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SOIL & GROUNDWATER BASELINE REPORT

ATTACHMENT 4.8.3

IE Licence Application 2018

For

AbbVie Ireland, NL B.V.,
Ballytivnan,
Sligo Town,
Co. Sligo

Technical Report Prepared For

Jacobs Engineering Ireland.
Merrion House,
Merrion Road,
Dublin 4.

Technical Report Prepared By

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Our Reference

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Signature		Teri Hayes
Name	Colm Driver	Teri Hayes
Title	Environmental Consultant	Director (Water)
Date	3rd September 2018	3rd September 2018

EXECUTIVE SUMMARY

This soil and groundwater quality baseline report has been completed as part of AbbVie Ireland, NL B.V. Ltd.'s IE application (Ref. LA001712). The report has been prepared in compliance with *European Commission Guidance concerning baseline reports under Article 22(2) of Directive 2010/75/EU on industrial emissions.*

Our review shows that, apart from fuel oil (10,000 litre diesel tank) and a high high strength wastewater storage tank (60,000 litre high high strength wastewater tank), there will be no other hazardous bulk liquids storage at the site. The diesel tank is double skinned and stored at the reserve generator. The high high strength tank is in a sunken, concrete bund with chemical resistant coating located beside the main building. There is a smaller high high strength wastewater sump with a capacity of 7,000 litres which is also stored in a designated sunken, concrete bund with chemical resistant coating.

Small quantities of chemicals in sealed bottles and drums will be stored within the Warehouse and in the 2 no. self-bunded and lockable external chemstores. Spill emergency procedures will be in place across the facility. All low strength wastewater is kept separate from the high high strength wastewater and is discharged to the Irish Water sewer through the on-site wastewater drainage system.

The risk from an accidental event is considered to be low, based on the low volume of hazardous chemicals stored, natural protection due to a thick clay layer overlying the aquifer and containment measures (bunding etc.) present at the facility.

There are no sites designated for nature conservation in close proximity to the proposed development. Environmental receptors include:

(i) The Bedrock Aquifer. This is classed as LI – Locally Important Aquifer (Moderately productive only in Local Zones). The aquifer is well protected due to hardstanding on the site and the natural overburden present underlying hardstanding areas of the site; and,

(ii) Hydrological receptors close to the site include the Willsborough Stream which is located close to the north western boundary of the site, the Lisnalurg Stream, a tributary of the Willsborough is 280m to the west and the largely culverted Shannon Eighter Stream is c.50m to the south of the site. There are no natural watercourses occurring within the proposed development site. The Shannon Eighter flows along half of the eastern site boundary and then enters a culvert located at the south-eastern corner of the site. The site's stormwater drains to the ditch along the eastern and southern boundaries of the site. No activities are undertaken external to the buildings or in the vicinity of the stormwater drainage points. Onsite protection systems include bunding of bulk liquid storage tanks (excluding liquid Nitrogen and LPG as per Compressed Gas Association Regulations), hardstand across the site, presence of oil interceptors, and use of self-bunded and lockable external chemstores. A new Class 1 Full retention hydrocarbon interceptor is proposed for the drainage line draining the area around the new bulk diesel tank.

It is concluded, based on the natural protection and control measures at the site, that there is a negligible risk to soil and groundwater.

A review of soil and groundwater quality data available confirms that there is no evidence of historic contamination at the site. This baseline data provides a basis for restoration (if required) at licence closure.

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1.0 INTRODUCTION

1.1 Instruction

AWN Consulting Ltd. (AWN) was appointed by AbbVie Ireland, NL B.V. Ltd. to complete a baseline soil and groundwater report for their Industrial Emissions (IE) licence application for the AbbVie bio-chemical pharmaceutical and bio-medical devices plant located in Ballytivnan, Co. Sligo. This report was completed in accordance with European Commission guidance concerning baseline reports under Article 22(2) of Directive 2010/75/EU on industrial emissions.

1.2 Background – Soil and Groundwater Compliance

In April 2013, Ireland implemented the requirements of the Industrial Emissions Directive (IED) through SI 137 of 2013 and SI 138 of 2013. The regulations came into operation on 7th January 2014. The requirements of the IE include a soil and groundwater compliance report.

Soil and groundwater compliance is defined in SI 138 in Regulation 13 as:

‘Baseline report and permanent cessation of activity’

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

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

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

(a) the current use and, where available, the past use of the site; and
(b) any available information on -

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

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

The scope of the baseline report is outlined in *European Commission Guidance concerning baseline reports under Article 22(2) of Directive 2010/75/EU on industrial emissions.*

1.3 Objectives and Reporting Format

The soil and groundwater baseline report includes items listed in Section 1.2 above and follow the guidance below:

- European Commission Guidance concerning baseline reports under Article 22(2) of Directive 2010/75/EU on industrial emissions, and, where relevant:
- Guidance on the Management of Contaminated Land and Groundwater at EPA Licensed Sites, EPA, July 2013;
- Guidance on the Authorisation of Discharges to Groundwater, EPA, December 2011;
- Guidelines for the Preparation of Soils, Geology and Hydrogeology Chapters of Environmental Impact Statements, Draft Guidance, IGI 2013.

1.4 Limitations of Report

The conclusions presented in this report are professional opinions based solely on the tasks outlined herein and the information made available to AWN. They are intended for the purpose outlined herein and for the indicated site and project. Furthermore, this report is produced solely for the benefit of AbbVie Ireland Ltd. to address an Environmental Protection Agency (EPA) requirement for their licence.

This report may not be relied upon by any other party without explicit agreement from AWN. Opinions and recommendations presented herein apply to the site conditions existing at the time of the recently completed field work and subsequent assessment. They cannot apply to changes at the site of which AWN is not aware and has not had the opportunity to evaluate. This report is intended for use in its entirety; no excerpt may be taken to be representative of this baseline assessment. All work carried out in preparing this report has utilised and is based on AWN professional knowledge and understanding of the current relevant Irish and European Community standards, codes and legislation.

2.0 METHODOLOGY

2.1 Methodology Outlined

Table 5 of the Guidance (European Commission Guidance concerning baseline reports under Article 22(2) of Directive 2010/75/EU on industrial emissions), outlines the requirements for this report. These requirements form the methodology adopted for this report which is outlined below as Stages 1 to 8.

- Stage 1 - Identifying the potential hazardous substances that are currently used, produced or released at the site
- Stage 2 - Identifying the relevant hazardous substances i.e. those which have the potential to cause soil and groundwater contamination
- Stage 3 - Assessment of the site-specific pollution risk
- Stage 4 - Site History
- Stage 5 - Environmental Setting
- Stage 6 - Conceptual Site Model
- Stage 7 - Site Investigation – Soil & Water Quality Assessment
- Stage 8 - Production of the Baseline Report

2.2 Sources of Information

Reference is made in this report to information from a number of existing data sources and reports including the following:

- Geological Survey of Ireland (GSI): On-line mapping resources, available at www.gsi.ie including *inter alia* groundwater well database, Karst feature database, geology, aquifer classification and vulnerability;
- Environmental Protection Agency (EPA): On-line data resources available at http://gis.epa.ie/Envision/;
- National Parks & Wildlife Service (NPWS): On-line data resources available at http://webgis.npws.ie/npwsviewer/;
- Environmental Impact Assessment Report (EIAR) (Engineering Inspection Specialists (EIS) Limited, 2018);
- Report on a Site Investigation for a development at AbbVie Ballytivnan, Co. Sligo. IGSL Limited. July 2018; and,
- Biannual Groundwater Monitoring Reports (2016 & 2017 Reports – 4 in total) for the AbbVie site, Co Sligo. TMS Environmental Limited.

2.3 Scope of Work Undertaken

The scope of the work undertaken for this assessment included the following:

- A desktop review of regional and site geology and hydrogeology, and review of the planned pharmaceutical operations at the AbbVie site.
- The desktop review included collation of data from previous site assessment reports including the recent Environmental Impact Assessment Report (EIAR) (Engineering Inspection Specialists (EIS) Limited, 2018).
- Report on a Site Investigation for a development at AbbVie Ballytivnan, Co. Sligo. IGSL Limited. July 2018;
- Biannual Groundwater Monitoring Reports (2016 & 2017 Reports – 4 in total) for the AbbVie site, Co Sligo. TMS Environmental Limited.

3.0 STAGE 1 & 2 - IDENTIFYING SUBSTANCES OF CONCERN

This section summarises the substances hazardous to water that are currently stored (or will be stored) and transported in significant volumes at the AbbVie bio-chemical pharmaceutical and bio-medical devices facility in Ballytivnan, Co. Sligo.

A full list of chemicals and their hazard statements is compiled and is present in Attachment 4.6.2 in Section 4 of this IE licence application. Table 3.1 summarises the explanations of Hazard Risk Statements. In reference to the risk to the soil and water environment, the Hazard Statements of note are H400/410/411/412 which are classified as damaging to the environment.

Table 3.1 *Hazard Statement Description*

Hazard Statements	Description
H203	Explosive; fire, blast or projection hazard
H221	Flammable gas
H225	Highly Flammable liquid and vapour
H226	Flammable liquid and vapour
H280	Contains gas under pressure; may explode if heated
H301	Toxic if swallowed
H302	Harmful if swallowed
H304	May be fatal if swallowed and enters airways
H311	Toxic in contact with skin
H312	Harmful in contact with skin
H314	Causes severe skin burns and eye damage
H315	Causes skin irritation
H317	May cause an allergic skin reaction
H318	Causes serious eye damage
H319	Causes serious eye irritation
H330	Fatal if inhaled
H331	Toxic if inhaled
H332	Harmful if inhaled
H334	May cause allergy or asthma symptoms or breathing difficulties if inhaled
H335	May cause respiratory irritation
H336	May cause drowsiness or dizziness
H351	Suspected cancer causing
H360	May damage fertility or the unborn child
H361	Suspected of damaging fertility or the unborn child
H372	Causes damage to organs through prolonged or repeated exposure
H373	Causes damage to organs through prolonged or repeated exposure
H400	**Very toxic to aquatic life**
H410	**Very toxic to aquatic life with long lasting effects**
H411	**Toxic to aquatic life with long lasting effects**
H412	**Harmful to aquatic life with long lasting effects**

The chemicals stored onsite, as listed in Attachment 4.6.2. of this IE licence application, which have a hazard statement of H400+ are listed in table 3.2. The EPA Classification of Hazardous and Non-Hazardous Substances in Groundwater (December 2010) were also considered.

Table 3.2 *Chemical list of hazardous chemicals stored on site.*

Material/ Substance	**CAS number**	**Amount Stored (tonnes)**	**Hazard Statements**	**Hazardous Substances in Groundwater (December 2010)**
Tosh Thinner	108-94-1 108-65-6 123-86-4	<0.5	H226, H302, H304, H318, H315, H335 H336, **H411**	
Tosh Ink	123-86-4 13048-33-4 15625-89-5 67906-98-3 63225-53-6 7473-98-5 75980-60-8 119-61-9 108-65-6	<0.5	H226, H319, H315, H317, H336, **H412**	
Butane Gas	68512-91-4	<0.02	H220	**Yes**
CASTROL OPTILEB GR UF00 Grease-Mixture. Contains petroleum.	8042-47-5 (white mineral oil, petroleum ≤5 %)	<0.02	NA	**Yes (petroleum)**
WD-40 Lubricant	64742-47-8 64742-58-1 64742-53-6 64742-56-9 64742-65-0 64742-47-8	<0.01	H226, H304, H336	**Yes (Petroleum distillate)**
Ambersil Label & Adhesive Remover (200ML)	64-17-5 586-62-9 5131-66-8 124-38-9 67-63-0 78-93-3	<0.005	H222, H229, H315, H317, H319, H336 **H411**	
HIBISCRUB (5LTR)	1643-20-5 67-63-0 56-81-5 18472-51-0	<0.05	H318, **H400 H410, H411**	
Toxin 1	cyto-toxin	< 0.1 kg	H300, H341, H351, H361	Cyto-toxin (highly toxic and mutagenic)
Toxin 2	cyto-toxin	< 1 kg	H301, H311, H331, H341, H351, H361	Cyto-toxin (highly toxic and mutagenic)
Diesel	68334-30-5	10m3	H226, H304, H351, H332, H315, H373, **H411,**	**Yes**

The majority of the hazardous chemicals that are or will be stored on site are stored in small quantities in drums and bottles. These will be stored in designated areas within the Warehouse or in the existing self-bunded external chemstores.

Additional chemicals not listed in Table 3.2 include refrigerants, oils and lubricants within the plant equipment. Those chemicals which have the potential to impact ground and surface water should they be released are listed in Table 3.3. These will not be stored onsite and will be contained within the equipment only. Specialist external contractors will change out these plant fluids annually or as required.

Refrigerants are stored within the designated, closed loop chiller systems and are topped up as required by specialised contractors.

Table 3.3 *Chemical list of hazardous chemicals contained within equipment.*

Material/ Substance	**CAS number**	**Amount Stored (tonnes)**	**Hazard Statements**	**Hazardous Substances in Groundwater (December 2010)**
R407c - Hydrofluorocarbons blend	811-97-2 354-33-6 75-10-5	<0.2	H280	**Yes (Pentafluoroethane & Difluoromethane)**
R717 - Ammonia	7664-41-7	<0.3	H221, H280, H331, H314, H318, **H400 H411**	
R410a - difluoromethane, pentafluoroethane	75-10-5 354-33-6	<1	H280, H220, H340, H350	**Yes**
R404a - Hydrofluorocarbons blend	354-33-6 420-46-2 811-97-2	<0.2	H280, H220	**Yes**
Kendall® Four Seasons Hydraulic Fluid	64742-54-7 64742-62-7	<200 L (within Lyo only)	N/A	Yes (Petroleum distillate)
Mechanical Pump Oil - white mineral oil (petroleum)	8042-47-5	<5 L (within Lyo only)	N/A	Yes (petroleum)

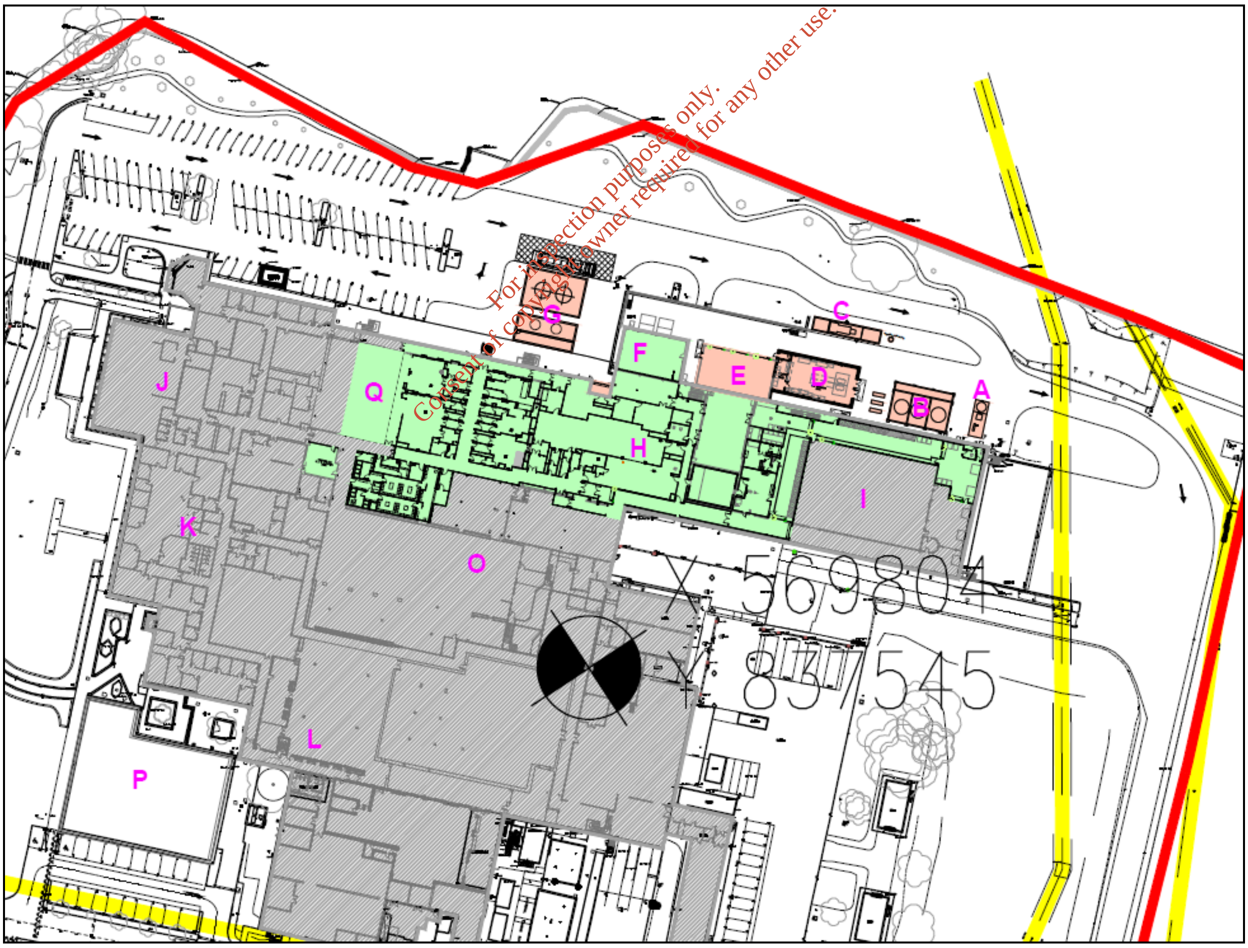
In addition, Table 3.4 presents the bulk hazardous chemicals and liquid wastes stored on site which have potential to impact on water quality. All of the chemicals in Table 3.3 are identified as environmentally hazardous to soils and groundwater if a release to ground occurred i.e. without mitigation.

Whilst the high high strength wastewater does not carry a H400+ hazard statement it will contain cytotoxins which are highly toxic and mutagenic. As such, the high high strength wastewater has been included in this assessment.

Table 3.4 *Bulk Materials and Corresponding Hazard Statements*

Chemical	**Units**	**Maximum Storage Quantity**	**Storage Container**	**Storage Location**	**Hazard Statements**
Diesel	Litres	10,000	Double skinned belly tank	Near Reserve Generator	H351, H304, H332, H315, H373, H226, H411,
High High Strength Waste Water	Litres	60,000	Sunken bunded bulk tank	Beside Main Building	Cyto-toxins (H300, H301, H311, H331, H341, H351, H361)
High High Strength Waste Water	Litres	7,000	Sunken bunded sump tank	Beside Main Building	Cyto-toxins (H300, H301, H311, H331, H341, H351, H361)

Insert 3.1 presents the location of the diesel tank and wastewater tanks. The diesel tank will be at the emergency generator.



Insert 3.1 *Location of the diesel tank (C) and wastewater system (G) at the subject site.*

4.0 STAGE 3 - ASSESSMENT OF THE SITE-SPECIFIC POLLUTION RISK

This section includes a review of the containment measures in place for potential hazardous substances (identified in Stage 2 above) and potential conduits for migration at the site.

4.1 Containment Systems for Chemical Storage

Chemical storage is limited to bunded tanks, drums stores and designated process areas. Handling and transfer of fuel and chemicals will be carefully controlled. Any spill of hazardous substances used in the process will be diverted to a designated drainage system for offsite disposal.

In general, the quantities of new materials stored on site will typically be low due to the high-value, low-volume nature of the bio-chemical production process.

Raw materials and supplies are delivered to site by contractors/vendors. Access to the site is via the security centre at the west of the site, the goods will then be escorted to the delivery unloading platform located at the rear of the Warehouse. Goods will be unloaded by trained operators and stored in the Warehouse until use.

Trolleys and carts will be used for all material movements within the facility. Separate trolleys/ carts will be used for the general circulation areas as opposed to the individual processing rooms. Each individual processing room will have dedicated trolleys/ carts which will stay within the relevant rooms and will only travel to the individual room material air lock (MAL) to receive materials. Single use mixers (SUM's) and totes will also be used for movement of materials and single use components around the process areas.

Staff are fully trained in site procedures, including all Standard Operating Procedures (SOP's) and emergency response and safety procedures in relation to the storage and handling of all substances being used at the facility.

4.1.1 Solvents

Isopropyl Alcohol (IPA) at 99.7% and 70% is used within the existing facility for surface decontamination. A 70% solution of Isopropyl Alcohol (IPA), as impregnated wipes, will also be used for cleaning and disinfecting the new production surfaces after use. IPA will be stored in pre-packaged wipes and sealed bottles within the Warehouse.

It is proposed that di-methyl alcohol (DMA) and di-methyl sulfoxide (DMSO) will be used for dilution of the toxin for Monoclonal Antibody (MAB) conjugation in small quantities (6L). 100% DMA and DMSO will be delivered to site in sealed 5L, 15L or 25L bottles, and will be stored within the designated flammables area of the Warehouse. DMA and DMSO will be transferred directly to the conjugation suite where it will be pumped into the vessel using a peristaltic pump and single use tubing.

Glacial acetic acid (required in small quantities as part of the buffer solution formulation) will be stored in sealed containers (1L bottles) in the Warehouse prior to use. These will be dispensed directly into the buffer solution within a controlled environment.

Within the existing processes, solvents are used as part of the printing process during the final stages of the bio-medical devices production. Solvents used in printing are stored in sealed containers in locked cabinets until use.

4.1.2 Sterilising Chemicals other than Solvents

Sodium Hydroxide (NaOH) will be stored in 200L drums in the Warehouse and will be transferred to the point of use as required. The NaOH will be pumped using a peristaltic pump and single use tubing into the conjugation reactors. The waste NaOH will then be diverted to the wastewater drain to the high high strength wastewater system

Vaporised Hydrogen Peroxide (VHP) will be used for sterilisation of the high containment isolator and will be stored onsite in canisters in the Warehouse. The VHP will be piped directly from the canisters to the isolators and will be vaporised. A catalytic container is used to make the gas safe for emission to atmosphere (i.e. converts to water and oxygen).

4.1.3 Diesel, Nitrogen and LPG Storage

A 10m^3 double skinned belly tank will be used to hold diesel for the emergency generator. The bulk diesel tank will also be equipped with leak detection.

A 30m^3 LPG tank (Liquid Petroleum Gas), to supply the new and existing boilers, and a 10m^3 Liquid Nitrogen tank are also installed on the site.

4.1.4 Hazardous Chemicals

Linker toxin used in the production of the pharmaceutical product has an Occupational Exposure Limit (OEL) of ≤1 microgram per m^3 and will only be used within high grade isolators. This will be stored within a designated, access controlled cold room within the Warehouse and will be transferred to the production suite via a bunded trolley.

As outlined in Attachment 4-6-2, up to 500g of toxin will be stored onsite at any one time in 1-50g containers.

4.1.5 Powders

Powders used in solutions will be stored in the Warehouse in 1kg or 5kg bags. The powders will be transferred directly to the single use mixer room within the sealed bags and opened and dispensed into the mixer within the laminar flow hood.

4.1.6 Single Use Components

Single use components will be stored in bulk within the Warehouse and will be transferred to the bio-chemical facility as required. A designated store room within the production area will also be provided for frequently used items.

Other single use items such as gowning materials and space cleaning consumables will be stored in a separate designated store within the production area.

4.1.7 Refrigerants and Coolants

Refrigerants will be stored across the site within the chiller systems. These are stored in closed loop systems and will be topped up as required.

20% Propylene glycol will be used in the jackets of the temperature control units. Glycol will be arrive on site and be stored 200l drums (up to 1m^3). Waste glycol will be drummed and disposed of offsite.

4.1.8 Liquid Nitrogen

Liquid nitrogen will be stored in a 10m^3 bulk tank in the yard. The vaporized nitrogen will provide nitrogen to the lyophiliser and isolators. The nitrogen pad will be free of sumps, open drains or other areas where cold nitrogen gas could accumulate in the event of a release.

4.1.9 Oils and other Chemicals within Plant

Oils and lubricants will be supplied to the plant equipment (e.g. the Lyo) by an external contractor with responsibility for maintaining the equipment. There will therefore be no storage of these oils/lubricants onsite other than within the plant itself.

Heat transfer oil will similarly be held within the Lyo plant equipment and will not be stored onsite.

4.1.10 Bunding

Bulk chemical storage including the new diesel tank and the high high and low strength wastewater tanks will be bunded (wastewater tanks) or double lined (diesel belly tank). In the event of a spillage in the first level of containment, the secondary containment shall be inspected, and liquids diverted for collection and safe disposal as required. Drainage from the unloading facility for diesel trucks and for the transfer area to a wastewater road tanker is also diverted for collection and safe disposal.

Liquid Nitrogen and LPG will also be stored in bulk tanks however these do not require bunding and will vaporise in the event of a leak.

All proposed tanks, bunded storage and pipelines have been designed for their specific purpose and their contents. As required the structures will be rendered impervious to the materials stored therein. Tanks will be stored in bunds meeting the requirements of Agency guidelines on the “Storage and Transfer of Materials for Scheduled Activities”.

With respect to integrity testing all bulk tanks, bunds and associated pipelines are new structures. As such no integrity testing of these structures has been carried out to date. It is anticipated that all bunds will be tested in accordance with standard licence requirements (testing is required typically every 3 years). Integrity testing will be completed in accordance with BS8007 “Code of Practice for design of concrete structures for retaining aqueous liquids” i.e. bunds will be demonstrated to be capable of holding 110% of the capacity of the largest tank or drum within the bunded area or 25% of the total volume of substances stored within the bund (whichever is the larger).

4.2 Stormwater Management

There are 3 no. stormwater discharge points which will drain to the stormwater drainage ditch along the eastern and southern boundaries via 4 no. existing hydrocarbon interceptors previously installed for the existing facility. A drainage drawing is provided in Appendix A of this document.

A new Class 1 Full retention hydrocarbon interceptor is proposed for the drainage line draining the area around the new bulk diesel tank as is required.

The interceptors will be cleaned as required. The stormwater discharge points have manholes which allow for visual inspection on a weekly basis.

4.3 Foul Effluent and Wastewater

Foul effluent will comprise domestic effluent from welfare facilities such as toilets, showers and canteen facilities, as well as low strength wastewater.

Wastewater is segregated into two categories; High High Strength and Low Strength. Only the Low Strength wastewater will be discharged, along with the foul effluent, to the Irish Water sewer.

The discharge to sewer will be via SE1 in the south east corner of the site. The main foul line (F15) is constructed of 225mm PVC pipe. Upstream of this the foul lines are 225mm concrete pipe. The average flow will be 6.7m^3/hour with a max flow of 12.7m^3/hour.

4.3.1 High High Strength Wastewater

High High Strength Wastewater is wastewater from high containment areas or waste that has been identified that may contain trace toxin or other harmful substances. This waste is considered hazardous and is not suitable for treatment by conventional WWT (Waste Water Treatment) technology.

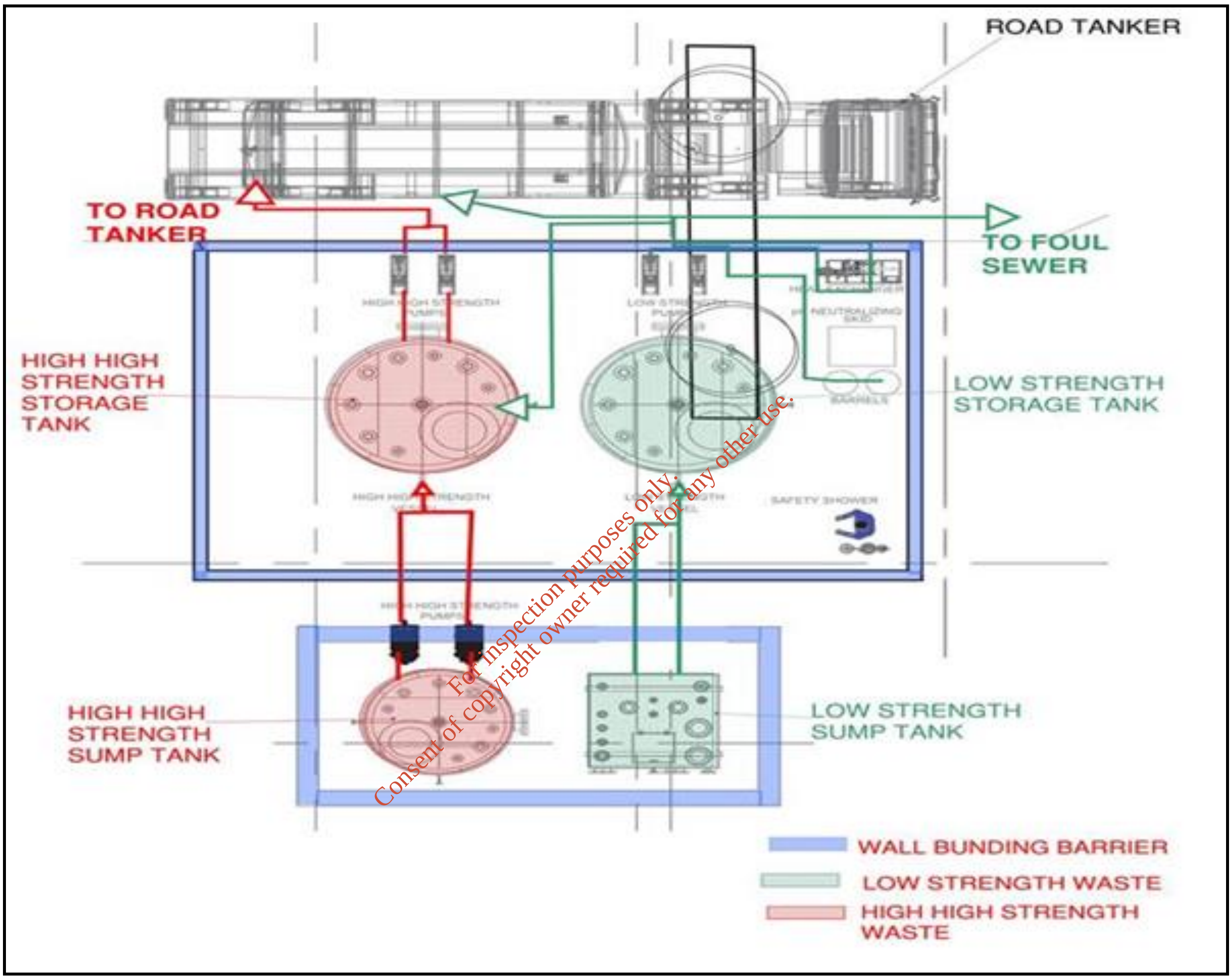
High high strength waste will be routed to the designated gulley in the locality by means of closed pipework from the respective users. All High High Strength process drain points are on the ground floor. The drainage will all be double-contained, gravity drained (1:100 slope) polypropylene (PP) pipe. The main collection header is 6-inch internal diameter and enters the sunken High High strength wastewater sump tank outside the building. Waste water will be continuously pumped from the sump to the high high strength wastewater bulk storage tank

The High High Strength wastewater sunken sump tank will be a stainless steel, single skin, flat bottomed, vertical cylindrical tank with an ellipsoidal top. The approximate operating volume of the tank will be 7000 L. It will be located within a designated concrete bund with the low strength wastewater sump tank. The bund will have a chemical resistant coating. Level switch controlled self-priming pumps (Duty and Stand-by) on top of the tank will pump waste from the sump to the high high strength wastewater bulk storage tank. Quick connects with valves are available for cleaning though transfer lines and spray balls, using towns water from site services.

The High High Strength wastewater sunken bulk storage tank will be a 60,000 L flat bottomed, vertical cylindrical tank stainless steel tank with an ellipsoidal top. This tank will be in the same bund as the low strength wastewater bulk storage tank, which also has a chemical resistant coating.

The high high strength wastewater bulk storage tank will be emptied routinely into a road tanker to be incinerated / disposed of off-site. Approximately two road tankers a week are estimated to be required when working at maximum capacity.

The containment of the high high strength wastewater will be subject to EPA licence conditions to minimise potential for leakage/spillage. The bund will be equipped with level detection, and in the unlikely event that any liquid enters the bund it can be tested and pumped to the appropriate wastewater tank for further treatment or disposal.



Insert 4.1 *Wastewater Block Flow Diagram*

4.3.2 Low Strength Wastewater

Low Strength Wastewater is wastewater from the industrial activity and includes reject water from water purification systems, boilers and cooling towers blowdown, and wastewater from non-product contact equipment. There is no toxin in this wastewater.

The drain lines for the Low Strength wastewater will be stainless steel with the underground drainage transitioning to double contained, gravity drained polypropylene pipe. Two collection headers will feed the main 6-inch header which will drain into the low strength sump tank.

The low strength sump tank will be a rectangular GRP tank with approx. 10,000 L operating volume. It will be bunded in the same concrete bund as the high high strength sump tank. The waste will be pumped into the Low Strength wastewater bulk storage tank by two (duty and standby) submersible pumps inside the sump tank.

The sunken bulk storage tank will be a 30,000 L GRP tank. The waste will be sampled and will generally be sent to the foul sewer (municipal waste water treatment). The facility includes for pH and temperature adjustment if required before discharge. The wastewater can also be pumped into the high high strength wastewater tank or to a road tanker if there is ever a concern about the possibility of contamination of the waste.

Operation of the wastewater system will be according to BAT (Best Available Technology) principles and in compliance with the licence for the site to ensure that inputs to, and subsequent contamination of, soil and water environments does not occur during normal and/ or emergency conditions (material spillage or fire event situations).

4.4 Process Controls

The proposed bio-chemical facility will be located in a shell space in Building 03 on the Sligo Ballytivnan site, along with required support facilities, equipment and utilities.

The process is constrained by Good Management Practice (GMP) regulations and as such there is limited opportunity for alternative processes. However, the facility has been designed to conform with best industrial practice for a high-containment facility. The process will be fully enclosed, and all equipment sealed in accordance with good engineering practice and relevant GMP standards.

Product recipes and materials management systems are designed to minimise wastes in both the new and existing facility. Process automation system (a series of smaller controllers at the equipment level) will ensure consistency of operation from batch to batch at each step in the process in both facilities.

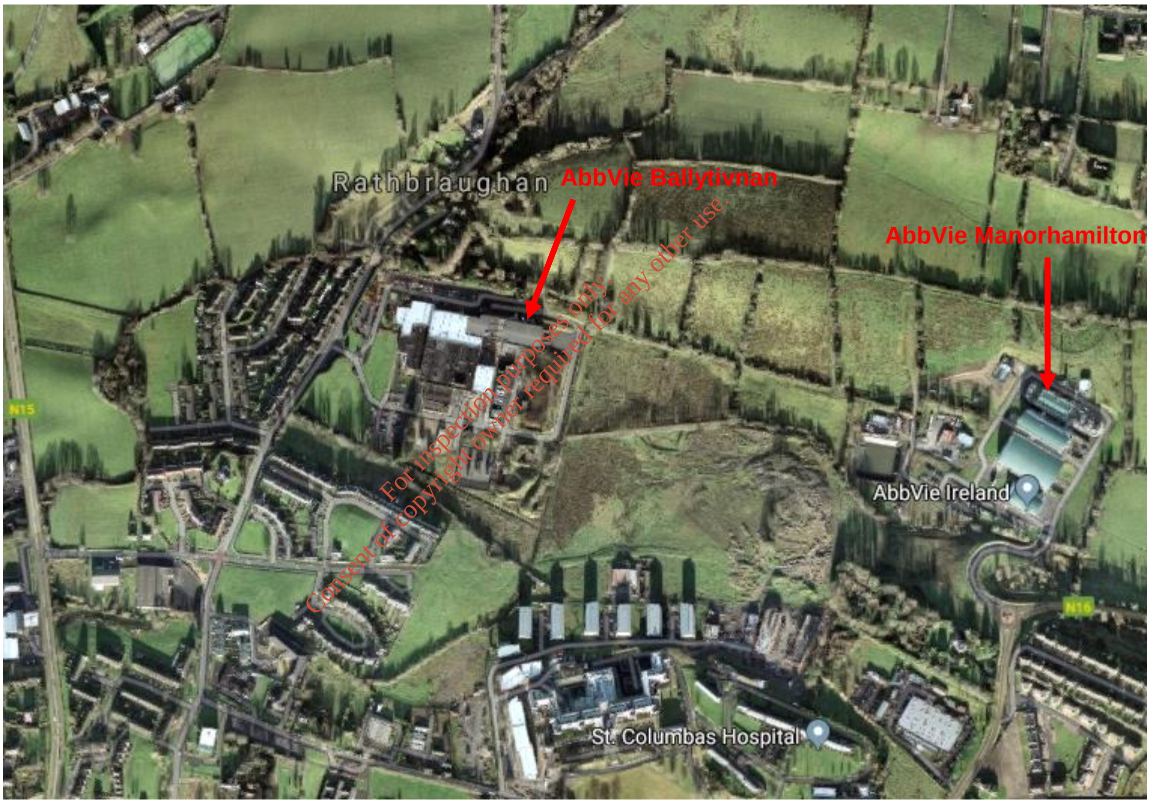
5.0 STAGE 4 – SITE HISTORY

This section includes an evaluation of the likelihood of the presence of any contamination on soil/ groundwater at the site and an overview of the site history.

The surrounding area is primarily residential with some commercial, light industrial and industrial lands. To the south of the site is a combination of residential, commercial, industrial buildings and recreational lands. A parcel of undeveloped land is located to the south and east of the site.

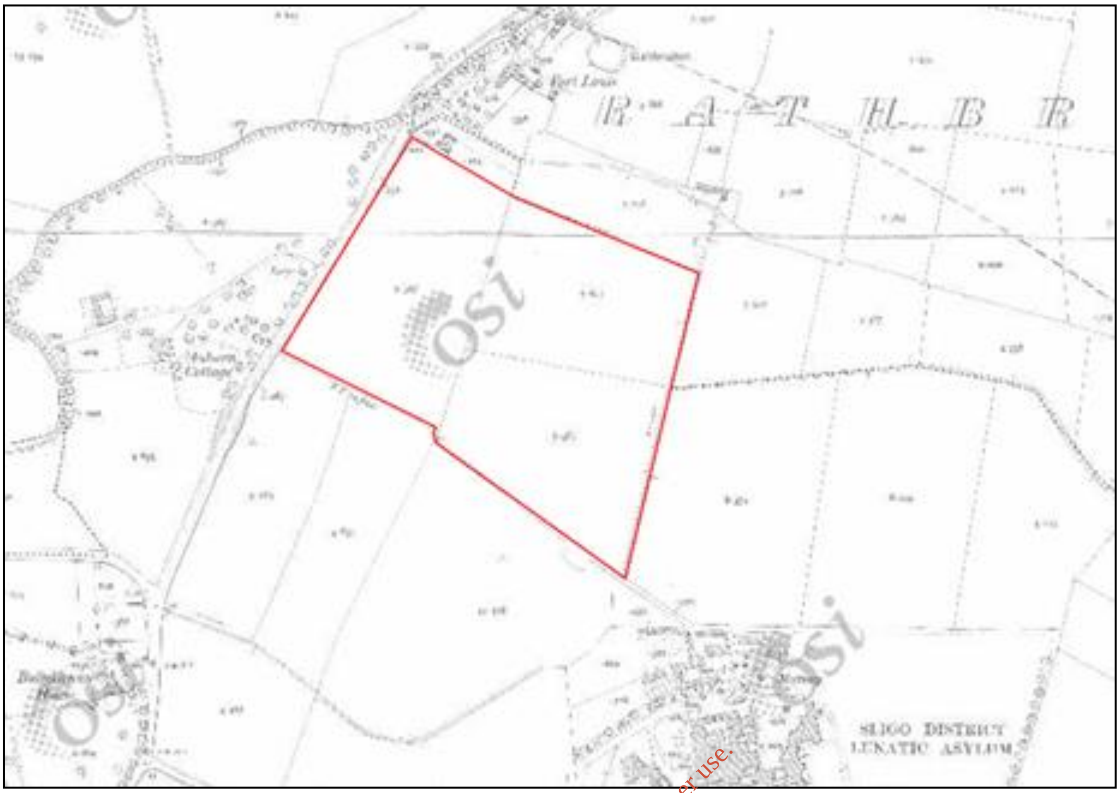
The AbbVie Manorhamilton site is located 1km east of the subject site. Whilst both facilities are owned by the same parent company, they operate as separate facilities with no shared utilities or resources.

See Insert 5.1 for the existing land use of the area.



Insert 5.1 *Existing Land Use (Source: Google, 2018)*

Prior to its development into industrial land use, the AbbVie Ballytivnan site and surrounding area were used for agricultural purposes. A historical map from 1888-1913 is shown in Insert 5.2. The next available map is from 1995 (with Google Maps historical maps going back as far as 2006 only); however, it is highly likely that the lands remained in agricultural use until they were developed into industrial use in the 1970s. As such, the likelihood for major soil and groundwater contamination from this land use is low.



Insert 5.2 *Historical Map 25 inch (1888-1913) – site location outlined (source www.osi.ie, 2018).*

The subject site was used for the manufacture of nutritional sets from c.1972 (previously under the ownership of Abbott Nutrition) until May 2018. As a device manufacturing facility there would have been no bulk chemical storage requirement apart from diesel fuel oil storage. Cyclohexanane, Isopropyl alcohol and Methylene chloride were also stored onsite; however, these were stored in drums within the external solvent store building (discontinued Q1 2018).

As with all industrial sites under prior ownership there is potential for uncovered historical contamination; however, as outlined in Section 8 of this report, the existing groundwater and soil quality (as monitored) is good and as such the potential for existing historical pollution from the previous ownership is low.

In January 2013, AbbVie established the bio-medical devices manufacturing facility. Since the change in ownership there have been no major spills or environmental breaches at the facility. Bulk storage of chemicals consisted of a diesel tank only which has now been removed, with the dis-used bund planned for demolition.

It is concluded that the likelihood of historical contamination prior to development as a medical device manufacturer is low. The likelihood of historical contamination at the site as a result of its use as a bio-medical devices facility is moderate as the site was previously under different ownership. The risk of significant historical contamination is therefore considered to be low - moderate based on the nature of the materials used on site in past operations and the good soil water quality measured on site as reported in Section 8 of this document.

6.0 STAGE 5 – ENVIRONMENTAL SETTING

This section includes an assessment of the environmental sensitivity (soils, bedrock, hydrogeology and hydrology) of the location in which this plant is located.

6.1 Topography

The AbbVie site is located at the Old Bundoran Road, Ballytivnan, Sligo, approximately 1.8km north of Sligo Town centre. The main site entrance is from the west from The Old Bundoran Road. Residential housing is to the west and south of the site with greenfield to the south-east and east. The grove student complex and Clayton hotel Sligo can be found c.450m to the south west. The topography of the site is mostly flat with an approximate elevation of 10.5mAOD. Regional topography slopes in a west-east direction, with topography gently decreasing towards the coast – Sligo Bay.

6.2 Hydrology

The proposed development site is located within the Western River Basin District (WRBD) in Hydrometric Area No. 35 of the Irish River Network. The First Cycle WRBD Management Plan (2009-2015) is to be superseded by Second Cycle River Basin Management Plan (2018-2021) and has recently completed public consultation in August 2017. The new River Basin Management Plan defines a single national river basin district. This has been broken down into 46 catchment management units, which are further sub-divided into 583 sub-catchments. These 583 sub-catchments contain a total of 4,832 water bodies ranging from 3 to 15 water bodies in each sub-catchment. The Western River Management Plan defines that the area of the proposed development is within the Sligo Bay & Drowse catchment and the Bonet sub-catchment.

The Willsborough Stream is located close to the north western boundary of the AbbVie site. The Lisnalurg Stream, a tributary of the Willsborough is 280m to the west. The largely culverted Shannon Eighter Stream is >50m to the south of the site.

The site is not located within a Special Area of Conservation (cSAC) or a Specially Protected Area (SPA). The nearest SAC and SPA is Cummeen Strand/Drumcliff Bay (Sligo Bay) located approximately 0.7 km away from the proposed development

There are no natural watercourses occurring within the proposed development site as shown in Insert 6.1 below. The nearest watercourse is the Willsborough Stream and Shannon Eighter. The Shannon Eighter flows along half of the eastern site boundary and then enters a culvert located at the south-eastern corner of the site which is located less than 50m away from the subject site.

Insert 6.1 *Hydrological Environment Map (source www.gsi.ie, 2018)*

Surface Water Quality

The proposed development is located within the Western River Basin District (WRBD), as defined under the European Communities Directive 2000/60/EC, establishing a framework for community action in the field of water policy, (commonly known as the Water Framework Directive [WFD]).

The WFD requires 'Good Water Status' for all European waters by 2015, to be achieved through a system of river basin management planning and extensive monitoring. 'Good status' means both 'Good Ecological Status' and 'Good Chemical Status'. In 2009, the Eastern River Basin District (ERBD) River Management Plan (RMP) 2009-2015 was published. In the WRBD RMP, the impacts of a range of pressures were assessed including diffuse and point pollution, water abstraction and morphological pressures (e.g. water regulation structures). The purpose of this exercise was to identify water bodies at risk of failing to meet the objectives of the WFD by 2015 and include a programme of measures to address and alleviate these pressures by 2015.

The strategies and objectives of the WFD in Ireland have influenced a range of national legislation and regulations. These include the following:

- Statutory Instrument (SI) No. 293 of 1988 European Communities (Quality of Salmonid Waters) Regulations 1988;
- Local Government (Water Pollution) Acts 1977-1990;
- SI No. 258 of 1988 Water Quality Standards for Phosphorus Regulations 1998; and
- SI No. 272 of 2009 European Communities Environmental Objectives (Surface Waters) Regulations 2009

In accordance with the WFD, each river catchment within the WRBD was assessed and a water management plan detailing the programme of measures was put in place.

Q-Values are used by the EPA to express biological water quality, based on changes in the macro invertebrate communities of riffle areas brought about by organic pollution. Table 6.1 below summarises an explanation of the ratings; for example, Q1 indicates a seriously polluted water body while Q5 indicates unpolluted water of high quality.

Table 6.1 *EPA Biological Q Ratings & Key*

Quality Ratings (Q)	**Status**	**Water Quality**	**Key**
Q5, Q4-5	High	Unpolluted	🔵
Q4	Good	Unpolluted	🟢
Q3-4	Moderate	Slightly Polluted	🟡
Q3, Q2-3	Poor	Moderately Polluted	🟠
Q2, Q1-2, Q1	Bad	Seriously Polluted	🔴

Available data for 2015 from the EPA on-line mapping database *EPA Maps* is presented in Table 6.2 below together with the most recent Q-Value for the watercourse at the locations closest to the site.

Table 6.2 *EPA sampling locations for the Willsborough Stream*

Entity Name	**Willsborough Stream**		
Station Name:	Bridge W of Willsborough	1.5 km W.S.W. of Willsborough	Bridge on Sligo-Bundoran Road
Station ID:	RS35W010150	RS35W010200	RS35W010300
WFD CODE:	IE_EA_35W010150	IE_EA_35W010200	IE_EA_35W010300
Type of water monitored:	River Water	River Water	River Water
River Basin District:	WRBD	WRBD	WRBD
Station Type (WFD):	Operational	Operational	Operational
Easting:	171207.22	169972	169258.31
Northing:	338306.55	337947	337375.33
Last Q Year:	2015	1990	2015
Last Q Value:	4	4	4
Q Legend:	Good	Good	Good
Q Linear Value:	4	4	4

Insert 6.2 presents the river catchment map and water quality status (including current EPA monitoring stations).

Insert 6.2 *River Catchment Map & Quality (EPA, 2018) (Site Location Red Cross).*

The values listed above are for monitoring stations located both upstream and downstream of the subject site. The downstream monitoring location (RS35W010300) has a Q Linear Value of 4 (*'Good Status')* this is similar to the upstream monitoring location (RS35W010150) which also has a Q Linear Value of 4 (*'Good Status')*. The linear value takes in account the current and previous Q-values to determine the expected Q-value for next year. The Willsborough Stream is classified as being 'Not At Risk of Achieving Good Status". The WFD status (2010-2015) is designated as Good.

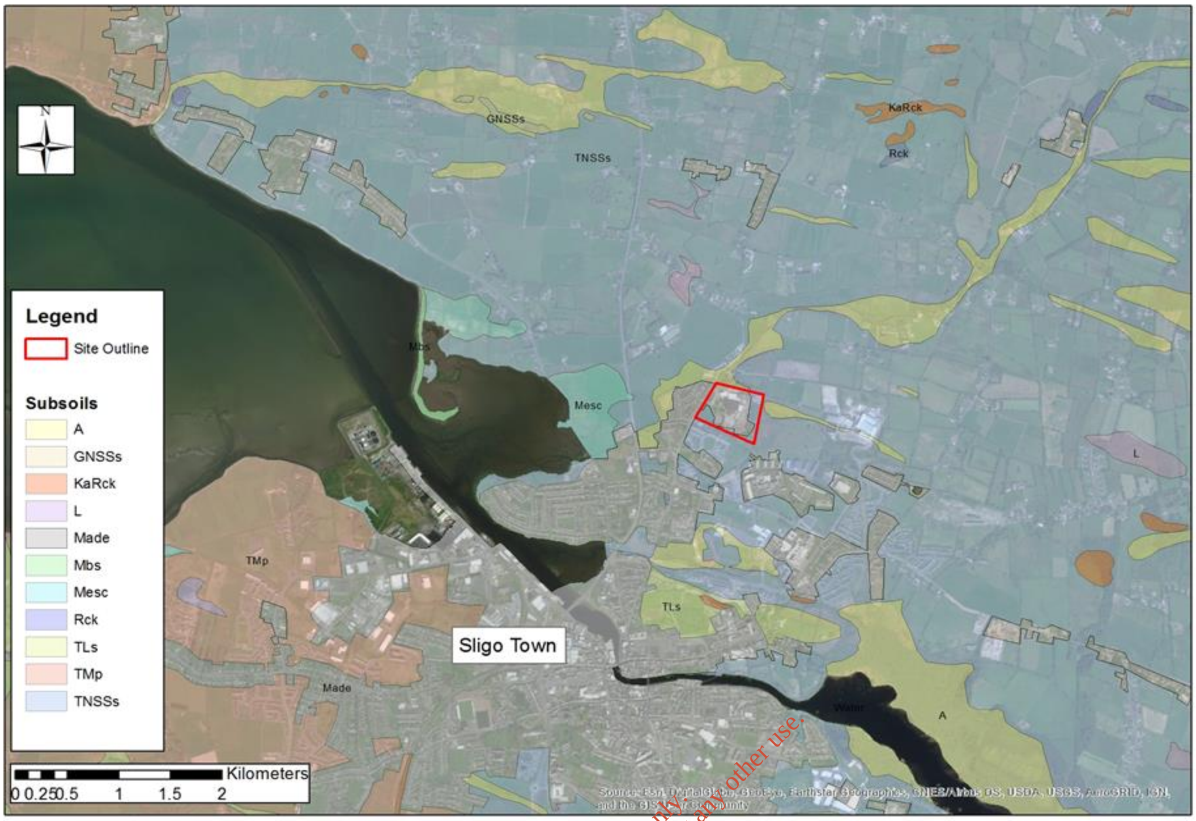
EPA's *Envision* Database was also consulted to determine if any designated salmonid waters (S.I. 293/1988-European Communities (Quality of Salmonid Waters) Regulations, 1988) existed close to the site or are located so that they may be adversely impacted by the proposed development or operation of the facility. The Willsborough Stream was previously not included in the register of salmonid waters included in those regulations.

6.3 Geology & Hydrogeology

The existing facility and its processes does not entail any direct discharges to ground. A summary of the underlying geology and hydrogeology is provided below together with current knowledge of the water quality based on on-site sampling of the monitoring wells on the subject site.

6.3.1 Soils & Subsoils

Reference to the Geological Survey of Ireland (GSI) (2018) on-line mapping indicates the predominant subsoil type in the general area at the AbbVie site is Made Ground and limestone tills. (Insert 6.3 below). The Teagasc subsoil map of Ireland illustrates the natural soil covering the site to be predominantly Tills derived chiefly from limestone rocks (TNSSs). The soils distribution across the study area is provided on the EPA/Teagasc Soils Map. The map identified podzolics, gleys and alluvium as the distinct soil types that exist in the general area.

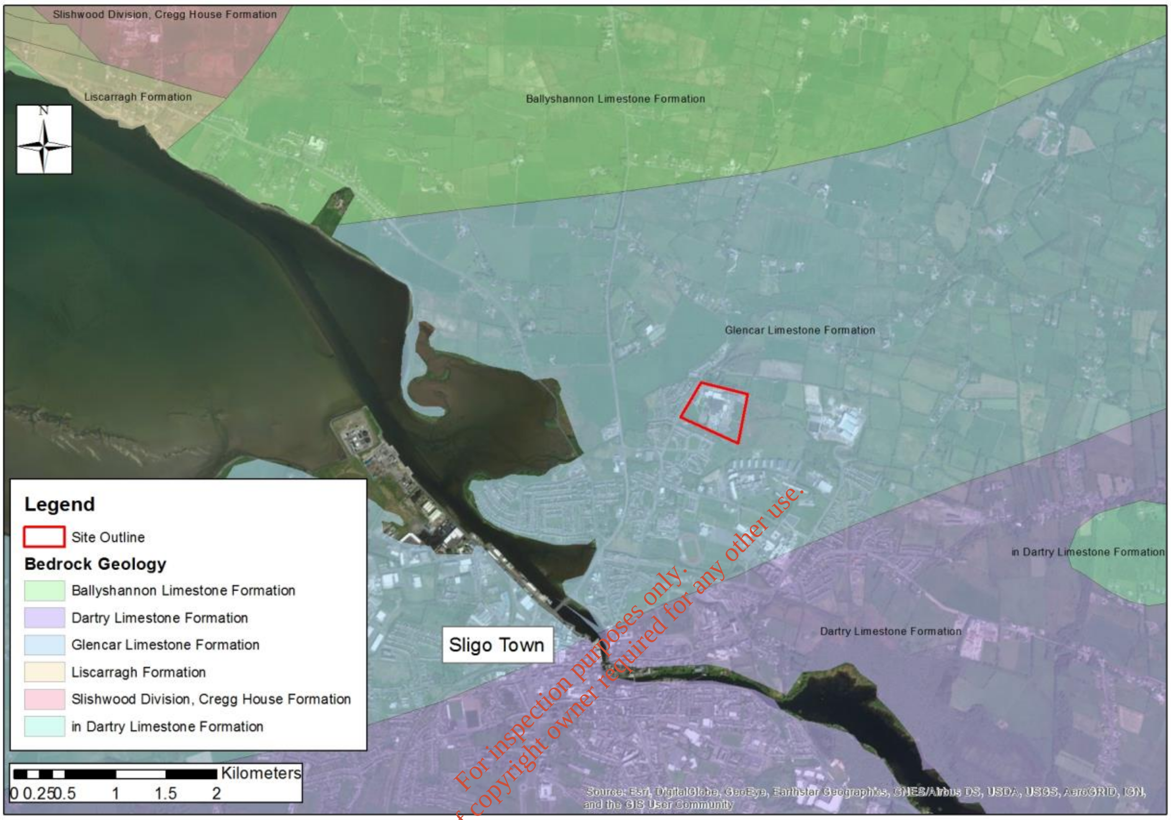


Insert 6.3 *Subsoils map for the proposed development site (GSI, 2018).*

6.3.2 Bedrock Geology

As shown in Insert 6.4 below, the site is underlain by Glencar Limestone. the GSI Bedrock Geology Map for Sligo and Leitrim (Sheet 7) indicates that the site is underlain by Carboniferous limestones (Holkerian Stage) of the Glencar Limestone formation. This geological formation comprises argillaceous calcisiltite, very fine calcarenite limestone, interbedded with dark calcareous shale and is locally abundant. The GSI online database maps indicate that the site is underlain by Dinantian Upper Impure Limestones (DUIL).

There are no geological faults indicated on the GSI bedrock geology maps beneath the proposed development. However, faults are located north of the site. Geological faults in the area would be expected to influence the local hydrogeological regime to some extent because they would facilitate groundwater flow. It should be noted, however, that the location of geological faults on bedrock maps by the GSI are indicative only.

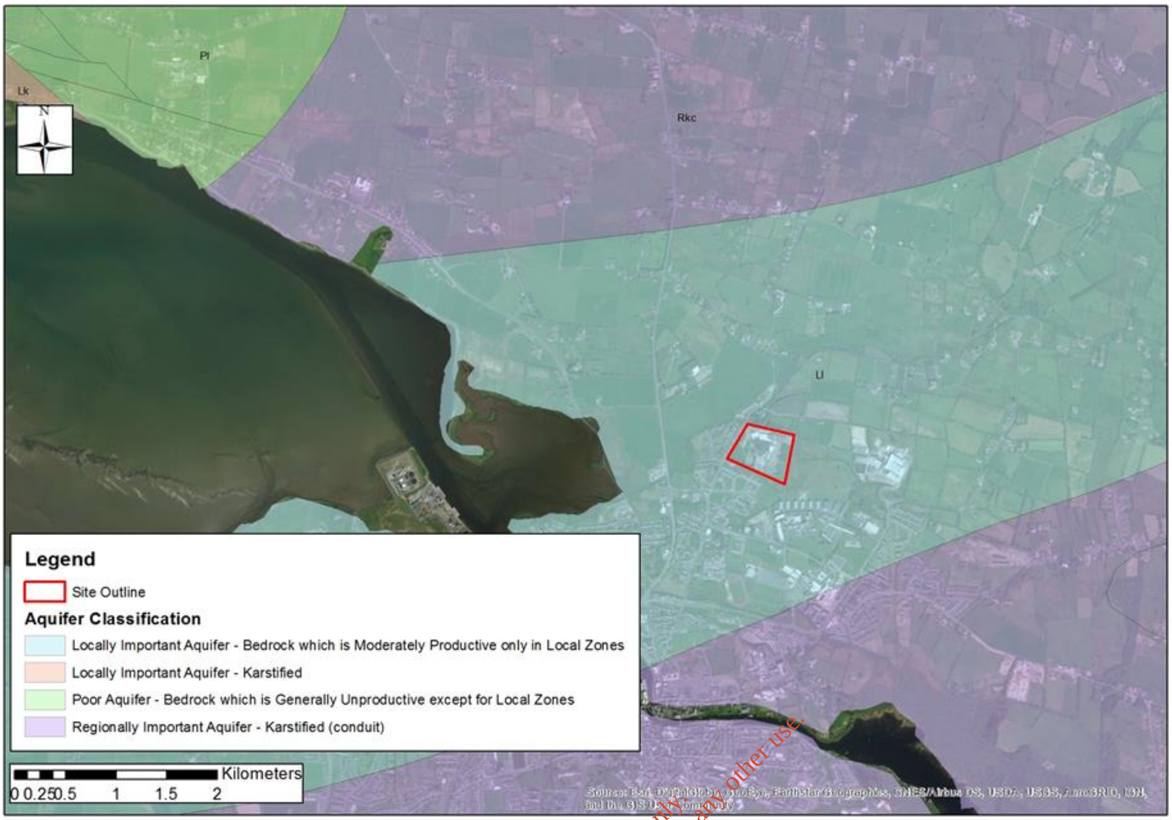


Insert 6.4 *Bedrock Geology map (GSI, 2018).*

6.3.3 *Aquifer classification and Groundwater Body Classification*

Aquifers are generally classified as rocks or other matrices that contain sufficient void spaces and which are permeable enough to allow water to flow through them in significant quantities.

The GSI (2018) currently classifies the bedrock aquifer underlying the site as a (Ll) Locally Important Aquifer - Bedrock which is Moderately Productive only in Local Zones. Insert 6.5 below presents the current bedrock aquifer map for the site and surrounding area. According to the GSI National Draft Gravel Aquifer Map for the region, the subject site is not underlain by a gravel aquifer.



Insert 6.5 *Aquifer Classification map (GSI, 2018).*

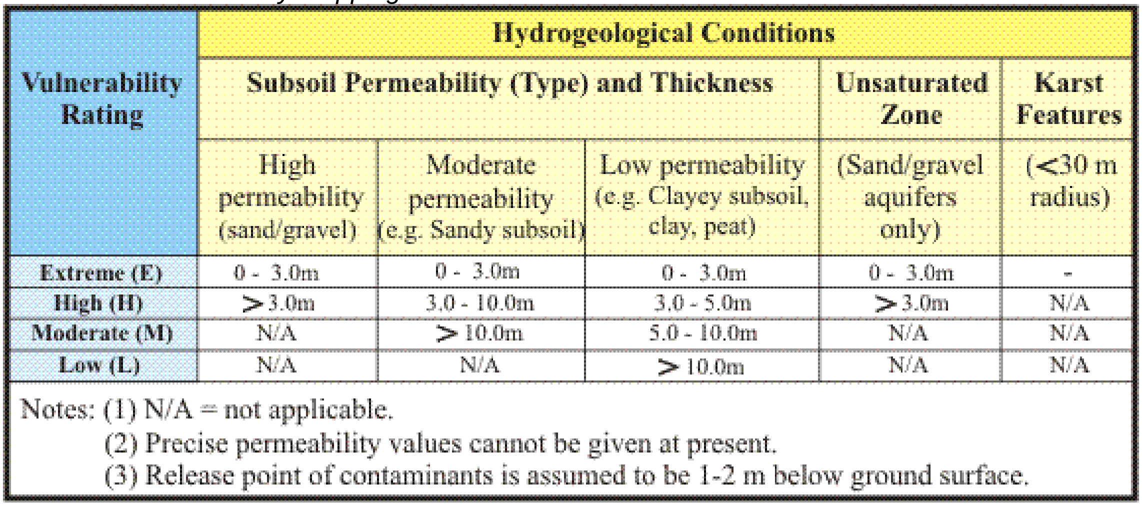
The GSI (2018) mapping online database shows no karst features on the subject site but the mapping shows karst features approximately 4.5km east of the site in Magheraghanrush, Co. Sligo. These karst features are caves.

The Groundwater Body (GWB) regionally underlying the site is the Drumcliff Strandhill GWB (EU Groundwater Body Code: IE_WE_0044). Currently, the EPA (2018) on-line mapping classifies the GWB as “under review” meaning it may or may not achieve good status.

6.3.4 *Aquifer Vulnerability*

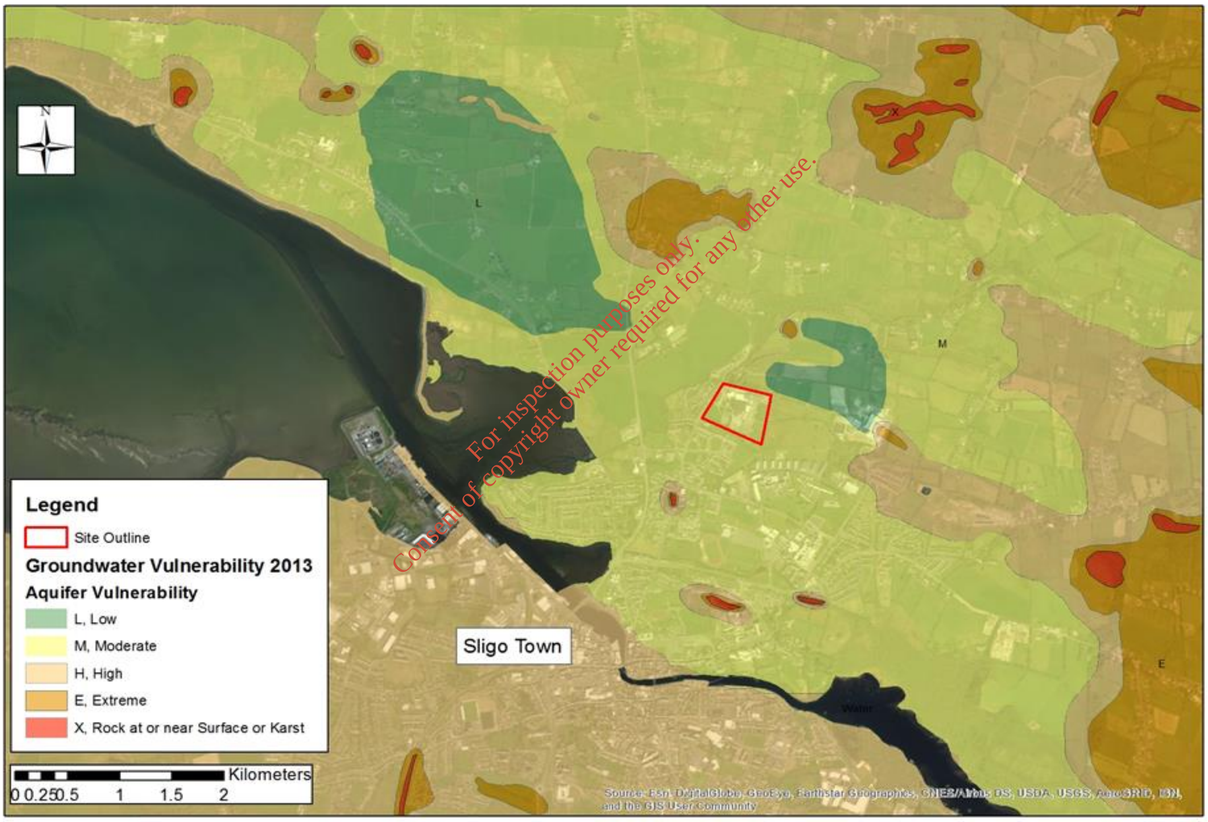
Reference to the GSI Interim Vulnerability Groundwater Map (see Insert 6.6) indicates that the vulnerability of the bedrock aquifer beneath the subject site has been classed as Moderate. This indicates the presence of subsoils 5.0 - 10m in thickness overlying the bedrock aquifer, as shown in Table 6.1 below.

Table 6.3 *Vulnerability Mapping Guidelines*



Vulnerability Rating	**Hydrogeological Conditions**				
	Subsoil Permeability (Type) and Thickness			**Unsaturated Zone**	**Karst Features**
	High permeability (sand/gravel)	Moderate permeability (e.g. Sandy subsoil)	Low permeability (e.g. Clayey subsoil, clay, peat)	(Sand/gravel aquifers only)	(<30 m radius)
Extreme (E)	0 - 3.0m	0 - 3.0m	0 - 3.0m	0 - 3.0m	-
High (H)	>3.0m	3.0 - 10.0m	3.0 - 5.0m	>3.0m	N/A
Moderate (M)	N/A	>10.0m	5.0 - 10.0m	N/A	N/A
Low (L)	N/A	N/A	>10.0m	N/A	N/A

Notes: (1) N/A = not applicable.
(2) Precise permeability values cannot be given at present.
(3) Release point of contaminants is assumed to be 1-2 m below ground surface.



Insert 6.6 *Aquifer Vulnerability map (GSI, 2018).*

The presence of concrete cover over the majority of the site combined with the natural moderate vulnerability present will impede the vertical migration of any contamination to the underlying aquifer should a leak occur.

<u>Groundwater Wells</u>

The GSI Well Card Index is a record of wells drilled in Ireland. It is noted that this record is not comprehensive as licensing of wells is not currently a legal requirement in the Republic of Ireland. Insert 6.7 below presents the recorded wells in the area of the site The GSI well search for the area surrounding the site does not identify any groundwater abstraction wells within 1.5 km of the subject site. It should be noted that the area is serviced by public water supply however agricultural wells may be present.

There are groundwater wells located on the subject site and the AbbVie site located 1.2km to the east. There are seven (7) boreholes on the subject site and three (3) monitoring wells on the other AbbVie site.

Source: Esri, DigitalGlobe, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community

Insert 6.7 *Wells map (GSI, 2018)*

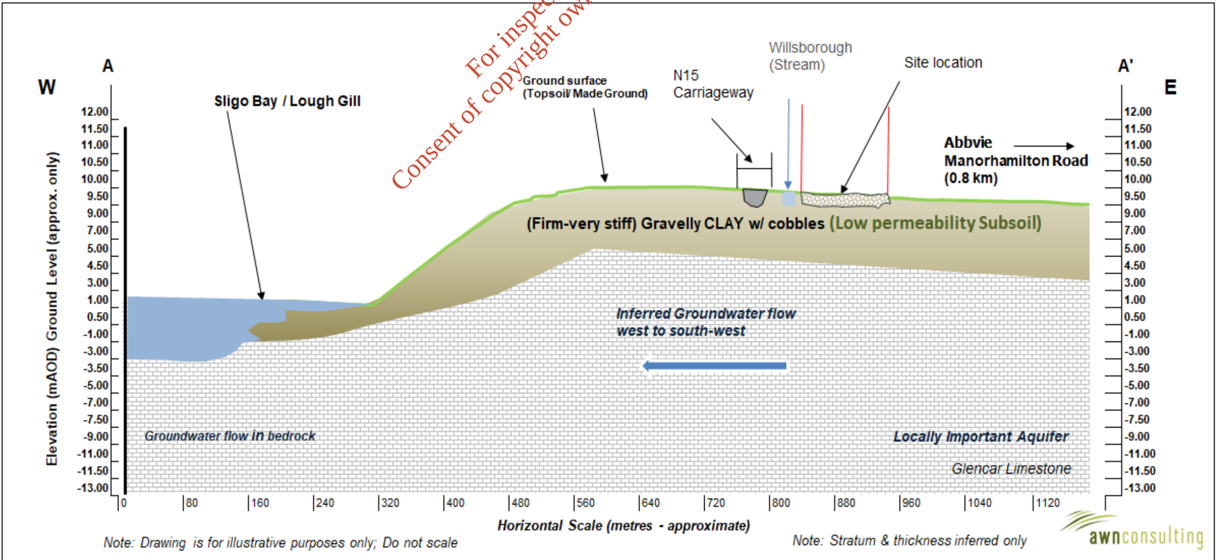
6.4 Areas of Conservation

The GSI and National Parks and Wildlife Service (NPWS) on-line databases presently list no ecological designated areas within or immediately adjacent to the proposed development site. The Lough Gill (site code: 0001976 SAC & site code: 004035 SPA) SAC (Special Area of Conservation) & SPA (Special Protection Area) is located approx. 1 km to the west and southwest of the proposed development site. This area is also a proposed Natural Heritage Areas (pNHA), with a site code 000627 - Cummeen Strand/Drumcliff Bay (Sligo Bay).

7.0 STAGE 6 – CONCEPTUAL SITE MODEL

To summarise the current conceptual site model (CSM), a regional cross section is presented below as Insert 7.1. The CSM for the site is as follows:

- The site for the proposed development is located on an existing industrial site, i.e. Made Ground. There has been a device manufacturing facility on this site since the late 1970's.
- The site is underlain by Made Ground underlain by Glacial limestone derived clays with a shallow depth to rock.
- The bedrock beneath the site is Limestone, this is a (LI) Locally Important Aquifer.
- Potential environmental receptors are the underlying Locally Important Aquifer and the nearby Willsborough and Shannon Eighter Streams. There are no known or expected groundwater supply wells as the area is serviced by mains. The underlying bedrock of interbedded limestone and shale by nature has a low fracture index with little connectivity and therefore there is no likely hydrogeological connectivity with Lough Gill SAC located 1 km from the proposed development site or Cummeen Strand/Drumcliff Bay (Sligo Bay) pNHA.
- The footprint of the proposed development area was previously industrial in nature (Medical Device Manufacture). A review of groundwater quality and soil quality confirms that there is no evidence of historic contamination and of relative good quality at the site. This is discussed further in Section 8.3 of this report. There is no likely impact on groundwater quality based on the activity on site. The EPA has given the aquifer a "good status" with a risk score of 'under review'.



Insert 7.1 *Schematic cross section of the subject site and the surrounding area.*

8.0 STAGE 7 – SOIL & WATER QUALITY ASSESSMENT

In July 2018, IGSL carried out site investigations at this AbbVie site which included the construction of four (4) new boreholes and three machine excavated trial pits in accessible locations. One soakaway test was carried out at TP01 while plate bearing test was also completed in this area.

A programme of laboratory testing was carried out to confirm geotechnical and environmental soil parameters within the existing soil conditions. The full IGSL site investigation report is presented in Appendix B of this report, along with the 2017 biannual groundwater monitoring reports.

8.1 Site Investigations

Boreholes

The four (4) exploratory holes were bored with conventional 200mm cable-tool methods using a Dando Exploratory Rig.

Boreholes commenced on Tarmac or Concrete surface with granular FILL (engineering FILL) below the surfacing to 0.70 mbgl (metres below ground level) in all four boreholes.

Soft to firm mottled grey brown gravelly CLAY was noted below the upper FILL at BH01, BH03 and BH04. This stratum shows an increasing strength / depth pattern.

In the above three locations a dense sandy GRAVEL stratum was encountered below the gravelly CLAY at depths between 3.00 and 3.50 metres. These boreholes were terminated at depths between 4.60 and 5.50 metres due to the obstruction of a cobble or boulder.

The stratification at BN02 is markedly different. Stiff brown gravelly CLAY is noted below the engineering FILL at 0.70 metres and the stratum continues to borehole completion at 5.00 metres.

Groundwater was noted only in BH03 in the gravel stratum at 4.70mbgl. No free water was observed in the other three boreholes.

Trial Pits

Trial pits were excavated at three specified locations north of the existing building under the supervision of an engineer.

Trial Pit 01 (TP01) penetrated surface topsoil to underlying firm brown silty CLAY with root fibres. Firm gravelly silty CLAY was then noted and continues to the final depth of 2 metres. No groundwater was noted in this trial pit.

At TP02, topsoil overlies a stratum of granular FILL with some plastic, wire and roots. Firm silty CLAY extends from 0.80 to 1.50 metres with stiff grey brown sandy gravelly CLAY noted from 1.50 to final depth of 2.10 metres. No groundwater was noted in this trial pit.

TP03 was located close to the existing building and MADE GROUND extends to 0.80 overlying firm organic silty CLAY from 0.80 to 1.50 metres. Firm gravelly CLAY with thin gravel band extends from 1.50 to the final depth of 2.10 metres. Groundwater ingress was noted at 2.05mbgl in a thin layer of gravel.

8.2 Baseline Soil Analysis

Soil sampling was taken as part of the site investigations carried out by IGSL in July 2018 on the subject site.

One soil sample was collected during the trial pitting which was analysed for Waste Acceptance Criteria (WAC) suite which includes metals, TPH CWG, PAHs, leachate analysis and other parameters. This suite indicates the suitability of a waste for disposal. The soil sample was taken from TP2 at 0.8mbgl. TP2 is located to the north of the existing building. The full site investigation report with the full laboratory report are presented in Appendix B of this report.

In summary, the laboratory results indicate very low or negligible concentrations of the various WAC parameters. All the recorded concentrations were below the Inert threshold values, therefore, the soil is considered 'Inert' for disposal purposes and can be disposed of to a licensed waste (landfill) facility. No traces of asbestos were identified in the soil sample or during the site investigations.

8.3 Baseline Groundwater Analysis

Biannual groundwater sampling has been carried out on the AbbVie site for the past 5 years by TMS Environmental Limited. There are three (3) monitoring wells on the subject site.

AbbVie decided to carry out more frequent biannual groundwater sampling since 2013 to build up better information on trends in groundwater quality as this can vary with time. This will be especially important with regard to the low-level hydrocarbon contamination which was detected previously in MW1 pre-2013.

The groundwater parameters analysed are outlined below:

- pH;
- Dissolved Oxygen;
- Conductivity;
- Temperature;
- Major Cations (Ca, Mg, Na, K);
- Major Anions (Cl, NO3, SO4);
- Total Alkalinity;
- Total Ammonia;
- Nitrite;
- Iron & Manganese;
- Fluoride;
- Orthophosphate;
- Total Phosphorus;
- Chemical Oxygen Demand (COD);
- 14 No. Trace Metals (Ag, Al, As, Cd, Co, Cr, Cu, Hg, Ni, Pb, Sb, Se, Sn, Zn);
- Total Petroleum Hydrocarbons (TPH);
- Volatile Organic Compounds (VOCs);
- Semi-Volatile Organic Compounds (SVOCs);
- Polycyclic Aromatic Hydrocarbons (PAHs);
- Diesel Range Organics (DRO)
- Petrol Range Organics (PRO)
- Total Coliforms;
- Faecal Coliforms;
- E. coli; and,
- Cyclohexanone.

The full TMS Environmental biannual groundwater monitoring report for 2017 is presented in Appendix B.

The results are compared with Drinking Water Parametric Values (PVs) provided in the European Union (Drinking Water) Regulations 2014 (S.I. No. 122 of 2014), and Groundwater Threshold Values (GTVs) from the European Union Environmental Objectives (Groundwater) (Amendment) Regulations 2016 (S.I. No. 366 of 2016). GTVs are trigger values (‘threshold’ values) which warn of potential breaches of water quality standards, but not water quality standards themselves.

Overall, the groundwater quality is good with no major noticeable contamination across the AbbVie site apart from minor exceedances of some inorganics (see Table 8.1 below). No Volatile Organic Compounds (VOCs), Semi Volatile Organic Compounds (SVOCS), Polycyclic Aromatic Hydrocarbons (PAHs) and most inorganic parameters were not detected above statutory or guidleine levels during groundwater monitoring.

Table 8.1 *Groundwater quality exceedances for December 2017*

Parameter	**GTV / PV**	**Exceedances**
Conductivity	800µS/cm / 2500 µS/cm	MW1, MW2
Chloride	24mg/l / 250mg/l	MW1, MW2
Arsenic	7.5µg/l / 10µg/l	MW2
Aluminium	0.15mg/l	MW1, MW2, MW3
Nickel	20µg/l	MW3
Iron	0.2mg/l	MW1, MW2, MW3
Manganese	0.05mg/l	MW1, MW2, MW3

Chloride was detected above the Groundwater Threshold Value (GTV) of 24mg/l at MW1 (63.5mg/l) and MW2 (25.8mg/l). This 24mg/l threshold is used to assess whether the groundwater is affected by saline or other intrusions. However, both concentrations are below the threshold value of 187.5mg/l which is used as an assessment for drinking water and areas that are impacted by pollutants. Background concentrations of chloride in groundwater are variable across Ireland ranging from approximately 15mg/l in the midlands to approximately 30mg/l in coastal areas. Concentrations above this are usually associated with anthropogenic sources of contamination. Elevated chloride itself is not harmful to human health (e.g. drinking water PV of 250mg/l).

Elevated aluminum, nickel, iron, arsenic and manganese was detected in groundwater samples at concentrations above the GTVs. However, the groundwater samples for trace metals were not filtered or preserved in the field, rather they were filtered in the laboratory and the filtered water digested whole giving a ‘Total’ metal result, which in practice approximates the dissolved concentrations.

Conductivity has historically been slightly higher in the down-gradient wells (MW1 and MW2) than the upgradient well (MW3). As conductivity reflects the dissolved content in the groundwater, the recorded exceedances suggest the groundwater down-gradient of the site is higher in chloride, sulphate, calcium, magnesium and / or sodium. There were also exceedances in chloride recorded within the down-gradient wells. This may be representative of minor leaks from the site's foul sewer. Integrity testing of the sewer was last undertaken in April 2017.

9.0 CONCLUSIONS

On the basis of the current soil and groundwater assessment undertaken at the AbbVie Ireland, NL B.V. pharmaceutical site and an assessment of source pathways and receptors based on a comprehensive conceptual site model (CSM), the following conclusions have been made:

- There are no significant volumes of hazardous chemicals stored on site which have the potential to cause significant pollution to soil or groundwater within the area proposed for IE Licence activities. The only potential bulk source identified is an oil storage tank and the wastewater storage tanks which will be either bunded or double skinned. Other chemicals are stored in sealed bottles or drums which are stored within the Warehouse and / or the self-bunded external chemstore.

- The aquifer vulnerability at the site is categorised as Moderate as the site is underlain by natural gravelly and sandy firm Clays ranging in thickness from 5 m to 10 mbgl.

- Potential environmental receptors are the underlying Locally Important Aquifer and the nearby Willsborough Stream. There are no known or expected groundwater supply wells as the area is serviced by mains. The underlying bedrock of interbedded limestone and shale by nature has a low fracture index with little connectivity and therefore there is no likely hydrogeological connectivity with Lough Gill SAC located 1 km from the proposed development site or Cummeen Strand/Drumcliff Bay (Sligo Bay) pNHA.

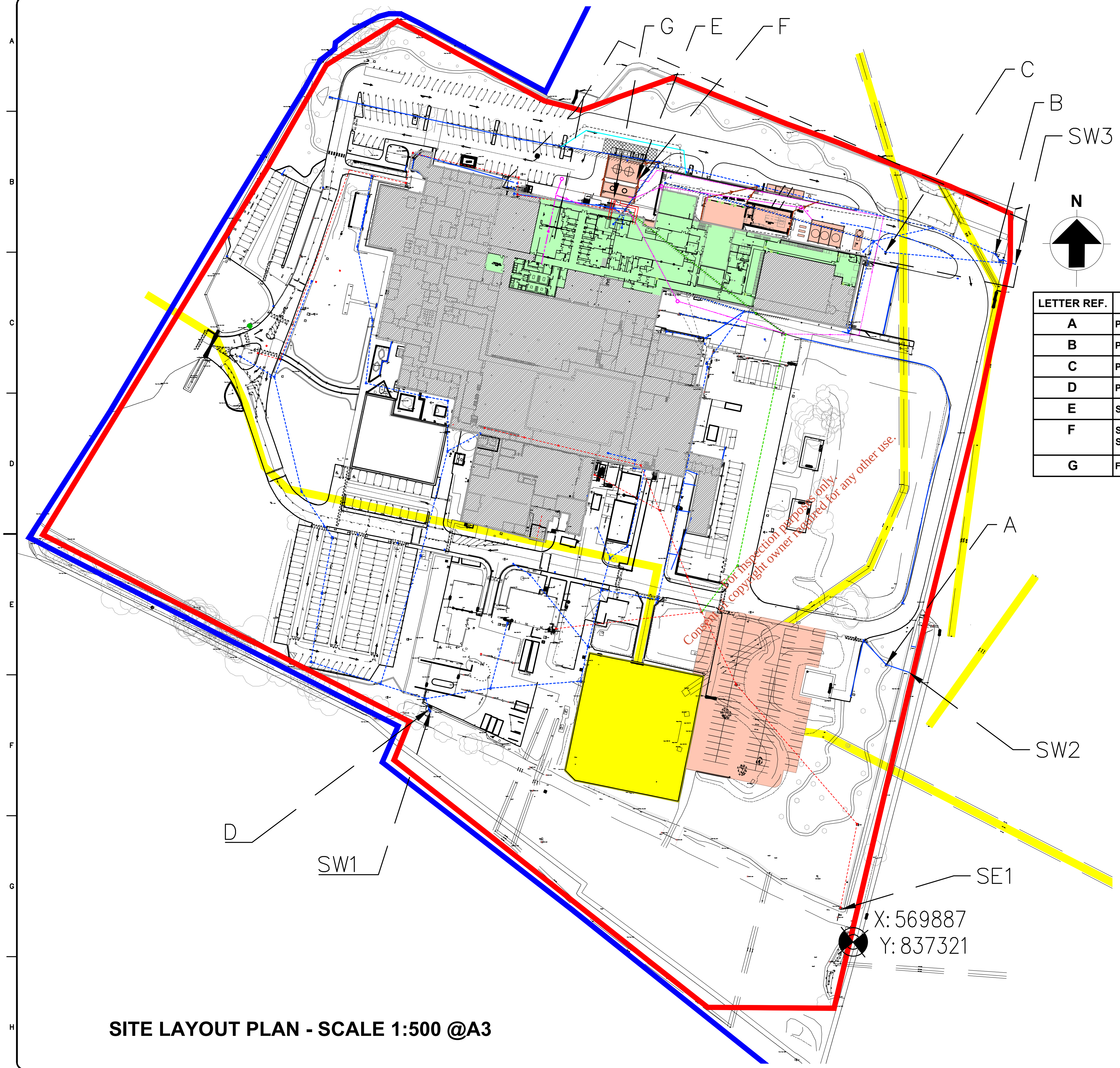
- The risk to these receptors is considered to be low based on the containment and protective measures on site, together with the presence of the thick natural clay cover. The onsite protection systems include: above ground storage, bunding, hard stand, filling procedures, oil interceptors, and solvent and hydrocarbon storage units which are self-bunded.

- A review of soil quality and groundwater quality data collected indicate that there is no evidence of historic or current contamination at the site.

- A review of groundwater quality data collected on site found that the groundwater beneath the site is of generally good quality.

APPENDIX 4.8.3 - A

SITE DRAINAGE DRAWING



SITE LAYOUT PLAN - SCALE 1:500 @A3

LETTER REF.	DESCRIPTION
A	PETROL INTERCEPTOR
B	PETROL INTERCEPTOR
C	PETROL INTERCEPTOR
D	PETROL INTERCEPTOR
E	SE1a - IED LICENCE FLOW MONITORING STATION
F	SE1b - IED LICENCE EFFLUENT MONITORING STATION (pH & TEMP)
G	FIRE WATER RETENTION BUND

NORTH INDICATOR

KEYPLAN LOCATION

Notes:

🟥	EXTENT OF LANDS SUBJECT TO PLANNING APPLICATION
🟦	EXTENT OF LANDS IN APPLICANT'S OWNERSHIP
🟨	WAYLEAVE
▬	NEW STORMWATER DRAINAGE PIPE (SW)
┅	EXISTING STORMWATER DRAINAGE PIPE (SW)
┅	EXISTING COMBINED FOUL & TRADE EFFLUENT (FW)
┅	EXISTING FOUL DRAINAGE PIPE (FW)
┅	NEW TRADE EFFLUENT PIPE (FW)
🟩	PROPOSED INTEGRATED BIO-CHEMICAL MANUFACTURING FACILITY
🟧	PROPOSED NEW YARD LAYOUT/ ELECTRICAL EXTENSION / ENCLOSURE TO WALLED YARD AND TEMPORARY CONTRACTORS CAR PARK.
▨	EXISTING FACILITY
⊕	GRID COORDINATE

STATUS

REV	Subject of revision	DRW	CHK	APPROVED	DATE
A	Issued for I.E.D Licence Application				31 Aug 18

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PROJECT
AbbVie
Trinity BT
Ballytivnan, Sligo
Ballytivnan, Sligo

LOGO
abbvie

DRAWING TITLE
I.E.D Licence Application
Site Drainage Plan

CADFILE REF	DWG SCALE	PLOT SCALE	STARTED BY	START DATE
99B04P0008.DWG	1:500	1:1		

PROJECT NO	DRAWING NO	REVISION
76635800	99/B.04P/0008	A

[Metric A3: 420x297] DO NOT SCALE, THIS DRAWING WAS GENERATED USING CAD AND MUST NOT BE ALTERED MANUALLY

APPENDIX 4.8.3 - B

IGSL SITE INVESTIGATION REPORT & GROUNDWATER QUALITY DATA (TMS ENVIRONMENTAL)

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ISO 17025
INAB ACCREDITED
TESTING
DETAILED IN SCOPE REG NO 150T

GROUNDWATER MONITORING REPORT

ABBVIE IRELAND NL B.V.
BALLYTIVNAN
CO. SLIGO

2nd Biannual Monitoring Round, December 2017

Report Ref. 24808
TMS Environment Ltd
Issued: 05 February 2018

Prepared by: Nick Owen
Senior Environmental Scientist

Approved by: Craig O'Connor

Craig O'Connor
Senior Consultant

Date: 05 February 2018

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2. This report relates only to the items tested
3. Complaints should be addressed in writing to the Quality Manager

Table of Contents

1.0 Introduction & Scope

This report presents the results of the analysis of groundwater samples collected from Abbvie Ballytivnan for the second biannual monitoring event carried out in December 2017.

AbbVie have decided to carry out more frequent biannual groundwater sampling to build up better information on trends in groundwater quality as this can vary with time. This will be especially important with regard to the low level hydrocarbon contamination which was detected previously in MW1 or if a potable groundwater supply was being considered for the site.

At the request of AbbVie, TMS Environment Ltd has also briefly reviewed the results of previous groundwater analyses from the site and considered these latest results in the context of the historic analyses. The scope of the sampling and report is outlined in our fee proposal to AbbVie reference QF-5426, dated June 2017, and is in line with the requirements of the AbbVie Ballytivnan Procedure AVBAL.ES.042. It should be noted that interpretations and opinions stated in this report are not accredited.

The requested groundwater parameters are outlined below:

- pH;
- Dissolved Oxygen;
- Conductivity;
- Temperature;
- Major Cations (Ca, Mg, Na, K);
- Major Anions (Cl, NO_3, SO_4);
- Total Alkalinity;
- Total Ammonia;
- Nitrite;
- Iron & Manganese;
- Fluoride;
- Orthophosphate;
- Total Phosphorus;
- Chemical Oxygen Demand (COD);
- 14 No. Trace Metals (Ag, Al, As, Cd, Co, Cr, Cu, Hg, Ni, Pb, Sb, Se, Sn, Zn);
- Total Petroleum Hydrocarbons (TPH);
- Volatile Organic Compounds (VOCs);
- Semi-Volatile Organic Compounds (SVOCs);
- Polycyclic Aromatic Hydrocarbons (PAHs);
- Diesel Range Organics (DRO)

- Petrol Range Organics (PRO)
- Total Coliforms;
- Faecal Coliforms;
- *E. coli*;
- Cyclohexanone.

2.0 Methodology

2.1 Sample Collection

TMS Environment Ltd personnel (Nick Owen) collected the samples on 12th December 2017 from the 3 No. monitoring wells on site (MW1-MW3); a well location map is provided in Appendix I. Wells were checked to ensure the sampling points had no damage before sampling, and photographic evidence was obtained. A site H&S risk assessment was completed prior to commencement of any sampling to confirm that the sampling could be carried out in a safe manner. All necessary PPE was worn at all times on site. Table 1 presents a summary of the field measurement of monitoring wells prior to sampling.

Table 1: Field Measurements of Monitoring Wells

		MW1	MW2	MW3
Static Water Level	mbtoc	2.20	1.07	4.45
Total Depth	mbtoc	5.72	10.44	6.25
Top of Casing	magl	0.61	0.52	0.58

Notes: mbtoc - meters below top of casing
magl - meters above ground level

To ensure the collection of a representative sample of groundwater the wells were purged to remove any stagnant water that may be present. There are no set standards on the quantity of water to be removed from a well prior to collection of a groundwater sample. A common practice is to remove at least three times the standing water volume. A preferred practice is to purge until a number of field parameters have stabilised.

The monitoring wells on site were purged by removing at least three times the standing water volume in the wells, with continued purging until field parameters had stabilised. All of the wells were purged and sampled with a dedicated disposable PVC bailer. Field measurements were made and a visual description of the samples was recorded at the time of collection following purging (Table 2).

Table 2: Field Measurements

Well	**Temp** (°C)	**Conductivity** (µS/cm)	**pH**	**Dissolved Oxygen** (mg/l O_2)	**Dissolved Oxygen** (% sat.)	**Sample Description**
MW1	9.8	927	6.71	4.40	39.8	Slight Yellow tint, few suspended particles, no odour or sheen.
MW2	9.9	912	7.22	4.53	40.4	Slight Yellow tint, few suspended particles, no odour or sheen
MW3	10.2	568	7.45	3.48	30.6	Clear, many suspended particles, no odour or sheen

To ensure the collection of a representative sample of groundwater the monitoring wells were purged following the procedure described in QP-SITE-6002 which adheres to ISO 5667-11: 2009, ‘Water Quality – Sampling – Part 11: Guidance on sampling of groundwaters’, International Organization for Standardization (ISO)). Wells were purged and sampled using dedicated disposable PVC bailers. There were no deviations from the standard procedure.

2.2 Sample Preservation & Analysis

Groundwater samples for inorganic and metal analysis were collected in 2 x 1 litre high-density polyethelene bottles and one 500ml plastic bottle preserved with H_2SO_4; samples for organic analysis were collected in pre-conditioned amber glass bottles and glass vials. Samples for microbiological analysis were collected in 250ml plastic sterile bottles with 3% sodium thiosulfate. Groundwater samples for trace metal analysis were not filtered or preserved in the field, but were filtered in the lab (see Section 4.0).

Samples were stored in cooler boxes with ice packs and transported to the laboratory on the day of collection. A full chain of custody was maintained for all samples. The TMS Laboratory is accredited to ISO 17025. The laboratory registration number is 150T and the current scope of accreditation can be viewed on the Irish National Accreditation Board website www.inab.ie. Analysis details are listed in Table 3 below. Subcontracted analyses were conducted by ALS Environmental UK and CLS.

Table 3: Groundwater Analysis Details

Parameter	Analysis
pH	In the field
Conductivity	In the field
Dissolved Oxygen	In the field
Temperature	In the field
Major Cations (Ca, Mg, Na, K)	ALS Environmental
Major Anions (Cl, NO3, SO4)	TMS Laboratory / ALS Environmental
Alkalinity	TMS Laboratory
Total Ammonia	TMS Laboratory
Nitrite	TMS Laboratory
Iron & Manganese	ALS Environmental
Fluoride	TMS Laboratory
Orthophosphate	TMS Laboratory
Total Phosphorus	ALS Environmental
Chemical Oxygen Demand (COD)	TMS Laboratory
14 No. Trace Metals (Ag, Al, As, Cd, Co, Cr, Cu, Hg, Ni, Pb, Sb, Se, Sn, Zn)	ALS Environmental
Total Petroleum Hydrocarbons (TPH)	TMS Laboratory
Volatile Organic Compounds (VOCs)	TMS Laboratory
Semi-Volatile Organic Compounds (SVOCs)	TMS Laboratory
Polycyclic Aromatic Hydrocarbons (PAHs)	TMS Laboratory
Diesel Range Organics (DRO)	TMS Laboratory
Petrol Range Organics (PRO)	TMS Laboratory
Total Coliforms	ALS Environmental
Faecal Coliforms	ALS Environmental
E. coli	ALS Environmental
Cyclohexanone	CLS

3.0 Results

The laboratory results are presented in Appendix II.

The results are compared with Drinking Water Parametric Values (PVs) provided in the European Union (Drinking Water) Regulations 2014 (S.I. No. 122 of 2014), and Groundwater Threshold Values (GTVs) from the European Union Environmental Objectives (Groundwater) (Amendment) Regulations 2016 (S.I. No. 366 of 2016). GTVs are trigger values (‘threshold’ values) which warn of potential breaches of water quality standards, but not water quality standards themselves. Annual-average results are usually compared with GTVs; comparing individual results to GTVs is a more conservative approach.

Table 4: GTV and PV Exceedances

Parameter	GTV / PV	Exceedances
Conductivity	800µS/cm / 2500 µS/cm	MW1, MW2
Chloride	24mg/l / 250mg/l	MW1, MW2
Arsenic	7.5µg/l / 10µg/l	MW2
Aluminium	0.15mg/l	MW1, MW2, MW3
Nickel	20µg/l	MW3
Iron	0.2mg/l	MW1, MW2, MW3
Manganese	0.05mg/l	MW1, MW2, MW3

Chloride is elevated above the GTV of 24mg/l at MW1 (63.5mg/l) and MW2 (25.8mg/l). Background concentrations of chloride in groundwater are variable across Ireland ranging from approximately 15mg/l in the midlands to approximately 30mg/l in coastal areas. Concentrations above this are usually associated with anthropogenic sources of contamination. The source of the elevated Chloride at MW1 is unknown but may be related to a discharge to ground on site as this monitoring well is most likely down-gradient of the facility (see Section 4.0). Elevated chloride itself is not harmful to human health (e.g. drinking water PV of 250mg/l) but its significance is that it indicates other contaminants associated with a discharge may be present in groundwater.

Elevated aluminium was detected in groundwater samples at concentrations above the GTV of 0.15mg/l at MW1 (0.6mg/l) MW2 (0.4 mg/l) and MW3 (0.6 mg/l). Arsenic was also detected at 42µg/l in MW2, above the GTV of 7.5µg/l, with elevated nickel also detected in MW3 (0.038 mg/l), above the PV of 0.02mg/l. The groundwater samples for trace metals were not filtered or preserved in the field, rather they were filtered in the laboratory and the filtered water digested whole giving a 'Total' metal result, which in practice approximates the dissolved concentrations. The trace metal concentrations detected in this round, including past rounds, are most likely artefacts of the sampling method (bailer); bailing is a simple groundwater sampling method which can mobilize considerable fines into suspension which can interact with the sample between storage and analysis. In addition, any fine particles less than the filter pore size (0.45µm) may contribute to the detected concentration (see Section 7.0).

As before, elevated concentrations of iron and manganese were detected in groundwater up-gradient and down-gradient of the site. Elevated iron and manganese in solution is often found in groundwater where the dissolved oxygen has been reduced due to natural processes or pollution. Reduced dissolved oxygen concentrations were measured on site in the past following purging which would explain the elevated manganese in solution. Reduced dissolved oxygen in groundwater at the site is probably related to poor background groundwater quality as it has been detected both up-gradient and down-gradient of the site.

The remaining parameters are all below their respective GTVs and PVs.

4.0 Evaluation of Results

For this section, it is important to note that opinions and interpretations given are not accredited.

4.1 Groundwater Flow Direction

The *regional* topography of the area is quite flat with a slight westerly gradient towards the coast, 800m west of the site. However, site ground levels show a southeasterly topographic gradient across the site – this is most probably due to the site being raised prior to construction to improve drainage. Geological Survey of Ireland subsoil mapping in the area indicates that the site is underlain by Made Ground. The ground to the southeast of the site is low-lying; vegetation would suggest it is either poorly drained or is a discharge zone for groundwater.

There is a small unnamed river close to the eastern site boundary and a more recent drainage ditch has been excavated along the southern boundary of the site. MW2 is close (<35m) to the eastern unnamed river.

Borehole logs are unavailable for the three monitoring wells on site, however it is assumed that the wells monitor groundwater in the limestone bedrock based on the total depths of the wells and likely thin cover of overburden.

Interpreting the groundwater flow direction for the site is not straight forward. The low lying area to the southeast of the site is either a natural groundwater discharge zone (i.e. where the water table is shallow) or is poorly drained (i.e. underlain by low permeability deposits).

Given the shallow water table observed at MW2 (1.07m below ground) and the elevation of the base of the adjacent ditch, it is likely that groundwater in the vicinity of MW2 is flowing east/southeast into the drainage ditch as baseflow. The difference in elevation between the water table at MW1 and the base of the southern ditch would also suggest that there is at least local groundwater discharge in the south of the site into this ditch. However in the northwest of the site, it is likely that groundwater in the vicinity of MW3 is flowing west towards the unnamed river, given its close proximity.

In summary, the water table in the limestone beneath the site is shallow and the groundwater flow direction is not uniform across the site. It is likely that a groundwater divide exists across the site, where groundwater in the west of the site flows to the west/southwest and groundwater in the east flows to the southeast, with some local groundwater drainage along the southern site boundary into the drainage ditch. It is therefore likely that MW3 is located up-gradient of the facility, and MW1 and MW2 are down-gradient of the facility.

4.2 Brief Review of Historical Analyses

Groundwater was sampled at the site on 15 previous occasions by TMS Environment Ltd:

- TMS Report No. 9429 (Sampled 6th December 2005);
- TMS Report No. 9816 (Sampled 8th March 2006);
- TMS Report No. 10348 (Sampled 29th June 2006);
- TMS Report No. 11090 (Sampled 7th December 2006);
- TMS Report No. 16005 (Sampled 24th November 2009);
- TMS Report No. 17052 (Sampled 14th September 2010);
- TMS Report No. 20064 Rev 1.0 (Sampled 16th May 2013);
- TMS Report No. 20771 (Sampled 9th December 2013);
- TMS Report No. 21573 (Sampled 11th September 2014);
- TMS Report No. 21786 (Sampled 27th November 2014);
- TMS Report No. 22756 (Sampled 19th November 2015);
- TMS Report No. 22817 (Sampled 17th December 2015);
- TMS Report No. 23305 (Sampled 15th June 2016);
- TMS Report No. 23826 (Sampled 12th December 2016);
- TMS Report No. 24354 (Sampled 12th July 2017);

In November 2009 elevated chloride, total ammonia, orthophosphate and manganese were detected in groundwater from MW1, with elevated orthophosphate detected at MW3. In September 2010 chloride, total ammonia, orthophosphate were lower at MW1, however manganese was similarly elevated. Orthophosphate was not detected above the laboratory detection limit at MW3 in September 2010. These parameters were not analysed in the earlier sampling rounds therefore it is not possible to compare these concentrations with earlier results. In May 2013 elevated chloride, manganese and DRO were detected in groundwater from MW1, with elevated chloride, iron and manganese detected at MW3. Faecal coliform bacteria were detected in all 3 No. monitoring wells. In December 2013 elevated chloride and total ammonia were detected in groundwater from MW1, with elevated iron detected in MW2 and MW3, and elevated manganese detected in all 3 No. monitoring wells. In September 2014 elevated chloride was detected in groundwater from MW1, with traces of DRO detected in MW2; iron, manganese and faecal coliform bacteria were detected in all 3 No. monitoring wells. Elevated metals (Iron, Manganese, Arsenic, Nickel and Aluminium) were detected at each sampling visit between 2015 and the 1st biannual of 2016. Coliform bacteria were present during both sampling visits in 2015, but absent from the 1st biannual 2016. Hydrocarbons and mercury were detected slightly above their respective GTVs during the 1st biannual sampling visit of 2016. During the 2nd Biannual sampling event in 2016, chloride was detected elevated above the GTV in MW1, MW2 and MW3, with elevated iron, manganese, lead and aluminium also present. In MW2 arsenic was elevated above the GTV. Faecal coliform bacteria were also detected in MW3 on this occasion. For the 1st Biannual sampling event in 2017, chloride was detected elevated above the GTV in MW1, MW2 and MW3, with elevated iron, manganese, lead, arsenic, aluminium and coliform bacteria also present.

During this sampling event Chloride is elevated above the GTV in MW1 and MW2, with elevated iron, manganese, nickel, arsenic and aluminium also present.

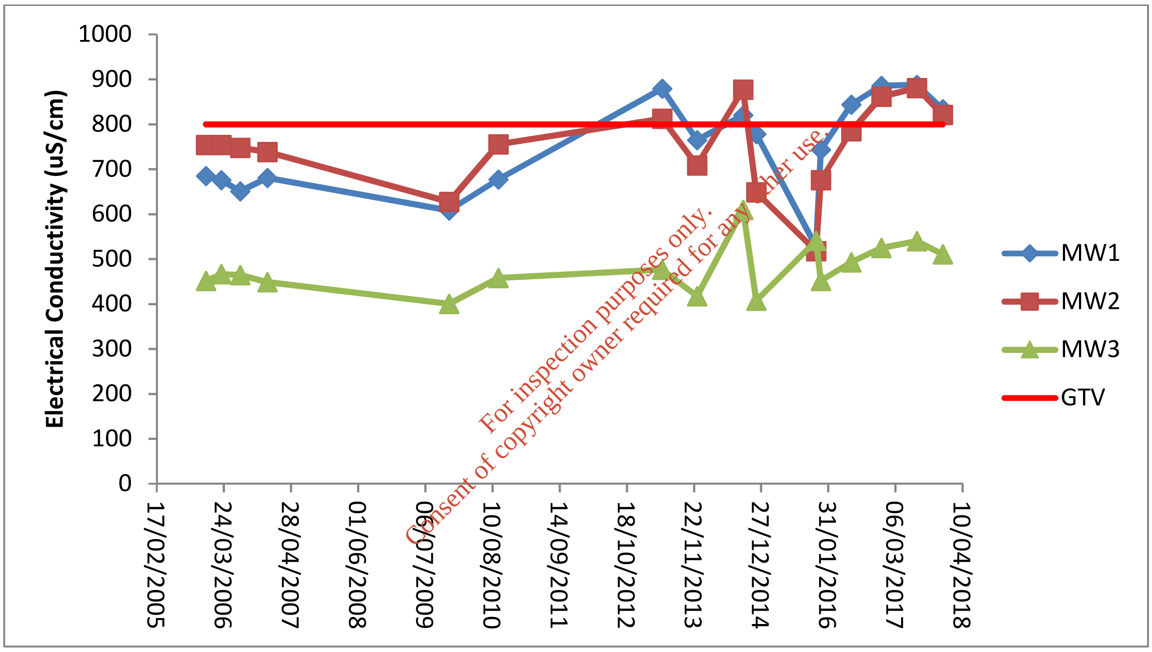
Some interesting characteristics of groundwater quality on site are highlighted by the previous analyses:

1. Electrical Conductivity of groundwater from all three wells has historically been very consistent, with groundwater down-gradient of the facility (MW1 and MW2) having a slightly higher EC than up-gradient of the facility (MW3);
2. Iron has historically been intermittently elevated in all three wells, especially at MW1. Manganese has been consistently elevated at MW1, with occasional high concentrations at MW3;

Electrical conductivity (EC) is a general parameter that reflects the dissolved content of groundwater - elevated EC indicates an elevated dissolved content. The significance of elevated EC is that other more specific water quality parameters may also be elevated.

The EC values measured in previous sampling events are almost identical to those measured in December 2017 suggesting that groundwater quality should be broadly similar to previous sampling events (i.e. no gross changes between sampling events). Analysis of the major ions in groundwater would suggest groundwater down-gradient of the site has higher chloride, sulphate, calcium, magnesium and sodium concentrations. It is possible this is due to leaks from foul sewers on site.

EC was measured in the laboratory for the first four sampling rounds and in December 2013 to a reference temperature of 20°C. EC was measured in the field for five rounds using a field meter with a reference temperature of 25°C. When the field ECs are converted to the lower reference temperature the corrected ECs are graphed below:



Historically elevated iron and manganese concentrations have been detected in all three monitoring wells, to varying levels. This may be related to background groundwater quality. The concentrations of iron and manganese detected are presented in Table 5.

Table 5: Iron & Manganese in Groundwater (mg/l)

Parameter	Date	MW1	MW2	MW3
Iron	06/12/2005	13	0.74	0.02
	08/03/2006	0.056	0.02	0.012
	29/06/2006	9.41	0.57	0.19
	07/12/2006	0.362	0.181	0.027
	24/11/2009	< 0.005	< 0.005	< 0.005
	14/09/2010	7.6	0.43	0.022
	16/05/2013	< 0.23	< 0.23	0.32
	09/12/2013	< 0.23	0.47	0.28
	11/09/2014	16.9	4.71	2.16
	27/11/2014	< 0.23	< 0.23	< 0.23
	19/11/2015	16	8.74	< 0.23
	17/12/2015	13.8	9.49	1.55
	15/06/2016	23.2	8.78	3.27
	12/12/2016	20.5	10.5	3.26
	12/07/2017	18.5	12.7	3.48
	12/12/2017	16.0	7.03	0.58

Parameter	Date	MW1	MW2	MW3
Manganese	06/12/2005	0.8	0.03	0.02
	08/03/2006	0.439	0.014	0.037
	29/06/2006	0.59	0.04	0.09
	07/12/2006	0.571	0.026	0.032
	24/11/2009	0.11	< 0.005	0.011
	14/09/2010	0.45	0.011	0.16
	16/05/2013	0.849	0.046	0.311
	09/12/2013	0.732	0.053	0.19
	11/09/2014	1.01	0.177	1.3
	27/11/2014	0.869	0.031	0.014
	19/11/2015	0.997	0.125	0.384
	17/12/2015	0.879	0.153	2.41
	15/06/2016	0.947	0.096	6.64
	12/12/2016	1.03	0.09	4.80
	12/07/2017	1.04	0.127	3.47
	12/12/2017	1.06	0.063	1.34

The groundwater samples for trace metals were not filtered or preserved in the field, rather they were filtered in the laboratory and analysed whole giving a Total metal result. Trace metals were detected above the laboratory detection limits suggesting that past detections of trace metals in groundwater samples were related to particles in suspension and not truly dissolved concentrations.

5.0 Conclusions

We conclude from the results of the latest groundwater sampling event:

- Groundwater in general on site has variable dissolved oxygen. This may be related to poor background groundwater quality as a result of agricultural practices up-gradient of the site;

- Groundwater from MW1 shows an elevated concentration of chloride above the Groundwater Threshold Value (GTV) and significantly higher than values detected in MW2 and MW3, which may be related to a discharge to ground on site as MW1 is most likely located down-gradient of the facility (e.g. leaky foul sewer). Background chloride levels (provided by the upgradient MW3), could suggest that a significant amount of chloride may be coming from a site upgradient;

- Elevated trace metal concentrations were found in MW1, MW2 and MW3; elevated concentrations of trace metals have been detected in the past and are most likely related to high turbidity in groundwater samples rather than groundwater pollution.

6.0 Recommendations

1. The determination of groundwater flow direction is central to any groundwater monitoring exercise. This report presents an initial interpretation of the groundwater flow direction at the site based on the information available (see Section 4.0). There is a significant element of uncertainty in this interpretation due to the lack of monitoring wells on site. AbbVie should consider investigating the groundwater flow direction on

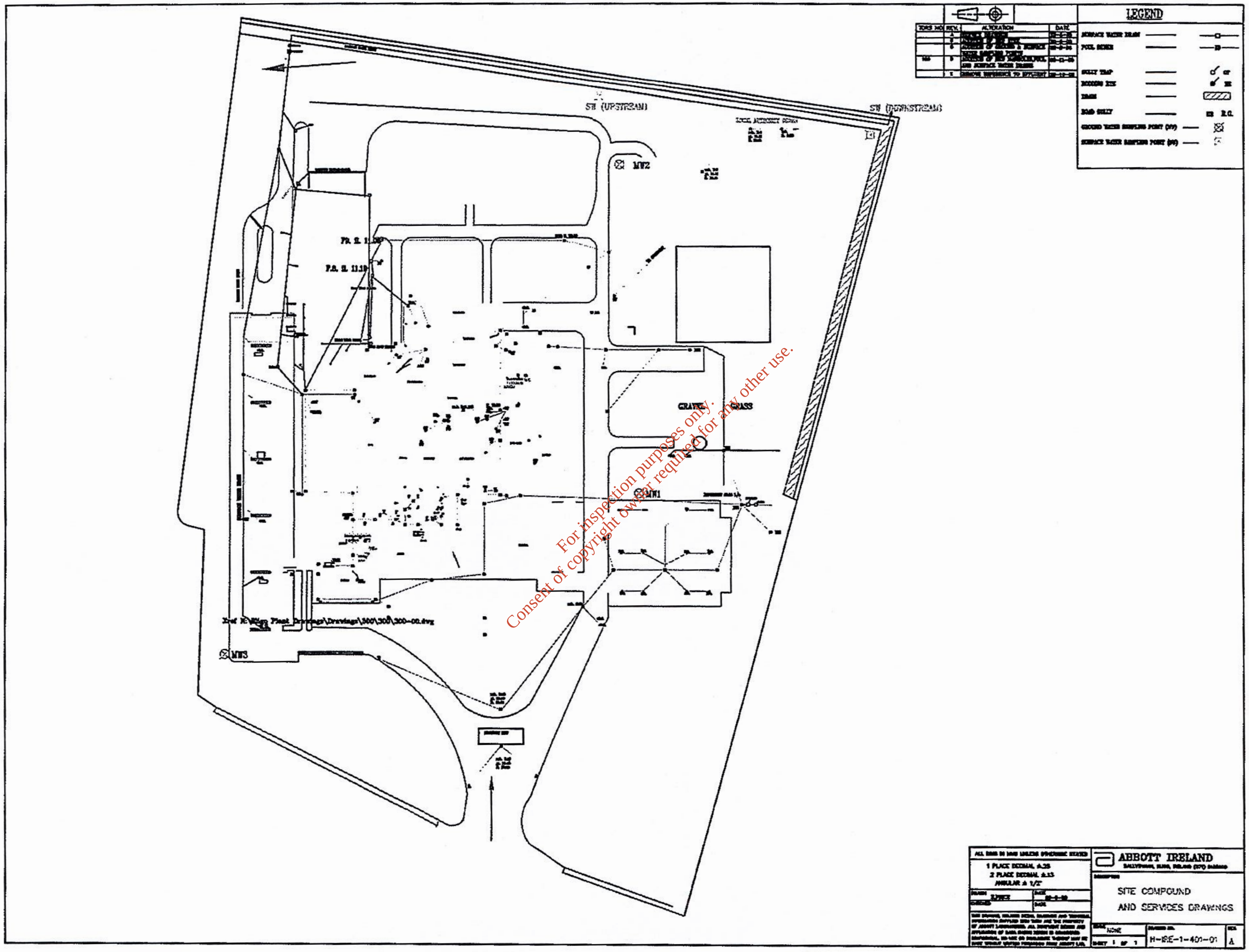
site more accurately at some stage in the future. This would be useful in determining the source of any groundwater pollution detected in monitoring wells on site, or the fate of any product spill. To determine the groundwater flow direction more accurately additional monitoring wells would be required. The location of monitoring wells is important for groundwater monitoring to be representative for a site.

2. It is possible that the difference in groundwater quality between up-gradient of the site (MW3) and down-gradient of the site (MW1 and MW2) is as a result of a discharge to ground on site (e.g. leaky foul sewer line). AbbVie should review any foul sewer integrity tests/pressure tests carried out to determine if there are leaking drains on site which may be impacting on groundwater quality.

3. It is recommended that a comparative study using a no-flow sampling method and regular bailer sampling with on-site filtering and preservation be employed in the near future to determine if the extent to which elevated trace metals concentrations are true results or artefacts of the sampling method employed.

APPENDIX I

Monitoring Well Location Map


LEGEND
ALTERATION
DATE
REV.
SURFACE WATER DRAIN
FOUL SEWER
GULLY TRAP
RODDING EYE
DRAIN
ROAD GULLY
R.G.
GROUND WATER SAMPLING POINT (GW)
SURFACE WATER SAMPLING POINT (SW)
SW (UPSTREAM)
SW (DOWNSTREAM)
MW2
MW1
MW3
GRAVEL
GRASS
F.S. 11.19
Xref N:\Elga Plant Drawings\Drawings\300\300\300-00.dwg
ALL DIMS IN MMS UNLESS OTHERWISE STATED
1 PLACE DECIMAL ±.25
2 PLACE DECIMAL ±.13
ANGULAR ± 1/2°
ABBOTT IRELAND
SITE COMPOUND
AND SERVICES DRAWINGS
SCALE NONE
SHEET 1 OF 1
H-IRE-1-401-01
A

Appendix II

Laboratory report

tms environment ltd

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ISO 17025 INAB ACCREDITED TESTING DETAILED IN SCOPE REG NO.150T

Confidential Laboratory Test Report

Client: AbbVie Ireland NL B.V.
Rathbraghan
Ballytivnan
Sligo
Co. Sligo

F.T.A.O: Paul McGarry
Commencement Date: 12 Dec 2017
Completion Date: 22 Jan 2018
Report Date: 23 Jan 2018
Revision Issued: 02 Feb 2018
Page: 1 of 11

TMS Environment Ref: 24808 Rev 1.0

Sample Type: Ground Water

TEST RESULTS

Parameter	24808-1 MW-01	24808-2 MW-02	24808-3 MW-03	Units	Methodology	Test Procedure Ref.
COD*	25	< 5	5	mg/L O_2	Microdigestion & Spectrophotometry	QP-CHEM-2065
Ammonia*	0.40	0.04	0.03	mg/L N	Spectrophotometry	QP-CHEM-2037
Alkalinity*	504	416	246	mg/L $CaCO_3$	Titration	QP-CHEM-2012
Ortho Phosphate*	0.57	0.05	0.12	mg/L P	Spectrophotometry	QP-CHEM-2040
Fluoride*	0.19	0.22	0.16	mg/L F	Ion Selective Electrode	QP-CHEM-2036
Nitrite$^{\text{Note 1}}$	0.038	0.021	0.002	mg/L N	Spectrophotometry	QP-CHEM-2040
Sulphate*	30.3	29.2	2.35	mg/L SO_4^{2-}	Turbidimetry	QP-CHEM-2050
Chloride*	63.5	25.8	23.8	mg/L Cl	Titration	QP-CHEM-2035
Nitrate	3.42	< 1	1.83	mg/L NO_3	Ion Selective Electrode	QP-CHEM-2043
Conductivity**	927	912	568	µS/cm @ 25°C	Conductivity Meter	QP-SITE-6002
Temperature**	9.8	9.9	10.2	°C	DO Meter	QP-SITE-6002
pH**	6.71	7.22	7.45	-	pH Meter	QP-SITE-6002
DO**	4.40	4.53	3.48	mg/L O_2	DO Meter	QP-SITE-6001
DO**	39.8	40.4	30.6	% Sat	DO Meter	QP-SITE-6001
Total Phosphorus***	0.62	< 0.12	< 0.12	mg/L P	Note 2	Note 2
Total Coliforms	0	0	0	mpn/100 ml	Note 2	Note 2
Escherichia Coli	0	0	0	mpn/100 ml	Note 2	Note 2
Faecal Coliforms	0	0	0	mpn/100 ml	Note 2	Note 2

*In-house Accredited Test
**On-site Accredited Test
***Subcontracted Accredited Test
Note 1: Analysis carried out outside holding time, therefore result may be compromised
Note 2: Analysis subcontracted to ALS

TOTAL METAL RESULTS

Units: mg/L **040660Sb, As, Hg, Se:** µg/L

Parameter [Note 2]	**24808-1** **MW-01**	**24808-2** **MW-02**	**24808-3** **MW-03**
Aluminium* **	0.6	0.4	0.6
Antimony* **	< 1.2	< 1.2	< 1.2
Arsenic* **	1.5	42	< 1.0
Cadmium* **	< 0.0006	< 0.0006	< 0.0006
Calcium* **	186	141	90.1
Chromium* **	< 0.002	< 0.002	< 0.002
Cobalt* **	< 0.002	< 0.002	0.002
Copper* **	< 0.009	< 0.009	< 0.009
Iron* **	16.0	7.03	0.58
Lead* **	< 0.006	< 0.006	< 0.006
Magnesium* **	13.9	26.8	8.3
Manganese* **	1.06	0.063	1.34
Mercury	< 0.05	< 0.05	< 0.05
Nickel* **	0.005	0.009	0.038
Potassium* **	1.02	2.51	1.91
Selenium* **	< 0.80	< 0.80	< 0.80
Silver	< 0.0007	< 0.0007	< 0.0007
Sodium* **	34.7	13.5	11.7
Tin* **	< 0.007	< 0.007	< 0.007
Zinc* **	< 0.018	< 0.018	< 0.018

***Subcontracted Accredited Test

Note 2: Analysis subcontracted to ALS

VOC TEST RESULTS

Parameter	24808-1 MW-01	24808-2 MW-02	24808-3 MW-03	Units	Methodology	Test Procedure Ref.
Dichlorodifluoromethane	< 1.00	< 1.00	< 1.00	ppb	Purge & Trap GCMS	QP-CHEM-2022
Chloromethane	< 1.00	< 1.00	< 1.00	ppb	Purge & Trap GCMS	QP-CHEM-2022
Chloroethane	< 1.00	< 1.00	< 1.00	ppb	Purge & Trap GCMS	QP-CHEM-2022
Bromomethane	< 1.00	< 1.00	< 1.00	ppb	Purge & Trap GCMS	QP-CHEM-2022
Trichlorofluoromethane	< 1.00	< 1.00	< 1.00	ppb	Purge & Trap GCMS	QP-CHEM-2022
1,1-Dichloroethylene	< 1.00	< 1.00	< 1.00	ppb	Purge & Trap GCMS	QP-CHEM-2022
Dichloromethane	< 1.00	< 1.00	< 1.00	ppb	Purge & Trap GCMS	QP-CHEM-2022
1,1-Dichloroethane	< 1.00	< 1.00	< 1.00	ppb	Purge & Trap GCMS	QP-CHEM-2022
cis-1,2-Dichloroethylene	< 1.00	< 1.00	< 1.00	ppb	Purge & Trap GCMS	QP-CHEM-2022
2,2-Dichloropropane	< 1.00	< 1.00	< 1.00	ppb	Purge & Trap GCMS	QP-CHEM-2022
Chloroform	< 1.00	< 1.00	< 1.00	ppb	Purge & Trap GCMS	QP-CHEM-2022
Bromochloromethane	< 1.00	< 1.00	< 1.00	ppb	Purge & Trap GCMS	QP-CHEM-2022
1,1,1-Trichloroethane	< 1.00	< 1.00	< 1.00	ppb	Purge & Trap GCMS	QP-CHEM-2022
1,1-Dichloropropene	< 1.00	< 1.00	< 1.00	ppb	Purge & Trap GCMS	QP-CHEM-2022
1,2-Dichloroethane	< 1.00	< 1.00	< 1.00	ppb	Purge & Trap GCMS	QP-CHEM-2022
Benzene	< 1.00	< 1.00	< 1.00	ppb	Purge & Trap GCMS	QP-CHEM-2022
1,2-Dichloropropane	< 1.00	< 1.00	< 1.00	ppb	Purge & Trap GCMS	QP-CHEM-2022
Trichloroethylene	< 1.00	< 1.00	< 1.00	ppb	Purge & Trap GCMS	QP-CHEM-2022
Bromodichloromethane	< 1.00	< 1.00	< 1.00	ppb	Purge & Trap GCMS	QP-CHEM-2022
Dibromomethane	< 1.00	< 1.00	< 1.00	ppb	Purge & Trap GCMS	QP-CHEM-2022
cis-1,3-Dichloropropene	< 1.00	< 1.00	< 1.00	ppb	Purge & Trap GCMS	QP-CHEM-2022
Toluene	< 1.00	< 1.00	< 1.00	ppb	Purge & Trap GCMS	QP-CHEM-2022
trans-1,3-Dichloropropene	< 1.00	< 1.00	< 1.00	ppb	Purge & Trap GCMS	QP-CHEM-2022
1,1,2-Trichloroethane	< 1.00	< 1.00	< 1.00	ppb	Purge & Trap GCMS	QP-CHEM-2022
Carbon Tetrachloride	< 1.00	< 1.00	< 1.00	ppb	Purge & Trap GCMS	QP-CHEM-2022
Vinyl Chloride	< 0.50	< 0.50	< 0.50	ppb	Purge & Trap GCMS	QP-CHEM-2022
Tetrachloroethene	< 1.00	< 1.00	< 1.00	ppb	Purge & Trap GCMS	QP-CHEM-2022

Parameter	24808-1 MW-01	24808-2 MW-02	24808-3 MW-03	Units	Methodology	Test Procedure Ref.
Dibromochloromethane	< 1.00	< 1.00	< 1.00	ppb	Purge & Trap GCMS	QP-CHEM-2022
1,2-Dibromoethane	< 1.00	< 1.00	< 1.00	ppb	Purge & Trap GCMS	QP-CHEM-2022
Chlorobenzene	< 1.00	< 1.00	< 1.00	ppb	Purge & Trap GCMS	QP-CHEM-2022
1,1,1,2-Tetrachloroethane	< 1.00	< 1.00	< 1.00	ppb	Purge & Trap GCMS	QP-CHEM-2022
Ethyl Benzene	< 1.00	< 1.00	< 1.00	ppb	Purge & Trap GCMS	QP-CHEM-2022
m&p-Xylene	< 1.00	< 1.00	< 1.00	ppb	Purge & Trap GCMS	QP-CHEM-2022
o-Xylene	< 1.00	< 1.00	< 1.00	ppb	Purge & Trap GCMS	QP-CHEM-2022
Styrene	< 1.00	< 1.00	< 1.00	ppb	Purge & Trap GCMS	QP-CHEM-2022
Bromoform	< 1.00	< 1.00	< 1.00	ppb	Purge & Trap GCMS	QP-CHEM-2022
Isopropylbenzene	< 1.00	< 1.00	< 1.00	ppb	Purge & Trap GCMS	QP-CHEM-2022
trans-1,2-Dichloroethylene	< 1.00	< 1.00	< 1.00	ppb	Purge & Trap GCMS	QP-CHEM-2022
1,1,2,2-Tetrachloroethane	< 1.00	< 1.00	< 1.00	ppb	Purge & Trap GCMS	QP-CHEM-2022
1,2,3-Trichloropropane	< 1.00	< 1.00	< 1.00	ppb	Purge & Trap GCMS	QP-CHEM-2022
n-Propylbenzene	< 1.00	< 1.00	< 1.00	ppb	Purge & Trap GCMS	QP-CHEM-2022
Bromobenzene	< 1.00	< 1.00	< 1.00	ppb	Purge & Trap GCMS	QP-CHEM-2022
2-Chlorotoluene	< 1.00	< 1.00	< 1.00	ppb	Purge & Trap GCMS	QP-CHEM-2022
1,3,5-Trimethylbenzene	< 1.00	< 1.00	< 1.00	ppb	Purge & Trap GCMS	QP-CHEM-2022
4-Chlorotoluene	< 1.00	< 1.00	< 1.00	ppb	Purge & Trap GCMS	QP-CHEM-2022
tert-Butylbenzene	< 1.00	< 1.00	< 1.00	ppb	Purge & Trap GCMS	QP-CHEM-2022
1,2,4-Trimethylbenzene	< 1.00	< 1.00	< 1.00	ppb	Purge & Trap GCMS	QP-CHEM-2022
sec-Butylbenzene	< 1.00	< 1.00	< 1.00	ppb	Purge & Trap GCMS	QP-CHEM-2022
p-Isopropyltoluene	< 1.00	< 1.00	< 1.00	ppb	Purge & Trap GCMS	QP-CHEM-2022
1,3-Dichlorobenzene	< 1.00	< 1.00	< 1.00	ppb	Purge & Trap GCMS	QP-CHEM-2022
1,4-Dichlorobenzene	< 1.00	< 1.00	< 1.00	ppb	Purge & Trap GCMS	QP-CHEM-2022
n-Butylbenzene	< 1.00	< 1.00	< 1.00	ppb	Purge & Trap GCMS	QP-CHEM-2022
1,2-Dichlorobenzene	< 1.00	< 1.00	< 1.00	ppb	Purge & Trap GCMS	QP-CHEM-2022
1,2-Dibromo-3-chloropropane	< 1.00	< 1.00	< 1.00	ppb	Purge & Trap GCMS	QP-CHEM-2022

Parameter	24808-1 MW-01	24808-2 MW-02	24808-3 MW-03	Units	Methodology	Test Procedure Ref.
1,2,4-Trichlorobenzene	< 1.00	< 1.00	< 1.00	ppb	Purge & Trap GCMS	QP-CHEM-2022
Hexachlorobutadiene	< 1.00	< 1.00	< 1.00	ppb	Purge & Trap GCMS	QP-CHEM-2022
Naphthalene	< 1.00	< 1.00	< 1.00	ppb	Purge & Trap GCMS	QP-CHEM-2022
1,2,3-Trichlorobenzene	< 1.00	< 1.00	< 1.00	ppb	Purge & Trap GCMS	QP-CHEM-2022

SEMIVOLATILE TEST RESULTS

Parameter	24808-1 MW-01	24808-2 MW-02	24808-3 MW-03	Units	Methodology	Test Procedure Ref.
BASE/NEUTRALS MIX 1						
Bis(2-chloroethyl) ether	< 2	< 2	< 2	ppb	Solvent Extraction GCMS	QP-CHEM-2068
N-Nitrodimethylamine	< 10	< 10	< 10	ppb	Solvent Extraction GCMS	QP-CHEM-2068
Bis(2-Chloroisopropyl) ether	< 2	< 2	< 2	ppb	Solvent Extraction GCMS	QP-CHEM-2068
N-nitroso-di-N-propylamine	< 2	< 2	< 2	ppb	Solvent Extraction GCMS	QP-CHEM-2068
Bis(2-Chloroethoxy) methane	< 2	< 2	< 2	ppb	Solvent Extraction GCMS	QP-CHEM-2068
Dimethylphthalate	< 2	< 2	< 2	ppb	Solvent Extraction GCMS	QP-CHEM-2068
4-Chlorophenyl-phenylether	< 2	< 2	< 2	ppb	Solvent Extraction GCMS	QP-CHEM-2068
Diethyl Phthalate	< 2	< 2	< 2	ppb	Solvent Extraction GCMS	QP-CHEM-2068
N-Nitroso diphenylamine	< 2	< 2	< 2	ppb	Solvent Extraction GCMS	QP-CHEM-2068
4-Bromophenyl-phenylether	< 2	< 2	< 2	ppb	Solvent Extraction GCMS	QP-CHEM-2068
Di-N-butylphthalate	< 2	< 2	< 2	ppb	Solvent Extraction GCMS	QP-CHEM-2068
Butyl phthalate	< 2	< 2	< 2	ppb	Solvent Extraction GCMS	QP-CHEM-2068
Butyl benzyl phthalate	< 2	< 2	< 2	ppb	Solvent Extraction GCMS	QP-CHEM-2068
Bis (2-ethylhexyl) phthalate	< 2	< 2	< 2	ppb	Solvent Extraction GCMS	QP-CHEM-2068
Di-n-octyl phthalate	< 2	< 2	< 2	ppb	Solvent Extraction GCMS	QP-CHEM-2068
BASE/NEUTRALS MIX 2						
1,2-dichlorobenzene	< 2	< 2	< 2	ppb	Solvent Extraction GCMS	QP-CHEM-2068
1,3-dichlorobenzene	< 2	< 2	< 2	ppb	Solvent Extraction GCMS	QP-CHEM-2068
1,4-dichlorobenzene	< 2	< 2	< 2	ppb	Solvent Extraction GCMS	QP-CHEM-2068
Hexachloroethane	< 2	< 2	< 2	ppb	Solvent Extraction GCMS	QP-CHEM-2068
Nitrobenzene	< 2	< 2	< 2	ppb	Solvent Extraction GCMS	QP-CHEM-2068
Isophorone	< 2	< 2	< 2	ppb	Solvent Extraction GCMS	QP-CHEM-2068

Parameter	24808-1 MW-01	24808-2 MW-02	24808-3 MW-03	Units	Methodology	Test Procedure Ref.
1,2,4-trichlorobenzene	< 2	< 2	< 2	ppb	Solvent Extraction GCMS	QP-CHEM-2068
Hexachlorobutadiene	< 2	< 2	< 2	ppb	Solvent Extraction GCMS	QP-CHEM-2068
Hexachlorocyclopentadiene	< 2	< 2	< 2	ppb	Solvent Extraction GCMS	QP-CHEM-2068
2-Chloronaphthalene	< 2	< 2	< 2	ppb	Solvent Extraction GCMS	QP-CHEM-2068
2,4-Dinitrotoluene	< 2	< 2	< 2	ppb	Solvent Extraction GCMS	QP-CHEM-2068
2,6-Dinitrotoluene	< 2	< 2	< 2	ppb	Solvent Extraction GCMS	QP-CHEM-2068
Azobenzene	< 2	< 2	< 2	ppb	Solvent Extraction GCMS	QP-CHEM-2068
Hexachlorobenzene	< 2	< 2	< 2	ppb	Solvent Extraction GCMS	QP-CHEM-2068
Carbazole	< 2	< 2	< 2	ppb	Solvent Extraction GCMS	QP-CHEM-2068
HAZARDOUS SUBSTANCES MIX 1						
2-Methylphenol	< 2	< 2	< 2	ppb	Solvent Extraction GCMS	QP-CHEM-2068
4-Methylphenol	< 5	< 5	< 5	ppb	Solvent Extraction GCMS	QP-CHEM-2068
Benzoic acid	< 250	< 250	< 250	ppb	Solvent Extraction GCMS	QP-CHEM-2068
2,4,5-Trichlorophenol	< 20	< 20	< 20	ppb	Solvent Extraction GCMS	QP-CHEM-2068
HAZARDOUS SUBSTANCES MIX 2						
Benzyl alcohol	< 10	< 10	< 2	ppb	Solvent Extraction GCMS	QP-CHEM-2068
Aniline	< 10	< 10	< 2	ppb	Solvent Extraction GCMS	QP-CHEM-2068
4-Chloroaniline	< 10	< 10	< 2	ppb	Solvent Extraction GCMS	QP-CHEM-2068
2-Methylnaphthalene	< 2	< 2	< 2	ppb	Solvent Extraction GCMS	QP-CHEM-2068
2-Nitroaniline	< 2	< 2	< 2	ppb	Solvent Extraction GCMS	QP-CHEM-2068
3-Nitroaniline	< 5	< 5	< 5	ppb	Solvent Extraction GCMS	QP-CHEM-2068
Dibenzofuran	< 2	< 2	< 2	ppb	Solvent Extraction GCMS	QP-CHEM-2068
4-Nitroaniline	< 10	< 10	< 10	ppb	Solvent Extraction GCMS	QP-CHEM-2068
BENZIDINE MIX						
Benzidine	< 20	< 20	< 20	ppb	Solvent Extraction GCMS	QP-CHEM-2068
3,3-Dichlorobenzidine	< 20	< 20	< 20	ppb	Solvent Extraction GCMS	QP-CHEM-2068

Parameter	24808-1 MW-01	24808-2 MW-02	24808-3 MW-03	Units	Methodology	Test Procedure Ref.
PHENOLS MIX						
Pentachlorophenol	< 2	< 2	< 2	ppb	Solvent Extraction GCMS	QP-CHEM-2068
Phenol	< 2	< 2	< 2	ppb	Solvent Extraction GCMS	QP-CHEM-2068
2-Chlorophenol	< 2	< 2	< 2	ppb	Solvent Extraction GCMS	QP-CHEM-2068
2-Methyl-4,6-dinitrophenol	< 2	< 2	< 2	ppb	Solvent Extraction GCMS	QP-CHEM-2068
2-Nitrophenol	< 2	< 2	< 2	ppb	Solvent Extraction GCMS	QP-CHEM-2068
2,4-Dimethylphenol	< 2	< 2	< 2	ppb	Solvent Extraction GCMS	QP-CHEM-2068
2,4-Dinitrophenol	< 2	< 2	< 2	ppb	Solvent Extraction GCMS	QP-CHEM-2068
2,4-Dichlorophenol	< 2	< 2	< 2	ppb	Solvent Extraction GCMS	QP-CHEM-2068
2,4,6-Trichlorophenol	< 2	< 2	< 2	ppb	Solvent Extraction GCMS	QP-CHEM-2068
4-Chloro-3-methylphenol	< 2	< 2	< 2	ppb	Solvent Extraction GCMS	QP-CHEM-2068
4-Nitrophenol	< 2	< 2	< 2	ppb	Solvent Extraction GCMS	QP-CHEM-2068
PAH MIX						
Naphthalene	< 0.1	< 0.1	< 0.1	ppb	Solvent Extraction GCMS	QP-CHEM-2068
Acenaphthene	< 0.1	< 0.1	< 0.1	ppb	Solvent Extraction GCMS	QP-CHEM-2068
Acenaphthlene	< 0.1	< 0.1	< 0.1	ppb	Solvent Extraction GCMS	QP-CHEM-2068
Fluorene	< 0.1	< 0.1	< 0.1	ppb	Solvent Extraction GCMS	QP-CHEM-2068
Anthracene	< 0.1	< 0.1	< 0.1	ppb	Solvent Extraction GCMS	QP-CHEM-2068
Phenanthrene	< 0.1	< 0.1	< 0.1	ppb	Solvent Extraction GCMS	QP-CHEM-2068
Fluoranthene	< 0.1	< 0.1	< 0.1	ppb	Solvent Extraction GCMS	QP-CHEM-2068
Pyrene	< 0.1	< 0.1	< 0.1	ppb	Solvent Extraction GCMS	QP-CHEM-2068
Benzo (a) Anthracene	< 0.1	< 0.1	< 0.1	ppb	Solvent Extraction GCMS	QP-CHEM-2068
Chrysene	< 0.1	< 0.1	< 0.1	ppb	Solvent Extraction GCMS	QP-CHEM-2068

Parameter	24808-1 MW-01	24808-2 MW-02	24808-3 MW-03	Units	Methodology	Test Procedure Ref.
Benzo(a)Anthracene	< 0.1	< 0.1	< 0.1	ppb	Solvent Extraction GCMS	QP-CHEM-2068
Benzo(b)Fluoranthene*	< 0.1	< 0.1	< 0.1	ppb	Solvent Extraction GCMS	QP-CHEM-2068
Benzo(k)fluoranthene*	< 0.1	< 0.1	< 0.1	ppb	Solvent Extraction GCMS	QP-CHEM-2068
Benzo(a)Pyrene*	< 0.1	< 0.1	< 0.1	ppb	Solvent Extraction GCMS	QP-CHEM-2068
Dibenzo(ghi)perylene*	< 0.1	< 0.1	< 0.1	ppb	Solvent Extraction GCMS	QP-CHEM-2068
Indenol (1,2,3, -cd) pyrene*	< 0.1	< 0.1	< 0.1	ppb	Solvent Extraction GCMS	QP-CHEM-2068

*** Relative to naphtalene**

TPH RESULTS

Parameter	24808-1 MW-01	24808-2 MW-02	24808-3 MW-03	Units	Methodology	Test Procedure Ref.
TPH	< 10	< 10	< 10	µg/L	GCMS	QP-CHEM-2022

DRO RESULTS

Parameter	24808-1 MW-01	24808-2 MW-02	24808-3 MW-03	Units	Methodology	Test Procedure Ref.
Decane	< 5.0	< 5.0	< 5.0	ppb	Purge & Trap GCMS	QP-CHEM-2022
Undecane	< 5.0	< 5.0	< 5.0	ppb	Purge & Trap GCMS	QP-CHEM-2022
Dodecane	< 5.0	< 5.0	< 5.0	ppb	Purge & Trap GCMS	QP-CHEM-2022
Tridecane	< 5.0	< 5.0	< 5.0	ppb	Purge & Trap GCMS	QP-CHEM-2022
Tetradecane	< 5.0	< 5.0	< 5.0	ppb	Purge & Trap GCMS	QP-CHEM-2022
Pentadecane	< 5.0	< 5.0	< 5.0	ppb	Purge & Trap GCMS	QP-CHEM-2022
Hexadecane	< 5.0	< 5.0	< 5.0	ppb	Purge & Trap GCMS	QP-CHEM-2022
Heptadecane	< 5.0	< 5.0	< 5.0	ppb	Purge & Trap GCMS	QP-CHEM-2022
Octadecane	< 5.0	< 5.0	< 5.0	ppb	Purge & Trap GCMS	QP-CHEM-2022
Nonadecane	< 5.0	< 5.0	< 5.0	ppb	Purge & Trap GCMS	QP-CHEM-2022
Eicosane	< 5.0	< 5.0	< 5.0	ppb	Purge & Trap GCMS	QP-CHEM-2022
Heneicosane	< 5.0	< 5.0	< 5.0	ppb	Purge & Trap GCMS	QP-CHEM-2022
Docosane	< 5.0	< 5.0	< 5.0	ppb	Purge & Trap GCMS	QP-CHEM-2022
Tricosane	< 5.0	< 5.0	< 5.0	ppb	Purge & Trap GCMS	QP-CHEM-2022
Tetracosane	< 5.0	< 5.0	< 5.0	ppb	Purge & Trap GCMS	QP-CHEM-2022
Pentacosane	< 5.0	< 5.0	< 5.0	ppb	Purge & Trap GCMS	QP-CHEM-2022
Hexacosane	< 5.0	< 5.0	< 5.0	ppb	Purge & Trap GCMS	QP-CHEM-2022
Total DROs in std mixture	< 5.0	< 5.0	< 5.0	ppb	Purge & Trap GCMS	QP-CHEM-2022
***Total Other DRO Compounds**	< 5.0	< 5.0	< 5.0	ppb	Purge & Trap GCMS	QP-CHEM-2022

*Relative to Decane

PRO RESULTS

Parameter	24808-1 MW-01	24808-2 MW-02	24808-3 MW-03	Units	Methodology	Test Procedure Ref.
Pentane	< 5.0	< 5.0	< 5.0	ppb	Purge & Trap GCMS	QP-CHEM-2022
Hexane	< 5.0	< 5.0	< 5.0	ppb	Purge & Trap GCMS	QP-CHEM-2022
Heptane	< 5.0	< 5.0	< 5.0	ppb	Purge & Trap GCMS	QP-CHEM-2022
Octane	< 5.0	< 5.0	< 5.0	ppb	Purge & Trap GCMS	QP-CHEM-2022
Nonane	< 5.0	< 5.0	< 5.0	ppb	Purge & Trap GCMS	QP-CHEM-2022
Total PROs	< 5.0	< 5.0	< 5.0	ppb	Purge & Trap GCMS	QP-CHEM-2022

Parameter	24808-1 MW-01	24808-2 MW-02	24808-3 MW-03	Units	Methodology	Test Procedure Ref.
Cyclohexanone	< 10	< 10	< 10	mg/L	Note 2	Note 2

Note 2: Analysis subcontracted to CLS

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Katie Waldron
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