemtest Sample ID.:**		491797	491798	491799	491800
			Client Sample ID.:		1099-Skip 1-Composite SS1	1099-Skip 2-Composite SS1	1099-Skip 3-Composite SS1	1099-Skip 4-Composite SS1
			Sample Type:		SOIL	SOIL	SOIL	SOIL
			Top Depth (m):		2.00	4.50	4.50	8.50
			Bottom Depth (m):		4.50	9.50	8.50	11.00
			Date Sampled:		28-Jul-2017	28-Jul-2017	28-Jul-2017	28-Jul-2017
			Asbestos Lab:		COVENTRY	COVENTRY	COVENTRY	COVENTRY
Determinand	**Accred.**	**SOP**	**Units**	**LOD**				
Moisture	N	2030	%	0.020	9.8	13	9.9	11
Dichlorodifluoromethane	U	2760	µg/kg	1.0	< 1.0	< 1.0	< 1.0	< 1.0
Chloromethane	U	2760	µg/kg	1.0	< 1.0	< 1.0	< 1.0	< 1.0
Vinyl Chloride	U	2760	µg/kg	1.0	< 1.0	< 1.0	< 1.0	< 1.0
Bromomethane	U	2760	µg/kg	20	< 20	< 20	< 20	< 20
Chloroethane	U	2760	µg/kg	2.0	< 2.0	< 2.0	< 2.0	< 2.0
Trichlorofluoromethane	U	2760	µg/kg	1.0	< 1.0	< 1.0	< 1.0	< 1.0
1,1-Dichloroethene	U	2760	µg/kg	1.0	< 1.0	< 1.0	< 1.0	< 1.0
Trans 1,2-Dichloroethene	U	2760	µg/kg	1.0	< 1.0	< 1.0	< 1.0	< 1.0
1,1-Dichloroethane	U	2760	µg/kg	1.0	< 1.0	< 1.0	< 1.0	< 1.0
cis 1,2-Dichloroethene	U	2760	µg/kg	1.0	< 1.0	< 1.0	< 1.0	< 1.0
Bromochloromethane	U	2760	µg/kg	5.0	< 5.0	< 5.0	< 5.0	< 5.0
Trichloromethane	U	2760	µg/kg	1.0	< 1.0	< 1.0	< 1.0	< 1.0
1,1,1-Trichloroethane	U	2760	µg/kg	1.0	< 1.0	< 1.0	< 1.0	< 1.0
Tetrachloromethane	U	2760	µg/kg	1.0	< 1.0	< 1.0	< 1.0	< 1.0
1,1-Dichloropropene	U	2760	µg/kg	1.0	< 1.0	< 1.0	< 1.0	< 1.0
Benzene	U	2760	µg/kg	1.0	< 1.0	< 1.0	< 1.0	< 1.0
1,2-Dichloroethane	U	2760	µg/kg	2.0	< 2.0	< 2.0	< 2.0	< 2.0
Trichloroethene	U	2760	µg/kg	1.0	< 1.0	< 1.0	< 1.0	< 1.0
1,2-Dichloropropane	U	2760	µg/kg	1.0	< 1.0	< 1.0	< 1.0	< 1.0
Dibromomethane	U	2760	µg/kg	1.0	< 1.0	< 1.0	< 1.0	< 1.0
Bromodichloromethane	U	2760	µg/kg	5.0	< 5.0	< 5.0	< 5.0	< 5.0
cis-1,3-Dichloropropene	N	2760	µg/kg	10	< 10	< 10	< 10	< 10
Toluene	U	2760	µg/kg	1.0	< 1.0	< 1.0	< 1.0	< 1.0
Trans-1,3-Dichloropropene	N	2760	µg/kg	10	< 10	< 10	< 10	< 10
1,1,2-Trichloroethane	U	2760	µg/kg	10	< 10	< 10	< 10	< 10
Tetrachloroethene	U	2760	µg/kg	1.0	< 1.0	< 1.0	< 1.0	< 1.0
1,3-Dichloropropane	U	2760	µg/kg	2.0	< 2.0	< 2.0	< 2.0	< 2.0
Dibromochloromethane	U	2760	µg/kg	10	< 10	< 10	< 10	< 10
1,2-Dibromoethane	U	2760	µg/kg	5.0	< 5.0	< 5.0	< 5.0	< 5.0
Chlorobenzene	U	2760	µg/kg	1.0	< 1.0	< 1.0	< 1.0	< 1.0
1,1,1,2-Tetrachloroethane	U	2760	µg/kg	2.0	< 2.0	< 2.0	< 2.0	< 2.0
Ethylbenzene	U	2760	µg/kg	1.0	< 1.0	< 1.0	< 1.0	< 1.0
m & p-Xylene	U	2760	µg/kg	1.0	< 1.0	< 1.0	< 1.0	< 1.0

Chemtest
The right chemistry to deliver results

Results - Soil

Project: Arran Chemical Company, Athlone, Co. Roscommon

Client: Minerex Environmental Limited			**Chemtest Job No.:**		17-20149	17-20149	17-20149	17-20149
Quotation No.:			**Chemtest Sample ID.:**		491797	491798	491799	491800
			Client Sample ID.:		1099-Skip 1-Composite SS1	1099-Skip 2-Composite SS1	1099-Skip 3-Composite SS1	1099-Skip 4-Composite SS1
			Sample Type:		SOIL	SOIL	SOIL	SOIL
			Top Depth (m):		2.00	4.50	4.50	8.50
			Bottom Depth (m):		4.50	9.50	8.50	11.00
			Date Sampled:		28-Jul-2017	28-Jul-2017	28-Jul-2017	28-Jul-2017
			Asbestos Lab:		COVENTRY	COVENTRY	COVENTRY	COVENTRY
Determinand	**Accred.**	**SOP**	**Units**	**LOD**				
o-Xylene	U	2760	µg/kg	1.0	< 1.0	< 1.0	< 1.0	< 1.0
Styrene	U	2760	µg/kg	1.0	< 1.0	< 1.0	< 1.0	< 1.0
Tribromomethane	U	2760	µg/kg	1.0	< 1.0	< 1.0	< 1.0	< 1.0
Isopropylbenzene	U	2760	µg/kg	1.0	< 1.0	< 1.0	< 1.0	< 1.0
Bromobenzene	U	2760	µg/kg	1.0	< 1.0	< 1.0	< 1.0	< 1.0
1,2,3-Trichloropropane	N	2760	µg/kg	50	< 50	< 50	< 50	< 50
N-Propylbenzene	U	2760	µg/kg	1.0	< 1.0	< 1.0	< 1.0	< 1.0
2-Chlorotoluene	U	2760	µg/kg	1.0	< 1.0	< 1.0	< 1.0	< 1.0
1,3,5-Trimethylbenzene	U	2760	µg/kg	1.0	< 1.0	< 1.0	< 1.0	< 1.0
4-Chlorotoluene	U	2760	µg/kg	1.0	< 1.0	< 1.0	< 1.0	< 1.0
Tert-Butylbenzene	U	2760	µg/kg	1.0	< 1.0	< 1.0	< 1.0	< 1.0
1,2,4-Trimethylbenzene	U	2760	µg/kg	1.0	< 1.0	< 1.0	< 1.0	< 1.0
Sec-Butylbenzene	U	2760	µg/kg	1.0	< 1.0	< 1.0	< 1.0	< 1.0
1,3-Dichlorobenzene	U	2760	µg/kg	1.0	< 1.0	< 1.0	< 1.0	< 1.0
4-Isopropyltoluene	U	2760	µg/kg	1.0	< 1.0	< 1.0	< 1.0	< 1.0
1,4-Dichlorobenzene	U	2760	µg/kg	1.0	< 1.0	< 1.0	< 1.0	< 1.0
N-Butylbenzene	U	2760	µg/kg	1.0	< 1.0	< 1.0	< 1.0	< 1.0
1,2-Dichlorobenzene	U	2760	µg/kg	1.0	< 1.0	< 1.0	< 1.0	< 1.0
1,2-Dibromo-3-Chloropropane	U	2760	µg/kg	50	< 50	< 50	< 50	< 50
1,2,4-Trichlorobenzene	U	2760	µg/kg	1.0	< 1.0	< 1.0	< 1.0	< 1.0
Hexachlorobutadiene	U	2760	µg/kg	1.0	< 1.0	< 1.0	< 1.0	< 1.0
1,2,3-Trichlorobenzene	U	2760	µg/kg	2.0	< 2.0	< 2.0	< 2.0	< 2.0
Methyl Tert-Butyl Ether	U	2760	µg/kg	1.0	< 1.0	< 1.0	< 1.0	< 1.0
Tetrahydrofuran	N	2760	µg/kg	10	< 10	< 10	< 10	< 10
Acetone	N	2760	µg/kg	1.0	< 1.0	< 1.0	< 1.0	< 1.0
Methanol	N		mg/kg	10	< 10	< 10	< 10	< 10
Ethanol	N		mg/kg	10	< 10	< 10	< 10	< 10
Isopropanol	N		mg/kg	10	< 10	< 10	< 10	< 10
Acetonitrile	N	2760	µg/kg	1.0	< 1.0	< 1.0	< 1.0	< 1.0
Ethyl Acetate	N	2760	µg/kg	1.0	< 1.0	< 1.0	< 1.0	< 1.0

Test Methods

SOP	Title	Parameters included	Method summary
2030	Moisture and Stone Content of Soils(Requirement of MCERTS)	Moisture content	Determination of moisture content of soil as a percentage of its as received mass obtained at <37°C.
2760	Volatile Organic Compounds (VOCs) in Soils by Headspace GC-MS	Volatile organic compounds, including BTEX and halogenated Aliphatic/Aromatics.(cf. USEPA Method 8260)*please refer to UKAS schedule	Automated headspace gas chromatographic (GC) analysis of a soil sample, as received, with mass spectrometric (MS) detection of volatile organic compounds.

Report Information

Key

U	UKAS accredited
M	MCERTS and UKAS accredited
N	Unaccredited
S	This analysis has been subcontracted to a UKAS accredited laboratory that is accredited for this analysis
SN	This analysis has been subcontracted to a UKAS accredited laboratory that is not accredited for this analysis
T	This analysis has been subcontracted to an unaccredited laboratory
I/S	Insufficient Sample
U/S	Unsuitable Sample
N/E	not evaluated
<	"less than"
>	"greater than"

Comments or interpretations are beyond the scope of UKAS accreditation
The results relate only to the items tested
Uncertainty of measurement for the determinands tested are available upon request
None of the results in this report have been recovery corrected
All results are expressed on a dry weight basis
The following tests were analysed on samples as received and the results subsequently corrected to a dry weight basis TPH, BTEX, VOCs, SVOCs, PCBs, Phenols
For all other tests the samples were dried at < 37°C prior to analysis
All Asbestos testing is performed at the indicated laboratory
Issue numbers are sequential starting with 1 all subsequent reports are incremented by 1

Sample Deviation Codes

A - Date of sampling not supplied
B - Sample age exceeds stability time (sampling to extraction)
C - Sample not received in appropriate containers
D - Broken Container
E - Insufficient Sample

Sample Retention and Disposal

All soil samples will be retained for a period of 45 days from the date of receipt
All water samples will be retained for 14 days from the date of receipt
Charges may apply to extended sample storage

If you require extended retention of samples, please email your requirements to:
customerservices@chemtest.co.uk

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F: +353 1 89 25001
www.water.ie

Mr Cyril Furey,
EHS Manager
Arran Chemical Company Ltd,
Monksland Industrial Estate,
Athlone,
Co Roscommon,
Reg No: PO110-02

Ref: - Proposal to amend conditions relating to emissions to sewer via Technical Amendment.

17 April 2019

Dear Mr Furey,

I refer to your proposal to amend conditions relating to emissions to sewer set out in EPA Licence Reg. No. P0110-02 via Technical Amendment. Irish Water is satisfied to support your Technical Amendment request to the EPA subject to the amendments of *Schedule B.3 Emissions to Sewer and Schedule C .3.2 Monitoring of Emissions to Sewer* of P0110-02 as outlined below;

Schedule B.3

Emission Point Reference No.:	SE1	
Name of Receiving Sewer:	Irish Water sewer	
Location:	IW sewer in Monksland Industrial Estate	
Volume to be emitted:	Maximum in any one hour:	5.5 m^3
	Maximum in any one day:	100 m^3
	Average in any one day (on monthly basis):	80 m^3

Parameter	Emission Limit Value	
pH	7-11 pH Units	
Temperature	35 ° C	
	mg/l	**kg/day**
Biochemical Oxygen Demand	5,000	240
Chemical Oxygen Demand	10,000	600
Suspended Solids	500	30
Sulphates (as SO4)	1,500	90
Sulphites (as SO3)	200	12
Chlorides (as Cl)	3,750	225
Phenols (as C6H5OH)	15	0.9
Total Phosphorus (as P)	10	0.6

Total Dissolved Solids	7,500	450
Detergents (as Lauryl Sulphate)	10	0.6
Total Heavy Metals	5	0.3
Cadmium (Cd)	1	0.06
Chromium (Cr)	0.5	0.03
Copper (Cu)	0.5	0.03
Lead (Pb)	0.05	0.003
Mercury (Hg)	0.05	0.003
Nickel (Ni)	0.5	0.03
Silver (Ag)	0.05	0.003
Zinc (Zn)	1	0.06
Molybdenum	0.5	0.03

Schedule C.3.2 Monitoring of Emissions to Sewer

Parameter	Monitoring Frequency	Analysis Method/Technique
Flow	Continuous	On-line flow meter with recorder
Temperature	Daily (when discharged) Note 2	Temperature probe
pH	Continuous	pH electrode/meter and recorder
Chemical Oxygen Demand	Weekly Note 1	Standard Method
Biochemical Oxygen Demand	Monthly Note 1	Standard Method
BOD/COD Ratio	Monthly	-
Dissolved Oxygen	Daily (when discharged) Note 2	Dissolved Oxygen meter
Suspended Solids	Monthly Note 1	Gravimetric
Sulphates (as SO4)	Monthly Note 1	Standard Method
Sulphites (as SO3)	Quarterly Note 1	Standard Method
Chlorides (Cl)	Monthly Note 1	Standard Method
Phenols (as C6H5OH)	Quarterly Note 1	Standard Method
Total Dissolved Solids	Monthly Note 1	Standard Method
Total Phosphorus (as P)	Quarterly Note 1	Standard Method
Orthophosphate	Quarterly Note 1	Standard Method
Full Metal Suite	Quarterly Note 1	Atomic Absorption/ICP
Detergents (as Lauryl Sulphate)	Quarterly Note 1	Standard Method
Organic Solvents Note 3	Quarterly Note 1	Gas Chromatography
Respirometry	Annually Note 1	Standard Method
Toxicity	As Required	Standard Method

Note 1: All samples shall be collected on a 24 hour flow proportional composite sampling basis.

Note 2: Sample to be obtained by discrete sampling.

Note 3: Screening for priority pollutant list substances (such as US EPA volatile and/or semi-volatile compounds). This analysis shall include those organic solvents

Irish water shall only support the amendments as outlined above.

If you have any further queries, please do not hesitate to contact Irish Water.

Yours sincerely

_____

Ronan Connolly,
Licensing Manager
Wastewater Source Control