Reports in support of the Appropriate Assessment Process

[Section 1] Introduction

[Sections 2-5] Report on Screening for Appropriate Assessment

[Section 6] Natura Impact Statement

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Prepared for: Aughinish Alumina Ltd.

Prepared by:

Ecology Ireland Ltd. & RSK Group

November 2021

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Executive Summary

A Natura Impact Statement (NIS) has been prepared in relation to a Planning Application by Aughinish Alumina Ltd. (AAL) for development at an existing facility located in the townlands of Aughinish East, Aughinish West, Island Mac Teige, Glenbane West, and Fawnamore at or adjacent to Aughinish Island, Askeaton, Co. Limerick. Planning permission is being sought for development comprising the expansion of the Bauxite Residue Disposal Area (BRDA) including Salt Cake Disposal Cell (SCDC), Borrow Pit and Stockpile Area to facilitate the increased disposal of Bauxite residue on site arising from the continued operation of the adjoining alumina refinery facility located on the wider AAL site. In addition, upgrades are proposed to the existing water management infrastructure to accommodate the BRDA development to Stage 16 which will also allow for greater Inflow Design Flood (IDF) capacity for the entirety of the BRDA.

The facility is operated in accordance with the Conditions of the Industrial Emissions Licence (IEL) P0035-07 issued by the Environmental Protection Agency (EPA). The lands subject to this current application measure c. 222 ha and currently accommodate processes associated with the operation of the wider facility. The overall landholding of the Applicant extends to c. 601 ha.

The proposed development principally relates to works to the existing Bauxite Residue Disposal Area (BRDA). Works to the BRDA principally consist of an expansion of its storage capacity to accommodate additional bauxite residue resulting in a proposed increase in height of c.12m above the currently permitted levels. Additional works proposed as part of this application an extension to the existing Salt Cake Disposal Cell (SCDC), located within the BRDA, to accommodate further storage of salt cake resulting in an increase in height of c.2.25m. An extension of the permitted borrow pit, located to the east of the BRDA, is also proposed. This extension proposes to increase the footprint of the borrow pit from c.4.5ha to c.8.4ha. This extension will provide an additional 380,000m^3 of rock fill material which is needed to satisfy the requirements of the construction and operation of the BRDA.

On behalf of the applicant, Ecology Ireland Wildlife Consultants Ltd. assisted by RSK Group has prepared a NIS in support of the Appropriate Assessment process. This NIS examines in detail the potential impacts of the development on Natura 2000 sites in the potential Zone of Influence (ZoI) of the proposed development. The potential impacts include those associated with sources of emission from the development site e.g. noise, dust etc. The historical context of the site and operations is discussed and the proposed development which will facilitate the continued operation of the facility is considered in detail. Supporting information includes a Conceptual Site Model (CSM) which provides an assessment of the likely pathways for potential contaminant sources through which pollutants may enter the environment and the likelihood of these pathways being realised based on available evidence.

The proposed development would enable an extension of operational life to the existing alumina refinery plant. The increase in the height of the BRDA and extension to the permitted borrow pit are considered, taking particular account of the potential sources of impact arising from these project elements. For instance, the potential change in emissions in terms of noise and vibration related to the blasting activities associated with the extended borrow pit is considered in relation to special conservation and qualifying interest species that may occur locally.

The NIS considers the emissions to air, water, noise and vibration and light associated with the proposed development operation and the potential impacts of these emissions on Natura 2000 sites and their conservation objectives. In addition, the potential for cumulative and in-combination impacts are considered from the operation of the overall refinery plant and in relation to other projects and plans in the wider area.

It has been objectively concluded that the proposed project will not adversely affect the integrity of any Natura 2000 site, and there is no reasonable scientific doubt in relation to this conclusion.

1 Introduction

Ecology Ireland Wildlife Consultants Ltd. (Ecology Ireland) was commissioned on behalf of Aughinish Alumina Ltd. (AAL), to prepare a Natura Impact Statement (NIS) in relation to their planning application for development at an existing alumina production facility located in the townlands of Aughinish East, Aughinish West, Island Mac Teige, Glenbane West, and Fawnamore at or adjacent to Aughinish Island, Askeaton, Co. Limerick.

The proposed development comprises of:

- An expansion of the Bauxite Residue Disposal Area (BRDA) to increase its disposal capacity in order to accommodate additional bauxite residue resulting in a proposed increase in height of c.12m (to c. 44m OD) above the currently permitted levels. No increase to the existing footprint of the BRDA is proposed.

- An extension to the existing Salt Cake Disposal Cell (SCDC) to accommodate further disposal of salt cake resulting in an increase in height of the cell by c.2.25m. The SCDC is located within the BRDA area. A description of the existing SCDC and its function is provided in Chapter 2 of this EIAR.

- An extension of the permitted borrow pit, located to the east of the BRDA, is also proposed. This extension proposes to increase the footprint of the borrow pit from c.4.5ha to c.8.4ha. This extension will provide an additional 380,000m^3 of rock fill material which is needed to satisfy the requirements of the construction and operation of the BRDA.

- The continued use of an existing stockpile area at the south east of the subject site to store topsoil in order to satisfy the additional restoration requirements of the extended BRDA.

- Upgrades to the existing water management infrastructure to accommodate the BRDA development to Stage 16 which will also allow for greater Inflow Design Flood (IDF) capacity for the entirety of the BRDA.

The facility is operated in accordance with the Conditions of the Industrial Emissions Licence (IEL) P0035-07 issued by the Environmental Protection Agency (EPA). The lands subject to this current application measure c. 222 ha and currently accommodate processes associated with the operation of the wider facility. The overall landholding of the Applicant extends to c. 601 ha.

Ecology Ireland was supported in the preparation of the NIS by RSK Environment Ltd (RSK) and their associate IEH Consulting. RSK and IEH prepared the Conceptual Site Model (CSM) for the project, which included a programme of baseline marine sediment monitoring undertaken by Aquafact Environmental Consultants.

Ecology Ireland also prepared the Biodiversity Chapter (Chapter 6) of the Environment Impact Assessment Report (EIAR).

Recently, the overall operation of the AAL facility has been subject to AA as part of the Environmental Protection Agency (EPA) Integrated Emissions Licence review process (P0035-07). In the issue of the emissions licence (P0035-07; September 2021) the EPA state that it completed an Appropriate Assessment of potential impacts on Natura 2000 sites and *"has made certain, based on best scientific knowledge in the field and in accordance with the European Communities (Birds and Natural Habitats) Regulations 2011 as amended, pursuant to Article 6(3) of the Habitats Directive, that the activities, individually or in combination with other plans or projects, will not adversely affect the integrity of any European site..."* The NIS which informed the EPA's Appropriate Assessment was prepared by Ecology Ireland Ltd. (Ecology Ireland 2020).

The proposed development will result in an increase in the capacity of the BRDA, a raise to the existing SCDC and an extension to the permitted borrow pit. An existing rockfill and soil stockpile area will continue to be used for this purpose. The development is designed to extend the operational life of the refinery plant by c. 9 years during which time the refinery plant will continue to operate according to the environmental management system and strict emission licence limits set by the EPA. The proposed development provides detail of water management including improvements to the water management system for the proposed BRDA development which will be implemented to allow for the existing Perimeter Interceptor Channel (PIC) system, Storm Water Pond (SWP) and Liquid Waste Pond (LWP) to accommodate the Inflow Design Flood (IDF) for the Proposed Development (see Chapter 10 EIAR Hydrology).

1.1 Statement of Authority

This NIS was prepared by Dr. Gavin Fennessy of Ecology Ireland Ltd., with the support of specialist environmental scientists and ecotoxicologists from RSK Environment Ltd and their associates. RSK Environment Ltd were also responsible for the undertaking of a programme of marine sediment monitoring in the vicinity of the project, the results of which were input into the CSM which supports this NIS.

Dr. Fennessy (Director & Principal Ecologist, Ecology Ireland Ltd.) is an ecologist with over 20 years of experience in professional consultancy. He has carried out and reported on ecological surveys (including Screening for Appropriate Assessment) at the AAL facility since 2012. He is a full member of the Chartered Institute of Ecology and Environmental Management (CIEEM) and he sits on the Policy Group of the Irish Section of the CIEEM. Gavin is a Guest Lecturer on Ecological Impact Assessment (EcIA) and Appropriate Assessment (AA) at University College Cork (UCC). In 2020, Gavin was lead author on the NIS which informed the EPA's recent AA on the overall operation of the facility, carried out as part of the licence review process (P0035-07).

Dr Dave Watson (Director, RSK Environment Ltd.) is a marine scientist, with experience in marine consulting and environmental monitoring. Dave has a PhD in Marine Chemistry, and is experienced in survey design for marine chemistry including water and sediment quality, along with biotic surveys. Dave has been involved in the Corrib offshore development and has designed and managed several marine surveys, including water and sediment quality, benthic macrofauna and long-term marine mammal monitoring. He has also managed various environmental studies, including EIAs, for a variety of oil and gas, and marine renewables projects.

Jason Weeks (Director, IEH Consulting Ltd.) is a professor of marine chemistry and a specialist in the field of marine ecotoxicology. He has more than 28 years' experience as an environmental toxicologist, with extensive experience in the environment, food safety, pharmaceutical (human and veterinary), regulatory and aquaculture sectors. Jason is an internationally recognised expert on ecological and environmental risk assessment, and has particular expertise in understanding the ecological effects of pharmaceuticals in the environment.

Andrew Bendell (Principal Marine Ecologist, RSK Environment Ltd.) is a marine consultant with over 20 years of experience in marine consulting and marine environmental survey. He has particular experience in marine ecology surveys, and the subsequent analysis and reporting of marine survey data for environmental impact assessment (EIA) projects. Andrew has experience in undertaking offshore EIA projects for a range of developments, including upstream oil and gas, ports and harbours, and renewables developments in the UK and worldwide. Andrew has undertaken a number of environmental impact assessments (and supplementary updates), appropriate assessment screening as well as full appropriate assessments requiring the drafting of Natura Impact Statements for the Corrib offshore gas project. These assessments have included environmental and maintenance and inspection surveys of the offshore gas pipeline, remedial works and renewals on subsea infrastructure and for a programme of Ocean Bottom Cable (OBC) seismic exploration surveys in the vicinity of the Corrib gas field. Andrew has a good understanding of the Irish offshore permitting requirements, particularly around EIA and AA. Andrew has also undertaken a number of offshore, nearshore and shoreline environmental surveys on the west coast of Ireland.

Ellie Cooper (Senior Marine Ecologist, RSK Environment Ltd.) is a marine biologist with 5 years of experience as a marine environmental consultant. Ellie has been involved in the undertaking of multiple marine environmental impact assessments (EIA), as well as appropriate assessments (AA) for Corrib gas pipeline environmental and maintenance surveys. She has a working knowledge of the Irish legislative framework for EIA and AA, and has carried out intertidal ecological surveys including contaminant sampling around the UK.

2 Background to the Appropriate Assessment Process

The Council Directive 92/43/EEC on the Conservation of Natural Habitats and of Wild Fauna and Flora, better known as "The Habitats Directive", provides legal protection for habitats and species of European importance. Articles 3 to 9 provide the legislative means to protect habitats and species of Community interest through the establishment and conservation of an EU-wide network of sites known as European Sites. These are Special Areas of Conservation (SACs) designated under the Habitats Directive and Special Protection Areas (SPAs) designated under the Conservation of Wild Birds Directive (79/409/ECC) as codified by Directive 2009/147/EC.

Articles 6(3) and 6(4) of the Habitats Directive set out the decision-making tests for plans and projects likely to affect European Sites (Annex 1.1). Article 6(3) establishes the requirement for Appropriate Assessment (AA);

> *Any plan or project not directly connected with or necessary to the management of the [European] site but likely to have a significant effect thereon, either individually or in combination with other plans or projects, shall be subjected to appropriate assessment of its implications for the site in view of the site's conservation objectives. In light of the conclusions of the assessment of the implications for the site and subject to the provisions of paragraph 4, the competent national authorities shall agree to the plan or project only after having ascertained that it will not adversely affect the integrity of the site concerned and, if appropriate, after having obtained the opinion of the general public.*

Article 6(4) states;

> *If, in spite of a negative assessment of the implications for the [European] site and in the absence of alternative solutions, a plan or project must nevertheless be carried out for imperative reasons of overriding public interest, including those of a social or economic nature, Member States shall take all compensatory measures necessary to ensure that the overall coherence of European Site is protected. It shall inform the Commission of the compensatory measures adopted.*

2.1 Guidance for the Appropriate Assessment Process

Article 6(3) of the EU Habitats Directive (92/43/EEC) defines the requirement for AA of certain plans and projects. In order to inform the requirements of this Screening and NIS the following guidance documents have been referred to;

<u>European and National Legislation</u>

- Council Directive 92/43/EEC on the conservation of natural habitats and of wild fauna and flora (also known as the 'Habitats Directive');
- Council Directive 2009/147/EC on the conservation of wild birds, codified version, (also known as the 'Birds Directive');
- European Communities (Birds and Natural Habitats) Regulations 2011 to 2015; and
- Planning and Development Act 2000 (as amended).

Guidance

- European Commission (2015) Ecological flows in the implementation of the Water Framework Directive – Guidance Document No. 31.
- European Court of Justice, Case – C-664/15
- European Court of Justice, Case – C117/00
- European Court of Justice, Case – C461/13
- European Court of Justice, Case – C323/17
- DoEHLG (2010) Appropriate Assessment of Plans and Projects in Ireland. Guidance for Planning Authorities. Department of the Environmental Heritage and Local Government.
- European Commission (2018) Managing European Sites: the provisions of Article 6 of the 'Habitats' Directive 92/43/EEC.
- European Commission (2021) Assessment of plans and projects in relation to Natura 2000 sites – Methodological guidance on the provisions of Article 6(3) and (4) of the Habitats Directive 92/43/EEC (2021/C 437/01).
- European Commission (2000) Communication from the Commission on the Precautionary Principle. Office for Official Publications of the European Communities, Luxembourg. European Commission.
- European Commission (2001) Assessment of plans and projects significantly affecting European Sites: Methodological guidance on the provisions of Articles 6(3) and (4) of the Habitats Directive 92/43/EEC.
- Commission notice Guidance document on the strict protection of animal species of Community interest under the Habitats Directive (C/2021/7301 European Commission; October 2021).
- European Commission (2007) Guidance document on Article 6(4) of the 'Habitats Directive' 92/49/EEC; clarification of the concepts of: Alternative solutions, Imperative reasons of overriding public interest, Compensatory Measures, Overall Coherence, Opinion of the Commission.
- European Commission (2013). Interpretation Manual of European Union Habitats. Version EUR 28. European Commission

Departmental/ NPWS Circulars

- Appropriate Assessment under Article 6 of the Habitats Directive: Guidance for Planning Authorities. Circular NPWS 1/10 & PSSP 2/10. (DoEHLG, 2010);
- Appropriate Assessment of Land Use Plans. Circular Letter SEA 1/08 & NPWS 1/08;
- Water Services Investment and Rural Water Programmes – Protection of Natural Heritage and National Monuments. Circular L8/08;

- Guidance on Compliance with Regulation 23 of the Habitats Directive. Circular Letter NPWS 2/07; and
- Compliance Conditions in respect of Developments requiring (1) Environmental Impact Assessment (EIA); or (2) having potential impacts on European Sites. Circular Letter PD 2/07 and NPWS 1/07.

2.2 Stages of Article 6 Assessment

The European Commission's guidance promotes a staged process, as set out below, the need for each being dependent upon the outcomes of the preceding stage:

(1) Screening

(2) Appropriate Assessment

(3) Assessment of Alternative Solutions

(4) Assessment where no alternative solutions remain and where adverse impacts remain. The "IROPI test" (Imperative Reasons of Over-riding Public Interest) and compensatory measures.

The Habitats Directive promotes a hierarchy of avoidance, mitigation and compensatory measures.

Stage 1 of the process is intended to identify whether the project is 'likely to have a significant effect' upon a European site, referred to as 'Screening for Appropriate Assessment'.

If the screening process identifies effects to be significant, potentially significant or uncertain, or if the screening process becomes overly complicated, then the process must proceed to Stage 2 (AA). Screening is undertaken without the inclusion of mitigation, unless potential impacts clearly can be avoided though the modification or redesign of the plan or project, in which case the screening process is repeated on the altered plan or project. The greatest level of evidence and justification will be needed in circumstances when the process ends at screening stage on grounds of no impact.

Section 177U of the Planning and Development Act 2010 (and Article 42, Birds and Habitats Regulations, 2011) states that; "*the competent authority shall determine that an appropriate assessment of the proposed development is not required if it can be excluded, on the basis of objective information, that the proposed development, individually or in combination with other plans or projects, will not have a significant effect on a European site*."

Stage 2 of the process, Appropriate Assessment, considers any potential impacts of the plan or project in greater detail including whether further mitigation measures are required. Specifically, it is focused on the potential for the proposed plan or project to impact on the conservation objectives of the European Sites and the integrity of the European Sites. This stage involves the collection of information which is specifically relevant to determining impacts including a description of the proposed plan or project, the conservation objectives of the European Sites and an understanding of current factors which either maintain or threaten those conservation objectives, an assessment of aspects of the proposed plan or project which could negatively impact the conservation objectives of the European Sites, both in the absence of and with mitigation measures.

If an adverse impact upon the site's integrity cannot be ruled out, then **Stage 3** will need to be undertaken to assess whether alternative solutions exist. If no alternatives exist that have a lesser effect upon the European Site/s in question, the project can only be implemented if there are 'imperative reasons of overriding public interest', **Stage 4**, as detailed in Article 6(4). In essence, the work at Stage 1 will determine whether further stages of the process are required.

3 Methodology

This report presents in brief the outcome of a Screening for Appropriate Assessment. The subsequent Natura Impact Statement (NIS) is prepared to discuss the potential impacts of the proposed development alone and in combination with other plans and projects, on the Natura 2000 sites (and their conservation objectives) within the Zone of Influence (ZoI).

The general operation of the entire AAL facility was subject to AA as part of the recent EPA licence review for the site. The Environmental Protection Agency (EPA) requested that AAL, prepare and submit a NIS in relation to the IEL Review (P0035-07) to inform the AA process. As described in Section 1 of this NIS, the EPA in the issue of the emissions licence (P0035-07; September 2021) state that it completed an Appropriate Assessment of potential impacts on Natura 2000 sites and *"has made certain, based on best scientific knowledge in the field and in accordance with the European Communities (Birds and Natural Habitats) Regulations 2011 as amended, pursuant to Article 6(3) of the Habitats Directive, that the activities, individually or in combination with other plans or projects, will not adversely affect the integrity of any European site…."* The EPA review process considered all aspects of the operation of the AAL facility, not limited to, or focussed on the operation of the permitted borrow pit and BRDA. Their determination was based on the nature and scale of the activities, the proximity of the installation to a number of European sites and the potential effects such activities may have on European Sites and their qualifying interests. The EPA expressly requested that the NIS prepared as part of the licence review, should consider all emissions from the facility. The EPA undertakes Appropriate Assessment in accordance with Regulation 42(1) of the European Communities (Birds and Natural Habitats) Regulations 2011.

The AA process considers whether a proposed development, in view of best scientific knowledge and in light of the conservation objectives of any relevant European sites, when considered as an individual project, or in combination with other plans and projects, will have an adverse effect on the integrity of any European Site. It is important to emphasise that a screening assessment does not have to ascertain the existence of a significant effect or impact on a Natura 2000 site as such; it only has to establish whether a significant effect or impact is possible or may occur. At the NIS stage, all mitigation measures necessary to avoid, reduce or offset negative effects are considered.

The conservation objectives of Natura 2000 sites have been compiled by the National Parks & Wildlife Service (NPWS) in relation to the habitats and species (*i.e.* qualifying interests) for which the sites are selected. These conservation objectives are referred to when carrying out appropriate assessments for plans and projects that might impact on these sites.

3.1.1 Information Consulted for this Report

This assessment has been informed by the following sources of data:

- Biodiversity Chapter of the EIAR (Chapter 6) for the proposed development;
- Desk based surveys and site surveys of the proposed development site and surrounding areas;
    - Ecology Ireland has carried out field and desktop assessments in relation to several projects at AAL in recent years including the installation of a deep cone thickener,

  a second bauxite unloader, proposed development and operation of the permitted borrow pit, repairs to the seawall etc.
  - RSK carried out detailed sediment analysis upstream and downstream of Aughinish Island in 2021 to inform the CSM and the current NIS. The conclusions from the CSM have been used to inform this NIS
- Previous reports, including Annual Environmental Reports to the EPA, Screening Reports, EIAR, NIS, monitoring and modelling reports etc.;
- Details of the monitoring of emissions from the operation of the facility;
- Details of the management and mitigation of the licensed facility;
- Information contained in the 2019 IEL licence review application (application in 2019, Granted in 2021 – P0035-07) as provided by the client.;
- Environmental Reports (including Screening for AA, NIS' etc.) in relation to other projects and plans in the wider area;
- Office of Public Works (OPW) National Flood Hazard Mapping website (www.floodmaps.ie)
- Environmental Protection Agency (EPA) geoportal mapping tool (https://gis.epa.ie/EPAMaps/);
- National Parks and Wildlife Service protected site and species information and data (https://www.npws.ie/protected-sites);
- National Biodiversity Data Centre (www.biodiversityireland.ie); and
- Ordnance Survey of Ireland mapping and aerial photography (www.osi.ie).

4 Stage 1: Screening for Appropriate Assessment

4.1 Site location

The location of the proposed development is on Aughinish Island, near Foynes Co. Limerick (Figure 4.1).

The AAL facility was constructed on Aughinish Island between 1978 and 1983. Aughinish Island is located c. 6km northwest of Askeaton and c. 30km west of Limerick City Centre on the southern side of the Shannon Estuary near the industrial port of Foynes, Co. Limerick. The facility has been in operation, subject to planning and environmental regulation since that time. The overall landholding extends to c. 601 hectares (Figure 4.1)

The Limerick – Foynes railway line (closed in 2002) runs to the south of the island, as does the N69 National Secondary Route between Limerick and Tarbert. Aughinish Island is accessed via the L1234 Aughinish Road, which is a two-way local road which connects with the N69. The application site is located at the western portion of the Applicant's overall landholding at Aughinish Island, to the southwest of the process area of the refinery plant (Figure 4.1). The subject site is bounded by grassland and vegetation to the north, beyond which lies the Shannon Estuary.

The process area of the refinery plant is located to the northeast of the site with AAL Sports Complex, a Limerick City and County Council (LCCC) water treatment plant and main site access road all located to the east of the site. The western boundary of the site runs parallel with the Robertstown River, the edge of which is defined by an existing flood tidal defence berm (FTDB) and drainage channel. The application site, showing the extent of the existing BRDA and the local watercourses is shown in Figure 4.2.

4.2 Plant Operation & History

The AAL facility has operated under EPA license since 1998 and AAL was most recently granted a revised IEL (P0035-07) in September 2021. The Licence grants AAL permission to carry out the following activities in accordance with the requirements and conditions set out in the Licence:

- The production of inorganic chemicals
- The combustion of fuels installations with a total rated thermal input of 50MW or more; and
- The recovery or disposal of waste in a facility.

The AAL refinery plant extracts alumina from bauxite using the Bayer Process, a chemical method that has been developed and refined over the past century and is used by over 40 alumina extraction plants worldwide. Approximately 70% of the bauxite processed by AAL comes from Guinea in West Africa with the remainder coming from Brazil. The finished product, alumina (aluminium oxide), is exported for further processing through smelting to aluminium metal. Plant production has been continually increased since the commissioning of the refinery plant in 1983, up to its current maximum production of approximately 1.95 million tonnes of alumina per annum.

AAL extracts alumina from bauxite ore using the Bayer process, which comprises four principal stages:

1. Digestion of the bauxite ore, during which the ore is ground and mixed with a sodium hydroxide solution to form a slurry, with the digestion taking place at high pressure and temperature
2. Clarification of the liquor stream from the digestion process, with the stream containing the alumina in solution
3. Precipitation of alumina hydrate from the clarified stream
4. Calcination (removal of chemically bound water) of the alumina trihydrate to produce the finished alumina product.

The bauxite ore is unloaded, and processed alumina loaded at the deep-water marine terminal in the Shannon Estuary. The inner berth is used for the loading of alumina, as well as the unloading of acid and caustic deliveries, while the outer berth is used for unloading the incoming bauxite ore. Waste products from the Bayer process include bauxite residue and salt cake. The bauxite residue and the salt cake are deposited in the BRDA (Figure 4.2). Bauxite residue is classified as non-hazardous. Salt cake, which is hazardous, is deposited in a specially designed engineered cell within the BRDA.

The Phase 1 BRDA is formed from two facilities, the original Phase 1 BRDA constructed in the early 1980s, covering an area of 72 ha., and the Phase 1 BRDA extension, constructed in the mid-to-late 1990s, covering an area of 32 ha. The initial design for the Phase 1 BRDA was to provide a disposal area to the year 2009 based on the facility constructed to Stage 7 (elevation 18 mOD), which equates to a central dome elevation of 27.5 mOD or 26m above original ground level. The Phase 2 BRDA is a southern extension of the Phase 1 BRDA that was permitted in 2007 (Limerick County Council Reg. Ref. 05/1836; ABP Ref. PL13.217976) to Stage 10 with a maximum perimeter elevation of 24 mOD and a maximum central elevation of 32 mOD. The Phase 2 BRDA merges with the southern extent of the Phase 1 BRDA. The Phase 2 BRDA covers an area of approximately 80 ha. and was commissioned in 2011. The permitted BRDA provides a disposal area for bauxite residue at the facility until c. 2030. The current level of the BRDA residue varies, from 22 mOD to 32mOD in Phase 1 to 11mOD to 20mOD in Phase 2.

4.3 Proposed development

The proposed development comprises of:

- An expansion of the Bauxite Residue Disposal Area (BRDA) to increase its disposal capacity in order to accommodate additional bauxite residue resulting in a proposed increase in height of c.12m (to c. 44m OD) above the currently permitted levels. No increase to the existing footprint of the BRDA is proposed.
- An extension to the existing Salt Cake Disposal Cell (SCDC) to accommodate further disposal of salt cake resulting in an increase in height of the cell by c.2.25m. The SCDC is located within the BRDA area. A description of the existing SCDC and its function is provided in Chapter 2 of this EIAR.
- An extension of the permitted borrow pit, located to the east of the BRDA, is also proposed. This extension proposes to increase the footprint of the borrow pit from c.4.5ha to c.8.4ha. This extension will provide an additional 380,000m3 of rock fill material which is needed to satisfy the requirements of the construction and operation of the BRDA.

- The continued use of an existing stockpile area at the south east of the subject site to store topsoil in order to satisfy the additional restoration requirements of the extended BRDA.
- Upgrades to the existing water management infrastructure to accommodate the BRDA development to Stage 16 which will also allow for greater Inflow Design Flood (IDF) capacity for the entirety of the BRDA.

Figure 4.1 Site location map (background image from Bing Mapping c. 2013).

Figure 4.2 Application site and location of the principal features.

4.3.1 Management Structure

Since March 2008, AAL has been wholly owned by United Company RUSAL, which is the largest integrated aluminium company worldwide.

AAL has a structured management approach to the operation of the business in terms of product quality, process control, environment, safety, training and analytical capability. Training of personnel is a key function in the successful operation of the refinery plant.

The EPA licence conditions requires the company to establish and maintain an Environmental Management System (EMS) and the conditions of the licence outline the form that the EMS should take at AAL. In order to demonstrate its commitment to environmental protection, AAL has gained certification of its EMS to the updated international standard ISO 14001:2015 in December 2017. AAL has been certified to the ISO14001 EMS since 2000.

AAL has an Energy Management System which is accredited to ISO 50001:2011 since 2016, and an International Safety Rating System (ISRS) Advanced Level 8 Safety Management System.

Safety, environmental and quality management systems are audited on an ongoing basis by a combination of internal audit teams and external certification surveillance audits by the certification body Det Norske Veritas (DNV UK). The various management systems operated by AAL are summarised in Table 4.1.

Table 4.1: Management Systems at AAL

System	Accreditation Body
International Safety Rating System (ISRS)	DNV UK
ISO 9001 (2015) Quality Management System	DNV UK
ISO 14001 (2015) Environmental Management System	DNV UK
ISO 50001 Energy Management System	Certification Europe

4.3.2 History of Licencing and Operating Principles

Table 4.2 below summarises the licensing history of the site from the EPA.

Table 4.2: Licensing History of the site from the EPA.

Licence Reference	Date of Grant	Description
P0035-01	May 1998	Original IPC licence.
P0035-02	January 2004	To accommodate the installation of two natural gas fired turbines with a capacity of approximately 75 MW electrical output each.
P0035-03	October 2004	Application withdrawn
P0035-04	April 2008	To extend the bauxite residue disposal area, to accommodate the participation of the site in the national emissions reduction plan, and to update the licence to incorporate amendments to the EPA Act.
P0035-05	October 2012	To reflect the requirements of the European Communities Environmental Objectives (Surface Water) Regulations, the European Communities Environmental Objectives (Ground Water) Regulations, and the Waste Management (Management of Waste from the Extractive Industries) Regulations.
P0035-06	July 2014	To accommodate the installation and operation of two natural gas-fired boilers.
P0035-07	September 2021	To allow for operation of permitted borrow pit and a derogation on effluent emissions.

4.4 Best Available Technology (BAT)

The entire AAL facility operates according to Best Available Technology/Techniques (BAT) principles. The BAT concept was first used in the 1992 OSPAR Convention for the protection of the marine environment of the North-East Atlantic for all types of industrial installations. The 1996 Integrated Pollution Prevention and Control Directive, 96/61/EC, applied the concept of Best Available Techniques (BAT) to the integrated control of pollution to air, water and soil. The 2010 Industrial Emissions Directive (IED) (2010/75/EU) adapted the BAT concept.

Commission Implementing Decision EU 2016/1032 on the establishment of best available techniques (BAT) conclusions under Directive 2010/75/EU for the non-ferrous industries covers the production of aluminium oxide from bauxite prior to the production of primary aluminium, where this is an integral part of the production of the metal.

BAT for a given industrial sector are described in BAT reference documents called BREF's (Best Available Technology Reference documents), as defined by Article 3(11) of the IED. The BREFs are derived from information exchanges between Member States, members of the industry concerned, non-governmental organisations and the European Commission. The BREF contains the BAT Conclusions which are required to be implemented by the Member States when setting permit conditions for large industrial installations. In line with Article 15(2) of the IED, emission limit values (ELVs) and the equivalent parameters and technical measures granted in permits must be based on BAT, without prescribing the use of any specific technique or specific technology.

Best Available Technology (BAT) is defined in Section 5(1) of the Environmental Protection Agency Act 1992, as amended (Article 2(11) of the IPPC Directive as *'the most efficient and advanced stage in the development of an activity and its methods of operation, which indicates the practical suitability of particular techniques for providing, in principle, the basis for emission limit values, and in the case of an industrial emission directive activity other additional licence conditions, designed to prevent or eliminate or, where this is not practicable, generally to reduce an emission and its impact on the environment as a whole'*, where:

'Best' in relation to techniques, means the most effective in achieving a high general level of protection of the environment as a whole.

'Available techniques' means those techniques developed on a scale which allows implementation in the relevant schedules activities under the 1992 EPA Act, under economically and technical viable conditions, to be used by the activity

'Techniques' include both the technology used and the way in which the installation is designed, built, managed, maintained, operated and decommissioned.

The Directive sets out that competent authorities responsible for issuing permits are required to take account of the general principles set out in Article 3 of the Directive when determining the conditions of the permit. These conditions must include emission limit values. The Directive states that in all circumstances, the conditions of the permit must include provisions on the minimisation of long-distance or transboundary pollution and must insure a high level of protection for the environment.

Those BAT guidance documents, Commission Implementing Decisions and BREF documents which are applicable to AAL are summarised in Table 4.3.

Table 4.3: BAT Guidance, BREF documents, Commission Implementing Decisions applicable to AAL.

Document Type	Year of Issue	Title
Reference Document on Best Available Techniques (BREF)	2018	BREF on Management of Waste from Extractive Industries
Commission Implementing Decision (CID)	2017	CID for Large Combustion Plant
Commission Implementing Decision (CID)	2016	CID for Common Wastewater and Waste Gas Treatment in the Chemical Sector
Commission Implementing Decision (CID)	2017	CID for the Non-Ferrous Metals Industry
Reference Document on Best Available Techniques (BREF)	2009	BREF for Energy Efficiency
Reference Document on Best Available Techniques (BREF)	2006	BREF on Emissions from Storage
Reference Document on Best Available Techniques (BREF)	2001	BREF on Industrial Cooling Systems
Reference Document on Best Available Techniques (BREF)	2006	BREF on Economics and Cross Media Effects
Reference Document on Best Available Techniques (BREF)	2003	BREF on General Principles of Monitoring
Reference Document on Best Available Techniques (BREF)	2018	BREF on Management of Waste from Extractive Industries
Reference Document on Best Available Techniques (BREF)	2007	BREF on Large Volume Inorganic Chemicals, Solids and Other Industry
BAT Guidance Note	2008	General Inorganic and Alumina Sector

4.5 Conservation Sites & Natura 2000 Network

Designated nature conservation sites within the wider hinterland of the proposed development site were identified through a desktop review. European sites, Special Areas of Conservation (SACs) and Special Protection Areas (SPAs) have been designated under the EU Habitats Directive (92/43/EEC) and the EU Birds Directive (2009/147/EC) respectively. SACs and SPAs are collectively known as Natura 2000 sites and are legally protected by Irish law. The Qualifying Interests (QIs) of SACs include high value conservation habitats and species in the EU and listed in the Habitats Directive. The Special Conservation Interests (SCIs) of the SPAs are birds of European conservation importance and associated wetland habitats of particular importance for these species.

The application site is not located within any Natura 2000 site. The application site boundary is located 0.01km from the Lower River Shannon SAC (Site Code 002165) and the River Shannon and River Fergus Estuaries SPA (Site Code 004077; Figure 4.3a). The lands under the ownership of AAL include areas of natural/semi-natural grassland and wetland habitat some of which are located within these two designated Natura 2000 sites.

Additionally, there are a further three SAC's (Barrigone SAC, Site Code 000432, Askeaton Fen Complex SAC, Site Code 002279 & Curraghchase Woods SAC, Site Code 000174) and one more SPA (Stack's to Mullaghareirk Mts., West Limerick Hills & Mt. Eagle, Site Code 004161) located within 15km of the proposed development site (Figure 4.3a).

Table 4.4: Minimum distance from the application site to designated nature conservation sites in wider hinterland.

Site Name	Site Code	Minimum Distance (km)
Natura 2000 sites		
Lower River Shannon SAC	002165	0.01
River Shannon & River Fergus Estuaries SPA	004077	0.01
Barrigone SAC	000432	0.45
Stack's to Mullaghareirk Mts., West Limerick Hills & Mt. Eagle Bog SPA	004161	6.61
Askeaton Fen Complex SAC	002279	8.13
Curraghchase Woods SAC	000174	11.05

Details on the key features (qualifying and special conservation interests) of all of the Natura 2000 sites within 15km of the proposed development are outlined in Table 4.5. Full details of the site synopses and conservation objectives of each of these sites as published by NPWS are available online (www.npws.ie). The designated Natura 2000 sites proximate to the application site are shown in Figure 4.3b.

The conservation objectives of the Lower River Shannon SAC relate to a wide range of largely aquatic habitats and species with a number of different Annex I habitats and associated Annex II species. These include:

- Otter *(Lutra lutra)*
- Freshwater Pearl Mussel (*Margaritifera margaritifera*),
- Salmon (*Salmo salar*),
- Sea Lamprey (*Petromyzon marinus)*
- Brook Lamprey *(Lampetra planeri)*

- River Lamprey (*Lampetra fluviatilis*)
- Estuaries
- Sandbanks which are slightly covered by sea water all the time
- Coastal lagoons
- Mudflats and sandflats not covered by seawater all the time

The conservation objectives of the River Shannon and River Fergus Estuaries SPA relate chiefly to wintering bird species;

- Whooper Swan (*Cygnus cygnus*)
- Light-bellied Brent Goose (*Branta bernicla hrota*)
- Shelduck (*Tadorna tadorna*)
- Wigeon (*Anas penelope*)
- Teal (*Anas crecca*)
- Pintail (*Anas acuta*)
- Shoveler (*Anas clypeata*)
- Scaup (*Aythya marila*)
- Ringed Plover (*Charadrius hiaticula*)
- Golden Plover (*Pluvialis apricaria*)
- Grey Plover (*Pluvialis squatarola*)
- Lapwing (*Vanellus vanellus*)
- Knot (*Calidris canutus*)
- Dunlin (*Calidris alpina*)
- Black-tailed Godwit (*Limosa limosa*)
- Bar-tailed Godwit (*Limosa lapponica*)
- Curlew (*Numenius arquata*)
- Redshank (*Tringa totanus*)
- Greenshank (*Tringa nebularia*)
- Black-headed Gull (*Chroicocephalus ridibundus*)

Cormorant (*Phalacrocorax carbo*) is also listed as a conservation objective but for both wintering and breeding numbers.

Barrigone SAC is an area of species rich, calcareous grassland. It has been designated as an SAC for the following conservation objectives:

- Marsh Fritillary (*Euphydryas aurinia*)
- *Juniperus communis* formations on heaths or calcareous grasslands
- Semi-natural dry grasslands and scrubland facies on calcareous substrates (Festuco Brometalia; important orchid sites)
- Limestone pavements

Askeaton Fen Complex SAC comprises of a number of small fen areas that have been designated for the following habitats:

- Calcareous fens with *Cladium mariscus* and species of the Caricion davallianae

- Alkaline fens

The Stack's to Mullaghareirk Mountains, West Limerick Hills and Mt Eagle SPA is a large upland site designated for the conservation of a single species:

- Hen Harrier (*Circus cyaneus*)

Curraghchase Woods SAC, located 11km from the licensed facility boundary, is designated for the conservation of two priority Annex I habitats and one Annex II species:

- Alluvial forests with Alder, *Alnus glutinosa* and Ash, *Fraxinus excelsior* (Alno-Padion, Alnion incanae, Salicion albae)
- Yew, *Taxus baccata*, woods of the British Isles
- Lesser Horseshoe Bat, *Rhinolophus hipposideros*

The overall aim of the Habitats Directive is to maintain or restore the favourable conservation status of habitats and species of community interest. These habitats and species are listed in the Habitats and Birds Directives and SACs and SPAs are designated to afford protection to the most vulnerable of them. According to the Habitats and Birds Directive the 'Favourable' conservation status of a habitat is achieved when:

- its natural range, and area it covers within that range, are stable or increasing, and
- the specific structure and functions which are necessary for its long-term maintenance exist and are likely to continue to exist for the foreseeable future, and
- the conservation status of its typical species is favourable.

The 'Favourable' conservation status of a species is achieved when:

- population dynamics data on the species concerned indicate that it is maintaining itself on a long-term basis as a viable component of its natural habitats, and
- the natural range of the species is neither being reduced nor is likely to be reduced for the foreseeable future, and
- there is, and will probably continue to be, a sufficiently large habitat to maintain its populations on a long-term basis.

The above objectives form the basis of conservation objectives developed for Natura 2000 sites by NPWS and are published online as 'Generic Conservation Objectives' for Natura 2000 sites in Ireland.

Site specific conservation objectives are also available for certain Natura 2000 sites which detail contextual conservation targets for the qualifying criteria of the individual Natura 2000 sites. These site-specific conservation objectives are typically accompanied by backing documentation in the form of 'Conservation objectives supporting documents' or 'Conservation Plans'.

Table 4.5: Summary of European Designated Sites located in the 15km Hinterland of the application site.

Site Name & Code	Summary Details	Minimum Distance (km)
Lower River Shannon SAC (002165)	The conservation objectives of this site are to maintain the favourable conservation condition of the Annex I habitats and fauna listed as Special Conservation Interests for this SAC: • Sandbanks • Estuaries • Tidal Mudflats and Sandflats • Coastal Lagoons* • Large Shallow Inlets and Bays • Reefs • Perennial Vegetation of Stony Banks • Vegetated Sea Cliffs • *Salicornia* Mud • Atlantic Salt Meadows • Mediterranean Salt Meadows • Floating River Vegetation • *Molinia* Meadows • Alluvial Forests* • Freshwater Pearl Mussel *Margaritifera margaritifera* • Sea Lamprey *Petromyzon marinus* • Brook Lamprey *Lampetra planeri* • River Lamprey *Lampetra fluviatilis* • Atlantic Salmon *Salmo salar* • Bottlenose Dolphin *Tursiops truncatus* • Otter *Lutra lutra*	0.01 km
River Shannon and River Fergus Estuaries SPA (004077)	The conservation objectives of this site are to maintain the favourable conservation condition of the bird species listed as Special Conservation Interests for this SPA: Breeding and Wintering • Cormorant *Phalacrocorax carbo* Wintering • Whooper Swan *Cygnus cygnus* • Light-bellied Brent Goose *Branta bernicla hrota* • Shelduck *Tadorna tadorna* • Wigeon *Anas penelope* • Teal *Anas crecca* • Pintail *Anas acuta* • Shoveler *Anas clypeata*	0.01 km

Site Name & Code	Summary Details	Minimum Distance (km)
	● Scaup *Aythya marila* ● Ringed Plover *Charadrius hiaticula* ● Golden Plover *Pluvialis apricaria* ● Grey Plover *Pluvialis squatarola* ● Lapwing *Vanellus vanellus* ● Knot *Calidris canutus* ● Dunlin *Calidris alpina* ● Black-tailed Godwit *Limosa limosa* ● Bar-tailed Godwit *Limosa lapponica* ● Curlew *Numenius arquata* ● Redshank *Tringa totanus* ● Greenshank *Tringa nebularia* ● Black-headed Gull *Chroicocephalus ridibundus* ● Wetlands	
Barrigone SAC (000432)	The conservation objectives of this site are to maintain the favourable conservation condition of the habitats and fauna listed as Special Conservation Interests for this SAC: ● *Juniperus communis* formations on heaths or calcareous grasslands ● Semi-natural dry grasslands and scrubland facies on calcareous substrates (Festuco Brometalia) (* important orchid sites)* ● Limestone pavements* ● Marsh Fritillary *Euphydryas aurinia*	0.5 km
Stacks to Mullaghareirk Mts., West Limerick Hills & Mt. Eagle SPA (004161)	The conservation objectives of this site are to maintain the favourable conservation condition of the bird species listed as Special Conservation Interests for this SPA: ● Hen Harrier (*Circus cyaneus*)	6.6 km
Askeaton Fen Complex SAC (002279)	The conservation objectives of this site are to maintain the favourable conservation condition of the Annex I habitats listed as Special Conservation Interests for this SAC ● Calcareous fens with *Cladium mariscus* and species of the Caricion davallianae* ● Alkaline fens	8.1 km
Curraghchase Wood SAC (000174)	The conservation objectives of this site are to maintain the favourable conservation condition of the habitats and fauna listed as Special Conservation Interests for this SAC: ● Alluvial forests with *Alnus glutinosa* and *Fraxinus excelsior* (Alno-Padion, Alnion incanae, Salicion albae)* ● *Taxus baccata* woods of the British Isles* ● Lesser Horseshoe Bat *Rhinolophus hipposideros*	11.1 km

* denotes a priority habitat

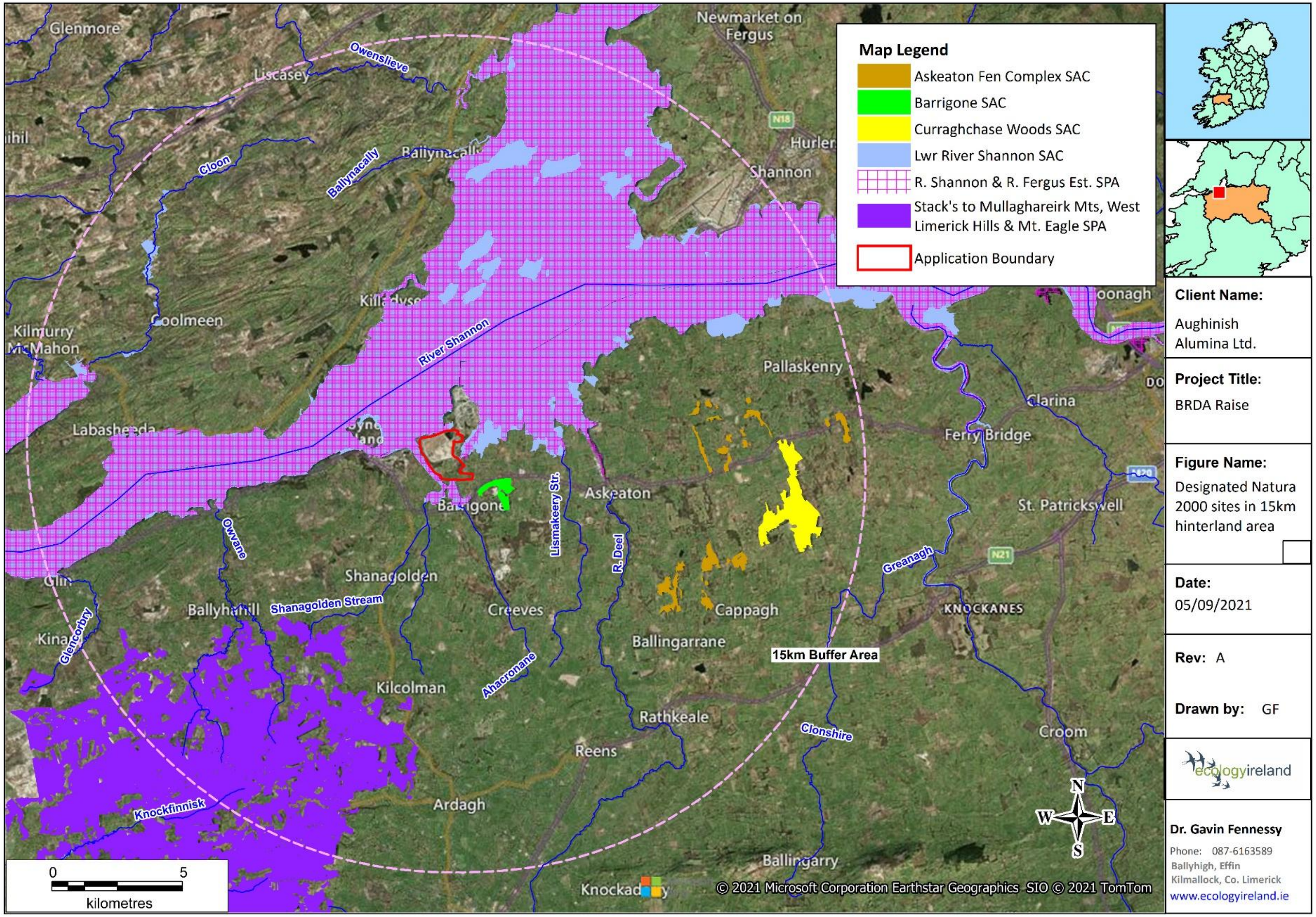

Figure 4.3a Designated Natura 2000 sites in 15km hinterland (background image from Bing Mapping c. 2013).

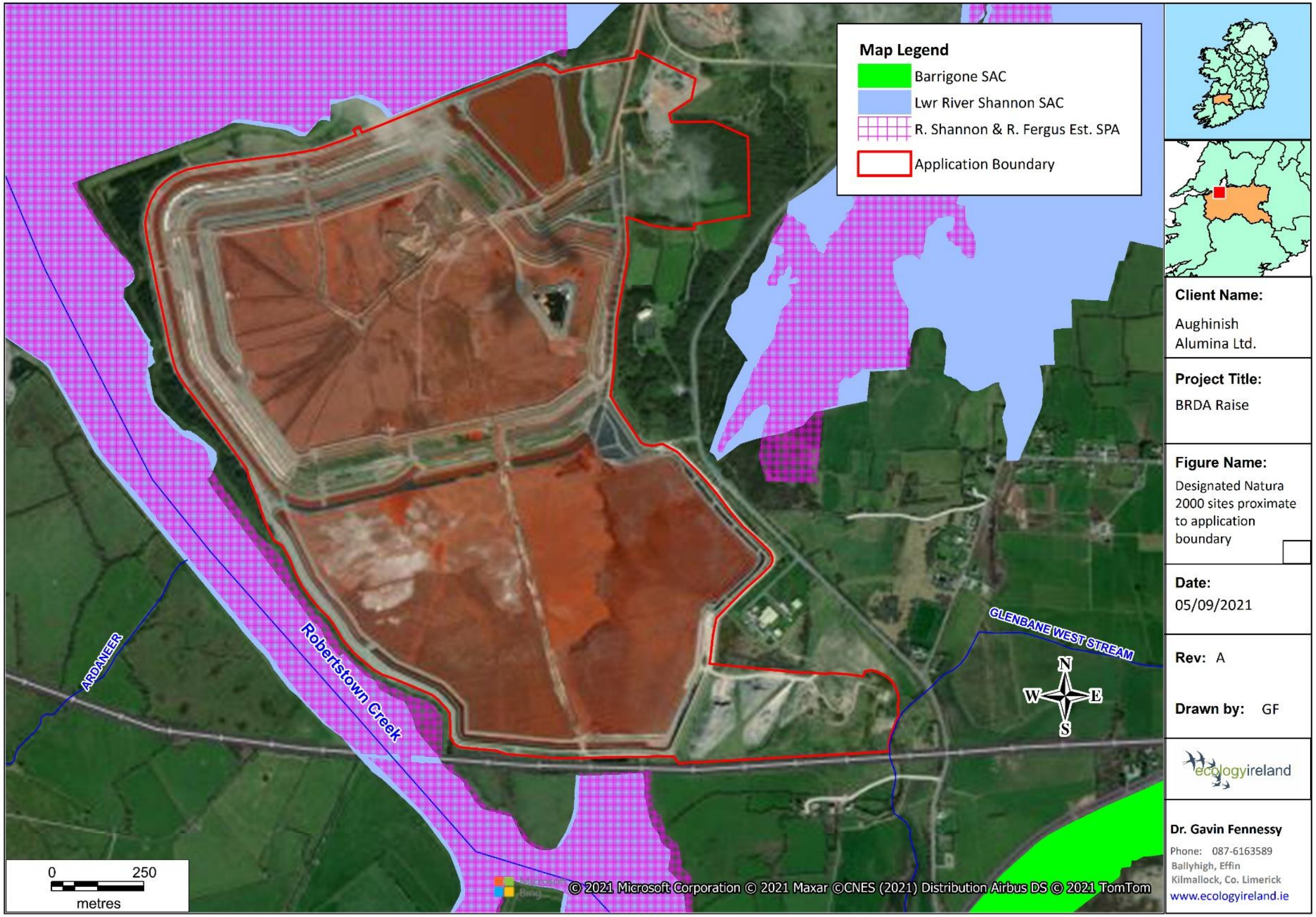

Figure 4.3b Designated Natura 2000 sites proximate to the application boundary (background image from Bing Mapping c. 2013)**.**

5 Stage 1: Assessment Criteria

The proposed development is not connected with or necessary for the conservation management of any Natura 2000 site.

The screening stage assessment summarised herein considers the proposed project on its own and in combination with other plans and projects and the likelihood for significant effects on Natura 2000 sites to arise in relation with the development at this location.

The proposed development will see an increase in the height of the BRDA and extension to the permitted borrow pit. The operation of the refinery plant will continue according to the licence conditions which set strict limits for emissions.

Emissions are discussed broadly in respect of the Proposed Development (i.e. increase in the BRDA height, extension to the SCDC and extension to the permitted borrow pit). Due consideration is given to aspects of the proposed development which could potentially result in the likelihood of significanteffects upon the designated sites within the zone of influence.

We present below a summary of the screening process of Natura 2000 sites where likely significant effects might potentially occur, in the absence of mitigation. We have set the study area to a nominal 15km offset from the facility boundary. This is an arbitrary distance typically used for illustrative purposes (e.g. DoEHLG 2009). The potential for impacts upon more distant designated sites is considered in the event that any likely significant effects are identified in relation to these distant sites during the assessment process.

The operation of the AAL facility has been subject to the terms of the existing IE licence and AAL report on the monitoring of licensed emissions at agreed intervals. The operation of the overall facility was subject to Appropriate Assessment by the EPA as part of the licence review (IEL P0035-07), which was applied for in order to operate the permitted borrow pit. The NIS prepared in support of the AA process for the recent IEL review is presented in Appendix A to the current NIS.

5.1 Elements of the Project Likely to Impact on the Natura 2000 Sites

As described in Chapter 1 of the accompanying EIAR the proposed development comprises of:

- An expansion of the Bauxite Residue Disposal Area (BRDA) to increase its disposal capacity in order to accommodate additional bauxite residue resulting in a proposed increase in height of c.12m (to c. 44m OD) above the currently permitted levels. No increase to the existing footprint of the BRDA is proposed.
- An extension to the existing Salt Cake Disposal Cell (SCDC) to accommodate further disposal of salt cake resulting in an increase in height of the cell by c.2.25m. The SCDC is located within the BRDA area. A description of the existing SCDC and its function is provided in Chapter 2 of this EIAR.

- An extension of the permitted borrow pit[1], located to the east of the BRDA, is also proposed. This extension proposes to increase the footprint of the borrow pit from c.4.5ha to c.8.4ha. This extension will provide an additional 380,000m^3 of rock fill material which is needed to satisfy the requirements of the construction and operation of the BRDA.
- The continued use of an existing stockpile area at the south east of the subject site to store topsoil in order to satisfy the additional restoration requirements of the extended BRDA.
- Upgrades to the existing water management infrastructure to accommodate the BRDA development to Stage 16 which will also allow for greater Inflow Design Flood (IDF) capacity for the entirety of the BRDA.

5.1.1 BRDA AND SALT CAKE DISPOSAL CELL

The BRDA comprises the majority of the subject site area. The Phase 1 BRDA area, located at the north of the application site measures c.104ha. The Phase 2 BRDA area, located at the south of the subject site measures c.80ha. As outlined in the accompanying EIAR, the BRDA areas are principally comprised of perimeter walls and channels enclosing a basin of bauxite residue which is stored in a terraced form structure comprising 10 no. permitted terraces known as stage raises. Deposits within the Phase 1 BRDA are at the stage 10 level, whilst deposits within the Phase 2 area, which has been in operation for a shorter time period, is deposited at the stage 4 level. Ancillary infrastructure located within the BRDA area includes the Salt Cake Disposal Cell, located at the east of the Phase 1 area and a Storm Water Pond (SWP) and Liquid Waste Pond (LWP) located to the northeast of the Phase 1 BRDA area. The main parts of the site are shown in Figure 5.1 below.

The location of the Bauxite Residue Disposal Area (BRDA) is shown in Figure 5.1 and it occupies 94.5 ha in Phase 1 and 74 ha in Phase 2. The BRDA is a dedicated extractive waste facility operated and owned by AAL for the permanent disposal of bauxite residue generated during the alumina extraction process. Bauxite residue and process related wastes generated during the alumina extractive process are deposited in accordance with the requirements of the IEL. These wastes represents about 99% of the total residue disposed of in the BRDA, with the other 1% consisting of salt cake, which is deposited in a dedicated specially engineered cell within the BRDA. The bauxite residue is subject to counter-current washing and dewatering via vacuum filtration to provide a high-density slurry. This is pumped to the BRDA and farmed to achieve atmospheric carbonation. Farmed bauxite residue is classified as non-hazardous (LoW 01 03 09) while the salt cake is classified as hazardous (LoW 01 03 07).

[1] Limerick City and County Council (LCCC) Reg. Ref. 17/714; An Bord Pleanála (ABP) Ref. 301011-18

Figure 5.1 Main elements within the application site (after Golder).

5.1.2 BORROW PIT

The permitted borrow pit area is located at the northeast of the application site and is c.4.5ha in size (LCCC Reg. Ref. 17/714; ABP Ref. 301011-18). It will serve the construction and operation of the BRDA by providing processed rock which is required to build up the stage raises before residue is deposited and then contained by the rock-fill. The permitted borrow pit area has a permitted depth of c.8.5m OD. Rock extraction and the initial blasts at this borrow pit are expected to take place during April 2022. The current borrow pit area is expected to provide 375,000 m^3 of rock fill material which is considered to be sufficient to construct the permitted BRDA to Stage 10 (220,000 m^3), to implement the closure design (105,000 m^3) and miscellaneous rock fill (50,000 m^3). Adjacent to the existing borrow pit area to the east is an area which is currently covered in vegetation which is also part of the current application site. It is proposed that the borrow pit will extend eastwards into this area to facilitate the expansion and raising of the BRDA. Details in this regard are provided in Chapter 3 of the accompanying EIAR.

5.1.3 STOCKPILE AREA

An existing storage/stockpile area is located at the southeast of the application site. This area measures c.12.5ha. The area currently accommodates rock and topsoil which is used to construct and progressively restore the BRDA. In addition, portions of the area are covered in vegetation at present.

5.1.4 UPGRADES TO WATER MANAGEMENT INFRASTRUCTURE

As described in Chapter 10 of the EIAR improvements to the water management system for the proposed BRDA development will be implemented to allow for the existing PIC system, SWP and LWP to accommodate the Inflow Design Flood (IDF) for the Proposed Development. Improvements to be implemented include the following:

- Provision of additional culverts for several PICs;
- Increases to PIC crest elevations for several PICs;
- Construction of PIC-M;
- PIC pump arrangement upgrades for PICs G and K;
- Pumped flows from the refinery plant Site to discharge to the SWP rather than the PIC system. This is intended to reduce the volume of water discharging to the PIC during the IDF and reduce the overall PIC pumping capacity required to accommodate the IDF.

5.1.5 Consideration of Natura 2000 sites and Zone of Influence

Details of the proposed development were considered in relation to the distribution of Natura 2000 sites in the wider area. Consideration of the Source-Receptor-Pathway (SPR) model was key to the preliminary screening process. This considered the potential sources of emission arising from the development site, during operation, closure and post-closure of the facility. The potential pathways through air, water etc. were all considered with the specialist information presented in the EIAR and the previous NIS important resources in this regard. Assessments of traffic, noise (e.g. in relation to blasting) were all reviewed to understand the baseline and predicted levels of potential sources of disturbance associated with the proposed development.

Following this initial screening of Natura 2000 sites, there were no sites identified beyond 15km from the application boundary, which were adjudged likely to be affected by likely significant effects associated with the proposed development.

This finding is in keeping with the NIS from the overall AAL facility, prepared for the IEL Review in 2020 (Ecology Ireland 2020; Appendix A) which considered all sources of emission. Each of the Natura 2000 sites within 15km of the application boundary was considered in detail in the screening process and this process is summarised below). The potential for habitat loss or degradation was assessed along with the potential for disturbance and displacement of faunal species arising from the proposed development.

The application site is proximate to two designated sites, the Lower River Shannon SAC and River Shannon & River Fergus Estuaries SPA.

Barrigone SAC is designated for habitats and one fauna species; Marsh Fritillary *Euphydryas aurinia*. There are no habitats relating to the conservation objective of Barrigone SAC present within the application site including the proposed borrow pit extension area and no suitable food plant (i.e. Devil's-bit Scabious *Succisa pretense*) for Marsh Fritillary has been documented here. However, Devil's-bit Scabious has been recorded in the diverse grassland elsewhere on the island (e.g. at the back of the old sea-wall at the west of the site). Given the proximity of the Barrigone SAC to the licensed facility there is some likelihood of significant effects, in the absence of suitable mitigation. Therefore, Barrigone SAC and its Conservation Objectives have been included for further consideration at NIS stage.

The Stacks to Mullaghareirk Mts., West Limerick Hills & Mt. Eagle SPA is designated for Hen Harrier only. Due to the location of this designated site in relation to the AAL facility, a lack of suitable Hen Harrier habitat within the application site and no potential direct or indirect hydrological link; no impacts on this designated site are therefore expected as a result of the proposed development and this designated site will not be assessed further in this report.

Askeaton Fen Complex SAC is designated for the protection of qualifying habitats only and does not contain any fauna that could suffer disturbance/displacement impacts (including ex-situ impacts) as a result of the operations at the AAL facility. There will be no direct or indirect loss of habitat and no disturbance impacts on this designated site are expected as a result of the proposed development and this site will not be assessed further in this report.

Curraghchase Woods SAC is designated for the protection of qualifying woodland habitats and for Lesser Horseshoe Bat, *Rhinolophus hipposideros*. No habitats associated with this designated site are located within the operational footprint of the refinery plant, including within the application site boundary and there is no potential direct, or indirect, hydrological link with the site and no known day roost for the species has been recorded on the island. There is also limited foraging potential for the species within the application site boundary. The BRDA is relatively open and exposed in nature and unattractive to commuting or foraging bats. The scrub and woodland patches within the application site have some potential for foraging bats but these areas are relatively small and do not have a high resource value for Lesser Horseshoe Bats. There is no likelihood of significant effects arising from the proposed development on Curraghchase Woods SAC located over 11km distant.

We further considered the likely significant effects of the proposed development on designated Natura 2000 sites with reference to the nature of the activity and in particular the potential emissions arising from the application site in relation to the following screening assessment criteria:

- Size, scale, area, land-take of the project
- Physical changes that will occur as a result of the plan
- Resource requirements (water abstraction etc.)
- Construction and operational requirements

- Emissions and waste (disposal to land, water or air)
- Transportation requirements
- Duration of construction and operation
- Disturbance and displacement
- Cumulative impacts with other projects or plans

In conjunction with consideration of the likely changes to the Natura 2000 sites, including:

- Loss of habitat
- Habitat or species fragmentation
- Disturbance to key species
- Reduction in species density
- Changes in key indicators of conservation value (water quality *etc*.)
- Change to key elements of the site

The proposed development will change very little in relation to the licensed activities at the AAL facility. The purpose of the application is principally to extend the lifetime of the refinery plant by increasing the capacity of the BRDA. The rate of alumina production and bauxite residue deposition is not anticipated to change as a result of the proposed development. The facility operates under licence from the EPA. The EPA issue the strict conditions and emissions limits under which the AAL facility operates. It is somewhat artificial in these circumstances to imagine the operation of a facility such as AAL without controls, monitoring and time-proven measures designed to ensure the protection of the receiving environment, including habitats, flora and fauna. However, insofar as these measures (along with any future license or planning conditions) constitute mitigation of potential impacts on sensitive receptors, these elements have not been considered as part of this Stage 1 Screening Assessment.

Given the proximity of these Natura 2000 sites (Lower River Shannon SAC, Barrigone SAC and River Shannon and River Fergus Estuaries SPA) and the sensitivity of the qualifying and special conservation interests of these sites, the potential for likely significant effects on these designated areas (in the absence of appropriate mitigation) cannot be discounted at Screening Stage.

5.2 Likely Impacts of the Project on the Natura 2000 Sites

As outlined in Section 5.1 above, it is deemed that the proposed development could lead to significant effects on three Natura 2000 sites within the project ZoI; without the implementation of best practice measures, BAT, adherence to national and international emission standards and all mitigation and monitoring requirements required through planning and licensing of operations.

5.2.1 Size, Scale & Land-take

The lands subject to this current application measure c. 222 ha and currently accommodate processes associated with the operation of the wider facility. The overall landholding of the Applicant extends to c. 601 ha.

The lands within the application site are largely developed and dominated by the existing BRDA. The primary aspect of the proposed development would see an increase in the permitted height of the BRDA. Ultimately, the BRDA will be capped and the landscaping and closure plan implemented as described in the accompanying EIAR.

5.2.2 Distance from or Key Features of the Natura 2000 Sites

As described in Tables 4.4 & 4.5.

5.2.3 Resource Requirements (water abstraction *etc.*)

The proposed development will not require any resources (e.g. water abstraction) from any designated Natura 2000 site. Rock fill to facilitate the construction and operation of the BRDA will be sourced from the permitted and proposed borrow pit within the application site (See 5.2.4 below). Stockpiles of material (including rockfill and soil) will be stored in an area of the site which is currently used for a similar purpose – these materials will be used on site as part of the progressive restoration plan.

5.2.4 Excavation Requirements

It is proposed to extend the permitted Borrow Pit (17/714; ABP 301011) from 4.5ha to c. 8.4ha. This extension will provide an additional 380,000m^3 of rock fill material which is needed to satisfy the requirements of the construction and operation of the BRDA.

5.2.5 Emissions (disposal to land, water or air)

There are a range of existing and potential emissions from the application site. These emissions, particularly the emissions to air and water have the potential to impact on the three designated Natura 2000 sites within the ZoI in the absence of adequate monitoring and mitigation. For this reason, emissions from the application site are a principal focus of the NIS. A Conceptual Site Model (CSM) has been produced which assesses the potential for contaminant source receptor pathways from site emissions to the marine environment. The CSM is appended to this document (Appendix B).

5.2.6 Transportation Requirements

The proposed development will not increase the maximum output of the deposited wastes. The borrow pit will provide the stone-fill to facilitate the proposed stage raises to the BRDA. Sourcing this stone on-site will remove the need for externally sourced stone and the associated transportation requirements. Chapter 14 of the EIAR acknowledges that while the proposed development will extend the operational life of the AAL production facility that it will not contribute to a material increase in local traffic above current levels.

5.2.7 Duration of Operations

The site has been in operation since 1983 and is continuing to operate in accordance with its planning permission and IE Licence. The proposed development would facilitate an extension in the lifetime of the industrial operation by providing increased capacity within the BRDA. The operation of the facility will continue to operate in accordance with the existing commitments including monitoring and licensing requirements of the EPA.

5.2.8 In-combination Effects

The potential cumulative impact of the Proposed Development with other existing and/or approved projects has also been assessed. A survey of existing and/or approved projects in the area was undertaken to determine whether the nature and scale of each of these projects could be sufficient to generate cumulative impacts of significance on the environment. The projects identified as part of this survey are listed in Appendix 18.1 in the EIAR and reproduced below in Table 5.1.

For the purposes of this survey, all planning applications which were recorded on the National Planning Applications Database (DoHPLG) with extant permissions or were otherwise under consideration as of August 2021 within a c. 15km radius of the Subject Development were included. A record of 'major' planning applications within c. 15km of the planning boundary was established in August 2021. These applications were determined to constitute new development of a commercial, industrial, agricultural or residential nature, which may be of significance to the cumulative assessment. The following types of applications were excluded from the final listing:

- Minor change of use applications;
- Residential applications of less than 10 no. units located greater than c. 1.5km of the subject site;
- Minor amendments to permitted applications;
- Retention applications;
- Minor signage applications;
- ESB infrastructure (i.e. substations, switch rooms and towers);
- Minor utilities works including lighting and junction upgrades;
- Developments of a scale that would not exacerbate significant environmental effects (e.g. internal reorganisation, car parking of less than 20 spaces, continuance of use, etc.);
- Developments that have become operational by the time of writing (as they have been considered in the baseline); and
- Applications that were granted prior to February 2016 as it is assumed that these permissions will have lapsed, unless otherwise stated in the Grant of Permission.

The 2017 EPA Draft Guidance (https://www.epa.ie/publications/monitoring--assessment/assessment/EPA_EIAR_Guidelines.pdf) describes cumulative effects as follows:

"*The addition of many minor or significant effects, including effects of other projects, to create larger, more significant effects. While a single activity may itself result in a minor impact, it may, when combined with other impacts (minor or significant), result in a cumulative impact that is collectively significant*." It is necessary to consider the potential for cumulative effects due to cumulation of effects with those of other projects that are existing or are approved, but not yet built or operational. Operational projects may act in combination with impacts arising from a proposed scheme, but effects associated with operational projects may already be part of the background baseline recorded in the receiving environment.

A sample of the projects considered as part of this assessment are summarised in Table 5.1. These projects were by and large subject to their own assessments and where applicable, specific mitigation to minimise impacts upon the receiving environment. The potential for residual impacts and those that would act in concert or synergistally with the proposed development was considered.

Notable projects which may have the potential to result in cumulative effects include the capacity extension at Shannon Foynes Port and the Foynes to Limerick N69 road scheme.

The facility is located close to the Shannon Estuary and just upstream of Shannon-Foynes Port. Shannon Foynes deep water port is a significant national port, Ireland's second largest port operation and has statutory jurisdiction over all marine activities on a 500 km^2 area on the Shannon Estuary, stretching from Kerry/Loop Heads to Limerick City. It is responsible for most of the commercial ship traffic on the Shannon estuary. The planned developments at Shannon Foynes Port were considered and environmental assessments prepared as part of proposed expansions and improvements to the facility were studied.

In December 2019, Limerick City and County Council (LCCC) applied under section 51(2) of the Roads Act 1993 (as amended) to An Bord Pleanála for approval as Strategic Infrastructure Development (SID) in relation to a proposed road development consisting of:

- Approximately 15.6km of Type 2 dual carriageway express road extending from Foynes to Rathkeale (with an intermediate roundabout junction at Ballyclogh) along with approximately 1.9km of single carriageway road between Ballyclogh and Askeaton;
- Approximately 17.5km of dual carriageway motorway, of which approximately 15.5km is new construction and/or widening of the existing road, from Rathkeale to Attyflin;
- A Service Area for Heavy Goods Vehicles approximately 5 ha in size near Foynes with access road and service roads, parking, facilities building and a new at-grade junction onto the Foynes port access road;
- LCCC submitted to the Board the Environmental Impact Assessment Report (formerly referred to as an Environmental Impact Statement) prepared in accordance with section 50 of the Roads Acts 1993 (as amended) in respect of the proposed road development. A Natura Impact Statement was also prepared and was submitted to the Board in respect of the proposed road development in accordance with Part XAB of the Planning and Development Acts 2000 – 2019. A decision from ABP is scheduled for late November 2021.

The permitted or existing projects given detailed consideration when assessing the potential for in-combination and cumulative impacts included the operation of the Wyeth Nutritionals Ireland Ltd. plant at Coolrahnee, Askeaton, licensed aquaculture activities and dredging and dumping activities in the Lower River Shannon.

No potential for significant cumulative or in combination effects on the local biodiversity were identified in relation to the plans and projects considered. Proposed projects of note such as the Foynes-Limerick N69 Roads scheme took into account potential impacts on biodiversity arising from their own project and in combination with other plans and projects and the detailed mitigation and monitoring commitments greatly lessened the scale and nature of potential residual impacts on biodiversity. Plans and projects might in themselves have identified potential ecological impacts, even some relatively minor residual effects. The potential for such residual effects, even when minor in scale or extent, to create larger more significant effects, was considered.

There was no project (or projects) identified where there was potential for significant additive or synergistic effects with the proposed AAL development.

Given the context of the existing site and considering the nature of the proposed works, it is concluded that it is unlikely that there will be any significant in-combination impacts upon any of the designated Natura 2000 sites or their conservation objectives.

Table 5.1 Projects considered as part of the cumulative and in-combination assessment.

Reg. Ref.	Description of proposed development	Address of development	Name of Planning Authority	Hyperlink to application on Planning Authority website
1724	for the following proposed development which will comprise of the construction of a new steel framed aircraft hangar within the airport lands at Shannon Airport, Co. Clare. The hangar building includes for ancillary office space, workshops, plant rooms and storage space. The building will have signage on the eastern, southern and western facades. Ancillary buildings and structures within the curtilage of the site including an external pump house, gas skid and fire suppression tank are also proposed. Site works proposed include car parking, hardstands, landscaping, and all ancillary site developments at this address. An Integrated Pollution and Control License is required for the facility	Lismacleane & Ballyhennessy, Bunratty Lower, Shannon Airport	Clare County Council	http://www.eplanning.ie/ClareCC/AppFileRefDetails/1724/0
1918	a ten year permission for the complete development of a Solar PV Energy development with a total site area of 30.15 hectares, to include, electrical transformer and invertor station modules, Solar PV panels ground mounted on support structures, access roads and internal access roads and internal access tracks, fencing, electrical cabling and ducting, CCTV and other ancillary infrastructure, a temporary site compound area, additional landscaping and habitat enhancement as required and associated site development works located in the townlands of Deelish and Mullagh. The proposed solar farm will be connected to the National Grid via the adjoining Ellaha and Ballinknockane solar	Deelish & Mullagh, Shanagolden, Co. Limerick.	Limerick County Council	http://eplan.limerick.ie/AppFileRefDetails/1918/0

Reg. Ref.	Description of proposed development	Address of development	Name of Planning Authority	Hyperlink to application on Planning Authority website
	farm previously granted planning permission under Limerick city & County Council planning ref 17/1220			
15468	smokeless and bio-mass based solid fuel manufacturing and packaging facility at and adjacent to existing coal storage and baggage facility. The development includes the demolition of existing buildings and storage structures, the upgrading, extension and change of use of an existing warehouse building for use as a solid fuel manufacturing process plant, construction of a new packaging plant building, construction of a new administration block and associated car park, installation of weighbridges and an associated kiosk, re-surfacing of the site and installation of a new drainage system, construction of storage areas for raw materials and finished product, construction of a new electricity substation, new site entrance works including the relocation of an existing entrance and construction of a new entrance and all associated site works including waste water treatment plant. This application is accompanied by an Environmental Impact Statement (EIS) and a Natura Impact Statement (NIS)	Durnish, International Port Road, Shannon Foynes Port	Limerick County Council	http://eplan.limerick.ie/AppFileRefDetails/15468/0
15948	(1) portacabin used as staff canteen, (2) silo, mixing room and hoppers for materials, Planning Permission for (3) the construction of an extension to the main production building and (4) lay a concrete yard over existing hardcore area	Greaney Concrete, Robertstown, Shanagolden	Limerick County Council	http://eplan.limerick.ie/AppFileRefDetails/15948/0

Reg. Ref.	Description of proposed development	Address of development	Name of Planning Authority	Hyperlink to application on Planning Authority website
16192	a New Bulk fertiliser store and all associated works (this proposed development is within an existing Seveso site)	Morgan's South, Askeaton	Limerick County Council	http://eplan.limerick.ie/AppFileRefDetails/16192/0
16418	a ten year permission for development on a site of c. 0.225 ha located within the existing Aughinish Alumina plant consisting of the installation of 2 no. deep thickeners (steel vessels with a diameter of c. 22m and maximum overall height of c.21.9m) and ancillary elements, including stairs, access platforms and walkways linking to adjacent vessels, pumps, cabling and pipework. The development will also consist of the provision of a hardstanding, an internal road (c. 6.1m wide and c. 40.6m long) to the east of the thickeners and all other site development works above and below ground (the application relates to development which comprises or is for the purposes of an activity requiring an Industrial Pollution & Control Licence, now replaced by an Industrial Emissions Licence)	Aughinish East Aughinish West Island Mac Teige Glenbane West, Morgan North & Fawnamore, at/or adjacent to Aughinish Island Askeaton	Limerick County Council	http://eplan.limerick.ie/AppFileRefDetails/16418/0
16669	for development which consists of the construction of a single storey high-bay factory floor building with associated 2 storey commercial office building, with roof level plant over, a single storey external re-finishing to an existing ESB substation, which is currently located within the existing buildings of Block E (which are to be demolished under Permission No. P15/217), new entrance to roadway and associated carparking (91 approx. No), modification of 2 No. existing vehicular entrances to the north of	Block E, Shannon Free Zone, Shannon	Clare County Council	http://www.eplanning.ie/ClareCC/AppFileRefDetails/16669/0

Reg. Ref.	Description of proposed development	Address of development	Name of Planning Authority	Hyperlink to application on Planning Authority website
	the site, set down areas, marshalling yard, with dock leveller, bicycle parking (40 approx. No.), a single storey refuse compound, building signage and all ancillary landscaping, site works and services.			
16767	construction of a dwelling house, shed, treatment plant, percolation area and all ancillary site works	Morgans North, Barrigone, Askeaton	Limerick County Council	http://eplan.limerick.ie/AppFileRefDetails/16767/0
16788	for the development within a Strategic Development Zone of a Fire Training Ground at the Secondary Surveillance Radar Equipment site on the north side of Runway 06-24, Shannon Airport, Co Clare. The development will comprise of the installation of a Simulated Steel Aircraft Shell, a Fire Screen and Engine Rig for the purpose of training fire fighting personnel. Also included in the development will be an overground Water Storage Tank, 2 No. 2 Tonne LPG Gas Tanks, a 300 Gallon Jet A1 Fuel Tank, 3 No. sheds to house controls and fuel pressurisation unit, security fencing to surround site perimeter, concrete hardstanding areas, site lighting and all other associated site works. An Appropriate Assessment screening statement accompanies this planning Application.	Shannon Airport, Co Clare	Clare County Council	http://www.eplanning.ie/ClareCC/AppFileRefDetails/16788/0
16917	to develop holiday retreat accommodation comprising of 8 No. units, create new entrance, car parking, install a new wastewater	Cullenagh, Cloonkerry	Clare County Council	http://www.eplanning.ie/ClareCC/AppFileRefDetails/16917/0

Reg. Ref.	Description of proposed development	Address of development	Name of Planning Authority	Hyperlink to application on Planning Authority website
	treatment system and water facilities along with all associated works	West, Labasheeda		
16977	the construction of a reception building which will include an assembly room with associated locker rooms, toilets and shower facilities, and a new waste water treatment and disposal system to serve both the existing dwelling house and new reception building and all associated works	Shannongrove, Pallaskenry	Limerick County Council	http://eplan.limerick.ie/AppFileRefDetails/16977/0
16986	a juvenile playing field, to widen existing access roadway and incorporate a pedestrian footpath link from existing sports field to the public footpath and all associated works	Corgrig, Foynes	Limerick County Council	http://eplan.limerick.ie/AppFileRefDetails/16986/0
17111	for the construction of a single storey meeting hub/coffee dock building with concealed bin store and plant area, adjustments to existing parking, provision of new car and cycle parking, building signage and all ancillary landscaping, site works and services	Shannon Industrial Estate, Shannon Free Zone, Shannon	Clare County Council	http://www.eplanning.ie/ClareCC/AppFileRefDetails/17111/0
17144	the installation of an all weather playing surface, erection of enclosure fencing, stop nets, floodlights, new vehicular entrance, roadway, car park and all associated site developments works	Ministersland & The Cross, Ardagh, Co Limerick	Limerick County Council	http://eplan.limerick.ie/AppFileRefDetails/17144/0

Reg. Ref.	Description of proposed development	Address of development	Name of Planning Authority	Hyperlink to application on Planning Authority website
17148	the construction of a stand-alone single storey Gym/PE Hall with ancillary spaces over two storeys and all ancillary site works	Colaisten Na Trocaire, Rathkeale, Co Limerick	Limerick County Council	http://eplan.limerick.ie/AppFileRefDetails/17148/0
17250	for the completion of the existing landfill and storage of timber overground (planning ref:s 06/233, 11/7059 & 12/164, the permission requires a waste licence.	Stokesfield, Shanagolden, Co Limerick	Limerick County Council	http://eplan.limerick.ie/AppFileRefDetails/17250/0
17293	(a) Construction of an Agricultural Building to include Rotary Milking Parlour, Dairy, Ancillary Rooms, Underground Slatted Tank, Unroofed Waiting Yard and Livestock Handling Facilities, (b) Erection of a Meal Bin, (c) Construction of an extension to existing slatted shed to include cubicle housing, (d) Construction of a modification to existing agricultural building to include handling area, (e) Construction of a modification to existing agricultural building to include additional cubicles and straw bedding, (f) Construction of 2no. extensions to existing agricultural building to accommodate underground slatted tanks and cubicles, (g) Construction of a livestock underpass along with associated soiled water storage facilities & all other associated site works	Shannongrove, Pallaskenry, Co Limerick	Limerick County Council	http://eplan.limerick.ie/AppFileRefDetails/17293/0
17302	extension of the existing Natural Gas Above Ground Installation in the townland consisting of the extension of the existing site footprint and boundary fence, installation of regulator/meter kiosk, instrumentation/boiler kiosk, underground and overground	Barrigone, Askeaton, Co Limerick	Limerick County Council	http://eplan.limerick.ie/AppFileRefDetails/17302/0

Reg. Ref.	Description of proposed development	Address of development	Name of Planning Authority	Hyperlink to application on Planning Authority website
	pipework, 2.4m high palisade fencing, light column and all associated civil, mechanical & electrical			
17346	1.Demolition of existing redundant storage sheds to south and east of existing museum premises. 2. Provision of new vehicular entrance gateway to N69. 3.Construction of a 2 storey extension south wing to provide additional archive and exhibition/display areas. 3. Construction of a 2 storey extension to the south of existing museum and modifications to the existing south wing to provide additional meeting/exhibition/display areas in existing west wing. 5. Construction of single storey Irish coffee area extension facing the N69 (this is a protected structure 1182)	Aras Ide, Foynes, Co Limerick	Limerick County Council	http://eplan.limerick.ie/AppFileRefDetails/17346/0
17566	demolition of existing warehouse building, existing grain hopper & adjoining derelict building. The construction of an office extension to the rear of the existing Mill House Office building, works will include a glazed linkage between the new & existing Mill House, modifications to the existing Mill House, modifications to the existing entrance, new car parking area, construction o boundary wall, site landscaping, upgrade of exiting site services and all associated ancillary works associated with the site development and building works	Mill House, Leahies Foynes, Co Limerick V94 R232	Limerick County Council	http://eplan.limerick.ie/AppFileRefDetails/17566/0

Reg. Ref.	Description of proposed development	Address of development	Name of Planning Authority	Hyperlink to application on Planning Authority website
17583	for the further completion of construction of Westpark Business Campus with the construction of Block 6000, (immediately south of existing Block 7000), a mixed use, multi-storey block, similar to that granted under parent planning permission under Clare County Council PA Ref: P01-1066 and APB Ref: PL03.130244. Block 6000 will have a total gross internal area of 12,045 sqms with offices at upper floors 300-500 and data centre/light industrial / storage/ Research and Development uses at lower levels 100-200. The construction of an ancillary, multi-deck carpark (MDCP) located to the South of Block 4000 within the Campus. The MDCP will accommodate 580 spaces and will replace the existing, 101 at grade, split level, car park located to the South of Block 4000. The car park will also replace the 500 space MDCP located to the South of the Campus, granted by Clare County Council under Ref: P01-1066 and APB Ref PL.03-130244. The proposed development will use existing drainage services in place within the overall campus and the existing road network. The development includes, landscaping, ancillary parking adjacent to Block 6000, ESB Substation, service areas for goods vehicles. The application includes all other ancillary site development works as required to complete the block.	Westpark Business Campus, Shannon, Co. Clare	Clare County Council	http://www.eplanning.ie/ClareCC/AppFileRefDetails/17583/0
17584	the demolition of 2 no. existing Oil Tanks and associated low-level bund wall, the construction of a two-storey Water Treatment Building at ground floor level consisting of plant/equipment rooms, the construction of a two-storey Waste Treatment Building	Deely North, Askeaton, Co Limerick	Limerick County Council	http://eplan.limerick.ie/AppFileRefDetails/17584/0

Reg. Ref.	Description of proposed development	Address of development	Name of Planning Authority	Hyperlink to application on Planning Authority website
	at ground floor level consisting of plant/equipment rooms at its existing manufacturing facility			
17645	to construct 16 no. semi-detached residential dwellings (a mix of three and four bedroom house types) & all associated infrastructure including new vehicular access onto Main Street, connections to public utilities and all ancillary site development works	Main Street, Pallaskenry, Co. Limerick	Limerick County Council	http://eplan.limerick.ie/AppFileRefDetails/17645/0
17714	a ten year permission for development on this site of c. 7 hectares located adjoining the existing Aughinish Alumina Ltd plant for the provision of a Borrow Pit with an extraction area of c. 4.5 hectares to extract c. 374.000 m^3 of rock over a 10 year period. The extraction area is sought up to a maximum depth of c. 8.5 m O.D., with extraction to occur between April and September each year. The proposed development includes the demolition of a contractors shed and all ancillary site development, areas of stockpiling, landscaping and boundary treatment works above and below ground, including restoration of the extraction area. Aughinish Alumina Limited carries out an activity requiring an Industrial Pollution Prevention and Control Licence (now replaced by an Industrial Emissions Licence – Licence Register No. P0035-06). The development and operation of the proposed Borrow Pit is not a licensable activity.	Aughinish East Aughinish West Island Mac Teige Glenbane West Morgan North and Fawnamore at or adjacent to Aughinish Island, Askeaton, Co. Limerick	Limerick County Council	http://eplan.limerick.ie/AppFileRefDetails/17714/0

Reg. Ref.	Description of proposed development	Address of development	Name of Planning Authority	Hyperlink to application on Planning Authority website
	An Environmental Impact Statement (EIS) will be submitted to the Planning Authority with the application.			
17742	for extension to the External Car Park ancillary to the AAG Hanger Facility at Shannon Industrial Estate, Shannon, Co. Clare. The proposed works will involve relocation of the adjoining Shannon Airport boundary fence to the South West of the site, to provide 87 no. additional car parking spaces, external lighting and all associated site works and services	Shannon Industrial Estate, Shannon, Co. Clare	Clare County Council	http://www.eplanning.ie/ClareCC/AppFileRefDetails/17742/0
17768	to erect an extension to existing milking parlour and provide a new dairy. Also for permission to demolish existing cow shed and construct an underground slurry tank adjacent to milking parlour and provide a cattle crush. Also to construct 2 no. underground slurry tanks adjacent to existing cattle sheds all on farmyard	Mount Trenchard, Foynes.	Limerick County Council	http://eplan.limerick.ie/AppFileRefDetails/17768/0
17872	the installation of a 0.51m x 1.42m x1.8m (LxWxH) above ground enclosure to house a new natural gas District Regulating Installation (DRI) with all ancillary services and associated works, including vent stack	Main Street, Ballyhahill	Limerick County Council	http://eplan.limerick.ie/AppFileRefDetails/17872/0
17877	hardcore existing green field and concrete pad, extension to existing production building and two silo's to the north of existing production building and one silo to the south of existing	Ballygiltenan North, Glin.	Limerick County Council	http://eplan.limerick.ie/AppFileRefDetails/17877/0

Reg. Ref.	Description of proposed development	Address of development	Name of Planning Authority	Hyperlink to application on Planning Authority website
	production building, and permission for a new carpark and entrance for a one way traffic system and all associated works			
17998	Further to previously granted planning application Ref: P16-405 for amendments and additions to the car parking area and all associated site works and services. Previously granted were 202 nr. parking spaces. The new total will be 298 nr spaces (96 nr. additional) including 15 nr. accessible spaces and 29 nr. electrical car recharge spaces	Shannon Airport, Shannon, Co. Clare	Clare County Council	http://www.eplanning.ie/ClareCC/AppFileRefDetails/17998/0
18188	for extension of the existing carpark area and construction of an entrance wall and canopy at Building 156, Shannon Free Zone. The proposed works will include extension of the existing car park to provide 24 No. additional car parking spaces, 4 No. accessible car parking spaces and construction of a wall and entrance canopy to the North elevation together with all site works and services	156 Shannon Free Zone, Shannon, Co. Clare	Clare County Council	http://www.eplanning.ie/ClareCC/AppFileRefDetails/18188/0
18310	construction of 3 no. buildings for production and storage purposes ancillary to existing manufacturing facility and all associated works	Ballygiltenan North, Glin, Co. Limerick.	Limerick County Council	http://eplan.limerick.ie/AppFileRefDetails/18310/0
18376	6 no. new flood lights, provision of a new walking track around the pitch and to widen the existing site entrance and all ancillary site works. Retention Permission is also sought for 6 no. flood lights	Ballingarrane, Cappagh, Askeaton Co. Limerick.	Limerick County Council	http://eplan.limerick.ie/AppFileRefDetails/18376/0

Reg. Ref.	Description of proposed development	Address of development	Name of Planning Authority	Hyperlink to application on Planning Authority website
18448	a 60m x 50m Floodlight Astroturf pitch, warm up area and associated site works including 2.5m high netting on top of 2.4m high perimeter fence and a new 4m wide gateway from existing playing pitch	Ballygiltenan North, Glin, Co. Limerick.	Limerick County Council	http://eplan.limerick.ie/AppFileRefDetails/18448/0
18490	to construct an extension to existing car park including automated car park, control barriers, zebra crossing and all associated, above and below ground site works	Universal House, 1 Airport Avenue, Shannon Free Zone Shannon	Clare County Council	http://www.eplanning.ie/ClareCC/AppFileRefDetails/18490/0
18661	the construction of a new vehicular entrance, single storey small animal veterinary clinic (floor area 280 sq. m) with carport and ancillary facilities, surface car parking, waste water treatment system with polishing filter and all associated site works together with the relocation of existing farm entrance	Kyletuan, Rathkeal , Co. Limerick.	Limerick County Council	http://eplan.limerick.ie/AppFileRefDetails/18661/0
18912	for the construction of 3 no. Advanced Manufacturing Units at Blocks K & L. The buildings consist of a single storey high-bay industrial floor with ancillary office area and roof plant. Sites-works for all 3 buildings to include both a mix of new and upgraded vehicular entrances to service delivery/service yards and 296 no. car parking spaces. The construction of new hard surfaced ancillary delivery/service yards, 148 no. bicycle parking spaces, single storey refuse compounds, building signage, rainwater harvesting tanks, and all ancillary landscaping and associated site	Shannon Free Zone West, Shannon, Co. Clare	Clare County Council	http://www.eplanning.ie/ClareCC/AppFileRefDetails/18912/0

Reg. Ref.	Description of proposed development	Address of development	Name of Planning Authority	Hyperlink to application on Planning Authority website
	works and services. The buildings are to replace the existing structures on site, the demolition of which was granted under Pl. Ref no's 18/416 and 18/417. The planning application is accompanied by a Natura Impact Statement.			
18958	phase 1 to consist of 30 no. dwellings as follows - 12 no. two storey 3 bed terrace units, 18 no. two storey semi detached 3 bed units, together with all associated access roadways, landscaping and all associated site works and connection to existing services	Pallas, Pallaskenry, Co. Limerick.	Limerick County Council	http://eplan.limerick.ie/AppFileRefDetails/18958/0
19205	a ten year planning permission for a spectator stand, changing rooms, gymnasium and toilet facilities. Inclusive of all associated ancillary building and site works	Mick Neville Park, Wolfesburgess, Rathkeale, Co. Limerick.	Limerick County Council	http://eplan.limerick.ie/AppFileRefDetails/19205/0
19226	for the further completion of construction of Westpark Business Campus with the construction of Block 6000 (immediately south of existing Block 7000), for a building of five storeys (with an additional area for mechanical plant on the roof area) on the western portion of the proposed building facing into the centre of the Campus with a further two basement storeys linking into a proposed, ancillary, multi-deck car park (MDCP) to the east of the site. Block 6000 will have a total gross floor area of 10,800 sqms for office use. The office building includes ancillary services including, secure internal, cycle parking with staff toilets and	Westpark Business Campus, Shannon, Co. Clare	Clare County Council	http://www.eplanning.ie/ClareCC/AppFileRefDetails/19226/0

Reg. Ref.	Description of proposed development	Address of development	Name of Planning Authority	Hyperlink to application on Planning Authority website
	shower facilities. The ESB sub station and mechanical plant areas are contained within the office building. The proposed development will use existing drainage services in place within the overall Campus and the existing road network. The development includes all other ancillary site development works as required to complete the block			
19421	the construction of a seven unit glamping facility incorporating the conversion of an existing cottage to toilet and kitchen area, installation of a proprietary waste water system and all associated services	Kilcool, Rathkeale, Co. Limerick.	Limerick County Council	http://eplan.limerick.ie/AppFileRefDetails/19421/0
19465	developing existing terrace of derelict buildings into 5 no. holiday homes and a management office, to install new waste treatment system, to form new entrance and site works and to consolidate and make sound the castle structure as a ruin. This is a Protected Structure 179 N3(1) and a Recorded Monument (RMP L1003-002)	Beagh Castle, Ballysteen, Co. Limerick.	Limerick County Council	http://eplan.limerick.ie/AppFileRefDetails/19465/0
19531	for development which consists of the demolition of an existing service yard and ancillary carparking area to facilitate the construction of a two-storey extension to the existing light-industrial manufacturing facility. Works also include ancillary office and R & D areas with a new entrance foyer constructed over 3no. levels resulting in additional gross floor area of 9844m2. Other works include the reconfiguration and extension of an existing car park to the south of the proposed building to provide 75 no.	Shannon Industrial Estate, Shannon, Co. Clare	Clare County Council	http://www.eplanning.ie/ClareCC/AppFileRefDetails/19531/0

Reg. Ref.	Description of proposed development	Address of development	Name of Planning Authority	Hyperlink to application on Planning Authority website
	additional spaces ad the construction of a new car park to provide 44 no. spaces including accessible spaces and set down area. The provision of 2 no. loading bays to the rear of the proposed extension, upgraded vehicular and delivery/service yards, entrances, secure bicycle parking spaces, external open-sided storage enclosure, plant and services compound, signage to the proposed extension and wayfinding signage to the campus, rainwater harvesting tanks, plant and photovoltaic units to the roof level with all ancillary landscaping and associated site works and services. The development will also include the partial re-roofing of the existing facility to the northern corner of the campus			
19535	for the construction of a single storey Switchroom and amendments to existing substation with all associated site works at Block L, Shannon Free Zone West, Shannon, Co. Clare	Shannon Free Zone, Shannon, Co. Clare	Clare County Council	http://www.eplanning.ie/ClareCC/AppFileRefDetails/19535/0
19693	for amendments to include the following; the inclusion of two number, approximately 17.6 meter tall fire suppression tanks in lieu of the original 5.3 meter tanks, minor alterations to the North Elevation to increase the quantity of brickwork, reduce ridge heights, alterations to the vehicle parking layout including a new storage area and an increase in size of the Pump House by 2.0 meters. An Integrated Pollution and Control Licence is required for the facility. The application falls within the remit of a Strategic Development Zone.	Shannon, Co. Clare	Clare County Council	http://www.eplanning.ie/ClareCC/AppFileRefDetails/19693/0

Reg. Ref.	Description of proposed development	Address of development	Name of Planning Authority	Hyperlink to application on Planning Authority website
19853	the construction of a single storey industrial packaging shed with conveyors supply mechanism, rectangular roller tray outfeed and all ancillary site works	Durnish Internal Port Road, Shannon Foynes Port, Foynes Co. Limerick.	Limerick County Council	http://eplan.limerick.ie/AppFileRefDetails/19853/0
20319	construction of Phase 1 of a housing development consisting of 10no. semi-detached dwelling houses, 2no. detached dwelling houses, new entrance, roads and services layout, connection to the public sewer together with all associated site works	Ballyhahill, Co. Limerick	Limerick County Council	http://eplan.limerick.ie/AppFileRefDetails/20319/0
20401	amendments to Planning Reference 17/1152 which comprised of a) permission for site development works which will consist of vehicular/pedestrian access, internal roads and footpaths, connections to all adjacent utilities including foul sewer, provision of public lighting, boundary treatment, landscaping and all ancillary site works and b) Outline Permission for 9 no. serviced residential sites. The amendments sought include a revision to site boundaries and an increase in the overall density from 9 to 11 no. detached dwellings which will necessitate minor revisions to the overall site layout including the drainage design	Loughill, Co. Limerick	Limerick County Council	http://eplan.limerick.ie/AppFileRefDetails/20401/0
20416	the development consists of the construction of a series of M&E Buildings to the yard of Building 2. There is a requirement for four buildings, to house a transformer, a substation, a RMU and a sprinkler tank room. We are also seeking PERMISSION for a	Building 2 Block K, Airport Avenue	Clare County Council	http://www.eplanning.ie/ClareCC/AppFileRefDetails/20416/0

Reg. Ref.	Description of proposed development	Address of development	Name of Planning Authority	Hyperlink to application on Planning Authority website
	sprinkler tank. We are proposing three ancillary plant compounds, housing the chiller plant, bin store and Air Conditioning Units. We propose minor changes to the elevations to include louvres and doors to access the proposed plant. There are minor amendments to the landscaping between buildings 2 and 3 to improve access to the site	Shannon Free Zone, Shannon		
20575	to: construct of 1 no Advanced Technology Manufacturing Unit. The building consists of a single storey high-bay industrial floor with ancillary office area and roof plant. Site works consists of the provision of an enclosed service yard with dedicated plant and refuse storage compound, rainwater harvesting tank and new sub-station, cycle parking and external landscaping, along with all associated site works, services and signage. Demolition of existing sub-station. The Building will replace the existing structures on site, the demolition which was granted under planning reference no P19-822.	Bay 77-79 Block R, Shannon Industrial Estate, Shannon Free Zone	Clare County Council	http://www.eplanning.ie/ClareCC/AppFileRefDetails/20575/0
20688	the completion of the existing landfill and storage of timber overground (previous planning ref:s 06/233, 11/7059, 12/164& 17/250. The permission requires a waste licence	Stokesfield, Shanagolden, Co Limerick	Limerick County Council	http://eplan.limerick.ie/AppFileRefDetails/20688/0
20705	for a renewable energy development on a 3.5 hectare site in the townland of Stonehall, Newmarket on Fergus, Co Clare. The proposed development will constitute the provision of the following: Construction of a Biomass processing and storage area	Stonehall, Newmarket on Fergus, Co Clare	Clare County Council	http://www.eplanning.ie/ClareCC/AppFileRefDetails/20705/0

Reg. Ref.	Description of proposed development	Address of development	Name of Planning Authority	Hyperlink to application on Planning Authority website
	utilising forestry products. Construction of a Gasification and Methanation Plant for the production of advanced biofuels. Construction of a Gasification and Combined Heat Power Plant for production of electricity and heating. Construction of a Battery Storage Facility (20MW). Construction of a Thermal Energy recovery and storage facility for district heating distribution. Construction of new on site 38kV substation. Creation of a new access road from the L-3169-0. All ancillary development including the provision of site office, car parking, internal access roads, perimeter landscaping, fencing, lighting, and on sire drainage. The Planning application is accompanied by a Natura Impact Statement.			
20786	the development consists of the demolition of an existing carparking area and the relocation of an existing ESB substation to facilitate the construction of a four-storey office building with a gross floor area of 5636m2. Other works include the provision of 317no. carparking spaces including accessible spaces, EV charging areas and set-down areas, a relocated vehicular access to the site, an additional vehicular access point to ancillary parking on the opposite side of the road with a pedestrian crossing connecting both. Secure bicycle parking spaces, refuse store and plant and services building, incorporating the relocated substation. Signage and wayfinding, services plant and photovoltaic units to roof level	Shannon Free Zone, Shannon, Co Clare	Clare County Council	http://www.eplanning.ie/ClareCC/AppFileRefDetails/20786/0

Reg. Ref.	Description of proposed development	Address of development	Name of Planning Authority	Hyperlink to application on Planning Authority website
	with all landscaping and associated site works & services The planning application is accompanied by a Natura Impact Statement			
20824	for development comprising an increased wind turbine blade length and associated reduction in turbine hub height, creation of a splayed junction, and all associated cabling, services and ancillary works at land at the site of the consented Crossmore Wind Farm. This site is located approximately 4km north of Kilmurry McMahon, 4.5km southeast of Kilmihil and 15km east of Kilrush in the townlands of Crossmore and Derrnageeha, Co Clare. The development will consist of: 1. An increase in the blade length of the previously-consented 7 no. wind turbine Crossmore Wind Farm, consented under planning application Ref: P09/123, from 45 metres to up to 57.5 metres; 2. Associated reduction in turbine hub height of up to 12.5m to maintain the previously approved overall turbine tip height of up to 125m (the previously approved hub height was 80m) 3. Creation of a splayed junction at the wind farm entrance on the Ballyduneen Road, off the N68, necessary to facilitate the proposed turbine / blade configuration; 4. All associated services and ancillary works. The application is seeking a ten year planning permission and 30 year operational life from the date of commissioning of the renewable energy development.	Crossmore and Derrynageeha, Co Clare	Clare County Council	http://www.eplanning.ie/ClareCC/AppFileRefDetails/20824/0

Reg. Ref.	Description of proposed development	Address of development	Name of Planning Authority	Hyperlink to application on Planning Authority website
21106	for ground investigation (GI) works, to inform the option selection and design of the proposed Shannon Town and Environs Flood Relief Scheme at Rineanna South, Shannon, Co Clare. The objective of the GI works is to establish ground conditions within the study area and contribute towards the option selection process for the proposed FRS. The GI sites are primarily located within or adjacent to existing flood embankments on the edge of the River Shannon estuary in proximity to residential and industrial areas. The proposed preliminary GI works will consist of the following: a) 54 No Borehole Cable Percussion (BHCP) (shell and auger); b) 65 No. Rotary Cores; c) 62 No. Cone Penetration Tests (CPTS); and, d) 25 No. Groundwater Standpipes. This application is accompanied by a Natura Impact Statement (NIS)	Rineanna South, Shannon, Co Clare	Clare County Council	http://www.eplanning.ie/ClareCC/AppFileRefDetails/21106/0
167005	Extension of Permission 10/40 for the demolition of existing domestic garage, the construction of 4 no. detached dwellings, 16 no. semi-detached dwellings, together with access road, car parking and associated site works (this site is located in a proposed architectural conservation area)	Lower Main Street, Rathkeale	Limerick County Council	http://eplan.limerick.ie/AppFileRefDetails/167005/0
167044	extension of permission 101008 for a new two storey Primary Care Centre consisting of 397sqm of general practitioners care centre on the ground floor and 546sqm of regional pimary care centre on the first floor, 33 carspaces to serve the new centre and all related	Church Street, Glin	Limerick County Council	http://eplan.limerick.ie/AppFileRefDetails/167044/0

Reg. Ref.	Description of proposed development	Address of development	Name of Planning Authority	Hyperlink to application on Planning Authority website
	site works including the demolition of the existing manufacturing building on the site			
171174	ten year permission to develop a solar farm consisting of construction & operation of solar PV arrays mounted on metal frames on a 18HA site including: 1 no. electrical control building & onsite substation. Up to 4 no. inverter units, a temporary construction area & ancillary facilities, boundary fencing with CCTV units, an access track, all associated works, including (gross floor space of proposed works up to 144.80sqm) & habitat management & enhancement measures & drainage swale. The planning application is accompanied by an environmental report & stage 1 screening for appropriate assessment	Ballynash (Bishop, Foynes, Co. Limerick.	Limerick County Council	http://eplan.limerick.ie/AppFileRefDetails/171174/0
171220	a ten year permission for the complete development of a Solar PV Energy development with a total site area of 61.29 hectares, to include one Transmission System Operator (TSO) electrical substation with associated switchgear, TSO compound and control building, one customer substation with transformer, communications pole, compound and control building, electrical transformer and inverter station modules, Solar PV panels ground mounted on support structures, access roads and internal access tracks, spare parts storage containers, fencing, electrical cabling and ducting, CCTV and other ancillary infrastructure, a temporary	Ellaha and Ballinknockane, Co. Limerick.	Limerick County Council	http://eplan.limerick.ie/AppFileRefDetails/171220/0

Reg. Ref.	Description of proposed development	Address of development	Name of Planning Authority	Hyperlink to application on Planning Authority website
	site compound area, additional landscaping and habitat enhancement as required and associated site development works			
177019	Extension of Permission from Ref No: 12/212 (2.49 hectares of reclamation at the East Jetty in Foynes Port. The reclamation works will be carried out between the rear of the existing East Jetty and the adjacent shoreline and will include dredging, importation of fill material, retaining wall construction, surfacing, drainage installation and site lighting. No buildings are proposed on the proposed reclaimed area which will be used for the storage and handling of cargo up to an anticipated height of approximately 7.7m. An Environmental Impact Statement (EIS) and Natura Impact Statement (NIS) accompany this application)	Foynes Port, Corgrig	Limerick County Council	http://eplan.limerick.ie/AppFileRefDetails/177019/0
181091	construction of a viewing stand, access footpaths and all associated works	Kyletaun, Rathkeale, Co. Limerick.	Limerick County Council	http://eplan.limerick.ie/AppFileRefDetails/181091/0
181236	the demolition of the existing three span bridge and construction of a new single span bridge consisting of piled abutments and a stell truss superstructure to facilitate the potential future re-introduction of freight traffic on the Limerick to Foynes railway line at Churchfield/Island MacTeige. The existing intermediate piers will remain in place in a non load bearing capacity. The works also includes the temporary relocation of a salt marsh during the	Churchfield/Island MacTeige, Foynes, Limerick.	Limerick County Council	http://eplan.limerick.ie/AppFileRefDetails/181236/0

Reg. Ref.	Description of proposed development	Address of development	Name of Planning Authority	Hyperlink to application on Planning Authority website
	construction of the bridge structure. A Natura Impact Statement has been prepared for the development			
191006	for refurbishment works to existing coastal defence embankments at Shannon Airport, Shannon, Rineanna South, Co Clare. The proposed works include different combinations of armouring, top-soiling and grassing along the embankments. A Natura Impact Statement has been prepared and is included in the application. An Environmental Impact Assessment screening report has been prepared and is included in the application. It concluded that an Environmental Impact Assessment is not required	Shannon Airport, Shannon, Rineanna South	Clare County Council	http://www.eplanning.ie/ClareCC/AppFileRefDetails/191006/0
191221	an extension to the existing burial ground to incorporate laying of concrete footpaths providing access for 263 new grave plots and all associated works	Ballycannon, Croagh, Co. Limerick.	Limerick County Council	http://eplan.limerick.ie/AppFileRefDetails/191221/0
198000	the proposed improvement works will be carried out within the existing 60kph speed limit zone over a length of 750m between L6135 Curraghchase Junction and the L6125 Junction. The improvement works proposed comprise a reduction of the N69 carriageway width to 6.5m over the 750m length of the scheme with a footway installed on the southern side (school side) and kerbing and a grass verge on the northern side of the carriageway. The proposed works also include for the installation of LED public lighting on the northern side of the carriageway, road lining and signage as well as surface water drainage along both sides of the	townlands of Killeen Ballyvogue, Cowpark Curraghchase North and Boherboy, Kilcornan Co. Limerick.	Limerick County Council	http://eplan.limerick.ie/AppFileRefDetails/198000/0

Reg. Ref.	Description of proposed development	Address of development	Name of Planning Authority	Hyperlink to application on Planning Authority website
	N69 carriageway and pavement improvement works. Accommodation works will be undertaken as required including improvement works in and around the community hub of the national school and GAA club grounds. The implementation of the works proposed will result in a rearrangement of the existing road network in the vicinity of the scheme. Changes to the existing road network will include the reduction of road width to 6.5m over a 750m length and the installation of a kerbed footway abutting the westbound carriageway and kerbing and a verge abutting the eastbound carriageway over the scheme length			
201041	the construction of a new hurling wall and adjacent all-weather training area with perimeter fencing and floodlighting including all ancillary site works	Pallaskenry, Co. Limerick	Limerick County Council	http://eplan.limerick.ie/AppFileRefDetails/201041/0
201059	construction of a two storey dwelling house, detached domestic garage, front boundary entrance walls, mechanical aeration unit with polishing filter system with all associated site works	Robertstown, Foynes, Co. Limerick	Limerick County Council	http://eplan.limerick.ie/AppFileRefDetails/201059/0
201325	the provision of nature trail and upgrade of existing nature trail, construction of a car park comprising 29 no. car parking spaces, new vehicular access and associated landscaping and boundary treatment works. It is also sought to demolish existing derelict structures and a bird hide and construct a new bird hide in its	Fawnamore & Aughinish East, Aughinish Island, Askeaton Co. Limerick	Limerick County Council	http://eplan.limerick.ie/AppFileRefDetails/201325/0

Reg. Ref.	Description of proposed development	Address of development	Name of Planning Authority	Hyperlink to application on Planning Authority website
	place. A Natura Impact Statement(NIS) will be submitted to the planning authority with the application			
208004	refurbishment of Ardagh Station House (which is a protected structure) and goods shed & change of use to commercial, community & tourism use, the refurbishment and renovation of the station house and goods shed and associated site works, the provision of car parking spaces and camper van parking bays, provision of a playground facility, enhancement and landscaping works to the site, circa 2.5 acres and entrance area, the provision of LED public lighting throughout the facility, new connections to existing public sewer and water services and all associated site works including installation of a holding tank and mechanical pumping system to nearby Irish Water pump station, connecting to Irish Water watermain on public road and lay firemain on site, construct stormwater network on site with interceptors and discharge to outfall, install timber post and rail fencing along boundary of greenway and parking area, installation of greenway furniture including seating, benches and cycle stands on the site, the removal of a section of stone wall to facilitate the widening of the existing entrance to accommodate 2-way traffic, installation of signage including information sign boards and related structures and additional directional signage on the greenway and related roads and the refurbishment of Barnagh Station House (which is a protected structure) and change of use to a community & tourism use on the Great Southern Greenway Limerick, the refurbishment	Ardagh Station House Kilreash Ardagh, & Barnagh Station House Ballymurragh East, Co. Limerick	Limerick County Council	http://eplan.limerick.ie/AppFileRefDetails/208004/0

Reg. Ref.	Description of proposed development	Address of development	Name of Planning Authority	Hyperlink to application on Planning Authority website
	and renovation of the station house and associated site works, upgrade of the railway platform, installation of signage including, information sign boards and related structures, the provision of LED lighting, enhancement and landscaping works to the site and install fencing along the boundary			
PL91. 301561	Port capacity extension to consist of modifications to the existing jetties and quays, phased expansion of the port estate and all associated site development works	Port of Foynes, in the townlands of Corgrig and Durnish, Foynes, Co. Limerick		https://www.pleanala.ie/en-ie/case/301561
PL91. 306199	Foynes to Rathkeale Protected Road Scheme 2019, Rathkeale to Attyflin Motorway Scheme 2019 and Foynes Service Area Scheme 2019 (forming the Foynes to Limerick Road (including Adare Bypass)).	Shangolden, Craggs, Askeaton West, Lismakeery, Nantian, Riddlestown, Rathkeale Rural, Rathkeale Urban, Dromard, Croagh, Adare		https://www.pleanala.ie/en-ie/case/306199

Reg. Ref.	Description of proposed development	Address of development	Name of Planning Authority	Hyperlink to application on Planning Authority website
		North, Adare South, Clarina and Patrickswell, Co. Limerick.		
PL03. 307798	Proposed 400kV electricity transmission cables, extension to the existing Kilpaddoge Electrical Substation and associated works, between the existing Moneypoint 400kV Electrical Substation in the townland of Carrowdoita South County Clare and existing Kilpaddoge 220/110kV Electrical Substation in the townland of Kilpaddoge County Kerry. The development includes work in the foreshore.	Townland of Carrowdotia South County Clare and Kilpaddoge County Kerry		https://www.pleanala.ie/en-ie/case/307798
PA08. 311233	Proposed Shannon Technology and Energy Park consisting of power plant, battery energy storage system, floating sorage and regasification unit, jerry, onshore receiving facilities, above ground installation and all ancillary structures/works.	Townlands or Kilcolgan Lower and Ralappane, Ballylongford, Co. Kerry		https://www.pleanala.ie/en-ie/case/311233
EC21/19	Section 5 Declaration: Whether the proposed installation of additional plant and machinery within the existing industrial facility at Aughinish Alumina is Development or is or is not Exempted Development. The plant will provide for a caustic	Aughinish Alumina Ltd., Askeaton, Co. Limerick		

Reg. Ref.	Description of proposed development	Address of development	Name of Planning Authority	Hyperlink to application on Planning Authority website
	recovery process which eliminates the production of sodium oxalate at the overall facility. Declared exempted devleopment.			

5.3 Likely Changes to the Natura 2000 Sites

Without adequate monitoring and mitigation there is a likelihood of significant effects on the three Natura 2000 sites proximate to the facility.

5.3.1 Reduction of Habitat Area

The application site is located outside any Natura 2000 sites. There are no plans to directly impact upon habitats within the designated Natura 2000 sites in the wider area. There is the potential for indirect habitat loss or deterioration of Natura 2000 sites within the project ZoI from the effects of run-off or discharge into the aquatic and intertidal environment through impacts such as increased siltation, nutrient release and/or contamination. Without adequate mitigation or monitoring there is the potential for significant effects on the marine and intertidal mudflat habitats present within the Lower River Shannon SAC and River Shannon & River Fergus Estuaries SPA. Similarly, uncontrolled emissions to air could potentially lead to indirect habitat loss or degradation (e.g. from fugitive dust) that could result in significant effects on the three Natura 2000 sites identified as within the ZoI.

5.3.2 Habitat or Species Fragmentation

The application site is dominated by highly modified habitats associated with the existing BRDA. The semi-natural habitats that will be directly impacted do not contain any areas of Annex I habitat. The BRDA footprint will not be extended, in fact the surface area of the BRDA is reduced with each stage raise.

The AAL facility which has been operational since 1983 and in continuing to operate with the relatively minor changes associated with the proposed development, it is considered unlikely to cause significant habitat or species fragmentation of relevance to the Natura 2000 sites, on its own or in combination with any other plans or projects within the ZoI.

5.3.3 Disturbance / Displacement of Fauna

Significant disturbance/displacement effects in relation to noise and/or visual cues (including lighting) arising from the proposed development on fauna associated with the designated Natura 2000 sites is considered unlikely. Apart from a few critical areas (e.g. in the vicinity of the SCDC) the BRDA is not lit at night.

Across most of application site the operational noise will not change to any significant extent as a result of the proposed development. A borrow pit operated at the site in the past and there is permission for the operation of a borrow pit within the application site. However, given that it is proposed to operate an extended borrow pit as part of the proposed development, there is the likelihood, in the absence of mitigation of significant effects through disturbance and displacement of fauna, e.g. as a result of blasting events.

In the absence of adequate mitigation, the operational noise and vibration (e.g. from blasting at the extended borrow pit) could potentially lead to the disturbance and/or displacement of key species (e.g. Otter). Most of the bird species that are Special Conservation Interests of the SPA are wintering birds. Uncontrolled noise and vibration during the overwintering period, would in particular, have the potential to cause disturbance to such species occurring in areas of the SPA close to the operational facility.

5.3.4 Reduction in Species Density

In the event that there was indirect habitat loss or degradation associated with the operation of the proposed development, without adequate monitoring and mitigation, it would be likely that this could see a reduction in certain species, at least locally within the ZoI.

5.3.5 Changes in Key Indicators of Conservation Value (water quality *etc.*)

In the absence of appropriate mitigation and monitoring there is some potential for the proposed development to contribute towards changes in water quality and contamination of sediments within the Lower River Shannon SAC and River Shannon & River Fergus SPA. Similarly, uncontrolled emissions to air, e.g. fugitive dust, could lead to a deterioration of habitats with the three Natura 2000 sites identified within the ZoI. Inadequate mitigation of all emissions from the site have some potential to result in significant effects on the three Natura 2000 sites within the ZoI.

5.3.6 Likely Impacts on the Natura 2000 Sites as a Whole

Such impacts cannot be discounted without adequate monitoring and mitigation commitments being implemented and/or site-specific mitigation measures being implemented.

5.3.7 Interference with the Key Relationships that Define the Structure and Function of the Natura 2000 Sites

Without the implementation of adequate monitoring and mitigation the emissions arising from the operation of the proposed development have the potential to contribute towards significant negative effects that may interfere with the structure and function of Natura 2000 sites within the project ZoI; Lower River Shannon SAC, River Shannon & River Fergus Estuaries SPA and Barrigone SAC.

5.4 Indicators of Significance as a Result of the Identification of Effects Set Out Above

As outlined in the above sections, it is considered that in the absence of appropriate monitoring and mitigation that emissions arising from the operation of the proposed development has the potential to impact Natura 2000 sites within the project Zone of Influence (ZoI).

5.4.1 Loss

There is the potential for indirect habitat loss or deterioration of Natura 2000 sites within the project ZoI from the effects of inadequately mitigated emissions e.g. run-off or discharge into the aquatic environment could result in impacts such as increased siltation, nutrient release and/or contamination.

5.4.2 Fragmentation

Not applicable.

5.4.3 Disruption

There is the potential for indirect habitat loss or disruption of Natura 2000 sites within the project ZoI from the effects of emissions arising from the proposed development: e.g. run-off or discharge into the aquatic environment from the BRDA, and/or through impacts such as increased siltation, nutrient release and/or contamination, particularly during the operational phase.

5.4.4 Disturbance

In the absence of appropriate mitigation emissions, in particular noise and vibration (e.g. associated with blasting in the extended borrow pit) have the potential to cause disturbance to faunal species listed among the QIs/SCIs of the designated Natura 2000 sites within the ZoI.

5.4.5 Change to Key Elements of the Site

Without the implementation of adequate mitigation and monitoring measures during the operation of the proposed BRDA raise and associated elements described in the planning application (e.g. closure plan), it is considered that elements of the project (in particular potential emissions from the site) may have the potential to contribute towards significant negative effects that may interfere with the structure and function of Natura 2000 sites within the project ZoI; Lower River Shannon SAC, River Shannon & River Fergus Estuaries SPA and Barrigone SAC.

5.5 Elements of the Project Likely to Significantly Impact on the Natura 2000 Sites or where the Scale or Magnitude of Impacts are Unknown

The screening elements are summarised in the following sections – before proceeding to consider in detail the scientific data from recent years regarding the control of emissions associated with the BRDA and associated elements within the application site.

It cannot be excluded on the basis of objective information that the project will have significant effects on the sites concerned either individually, or in combination with other plans or projects. Therefore Stage 2 NIS (AA) is required.

A Natura Impact Statement (NIS) is presented in **Section 6**, to provide scientific examination of the project, based on the contemporary scientific data, to enable An Bord Pleanála to undertake an AA. The NIS examines potential effects to Natura 2000 sites screened in as part of this Screening for Appropriate Assessment; Lower River Shannon SAC, River Shannon & River Fergus Estuaries SPA and Barrigone SAC.

6 Natura Impact Statement

6.1 Description of Project

The proposed development comprises of:

- An expansion of the Bauxite Residue Disposal Area (BRDA) to increase its disposal capacity in order to accommodate additional bauxite residue resulting in a proposed increase in height of c.12m (to c. 44m OD) above the currently permitted levels. No increase to the existing footprint of the BRDA is proposed.

- An extension to the existing Salt Cake Disposal Cell (SCDC) to accommodate further disposal of salt cake resulting in an increase in height of the cell by c.2.25m. The SCDC is located within the BRDA area. A description of the existing SCDC and its function is provided in Chapter 2 of this EIAR.

- An extension of the permitted borrow pit, located to the east of the BRDA, is also proposed. This extension proposes to increase the footprint of the borrow pit from c.4.5ha to c.8.4ha. This extension will provide an additional 380,000m^3 of rock fill material which is needed to satisfy the requirements of the construction and operation of the BRDA.

- The continued use of an existing stockpile area at the south east of the subject site to store topsoil in order to satisfy the additional restoration requirements of the extended BRDA.

- Upgrades to the existing water management infrastructure to accommodate the BRDA development to Stage 16 which will also allow for greater Inflow Design Flood (IDF) capacity for the entirety of the BRDA.

The location of the proposed development is on Aughinish Island, near Foynes Co. Limerick (Figure 4.1). The AAL facility was constructed on Aughinish Island between 1978 and 1983. Aughinish Island is located c. 6km northwest of Askeaton and c. 30km west of Limerick City Centre on the southern side of the Shannon Estuary near the industrial port of Foynes, Co. Limerick. The facility has been in operation, subject to planning and environmental regulation since that time. The overall landholding extends to c. 601 hectares (Figure 4.1)

The Limerick – Foynes railway line (closed in 2002) runs to the south of the island, as does the N69 National Secondary Route between Limerick and Tarbert. Aughinish Island is accessed via the L1234 Aughinish Road, which is a two-way local road which connects with the N69. The application site is located at the western portion of the Applicant's overall landholding at Aughinish Island, to the southwest of the process area of the refinery plant (Figure 4.1). The subject site is bounded by grassland and vegetation to the north, beyond which lies the Shannon Estuary.

The process area of the refinery plant is located to the northeast of the site with AAL Sports Complex, a Limerick City and County Council (LCCC) water treatment plant and main site access road all located to the east of the site. The western boundary of the site runs parallel with the Robertstown River, the edge of which is defined by an existing flood tidal defence berm (FTDB) and drainage channel. The application site, showing the extent of the existing BRDA and the local watercourses is shown in Figure 4.2.

6.2 Background to the NIS

This section of the report provides the necessary information to inform AA to be completed by An Bord Pleanála in relation to proposed development. This NIS provides the relevant scientific information to enable the competent authority in carrying out its AA to determine whether or not the proposed development would adversely affect the integrity of Natura 2000 sites.

The NIS assesses whether or not the proposed development would adversely affect the integrity of Natura 2000 sites within the project ZoI, for which effects could not be excluded during the Screening for AA. The Natura 2000 sites are as follows:

- Lower River Shannon SAC
- River Shannon & River Fergus Estuaries SPA
- Barrigone SAC

Aspects of the proposed development with the potential to result in likely significant effects on the Natura 2000 sites and their conservation objectives were considered. The operation of the overall AAL facility was recently subject to AA with the NIS prepared in 2020 (Ecology Ireland 2020) provided in Appendix A. It considered in detail the extensive environmental data that has been gathered in this area and assessed the adequacy of the prevailing environmental controls in mitigating potential impacts upon the receiving environment. It was concluded that the activities at the site, individually, or in combination with other plans or projects, would not adversely affect the integrity of any European site. This view was subsequently supported by the EPA in their AA determination.

6.3 Conceptual Site Model

The proposed project effectively increases the operation life of the facility by approximately 9 years. It will not change the location, source or nature of potential emissions considered in the NIS prepared for the licence review. A Conceptual Site Model (RSK 2021; Appendix B) was prepared to consider whether there was potential for bioaccumulation in the sensitive marine environment as a result of the emissions from the refinery plant. Such bioaccumulation could be significant, especially in relation to the effective extension of operations that the proposed development would facilitate.

The CSM considered all the major priority pathways for entry of potential contaminant sources from the entire manufacturing site (and all associated activities) into the environment from the point of manufacturing to point of likely impact. It used risk-based methodologies to consider the source-pathway-receptor (SPR) model for deriving a system CSM for assessing likely pathways and subsequently quantifying priority pathways (corridors or routes) through which pollutants or chemicals of concern might enter the environment from industrial activities and the potential impacts on environmental health. Pollutants could potentially enter the environment through numerous routes (pathways), with common points of entry into the environment being via licensed emissions points and fugitive emissions. Different entry routes to the environment could occur via accidental or improper disposal of waste materials.

The model considered the available scientific evidence and the fundamental source-pathway-receptor model to evaluate the potential pathways that could connect activities at the refinery plant and the immediate marine and terrestrial environments. A further confirmatory study to collect additional marine sediment data was undertaken in May 2021 (RSK 2021; Appendix B) to assess the significance of any potential releases from the refinery plant on the possible elevation of heavy metals concentrations in marine sediments in the immediate vicinity of the refinery plant.

The potential for chemicals (heavy metals) from the refinery plants current and future activities to impact on the health of the environment - through environmental exposure routes was assessed as very unlikely, given the comprehensive qualitative and often quantitative review of evidence (RSK 2021).

Based on the refinery plant's activities and consideration of the wider likely or potential pathways or exposure scenarios, the main pathways by which chemicals could leave the site are via:

- Direct/or fugitive discharges into water, or onto the land;
- Fugitive emissions to the surrounding environment including soils and waters.

The initial distribution and fate of chemicals in the environment is largely dependent on their entry pathway(s) into the environment and their subsequent metabolism and/or transformation. However, once released into the environment, the fate of the heavy metals in terms of toxicity and bioavailability will depend on their physicochemical properties (e.g., molecular structure, size, shape, form, solubility speciation etc.) and a variety of environmental factors (e.g., climatic conditions, soil types and hydrological effects). In addition, sorption properties of metals to organic and other substrates with varying degrees of mineralisation/ binding / transformation by both abiotic or biological processes, will also determine how they partition into different environmental compartments and therefore how toxic they are likely to be. Heavy metals released into the environment will not degrade. However, both bioavailability and toxicity are influenced (amongst other things) by the temperature, moisture, pH and ionic strength of the environment and the composition of the receiving environment. The methodology used to determine the concentration of heavy metals in the surrounding marine sediments used an extraction methodology that would best reflect the bioavailable concentrations (in the sediment), and hence the likely most toxic to resident marine biota. Other determinations have extracted heavy metals from dust and soils using very aggressive procedures to determine the total concentrations in the samples. Overall, there is no evidence of exceedance heavy metals in the surrounding marine sediments or soil concentrations.

6.3.1 Summary of the CSM findings

The CSM highlighted the potential pathways that could connect activities at the refinery plant and the immediate marine and terrestrial environments. A further confirmatory study to collect additional marine sediment data was undertaken in May 2021 (see Appendix B) to assess the significance of any potential releases from the refinery plant on the possible elevation of heavy metals concentrations in marine sediments in the immediate vicinity of the refinery plant. The sampling data from the study indicated that no pathways are being realised that may impact on sediment metal concentrations in the immediate marine environment. The data showed that metal sediment concentrations were around the typical background concentrations for the marine environment in Ireland, and therefore additional studies were not recommended on the basis that no pathway for heavy metals has realised an impact on the marine sediments, and hence marine benthic species in the immediate vicinity of the refinery plant.

So, in summary there is no evidence that heavy metals concentrations are elevated in the marine sediments, and consequently no evidence that toxic impacts would occur to the marine benthic biota. These data indicate that there is no pathway from the AAL activity producing a negative impact on the designated prey species of intertidal feeding birds and other higher fauna in the designated estuarine Natura 2000 sites.

6.4 Scope of NIS

The supporting information provided (e.g. CSM and NIS for licence review) with this NIS forms a considerable body of scientific evidence on the operation of the existing AAL facility and the nature of emissions arising from the diffuse and point sources therein. This information is provided as part of this NIS but given the nature of the proposed development the focus of the body text is on the particular sources of potential impact that are associated with the BRDA and SCDC raises, borrow pit extension and continued use of the rockfill and soil stockpile areas.

The RSK studies (Appendix B) have confirmed that there is no evidence of emissions contaminating terrestrial or marine areas in the vicinity of Aughinish Island. This further supports the conclusion of the NIS prepared for the EPA licence review. Therefore, in this NIS it is proposed to focus on discussing sources of potential impact particularly associated with the proposed development. Detailed information on the historic environmental monitoring and compliance records are presented within the supporting appendices.

6.5 Impact Assessment & Conservation Objectives

Designated nature conservation sites within the wider hinterland of the proposed development site were identified through a desktop review. European sites, Special Areas of Conservation (SACs) and Special Protection Areas (SPAs) have been designated under the EU Habitats Directive (92/43/EEC) and the EU Birds Directive (2009/147/EC) respectively. SACs and SPAs are collectively known as Natura 2000 sites and are legally protected by Irish law. The Qualifying Interests (QIs) of SACs include high value conservation habitats and species in the EU and listed in the Habitats Directive. The Special Conservation Interests (SCIs) of the SPAs are birds of European conservation importance and associated wetland habitats of particular importance for these species.

According to the Habitats Directive, the Conservation Status of a natural habitat will be taken as ‘favourable’ within its biogeographic range when:

- its natural range and areas it covers within that range are stable or increasing, and
- the specific structure and functions which are necessary for its long-term maintenance exist and are likely to continue to exist for the foreseeable future, and
- the Conservation Status of its typical species is favourable as defined below.

According to the Habitats Directive, the Conservation Status of a species means the sum of the influences acting on the species concerned that may affect the long-term distribution and abundance of its populations. The Conservation Status will be taken as ’favourable’ within its biogeographic range when:

- population dynamics data on the species concerned indicate that it is maintaining itself on a long-term basis as a viable component of its natural habitats, and
- the natural range of the species is neither being reduced nor is likely to be reduced for the foreseeable future, and
- there is, and will probably continue to be, a sufficiently large habitat to maintain its populations on a long-term basis.

These outline goals form the basis of conservation objectives developed for Natura 2000 sites by NPWS and are published online as 'Generic Conservation Objectives' for Natura 2000 sites in Ireland.

Site specific conservation objectives are also available for certain Natura 2000 sites which detail contextual conservation targets for the qualifying criteria of the individual Natura 2000 sites. These site-specific conservation objectives are typically accompanied by backing documentation in the form of 'Conservation objectives supporting documents' or 'Conservation Plans'.

The application site is not located within any Natura 2000 site. The application site boundary is located 0.01km from the Lower River Shannon SAC (Site Code 002165) and the River Shannon and River Fergus Estuaries SPA (Site Code 004077; Figure 4.3a). The lands under the ownership of AAL include areas of natural/semi-natural grassland and wetland habitat some of which are located within these two designated Natura 2000 sites. Barrigone SAC (Site Code 000432) is located 0.45km from the application boundary south of Aughinish Is.

Details on the key features (qualifying and special conservation interests) of all of three Natura 2000 sites where likely significant effects could occur in relation to the proposed development (as described in the Screening Stage assessment) are presented in Table 6.5.1. Full details of the site synopses and conservation objectives of each of these sites as published by NPWS are available online (www.npws.ie). The designated Natura 2000 sites proximate to the application site are shown in Figure 4.3b.

The conservation objectives of the Lower River Shannon SAC relate to a wide range of largely aquatic habitats and species with a number of different Annex I habitats and associated Annex II species. These include:

- Otter *(Lutra lutra)*
- Freshwater Pearl Mussel (*Margaritifera margaritifera*),
- Salmon (*Salmo salar*),
- Sea Lamprey (*Petromyzon marinus)*
- Brook Lamprey *(Lampetra planeri)*
- River Lamprey (*Lampetra fluviatilis*)
- Estuaries
- Sandbanks which are slightly covered by sea water all the time
- Coastal lagoons
- Mudflats and sandflats not covered by seawater all the time

The conservation objectives of the River Shannon and River Fergus Estuaries SPA relate chiefly to wintering bird species;

- Whooper Swan (*Cygnus cygnus*)

- Light-bellied Brent Goose (*Branta bernicla hrota*)
- Shelduck (*Tadorna tadorna*)
- Wigeon (*Anas penelope*)
- Teal (*Anas crecca*)
- Pintail (*Anas acuta*)
- Shoveler (*Anas clypeata*)
- Scaup (*Aythya marila*)
- Ringed Plover (*Charadrius hiaticula*)
- Golden Plover (*Pluvialis apricaria*)
- Grey Plover (*Pluvialis squatarola*)
- Lapwing (*Vanellus vanellus*)
- Knot (*Calidris canutus*)
- Dunlin (*Calidris alpina*)
- Black-tailed Godwit (*Limosa limosa*)
- Bar-tailed Godwit (*Limosa lapponica*)
- Curlew (*Numenius arquata*)
- Redshank (*Tringa totanus*)
- Greenshank (*Tringa nebularia*)
- Black-headed Gull (*Chroicocephalus ridibundus*)

Cormorant (*Phalacrocorax carbo*) is also listed as a conservation objective but for both wintering and breeding numbers.

Barrigone SAC is an area of species rich, calcareous grassland. It has been designated as an SAC for the following conservation objectives:

- Marsh Fritillary (*Euphydryas aurinia*)
- *Juniperus communis* formations on heaths or calcareous grasslands
- Semi-natural dry grasslands and scrubland facies on calcareous substrates (Festuco Brometalia; important orchid sites)
- Limestone pavements

Table 6.5.1: Summary of European Designated Sites located in the 15km Hinterland of the application site.

Site Name & Code	Summary Details	Minimum Distance (km)
Lower River Shannon SAC (002165)	The conservation objectives of this site are to maintain the favourable conservation condition of the Annex I habitats and fauna listed as Special Conservation Interests for this SAC: ● Sandbanks ● Estuaries ● Tidal Mudflats and Sandflats ● Coastal Lagoons* ● Large Shallow Inlets and Bays ● Reefs ● Perennial Vegetation of Stony Banks ● Vegetated Sea Cliffs ● *Salicornia* Mud ● Atlantic Salt Meadows ● Mediterranean Salt Meadows ● Floating River Vegetation ● *Molinia* Meadows ● Alluvial Forests* ● Freshwater Pearl Mussel *Margaritifera margaritifera* ● Sea Lamprey *Petromyzon marinus* ● Brook Lamprey *Lampetra planeri* ● River Lamprey *Lampetra fluviatilis* ● Atlantic Salmon *Salmo salar* ● Bottlenose Dolphin *Tursiops truncatus* ● Otter *Lutra lutra*	0.01 km
River Shannon and River Fergus Estuaries SPA (004077)	The conservation objectives of this site are to maintain the favourable conservation condition of the bird species listed as Special Conservation Interests for this SPA: Breeding and Wintering ● Cormorant *Phalacrocorax carbo* Wintering ● Whooper Swan *Cygnus cygnus* ● Light-bellied Brent Goose *Branta bernicla hrota* ● Shelduck *Tadorna tadorna* ● Wigeon *Anas penelope* ● Teal *Anas crecca* ● Pintail *Anas acuta* ● Shoveler *Anas clypeata*	0.01 km

Site Name & Code	Summary Details	Minimum Distance (km)
	• Scaup *Aythya marila* • Ringed Plover *Charadrius hiaticula* • Golden Plover *Pluvialis apricaria* • Grey Plover *Pluvialis squatarola* • Lapwing *Vanellus vanellus* • Knot *Calidris canutus* • Dunlin *Calidris alpina* • Black-tailed Godwit *Limosa limosa* • Bar-tailed Godwit *Limosa lapponica* • Curlew *Numenius arquata* • Redshank *Tringa totanus* • Greenshank *Tringa nebularia* • Black-headed Gull *Chroicocephalus ridibundus* • Wetlands	
Barrigone SAC (000432)	The conservation objectives of this site are to maintain the favourable conservation condition of the habitats and fauna listed as Special Conservation Interests for this SAC: • *Juniperus communis* formations on heaths or calcareous grasslands • Semi-natural dry grasslands and scrubland facies on calcareous substrates (Festuco Brometalia) (* important orchid sites)* • Limestone pavements* • Marsh Fritillary *Euphydryas aurinia*	0.5 km

* denotes a priority habitat

6.5.1 Characterising Impacts

The methodology for the assessment of impacts is derived from the Assessment of Plans and Projects Significantly Affecting Natura 2000 Sites (EC, 2002). When describing changes/activities and impacts on ecosystem structure and function, the types of impacts that are commonly presented include the following:

- direct and indirect effects,
- short- and long-term effects,
- construction, operational and deconstruction / demolition effects, and
- isolated, interactive and cumulative effects.

Impacts that could potentially occur through the implementation of the project can be categorised under a number of impact categories as outlined in the EC 2002 document as follows:

- Loss/Reduction of habitat area,
- Disturbance to key species,

- Habitat or species fragmentation,
- Reduction in species density, and
- Changes in key indicators of conservation value such as decrease in water quality and quantity.

Meaning of ‘Adversely Affect the Integrity of the Site’

The concept of the ‘integrity of the site’ is explained in the EU publication Managing Natura 2000 sites: The provisions of Article 6 of the 'Habitats' Directive 92/43/EEC, as follows;

‘It is clear from the context and from the purpose of the directive that the ‘integrity of the site’ relates to the site’s conservation objectives. For example, it is possible that a plan or project will adversely affect the integrity of a site only in a visual sense or only habitat types or species other than those listed in Annex I or Annex II. In such cases, the effects do not amount to an adverse effect for purposes of Article 6(3), provided that the coherence of the network is not affected. On the other hand, the expression ‘integrity of the site’ shows that focus is here on the specific site. Thus, it is not allowed to destroy a site or part of it on the basis that the conservation status of the habitat types and species it hosts will anyway remain favourable within the European territory of the Member State.

As regards the connotation or meaning of ‘integrity’, this can be considered as a quality or condition of being whole or complete. In a dynamic ecological context, it can also be considered as having the sense of resilience and ability to evolve in ways that are favourable to conservation. The ‘integrity of the site’ has been usefully defined as ‘the coherence of the site’s ecological structure and function, across its whole area, or the habitats, complex of habitats and/or populations of species for which the site is or will be classified’

A site can be described as having a high degree of integrity where the inherent potential for meeting site conservation objectives is realised, the capacity for self-repair and self-renewal under dynamic conditions is maintained, and a minimum of external management support is required. When looking at the ‘integrity of the site’, it is therefore important to take into account a range of factors, including the possibility of effects manifesting themselves in the short, medium and long-term.

The integrity of the site involves its ecological functions. The decision as to whether it is adversely affected should focus on and be limited to the site’s conservation objectives.

6.6 Potential Effects from the Proposed Development to Qualifying Habitats and Species of Natura 2000 Sites within the Project Zone of Influence

Potential effects associated with the proposed development to the Qualifying Habitats and Species of Natura 2000 Sites within the project Zone of Influence (Lower River Shannon SAC, River Shannon & River Fergus Estuaries SPA, Barrigone SAC may involve:

- Outputs and emissions arising from the operation of the BRDA, SCDC and extended borrow pit and associated project elements. This would include emissions to air (e.g. fugitive dust) and water, noise, visual disturbance (e.g. movement of plant and personnel and night-time illumination).

The overall AAL facility is an industrial refinery plant with multiple points and types of emission. The nature of these emissions and their potential to impact upon the receiving environment was assessed in detail in the NIS for the EPA licence review in 2020 (see Appendix A). In addition, as described in Section 6.1, a CSM was produced which concluded that there is no pathway from the AAL facility producing a negative impact on the designated prey species of intertidal feeding birds and other higher fauna in the designated estuarine Natura 2000 sites.

The overall AAL facility operates under license from the EPA (P0035-07) and as such the emission limits are set by the regulatory authority to ensure that there is no damaging impact upon the receiving environment. The setting of limits and the monitoring of the emissions to ensure compliance with these levels, is therefore intrinsically mitigation of the impacts of various types of emission that the regulatory authority understands to pose a potential threat to the receiving environment. It is reasonable to conclude that in the absence of such appropriate environmental controls, monitoring and limits, that outputs and emissions arising from the proposed development site could adversely impact upon the integrity of Natura 2000 sites within the zone of influence. However, in the context of this site and its continued operation it is important to recognise that control of sources of potential emission are already strictly controlled.

The following sections of the NIS consider the potential for emissions of various types associated with the proposed development, examining the historical data and nature of predicted future emissions arising from the application site. The environmental monitoring data (e.g. in relation to the estuarine sediment) will naturally include consideration of the background baseline conditions that in many cases will be reflecting the overall inputs into the environment from a wide variety of plans, projects and activities. Separation of all in-combination and cumulative sources of emissions in such cases is impractical. However, an effort is made first of all to assess the potential impacts of the proposed project upon the designated Natura 2000 sites (and their conservation objectives) under consideration at the NIS stage. In addition, the potential for projects and plans to act cumulatively or in combination with the proposed project to impact upon the Lower River Shannon SAC, The River Shannon and River Fergus Estuaries SPA and Barrigone SAC is also considered.

6.7 Emissions to Air

6.7.1 Results of Ambient Air Monitoring

The Annual Environmental Reports (AERs) submitted to the Environmental Protection Agency, as required by their licence, for the period 2014 to 2020, were reviewed. Condition 5.9 of the IEL requires AAL to carry out a programmes of ambient air monitoring both on-site and off-site. The levels of deposited dust, particulate matter (<10 µm and <2.5 µm) must be determined at the ambient air quality monitoring locations. The results are compared to the limits given in the CAFÉ Directive (2008/50/EC) which was transposed into Irish legislation under the Air Quality Standard Regulations 2011 [S.I. No. 180 of 2011]. The following emissions are monitored and reported upon as part of the IEL requirements:

- Deposited Dust
- Particulate Matter (< 10 µm – PM_{10})
- Particulate Matter (< 2.5 µm – $PM_{2.5}$).

The findings of the assessment are given in Table 6.1. Chapter 11 of the accompanying EIAR considers in detail the potential impacts on the environment from emissions to air associated with the proposed development. The location of the point and diffuse sources of emissions from the existing facility and the historic monitoring data is described in detail in Appendix A.

During the operational phase, the potential sources of dust are those associated with the Borrow Pit extraction, wind erosion from the surface of the BRDA and internal site vehicle movements to the BRDA area where the phasing will see the height of the existing BRDA increase from Stage 10 to Stage 16. In addition, the salt cake cell will also be raised as part of the proposed BRDA raise. There is a requirement for c. 50,000 m³ of rock (equates to c.90,000 tonnes) per year to provide for ongoing works associated with the BRDA over the lifetime of the permitted development at the site. The extracted rock will be used within the confines of the site and will not be transported off site.

Ambient dust deposition monitoring is carried out monthly at 35 locations (DG1-DG35; Figure 6.1). Locations DG29-DG32 are external to the overall facility, the remaining ambient air sampling locations are within the site boundary. Dust deposition monitoring is determined using a Bergerhoff Gauge and results are reported as $mg/m^2/d$. Ambient particulate monitoring (PM_{10} and $PM_{2.5}$) is conducted at 6 locations around the site (Figure 6.1).

Details of the assessment of air quality and the potential impacts arising from the proposed development are presented in detail in Chapter 11 of the accompanying EIAR. A review of the reported monitoring data for the dust collection units on-site shows that there was 100% compliance with the licensed mass emissions limits for all parameters. Furthermore, all reported annual and bi-annual grab sampling were compliant with the emission limit values for dust as outlined in the licence.

Results of directional dust deposition monitoring at 4 locations within or near the AAL boundary from January 2020 to December 2020 confirmed that average dustfall levels measured at these locations were within the TA Luft limit value of 350 $mg/(m^2*day)$ over 2020 with a maximum monthly average of 232 $mg/(m^2*day)$ at DG14 in February 2020 (see Chapter 11 of the EIAR). In terms of directional variation, it would be expected that the west facing directional results would be higher than the other three directions if the BRDA was contributing a significant fraction of the measured dust deposition levels. However, little variation was recorded between the average west results and the average overall results indicating that there is no significant contribution, above background levels, from the BRDA to locally deposited dust.

Table 6.1: Summary results related to ambient air monitoring from 2014-2020.

Year	Findings	Compliance with CAFÉ Directive & Air-Quality Standard, 2011
2014	Dust deposition monitoring results were all less than 350 mg/m^2/d. Dust deposition at 2 off-site locations were less than the 350 mg/m^2/d limit. The continuous particulate monitoring stations outside the site boundary all had levels of $PM_{2.5}$ levels (5ug/m^3) at all three sites which is less than the CAFÉ air quality standard of 25 µg/m^3. The Foynes site had a PM_{10} annual mean level of 11 µg/m^3 while the Ballysteen and Limerick City and County Council Water Treatment Plant (LCC WTP) site had levels of 10 µg/m^3. These are less than the PM_{10} requirements of 40 µg/m^3. Continuous particulate monitoring on site detected $PM_{2.5}$ levels of 14 and 6 µg/m^3 at locations SW and NE of plant respectively. PM_{10} levels for the same locations were 110 and 13 µg/m^3 respectively. AAL reported that air monitoring location 'SW of Plant' is adjacent to a heavily trafficked haul road.	100% Compliance with the TA Luft 350 mg/m^2/d limit and 100 % compliance with the CAFÉ Directive PM_{10} and $PM_{2.5}$ limits. The Location SW of the Plant which had a PM_{10} annual mean level of 110 µg/m^3 is regarded as an on-site source and hence ambient air quality limits (CAFÉ Directive and the 2011 Air Quality Standard Regulations do not apply. The results of the off-site monitoring indicate the ambient air quality at off-site monitoring points is good with the various values in general falling within the relevant targets for those parameters.
2015	Dust deposition monitoring results were all less than 350 mg/m^2/d. Dust deposition monitoring at the 5 off-site locations had levels less than 350 mg/m^2/d. The $PM_{2.5}$ annual mean levels at Foynes, Ballysteen and LCC WTP were 5, 6 and 4 µg/m^3. These levels are less than the CAFÉ Directive limits of 25 µg/m^3. The PM_{10} annual mean levels at Foynes, Ballysteen and LCC WTP were 9, 13 and 9 µg/m^3. The Ballysteen level was higher than the 2014 level of 10 µg/m^3. These levels are less than the CAFÉ Directive limits of 40 µg/m^3.	100% Compliance with the TA Luft 350 mg/m^2/d limit and 100 % compliance with the CAFÉ Directive PM_{10} and $PM_{2.5}$ limits. The results of the off-site monitoring indicate the ambient air quality at off-site monitoring points is good (as defined by EPA ambient air monitoring programme) with all parameters monitored falling within the relevant targets/limits for those parameters.

Year	Findings	Compliance with CAFÉ Directive & Air-Quality Standard, 2011
	Particulate monitoring on site detected $PM_{2.5}$ levels of 12 and 7 µg/m^3 at locations SW and NE of plant respectively. PM_{10} levels for the same locations were 64 and 16 µg/m^3 respectively. The PM_{10} levels at the SW Plant monitoring location were about half of the 2014 levels.	
2016	Dust deposition monitoring results were all less than 350 mg/m^2/d. Dust deposition monitoring at the 5 off-site locations had levels less than 350 mg/m^2/d. The $PM_{2.5}$ annual mean levels at Foynes, Ballysteen and LCC WTP were 4, 3 and 2 µg/m^3. These levels are less than the CAFÉ Directive limits of 25 µg/m^3. The PM_{10} annual mean levels at Foynes, Ballysteen and LCC WTP were 9, 7 and 4 µg/m^3. These levels are less than the CAFÉ Directive limits of 40 µg/m^3. Particulate monitoring on site detected $PM_{2.5}$ levels of 7 and 6 µg/m^3 at locations SW and NE of plant respectively. PM_{10} levels for the same locations were 36 and 18 µg/m^3 respectively. The PM_{10} levels at the SW Plant monitoring location were about half of the 2015 levels.	100% Compliance with the TA Luft 350 mg/m^2/d limit and 100 % compliance with the CAFÉ Directive PM_{10} and $PM_{2.5}$ limits. The results of the off-site monitoring indicate the ambient air quality at off-site monitoring points is good (as defined by EPA ambient air monitoring programme) with all parameters monitored falling within the relevant targets/limits for those parameters.
	Dust deposition monitoring results were all less than 350 mg/m^2/d. Dust deposition monitoring at the 5 off-site locations had levels less than 350 mg/m^2/d.	100% Compliance with the TA Luft 350 mg/m^2/d limit and 100 % compliance with the CAFÉ Directive PM_{10} and $PM_{2.5}$ limits.

Year	Findings	Compliance with CAFÉ Directive & Air-Quality Standard, 2011
2017	The $PM_{2.5}$ annual mean levels at Foynes, Ballysteen and LCC WTP were 6, 6 and 5 µg/m³. These levels are less than the CAFÉ Directive limits of 25 µg/m³, but slightly up from the 2016 levels detected at these stations. The PM_{10} annual mean levels at Foynes, Ballysteen and LCC WTP were 9, 9 and 9 µg/m³. These levels are less than the CAFÉ Directive limits of 40 µg/m³. Particulate monitoring on site detected $PM_{2.5}$ levels of 7 and 8 µg/m³ at locations SW and NE of plant respectively. PM_{10} levels for the same locations were 14 and 13 µg/m³ respectively. The PM_{10} levels at the SW Plant monitoring location have significantly reduced form the 2016 levels.	The results of the off-site monitoring indicate the ambient air quality at off-site monitoring points is good (as defined by EPA ambient air monitoring programme) with all parameters monitored falling within the relevant targets/limits for those parameters.
2018	Dust deposition monitoring results were all less than 350 mg/m²/d. Dust deposition monitoring at the 5 off-site locations had levels less than 350 mg/m²/d. The levels of $PM_{2.5}$ detected at Foynes, Ballysteen and LCC WTP were 6.5 µg/m³, 6.1 µg/m³ and 6.6 µg/m³ respectively which is below the CAFÉ Directives limit of 25 µg/m³. The levels of PM_{10} at these sites were 10.9 µg/m³, 8.2 µg/m³ and 8.8 µg/m³ respectively. These levels are below the CAFÉ Directive limits of 40 µg/m³. The on-site PM_{10} and $PM_{2.5}$ monitoring locations (SW of Plant and NE of Plant) had $PM_{2.5}$ levels of 5.9 µg/m³ and 10.1 µg/m³ respectively. The PM_{10} levels at these sites were 12.5 µg/m³ and 18.6 µg/m³ respectively.	100% Compliance with the TA Luft 350 mg/m²/d limit and 100 % compliance with the CAFÉ Directive PM_{10} and $PM_{2.5}$ limits. The results of the off-site monitoring indicate the ambient air quality at off-site monitoring points is good (as defined by EPA ambient air monitoring programme) with all parameters monitored falling within the relevant targets/limits for those parameters.

Year	Findings	Compliance with CAFÉ Directive & Air-Quality Standard, 2011
2019	Dust deposition monitoring results were all less than 350 $mg/m^2/d$. Dust deposition monitoring at the 5 off-site locations had levels less than 350 $mg/m^2/d$. The levels of $PM_{2.5}$ detected at Foynes, Ballysteen and LCC WTP were 4.9 $\mu g/m^3$, 4.4 $\mu g/m^3$ and 7.1 $\mu g/m^3$ respectively which is below the CAFÉ Directives limit of 25 $\mu g/m^3$. The levels of PM_{10} at these sites were 6.0 $\mu g/m^3$, 5.7 $\mu g/m^3$ and 10.1 $\mu g/m^3$ respectively. These levels are below the CAFÉ Directive limits of 40 $\mu g/m^3$. The on-site PM_{10} and $PM_{2.5}$ monitoring locations (SW of Plant and NE of Plant) had $PM_{2.5}$ levels of 6.5 $\mu g/m^3$ and 8.1 $\mu g/m^3$ respectively. The PM_{10} levels at these sites were 10.6 $\mu g/m^3$ and 13.9 $\mu g/m^3$ respectively.	100% Compliance with the TA Luft 350 $mg/m^2/d$ limit and 100 % compliance with the CAFÉ Directive PM_{10} and $PM_{2.5}$ limits. The results of the off-site monitoring indicate the ambient air quality at off-site monitoring points is good (as defined by EPA ambient air monitoring programme) with all parameters monitored falling within the relevant targets/limits for those parameters.
2020	Dust deposition monitoring results were all less than 350 $mg/m^2/d$. Dust deposition monitoring at the 5 off-site locations had levels less than 350 $mg/m^2/d$. The levels of $PM_{2.5}$ detected at Foynes, Ballysteen and LCC WTP were 6.6 $\mu g/m^3$, 5.0 $\mu g/m^3$ and 5.9 $\mu g/m^3$ respectively which is below the CAFÉ Directives limit of 25 $\mu g/m^3$. The levels of PM_{10} at these sites were 9.6 $\mu g/m^3$, 7.9 $\mu g/m^3$ and 8.5 $\mu g/m^3$ respectively. These levels are below the CAFÉ Directive limits of 40 $\mu g/m^3$.	100% Compliance with the TA Luft 350 $mg/m^2/d$ limit and 100 % compliance with the CAFÉ Directive PM_{10} and $PM_{2.5}$ limits. The results of the off-site monitoring indicate the ambient air quality at off-site monitoring points is good (as defined by EPA ambient air monitoring programme) with all parameters monitored falling within the relevant targets/limits for those parameters.

Year	Findings	Compliance with CAFÉ Directive & Air-Quality Standard, 2011
	The on-site PM_{10} and $PM_{2.5}$ monitoring locations (SW of Plant and NE of Plant) had $PM_{2.5}$ levels of 7.1 µg/m^3 and 8.0 µg/m^3 respectively. The PM_{10} levels at these sites were 12.6 µg/m^3 and 13.0 µg/m^3 respectively.	

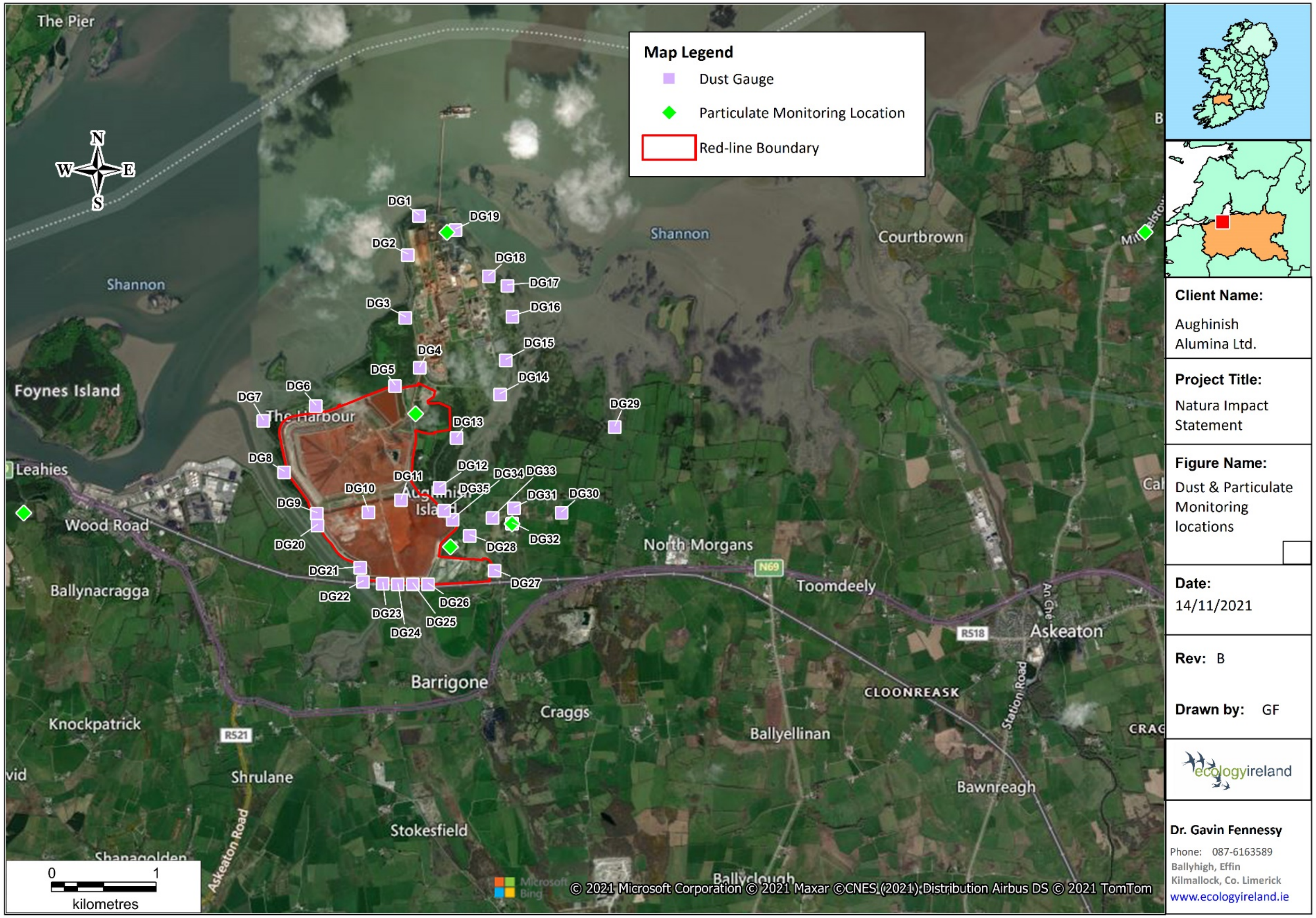

Figure 6.1 Dust and particulate monitoring locations (background image from Bing Mapping c. 2013).

6.7.2 Air Quality Modelling

Construction dust has the potential to cause local impacts through dust nuisance at the nearest sensitive receptors. Construction activities such as excavation, earth moving and backfilling may generate quantities of dust, particularly in dry and windy weather conditions. The saltcake, due to the high moisture content of approximately 45%, will not be a significant source of dust. While dust from construction activities tends to be deposited within 200m of a construction site, the majority of the deposition occurs within the first 50m. The extent of any dust generation depends on the nature of the dust (soils, peat, sands, gravels, silts etc.) and the nature of the construction activity. In addition, the potential for dust dispersion and deposition depends on local meteorological factors such as rainfall, wind speed and wind direction. Vehicles transporting material to and from the site also have the potential to cause dust generation along the selected haul routes from the construction areas.

Appendix 8 of the "*Guidelines for the treatment of Air Quality During the Planning & Construction of National Road Schemes*" discusses construction phase impacts. Table 6.2 below shows the risk from dust soiling ranges from 25m–100m and in relation to PM_{10} the risk ranges from 10m–25m depending on the scale of the construction activity. The guidance above would indicate that there is negligible potential for impacts from soiling, PM_{10} and to vegetation and therefore, no significant impacts are expected with the application of appropriate mitigation. The impact due to construction dust at sensitive receptors is predicted to be temporary, reversible, and imperceptible.

Table 6.2 Assessment Criteria for the Impact of Dust Emissions from Construction Activities with Standard Mitigation in Place.

Source		Potential Distance for Significant Effects (Distance from source)		
Scale	**Description**	**Soiling**	**PM_{10}**	**Vegetation Effects**
Major	Large construction sites with high use of haul routes	100m	25m	25m
Moderate	Moderate sized construction sites with moderate use of haul routes	50m	15m	15m
Minor	Minor construction sites with limited use of haul routes	25m	10m	10m

Source: Appendix 8: Assessment of Construction Impacts taken from "*Guidelines for the treatment of Air Quality During the Planning & Construction of National Road Schemes*"

During the operation of the BRDA, the phasing of the BRDA raise over time will result in the elevation increasing as each stage is completed. For the purposes of this assessment the following stages of the BRDA development has been assessed (AWN 2021; Chapter 11 of the EIAR);

- Current ('Scenario 1')
- Phase 1 at Stage 10; Phase 2 at Stage 4 ('Scenario 2')
- Phase 1 at Stage 12; Phase 2 at Stage 8 ('Scenario 3')
- Phase 1 at Stage 14; Phase 2 at Stage 12 ('Scenario 4')
- All at Stage 16 including the restoration activity ('Scenario 5').

Predicted PM_{10} concentrations at the AAL boundary are below the ambient air quality standards at the worst-case off-site location due to emissions from the BRDA plus the borrow pit and its associated traffic movments (see Chapter 11 of the EIAR). Modelling of operational particulate concentrations for the different stage raises is presented in Chapter 11 of the EIAR. The predicted 24-hour (90th%ile) and annual concentrations (excluding background) at the worst-case off-site location peak at 4.7 and 1.4 µg/m^3, respectively with peaks generally located at the site boundary. Based on a background PM_{10} concentration of 10 µg/m^3 in the region, the combined annual PM_{10} concentration including the emissions form the BRDA and borrow pit peaks at 11.4 µg/m^3. This predicted level equates to at most 28.5% of the annual limit value of 40 µg/m^3. The predicted 24-hour PM_{10} concentration (including background) peaks at 14.7 µg/m^3 which is 29.4% of the 24-hour limit value of 50 µg/m^3 (measured as a 90.4th%ile). Concentrations at the worst-case sensitive receptor are significantly lower than the worst-case off-site location.

Predicted $PM_{2.5}$ concentrations at the AAL boundary are below the ambient air quality standard at the worst-case off-site location due to emissions from the BRDA plus the borrow pit and its associated traffic moments. The predicted annual concentration (excluding background) at the worst-case off-site location peaks at 1.4 µg/m^3 with peaks generally located at the site boundary. Based on a background $PM_{2.5}$ concentration of 7 µg/m^3 in the region, the combined annual $PM_{2.5}$ concentration including the emissions form the BRDA and borrow pit peaks at 8.4 µg/m^3. This predicted level equates to at most 34% of the annual limit value of 25 µg/m^3. Concentrations at the worst-case sensitive receptor are significantly lower than the worst-case off-site location.

Results of the modelling of particulates are broadly similar for Scenarios 1 – 4 with a tendency to slightly decrease in ambient concentration as the BRDA is raised. Scenario 5 (all at Stage 16) is lower as the surface area of the BRDA is significantly reduced compared to the other four scenarios.

Predicted dust deposition levels at the worst-case off-site location are significantly lower than the limit value of 350 mg/m^2/day. Based on a background dust deposition level of 20 mg/m^2/day in the region, the annual dust deposition level due to emissions from the BRDA plus the borrow pit and its associated traffic moments peaks at 33.1 mg/m^2/day. This peak level equates to 9.5% of the annual guideline value for dust deposition. Again, results are broadly similar for Scenarios 1 – 4 with a tendency to slightly decrease in ambient dust deposition levels as the BRDA is raised. Scenario 5 (all at stage 16) is lower as the surface area of the BRDA is significantly reduced compared to the other four scenarios.

The emission of heavy metals from the BRDA was also modelled based on the assumption that the percentage of heavy metals identified in the sampling of the farmed bauxite residue in Year 2020 are also emitted into and dispersed by the atmosphere in the same ratio. The results indicate that based on the reported heavy metal concentration over the period, all heavy metals are in compliance with the relevant ambient annual mean air quality standard.

The CSM has concluded that there is no emission pathway associated with the AAL facility producing a negative impact on the nearby Natura 2000 sites. This also supports the conclusion that with the application of appropriate mitigation that there is no risk of significant adverse impacts upon the designated sites in relation to emissions to air as a result of the proposed development.

6.8 Emissions to Surface Water, Transitional Water and Marine

6.8.1 Introduction

This section of the report discusses discharges to surface water, transitional waters and the marine environment. The hydrology and hydrogeology assessment of the proposed development is presented in Chapter 10 of the accompanying EIAR. Additional information on the sources of water emissions from the overall facility and historic water quality monitoring is presented in the NIS prepared for the recent EPA licence review (Appendix A). Surface water related impacts could potentially impact upon the two estuarine Natura 2000 sites within the ZoI.

The proposed development involves construction activities as an intrinsic part of the preparatory, construction, operational and closure phases, as the facility is progressively raised in elevation as it is filled with bauxite residue and is progressively restored on the side-slopes. The proposed development will enter into an aftercare phase following the completion of the combined construction/operational phase. In accordance with Condition 10 of the EPA issued licence (IEL P0035-07), AAL are required to have an approved plan in place for the orderly closure, decommissioning and aftercare of the facility. This plan is called the Closure, Restoration and Aftercare Management Plan (CRAMP) and covers both the refinery plant area and the BRDA. The most recent update was conducted by AAL during 2019 as part of the licence review for IEL P0035-07.

The topography of the Application Site currently varies from c. 22 mOD to 32 mOD in the Phase 1 BRDA, from c. 11 mOD to 20.0 mOD in the Phase 2 BRDA. The ground elevations at the downstream toe of the facility (pre-development ground elevations) vary from c. 1 mOD in the north to c. 6 mOD in the south. The BRDA portion of this Application seeks to raise the height of the existing BRDA, therefore the current baseline of the Proposed Development is located over the existing BRDA, which for the majority of the footprint has a downstream toe of c. 1.0 mOD. The BRDA is surrounded by the composite lined Perimeter Interceptor Channel (PIC) which collects water emerging from the BRDA (bauxite residue bleed water, surface water runoff, sprinkler water and seepage) and transfers the free water by gravity to the pumping stations. The pumps convey the waters either to the ECS located in the Plant or to the SWP, which is also composite lined.

The topography of the Borrow Pit Extension varies between 16 mOD and 20 mOD, with the higher ground located to the north-east of the footprint. The permitted Borrow Pit area comprises land which was previously disturbed ground which has been partly used as a compound area for an on-site Landscaping Contractor for AAL. The proposed Borrow Pit Extension area comprise land that is undisturbed and adjoins to east side of the permitted Borrow Pit. There is a difference in height of c. 9 m between the base of the former Borrow Pit (last used in the early 1980s) and the rest of the Site surface due to the previous extraction.

6.8.2 Sources of Water Emissions from overall facility

The main sources of water emissions from the plant are:

- The wastewater treatment plant – discharge point W1-1 (see Figure 6.6.1).
- Sanitary effluent via the sanitary effluent treatment plant – discharge point W1-1.

- Stormwater from the northern section of the site is directed to the Shannon Estuary via silt traps at emission points SS1 to SS5. A separate drainage system is engaged for the southern portion of the site, which contains all the main processing areas and the BRDA. This stormwater is sent to the on-site effluent treatment plant and discharged to the Shannon Estuary via licenced discharge point W1-1.

6.8.3 Relevant Legislation

Legislation covering discharges for the facility includes:

- European Union (Planning and Development) (Environmental Impact Assessment) Regulations 2018, S.I. 296 of 2018.
- Irish Government. Guidelines for Planning Authorities and An Bord Pleanála on carrying out Environmental Impact Assessment (2018).
- The EPA Guidelines on the Information to be Contained in Environmental Impact Assessment Reports (Draft, August 2017).
- European Commission. Environmental Impact Assessment of Projects: Guidance on the preparation of the Environmental Impact Assessment Report (2017).
- Institute of Geologists of Ireland. Guidelines for the Preparation of Soils, Geology and Hydrogeology Chapters of Environmental Impact Statements (April 2013).
- Directive 2011/92/EU as amended by 2014/52/EU of the European Parliament and of the Council.
- S.I. No. 9/2010 – European Communities Environmental Objectives (Groundwater) Regulations) 2010, as amended by S.I. No. 149 of 2012 and S.I. No.366 of 2016.
- S.I. No. 272/2009 – European Communities Environmental Objectives (Surface Waters) Regulations 2009, as amended by S.I. No. 327 of 2012, S.I. No. 386 of 2015 and S.I. No. 77 of 2019.
- The EU Directive on the Assessment and Management of Flood Risks (2007/60/EC) is transposed into Irish law by the European Communities (Assessment and Management of Flood Risks) Regulations 2010 and its subsequent amendment. The legislation outlines the requirements for flood risk assessments to be completed as part of the planning process.
- Planning and Development Regulations, S.I. No. 600/2001, as amended.
- The European Union (EU) Water Framework Directive (WFD) (2000/60/EC) is the European legislation that establishes a framework for the protection of groundwater and surface water, including the establishment of river basin districts, the requirement to prevent further deterioration by preventing or limiting inputs of pollutants into groundwater, reducing pollution and promoting sustainable water use.
- The Groundwater Daughter Directive (GWDD) (2006/118/EC) sits beneath the WFD and relates to water protection and management. It establishes measures to prevent and control groundwater pollution, including criteria for assessing good chemical status and identifying trends.

The WFD and GWDD has been transposed into Irish law by means of many Regulations. These Regulations cover governance, the shape of the WFD characterisation, monitoring and status assessment programmes in terms of assigning responsibilities for the monitoring of different water categories, determining the quality elements and undertaking the characterisation and classification assessments. They include, but are not limited to, the following:

- European Communities (Water Policy) Regulations 2003 and its subsequent amendments;
- European Communities Environmental Objectives (Surface Waters) Regulations, 2009 and its subsequent amendments;
- European Communities Environmental Objectives (Groundwater) Regulations, 2010 and its subsequent amendments; and
- European Communities (Technical Specifications for the Chemical Analysis and Monitoring of Water Status) Regulations 2011.
- The Local Government (Water Pollution) Act 1977 (as amended) and associated Statutory Instrument Regulations made under that Act outline the general prohibition of entry of polluting matter to water, the requirement to licence both trade and sewage effluent discharges, licencing of water abstractions, controlling discharges to aquifers, and notification of accidental damages.

6.8.4 Assessment Methodology

The assessment approach for the proposed development on the local water quality, as detailed in Chapter 10 of the EIAR is summarised as follows:

1) Confirm baseline conditions – determine baseline and develop conceptual site model by consideration of available records and data sets, site reports and published information.
2) Confirm the key receptors and their value/importance.
3) Qualitatively characterise the magnitude of impacts on the receptors – describe what potential changes could occur to each receptor as a result of the Proposed Development, identify source-pathway receptor linkages, and assign the magnitudes of impact. This stage takes into account embedded design mitigation, good practice in construction environment management and pollution prevention.
4) Determine the initial effect significance of each potential impact on each sensitive receptor.
5) Consider the need for additional mitigation if it is considered necessary to reduce the initial magnitude of the impact and associated effect significance further.
6) Assess the residual impact magnitude and residual effect significance after all mitigation is applied.

6.8.5 Licenced Emission Limit Values for Water Emissions

AAL is required by their licence to control and monitor water emissions from the site. Schedule B, Section B.2 – Emissions to Water sets out the emission limit values for treated effluent to the Shannon Estuary. A maximum daily volume of 30,000 m^3 at a maximum hourly rate of 1,250 m^3 is permitted. Section C.2.2 – Monitoring of Emissions to Water requires AAL to monitor flow, temperature, pH, biochemical oxygen demand, suspended solids, total organic carbon, total phosphorus, soda, aluminium, oils, fats & greases, toxicity, and heavy metals (Mg, Al, As, Cd, Cr, Cu, Fe, Hg, Pd, Zn and Ti).

The drainage system on the southern part of the site which contains the processing areas and the BRDA is directed to the wastewater treatment plant and discharges at W1-1. Sanitary effluent is treated by a dedicated activated sludge plant. This discharge from the sanitary treatment system joins with the treated process effluent flow and ultimately discharges also at licensed emission point W1-1.

Surface water monitoring is carried out routinely for surface water bodies in the vicinity of the BRDA site in accordance with Schedule C.2.3 of the Industrial Emissions Licence (IEL) P0035-07. Three licensed locations are currently monitored: Mangan's Lough, the Office of Public Works (OPW) Channel and Phase 2 West Robertstown Gate (see Chapter 10 of the EIAR; Figure 6.6.1). The parameters required to be monitored are pH, electrical conductivity and soda as well as a visual inspection.

Caustic soda, pH and electrical conductivity are considered to be indicator parameters or substances that can identify impacts from activities at the site, however, surface waters surrounding the BRDA are brackish from the nearby Shannon and Robertstown River estuaries and saline intrusion can also lead to interference in the results.

Soda is highly alkaline with high pH values which can vary according to the strength of the solution, and it is readily neutralised in brackish and saline waters. Saline intrusion from the surface waters can lead to interference with the electrical conductivity (naturally elevating it) and where this happens, analysis for soda may also experience interference. However, where pH, soda and electrical conductivity are all elevated, it is considered to be likely the result of onsite activities.

Surface water generated at the northern section of the site (raw material storage area) is discharged to a number of discharge locations (SS1, SS2, SS3, SS4 and SS5; Figure 6.6.2). The licence requires levels of soda, conductivity and pH to be recorded monthly at these locations. Surface water trigger values for SS1-SS5, which are agreed with the EPA, are given in Table 6.3.

Table 6.3: Storm water trigger values for SS1-SS5.

Parameter	Warning Level	Action Level
pH	≤6.5≥9	≤6≥9.5
Conductivity (uS/cm)	>2000	>2500
Soda (g/l)	>1.5	>2

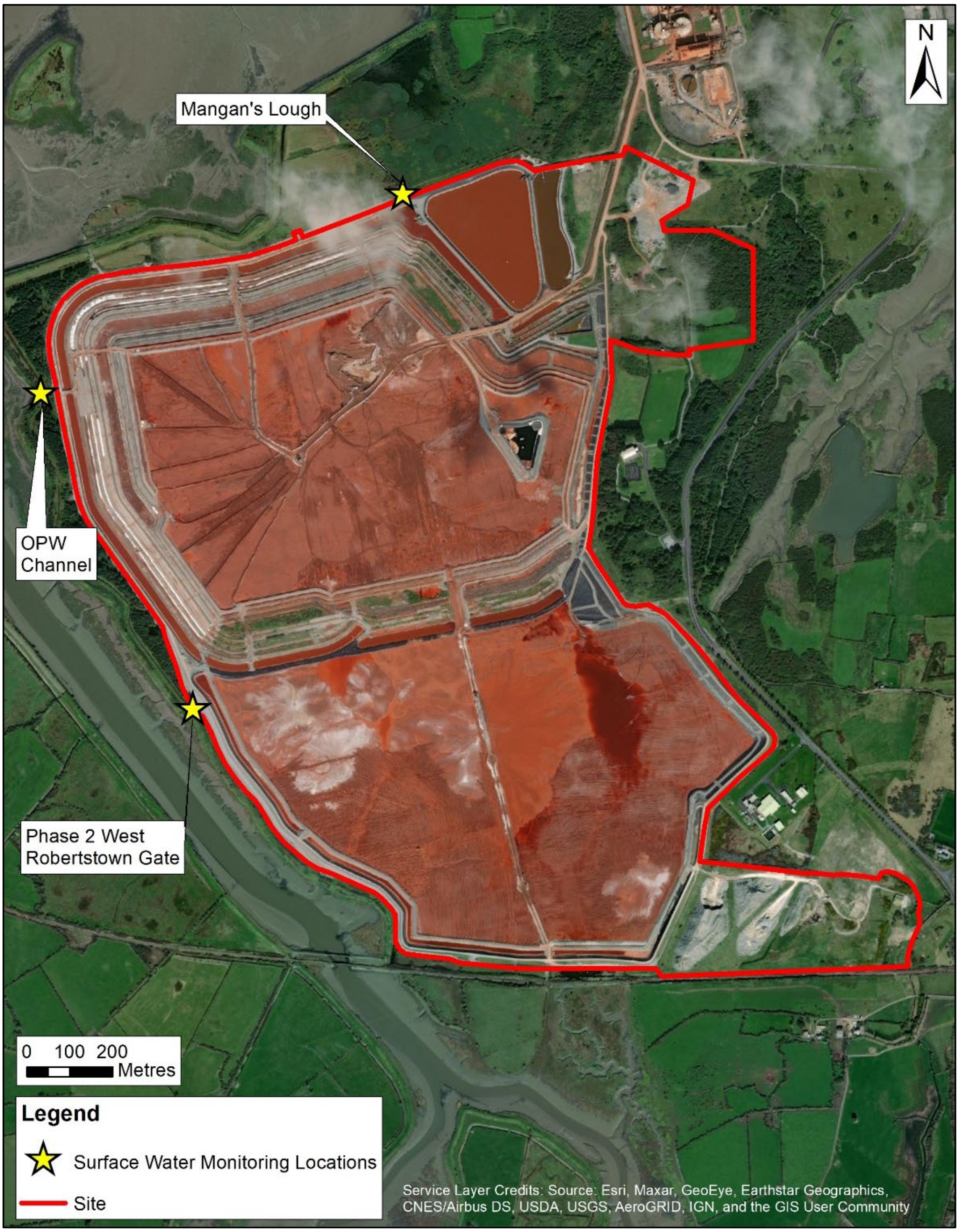

Figure 6.6.1 Surface water sampling locations in vicinity of the BRDA (after Golder 2021; background image from Bing Mapping c. 2013**).**

6.8.6 Review of Monitoring Results

A review was undertaken of the annual averages for pH, soda and conductivity from the surface water sampling locations close to the BRDA between 2008 – 2020 (data extracted from the AAL AERs). An average of the available monthly data for 2021 has also been included; this is an average of nine (9) months of data i.e., to September 2021. This data is presented in Figure 6.6.2, Figure 6.6.3 and Figure 6.6.4 below.

Note: *Phase 2 West Robertstown Gate was only added to the monitoring program in 2015.*

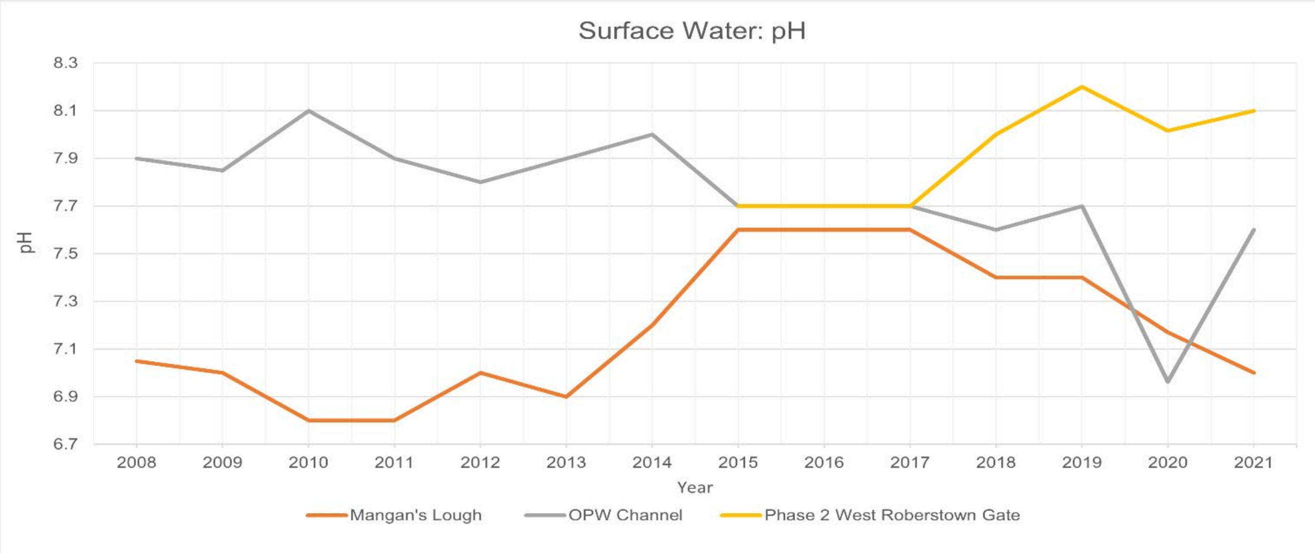

Figure 6.6.2: Annual Averages for pH at the Surface Water Monitoring points between 2008 and 2021 (after Golder, 2021)

Annual average pH levels (Figure 6.6.2) for the surface water monitoring points between 2008 and 2020 have between within the range of 6.8 to 8.2 for all the data. While the Irish Surface Water Regulations (2009, as amended) have not set a threshold value on pH for transitional waters, a recommended threshold for rivers and lakes is under 9.0 pH (Golder 2021; Chapter 10 of the EIAR).

There was a slight increase in pH for Mangan's Lough and slight decrease in pH for the OPW Channel from 2013 to 2015 and both plateaued until 2017 before continuing in a steady downward trend. It is noted that a strong downward trend is continuing in the 2021 data for Mangan's Lough. OPW Channel is elevated compared to the 2020 level, however, this is not yet an annual average and the broad downtrend seen since 2017 continues. The highest level was observed in OPW Channel for 2010 at 8.1 pH. pH annual averages for 2020 for OPW Channel was 6.96 while Mangan's Lough was 7.17.

Phase 2 West Robertstown Gate is a recent addition to the monitoring programme (Chapter 10 of the EIAR). Similarly, to the other two locations, Phase 2 West Robertstown Gate showed a steady pH between 2015 and 2017. Between 2017 and 2019, the annual average pH increased slightly from 7.7 pH to 8.2 pH before showing a downward trend in line with the other two surface water bodies pH since 2019 and averaged 8.01 pH for 2020.

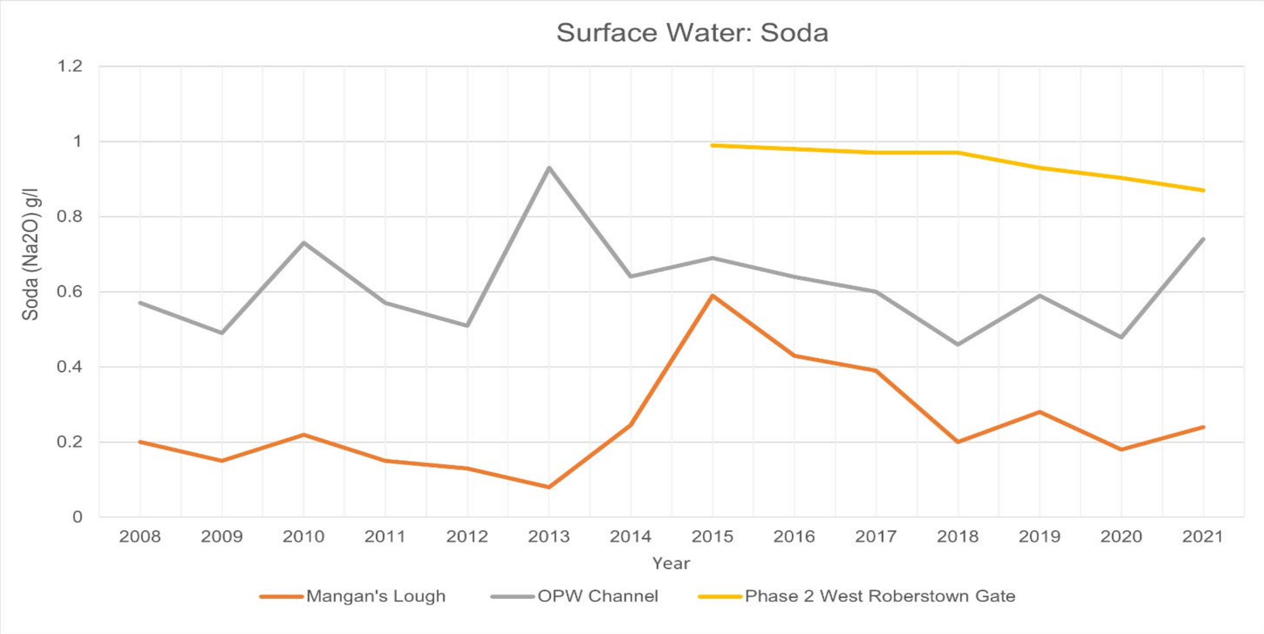

Figure 6.6.3: Annual Averages for Soda at the Surface Water Monitoring points between 2008 and 2021 (after Golder 2021).

Soda levels in Mangan's Lough and OPW Channel monitoring points have shown fluctuations in annual averages between 2008 and 2020. Between 2008 and 2013, Mangan's Lough maintained averages between 0.08 g/l and 0.22 g/l soda. From 2013 to 2015, an upward trend was observed for soda at Mangan's Lough, which coincides with a slight increase in pH over this time period and indicates that it may not be solely due to saline interference from the brackish water. Since 2015, a downward trend in soda has been observed at Mangan's Lough and soda averaged 0.18 g/l for 2020 which is in line with historical data. Soda levels in OPW Channel have varied between 2008 and 2020, although there appears to be a gradual decline in soda levels since 2013 to an average of 0.48 g/l for 2020.

The Phase 2 West Robertstown Gate monitoring point has shown a declining soda trend since monitoring began in 2015 and levels averaged 0.9 g/l for 2020. While the average pH increased in Phase 2 West Robertstown Gate between 2017 and 2019, soda levels decreased during this period.

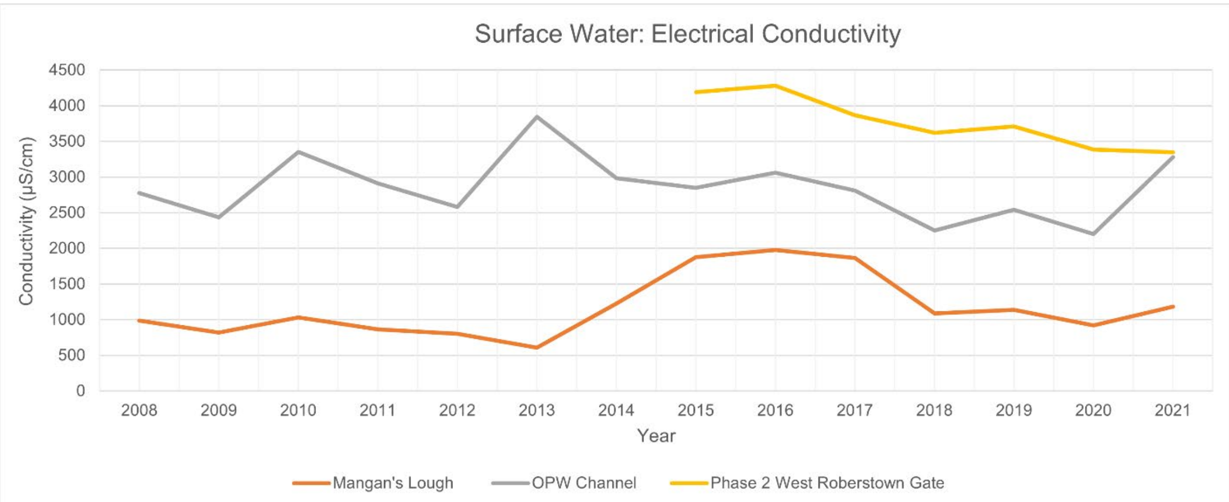

Figure 6.6.4: Annual Averages for Electrical Conductivity at the Surface Water Monitoring Points between 2008 and 2021 (after Golder 2021).

Electrical conductivity between 2013 and 2017 showed a slight elevation against normal levels at Mangan's Lough which follows a trend seen for both pH and soda during the same period at this location indicating that there may have been a slight impact from operations onsite during this period. However, since 2017 electrical conductivity has steadily decreased to an average of 921 µS/cm for 2020 compared to an average of 985 µS/cm for 2008. At the highest, the average was 1977 µS/cm for 2016.

Electrical conductivity at OPW Channel has shown a similar trend to soda during the period 2008 and 2020, with elevated averages in 2010 and 2013 and a gradual decline in levels since 2013 to an annual average of 2,200 µS/cm for 2020.

Phase 2 West Robertstown Gate has shown a gradual decline in electrical conductivity since 2015 (of 4,190 µS/cm) to an average of 3388.17 µS/cm for 2020, this declining trend is also seen in soda, but pH has shown a slight lag, before decreasing since 2019.

The AERs for 2014 – 2020 were reviewed and results of effluent monitoring results are summarised in Table 6.4 below.

Table 6.4: Summary of the review of effluent monitoring results for 2014-2020 against licence limits (W1-1)

Parameter	2014	2015	2016	2017	2018	2019	2020	Licence Limits
Volume of Process Effluent (m^3)	5,239,106	5,479,337	4,844,726	4,977,404	4,656,823	5,131,610	5,560,123	10,950,000 m^3/yr
BOD (tonnes)	367.4	160.3	372.9	256,7	292.1	196.2	296.4	861.4 tonnes/yr
Suspended Solids (tonnes)	68.5	70.3	80.1	78,8	54.3	66.4	57.3	547.5 tonnes/yr
Oils, fats & grease (tonnes)	5.2	5.5	5	5	4.7	5.1	12.7	164.3 tonnes/yr
Toxicity Units (TU)	<5	<5	<5	<5	<5	<5	<5	5 TU

The monthly pH, Conductivity and soda levels for surface water discharge monitoring points SS1, SS2, SS3, SS4 and SS5 are given in the following tables for 2014 – 2020 (Table 6.5a-Table 6.5g).

Figure 6.6.5 Licensed Treated Surface Water emission point (background image from Bing Mapping c. 2013).

Figure 6.6.6 Licensed Storm Water Emission points (background image from Bing Mapping c. 2013)**.**

Table 6.5a: Surface Water Discharge Monitoring Results for 2014

Emission Ref.	pH	Conductivity (µS/cm)	Soda (mg/l)
Frequency	Monthly	Monthly	Monthly
SS1	8.4	153	0.007
SS2	8.2	182	0.014
SS3	8.1	252	0.01
SS4	8.2	152	0.01
SS5	8.4	923	0.155

Table 6.5b: Surface Water Discharge Monitoring Results for 2015

Emission Ref.	pH	Conductivity (µS/cm)	Soda (mg/l)
Frequency	Monthly	Monthly	Monthly
SS1	8.5	112	0.02
SS2	8.3	181	0.01
SS3	8.1	171	0.02
SS4	8.2	180	0.02
SS5	8.3	314	0.05

Table 6.5c: Surface Water Discharge Monitoring Results for 2016

Emission Ref.	pH	Conductivity (µS/cm)	Soda (mg/l)
Frequency	Monthly	Monthly	Monthly
SS1	8.7	146	0.02
SS2	8.2	244	0.02
SS3	8.1	257	0.02
SS4	8.1	121	0.01
SS5	8.3	306	0.04

Table 6.5d: Surface Water Discharge Monitoring Results for 2017

Emission Ref.	pH	Conductivity (µS/cm)	Soda (mg/l)
Frequency	Monthly	Monthly	Monthly
SS1	8.3	136	0.02
SS2	8.2	203	0.01
SS3	8.4	174	0.01
SS4	8.2	94	0.01

Emission Ref.	pH	Conductivity (µS/cm)	Soda (mg/l)
SS5	8.3	279	0.03

Table 6.5e: Surface Water Discharge Monitoring Results for 2018

Emission Ref.	pH	Conductivity (µS/cm)	Soda (mg/l)
Frequency	Monthly	Monthly	Monthly
SS1	8.4	257	0.02
SS2	8.3	152	0.01
SS3	8.4	158	0.01
SS4	8.1	144	0.02
SS5	8.2	245	0.02

Table 6.5f: Surface Water Discharge Monitoring Results for 2019

Emission Ref.	pH	Conductivity (µS/cm)	Soda (mg/l)
Frequency	Monthly	Monthly	Monthly
SS1	8.0	126	0.01
SS2	8.1	149	0.01
SS3	8.3	132	0.01
SS4	8.1	111	0.01
SS5	8.1	170	0.01

Table 6.5g: Surface Water Discharge Monitoring Results for 2020

Emission Ref.	pH	Conductivity (µS/cm)	Soda (mg/l)
Frequency	Monthly	Monthly	Monthly
SS1	7.9	149	0.01
SS2	7.9	146	0.01
SS3	8.1	143	0.01
SS4	7.8	120	0.01
SS5	8.0	196	0.01

Wastewater volumes and mass emissions for biochemical oxygen demand, suspended solids and oil fat & greases for 2014 to 2020 were within the licence limits for these parameters.

Aquafact International Services Ltd. undertook a baseline water characterisation survey around the Aughinish Port in 2018 (see Figure 6.6.7). Sampling was carried out at various stages of the tide and the water samples were submitted to the laboratory for a range of analysis including biochemical oxygen demand, chemical oxygen demand, total organic carbon, polyaromatic hydrocarbons, BTEX

(Benzene, Toluene, Ethylbenzene, and Xylene), phenols, Total Nitrogen, Total Inorganic Nitrogen, Phosphorus and heavy metals.

The findings of the assessment showed that:

- Volatiles, phenols and BTEX were non-detectable upstream, and downstream of the jetty.
- Total dissolved solid (TDS) results ranged from 1,910 - 2,330 mg/l at mid-ebb, 1,736 – 2,136 mg/l at low water and 2,247 - 2,506 mg/l at mid-flood. Concentrations of TDS vary consistently upstream and downstream of the discharge.
- Total Nitrogen levels were low and consistent upstream and downstream of the jetty.
- The levels of zinc in the water samples were higher than the other heavy metals (lead, mercury, copper, nickel, vanadium, chromium, cadmium, and barium) detected. The levels of zinc ranged from 91 µg/l to 505 µg/l. The highest level was recorded 500 m downstream of the jetty at mid-ebb.
- Mercury levels varied from less than the detection levels (0.03 µg/l) to 2.14 µg/l, 500 m upstream of the jetty on a low tide.

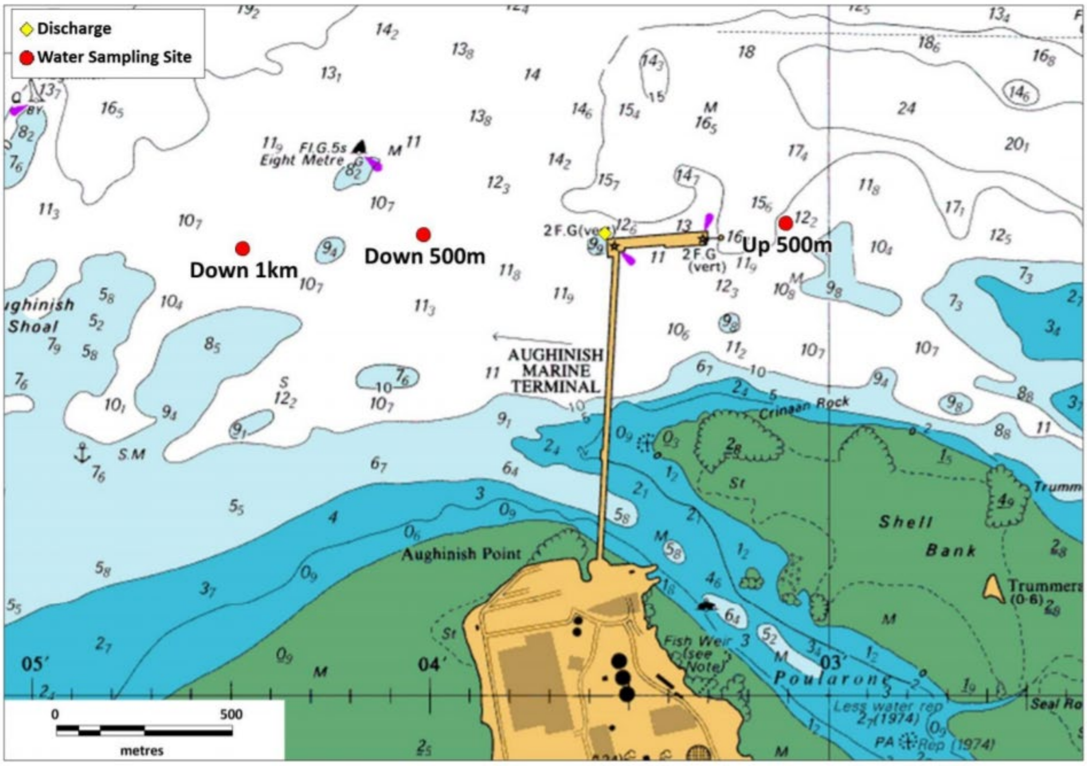

Figure 6.6.7: Water Sampling Locations, April 2018 (Aquafact, 2018)

A repeat baseline water characterisation survey was carried out in February 2019 (Aquafact 2019; Appendix A). The monitoring results found:

- Volatiles, phenols and BTEX were non-detectable upstream, and downstream of the jetty.

- Mercury levels were all below the method limits of detection at all sampling locations (<0.03 µg/l)
- Zinc levels were lower than the previous sampling event in 2018. The highest concentration of zinc detected was 82 µg/l on a mid-flood tide 500 m upstream of the jetty.
- Total dissolved solids (TDS) levels were significantly higher than the previous sampling event in 2018. TDS levels ranged from 12,833-14,045 mg/l at mid-ebb, 10,510-15,682 mg/l at low water and 16,289-20,083 mg/l at mid-flood.

6.8.7 The Impact of emissions to water on the Designated Sites

A review of the soil mapping compiled by the National Soil Survey found that the principle soil types underlying the borrow pit are renzinas – lithosols which have originated for limestone glacial till. Sub-soils at the borrow pit site are either absent or consist of glacial till of Carboniferous origin. The bedrock in the area of the site is Waulsortian limestone. Surface water control and re-fuelling of site vehicles in dedicated areas ensure that both surface water and groundwater will be adequately protected. Furthermore, the proposed borrow pit extension design is such that interaction with the groundwater will be avoided by keeping the base level of the borrow pit above the known level of the water table. That is the same approach as was taken for the permitted borrow pit.

The CSM (Appendix B) has identified the potential for pathways for impacts on the marine environment via effluent discharges. It is stated however that all wastewater is treated prior to disposal at the W1-1 licensed emission point including all rainfall diverted from process areas and that only rainfall which falls on northern end of the site is discharged as surface water after passing through a stone trap. As such it is not envisaged that there would be significant impacts on local water quality as a result of discharges from the site.

As discussed above, the IEL (P0035-07) sets limits on maximum discharge rates and the licence stipulates emission limit values and monitoring requirements and frequencies for the effluent. Determination of the levels of heavy metals in the effluent is required, but no emission limit values are set in the licence.

In accordance with the Waste Water Discharge (Authorisation) Regulations 2007, the EPA cannot grant an authorisation for a waste discharge which, in the opinion of the Agency, can cause a deterioration in the chemical status or exclude or compromise the achievement of the objectives established for protected species and natural habitats. The ecological constraint applies in the case of European Sites where the maintenance or improvement of the status of water is important. Consequently, compliance with the discharge limits specified in the licence will help to maintain or improve the chemical and ecological status of the Shannon Estuary. A review of the EPA's Catchment website (www.catchments.ie) shows that the current water quality status of the Lower Shannon Estuary is good. The water quality in the Lower Shannon Estuary was classified as moderate between 2007-2009, good water quality for 2010-2012 and moderate between 2012 and 2015, and good between 2013-2018. The Water Framework Risk assessment of the estuary classifies that water quality in the estuary is not at risk of deteriorating or being at less than Good status in the future. While the EPA in their Shannon South Estuary Catchment Assessment 2010-2015 (HA 24) report lists agriculture and industry as significant pressure affecting the Lower Shannon Estuary, no significant pressures are listed in the 2013-2018 update.

The review of the effluent monitoring results shows that effluent quality meets the requirements of the ELV's given in the IEL. Although no ELV's are given in the licence for heavy metals a review was conducted of the results presented in the AER's for 2014-2020.

Table 6.6 below shows the range of levels of heavy metals in the discharge from the site for the various years.

Table 6.6: Average annual levels of heavy metals and soda in process effluent levels from W1-1

Metal (mg/l)	2014	2015	2016	2017	2018	2019	2020
As	0.065	0.049	0.067	0.033	0.055	0.043	0.042
Cr	0.015	0.0065	0.011	0.016	0.015	0.015	0.011
Cu	0.011	0.018	0.01	0.016	0.005	0.013	0.016
Pb	0.0002	0.0003	0.0006	0.0051	0.0007	0.0014	0.0007
Zn	0.004	0.18	0.006	0.006	0.054	0.037	0.010
Al	1.51	2.44	2.62	2.04	3.83	2.07	1.67
Cd	0.0007	0.009	0.0018	0.0054	0.00075	0.0007	0.002
Fe	0.0635	0.0695	0.138	0.016	0.227	0.044	0.056
Mg	1.61	3.5	7.52	786*	0.048	4.83	3.78
Hg	0.001	0.009	0.015	0.006	0.002	0.0003	0.001
Ti	0.0015	0.0055	0.007	0.005	0.024	0.007	0.005
Soda(g/l)	2.77	2.75	2.79	3.0	3.29	2.69	2.67

*Anomaly following analysis by third party laboratory

6.8.8 Sediments

Marine Sediments

Sediment pollution can lead to disruption of the benthic communities by either toxic effects or sediment deposition on a species habitat.

Microbenthic communities have been used by biologists for years as indicators of pollution. The communities are normally long-lived and are a good indicator of the chronic impacts of a pollutant on a community. They are by their nature stationary and provide a true reflection on environmental conditions. They are normally found at the bottom of the food chain and their survival and distribution effects the survival and distribution of species higher up the food chain.

Research at Trinity College Dublin funded by the Marine Institute (Giltrap *et al.*, 2014) undertook an assessment of the biological effects and chemical measurements in Irish Marine Waters. The Shannon Estuary was one of the sampling points for this study. The study undertook sampling and analysis of sediment in the estuary. Analysis was carried out in the sieved sediment (<63 um). The results for heavy metal concentrations in the sediment as part of this study is shown in Table 6.

Table 6.7: Heavy metals levels in sediment Shannon Estuary (Marine Research 2014)

Heavy Metal	Cd	Hg	Pb	As	Cr	Cu	Ni	Zn
Concentration (µg/kg dry weight)	220	NA	6,930	11,300	18,400	2,600	11,300	18,600

6.8.9 Aquafact Sediment Sampling, 2017

AAL has a Dumping at SEA Permit (S0026-01) to carry out plough-dredging at three permitted areas around the site jetty area. As part of the conditions of the permit an updated marine sediment characterisation report was prepared by Aquafact in 2018 (Appendix A), with samples taken in December 2017. A total of 3 sediment samples were taken, and the samples were analysed for a range of parameters including heavy metals, total organic carbon, dibutyltin, tributyltin, lindane, HCB, PCB 7, PAHs and TEH. Table 6.8 summarises the results for heavy metal levels detected in the sediment samples. Figure 6.6.8 illustrates the sampling locations.

The sediments analysed (Table 6.8) were below the lower Irish action limits for organochlorines, PCBs, total extractable hydrocarbons, organotins and ∑16 PAH's.

Arsenic was above the lower Irish action limit at two of the three stations sampled, Nickel was above the lower Irish action limit at all three stations and Zinc was above the upper Irish action limit at one out of the three stations sampled. All other metals were below the lower Irish action limit. The findings of the report were reviewed by Dr. Rick Boelens, a marine specialist with over 40 years of experience in marine sediments and toxicology.

Table 6.8: Sediment Sampling Results (mg/kg), December 2017. Lower and Upper Actions Limits as per Cronin *et al*., 2006.

Parameter	Lower Action Limit	Upper Action Limit	S1	S2	S3
Hg	0.2	0.7	0.05	0.03	0.03
Al	N/A	N/A	34,800	31,500	55,300
As	9	70	12.2	7.9	11.2
Cd	0.7	4.2	0.4	0.7	0.4
Cr	120	370	46.9	44.8	105
9Cu	40	110	22.8	32.1	19.5
Li	N/A	N/A	24.6	19.7	23.4
Ni	21	60	26.9	21.7	22.7
Zn	160	410	107	652	74.4
Fe	N/A	N/A	34,600	22,700	30,900
Mn	N/A	N/A	843	710	807
Ti	N/A	N/A	1,390	1,390	2,730

Figure 6.6.8: Sediment Sampling Locations, December 2017

Levels of zinc in sediment samples from Irish inshore waters are typically <300 mg/kg with the majority <100mg/kg. The levels of zinc detected in the Marine Institute sediment survey of the Shannon (2014) was 18.6 mg/kg. Higher values tend to be associated with acid mine drainage or the transport of metalliferous ores. The current Irish Action Level for zinc in sediments to be dredged is >410 mg/kg. The levels of zinc in Samples 1 and 3 were well within expected background levels and of no biological concern. Dr. Boelens concluded that the elevated result for zinc in the sediment sample taken in 2017 at the Sample 2 location, may have arisen because of very localised levels and further sampling was recommended to confirm this. Additional sampling was carried out in April 2018 to confirm the zinc levels detected in the sediment. The survey found that one of the sites (S1) exceeded (206 mg/kg) the Lower Action Limits of 160 mg/kg for zinc. The remaining four sampling locations had zinc levels less than the Lower Action Limits. It appears that the elevated zinc levels found in the December 2017 sampling event was a one-off and very localised.

6.8.10 Aquafact Sediment Sampling, 2020

Aquafact undertook another round of sediment sampling in February 2020 (Appendix A). The sampling locations are shown in Figure 6.6.9 and the results are presented in Table 6.9 and Table 6.10. The sampling locations were chosen to reflect areas within the designated sites surrounding the AAL plant. Some marine sediment samples were also taken (see Figure 6.6.5). The numbering sequence for the samples is not sequential because some sampling points could not be taken because of health and safety issues and because of access onto private lands. Samples S11, S14, S17, S20, S22 and S24 were not sampled.

For the purposes of this discussion, sampling locations S1, S2, S3, S4, S6, S7, S21, S23, S26, S28, S27, S29 and S30 were assigned as marine sampling sites and analytical results were assessed against the Guidelines for the Assessment of Dredge Material for Disposal in Irish Waters (Cronin *et al.*, 2006) lower and upper limits for Annex 1 heavy metals. The guidance document aims to provide an integrated assessment of the ecological risk associated with marine sediments. It considers the bioaccumulation and toxicity potential of a sediment. The guidelines set two Action Levels (as per the requirement of the OSPAR guidelines, 2004); the lower level (Level 1) defines a concentration (i.e. a guidance value) of a contaminant in sediment below which biological effects are not anticipated. The upper level (Level 2) defines a contaminant concentration above which biological effects are anticipated to occur. The more parameters exceeding the upper limit values for the corresponding parameter the more likely the material will cause biological effects. The Upper Level values are set at the lowest end of the known range of effective concentrations i.e. the lowest concentration known to have adverse effects on marine organisms.

The Lower Level guidance values corresponds to contaminant concentrations below which the sediment is not anticipated to have a biological impact on the environment. The Upper Level guidance values are concentrates above which adverse effects are anticipated.

Figure 6.6.9: Sediment sampling locations, February 2020 (Source: Aquafact, 2020; background image from Bing Mapping c. 2013**).**

The results of the sediment sampling undertaken by Aquafact in February 2020 (Tables 6.9 & 6.10) shows that the levels of arsenic detected in all the marine sampling locations exceed the Lower Level (9 mg/kg), however the levels were below the Upper Action Level. Annex 7 of the Guidance Document (Cronin *et al.*, 2006) shows that the background arsenic levels in Irish Ports and Harbours is 38.90 mg/kg (95%ile). All of the marine sediment samples taken during this assessment had arsenic levels below this background level, and the levels of arsenic detected in the sediments are not predicted to have any significant impact on the marine fauna in the area.

The levels of zinc detected in S16 (195 mg/kg) are above the Lower Action Limits for zinc (160 mg/kg). Accumulations of zinc in sediments above a concentration of 124 mg/kg can pose a hazard to sediment living organisms (Canadian Council of Resource and Environmental Ministers, 1987). The levels of zinc detected in this survey are above the 124 mg/kg. This is likely to have been a one-off result based on some localised higher levels.

All other metals were less than the Lower Action levels and consequently no biological effects are anticipated. Heavy metals are naturally present in nature and these chemicals are used by plants and animals for growing/manufacture of cells and as neural transmitters. The toxicity of heavy metals is dependent upon the form of the metal that is present in the water or the sediment i.e. metallic or inorganic. The presence of suspended solids, both natural and anthropogenic, in the water body of the River Shannon will have the effect of complexing some of the metal species and making them less available for invertebrate/fish species and consequently less toxic. The range and levels of heavy metals detected in the sediment at the jetty were generally low or typical of background levels.

The sediment samples taken at locations S5 and S8 (See Figure 6.6.9) best reflect non-marine environment samples. Table 6.9 and 6.10 below shows the range and location of metals detected at the sampling locations. Please refer to Figure 6.4.5 for sampling locations (shown in brackets). Table 6.9 summarises the soil and sediment sampling results from each of the locations included in the Aquafact (2020) survey.

Table 6.9: Range of Heavy Metals detected in sediment samples, February 2020 (Aquafact 2020)

Heavy Metal	Minimum mg/kg	Maximum mg/kg
Aluminium	1,800 (S8)	63,300 (S5)
Arsenic	9.9 (S27)	22.4 (S12)
Cadmium	<0.1 (S30)	2.1 (S19)
Lead	13.1 (S21)	35.4 (S6)
Mercury	0.01 (S30)	0.1 (S8)
Nickel	9.0 (S30)	49.4 (S5)
Zinc	40.6 (S30)	195 (S16)
Copper	4.9 (S30)	37.5 (S3)
Chromium	15.2 (S30)	57.1 (S5)
Total Organic Carbon	0.46 (S30)	> 25 (S8)

Similarly, cadmium levels in S1, S2, S3, S4, S6, S7, S9, S10, S16, S19, S21, S23 and S26 exceeded the Lower Action Level of 0.7 mg/kg but are below the Upper Action Levels. Cronin *et al*. (2006) reports in Annex 7 that typical background levels of cadmium in Irish Ports and harbours is 0.97 mg/kg. The Effects Range – Medium (ERM) for cadmium is 9.6 mg/kg. The sediment sampling and analysis carried out by Aquafact (2020) had cadmium levels less than 9.6 mg/kg in the marine samples. Consequently, no significant impacts of cadmium on the marine habitats appeared to be occurring in the estuary.

With the exception of S1, S19, S28 and S29, the levels of nickel detected in all of the marine samples exceeded the Lower Action Level of 21 mg/kg. The highest level of nickel recorded during this survey was 49.4 mg/kg in S5. Because nickel does not bioaccumulate in marine organisms, and based on the information available, the impact of nickel on the habitats and species using the SAC and SPA is not considered significant.

Table 6.10: Sediment sampling results, February 2020 (Aquafact, 2020)

Station	Arsenic	Cadmium	Chromium	Copper	Lead	Nickel	Zinc	Aluminium	Lithium	Mercury	Total Organic Carbon
Units	mg/Kg	mg/Kg	mg/Kg	mg/Kg	mg/Kg	mg/Kg	mg/Kg	mg/Kg	mg/Kg	mg/Kg	mg/Kg
S1	15.1	1.0	34.9	10.9	22.4	19.4	85.8	31600	25.4	0.07	1.28
S2	14.2	1.1	49.8	10.4	25.8	27.0	95.2	43100	35.7	0.07	1.82
S3	15.5	1.2	40.4	37.3	21.6	22.0	73.0	34000	29.2	0.05	1.35
S4	16.9	1.0	48.6	11.5	24.1	25.9	86.6	41500	34.8	0.04	1.69
S5	16.2	1.9	57.1	15.7	29.2	49.4	108.1	63300	41.5	0.09	8.20
S6	16.6	1.3	55.7	8.9	35.4	29.8	94.9	45500	37.9	0.05	2.28
S7	15.9	1.1	44.6	10.0	24.1	24.0	83.3	36100	29.4	0.02	1.62
S8	13.2	2.0	18.7	12.4	29.5	16.9	122	18100	16.1	0.10	>25.0
S9	17.3	1.1	39.8	10.4	16.6	21.4	62.9	33400	26.6	0.02	1.03
S10	15.0	0.9	50.8	10.6	29.3	27.1	86.4	43000	37.1	0.03	1.54
S12	22.4	1.2	47.1	10.2	24.6	23.9	75.3	38600	31.3	0.03	1.43
S13	16.3	1.4	48.4	10.9	22.7	26.2	81.4	39200	33.3	0.03	1.91
S15	18.4	1.4	40.3	8.2	18.9	21.0	64.9	32100	26.7	0.02	1.00

Table 6.10 Continued: Sediment sampling results, February 2020 (Aquafact, 2020)

Station	Arsenic	Cadmium	Chromium	Copper	Lead	Nickel	Zinc	Aluminium	Lithium	Mercury	Total Organic Carbon
S16	21.5	1.7	52.8	11.1	25.7	27.2	195	42700	35.6	0.04	2.14
S18	20.1	1.3	47.9	6.8	23.1	25.0	85.3	38300	32.3	0.04	2.00
S19	18.0	2.1	38.4	8.6	15.9	20.1	60.9	31800	25.8	0.03	0.97
S21	17.5	1.7	31.3	7.4	13.1	16.8	54.3	26100	22.0	0.02	0.91
S23	18.2	1.9	41.4	9.7	17.7	21.9	68.8	32400	25.6	0.02	1.24
S26	16.5	1.3	44.9	9.6	20.4	24	76.6	36800	28.8	0.03	1.54
S27	9.9	0.6	36.0	9.6	17.1	19.6	65.7	27900	25.3	0.04	1.07
S28	11.0	0.5	31.5	8.1	15.0	16.4	55.1	25400	23.6	0.03	0.89
S29	12.6	0.5	33.2	8.5	16.9	17.4	60.9	26300	24.3	0.02	1.01
S30	16.3	<0.1	15.2	4.9	14.4	9.0	40.6	11800	12.2	0.01	0.46

6.8.11 Marine Sediment Sampling, 2021

The following section describes the results of marine sediment sampling undertaken by Aquafact in May 2021. The results from this study were used to inform the CSM and are summarised in the sections below.

Stations were selected to provide representative coverage of the intertidal areas of the Shannon Estuary both up and down tide and on both shorelines of the estuary where there was the potential for contaminants to accumulate in the sediments (Figure 6.6.10). A greater frequency of sampling locations were selected in the creeks and on the main estuary shorelines in closest proximity to the AAL site and hence closest to areas of potential for pathway impacts.

Figure 6.6.10: Marine sediment sampling locations – Aquafact - 2021

The sampling locations shown in Figure 6.4.6 above correspond to the shorelines at the following eight locations:

Shannon Golf Course, Ringmoylan Pier, Poulaweela Creek, Robertstown River, Foynes foreshore, Carrowbane Pier, Rinealon Bay and a further site, more remote from the AAL plant near Foynes.

The locations are shown at the position of the uppermost point on each sampling transect close to Mean High Water Springs (MHWS) in the Table 6.11 below:

Table 6.11: Marine sampling locations – Aquafact 2021

Location	Identifier	Coordinates	
Shannon Golf Course	1	52.6873757	-8.9381621
Ringmoylan Pier	2	52.6604693	-8.9484469
Poulaweela Creek	3	52.6223086	-9.0476347
Robertstown River	4	52.6056273	-9.0749154
Foynes	5	52.6157899	-9.0910371
Carrowbane Pier	6	52.5934516	-9.222985
Rinealon Bay	7	52.6220253	-9.1759664

Location	Identifier	Coordinates	
Shannon/Foynes	8	52.62658	-9.07107

Sampling was undertaken between the 5th and 7th May 2021 for all sites with the exception of the additional site near Foynes, which was sampled on the 25th May 2021. These dates corresponded with spring tidal cycles to allow good access to sample the shorelines on foot with maximum exposure or by Rigid Inflatable Boat (RIB) with safe water depth from which to sample.

Samples were taken from three sampling stations at each of the eight locations. The three sampling stations corresponding to upper, middle and lower intertidal shoreline levels. The uppermost stations were sampled close to the point of MHWS, while lower stations were taken at a point close to MLWS. Mid shoreline locations were collected from a point that was considered to be halfway between the two at the respective locations based on the spring tidal conditions that were prevalent at the time of the sampling.

Samples were analysed for heavy and trace metals, Total Organic Content and particle size distribution.

Typically for sediments two generally accepted criteria are used to assess the toxicological significance of a given sediment metal concentration and all are based on total concentrations; namely the:

- Background Assessment Concentration (BAC)
- Effects Range Low (ERL)

BACs were developed within the Oslo and Paris Commission framework with scientific advice from the International Council for the Exploration of the Sea. Mean metal concentrations in sediments significantly below the BAC are said to be near background. ERLs were developed by the United States Environmental Protection Agency (US-EPA) for assessing the ecological significance of marine sediment concentrations. Concentrations below the ERL rarely cause adverse effects in marine organisms. Table 6.12 shows the BACs and ERLs that are available for the following metals in marine sediments.

Table 6.12: List of BACS and ERLs for metal concentrations in marine sediments above which effects may be seen (mg/kg).

	BAC	ERL
Arsenic (As)	25	8.2
Cadmium (Cd)	0.31	1.2
Chromium (Cr)	81	81
Copper (Cu)	27	34
Mercury (Hg)	0.07	0.15
Nickel (Ni)	36	21
Lead (Pb)	38	47
Zinc (Zn)	122	150

As discussed above, Cronin *et al*. (2006) produced guidelines for the assessment of dredged material for disposal in Irish Waters. The Action Levels (Lower Action Level and Upper Action Level) have been defined, with the lower defining a concentration (i.e., a guidance value) of a contaminant in sediment below which biological effects are not anticipated, and the upper defining a contaminant concentration above which biological effects are anticipated to occur.

<u>Heavy metals in marine sediments</u>

As with pollution of surface and marine waters, pollution by heavy metals of sediments can lead to significant impacts on marine benthic communities through either direct toxic effects or changes in ecosystem dynamics.

Estuarine sediments are dynamic environments where grain sizes, organic fractions and salinities are particularly important in regulating concentrations of heavy metals and these may fluctuate daily. Suspended solids and both natural and anthropogenic materials, in the water body of the River Shannon will affect the formation of metal complexes, metal speciation and complexation and metal/ligand interactions and hence bioavailability and toxicity. Once heavy metals are bound to particles in the water column they tend to settle out in depositional areas of the estuary.

The free metal ion speciation[2] of heavy metals typically determines bioavailability and hence toxicity to organisms. The data collected for the sediments samples during the May 2021 survey showed no exceedances of any recognised marine sediment standard.

Overall, the range and concentrations of heavy metals detected in the marine sediments sampled from the eight transects during May 2021 are generally low or typical of background levels. This quantitative overview of determined sediment metal concentrations has indicated that the manufacturing activities and controlled emissions from the plant appear to have little effect on sediment heavy metal concentrations in the vicinity of the site.

The below is a summary overview for relevant heavy metal contaminants.

Cadmium

Cadmium is a non-essential metal and inherently toxic. Cadmium can adsorb to sediments and is often associated with total organic carbon and the May 2021 data indicates a correlation between cadmium concentration and both Total Organic Carbon (TOC) and the silt fraction of the sediment. The concentrations determined in the sampled sediments in the vicinity of the plant are below any action levels.

[2] Metal ions form complexes with naturally occurring complexing agents or ligands released into the environment. The metal complexes are thereby mobilised and transported in environmental and biological systems. The impact of such metal complexes depends on the metal complex species that are kinetically and thermodynamically stable in these homogeneous and heterogeneous systems. The distribution of metal complex species in these complex systems can be calculated from available formation constant data.

Cobalt

No reliable acute or chronic toxicity data for the marine sediment compartment for cobalt exist in either the open literature or non-peer reviewed paper. Because of the apparent observed decreased sensitivity of marine water-column dwelling organisms versus freshwater water-column dwelling organisms, it has been decided by European Chemicals Agency (ECHA) to use the freshwater Predicted No Effect Concentration, $PNEC_{sediment,\ freshwater}$ as an environmentally conservative approach that would be protective of the marine environment. The freshwater value for the EC_{50}[3] for freshwater sediment is 1703 mg/kg. The results of the samples collected in May 2021 are significantly below this value. Cobalt appears poorly correlated to sediment size fraction or TOC but correlates well with total aluminium concentration.

Copper

Cu^{2+} is the most environmental relevant species of copper. It is recognised that free Cu^{2+} ions are the most active copper species and cause environmental effects, whereas total Cu concentrations in aqueous media are not directly related to ecological effects. The ecotoxicity of copper is caused by the soluble copper ions. For this reason, it is possible to read-across from ecotoxicity and environmental fate studies conducted with all soluble copper compounds. Copper can exist naturally in water as either dissolved (as Cu^{++}) or complexed with organic matter or suspended particles, however the May 2021 results showed a poor correlation with both. Copper can also be absorbed to bottom sediments. The concentration of these forms of complexes is dependent upon several other factors such as pH, salinity, hardness and alkalinity. The total concentrations of copper determined in the sediments was low, so no significant impacts on marine sediment dwelling species are anticipated.

Lead

Much of the lead in the marine environment is absorbed onto sediment and suspended particles thereby reducing its availability to marine organisms. Sediments form a sink for lead in the marine environment. The data for lead from the May 2021 shows a trend in association with sediment and organic material. The determined concentrations for lead are significantly lower than the effects level (ERL: 47 mg/kg).

Mercury

Dissolved mercury has a strong affinity for organic matter and suspended solids and consequently it will bind to these particles in the water column and may ultimately accumulate in sediments. The May 2021 sediment data show a highly variable association to both sediment fraction size TOC. Once in the sediments, mercury can undergo methylation to produce methylmercury. The results were well below the No Observed Effect Concentration (NOEC) mercury in marine sediment (930 mg/kg), although one of the samples exceeded the BAC (0.07 mg/kg) at 0.11 mg/kg.

[3] Half maximal effective concentration; the concentration of a toxicant which induces a response halfway between the baseline and maximum after a specified exposure time.

Nickel

Nickel toxicity can vary considerably among marine sediments particularly with different physico-chemical characteristics. Consequently, bioavailability models have been developed to directly compare sediment toxicity and to generate sediment threshold values, e.g., $PNEC_{sed}$. In order to understand nickel toxicity, it is important to estimate site-specific bioavailable nickel PNEC values. The availability of sediment physico-chemistry data, such as acid volatile sulphide (AVS) content, allows site-specific nickel PNEC values to be calculated and a more accurate site-specific risk characterisation to be conducted. Five of the May 2021 sediment samples approached or just exceeded the ERL of 21 mg/kg for nickel. However, the ERL determination for nickel is below the OSPAR BAC of 36 mg/kg. Therefore, respectively, nickel concentrations are only assessed against the BAC (36 mg/kg) and only one sample exceeded this value at 44.9 mg/kg. This concentration, however, is still significantly lower than the PNEC sediment value (for marine waters) of 109 mg/kg.

Chromium

In the hexavalent state chromium can occur in water with a low organic content. In its trivalent form chromium will form insoluble compounds. The solubility of chromium III in seawater varies with salinity, and the main removal process is adsorption to suspended materials. Chromium IV in particular is not adsorbed by sediments. May 2021 analysis determined total chromium but there was little correlation between sediment and total chromium concentrations demonstrated. The concentrations of metals determined in the marine sediments sampled are significantly lower than the recognised sediment standards. No significant effects on habitats or species are predicted. It is worth noting that the ERL for chromium equals the BAC; and therefore, chromium concentrations should only be assessed against the ERL.

Zinc

In an estuarine environment, zinc is absorbed to suspended materials in the water column. In low salinity areas within an estuary absorbed zinc can be mobilised from particles by microbial degradation of organic matter. In seawater, zinc is normally dissolved as either organic or inorganic complexes. The May 2021 sample data indicated a positive correlation between zinc and both TOC and the fine sediment fraction. The determined concentrations of total zinc in several sampled sediment locations exceeded the Probable Effects Concentration (PEL) of 271 mg/kg, the BAC (122 mg/kg) and the ERL (150 mg/kg). However, total zinc concentration is not necessarily a determinant of actual bioavailable and hence toxicity of zinc.

From sampling done in May 2021, four samples from different locations had a total zinc sediment concentration of 244, 268, 458 mg/kg and 634 mg/kg. These isolated sediment concentrations may indicate that as zinc can accumulate in sediments that a risk to sediment dwelling organisms may exist at these locations. It is recognised, however, that concentrations of zinc in sediment samples from Irish inshore waters are typically <300 mg/kg with the majority <100 mg/kg (Nag and Cummins 2021), a situation generally reflected in the May 2021 samples. The current Irish Action Level for zinc in sediments to be dredged is >410 mg/kg. It is very likely that this May 2021 value is an isolated occurrence, as concentrations throughout the remainder of the locations sampled are all below the threshold Effects Range Low (ERL; 160 mg/kg).

Aluminium

Aluminium is more stable in the solid than aqueous phase and in the marine environment tends to be absorbed on the surrounding sediments. This acts as a sink for aluminium for biota but only a small portion is bioavailable, which is turn is controlled by pH conditions with aluminium toxicity being higher at lower pH's. Aluminium is most toxic at pH 5.5 – 6 and least toxic around pH 7. The buffering capacity of saline estuarine water ensures that aluminium remains in its original chemical form and therefore no significant impacts on the designated areas in the wider hinterland of the AAL facility are predicted from the levels recorded.

<u>Soils</u>

Soils contain natural background levels of heavy metals depending upon the parent rock. The Teagasc 2007 Soil Geochemical Atlas of Ireland states that the levels of aluminium in soil can range from 40,000 – 50,000 mg/kg. The results for the soil samples generally fall within the typical naturally occurring range. Therefore, there is no likelihood that the levels of aluminium in the soil are significantly impacting on the designated sites around AAL.

Soil sampling was undertaken along with marine sediment sampling in the programme undertaken by Aquafact in 2020. The results of the metals in soil samples are shown in Table 6.10. Station S5, which is located east of the Plant Area had the highest levels of aluminium detected (63,300 mg/kg). This level is above the expected background levels (40,000 – 45,000 mg/kg) in soil in this part of Ireland. S5 is close to the Poulaweala Creek which forms part of the Lower River Shannon SAC. The aluminium levels detected in S3 (closest to the Plant Area) were 34,000 mg/kg and S4 (located in Poulaweala Creek between S3 and S5) had aluminium levels of 41,400 mg/kg. Given that levels seen in S3 and S4, which are closest to the activity and are within expected background levels, the level seen at S5 is likely to be a once off at that particular sampling location. The total organic content at S5 (8.20 mg/kg) will help to retain the aluminium in the soil.

The reported natural background levels for cadmium is >1mg/kg for the north Clare/southwest Limerick regions (Teagasc, 2007). The highest levels of cadmium detected in the soil around AAL was 2.0 mg/kg (S8). These levels are similar the background levels and are not predicted to have any significant effects on the habitats or species present within the designated sites in the ZoI.

Typical background levels for nickel reported (Teagasc, 2007) for the Limerick area are 30–37.5 mg/kg. The highest level detected around the AAL site was 49.4 mg/kg (S5). S5, which is located on the opposite side of Poulaweala Creek to the plant, had high levels of organic matter and therefore it is likely that nickel present will bind to the organic material and not be available for dispersion via water. Consequently, no significant effects on the receiving environment are predicted.

Teagasc (2007) reports that the background levels of zinc in the Limerick area is between 80–120 mg/kg. The highest levels detected in the soil around AAL were 108.1 mg/kg (S5). The levels detected are probably due to a natural variation in the geology and soils in the area and these levels would not have a significant impact on the designated sites.

Teagasc (2007) reports that the background levels for lead in soil in the Limerick area is between 501-800 mg/kg. The levels of lead detected in the soil samples for this survey are within this range. No significant impacts are predicted for the receiving environment.

Typical background copper levels in soil as reported by Teagasc (2007) in uncontaminated soils is between 6 and 60 mg/kg. The levels detected in this survey are within those levels no significant impacts of copper are predicted for the designated sites and their conservation objectives.

Background chromium levels in the soil along the Shannon Estuary are reported by Teagasc (2007) to be in the range of 30-40 mg/kg. The levels detected within this survey are slightly above these levels but not elevated enough to be of concern. No significant impacts are predicted for the receiving environment.

In conclusion, the levels of heavy metals detected in the marine sediment and the soil samples taken around the site in recent sampling programmes are generally typical background levels for marine sediments and soils around this the Limerick/Shannon area. With the exception of aluminium at one location in 2020 (S5, as discussed above), the levels of heavy metal in the sediment samples are representative of background levels and no significant effects are predicted on the designated Natura 2000 sites and their conservation objectives within the ZoI.

There is no evidence that heavy metals concentrations are elevated in the marine sediments, and consequently no evidence that toxic impacts would occur to the marine benthic biota as a result of the existing and proposed development. The CSM has concluded that there is no emission pathway associated with the AAL facility producing a negative impact on the designated prey species of intertidal feeding birds and other higher fauna in the designated estuarine Natura 2000 sites. This also supports the conclusion that with the application of appropriate mitigation that there is no risk of significant adverse impacts upon the hydrologically connected designated sites as a result of the proposed development.

6.9 Groundwater and Geology

6.9.1 Introduction

Prior to the construction of the plant in 1978, the area was a greenfield site. Two limestone outcrops with elevations of 28.7 metres AOD and 19 m AOD dominated the northeast section of the island, which is now the location of the Plant Area. A northeast-southwest trending valley, dipping towards the southwest separated this area. It is considered that this area would have been largely undeveloped or utilised for any purpose at this time.

The detailed assessment of Soils, Lands & Geology is presented in Chapter 8 and the assessment of Hydrology and Hydrogeology is presented in Chapter 10 of the accompanying EIAR. Potential impacts on groundwater arising from the proposed development could potentially impact upon the estuarine Natura 2000 sites under consideration.

Regional Geology

Aughinish Island is underlain by Lower Carboniferous carbonates of the Limerick Limestone Formation and Rathkeale Formations. It is situated on the eastern margin of the Upper Carboniferous Clare Basin, sits on the western limb of the Shannon Anticline, which plunges gently WSW along the estuary (Clark et al., 1981).

The wider Study Area comprises several Carboniferous formations including the Clare Shale, Parsonage & Corgrig Lodge, Shanagolden, Durnish, Rathkeale and Waulsortian Limestone Formations (GSI, 2021).

Local Geology

During the earlier part of the construction of the plant in 1979 to 1980, the plant area was re-contoured by the removal of the two dominant limestone outcrops located at the centre of the proposed Plant Area. Approximately 8m of the resulting limestone crushed rock fill was placed in the northeast-southwest trending valley running through the centre of the site to create level surfaces for the plant structures.

Limestone Bedrock

The plant area is underlain by Lower Carboniferous carbonates of the Limerick Limestone Formation which comprises medium bedded to massive, fine to coarsely crystalline, blue-grey Waulsortian Limestone. There are several major faults trending northeast-southwest across the Plant Area.

Waulsortian Formation (medium bedded to massive, fine to coarsely crystalline, blue grey) limestones occur on the eastern side of the BRDA with Rathkeale Formation (impure muddy) limestones and (shaley) mudstones on the western side (GSI, 2021). Beneath the permitted Borrow Pit site and proposed Borrow Pit Extension site is Waulsortian Formation limestones.

Site investigations and groundwater studies in 1983, after the commissioning of the plant, found elevated pH and soda concentrations in springs along the eastern coastline and in valley to the western and southern limits of the plant area.

6.9.2 Groundwater

The application site is underlain by two separate aquifer units, one is a Locally Important Bedrock Aquifer (Rathkeale Formation) and the other is a Regionally Important Karstified Bedrock Aquifer (Waulsortian Formation), see Figure 6.7.1.

The majority of the BRDA site is underlain by the locally important bedrock aquifer, while the SCDC, existing Borrow Pit site and the Borrow Pit Extension site sit within the regionally important karstified bedrock aquifer unit. No shallow gravel aquifers have been identified beneath the Application Site. The wider Study Area is divided broadly into the Locally Important Bedrock Aquifer on the Western side and the Regionally Important Karstified Bedrock Aquifer on the eastern side. A third aquifer type (a Poor Aquifer with bedrock which is generally unproductive) is found further west within the Study Area beneath Foynes town, see Figure 6.7.1.

The Regionally Important Karstified Bedrock Aquifer underlying the east side of the Aughinish site is an important water resource for County Limerick, as a consequence of enhanced secondary permeability from faulting and fracturing and enhanced primary permeability from dolomitization. The interpretation of the hydrogeological conceptual model presented by Golder 2015 identified that the groundwater present beneath Aughinish Island comprises a freshwater lens isolated laterally from the mainland by being laterally hydraulically isolated by the Poulaweala Creek and the Robertstown River and the underlying saline groundwater (see Chapter 10 of the EIAR).

The Waulsortian Limestone bedrock has a very low primary permeability. As a consequence, flow of groundwater is dominated by the location of karstified fracture zones and valley infill. The depth at which groundwater is encountered across this unit is typically within 1.5 m to 10 m of ground level which implies that the fracture zones start from a relatively shallow depth, and that, in the centre of the unit, groundwater flows preferentially through the limestone rock fill used to level the valleys during the initial construction phase of the overall Aughinish Site.

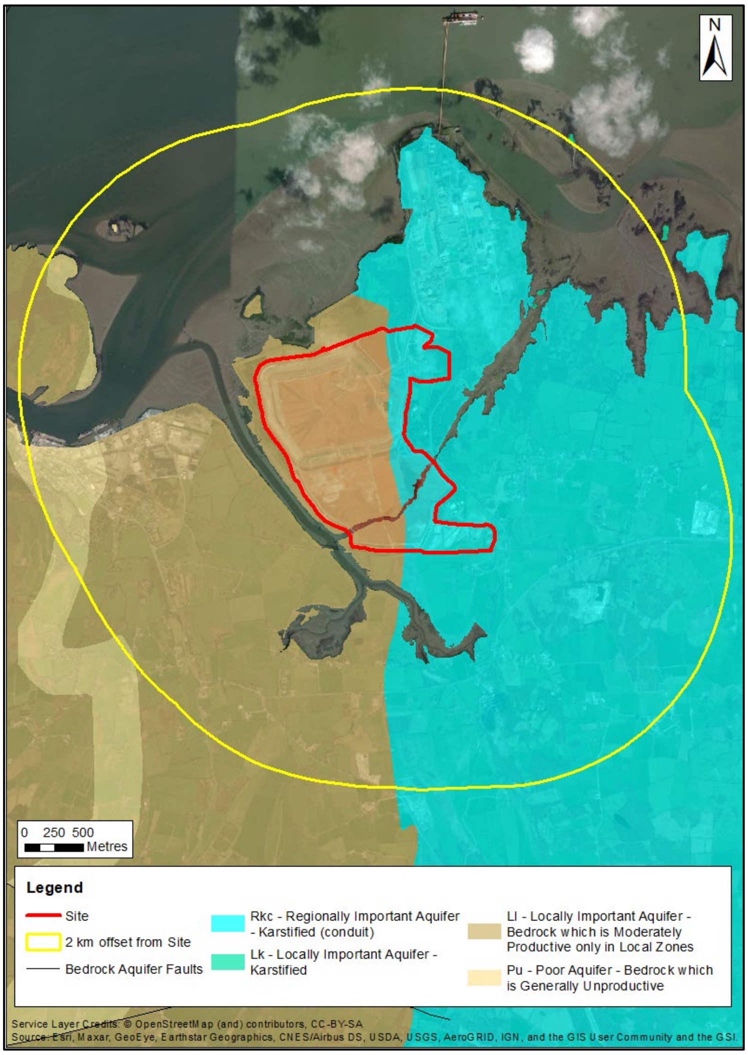

Figure 6.7.1: Bedrock Aquifer Classification (Source: Golder, 2021)

Groundwater vulnerability (see Figure 6.7.2) under most of the Plant Area is extreme with rock close to the surface or karst being present at the boundaries of the Poularone Creek and the River Shannon and to the south of the plant area.

Under the BRDA the groundwater vulnerability is classified between low and extreme, with rock at or near surface or karst, depending on the bedrock geology and presence of either glacial drift or alluvial deposits. Under the existing and proposed Borrow Pit Extension sites the groundwater vulnerability is classified as Extreme with 'rock at or near surface or karst'.

Groundwater flow in the plant area is radial from approximately the centre of the plant area and discharges via springs (Estuarine Streams) to the Shannon Estuary and Poularone Creek.

Groundwater flow to the west and south of the BRDA is likely to be towards Robertstown River, through flow and run-off from estuarine deposits. Surface water flow outside the north and west perimeters of the BRDA is discharged to the estuary via the OPW channel which discharges at low tide to maintain a consistently low level beneath the BRDA. The groundwater flow in the underlying bedrock in the southeast corner of the BRDA is towards the topographically lower areas of Poulaweala Creek and other low marsh areas adjacent to the Robertstown River.

Historical ground mapping for the Borrow Pit Extension site indicates that a groundwater divide may be present in the site area. The groundwater aquifer beneath the majority of the BRDA site is a locally important aquifer while the eastern sector of the BRDA, the SCDC and the Borrow Pit Extension areas overlie a regionally important groundwater aquifer. However, within the application site the groundwater aquifers are largely subject to saline intrusion and do not have a significant resource potential for the wider area.

Sediments under the footprint of the BRDA are classified as being bedrock outcrop and subcrop with a potential recharge coefficient of 7.5 - 20%, while the recharge coefficient beneath the borrow pit site is 85% reflecting the shallow bedrock. The ability of the bedrock aquifers to accept all available groundwater recharge is variable; it is considered to be low (maximum 200 mm/yr) beneath the majority of the BRDA site, and moderate beneath the Borrow Pit sites (maximum 494 mm/yr).

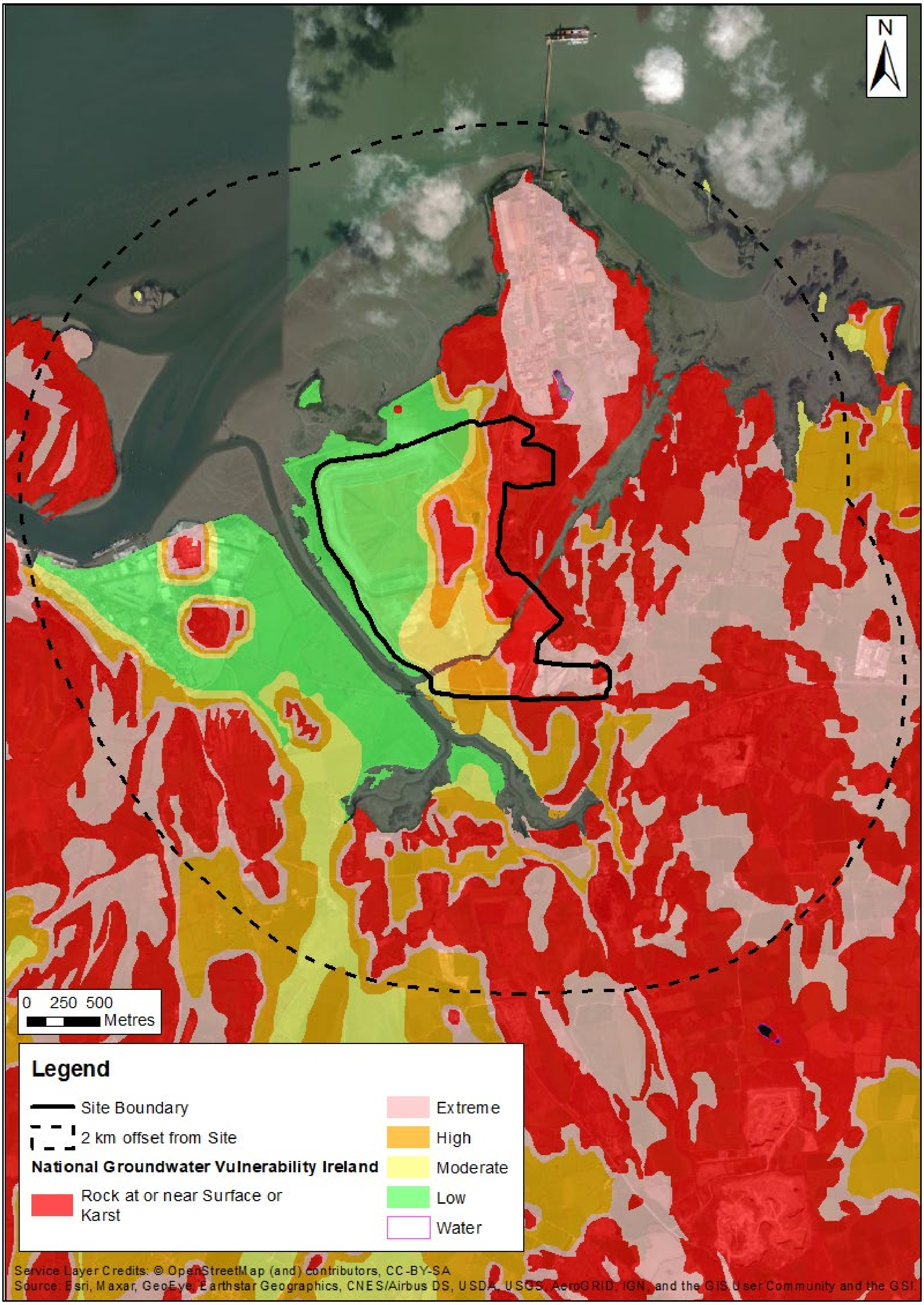

Figure 6.7.2: Groundwater Vulnerability at Aughinish Island (Source: Golders, 2021).

6.9.2.1 Groundwater Monitoring Locations

At the BRDA groundwater is monitored at a series of Observation Wells (OWs). There are 34 OWs currently monitored: In 1997, OW3, OW4, OW5 and OW6 were capped as part of an extension of the original BRDA. OW7, OW8, OW16, OW17, OW18, OW19 and OW23 were decommissioned during 2010 as part of the Phase 2 BRDA extension. Groundwater flow beneath the plant area discharges from the island via discrete estuarine streams (ESs). These estuarine streams or ESs are monitored in accordance with IE licence requirements by AAL. The monitoring wells in the plant area are known as plant observation wells (POW). Groundwater is monitored at 33 POWs. The location of the POWs and OWs at the facility are shown in Figure 6.7.3.

6.9.2.2 Review of Groundwater Monitoring Data

An overview of the trends in average annual pH, conductivity, soda fluoride, chloride, and sulphate of the OW around the BRDA perimeter is presented here, summarised from Chapter 10 of the EIAR.

Since 2010, annual average pH has been within the range of 6.6 to 8.2 for the OWs, with slight fluctuations within the range.

In terms of annual average electrical conductivity values there are three broad categories of wells for the Phase 1 BRDA section, dependent on the level of saline influence:

- Those with strong saline influence (OW9, OW10, OW11, OW12, OW21) have average conductivity values over the 1,875 µS/cm threshold; values between 12,068 µS/cm and 31,425 µS/cm
- Those influenced by brackish water (OW1, OW2, OW20, OW22), also with average conductivity values over the 1,875 µS/cm threshold; values generally between 1,465 and 5,218 µS/cm
- Those with minimal saline influence, located on the eastern and most inland perimeter of the BRDA (OW13, OW14, OW15) with average conductivity values under the 1,875 µS/cm threshold; values between 473 µS/cm and 762 µS/cm

For the OWs around the Phase 2 BRDA perimeter, a similar trend is seen:

- wells influenced by saline intrusion have a very high electrical conductivity (OW24, OW25, OW26, OW27, OW28, OW29, OW30, OW31, OW32, OW33, OW35, OW36, and OW43 all have high conductivity ranges between 1,906.75 µS/cm and 38,150 µS/cm between 2011 and 2020),
- while wells on the south and eastern side of the Phase 2 BRDA are less impacted by saline intrusion to varying degrees based on proximity to the transitional waterbodies (OW34, OW37, OW38, OW39, OW40, OW41, OW42, OW44, OW45 have conductivity values below 5,000 µS/cm).

7 wells around the Phase 1 BRDA (OW1, OW2, OW13, OW14, OW15, OW20 and OW22) show annual average concentrations of soda generally between 0 g/l and 1.1 g/l. These wells are generally to the east and north-northeast of the BRDA and ponds and consist of both overburden and bedrock wells.

Five wells (OW9, OW10, OW11, OW12 and OW21) show slightly elevated soda levels (between 2.7 g/l and 8.4 g/l), with greater fluctuations, and are found along the north and west of the Phase 1 BRDA. These wells are both overburden and bedrock and are more coastally located compared to the other 7 wells and thus, subject to saline intrusion which is likely causing interference in the readings.

Around the Phase 2 BRDA perimeter, 11 wells have a relatively level soda concentrations of below 0.7 g/l and 11 wells have higher soda values with more variability in results. These wells with soda concentration level fluctuations are found on the western side of the Phase 2 BRDA, near to the Robertstown River, and include both bedrock and overburden wells. With the exception of OW32, these wells had annual average soda values between 0.72 g/l and 5.21 g/l. OW32, a bedrock well, had historically elevated levels of soda in 2016 with an average of 10.6 g/l but has shown steady decline in soda since then and had an annual average of 3.3 g/l soda for 2020.

In 2020, average annual soda levels were below 8 g/l for all OWs.

Annual average fluoride concentrations have fluctuated around the 1.0 mg/l IGV threshold value of set by the EPA. In 2020, only two annual averages were above the threshold: OW26 with an average of 1.04 mg/l fluoride and OW20 at 1.29 mg/l.

Chloride annual average values are very similar in trend to electrical conductivity trends which is expected given the strong saline influence in some wells. The three Phase 1 wells furthest removed from saline intrusion (OW13, OW14 and OW15) have averages between 17 and 137 mg/l chloride between 2008 and 2020, while OW32 is has the highest historical chloride concentration at 12,000 mg/l chloride in 2016, and OW10, OW11, OW12 and OW21 had levels above 8,000 mg/l. In 2020, all OW levels are below 8,000 mg/l chloride.

Wells which are more strongly influenced by saline intrusions show stronger elevations in sulphate. Annual average concentrations have ranged from just over 2,500 mg/l down to 0 mg/l sulphate, while the average concentrations in 2020 for most wells were below 1,000 mg/l. OW25 was just above 1,000 mg/l sulphate while OW32 and OW33 were around 2,000 mg/l sulphate.

From the April 2021 monitoring cycle at the BRDA sites, most OWs had results for heavy metals within the ground water threshold levels. However, there were exceedance of heavy metal threshold values at the following OWS:

- Arsenic: OW9, OW10, OW21, OW24, OW27, OW29
- Cadmium: OW10, OW14
- Iron: OW9, OW10, OW24, OW25, OW27, OW28, OW29, OW31, OW33
- Magnesium: OW9, OW10, OW11, OW12, OW21, OW24, OW25, OW26, OW27, OW28, OW29, OW31, OW32, OW33, OW35, OW36
- Nickel: OW10, OW24
- Zinc: OW2, OW10, OW14, OW24, OW35, OW36

At observation wells around the borrow pit, pH is below the 9.5 threshold value (between 7.2 and 8.5), while chloride, fluoride, sulphate and soda concentration values are within the groundwater threshold values. Electrical conductivity is below the threshold value at all sites, except MW2, however, this site is considered to be strongly impacted by saline intrusion form the nearby Poulaweala Creek.

From the April 2021 monitoring cycle of the borrow pit sites, most OWs had results for heavy metals within the ground water threshold levels. However, there was exceedance of heavy metal threshold values at the following OWS:

- Arsenic: MW4
- Magnesium: MW2, OW13
- Mercury: MW1, MW2, MW3, MW4, BH1 - It is considered likely that the slightly elevated mercury in these wells is naturally occurring.
- Zinc: MW2, BH1, SPW3, SPW4, OW13
- Aluminium was elevated against the groundwater threshold value of 150 µg/l at BH2 (2,009 µg/l) and OW13 (553 µg/l). Subsequent monitoring at OW13 resulted in a below limit of detection reading of <80 µg/l Al, while the increased alumnium at BH2 is unlikely to be related to the BRDA as it is across a groundwater divide.

Analysis of the monitoring data from MW2 can be excluded due to saline intrusion influence. The other exceedances occur in isolation to other parameters i.e. just a single metal exceeding a threshold value in a round of readings (usually zinc or arsenic and sometimes mercury) and then are not present for future rounds and hence are considered to be natural.

A detailed assessment of the risks to groundwater arising from the operational and post-closure phases of the proposed development has been carried out. The existing controls mean that the predicted effect on groundwater, in the absence of additional mitigation would be slight adverse. With the implementation of the mitigation measures presented in the EIAR (and CEMP) the predicted residual impacts on groundwater are assessed as negligible non-significant/slight in nature.

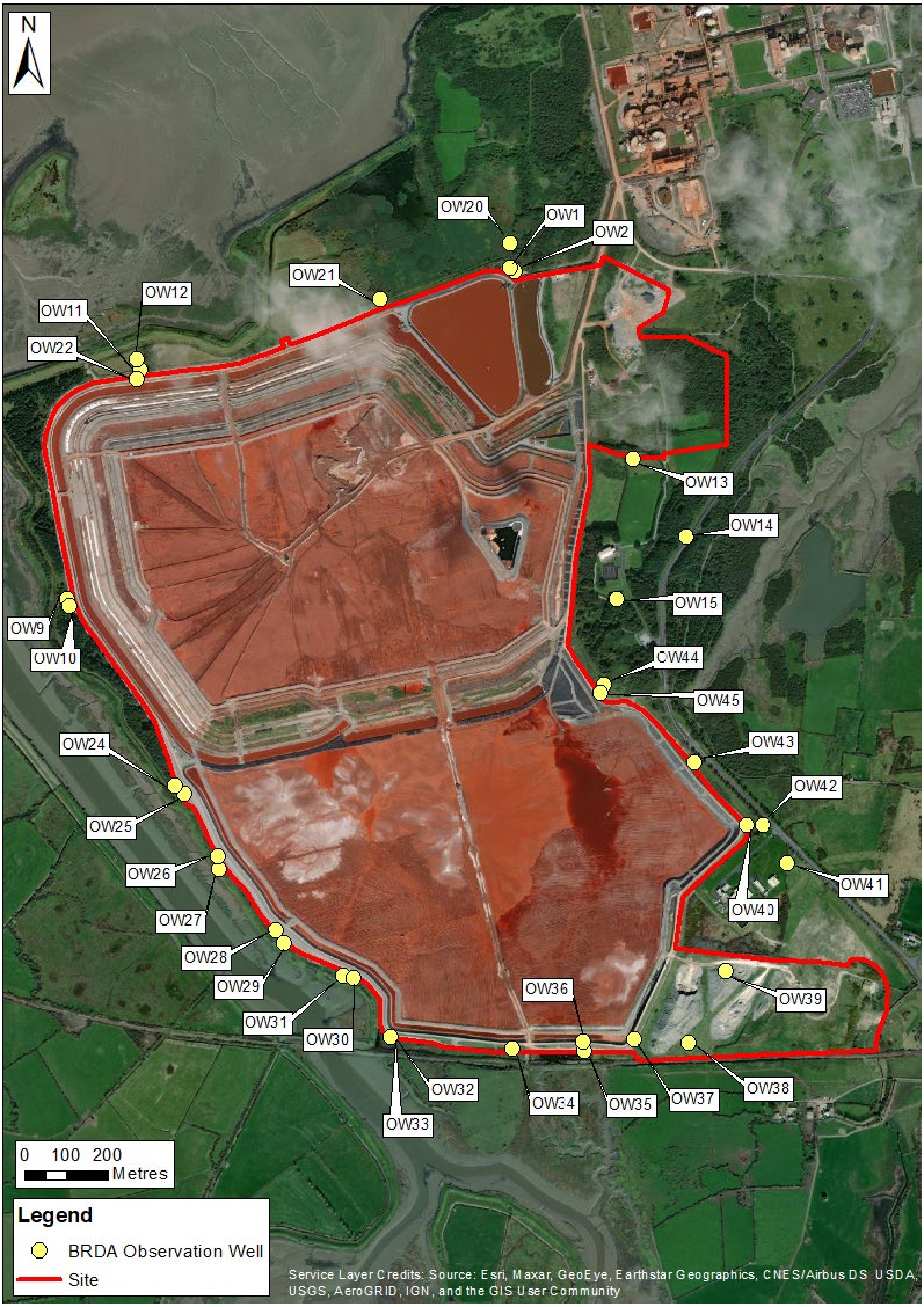

Figure 6.7.3 Groundwater Observation Wells around perimeter of the BRDA (Golder 2021; background image from Bing Mapping c. 2013**).**

6.10 Noise and Vibration

The proposed development was subject to a dedicated Noise and Vibration Assessment (see Chapter 12 of the EIAR). Noise and vibration associated with the proposed development have the potential to disturb faunal qualifying/special conservation interests of the Natura 2000 sites under consideration.

6.10.1 Introduction

As part of AAL's operating licence (ref. Industrial Emissions Licence Reg No. P0035-07) the site is required to carry out annual noise monitoring with the results submitted to the EPA each year.

Measurements are conducted at five (5) nearby noise sensitive locations (NSL's) as defined in AAL's operating licence (ref. Industrial Emissions Licence Reg No. P0035-07; Figure 6.8.1) and described below.

- NSL 1 is located approximately 600m southeast of the facility adjacent to Poulaweela Creek.
- NSL2 is located approximately 1,200m to the southeast of the facility in the vicinity of a residential dwelling.
- NSL3 is located approximately 3km to the south of the facility in the townland of Oola.
- NSL4 is located approximately 2.6km to the southwest. Located at the eastern end of Foynes Port.
- NSL5 is located 1.9km directly south of the facility in the vicinity of a residential building at a crossroads.

Noise measurements are conducted at each location for daytime, evening and night-time periods[4]. AAL is required, under condition 4.5 and 6.16 of the IEL to conduct annual noise monitoring at the site boundary and off-site noise sensitive locations. The noise limits at the noise sensitive locations are:

- Daytime: 55 dB(A) Leq
- Evening time: 50 dB(A) Leq
- Night-time: 45 dB(A) Leq.

The location of the noise monitoring locations is shown in Figure 6.8.1. A comprehensive review of the potential impacts of noise and vibration associated with the proposed development, in particular with activities associated with the operation of the extended borrow pit is described in detail by AWN in Chapter 12 of the accompanying EIAR. Noise and vibration was also fully assessed in relation to the planning application for the permitted borrow pit development (17/714; ABP 301011-18). The results presented in the AERs from recent years confirm that AAL is compliant with the limits set in its licence in relation to noise and vibration.

[4] Note that NSL1 is an amenity area not a dwelling. As a result it is only considered sensitive during daytime and evening time periods and is not surveyed at night.

6.10.2 Operational Phase Site Activity

During the operational phase of the proposed development, the potential sources of noise and vibration are primarily those associated with the Borrow Pit extraction and internal site vehicle movements to the BRDA area where the phasing will see the height of the existing BRDA increase from Stage 10 to Stage 16. Activity within the Borrow Pit will include occasional blasting to remove rock, on site breaking and crushing of the rock and excavator, loading shovel and dump truck movements to stockpile the materials.

On the BRDA there will be several excavators in operation in addition to a low ground pressure bulldozer, amphirol equipment and compactors for mud farming. Note that the proposed development will not generate additional vehicle movements on site and the development is continued operation of the BRDA up to Stage 16, construction and operation of the Salt Cake Cell and extending the borrow pit footprint. The same activity currently permitted within the borrow pit and BRDA will continue to operate within the proposed development.

During the operational phase of the proposed development, the potential noise and vibration impacts relate to the following:

- General Operational Phase Site Activity, and;
- Blasting.

During the operation of the BRDA the existing machinery will continue to be used. However, the phasing of the BRDA raise over time will result in the elevation of this machinery increasing above ground as each stage is completed. Note that the SCDC that is part of the development will be raised to its final height in one single phase and is not incrementally raised like the BRDA. For the purposes of this assessment the following stages of the BRDA development have been assessed,

- Current
- Phase 1 at Stage 10; Phase 2 at Stage 4
- Phase 1 at Stage 12; Phase 2 at Stage 8
- Phase 1 at Stage 14; Phase 2 at Stage 12
- All at Stage 16 including the restoration activity

To assess the noise impact of the proposed development a 3D noise model of the developments has been developed. Brüel & Kjær Type 7810 Predictor is a proprietary noise calculation package for computing noise levels in the vicinity of noise sources. Predictor predicts noise levels in different ways depending on the selected prediction standard. The resultant noise level is generally calculated taking into account a range of factors affecting the propagation of sound, including:

- the magnitude of the noise source in terms of sound power;
- the distance between the source and receiver;
- the presence of obstacles such as screens or barriers in the propagation path;

- the presence of reflecting surfaces;
- the hardness of the ground between the source and receiver;
- attenuation due to atmospheric absorption, and;
- meteorological effects such as wind gradient, temperature gradient and humidity (these have significant impact at distances greater than approximately 400m).

Prediction calculations have been performed using Predictor in accordance with ISO 9613 (1996): Acoustics – Attenuation of sound outdoors – Part 2: General method of calculation.

For the purposes of the assessment the following activity has been included in the noise model. All source levels are taken from BS5228 – 2009+A1(2014): Code of practice for noise and vibration control on construction and open sites Part 1 – Noise.

Borrow Pit

- Tracked Crusher;
- Wheeled Loader;
- Dump Truck;
- Excavator Mounted Breaker, and;
- Excavator.
- Loading shovel

BRDA

- 9 no. excavators – 5 assumed to operate concurrently;
- no. Tractors – 5 assumed to operate concurrently;
- 2 no. Amphirol vehicles – both assumed to operate concurrently;
- 1 no. bulldozer, and;
- 1 no. 40t Moxy Dump Truck.

The noise level generated by each plant item has been taken from manufacturers datasheets or where not available from BS5228-1. Table 6.13 details the sound power level associated with each item of plant. Activity within the BRDA and Borrow Pit only occurs during daylight hours and based on activity logs provided by AAL an on-time of 66% has been applied, i.e. equipment is assumed to be in operation for 66% of the time.

Table 6.13 Sound Power Level of Each Plant Item

Plant Item	Sound Power Level, dB $L_{w(A)}$
Amphiroll	111
Excavator	98 – 102
Tractor	108
Moxy	107
Excavator Mounted Breaker	118
Wheeled Loader	107
Crusher	110
Dump Truck Dumping Stone in Borrow Pit	108

The noise level at the nearest sensitive locations has been predicted for each of the five stages of BRDA construction as described earlier. For the purpose of the noise assessment it is assumed that works are occurring either within the Phase 1 area or the Phase 2 area plus the extended borrow pit. The assessment shows that the calculated noise level at all locations for all scenarios considered is below the daytime criterion of 55 dB $L_{Ar,T}$. Furthermore, the proposed BRDA raise to higher elevations will result in a reduction in noise level at some locations as a result of additional screening offered by the BRDA stage raise embankments.

It is predicted that emission from the general operation of the proposed development will not change the existing soundscape and no significant noise impact is expected. Furthermore, it should be noted that the use of the Borrow Pit site to source crushed stone for use by site operations has the beneficial effect of removing truck movements from the local road network where previously crushed stone was imported from off-site quarries.

Blasting will be required within the Borrow Pit, up to 7 blasts will be required per year. To assess the likely air overpressure from a blast the following inputs were modelled,

- 35kg charge mass;
- Flat ground topography to assess a worst-case scenario;
- No screening due to environmental berm proposed, and;
- Blast at the south eastern corner of the extended borrow pit site and at grade.

Established scaling methods allow the pressure levels from a blast to be calculated from the relationship between the charge mass, distance and blast vibration levels.

Table 6.14 presents the calculated air overpressure level for a range of distances from the blast.

Distance from the Blast, m	Air Overpressure, dB (Lin)
150	106
400	96
900	88
1300	84
1750	81

To put the values in Table 6.14 into context air overpressure of the order of 120dB (Lin) is equivalent to the pressure felt from a 20mph wind. The effects due to air overpressure values presented in Table 6.14 as a result of blasting required at the proposed development are orders of magnitude less than this. Similarly, in relation to vibration from blasting, using the same inputs as described above for the air overpressure assessment Golder have calculated the expected vibration levels from blasting. Figure 6.8.2 presents the predicted vibration contours due to Borrow Pit blasting.

Vibration levels during blasting are predicted to be less than 1mm/s at the nearest sensitive locations.

With regards to airborne noise from blasting there is no agreed methodology for predicting the maximum instantaneous noise level that will be heard as a result of a blast. However, it is well established that sound pressure decays at a rate of 6dB per doubling of distance. Table 6.15 describes the attenuation of sound at a variety of distances from the blast site without considering any attenuation due to the borrow pit walls or soft ground cover between the borrow pit and receiver.

Table 6.15 Calculated Attenuation of Blast Noise over Distance

Distance from the Blast, m	Reduction in Noise, dB
100	40
250	48
500	54
750	58
1000	60
2000	66
4000	72

Blasts would be expected to be audible in terms of an instantaneous loud noise, however, once attenuation due to distance is considered the sound pressure level of the blast would not be so high as to constitute a significant impact.

Figure 6.8.1 Noise Monitoring locations (after AWN, Chapter 12 of the EIAR).

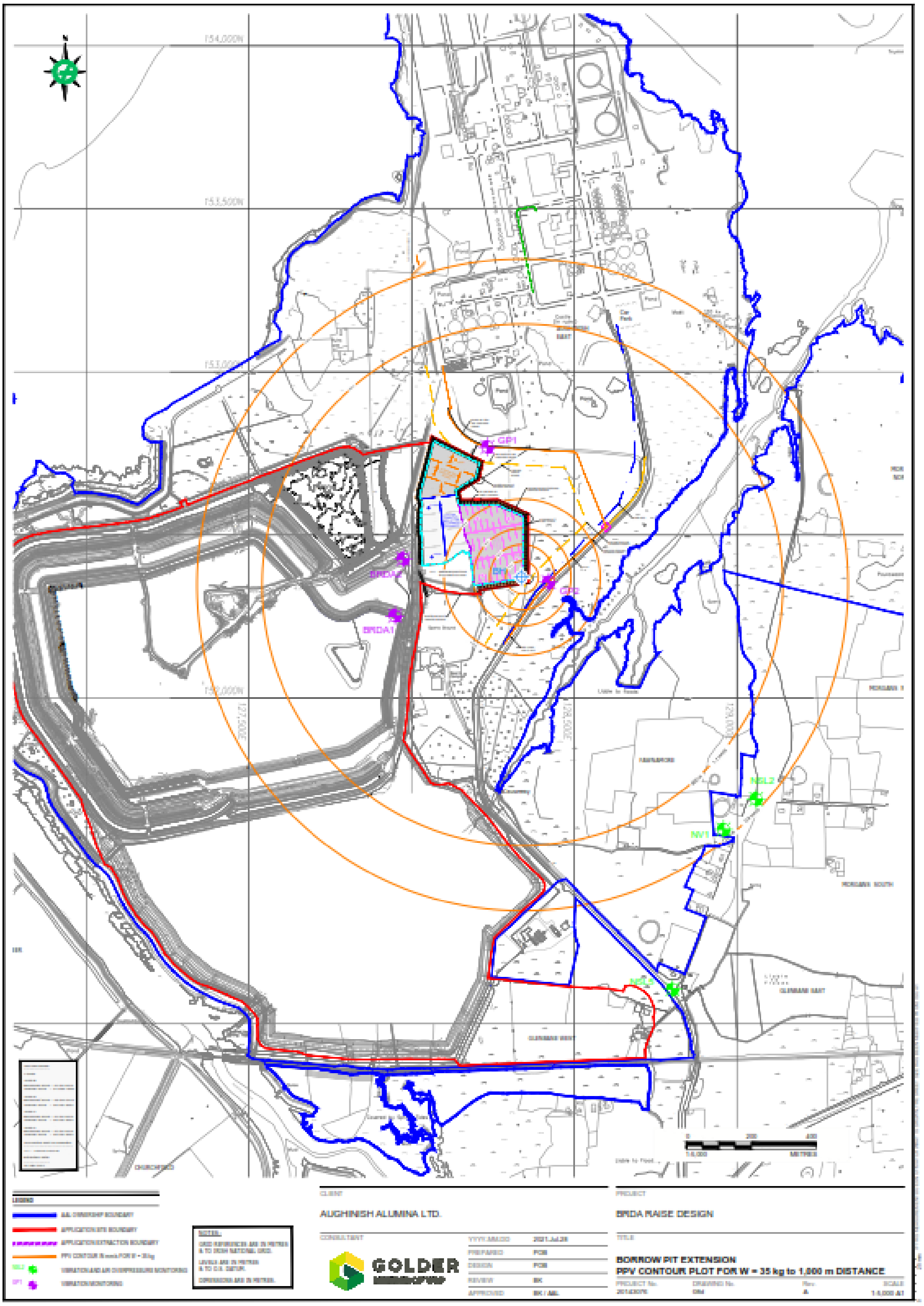

Figure 6.8.2 Calculated Vibration Levels from Blasting at Distance (after Golder 2021).

6.10.3 Impact of Noise & Vibration on Biodiversity

The main sources of noise generated at the site is traffic noise, industrial noise and noise from shipping operations. The Shannon Estuary and Shannon Airport also contribute to background noise in the area. Noise as a singular disturbance factor for fauna species in the vicinity of the licensed facility is difficult to assess, as noise is very rarely the only cause of disturbance for wildlife. Noise associated with on-site traffic and employees entering and leaving the site is also accompanied by vibration disturbance.

A 3dB increase in background noise levels means a doubling in sound energy and about a 23% increase in loudness. A 10dB increase in background noise levels would equate to a doubling of noise.

The River Shannon & River Fergus Estuaries SPA is designated for the protection of bird species, mostly overwintering waterbirds. The range of hearing of birds is largely in the bandwidth up to 10 Hz. Outside this range, sensitivity is considerably lower (Dooling *et al*. 2000). Much of the research on the impacts of anthropogenic noise on bird focuses on road traffic noise, with the finding that song frequency shifts under noisy conditions (e.g. Patricelli & Blickley, 2006).

The site has been in operation for over 30 years and has developed and expanded over this period. Birds and mammals become accustomed (habituate) to noise and vibration and as the recent bird and bat surveys carried out at the site demonstrate, they continue to use the site. The operation of the proposed borrow pit extension will generate sources of noise and vibration from site machinery, vehicular movements, rock crushing and blasting. It is anticipated that up to 7 blasts per year will occur at the site. Blasting technology is controlled to reduce the air over pressure values and vibrations. To achieve the expected production, up to 7 blasts will be required per year. In order to control vibration, the best practical approach is to implement a scheme to reduce vibration levels at the source and monitor vibration at receivers.

The EIAR for the permitted borrow pit (17/714; ABP 301011-18) provided an assessment of the effect of blasting within the footprint of the proposed Borrow Pit and was found to pose minimal risk to the stability of the adjacent BRDA. Chapter 12 of the EIAR accompanying the application for the proposed development provides a detailed assessment of the predicted noise and vibration associated with blasting and other activities at the site.

As part of the recent Industrial Emissions Licensing review for Aughinish Alumina Ltd. (Reg. No.: P0035-07) a Marine Mammal Risk Assessment was requested by the Environmental Protection Agency (EPA) with a letter (dated 6th May 2020), stating:

'In view of the proximity of the activity to the Lower River Shannon SAC (Site Code 002165) and the potential for impact on the Shannon Estuary's Bottlenose Dolphin population, particularly due to noise and vibration as a result of blasting at the borrow pit, please submit a marine mammal risk assessment (MMRA), completed by a suitably qualified marine ecologist, evaluating the risk to marine mammals from the proposed activities.

The risk assessment should be completed in accordance with the approach outlined in Guidance to Manage Risk to Marine Mammals from Man-made Sound Sources in Irish Waters published in January

2014 by the Department of Heritage, Culture and the Gaeltacht (available at https://www.npws.ie/marine/best-practice-guidelines). The MMRA shall clearly outline any additional mitigation measures required to protect marine mammals, as necessary.'

Ecology Ireland assisted by marine mammal specialist Dr. Daphne Roycroft prepared a MMRA (see Appendix 6.4 to Chapter 6 of the EIAR). This report concluded that given the terrestrial location of the borrow pit site and the fact that all blasting activities will take place on land and not in the underwater environment, that this project was not considered to pose any risk of death, injury or disturbance to any marine mammal individuals. Dr. Roycroft confirmed that the same conclusion applies to the proposed borrow pit extension (Daphne Roycroft pers comm.).

The only other faunal qualifying interest of the Lower River Shannon SAC with any potential to occur or proximate to the proposed application site is Otter. Otter sightings or signs have tended to be restricted to the coastal areas of Aughinish Island. The trail camera locations where Otters were recorded as part of the current study (see Chapter 6 of the EIAR) confirmed the coastal nature of the species on Aughinish Island. It is unlikely that Otters occur within or closely adjacent to the application site with any regularity. The activity at the proposed borrow pit extension will be largely restricted to daylight hours when Otters are much less likely to be present in the area. This further minimises the risk that any Otters would be disturbed or displaced through the operation of machinery and personnel in the area. There are no signs that the areas within or adjacent to the proposed borrow pit extension area are of importance for Otters and it is not expected that the proposed development will have any significant impact upon Otters in the wider area.

The River Shannon & River Fergus Estuaries SPA is designated for the protection of highly mobile bird species (e.g. e.g. wintering Golden Plover, Lapwing, Curlew and Breeding Cormorant). Given the habitat characteristics and location within the active plant, the proposed development does not and is unlikely to attract any significant numbers of foraging wintering bird species into the application site during the active life of the facility. The limiting of the blasting events to outside of the wintering period will effectively minimise the potential disturbance of the SCI species.

There is no suitable habitat for breeding Cormorant within the proposed development boundary. Due to the overall low level of wintering bird activity recorded within or adjacent to the terrestrial areas within the application site (during this and previous studies at the same site), the availability of more expansive and suitable habitat locally (e.g. intertidal mudflats of Shannon Estuary, Fergus Estuaries etc.) the proposed development site is considered of negligible importance to SPA qualifying species overall, and as such there is no potential for adverse impacts related to noise and vibration on the faunal species of the nearby designated sites as a result of loss of habitats at the proposed application site.

The proposed working hours for the operation of the borrow pit is between 08:00 and 18:00 hours on Monday to Friday (see Chapter 3, EIAR, Description of Project). No operations will take place on site on Sundays and Public Holidays. Blasting and rock crushing has previously occurred with in this general location at Aughinish Island and there has been no change noted in the usage of the nearby parts of the SPA by any of the qualifying avian interests.

The low level of blasting, occurring over the April to September summer period is unlikely to have significant adverse impact on bird species of nearby designated sites overall. Extraction works will take place during the hours of daylight, minimising disturbances to roosting birds and mammals and birds active in the nocturnal/crepuscular period. Furthermore, species are likely to be already somewhat tolerant of ongoing noise from the overall AAL industrial facility and an overall suburban anthropogenic-influenced environment heading towards Foynes and Shannon-Foynes Port. For these reasons, there is no predicted significant impacts on key faunal species as a result of noise and vibration from blasting or extraction operations associated with the proposed development.

The proposed development will see little change in the scale or type of activity within the application site. The borrow pit is proposed to be extended but will operate in line with the commitments provided for the permitted borrow pit. Therefore, there will be no blasting in the winter months (October through March) and the number of blasts during the summer period will be limited to seven annually.

There will be some additional human activity/vehicular noise associated with the operation of the borrow pit which will lead to a slight increase in human activity/vehicular noise levels in the vicinity of the application site. However, the BRDA is already a highly industrialised area with regular human disturbance, and any wildlife species occurring in the vicinity of the BRDA, Borrow Pit and Soil Storage area are likely to be tolerant to or accustomed to anthropogenic disturbance.

Noise and vibration levels associated with operational plant and equipment are expected to be well within the adopted criteria values at the nearest sensitive properties taking into account the site layout, location of proposed plant areas and distances to nearest residences. It is not anticipated that the frequency of blasting will have a significant impact on wildlife in the area of the site. The blasting will only take place outside of the overwintering period, thereby effectively eliminating the risk of disturbance to overwintering SCI bird species.

Post closure there will be relatively low (similar or lower to typical agricultural levels) of anthropogenic sources of noise and vibration activity at the proposed development site.

Without adequate and appropriate control of noise (e.g. associated with blasting) there would be some potential for adverse impacts upon sensitive fauna, including wintering birds and Otter. The control of the timing and extent of blasting will be effective in minimising the potential for any significant disturbance or displacement of sensitive species.

6.11 Ambient Light

The process areas of the plant, as well as the marine terminal are illuminated at night. There are also streetlights around footpaths, car-parks, roads and offices. The lighting regimen at the facility has remained largely unchanged for many years. The BRDA is largely in darkness during the night-time hours (G. Fennessy pers obs.) with minimal lighting at key locations e.g. on the access track to the Salt Cake Disposal Cell. The lighting is shielded and downward directed. The lightspill from lighting on the BRDA is minimal. No significant change or intensification of lighting of the BRDA is proposed as a result of the proposed development. There will be no permanent lighting of the borrow pit or spoil storage areas.

There are no specific anthropogenic lighting levels or limits set out in Irish legislation. A lighting study was carried out as part of the NIS for the EPA licence review (Appendix A) which sampled light levels across two night-time periods. A total number of 45 points were surveyed, over the duration of two nights. 18 No. points were measured within the operational plant and 27 No. points were measured around the site perimeter, including 2 No. points on the jetty (Figure 6.9.1). The Lux levels were measured using a calibrated Hagner EC1 Lux Meter.

The study confirmed that areas where people and machinery are commuting and working at night are lit to typical safe levels. The four sampling points with the highest level of illuminance (>15 lx) were associated with the core of the processing plant (Points No. 01, 02 & 05) and at the marine jetty (Point No. 12). The standard range of illuminance for safe work at construction sites and loading bays is given in the range of 20-50lx. The peak lux level recorded, at the marine jetty was 32lx, very much within the range of lighting required for safe work in this working environment. The standard range of illuminance for safe movement of people and vehicles at night is presented as in the range of 5-20lx. Again, in the safety critical parts of the operating facility the 2020 lighting survey shows that AAL is within the expected range.

The 2020 survey recorded lux levels at areas away from those where night-time work would typically be undertaken, including sampling areas proximate to the Lower River Shannon SAC and River Shannon & River Fergus Estuaries SPA. Barrigone SAC is over 0.5km from the facility red-line boundary and significantly further from the illuminated process areas. There is no likelihood that night-time lighting could significantly impact upon Barrigone SAC or its conservation objectives. Similarly, there is no potential for qualifying habitats of the Lower River Shannon SAC to be significantly affected, given the distribution of these qualifying habitats, the location of the light sources and/or the sensitivity of the habitats to artificial lighting.

The sampling locations No. 21 and No. 22 were taken atop the sea-wall directly adjacent to the intertidal mudflats, part of the both the Lower River Shannon SAC and the River Shannon & River Fergus Estuaries SPA. At both of these locations, there was a reading of 0lx, indicating no appreciable influence of artificial illuminance.

The sampling points close to Poulaweala Creek also confirmed a negligible influence of artificial illuminance (Points 35, 37, 38, 39 & 41 all had readings of 0-0.2lx). Other sampling points around the perimeter of the island, and proximate to the designated sites had similarly low lux readings.

Ecological studies at the site confirm the regular presence of nocturnal mammals and birds within and adjacent to the licensed facility boundary. For instance, Otters have been recorded widely and frequently around the coastal sections, adjacent to the Shannon, Poulaweala Creek and Robertstown Stream (pers obs.; see Chapter 6 of the EIAR). The area at the marine terminal is located in a deepwater area part of the Shannon and therefore is not an area of importance for feeding or roosting wading birds. It has been observed that Black-headed Gulls (*Chroicocephalus ridibundus*) regularly roost and preen in the areas on and adjacent to the well-illuminated marine terminal during night-time hours.

Most bird species habituate rapidly to sources of artificial lighting, but anthropogenic sources of light have been shown to impact on the feeding ecology (e.g. Clewley *et al*. 2016) and territorial behaviour (da Silva *et al*. 2015). Lighting of the sky, through omni-directional lighting, up-lighting, reflected glare and high-intensity lighting etc. can cause disorientation in migratory species (Cabrera Cruz *et al*. 2018). There is no evidence that the night-time lighting at AAL has been a source of significant disturbance, displacement or mortality (through collision) of birds occurring in the area.

AAL has had a designated wildlife specialist on staff since 2005. The wildlife specialist records wildlife sightings and monitor high biodiversity value areas within and adjacent to the site on a weekly basis. There have been no records of collision mortality of waterbirds recorded at AAL. A pair of Peregrine Falcons (*Falco peregrinus*) have successfully bred within the process area of the plant in recent years and this further reduces the likelihood that waterbirds would occur on lands in close proximity to the plant. It is worth adding here that Limerick is not on a major migratory flyway for birds (Irish Aviation Authority, Integrated Aeronautical Information Package). Migration of birds in Ireland in the spring and autumn is concentrated mainly on the coast. Swans and Geese are tracked migrating at height of greater than 750m above ground on these coasts in October and November and again from the end of February to the end of April (Irish Aviation Authority, Integrated Aeronautical Information Package).

The design of the lighting of the proposed development will not lead to any significant change on baseline levels. There is no potential for adverse impacts upon the integrity of any of the designated Natura 2000 sites considered in this NIS.

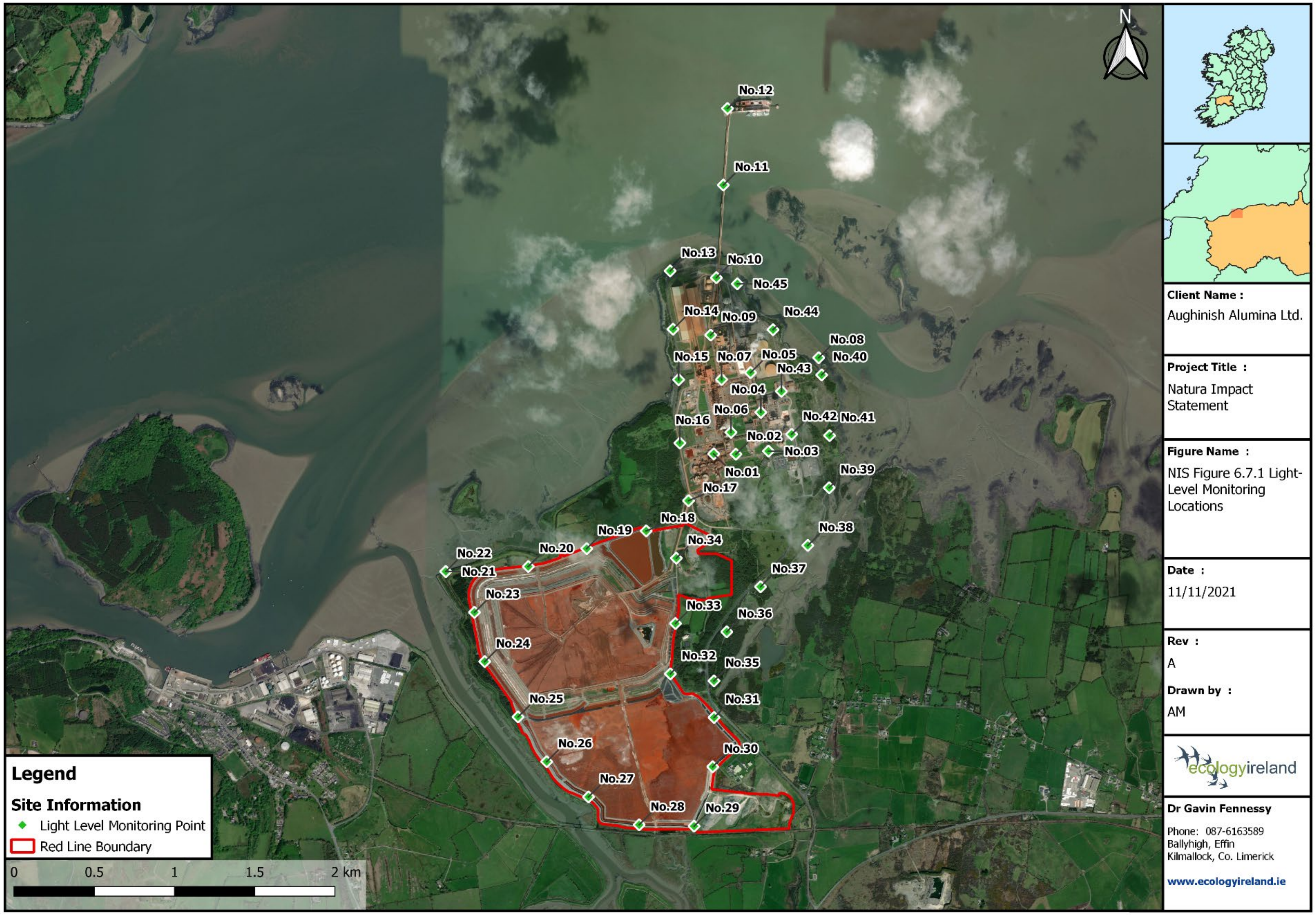

Figure 6.9.1 Lux-sampling locations at the AAL facility in February 2020 (background image from Bing Mapping c. 2013)..

6.12 Cumulative & In Combination Effects

A review of known projects and plans within the wider (15km hinterland) area was carried out by Tom Phillips & Associates. Obviously, in a search area that large there was a considerable number of projects, many of which were of a small scale (e.g. domestic) and without any significant potential to interact with the proposed development on Aughinish Island. It did also identify some larger projects and those more proximate to the application site and the designated sites under consideration.

The potential cumulative impact of the Proposed Development with other existing and/or approved projects has also been assessed. A survey of existing and/or approved projects in the area was undertaken to determine whether the nature and scale of each of these projects could be sufficient to generate cumulative impacts of significance on the environment. The projects identified as part of this survey are listed in Appendix 18.1 in the EIAR and reproduced below in Table 5.1.

For the purposes of this survey, all planning applications which were recorded on the National Planning Applications Database (DoHPLG) with extant permissions or were otherwise under consideration as of August 2021 within a c. 15km radius of the Subject Development were included. A record of 'major' planning applications within c. 15km of the planning boundary was established in August 2021. These applications were determined to constitute new development of a commercial, industrial, agricultural or residential nature, which may be of significance to the cumulative assessment. The following types of applications were excluded from the final listing:

- Minor change of use applications;
- Residential applications of less than 10 no. units located greater than c. 1.5km of the subject site;
- Minor amendments to permitted applications;
- Retention applications;
- Minor signage applications;
- ESB infrastructure (i.e. substations, switch rooms and towers);
- Minor utilities works including lighting and junction upgrades;
- Developments of a scale that would not exacerbate significant environmental effects (e.g. internal reorganisation, car parking of less than 20 spaces, continuance of use, etc.);
- Developments that have become operational by the time of writing (as they have been considered in the baseline); and
- Applications that were granted prior to February 2016 as it is assumed that these permissions will have lapsed, unless otherwise stated in the Grant of Permission.

Notable projects which are highlighted within some of the EIAR chapters as having the potential to result in cumulative effects include the capacity extension at Shannon Foynes Port and the Foynes to Limerick N69 road scheme.

The AAL facility is located close to the Shannon Estuary and just upstream of Shannon-Foynes Port. Shannon Foynes deep water port is a significant national port, Ireland’s second largest port operation and has statutory jurisdiction over all marine activities on a 500 km^2 area on the Shannon Estuary, stretching from Kerry/Loop Heads to Limerick City. It is responsible for most of the commercial ship traffic on the Shannon estuary.

The proposed works will occur within an area which is heavily modified and industrialised, and disturbed by human activities. The overall AAL facility is subject to strict emission limits, as set out in the EPA IEL conditions. It is required to produce regular detailed environmental monitoring reports. The proposed development will facilitate an extension of life of the overall AAL facility and therefore increase the period during which there will be high-levels of anthropogenic activity in the area and also the duration for which there will be emissions associated with the operation of the plant. The nature of the activities in the processing area will be essentially unchanged but the increase in storage capacity in the BRDA will extend the lifetime of the overall facility. Therefore, the potential for bioaccumulation of potential contaminants arising from the operational site during these extended operations must be assessed. The accumulated scientific information of the receiving environment over the lifetime of the AAL facility to date provides a considerable amount of information on the local environment. The CSM has evaluated the SPR model for all potential sources of emissions from the overall facility as part of the consideration of the in-combination effects.

In December 2019, Limerick City and County Council (LCCC) applied under section 51(2) of the Roads Act 1993 (as amended) to An Bord Pleanála for approval as Strategic Infrastructure Development (SID) in relation to a proposed road development consisting of:-

- Approximately 15.6km of Type 2 dual carriageway express road extending from Foynes to Rathkeale (with an intermediate roundabout junction at Ballyclogh) along with approximately 1.9km of single carriageway road between Ballyclogh and Askeaton;
- Approximately 17.5km of dual carriageway motorway, of which approximately 15.5km is new construction and/or widening of the existing road, from Rathkeale to Attyflin;
- A Service Area for Heavy Goods Vehicles approximately 5 ha in size near Foynes with access road and service roads, parking, facilities building and a new at-grade junction onto the Foynes port access road;
- LCCC submitted to the Board the Environmental Impact Assessment Report (formerly referred to as an Environmental Impact Statement) prepared in accordance with section 50 of the Roads Acts 1993 (as amended) in respect of the proposed road development. A Natura Impact Statement was also prepared and was submitted to the Board in respect of the proposed road development in accordance with Part XAB of the Planning and Development Acts 2000 – 2019. A decision from ABP is scheduled for late November 2021.

The selection of permitted or existing projects considered when assessing the potential for in-combination and cumulative impacts included the operation of the Wyeth Nutritionals Ireland Ltd. plant at Coolrahnee, Askeaton, licensed aquaculture activities and dredging and dumping activities in the Lower River Shannon and a sample of the projects considered as part of this assessment are summarised in Table 5.1. These projects were subject to their own assessments and where applicable, specific mitigation to minimise impacts upon the receiving environment. No potential for significant cumulative or in combination effects on the local biodiversity were identified in relation to the plans and projects considered.

Given the context of the existing site and considering the nature of the proposed works, it is concluded that it is unlikely that there will be any significant in-combination impacts upon any of the designated Natura 2000 sites or their conservation objectives.

6.13 Proposed Mitigation Measures & Environmental Controls

The EIAR prepared in relation to the proposed development presents detailed mitigation and monitoring commitments for the operational and post-closure phases. These are comprehensive measures that will effectively address potential risks to the receiving environment associated with proposed development.

The measures along with the existing environmental controls in place at the licensed facility will mitigate the potential risks associated with emissions to air, water and those associated with sources of potential disturbance to fauna.

6.14 Evaluation of Qualifying Interests and Special Conservation Interests

The environmental controls in place and mitigation committed to (and described herein and in the accompanying EIAR) minimise the potential for negative impacts upon the receiving environment.

For Barrigone SAC, it is clear that effective control of emissions to air will ensure that there is no potential for residual impacts upon this site's qualifying interests. There is no groundwater or surface water linkage with Barrigone SAC and the site is outside the range of likely impacts of emissions from noise, vibration or light. Table 6.16 summarises the conclusion that there is no potential for adverse impacts upon Barrigone SAC and its conservation objectives. The 2017 Article 17 reporting as per the Standard Data Form (www.npws.ie) highlights a good conservation status for the qualifying interests of Barrigone SAC with the threats and pressures to the site identified as those related to inadequate grazing and vegetation management.

Following consideration of the controls of the emissions (monitoring and mitigation) from the proposed development and overall licensed AAL facility it is concluded that there is no potential for residual adverse impacts upon Barrigone SAC and its conservation objectives. No potential for any significant in combination or cumulative impacts were identified in relation to Barrigone SAC. Therefore, Barrigone SAC will be excluded from further consideration in the NIS.

The qualifying interests of the Lower River Shannon SAC includes several habitats and species whose range is known not to occur in the vicinity of Aughinish Island. The Lower River Shannon is an extremely large and diverse conservation site which stretches along the Shannon valley from Killaloe in Co. Clare to Loop Head/ Kerry Head, a distance of approximately 120 km. The site encompasses the Shannon, Feale, Mulkear and Fergus estuaries as well as, the lower freshwater reaches of the River Shannon (between Killaloe and Limerick), the freshwater stretches of much of the Feale and Mulkear catchments and the marine area between Loop Head and Kerry Head. This site is of considerable ecological interest as it contains a high number of habitats and species listed on Annexes I and II of the E.U. Habitats Directive. Table 6.17 summarises the qualifying interests that occur, or are likely to occur, in the vicinity of Aughinish Island.

Table 6.16: Consideration of Impacts upon Barrigone SAC qualifying interests

Qualifying Feature	Potential for Significant Impacts	Rationale
Barrigone SAC		
Juniperus communis formations on heaths or calcareous grasslands [5130]	No	No evidence of declining conservation status arising from emissions from AAL. Currently Good conservation status, with NPWS Threats and Pressures reported as Species Composition Change (Succession), Abandonment of Pastoral systems (lack of grazing).
Semi-natural dry grasslands and scrubland facies on calcareous substrates (Festuco-Brometalia) (* important orchid sites) [6210]	No	No evidence of declining conservation status arising from emissions from AAL. Currently Good conservation status, with NPWS Threats and Pressures reported as Species Composition Change (Succession), Abandonment of Pastoral systems (lack of grazing).
Limestone pavements [8240]	No	No evidence of declining conservation status arising from emissions from AAL. Currently Good conservation status, with NPWS Threats and Pressures reported as Species Composition Change (Succession), Abandonment of Pastoral systems (lack of grazing).
Euphydryas aurinia (Marsh Fritillary) [1065]	No	Marsh Fritillary has not been recorded within Barrigone SAC in recent years. The association of the species with the SAC derives from a paper by Lavery (1993) which refers to a site called Foynes/Barrigone as being one of three major populations in Ireland. A survey in 2012 did not find the species in the SAC (Wilson *et al.*, 2013). As long as there are no significant impacts on the quality and extent of the qualifying habitats within the SAC there is no potential for adverse impacts on Marsh Fritillary arising from AAL.

Table 6.17: Summary of the known distribution of the qualifying interests of the Lower River Shannon SAC. The species and habitats that need further consideration are emphasized.

Qualifying Interest	**Potential for Impact**
Sandbanks which are slightly covered by sea water all the time [1110]	No - distribution near mouth of estuary
Estuaries [1130]	Yes - this habitat covers all of the tidal range of the site
Mudflats and sandflats not covered by seawater at low tide [1140]	Yes - there are areas of mudflat and sandflat around Aughinish Island
Coastal lagoons [1150]	Yes - Poulaweala & Quayfield Loughs (IL031) are not located on Aughinish Island, but on Morgan's North to the east.
Large shallow inlets and bays [1160]	No - distribution not proximate to AAL site
Reefs [1170]	No - distribution not proximate to AAL site
Perennial vegetation of stony banks [1220]	No - distribution not proximate to AAL site
Vegetated sea cliffs of the Atlantic and Baltic coasts [1230]	No - distribution not proximate to AAL site
Salicornia and other annuals colonising mud and sand [1310]	No - distribution not proximate to AAL site
Atlantic salt meadows (Glauco-Puccinellietalia maritimae) [1330]	Yes - areas of Atlantic Salt Meadow locally, e.g. on Robertstown Creek Estuary
Mediterranean salt meadows (Juncetalia maritimi) [1410]	Yes - small areas of Mediterranean Salt Meadow locally, e.g. on Robertstown Creek Estuary
Water courses of plain to montane levels with the Ranunculion fluitantis and Callitricho-Batrachion vegetation [3260]	No - distribution not proximate to AAL site
Molinia meadows on calcareous, peaty or clayey-silt-laden soils (Molinion caeruleae) [6410]	No - distribution not proximate to AAL site
Alluvial forests with Alnus glutinosa and Fraxinus excelsior (Alno-Padion, Alnion incanae, Salicion albae) [91E0]	No - distribution not proximate to AAL site
Margaritifera margaritifera (Freshwater Pearl Mussel) [1029]	No - distribution not proximate to AAL site
Petromyzon marinus (Sea Lamprey) [1095]	Yes - Marine and freshwater species which may occur locally
Lampetra planeri (Brook Lamprey) [1096]	No - exclusively Freshwater species
Lampetra fluviatilis (River Lamprey) [1099]	Yes - Marine and freshwater species which may occur locally
Salmo salar (Salmon) [1106]	Yes - Anadramous species - may occur locally

Qualifying Interest	Potential for Impact
Tursiops truncatus (Common Bottlenose Dolphin) [1349]	Yes - not common upstream of Glin but may occur locally
Lutra lutra (Otter) [1355]	Yes - occurs on Aughinish Island

Each of the qualifying interests of the Lower River Shannon identified as potentially occurring in areas proximate to the proposed development site are discussed below. The potential for adverse impacts is considered based on the technical review of emissions, the compliance with license limits, mitigation and monitoring commitments and the ecology of the qualifying interests themselves.

Estuaries [1130]

The area of estuary designated as a qualifying interest is 24,273 hectares. Estuaries are highly productive ecosystems supporting a diverse range of a species. The associated conservation objectives are to maintain habitat area and community distribution within the Lower River Shannon SAC. The latest Standard Data Form for Article 17 reporting to the EU, lists a good conservation status for this qualifying interest (www.npws.ie). There is no evidence that the existing activities at, or emissions from the licensed AAL facility are negatively impacting upon the conservation objectives for the estuarine habitat in the area. Similarly, there are no features of the proposed development that raise concerns that there will be any significant residual impacts (upon application of the mitigation measures) on this qualifying interest. There is no concern of adverse impacts upon the conservation objectives from the proposed development. No significant potential for cumulative or in combination effects with other plans or projects on this QI arising from the proposed development was identified.

Mudflats & Sandflats not covered by seawater at low tide [1140]

Mudflats and sandflats not covered by seawater at low tide are important habitats for infauna and the species that feed in these habitats. A total of over 8,800 hectares of this habitat is present within the Lower River Shannon SAC. There are extensive intertidal mudflats around Aughinish Island, particularly to the northwest of the licensed facility. The conservation objectives are to maintain the habitat area and community distribution of this habitat within the SAC. The latest Standard Data Form for Article 17 reporting to the EU, lists a good conservation status for this qualifying interest (www.npws.ie). There is no evidence that the activities at, or emissions from the licensed AAL facility are negatively impacting upon the conservation objectives for these two intertidal habitat types in the area. Similarly, there are no features of the proposed development that raise concerns that there will be any significant residual impacts (upon application of the mitigation measures) on this qualifying interest. There is no concern of adverse impacts upon the conservation objectives from the proposed development. No significant potential for cumulative or in combination effects with other plans or projects on this QI arising from the proposed development was identified.

Coastal Lagoons [1150]

There are a number of coastal lagoons identified within Lower River Shannon SAC. Two of these are linked sites Quayfield and Poulaweala Loughs, located at Morgan's North to the east of Aughinish Island (IL031). These loughs are 2.5ha in area and according to the Conservation Objectives Supporting Document, they have an unfavourable/inadequate conservation status. Poulaweala and Quayfield Loughs are both small and Poulaweala is closer to a freshwater lake than a lagoon. Quayfield Lough is largely dominated by lagoonal specialist species. It is also a karst lagoon, with connection to the estuary through underground fissures, which is an unusual lagoon type in Europe. Therefore, despite its small size, as a lagoon it is regarded as of moderate conservation value. The conservation status is unfavourable/inadequate due to natural eutrophication and the associated growth of emergent vegetation in Poulaweala Lough. The latest Standard Data Form for Article 17 reporting to the EU, lists a good conservation status for this qualifying interest (www.npws.ie). There is no evidence that the activities at, or emissions from the licensed AAL facility are negatively impacting upon the conservation objectives for the coastal lagoons in the area. Similarly, there are no features of the proposed development that raise concerns that there will be any significant residual impacts (upon application of the mitigation measures) on this qualifying interest. There is no concern of adverse impacts upon the conservation objectives from the proposed development. No significant potential for cumulative or in combination effects with other plans or projects were identified.

Atlantic salt meadows (Glauco-Puccinellietalia maritimae) [1330] & Mediterranean salt meadows (Juncetalia maritimi) [1410]

Within the Lower River Shannon SAC, 10 sub-sites that supported Atlantic salt meadow (ASM) were mapped (119.36ha) and additional areas of potential saltmarsh (376.07ha) were identified from an examination of aerial photographs, giving a total estimated area of 495.43ha. The Barrigone-Aughinish sub-site held c. 10.3ha of ASM and an additional 2.4ha of Mediterranean Salt Meadow (MSM) habitat type (Figure 6.11.1). The conservation prospects of ASM in the area are considered 'unfavourable-bad' due principally to the agricultural land use (including grazing) and maintenance of OPW flood embankments that was observed in this area (www.npws.ie). The extent, structure and function and future prospects of MSM in the area are considered favourable (www.npws.ie). There is no evidence that the activities at, or emissions from the licensed AAL facility are negatively impacting upon the conservation objectives for these two saltmarsh habitat types in the area. Similarly, there are no features of the proposed development that raise concerns that there will be any significant residual impacts (upon application of the mitigation measures) on this qualifying interest. There is no concern of adverse impacts upon the conservation objectives from the proposed development. No significant potential for cumulative or in combination effects with other plans or projects were identified.

Petromyzon marinus (Sea Lamprey) [1095] & *Lampetra fluviatilis* (River Lamprey) [1099]

The Sea Lamprey, *Petromyzon marinus* is a migratory species which matures in the sea and migrates to freshwater to spawn. They typically migrate through the estuary from the sea in April and May (Hardisty, 1969) and spawn in rivers in late May or June before returning to the sea. There are records of the species throughout the Fergus Estuary and eastern half of the Shannon Estuary (www.npws.ie).

The River Lamprey, *Lampetra fluviatilis*, is also migratory species which grows to maturity in estuaries and migrate to freshwater to spawn from October to December (Maitland, 2003). Spawning typically occurs in the rivers in March and April. When they reach 3-5 years of age, individuals migrate during darkness to the estuary in the late summer period.

Both species listed as having a Good conservation status in the most recently submitted Article 17 Standard Data Form (www.npws.ie). There is no evidence that the activities at, or emissions from the licensed AAL facility are negatively impacting upon the conservation objectives for these two Lamprey species in the area. Similarly, there are no features of the proposed development that raise concerns that there will be any significant residual impacts (upon application of the mitigation measures) on these qualifying interests. There is no concern of adverse impacts upon the conservation objectives from the proposed development. No significant potential for cumulative or in combination effects with other plans or projects on this QI arising from the proposed development was identified.

Salmo salar (Salmon) [1106]

Salmon are found widely in the Lower Shannon SAC. Smolts typically head out to sea between March and June and adults return to the river between March and August. Salmon have undergone a serious decline, over much of their range, in recent decades. In the Shannon catchment this is attributed to habitat degradation, hydroelectric impoundment (Ardnacrusha), water pollution and overfishing. Given the distribution and ecology of the species: which is listed as having an excellent conservation status in the most recently submitted Article 17 Standard Data Form for the Lower River Shannon SAC (www.npws.ie) there is no likelihood that the activities at, or emissions from the licensed AAL facility are negatively impacting upon the conservation objectives for Atlantic Salmon in the Lower River Shannon SAC. Similarly, there are no features of the proposed development that raise concerns that there will be any significant residual impacts (upon application of the mitigation measures) on this qualifying interest. There is no concern of adverse impacts upon the conservation objectives from the proposed development. No significant potential for cumulative or in combination effects with other plans or projects on this QI arising from the proposed development was identified.

Tursiops truncatus (Common Bottlenose Dolphin) [1349]

Rogan *et al*. (2018) found that Bottlenose Dolphins were infrequently present upstream of Glin, within the Lower Shannon Estuary SAC. The main areas used within the estuary by this cetacean, are the outer and mid estuary and these areas are considered core areas for the species (www.npws.ie). Analysis of Static Acoustic Monitoring (SAM) data, which was carried out at Aughinish from 2011-2014 found evidence of the local presence of the species for 29% of days monitored (as per MWP 2016). The conservation objectives are to maintain the favourable conservation condition of Bottlenose Dolphin in the Lower River Shannon SAC, according to three attributes: Access to Suitable Habitat, the habitat use of critical habitat areas and disturbance. The latest Standard Data Form for Article 17 reporting to the EU, lists a good conservation status for this qualifying interest (www.npws.ie). There is no evidence that the activities at, or emissions from the licensed AAL facility are negatively impacting upon the conservation objectives for Bottlenose Dolphins in the area. A note prepared in relation to the recent EPA IEL Review on the potential impact of the operation of a borrow pit at this site on marine mammals, in particular Bottlenose Dolphin, is provided in Appendix 6.4 in the EIAR. It concluded that there was no risk of likely significant effects on the species arising from noise and vibration impacts from the borrow pit site. Similarly, there are no features of the proposed development that raise concerns that there will be any significant residual impacts (upon application of the mitigation measures) on this qualifying interest. There is no concern of adverse impacts upon the conservation objectives from the proposed development. No significant potential for cumulative or in combination effects with other plans or projects on this QI arising from the proposed development was identified.

Lutra lutra (Otter) [1355]

Otters and their signs (spraint, prey remains, tracks etc.) are frequently recorded around the coast of Aughinish Island (pers obs.). However, no active holt has been recorded on the island in recent years. There is no detailed field survey data for the Lower River Shannon SAC, but Otters are believed to have an excellent conservation status according to the latest Article 17 Standard Data Form (www.npws.ie). Certainly, Otters appear to be doing well locally, with a feeding adult and young seen at Poulaweala Creek in 2020 (Seán Dundon pers comm.). Otters were frequently recorded as part of mammal surveys carried out as part of the EIAR (see Chapter 6 of the EIAR). The records were confined to the coastal part of Aughinish Is. with no records from the proposed development area. Otters are relatively tolerant of anthropogenic sources of disturbance (Sleeman & Moore, 2005), colonising and breeding in our cities. The availability of prey, breeding and resting places are important factors in determining the success of Otters and this is reflected in the conservation objectives for the species. There is no evidence that the activities at, or emissions from the licensed AAL facility are negatively impacting upon the conservation objectives for Otters in the area. There is no concern of adverse impacts upon the conservation objectives of Otters within the Lower River Shannon SAC arising from the licensed operation of the facility. Similarly, there are no features of the proposed development that raise concerns that there will be any significant residual impacts (upon application of the mitigation measures) on this qualifying interest. There is no concern of adverse impacts upon the conservation objectives from the proposed development. No significant potential for cumulative or in combination effects with other plans or projects on this QI arising from the proposed development was identified.

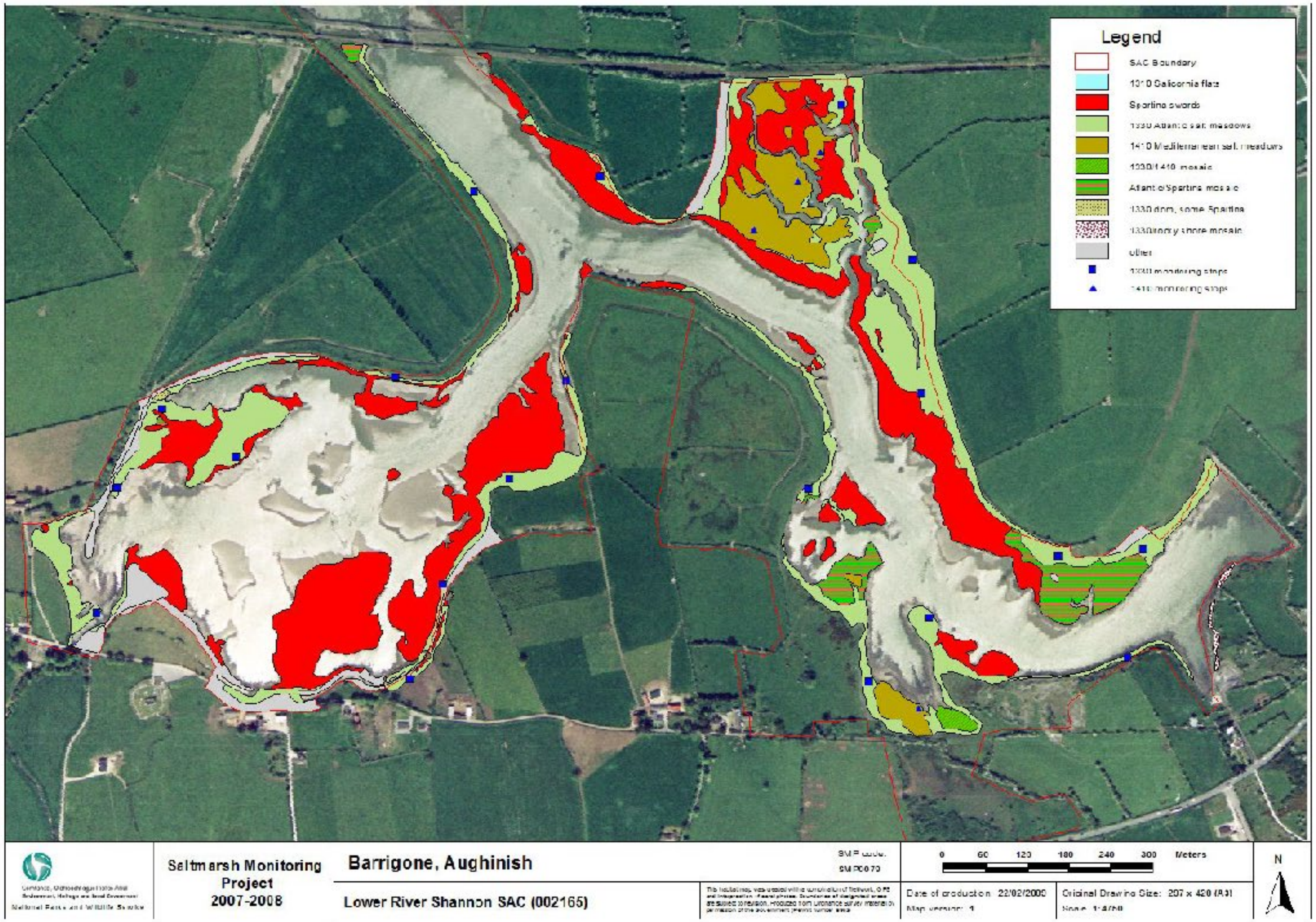

Figure 6.11.1 Distribution of Saltmarsh habitat, Robertstown River (www.npws.ie).

The River Shannon and River Fergus Estuaries form the largest estuarine complex in Ireland and located in the mid-west, the complex spans three counties, Clare (north shore), Limerick and Kerry (southern shoreline). The vast intertidal mudflats exposed at low tide together with a diversity of other wetland habitats results in the estuarine complex being especially important for birds. Over 32,000 hectares are designated as the River Shannon and River Fergus Estuaries SPA. The special conservation interests of the River Shannon & River Fergus Estuaries are mostly wintering waterbird species. Cormorants are listed as SCI species for both their wintering and breeding populations. There is a large breeding colony on the Shannon, close to the Limerick Tunnel on the N18. There is no breeding site for Cormorant proximate to the AAL facility.

The conservation objectives of this site are to maintain the favourable conservation condition of the bird species listed as Special Conservation Interests for this SPA:

Breeding and Wintering

- Cormorant *Phalacrocorax carbo*

Wintering

- Whooper Swan *Cygnus cygnus*
- Light-bellied Brent Goose *Branta bernicla hrota*
- Shelduck *Tadorna tadorna*
- Wigeon *Anas penelope*
- Teal *Anas crecca*
- Pintail *Anas acuta*
- Shoveler *Anas clypeata*
- Scaup *Aythya marila*
- Ringed Plover *Charadrius hiaticula*
- Golden Plover *Pluvialis apricaria*
- Grey Plover *Pluvialis squatarola*
- Lapwing *Vanellus vanellus*
- Knot *Calidris canutus*
- Dunlin *Calidris alpina*
- Black-tailed Godwit *Limosa limosa*
- Bar-tailed Godwit *Limosa lapponica*
- Curlew *Numenius arquata*
- Redshank *Tringa totanus*
- Greenshank *Tringa nebularia*
- Black-headed Gull *Chroicocephalus ridibundus*
- Wetlands

The SPA is one of the most important sites for a wide range of wintering bird species in Ireland. The overarching Conservation Objective for the River Shannon and River Fergus Estuaries SPA is to ensure that waterbird populations and their wetland habitats are maintained at, or restored to, favourable conservation condition. This includes, as an integral part, the need to avoid deterioration of habitats and significant disturbance; thereby ensuring the persistence of site integrity. Table 6.18 summarises the national and importance of the SPA for the SCI species. The SCI species site conservation status is summarised in Table 6.19. Detailed bird surveys of the SPA have also been undertaken under the Strategic Integrated Framework Plan (SIFP) for the Shannon Estuary 2013-2020, an inter-jurisdictional land and marine-based framework to guide the future development and management of the Estuary.

Two of the bird count subsites are adjacent to Aughinish Island (01437 Aughinish East, 01438 Aughinish Is.). These sites both rank within the top ten subsites within the SPA complex – with typical diversity of around 19 bird species recorded at each sub-site during the winter period. Table 6.19 highlights that Wigeon is a species with a highly unfavourable conservation condition within the SPA. The species has declined across its European range in recent decades, perhaps related to climate related changes in breeding habitat (e.g. Pöysä *et al*., 2017). The intertidal mudflats around Aughinish are amongst the most important feeding sites for this overwintering bird. There is no evidence of disturbance or displacement of intertidal feeding waterbirds anywhere in the vicinity of the operational AAL facility. In order, to minimise any disturbance or displacement risks associated with blasting operations for the proposed borrow pit, blasts will only take place in the period April to September.

The SPA, and indeed subsites close to the licensed facility, continue to be of significant importance to a range of wintering waterbirds. The quality of the habitats present is evidenced by the diversity and abundance of wintering waterbirds the area supports. With the application of the mitigation measures outlined earlier in Section 6.10 there is no risk of significant adverse impacts arising from the project. Similarly, no significant potential for cumulative or in combination effects with other plans or projects on the SCI species arising from the proposed development was identified.

The CSM (Appendix B) highlighted the potential pathways that could connect activities at the plant and the immediate marine and terrestrial environments. The sampling data from the study indicated that no pathways are being realised that may impact on sediment metal concentrations in the immediate marine environment. These data showed that metal sediment concentrations were around the typical background concentrations for the marine environment in Ireland and no pathway for heavy metals has realised an impact on the marine sediments, and hence marine benthic species in the immediate vicinity of the plant. So, in summary there is no evidence that heavy metals concentrations are elevated in the marine sediments, and consequently no evidence that toxic impacts would occur to the marine benthic biota. These data indicate that there is no pathway from the Aughinish activity producing a negative impact on the designated prey species of intertidal feeding birds and other higher fauna in the designated estuarine Natura 2000 sites. This provides considerable assurance in relation to the adequacy of the environmental controls and the likely success of the mitigation in relation to the proposed development.

Table 6.18: Designation Summary for River Shannon & River Fergus Estuaries SPA (after NPWS Conservation Objectives Supporting Document; www.npws.ie).

	Special Conservation Interests	Annex I species	Baseline Population[a]	Population status at baseline	National Importance Rank[1]	Regional Importance Rank[2]	County Importance Rank[3]
Selection Species	Whooper Swan	Yes	118	All-Ireland Importance	16	2	2
	Light-bellied Brent Goose		494	International Importance	13	1	3
	Shelduck		1,025	All-Ireland Importance	1	1	1
	Wigeon		3,761	All-Ireland Importance	1	1	2
	Teal		2,260	All-Ireland Importance	2	1	1
	Cormorant (non-breeding)		245	All-Ireland Importance	6	1	1
	Ringed Plover		223	All-Ireland Importance	8	2	4
	Golden Plover	Yes	5,664	All-Ireland Importance	9	1	2
	Grey Plover		558	All-Ireland Importance	3	1	1
	Lapwing		15,126	All-Ireland Importance	1	1	1
	Knot		2,015	All-Ireland Importance	4	1	1
	Dunlin		15,131	International Importance	1	1	1
	Black-tailed Godwit		2,035	International Importance	2	1	1
	Bar-tailed Godwit	Yes	460	All-Ireland Importance	11	1	2
	Curlew		2,396	All-Ireland Importance	1	1	1
	Greenshank		61	All-Ireland Importance	1	1	1
	Redshank		2,645	All-Ireland Importance	1	1	1
Additional Special Conservation Interests	Pintail		62	All-Ireland Importance	8	1	2
	Shoveler		107	All-Ireland Importance	10	2	2
	Scaup		102	All-Ireland Importance	6	1	3
	Cormorant (breeding)		93 pairs	All-Ireland Importance	12	-	-
	Black-headed Gull		2,681	All-Ireland Importance	6	1	1
Other conservation designations associated with the site[b]		SAC	RAMSAR SITE	IMPORTANT BIRD AREA (IBA)	WILDFOWL SANCTUARY	OTHER	
		Yes	Yes	Yes	Yes		

[a] Baseline data from I-WeBS with the exception of Whooper Swan (Robinson et al. 2004a) and Light-bellied Brent Goose (Robinson et al. 2004b).
[b] Note that other conservation designations associated with the River Shannon and River Fergus estuaries may relate to different areas and/or some of these areas may extend outside the SPA boundary.
[1] National importance rank - the number given relates to the importance of the site for the non-breeding population of a SCI species during the baseline period (1995/96 – 1999/00) relative to other wetland SPA sites in Ireland.
[2] Regional importance rank - the number given relates to the importance of the site for the non-breeding population of a SCI species during the baseline period (1995/96 – 1999/00) relative to other wetland SPA sites within the mid-western region (note that this site does extend into the south-western region but for the purpose of this assessment only the mid-western region is considered; the mid-western region includes Counties Clare, North Tipperary and Limerick).
[3] County importance rank - the number given relates to the importance of the site for the non-breeding population of a SCI species during the baseline period (1995/96 – 1999/00) relative to other wetland SPA sites within Counties Limerick, Clare and Kerry.

Table 6.19: The Conservation condition of the SCI species (after NPWS Conservation Objectives Supporting Document; www.npws.ie).

Special Conservation Interests (SCIs)	Method used for trend analysis[1]	Resulting % Change[1]	Level of caution applied[1]	Conservation Condition[2]	BoCCI Category[3]	Current all-Ireland Trend[4]	Current International Trend[5]
Whooper Swan*	1	Increase	Low	Favourable	Amber	+ 43.9	Increase
Light-bellied Brent Goose*	2	Decline >50%	Moderate	Undetermined	Amber	+ 58	Increase
Shelduck*	1	Decline >50%	Moderate	Undetermined	Amber	+ 4.46	Stable
Wigeon*	1	Decline >50%	Low	Highly unfavourable	Amber	- 20.1	Stable
Teal*	1	Decline >50%	Moderate	Undetermined	Amber	+ 11.3	Increase
Cormorant*	1	Decline 1.0 – 24.9%	Moderate	Undetermined	Amber	+ 31.5	Increase
Ringed Plover*	2	Decline >50%	High	Undetermined	Amber	+ 21.8	Decline
Golden Plover*	1	Decline >50%	Moderate	Undetermined	Red	- 2.2	Decline
Grey Plover*	2	Decline >50%	Moderate	Undetermined	Amber	- 33.1	Decline
Lapwing*	1	Decline >50%	Moderate	Undetermined	Red	- 40.1	Decline
Knot*	2	Decline >50%	Moderate	Undetermined	Red	- 2.91	Decline
Dunlin*	2	Decline >50%	High	Undetermined	Amber	- 46.5	Stable (*alpina*)
Black-tailed Godwit*	2	Decline >50%	High	Undetermined	Amber	+ 70.2	Increase
Bar-tailed Godwit*	n/c	-	-	Undetermined	Amber	+ 1.5	Stable
Curlew*	1	Decline >50%	Moderate	Undetermined	Red	- 25.7	Decline
Greenshank*	2	Decline -25.0% to -49.9%	High	Undetermined	Amber	+ 79.7	Stable
Redshank*	1	Decline >50%	Moderate	Undetermined	Red	+ 22.7	Stable/Decline
Pintail	n/c	-	-	Undetermined	Red	+ 26.8	Stable
Shoveler	n/c	-	-	Undetermined	Red	+ 21.3	Stable
Scaup	n/c	-	-	Undetermined	Amber	+ 88.7	Stable
Black-headed Gull	1	Decline -25.0% to -49.9%	Moderate	Undetermined	Red	n/c	n/c

*Denotes site selection species; [1] See methods in Section 4.2.1; [2] See methods in Section 4.2.2. n/c = not calculated.
[3] See Lynas *et al.* (2007) for detailed listing criteria; [4] all-Ireland trend calculated for period 1994/95 to 2008/09; [5] international trend after Wetland International (2006).

6.15 NIS Summary and Conclusion

6.15.1 Integrity of the Designated Sites

From the *Assessment of Plans and Projects Significantly Affecting Natura 2000 Sites: Methodological guidance on the provisions of Article 6(3) and (4) of the Habitats Directive 92/43/EEC* (EC, 2002), the meaning of integrity is described as follows:

'*The integrity of a site involves its ecological functions. The decision as to whether it is adversely affected should focus on and be limited to the site's conservation objectives'*.

The concept of the 'integrity of the site' is also explained in the EU publication Managing Natura 2000 sites: The provisions of Article 6 of the 'Habitats' Directive 92/43/EEC (EC, 2000), as follows:

'It is clear from the context and from the purpose of the directive that the 'integrity of the site' relates to the site's conservation objectives. For example, it is possible that a plan or project will adversely affect the integrity of a site only in a visual sense or only habitat types or species other than those listed in Annex I or Annex II. In such cases, the effects do not amount to an adverse effect for purposes of Article 6(3), provided that the coherence of the network is not affected. On the other hand, the expression 'integrity of the site' shows that focus is here on the specific site. Thus, it is not allowed to destroy a site or part of it on the basis that the conservation status of the habitat types and species it hosts will anyway remain favourable within the European territory of the Member State.

6.16 Integrity of the Natura 2000 Sites within the Project Zone of Influence

Potential for any significant adverse effects will be resolved through the mitigation and monitoring commitments outlined herein and the ongoing compliance with national and international best practice, IEL conditions and limits.

From the information gathered and the predictions made about the changes that are likely to result from the proposed development, an Integrity of Site Checklist for Natura 2000 sites considered in this Natura Impact Statement is presented in Table 6.20 below.

Table 7.1: Integrity of Site Checklist for Natura 2000 Sites within the Project Zone of Influence.

Conservation Objectives		
Does the project have the potential to:	**Yes or No**	**Comment**
Cause delays in progress towards achieving the conservation objectives of the site?	No	There will be no direct impacts to the QIs/SCIs of Natura 2000 sites located within the project ZoI and considered in this NIS. The overall AAL facility is subject to IEL limits and auditing. Ongoing compliance with the strict limits on emissions will ensure no significant indirect impacts on the Natura 2000 sites within the ZoI. The monitoring and mitigation commitments described herein provide confidence in this conclusion.
Interrupt progress towards achieving the conservation objectives of the site?	No	There will be no direct impacts to the QIs/SCIs of Natura 2000 sites located within the project ZoI and considered in this NIS. The AAL facility is subject to IEL limits and auditing. Ongoing compliance with the strict limits on emissions will ensure no significant indirect impacts on the Natura 2000 sites within the ZoI. The monitoring and mitigation commitments described herein provide confidence in this conclusion.
Disrupt those factors that help to maintain the favourable conditions of the site?	No	
Interfere with the balance, distribution and density of key species that are the indicators of the favourable condition of the site?	No	
Other Objectives: Does the project have the potential to:	**Yes or No**	**Comment**
Cause changes to the vital defining aspects (e.g. nutrient balance) that determine how the site functions as a habitat or ecosystem?	No	There will be no direct impacts to the QIs/SCIs of Natura 2000 sites located within the project ZoI and considered in this NIS. The overall AAL facility is subject to IEL limits and auditing. Ongoing compliance with the strict limits on emissions will ensure no significant indirect impacts on the Natura 2000 sites within the ZoI. The monitoring and mitigation commitments described herein provide confidence in this conclusion.
Change the dynamics of the relationships (between, for example, soil and water or plants and animals) that define the	No	

<table>
<tr><th colspan="3">Conservation Objectives</th></tr>
<tr><th>Does the project have the potential to:</th><th>Yes or No</th><th>Comment</th></tr>
<tr><td>structure and/or function of the site?</td><td></td><td></td></tr>
<tr><td>Interfere with predicted or expected natural changes to the site (such as water dynamics or chemical composition)?</td><td>No</td><td>There will be no direct impacts to the QIs/SCIs of Natura 2000 sites located within the project ZoI and considered in this NIS. The overall AAL facility is subject to IEL limits and auditing. Ongoing compliance with the strict limits on emissions will ensure no significant indirect impacts on the Natura 2000 sites within the ZoI. The monitoring and mitigation commitments described herein provide confidence in this conclusion.</td></tr>
<tr><td>Reduce the area of key habitats?</td><td>No</td><td rowspan="4">There will be no direct impacts to the QIs/SCIs of Natura 2000 sites located within the project ZoI and considered in this NIS. The overall AAL facility is subject to IEL limits and auditing. Ongoing compliance with the strict limits on emissions will ensure no significant indirect impacts on the Natura 2000 sites within the ZoI. The monitoring and mitigation commitments described herein provide confidence in this conclusion.</td></tr>
<tr><td>Reduce the population of key species?</td><td>No</td></tr>
<tr><td>Change the balance between key species?</td><td>No</td></tr>
<tr><td>Reduce diversity of the site?</td><td>No</td></tr>
<tr><td>Result in disturbance that could affect population size or density or the balance between key species?</td><td>No</td><td>There will be no direct impacts to the QIs/SCIs of Natura 2000 sites located within the project ZoI and considered in this NIS. The overall AAL facility is subject to IEL limits and auditing. Ongoing compliance with the strict limits on emissions will ensure no significant indirect impacts on the Natura 2000 sites within the ZoI. The monitoring and mitigation commitments described herein provide confidence in this conclusion.</td></tr>
<tr><td>Result in fragmentation?</td><td>No</td><td>There will be no fragmentation of Natura 2000 sites within the project ZoI. There will be no direct impacts to the QIs/SCIs of Natura 2000 sites located within the project ZoI and considered in this NIS. The AAL facility is subject</td></tr>
</table>

Conservation Objectives		
Does the project have the potential to:	Yes or No	Comment
		to IEL limits and auditing. Ongoing compliance with the strict limits on emissions will ensure no significant indirect impacts on the Natura 2000 sites within the ZoI. The monitoring and mitigation commitments described herein provide confidence in this conclusion.
Result in loss or reduction of key features (e.g. tree cover, tidal exposure, annual flooding, etc.)?	No	The proposed development will not result in the loss or reduction of key features of Natura 2000 Sites. There will be no direct impacts to the QIs/SCIs of Natura 2000 sites located within the project ZoI and considered in this NIS. The overall AAL facility is subject to IEL limits and auditing. Ongoing compliance with the strict limits on emissions will ensure no significant indirect impacts on the Natura 2000 sites within the ZoI. The monitoring and mitigation commitments described herein provide confidence in this conclusion.

6.17 Conclusion

This NIS was prepared to accompany the EIAR and planning application for the proposed development at Aughinish Alumina, Co. Limerick.

A preliminary Screening for AA found that it could not be excluded, on the basis of objective scientific information that the proposed works, individually or in combination with other plans or projects, would have a significant effect on three Natura 2000 sites: Lower River Shannon SAC, River Shannon & River Fergus Estuaries SPA and Barrigone SAC. Therefore, a NIS (presented in **Section 6** of this report) was required to ascertain whether the proposed works would have an adverse effect on the integrity of the Natura 2000 sites.

The particular mitigation commitments associated with the proposed development as presented in the accompanying EIAR are also considered.

It has been objectively concluded that the proposed project will not adversely affect the integrity of any Natura 2000 site, and there is no reasonable scientific doubt in relation to this conclusion.

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Appendix A

NIS prepared in relation to the EPA licence review (Ecology Ireland 2020)

Natura Impact Statement

IEL Application P0035-07

in support of the Appropriate Assessment Process

Prepared for: Aughinish Alumina Ltd.

Prepared by:

Ecology Ireland Ltd.

April 2020

Natura Impact Statement

IEL Application P0035-07

in support of the Appropriate Assessment Process

Document Rev. No.	Details	Contributors	Date
0	For Issue to Client	DE/GF	11/04/2020
1	Final Version	DE/GF	14/04/2020

Contents

Appendices

Executive Summary

The EPA has requested the applicant, Aughinish Alumina Ltd. (AAL) to prepare and submit a Natura Impact Statement (NIS) in relation to the Industrial Emissions Licence Review application (P0035-07) currently under consideration. Their determination was based on the nature and scale of the activities, the proximity of the installation to a number of European sites and the potential effects such activities may have on European Sites and their qualifying interests. The EPA have requested that the NIS consider all emissions from the facility.

The EPA undertakes Appropriate Assessment (AA) in accordance with Regulation 42(1) of the European Communities (Birds and Natural Habitats) Regulations 2011. On behalf of the applicant, Ecology Ireland Wildlife Consultants Ltd. assisted by JBA Consulting Ltd. has prepared a NIS in support of the Appropriate Assessment process. In 2014, EPA carried out a screening for AA in relation to the previous IEL licence review (P0035-06) and concluded that on *'the basis of objective scientific information, that the activity, individually or in combination with other plans or projects'* will not have a *'significant effect on a European site'*. Thus, in 2014 the Agency determined that an AA was not required in relation to the activities at the licensed facility. Accordingly, the EPA stated that *'this installation is not likely to have significant effects on any European site, in view of the information submitted by the Applicant and due to the overall reduction of emissions to air from the installation'*. However, it is recognised that in the interim, there have been a number of legal judgements which have resulted in the re-interpretation of aspects of the AA process. This NIS examines in detail the sources of emission from the plant, the compliance with licensed limits, the associated monitoring, management and mitigation that are in place and committed to as part of the licence review application.

While the historical context of the site and operations is discussed, the 'project' under consideration is the continued operation of the facility, including the proposed operation of the borrow pit, under licence. As part of its application, AAL submitted an application for a derogation from the emission levels associated with best available techniques (BAT-AELs) for TOC and COD. Emissions are discussed broadly and in detail but concentrating on the scientific data from 2014 onwards – the period to which the existing license pertains. Particular attention is given to highlight any recent relevant changes in the operation of the facility that could potentially result in a different likelihood of significant effects, or adverse impacts, upon the designated sites within the zone of influence. It is noted that the only proposed change in emissions from the site is noise and vibration related to the blasting activities associated with the proposed Borrow Pit.

The NIS considers the emissions to air, water, noise and vibration and light associated with the operation of the facility and the potential impacts of these emissions on the Natura 2000 sites and their conservation objectives. In addition, the potential for cumulative and in-combination impacts are considered.

It has been objectively concluded that the proposed project will not adversely affect the integrity of any Natura 2000 site, and there is no reasonable scientific doubt in relation to this conclusion.

1 Introduction

Ecology Ireland Wildlife Consultants Ltd. were commissioned on behalf of Aughinish Alumina Ltd. (AAL), to prepare a Natura Impact Statement (NIS) in relation to their application for a review of their Industrial Emissions Licence (IEL). The facility infrastructure includes a deepwater terminal on the Shannon estuary that facilitates the delivery of raw materials to the plant as well as product from the plant.

The Environmental Protection Agency (EPA) has required the applicant, AAL, to prepare and submit a NIS in relation to the IEL Review (P0035-07) currently under consideration. Their determination was based on the nature and scale of the activities, the proximity of the installation to a number of European sites and the potential effects such activities may have on European Sites and their qualifying interests. The EPA have requested that the NIS consider all emissions from the facility.

We present herein the historical context and ongoing facility operations. Emissions are discussed broadly and in detail, concentrating on the scientific data from 2014 onwards – the period to which the existing license pertains. Particular attention is given to highlight any recent relevant changes in the operation of the facility that could potentially result in a different likelihood of significant effects, or adverse impacts, upon the designated sites within the zone of influence. It is noted that the only proposed change in emission from the site is noise and vibration related to the blasting activities associated with the proposed borrow pit.

1.1 Statement of Authority

This NIS was prepared by Dr. Gavin Fennessy of Ecology Ireland Ltd., with the support of environmental scientist Mr. Declan Egan of JBA Consulting Ltd. Dr. Fennessy (Director & Principal Ecologist, Ecology Ireland Ltd.) is an ecologist with over 20 years of experience in professional consultancy. He has carried out and reported on ecological surveys (including Screening for Appropriate Assessment) at the facility since 2012. He is a full member of the Chartered Institute of Ecology and Environmental Management (CIEEM) and he sits on the Policy Group of the Irish Section of the CIEEM. Gavin is a Guest Lecturer on Ecological Impact Assessment (EcIA) and Appropriate Assessment (AA) at University College Cork (UCC).

Mr. Egan, Technical Director with JBA Consulting Ltd., is a highly experienced Environmental Scientist with almost 30 years of experience in professional consultancy. Declan has particular experience in project management, environmental impact assessment (EIA) for large infrastructure and energy projects, strategic environmental assessment (SEA), planning applications, waste management for local authorities and the private sector, contaminated land assessment and remediation, pre-acquisition environmental assessments and environmental auditing. Declan is a Chartered Scientist, Chartered Environmentalist and a Chartered Water and Environmental Manager. He is a chartered member of the Chartered Institute of Water and Environmental Management (CIWEM) and a chartered member of the Chartered Institute of Waste (CIWM). Declan is a Member of the Technical Committee of CIWEM for environmental management. He is a Guest Lecturer at UCC on undergraduate and adult education environmental diploma and degree courses.

Curricula Vitae for the contributing Authors are provided in Appendix 1.

2 Background to Appropriate Assessment Process

A screening assessment is part of an appropriate assessment process that consists of up to four stages, where each stage follows on from the preceding one. In Stage 1, a screening process is undertaken to identify whether significant impacts on a Natura 2000 site are likely to arise from the project or plan in question. If significant impacts are likely to occur, then the process moves on to Stage 2 where an appropriate assessment (AA) considers potential mitigation measures for adverse impacts. If it is considered that mitigation measures will not be able to adequately minimise potential adverse impact on a Natura 2000 site then an assessment of alternative solutions is considered in Stage 3. This may then be followed by Stage 4 of the process in the event that adverse impacts remain and the proposed activity or development is deemed to be of Imperative Reasons of Overriding Public Interest (IROPI), allowing an assessment of compensatory measures to be considered. The outcome of a Stage 2 and higher assessment is presented in a report known as a Natura Impact Statement (NIS).

The first part of the assessment is a screening process to identify whether significant[1] effects on a Natura 2000 site are likely to arise from the project or plan in question, in view of best scientific knowledge and in light of the conservation objectives of any relevant European sites, when considered as an individual project or in combination with other plans and projects. If significant effects are likely to occur or if it is unclear whether significant effects are likely to occur, then the process moves onto the next phase where the project is subject to an appropriate assessment (AA) to determine whether the plan or project would directly affect the integrity of a European site. At this stage, potential mitigation measures for adverse impacts identified in Screening are considered. Typically, a NIS is prepared by consultants on behalf of the promoter/developer of a plan or project and this is part of the information used by the competent authority in carrying out an Appropriate Assessment of the proposed plan or project. If the competent authority is satisfied that the plan or project will not adversely affect the integrity of the site concerned, it may approve the project. If it is considered that mitigation measures will not be able to satisfactorily reduce potential adverse impact on a Natura 2000 site then an assessment of alternative solutions is considered in third phase of the assessment process. If adverse impacts remain and the proposed activity or development is deemed to be of Imperative Reasons of Overriding Public Interest (IROPI), the final assessment step permits consideration of permission for development with consideration of compensatory measures.

While a screening assessment appraisal, or NIS, may be provided by the advocate of the plan or project in question, the AA itself is undertaken by the competent authority (*e.g.* the Industrial Emissions licensing, or planning authority and An Bord Pleanála). So, in this case, the Appropriate Assessment for the project described herein, is undertaken by the Environmental Protection Agency; informed by this Screening for AA and NIS and any other relevant information provided to the statutory body.

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[1] A European Court of Justice ruling in 2013 (Case C‑258/11) has stated the following regarding significant effect: "Where a plan or project not directly connected with or necessary to the management of a site is likely to undermine the site's conservation objectives, it must be considered likely to have a significant effect on that site."

2.1 Methodology

This report presents in brief the outcome of a Screening for Appropriate Assessment. The subsequent Natura Impact Statement (NIS) is prepared to discuss the operation and emissions from the AAL facility, in the context of the monitoring and mitigation in place and the potential impacts on the Natura 2000 sites (and their conservation objectives) with the Zone of Influence (ZoI).

The EPA has requested the applicant, AAL, to prepare and submit a NIS in relation to the IEL Review (P0035-07) currently under consideration. Their determination was based on the nature and scale of the activities, the proximity of the installation to a number of European sites and the potential effects such activities may have on European Sites and their qualifying interests. The EPA have requested that the NIS consider all emissions from the facility.

As already described, the EPA undertakes Appropriate Assessment in accordance with Regulation 42(1) of the European Communities (Birds and Natural Habitats) Regulations 2011. On behalf of the applicant, Ecology Ireland Wildlife Consultants Ltd. assisted by JBA Consulting Ltd. has prepared a NIS in support of the Appropriate Assessment process.

In 2014, the EPA carried out a screening for AA in relation to the previous IEL licence review (P0035-06) and concluded that on *'the basis of objective scientific information, that the activity, individually or in combination with other plans or projects'* will not have a *'significant effect on a European site'*. Thus, in 2014 the Agency determined that an AA was not required in relation to the activities at the licensed facility. Accordingly, the EPA stated that *'this installation is not likely to have significant effects on any European site, in view of the information submitted by the Applicant and due to the overall reduction of emissions to air from the installation'*. However, it is recognised that in the interim, there have been a number of legal judgements which have resulted in the re-interpretation of aspects of the AA process. This NIS examines in detail the sources of emission from the plant, the compliance with licensed limits, the associated monitoring, management and mitigation that are in place and committed to as part of the licence review application.

While the historical context of the site and operations is discussed, the 'project' under consideration is the continued operation of the facility under licence, including the activities associated with the operation of the proposed borrow pit. As part of its application, AAL submitted an application for a derogation from the emission levels associated with best available techniques (BAT-AELs) for TOC and COD. Emissions are discussed broadly and in detail but concentrating on the scientific data from 2014 onwards – the period to which the existing license pertains. Particular attention is given to highlight any recent relevant changes in the operation of the facility that could potentially result in a different likelihood of significant effects, or adverse impacts, upon the designated sites within the zone of influence. It is noted that the only potential change in emission from the site is noise and vibration due to the blasting activities associated with the proposed borrow pit.

The NIS considers the emissions to air, water, noise and vibration and light associated with the operation of the facility and the potential impacts of these emissions on the Natura 2000 sites and their conservation objectives. In addition, the potential for cumulative and in-combination impacts are considered.

The AA process considers whether the proposed development, in view of best scientific knowledge and in light of the conservation objectives of any relevant European sites, when considered as an individual project or in combination with other plans and projects, will have an adverse effect on the integrity of any European Site. It is important to emphasise that a screening assessment does not have to ascertain the existence of a significant effect or impact on a Natura 2000 site as such; it only has to establish whether a significant effect or impact is possible or may occur (as per judgement by Ms. Justice Finlay Geoghegan; see guidelines below). At the NIS stage, all mitigation measures necessary to avoid, reduce or offset negative effects are considered.

The conservation objectives of Natura 2000 sites have been compiled by the National Parks & Wildlife Service (NPWS) in relation to the habitats and species (*i.e.* qualifying interests) for which the sites are selected. These conservation objectives are referred to when carrying out appropriate assessments for plans and projects that might impact on these sites.

2.1.1 Guidance

Documents associated with the proposed development and relevant ecology databases were consulted as part of this assessment. Dr Gavin Fennessy (who produced this Screening for AA and NIS) carried out baseline field studies of the site in order to inform the EcIA and Screening Assessment. The following guidelines and legal judgements were used in the completion of this assessment;

- Assessment of Plans and Projects Significantly Affecting Natura 2000 Sites – European Commission Methodical Guidance on the provisions of Article 6(3) and 6(4) of the 'Habitats' Directive 92/43/EEC (European Commission 2001)
- Appropriate Assessment of Plans and Projects in Ireland – Guidance for Planning Authorities (DoEHLG 2009)
- Integrated Biodiversity Impact Assessment – Streamlining AA, SEA and EIA Processes: Practitioner's Manual (EPA 2013)
- European Court of Justice Ruling 11th April 2013 Case C‑258/11 Peter Sweetman and Others v An Bord Pleanála - Criteria to be applied when assessing the likelihood that N6 Galway City Outer Bypass road scheme will adversely affect the integrity of Lough Corrib SAC
- High Court Ruling 25th July 2014 by Ms. Justice Finlay Geoghegan; Neutral Citation [2014] IEHC 400; High Court Record No. 2013 802 JR; Kelly -v- An Bord Pleanála – Judicial review of grant of planning by An Bord Pleanála for two wind farm phases in County Roscommon
- High Court Ruling 24th November 2014 by Mr. Justice Hedigan; Neutral Citation [2014] IEHC 557; High Court Record No. 2014 320 JR; Rossmore Properties Limited & Anor -v- An Bord Pleanála
- High Court Ruling 25th February 2016 by Mr. Justice Barton. Neutral Citation [2016] IEHC 134; High Court Record No. 2013 450 JR; Balz & Anor -v- An Bord Pleanála.
- European Court of Justice ruling 12th April 2018 in respect of Case C-323/17 (People Over Wind & Sweetman) - it is not appropriate for the purposes of Appropriate Assessment (AA), at the screening stage, to take account of the measures intended to avoid or reduce the harmful effects of a plan or project.

- European Court of Justice ruling 19th April 2018 in respect of Case C-164/17, Compensation vs Mitigation, Grace & Sweetman Vs ABP.
- High Court Ruling 8th February 2019 by Justice Barniville in respect of Kelly -v- An Bord Pleanála & anor. The Court concludes "*as a matter of fact and law, that SUDS are not mitigation measures which a competent authority is precluded from considering at the stage 1 screening stage*". The Irish High Court ([2019] IEHC 84)
- Heather Hill Management Company CLG v An Bord Pleanála (Burkeway Homes Limited as Notice Party) [2019] IEHC 450. Mr. Justice Garrett Simons granted an order of certiorari setting aside the decision of the Board to grant permission for a residential development of 197 units at Bearna Co. Galway, on the basis that it was a material contravention of the Galway County Development Plan (the CDP), it failed to carry out a 'justification test' as required and failed to carry out proper Appropriate Assessment screening.
- European Commission. *Managing Natura 2000 Sites: The provisions of Article 6 of the 'Habitats' Directive 92/43/EEC*, (21-11-18) C (2018) 7261 Final. Commission Notice Brussels.

2.1.2 Information Consulted for this Report

This assessment has been informed by the following sources of data:

- Desk based surveys and site surveys of the proposed development site;
    - Ecology Ireland has carried out field and desktop assessments in relation to several projects at AAL in recent years including the installation of a deep cone thickener, a second bauxite unloader, proposed development and operation of a borrow pit, repairs to the seawall etc.
- Previous reports, including Annual Environmental Reports to the EPA, Screening Reports, EIAR, NIS, monitoring and modelling reports etc.;
- Details of the monitoring of emissions from the operation of the facility;
- Details of the management and mitigation of the licensed facility;
- Information contained in the IEL licence review application as provided by the client;
- Environmental Reports (including Screening for AA, NIS' etc.) in relation to other projects and plans in the wider area;
- Office of Public Works (OPW) National Flood Hazard Mapping website (www.floodmaps.ie)
- Environmental Protection Agency (EPA) geoportal mapping tool (https://gis.epa.ie/EPAMaps/);
- National Parks and Wildlife Service protected site and species information and data (https://www.npws.ie/protected-sites);
- National Biodiversity Data Centre (www.biodiversityireland.ie); and
- Ordnance Survey of Ireland mapping and aerial photography (www.osi.ie).

3 Stage 1: Screening for Appropriate Assessment

3.1 Brief History of the Site

The AAL facility was constructed on Aughinish Island between 1978 and 1983. Aughinish Island is located c. 6km northwest of Askeaton and c. 30km west of Limerick City Centre. The facility has been in operation, subject to planning and environmental regulation since that time.

The EPA was founded in 1993, following the passing into law of the Environmental Protection Agency Act of 1992. In 2014, it merged with the Radiological Protection Institute of Ireland, which was itself founded in 1992. The present-day EPA continues the activities of both groups.

Environmental Protection Agency (Industrial Emissions) (Licensing) Regulations 2013, S.I. 137 of 2013 provides for various procedural matters in relation to the integrated licensing by the EPA of Industrial Emissions Directive activities specified in the First Schedule to the EPA Act 1992 (as amended), and transposes Directive 2010/75/EU of the European Parliament and of the Council of 24 November 2010 on industrial emissions (IPPC; Recast). The Regulations provide for applications for licences, reviews of licences or revised licences, consideration by the EPA of objections, including the holding of oral hearings, public participation procedures associated with the industrial emissions licensing system administered by the EPA and the contents of the register of licences.

The facility has operated under EPA license since 1998 and AAL was most recently granted a revised IEL (IEL P0035-06) in July 2014. The Licence grants AAL permission to carry out the following activities in accordance with the requirements and conditions set out in the Licence:

- The production of inorganic chemicals
- The combustion of fuels installations with a total rated thermal input of 50MW or more; and
- The recovery or disposal of waste in a facility.

The AAL plant extracts alumina from bauxite using the Bayer Process, a chemical method that has been developed and refined over the past century and is used by over 40 alumina extraction plants worldwide. Approximately 70% of the bauxite processed by AAL comes from Guinea in West Africa with the remainder coming from Brazil. The finished product, alumina (aluminium oxide), is exported for further processing through smelting to aluminium metal. The production output of the plant in 2018 was 1,818,065 tonnes of alumina. In terms of air emissions reduction, one of the most significant continuous improvement projects in recent years was completed in 2014 with the installation and commissioning of two natural gas boilers, which replace the three older Heavy Fuel Oil (HFO) boilers as primary sources of steam.

3.2 Site Location

AAL is the largest alumina refinery in Europe and is operated by UC RUSAL. The AAL facility is located on Aughinish Island on the south side of the Shannon Estuary. Aughinish Island which is located between Foynes and Askeaton has an area of approximately 400 ha. The River Shannon is located to the north of the site, Poulaweala Creek to the east and south east and Robertstown River to the west and south west of the plant. This site location is shown in Figure 3.1.

3.3 Management Structure

Since March 2008, AAL has been wholly owned by United Company RUSAL, which is the largest integrated aluminium company worldwide.

AAL has a structured management approach to the operation of the business in terms of product quality, process control, environment, safety, training and analytical capability. Training of personnel is a key function in the successful operation of the plant.

The IEL requires the company to establish and maintain an Environmental Management System (EMS) and the conditions of the licence outline the form that the EMS should take at AAL. In order to demonstrate its commitment to environmental protection, AAL has gained certification of its EMS to the updated international standard ISO 14001:2015 in December 2017. AAL has been certified to the ISO14001 EMS since 2000.

AAL has an Energy Management System which is accredited to ISO 50001:2011 since 2016, and an International Safety Rating System (ISRS) Advanced Level 8 Safety Management System.

Safety, environmental and quality management systems are audited on an ongoing basis by a combination of internal audit teams and external certification surveillance audits by our certification body Det Norske Veritas (DNV UK). The various management systems operated by AAL are summarised in Table 3.1.

Table 3.1: Management Systems at AAL

Year	System	Accreditation Body
1993	International Safety Rating System (ISRS)	DNV
1995	ISO 9001 Quality Management System	DNV
2000	ISO 14001Environmental Management System	DNV
2016	ISO 50001 Energy Management System	Certification Europe
2017	ISO 14001:2015	DNV
2017	ISO 9001:2015	DNV

Figure 3.1 Site location Map

3.4 Classes of Activity Applicable to the site

The following classes of activity are carried out at the site:

- Class 5.13: The production of inorganic chemicals, such as: (e) non-metals, metal oxides or other inorganic compounds such as calcium carbide, silicon, silicon carbide.
- Class 2.1: Combustion of fuels in installations with a total rated thermal input of 50 MW or more
- Class 11.1: The recovery or disposal of waste in a facility, within the meaning of the Act of 1996, which facility is connected or associated with another activity specified in this Schedule in respect of which a licence or revised licence under Part IV is in force or in respect of which a licence under the said Part is or will be required.

AAL extracts alumina from bauxite ore using the Bayer process, which comprises four principal stages:

1. Digestion of the bauxite ore, during which the ore is ground and mixed with a sodium hydroxide solution to form a slurry, with the digestion taking place at high pressure and temperature
2. Clarification of the liquor stream from the digestion process, with the stream containing the alumina in solution
3. Precipitation of alumina hydrate from the clarified stream
4. Calcination (removal of chemically bound water) of the alumina trihydrate to produce the finished alumina product.

The bauxite ore is unloaded, and processed alumina loaded at the deep-water marine terminal in the Shannon Estuary. The inner berth is used for the loading of alumina, as well as the unloading of acid and caustic deliveries, while the outer berth is used for unloading the incoming bauxite ore.

Waste products from the Bayer process include bauxite residue and salt cake. The bauxite residue and the salt cake are deposited in the Bauxite Residue Disposal Area (BRDA; Figure 3.2). Bauxite residue is classified as non-hazardous. Salt cake, which is hazardous, is deposited in a specially designed engineered cell within the BRDA.

Figure 3.2 Location of the BRDA

3.5 History of Licencing and Statutory Permissions/Permits for the site

Table 3.2 below summarises the licensing history of the site from the EPA.

Table 3.2: Licensing History of the site from the EPA.

Licence Reference	Date of Grant	Description
P0035-01	May 1998	Original IPC licence.
P0035-02	January 2004	To accommodate the installation of two natural gas fired turbines with a capacity of approximately 75 MW electrical output each.
P0035-03	October 2004	Application withdrawn
P0035-04	April 2008	To extend the bauxite residue disposal area, to accommodate the participation of the site in the national emissions reduction plan, and to update the licence to incorporate amendments to the EPA Act.
P0035-05	October 2012	To reflect the requirements of the European Communities Environmental Objectives (Surface Water) Regulations, the European Communities Environmental Objectives (Ground Water) Regulations, and the Waste Management (Management of Waste from the Extractive Industries) Regulations.
P0035-06	July 2014	To accommodate the installation and operation of two natural gas-fired boilers.

3.6 Best Available Technology (BAT)

The facility operates according to Best Available Technology/Techniques (BAT) principles. The BAT concept was first used in the 1992 OSPAR Convention for the protection of the marine environment of the North-East Atlantic for all types of industrial installations. The 1996 Integrated Pollution Prevention and Control Directive, 96/61/EC, applied the concept of Best Available Techniques (BAT) to the integrated control of pollution to air, water and soil. The 2010 Industrial Emissions Directive (IED) (2010/75/EU) adapted the BAT concept.

Commission Implementing Decision EU 2016/1032 on the establishment of best available techniques (BAT) conclusions under Directive 2010/75/EU for the non-ferrous industries covers the production of aluminium oxide from bauxite prior to the production of primary aluminium, where this is an integral part of the production of the metal.

BAT for a given industrial sector are described in BAT reference documents called BREF's (Best Available Technology Reference documents), as defined by Article 3(11) of the IED. The BREFs are derived from information exchanges between Member States, members of the industry concerned, non-governmental organisations and the European Commission. The BREF contains the BAT Conclusions which are required to be implemented by the Member States when setting permit conditions for large industrial installations. In line with Article 15(2) of the IED, emission limit values (ELVs) and the equivalent parameters and technical measures granted in permits must be based on BAT, without prescribing the use of any specific technique or specific technology.

Best Available Technology (BAT) is defined in Section 5(1) of the Environmental Protection Agency Act 1992, as amended (Article 2(11) of the IPPC Directive as *'the most efficient and advanced stage in the development of an activity and its methods of operation, which indicates the practical suitability of particular techniques for providing, in principle, the basis for emission limit values, and in the case of an industrial emission directive activity other additional licence conditions, designed to prevent or eliminate or, where this is not practicable, generally to reduce an emission and its impact on the environment as a whole'*, where:

'Best' in relation to techniques, means the most effective in achieving a high general level of protection of the environment as a whole.

'Available techniques' means those techniques developed on a scale which allows implementation in the relevant schedules activities under the 1992 EPA Act, under economically and technical viable conditions, to be used by the activity

'Techniques' include both the technology used and the way in which the installation is designed, built, managed, maintained, operated and decommissioned.

The Directive sets out that competent authorities responsible for issuing permits are required to take account of the general principles set out in Article 3 of the Directive when determining the conditions of the permit. These conditions must include emission limit values. The Directive states that in all circumstances, the conditions of the permit must include provisions on the minimisation of long-distance or transboundary pollution and must insure a high level of protection for the environment.

Those BAT guidance documents, Commission Implementing Decisions and BREF documents which are applicable to AAL are summarised in Table 3.3.

Table 3.3: BAT Guidance, BREF documents, Commission Implementing Decisions applicable to AAL.

Document Type	Year of Issue	Title
Commission Implementing Decision (CID)	2017	CID for Large Combustion Plant
Commission Implementing Decision (CID)	2016	CID for Common Wastewater and Waste Gas Treatment in the Chemical Sector
Commission Implementing Decision (CID)	2017	CID for the Non Ferrous Metals Industry
Reference Document on Best Available Techniques (BREF)	2009	BREF for Energy Efficiency
Reference Document on Best Available Techniques (BREF)	2006	BREF on Emissions from Storage
Reference Document on Best Available Techniques (BREF)	2001	BREF on Industrial Cooling Systems
Reference Document on Best Available Techniques (BREF)	2006	BREF on Economics and Cross Media Effects
Reference Document on Best Available Techniques (BREF)	2003	BREF on General Principles of Monitoring
Reference Document on Best Available Techniques (BREF)	2018	BREF on Management of Waste from Extractive Industries
Reference Document on Best Available Techniques (BREF)	2007	BREF on Large Volume Inorganic Chemicals, Solids and Other Industry
BAT Guidance Note	2008	General Inorganic and Alumina Sector

3.7 Conservation Sites & Natura 2000 Network

Designated nature conservation sites within the wider hinterland of the proposed development site were identified through a desktop review. European sites, Special Areas of Conservation (SACs) and Special Protection Areas (SPAs) have been designated under the EU Habitats Directive (92/43/EEC) and the EU Birds Directive (2009/147/EC) respectively. SACs and SPAs are collectively known as Natura 2000 sites and are legally protected by Irish law. The Qualifying Interests (QIs) of SACs include high value conservation habitats and species in the EU and listed in the Habitats Directive.

The Special Conservation Interests (SCIs) of the SPAs are birds of European conservation importance and associated wetland habitats of particular importance for these species.

Nature Reserves and Refuges for Fauna are protected under the Irish Wildlife Acts (1976 - 2010). Designated conservation sites include national sites, Natural Heritage Areas (NHAs) and Proposed Natural Heritage Areas (pNHAs). While NHAs are legally protected by the Irish Wildlife Acts (1976 - 2010), pNHAs are not.

The AAL red-line licence boundary (see Figure 3.1) includes areas of natural/semi-natural grassland and wetland habitat some of which include parts of two designated Natura 2000 sites: the Lower River Shannon SAC (Site Code 002165) and the River Shannon and River Fergus Estuaries SPA (004077; Figure 3.3a).

Additionally, there are a further three SAC's (Barrigone, Site Code 000432, Askeaton Fen Complex, Site Code 002279 & Curraghchase Woods, Site Code 000174) and one more SPA (Stack's to Mullaghareirk Mts., West Limerick Hills & Mt. Eagle, Site Code 004161) within 15km of the proposed development site (Figure 3.3a). The Inner Shannon Estuary – South Shore is also designated as a pNHA (Site Code 000435). Barrigone SAC is also designated as a pNHA (Site Code 000432). In all there are 3 NHAs and a further 19 pNHAs located within 15km of the licensed facilities site boundary (Figure 3.3b)

Minimum distances to the Natura 2000 sites and the nationally designated (pNHA and NHA) sites in the wider area are summarised in Table 3.4.

Table 3.4: Minimum distance of the AAL licensed facility from designated conservation sites.

Site Name	Site Code	Minimum Distance (km)
Natura 2000 sites		
Lower River Shannon SAC	002165	0.0
River Shannon & River Fergus Estuaries SPA	004077	0.0
Barrigone SAC	000432	0.5
Stack's to Mullaghareirk Mts., West Limerick Hills & Mt. Eagle Bog SPA	004161	6.6
Askeaton Fen Complex SAC	002279	7.9
Curraghchase Woods SAC	000174	11.0
Knockanira House SAC	002318	15.1
Nationally Designated Sites		
Inner Shannon Estuary - S. Shore pNHA	000435	0.0
Barrigone pNHA	000432	0.5
Fergus Estuary & Inner Shannon, N. Shore pNHA	002048	0.7
Sturamus Is. pNHA	001436	1.2
Cahiracon Wood pNHA	001000	4.0
Gortglass Lough pNHA	001015	7.0
Paradise House pNHA	000062	7.1
Cloonsnaghta Lough pNHA	001004	7.7
Ballymorrisheen Marsh pNHA	001425	8.1
Gorteenamrock pNHA	001433	9.3
Fort Fergus pNHA	000035	9.3
Cappagh Fen pNHA	001429	9.4
Ballinvirick Marsh pNHA	001427	10.1
Moyreen Bog NHA	002361	10.8
Ardagh Church pNHA	000430	10.8
Curraghchase Woods pNHA	000174	11.0
Derrygeeha Lough pNHA	000050	11.6
Clonderalaw Bay pNHA	000027	11.8
Carrigkerry Bogs NHA	002399	12.1
Glenastar Wood pNHA	001431	12.7
Dromore & Bleach Loughs pNHA	001030	14.3
Lough Acrow Bogs NHA	002421	14.4

Details on the key features (qualifying and special conservation interests) of all of the conservation sites within 15km of the proposed development are outlined in Table 3.5. Full details of the site synopses and conservation objectives of each of these sites as published by NPWS are available online (www.npws.ie). The designated Natura 2000 sites proximate to the licensed AAL facility are shown in Figure 3.3c.

The conservation objectives of the Lower River Shannon SAC relate to a wide range of largely aquatic habitats and species with a number of different Annex I habitats and associated Annex II species. These include:

- Otter *(Lutra lutra)*
- Freshwater Pearl Mussel (*Margaritifera margaritifera*),
- Salmon (*Salmo salar*),
- Sea Lamprey (*Petromyzon marinus)*
- Brook Lamprey *(Lampetra planeri)*
- River Lamprey (*Lampetra fluviatilis*)
- Estuaries
- Sandbanks which are slightly covered by sea water all the time
- Coastal lagoons
- Mudflats and sandflats not covered by seawater all the time

The conservation objectives of the River Shannon and River Fergus Estuaries SPA relate chiefly to wintering bird species;

- Whooper Swan (*Cygnus cygnus*)
- Light-bellied Brent Goose (*Branta bernicla hrota*)
- Shelduck (*Tadorna tadorna*)
- Wigeon (*Anas penelope*)
- Teal (*Anas crecca*)
- Pintail (*Anas acuta*)
- Shoveler (*Anas clypeata*)
- Scaup (*Aythya marila*)
- Ringed Plover (*Charadrius hiaticula*)
- Golden Plover (*Pluvialis apricaria*)
- Grey Plover (*Pluvialis squatarola*)
- Lapwing (*Vanellus vanellus*)
- Knot (*Calidris canutus*)
- Dunlin (*Calidris alpina*)
- Black-tailed Godwit (*Limosa limosa*)
- Bar-tailed Godwit (*Limosa lapponica*)
- Curlew (*Numenius arquata*)
- Redshank (*Tringa totanus*)
- Greenshank (*Tringa nebularia*)
- Black-headed Gull (*Chroicocephalus ridibundus*)

Cormorant (*Phalacrocorax carbo*) is also listed as a conservation objective but for both wintering and breeding numbers.

Barrigone SAC is an area of species rich, calcareous grassland. It has been designated as an SAC for the following conservation objectives:

- Marsh Fritillary (*Euphydryas aurinia*)
- *Juniperus communis* formations on heaths or calcareous grasslands
- Semi-natural dry grasslands and scrubland facies on calcareous substrates (Festuco Brometalia; important orchid sites)
- Limestone pavements

Askeaton Fen Complex SAC comprises of a number of small fen areas that have been designated for the following habitats:

- Calcareous fens with *Cladium mariscus* and species of the Caricion davallianae
- Alkaline fens

The Stack's to Mullaghareirk Mountains, West Limerick Hills and Mt Eagle SPA is a large upland site designated for the conservation of a single species:

- Hen Harrier (*Circus cyaneus*)

Curraghchase Woods SAC, located 11km from the licensed facility boundary, is designated for the conservation of two priority Annex I habitats and one Annex II species:

- Alluvial forests with Alder, *Alnus glutinosa* and Ash, *Fraxinus excelsior* (Alno-Padion, Alnion incanae, Salicion albae)
- Yew, *Taxus baccata*, woods of the British Isles
- Lesser Horseshoe Bat, *Rhinolophus hipposideros*

The overall aim of the Habitats Directive is to maintain or restore the favourable conservation status of habitats and species of community interest. These habitats and species are listed in the Habitats and Birds Directives and SACs and SPAs are designated to afford protection to the most vulnerable of them. According to the Habitats and Birds Directive the 'Favourable' conservation status of a habitat is achieved when:

- its natural range, and area it covers within that range, are stable or increasing, and
- the specific structure and functions which are necessary for its long-term maintenance exist and are likely to continue to exist for the foreseeable future, and
- the conservation status of its typical species is favourable.

The 'Favourable' conservation status of a species is achieved when:

- population dynamics data on the species concerned indicate that it is maintaining itself on a long-term basis as a viable component of its natural habitats, and

- the natural range of the species is neither being reduced nor is likely to be reduced for the foreseeable future, and
- there is, and will probably continue to be, a sufficiently large habitat to maintain its populations on a long-term basis.

The above objectives form the basis of conservation objectives developed for Natura 2000 sites by NPWS and are published online as 'Generic Conservation Objectives' for Natura 2000 sites in Ireland.

Site specific conservation objectives are also available for some Natura 2000 sites which detail contextual conservation targets for the qualifying criteria of the individual Natura 2000 sites. These site-specific conservation objectives are usually accompanied by backing documentation in the form of 'Conservation objectives supporting documents' or 'Conservation Plans'.

Table 3.5: Summary of Designated Sites located in the 15km Hinterland of the licensed facility boundary.

Site Name & Code	Summary Details	Minimum Distance (km)
Inner Shannon Estuary – South pNHA (000435)	This pNHA is part of the River Shannon Estuary and is comprised of extensive intertidal mudflats, fringing reedbeds, swamps, polders, salt marsh and wet marsh habitats; habitats which support many thousands of wading birds and duck. Greenland White-fronted and Greylag Geese frequent the southern shores of the estuary during the winter months. The estuary is also a stronghold for two rare plant species; triangular rush *Scirpus triqueter* and summer snowflake *Leucojuin pestirum*. The Inner Shannon Estuary – South overlaps with section of the Lower Shannon River SAC and The River Shannon and Fergus Estuaries SPA Natura 200 sites (see below for conservation objectives).	0 km
Lower River Shannon SAC (002165)	The conservation objectives of this site are to maintain the favourable conservation condition of the Annex I habitats and fauna listed as Special Conservation Interests for this SAC: • Sandbanks • Estuaries • Tidal Mudflats and Sandflats • Coastal Lagoons* • Large Shallow Inlets and Bays • Reefs • Perennial Vegetation of Stony Banks • Vegetated Sea Cliffs • *Salicornia* Mud • Atlantic Salt Meadows • Mediterranean Salt Meadows • Floating River Vegetation • *Molinia* Meadows • Alluvial Forests* • Freshwater Pearl Mussel *Margaritifera margaritifera* • Sea Lamprey *Petromyzon marinus* • Brook Lamprey *Lampetra planeri* • River Lamprey *Lampetra fluviatilis* • Atlantic Salmon *Salmo salar* • Bottle-nosed Dolphin *Tursiops truncatus* • Otter *Lutra lutra*	0 km

Site Name & Code	Summary Details	Minimum Distance (km)
River Shannon and River Fergus Estuaries SPA (004077)	The conservation objectives of this site are to maintain the favourable conservation condition of the bird species listed as Special Conservation Interests for this SPA: Breeding and Wintering • Cormorant *Phalacrocorax carbo* Wintering • Whooper Swan *Cygnus cygnus* • Light-bellied Brent Goose *Branta bernicla hrota* • Shelduck *Tadorna tadorna* • Wigeon *Anas penelope* • Teal *Anas crecca* • Pintail *Anas acuta* • Shoveler *Anas clypeata* • Scaup *Aythya marila* • Ringed Plover *Charadrius hiaticula* • Golden Plover *Pluvialis apricaria* • Grey Plover *Pluvialis squatarola* • Lapwing *Vanellus vanellus* • Knot *Calidris canutus* • Dunlin *Calidris alpina* • Black-tailed Godwit *Limosa limosa* • Bar-tailed Godwit *Limosa lapponica* • Curlew *Numenius arquata* • Redshank *Tringa totanus* • Greenshank *Tringa nebularia* • Black-headed Gull *Chroicocephalus ridibundus* • Wetlands	0 km
Barrigone SAC & pNHA (000432)	The conservation objectives of this site are to maintain the favourable conservation condition of the habitats and fauna listed as Special Conservation Interests for this SAC: • *Juniperus communis* formations on heaths or calcareous grasslands • Semi-natural dry grasslands and scrubland facies on calcareous substrates (Festuco Brometalia) (* important orchid sites)* • Limestone pavements* • Marsh Fritillary *Euphydryas aurinia*	0.5 km
Fergus Estuary & Inner Shannon, N. Shore pNHA (002048)	Fergus Estuary & Inner Shannon, N. Shore pNHA overlaps with The River Shannon and River Fergus Estuary and as such is of conservation significance for bird species and coastal/wetland habitats.	0.7 km

Site Name & Code	Summary Details	Minimum Distance (km)
Sturamus Island pNHA (001436)	Sturamus Island is situated within the estuary of the River Shannon estuary and overlaps with The River Shannon and River Fergus Estuary SPA and Lower River Shannon SAC. The site is a pNHA, of conservation interest as it is the only site in Co. Limerick that supports a Common Tern breeding colony.	1.2 km
Cahiracon Wood pNHA (001000)	Cahiracon Wood is an 8 ha Oak (*Quercus* species) woodland situated on the northern shore of the Shannon Estuary approx. 5km south of Killadysert in Co. Clare. The ground flora is a rich, comprised of species such as Ling Heather *Calluna vulgaris*, Wood Sage, *Teucrium scarodania* and Broad Buckler Fern, *Dryopteris dilata*. On the woodland margins the Great Horsetail, *Equisetum telmeteia* and Pendulous Sedge, *Carex pendula* are frequent. This site is of international scientific interest for Annex I Oak woodlands and breeding Peregrine Falcon, a species listed in Annex I of the EU Birds Directive.	4.0 km
Stacks to Mullaghareirk Mts., West Limerick Hills & Mt. Eagle SPA (004161)	The conservation objectives of this site are to maintain the favourable conservation condition of the bird species listed as Special Conservation Interests for this SPA: • Hen Harrier (*Circus cyaneus*)	6.6 km
Gortglass Lough pNHA (001015)	This conservation site is primarily designated as a pNHA for Arctic Char, *Salvelinus alpinas*, however it also contains an excellent example of acid lake and associated habitats.	7.0 km
Paradise House pNHA (000062)	A lesser horseshoe roost *Rhinolophus hipposideros* is present in the outbuildings associated with the ruins of Paradise House, outside Ballynacally, Co. Clare. A small number of bats (<50) use the outbuildings during the summer months, but it is not known if the site is a nursery site or a roost of male and non-breeding females. Surrounding mature woodland and the Shannon Estuary provide ideal foraging habitat for Lesser Horseshoe Bat.	7.1 km
Cloonsnaghta Lough pNHA (001004)	This pNHA site is of conservation importance primarily for supporting Arctic Char *Salvelinus alpinas* an Irish Red Data Book species. However, the lakes themselves are Annex I Habitat types. Blanket bog (small, individually, not more than 2ha) is present around each lake shore as is semi-natural wet grassland and scrub habitat.	7.7 km
Askeaton Fen Complex SAC (002279)	The conservation objectives of this site are to maintain the favourable conservation condition of the Annex I habitats listed as Special Conservation Interests for this SAC • Calcareous fens with *Cladium mariscus* and species of the Caricion davallianae* • Alkaline fens	7.9 km

Site Name & Code	Summary Details	Minimum Distance (km)
Ballymorrisheen Marsh pNHA (001425)	Ballymorrisheen Fen is located approx. 3km south east of Askeaton, Co. Limerick. This is a small to medium sized wetland site characterised by three small waterbodies with fen vegetation/habitat along the shores, dominated by Saw Sedge *Cladium mariscus* and Common Reed *Phragmites australis*. The conservation importance of this site is in its value as a wildlife refuge in an intensively managed landscape. Because of its Loughs and pools, which vary considerably in size and depth this area contains a wider range of habitat types.	8.1 km
Gorteenanrock pNHA (001433)	This small wetland site is located c. 5km to the south east of Askeaton. Fen habitat present is dominated by Saw Sedge to the north and Common Reed further south. This is considered of conservation significance as a wildlife refuge in an otherwise managed landscape. The fen habitat is of botanical interest and the site may support Otter, *Lutra lutra*.	9.3 km
Fort Fergus pNHA (000035)	A Lesser horseshoe bat (*Rhinolophus hipposideros*) roost is located in four small lofts in the farm buildings of Fort Fergus House, Ballynacally, Co. Clare. Small numbers of bats (<50) use the lofts during the summer, it is not known if the site is a nursery site or a roost of male and non-breeding females.	9.3 km
Cappagh Fen pNHA (001429)	This is a fen lake site with almost total dominance by reed beds. Three beds make up the site and only of them has open water. The extensive reed beds with common reed (*Phragmites australis*) Bulrush (*Typha latifolia*) and SHW Sedge (*Cladium mariseus*) provide useful habitats although they may not be especially species rich.	9.4 km
Ballinvirick Marsh pNHA (001427)	This is a small low-lying wetland site which has a good diversity of grassland species typically associated with calcareous grassland is found to the northwest of the site. Here early purple orchid (*Orchis mascula*) along with the caroline thistle (*Carlina vulgaris*) and Mountain everlasting (*Antennania dioica*) are found.	10.1 km
Ardagh Church, Newcastlewest pNHA (000430)	The loft of the derelict Ardagh Church (or Las Church) supports a nursery colony of Natterer's bats *Myotis nattereri*, with up to 100 bats counted here in 1993, making it one of the biggest in the country at the time.	10.8 km
Moyreen Bog NHA (002361)	Moyreen Bog NHA is an area of lowland blanket bog located 8km south east of Glin, 7km south of Loghill and 10km south west of Foynes in the townland of Moyreen in north Co. Limerick. Moyreen Bog NHA is of considerable conservation significance as it is a good example of a lowland blanket bog. It supports a wide range of lowland blanket bog species including a number of species of regional and international importance.	10.8 km

Site Name & Code	Summary Details	Minimum Distance (km)
Curraghchase Wood SAC & pNHA (000174)	The conservation objectives of this site are to maintain the favourable conservation condition of the habitats and fauna listed as Special Conservation Interests for this SAC: • Alluvial forests with *Alnus glutinosa* and *Fraxinus excelsior* (Alno-Padion, Alnion incanae, Salicion albae)* • *Taxus baccata* woods of the British Isles* • Lesser Horseshoe Bat *Rhinolophus hipposideros*	11.0 km
Derrygeeha Lough pNHA (000050)	Derrygeeha Lough is a small freshwater lake approximately 2km inland from Clonderalaw Bay, with lake, wet woodland and cutover bog habitats. Its main interest is as one of only two known stations for the caddis fly *Cyrnus insolutus* in Ireland.	11.6 km
Clonderalaw Bay pNHA (000027)	Clonderalaw bay is comprised of a narrow estuary associated with Crompaun and Cloon Rivers within the River Shannon estuary. This pHNA site overlaps with The River Shannon and River Fergus Estuaries SPA and as such is of conservation importance as part of the SPA complex.	11.8 km
Carrigkerry Bogs NHA (002399)	Carrigkerry Bogs NHA consists of two upland blanket bogs that are both located within 2.5km of the village of Carrigkerry, Co. Limerick. These bogs are very interesting examples of an unusual peatland habitat, one that is intermediate in type between a raised bog and an upland blanket bog. Carrigkerry Bogs NHA is a site of high conservation value consisting of upland blanket bog with characteristic features and notable species of flora and fauna.	12.1 km
Dromore & Bleach Loughs pNHA (001030)	The open water lakes make up the main habitat in this site. The lake margins are fringed with Common Reed (*Phragmites australis*) and Great fen-sedge (*Cladium mariscus*). The lakes are fed by drains running through the fen which separates the lakes. While some peripheral drains have been cleared others have been allowed fill with vegetation. Near the reed beds these drains support a diverse flora including White Waterlily (*Nymphera alba*), Bogbean (*Menyanthes trifoliata*) and Common Spike-rush (*Eleocharis palustris*). The second major habitat in this site is an area of fen between the lakes.	14.3 km
Glenastar Wood pNHA (001431)	This is a small woodland site comprised primarily of Oak (*Quercus petraea*), and Birch (*Betula pubescens*). This site is of flora and fauna interest and provides an important wildlife refuge in the region.	14.4 km

* denotes a priority habitat

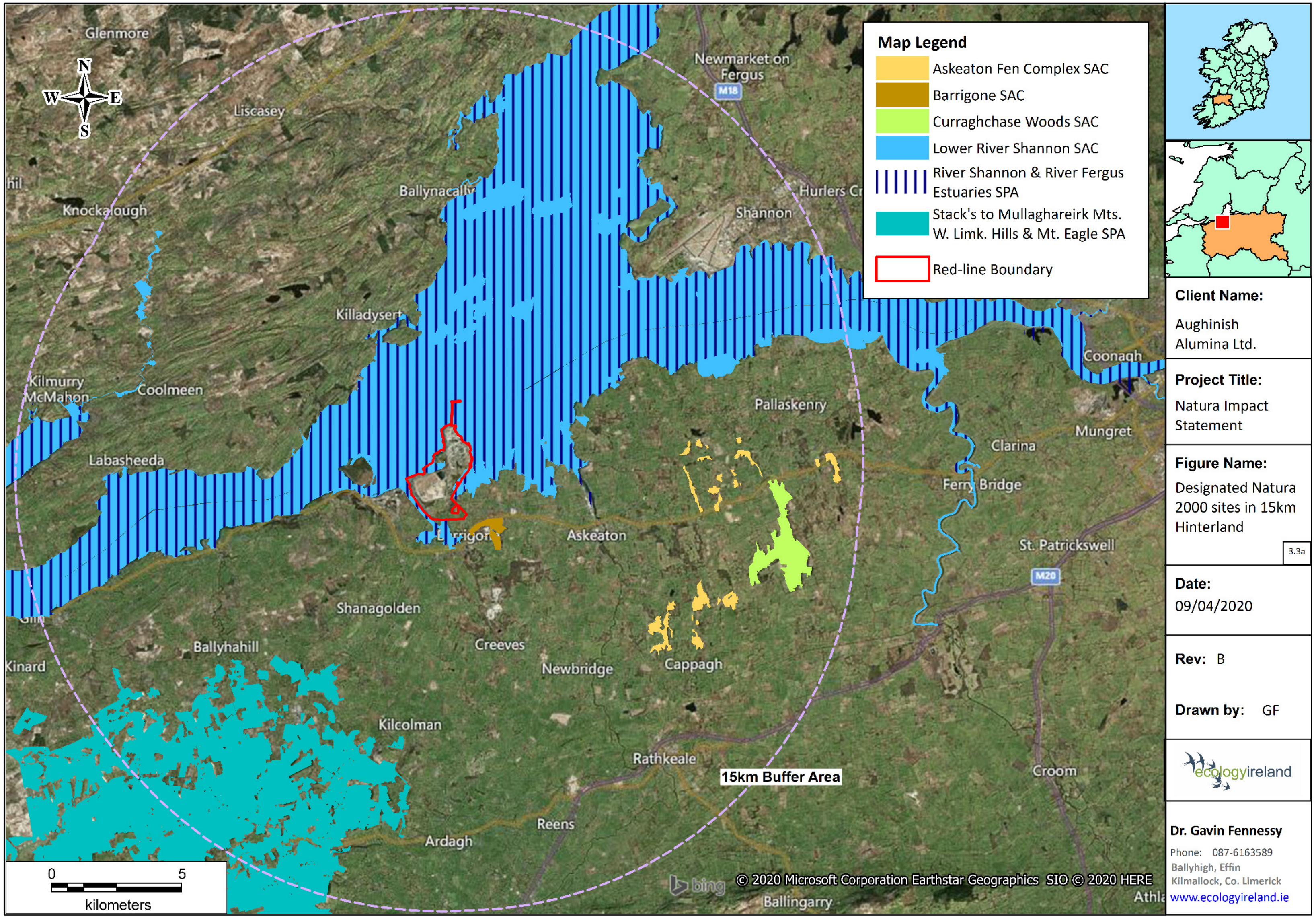


Figure 3.3a Designated Natura 2000 sites in 15km hinterland

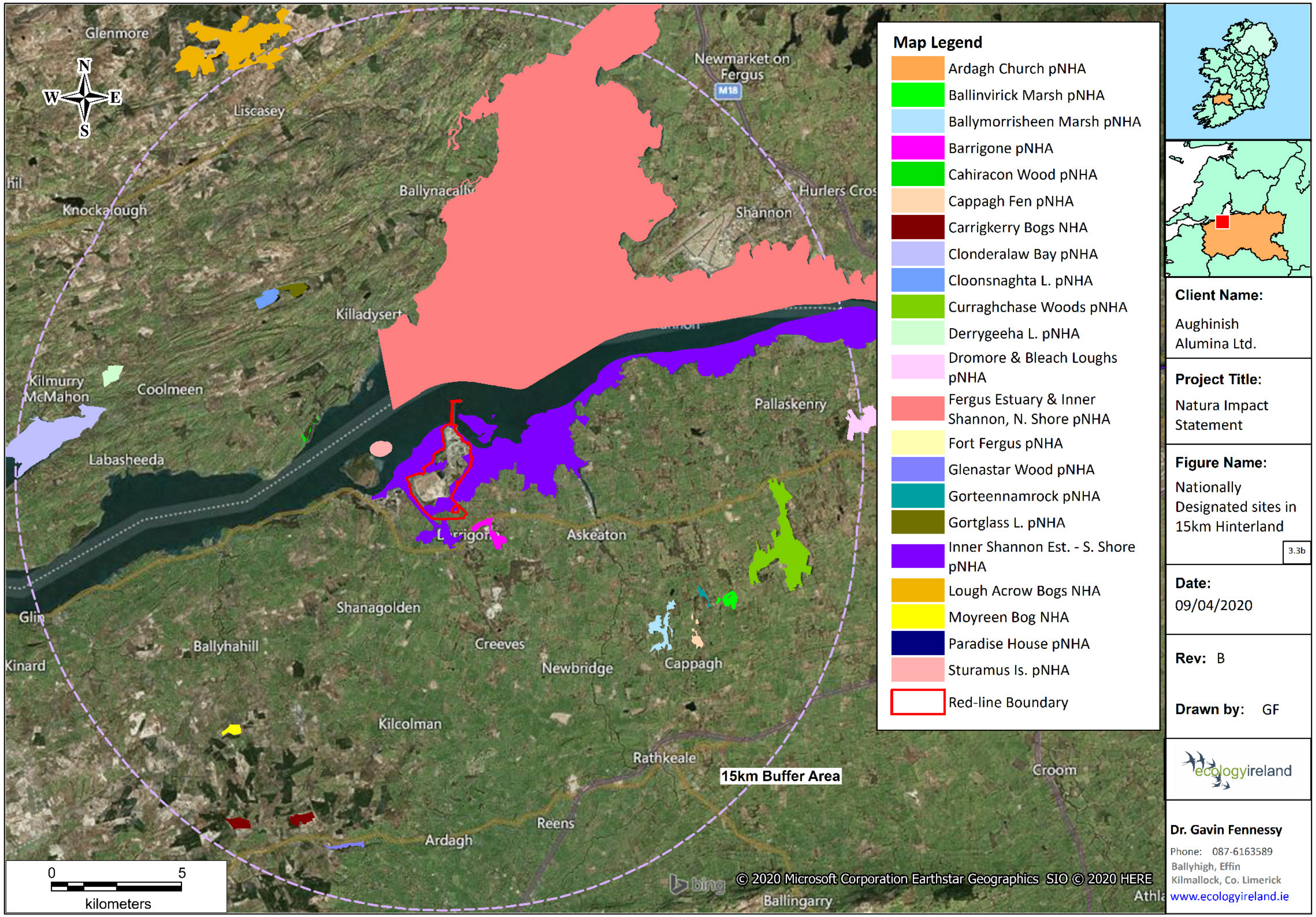


Figure 3.3b Nationally designated sites in 15km hinterland

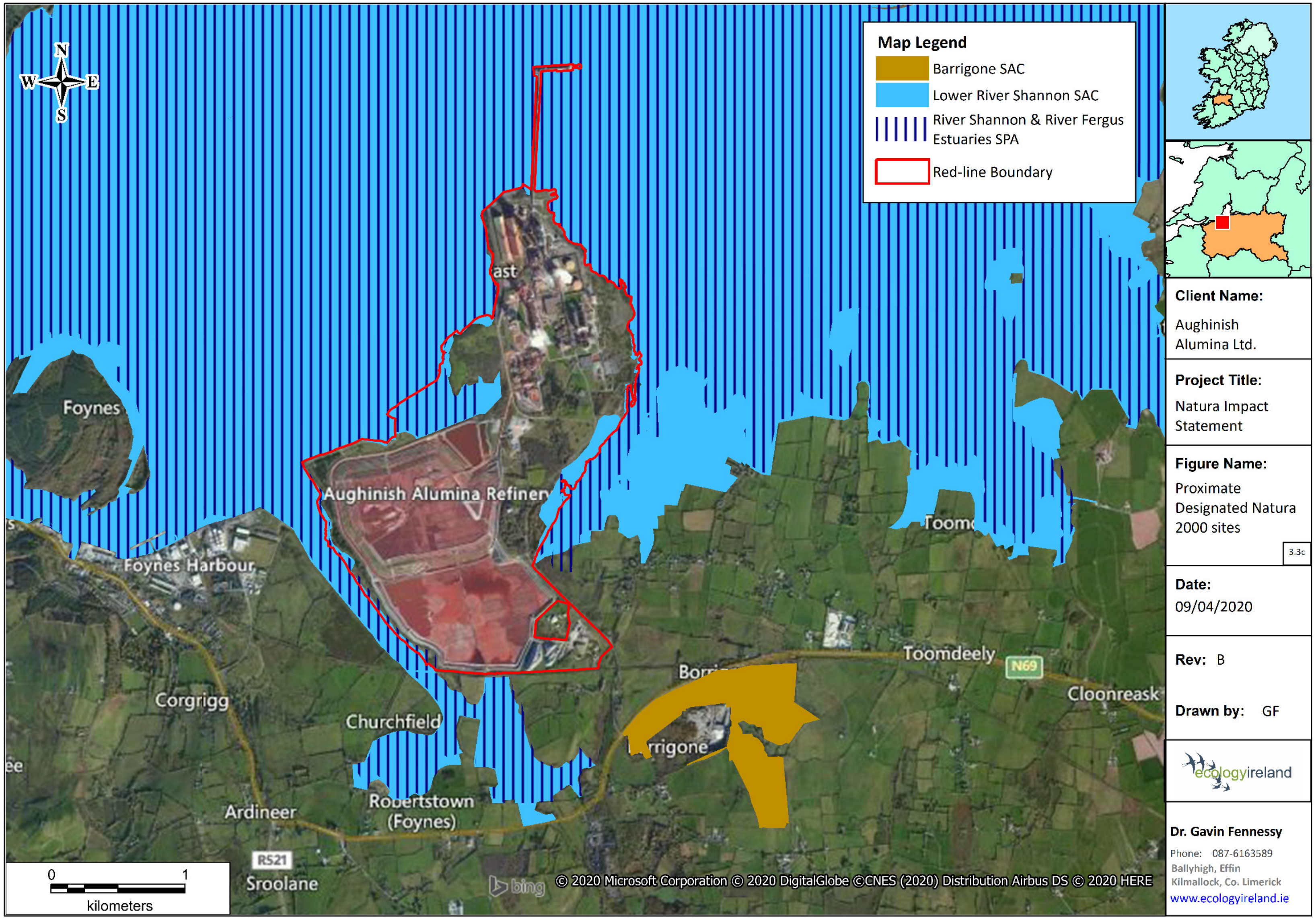


Figure 3.3c Proximate designated Natura 2000 sites

4 Stage 1: Assessment Criteria

The EPA in their consideration of the application of IEL review for AAL requested that a NIS be prepared by the applicant. The EPA undertakes Appropriate Assessment in accordance with Regulation 42(1) of the European Communities (Birds and Natural Habitats) Regulations 2011. The operation of the licensed facility is not connected with or necessary to the conservation management of a Natura 2000 site. On behalf of the applicant, Ecology Ireland Wildlife Consultants Ltd. assisted by JBA Consulting Ltd. has prepared a NIS in support of the Appropriate Assessment process.

In 2014, EPA carried out a screening for AA in relation to the previous IEL licence review (P0035-06) and concluded that on *'the basis of objective scientific information, that the activity, individually or in combination with other plans or projects'* will not have a *'significant effect on a European site'*. Thus, in 2014 the Agency determined that an AA was not required in relation to the activities at the licensed facility. Accordingly, the EPA stated that *'this installation is not likely to have significant effects on any European site, in view of the information submitted by the Applicant and due to the overall reduction of emissions to air from the installation'*. However, it is recognised that in the interim, there have been a number of legal judgements (see Section 2.1.1) which have resulted in the re-interpretation of aspects of the AA process.

While the historical context of the site and operations is discussed, the 'project' under consideration is the continued operation of the facility and proposed borrow pit under licence. As part of its licence review application, AAL has submitted an application for a derogation from the BAT-AEL for total organic carbon (TOC) and chemical oxygen demand (COD), as provided for under Article 15 of Directive 2010/75/EU on industrial emissions (integrated pollution prevention and control). Byrne Ó Cléirigh (BÓC, 2020; Appendix 2) prepared an assessment of the assimilative capacity of the Shannon Estuary in the context of the excess TOC and COD emission, and demonstrated quantitatively that the discharge to the estuary is not environmentally significant (Appendix 2).

Emissions are discussed broadly and in detail but concentrating on the scientific data from 2014 onwards – the period to which the existing license pertains. Particular attention is given to highlight any recent or proposed relevant changes in the operation of the facility (e.g. the operation of the borrow pit) that could potentially result in a different likelihood of significant effects, or adverse impacts, upon the designated sites within the zone of influence.

We present below a summary of the screening process of Natura 2000 sites where likely significant effects might potentially occur, in the absence of mitigation. We have set the study area to a nominal 15km offset from the facility boundary. This is an arbitrary distance used to present a framework for the assessment – however, in the event that likely significant effects are identified in relation to sites outside of that nominal distance these would be highlighted and discussed.

The operation of the AAL facility has been subject to the terms of the existing IE licence and AAL report on the monitoring of licensed emissions at agreed intervals. There have been a number of changes in the operation of the facility that have occurred since the last full licence review. In 2014, two new Gas Boilers were installed in the plant, completing the move to Natural Gas (as considered in P0035-06). In 2015, AAL undertook the conversion of a redundant Heavy Fuel Oil Tank to a caustic storage tank. This allows the facility to receive larger caustic ships, reducing the number of ship movements at the deep-water jetty. During 2016 and 2017 work was completed on the installation of a new Jetty unloader at the marine terminal. The most significant proposed change under consideration in the license review is for permission to operate a borrow pit of *c*. 4.5 hectares (ha) to extract *c*. 374,000 m^3 of rock within an area comprised of previously disturbed ground. The borrow pit was subject to separate assessment by the planning authority and An Bord Pleanála, and included an EIAR and Screening for AA. It is noted that the only proposed change in emission from the site is noise and vibration associated with the blasting activities in relation to the proposed borrow pit. As highlighted above, the licence review application includes for a derogation from the BAT-AEL for TOC and COD. This does not involve any proposed change in emissions from the current situation. The BÓC (2020) assimilative capacity assessment demonstrates that the difference in the concentrations of both TOC and COD in the receiving water are not significant between the application of the BAT AEL to the discharge, and if the derogation were to be granted. The difference between the two is negligible compared to the existing background concentrations of the two parameters in the Lower Shannon Estuary (Appendix 2).

In the following section we discuss in brief the designated Natura 2000 sites in terms of likely significant effects within a Zone of Influence (ZoI) from the facility.

4.1 Elements of the Project Likely to Impact on the Natura 2000 Sites

The 'project' as defined, is the operation of the AAL facility under licence, taking into account in particular information from the period during which the existing licence was in force (from July 2014) and any significant changes in the emissions from the site that may have, or would be likely to occur as a result of the issue of a revised IEL (P0035-07).

Following an initial screening of sites outside of 15km there was no sites identified as being affected by likely significant effects from the operation of the AAL facility. Each of the other Natura 2000 sites within 15km of the facility boundary were considered in more detail in the screening process. We considered the potential for habitat loss or degradation, and disturbance and displacement of faunal species arising from the operation of the facility.

The AAL facility overlaps with two designated sites Lower River Shannon SAC and River Shannon & River Fergus Estuaries SPA. Given the proximity of these Natura 2000 sites and the potential for likely significant effects, the potential for adverse impacts on the designated areas could not be discounted at Screening Stage. Barrigone SAC is designated for habitats and one fauna species; Marsh Fritillary *Euphydryas aurinia*. There are no habitats relating to the conservation objective of Barrigone SAC present within the operational facility including the proposed borrow pit location and no suitable food plant (i.e. Devil's-bit Scabious *Succisa pretense*) for Marsh Fritillary has been documented here. However, Devil's-bit Scabious has been recorded in the diverse grassland on site (e.g. at the back of the old sea-wall at the west of the site). Given the proximity of the Barrigone SAC to the licensed facility there is some likelihood of significant effects, in the absence of suitable mitigation. Therefore, Barrigone SAC and its Conservation Objectives have been included for further consideration at NIS stage.

The Stacks to Mullaghareirk Mts., West Limerick Hills & Mt. Eagle SPA is designated for Hen Harrier only. Due to the location of this designated site in relation to the AAL facility, a lack of suitable Hen Harrier habitat and no potential direct or indirect hydrological link; no impacts on this designated site are therefore expected as a result of the proposed development and this designated site will not be assessed further in this report.

Askeaton Fen Complex SAC is designated for the protection of qualifying habitats only and does not contain any fauna that could suffer disturbance/displacement impacts (including ex-situ impacts) as a result of the operations at the AAL facility. There will be no direct or indirect loss of habitat and no disturbance impacts on this designated site are expected as a result of the proposed development and this site will not be assessed further in this report.

Curraghchase Woods SAC is designated for the protection of qualifying woodland habitats and for Lesser Horseshoe Bat, *Rhinolophus hipposideros*. No habitats associated with this designated site are located within the operational footprint of the plant, including the proposed borrow pit development site and there is no potential direct, or indirect, hydrological link with the site and there is no known day roost for the species on the island. There is also limited foraging potential at the proposed borrow pit site for Lesser Horseshoe Bat. No loss of habitat, potential direct or indirect hydrological impacts or disturbance impacts of significance for Lesser Horseshoe Bat are expected as a result of the licensed operation of the AAL facility and this designated site will not be assessed further in this report.

We further considered the likely significant effects of the operation of the facility (under revised IEL) on designated sites with reference to the nature of the activity and in particular the emissions from the site in relation to the following screening assessment criteria:

- Size, scale, area, land-take of the project
- Physical changes that will occur as a result of the plan
- Resource requirements (water abstraction etc.)
- Construction and operational requirements
- Emissions and waste (disposal to land, water or air)
- Transportation requirements
- Duration of construction and operation
- Disturbance and displacement
- Cumulative impacts with other projects or plans

In conjunction with consideration of the likely changes to the Natura 2000 sites, including:

- Loss of habitat
- Habitat or species fragmentation

- Disturbance to key species
- Reduction in species density
- Changes in key indicators of conservation value (water quality *etc.*)
- Change to key elements of the site

Very little has materially changed in the operation of the facility (in terms of operational practices or emissions) since the previous licence review. However, given the proximity of the licensed facility to three Natura 2000 sites it is recognised that without the application of appropriate mitigation there is a likelihood of significant effects on these sites and therefore a NIS has been prepared as requested to support the EPA in carrying out the AA process. It is also worth noting that the facility could not continue to operate without licensing from the EPA and that as the licensing body they develop and implement the strict emissions limits under which such industrial plants operate. It is somewhat artificial in these circumstances to imagine the operation of a facility such as AAL without controls, monitoring and time-proven measures designed to ensure the protection of habitats, flora and fauna. However, insofar as these measures, along with any future license conditions constitute mitigation of potential impacts on these sensitive receptors, these elements must be considered as part of the Stage 2 NIS process.

The screening elements are summarised in the following sections – before proceeding to consider in detail the scientific data from recent years regarding the control of emissions and the elements of change under consideration in the current licence review.

4.1.1 Direct Habitat Loss

None of the features related to the day-to-day operation of the facility are located within any of the designated Natura 2000 sites. Neither, is there any proposed plans to directly impact in any way the habitats within the designated Natura 2000 sites in the wider area.

4.1.2 Indirect Habitat Loss or Deterioration

Indirect habitat loss or deterioration of designated sites could potentially occur from the effects of run-off or discharge of pollutants into the aquatic or intertidal environment. There is a licensed surface water emission point (W1-1) where treated wastewater is discharged. Without adequate mitigation or monitoring there is a likelihood of significant effects on the marine, intertidal and mudflat habitats present within the Lower River Shannon SAC and River Shannon & River Fergus Estuaries SPA. Similarly, in the absence of mitigation and monitoring there is potential for emissions to air, as well as noise, groundwater and light to all have likely significant effects on the three Natura 2000 sites considered within the ZoI: Lower River Shannon SAC, River Shannon & River Fergus Estuaries SPA and Barrigone SAC.

4.1.3 Disturbance / Displacement of Fauna

Significant disturbance/displacement effects in relation to noise and/or visual cues (including lighting) on fauna associated with designated is considered unlikely. The lighting regimen at the site has not changed to any appreciable extent over the past decades. Neither, has the operational noise changed to any significant extent. However, given that in this licence review it is proposed to operate a borrow pit it is accepted, that without mitigation there is the likelihood of significant effects through disturbance and displacement of fauna, e.g. as a result of blasting events.

Without mitigation, there is some likelihood of the operation of the facility according to the revised IEL license disturbing species occurring locally through noise, or light disturbance or for instance, by attracting in species (including SCIs of SPA sites in the wider area) into the site.

4.2 Likely Impacts of the Project on the Natura 2000 Sites

As outlined in Section 4.1 above, it is deemed that the operation of the facility according to the licence elements under review could lead to significant effect on three Natura 2000 sites within the project ZoI; without the implementation of best practice measures, BAT, adherence to national and international emission standards and all mitigation and monitoring requirements required through planning and licensing of operations.

4.2.1 Size, Scale & Land-take

The facility will be unchanged in area since the previous licence review.

4.2.2 Distance from or Key Features of the Natura 2000 Sites

As described in Table 3.4 & 3.5.

4.2.3 Resource Requirements (water abstraction *etc.*)

No change since 2014.

4.2.4 Excavation Requirements

The only significant excavation requirement covered under this license review is the proposed Borrow Pit. The license review seeks permission to operate a borrow pit of c. 4.5 ha to extract c. 374,000 m^3 of rock within an area comprised of previously disturbed ground. The EIAR which accompanied the borrow pit application (P17/714; ABP 301011) sets out environmental controls, including measures to avoid potential impacts on the nearby designated sites. These measures are described in detail in Section 5 of this report.

4.2.5 Emission (disposal to land, water or air)

As part of its license review application, AAL has submitted an application for a derogation from the BAT-AEL for TOC and COD. Byrne Ó Cléirigh (BÓC, 2020; Appendix 2) prepared an assessment of the assimilative capacity of the Shannon Estuary in the context of the excess TOC and COD emission, and demonstrated quantitatively that the discharge to the estuary is not environmentally significant (Appendix 2).

There are a range of emissions from the facility and these have been licensed by the EPA since 1998. These emissions, particularly the emissions to air and water have the potential to impact on the three designated Natura 2000 sites within the ZoI in the absence of adequate monitoring and mitigation. For this reason, emissions from the operation of the facility are a principal focus of the NIS.

4.2.6 Transportation Requirements

There will be an expected reduction in the number of truck movements to the site associated with the proposed operation of the borrow pit at the site. This would be expected to be of the order of 41-50 trucks per day during a haulage period of c. 16-20 consecutive weeks per year.

4.2.7 Duration of Operations

The site has been in operation since 1983 and its continuing operation is subject to planning permission and licensing.

4.2.8 Cumulative and In-combination Effects

The AAL facility is located near Shannon Foynes Port in Co. Limerick. Shannon Foynes deep water port is a significant national port, Ireland's second largest port operation and has statutory jurisdiction over all marine activities on a 500 km^2 area on the Shannon Estuary, stretching from Kerry/Loop Heads to Limerick City. It is responsible for most of the commercial ship traffic on the Shannon estuary.

In December 2019, Limerick City and County Council (LCCC) applied under section 51(2) of the Roads Act 1993 (as amended) to An Bord Pleanála for approval as Strategic Infrastructure Development (SID) in relation to a proposed road development consisting of:-

- Approximately 15.6km of Type 2 dual carriageway express road extending from Foynes to Rathkeale (with an intermediate roundabout junction at Ballyclogh) along with approximately 1.9km of single carriageway road between Ballyclogh and Askeaton;
- Approximately 17.5km of dual carriageway motorway, of which approximately 15.5km is new construction and/or widening of the existing road, from Rathkeale to Attyflin;
- A Service Area for Heavy Goods Vehicles approximately 5 ha in size near Foynes with access road and service roads, parking, facilities building and a new at-grade junction onto the Foynes port access road;
- LCCC has submitted to the Board the Environmental Impact Assessment Report (formerly referred to as an Environmental Impact Statement) prepared in accordance with section 50 of the Roads Acts 1993 (as amended) in respect of the proposed road development. A Natura Impact Statement was also been prepared and was submitted to the Board in respect of the proposed road development in accordance with Part XAB of the Planning and Development Acts 2000 – 2019.

Other projects considered when assessing the potential for in-combination and cumulative impacts included the operation of the Wyeth Nutritionals Ireland Ltd. plant at Coolrahnee, Askeaton, licensed aquaculture activities and dredging and dumping activities in the Lower River Shannon.

4.3 Likely Changes to the Natura 2000 Sites

Without adequate monitoring and mitigation there is a likelihood of significant effects on the three Natura 2000 sites proximate to the facility.

4.3.1 Reduction of Habitat Area

There is the potential for indirect habitat loss or deterioration of Natura 2000 sites within the project ZoI from the effects of run-off or discharge into the aquatic and intertidal environment through impacts such as increased siltation, nutrient release and/or contamination. Similarly, uncontrolled emissions to air could potentially lead to indirect habitat loss or degradation e.g. from fugitive dust.

4.3.2 Disturbance to Key Species

In the absence of adequate mitigation, the operational noise and vibration (e.g. from blasting at the borrow pit) could potentially lead to the disturbance and/or displacement of key species. Most of the bird species that are Special Conservation Interests of the SPA are wintering birds. Uncontrolled noise and vibration during the overwintering period, would in particular, have the potential to cause disturbance to such species occurring in areas of the SPA close to the operational facility.

4.3.3 Habitat or Species Fragmentation

The facility which has been operational since 1983 is not likely, in continuing to operate, to cause significant habitat or species fragmentation of relevance to the Natura 2000 sites within the ZoI.

4.3.4 Reduction in Species Density

In the event that there was indirect habitat loss or degradation associated with the operation of the facility without adequate monitoring and mitigation, it would be likely that this could see a reduction in certain species, at least locally within the ZoI.

4.3.5 Changes in Key Indicators of Conservation Value (water quality *etc*.)

In the absence of appropriate mitigation and monitoring there is some potential for the proposed project to contribute towards changes in water quality and contamination of sediments within the Lower River Shannon SAC and River Shannon & River Fergus SPA. Similarly, uncontrolled emissions to air, e.g. fugitive dust, could lead to a deterioration of habitats with the three Natura 2000 sites identified within the ZoI. Inadequate mitigation of all emissions from the site have some potential to result in significant effects on the three Natura 2000 sites within the ZoI.

4.3.6 Likely Impacts on the Natura 2000 Sites as a Whole

Such impacts cannot be discounted without adequate monitoring and mitigation commitments being implemented and/or site-specific mitigation measures being put in place during the next license period.

4.3.7 Interference with the Key Relationships that Define the Structure and Function of the Natura 2000 Sites

Without the implementation of adequate monitoring the emissions arising from the operation of the facility have the potential to contribute towards significant negative effects that may interfere with the structure and function of Natura 2000 sites within the project ZoI; Lower River Shannon SAC, River Shannon & River Fergus Estuaries SPA and Barrigone SAC.

4.4 Indicators of Significance as a Result of the Identification of Effects Set Out Above

As outlined in the above sections, it is considered that in the absence of appropriate monitoring and mitigation that emissions arising from the operation of the facility have the potential to impact Natura 2000 sites within the project Zone of Influence (ZoI).

4.4.1 Loss

There is the potential for indirect habitat loss or deterioration of Natura 2000 sites within the project ZoI from the effects of inadequately mitigated emissions e.g. run-off or discharge into the aquatic environment could result in impacts such as increased siltation, nutrient release and/or contamination.

4.4.2 Fragmentation

Not applicable.

4.4.3 Disruption

There is the potential for indirect habitat loss or disruption of Natura 2000 sites within the project ZoI from the effects of emissions arising from the operation of the AAL facility: e.g. run-off or discharge into the aquatic environment through impacts such as increased siltation, nutrient release and/or contamination, particularly during the project construction phase.

4.4.4 Disturbance

In the absence of appropriate mitigation emissions, in particular noise and vibration (e.g. associated with blasting) and light have the potential to cause disturbance to faunal species listed among the QIs/SCIs of the designated Natura 2000 sites within the ZoI.

4.4.5 Change to Key Elements of the Site

Without the implementation of adequate mitigation and monitoring measures during the operation of the facility, it is considered that elements of the project (in particular potential emissions from the site) may have the potential to contribute towards significant negative effects that may interfere with the structure and function of Natura 2000 sites within the project ZoI; Lower River Shannon SAC, River Shannon & River Fergus Estuaries SPA and Barrigone SAC.

4.5 Elements of the Project Likely to Significantly Impact on the Natura 2000 Sites or where the Scale or Magnitude of Impacts are Unknown

It cannot be concluded, that in the absence of mitigation and other environmental controls, e.g. IE licence conditions, that the proposed project, individually or in combination with other plans or projects, will not have a significant effect on the Natura 2000 sites within the ZoI, without the consideration and analysis of further information. Therefore Stage 2 NIS (AA) is required.

A Natura Impact Statement (NIS) is presented in **Section 5**, to provide scientific examination of the project, based on the contemporary scientific data, to enable the competent authority to undertake an AA. The NIS will examine potential effects to Natura 2000 sites screened in as part of this Screening for Appropriate Assessment; Lower River Shannon SAC, River Shannon & River Fergus Estuaries SPA and Barrigone SAC.

5 Natura Impact Statement

This NIS examines in detail the sources of emission from the plant, the compliance with licensed limits, the associated monitoring, management and mitigation that are in place and committed to as part of the licence review application.

This section of the report provides the necessary information to inform AA to be completed by the EPA in relation to the licence review application (P0035-07). This NIS provides the relevant scientific information to enable the competent authority in carrying out its AA to determine whether or not the 'Project' i.e. the continuing operation of the facility under license and operation of the proposed borrow pit would adversely affect the integrity of Natura 2000 sites.

The NIS assesses whether or not the proposed development would adversely affect the integrity of Natura 2000 sites within the project ZoI, for which effects could not be excluded during the Screening for AA. The Natura 2000 sites are as follows:

- Lower River Shannon SAC
- River Shannon & River Fergus Estuaries SPA
- Barrigone SAC

According to the Habitats Directive, the Conservation Status of a natural habitat will be taken as 'favourable' within its biogeographic range when:

- its natural range and areas it covers within that range are stable or increasing, and
- the specific structure and functions which are necessary for its long-term maintenance exist and are likely to continue to exist for the foreseeable future, and
- the Conservation Status of its typical species is favourable as defined below.

According to the Habitats Directive, the Conservation Status of a species means the sum of the influences acting on the species concerned that may affect the long-term distribution and abundance of its populations. The Conservation Status will be taken as 'favourable' within its biogeographic range when:

- population dynamics data on the species concerned indicate that it is maintaining itself on a long-term basis as a viable component of its natural habitats, and
- the natural range of the species is neither being reduced nor is likely to be reduced for the foreseeable future, and
- there is, and will probably continue to be, a sufficiently large habitat to maintain its populations on a long-term basis.

The specific conservation objectives for each site are available on www.npws.ie. These have been accessed for the sites listed above on March 23rd 2020. Site specific and detailed Conservation Objectives Series documents are available for all three of the Natura 2000 sites, with specific conservation objectives published for Barrigone SAC on February 15th 2019. The detailed conservation objectives for the Lower River Shannon SAC and River Shannon & River Fergus SPA sites have not been updated since 2012. All conservation objectives together with other designated site information are available on http://www.npws.ie/protectedsites/.

5.1 Impact Assessment

5.1.1 Characterising Impacts

The methodology for the assessment of impacts is derived from the Assessment of Plans and Projects Significantly Affecting Natura 2000 Sites (EC, 2002). When describing changes/activities and impacts on ecosystem structure and function, the types of impacts that are commonly presented include the following:

- direct and indirect effects,
- short- and long-term effects,
- construction, operational and deconstruction / demolition effects, and
- isolated, interactive and cumulative effects.

Impacts that could potentially occur through the implementation of the project can be categorised under a number of impact categories as outlined in the EC 2002 document as follows:

- Loss/Reduction of habitat area,
- Disturbance to key species,
- Habitat or species fragmentation,
- Reduction in species density, and
- Changes in key indicators of conservation value such as decrease in water quality and quantity.

Meaning of 'Adversely Affect the Integrity of the Site'

The concept of the 'integrity of the site' is explained in the EU publication Managing Natura 2000 sites: The provisions of Article 6 of the 'Habitats' Directive 92/43/EEC, as follows;

'It is clear from the context and from the purpose of the directive that the 'integrity of the site' relates to the site's conservation objectives. For example, it is possible that a plan or project will adversely affect the integrity of a site only in a visual sense or only habitat types or species other than those listed in Annex I or Annex II. In such cases, the effects do not amount to an adverse effect for purposes of Article 6(3), provided that the coherence of the network is not affected. On the other hand, the expression 'integrity of the site' shows that focus is here on the specific site. Thus, it is not allowed to destroy a site or part of it on the basis that the conservation status of the habitat types and species it hosts will anyway remain favourable within the European territory of the Member State.

As regards the connotation or meaning of 'integrity', this can be considered as a quality or condition of being whole or complete. In a dynamic ecological context, it can also be considered as having the sense of resilience and ability to evolve in ways that are favourable to conservation. The 'integrity of the site' has been usefully defined as 'the coherence of the site's ecological structure and function, *across its whole area, or the habitats, complex of habitats and/or populations of species for which the site is or will be classified'*

A site can be described as having a high degree of integrity where the inherent potential for meeting site conservation objectives is realised, the capacity for self-repair and self-renewal under dynamic conditions is maintained, and a minimum of external management support is required. When looking at the 'integrity of the site', it is therefore important to take into account a range of factors, including the possibility of effects manifesting themselves in the short, medium and long-term.

The integrity of the site involves its ecological functions. The decision as to whether it is adversely affected should focus on and be limited to the site's conservation objectives.

5.1.2 Potential Effects from the Proposed Development to Qualifying Habitats and Species of Natura 2000 Sites within the Project Zone of Influence

Potential effects associated with the proposed development to the Qualifying Habitats and Species of Natura 2000 Sites within the project Zone of Influence (Lower River Shannon SAC, River Shannon & River Fergus Estuaries SPA, Barrigone SAC may involve:

- Outputs and emissions arising from the operation of the AAL facility including the proposed borrow pit. The AAL facility is an industrial plant with multiple points and types of emission. To operations at the AAL plant require an IE licence from the EPA. In the following sections we describe the different types of emission that are associated with the operation of the facility, the limits set by the Agency for different emissions, the history of compliance under the existing licence, and the applicants ongoing commitment to monitoring and mitigation.

In the following section the different types and sources of emissions associated with the operation of the facility and the proposed borrow pit are described in detail. The AAL facility operates under license from the EPA and as such the emission limits are set by the regulatory authority to ensure that there is no damaging impact upon the receiving environment. The setting of limits and the monitoring of the emissions to ensure compliance with these levels, is therefore intrinsically mitigation of the impacts of various types of emission that the regulatory authority understands to pose a potential threat to the receiving environment.

The locations of licensed emission points and monitoring locations are illustrated and the contemporary record of compliance with EPA licence conditions is discussed. In addition, light emissions are discussed and the potential for adverse impacts on the integrity of the three Natura 2000 sites within the ZoI are considered. The results of the monitoring of emissions and the compliance with limits set by the regulatory authority in line with national and international standards is discussed.

5.2 Air Emissions – Point Sources

Under licence P0035-06, AAL has 17 licenced air emission points (Figure 5.2a). The Gas Boilers (Emission Ref. A4-A and A4B), the Combined Heat and Power Plant (CHP) (Emission Ref. A3-A, A3-B), the Calciners (Emission Ref. A2) and the Heavy Fuel Boilers (Emission Ref. A1) are the primary air emission sources from the site. In 2014 the gas boilers were installed and replace the Heavy Fuel Oil boilers as the main source of steam. Figure 5.2a outlines the locations and labelling system for the air emissions points. Table 5.1 below describes the emissions.

Table 5.1: Point Source Air Emissions.

Emission Point Code	Sources of Air emissions	Licence Limits
A1	HFO Boiler (2 No. Units). Operates for < 10 days/year as back-up only.	750 mg/Nm^3 Nitrogen Oxides 1700 mg/Nm^3 Oxides of Sulphur
A2	Calciners (3 No. units)	150 mg/Nm^3 Nitrogen Oxides50 mg/Nm^3 Particulates
A3-A	Gas Turbine	120 mg/Nm^3 Oxides of Sulphur 100 mg/Nm^3 Carbon Monoxide 75/90 mg/Nm^3 Nitrogen Oxides
A3-B	Gas Turbine	120 mg/Nm^3 Oxides of Sulphur 100 mg/Nm^3 Carbon Monoxide 75/90 mg/Nm^3 Nitrogen Oxides
A4-A	Gas Boiler	100 mg/Nm^3 Carbon Monoxide 100 mg/Nm^3 Nitrogen Oxides
A4-B	Gas Boiler	100 mg/Nm^3 Carbon Monoxide 100 mg/Nm^3 Nitrogen Oxides
5	General extraction	100 mg/Nm^3 Particulates (Not in Service)
6	General extraction	100 mg/Nm^3 Particulates
8	General extraction	100 mg/Nm^3 Particulates (Not in Service)
11	General extraction	Unit Decommissioned
12	General extraction	50 mg/Nm^3 Particulates
13	Boiler (for building heating)	Gas Oil, 0.2% Sulphur
14	Boiler (for building heating)	Gas Oil, 0.2% Sulphur
15	Boiler (for building heating)	Gas Oil, 0.2% Sulphur
16	General extraction	50 mg/Nm^3 Particulates

Emission Point Code	Sources of Air emissions	Licence Limits
17	Dry fabric bag filter	50 mg/Nm^3 Particulates
18	Dry fabric bag filter	50 mg/Nm^3 Particulates
19	Dry fabric bag filter	50 mg/Nm^3 Particulates

There are 67 minor emission points scattered around the plant. Air and stream comprise most emissions.

Ambient dust deposition monitoring is carried out monthly at 35 locations (DG1-DG35; Figure 5.2b). Locations DG29-DG32 are external to the site, the remaining ambient air sampling locations are within the site boundary. Dust deposition monitoring is determined using a Bergerhoff Gauge and results are reported as $mg/m^2/d$.

Ambient particulate monitoring (PM_{10} and $PM_{2.5}$) is conducted at 5 locations around the site; 2 stations on-site and the remaining 3, off-site. Recently AAL added another particulate monitoring station at Fawnamore (Figure 5.2b).

5.2.1 Relevant Legislation

The following regulations with regards to air emissions are applicable to the site:

- Directive 2015/2193/EU on the limitations of emissions of certain pollutants into the air from medium combustion plants. Annex II sets out emission limit values for sulphur dioxide, nitrogen oxide (NO_x as NO_2) to be applied to new medium combustion plants by December 2018. Operators of existing medium combustion plants are not required to meet specific ELVs until 2025.
- S.I. No. 490 of 2012 European Communities (Greenhouse Gas Emission Trading) Regulations 2012 sets out the requirement for a Green House Gas Emission Permit for the plants. AAL operates under GHG Permit No. IE-GHG038-10361-3 for the following emission sources:
  - 3 Calciner Units (74.6 MW each)
  - 2 Natural Gas boilers (102.76 MW each)
  - 2 Natural Gas CHP units (252.35 MW each)
  - HFO boilers (1 at 158.6.MW and 1 of 159.8 MW)
  - 6 Diesel/gas oil package boilers (total of 6.69 MW)
  - 2 Diesel/gas oil backup generators (total of 2.87 MW)
  - Laboratory propane use (0.5 MW)
  - 2 CHP natural gas heaters (0.5MW each)
  - 5 BGE gas heaters (0.28 MW each)
  - Diesel/gas oil fire water pump (0.06 MW)
  - Mobile welding equipment (0.1 MW).

- S.I. 180 of 2011 – EU Directive 2008/50/EC. These Regulations transpose the Directive on ambient air quality and cleaner air for Europe (CAFE) into Irish law. They introduce a limit value to $PM_{2.5}$ in addition to the existing limit values for PM_{10}, nitrogen dioxide and oxides of nitrogen, sulphur dioxide, lead, ozone, carbon monoxide and benzene. The limits for the pollutants are given in Table 5.2.

Figure 5.2a Licensed Air Emission Points

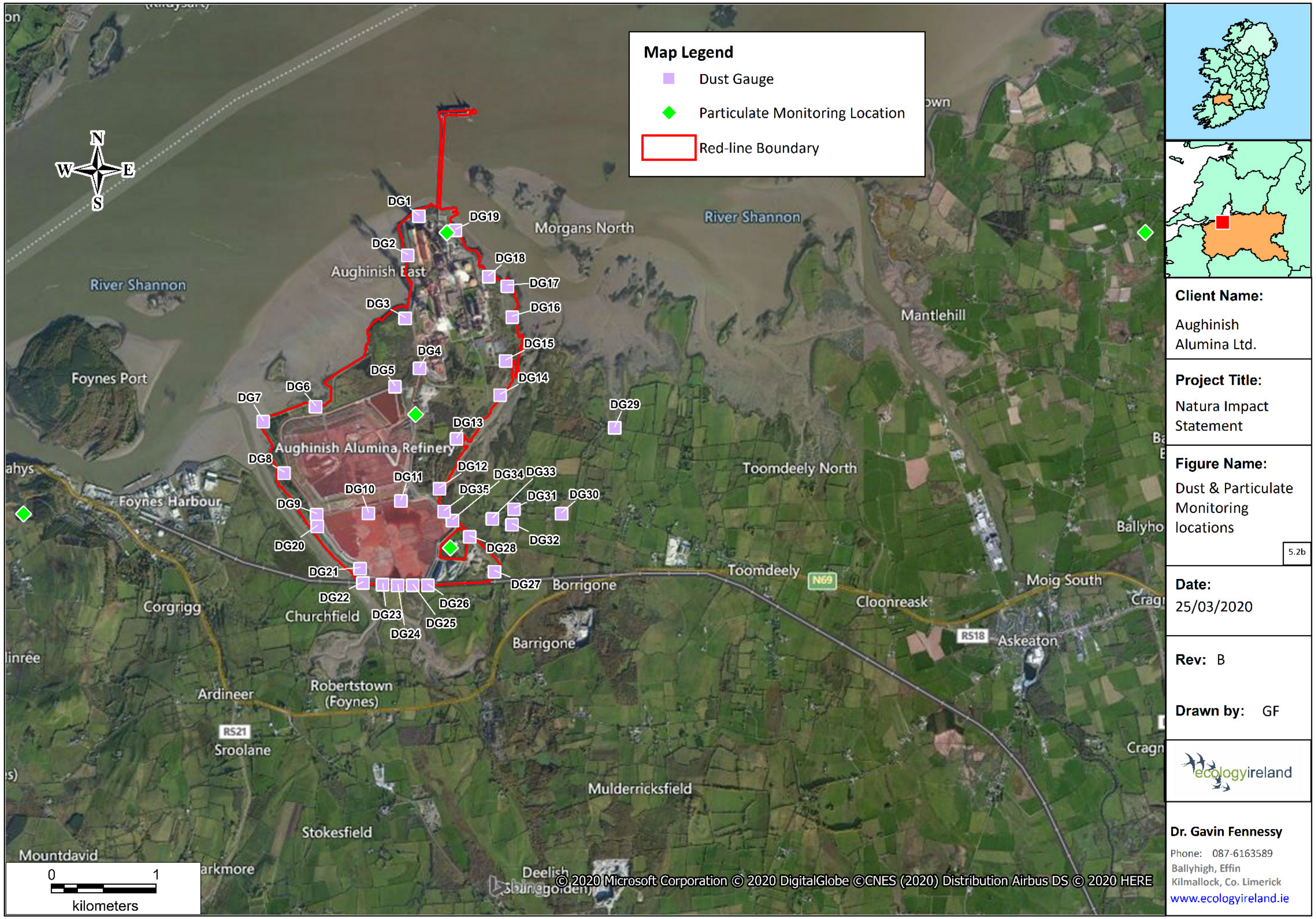


Figure 5.2b Dust & Particulate Monitoring locations

Table 5.2: Ambient Air Quality Standards

Pollutant	Ambient Air Quality Standard (ug/m3)	Reference to the Limits
Sulphur Dioxide		
SO_2 99.7th Percentile Hourly (Protection of Human Health)	350	EU Directive 2008/50/EC / S.I. 180 of 2011
SO_2 99.2th Percentile Daily (Protection of Human Health)	125	EU Directive 2008/50/EC / S.I. 180 of 2011
SO_2 Annual (Protection of Vegetation)	20	EU Directive 2008/50/EC / S.I. 180 of 2011
Oxides of Nitrogen (NO2/NOx)		
NO_2 99.8th Percentile hourly (Protection of Human Health)	200	EU Directive 2008/50/EC / S.I. 180 of 2011
NO_2 Annual (Protection of Human Health)	40	EU Directive 2008/50/EC / S.I. 180 of 2011
NO_x Annual (Protection of Vegetation)	30	EU Directive 2008/50/EC / S.I. 180 of 2011
Carbon Monoxide		
CO 8-hour (Protection of Human Health)	10,000	EU Directive 2008/50/EC / S.I. 180 of 2011
Particulate Matter PM10		
PM_{10} 90.4th Percentile Daily (Protection of Human Health)	50	EU Directive 2008/50/EC / S.I. 180 of 2011
PM_{10} Annual (Protection of Human Health)	40	EU Directive 2008/50/EC / S.I. 180 of 2011
Particulate Matter $PM_{2.5}$		
$PM_{2.5}$ Annual Stage 1 (Protection of Human Health)	25	EU Directive 2008/50/EC / S.I. 180 of 2011.
$PM_{2.5}$ Annual Stage 22 (Protection of Human Health)	20	EU Directive 2008/50/EC / S.I. 180 of 2011

5.2.2 BAT for Air Emissions

BAT Guidance for the Large Volume Inorganic Chemical-Solids and Other Industry (LVIC-S) requires several controls for air emissions. Table 5.3 below outline the relevant BAT.

Table 5.3: **BAT Guidance for the LVIC-S-Industry.**

BAT Description	Description in AAL
When possible the use of fuel with a low sulphur content is preferable for abatement of sulphur dioxide emissions. Sulphur can be abated using alkaline scrubbing.	Low sulphur HFO serves only as a strategic back-up in the event of loss of natural gas to the site.
NOx emissions can be reduced by applying both primary and secondary end-of-pipe measures. In some cases, control measures are taken to minimise NOx and no further abatement is required.	Secondary measures such as selective non-catalytic reduction (SNCR) not required for modern gas turbines nor for modern gas fired boilers. Each boiler system at AAL has its own Distributed Control System (DCS) computerised control system. This ensures optimum boiler energy performance, maximum combustion safety and optimum emissions control. Gas boilers are low NOx boilers compliant with the Industrial Emissions Directive.
Many techniques available (e.g. cyclones, bag filters, scrubbers) can be used to treat ducted streams for dust.	Waste gas from the alumina handling systems is filtered through fabric filters prior to exhaust. Waste gas from the bauxite handling systems is dedusted in wet scrubbers prior to exhaust. ESP's are installed on calciner stack exhaust.
Control of combustion conditions e.g. by means of an advanced control system, is the most usual way to reduce carbon monoxide emissions.	Each boiler system at AAL has its own DCS computerised control system. This ensures optimum boiler energy performance, maximum combustion safety and optimum emissions control.
Process optimisation to minimise CO_2 emissions to atmosphere.	Each boiler system at AAL has its own DCS computerised control system. This ensures optimum boiler energy performance, maximum combustion safety and optimum emissions control. As all energy consumed is derived from natural gas, CO_2 emissions are minimised by maximising energy efficiency i.e. minimising the KPI GJ/ton alumina. AAL is one of the most efficient alumina refineries in this regard.
Special attention has to be paid to incidental and fugitive emissions of gases contained in vessels and pipes.	The only gaseous streams are High Pressure (HP)/Low Pressure (LP) steam and natural gas. Steam leaks are immediately evident. Gas system are ATEX compliant which ensure that there are no fugitive leaks.

BAT Description	Description in AAL
Action to reduce emissions of hazardous substances should be taken considering safety, properties and concentration of substances, legal requirements and costs of material losses.	AAL operates in accordance with an ISRS safety management system. The principal hazardous substance stored and transferred is concentrated sodium hydroxide. As this is corrosive to tissue it is necessary to eliminate any fugitive emissions immediately. The low level of chemical burns in the plant is testament to the successful avoidance of fugitive caustic emissions.
The impact and effectiveness of environmental preventative measures have to be considered and assessed, taking into account possible cross media effects.	The process design, plant operation and comprehensive maintenance management all contribute to minimal impact. There is also an accident prevention policy and an emergency preparedness system for all of the identified risk scenarios

5.2.3 Licenced Emission Limit Values for Air Emissions

<u>Monitoring and Reporting Requirements</u>

AAL is required as part of their licence to monitor the following parameters for air emissions from the site (Table 5.4; Figure 5.2a).

Table 5.4: Air Monitoring Requirements at the Plant.

Emission Reference	Description	Pollutant Parameter
A1	HFO Boiler Stack	NOx, SO_2, Dust
A2	Calciner Stack	NOx, Dust
A3-A	Gas Turbine 1	NOx, CO
A3-B	Gas Turbine 2	NOx, CO
A4-A	D Boiler	NOx, CO
A4-B	E Boiler	NOx, CO
5	Scrubber Exhaust Fan – Transfer Tower 4 & 5	Dust (Not in Service)
6	Bauxite Crusher and Wobbler Feeder – Scrubber Exhaust Fan	Dust
8	Scrubber Exhaust Fan – Transfer Tower 3	Dust (Not in Service)
11	Alumina Loader Dust Fan	Dust (Unit Decommissioned)
12	Alumina Loader Dust Fan	Dust
16	Silo 1 – Exhaust Fan	Dust
17	Silo 2 – Exhaust Fan	Dust
18	Silo 3 – Exhaust Fan	Dust
19	Exhaust Fan between Silos 1 and 2	Dust

5.2.4 Review of Air Monitoring Results 2014 – 2019

The submissions from AAL to the EPA in their Annual Environmental Reports AER) were reviewed. Information on air emissions is required as part of the annual submission. The information presented in the AER's from 2014 to 2018 is summarised in Table 5.5 (a-d) below.

Table 5.5a: Summary of the Findings for the Annual Environmental Reports 2014 – 2018: <u>HFO Boilers</u>

Parameter	2014 (tonnes)	2015 (tonnes)	2016 (tonnes)	2017 (tonnes)	2018 (tonnes)	Licence Limit (tonnes)
Oxides of Sulphur (as SO_2)	571	49.6	10.8	8.5	19.8	5,474.3
Nitrogen Oxides (as NO_2)	261.3	20.9	4	2.6	7	2,415.1

Parameter	2014 (tonnes)	2015 (tonnes)	2016 (tonnes)	2017 (tonnes)	2018 (tonnes)	Licence Limit (tonnes)
Dust	19.4	2.5	0.4	0.06	0.14	161

The review of the reported monitoring data for the HFO boilers show that there was 100% compliance with the licensed mass emissions limits for all parameters. Furthermore, all monthly and 48-hour average reported values were compliant with the emission limit values for nitrogen oxides and oxides of sulphur as outlined in the licence.

Table 5.5b: Summary of the Findings for the Annual Environmental Reports 2014 – 2018: Gas Boilers

Parameter	2014 (tonnes)	2015 (tonnes)	2016 (tonnes)	2017 (tonnes)	2018 (tonnes)	Licence Limit (tonnes)
Nitrogen Oxides (as NO_2)	37.4	84	89.9	95.5	89.9	227.8
Carbon Monoxide	4.6	13	17.3	21.4	25	227.8

The review of the reported monitoring data for the gas boilers show that there was 100% compliance with the licensed mass emissions limits for all parameters. Furthermore, all monthly, daily and hourly average reported values were compliant with the emission limit values for nitrogen oxides and oxides of sulphur as outlined in the licence.

Table 5.5c: Summary of the Findings for the Annual Environmental Reports 2014 – 2018: Calciners

Parameter	2014 (tonnes)	2015 (tonnes)	2016 (tonnes)	2017 (tonnes)	2018 (tonnes)	Licence Limit (tonnes)
Nitrogen Oxides (as NO_2)	434.8	537.3	528.2	498.4	464.5	878.6
Dust	180.6	108.6	111.6	117.2	61.9	235.1

The review of the reported monitoring data for the calciners show that there was 100% compliance with the licensed mass emissions limits for all parameters. Furthermore, all daily and hourly average reported values were compliant with the emission limit values for nitrogen oxides and oxides of sulphur as outlined in the licence.

Table 5.5d: Summary of the Findings for the Annual Environmental Reports 2014 – 2018: CHP

Parameter	2014 (tonnes)	2015 (tonnes)	2016 (tonnes)	2017 (tonnes)	2018 (tonnes)	Licence Limit (tonnes)
Nitrogen Oxides (as NO_2)	228.9	291.1	391.6	414.3	389.6	946.1
Carbon Monoxide	5.5	19.5	61.8	68.1	79	1,261.4

The review of the reported monitoring data for the CHP plant show that there was 100% compliance with the licensed mass emissions limits for all parameters. Furthermore, all monthly, daily and hourly average reported values were compliant with the emission limit values for nitrogen oxides and oxides of sulphur as outlined in the licence.

A summary derived from the AER's from 2014-2018 in relation to the dust extraction emission points is presented in Table 5.6.

Table 5.6: Summary of the Findings for the Annual Environmental Reports 2014 – 2018: Dust Extraction Emission Points

Emission Point Ref.	2014 (tonnes)	2015 (tonnes)	2016 (tonnes)	2017 (tonnes)	2018 (tonnes)	Licence Limit (tonnes)
5	N/A	N/A	N/A	N/A	N/A	51.8
6	3.1	3.7	3	3.3	8.5	49
8	N/A	N/A	N/A	N/A	N/A	21.5
11	N/A	N/A	N/A	N/A	N/A	20.7
12	1.3	1.6	0.8	1	0.5	9.7
16	2	2.9	1.3	0.6	1.6	6.6
17	2	1.8	2.8	3.7	3.2	6.6
18	1.2	1.4	0.5	0.7	0.9	4.4
19	0.6	0.6	0.3	0.2	0.5	4.4

The review of the reported monitoring data for the dust collection units on-site show that there was 100% compliance with the licensed mass emissions limits for all parameters. Furthermore, all reported annual and bi-annual grab sampling were compliant with the emission limit values for dust as outlined in the licence.

5.2.5 Impact of air emissions from point sources

The air pollutants generated from the on-site point sources are:

- Nitrogen oxides
- Sulphur oxides
- Carbon monoxide
- Dust
- PM_{10}
- $PM_{2.5}$

The conversion from HFO to gas has resulted in a net annual reduction of 46 tonnes of dust (a 94% reduction), 1,700 tonnes of SOx (a 96% reduction), 480 tonnes of NOx (a 92% reduction) and 75,000 tonnes of CO_2 (a 25% reduction). The Gas Boilers are run on natural gas only, using low NOx burner and flue gas recirculation. There is a Distributed Control System (DCS) computerised system for the boilers and a Continuous Emissions Monitoring System (CEMS) is installed for emission monitoring. This ensures optimum plant energy performance, maximum combustion safety and optimum emissions control. The Gas Turbines are controlled by a DCS computerised control system to ensure maximum burring efficiency.

The calciners operate on natural gas since their conversion from HFO in 2012 so there are no emissions of SOx from this equipment. Electrostatic precipitators on the calciners abate dust emissions. These have a DCS computerised control system and a CEMS installed for emission monitoring. This ensures optimum emissions control. The general extraction systems throughout the plant have either wet scrubbers or dry fabric bag filters to capture dusts. Boilers for heating the administration buildings are run on gas oil with <0.2% sulphur.

In the boiler house area of the plant, one HFO boiler has been decommissioned while the remaining two boilers provide backup only. Therefore, the emissions of potential pollutants, particularly oxides of sulphur, from these boilers has been significantly reduced. This scenario also results in a reduction in dust emissions.

A new bauxite unloader was installed on the jetty in late 2017. The dust control mechanisms meet the relevant BAT document on Emission Storage, July 2006.

The sensitive receptors to air emissions emanating from the point sources are humans and ecological habitats and species. The site is located on the Shannon Estuary which is a Special Area of Conservation (SAC). The Shannon/Fergus Estuary is recognised for the important numbers of bird species that it holds and consequently is a designed Special Protection Area (SPA). Barrigone SAC is located within 0.5km of the licensed site boundary.

Holden *et al*. (2019)[3] on the assessment of air quality impacts on designated nature conservation site, mentions that the impact of sulphur dioxide emissions and associated acid rain formation has significantly reduced since it was first recognised in the 1980's. However, there may be legacy effects in some habitats from accumulated deposition. The use of HFO at the AAL site has reduced significantly since 2014, with the installation of the gas boilers and the consequent levels of SOx emissions from the site has fallen. The levels of SOx have reduced from 571 tonnes in 2014, to 49.6 tonnes in 2015 and 10.8 tonnes in 2016. In 2018 SOx emissions from the HFO boilers amounted to 19.8 tonnes.

The other pollutant that can potentially affect vegetation and ecosystems is nitrogen oxides (NOx). Nitrogen oxides can have both direct effects e.g. through exposure to the gas itself; and indirect effects, e.g. through deposition of the gas to soil and freshwater (dry deposition) or with precipitation (wet deposition). The United Nations Economic Commission for Europe (UN ECE) Convention on Long-Term Transboundary Air Pollution (CLRTAP) introduced the concept of critical levels and critical loads. A critical level is defined by the UNECE as 'concentrations of pollutants in the atmosphere above which direct adverse effects on receptors, such as human beings, plants, ecosystems or materials, may occur according to present knowledge'. The critical levels adapted by the EU are summarised in Table 5.7.

Table 5.7: Critical Levels (UNECE).

Pollutant	Averaging Period	Critical Level
Oxides of Nitrogen (NOx)	24 hr	75 / 200 µg/m^3
	Annual	30 µg /m^3*
Sulphur Dioxide	Annual	10 µg /m^3 (for lichens and bryophytes)
	Annual	20 µg /m^3*

*** These levels correspond with the Air Quality Standards Regulations, 2011.**

In February 2020 AAL commissioned AWN Consultants to undertake an air dispersion model of licensed emissions from the facility on nearby ecologically sensitive receptors (AWN, 2020; Appendix 3). The model contains information on typical background levels for NOx, CO, SO_2, PM_{10} and $PM_{2.5}$/PM_{10} ratios for a Zone D location (as per the EPA ambient air quality monitoring programme). The conservative background levels were 8 µg/m^3, 0.5 µg/m^3, 3 µg/m^3 and 12 µg/m^3 for NOx, CO, SO_2 and PM_{10} respectively. A $PM_{2.5}$/PM_{10} ratio of 0.6 was used to generate a background $PM_{2.5}$ concentration of 7.2 µg/m^3. Three scenarios were modelled to allow for all likely operational scenarios that may occur on-site:

- Baseline – 2 gas boilers running; 2 CHP units running, 3 calciners running, and all other operational dust extraction units running.
- Alternative Baseline – One CHP running for 92% of the year and boiler A1-C runs for up to 8% of the year when CHP plant is on maintenance
- Scenario Three – Boiler A1-C and A1-A runs for up to 8% of the year when a CHP plant and Gas Boiler plant are on scheduled maintenance. CHP Plant A3-A running for 92% of the year and gas boiler A4-A running for 92% of the year.

The report provides input data (stack diameters, stack exit velocities, concentration of gases) and the model utilises 5 year's metrological data from Shannon Airport. The predicted concentrations of NOx (including background) is provided in Table 5.8 and Figure 5.2.1.

Baseline Scenario

<u>NO_2 Emissions</u>

The NO_2 baseline emission scenario demonstrate that the predicted ground level concentrations are less than the relevant air quality standards for NO_2 (99.8% 1 hr: 200µg/Nm^3 and Annual Mean limits of 40µg/Nm^3).

<u>NOx Emissions</u>

For a worse case year, i.e. highest predicted NOx concentration including background, is 70% of the annual limit value at the worst-case receptor (see Table 5.7).

Table 5.8: Predicted NOx emissions (AWN, 2020)

Pollutant/Year	Averaging Period	Predicted Concentration NOx (µg/Nm^3)	Standard (µg/Nm^3)
NOx/2015	Annual Mean	20.4	30
NOx/2016	Annual Mean	19.6	30
NOx/2017	Annual Mean	20.9	30
NOx/2018	Annual Mean	20.0	30
NOx/2019	Annual Mean	19.5	30

The predicted NOx emissions from the point sources at the site for 2015, 2016, 2017, 2018 and 2019 are less than the 2011 Irish Air Quality Standard limit of 30 µg/m^3 for the protection of vegetation.

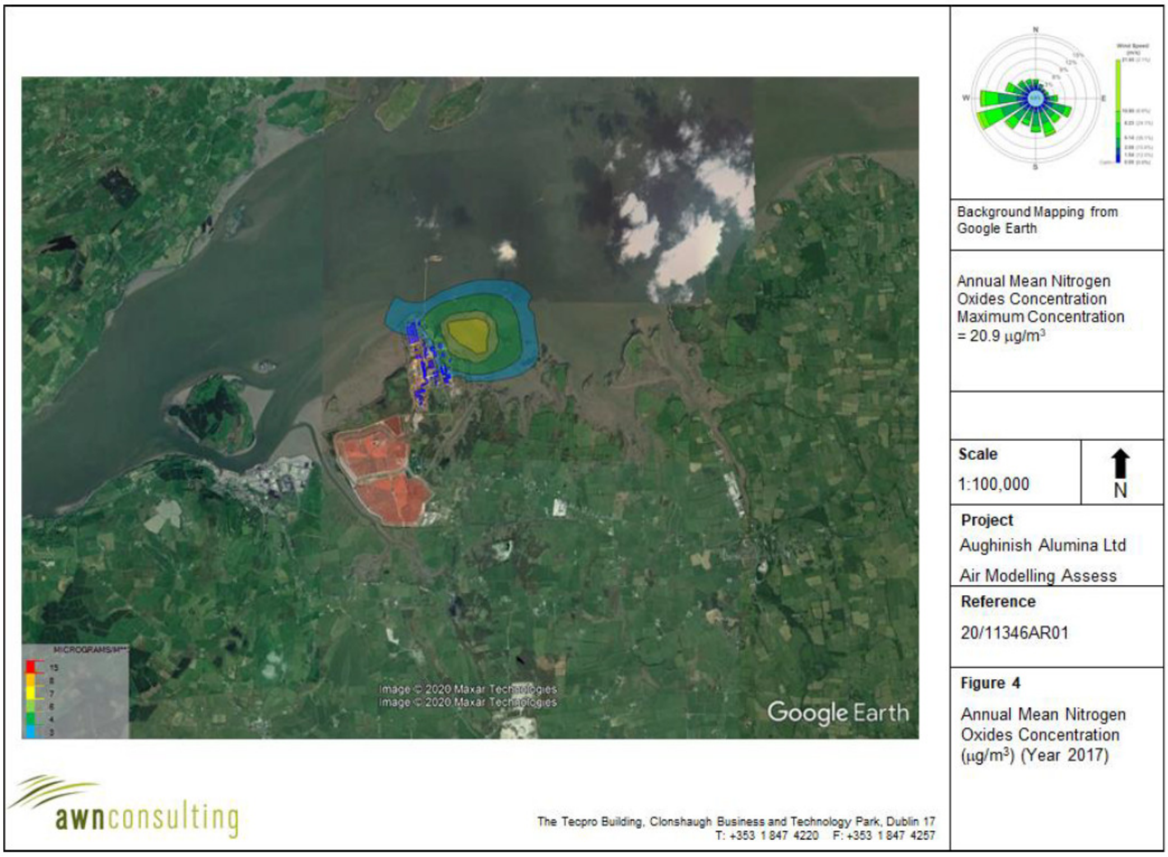


Figure 5.2.1: Annual Mean NOx Concentrations (Source: AWN Consulting, 2020)

To assess the impacts of NOx deposition on the designated habitats in the area of the site, the impacts of emissions on eutrophication (enrichment) at these sites was determined. The critical load for salt marshes and Estuaries, Atlantic Salt Meadows, Mudflats and sandflats was used to reflect the habitat types surrounding the AAL plant. The dry deposition flux was calculated at 0.0314 µg/m^2/s or 3.01 kg/ha/year as N. The United Nations Economic Commission for Europe (UNECE) 2010 critical load for salt marshes is 20-30 kg/ha/y, with the critical load for Estuaries, Atlantic Salt Meadows, Mudflats and sandflats being 8-15 kg/ha/y. The predicted critical load (3.01 kg/ha/yr) is significantly lower than the limit. Consequently, the NOx emissions will not significantly impact on the ecology around the site.

<u>CO Emissions</u>

The predicted carbon monoxide levels for the baseline scenario for emissions from the site are given in Table 5.9. The results demonstrate that the predicted ground level concentrations, including background, are below the relevant air quality standards for CO. For the worst-case year, emissions from the site lead to an ambient CO concentration (including background) which is 6% of the maximum ambient 8-hour limit value. The limits given in Table 5.9 are for the protection of human health. There are no corresponding limits for the protection of vegetation and ecosystems, but as is illustrated in the table below the predicted levels, including background are significantly less than the standard limits (10 mg/m^3). The air dispersion modelling contour plot for carbon monoxide (8-hour maximum levels) is shown in Figure 5.2.2.

Table 5.9: Predicted Carbon Monoxide levels

Pollutant/Year	Averaging Period	Predicted Concentration CO (mg/m^3)	Standard (mg/m^3)
CO/2015	8-Hr Max	0.59	10
CO/2016	8-Hr Max	0.59	10
CO/2017	8-Hr Max	0.59	10
CO/2018	8-Hr Max	0.59	10
CO/2019	8-Hr Max	0.59	10

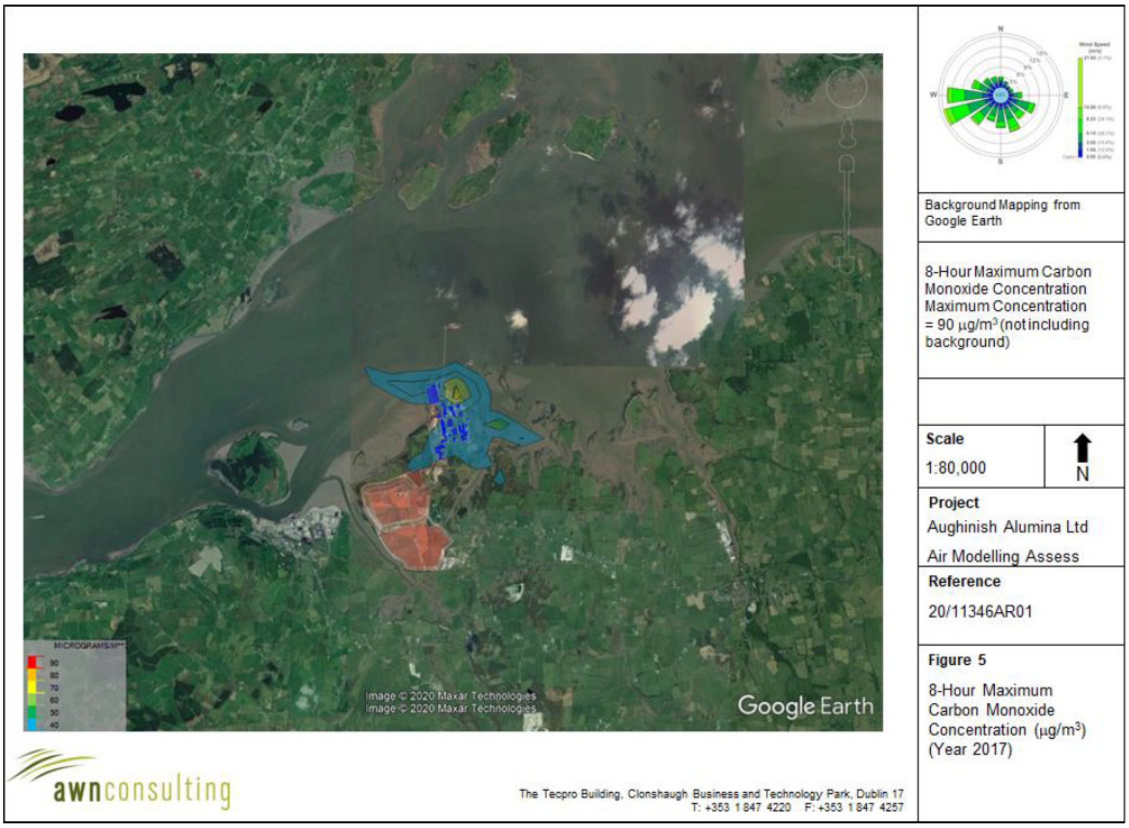


Figure 5.2.2: 8-Hour Maximum Carbon Monoxide Levels (Source: AWN Consulting, 2020)

<u>PM_{10} Emissions</u>

The predicted annual mean PM_{10} levels for the baseline scenario, including background are shown in Table 5.10 and Figure 5.2.3. The modelling results for the baseline scenario show that ambient ground level concentrations are below the relevant air quality standards for PM_{10}. Worst case scenario including background the site leads to a PM_{10} concentration which is 66% of the maximum ambient 24-hour limit value and 46% of the annual limit at the worst-case receptor.

Table 5.10: Predicted PM_{10} levels

Pollutant/Year	Averaging Period	Predicted Concentration PM_{10} (µg/Nm^3)	Standard (µg/Nm^3)
PM_{10}/2015	Annual Mean	17.9	40
PM_{10}/2016	Annual Mean	18.4	40
PM_{10}/2017	Annual Mean	18.0	40
PM_{10}/2018	Annual Mean	17.6	40
PM_{10}/2019	Annual Mean	18.3	40

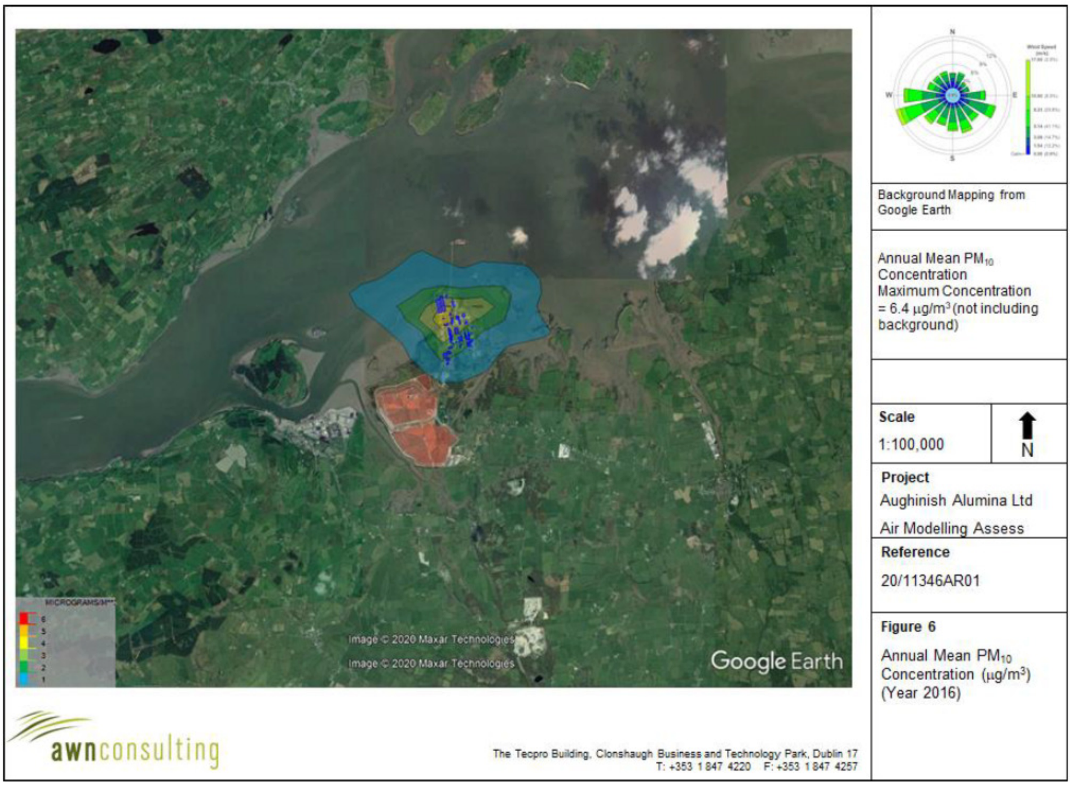


Figure 5.2.3: Annual Mean PM_{10} levels (Source: AWN Consulting, 2020)

<u>$PM_{2.5}$ emissions</u>

The $PM_{2.5}$ modelling results for the baseline scenario show that the ambient ground level concentrations are below the relevant air quality standards for $PM_{2.5}$. The worst-case year emissions from the site lead to an ambient $PM_{2.5}$ concentration (including background) which is 54% of the annual limit value at the worst-case receptor.

Alternative Scenario

NO_2 Emissions

The NO_2 modelling for the alternative scenario demonstrates that the ambient ground level concentrations are below the relevant air quality standard for NO_2. Worst case year emissions from the site show an ambient NO_2 concentration (including background) which is 52% of the maximum 1-hour limit value (200 µg/Nm^3) and 44% of the annual limit (40 µg/Nm^3) at the worst-case receptor. The predicted maximum 1-hour is 103.6 µg/Nm^3 and annual is 17.6 µg/Nm^3.

The nitrogen critical load for this scenario using the default deposition velocities as given in Section 3.4.2 of AWN, 2020 Air Dispersion Modelling Report, is calculated at 2.99 kg/ha/yr as Nitrogen. Comparing the critical loads for N deposition in with the UNECE, 2010 critical loads of 8-15 kg/ha/yr for estuaries, Atlantic Salt Meadows, Mudflats and sandflats and 23-30 kg/ha/yr for salt marshes, the predicted loading of 2.99 kg/ha/yr is significantly below the recommended deposition levels. The anticipated impacts, based on the modelling predictions, will not be significant on the mudflats.

NOx Emissions

For a worse case year (i.e. highest ambient NOx including background) the predicted ambient NOx concentration (including background) of 20.8 µg/m^3 is 70% of the annual limit value (30 µg/m^3) at the worst-case receptor.

CO Emissions

The model predicted that the ambient ground level concentrations are below the relevant air quality standard for CO. For the worst-case year, emissions from the site show an ambient CO concentration (including background) of 0.59 mg/m^3 which is 6% of the maximum ambient 8-hour limit.

SO_2 Emissions

The model predicted that the ambient ground level concentrations are below the relevant air quality standard for SO_2. For the worst-case year, emissions from the site lead to an ambient SO_2 concentration (including background) of 37 µg/m^3, which is 11% of the maximum 1-hour limit value (350 µg/m^3). The maximum predicted 24-hour level was 21.5 µg/m^3 which is 17% of the allowable 24-hour limit (125 µg/m^3). The predicted annual mean for the protection of vegetation (3.51 µg/m^3) was 18% of the allowable levels (20 µg/m^3).

The predicted annual SO_2 levels 3.51 µg/m^3 which is less than the UNCEN 2010 recommended levels of 10 µg/m^{3}for the protection of lichens or bryophytes and 20 µg/m^{3}for the protection of the environment. The 20 µg/m^3 limit is also given in the 2011 Air Standard Regulations, which reflects the CAFE Directive, for the protection of vegetation.

PM$_{10}$ Emissions

The predicted worst-case emissions from the site (including background) gave a level of 18.4 μg/m^3 which is 46% of the annual limit (40 μg/m^3). The worst-case 90.4%-ile 24-hour level was predicted at 32.8 μg/m^3, which is 66% of the allowable limit of 50 μg/m^3.

PM$_{2.5}$ Emissions

The model predicted for the worst case annual mean PM$_{2.5}$ levels (including background) were 13.6 μg/m^3 which is 55% of the annual mean limit of 25 μg/m^3.

Scenario Three

NO_2

For the worst-case year (i.e. the year of the highest predicted ambient NO_2 levels) predicted concentrations (including background) are 17.6 μg/m^3 NO_2 which is 44% of the allowable standard (40 μg/m^3). The predicted 1-hour NO_2 ground level concentration (including background) is 103.7 μg/m^3 which is 52% of the allowable standard (200 μg/m^3).

NOx Emissions

The model predicts worst-case annual mean NOx concentrations (including background) of 20.7 μg/m^3 which is 69% of the allowable standard of 30 μg/m^3.

The nitrogen critical load for this scenario using the default deposition velocities as given in Section 3.4.2 of AWN, 2020 Air Dispersion Modelling Report, is calculated at 2.98 kg/ha/yr as Nitrogen. Comparing the critical loads for N deposition in with the UNECE, 2010 critical loads of 8-15 kg/ha/yr for estuaries, Atlantic Salt Meadows, Mudflats and sandflats and 23-30 kg/ha/yr for salt marshes, the predicted loading of 2.99 kg/ha/yr is significantly below the recommended deposition levels. The anticipated impacts, based on the modelling predictions, will not be significant on the mudflats.

CO Emissions

The model predicts worst-case maximum 8-hour CO emissions from the site (including background) of 0.59 mg/m^3 which is 6% of the allowable standard of 10 mg/m^3.

SO_2 Emissions

The model predicts worst-case year, 1-hour SO_2 emissions from the site (including background) of 9 61.9 μg/m^3 which is 18% of the allowable standard of 350 μg/m^3. The predicted worst-case 24-hour emissions from the site (including background) is 37.1 μg/m^3 – 30% of the allowable standard of 125 μg/m^3. The model predicts worst-case year, annual SO_2 emissions from the site (including background) of 4.0 μg/m^3 which is 20% of the allowable standard of 20 μg/m^3.

The predicted annual SO_2 levels 3.51 μg/m^3 is less than the UNCEN 2010 recommended levels of 10 μg/m^3 for the protection of lichens or bryophytes and 20 μg/m^3 for the protection of the environment. The 20 μg/m^3 limit is also given in the 2011 Air Standard Regulations, which reflects the CAFE Directive, for the protection of vegetation.

PM$_{10}$ Emissions

The predicted worst-case annual concentrations (including background) gave a level of 18.4 µg/m^3 which is 46% of the annual limit (40 µg/m^3). The worst-case 90.4%-ile 24-hour level was predicted at 32.8 µg/m^3, which is 66% of the allowable limit of 50 µg/m^3.

PM$_{2.5}$ Emissions

The model predicted for the worst case annual mean PM$_{2.5}$ levels (including background) were 13.6 µg/m^3 which is 55% of the annual mean limit of 25 µg/m^3.

5.3 Air Emission – Diffuse Sources

5.3.1 Introduction

The location of the Bauxite Residue Disposal Area (BRDA) is shown in Figure 3.2 and it occupies 94.5 ha in Phase 1 and 74 ha in Phase 2. The BRDA is a dedicated extractive waste facility operated and owned by AAL for the permanent disposal of bauxite residue generated during the alumina extraction process. Bauxite and process related wastes generated during the alumina extractive process are deposited in accordance with the requirements of the IEL. Bauxite residue represents about 99% of the total residue disposed of in the BRDA, with 1% consisting of salt cake, which is deposited in a dedicated specially engineered cell within the BRDA. The bauxite residue is subject to counter-current washing and dewatering via vacuum filtration to provide a high-density slurry. This is pumped to the BRDA and farmed to achieve atmospheric carbonation. Farmed bauxite residue is classified as non-hazardous (LoW 01 03 09) while the salt cake is classified as hazardous.

5.3.2 BAT for the Extractive Waste Industries

The operational controls applied by AAL in the BRDA follows the BAT Guidelines for Extractive Waste Industries and the internationally recognised Canadian Dam Association Guidance. The Extractive Waste Directive (2006/21/EC) requires AAL to design, construct and close and remediate the site and to avoid risk to stability, and risk to the environment. The Extractive Waste Management Plan (EWMP) for the BRDA prepared by AAL and approved by the EPA puts in place a plan for the management, treatment, recovery and disposal of the extractive waste at the site. To meet the objectives of the EWMP, AAL has several programmes to minimise the quantities of waste for example, by only processing high quality bauxite, ensuring maximum extraction efficiency, maximising caustic washing and farming the bauxite residue to maximise compaction and reduce residual caustic. Stability of the bauxite residue is maximised by draining and compacting in situ and continuing monitoring of air quality, surface and groundwater ensures compliance with the conditions of the IE licence. AAL has consulted with Limerick City and County Council with regards to an External Emergency Plan for a BRDA containment failure. The public were consulted on that document. A full Closure and Aftercare Management Plan (CRAMP) has been prepared by AAL and approved by the EPA for the BRDA and financial provisions are approved by the EPA and in place.

5.3.3 Ambient Dust Monitoring

AAL continually monitors ambient dust deposition at 35 locations (DG1-DG35) around the site, 5 of which are external to the site (DG29-DG32; Figure 5.2b).

Ambient particulate monitoring (PM_{10} and $PM_{2.5}$) is conducted at 5 locations around the site; 2 stations on-site and the remaining 3, off-site (Figure 5.2b). Recently AAL added another particulate monitoring station at Fawnamore.

5.3.4 Results of Ambient Air Monitoring

The Annual Environmental Reports (AERs) submitted to the Environmental Protection Agency, as required by their licence, for the period 2014 to 2018, were reviewed. Condition 5.8 and 6.18 of the IEL requires AAL to carry out a programmes of ambient air monitoring both on-site and off-site. The levels of sulphur dioxide, deposited dust, particulate matter (<10 µm and <2.5 µm) must be determined at the ambient air quality monitoring locations. The results are compared to the limits given in the CAFÉ Directive (2008/50/EC) which was transposed into Irish legislation under the Air Quality Standard Regulations 2011 [S.I. No. 180 of 2011]. The following emissions are monitored and reported upon as part of the IEL requirements:

- Deposited Dust
- Particulate Matter (< 10 µm – PM_{10})
- Particulate Matter (< 2.5 µm – $PM_{2.5}$).

The findings of the assessment are given in Table 5.11.

Table 5.11: Summary results related to ambient air monitoring from 2014-2018.

Year	Findings	Compliance with CAFÉ Directive & Air-Quality Standard, 2011
2014	Dust deposition monitoring results were all less than 350 mg/m^2/d. Dust deposition at 2 off-site locations were less than the 350 mg/m^2/d limit. The continuous particulate monitoring stations outside the site boundary all had levels of $PM_{2.5}$ levels (5ug/m^3) at all three sites which is less than the CAFÉ air quality standard of 25 µg/m^3. The Foynes site had a PM_{10} annual mean level of 11 µg/m^3 while the Ballysteen and Limerick City and County Council WTP site had levels of 10 µg/m^3. These are less than the PM_{10} requirements of 40 µg/m^3. Continuous particulate monitoring on site detected $PM_{2.5}$ levels of 14 and 6 µg/m^3 at locations SW and NE of plant respectively. PM_{10} levels for the same locations were 110 and 13 µg/m^3 respectively. AAL reported that air monitoring location 'SW of Plant' is adjacent to a heavily trafficked haul road.	100% Compliance with the TA Luft 350 mg/m^2/d limit and 100 % compliance with the CAFÉ Directive PM_{10} and $PM_{2.5}$ limits. The Location SW of the Plant which had a PM_{10} annual mean level of 110 µg/m^3 is regarded as an on-site source and hence ambient air quality limits (CAFÉ Directive and the 2011 Air Quality Standard Regulations do not apply. The results of the off-site monitoring indicate the ambient air quality at off-site monitoring points is good with the various values in general falling within the relevant targets for those parameters.

Year	Findings	Compliance with CAFÉ Directive & Air-Quality Standard, 2011
2015	Dust deposition monitoring results were all less than 350 mg/m^2/d. Dust deposition monitoring at the 5 off-site locations had levels less than 350 mg/m^2/d. The $PM_{2.5}$ annual mean levels at Foynes, Ballysteen and LCC WTP were 5, 6 and 4 µg/m^3. These levels are less than the CAFÉ Directive limits of 25 µg/m^3. The PM_{10} annual mean levels at Foynes, Ballysteen and LCC WTP were 9, 13 and 9 µg/m^3. The Ballysteen level was higher than the 2014 level of 10 µg/m^3. These levels are less than the CAFÉ Directive limits of 40 µg/m^3. Particulate monitoring on site detected $PM_{2.5}$ levels of 12 and 7 µg/m^3 at locations SW and NE of plant respectively. PM_{10} levels for the same locations were 64 and 16 µg/m^3 respectively. The PM_{10} levels at the SW Plant monitoring location were about half of the 2014 levels.	100% Compliance with the TA Luft 350 mg/m^2/d limit and 100 % compliance with the CAFÉ Directive PM_{10} and $PM_{2.5}$ limits. The results of the off-site monitoring indicate the ambient air quality at off-site monitoring points is good (as defined by EPA ambient air monitoring programme) with all parameters monitored falling within the relevant targets/limits for those parameters.

Year	Findings	Compliance with CAFÉ Directive & Air-Quality Standard, 2011
2016	Dust deposition monitoring results were all less than 350 mg/m^2/d. Dust deposition monitoring at the 5 off-site locations had levels less than 350 mg/m^2/d. The $PM_{2.5}$ annual mean levels at Foynes, Ballysteen and LCC WTP were 4, 3 and 2 µg/m^3. These levels are less than the CAFÉ Directive limits of 25 µg/m^3. The PM_{10} annual mean levels at Foynes, Ballysteen and LCC WTP were 9, 7 and 4 µg/m^3. These levels are less than the CAFÉ Directive limits of 40 µg/m^3. Particulate monitoring on site detected $PM_{2.5}$ levels of 7 and 6 µg/m^3 at locations SW and NE of plant respectively. PM_{10} levels for the same locations were 36 and 18 µg/m^3 respectively. The PM_{10} levels at the SW Plant monitoring location were about half of the 2015 levels.	100% Compliance with the TA Luft 350 mg/m^2/d limit and 100 % compliance with the CAFÉ Directive PM_{10} and $PM_{2.5}$ limits. The results of the off-site monitoring indicate the ambient air quality at off-site monitoring points is good (as defined by EPA ambient air monitoring programme) with all parameters monitored falling within the relevant targets/limits for those parameters.

Year	Findings	Compliance with CAFÉ Directive & Air-Quality Standard, 2011
2017	Dust deposition monitoring results were all less than 350 mg/m^2/d. Dust deposition monitoring at the 5 off-site locations had levels less than 350 mg/m^2/d. The $PM_{2.5}$ annual mean levels at Foynes, Ballysteen and LCC WTP were 6, 6 and 5 µg/m^3. These levels are less than the CAFÉ Directive limits of 25 µg/m^3, but slightly up from the 2016 levels detected at these stations. The PM_{10} annual mean levels at Foynes, Ballysteen and LCC WTP were 9, 9 and 9 µg/m^3. These levels are less than the CAFÉ Directive limits of 40 µg/m^3. Particulate monitoring on site detected $PM_{2.5}$ levels of 7 and 8 µg/m^3 at locations SW and NE of plant respectively. PM_{10} levels for the same locations were 14 and 13 µg/m^3 respectively. The PM_{10} levels at the SW Plant monitoring location have significantly reduced form the 2016 levels.	100% Compliance with the TA Luft 350 mg/m^2/d limit and 100 % compliance with the CAFÉ Directive PM_{10} and $PM_{2.5}$ limits. The results of the off-site monitoring indicate the ambient air quality at off-site monitoring points is good (as defined by EPA ambient air monitoring programme) with all parameters monitored falling within the relevant targets/limits for those parameters.

Year	Findings	Compliance with CAFÉ Directive & Air-Quality Standard, 2011
2018	Dust deposition monitoring results were all less than 350 mg/m²/d. Dust deposition monitoring at the 5 off-site locations had levels less than 350 mg/m²/d. The levels of $PM_{2.5}$ detected at Foynes, Ballysteen and Limerick County Council water treatment plant were 6.5 µg/m³, 6.1 µg/m³ and 6.6 µg/m³ respectively which is below the CAFÉ Directives limit of 25 µg/m³. The levels of PM_{10} at these sites were 10.9 µg/m³, 8.2 µg/m³ and 8.8 µg/m³ respectively. These levels are below the CAFÉ Directive limits of 40 µg/m³. The on-site PM_{10} and $PM_{2.5}$ monitoring locations (SW of Plant and NE of Plant) had $PM_{2.5}$ levels of 5.9 µg/m³ and 10.1 µg/m³ respectively. The PM_{10} levels at these sites were 12.5 µg/m³ and 18.6 µg/m³ respectively.	100% Compliance with the TA Luft 350 mg/m²/d limit and 100 % compliance with the CAFÉ Directive PM_{10} and $PM_{2.5}$ limits. The results of the off-site monitoring indicate the ambient air quality at off-site monitoring points is good (as defined by EPA ambient air monitoring programme) with all parameters monitored falling within the relevant targets/limits for those parameters.

5.3.5 Impacts of air emissions on the environment and ecology of the area

The review of the monitoring results (Table 5.11) for ambient air sampling shows full compliance with the National Air Quality Standards for PM_{10} and $PM_{2.5}$, the TA Luft guideline value for dust deposition and the requirements of the CAFÉ Directive.

AWN Consulting was retained by AAL to conduct an air quality assessment of the BRDA (Appendix 4). The assessment looked at the potential impacts of dust, PM_{10} and $PM_{2.5}$ and heavy metal emissions from the BRDA on the nearby designated sites. AERMOD was used to model emission and 5 years of metrological data from Shannon Airport was used to get worst-case metrological conditions. The model was validated using monitoring results for an ambient air quality survey undertaken over the 12 months of 2019. The predicted modelling results were compared to the 2008/50/EC (CAFÉ Directive) limits for PM_{10} and $PM_{2.5}$, the TA-Luft guideline value for dust deposition as shown in Table 5.12 below. The predicted metal concentrations were compared against relevant environmental assessment levels as outlined in the AWN modelling report included in Appendix 4.

Table 5.12: European Ambient Air Quality Standards Limits

Air Pollutant	Regulations	Limit Type	Value
Particulate Matter (PM_{10})	2008/50/EC	24-hour limit for the protection of human health. Annual limit for the protection of human health	50 µg/m^3 40 µg/m^3
Particulate Matter ($PM_{2.5}$)	2008/50/EC	Annual limit for the protection of human health	25 µg/m^3
Dust Deposition	TA-Luft	Dust deposition limits at site boundary	350 mg/m^2/d

PM_{10} and $PM_{2.5}$

The following is a discussion on the findings of the air dispersion model for the BRDA. The predicted PM_{10} and $PM_{2.5}$ results for the model, including background concentrations are shown in Table 5.13 below.

Table 5.13: PM_{10}/$PM_{2.5}$ Modelling results Including Background (µg/m^3)

Met Data	Receptor	Annual Mean PM_{10} (ug/m3)	Max. 24-hr PM_{10} (ug/m3)	Annual Mean $PM_{2.5}$ (ug/m3)
2015	Lower River Shannon SAC, River Shannon and Fergus SPA. Barrigone SAC.	13.2	24.3	8.4
2016		12.6	21.0	7.9
2017		12.8	20.8	8.0
2018		18.3	22.3	13.5
2019		12.9	20.8	8.1
Limit Value		40	50	25

The annual mean PM_{10} concentrations (µg/m^3) at 98% abatement efficiency is given in Figure 5.3.1. Figure 5.3.2 shows the model plot for the 90%-ile maximum PM_{10} concentrations at 98% abatement efficiency. These contour plots exclude background data.

The results of the model show that the peak concentrations recorded are generally to the north and east of the BRDA boundary. PM_{10} concentrations rapidly decline away from the site boundary. The annual peak PM_{10} concentrations peak at 18.3 µg/m^3 which is 46% of the allowable limit of 40 µg/m^3. The maximum 24-hour PM_{10} level was predicted at 24.3 µg/m^3. This level is 49% of the limit value at the boundary of the Lower Shannon SAC/River Shannon and Fergus River SPA and the Barrigone SAC. The annual mean predicted $PM_{2.5}$ concentrations peak at 13.5 µg/m^{3}at the boundary of the Lower Shannon SAC/River Shannon and Fergus River SPA and the Barrigone SAC.

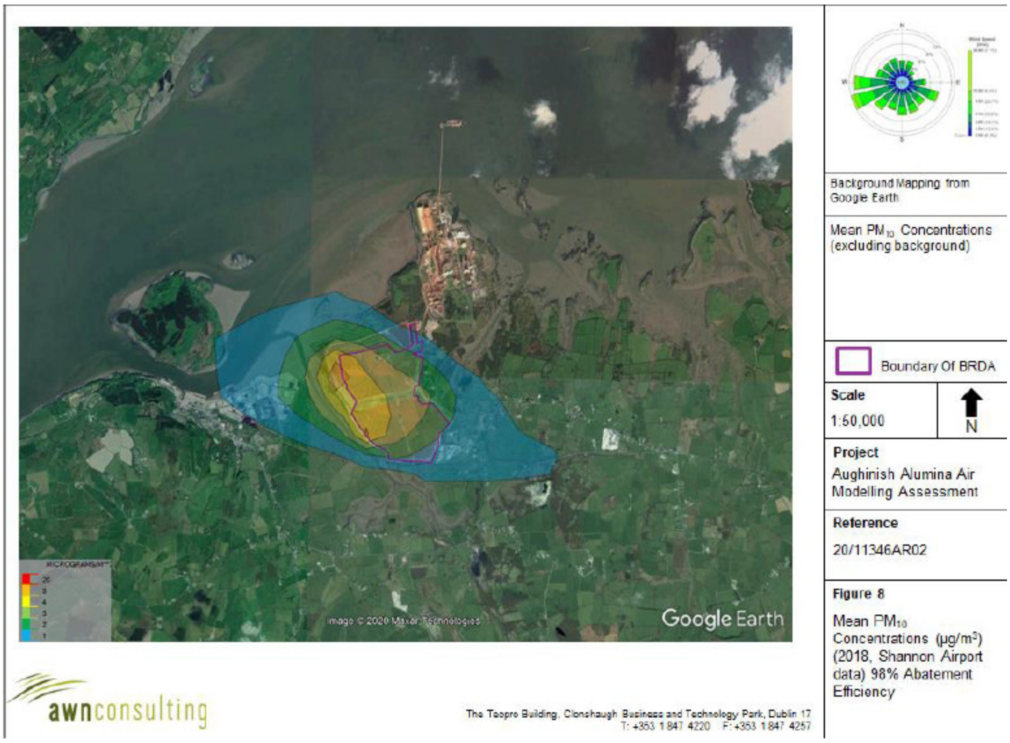


Figure 5.3.1: Annual Mean PM_{10} Concentrations (excluding Background). (Source: AWN Consulting, 2020)

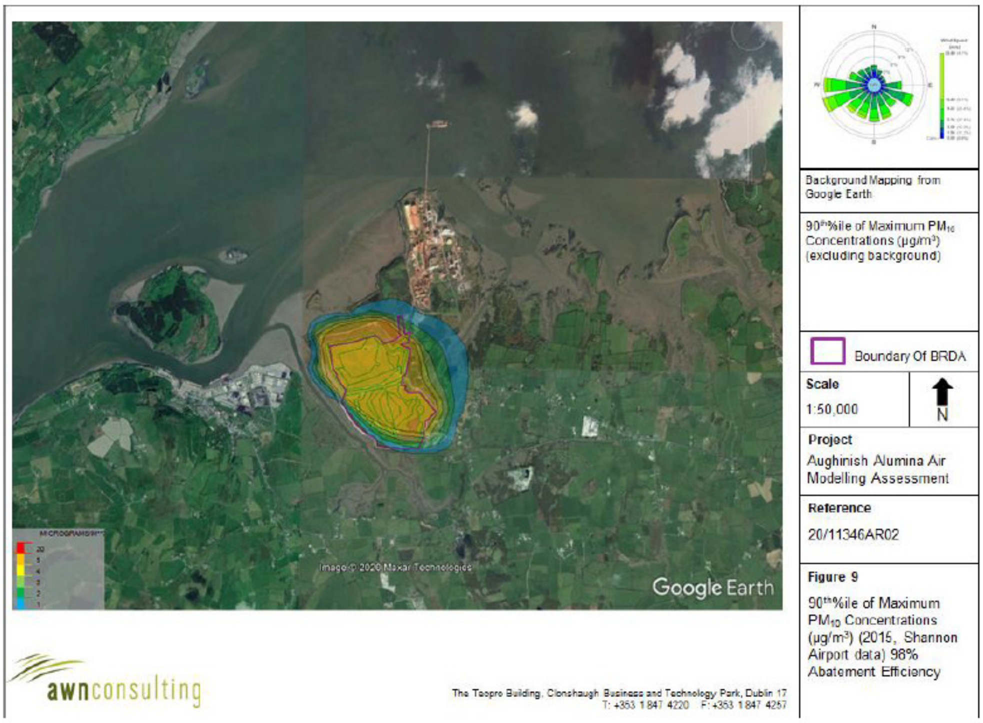


Figure 5.3.2: 24-hour 90%-ile PM_{10} (excluding background). (Source: AWN Consulting, 2020)

<u>Dust Deposition</u>

The predicted annual mean dust depostion reults are given in Table 5.14 below. The values are the sum of wet and dry deposition and represent the total deposition. Dry deposition acocunts for at 99.5% of the reported total dust deposition levels.

Table 5.14: Total Dust predicted concentrations for 2015-2019 including background (mg/m²/d).

Year	Receptor	Annaul Mean Total Dust Deposition (mg/m²/d)
2015	Lower River Shannon SAC, River Shannon and Fergus SPA. Barrigone SAC.	61.4
2016		32.8
2017		24.8
2018		39.0
2019		34.1
Limit Value		**350**

The contour plot below shows the predicted total dust deposition (mg/m²/d)excluding background deosposition levels.

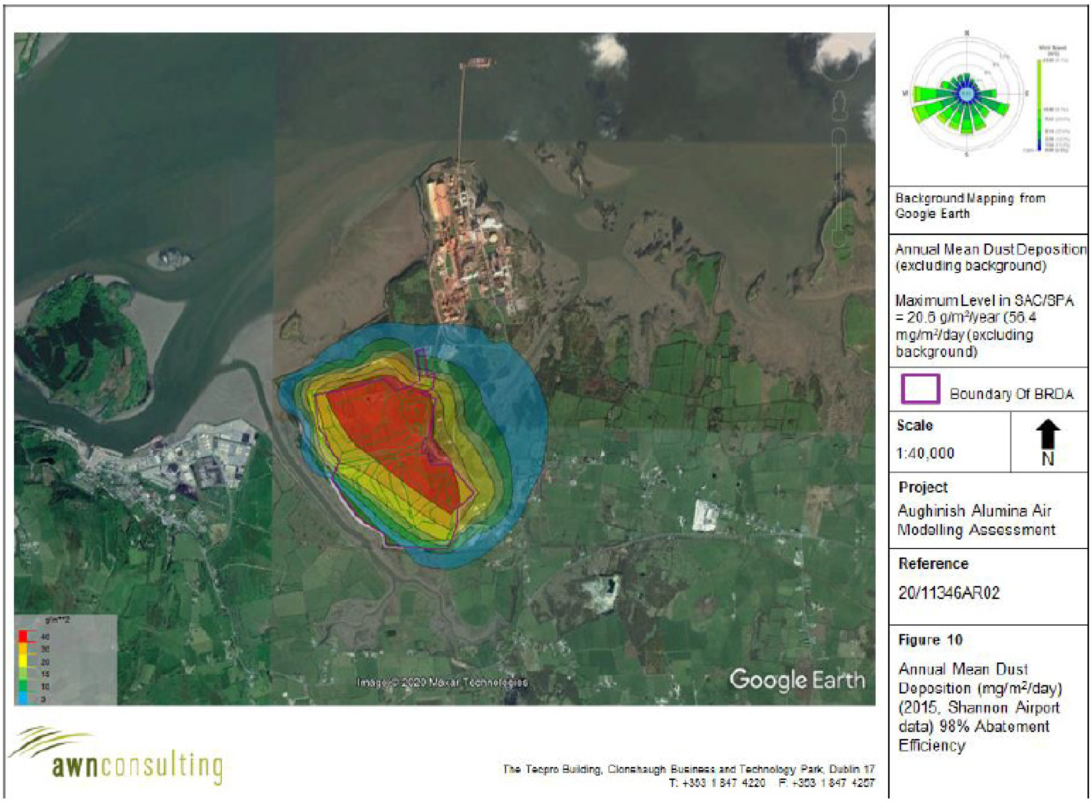


Figure 5.3.3: Predicted Dust Deposition modelling results. (Source: AWN Consulting, 2020)

The plot illustrates that the peak deposition occurs to the north and east of the BRDA boundary with a rapid fall-off on dust as one moves away from the site boundary. AWN (2020) reports that the dust nuisance criteria of 350 $mg/m^2/d$ will not be exceeded in the Lower River Shannon SAC, River Shannon and Fergus SPA. Barrigone SAC.

Heavy Metals

The heavy metal Ambient Air Quality Standards & Guidelines for the Protection of Human Health are summarised in Table 5.15. The air dispersion modelling for the heavy metals assumed that the percentage of heavy metals identified in the sampling of the bauxite residue over 2015-2019 are emitted and dispersed by the atmosphere in the same ratios. Modelling was based on the average sample results for the heavy metals identified in the bauxite residue over this period. These are shown in Table 5.16. The predicted heavy metal concentrations are based on the maximum modelling PM_{10} annual mean concentration to reflect the percentage of heavy metals in the dust. The results show that the predicted annual concentrations for 2015, 2016, 2017 2018 and 2019 for the heavy metals are within the relevant environmental assessment levels and will not impact on the Lower River Shannon SAC, River Shannon and Fergus SPA or Barrigone SAC.

The results of the air dispersion modelling for dust from the BRDA demonstrates that the predicted levels of heavy metals are less that their corresponding Council Directive 2004/107/EC air limits, the Environmental Agency IPPC H1 – Environmental Assessment of BAT and the WHO (2000) Air Quality Guidelines for Europe. The modelling output shows that the fugitive emissions from the BRDA were within air quality guidelines and the results show that the levels will not pose a risk to the designated sites.

Table 5.15: Heavy Metal Ambient Air Quality Standards & Guidelines for the Protection of Human Health.

Metal	Long term EAL (annual)	Regulation
Cadmium	0.005 µg/m^3	EU[1] / EAL[2]
Titanium	40 µg/m^3	EAL[2]
Inorganic Mercury (as Hg)	1 µg/m^3	WHO[3]
Aluminium	20 µg/m^3	EAL[2]
Arsenic	0.006 µg/m^3	EU[1] / EAL[2]
Lead	0.5 µg/m^3	EU[1]
Chromium (except VI)	5.0 µg/m^3	EAL[2]
Chromium (VI)	0.0002 µg/m^3	EAL[2]
Iron	10 µg/m^3	EAL[2]
Manganese	100 µg/m^3	EAL[2]
Copper (dusts & mists)	10 µg/m^3	EAL[2]
Zinc	50 µg/m^3	EAL[2]
Nickel (inorganic)	0.020 µg/m^3	EU[1]

[1]Council Directive 2004/107/EC [2]Environmental Agency IPPC H1 – Environmental Assessment of BAT [3]WHO (2000) Air Quality Guidelines for Europe.

Table 5.16: Predicted Heavy Metal Concentrations Based on Shannon Airport Met Data 2015-2019 (μg/m³). Based on average bauxite residue concentration (mg/Kg)

Shannon Airport	Al*	As*	Cd*	Cr*	Cu*	Fe*	Pb*	Mg*	Hg*	Ni*	Ti*	Zn*
Soil Units	mg/Kg	mg/Kg	mg/Kg	mg/Kg	mg/Kg	mg/Kg	mg/Kg	mg/Kg	mg/Kg	mg/Kg	mg/Kg	mg/Kg
Average Soil Levels	164,191	2.5	1.4	164.1	9.5	10,928	16.2	195.5	0.0	1.9	9480	44.3
Air Modelling Units	μg/m³	ng/m³	ng/m³	μg/m³	μg/m³	μg/m³	μg/m³	μg/m³	ng/m³	ng/m³	μg/m³	μg/m³
Predicted Annual Concentration 2015	0.197	0.003	0.002	2.0E-04	1.1E-05	0.013	1.9E-05	2.3E-04	3.0E-06	2.3E-03	1.1E-02	5.3E-05
Predicted Annual Concentration 2016	0.099	0.002	0.001	9.8E-05	5.7E-06	0.007	9.7E-06	1.2E-04	1.5E-06	1.1E-03	5.7E-03	2.7E-05
Predicted Annual Concentration 2017	0.131	0.002	0.001	1.3E-04	7.6E-06	0.009	1.3E-05	1.6E-04	2.0E-06	1.5E-03	7.6E-03	3.5E-05
Predicted Annual Concentration 2018	1.034	0.016	0.009	1.0E-03	6.0E-05	0.069	1.0E-04	1.2E-03	1.6E-05	1.2E-02	6.0E-02	2.8E-04
Predicted Annual Concentration 2019	0.148	0.002	0.001	1.5E-04	8.6E-06	0.010	1.5E-05	1.8E-04	2.3E-06	1.7E-03	8.5E-03	4.0E-05
Annual Limits	**20**	**6**	**5**	**5**	**10**	**10**	**0.5**	**100**	**250**	**20**	**40**	**50**

5.3.6 Impacts of the Proposed Borrow Pit on Air Quality

The proposed borrow pit is located within the AAL site boundary and will provide about 374,000m^3 of rock for the BRDA over a period of 10 years. An air dispersion model (AERMOD) was prepared as part of the planning permission application for the proposed borrow pit (planning granted by An Bord Pleanála - 301011-18) to predict the emissions of PM_{10} and $PM_{2.5}$ from proposed site operations. Dust generation rates were calculated from factors derived from empirical assessment. Worst case emissions were modelled. The modelling found that:

- There is negligible potential for impacts from soiling, PM_{10} and to vegetation during the construction phase.
- Blasting and crushing will be restricted to a period between April to September (outside of the overwintering period for birds) to minimise impacts on ecology/species. Blasting will take place about every 3 weeks and the operation hours of the pit will be 8.00 am to 6.00 pm.
- Dust deposition from operations at the borrow pit will average 4.96 mg/m^2/d over a full year. This emission rate combined with the background dust deposition rate of 37 mg/m^2/d will contribute only 12% of the TA Luft air deposition limits of 350 mg/m^2/d. The impacts of borrow pit operations on dust deposition will be a long-term negligible impact.
- The predicted worst-case 24-hour PM_{10} concentrations (90%-ile) was 13.6 µg/m^3. Based on a background PM_{10} level of 12 µg/m^3, the combined predicted annual level is 20.6 µg/m^3. The predicted annual PM_{10} is 8.6 µg/m^3. The operation of the borrow pit will increase the ambient mean PM_{10} levels by (at worst) 0.07 µg/m^3. This increase is not significant and the predicted levels are within the requirements of the CAFÉ Directive, which is primarily aimed at the protection of human health. Compliance with these limits, as demonstrated by the model, will ensure protection of the designated habitats around the site.
- Based on worst case scenarios the annual $PM_{2.5}$ concentration from the borrow pit and including background concentrations of $PM_{2.5}$ will be 11.48 µg/m^3, which is less that the 25 µg/m^3 limit given in the CAFÉ Directive.

In summary operations at the proposed borrow pit with the proposed mitigation measures, will ensure that no significant impact on the designated ecology/habitats around the site will arise.

5.4 Emissions to Surface Water, Transitional Water and Marine

5.4.1 Introduction

This section of the report discusses discharges to surface water, transitional waters and the marine.

5.4.2 Sources of Water Emissions

The main sources of water emissions from the plant are:

- The wastewater treatment plant – discharge point W1-1 (see Figure 5.4.1).
- Sanitary effluent via the wastewater treatment plant – discharge point W1-1.
- Stormwater from the northern section of the site is directed to the Shannon Estuary via silt traps at emission points SS1 to SS5. A separate drainage system is engaged for the southern portion of the site, which contains all the main processing areas and the BRDA. This stormwater is sent to the on-site effluent treatment plant and discharged to the Shannon Estuary via licenced discharge point W1-1.

5.4.3 Relevant Legislation

Legislation covering discharges for a facility includes:

- The Water Framework Regulations
- 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
- SI No. 272 of 2009, European Communities Environmental Objectives (Surface Waters) Regulations, 2009
- SI No. 386 of 2015, European Communities Surface Water Regulations (Amendment).

5.4.4 Licenced Emission Limit Values for Water Emissions

AAL is required by their licence to control and monitor water emissions from the site. Schedule B, Section B.2 – Emissions to Water sets out the emission limit values for treated effluent to the Shannon Estuary. A maximum daily volume of 30,000 m^3 at a maximum hourly rate of 1,250 m^3 is permitted. Section C.2.2 – Monitoring of Emissions to Water requires AAL to monitor flow, temperature, pH, biochemical oxygen demand, suspended solids, soda, aluminium, oils, fats & greases, toxicity, and heavy metals (Mg, Al, As, Cd, Cr, Cu, Fe, Hg, Pd, Zn and Ti).

The drainage system on the southern part of the site which contains the processing areas and the BRDA is directed to the wastewater treatment plant and discharges at W1-1. Sanitary effluent is treated by a dedicated activated sludge plant. This discharge from the sanitary treatment system joins with the treated process effluent flow and ultimately discharges also at licensed emission point W1-1.

Surface water generated at the northern section of the site (raw material storage area) is discharged to a number of discharge locations (SS1, SS2, SS3, SS4 and SS5; Figure 5.4.2). The licence requires levels of soda, conductivity and pH to be recorded monthly at these locations. Surface water trigger values for SS1-SS5, which are agreed with the EPA, are given in Table 5.17.

Table 5.17: Storm water trigger values for SS1-SS5.

Parameter	Warning Level	Action Level
pH	≤6.5≥9	≤6≥9.5
Conductivity (uS/cm)	>2000	>2500
Soda (g/l)	>1.5	>2

Surface water in the area of the BRDA requires monthly monitoring for pH, conductivity and soda.

5.4.5 Review of Monitoring Results

The AERs for 2014 – 2018 were reviewed and the findings are summarised in Table 5.18 below.

Table 5.18: Summary of the review of effluent monitoring results for 2014-2018 against licence limits

Parameter	2014	2015	2016	2017	2018	Licence Limits
Volume of Process Effluent (m^3)	5,239,106	5,479,337	4,844,726	4,977,404	4,656,823	10,950,000 m^3/yr
BOD (tonnes)	367.4	160.3	372.9	256,7	292.1	861.4 tonnes/yr
Suspended Solids (tonnes)	68.5	70.3	80.1	78,8	54.3	547.5 tonnes/yr
Oils, fats & grease (tonnes)	5.2	5.5	5	5	4.7	164.3 tonnes/yr
Toxicity (TU)	<5	<5	<5	<5	<5	5 TU

The monthly pH, Conductivity and soda levels for surface water discharge monitoring points SS1, SS2, SS3, SS4 and SS5 are given in the following tables for 2014 – 2018 (Table 5.19a-Table 5.19e).

Figure 5.4.1 Licensed Surface Water emission point

Figure 5.4.2 Licensed Storm Water Emission Point

Table 5.19a: Surface Water Discharge Monitoring Results for 2014

Emission Ref.	pH	Conductivity (µS/cm)	Soda (mg/l)
Frequency	Monthly	Monthly	Monthly
SS1	8.4	153	0.007
SS2	8.2	182	0.014
SS3	8.1	252	0.01
SS4	8.2	152	0.01
SS5	8.4	923	0.155

Table 5.19b: Surface Water Discharge Monitoring Results for 2015

Emission Ref.	pH	Conductivity (µS/cm)	Soda (mg/l)
Frequency	Monthly	Monthly	Monthly
SS1	8.5	112	0.02
SS2	8.3	181	0.01
SS3	8.1	171	0.02
SS4	8.2	180	0.02
SS5	8.3	314	0.05

Table 5.19c: Surface Water Discharge Monitoring Results for 2016

Emission Ref.	pH	Conductivity (µS/cm)	Soda (mg/l)
Frequency	Monthly	Monthly	Monthly
SS1	8.7	146	0.02
SS2	8.2	244	0.02
SS3	8.1	257	0.02
SS4	8.1	121	0.01
SS5	8.3	306	0.04

Table 5.19d: Surface Water Discharge Monitoring Results for 2017

Emission Ref.	pH	Conductivity (µS/cm)	Soda (mg/l)
Frequency	Monthly	Monthly	Monthly
SS1	8.3	136	0.02
SS2	8.2	203	0.01
SS3	8.4	174	0.01

Emission Ref.	pH	Conductivity (µS/cm)	Soda (mg/l)
SS4	8.2	94	0.01
SS5	8.3	279	0.03

Table 5.19e: Surface Water Discharge Monitoring Results for 2018

Emission Ref.	pH	Conductivity (µS/cm)	Soda (mg/l)
Frequency	Monthly	Monthly	Monthly
SS1	8.4	257	0.02
SS2	8.3	152	0.01
SS3	8.4	158	0.01
SS4	8.1	144	0.02
SS5	8.2	245	0.02

Wastewater volumes and mass emissions for biochemical oxygen demand, suspended solids and oil fat & greases for 2014 to 2018 were within the licence limits for these parameters (see Table 5.19 above for licenced limits for these parameters). It is noted that during the review of the licence in 2011 (P0035-05), it was concluded that the biochemical oxygen demand limits and loadings from the wastewater treatment plant met the requirements of the EC Environmental Objectives (Surface Water) Regulations 2009 [S.I. No. 272 of 2009].

Aquafact International Services Ltd. undertook a baseline water characterisation survey around the Aughinish Port in 2018 (see Figure 5.4.3; Appendix 5). Sampling was carried out at various stages of the tide and the water samples were submitted to the laboratory for a range of analysis including biochemical oxygen demand, chemical oxygen demand, total organic carbon, polyaromatic hydrocarbons, BTEX (Benzene, Toluene, Ethylbenzene, and Xylene), phenols, Total Nitrogen, Total Inorganic Nitrogen, Phosphorus and heavy metals.

The findings of the assessment showed that:

- Volatiles, phenols and BTEX were non-detectable upstream, and downstream of the jetty.
- Total dissolved solid (TDS) results ranged from 1,910 - 2,330 mg/l at mid-ebb, 1,736 – 2,136 mg/l at low water and 2,247 - 2,506 mg/l at mid-flood. Concentrations of TDS vary consistently upstream and downstream of the discharge.
- Total Nitrogen levels were low and consistent upstream and downstream of the jetty.
- The levels of zinc in the water samples were higher than the other heavy metals (lead, mercury, copper, nickel, vanadium, chromium, cadmium, and barium) detected. The levels of zinc ranged from 91 µg/l to 505 µg/l. The highest level was recorded 500 m downstream of the jetty at mid-ebb.
- Mercury levels varied from less than the detection levels (0.03 µg/l) to 2.14 µg/l, 500 m upstream of the jetty on a low tide.

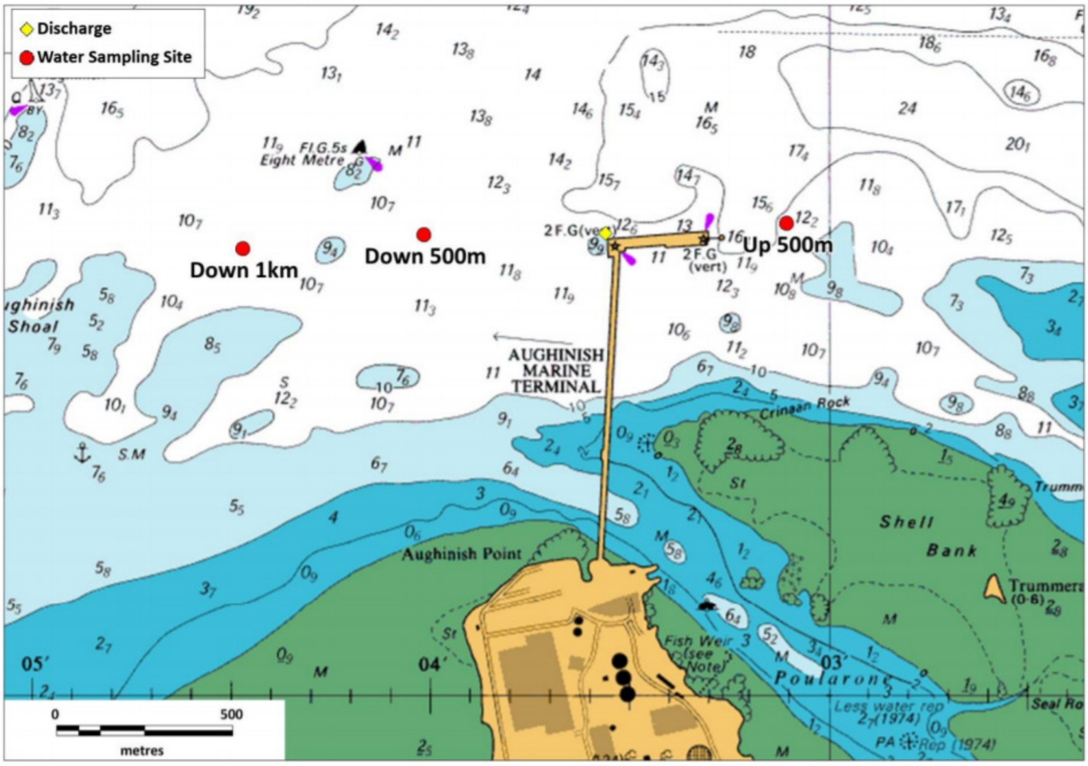


Figure 5.4.3: Water Sampling Locations, April 2018 (Aquafact, 2018)

A repeat baseline water characterisation survey was carried out in February 2019 (Aquafact 2019; Appendix 6). The monitoring results found:

- Volatiles, phenols and BTEX were non-detectable upstream, and downstream of the jetty.
- Mercury levels were all below the method limits of detection at all sampling locations (<0.03 µg/l)
- Zinc levels were lower than the previous sampling event in 2018. The highest concentration of zinc detected was 82 µg/l on a mid-flood tide 500 m upstream of the jetty.
- Total dissolved solids (TDS) levels were significantly higher than the previous sampling event in 2018. TDS levels ranged from 12,833-14,045 mg/l at mid-ebb, 10,510-15,682 mg/l at low water and 16,289-20,083 mg/l at mid-flood.

5.4.6 The Impact of effluent emissions on the Designated Sites

Untreated process effluent is slightly alkaline and contains traces of sodium aluminate and sodium carbonate. The effluent is collected in ponds prior to pumping to the effluent neutralisation and clarification area. The effluent is neutralised using concentrated sulphuric acid and a fine aluminium hydroxide precipitate is generated. Up to 5 g/l suspended aluminium hydroxide is generated and this is flocculated using an anionic flocculant. The flocculate is clarified in a raked gravity settler.

The supernatant from this process is pumped to a Liquid Waste Pond where it can be used to supply the automated sprinkler system on the BRDA or discharged to the river as a treated neutralised effluent in accordance with licence requirements. A portion of the sludge is recycled back to the neutralisation tank to seed the fresh precipitate. Some of the sludge is transferred to the alumina production process to help keep the recycling sludge inventory in the effluent neutralisation tank in balance.

Sanitary effluent is pumped to the sanitary effluent treatment plant on-site. The effluent undergoes primary treatment via an influent tank which breaks up and physically removes some of the waste. The primary treated effluent is forward pumped to the activated sludge tank where organic material is broken down. The treated effluent discharges to a secondary clarifier where the activated sludge settles to the bottom of the tank and some of it is wasted and some returned to the activated sludge tank to ensure a correct food:microorganism ratio. The supernatant (the treated effluent) from the clarifier is pumped into an effluent tank before it is discharged to the River Shannon via W1-1 licensed emission point.

As discussed above, the IEL sets limits on maximum discharge rates and the licence stipulates emission limit values and monitoring requirements and frequencies for the effluent. Determination of the levels of heavy metals in the effluent is required, but no emission limit values are set in the licence.

In accordance with the Waste Water Discharge (Authorisation) Regulations 2007, the EPA cannot grant an authorisation for a waste discharge which, in the opinion of the Agency, can cause a deterioration in the chemical status or exclude or compromise the achievement of the objectives established for protected species and natural habitats. The ecological constraint applies in the case of European Sites where the maintenance or improvement of the status of water is important. Consequently, compliance with the discharge limits specified in the licence will help to maintain or improve the chemical and ecological status of the Shannon Estuary. A review of the EPA's Catchment website (www.catchments.ie) shows that the current water quality status of the Lower Shannon Estuary is moderate. The water quality in the Lower Shannon Estuary was classified as moderate between 2007-2009, good water quality for 2010-2012 and moderate between 2012 and 2015. The Water Framework Risk assessment of the estuary classifies that water quality in the estuary is at risk of deteriorating or being at less that Good status in the future. The EPA in their Shannon South Estuary Catchment Assessment 2010-2015 (HA 24) report lists agriculture and industry as significant pressure affecting the Shannon Estuary.

The review of the effluent monitoring results (see Table 5.18) shows that effluent quality meets the requirements of the ELV's given in the IEL. Although no ELV's are given in the licence for heavy metals a review was conducted of the results presented in the AER's for 2014-2018. Table 5.20 below shows the range of levels of heavy metals in the discharge from the site for the various years.

Table 5.20: Average annual levels of heavy metals and soda in process effluent levels from W1-1

Metal (mg/l)	2014	2015	2016	2017	2018
As	0.065	0.049	0.067	0.033	0.055
Cr	0.015	0.0065	0.011	0.016	0.015
Cu	0.011	0.018	0.01	0.016	0.005
Pb	0.0002	0.0003	0.0006	0.0051	0.0007
Zn	0.004	0.18	0.006	0.006	0.054
Al	1.51	2.44	2.62	2.04	3.02
Cd	0.0007	0.009	0.0018	0.0054	0.00075
Fe	0.0635	0.0695	0.138	0.016	0.227
Mg	1.61	3.5	7.52	786*	0.048
Hg	0.001	0.009	0.015	0.006	0.002
Ti	0.0015	0.0055	0.007	0.005	0.024
Soda(g/l)	2.77	2.75	2.79	3.0	3.23

*Anomaly following analysis by third party laboratory

The following is a discussion on the fate of these heavy metals on the estuarine/marine environment.

5.4.7 Aluminium

Aluminium is more stable in the solid than aqueous phase and aluminium in the marine environment tends to be absorbed on the surrounding sediments. This acts as a sink for aluminium for biota but only a small portion is bioavailable, which is turn is controlled by pH conditions. Aluminium toxicity is higher at lower pH's. Research undertaken by Leleyter *et al*. (2016**)** has demonstrated that aluminium contamination has a strong impact on diatom communities growing at the sediment surface. Benthic diatoms are an important component of the phytobenthos inhabiting mudflats. They are primary producers in the food chain in an estuary. The research found that a negative effect on benthic diatoms can be detected at concentrations of > 10mg/kg of sediment.

The most important environmental factor controlling the toxicity of aluminium is pH. Aluminium is most toxic at pH 5.5 – 6 and lowest near pH 7. The buffering capacity of the seawater ensures that the aluminium remains in its original chemical form and therefore no significant impacts on the designated areas in the wider hinterland of the AAL facility are predicted.

5.4.8 Zinc

In an estuarine environment, zinc is absorbed to suspended materials in the water column. In low salinity areas of an estuary the absorbed zinc can be mobilised from the particles by microbial degradation of the organic matter. In seawater, zinc is normally dissolved as either organic or inorganic complexes. Accumulations of zinc in sediments above a concentration of 124 mg/kg can pose a hazard to sediment living organisms (Canadian Council of Resource and Environmental Ministers, 1987).

Invertebrates are generally more sensitive to zinc that fish species. Zinc accumulates in sediment and can pose a risk to sediment dwelling organisms. However, the low quantities of zinc discharged means that no significant impacts on water quality in the estuary are predicted.

5.4.9 Copper

Copper can exist naturally in water as either dissolved (as Cu^{++}) or complexed with organic matter or suspended particles. It can also be absorbed in the bottom sediments. The concentration of these forms of complexes is dependent upon several other factors such as pH, salinity, hardness and alkalinity. The high levels of suspended solids naturally found in an estuary, like the Shannon Estuary, facilitates the removal of the copper in solution by absorption onto the suspended material. This in turn becomes available for deposition in the sediments.

Macroinvertebrates are more sensitive to copper than fish although whole-body concentrations tend to decrease with increasing trophic levels. CCREM, (1987) reports that copper is regulated or immobilised in many species and is not biomagnified in the food chain to any significant extent. In a study undertaken by Brown *et al*., (2004) researching biomarkers as a marker of stress to various species, found that mussels (*Mytilus edulis*) was the most tolerant species to copper with significant effect being observed at levels of 68 ug/l. Similar observations were made with the shore crab (*Carcinus maenas*). The common limpet (*Patella vulgate*) was most sensitive at levels as low as 6.1 ug/l. Copper accumulations in sediments can pose a hazard at concentrations above 18.7 mg/kg according to the Canadian interim marine sediment guidelines.

The levels of copper detected in the process effluent were at a maximum 18 µg/l copper and in general substantially lower, so no significant impacts on marine species are anticipated. Copper does not bioaccumulate, and it is anticipated that birds which feed on the macroinvertebrates will not experience any significant impacts.

5.4.10 Arsenic

Arsenic can be found as different forms of organic and inorganic arsenic. In water it is normally found in the form of arsenate or arsenite. Sedimentation of arsenic in association with iron and aluminium may be considerable. Algae and other green plants are the primary target of arsenate in both the freshwater and marine environment (Lander, 1998). This step forms an important pathway for arsenic entrance into the marine food chain. Very little dissolved arsenic in water is taken up by marine invertebrates or vertebrates and where it is taken up arsenate is transformed to a complex organic arsenic species, which generally has a lower toxicity than arsenate or arsenite (Lander, 1998). The level of arsenic discharged in the effluent from the plant is low. No significant effects on habitats or species are predicted.

5.4.11 Mercury

Dissolved mercury has a strong affinity for organic matter and suspended solids and consequently it will bind to these particles in the water column and accumulate in sediments. Once in the sediments, mercury can undergo methylation to produce methylmercury. This is the form of mercury that is bioavailable and is a hazard to aquatic life.

Aquatic plants are affected by mercury in water at concentrations within the 1 mg/l range for inorganic mercury. The level for organic mercury is much lower.

Mercury's impact on aquatic invertebrates varies with concentration and species. The development stage of the species, temperature and salinity all play a part in toxicity. Methylmercury is more toxic than inorganic mercury. Levels in the range 1-10 µg/l causes acute toxicity for most developing species of marine invertebrates.

Inorganic mercury is toxic to fish at low concentrations. A 96-hr LC50 as low as 30 µg/l has been reported. Fish reproduction is adversely affected by mercury.

Even if the concentrations of mercury in water is low, organisms have the capacity to bioaccumulate mercury. In situations where the inorganic mercury is methylated in the environment the resultant methylmercury is taken up more readily by the organisms.

Inorganic mercury accumulates in sediments and may be a hazard to marine sediment dwelling organisms at concentrations above 0.13 mg/kg, according to the Canadian interim marine sediment quality guidelines. Cronin et al. 2006 recommend a Lower Action Level of 0.2 mg/kg and Upper Action Limit of 0.7 mg/kg for mercury in sediments.

The results presented in Table 5.20 for the average heavy metal levels detected in the final treated effluent from W1-1 for 2016, showed that a mercury level of 15 µg/l was detected. Mercury levels for the remaining years were less than this, and it can be concluded that no significant impacts on habitats has arisen from this source.

5.4.12 Lead

Except for the chloride, nitrate and chlorate forms of lead, the salts of lead are relativity insoluble in water. Much of the lead in the marine environment is absorbed onto sediment and suspended particles thereby reducing its availability to marine organisms. Sediments form a sink for lead in the marine environment.

Young stages of fish are more susceptible to lead than adults or eggs. Organic forms of lead are more toxic to fish than the inorganic lead salts and the toxic effects of lead on fish mortality decreases at higher dissolved organic carbon concentrations. According to the Canadian interim marine sediment quality guidelines sediment dwelling organisms can be exposed to hazardous levels above 30.2 mg/kg. In fish lead is accumulated in the gills, liver and kidney. Cronin et al. 2006 recommend a Lower Action Level of 60 mg/kg and Upper Action Limit of 218 mg/kg for lead in sediments. The levels of lead discharged in the effluent from the plant is low. No significant effects on habitats or species are predicted.

5.4.13 Chromium

In the hexavalent state chromium can occur in water with a low organic content. In its trivalent form chromium will form insoluble compounds. The solubility of chromium III in seawater varies with salinity, and the main removal process is adsorption to suspended materials. Cr IV is not so adsorbed by sediments.

Chromium in sediments can pose a hazard to sediment dwelling organisms at concentration above 52.3 mg/kg according to the Canadian interim marine sediment quality guidelines. Cronin *et al*. (2006) recommend a Lower Action Level of 120 mg/kg and Upper Action Limit of 370 mg/kg for chromium in sediments. The levels of chromium discharged in the effluent from the plant is low. No significant effects on habitats or species are predicted.

5.4.14 Cadmium

The speciation of cadmium in the environment is important in evaluating its potential hazard. Cadmium slats such as sulphide, carbonate and oxides are poorly soluble in water. The sulphate, nitrate and halides forms are soluble in water. Cadmium can be adsorbed onto sediments.

Cadmium uptake by aquatic organism is variable and depends on salinity, pH and the organic matter content. Zinc increases the toxicity of cadmium to aquatic invertebrates. Salmonids are particularly susceptible to cadmium toxicity. Cadmium bioaccumulates in organisms and the main uptake routes are dissolved cadmium form water and cadmium associated with prey species.

Accumulation of cadmium in sediments can cause potential risk to sediment dwelling organisms at levels greater than 0.7 mg/kg according to the Canadian interim marine sediment quality guidelines. Cronin et al. 2006 recommend a Lower Action Level of 0.7 mg/kg and Upper Action Limit of 4.2 mg/kg for cadmium in sediments. The levels of cadmium discharged in the effluent from the plant is low. No significant effects on habitats or species are predicted.

5.4.15 Iron

Background iron concentrations in saltmarsh sediments are frequently higher than the overlying water. Iron in the form of oxyhyrdroxides are immediately precipitated in seawater particularly at salinities at greater than 10 ppt. In anoxic marine waters, ferrous iron is mobilised from sediment s and diffuses back into the water column.

Marine organisms accumulate iron but excrete it in clean water conditions. Tissue concentrations vary seasonably, being lower in the winter and spring than in summer and autumn. The bioaccumulation of iron by marine organisms does not appear to pose a hazard to higher trophic levels. The levels of iron discharged in the effluent from the plant is low. No significant effects on habitats or species are predicted.

5.4.16 Magnesium

Magnesium is naturally found in seawater in the form of magnesium chloride. Typical concentrations in seawater is about 1,300 ppm. The levels in seawater will change depending on the tides, meteorological conditions and temperatures. The levels detected in the treated effluent discharged from W1-1 will not cause a significant impact on marine mammals or habitats.

5.4.17 Sediments

<u>Marine Sediments</u>

Sediment pollution can lead to disruption of the benthic communities by either toxic effects or sediment deposition on a species habitat.

Microbenthic communities have been used by biologists for years as indicators of pollution. The communities are normally long-lived and are a good indicator of the chronic impacts of a pollutant on a community. They are by their nature stationary and provide a true reflection on environmental conditions. They are normally found at the bottom of the food chain and their survival and distribution effects the survival and distribution of species higher up the food chain.

Research at Trinity College Dublin funded by the Marine Institute (Giltrap *et al.*, 2014) undertook an assessment of the biological effects and chemical measurements in Irish Marine Waters. The Shannon Estuary was one of the sampling points for this study. The study undertook sampling and analysis of sediment in the estuary. Analysis was carried out in the sieved sediment (<63 um). The results for heavy metal concentrations in the sediment as part of this study is shown in Table 5.21.

Table 5.21: Heavy metals levels in sediment Shannon Estuary (Marine Research 2014)

Concentration (µg/kg dry weight)	Cd	Hg	Pb	As	Cr	Cu	Ni	Zn
	220	NA	6,930	11,300	18,400	2,600	11,300	18,600

5.4.18 Aquafact Sediment Sampling, 2017

AAL has a Dumping at SEA Permit (S0026-01) to carry out plough-dredging at three permitted areas around the site jetty area. As part of the conditions of the permit an updated marine sediment characterisation report was prepared by Aquafact in 2018 (Appendix 7), with samples taken in December 2017. A total of 3 sediment samples were taken, and the samples were analysed for a range of parameters including heavy metals, total organic carbon, dibutyltin, tributyltin, lindane, HCB, PCB 7, PAHs and TEH. Table 5.22 summarises the results for heavy metal levels detected in the sediment samples. Figure 5.4.4 illustrates the sampling locations.

The sediments analysed (Table 5.22) were below the lower Irish action limits for organochlorines, PCBs, total extractable hydrocarbons, organotins and ∑16 PAH's.

Arsenic was above the lower Irish action limit at two of the three stations sampled, Nickel was above the lower Irish action limit at all three stations and Zinc was above the upper Irish action limit at one out of the three stations sampled. All other metals were below the lower Irish action limit. The findings of the report were reviewed by Dr. Rick Boelens, a marine specialist with over 40 years of experience in marine sediments and toxicology.

Table 5.22: Sediment Sampling Results (mg/kg), December 2017. Lower and Upper Actions Limits as per Cronin *et al*., 2006.

Parameter	Lower Action Limit	Upper Action Limit	S1	S2	S3
Hg	0.2	0.7	0.05	0.03	0.03
Al	N/A	N/A	34,800	31,500	55,300
As	9	70	12.2	7.9	11.2
Cd	0.7	4.2	0.4	0.7	0.4
Cr	120	370	46.9	44.8	105
Cu	40	110	22.8	32.1	19.5
Li	N/A	N/A	24.6	19.7	23.4
Ni	21	60	26.9	21.7	22.7
Zn	160	410	107	652	74.4
Fe	N/A	N/A	34,600	22,700	30,900
Mn	N/A	N/A	843	710	807
Ti	N/A	N/A	1,390	1,390	2,730

Figure 5.4.4: Sediment Sampling Locations, December 2017

Levels of zinc in sediment samples from Irish inshore waters are typically <300 mg/kg with the majority <100mg/kg. The levels of zinc detected in the Marine Institute sediment survey of the Shannon (2014; see Table 5.21) was 18.6 mg/kg. Higher values tend to be associated with acid mine drainage or the transport of metalliferous ores. The current Irish Action Level for zinc in sediments to be dredged is >410 mg/kg. The levels of zinc in Samples 1 and 3 were well within expected background levels and of no biological concern. Dr. Boelens concluded that the elevated result for zinc in the sediment sample taken in 2017 at the Sample 2 location, may have arisen because of very localised levels and further sampling was recommended to confirm this. Additional sampling was carried out in April 2018 to confirm the zinc levels detected in the sediment. The survey found that one of the sites (S1) exceeded (206 mg/kg) the Lower Action Limits of 160 mg/kg for zinc. The remaining four sampling locations had zinc levels less than the Lower Action Limits. It appears that the elevated zinc levels found in the December 2017 sampling event was a one-off and very localised.

5.4.19 Aquafact Sediment Sampling, 2020

Aquafact undertook another round of sediment sampling in February 2020 (Appendix 8). The sampling locations are shown in Figure 5.4.5 and the results are presented in Table 5.24. The sampling locations were chosen to reflect areas within the designated sites surrounding the AAL plant. Some marine sediment samples were also taken (see Figure 5.4.5). The numbering sequence for the samples is not sequential because some sampling points could not be taken because of health and safety issues and because of access onto private lands. Samples S11, S14, S17, S20, S22 and S24 were not sampled.

For the purposes of this discussion, JBA has assigned sampling locations S1, S2, S3, S4, S6, S7, S21, S23, S26, S28, S27, S29 and S30 as marine sampling sites and have assessed the analytical results against the Guidelines for the Assessment of Dredge Material for Disposal in Irish Waters (Cronin *et al*., 2006) lower and upper limits for Annex 1 heavy metals. The guidance document aims to provide an integrated assessment of the ecological risk associated with marine sediments. It considers the bioaccumulation and toxicity potential of a sediment. The guidelines set two Action Levels (as per the requirement of the OSPAR guidelines, 2004); the lower level (Level 1) defines a concentration (i.e. a guidance value) of a contaminant in sediment below which biological effects are not anticipated. The upper level (Level 2) defines a contaminant concentration above which biological effects are anticipated to occur. The more parameters exceeding the upper limit values for the corresponding parameter the more likely the material will cause biological effects. The Upper Level values are set at the lowest end of the known range of effective concentrations i.e. the lowest concentration known to have adverse effects on marine organisms.

The Lower Level guidance values corresponds to contaminant concentrations below which the sediment is not anticipated to have a biological impact on the environment. The Upper Level guidance values are concentrates above which adverse effects are anticipated.

Figure 5.4.5: Sediment sampling locations, February 2020 (Source: Aquafact, 2020)

The results of the sediment sampling undertaken by Aquafact in February 2020 (Tables 5.23 & 5.24) shows that the levels of arsenic detected in all the marine sampling locations exceed the Lower Level (9 mg/kg), however the levels were below the Upper Action Level. Annex 7 of the Guidance Document (Cronin *et al*., 2006) shows that the background arsenic levels in Irish Ports and Harbours is 38.90 mg/kg (95%ile). All of the marine sediment samples taken during this assessment had arsenic levels far below this background level, and the levels of arsenic detected in the sediments are not predicted to have any significant impact on the marine fauna in the area.

The levels of zinc detected in S16 (195 mg/kg) are above the Lower Action Limits for zinc (160 mg/kg). Accumulations of zinc in sediments above a concentration of 124 mg/kg can pose a hazard to sediment living organisms (Canadian Council of Resource and Environmental Ministers, 1987). The levels of zinc detected in this survey are above the 124 mg/kg. This is likely to have been a one-off result based on some localised higher levels.

Table 5.22: Proposed Guidance Values for Sediment Quality Guidelines (Cronin *et al*., 2006)

Parameter	Lower Level (mg/kg dry wt.)	Upper Level (mg/kg dry wt.)
Arsenic	9	70
Cadmium	0.7	4.2
Chromium	120	370
Copper	40	110
Lead	60	218
Mercury	0.2	0.7
Nickel	21	60
Zinc	160	410
Sum TBT & DBT	0.1	0.5
Lindane (ug/kg)	0.3	1
HCB (ug/kg)	0.3	1
PCB (individual congers) (ug/kg)	1	180
PCB (sum of 7) (ug/kg)	7	1260
PAH (sum of 16) (ug/kg)	4000	-
Total Extractable HC (g/kg)	1.0	-

All other metals are less than the Lower Action levels and consequently no biological effects are anticipated. Heavy metals are naturally present in nature and these chemicals are used by plants and animals for growing/manufacture of cells and as neural transmitters. The toxicity of heavy metals is dependent upon the form of the metal that is present in the water or the sediment i.e. metallic or inorganic. The presence of suspended solids, both natural and anthropogenic, in the water body of the River Shannon will have the effect of complexing some of the metal species and making them less available for invertebrate/fish species and consequently less toxic. The range and levels of heavy metals detected in the sediment at the jetty are generally low or typical of background levels.

The sediment samples taken at locations S5 and S8 (See Figure 5.4.5) best reflect non-marine environment samples. Table 5.23 below shows the range and location of metals detected at the sampling locations. Please refer to Figure 5.4.5 for sampling locations (shown in brackets). Table 5.24 summarises the soil and sediment sampling results from each of the locations included in the Aquafact (2020) survey.

Table 5.23: Range of Heavy Metals detected in sediment samples, February 2020 (Aquafact 2020)

Heavy Metal	Minimum mg/kg	Maximum mg/kg
Aluminium	1,800 (S8)	63,300 (S5)
Arsenic	9.9 (S27)	22.4 (S12)
Cadmium	<0.1 (S30)	2.1 (S19)
Lead	13.1 (S21)	35.4 (S6)
Mercury	0.01 (S30)	0.1 (S8)
Nickel	9.0 (S30)	49.4 (S5)
Zinc	40.6 (S30)	195 (S16)
Copper	4.9 (S30)	37.5 (S3)
Chromium	15.2 (S30)	57.1 (S5)
Total Organic Carbon	0.46 (S30)	> 25 (S8)

Similarly, cadmium levels in S1, S2, S3, S4, S6, S7, S9, S10, S16, S19, S21, S23 and S26 exceed the Lower Action Level of 0.7 mg/kg but are below the Upper Action Levels. Cronin *et al*. (2006) reports in Annex 7 that typical background levels of cadmium in Irish Ports and harbours is 0.97 mg/kg. The Effects Range – Medium (ERM) for cadmium is 9.6 mg/kg. The sediment sampling and analysis carried out by Aquafact (2020) had cadmium levels less than 9.6 mg/kg in the marine samples. Consequently, no significant impacts of cadmium on the marine habitats appears to be occurring in the estuary.

With the exception of S1, S19, S28 and S29, the levels of nickel detected in all of the marine samples exceed the Lower Action Level of 21 mg/kg. The highest level of nickel recorded during this survey was 49.4 mg/kg in S5. Because nickel does not bioaccumulate in marine organisms, and based on the information available, the impact of nickel on the habitats and species using the SAC and SPA is not significant.

Table 5.24: Sediment sampling results, February 2020 (Aquafact, 2020)

Station	Arsenic	Cadmium	Chromium	Copper	Lead	Nickel	Zinc	Aluminium	Lithium	Mercury	Total Organic Carbon
Units	mg/Kg	mg/Kg	mg/Kg	mg/Kg	mg/Kg	mg/Kg	mg/Kg	mg/Kg	mg/Kg	mg/Kg	mg/Kg
S1	15.1	1.0	34.9	10.9	22.4	19.4	85.8	31600	25.4	0.07	1.28
S2	14.2	1.1	49.8	10.4	25.8	27.0	95.2	43100	35.7	0.07	1.82
S3	15.5	1.2	40.4	37.3	21.6	22.0	73.0	34000	29.2	0.05	1.35
S4	16.9	1.0	48.6	11.5	24.1	25.9	86.6	41500	34.8	0.04	1.69
S5	16.2	1.9	57.1	15.7	29.2	49.4	108.1	63300	41.5	0.09	8.20
S6	16.6	1.3	55.7	8.9	35.4	29.8	94.9	45500	37.9	0.05	2.28
S7	15.9	1.1	44.6	10.0	24.1	24.0	83.3	36100	29.4	0.02	1.62
S8	13.2	2.0	18.7	12.4	29.5	16.9	122	18100	16.1	0.10	>25.0
S9	17.3	1.1	39.8	10.4	16.6	21.4	62.9	33400	26.6	0.02	1.03
S10	15.0	0.9	50.8	10.6	29.3	27.1	86.4	43000	37.1	0.03	1.54
S12	22.4	1.2	47.1	10.2	24.6	23.9	75.3	38600	31.3	0.03	1.43
S13	16.3	1.4	48.4	10.9	22.7	26.2	81.4	39200	33.3	0.03	1.91
S15	18.4	1.4	40.3	8.2	18.9	21.0	64.9	32100	26.7	0.02	1.00

Table 5.24 Continued: Sediment sampling results, February 2020 (Aquafact, 2020)

Station	Arsenic	Cadmium	Chromium	Copper	Lead	Nickel	Zinc	Aluminium	Lithium	Mercury	Total Organic Carbon
S16	21.5	1.7	52.8	11.1	25.7	27.2	195	42700	35.6	0.04	2.14
S18	20.1	1.3	47.9	6.8	23.1	25.0	85.3	38300	32.3	0.04	2.00
S19	18.0	2.1	38.4	8.6	15.9	20.1	60.9	31800	25.8	0.03	0.97
S21	17.5	1.7	31.3	7.4	13.1	16.8	54.3	26100	22.0	0.02	0.91
S23	18.2	1.9	41.4	9.7	17.7	21.9	68.8	32400	25.6	0.02	1.24
S26	16.5	1.3	44.9	9.6	20.4	24	76.6	36800	28.8	0.03	1.54
S27	9.9	0.6	36.0	9.6	17.1	19.6	65.7	27900	25.3	0.04	1.07
S28	11.0	0.5	31.5	8.1	15.0	16.4	55.1	25400	23.6	0.03	0.89
S29	12.6	0.5	33.2	8.5	16.9	17.4	60.9	26300	24.3	0.02	1.01
S30	16.3	<0.1	15.2	4.9	14.4	9.0	40.6	11800	12.2	0.01	0.46

Soils

Soils contain natural background levels of heavy metals depending upon the parent rock. The Teagasc 2007 Soil Geochemical Atlas of Ireland states that the levels of aluminium in soil can range from 40,000 – 50,000 mg/kg. The results for the soil samples generally fall within the typical naturally occurring range. Therefore, there is no likelihood that the levels of aluminium in the soil are significantly impacting on the designated sites around AAL.

S5, which is located east of the Plant Area had the highest levels of aluminium detected (63,300 mg/kg). This level is above the expected background levels (40,000 – 45,000 mg/kg) in soil in this part of Ireland. S5 is close to the Poulaweala Creek which forms part of the Lower River Shannon SAC. The aluminium levels detected in S3 (closest to the Plant Area) were 34,000 mg/kg and S4 (located in Poulaweala Creek between S3 and S5) had aluminium levels of 41,400 mg/kg. Given that levels seen in S3 and S4, which are closest to the activity and are within expected background levels, the level seen at S5 is likely to be a once off at that particular sampling location. The total organic content at S5 (8.20 mg/kg) will help to retain the aluminium in the soil.

The reported natural background levels for cadmium is >1mg/kg for the north Clare/southwest Limerick regions (Teagasc, 2007). The highest levels of cadmium detected in the soil around AAL was 2.0 mg/kg (S8). These levels are similar the background levels and are not predicted to have any significant effects on the habitats or species present within the designated sites in the ZoI.

Typical background levels for nickel reported (Teagasc, 2007) for the Limerick area are 30–37.5 mg/kg. The highest level detected around the AAL site was 49.4 mg/kg (S5). S5, which is located on the opposite side of Poulaweala Creek to the plant, had high levels of organic matter and therefore it is likely that nickel present will bind to the organic material and not be available for dispersion via water. Consequently, no significant effects on the receiving environment are predicted.

Teagasc (2007) reports that the background levels of zinc in the Limerick area is between 80–120 mg/kg. The highest levels detected in the soil around AAL were 108.1 mg/kg (S5). The levels detected are probably due to a natural variation in the geology and soils in the area and these levels would not have a significant impact on the designated sites.

Teagasc (2007) reports that the background levels for lead in soil in the Limerick area is between 501-800 mg/kg. The levels of lead detected in the soil samples for this survey are within this range. No significant impacts are predicted for the receiving environment.

Typical background copper levels in soil as reported by Teagasc (2007) in uncontaminated soils is between 6 and 60 mg/kg. The levels detected in this survey are within those levels no significant impacts of copper are predicted for the designated sites and their conservation objectives.

Background chromium levels in the soil along the Shannon Estuary are reported by Teagasc (2007) to be in the range of 30-40 mg/kg. The levels detected within this survey are slightly above these levels but not elevated enough to be of concern. No significant impacts are predicted for the receiving environment.

In conclusion, the levels of heavy metals detected in the marine sediment and the soil samples taken around the site are generally typical background levels for soils around this the Limerick/Shannon area. With the exception of aluminium at one location (S5, as discussed above), the levels of heavy metal in the sediment samples are representative of background levels and no significant effects are predicted on the designated Natura 2000 sites and their conservation objectives within the ZoI.

5.4.20 Impact of the Proposed Borrow Pit on Sediment

A review of the soil mapping compiled by the National Soil Survey found that the principle soil types underlying the borrow pit are renzinas – lithosols which have originated for limestone glacial till. Sub-soils at the borrow pit site are either absent or consist of glacial till of Carboniferous origin. The bedrock in the area of the site is Waulsortian limestone. Surface water control and re-fuelling of site vehicles in dedicated areas ensure that both surface water and groundwater will be adequately protected. Furthermore, the proposed borrow pit design is such that interaction with the groundwater will be avoided by keeping the base level of the borrow pit above the known level of the water table.

5.5 Groundwater and Geology

5.5.1 Introduction

Prior to the construction of the plant in 1978, the area was a greenfield site. Two limestone outcrops with elevations of 28.7 metres AOD and 19 m AOD dominated the northeast section of the island, which is now the location of the Plant Area. A northeast-southwest trending valley, dipping towards the southwest separated this area. It is considered that this area would have been largely undeveloped or utilised for any purpose at this time.

5.5.2 Geology

Regional Geology

Aughinish Island is underlain by Lower Carboniferous carbonates of the Limerick Limestone Formation and Rathkeale Formations. It is situated on the eastern margin of the Upper Carboniferous Clare Basin.

Local Geology

During the earlier part of the construction of the plant in 1979 to 1980, the plant area was re-contoured by the removal of the two dominant limestone outcrops located at the centre of the proposed Plant Area. Approximately 8m of the resulting limestone crushed rock fill was placed in the northeast-southwest trending valley running through the centre of the site to create level surfaces for the plant structures.

Limestone Bedrock

The plant area is underlain by Lower Carboniferous carbonates of the Limerick Limestone Formation which comprises medium bedded to massive, fine to coarsely crystalline, blue-grey Waulsortian Limestone. There are several major faults trending northeast-southwest across the Plant Area.

Site investigations and groundwater studies in 1983, after the commissioning of the plant, found elevated pH and soda concentrations in springs along the eastern coastline and in valley to the western and southern limits of the plant area.

Groundwater

The groundwater beneath Aughinish Island comprises a freshwater lens isolated laterally from the mainland by being laterally hydraulically isolated by Poulaweala Creek, Poularone Creek and the Robertstown River and the underlying saline groundwater. There are abstraction wells on the mainland within 5 km of the site, but these are not part of the same regional hydrogeological system as Aughinish Island. Figure 5.5.1 shows the aquifer classification for Aughinish Island and the surrounding mainland.

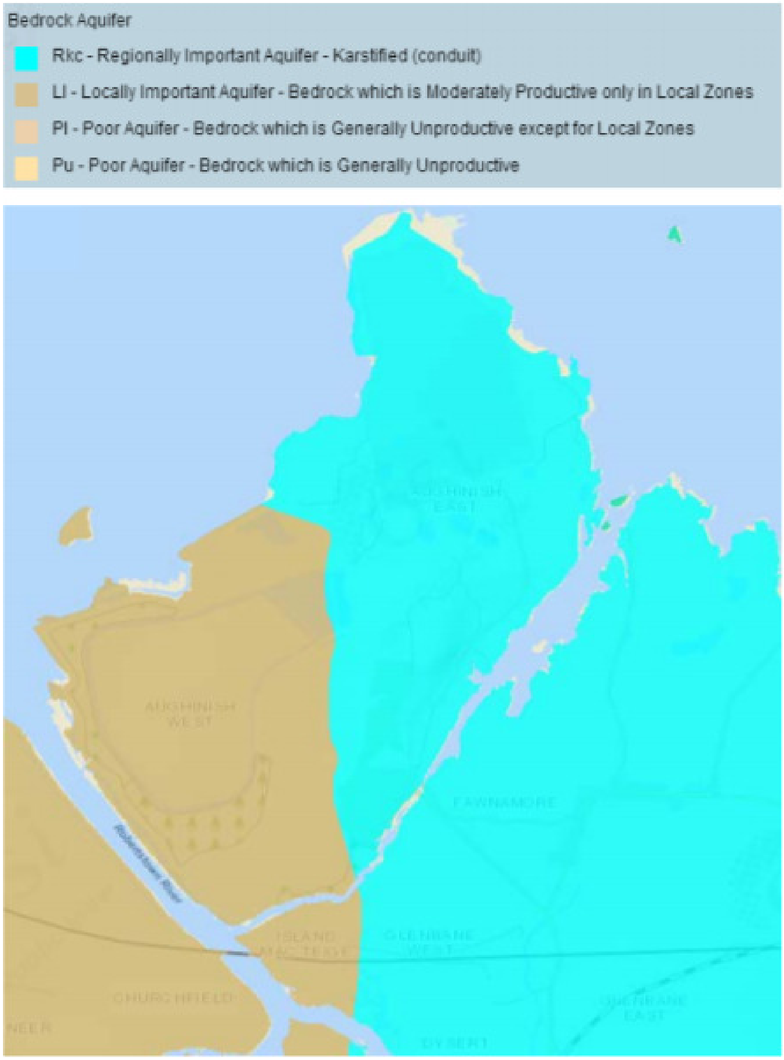


Figure 5.5.1: Aquifer Classification (Source: Golders, 2014)

Groundwater vulnerability (see Figure 5.5.2) under most of the Plant Area is extreme with rock close to the surface or karst being present at the boundaries of the Poularone Creek and the River Shannon and to the south of the plant area.

Under the BRDA the groundwater vulnerability is classified between low and extreme.

Groundwater flow in the plant area is radial from approximately the centre of the plant area and discharges via springs (Estuarine Streams) to the Shannon Estuary and Poularone Creek. Table 5.25 (after Golders 2014), is a summary of the groundwater catchments in the plant.

Groundwater flow to the west and south of the BRDA is likely to be towards Robertstown River. Surface water flow outside the north and west perimeters of the BRDA is discharged to the estuary via the OPW channel which discharges at low tide to maintain a consistently low level beneath the BRDA.

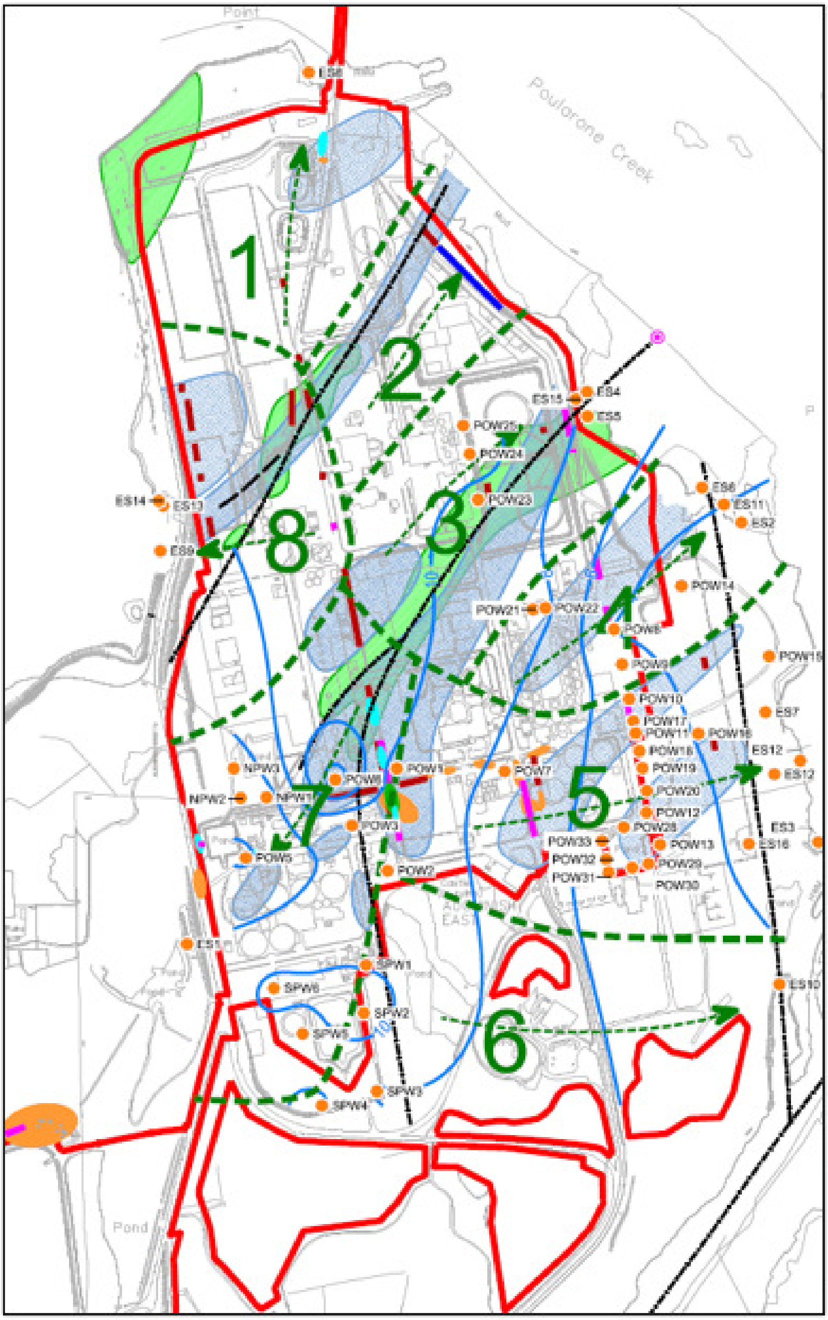


Figure 5.5.2. Groundwater Flow interpretation below the Plant Area (Golders, 2015)

Table 5.25: Summary of Groundwater Catchments: Plant Area (Golders, 2014)

Catchment Area No.	Area of Plant	Discharge Location
1	01 – Bauxite storage 38 – Liquid caustic storage	ES8, SS5
2	12 – Alumina storage 14 – Steam generation	Diffuse coastal
3	09 and 10 – Calcination 14 – Steam generation 23 – HFO storage 71 - Workshops	ES4 ES5 ES15
4	07- Precipitation	ES2, ES6, ES11
5	72-75 – Central administration building, canteen, laboratory and locker rooms 04 – Digestion (proximity to southeast corner) 05 – Sand filtration 41 – Vacuum flash heat exchange 06 – Hydrate thickening East Pond	ES3 ES7 ES12 ES16
6	South Pond	ES10
7	04 – Digestion 27 and 28 – Sand separation and decanting and mud wash 65 – Liquor purification 71 – Workshops 72-75 – Central administration building, canteen, laboratory and locker rooms North Pond West Pond South Pond	ES1
8	02 – Grinding 04 – Digestion 14 – Steam generation	ES9 ES13 ES14

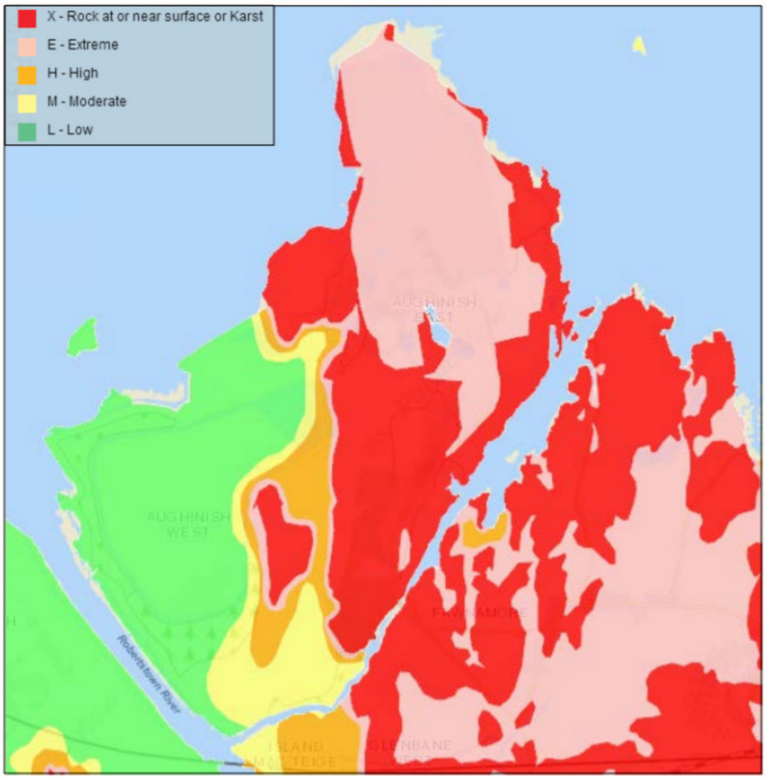


Figure 5.5.3: Groundwater Vulnerability at Aughinish Island (Source: Golders, 2014).

5.5.3 Groundwater Monitoring Locations

Groundwater flow beneath the plant area discharges from the island via discrete estuarine streams (ESs). An interpretation of the groundwater flow beneath the Plant Area and the location of the estuarine streams is shown in Figure 5.5.2. These estuarine streams or ESs are monitored in accordance with IE licence requirements by AAL. The monitoring wells in the plant area are known as plant observation wells (POW). Groundwater is monitored at 33 POWs. At the BRDA groundwater is monitored at a series of Observation Wells (OWs). The location of the POWs and OWs at the facility are shown in Figure 5.5.4.

5.5.4 Review of Groundwater Monitoring Data

The groundwater monitoring results presented in the Annual Environmental Reports for 2014, 2015, 2016, 2017 and 2018 were reviewed. The concentration of substances in the groundwater is compared to the Threshold Levels given in the Groundwater Regulations (2010) for conductivity (1,875 µS/cm), aluminium (0.15 mg/l) and pH (9.5).

Work carried out by ERCON following plant start-up identified sixteen groundwater discharge points around the perimeter of the site at the shoreline. These points are the licensed Estuarine Streams (ESs) (ES1 to ES16), as referenced in Schedule C.6 of AAL's IE licence, where the groundwater at Aughinish Island emanates at the shoreline. The Golder Associates report Groundwater Conceptual Model, Risk Screening and Technical Assessment 2015, state that the ESs are the dominant mechanism for the discharge of groundwater from the island, with negligible output via groundwater base flow to the Shannon Estuary and Poulaweala Creek. Figure 5.5.2 above identified the eight groundwater catchments and the likely direction of groundwater flow. The groundwater beneath the Plant Area which is represented by the POW's migrates towards the shore where it discharges to the River Shannon, with the exception of those ESs that are recovered to the plant effluent treatment system, i.e. ES1, ES7, ES12, and ES16. Sampling and reporting of the pH, conductivity, soda and aluminium levels are required quarterly by the EPA as a condition on the licence.

ES1, ES7, ES12 and ES16 intercept groundwater flow via caisson pumps located upstream of the ES outfall. When groundwater reaches a certain level in the wells the groundwater is pumped back to the overall plant effluent stream and is ultimately sent for treatment where it is neutralised, flocculated and then discharged via licensed emission point W1-1.

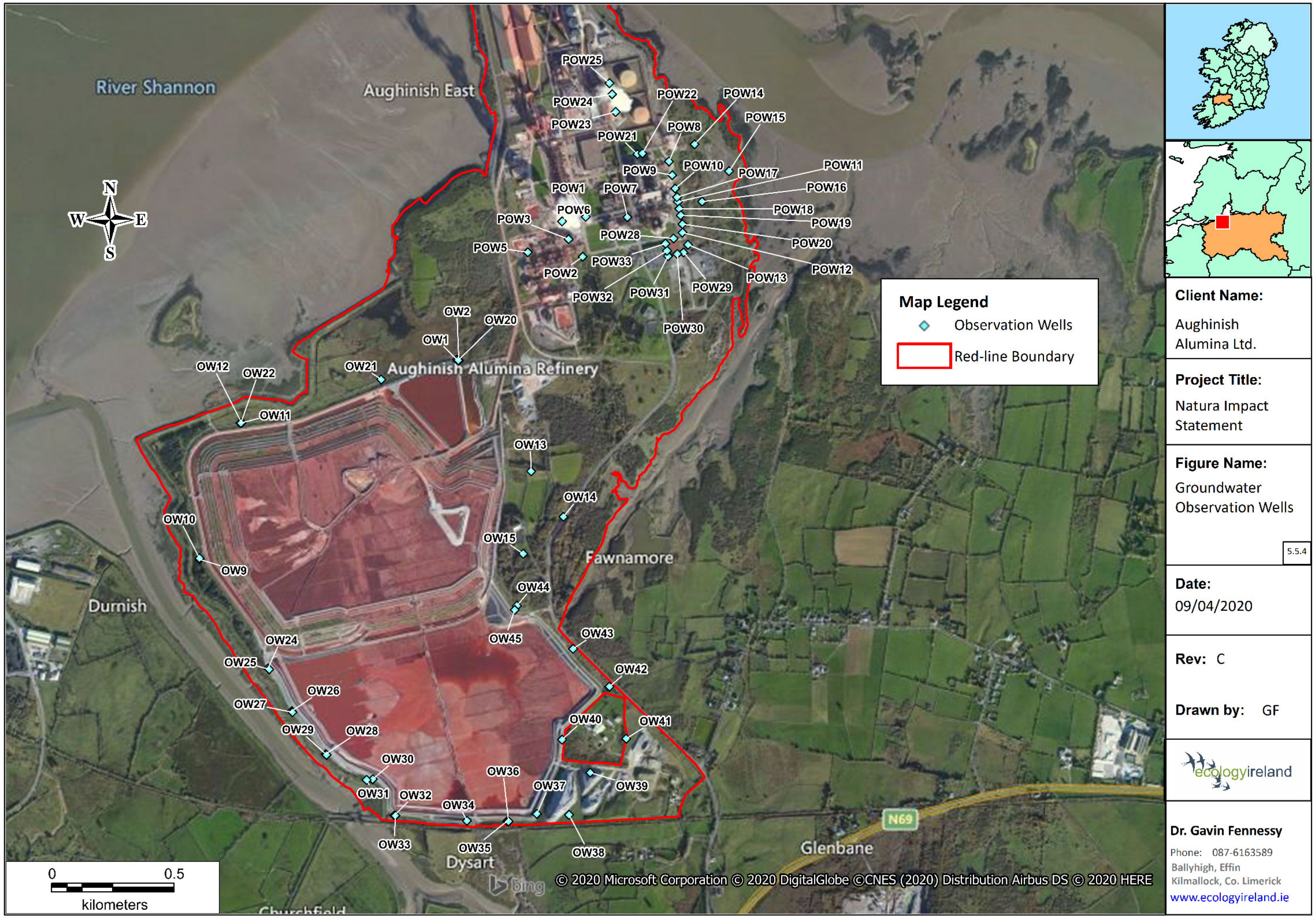


Figure 5.5.4 Groundwater Observation Wells

AER 2014

The 2014 AER reports pH above 9.5 in ES1, ES12 and ES16. These wells are pumped to the treatment plant for treatment and neutralisation. Conductivity levels in ES1, ES2, ES3, ES8, ES9, ES11, ES12, and ES16 exceed the 1,875 uS/cm limits in the Regulations. The ESs are subject to saline intrusion due to tidal activity, which leads to elevated conductivity levels at these monitoring points.

Aluminium levels in the Plant Observation Wells (POWs) exceeded the levels for aluminium (0.15 mg/l) in all the wells except for POW8 and POW15.

Arsenic, lead and mercury levels exceeded their groundwater thresholds for some of the plant observation wells in Catchment Area 5 of the Plant Area. AAL has an on-going capital investment programme in drains, sumps and bunds in the Plant Area. This programme is on-going, and it will ensure that heavy metal levels in the groundwater are reduced with a consequent benefit to the River Shannon.

AER 2015

The 2015 AER reports similar pH levels in ES1, ES12 and ES16 that exceed the Groundwater Regulations threshold value of 9.5. These wells are pumped to the treatment plant for treatment and neutralisation. Conductivity levels in all the wells except ES13 and ES15 and ES16 exceed the conductivity threshold values of 1,875 µS/cm. The ESs are subject to saline intrusion due to tidal activity, which leads to elevated conductivity levels at these monitoring points.

Aluminium levels in POW7, POW8, POW10, POW14, POW15 and POW21, POW31, POW32 and POW33 were less than the 0.15 mg/l threshold level in the Groundwater Regulations. The observation wells OW2 and OW33 in the BRDA had aluminium levels above the 0.15 mg/l threshold level in the Groundwater Regulations.

Arsenic, nickel and mercury levels exceeded their groundwater thresholds for some of the plant observation wells in Catchment Area 5 of the Plant Area. AAL has an on-going capital investment programme in drains, sumps and bunds in the Plant Area. This programme is on-going, and it will ensure that heavy metal levels in the groundwater are reduced with a consequent benefit to the River Shannon.

AER 2016

The 2016 AER reported pH levels above 9.5 in ES1 and ES12. These streams are intercepted and pumped to the wastewater treatment plant for neutralisation and treatment. Except for ES1, ES13 and ES16, conductivity levels exceeded the 1,875 µS/cm levels for the remainder of the Estuarine Stream wells. The ESs are subject to saline intrusion due to tidal activity, which leads to elevated conductivity levels at these monitoring points.

Except for POW8, POW9, POW14, POW15, POW21, POW25, POW33, SPW5, and NPW3, the aluminium levels detected in the remaining on-site groundwater wells were above the threshold limit of 0.15 mg/l. The aluminium levels in the BDRA observation wells were above this threshold for OW2, OW9, OW14, OW22, OW27, and OW31.

Arsenic, lead and mercury levels exceeded their groundwater thresholds for some of the plant observation wells in Catchment Area 5 of the Plant Area. AAL has an on-going capital investment programme in drains, sumps and bunds in the Plant Area. This programme is on-going, and it will ensure that heavy metal levels in the groundwater are reduced with a consequent benefit to the River Shannon.

AER 2017

The 2017 AER reports that pH levels in ES1, and ES12 exceeded the limit of 9.5. These streams are intercepted and pumped to the wastewater treatment plant for neutralisation and treatment. Except for ES13 and ES16, conductivity levels exceeded the 1,875 µS/cm levels in all the ES wells. The ESs are subject to saline intrusion due to tidal activity, which leads to elevated conductivity levels at these monitoring points.

Plant observation wells POW8, POW9, POW10, POW14, POW15, POW21, POW22, POW24, POW25, POW31, POW32, POW33, SPW3 had aluminium levels below the 0.15 mg/l threshold, the remaining well were above the threshold limit.

Arsenic, lead, nickel and mercury levels exceeded their groundwater thresholds for some of the plant observation wells in Catchment Area 5 of the Plant Area. AAL has an on-going capital investment programme in drains, sumps and bunds in the Plant Area. This programme is on-going, and it will ensure that heavy metal levels in the groundwater are reduced with a consequent benefit to the River Shannon.

AER 2018

The 2018 results show that pH levels above 9.5 in ES1 and ES12. These streams are intercepted and pumped to the wastewater treatment plant for neutralisation and treatment. Except for ES13 and ES16, conductivity levels exceeded the 1,875 µS/cm levels. The ESs are subject to saline intrusion due to tidal activity, which leads to elevated conductivity levels at these monitoring points.

Plant observation wells POW8, POW9, POW10, POW14, POW15, POW21, POW22, POW24, POW31, POW33, SPW3 and NPW3 had aluminium levels below the 0.15 mg/l threshold, the remaining wells were above the threshold limit.

Arsenic, and mercury levels exceeded their corresponding groundwater thresholds for some of the plant observation wells in Catchment Area 5 of the Plant Area. AAL has an on-going capital investment programme in drains, sumps and bunds in the Plant Area. This programme is on-going, and it will ensure that heavy metal levels in the groundwater are reduced with a consequent benefit to the River Shannon.

5.5.5 Impacts of Site Activities on Groundwater

A review of the groundwater monitoring undertaken at the site as part of licence requirements, found that pH, aluminium and conductivity are elevated in a few of the estuarine streams feeding into the River Shannon. These ESs, where levels are slightly elevated, are recovered to the plant effluent treatment system.

Sampling of the ESs allows an evaluation of the groundwater and if either pH or conductivity levels are elevated above the Groundwater Regulations threshold levels, the water is diverted to the wastewater treatment plant for neutralisation and treatment prior to discharge. However, aluminium levels above the threshold levels are detected in several of the plant observation wells (POWs) throughout the site. The toxicity of aluminium in the aquatic environment is dependent, upon other things, on pH. At lower pH's the toxicity of aluminium increases by impairing ion regulation. The estuarine streams are either sent for neutralisation and treatment prior to discharge, or the estuarine streams discharge directly to the River Shannon. The most important environmental factor controlling the toxicity of aluminium is pH. Aluminium is most toxic at pH 5.5 – 6 and lowest near pH 7. The buffering capacity of the seawater ensures that the aluminium remains in its original chemical form and therefore no significant impacts to designated sites surrounding the AAL facility are expected.

The on-going capital investment in drains, sumps and bunds in the Plant Area will support protection of the groundwater at the site.

AAL continues to mitigate the risk of contamination of the groundwater in the plant area by intercepting and recovering water from three of the estuarine streams, as well as other recovery wells at the site. pH levels in the ES boreholes are gradually returning to near neutral.

Furthermore, AAL continually invests up to €750,000 per annum on structural improvements to bunds, sumps and drains in the process area including retrofitting with steel liners where necessary. The combination of groundwater monitoring, groundwater recovery wells, on-going investment, including the replacement and upgrading of drains, pipework and bunds, has ensured that the impact of groundwater discharges from the site are not significantly impacting on the designated areas proximate to the site.

5.6 Noise and Vibration

5.6.1 Introduction

AAL is required, under condition 4.5 and 6.16 of the IEL to conduct annual noise monitoring at the site boundary and off-site noise sensitive locations. The noise limits at the noise sensitive locations are:

- Daytime: 55 dB(A) Leq
- Evening time: 50 dB(A) Leq
- Night-time: 45 dB(A) Leq.

The location of the noise monitoring locations is shown in Figure 5.6.1.

A comprehensive review of the potential impacts of noise and vibration associated with the construction and operation of the proposed borrow pit was contained within Chapter 11 of the EIAR in relation to the planning application for that development (17/714; ABP 301011-18). During the construction phase, the range of activities with potential to generate noise and vibration emissions to off-site sensitive receptors will include site preparation works, construction of the proposed earth bund at the development boundary, internal road construction and erection of any temporary buildings/compounds that may be required. During the operational phase, the potential significant sources of noise and vibration are those associated with rock removal (i.e. blasting activities, crushing of rock and any other rock breaking that may be required), as well as vehicular movement to, from and within the site.

5.6.2 Assessment of the noise levels emanating from site operations

The findings of the noise assessments carried out at the site submitted in the AER for 2014, 2015, 2016, 2017 and 2018 were reviewed.

AER 2014

The noise survey carried out at the noise sensitive locations found that the noise profile was dominated by traffic noise on the N69, road traffic to and from the AAL plant, and operations at Foynes Port. NSL5, which is located beside the N69 recorded the highest levels during daytime monitoring (67 dbA L_{eq}). However, traffic noise on the N69 was the dominant source of this noise.

No tones or impulsive noise was recorded during the surveys.

Noise levels measured at plant boundary locations during day-time periods ranged from LA_{eq} 37 dB(A) to 60 dB(A).

Noise levels measured at plant boundary locations during night-time periods ranged from LA_{eq} 34 dB(A) to 59 dB(A).

Noise levels emanating from the site are compliant with the licence conditions.

AER 2015

Like the 2014 noise monitoring data, noise sensitive location NS5 experienced the highest noise levels during the surveys. A daytime LA_{eq} of 60 dB(A) and an evening time LA_{eq} of 52 dB(A) was recorded at this location with traffic noise contributing to the noise.

No tones or impulsive noise was recorded during the surveys.

Noise levels measured at plant boundary locations during day-time periods ranged from LA_{eq} 38 dB(A) at location B7 to 60 dB(A) at location B3.

Noise levels measured at plant boundary locations during night-time periods ranged from LA_{eq} 38 dB(A) at location B8 to 62 dB(A) at location B1.

Noise levels emanating from the site are compliant with the licence conditions.

AER 2016

Traffic on nearby roads, traffic entering and leaving the AAL plant dominated the ambient noise levels at the noise sensitive locations during the 2016 survey. Location NSL5 experienced the highest noise levels (LA_{eq} 57 dB(A) daytime and 54 dB(A) night-time).

No tones or impulsive noise was recorded during the surveys.

Noise levels measured at plant boundary locations during day-time periods ranged from LA_{eq} 34 dB(A) at location B5 to 62 dB(A) at location B3.

Noise levels measured at plant boundary locations during night-time periods ranged from LA_{eq} 36 dB(A) at location B7 to 59 dB(A) at location B3.

Noise levels emanating from the site are compliant with the licence conditions.

AER 2017

Traffic dominated ambient noise levels at all the noise sensitive locations. The traffic generated on nearby roads and traffic entering and leaving the AAL plant would have contributed to the noise. NSL5 had the highest ambient noise level (67 dB(A) daytime).

No tones or impulsive noise was recorded during the surveys.

Noise levels measured at plant boundary locations during day-time periods ranged from LA_{eq} 39 dB(A) at location B8 to 67 dB(A) at location B1.

Noise levels measured at plant boundary locations during night-time periods ranged from LA_{eq} 34 dB(A) at location B9 to 63 dB(A) at location B1.

Noise levels emanating from the site are compliant with the licence conditions.

Figure 5.6.1 Noise Monitoring locations

AER 2018

Traffic dominated ambient noise levels at all the noise sensitive locations. The traffic generated on nearby roads and traffic entering and leaving the AAL plant would have contributed to the noise. NSL5 had the highest ambient noise level (64 dB(A) daytime).

No tones or impulsive noise was recorded during the surveys.

Noise levels measured at plant boundary locations during day-time periods ranged from LA_{eq} 43 dB(A) at location B7 to 65 dB(A) at location B1.

Noise levels measured at plant boundary locations during night-time periods ranged from LA_{eq} 32 dB(A) at location B5 to 59 dB(A) at location B3.

Noise levels emanating from the site are compliant with the licence conditions.

5.6.3 Impact of Noise & Vibration on biodiversity

B1 is located at the jetty and noise levels at this location is dominated by a ship unloading bauxite. Locations B2, B3 and B6 are representative of noise emanating from the main plant. Locations B5, B7 and B8 are within the BRDA.

A 3 dB increase in background noise levels means a doubling in sound energy and about a 23% increase in loudness. A 10dB increase in background noise levels would equate to a doubling of noise.

The main sources of noise generated at the site is traffic noise, industrial noise and noise from shipping operations. The Shannon Estuary and Shannon Airport also contribute to background noise in the area. Noise as a singular disturbance factor for fauna species in the vicinity of the licensed facility is difficult to assess, as noise is very rarely the only cause of disturbance for wildlife. Noise associated with on-site traffic and employees entering and leaving the site is also accompanied by vibration disturbance.

The River Shannon & River Fergus Estuaries SPA is designated for the protection of bird species, mostly overwintering waterbirds. The range of hearing of birds is largely in the bandwidth up to 10 Hz. Outside this range, sensitivity is considerably lower (Dooling *et al*. 2000). Much of the research on the impacts of anthropogenic noise on bird focuses on road traffic noise, with the finding that song frequency shifts under noisy conditions (e.g. Patricelli & Blickley, 2006).

A bird survey conducted as part of the EIAR for the proposed borrow pit, recorded the presence of Song Thrush, Mallard, Dunnock, Skylark, Swallow, Blue Tit, Pied Wagtail and Blackbird on the site. Off-site observations included Pheasant, Willow Warbler, Rook, Feral Pigeon, Woodpigeon, Starling, Jackdaw, Cormorant, Wren, Stonechat and Robin.

The site has been in operation for over 30 years and has developed and expanded over this period. Birds and mammals become accustomed (habituate) to noise and vibration and as the recent bird and bat surveys carried out at the site demonstrate, they continue to use the site. The proposed borrow pit during the operational phase will generate sources of noise and vibration from site machinery, vehicular movements, rock crushing and blasting. It is anticipated that about 6-7 blasts per year will occur at the site. Blasting technology is controlled to reduce the air over pressure values and vibrations. To achieve the expected production, a total of 6 to 7 blasts will be required per year. In order to control vibration, the best practical approach is to implement a scheme to reduce vibration levels at the source, and monitor vibration at receivers. The EIAR for the proposed borrow pit (17/714; ABP 301011-18) provides an assessment of the effect of blasting within the footprint of the proposed Borrow Pit and was found to pose minimal risk to the stability of the adjacent BRDA. The report also provides for recommendations which will be incorporated into the proposed development. For instance, the contractor will ensure that all best practice noise and vibration control methods will be used, as necessary in order to ensure emissions to external noise sensitive locations are not significant. In this regard, various mitigation measures will be applied as set out in the EIAR (P17/714; ABP 301011) during the construction of the proposed development, including:

- Limiting the hours during which site activities likely to create high levels of noise or vibration are permitted;
- Establishing channels of communication between the contractor/developer, Local Authority and residents;
- Appointing a site representative responsible for matters relating to noise and vibration;
- Monitoring levels of noise and vibration during critical periods and at sensitive locations;
- Maintaining site access roads even so as to mitigate the potential for vibration from lorries;
- Selection of plant with low inherent potential for generation of noise and/ or vibration.

Noise and vibration levels associated with operational plant and equipment are expected to be well within the adopted criteria values at the nearest sensitive properties taking into account the site layout, location of proposed plant areas and distances to nearest residences. It is not anticipated that the frequency of blasting will have a significant impact on wildlife in the area of the site. The blasting will only take place outside of the overwintering period, thereby eliminating the risk of disturbance to overwintering SCI bird species. Mitigation measures include limiting working hours, limiting the number of blasts, and erection of noise barriers around noisy pieces of plant. These measures will ensure that bird and mammal activity will not be significantly affected by the operation of the borrow pit, on its own and in combination with the existing sources of anthropogenic noise.

5.7 Ambient Light

The night-time lighting of the facility is not subject to any conditions in the IEL licence or historic planning permissions. There are no specific anthropogenic lighting levels or limits set out in Irish legislation.

The process areas of the plant, as well as the marine terminal are illuminated at night. There are also streetlights around footpaths, car-parks, roads and offices. The lighting regimen at the facility has remained largely unchanged for many years.

As night-time artificial lighting can be a source of potential disturbance, a baseline assessment of the illuminance across the facility was carried out in February 2020. Generally, measurements taken can be compared to international standards/guidance such as the CIBSE Code of Lighting or ISO 8995 – 2002 Lighting of indoor workplaces.

AAL commissioned PM Group to undertake a lux-level survey at specified locations throughout the facility, in close proximity to designated sites (Appendix 9). A total number of 45 points were surveyed, over the duration of two nights. 18 No. points were measured within the operational plant and 27 No. points were measured around the site perimeter, including 2 No. points on the jetty (Figure 5.7.1). The Lux levels were measured using a calibrated Hagner EC1 Lux Meter.

The light survey was performed over two nights, Wednesday 26th February and Thursday 27th February 2020. All measurements were taken during the hours of darkness. The weather conditions consisted of high-clouds and light rain on Wednesday 26th February and clear skies with scattered high clouds on Thursday 27th February. The light survey consisted of conducting lux level measurements at specified locations (Figure 5.7.1).

The lux levels were measured at a height of 1.2m above ground level, and where applicable, the lux levels were recorded in between light sources i.e. street lighting and/or facility lighting. The lux levels (lx) measured at each of the 45 sampling points is shown in Table 5.26.

The study confirmed that areas where people and machinery are commuting and working at night are lit to typical safe levels. The four sampling points with the highest level of illuminance (>15 lx) were associated with the core of the processing plant (Points No. 01, 02 & 05) and at the marine jetty (Point No. 12). For reference, the UK HSE published Guidance on night-time lighting in different types of workspaces is summarised in Table 5.27 (HSE HDG 38: Lighting at Work). The standard range of illuminance for safe work at construction sites and loading bays is given in the range of 20-50lx. The peak lux level recorded, at the marine jetty was 32lx, very much within the range of lighting required for safe work in this working environment. The standard range of illuminance for safe movement of people and vehicles at night is presented as in the range of 5-20lx. Again, in the safety critical parts of the operating facility the 2020 lighting survey shows that AAL is within the expected range.

The 2020 PM Group survey recorded lux levels at areas away from those where night-time work would typically be undertaken, including sampling areas proximate to the Lower River Shannon SAC and River Shannon & River Fergus Estuaries SPA. Barrigone SAC is over 0.5km from the facility red-line boundary and significantly further from the illuminated process areas. There is no likelihood that night-time lighting could significantly impact upon Barrigone SAC or its conservation objectives. Similarly, there is no potential for qualifying habitats of the Lower River Shannon SAC to be significantly affected, given the distribution of these qualifying habitats, the location of the light sources and/or the sensitivity of the habitats to artificial lighting.

The sampling locations No. 21 and No. 22 were taken atop the sea-wall directly adjacent to the intertidal mudflats, part of the both the Lower River Shannon SAC and the River Shannon & River Fergus Estuaries SPA. At both of these locations, there was a reading of 0lx, indicating no appreciable influence of artificial illuminance.

The sampling points close to Poulaweala Creek also confirmed a negligible influence of artificial illuminance (Points 35, 37, 38, 39 & 41 all had readings of 0-0.2lx). Other sampling points around the perimeter of the island, and proximate to the designated sites had similarly low lux readings.

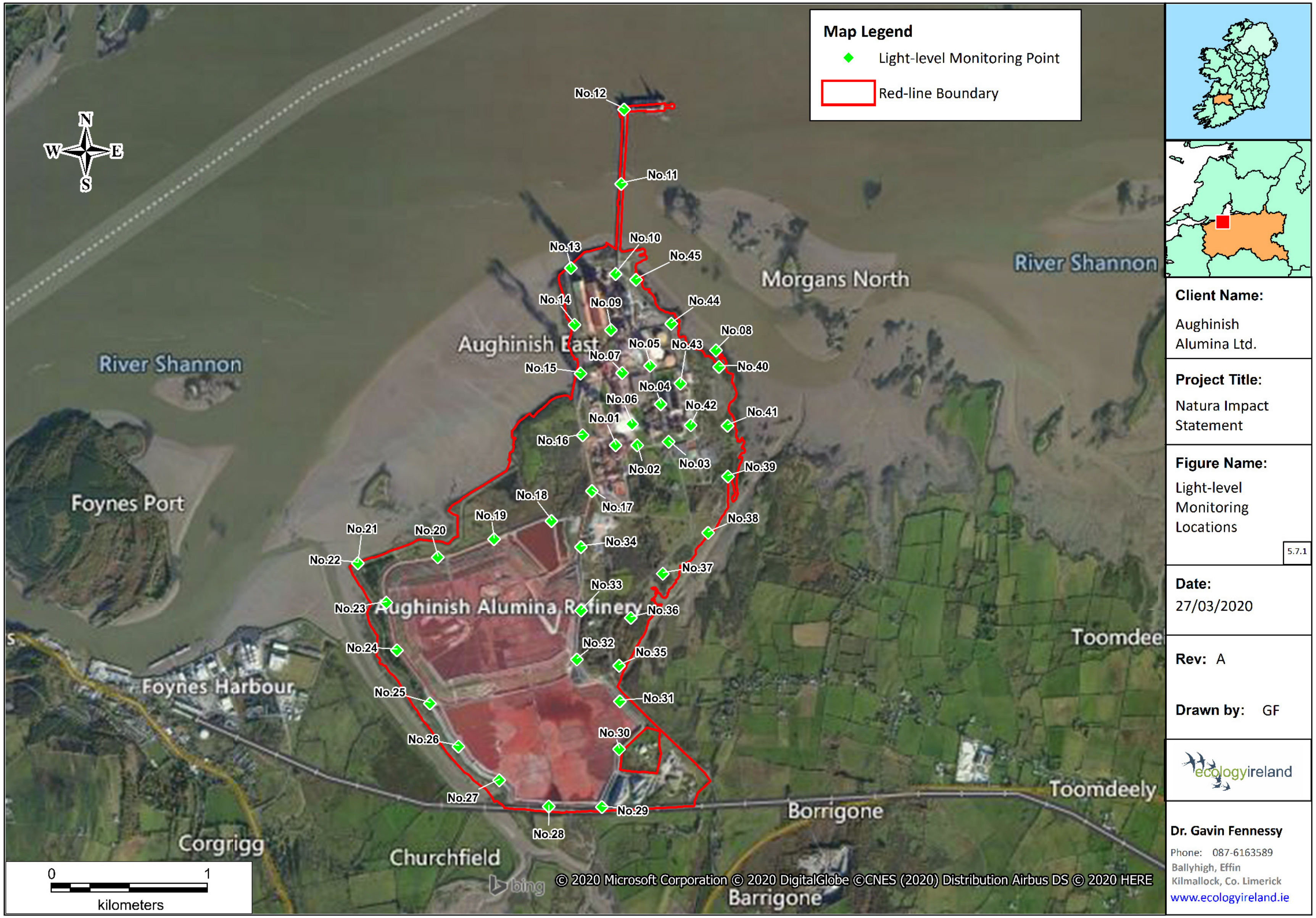
The marine jetty and terminal extend into the Shannon Estuary. The marine terminal pre-dated the designation of the conservation sites by many years (the Lower River Shannon was designated a cSAC in 2000; River Shannon & River Fergus Estuaries was proposed as a SPA in 1997). It is illuminated to safe working levels, particularly at the deep-water berths. The illumination of the jetty and terminal makes it visible to any night-time commuting birds. The visibility of structures in the environment would be expected to reduce the likelihood they would be a source of collision mortality with birds moving locally in the hours of darkness.

There is no evidence that the lighting of the licensed facility has an adverse impact on the integrity of the Lower River Shannon or River Shannon & Fergus Estuaries SPA. Ecological studies at the site confirm the regular presence of nocturnal mammals and birds within and adjacent to the licensed facility boundary. For instance, Otters have been recorded widely and frequently around the coastal sections, adjacent to the Shannon, Poulaweala Creek and Robertstown Stream (pers obs.). The area at the marine terminal is located in a deepwater area part of the Shannon and therefore is not an area of importance for feeding or roosting wading birds. It has been observed that Black-headed Gulls (*Chroicocephalus ridibundus*) regularly roost and preen in the areas on and adjacent to the well-illuminated marine terminal during night-time hours.

Most fish species have photoreceptors that discern wavelength, intensity and direction (polarity) of light. Exposure to anthropogenic light sources, both continuous and pulsed, can induce negative (Noatch and Suski, 2012) or positive phototaxis (Rich and Longcore, 2005; Ford *et al.,* 2018) in fish. There is no evidence that the lighting regimen on the marine terminal and jetty present any barrier to movement for qualifying interest species of the Lower River Shannon SAC. Another, marine qualifying species, Bottlenose Dolphin, is infrequently recorded upstream of Glin (Rogan *et al*. 2018).

Most bird species habituate rapidly to sources of artificial lighting, but anthropogenic sources of light have been shown to impact on the feeding ecology (e.g. Clewley *et al*. 2016) and territorial behaviour (da Silva *et al*. 2015). Lighting of the sky, through omni-directional lighting, up-lighting, reflected glare and high-intensity lighting etc. can cause disorientation in migratory species (Cabrera Cruz *et al*. 2018).

There is no evidence that the night-time lighting at AAL has been a source of significant disturbance, displacement or mortality (through collision) of birds occurring in the area. AAL has had designated wildlife specialists since 2005. The wildlife specialist records wildlife sightings and monitor high biodiversity value areas within and adjacent to the site on a weekly basis. They also liaise with visiting surveyors and provide day-to-day wildlife management advice to the management at AAL. There have been no records of collision mortality of waterbirds recorded at AAL. A pair of Peregrine Falcons (*Falco peregrinus*) have successfully bred within the process area of the plant in recent years and this further reduces the likelihood that waterbirds would occur on lands in close proximity to the plant. It is worth adding here that Limerick is not on a major migratory flyway for birds (Irish Aviation Authority, Integrated Aeronautical Information Package). Migration of birds in Ireland in the spring and autumn is concentrated mainly on the coast. Swans and Geese are tracked migrating at height of greater than 750m above ground on these coasts in October and November and again from the end of February to the end of April (Irish Aviation Authority, Integrated Aeronautical Information Package).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Light-level Monitoring Point
Red-line Boundary
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Aughinish Alumina Refinery
Foynes Harbour
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Borrigone
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Client Name:
Aughinish Alumina Ltd.
Project Title:
Natura Impact Statement
Figure Name:
Light-level Monitoring Locations
5.7.1
Date:
27/03/2020
Rev: A
Drawn by: GF
ecologyireland
Dr. Gavin Fennessy
Phone: 087-6163589
Ballyhigh, Effin
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www.ecologyireland.ie

Table 5.26: The lux levels measured at 45 sampling locations within the AAL facility, February 2020.

Sampling Point	Lux Level	Latitude	Longitude
No.01	28lx	52.626	-9.06032
No.02	15lx	52.626	-9.05828
No.03	9lx	52.6262	-9.05529
No.04	6lx	52.6283	-9.05604
No.05	20lx	52.6305	-9.05704
No.06	5lx	52.6272	-9.05876
No.07	7lx	52.6301	-9.0597
No.08	1lx	52.6314	-9.05079
No.09	7lx	52.6326	-9.06076
No.10	7lx	52.6358	-9.06032
No.11	11lx	52.641	-9.0598
No.12	32lx	52.6453	-9.05952
No.13	0.2lx	52.6362	-9.06458
No.14	0lx	52.6329	-9.06423
No.15	0lx	52.6301	-9.06365
No.16	0.2lx	52.6265	-9.06345
No.17	0.1lx	52.6233	-9.06258
No.18	7lx	52.6216	-9.06643
No.19	0lx	52.6206	-9.07188
No.20	0lx	52.6195	-9.07723
No.21	0lx	52.6191	-9.08482
No.22	0lx	52.6191	-9.08482
No.23	0.1lx	52.6169	-9.08212
No.24	0.1lx	52.6141	-9.08111
No.25	0.1lx	52.6111	-9.07797
No.26	0.2lx	52.6086	-9.07527
No.27	0.2lx	52.6067	-9.07138
No.28	0.3lx	52.6051	-9.06668
No.29	0.6lx	52.6051	-9.06162
No.30	1.2lx	52.6084	-9.05999
No.31	0.9lx	52.6112	-9.05993
No.32	0.2lx	52.6136	-9.06401
No.33	0.5lx	52.6164	-9.06361
No.34	0.6lx	52.6201	-9.06362
No.35	0.1lx	52.6133	-9.05999
No.36	0lx	52.616	-9.05888
No.37	0lx	52.6186	-9.05583
No.38	0.1lx	52.6209	-9.05154
No.39	0lx	52.6242	-9.04965
No.41	0.2lx	52.6271	-9.04969
No.40	0.1lx	52.6305	-9.05049
No.42	8lx	52.6271	-9.05318
No.43	4lx	52.6295	-9.05417

Sampling Point	Lux Level	Latitude	Longitude
No.44	0.4lx	52.633	-9.05503
No.45	0.5lx	52.6355	-9.05838

Table 5.27: Typical range of night-time illuminance for safe activity (as per UK HSE HDG 38: Lighting at Work).

Activity	Typical Types of Working Locations	Average Illuminance (lux) 1x	Minimum Measured illuminance (lux) 1x
Movement of people, machines and vehicles	Lorry park, corridors, circulation routes	20	5
Movement of people, machines and vehicles in hazardous areas: rough work not requiring any perception of detail	Construction sites clearance, excavation and soil work, loading bays, bottling and canning plant	50	20
Work requiring limited perception of detail	Kitchens, factories, assembling large components, potteries	100	50
Work requiring perception of details	Offices, sheet metal work, bookbinding	200	100
Work requiring perception of fine details	Drawing offices, factories assembling electronic components, textile production	500	200

5.8 Best Practice Design and Mitigation Measures

As described in the technical review of the emissions, AAL has operated an alumina refinery on Aughinish Island since 1983. The Natura 2000 sites located within the potential ZoI were proposed and designated many years after the commencement of operations at the alumina refinery. Since 1998, the facility has operated under licence from the EPA. As described, the EPA licence sets out limits on emissions to the receiving environment, including air, water and noise limits. AAL regularly report on the environmental monitoring of emissions, achieving an excellent record of compliance with the licence limits. In addition, AAL is committed to an annual programme of improvement and renewal including structural improvements to bunds, sumps and drains in the process area, including retrofitting with steel liners where necessary.

The principal change in proposed operations under consideration as part of the current IEL review (P0035-07) is the proposed borrow pit. Also, as part of the license review application, AAL has submitted an application for a derogation from the BAT-AEL for TOC and COD. Byrne Ó Cléirigh (BÓC, 2020; Appendix 2) prepared an assessment of the assimilative capacity of the Shannon Estuary in the context of the excess TOC and COD emission, and demonstrated quantitatively that the discharge to the estuary is not environmentally significant (Appendix 2). Therefore, the only proposed change in emissions from the site is the noise and vibration associated with the proposed borrow pit operations. The environmental impact assessment considered the potential for the operation of the borrow pit, on its own and cumulatively with other plans and projects. Mitigation commitments included a number of ecological mitigation measures which will ensure no residual environmental risk to the designated Natura 2000 sites within the ZoI. These measures include:

- No rock-blasting will take place during the overwintering period for birds (October to March inclusive).
- Rock blasting will only take place during daylight hours April to September inclusive
- Construction operations will take place during the hours of daylight to minimise disturbances to faunal species active in the nocturnal/crepuscular period.
- The borrow pit area will not be lit at night (with the exception of low-level switchable safety lighting). Any lighting systems present will be designed to minimise nuisance through light spillage. Shielded, downward directed lighting will be used wherever possible and all non-essential lighting will be switched off during the hours of darkness.
- To allow mammals to commute across the active borrow pit site openings of 200mm will be provided in the boundary fence at intervals of 100-200m along the fenced area.
- All edible and putrescible wastes will be stored and disposed of in an appropriate manner. Similarly, all construction materials will be stored and stockpiled at planned locations and double-handling of stripped soil will be avoided insofar as possible by implementation of a materials storage plan.

An EIAR was submitted with the planning application for the borrow pit to Limerick City and County Council (Planning Ref. 17/714), as well, upon appeal to An Bord Pleanála (Planning Ref. 301011-18). Detailed mitigation is provided in the borrow pit EIAR in relation to Water (Chapter 9, EIAR), Air

Quality (Chapter 10, EIAR) and Noise & Vibration (Chapter 11, EIAR). Planning permission for the proposed borrow pit has been granted by An Bord Pleanála, subject to specified conditions.

5.8.1 Consideration of Cumulative and In Combination Effects

A number of the recent proposed and permitted developments in the area were considered and the potential for significant cumulative and in-combination impacts were assessed.

The AAL facility is located near Shannon-Foynes Port in Co. Limerick. The Shannon-Foynes deep-water port is a significant national port, Ireland's second largest port operation and has statutory jurisdiction over all marine activities on a 500 km^2 area on the Shannon Estuary, stretching from Kerry/Loop Heads to Limerick City. It is responsible for most of the commercial ship traffic on the Shannon estuary. Shannon Foynes Port received planning permission from ABP in 2018 for an increase in capacity (SID 301561) following submission of an application with a detailed EIAR and NIS. The NIS presented detailed mitigation measures to eliminate the potential for adverse impacts upon the Lower River Shannon SAC and River Shannon & River Fergus Estuaries and their conservation objectives.

In December 2019, Limerick City and County Council (LCCC) applied under section 51(2) of the Roads Act 1993 (as amended) to An Bord Pleanála for approval in relation to a proposed road development consisting of:

- Approximately 15.6km of Type 2 dual carriageway express road extending from Foynes to Rathkeale (with an intermediate roundabout junction at Ballyclogh) along with approximately 1.9km of single carriageway road between Ballyclogh and Askeaton;
- Approximately 17.5km of dual carriageway motorway, of which approximately 15.5km is new construction and/or widening of the existing road, from Rathkeale to Attyflin;
- A Service Area for Heavy Goods Vehicles approximately 5 ha in size near Foynes with access road and service roads, parking, facilities building and a new at-grade junction onto the Foynes port access road;
- LCCC has submitted to the Board the EIAR prepared in accordance with section 50 of the Roads Acts 1993 (as amended) in respect of the proposed road development. An NIS was also prepared and was submitted to the Board in respect of the proposed road development in accordance with Part XAB of the Planning and Development Acts 2000 – 2019.

Aughinish Alumina Ltd. received planning permission from ABP for the operation of a proposed borrow pit (4.5ha in area) within the IEL site boundary. The application was accompanied by an EIAR and a Screening Assessment (17/714; 301011-18). The mitigation measures presented as part of the application have been considered in detail in relation to the current project.

The AA conclusion statement by the Department of Agriculture, Fisheries & the Marine for aquaculture activities in the Lower River Shannon & River Shannon & River Fergus Estuaries SPA summarised the AA process for potential aquaculture developments in the area. Accordingly, the Licensing Authority concluded that the licensing of certain aquaculture activities in the Shannon Estuary, along with specific management actions and mitigation measures, is not likely to have a significant effect on the integrity of the Lower River Shannon SAC and the River Shannon and Fergus Estuaries SPA https://www.agriculture.gov.ie/seafood/aquacultureforeshoremanagement/aquaculturelicensing/appropriateassessmentconclusionstatement/).

The maintenance dredging activities at Aughinish were subject to NIS (MWP 2016; https://www.housing.gov.ie/sites/default/files/foreshoreapplications/applicationdocuments/natura_impact_statement.pdf) and the evaluation of impacts, mitigation and conclusion were all considered as part of the assessment of potential cumulative impacts. Documentation in relation to other maintenance dredging applications subject to AA (e.g. East Jetty at Foynes Port: http://www.epa.ie/licences/lic_eDMS/090151b2804c311f.pdf) were also evaluated as part of this assessment.

All of the projects in question were found to have fully and adequately considered the potential for impacts on the Natura 2000 sites in the area, alone and in combination with other plans and projects. Many were subject to the AA process where the various licensing authorities also were tasked with considering the potential for any significant in combination or cumulative impacts. No significant potential for cumulative or in combination effects were identified in our review of other proposed and permitted plans and projects within the wider area.

5.8.2 Evaluation of Qualifying Interests and Special Conservation Interests

The environmental controls in place and committed to for the future operation of the facility minimise the potential for negative impacts upon the receiving environment. For Barrigone SAC, it is clear that the control of emissions to air ensure that there is no potential for residual impacts upon this site's qualifying interests. There is no groundwater or surface water linkage with Barrigone SAC and the site is outside the range of likely impacts of emissions from noise, vibration or light. Table 5.28 summarises the conclusion that there is no potential for adverse impacts upon Barrigone SAC and its conservation objectives. The 2017 Article 17 reporting as per the Standard Data Form (www.npws.ie) highlights a good conservation status for the qualifying interests of Barrigone SAC with the threats and pressures to the site identified as those related to inadequate grazing and vegetation management.

Following consideration of the controls of the emissions (monitoring and mitigation) from the licensed AAL facility (including the proposed borrow pit) it is concluded that there is no potential for residual adverse impacts upon Barrigone SAC and its conservation objectives. No potential for any significant in combination or cumulative impacts were identified in relation to Barrigone SAC. Therefore, Barrigone SAC will be excluded from further consideration in the NIS.

The qualifying interests of the Lower River Shannon SAC includes several habitats and species whose range is known not to occur in the vicinity of Aughinish Island. The Lower River Shannon is an extremely large and diverse conservation site which stretches along the Shannon valley from Killaloe in Co. Clare to Loop Head/ Kerry Head, a distance of approximately 120 km. The site encompasses the Shannon, Feale, Mulkear and Fergus estuaries as well as, the lower freshwater reaches of the River Shannon (between Killaloe and Limerick), the freshwater stretches of much of the Feale and Mulkear catchments and the marine area between Loop Head and Kerry Head. This site is of considerable ecological interest as it contains a high number of habitats and species listed on Annexes I and II of the E.U. Habitats Directive. Table 5.29 summarises the qualifying interests that occur, or are likely to occur, in the vicinity of Aughinish Island.

Table 5.28: Consideration of Impacts upon Barrigone SAC qualifying interests

Qualifying Feature	Potential for Significant Impacts	Rationale
Barrigone SAC		
Juniperus communis formations on heaths or calcareous grasslands [5130]	No	No evidence of declining conservation status arising from emissions from AAL. Currently Good conservation status, with NPWS Threats and Pressures reported as Species Composition Change (Succession), Abandonment of Pastoral systems (lack of grazing).
Semi-natural dry grasslands and scrubland facies on calcareous substrates (Festuco-Brometalia) (* important orchid sites) [6210]	No	No evidence of declining conservation status arising from emissions from AAL. Currently Good conservation status, with NPWS Threats and Pressures reported as Species Composition Change (Succession), Abandonment of Pastoral systems (lack of grazing).
Limestone pavements [8240]	No	No evidence of declining conservation status arising from emissions from AAL. Currently Good conservation status, with NPWS Threats and Pressures reported as Species Composition Change (Succession), Abandonment of Pastoral systems (lack of grazing).

Qualifying Feature	Potential for Significant Impacts	Rationale
Euphydryas aurinia (Marsh Fritillary) [1065]	No	Marsh Fritillary has not been recorded within Barrigone SAC in recent years. The association of the species with the SAC derives from a paper by Lavery (1993) which refers to a site called Foynes/Barrigone as being one of three major populations in Ireland. A survey in 2012 did not find the species in the SAC (Wilson *et al.*, 2013). As long as there are no significant impacts on the quality and extent of the qualifying habitats within the SAC there is no potential for adverse impacts on Marsh Fritillary arising from AAL.

Table 5.29: Summary of the known distribution of the qualifying interests of the Lower River Shannon SAC. The species and habitats that need further consideration are emphasized.

Qualifying Interest	Potential for Impact
Sandbanks which are slightly covered by sea water all the time [1110]	No - distribution near mouth of estuary
Estuaries [1130]	Yes - this habitat covers all of the tidal range of the site
Mudflats and sandflats not covered by seawater at low tide [1140]	Yes - there are areas of mudflat and sandflat around Aughinish Island
Coastal lagoons [1150]	Yes - Poulaweala & Quayfield Loughs (IL031) are not located on Aughinish Island, but on Morgan's North to the east.
Large shallow inlets and bays [1160]	No - distribution not proximate to AAL site
Reefs [1170]	No - distribution not proximate to AAL site
Perennial vegetation of stony banks [1220]	No - distribution not proximate to AAL site
Vegetated sea cliffs of the Atlantic and Baltic coasts [1230]	No - distribution not proximate to AAL site
Salicornia and other annuals colonising mud and sand [1310]	No - distribution not proximate to AAL site
Atlantic salt meadows (Glauco-Puccinellietalia maritimae) [1330]	Yes - areas of Atlantic Salt Meadow locally, e.g. on Robertstown Creek Estuary

Qualifying Interest	Potential for Impact
Mediterranean salt meadows (Juncetalia maritimi) [1410]	Yes - small areas of Mediterranean Salt Meadow locally, e.g. on Robertstown Creek Estuary
Water courses of plain to montane levels with the Ranunculion fluitantis and Callitricho-Batrachion vegetation [3260]	No - distribution not proximate to AAL site
Molinia meadows on calcareous, peaty or clayey-silt-laden soils (Molinion caeruleae) [6410]	No - distribution not proximate to AAL site
Alluvial forests with Alnus glutinosa and Fraxinus excelsior (Alno-Padion, Alnion incanae, Salicion albae) [91E0]	No - distribution not proximate to AAL site
Margaritifera margaritifera (Freshwater Pearl Mussel) [1029]	No - distribution not proximate to AAL site
Petromyzon marinus (Sea Lamprey) [1095]	Yes - Marine and freshwater species which may occur locally
Lampetra planeri (Brook Lamprey) [1096]	No - exclusively Freshwater species
Lampetra fluviatilis (River Lamprey) [1099]	Yes - Marine and freshwater species which may occur locally
Salmo salar (Salmon) [1106]	Yes - Anadramous species - may occur locally
Tursiops truncatus (Common Bottlenose Dolphin) [1349]	Yes - not common upstream of Glin but may occur locally
Lutra lutra (Otter) [1355]	Yes - occurs on Aughinish Island

Each of the qualifying interests of the Lower River Shannon identified as potentially occurring in areas proximate to the AAL facility are discussed below. The potential for adverse impacts is considered based on the technical review of emissions, the compliance with license limits, mitigation and monitoring commitments and the ecology of the qualifying interests themselves.

Estuaries [1130]

The area of estuary designated as a qualifying interest is 24,273 hectares. Estuaries are highly productive ecosystems supporting a diverse range of a species. The associated conservation objectives are to maintain habitat area and community distribution within the Lower River Shannon SAC. The latest Standard Data Form for Article 17 reporting to the EU, lists a good conservation status for this qualifying interest (www.npws.ie). There is no evidence that the activities at, or emissions from the licensed AAL facility are negatively impacting upon the conservation objectives for the estuarine habitat in the area. There is no concern of adverse impacts upon the conservation objectives from the licensed operation of the facility and the proposed operation of the borrow pit on-site.

Mudflats & Sandflats not covered by seawater at low tide [1140]

Mudflats and sandflats not covered by seawater at low tide are important habitats for infauna and the species that feed in these habitats. A total of over 8,800 hectares of this habitat is present within the Lower River Shannon SAC. There are extensive intertidal mudflats around Aughinish Island, particularly to the northwest of the licensed facility. The conservation objectives are to maintain the habitat area and community distribution of this habitat within the SAC. The latest Standard Data Form for Article 17 reporting to the EU, lists a good conservation status for this qualifying interest (www.npws.ie). There is no evidence that the activities at, or emissions from the licensed AAL facility are negatively impacting upon the conservation objectives for these two intertidal habitat types in the area. There is no concern of adverse impacts upon the conservation objectives from the licensed operation of the facility and the proposed operation of the borrow pit on-site.

Coastal Lagoons [1150]

There are a number of coastal lagoons identified within Lower River Shannon SAC. Two of these are linked sites Quayfield and Poulaweala Loughs, located at Morgan's North to the east of Aughinish Island (IL031). These loughs are 2.5ha in area and according to the Conservation Objectives Supporting Document, they have an unfavourable/inadequate conservation status. Poulaweala and Quayfield Loughs are both small and Poulaweala is closer to a freshwater lake than a lagoon. Quayfield Lough is largely dominated by lagoonal specialist species. It is also a karst lagoon, with connection to the sea through underground fissures, which is an unusual lagoon type in Europe. Therefore, despite its small size, as a lagoon it is regarded as of moderate conservation value. The conservation status is unfavourable/inadequate due to natural eutrophication and the associated growth of emergent vegetation in Poulaweala Lough. The latest Standard Data Form for Article 17 reporting to the EU, lists a good conservation status for this qualifying interest (www.npws.ie). There is no evidence that the activities at, or emissions from the licensed AAL facility are negatively impacting upon the conservation objectives for the coastal lagoons in the area. There is no concern of adverse impacts upon the conservation objectives from the licensed operation of the facility and the proposed operation of the borrow pit on-site.

Atlantic salt meadows (Glauco-Puccinellietalia maritimae) [1330] & Mediterranean salt meadows (Juncetalia maritimi) [1410]

Within the Lower River Shannon SAC, 10 sub-sites that supported Atlantic salt meadow (ASM) were mapped (119.36ha) and additional areas of potential saltmarsh (376.07ha) were identified from an examination of aerial photographs, giving a total estimated area of 495.43ha. The Barrigone-Aughinish sub-site held c. 10.3ha of ASM and an additional 2.4ha of Mediterranean Salt Meadow (MSM) habitat type (Figure 5.9.1). The conservation prospects of ASM in the area are considered 'unfavourable-bad' due principally to the agricultural land use (including grazing) and maintenance of OPW flood embankments that was observed in this area (www.npws.ie). The extent, structure and function and future prospects of MSM in the area are considered favourable (www.npws.ie). There is no evidence that the activities at, or emissions from the licensed AAL facility are negatively impacting upon the conservation objectives for these two saltmarsh habitat types in the area. There is no concern of adverse impacts upon the conservation objectives from the licensed operation of the facility and the proposed operation of the borrow pit on-site.

Petromyzon marinus (Sea Lamprey) [1095] & *Lampetra fluviatilis* (River Lamprey) [1099]

The Sea Lamprey, *Petromyzon marinus* is a migratory species which matures in the sea and migrates to freshwater to spawn. They typically migrate through the estuary from the sea in April and May (Hardisty, 1969) and spawn in rivers in late May or June before returning to the sea. There are records of the species throughout the Fergus Estuary and eastern half of the Shannon Estuary (www.npws.ie).

The River Lamprey, *Lampetra fluviatilis*, is also migratory species which grows to maturity in estuaries and migrate to freshwater to spawn from October to December (Maitland, 2003). Spawning typically occurs in the rivers in March and April. When they reach 3-5 years of age, individuals migrate during darkness to the estuary in the late summer period.

Both species listed as having a Good conservation status in the most recently submitted Article 17 Standard Data Form (www.npws.ie). There is no evidence that the activities at, or emissions from the licensed AAL facility are negatively impacting upon the conservation objectives for these two Lamprey species in the area. There is no concern of adverse impacts upon the conservation objectives from the licensed operation of the facility and the proposed operation of the borrow pit on-site.

Salmo salar (Salmon) [1106]

Salmon are found widely in the Lower Shannon SAC. Smolts typically head out to sea between March and June and adults return to the river between March and August. Salmon have undergone a serious decline, over much of their range, in recent decades. In the Shannon catchment this is attributed to habitat degradation, hydroelectric impoundment (Ardnacrusha), water pollution and overfishing. Given the distribution and ecology of the species: which is listed as having an excellent conservation status in the most recently submitted Article 17 Standard Data Form for the Lower River Shannon SAC (www.npws.ie) there is no likelihood that the activities at, or emissions from the licensed AAL facility are negatively impacting upon the conservation objectives for Atlantic Salmon in the Lower River Shannon SAC. There is no concern of adverse impacts upon the conservation objectives from the licensed operation of the facility and the proposed operation of the borrow pit on-site.

Tursiops truncatus (Common Bottlenose Dolphin) [1349]

Rogan *et al*. (2018) found that Bottlenose Dolphins were infrequently present upstream of Glin, within the Lower Shannon Estuary SAC. The main areas used within the estuary by this cetacean, are the outer and mid estuary and these areas are considered core areas for the species (www.npws.ie). Analysis of Static Acoustic Monitoring (SAM) data, which was carried out at Aughinish from 2011-2014 found evidence of the local presence of the species for 29% of days monitored (as per MWP 2016). The conservation objectives are to maintain the favourable conservation condition of Bottlenose Dolphin in the Lower River Shannon SAC, according to three attributes: Access to Suitable

Habitat, the habitat use of critical habitat areas and disturbance. The latest Standard Data Form for Article 17 reporting to the EU, lists a good conservation status for this qualifying interest (www.npws.ie). There is no evidence that the activities at, or emissions from the licensed AAL facility are negatively impacting upon the conservation objectives for Bottlenose Dolphins in the area. There is no concern of adverse impacts upon the conservation objectives from the licensed operation of the facility and the proposed operation of the borrow pit on-site.

Lutra lutra (Otter) [1355]

Otters and their signs (spraint, prey remains, tracks etc.) are frequently recorded around the coast of Aughinish Island (pers obs.). However, no active holt has been recorded on the island in recent years. There is no detailed field survey data for the Lower River Shannon SAC, but Otters are believed to have an excellent conservation status according to the latest Article 17 Standard Data Form (www.npws.ie). Certainly, Otters appear to be doing well locally, with a feeding adult and young seen at Poulaweala Creek in 2020 (Kilewee Wildlife Services pers comm.). Otters are relatively tolerant of anthropogenic sources of disturbance (Sleeman & Moore, 2005), colonising and breeding in our cities. The availability of prey, breeding and resting places are important factors in determining the success of Otters and this is reflected in the conservation objectives for the species. There is no evidence that the activities at, or emissions from the licensed AAL facility are negatively impacting upon the conservation objectives for Otters in the area. There is no concern of adverse impacts upon the conservation objectives of Otters within the Lower River Shannon SAC arising from the licensed operation of the facility and the proposed operation of the borrow pit on-site.

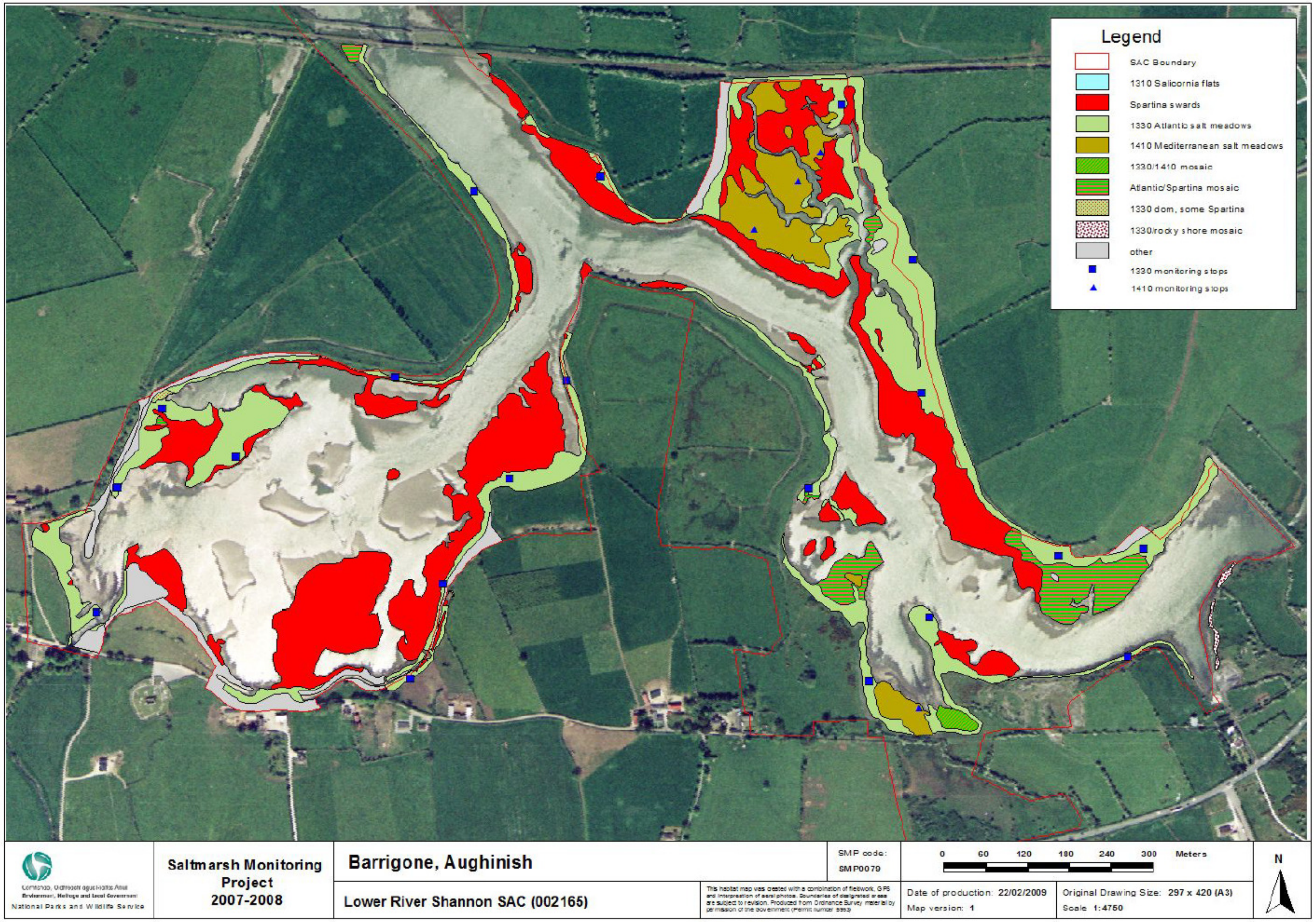

Figure 5.9.1 Distribution of Saltmarsh habitat, Robertstown Creek (www.npws.ie).

The River Shannon and River Fergus Estuaries form the largest estuarine complex in Ireland and located in the mid-west, the complex spans three counties, Clare (north shore), Limerick and Kerry (southern shoreline). The vast intertidal mudflats exposed at low tide together with a diversity of other wetland habitats results in the estuarine complex being especially important for birds. Over 32,000 hectares are designated as the River Shannon and River Fergus Estuaries SPA. The special conservation interests of the River Shannon & River Fergus Estuaries are mostly wintering waterbird species. Cormorants are listed as SCI species for both their wintering and breeding populations. There is a large breeding colony on the Shannon, close to the Limerick Tunnel on the N18. There is no breeding site for Cormorant proximate to the AAL facility.

The SPA is one of the most important sites for a wide range of wintering bird species in Ireland. The overarching Conservation Objective for the River Shannon and River Fergus Estuaries SPA is to ensure that waterbird populations and their wetland habitats are maintained at, or restored to, favourable conservation condition. This includes, as an integral part, the need to avoid deterioration of habitats and significant disturbance; thereby ensuring the persistence of site integrity. Table 5.30 summarises the national and importance of the SPA for the SCI species. The SCI species site conservation status is summarised in Table 5.31. Detailed bird surveys of the SPA have also been undertaken under the Strategic Integrated Framework Plan (SIFP) for the Shannon Estuary 2013-2020, an inter-jurisdictional land and marine-based framework to guide the future development and management of the Estuary.

Two of the bird count subsites are adjacent to Aughinish Island (01437 Aughinish East, 01438 Aughinish Is.). These sites both rank within the top ten subsites within the SPA complex – with typical diversity of around 19 bird species recorded at each sub-site during the winter period. Table 5.31 highlights that Wigeon is a species with a highly unfavourable conservation condition within the SPA. The species has declined across its European range in recent decades, perhaps related to climate related changes in breeding habitat (e.g. Pöysä *et al*., 2017). The intertidal mudflats around Aughinish are amongst the most important feeding sites for this overwintering bird. There is no evidence of disturbance or displacement of intertidal feeding waterbirds anywhere in the vicinity of the operational AAL facility. In order, to minimise any disturbance or displacement risks associated with blasting operations for the proposed borrow pit, blasts will only take place in the period April to September.

The SPA, and indeed subsites close to the licensed facility, continue to be of significant importance to a range of wintering waterbirds. The quality of the habitats present is evidenced by the diversity and abundance of wintering waterbirds the area supports. The only change proposed in the function of the licensed facility is the operation of the proposed borrow pit. With the application of the mitigation measures outlined earlier in Section 5.9 there is no risk of significant adverse impacts arising from the project.

Table 5.30: Designation Summary for River Shannon & River Fergus Estuaries SPA (after NPWS Conservation Objectives Supporting Document; www.npws.ie).

	Special Conservation Interests	Annex I species	Baseline Population[a]	Population status at baseline	National Importance Rank[1]	Regional Importance Rank[2]	County Importance Rank[3]
Selection Species	Whooper Swan	Yes	118	All-Ireland Importance	16	2	2
	Light-bellied Brent Goose		494	International Importance	13	1	3
	Shelduck		1,025	All-Ireland Importance	1	1	1
	Wigeon		3,761	All-Ireland Importance	1	1	2
	Teal		2,260	All-Ireland Importance	2	1	1
	Cormorant (non-breeding)		245	All-Ireland Importance	6	1	1
	Ringed Plover		223	All-Ireland Importance	8	2	4
	Golden Plover	Yes	5,664	All-Ireland Importance	9	1	2
	Grey Plover		558	All-Ireland Importance	3	1	1
	Lapwing		15,126	All-Ireland Importance	1	1	1
	Knot		2,015	All-Ireland Importance	4	1	1
	Dunlin		15,131	International Importance	1	1	1
	Black-tailed Godwit		2,035	International Importance	2	1	1
	Bar-tailed Godwit	Yes	460	All-Ireland Importance	11	1	2
	Curlew		2,396	All-Ireland Importance	1	1	1
	Greenshank		61	All-Ireland Importance	1	1	1
	Redshank		2,645	All-Ireland Importance	1	1	1
Additional Special Conservation Interests	Pintail		62	All-Ireland Importance	8	1	2
	Shoveler		107	All-Ireland Importance	10	2	2
	Scaup		102	All-Ireland Importance	6	1	3
	Cormorant (breeding)		93 pairs	All-Ireland Importance	12	-	-
	Black-headed Gull		2,681	All-Ireland Importance	6	1	1
Other conservation designations associated with the site[b]		SAC	RAMSAR SITE	IMPORTANT BIRD AREA (IBA)	WILDFOWL SANCTUARY	OTHER	
		Yes	Yes	Yes	Yes		

[a] Baseline data from I-WeBS with the exception of Whooper Swan (Robinson et al. 2004a) and Light-bellied Brent Goose (Robinson et al. 2004b).
[b] Note that other conservation designations associated with the River Shannon and River Fergus estuaries may relate to different areas and/or some of these areas may extend outside the SPA boundary.
[1] National importance rank - the number given relates to the importance of the site for the non-breeding population of a SCI species during the baseline period (1995/96 – 1999/00) relative to other wetland SPA sites in Ireland.
[2] Regional importance rank - the number given relates to the importance of the site for the non-breeding population of a SCI species during the baseline period (1995/96 – 1999/00) relative to other wetland SPA sites within the mid-western region (note that this site does extend into the south-western region but for the purpose of this assessment only the mid-western region is considered; the mid-western region includes Counties Clare, North Tipperary and Limerick).
[3] County importance rank - the number given relates to the importance of the site for the non-breeding population of a SCI species during the baseline period (1995/96 – 1999/00) relative to other wetland SPA sites within Counties Limerick, Clare and Kerry.

Table 5.31: The Conservation condition of the SCI species (after NPWS Conservation Objectives Supporting Document; www.npws.ie).

Special Conservation Interests (SCIs)	Method used for trend analysis[1]	Resulting % Change[1]	Level of caution applied[1]	Conservation Condition[2]	BoCCI Category[3]	Current all-Ireland Trend[4]	Current International Trend[5]
Whooper Swan*	1	Increase	Low	Favourable	Amber	+ 43.9	Increase
Light-bellied Brent Goose*	2	Decline >50%	Moderate	Undetermined	Amber	+ 58	Increase
Shelduck*	1	Decline >50%	Moderate	Undetermined	Amber	+ 4.46	Stable
Wigeon*	1	Decline >50%	Low	Highly unfavourable	Amber	- 20.1	Stable
Teal*	1	Decline >50%	Moderate	Undetermined	Amber	+ 11.3	Increase
Cormorant*	1	Decline 1.0 – 24.9%	Moderate	Undetermined	Amber	+ 31.5	Increase
Ringed Plover*	2	Decline >50%	High	Undetermined	Amber	+ 21.8	Decline
Golden Plover*	1	Decline >50%	Moderate	Undetermined	Red	- 2.2	Decline
Grey Plover*	2	Decline >50%	Moderate	Undetermined	Amber	- 33.1	Decline
Lapwing*	1	Decline >50%	Moderate	Undetermined	Red	- 40.1	Decline
Knot*	2	Decline >50%	Moderate	Undetermined	Red	- 2.91	Decline
Dunlin*	2	Decline >50%	High	Undetermined	Amber	- 46.5	Stable *(alpina)*
Black-tailed Godwit*	2	Decline >50%	High	Undetermined	Amber	+ 70.2	Increase
Bar-tailed Godwit*	n/c	-	-	Undetermined	Amber	+ 1.5	Stable
Curlew*	1	Decline >50%	Moderate	Undetermined	Red	- 25.7	Decline
Greenshank*	2	Decline -25.0% to -49.9%	High	Undetermined	Amber	+ 79.7	Stable
Redshank*	1	Decline >50%	Moderate	Undetermined	Red	+ 22.7	Stable/Decline
Pintail	n/c	-	-	Undetermined	Red	+ 26.8	Stable
Shoveler	n/c	-	-	Undetermined	Red	+ 21.3	Stable
Scaup	n/c	-	-	Undetermined	Amber	+ 88.7	Stable
Black-headed Gull	1	Decline -25.0% to -49.9%	Moderate	Undetermined	Red	n/c	n/c

*Denotes site selection species; [1] See methods in Section 4.2.1; [2] See methods in Section 4.2.2. n/c = not calculated.
[3] See Lynas *et al.* (2007) for detailed listing criteria; [4] all-Ireland trend calculated for period 1994/95 to 2008/09; [5] international trend after Wetland International (2006).

6 NIS Summary and Conclusion

6.1 Integrity of the Designated Sites

From the *Assessment of Plans and Projects Significantly Affecting Natura 2000 Sites: Methodological guidance on the provisions of Article 6(3) and (4) of the Habitats Directive 92/43/EEC* (EC, 2002), the meaning of integrity is described as follows:

'*The integrity of a site involves its ecological functions. The decision as to whether it is adversely affected should focus on and be limited to the site's conservation objectives*'.

The concept of the 'integrity of the site' is also explained in the EU publication Managing Natura 2000 sites: The provisions of Article 6 of the 'Habitats' Directive 92/43/EEC (EC, 2000), as follows:

'It is clear from the context and from the purpose of the directive that the 'integrity of the site' relates to the site's conservation objectives. For example, it is possible that a plan or project will adversely affect the integrity of a site only in a visual sense or only habitat types or species other than those listed in Annex I or Annex II. In such cases, the effects do not amount to an adverse effect for purposes of Article 6(3), provided that the coherence of the network is not affected. On the other hand, the expression 'integrity of the site' shows that focus is here on the specific site. Thus, it is not allowed to destroy a site or part of it on the basis that the conservation status of the habitat types and species it hosts will anyway remain favourable within the European territory of the Member State.

6.2 Integrity of the Natura 2000 Sites within the Project Zone of Influence

Potential for any significant adverse effects will be resolved through the mitigation and monitoring commitments outlined herein and the ongoing compliance with national and international best practice, IEL condition and limits, a Dumping at Sea (DaS) permit conditions and limits

From the information gathered and the predictions made about the changes that are likely to result from the project, an Integrity of Site Checklist for Natura 2000 sites considered in this Natura Impact Statement is presented in Table 6.1 below.

Table 6.1: Integrity of Site Checklist for Natura 2000 Sites within the Project Zone of Influence.

Conservation Objectives		
Does the project have the potential to:	**Yes or No**	**Comment**
Cause delays in progress towards achieving the conservation objectives of the site?	No	There will be no direct impacts to the QIs/SCIs of Natura 2000 sites located within the project ZoI and considered in this NIS. The AAL facility is subject to IEL limits and auditing. Ongoing compliance with the strict limits on emissions will ensure no significant indirect impacts on the Natura 2000 sites within the ZoI. The monitoring and mitigation commitments described herein provide confidence in this conclusion.
Interrupt progress towards achieving the conservation objectives of the site?	No	There will be no direct impacts to the QIs/SCIs of Natura 2000 sites located within the project ZoI and considered in this NIS. The AAL facility is subject to IEL limits and auditing. Ongoing compliance with the strict limits on emissions will ensure no significant indirect impacts on the Natura 2000 sites within the ZoI. The monitoring and mitigation commitments described herein provide confidence in this conclusion.
Disrupt those factors that help to maintain the favourable conditions of the site?	No	
Interfere with the balance, distribution and density of key species that are the indicators of the favourable condition of the site?	No	
Other Objectives: Does the project have the potential to:	**Yes or No**	**Comment**
Cause changes to the vital defining aspects (e.g. nutrient balance) that determine how the site functions as a habitat or ecosystem?	No	There will be no direct impacts to the QIs/SCIs of Natura 2000 sites located within the project ZoI and considered in this NIS. The AAL facility is subject to IEL limits and auditing. Ongoing compliance with the strict limits on emissions will ensure no significant indirect impacts on the Natura 2000 sites within the ZoI. The monitoring and mitigation commitments described herein provide confidence in this conclusion.
Change the dynamics of the relationships (between, for example, soil and water or plants and animals) that define the structure and/or function of the	No	

Conservation Objectives		
Does the project have the potential to:	Yes or No	Comment
site?		
Interfere with predicted or expected natural changes to the site (such as water dynamics or chemical composition)?	No	There will be no direct impacts to the QIs/SCIs of Natura 2000 sites located within the project ZoI and considered in this NIS. The AAL facility is subject to IEL limits and auditing. Ongoing compliance with the strict limits on emissions will ensure no significant indirect impacts on the Natura 2000 sites within the ZoI. The monitoring and mitigation commitments described herein provide confidence in this conclusion.
Reduce the area of key habitats?	No	There will be no direct impacts to the QIs/SCIs of Natura 2000 sites located within the project ZoI and considered in this NIS. The AAL facility is subject to IEL limits and auditing. Ongoing compliance with the strict limits on emissions will ensure no significant indirect impacts on the Natura 2000 sites within the ZoI. The monitoring and mitigation commitments described herein provide confidence in this conclusion.
Reduce the population of key species?	No	
Change the balance between key species?	No	
Reduce diversity of the site?	No	
Result in disturbance that could affect population size or density or the balance between key species?	No	There will be no direct impacts to the QIs/SCIs of Natura 2000 sites located within the project ZoI and considered in this NIS. The AAL facility is subject to IEL limits and auditing. Ongoing compliance with the strict limits on emissions will ensure no significant indirect impacts on the Natura 2000 sites within the ZoI. The monitoring and mitigation commitments described herein provide confidence in this conclusion.
Result in fragmentation?	No	There will be no fragmentation of Natura 2000 sites within the project ZoI. There will be no direct impacts to the QIs/SCIs of Natura 2000 sites located within the project ZoI and considered in this NIS. The AAL facility is subject to IEL limits and auditing. Ongoing compliance with the strict limits on emissions will ensure no significant indirect impacts on the Natura 2000 sites within the ZoI. The monitoring and mitigation

Conservation Objectives		
Does the project have the potential to:	Yes or No	Comment
		commitments described herein provide confidence in this conclusion.
Result in loss or reduction of key features (e.g. tree cover, tidal exposure, annual flooding, etc.)?	No	The proposed development will not result in the loss or reduction of key features of Natura 2000 Sites. There will be no direct impacts to the QIs/SCIs of Natura 2000 sites located within the project ZoI and considered in this NIS. The AAL facility is subject to IEL limits and auditing. Ongoing compliance with the strict limits on emissions will ensure no significant indirect impacts on the Natura 2000 sites within the ZoI. The monitoring and mitigation commitments described herein provide confidence in this conclusion.

6.3 Conclusion

The Environmental Protection Agency (EPA) requested that the applicant, AAL, prepare and submit a NIS in relation to the IEL Review (P0035-07) currently under consideration. Their determination was based on the nature and scale of the activities, the proximity of the installation to a number of European sites and the potential effects such activities may have on European Sites and their qualifying interests. The EPA requested that the NIS consider all emissions from the facility.

The AA Screening (see **Section 3-4**) found that it could not be excluded, on the basis of objective scientific information that the proposed works, individually or in combination with other plans or projects, would have a significant effect on three Natura 2000 sites: Lower River Shannon SAC, River Shannon & River Fergus Estuaries SPA and Barrigone SAC. Therefore, a NIS (presented in **Section 5**) was required to ascertain whether the proposed works would have an adverse effect on the integrity of the Natura 2000 sites.

The NIS includes a detailed technical review of the emissions to the receiving environment. The compliance with existing limits and ongoing commitments of AAL to monitoring and mitigation is discussed. In addition, AAL provides information on the existing lighting regimen at the facility.

It has been objectively concluded that the proposed project will not adversely affect the integrity of any Natura 2000 site, and there is no reasonable scientific doubt in relation to this conclusion.

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Appendix 1

Curricula Vitae

Declan Egan

BSc. (Env) MSc. CSci. CEnv. CWEM
Technical Director Environment
Project Manager

Key Skills

- Project Management
- Environmental Impact Assessment & Planning
- Strategic Environmental Assessment
- Environmental Auditing
- Waste Management
- Flood Management Plans
- Contaminated Land & Remediation
- Life Cycle Assessment

Short Biography

Declan, has over 25 years' experience in project management, environmental impact assessment (EIA) for large infrastructure, flood relief schemes and energy projects, strategic environmental assessment (SEA) for both land use plans and flood management programmes, planning applications, waste management for local authorities and the private sector, contaminated land assessment and remediation, pre-acquisition environmental assessments and environmental auditing.

Declan has project managed a number of EIS's ranging from flood relief schemes, waste management facilities, residential and commercial developments, infrastructure road projects, industrial developments, quarries and landfill sites. He project managed the EIS for Ireland's first off shore wind farm on the Arklow Bank which included detailed visual marine assessment and undertook full breeding bird surveys. He has also managed environmental portions of large infrastructure projects such as interurban roads schemes.

Declan is a Chartered Scientist, Chartered Environmentalist and a Chartered Water and Environmental Manager. He is a chartered member of the Chartered Institute of Water and Environmental Management (CIWEM) and a chartered member of the Chartered Institute of Waste (CIWM). Declan is a part time lecturer in the University of Cork.

Academic Qualifications

Date	Qualification	Subject	Educational Institution
2000	MSc (Masters)	Master of Science Environmental Auditing	University of Wales
1987	BSc (Degree)	Environmental Science & Technology	Sligo Institute of Technology
1982	Cert (Hons)	Quality Control	Dundalk Institute of Technology
1981	Cert (Hons)	Applied Biology	Dundalk Institute of Technology

Professional Affiliations

Designation

Chartered Scientist

Chartered Environmentalist

Chartered Water and Environmental Manager

Member of the Chartered Institution of Waste Management (MCIWM)

Member of the Chartered Institution of Water and Environmental Management (MCIWEM)

Member of Technical Committee of CIWEM for Environmental Management

Professional History

Dates	Position	Company
2015-present	Technical Director Environment	JBA Consulting
2011-2015	Owner / Director	Egan Environmental Consultancy Ltd
2010-2011	Technical Director	Fehily Timoney & Company
2001-2010	Associate	Fehily Timoney & Company
1992-2000	Senior Scientist (Environment)	Fehily Timoney & Company
1989-1990	Environmental Scientist	Eolas, Shannon, Co. Clare

Relevant Experience

Project Management	Declan has project managed a number of EIS's ranging from flood relief schemes, waste management facilities, residential and commercial developments, infrastructure road projects, industrial developments, quarries and landfill sites. He project managed the EIS for Ireland's first off shore wind farm on the Arklow Bank as well as the environmental portions of large infrastructure projects such as interurban roads schemes.
Environmental (General)	Key areas of experience include environmental impact assessment, strategic environmental assessments for land use plans, waste management, pollution control, integrated pollution control applications, environmental auditing, pre-acquisition assessments, divestiture audits, contaminated land assessment and project manage remediation, carbon management, sustainability, offshore wind farm environmental assessment and health and safety.
Strategic environmental assessment (SEA)	Declan has been involved with the Strategic Environmental Assessment (SEA) for 10 years. He has prepared a number of SEA's for County and Town Development Plans and Local Area Plans. He has also prepared the SEA's for the Flood Risk Management Plans for the Western CFRAM. Declan lectures on SEA in UCC.
Environmental impact assessment (EIA)	Declan has undertaken work on several Environmental Impact Assessments (EIAs) for a variety of projects. He has worked on a variety of Environmental Statements, Environmental Appraisals and Environmental Assessment reports, which require field and desk based investigations, along with identification of potential environmental impacts and mitigation measures. Declan lectures on EIS in UCC.
Contaminated land and site remediation	Declan has project managed a large number of contaminated land remediation projects. He has been involved from the initial site investigations to final closeout of these projects. He has evaluated analytical data and has prepared reports for client's outlining cost effective and environmentally sound remediation methodologies. Declan has project managed restoration and remediation of hazardous waste sites, asbestos burial sites, hydrocarbon contaminated sites and old gasworks sites. Declan has given evidence at oral hearings and has acted as an expert witness in court. He lectures on contaminated land and remediation in UCC's CAEC Environmental Management Degree and Environmental Science and Social Policy Diploma.
Training	Declan has provided environmental training to Project Management staff in the Office of Public Works. Declan also lecturers on a range of environmental topics for a Diploma in Environmental Science and Social Policy in UCC Adult Continued Learning Courses.

Project Experience

2017	**Project Manager**	**Environmental Training, OPW** Declan provided environmental training for staff at the OPW's Headford, Trim and Dublin offices. The training provided included environmental awareness, environmental impact assessment, planning, strategic environmental assessment and waste management.
2017	**Project Manager**	**Environmental Pre-Acquisition Assessment, Lidl** Declan involved in a Phase 1 and Phase 2 pre-acquisition environmental assessment. JBA involved in a Phase 1 desktop assessment. Recommendations for a Phase 2 assessments were made. A Phase 2 assessment involving the excavation of a number of trial pits, sampling, laboratory analysis, interpretation and reporting on the finding s of the assessment.
2017	**Project Manager**	**Site Investigation, Cairn Homes** Project Manager for a site investigation in an historically contaminated site in Dublin. JBA supervised soil and groundwater sampling, chemical analysis. JBA prepared a Conceptual Site Model for the site based on the analytical data. The analytical data was also used to characterise the material into inert, non-hazardous and hazardous material.
2016	**Project Manger**	**Preparation of Invasive Species Management Plan for Clonakilty Flood Scheme** Declan Project Managed the preparation of an Invasive Species Management Plan for the proposed drainage scheme in Clonakilty
2015-ongoing	**Environmental Lead**	**Environmental Impact Statement for Flood Relief Scheme in King's Island, Limerick City Council** Declan is the Environmental Lead for the preparation of the Environmental Impact Assessment Report for the proposed King's Island Flood Relief Scheme. Declan has project Managed the preparation of the Constraints Report and the environmental aspects of the Options Report. He is managing the collection and collation of the baseline assessment data for the EIAR.
2007-2009	**Project Manager**	**Strategic Environmental Assessment for Castletown Local Area Plan 2009-2015, Laois County Council** **Value: €20,000** Project managed the preparation of a Strategic Environmental Assessment for the Castletown Local Area Plan 2009-2015. This project involved: • Liaising with the statutory consultees • Preparation of an Environmental Report which assessed the impact of the Plan on the environment. In particular the impact of the plan on the amenity and historical value of the area was assessed • Liaising with Kildare County Council regarding our assessment.

Dr. Gavin Fennessy

Dr. Gavin Fennessy
B.Sc., Ph.D. MIEEM

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Qualifications

B.Sc. Zoology, University College Cork, National University of Ireland, Cork, 1996
PhD, Science, UCC, NUI Cork 2001
MIEEM, MESAI

Other Information

Awards
National University of Ireland, Cork College Scholar 1996.

Publications
Several scientific publications including book chapters, and
papers in International peer-reviewed journals.

Employment History

2011-present
Director & Principal Ecologist,
Ecology Ireland
2006 – 2011
Fehily Timoney & Company, Cork.
2002 — 2005
Post-Doctoral Research (HEA)
1999 — 2005
Environmental Consultant (Various)
1996 — 2001
Postgraduate Research (UCC)
2000 — Heritage Council
1999—CMRC
1999 — Coillte/UCC

Biography

Gavin is a specialist ecologist with 20 years of experience in environmental consultancy. He is the Director & Principal Ecologist of Ecology Ireland Wildlife Consultants.. He has contributed to and Project Managed numerous impact assessment projects including EcIA, EIA, AA, SEA etc. Gavin is a trained and experienced Expert Witness having presented expert testimony at several An Bord Pleanála Oral Hearings. He is also an experienced lecturer and has regularly contributed to B.Sc. Env. Sc. courses at UCC. Gavin is a member of the Policy Group of the CIEEM.

Gavin has a wide variety of field skills with particular expertise in:

- Project Management
- Avian surveys and Reports
- Mammal surveys (incl. Specialist Bat surveys)
- Wildlife Hazard Management – Collision Risk Modelling
- Ecological advice and representation

Selected Relevant Projects

Corrib Gas Project
Capital Value: >3 billion ***Completion Date: Ongoing***
Project Manager for various aspects of the environmental reporting of the Corrib Gas project. This includes field surveys as part of the route selection for Shell Ireland and monitoring of existing pipeline infrastructure for Bórd Gais. Presented expert witness testimony at An Bord Pleanála Oral Hearing 2009 & 2010.

Specialist Ecology Monitoring at Galway Wind Park
Capital Value: not disclosed ***Completion Date: 2017***
Project Manager for detailed ecological surveys during the construction of Ireland's largest wind farm on behalf of Roadbridge Ltd. Responsible for field team carrying out a wide range of specialist ecological surveys including Vantage Point surveys, breeding wader and Merlin studies, habitat regeneration monitoring, bat surveys etc. Liaising with and advising environmental manager through construction process.

Construction Phase & Post-Construction Ecological Monitoring at Mt. Lucas Wind Farm
Capital Value: not disclosed ***Completion Date: 2018***
Developed and agreed ecological survey programme with NPWS and carried out ecological monitoring work at Mount Lucas Wind Farm, Co. Offaly, during and post-construction, on behalf of Bord na Móna. Work included breeding and winter bird surveys, and fatality surveys and production of monitoring reports.

Constraints & Route Selection for GridLink Project
Capital value: not disclosed ***Completion Date: 2015***
Was retained by RPS to carry out baseline bird surveys to identify constraints and to input into the route selection process for the EirGrid GridLink project. Attended project steering group meetings and designed and co-ordinated bird surveys.

Clogheravaddy Wind Farm, Bird Surveys
Capital Value: not disclosed ***Completion Date: Ongoing***
Project Manager for ecology surveys and production of EcIA and Natura Impact Statement for a proposed wind farm development at Clogheravaddy, Co. Donegal on behalf of ABOWind Ireland Ltd. Project granted permission by ABP in 2016. Ecology Ireland appointed to carry out pre- and during-construction monitoring.

Ecological Monitoring at former Irish Steel site, Haulbowline, Cork
Capital Value: not disclosed ***Completion Date: 2019***
Provided expert witness testimony at the Oral Hearing for the remediation of the former Irish Steel site, Haulbowline, Cork. Carried out and reported upon pre- and during-works ecological monitoring (birds and marine mammals) at the site from 2014 to the completion of the landscaping works at the site in 2019.

Appendix 2

Assimilative Capacity Assessment of Effluent Discharge from Aughinish Alumina (BOC 2020)

Assimilative Capacity Assessment of Effluent Discharge from Aughinish Alumina

Prepared for

Aughinish Alumina

Ref: 532-20X0035 R0

1 April 2020

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Contents

1 INTRODUCTION

In April 2019, Aughinish Alumina Ltd (AAL) applied to the Environmental Protection Agency (EPA) for a review of its Industrial Emissions Licence (register no. P0035-06), which included the application of the *Commission Implementing Decision on the BREF on common waste water and waste gas treatment / management systems in the chemical sector* (Decision 2016/902).

AAL has assessed the characteristics of its treated effluent, which is discharged to the Shannon Estuary via licensed emission point W1-1, and has determined that it is not technically or economically feasible to treat the effluent to achieve the BAT associated emission level (BAT AEL) for total organic carbon (TOC) or chemical oxygen demand (COD). As part of its application, AAL submitted an application for a derogation from the BAT-AEL for TOC and COD.

In March 2020, the EPA issued a request for further information, which included the following:

> *Demonstrate, through quantitative environmental assessment, the impact of the "excess" contribution of TOC and COD over that of the relevant BAT Associated Emission Level (Commission Implementing Decision (EU) 2016/902), on the local receiving water environment.*

At the request of AAL, Byrne Ó Cléirigh (BÓC) has conducted an assessment of the assimilative capacity of the Shannon Estuary in the context of the discharge of treated effluent from AAL's licensed emission point W1-1, to demonstrate quantitatively that the discharge to the estuary is not environmentally significant.

2 SITE DESCRIPTION

2.1 Overview

AAL is Europe's largest alumina refinery, producing approximately 30% of the EU's alumina. The facility was constructed at a cost of approximately $1 billion and commenced operations in 1983, initially operating at a throughput of approximately 800,000 tonnes per annum. Since then, AAL has invested a further $733 million as part of its modernisation, environmental protection and efficiency programme, and it currently operates at approximately 1.9 million tonnes per annum.

2.2 Production Activity

AAL extracts alumina from bauxite ore using the Bayer process, comprising four principal stages:

1. Digestion of the bauxite ore, during which the ore is ground and mixed with a sodium hydroxide solution to form a slurry, with the digestion taking place at high pressure and temperature.
2. Clarification of the liquor stream from the digestion process, with the stream containing the alumina in solution.
3. Precipitation of alumina hydrate from the clarified stream.
4. Calcination (removal of chemically bound water) of the alumina trihydrate ($Al_2O_3.3H_2O$) to produce the finished alumina product.

2.3 Emissions to Water

2.3.1 Overview

There are seven licensed emissions to surface water at AAL:

- 5 no. storm water discharge points (designated as SS1 to SS5), which discharge storm water from the non-process areas via silt traps to the Shannon Estuary
- Emission point W1-1, which discharges treated process effluent from the effluent treatment plant to the Shannon Estuary
- The sanitary effluent discharge point, which discharges treated sanitary effluent from the sanitary effluent treatment plant to the industrial effluent discharge pipeline at a point upstream of the final discharge at W1-1.

2.3.2 Process Effluent

Process effluent and potentially contaminated storm water from higher risk areas of the site is collected in the process effluent drainage system and are treated in the site's effluent treatment plant. The effluent streams that are collected across the site comprise:

1. Storm water collected on the BRDA (over an area of 180 hectares), which may be contaminated by dilute residual sodium aluminate in the bauxite residue. In addition to the storm water that is collected on the BRDA, the sprinkler water (which forms part of AAL's dust management / control system) is collected and treated in the process effluent treatment system.
2. Storm water collected on the roadways and buildings within the process areas of the plant may be contaminated with process streams and therefore it is also treated in the process effluent treatment plant. The storm water in these areas is collected in the process area surface drainage system, which feeds the east and west surface water collection ponds. The water from the ponds is then transferred to the process effluent treatment system.
3. Storm water collected in the process bunds may be contaminated; it is either absorbed into the process or is collected in the process area surface drainage system (see no. (2)).
4. Groundwater recovered via the groundwater wells and from the estuarine stream recovery systems is recovered into the process effluent storage ponds and treated in the process effluent treatment plant.
5. Other streams that contribute to the process effluent include:
   - cooling tower bleed, which comprises concentrated steam condensate from the regenerative condenser system that feeds fresh make up steam to the central cooling towers
   - surplus process condensate from the process, which may be contaminated with traces of sodium aluminate and organics extracted from the bauxite
6. Backwash streams generated from the potable water treatment plant (which produces high quality treated water for steam generation) may contain precipitated hardness and therefore this stream undergoes clarification via the process effluent treatment system.

The typical contribution from each of the effluent streams treated in the plant is shown in Table 1, although the total volume (flow) to the plant depends on the level of rainfall and therefore the total flow can typically vary from 745 m^3/h to 1,250 m^3/h.

Table 1: Approximate process effluent volumes to AAL treatment plant

Stream	Flow (m^3/h)	TOC (mg/l)	pH (pH units)
Leachate from BRDA & rainwater runoff	290	160	13
Storm water from roads & buildings in process area, and contaminated condensate & groundwater	120	150	13
Central cooling tower bleed	30	60	12
Surplus process condensate	200	30	11
Water treatment plant backwash	60	30	11
Wastewater from Limerick City & County Council water treatment plant	45	-	7
Total	**745**	**123**	**-**

The results from AAL's effluent monitoring programme show that the typical volume of effluent discharged via emission point W1-1 (and treated in the effluent plant) is in the order of 4.85 million cubic metres per annum.

2.4 Emissions Monitoring

2.4.1 Overview

AAL monitors the discharges of treated effluent via W1-1 in accordance with Conditions 5 and 6, and Schedule C.2.2 of its licence, which requires monitoring for the licensed parameters set out in Table 2, together with monitoring for a selection of additional parameters.

Table 2: Monitoring requirement for emissions to water

Parameter	Monitoring frequency
Flow	Continuous
pH	Continuous
Temperature	Continuous
Biochemical oxygen demand	Quarterly
Suspended solids	Weekly
Soda	Weekly
Aluminium	Quarterly
Oils, fats & grease	Quarterly
Toxicity	Bi-Annually
Heavy metals	Bi-Annually
Effluent screen	Bi-annually

2.4.2 Monitoring Results

Table 3 shows the results from AAL's monitoring programme from 2018, as set out in the application for the licence review and the application for the derogation.

Table 3: Summary of monitoring of treated process effluent (2018)

Parameter		Concentration (mg/l, unless otherwise stated)		Load (kg, unless otherwise stated)	
		Annual average	Licence limit	Annual total	Licence limit
Volume (flow)		-	-	4,646,808 m^3	10,950,000 m^3
pH		7.5 – 7.7 pH units	6 – 9 pH units	-	-
Biochemical oxygen demand		100.5	-	292,083	861,400
Suspended solids		12.5	50	54,296	547,500
Soda		3,248	-	15,338,185	-
Aluminium		3.8	-	17,812	-
Oils, fats & grease		< 1	15	4,657	164,250
Heavy metals	Arsenic	0.055	-	253.9	-
	Cadmium	0.001	-	3.5	-
	Chromium	0.005	-	20.9	-
	Copper	0.005	-	22.3	-
	Mercury	0.002	-	9.3	-
	Nickel	0.005	-	23.2	-
	Lead	0.001	-	3.3	-
	Zinc	0.054	-	250.9	-
	Titanium	0.024	-	111.5	-
	Iron	0.103	-	478.6	-
	Magnesium	0.487	-	2,261	-

2.4.3 Additional Monitoring

In preparation for the submission of the licence application, AAL undertook monitoring of additional parameters (TOC and COD) in the treated effluent discharged from the effluent plant between April and September 2018, the results of which are summarised in Table 4.

Table 4: Additional effluent monitoring

Parameter	Units	Range	Average
Total organic carbon	mg/l	64.9 – 153.3	124.3
Chemical oxygen demand	mg/l	164 – 440	352.3

The results show a COD:TOC ratio of approximately 2.8:1.

3 Receiving Environment

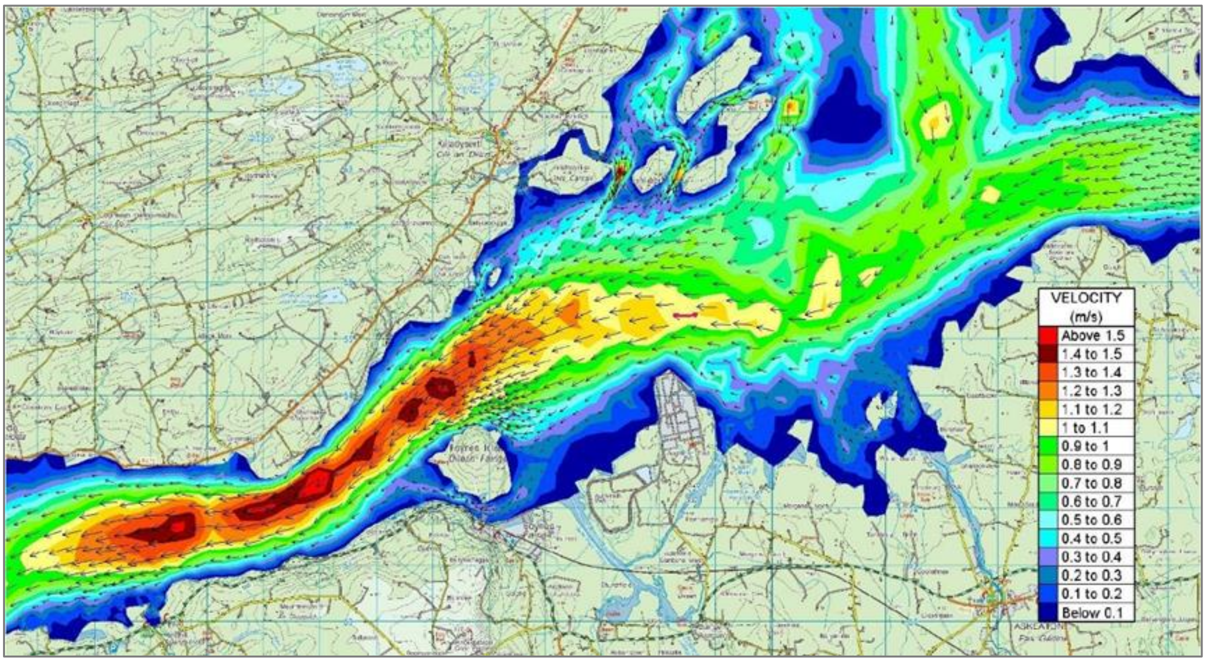
3.1 Overview

AAL's IE licence permits it to discharge treated effluent from its treatment plants to the Lower Shannon Estuary via licensed emission point W1-1. The Lower Shannon Estuary is designated as a transitional water (IE_SH_060_0300) and extends from (approximately) Shannon Airport / Ballinvoher Point in the east, to (approximately) Aylevarroo Point / Carrig Island in the west. The estuary to the west of Aylevarroo Point / Carrig Island is designated as a coastal water body and extends to the mouth of Shannon at Loop Head / Kerry Head.

3.2 Hydrodynamics

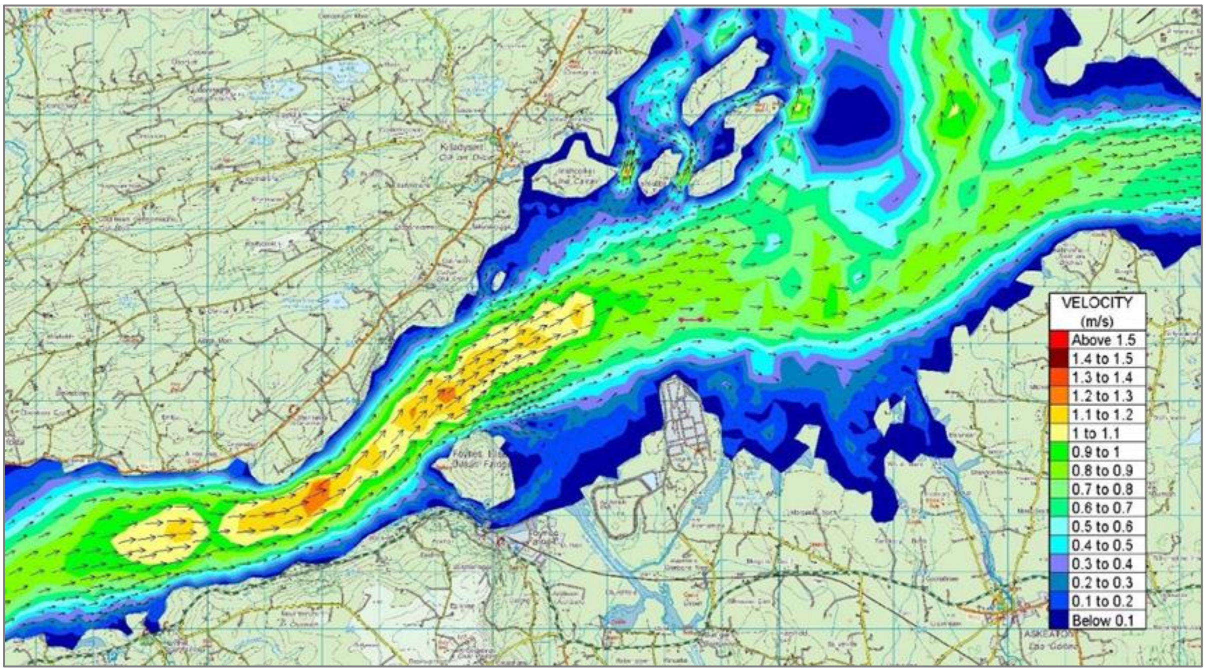
The hydrodynamics of the Shannon have been examined[1], with the analysis concluding that increased current flows are expected close to the centre of the estuary channel, as shown on the outputs from the hydrodynamic model for peak ebb and flood tides in the vicinity of the AAL jetty in Figure 1 and Figure 2.

Figure 1: Peak current flows during spring tide mid ebb



[1] *Sediment Transport Modelling of Proposed Maintenance Dredging of the Outer and Inner Berths at the Aughinish Marine Terminal, Shannon Estuary*, Hydro Environmental Limited, February 2016

Figure 2: Peak current flows during spring tide mid flood



The hydrodynamic model, which was developed (in part) to assess the transport of sediment from dredging at AAL's jetty, concluded that the dredged material is easily suspended and transported away with the tidal velocities on both spring and neap tides, and that due to the higher ebbing (outgoing) velocities the sediment plume travels further westward than eastward.

3.3 Aquatic Environment

The aquatic environment in the vicinity of AAL's discharge to the Shannon Estuary has been examined by AAL's ecological consultant[2] and the potential impacts on aquatic habitats and species have been assessed. As part of this assessment, the zone of potential impact to the marine sector has been examined to a radius of 3 km from the jetty (the nominal location of the licensed emission point).

The area surrounding the jetty falls within the Annex I qualifying interests of large shallow inlets and bays (EU habitat code 1160) and estuaries (code 1130). Large parts of the southern shoreline are designated as mudflats and sandflats not covered by seawater at low tide (code 1140), while a reef (code 1170) is recorded at the base of the main channel approximately 3 km west of the jetty. The waters within the Shannon are also designated for the Annex II species common bottlenose dolphin (*Tursiops truncatus*).

Figure 3 shows the habitats in the vicinity of the AAL jetty. The assessment also identified the marine mammals that may be present in the vicinity of the jetty (bottlenose dolphin, European otter, harbour seal, and grey seal).

[2] The assessment was for a separate project.

3.4 Marine Chemistry

The background environmental chemistry of the sediments surrounding the AAL jetty was recorded at three locations in 2016 as part of a dredging application[3], with the samples analysed for both organic (including total organic carbon) and inorganic parameters. A further six locations were sampled in 2018, including samples at the licensed discharge point, and 3 km downstream and 2 km upstream from the discharge point.

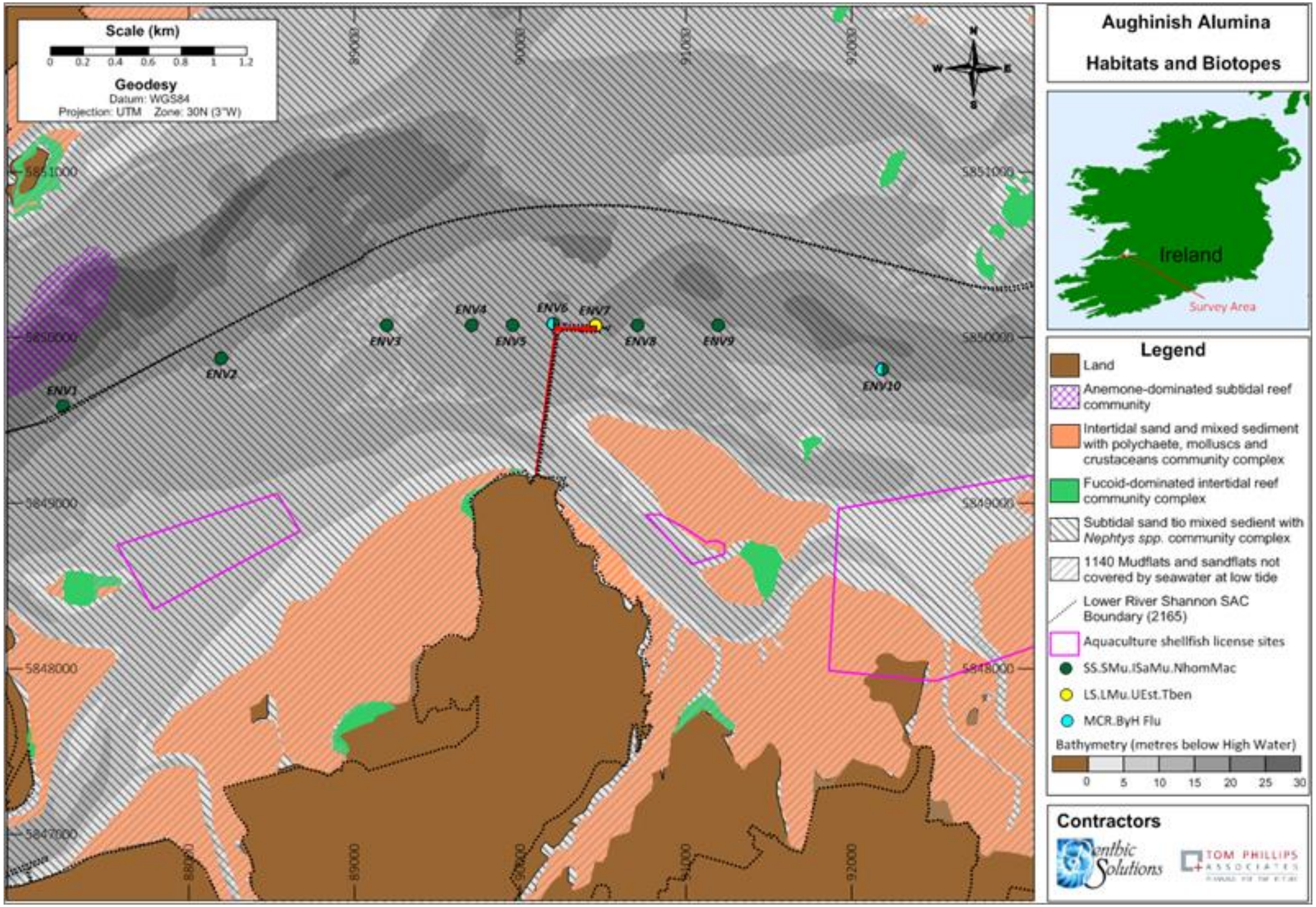
TOC is an important source of food for benthic fauna in surface sediments, although an overabundance may lead to reductions in species richness and abundance due to oxygen depletion. The TOC level in the sediment varied between 0.27% and 1.00%, with the locations downstream from the jetty showing lower TOC levels (0.27% to 0.31%), attributable to the stronger currents downstream. Previous sampling at the jetty indicated marginally higher levels of TOC than in the most recent study (2018). Table 5 shows the results for TOC from the 2018 and 2016 data.

Table 5: Sediment Organic Chemistry

Year	Location	Total Organic Carbon %
2018	ENV1 (downstream)	0.27
2018	ENV3	0.31
2018	ENV5	1.00
2018	ENV6	0.96
2018	ENV7	0.90
2018	ENV10 (upstream)	0.83
2018	2018 mean	0.71
2016	ST 2	1.08
2016	ST 3	1.61

[3] AAL operates under a Dumping at Sea Permit (Register No. S0026-01).

Figure 3: Lower River Shannon SAC and Habitats in the vicinity of the AAL Jetty



3.5 Water Column Quality

The structure of the water column has also been surveyed[2] at three locations along the estuary for conductivity (salinity), temperature, pressure (depth), dissolved oxygen, pH and turbidity. The three survey locations were:

- ENV01, approximately 3 km downstream from the jetty
- ENV06, at the jetty
- ENV10, approximately 2 km upstream from the jetty

The water profiles for all three locations were generally consistent showing only small differences, except for salinity and, to a lesser extent, turbidity. The general water profile indicated that the water temperature ranged from approximately 11°C to 11.5°C. The dissolved oxygen profile showed no notable differences between locations ENV1 (downstream) and ENV10 (upstream). However, higher readings of dissolved oxygen were recorded in the surface water layers at location ENV06, which may relate to photosynthetic processes from plankton close to the surface.

The turbidity data showed generally consistent data between all three locations, with higher turbidity generally recorded towards the lower water layers, attributed to suspended particulate matter on the riverbed and tidal driven turbidity. The results compare closely with previous data from a survey in November 2015. Overall, the assessment noted that the water quality (and turbidity) data confirms that the Shannon Estuary is susceptible to maintaining high total suspended solids loads throughout the year. The pH profile showed very little variation with water depth, ranging from 7.97 at the surface to a pH of 8.04 in the lower water layers of all three locations. The results are summarised in Table 6.

Table 6: Summary of water quality

Parameter	ENV10 (upstream)	ENV06 (jetty)	ENV01 (downstream)
Depth (m)	-1.1 to -23.6	-1.4 to -14.1	-1.1 to -29.0
Temperature (°C)	11.0 – 11.5	11.2 – 11.3	11.1 – 11.3
Salinity (PSU)	19.2 – 22.9	19.2 – 19.9	19.4 – 21.6
Turbidity (NTU)	24.2 – 116.0	48.0 – 72.3	46.1 – 78.6
Dissolved oxygen (%)	95.3 – 96.1	94.5 – 106.7	95.2 – 97.6
pH (pH units)	7.97 – 8.04	7.97 – 8.04	7.97 – 8.04

3.6 Surface Water Quality

The EPA's latest report on surface water quality – *Water Quality in Ireland 2013-2018* – was published in 2019. This notes that overall, there has been a 4.4% net decline in the quality of surface water bodies since 2010-2015. It noted that transitional water bodies are the worst performing water category with only 38% in good or high ecological status and the remaining 62% in moderate, poor or bad status. In this period however, the ecological performance of the Lower Shannon Estuary improved from *moderate* to *good* status. This is consistent with the 2010 report on the Lower Shannon Estuary under the Water Framework Directive (WFD), the outputs of which are summarised in Table 7.

Table 7: Waterbody Status of Lower Shannon Estuary[4]

Ref.	Element	Result
DIN	Dissolved Inorganic Nitrogen status	Good
MRP	Molybdate Reactive Phosphorus status	Good
DO	Dissolved oxygen as per cent saturation status	High
BOD	Biochemical Oxygen Demand (5-days) status	High
PHY	Macroalgae - phytobiomass status	High
FIS	Fish status	High
MOR	Morphology status	Good
SP	Specific Pollutant Status	Fail [Note 1]
PAS	Overall protected area status	At least good
ES	Ecological Status	Moderate
CS	Chemical Status	Fail [Note 1]

Note 1: See the corresponding entry in Table 8 for water quality status data since 2010.

The WFD report also identifies the risks and point pressures that waterbodies are exposed to, and the overall risk result for the body. The Lower Shannon Estuary is classified as *not at risk* from abstraction, *probably at risk* from dangerous substances and overall marine direct impacts, *at risk* from (municipal) wastewater treatment plants, and *not at risk* from combined sewer overflows, IPPC (IPC or IEL) facilities, or Section 4s licensed facilities (facilities with trade effluent licences). The overall risk from point sources is classified as *at risk* based on the worst case for (municipal) wastewater treatment plants. The history of the ecological and chemical status of the Lower Shannon Estuary is summarised in Table 8.

Table 8: History of ecological and chemical status of the Lower Shannon Estuary[5]

Parameter	2013-2018	2010 – 2015	2010 – 2012	2007 – 2009
Ecological Status or Potential	Good	Moderate	Good	Moderate
Biological Status or Potential	Good	Moderate	Good	Good
Phytoplankton Status or Potential	High	High	High	High
Invertebrate Status or Potential	Good	Good	High	-
Fish Status or Potential	Good	Moderate	Good	Good
Hydromorphological Conditions	Good	Good	Good	Good
Supporting Chemistry Conditions	Good	Good	High	High
General Conditions	Good	Good	High	High
Oxygenation Conditions	High	High	High	High

[4] Extracted from *Full Report for Waterbody Lower Shannon Estuary*, July 2010, from www.wfdireland.ie

[5] From the EPA catchments website:
https://www.catchments.ie/data/#/waterbody/IE_SH_060_0300?_k=6epuac

Parameter	2013-2018	2010 – 2015	2010 – 2012	2007 – 2009
Dissolved Oxygen (% Sat)	High	High	High	High
Other determinand for oxygenation conditions	High	High	High	High
Nutrient Conditions	Good	Good	High	Good
Other determinand for nutrient conditions	High	High	Good	Good
Phosphorous Conditions	Good	Good	High	High
Orthophosphate	Good	Good	High	High
Specific Pollutant Conditions	Pass	Pass	-	-
Chemical Surface Water Status	Good	Good	-	-

The EPA has also published two *Indicators Reports* on water quality – one for 2016 (*Water Quality in 2016 – An Indicators Report*) and one for 2017 (*Water Quality in 2017 – An Indicators Report*). The aim of these reports is to provide an indication of the current water quality, an indication of recent changes and, where possible, an indication of longer-term trends.

In the context of the environment in the vicinity of AAL, the *Indicators Reports* note that:

- 2016:
  - The overall number of river water bodies at satisfactory (high or good) quality declined in eight catchments (Foyle, Lough Swilly, Donagh–Moville, Liffey & Dublin Bay, Nore, Laune–Maine–Dingle Bay, Shannon Estuary North and Moy & Killala Bay)
- 2017
  - Of the 95 estuaries and coastal water bodies assessed for phosphorus, only one (Maigue Estuary, Co. Limerick) exceeded the relevant winter threshold compared to three in the 2010–2012 period.
  - The number of river water bodies at satisfactory quality (high or good) declined in 16 catchments, most notably in the Suir, Upper Shannon and Shannon Estuary South

Overall, the *Indicator Reports* provide a useful summary of water quality in Ireland in 2016 and 2017, and do not indicate that the quality of the receiving environment in the vicinity of AAL is being adversely affected by AAL's activities.

3.7 Ambient Monitoring

In April 2018, AAL engaged Aquafact to conduct ambient monitoring of the Shannon Estuary upstream and downstream of the discharge point W1-1 (during three tide levels and at three water depths, yielding nine data points, for which the average value is shown in Table 9). The ambient monitoring was repeated in March 2019, with the results from both monitoring rounds summarised in Table 9.

Table 9: Ambient Monitoring in Shannon Estuary

Parameter		Units	500 m upstream		500 m downstream		1 km downstream	
			2018	2019	2018	2019	2018	2019
Biological oxygen demand		mg/l	< 2.03	< 1.0	< 2.0	< 1.0	< 2.0	< 1.0
Total organic carbon		mg/l	4.03	5.48	4.13	5.10	3.95	5.01
Chemical oxygen demand		mg/l	96.11	343.4	97.22	445.7	97.22	480.9
Total nitrogen		mg/l	2.22	2.40	3.78	2.51	3.00	2.69
Total inorganic nitrogen		mg/l	1.32	1.59	1.82	1.57	1.11	1.56
Total phosphorous		mg/l	0.061	0.100	0.058	0.089	0.055	0.085
Heavy metals	Arsenic	µg/l	2.67	85.9	2.33	92.0	3.56	88.6
	Cadmium	µg/l	<1	85.9	<1	92.2	<1	88.7
	Chromium	µg/l	7.56	85.7	6.11	91.9	6.78	88.3
	Copper	µg/l	15.11	64.8	11.67	82.0	14.67	78.4
	Mercury	µg/l	1.02	< 0.03	0.34	< 0.03	0.36	< 0.03
	Nickel	µg/l	15.33	85.2	11.33	91.78	11.78	88.2
	Lead	µg/l	8.67	85.2	8.67	91.8	7.89	88.1
	Zinc	µg/l	226.9	42.2	208.1	48.8	235.6	45.1

The results from the ambient monitoring for the majority of the parameters, including total organic carbon, indicate that there is little difference between the quality of the Shannon Estuary upstream and downstream of AAL's discharge point. While the concentrations of total organic carbon, chemical oxygen demand, total nitrogen and total inorganic nitrogen are marginally higher downstream than upstream, the concentrations of the other parameters (total phosphorous and the heavy metals) decrease between the upstream and downstream monitoring locations. Overall, both the 2018[6] and 2019[7] reports on the ambient monitoring concluded that:

> *This survey showed no increase in background levels for any of the parameters analysed due to the discharge at Aughinish Alumina, as results showed similar variations upstream and downstream of the discharge.*

The sampling locations upstream and downstream from the discharge point were outside the effluent plume discharge zones. Therefore, the results in Table 9 can be considered to be the ambient concentrations in the Shannon Estuary upstream and downstream of AAL.

[6] *Baseline Water Characterisation Survey Aughinish, Shannon Estuary*, AQUAFACT International Services Ltd, April 2018 (JN1477)

[7] *Baseline Water Characterisation Survey Aughinish, Shannon Estuary*, AQUAFACT International Services Ltd, March 2019 (JN1526)

4 Assimilative Capacity Model

In August 2011, the EPA published guidance to support the review of licences as part of the application of the *European Communities Environmental Objectives (Surface Water) Regulations*, 2009, namely *EO Regulations Review – Simple Assimilative capacity model for transitional waters*. The simple model set out in the guidance provides an estimate for the concentration of a particular discharge parameter in a receiving transitional waterbody (a waterbody which has both freshwater and saltwater inputs, such as the Lower Shannon Estuary).

The methodology used to carry out the assessment is as follows:

1. Estimate the flow of dilution water in the receiving water body (Q_D), in this case in the Shannon Estuary at AAL's discharge point.
2. Estimate the background concentration of the parameter in the receiving water body (C_B), in this case TOC (and COD) in the Shannon Estuary.
3. Calculate the resultant concentration of the parameter in the receiving water body.
4. Compare the resultant concentration of the parameter in the receiving water body against a relevant environmental assessment level.

The flow of available dilution water (Q_D) is calculated as follows:

$$Q_D = \frac{(Q_E + Q_F) \cdot S_O}{(S_O - S)}$$

where:

- Q_D dilution water (m^3/s)
- Q_E flow rate of licensed discharge (m^3/s)
- Q_F flow rate of (incoming) freshwater inputs (m^3/s)
- S_O salinity in open water (psu[8])
- S salinity in vicinity of the discharge (psu)

The concentration downstream (C) is calculated as follows:

$$C = C_B + \left(\frac{(C_E - C_B)}{1 + \left(\frac{Q_D}{Q_L}\right)} \right)$$

where:

- C resultant concentration (mg/l)
- C_B background concentrations (mg/l)
- C_E concentration in effluent (mg/l)
- Q_D dilution water (m^3/s)
- Q_L maximum flow of the discharge substance (m^3/s)

[8] Practical Salinity Unit

5 Assessment Levels

5.1 Overview

To assess the significance, or otherwise, of the resultant concentration of the discharge parameter (TOC and COD) in the receiving water body requires an appropriate environmental assessment level or water quality indicator. In the case of TOC (and COD) in the Lower Shannon Estuary, the following sources of such assessment levels / quality indicators have been considered:

- Environmental Objectives (Surface Water) Regulations
- Water Framework Directive
- EPA Parameters of Water Quality
- Surface water monitoring carried out by both the EPA and AAL

5.2 Environmental Objectives (Surface Water) Regulations

The *Environmental Objectives (Surface Water*) *Regulations*, as amended, set out the measures for the protection of surface water bodies (lakes, rivers, transitional and coastal waters) whose status is determined to be high or good. The Shannon Estuary has a *good* status in the vicinity of AAL's licensed discharge point.

The Regulations also set standards for several parameters, including BOD, pH, temperature and nutrients, specific pollutants, and priority (hazardous) substances. However, the Regulations do not set any standards for TOC (or COD) and therefore do not provide an environmental assessment level against which the resultant concentration in the Shannon Estuary can be assessed.

5.3 Water Framework Directive

The *Water Framework Directive* (WFD) is the primary directive that sets out water quality objectives and common metrics for assessing and reporting on the quality of freshwater in Europe. These assessments are undertaken on a six-yearly cycle, with the outcomes reported by each country in their respective River Basin Management Plans.

The EPA has established Water Framework Directive (WFD) status classifications based on the WFD monitoring programme, which are based on samples and surveys targeting a variety of parameters including biological, physico-chemical, chemical and hydromorphological elements. The WFD classification scheme for water quality includes five status classes: high, good, moderate, poor and bad. Assessment of quality is based on the extent of deviation from the reference conditions, with *good* status meaning that there is a *slight* deviation, *moderate* status meaning a *moderate* deviation.

The Shannon Estuary is included in these assessments and achieved a *good* status in the WFD Status 2013-2018 assessment. However, the assessment does not include quantitative data (for TOC or COD) against which the resultant concentration in the receiving water from AAL's discharge can be assessed.

5.4 EPA Parameters of Water Quality

In 2001, the EPA published *Parameters of Water Quality – Interpretation and Standards*. The aim of the handbook was to distil the principal facts and figures on approximately 100 individual or group pollutants, and to set out the most relevant facts concerning each parameter, such as the limits (either advisory or mandatory) which either scientific or medical opinion or legislative bodies considered applicable. As such, the handbook presented a comprehensive set of all concentration levels specified in either Irish or EU legislation (at the time).

While the handbook covered a wide range of parameters, including total organic carbon, it did not provide guidance on quantitative environmental assessment levels for TOC and therefore there are no environmental assessment levels against which the resultant concentration in the Shannon Estuary can be assessed.

5.5 Ambient Monitoring Data

5.5.1 EPA Monitoring

The EPA monitors bathing water quality periodically; the closest beach to AAL that has been assessed is Cappagh Pier, Kilrush (IESHBWC060_0000_0100), which is located approximately 30 km downstream of W1-1. The current classification (2018) is *excellent water quality*.

The EPA also carries out ambient monitoring of surface water bodies, including rivers, lakes, transitional water bodies and coastal water bodies. However, while the quality of these water bodies has been assessed by the EPA and classified accordingly, there is no available data on the ambient / background concentrations of TOC or COD in the Lower Shannon Estuary.

5.5.2 AAL Monitoring

As noted in Section 3.7, in April 2018 AAL engaged Aquafact to conduct ambient monitoring of the Shannon Estuary upstream and downstream of the discharge point W1-1 during three tide levels and at three water depths. The ambient monitoring was repeated in March 2019. The results from both monitoring rounds for TOC are shown in Table 10.

Table 10: AAL Ambient Monitoring for TOC (mg/l)

Parameter	2018	2019	Average
500 m upstream	4.03	5.48	4.76
500 m downstream	4.13	5.1	4.62
1 km downstream	3.95	5.01	4.48
Average	4.04	5.20	4.62
Range	3.95 - 4.13	5.01 - 5.48	4.48 - 4.76

5.6 Summary

In the absence of suitable specific environmental assessment levels, the results from the assimilative capacity model for TOC have been assessed against the known ambient background concentrations, with a range from 3.95 mg/l to 5.48 mg/l, and an average ambient concentration of 4.62 mg/l.

6 ASSESSMENT

6.1 Overview

The simple assimilative capacity model for transitional waters estimates, for a given discharge parameter, the resultant concentration in the receiving waterbody. For this assimilative capacity assessment, the following have been considered:

1. The concentration of TOC (and COD) in the receiving water from AAL's current discharge of effluent under conditions giving rise to 'low', 'medium' and 'high' concentrations. For example, a lower discharge flow rate, a higher TOC discharge concentration, and a lower assumed background concentration represents the 'worst-case' discharge conditions, compared to higher discharge flow rate, a lower TOC discharge concentration, and a higher assumed background concentration.
2. The resultant concentration of TOC from AAL's discharge *if it were to achieve the BAT AEL* – this provides an assessment of the 'excess' contribution of TOC and COD over that of the relevant BAT Associated Emission Level as requested by the EPA.

6.2 Input Data

The input data to the assimilative capacity model is summarised in Table 11. In the case of the flow rate of the receiving water body (the Lower Shannon Estuary) and the salinity of the open water (the coastal water body into which the Lower Shannon Estuary discharges), there is an absence of definitive guidance on the appropriate data sources.

We have conservatively estimated the flow rate of the Lower Shannon Estuary based on the sum of the long-term average flow rates of the main rivers flowing into the estuary (the Shannon itself, the Fergus, the Maguire and the Deel), yielding a conservative (low) flow rate of 252.67 m^3/s.

For the open water salinity, the EPA's guidance[9] indicates that a value of 33 psu may be appropriate for a coastal water body, which is within the broader range of 30 to 40 psu advised by the Marine Irish Digital Atlas[10] and is close to the guidance in the EPA's *Parameters of Water Quality* of 35 psu. The *National Eutrophication Assessment Report under the Common Procedure Ireland - Final Report on the Second Application of the Comprehensive Procedure March 2008*, which was compiled by the EPA and the Marine Institute under the *OSPAR Convention for the Protection of the Marine Environment of the North-East Atlantic* notes that:

> *The landward boundary of a transitional water body (estuarine) was defined as the upper tidal (either freshwater or saltwater) limit, with the outer boundary, in the majority of cases, being defined by a surface salinity value of 30.0 PSU (Practical salinity Unit).*

[9] European Communities Environmental Objectives (Surface Water) Regulations, 2009, namely EO Regulations Review – Simple Assimilative capacity model for transitional waters

[10] http://mida.ucc.ie/pages/information/phys/oceanography/physicalWaterProperties/details.htm

Table 11: Assimilative Capacity Model Inputs and Results

Parameter	Description	Data source
Q_E	flow rate of licensed discharge	EPA licence P0035-06 & AAL effluent monitoring
Q_F	flow rate of (incoming) freshwater inputs	The sum of the long-term average flow rates for the main rivers flowing into the estuary from the EPA's hydrometric monitoring stations[11]: • Shannon (208.96 m^3/s) • Fergus (19 m^3/s) • Maguire (17.35 m^3/s) • Deel (7.36 m^3/s)
S_O	salinity in open water	• EPA / Marine Institute (30 psu) • EPA guidance on assimilative capacity model (33 psu) • EPA parameters of water quality (35 psu)
S	salinity in vicinity of the discharge	AAL ambient monitoring (see Table 6)
Q_L	maximum flow of the discharged substance	EPA licence P0035-06
C_B	background concentrations	AAL ambient monitoring (see Table 9)
C_E	effluent concentrations	AAL effluent discharge monitoring (see Table 4)

6.3 AAL Discharge

Table 13 shows the resultant concentration of TOC in the receiving water (the Lower Shannon Estuary) attributable to the discharge from AAL under three sets of conditions, as summarised in Table 12.

Table 12: Relative values for variable parameters in assimilative capacity model

Parameter	Low	Medium	High
Flow rate of licensed discharge	Low	Medium	High
Salinity of open water	Low	Medium	High
Salinity of water in vicinity of licensed discharge	High	Medium	Low
Background concentration	Low	Medium	High
Concentration in effluent discharge	Low	Medium	High

[11] SFPC Maintenance Dredging Application - Appropriate Assessment, IBE0215.00 / August 2011

Table 13: Simple Assimilative Capacity Model for TOC

-	Model Inputs	Unit	Low	Medium	High
Q_E	Flow rate of licensed discharge	m^3/h	750	1,000	1,250
	Flow rate of licensed discharge	m^3/s	0.21	0.28	0.35
Q_F	Flow rate of the receiving water	m^3/s	252.67	252.67	252.67
S_O	Salinity of the open water	psu	30	33	35
S	Salinity of the water in the vicinity of licensed discharge	psu	22.90	20.37	19.20
C_B	Background concentration	mg/l	3.95	4.62	5.48
C_E	Maximum effluent discharge concentration	mg/l	64.90	124.30	153.30
C	Concentration in receiving water	mg/l	**3.96**	**4.67**	**5.57**
	Change relative to background	mg/l	+0.01	+0.05	+0.09
	% change relative to background	%	+0.30%	+1.09%	+1.67%

The results from the model show that the contribution of total organic carbon discharged from AAL is in the order of 0.30% to 1.67% of the ambient background concentration. However, this does not take into account that the background concentration used as the environmental assessment level already accounts for the contribution from AAL.

The simple assimilative model for COD shows a similarly low contribution from AAL, summarised in Table 14.

Table 14: Simple Assimilative Capacity Model for COD

-	Model Inputs	Unit	Concentration in receiving water		
			Low	Medium	High
Q_E	Flow rate of licensed discharge	m^3/h	750	1,000	1,250
	Flow rate of licensed discharge	m^3/s	0.21	0.28	0.35
Q_F	Flow rate of the receiving water	m^3/s	252.67	252.67	252.67
S_O	Salinity of the open water	psu	30	33	35
S	Salinity of the water in the vicinity of licensed discharge	psu	22.90	20.37	19.20
C_B	Background concentration	mg/l	96.11	260.09	480.90
C_E	Maximum effluent discharge concentration	mg/l	164.0	352.3	440.0
C	Concentration in receiving water	mg/l	**96.12**	**260.13**	**480.87**
	Change relative to background	mg/l	+0.01	+0.04	-0.03
	% change relative to background	%	+0.01%	+0.01%	-0.01%

6.4 Discharge at BAT AEL Limits

As requested by the EPA, the 'excess' contribution of TOC and COD over the corresponding BAT Associated Emission Levels has also been examined, to compare the current discharge against the discharge *if* AAL were to achieve the BAT AEL[12].

In this case, the input parameters are the same as those from Table 13 and Table 14 for TOC and COD, respectively, with the exception of the *maximum effluent discharge concentrations* which have been set at the BAT AEL (33 mg/l for TOC and 100 mg/l for COD). The results are shown in Table 15 for TOC and Table 16 for COD.

Table 15: Simple Assimilative Capacity Model for TOC – at BAT AEL

<table>
<tr><th rowspan="2">-</th><th rowspan="2">Model Inputs</th><th rowspan="2">Unit</th><th colspan="3">Concentration in receiving water</th></tr>
<tr><th>Low</th><th>Medium</th><th>High</th></tr>
<tr><td rowspan="2">Q_E</td><td>Flow rate of licensed discharge</td><td>m^3/h</td><td>750</td><td>1,000</td><td>1,250</td></tr>
<tr><td>Flow rate of licensed discharge</td><td>m^3/s</td><td>0.21</td><td>0.28</td><td>0.35</td></tr>
<tr><td>Q_F</td><td>Flow rate of the receiving water</td><td>m^3/s</td><td>252.67</td><td>252.67</td><td>252.67</td></tr>
<tr><td>S_O</td><td>Salinity of the open water</td><td>psu</td><td>30</td><td>33</td><td>35</td></tr>
<tr><td>S</td><td>Salinity of the water in the vicinity of licensed discharge</td><td>psu</td><td>22.90</td><td>20.37</td><td>19.20</td></tr>
<tr><td>C_B</td><td>Background concentration</td><td>mg/l</td><td>3.95</td><td>4.62</td><td>5.48</td></tr>
<tr><td>C_E</td><td>Maximum effluent discharge concentration</td><td>mg/l</td><td>33.0</td><td>33.0</td><td>33.0</td></tr>
<tr><td rowspan="3">C</td><td>Concentration at BAT AEL</td><td>mg/l</td><td>3.96</td><td>4.63</td><td>5.50</td></tr>
<tr><td>Concentration with derogation</td><td>mg/l</td><td>3.96</td><td>4.67</td><td>5.57</td></tr>
<tr><td>'Excess'
(relative to concentration at BAT AEL)</td><td>mg/l</td><td>0.01
(+0.16%)</td><td>0.04
(+0.83%)</td><td>0.07
(+1.35%)</td></tr>
</table>

[12] The *Application for Derogation from BAT-AELs for Emissions of Total Organic Carbon & Chemical Oxygen Demand to Water* submitted in support of the application for a review of the IE licence concluded that it is not technically or economically feasible to treat the effluent to achieve the BAT associated emission level (BAT AEL) for total organic carbon (TOC) or chemical oxygen demand (COD) set out in the *Commission Implementing Decision on the BREF on common waste water and waste gas treatment / management systems in the chemical sector*.

Table 16: Simple Assimilative Capacity Model for COD – at BAT AEL

-	Model Inputs	Unit	Concentration in receiving water		
			Low	Medium	High
Q_E	Flow rate of licensed discharge	m^3/h	750	1,000	1,250
	Flow rate of licensed discharge	m^3/s	0.21	0.28	0.35
Q_F	Flow rate of the receiving water	m^3/s	252.67	252.67	252.67
S_O	Salinity of the open water	psu	30	33	35
S	Salinity of the water in the vicinity of licensed discharge	psu	22.90	20.37	19.20
C_B	Background concentration	mg/l	96.11	260.09	480.90
C_E	Maximum effluent discharge concentration	mg/l	100.0	100.0	100.0
C	Concentration *at BAT AEL*	mg/l	**96.11**	**260.02**	**480.66**
	Concentration *with derogation*	mg/l	96.12	260.13	480.87
	'Excess' (relative to concentration at BAT AEL)	mg/l	0.01 (+0.01%)	0.11 (+0.04%)	0.21 (+0.04%)

In both cases, the results show that the 'excess' concentrations of TOC and COD *with the derogation* above the BAT AEL limits are not significant (ranging from an 'excess' of 0.01% to 1.35%). As noted in Section 6.3, this does not take into account that the background concentration used as the environmental assessment level already accounts for the contribution from AAL.

7 CONCLUSIONS

The results of the assimilative capacity assessment demonstrate that the impact of the discharges to the Shannon Estuary from discharge point W1-1 with the derogation is not significant. The results show that the difference in the concentrations of both TOC and COD in the receiving water are not significant between the application of the BAT AEL to the discharge, and if the derogation were to be granted. The difference between the two – the 'excess' discharge – is negligible compared to the existing background concentrations of the two parameters in the Lower Shannon Estuary.

In our opinion, this assessment supports the Application for Derogation from BAT-AELs for Emissions of Total Organic Carbon & Chemical Oxygen Demand to Water, which showed that the available data on the water quality indicates that the quality of the receiving environment – the Lower Shannon Estuary – is not adversely impacted by the discharge from AAL, and that there is little difference in the quality of water upstream and downstream from the licensed emission point.

* * * * *

Appendix 3

Determination of the Air Emissions from the Aughinish Alumina facility, Co. Limerick (AWN Consulting 2020)

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Dublin 17, Ireland.

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DETERMINATION OF AIR EMISSIONS FROM THE, AUGHINISH ALUMINA FACILITY, COUNTY LIMERICK IN THE NEARBY ECOLOGICALLY SENSITIVE AREAS

Technical Report Prepared For

Aughinish Alumina Limited
Aughinish Island
Askeaton
Co. Limerick
Ireland

Technical Report Prepared By

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EXECUTIVE SUMMARY

AWN Consulting Ltd were commissioned by the Aughinish Alumina Ltd to carry out an air dispersion modelling study of emissions from the Aughinish Alumina Ltd facility in Aughinish, Co. Limerick based on the current operations. The modelling assessment has been undertaken in order to determine the impact of air emissions from the facility in the nearby ecologically sensitive areas including the Lower River Shannon SAC / River Shannon & River Fergus SPA and Barrigone SAC.

The air dispersion modelling undertaken herein compares the ambient air quality impact of the emissions of current operations of the facility with the relevant ambient air quality standards and guidelines.

Air dispersion modelling was carried out using the United States Environmental Protection Agency's regulatory model AERMOD (Version 19191). The aim of the study was to assess the contribution of these emission points to off-site levels of release substances and to identify the location and maximum of the worst-case ground level concentrations for each compound assessed. The dispersion model study consisted of the following components:

- Review of current emission data and other relevant information needed for the modelling study;
- Summary of background levels of pollutants of concern;
- Dispersion modelling of pollutants of concern under the current operational scenario;
- Presentation of predicted ground level concentrations of released substances;
- Evaluation of the significance of these predicted concentrations, including consideration of whether these ground level concentrations are likely to exceed the relevant ambient air quality guideline values in the nearby ecologically sensitive areas including the Lower River Shannon SAC / River Shannon & River Fergus SPA and Barrigone SAC.

Assessment Summary

The air dispersion modelling results have been compared with the ambient air quality standards for NO_2, NO_X, CO, SO_2 and PM_{10}/$PM_{2.5}$ for each of the three scenarios investigated. The results indicate that ambient levels of these pollutants will not lead to an exceedance of the ambient air quality standards for human health and vegetation / ecology under any of the three scenarios investigated.

In relation to nitrogen deposition, predicted levels are well below the critical loads for each type of habitat.

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1.0 INTRODUCTION

AWN Consulting Ltd were commissioned by the Aughinish Alumina Ltd to carry out an air dispersion modelling study of emissions from the Aughinish Alumina Ltd facility in Aughinish, Co. Limerick based on the current operations. The modelling assessment has been undertaken in order to determine the impact of air emissions from the facility in the nearby ecologically sensitive areas including the Lower River Shannon SAC / River Shannon & River Fergus SPA and Barrigone SAC.

The air dispersion modelling undertaken herein compares the ambient air quality impact of the emissions of current operations of the facility with the relevant ambient air quality standards and guidelines.

The site is located adjacent the waterfront in Aughinish. The Lower River Shannon SAC / River Shannon & River Fergus SPA is located immediately north and north-east of the site. Barrigone SAC is located approximately 1km south-east of the site.

Air dispersion modelling was carried out using the United States Environmental Protection Agency's regulatory model AERMOD (Version 19191). The aim of the study was to assess the contribution of these emission points to off-site levels of release substances and to identify the location and maximum of the worst-case ground level concentrations for each compound assessed. The dispersion model study consisted of the following components:

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Information supporting the conclusions has been detailed in the following sections. The assessment methodology and study inputs are presented in Section 2. The dispersion modelling results and assessment summaries are presented in Section 3 and 4. The model formulation is detailed in Appendix I and a review of the meteorological data used is detailed in Appendix II.

2.0 ASSESSMENT METHODOLOGY

Emissions from the facility have been modelled using the AERMOD dispersion model (Version 19191) which has been developed by the U.S. Environmental Protection Agency (USEPA)(1) and following guidance issued by the EPA(2). The model is a steady-state Gaussian plume model used to assess pollutant concentrations associated with industrial sources and has replaced ISCST3(3) as the regulatory model by the USEPA for modelling emissions from industrial sources in both flat and rolling terrain(4-6). The model has more advanced algorithms and gives better agreement with monitoring data in extensive validation studies(6). An overview of the AERMOD dispersion model is outlined in Appendix I.

The air dispersion modelling input data consisted of information on the physical environment (including building dimensions and terrain features), design details from all emission points on-site and appropriate hourly meteorological data for the period of concern. Using this input data the model predicted ambient ground level concentrations beyond the site boundary for each hour of the modelled meteorological period. The model post-processed the data to identify the location and maximum of the worst-case ground level concentration. This worst-case concentration was then added to the background concentration to give the worst-case predicted environmental concentration (PEC). The PEC was then compared with the relevant ambient air quality guideline to assess the significance of the releases from the site.

As outlined in AG4 (EPA, 2020), a cumulative impact assessment should be carried out if it is expected that the impact of two or more installations will overlap significantly. A review has been undertaken to determine whether nearby large air emitters such as Moneypoint and Tarbet Power Station or nearby licenced sites, such as Wyeth Nutritionals Ireland Limited, have the potential to significantly overlap with Aughinish Alumina Ltd. In relation to Moneypoint and Tarbet Power Station, both facilities are greater than 20km from the facility and thus there is no potential for a significant overlap in emissions. In relation to Wyeth Nutritionals Ireland Limited, which is 5km from the facility, the emissions of relevant pollutants are below the threshold required in AG4 and thus no cumulative impact assessment is necessary.

Throughout this study a worst-case approach was taken. This will most likely lead to an over-estimation of the levels that will arise in practice. The worst-case assumptions are outlined below:

- Maximum predicted concentrations were reported in this study, both within and outside of the nearby Lower River Shannon SAC / River Shannon & River Fergus SPA and Barrigone SAC;
- Worst-case background concentrations were used where relevant to assess the baseline levels of relevant pollutants;
- Background concentrations were added directly to the modelled results. Ambient monitoring data will capture existing emissions from nearby facilities and thus the current approach is conservative;
- The effects of building downwash, due to on-site and any nearby off-site buildings, has been included in the model;
- Worst-case operations for all emissions assumes that all emission points were running continuously for the period of concern;
- All parameters and emission points were modelled at the IED licence limits.

2.1 Ambient Air Quality Guidelines

In order to reduce the risk to health from poor air quality, national and European statutory bodies have set limit values in ambient air for a range of air pollutants. These limit values or "Air Quality Standards" are health- or environmental-based levels for which additional factors may be considered. The applicable standards in Ireland include the Air Quality Standards Regulations 2011, which incorporate EU Directive 2008/50/EC (see Table 1).

Ambient air quality legislation designed to protect human health and the environment is generally based on assessing ambient air quality at locations where the exposure of the population is significant relevant to the averaging time of the pollutant. However, in the current assessment, ambient air quality legislation has been applied to all locations within 20km of the facility regardless of whether any sensitive receptors (such as residential locations) are present. This represents a worst-case approach and an examination of the corresponding concentrations at the nearest sensitive receptors relative to the actual quoted maximum concentration indicates that these receptors generally experience ambient concentrations significantly lower than that reported for the worst-case location.

Pollutant	Regulation Note 1	Limit Type	Value
Nitrogen Dioxide (NO_2)	2008/50/EC	Hourly limit for protection of human health - not to be exceeded more than 18 times/year	200 μg/m^3
		Annual limit for protection of human health	40 μg/m^3
		Critical level for protection of vegetation	30 μg/m^3 NO + NO_2
Sulphur Dioxide (SO_2)	2008/50/EC	Hourly limit for protection of human health - not to be exceeded more than 24 times/year	350 μg/m^3
		24-Hourly limit for protection of human health - not to be exceeded more than 3 times/year	125 μg/m^3
		Critical level for protection of vegetation (annual and winter)	20 μg/m^3
Particulate Matter (as PM_{10})	2008/50/EC	24-hour limit for protection of human health - not to be exceeded more than 35 times/year	50 μg/m^3
		Annual limit for protection of human health	40 μg/m^3
Particulate Matter (as $PM_{2.5}$)	2008/50/EC	Annual limit for protection of human health	25 μg/m^3
Benzene	2008/50/EC	Annual limit for protection of human health	5 μg/m^3
Carbon Monoxide (CO)	2008/50/EC	8-hour limit (on a rolling basis) for protection of human health	10 mg/m^3 (8.6 ppm)

Note 1 EU 2008/50/EC – Clean Air For Europe (CAFÉ) Directive replaces the previous Air Framework Directive (1996/30/EC) and daughter directives 1999/30/EC and 2000/69/EC

Table 1 EU Ambient Air Quality Standards Based on Directive 2008/50/EC (S.I. 180 of 2011)

2.2 Background Concentrations Of Pollutants

Air quality monitoring programs have been undertaken in recent years by the EPA and Local Authorities[7,8]. The most recent annual report on air quality "Air Quality Monitoring Annual Report 2018"[7], details the range and scope of monitoring undertaken throughout Ireland.

As part of the implementation of the Framework Directive on Air Quality (1996/62/EC), four air quality zones have been defined in Ireland for air quality management and assessment purposes(7). Dublin is defined as Zone A and Cork as Zone B. Zone C is composed of 23 towns with a population of greater than 15,000. The remainder of the country, which represents rural Ireland but also includes all towns with a population of less than 15,000 is defined as Zone D. In terms of air monitoring, the area surrounding Aughninish Alumina is categorised as Zone D(7).

NO_2 and NO_X

NO_2 monitoring was carried out at two rural Zone D locations in 2018, Emo and Kilkitt and in one urban area, Castlebar(7). The NO_2 annual average in 2018 for both rural sites was 3 and 3 µg/m^3 respectively with the results for urban station averaging 8 µg/m^3. Hence long-term average concentrations measured at all locations were significantly lower than the annual average limit value of 40 µg/m^3. The average results over the last five years at a range of rural Zone D locations suggest an upper average of no more than 4 µg/m^3 as a background concentration as shown in Table 2. Based on the above information a conservative estimate of the background NO_2 concentration in the region of the facility is 6 µg/m^3.

Year	Enniscorthy (µg/m^3)	Kilkitt (µg/m^3)	Emo (µg/m^3)	Castlebar (µg/m^3)
2014	13	3	3	8
2015	9	2	3	8
2016	10	3	4	9
2017	-	2	3	7
2018	-	3	3	8
Average	11	3	3	8

Table 2 Annual Mean NO_2 Background Concentrations in Zone D Locations 2014 – 2018 (µg/m^3)

NO_X monitoring was carried out at two rural Zone D locations in 2018, Emo and Kilkitt and in one urban area, Castlebar(7). The NO_X annual average in 2018 for both rural sites was 4 and 5 µg/m^3 respectively with the results for urban station averaging 11 µg/m^3. Hence long-term average concentrations measured at all locations were significantly lower than the annual average limit value of 30 µg/m^3. The average results over the last five years at a range of rural Zone D locations suggest an upper average of no more than 5 µg/m^3 as a background concentration as shown in Table 3. Based on the above information a conservative estimate of the background NO_X concentration in the region of the facility is 8 µg/m^3.

Year	Enniscorthy (µg/m^3)	Kilkitt (µg/m^3)	Emo (µg/m^3)	Castlebar (µg/m^3)
2014	13	3	3	8
2015	9	2	3	8
2016	10	3	4	9
2017	-	2	3	7
2018	-	3	3	8
Average	11	3	3	8

Table 3 Annual Mean NO_X Background Concentrations in Zone D Locations 2014 – 2018 (µg/m^3)

The Ozone-Limited Method (OLM) was used to model NO_2 concentrations. The OLM is a regulatory option in AERMOD(1) which assumes that the amount of NO converted to NO_2 is proportional to the ambient ozone (O_3) concentration. The concentration is usually limited by the amount of ambient O_3 that is entrained in the plume. Thus, the ratio of the moles of O_3 to the moles of NO_X gives the ratio of NO_2/NO_X that is formed after the NO_X leaves the stack. In addition, it has been assumed that 10% of the NO_X in the stack gas is already in the form of NO_2 before the gas leaves the stack. The equation used in the algorithm to derive the ratio of NO_2/NO_X is:

$$NO_2/NO_X = (\text{moles } O_3/ \text{ moles } NO_X) + 0.10$$

The ozone data used in the OLM model runs was taken as 80 $\mu g/Nm^3$ which is a conservative upper limit of annual average rural stations in over the period 2014 – 2018[(7)].

In relation to the annual averages, the ambient background concentration was added directly to the process concentration with the short-term peaks calculated using twice the annual mean concentration as an hourly background in line with guidance from the UK DEFRA[(9)].

CO

Long-term CO monitoring was carried out at the Zone C locations of Portlaoise and Dundalk in 2018. The CO annual average measured 0.2 and 0.5 mg/m^3 respectively[(7)]. Previous monitoring from 2014 – 2017 at Zone C and D locations indicated annual averages ranging from 0.15 – 0.5 mg/m^3 (see Table 4). Based on the above information a conservative estimate of the background CO concentration in the region of the facility is 0.5 µg/m^3. The maximum 1-hour means for Portlaoise and Dundalk in 2018 was 2.8 mg/m^3 and 1.6 mg/m^3.

Year	Enniscorthy (mg/m^3)	Portlaoise (mg/m^3)	Dundalk (mg/m^3)
2014	0.4	0.5	-
2015	0.5	0.4	-
2016	0.6	0.4	-
2017	-	0.15	-
2018	-	0.2	0.5
Average	**0.5**	**0.3**	**0.5**

Table 4 Annual Mean CO Background Concentrations in Zone C and D Locations 2014 – 2018 (mg/m^3)

SO₂

Long-term SO_2 monitoring was carried out at the Zone D location of Kilkitt in 2018. The SO_2 annual average measured 2 µg/m^3 in 2018[(7)]. Previous monitoring from 2014 – 2017 at the three locations indicated annual averages ranging from 2 – 4 µg/m^3 (see Table 5). Based on the above information a conservative estimate of the background SO_2 concentration in the region of the facility is 3 µg/m^3. The 99.7th%ile of 1-hour means for Kilkitt in 2018 was 6.4 µg/m^3 whilst the 99.2th%ile of 24-hour means for Kilkitt in 2018 was 5.7 µg/m^3.

Year	Enniscorthy (µg/m^3)	Kilkitt (µg/m^3)	Shannon Estuary (µg/m^3)
2014	4	2	3
2015	2	2	2
2016	3	2	2
2017	-	2	2
2018	-	2	-
Average	**3**	**2**	**2**

Table 5 Annual Mean SO_2 Background Concentrations in Zone D Locations 2014 – 2018 ($\mu g/m^3$)

When calculating the short-term peak results, concentrations due to emissions from stacks cannot be combined by directly adding the annual background level to the modelling results. Guidance from the UK DEFRA(9) and EPA(2) advises that for SO_2 an estimate of the maximum combined pollutant concentrations can be obtained as shown below:

SO_2 - The 99.7th%ile of total 1-hour SO_2 is equal to the maximum of either A or B below:

a) 99.7th%ile hourly background SO_2 + (2 x annual mean process contribution SO_2)
b) 99.7th%ile hourly process contribution SO_2 + (2 x annual mean background contribution SO_2)

SO_2 - The 99.2th%ile of total 24-hour SO_2 is equal to the maximum of either A or B below:

a) 99.2th%ile of 24-hour mean background SO_2 + (2 x annual mean process contribution SO_2)
b) 99.2th%ile 24-hour mean process contribution SO_2 + (2 x annual mean background contribution SO_2)

PM_{10}

Long-term PM_{10} monitoring was carried out at the Zone D locations of Castlebar, Claremorris and Kilkitt in 2018. The PM_{10} annual averages for these three locations in 2018 ranged from 9 to 12 $\mu g/m^3$(7). The PM_{10} annual average in 2018 for the rural Zone D location of Kilkitt was 9 $\mu g/m^3$(7). In addition, data from the Phoenix Park provides a good indication of urban background levels, with an annual average in 2018 of 11 $\mu g/m^3$(7). Data from 2014 – 2018 for the rural Zone D locations as well as the Phoenix Park (Zone A) showed annual averages ranging from 8 to 12 $\mu g/m^3$ (see Table 6). Based on the above information, a conservative estimate of the background rural PM_{10} concentration of 12 $\mu g/m^3$ has been used and the maximum 24-hour averaging period was assessed using actual monitoring data for Kilkitt for the year 2018 and using the methodology outlined below.

Year	Castlebar ($\mu g/m^3$)	Claremorris ($\mu g/m^3$)	Enniscorthy ($\mu g/m^3$)	Kilkitt ($\mu g/m^3$)	Phoenix Park (Dublin) ($\mu g/m^3$)
2014	12	10	22	9	12
2015	13	10	18	9	12
2016	12	10	17	8	11
2017	11	11	29	8	9
2018	11	12	-	9	11
Average	**12**	**11**	**22**	**9**	**11**

Table 6 Annual Mean PM_{10} Background Concentrations in Zone D Locations 2014 – 2018 ($\mu g/m^3$)

In relation to the annual averages, the ambient background concentration was added directly to the process concentration. However, in relation to the short-term peak concentrations, guidance from the UK DEFRA(9) and EPA(2) advises that for PM_{10} an estimate of the maximum combined pollutant concentration can be obtained as shown below:

PM_{10} - The 90.4th%ile of total 24-hour mean PM_{10} is equal to the maximum of either A or B below:

a) 90.4th%ile of 24-hour mean background PM_{10} + annual mean process contribution PM_{10}

b) 90.4th%ile 24-hour mean process contribution PM_{10} + annual mean background PM_{10}

$PM_{2.5}$

The results of $PM_{2.5}$ monitoring at the Zone D location of Claremorris from 2014 - 2018(7) indicated that $PM_{2.5}/PM_{10}$ ratios ranged from 0.5 – 0.7 over that period. Based on this information, a ratio of 0.6 was used to generate a background $PM_{2.5}$ concentration of 7.2 µg/m^3.

2.3 Air Dispersion Modelling Methodology

The United States Environmental Protection Agency (USEPA) approved AERMOD dispersion model has been used to predict the ground level concentrations (GLC) of compounds emitted from the principal emission sources on-site.

The modelling incorporated the following features:

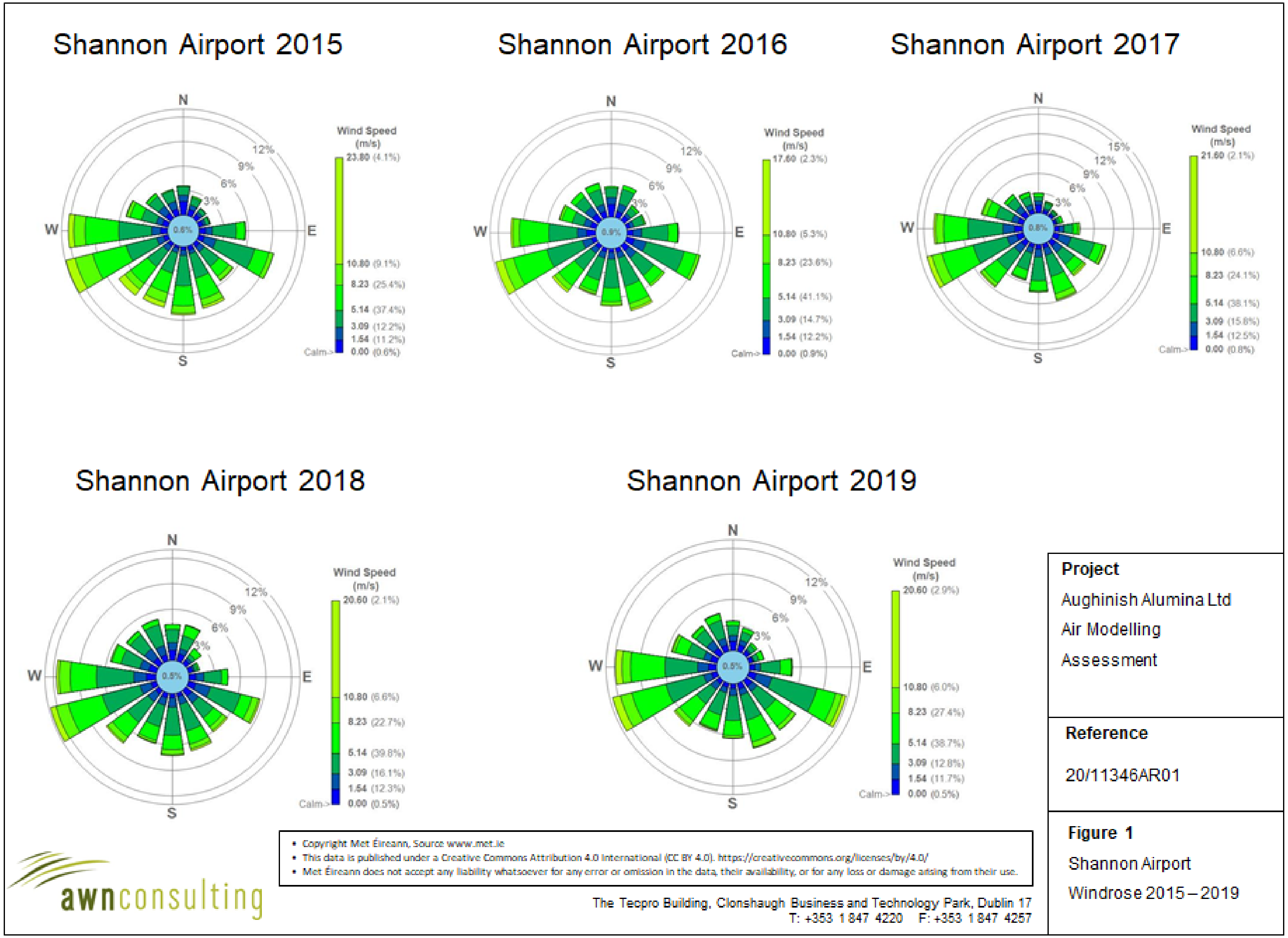
- Three receptor grids were created at which concentrations would be modelled. Receptors were mapped with sufficient resolution to ensure all localised "hot-spots" were identified without adding unduly to processing time. The receptor grids were based on Cartesian grids with the site at the centre. An outer grid extended to 20,000m x 20,000m with the site at the centre and with concentrations calculated at 1,000m intervals. A middle grid extended to 15,000m x 15,000m with the site at the centre and with concentrations calculated at 500m intervals. A smaller denser grid extended 4,000m x 4,000m from the site with concentrations calculated at 100m intervals. Boundary receptor locations were also placed along the boundary of the site, at 25m intervals, giving a total of 2,597 calculation points for the model.

- All on-site structures were mapped into the computer to create a three dimensional visualisation of the site and its emission points. Buildings and process structures can influence the passage of airflow over the emission stacks and draw plumes down towards the ground (termed building downwash). The stacks themselves can influence airflow in the same way as buildings by causing low pressure regions behind them (termed stack tip downwash). Both building and stack tip downwash were incorporated into the modelling.

- Detailed terrain has been mapped into the model using SRTM data with 30m resolution. The site is located in gentle terrain. All terrain features have been mapped in detail into the model using the terrain pre-processor AERMAP(10).

- Hourly-sequenced meteorological information has been used in the model. Meteorological data over a five-year period (Shannon Airport, 2015 - 2019) was used in the model as shown in Figure 1.

- The source and emission data, including stack dimensions, gas volumes and emission temperatures have been incorporated into the model.


Shannon Airport 2015
N
W
E
S
12%
9%
6%
3%
0.6%
Wind Speed (m/s)
23.80 (4.1%)
10.80 (9.1%)
8.23 (25.4%)
5.14 (37.4%)
3.09 (12.2%)
1.54 (11.2%)
Calm-> 0.00 (0.6%)
Shannon Airport 2016
N
W
E
S
12%
9%
6%
3%
0.9%
Wind Speed (m/s)
17.60 (2.3%)
10.80 (5.3%)
8.23 (23.6%)
5.14 (41.1%)
3.09 (14.7%)
1.54 (12.2%)
Calm-> 0.00 (0.9%)
Shannon Airport 2017
N
W
E
S
15%
12%
9%
6%
3%
0.8%
Wind Speed (m/s)
21.60 (2.1%)
10.80 (6.6%)
8.23 (24.1%)
5.14 (38.1%)
3.09 (15.8%)
1.54 (12.5%)
Calm-> 0.00 (0.8%)
Shannon Airport 2018
N
W
E
S
12%
9%
6%
3%
0.5%
Wind Speed (m/s)
20.60 (2.1%)
10.80 (6.6%)
8.23 (22.7%)
5.14 (39.8%)
3.09 (16.1%)
1.54 (12.3%)
Calm-> 0.00 (0.5%)
Shannon Airport 2019
N
W
E
S
12%
9%
6%
3%
0.5%
Wind Speed (m/s)
20.60 (2.9%)
10.80 (6.0%)
8.23 (27.4%)
5.14 (38.7%)
3.09 (12.8%)
1.54 (11.7%)
Calm-> 0.00 (0.5%)
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Air Modelling
Assessment
Reference
20/11346AR01
Figure 1
Shannon Airport
Windrose 2015 – 2019

2.4 Terrain

The AERMOD air dispersion model has a terrain pre-processor AERMAP[10] which was used to map the physical environment in detail over the receptor grid. The digital terrain input data used in the AERMAP pre-processor was obtained from SRTM. This data was run to obtain for each receptor point the terrain height and the terrain height scale. The terrain height scale is used in AERMOD to calculate the critical dividing streamline height, H_{crit}, for each receptor. The terrain height scale is derived from the Digital Elevation Model (DEM) files in AERMAP by computing the relief height of the DEM point relative to the height of the receptor and determining the slope. If the slope is less than 10%, the program goes to the next DEM point. If the slope is 10% or greater, the controlling hill height is updated if it is higher than the stored hill height.

In areas of complex terrain, AERMOD models the impact of terrain using the concept of the dividing streamline (H_c). As outlined in the AERMOD model formulation[1] a plume embedded in the flow below H_c tends to remain horizontal; it might go around the hill or impact on it. A plume above H_c will ride over the hill. Associated with this is a tendency for the plume to be depressed toward the terrain surface, for the flow to speed up, and for vertical turbulent intensities to increase.

AERMOD model formulation states that the model "*captures the effect of flow above and below the dividing streamline by weighting the plume concentration associated with two possible extreme states of the boundary layer (horizontal plume and terrain-following). The relative weighting of the two states depends on: 1) the degree of atmospheric stability; 2) the wind speed; and 3) the plume height relative to terrain. In stable conditions, the horizontal plume "dominates" and is given greater weight while in neutral and unstable conditions, the plume traveling over the terrain is more heavily weighted*"[1].

The terrain in the region of the facility is complex in the sense that the maximum terrain in the modelling domain peaks at 320m which is above the stack top of all emission points onsite. However, in general, the region of the site has gently sloping terrain particularly in the immediate vicinity of the facility.

2.5 Meteorological Data

The selection of the appropriate meteorological data has followed the guidance issued by the USEPA[4]. A primary requirement is that the data used should have a data capture of greater than 90% for all parameters. Shannon Airport meteorological station, which is located approximately 15 km north-east of the site, collects data in the correct format and has a data collection of greater than 90%. Long-term hourly observations at Shannon Airport meteorological station provide an indication of the prevailing wind conditions for the region. Data indicate that the prevailing wind direction is from south-easterly to westerly in direction as shown in Figure 1. The long-term mean wind speed was approximately 4.7 m/s over the period 1981-2010.

2.6 Geophysical Considerations

AERMOD simulates the dispersion process using planetary boundary layer (PBL) scaling theory[1]. PBL depth and the dispersion of pollutants within this layer are influenced by specific surface characteristics such as surface roughness, albedo and the availability of surface moisture. Surface roughness is a measure of the aerodynamic roughness of the surface and is related to the height of the roughness element. Albedo is a measure of the reflectivity of the surface whilst the Bowen ratio is a measure of the availability of surface moisture.

AERMOD incorporates a meteorological pre-processor AERMET[11] to enable the calculation of the appropriate parameters. The AERMET meteorological pre-processor requires the input of surface characteristics, including surface roughness (z_0), Bowen Ratio and albedo by sector and season, as well as hourly observations of wind speed, wind direction, cloud cover, and temperature. The values of albedo, Bowen Ratio and surface roughness depend on land-use type (e.g., urban, cultivated land etc) and vary with seasons and wind direction. The assessment of appropriate land-use type was carried out to a distance of 10km from the meteorological station for Bowen Ratio and albedo and to a distance of 1km for surface roughness in line with USEPA recommendations[11,12] as outlined in Appendix II.

In relation to AERMOD, detailed guidance for calculating the relevant surface parameters has been published[11]. The most pertinent features are:

- The surface characteristics should be those of the meteorological site (Shannon Airport) rather than the installation;
- Surface roughness should use a default 1km radius upwind of the meteorological tower and should be based on an inverse-distance weighted geometric mean. If land use varies around the site, the land use should be sub-divided by sectors with a minimum sector size of 30º;
- Bowen ratio and albedo should be based on a 10km grid. The Bowen ratio should be based on an un-weighted geometric mean. The albedo should be based on a simple un-weighted arithmetic mean.

AERMOD has an associated pre-processor, AERSURFACE[12], which has representative values for these parameters depending on land use type. The AERSURFACE pre-processor currently only accepts NLCD92 land use data which covers the USA. Thus, manual input of surface parameters is necessary when modelling in Ireland. Ordnance survey discovery maps (1:50,000) and digital maps such as those provided by the EPA, National Parks and Wildlife Service (NPWS) and Google Earth® are useful in determining the relevant land use in the region of the meteorological station. The Alaska Department of Environmental Conservation has issued a guidance note for the manual calculation of geometric mean for surface roughness and Bowen ratio for use in AERMET[13]. This approach has been applied to the current site with full details provided in Appendix II.

2.7 Building Downwash

When modelling emissions from an industrial installation, stacks which are relatively short can be subjected to additional turbulence due to the presence of nearby buildings. Buildings are considered nearby if they are within five times the lesser of the building height or maximum projected building width (but not greater than 800m).

The USEPA has defined the “Good Engineering Practice” (GEP) stack height as the building height plus 1.5 times the lesser of the building height or maximum projected building width. It is generally considered unlikely that building downwash will occur when stacks are at or greater than GEP[14].

When stacks are less than this height, building downwash will tend to occur. As the wind approaches a building it is forced upwards and around the building leading to the formation of turbulent eddies. In the lee of the building these eddies will lead to downward mixing (reduced plume centreline and reduced plume rise) and the creation of a cavity zone (near wake) where re-circulation of the air can occur. Plumes released from short stacks may be entrained in this airflow leading to higher ground level concentrations than in the absence of the building.

The Plume Rise Model Enhancements (PRIME)(6) plume rise and building downwash algorithms, which calculates the impact of buildings on plume rise and dispersion, have been incorporated into AERMOD. The building input processor BPIP-PRIME produces the parameters which are required in order to run PRIME. The model takes into account the position of each stack relative to each relevant building and the projected shape of each building for 36 wind directions (at 10º intervals). The model determines the change in plume centreline location with downwind distance based on the slope of the mean streamlines and coupled to a numerical plume rise model(6).

Given that all structures onsite are less than 2.5 times the lesser of the building height or maximum projected building width, building downwash was taken into account and the PRIME algorithm run prior to modelling with AERMOD. The dominant building may change as the wind direction changes for each of the 36 wind directions. The dominant building for each relevant stack will vary as a function of wind direction and relative building heights.

2.8 Process Emissions

Aughinish Alumina Ltd currently have an Industrial Emissions Licence (Licence number P0035-06) which has set air emission limit values for a range of main emission points onsite. Stack details are outlined in Table 7.

Stack Reference	Stack Location Note 1	Height Above Ground Level (m)	Exit Diameter (m)
Boiler A1 (1)	128345 153860	107	1.77
Boiler A1 (2)	128345 153860	107	1.77
Calciner A2 (1)	128445 153860	68.6	1.7
Calciner A2 (2)	128445 153860	68.6	1.7
Calciner A2 (3)	128445 153860	68.6	1.7
CHP A3-A	128325 153960	40	3.5
CHP A3-B	128330 153935	40	3.5
Gas Boiler A4-A	128340 153820	32	3.0
Gas Boiler A4-B	128340 153880	32	3.0
EP6 - Scrubber Exhaust Fan	128155 153732	18.5	1.48
EP12 – Alumina Loader Dust Fan	128344 153360	30	0.95
EP16 – Exhaust Fab FA12A017	128343 154094	50	0.80 x0.38
EP17 – Exhaust Fan FA12A018	128333 154140	50	0.80 x 0.37
EP18 – Exhaust Fan FA12A019	128323 154186	51	0.80 x 0.39
EP19 – Exhaust Fan FA12A020	128338 154117	50	0.28 x 0.60

Note 1 Stack location referenced to nearest 5 metres

Table 7 Stack Release Points Used In The Air Modelling

The information used in the dispersion model for the site is shown in Tables 7 - 9 for each scenario. The three scenario (Baseline, Alternative Baseline and Scenario Three) allow for all likely operational scenarios which may occur onsite under the current licence.

Stack Reference	Exit Diameter (m)	Cross-Sectional Area (m^2)	Temp (K)	Max Volume Flow (Nm^3/hr)	Exit Velocity (m/sec actual)	NO_2		CO		PM_{10}	
						Conc. (mg/Nm^3)	Mass Emission (g/s)	Conc. (mg/Nm^3)	Mass Emission (g/s)	Conc. (mg/Nm^3)	Mass Emission (g/s)
Gas Boiler (A4-A)	3.0	7.07	433.2	130,000	9.29	100	3.6	100	3.6	-	-
Gas Boiler (A4-B)	3.0	7.07	433.2	130,000	9.29	100	3.6	100	3.6	-	-
Calciner A2 (1)	1.7	2.27	428	343,333	39.9	100	9.3	-	-	50	4.6
Calciner A2 (2)	1.7	2.27	428	343,333	39.9	100	9.3	-	-	50	4.6
Calciner A2 (3)	1.7	2.27	428	343,333	39.9	100	9.3	-	-	50	4.6
CHP A3-A	3.5	9.62	441	720,000	27.4	50	10.0	100	20.0	-	-
CHP A3-B	3.5	9.62	441	720,000	27.4	50	10.0	100	20.0	-	-
EP6 - Scrubber Exhaust Fan	1.48	1.720	298.2	56,000	9.9	-	-	-	-	100	1.56
EP12 – Alumina Loader Dust Fan	0.95	0.709	312.2	22,100	9.9	-	-	-	-	50	0.31
EP16 – Exhaust Fab FA12A017	0.80 x 0.38	0.304	302.2	15,000	15.2	-	-	-	-	50	0.21
EP17 – Exhaust Fan FA12A018	0.80 x 0.37	0.296	300.2	15,000	15.5	-	-	-	-	50	0.21
EP18 – Exhaust Fan FA12A019	0.80 x 0.39	0.312	299.2	10,000	9.8	-	-	-	-	50	0.14
EP19 – Exhaust Fan FA12A020	0.28 x 0.60	0.168	303.2	10,000	18.4	-	-	-	-	50	0.14

Table 8 Summary Of Source Information for Baseline Scenario

Stack Reference	Exit Diameter (m)	Cross-Sectional Area (m^2)	Temp (K)	Max Volume Flow (Nm^3/hr)	Exit Velocity (m/sec actual)	NO_2		SO_2		PM_{10}		CO	
						Conc. (mg/Nm^3)	Mass Emission (g/s)	Conc. (mg/Nm^3)	Conc. (mg/Nm^3)	Conc. (mg/Nm^3)	Mass Emission (g/s)	Conc. (mg/Nm^3)	Mass Emission (g/s)
Gas Boiler (A4-A)	3.0	7.07	433.2	130,000	9.29	100	3.6	-	-	-	-	100	3.6
Gas Boiler (A4-B)	3.0	7.07	433.2	130,000	9.29	100	3.6	-	-	-	-	100	3.6
Calciner A2 (1)	1.7	2.27	428	343,333	39.9	100	9.3	-	-	50	4.6	-	-
Calciner A2 (2)	1.7	2.27	428	343,333	39.9	100	9.3	-	-	50	4.6	-	-
Calciner A2 (3)	1.7	2.27	428	343,333	39.9	100	9.3	-	-	50	4.6	-	-
CHP A3-A [Note 2]	3.5	9.62	441	720,000	27.4	50	10.0	-	-	-	-	100	20.0
CHP A3-B	3.5	9.62	441	720,000	27.4	50	10.0	-	-	-	-	100	20.0
Boiler A1 (C) [Note 1]	1.77	2.46	407	126,000	23.4	750	26.3	1700	59.5	-	-		
EP6 - Scrubber Exhaust Fan	1.48	1.720	298.2	56,000	9.9	-	-	-	-	100	1.56	-	-
EP12 – Alumina Loader Dust Fan	0.95	0.709	312.2	22,100	9.9	-	-	-	-	50	0.31	-	-
EP16 – Exhaust Fab FA12A017	0.80 x 0.38	0.304	302.2	15,000	15.2	-	-	-	-	50	0.21	-	-
EP17 – Exhaust Fan FA12A018	0.80 x 0.37	0.296	300.2	15,000	15.5	-	-	-	-	50	0.21	-	-
EP18 – Exhaust Fan FA12A019	0.80 x 0.39	0.312	299.2	10,000	9.8	-	-	-	-	50	0.14	-	-
EP19 – Exhaust Fan FA12A020	0.28 x 0.60	0.168	303.2	10,000	18.4	-	-	-	-	50	0.14	-	-

Note 1 Boiler A and C are existing - Boiler B has been decommissioned. Boiler (A1-C) runs for up to 8% of the year when a CHP plant is on scheduled maintenance (modelled as running for 15 days in February and 15 days in September)

Note 2 One of the CHP plants was modelled as running for 92% of the year as it is off-line 8% of year for scheduled maintenance

Table 9 Summary Of Source Information for Alternative Baseline Scenario

Stack Reference	Exit Diameter (m)	Cross-Sectional Area (m^2)	Temp (K)	Max Volume Flow (Nm^3/hr)	Exit Velocity (m/sec actual)	NO_2		SO_2		PM_{10}		CO	
						Conc. (mg/Nm^3)	Mass Emission (g/s)	Conc. (mg/Nm^3)	Conc. (mg/Nm^3)	Conc. (mg/Nm^3)	Mass Emission (g/s)	Conc. (mg/Nm^3)	Mass Emission (g/s)
Gas Boiler (A4-A)	3.0	7.07	433.2	130,000	9.29	100	3.6	-	-	-	-	100	3.6
Gas Boiler (A4-B)	3.0	7.07	433.2	130,000	9.29	100	3.6	-	-	-	-	100	3.6
Calciner A2 (1)	1.7	2.27	428	343,333	39.9	100	9.3	-	-	50	4.6	-	-
Calciner A2 (2)	1.7	2.27	428	343,333	39.9	100	9.3	-	-	50	4.6	-	-
Calciner A2 (3)	1.7	2.27	428	343,333	39.9	100	9.3	-	-	50	4.6	-	-
CHP A3-A Note 2	3.5	9.62	441	720,000	27.4	50	10.0	-	-	-	-	100	20.0
CHP A3-B	3.5	9.62	441	720,000	27.4	50	10.0	-	-	-	-	100	20.0
Boiler A1 (A) Note 1	1.77	2.46	407	126,000	23.4	750	26.3	1700	59.5	-	-		
Boiler A1 (C) Note 1	1.77	2.46	407	126,000	23.4	750	26.3	1700	59.5	-	-		
EP6 - Scrubber Exhaust Fan	1.48	1.720	298.2	56,000	9.9	-	-	-	-	100	1.56	-	-
EP12 – Alumina Loader Dust Fan	0.95	0.709	312.2	22,100	9.9	-	-	-	-	50	0.31	-	-
EP16 – Exhaust Fab FA12A017	0.80 x 0.38	0.304	302.2	15,000	15.2	-	-	-	-	50	0.21	-	-
EP17 – Exhaust Fan FA12A018	0.80 x 0.37	0.296	300.2	15,000	15.5	-	-	-	-	50	0.21	-	-
EP18 – Exhaust Fan FA12A019	0.80 x 0.39	0.312	299.2	10,000	9.8	-	-	-	-	50	0.14	-	-
EP19 – Exhaust Fan FA12A020	0.28 x 0.60	0.168	303.2	10,000	18.4	-	-	-	-	50	0.14	-	-

Note 1 Boiler A and C are existing - Boiler B has been decommissioned. Existing Boilers (A1-C and A1-A) runs for up to 8% of the year when a CHP plant and Gas Boiler plant are on scheduled maintenance (modelled as running for 15 days in February and 15 days in September)

Note 2 One of the CHP plants (A3-A) was modelled as running for 92% of the year as it is off-line 8% of year for scheduled maintenance

Note 3 One of the Gas Boilers (A4-A) was modelled as running for 92% of the year as it is off-line 8% of year for scheduled maintenance

Table 10 Summary Of Source Information for Scenario Three

3.0 RESULTS & DISCUSSION

3.1 Modelling Results For Baseline Scenario

NO_2 Emissions (Baseline Scenario)

The NO_2 modelling results for the Baseline Scenario are detailed in Table 11 and Figures 2 & 3. The results indicate that the ambient ground level concentrations are below the relevant air quality standards for NO_2. For the worst-case year (i.e. the year giving the highest ambient concentration), emissions from the site lead to an ambient NO_2 concentration (including background) which is 52% of the maximum ambient 1-hour limit value (measured as a 99.8th%ile) and 44% of the annual limit value at the worst-case receptor.

The NO_x modelling results for the Baseline Scenario are detailed in Table 12 and Figure 4. The results indicate that the ambient ground level concentrations are below the relevant air quality standards for NO_x for the protection of vegetation. For the worst-case year (i.e. the year giving the highest ambient concentration), emissions from the site lead to an ambient NO_x concentration (including background) which is 70% of the annual limit value at the worst-case receptor.

Pollutant / Year	Background ($\mu g/m^3$)	Averaging Period	Process Contribution NO_2 ($\mu g/m^3$)	Predicted Environmental Concentration NO_2 ($\mu g/Nm^3$)	Standard ($\mu g/Nm^3$)Note 1
NO_2 / 2015	12	99.8th%ile of 1-hr means	90.7	102.7	200
	6	Annual Mean	11.2	17.2	40
NO_2 / 2016	12	99.8th%ile of 1-hr means	91.6	103.6	200
	6	Annual Mean	10.5	16.5	40
NO_2 / 2017	12	99.8th%ile of 1-hr means	91.3	103.3	200
	6	Annual Mean	11.6	17.6	40
NO_2 / 2018	12	99.8th%ile of 1-hr means	90.9	102.9	200
	6	Annual Mean	10.8	16.8	40
NO_2 / 2019	12	99.8th%ile of 1-hr means	90.4	102.4	200
	6	Annual Mean	10.3	16.3	40

Note 1 Air Quality Standards 2011 (from EU Directive 2008/50/EC and S.I. 180 of 2011)

Table 11 Baseline Scenario Dispersion Model Results – NO_2

Pollutant / Year	Background ($\mu g/m^3$)	Averaging Period	Process Contribution NO_X ($\mu g/m^3$)	Predicted Environmental Concentration NO_x ($\mu g/Nm^3$)	Standard (mg/m^3)[Note 1]
NO_X / 2015	8.0	Annual Mean	12.4	20.4	30
NO_X / 2016	8.0	Annual Mean	11.6	19.6	30
NO_X / 2017	8.0	Annual Mean	12.9	20.9	30
NO_X / 2018	8.0	Annual Mean	12.0	20.0	30
NO_X / 2019	8.0	Annual Mean	11.5	19.5	30

Note 1 S.I. 180 of 2011 and EU Directive 2008/50/EC

Table 12 Baseline Scenario Dispersion Model Results – NO_X

CO Emissions (Baseline Scenario)

The CO modelling results for the Baseline Scenario are detailed in Table 13 and Figure 5. The results indicate that the ambient ground level concentrations are below the relevant air quality standards for CO. For the worst-case year, emissions from the site lead to an ambient CO concentration (including background) which is 6% of the maximum ambient 8-hour limit value.

Pollutant / Year	Background (mg/m^3)	Averaging Period	Process Contribution (mg/m^3)	Predicted Environmental Concentration (mg/m^3)	Standard mg (mg/m^3)[Note 1]
CO / 2015	0.5	8-Hr Maximum	0.09	0.59	10
CO / 2016	0.5	8-Hr Maximum	0.09	0.59	10
CO / 2017	0.5	8-Hr Maximum	0.09	0.59	10
CO / 2018	0.5	8-Hr Maximum	0.09	0.59	10
CO / 2019	0.5	8-Hr Maximum	0.08	0.58	10

Note 1 S.I. 180 of 2011 and EU Directive 2008/50/EC

Note 2 Short-term Concentrations calculated according to UK DEFRA guidance

Table 13 Baseline Scenario Dispersion Model Results – CO

PM_{10} Emissions (Baseline Scenario)

The PM_{10} modelling results for the Baseline Scenario are detailed in Table 14 and Figure 6. The results indicate that the ambient ground level concentrations are below the relevant air quality standards for PM_{10}. For the worst-case year (i.e. the year giving the highest ambient concentration), emissions from the site lead to an ambient PM_{10} concentration (including background) which is 66% of the maximum ambient 24-hour limit value (measured as a 90.4th%ile) and 46% of the annual limit value at the worst-case receptor.

The $PM_{2.5}$ modelling results for the Baseline Scenario are detailed in Table 15. The results indicate that the ambient ground level concentrations are below the relevant air quality standards for $PM_{2.5}$. For the worst-case year (i.e. the year giving the highest ambient concentration), emissions from the site lead to an ambient $PM_{2.5}$ concentration (including background) which is 54% of the annual limit value at the worst-case receptor.

Pollutant / Year	Background (μg/m³)	Averaging Period	Process Contribution PM_{10} (μg/m³)	Predicted Environmental Concentration PM_{10} (μg/Nm³)	Standard (μg/Nm³) Note 1
PM_{10} / 2015	12	90.4th%ile of 24-hr means	17.2	29.2	50
	12	Annual Mean	5.9	17.9	40
PM_{10} / 2016	12	90.4th%ile of 24-hr means	20.8	32.8	50
	12	Annual Mean	6.4	18.4	40
PM_{10} / 2017	12	90.4th%ile of 24-hr means	15.1	27.1	50
	12	Annual Mean	6.0	18.0	40
PM_{10} / 2018	12	90.4th%ile of 24-hr means	15.8	27.8	50
	12	Annual Mean	5.6	17.6	40
PM_{10} / 2019	12	90.4th%ile of 24-hr means	16.8	28.8	50
	12	Annual Mean	6.3	18.3	40

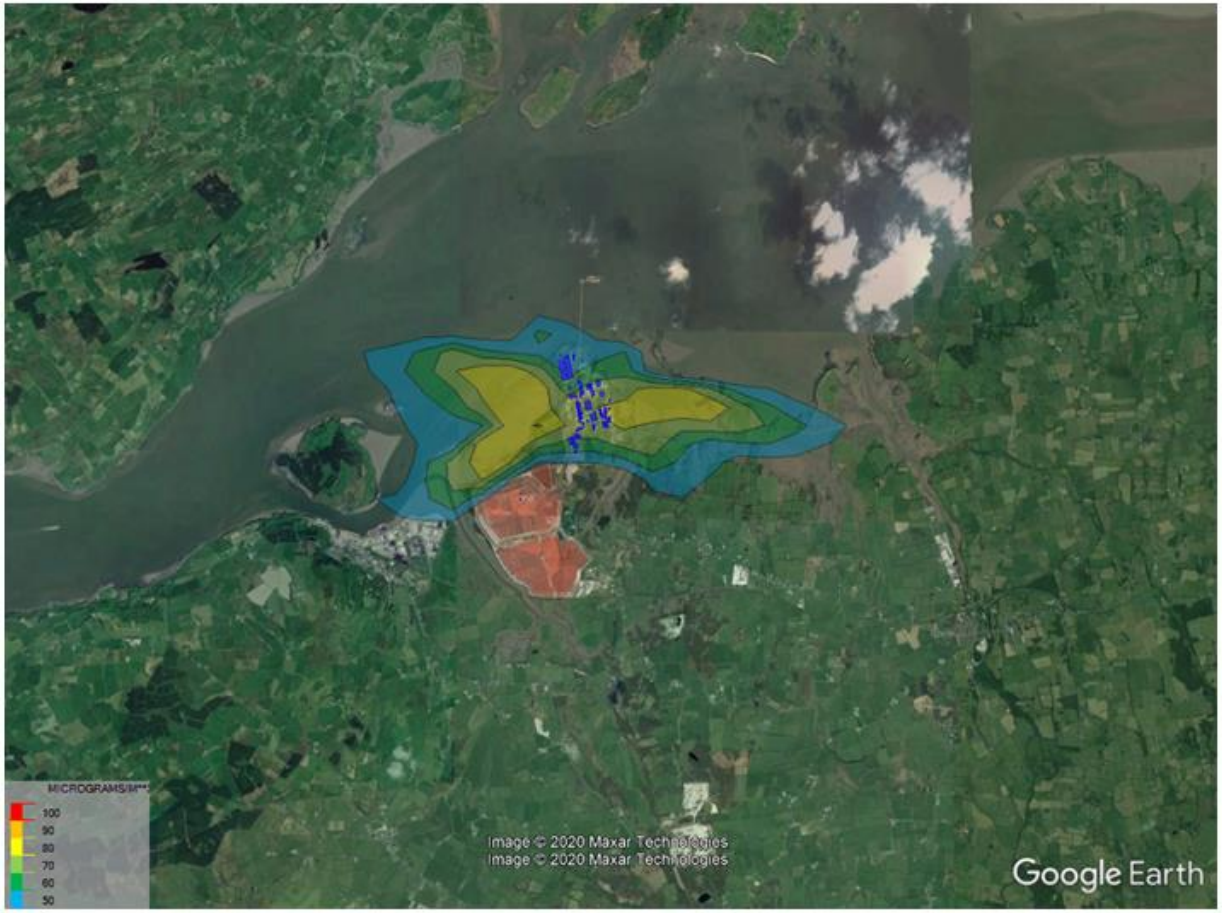
Note 1 Air Quality Standards 2011 (from EU Directive 2008/50/EC and S.I. 180 of 2011)

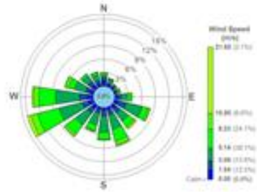
Table 14 Baseline Scenario Dispersion Model Results – PM_{10}

Pollutant / Year	Background (μg/m³)	Averaging Period	Process Contribution $PM_{2.5}$ (μg/m³)	Predicted Environmental Concentration $PM_{2.5}$ (μg/Nm³)	Standard (μg/m³) Note 1
$PM_{2.5}$ / 2015	7.2	Annual Mean	5.9	13.1	25
$PM_{2.5}$ / 2016	7.2	Annual Mean	6.4	13.6	25
$PM_{2.5}$ / 2017	7.2	Annual Mean	6.0	13.2	25
$PM_{2.5}$ / 2018	7.2	Annual Mean	5.6	12.8	25
$PM_{2.5}$ / 2019	7.2	Annual Mean	6.3	13.5	25

Note 1 S.I. 180 of 2011 and EU Directive 2008/50/EC

Table 15 Baseline Scenario Dispersion Model Results – $PM_{2.5}$





Background Mapping from Google Earth

Maximum 1-Hr Nitrogen Dioxide Concentration
Maximum Concentration
= 103.6 μg/m^3

Scale

1:80,000

N

Project

Aughinish Alumina Ltd

Air Modelling Assess

Reference

20/11346AR01

Figure 2

Maximum 1-Hr Nitrogen Dioxide Concentration (μg/m^3) (Year 2016)

awnconsulting

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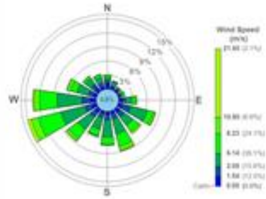
T: +353 1 847 4220 F: +353 1 847 4257



Background Mapping from Google Earth

Annual Mean Nitrogen Dioxide Concentration Maximum Concentration = 17.6 $\mu g/m^3$

Scale

1:100,000

N

Project

Aughinish Alumina Ltd

Air Modelling Assess

Reference

20/11346AR01

Figure 3

Annual Mean Nitrogen Dioxide Concentration ($\mu g/m^3$) (Year 2017)

awnconsulting

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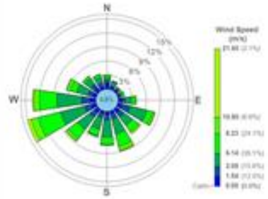

Background Mapping from Google Earth

Annual Mean Nitrogen Oxides Concentration Maximum Concentration = 20.9 µg/m^3

Scale

1:100,000

N

Project

Aughinish Alumina Ltd

Air Modelling Assess

Reference

20/11346AR01

Figure 4

Annual Mean Nitrogen Oxides Concentration (µg/m^3) (Year 2017)

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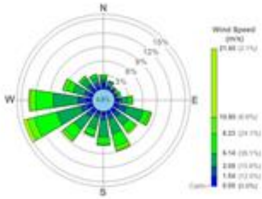

Background Mapping from Google Earth

8-Hour Maximum Carbon Monoxide Concentration Maximum Concentration = 90 µg/m³ (not including background)

Scale

1:80,000

N

Project

Aughinish Alumina Ltd

Air Modelling Assess

Reference

20/11346AR01

Figure 5

8-Hour Maximum Carbon Monoxide Concentration (µg/m³) (Year 2017)

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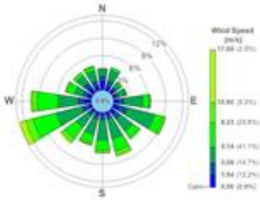

Background Mapping from Google Earth

Annual Mean PM_{10} Concentration
Maximum Concentration = 6.4 μg/m^3 (not including background)

Scale	
1:100,000	N

Project
Aughinish Alumina Ltd
Air Modelling Assess

Reference
20/11346AR01

Figure 6
Annual Mean PM_{10} Concentration (μg/m^3) (Year 2016)

awnconsulting

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3.2 Modelling Results For Alternative Scenario

NO_2 Emissions (Alternative Scenario)

The NO_2 modelling results for the Alternative Scenario are detailed in Table 16. The results indicate that the ambient ground level concentrations are below the relevant air quality standards for NO_2. For the worst-case year (i.e. the year giving the highest ambient concentration), emissions from the site lead to an ambient NO_2 concentration (including background) which is 52% of the maximum ambient 1-hour limit value (measured as a 99.8th%ile) and 44% of the annual limit value at the worst-case receptor.

The NO_x modelling results for the Alternative Scenario are detailed in Table 17. The results indicate that the ambient ground level concentrations are below the relevant air quality standards for NO_x for the protection of vegetation. For the worst-case year (i.e. the year giving the highest ambient concentration), emissions from the site lead to an ambient NO_X concentration (including background) which is 69% of the annual limit value at the worst-case receptor.

Pollutant / Year	**Background ($\mu g/m^3$)**	**Averaging Period**	**Process Contribution NO_2 ($\mu g/m^3$)**	**Predicted Environmental Concentration NO_2 ($\mu g/Nm^3$)**	**Standard ($\mu g/Nm^3$)$^{Note\ 1}$**
NO_2 / 2015	12	99.8th%ile of 1-hr means	90.7	102.7	200
	6	Annual Mean	11.2	17.2	40
NO_2 / 2016	12	99.8th%ile of 1-hr means	91.6	103.6	200
	6	Annual Mean	10.4	16.4	40
NO_2 / 2017	12	99.8th%ile of 1-hr means	91.3	103.3	200
	6	Annual Mean	11.6	17.6	40
NO_2 / 2018	12	99.8th%ile of 1-hr means	90.9	102.9	200
	6	Annual Mean	10.7	16.7	40
NO_2 / 2019	12	99.8th%ile of 1-hr means	90.2	102.2	200
	6	Annual Mean	10.2	16.2	40

Note 1 Air Quality Standards 2011 (from EU Directive 2008/50/EC and S.I. 180 of 2011)

Table 16 Alternative Scenario Dispersion Model Results – NO_2

Pollutant / Year	Background ($\mu g/m^3$)	Averaging Period	Process Contribution NO_X ($\mu g/m^3$)	Predicted Environmental Concentration NO_x ($\mu g/Nm^3$)	Standard ($\mu g/m^3$)Note 1
NO_X / 2015	8.0	Annual Mean	12.4	20.4	30
NO_X / 2016	8.0	Annual Mean	11.5	19.5	30
NO_X / 2017	8.0	Annual Mean	12.8	20.8	30
NO_X / 2018	8.0	Annual Mean	11.9	19.9	30
NO_X / 2019	8.0	Annual Mean	11.4	19.4	30

Note 1 S.I. 180 of 2011 and EU Directive 2008/50/EC

Table 17 Alternative Scenario Dispersion Model Results – NO_X

CO Emissions (Alternative Scenario)

The CO modelling results for the Alternative Scenario are detailed in Table 18. The results indicate that the ambient ground level concentrations are below the relevant air quality standards for CO. For the worst-case year, emissions from the site lead to an ambient CO concentration (including background) which is 6% of the maximum ambient 8-hour limit value.

Pollutant / Year	Background (mg/m^3)	Averaging Period	Process Contribution (mg/m^3)	Predicted Environmental Concentration (mg/m^3)	Standard mg (mg/m^3)Note 1
CO / 2015	0.5	8-Hr Maximum	0.09	0.59	10
CO / 2016	0.5	8-Hr Maximum	0.09	0.59	10
CO / 2017	0.5	8-Hr Maximum	0.09	0.59	10
CO / 2018	0.5	8-Hr Maximum	0.09	0.59	10
CO / 2019	0.5	8-Hr Maximum	0.08	0.58	10

Note 1 S.I. 180 of 2011 and EU Directive 2008/50/EC

Note 2 Short-term Concentrations calculated according to UK DEFRA guidance

Table 18 Alternative Scenario Dispersion Model Results – CO

SO_2 Emissions (Alternative Scenario)

The SO_2 modelling results for the Alternative Scenario are detailed in Table 19. The results indicate that the ambient ground level concentrations are below the relevant air quality standards for SO_2. For the worst-case year, emissions from the site lead to an ambient SO_2 concentration (including background) which is 11% of the maximum ambient 1-hour limit value (measured as a 99.7th%ile), 17% of the maximum ambient 24-hour limit value (measured as a 99.2nd%ile) and 18% of the annual mean for the protection of vegetation.

Pollutant / Year	Background ($\mu g/m^3$)	Averaging Period	Process Contribution ($\mu g/m^3$)	Predicted Environmental Concentration ($\mu g/m^3$)	Standard ($\mu g/m^3$)[Note 1]
SO_2 / 2015	6.4[(Note 2)]	99.7th%ile of 1-hr means	22.9	28.9	350
	5.7[(Note 2)]	99.2nd%ile of 24-hr means	7.4	13.4	125
	3.0	Annual Mean	0.14	3.14	20
SO_2 / 2016	6.4[(Note 2)]	99.7th%ile of 1-hr means	30.1	36.1	350
	5.7[(Note 2)]	99.2nd%ile of 24-hr means	13.0	19.0	125
	3.0	Annual Mean	0.50	3.50	20
SO_2 / 2017	6.4[(Note 2)]	99.7th%ile of 1-hr means	29.9	35.9	350
	5.7[(Note 2)]	99.2nd%ile of 24-hr means	15.5	21.5	125
	3.0	Annual Mean	0.39	3.39	20
SO_2 / 2018	6.4[(Note 2)]	99.7th%ile of 1-hr means	29.5	35.5	350
	5.7[(Note 2)]	99.2nd%ile of 24-hr means	14.4	20.4	125
	3.0	Annual Mean	0.45	3.45	20
SO_2 / 2019	6.4[(Note 2)]	99.7th%ile of 1-hr means	31.0	37.0	350
	5.7[(Note 2)]	99.2nd%ile of 24-hr means	14.0	20.0	125
	3.0	Annual Mean	0.51	3.51	20

Note 1 S.I. 180 of 2011 and EU Directive 2008/50/EC
Note 2 Short-term Concentrations calculated according to UK DEFRA guidance

Table 19 Alternative Scenario Dispersion Model Results – SO_2

PM_{10} Emissions (Alternative Scenario)

The PM_{10} modelling results for the Alternative Scenario are detailed in Table 20. The results indicate that the ambient ground level concentrations are below the relevant air quality standards for PM_{10}. For the worst-case year (i.e. the year giving the highest ambient concentration), emissions from the site lead to an ambient PM_{10} concentration (including background) which is 66% of the maximum ambient 24-hour limit value (measured as a 90.4th%ile) and 46% of the annual limit value at the worst-case receptor.

The $PM_{2.5}$ modelling results for the Alternative Scenario are detailed in Table 21. The results indicate that the ambient ground level concentrations are below the relevant air quality standards for $PM_{2.5}$. For the worst-case year (i.e. the year giving the highest ambient concentration), emissions from the site lead to an ambient $PM_{2.5}$

concentration (including background) which is 54% of the annual limit value at the worst-case receptor.

Pollutant / Year	Background ($\mu g/m^3$)	Averaging Period	Process Contribution PM_{10} ($\mu g/m^3$)	Predicted Environmental Concentration PM_{10} ($\mu g/Nm^3$)	Standard ($\mu g/Nm^3$)Note 1
PM_{10} / 2015	12	90.4th%ile of 24-hr means	17.2	29.2	50
	12	Annual Mean	5.9	17.9	40
PM_{10} / 2016	12	90.4th%ile of 24-hr means	20.8	32.8	50
	12	Annual Mean	6.4	18.4	40
PM_{10} / 2017	12	90.4th%ile of 24-hr means	15.1	27.1	50
	12	Annual Mean	6.0	18.0	40
PM_{10} / 2018	12	90.4th%ile of 24-hr means	15.8	27.8	50
	12	Annual Mean	5.6	17.6	40
PM_{10} / 2019	12	90.4th%ile of 24-hr means	16.8	28.8	50
	12	Annual Mean	6.3	18.3	40

Note 1 Air Quality Standards 2011 (from EU Directive 2008/50/EC and S.I. 180 of 2011)

Table 20 Alternative Scenario Dispersion Model Results – PM_{10}

Pollutant / Year	Background ($\mu g/m^3$)	Averaging Period	Process Contribution $PM_{2.5}$ ($\mu g/m^3$)	Predicted Environmental Concentration $PM_{2.5}$ ($\mu g/Nm^3$)	Standard ($\mu g/m^3$)Note 1
$PM_{2.5}$ / 2015	7.2	Annual Mean	5.9	13.1	25
$PM_{2.5}$ / 2016	7.2	Annual Mean	6.4	13.6	25
$PM_{2.5}$ / 2017	7.2	Annual Mean	6.0	13.2	25
$PM_{2.5}$ / 2018	7.2	Annual Mean	5.6	12.8	25
$PM_{2.5}$ / 2019	7.2	Annual Mean	6.3	13.5	25

Note 1 S.I. 180 of 2011 and EU Directive 2008/50/EC

Table 21 Alternative Scenario Dispersion Model Results – $PM_{2.5}$

3.3 Modelling Results For Scenario Three

NO_2 Emissions (Scenario Three)

The NO_2 modelling results for Scenario Three are detailed in Table 22. The results indicate that the ambient ground level concentrations are below the relevant air quality standards for NO_2. For the worst-case year (i.e. the year giving the highest ambient concentration), emissions from the site lead to an ambient NO_2 concentration (including background) which is 52% of the maximum ambient 1-hour limit value (measured as a 99.8th%ile) and 44% of the annual limit value at the worst-case receptor.

The NO_x modelling results for Scenario Three are detailed in Table 23. The results indicate that the ambient ground level concentrations are below the relevant air quality standards for NO_x for the protection of vegetation. For the worst-case year (i.e. the year giving the highest ambient concentration), emissions from the site lead to an ambient NO_X concentration (including background) which is 69% of the annual limit value at the worst-case receptor.

Pollutant / Year	Background ($\mu g/m^3$)	Averaging Period	Process Contribution NO_2 ($\mu g/m^3$)	Predicted Environmental Concentration NO_2 ($\mu g/Nm^3$)	Standard ($\mu g/Nm^3$)Note 1
NO_2 / 2015	12	99.8th%ile of 1-hr means	90.1	102.1	200
	6	Annual Mean	11.3	17.3	40
NO_2 / 2016	12	99.8th%ile of 1-hr means	91.7	103.7	200
	6	Annual Mean	10.3	16.3	40
NO_2 / 2017	12	99.8th%ile of 1-hr means	91.3	103.3	200
	6	Annual Mean	11.6	17.6	40
NO_2 / 2018	12	99.8th%ile of 1-hr means	91.1	103.1	200
	6	Annual Mean	10.6	16.6	40
NO_2 / 2019	12	99.8th%ile of 1-hr means	90.3	102.3	200
	6	Annual Mean	10.2	16.2	40

Note 1 Air Quality Standards 2011 (from EU Directive 2008/50/EC and S.I. 180 of 2011)

Table 22 Scenario Three Dispersion Model Results – NO_2

Pollutant / Year	Background ($\mu g/m^3$)	Averaging Period	Process Contribution NO_X ($\mu g/m^3$)	Predicted Environmental Concentration NO_x ($\mu g/Nm^3$)	Standard (mg/m^3)Note 1
NO_X / 2015	8.0	Annual Mean	12.4	20.4	30
NO_X / 2016	8.0	Annual Mean	11.4	19.4	30
NO_X / 2017	8.0	Annual Mean	12.7	20.7	30
NO_X / 2018	8.0	Annual Mean	11.7	19.7	30
NO_X / 2019	8.0	Annual Mean	11.2	19.2	30

Note 1 S.I. 180 of 2011 and EU Directive 2008/50/EC

Table 23 Scenario Three Dispersion Model Results – NO_X

CO Emissions (Scenario Three)

The CO modelling results for Scenario Three are detailed in Table 24. The results indicate that the ambient ground level concentrations are below the relevant air quality standards for CO. For the worst-case year, emissions from the site lead to an ambient CO concentration (including background) which is 6% of the maximum ambient 8-hour limit value.

Pollutant / Year	Background (mg/m^3)	Averaging Period	Process Contribution (mg/m^3)	Predicted Environmental Concentration (mg/m^3)	Standard mg (mg/m^3)Note 1
CO / 2015	0.5	8-Hr Maximum	0.09	0.59	10
CO / 2016	0.5	8-Hr Maximum	0.09	0.59	10
CO / 2017	0.5	8-Hr Maximum	0.09	0.59	10
CO / 2018	0.5	8-Hr Maximum	0.09	0.59	10
CO / 2019	0.5	8-Hr Maximum	0.08	0.58	10

Note 1 S.I. 180 of 2011 and EU Directive 2008/50/EC

Note 2 Short-term Concentrations calculated according to UK DEFRA guidance

Table 24 Scenario Three Dispersion Model Results – CO

SO_2 Emissions (Scenario Three)

The SO_2 modelling results for Scenario Three are detailed in Table 25. The results indicate that the ambient ground level concentrations are below the relevant air quality standards for SO_2. For the worst-case year, emissions from the site lead to an ambient SO_2 concentration (including background) which is 19% of the maximum ambient 1-hour limit value (measured as a 99.7th%ile), 30% of the maximum ambient 24-hour limit value (measured as a 99.2nd%ile) and 20% of the annual mean for the protection of vegetation.

Pollutant / Year	Background ($\mu g/m^3$)	Averaging Period	Process Contribution ($\mu g/m^3$)	Predicted Environmental Concentration ($\mu g/m^3$)	Standard ($\mu g/m^3$)Note 1
SO_2 / 2015	6.4(Note 2)	99.7th%ile of 1-hr means	45.8	51.8	350
	5.7(Note 2)	99.2nd%ile of 24-hr means	14.8	20.8	125
	3.0	Annual Mean	0.28	3.28	20
SO_2 / 2016	6.4(Note 2)	99.7th%ile of 1-hr means	60.2	66.2	350
	5.7(Note 2)	99.2nd%ile of 24-hr means	25.9	31.9	125
	3.0	Annual Mean	1.0	4.0	20
SO_2 / 2017	6.4(Note 2)	99.7th%ile of 1-hr means	59.9	65.9	350
	5.7(Note 2)	99.2nd%ile of 24-hr means	31.1	37.1	125
	3.0	Annual Mean	0.78	3.78	20
SO_2 / 2018	6.4(Note 2)	99.7th%ile of 1-hr means	59.0	65.0	350
	5.7(Note 2)	99.2nd%ile of 24-hr means	28.7	34.7	125
	3.0	Annual Mean	0.90	3.90	20
SO_2 / 2019	6.4(Note 2)	99.7th%ile of 1-hr means	61.9	67.9	350
	5.7(Note 2)	99.2nd%ile of 24-hr means	28.0	34.0	125
	3.0	Annual Mean	1.0	4.0	20

Note 1 S.I. 180 of 2011 and EU Directive 2008/50/EC

Note 2 Short-term Concentrations calculated according to UK DEFRA guidance

Table 25 Scenario Three Dispersion Model Results – SO_2

PM_{10} Emissions (Scenario Three)

The PM_{10} modelling results for Scenario Three are detailed in Table 26. The results indicate that the ambient ground level concentrations are below the relevant air quality standards for PM_{10}. For the worst-case year (i.e. the year giving the highest ambient concentration), emissions from the site lead to an ambient PM_{10} concentration (including background) which is 66% of the maximum ambient 24-hour limit value (measured as a 90.4th%ile) and 46% of the annual limit value at the worst-case receptor.

The $PM_{2.5}$ modelling results for Scenario Three are detailed in Table 27. The results indicate that the ambient ground level concentrations are below the relevant air quality standards for $PM_{2.5}$. For the worst-case year (i.e. the year giving the highest ambient concentration), emissions from the site lead to an ambient $PM_{2.5}$ concentration (including background) which is 54% of the annual limit value at the worst-case receptor.

Pollutant / Year	**Background (μg/m³)**	**Averaging Period**	**Process Contribution PM_{10} (μg/m³)**	**Predicted Environmental Concentration PM_{10} (μg/Nm³)**	**Standard (μg/Nm³)** Note 1
PM_{10} / 2015	12	90.4th%ile of 24-hr means	17.2	29.2	50
	12	Annual Mean	5.9	17.9	40
PM_{10} / 2016	12	90.4th%ile of 24-hr means	20.8	32.8	50
	12	Annual Mean	6.4	18.4	40
PM_{10} / 2017	12	90.4th%ile of 24-hr means	15.1	27.1	50
	12	Annual Mean	6.0	18.0	40
PM_{10} / 2018	12	90.4th%ile of 24-hr means	15.8	27.8	50
	12	Annual Mean	5.6	17.6	40
PM_{10} / 2019	12	90.4th%ile of 24-hr means	16.8	28.8	50
	12	Annual Mean	6.3	18.3	40

Note 1 Air Quality Standards 2011 (from EU Directive 2008/50/EC and S.I. 180 of 2011)

Table 26 Scenario Three Dispersion Model Results – PM_{10}

Pollutant / Year	**Background (μg/m³)**	**Averaging Period**	**Process Contribution $PM_{2.5}$ (μg/m³)**	**Predicted Environmental Concentration $PM_{2.5}$ (μg/Nm³)**	**Standard (μg/m³)** Note 1
$PM_{2.5}$ / 2015	7.2	Annual Mean	5.9	13.1	25
$PM_{2.5}$ / 2016	7.2	Annual Mean	6.4	13.6	25
$PM_{2.5}$ / 2017	7.2	Annual Mean	6.0	13.2	25
$PM_{2.5}$ / 2018	7.2	Annual Mean	5.6	12.8	25
$PM_{2.5}$ / 2019	7.2	Annual Mean	6.3	13.5	25

Note 1 S.I. 180 of 2011 and EU Directive 2008/50/EC

Table 27 Scenario Three Dispersion Model Results – $PM_{2.5}$

3.4 NO_X Deposition And Critical Loads Assessment

3.4.1 Baseline Scenario

In order to consider the effects of nitrogen deposition, owing to emissions from the installation, on the Lower River Shannon SAC / River Shannon & River Fergus SPA and Barrigone SAC, the installation's contribution to eutrophication has been determined.

As a first step, the NO_2 concentration determined above in Table 10 must be converted firstly into a dry deposition flux using the equation below which is taken from UK Environment Agency publication "*AGTAG06 – Technical Guidance On Detailed Modelling Approach For An Appropriate Assessment For Emissions To Air*" (EA, 2014):

Dry deposition flux (μg m^{-2} s^{-1}) = ground-level concentration (μg/m^3) x deposition velocity (m/s)

The deposition velocities for various pollutants are outlined in AQTAG06 (EA, 2014) and is reproduced below in Table 28. The land use type for the current region is more reflective of grassland that forest habitat and thus the grassland deposition velocity has been used.

Table 28 Recommended Dry Deposition Velocities

Chemical Species	Recommended Deposition Velocity (m/s)	
NO_2	Grassland	0.0015
	Forest	0.003
NH_3	Grassland	0.02
	Forest	0.03
HCl	Grassland	0.025
	Forest	0.06
HNO_3	0.04	

In order to convert the dry deposition flux from units of μg m^{-2} s^{-1} to units of kg ha^{-1} year^{-1} the dry deposition flux is multiplied by the conversion factors shown in Table 29 (taken from AQTAG06 (EA, 2014)):

Table 29 Conversion Factors To Convert Units From μg m^{-2} s^{-1} Of Species X to kg ha^{-1} year^{-1}

Chemical Species	Conversion factor μg m^{-2} s^{-1} of species X to kg ha^{-1} year^{-1}	
NO_2	Of N:	96
NH_3	Of N:	259.7
HNO_3	Of N:	70.1

The calculation of the nitrogen critical load is as follows for "*Baseline Scenario*" using the default deposition velocity (NO_X concentration has been used rather than NO_2 as a worst-case):

Dry deposition flux (μg m^{-2} s^{-1}) = ground-level concentration (NO_x, Year 2017) (μg/m^3) x deposition velocity (m/s)

= 20.9 μg/m^3 x 0.0015 m/s = 0.0314 μg m^{-2} s^{-1}

When expressed in units of kg ha^{-1} $year^{-1}$ as N

= 0.0314 x 96 kg ha^{-1} $year^{-1}$

NO_x dry deposition flux (kg ha^{-1} $year^{-1}$) = **3.01 kg ha^{-1} $year^{-1}$ as N**

Comparison With Critical Loads For Surrounding Land-Use For Do Something Scenario

The dominant land use categories in the Lower River Shannon SAC / River Shannon & River Fergus SPA and Barrigone SAC as shown in Table 31. Also shown in Table 28 are the relevant critical loads for Nitrogen taken from the WHO Guidelines for Europe (2000) and the more recent UNECE Empirical Critical Loads & Dose-Response Relationships (2010).

Table 31 Critical Loads For N Deposition (kg ha^{-1} $year^{-1}$)

Habitat Class	Critical load for N deposition (UK APIS)(1)	Critical load for N deposition (UNECE 2010)(3)
Salt-marshes	N: 10 – 20 kg ha^{-1} $year^{-1}$	N: 20 – 30 kg ha^{-1} $year^{-1}$
Estuaries, Atlantic Salt Meadows, Mudflats and sandflats	N: 20 – 30 kg ha^{-1} $year^{-1}$	N: 8 – 15 kg ha^{-1} $year^{-1}$

Note 1: UK APIS Website (http://www.apis.ac.uk/)
Note 2: Taken From WHO Guidelines For Europe (2000)
Note 3: UNECE (2010) Empirical Critical Loads & Dose-Response Relationships

Comparing the range of critical loads for N deposition in Table 31 across the various habitat types with the value of 3.01 kg ha^{-1} $year^{-1}$ indicates that the combined N deposition rate (from nitrogen oxide and nitrogen dioxide combined) is below the lower end of the range given for a range of marine / estuary habitat types.

3.4.2 Alternative Scenario

The calculation of the nitrogen critical load is as follows for the "*Alternative Scenario*" using the default deposition velocity:

Dry deposition flux (µg m^{-2} s^{-1}) = ground-level concentration (NO_x, Year 2017) (µg/m^3) x deposition velocity (m/s)

= 20.8 µg/m^3 x 0.0015 m/s = 0.0312 µg m^{-2} s^{-1}

When expressed in units of kg ha^{-1} $year^{-1}$ as N

= 0.0312 x 96 kg ha^{-1} $year^{-1}$

NO_2 dry deposition flux (kg ha^{-1} $year^{-1}$) = **2.99 kg ha^{-1} $year^{-1}$ as N**

Comparing the range of critical loads for N deposition in Table 31 across the various habitat types with the value of 2.99 kg ha^{-1} $year^{-1}$ for the "Alternative Scenario" indicates that the combined N deposition rate (from nitrogen oxide and nitrogen dioxide combined) is below the lower end of the range given for a range of marine / estuary habitat types.

3.4.3 Scenario Three

The calculation of the nitrogen critical load is as follows for "*Scenario Three*" using the default deposition velocity:

Dry deposition flux (μg m^{-2} s^{-1}) = ground-level concentration (NO_x, Year 2017) ($\mu g/m^3$) x deposition velocity (m/s)

= 20.7 $\mu g/m^3$ x 0.0015 m/s = 0.0311 $\mu g\ m^{-2}\ s^{-1}$

When expressed in units of kg ha^{-1} $year^{-1}$ as N

= 0.0311 x 96 kg ha^{-1} $year^{-1}$

NO_2 dry deposition flux (kg ha^{-1} $year^{-1}$) = **2.98 kg ha^{-1} $year^{-1}$ as N**

Comparing the range of critical loads for N deposition in Table 31 across the various habitat types with the value of 2.98 kg ha^{-1} $year^{-1}$ for "Scenario Three" indicates that the combined N deposition rate (from nitrogen oxide and nitrogen dioxide combined) is below the lower end of the range given for a range of marine / estuary habitat types.

4.0 ASSESSMENT SUMMARY

The air dispersion modelling results have been compared with the ambient air quality standards for NO_2, NO_X, CO, SO_2 and PM_{10}/$PM_{2.5}$ for each of the three scenarios investigated. The results indicate that ambient levels of these pollutants will not lead to an exceedance of the ambient air quality standards for human health and vegetation / ecology under any of the three scenarios investigated.

In relation to nitrogen deposition, predicted levels are well below the critical loads for each type of habitat.

References

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(4) USEPA (2017) Guidelines on Air Quality Models, Appendix W to Part 51, 40 CFR Ch.1
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APPENDIX I

Description of the AERMOD Model

The AERMOD dispersion model has been developed in part by the U.S. Environmental Protection Agency (USEPA)[1,4]. The model is a steady-state Gaussian model used to assess pollutant concentrations associated with industrial sources. The model is an enhancement on the Industrial Source Complex-Short Term 3 (ISCST3) model which has been widely used for emissions from industrial sources.

Improvements over the ISCST3 model include the treatment of the vertical distribution of concentration within the plume. ISCST3 assumes a Gaussian distribution in both the horizontal and vertical direction under all weather conditions. AERMOD with PRIME, however, treats the vertical distribution as non-Gaussian under convective (unstable) conditions while maintaining a Gaussian distribution in both the horizontal and vertical direction during stable conditions. This treatment reflects the fact that the plume is skewed upwards under convective conditions due to the greater intensity of turbulence above the plume than below. The result is a more accurate portrayal of actual conditions using the AERMOD model. AERMOD also enhances the turbulence of night-time urban boundary layers thus simulating the influence of the urban heat island.

In contrast to ISCST3, AERMOD is widely applicable in all types of terrain. Differentiation of the simple versus complex terrain is unnecessary with AERMOD. In complex terrain, AERMOD employs the dividing-streamline concept in a simplified simulation of the effects of plume-terrain interactions. In the dividing-streamline concept, flow below this height remains horizontal, and flow above this height tends to rise up and over terrain. Extensive validation studies have found that AERMOD (precursor to AERMOD with PRIME) performs better than ISCST3 for many applications and as well or better than CTDMPLUS for several complex terrain data sets[8].

Due to the proximity to surrounding buildings, the PRIME (Plume Rise Model Enhancements) building downwash algorithm has been incorporated into the model to determine the influence (wake effects) of these buildings on dispersion in each direction considered. The PRIME algorithm takes into account the position of the stack relative to the building in calculating building downwash. In the absence of the building, the plume from the stack will rise due to momentum and/or buoyancy forces. Wind streamlines act on the plume leads to the bending over of the plume as it disperses. However, due to the presence of the building, wind streamlines are disrupted leading to a lowering of the plume centreline.

When there are multiple buildings, the building tier leading to the largest cavity height is used to determine building downwash. The cavity height calculation is an empirical formula based on building height, the length scale (which is a factor of building height & width) and the cavity length (which is based on building width, length and height). As the direction of the wind will lead to the identification of differing dominant tiers, calculations are carried out in intervals of 10 degrees.

In PRIME, the nature of the wind streamline disruption as it passes over the dominant building tier is a function of the exact dimensions of the building and the angle at which the wind approaches the building. Once the streamline encounters the zone of influence of the building, two forces act on the plume. Firstly, the disruption caused by the building leads to increased turbulence and enhances horizontal and vertical dispersion. Secondly, the streamline descends in the lee of the building due to the reduced pressure and drags the plume (or part of) nearer to the ground, leading to higher ground level concentrations. The model calculates the descent of the plume as a function of the building shape and, using a numerical plume rise model, calculates the change in the plume centreline location with distance downwind.

The immediate zone in the lee of the building is termed the cavity or near wake and is characterised by high intensity turbulence and an area of uniform low pressure. Plume mass captured by the cavity region is re-emitted to the far wake as a ground-level volume source. The volume source is located at the base of the lee wall of the building, but is only evaluated near the end of the near wake and beyond. In this region, the disruption caused by the building downwash gradually fades with distance to ambient values downwind of the building.

AERMOD has made substantial improvements in the area of plume growth rates in comparison to ISCST3[1,3]. ISCST3 approximates turbulence using six Pasquill-Gifford-Turner Stability Classes and bases the resulting dispersion curves upon surface release experiments. This treatment, however, cannot explicitly account for turbulence in the formulation. AERMOD is based on the more realistic modern planetary boundary layer (PBL) theory which allows turbulence to vary with height. This use of turbulence-based plume growth with height leads to a substantial advancement over the ISCST3 treatment.

Improvements have also been made in relation to mixing height[1,3]. The treatment of mixing height by ISCST3 is based on a single morning upper air sounding each day. AERMOD, however, calculates mixing height on an hourly basis based on the morning upper air sounding and the surface energy balance, accounting for the solar radiation, cloud cover, reflectivity of the ground and the latent heat due to evaporation from the ground cover. This more advanced formulation provides a more realistic sequence of the diurnal mixing height changes.

AERMOD also has the capability of modelling both unstable (convective) conditions and stable (inversion) conditions. The stability of the atmosphere is defined by the sign of the sensible heat flux. Where the sensible heat flux is positive, the atmosphere is unstable whereas when the sensible heat flux is negative the atmosphere is defined as stable. The sensible heat flux is dependent on the net radiation and the available surface moisture (Bowen Ratio). Under stable (inversion) conditions, AERMOD has specific algorithms to account for plume rise under stable conditions, mechanical mixing heights under stable conditions and vertical and lateral dispersion in the stable boundary layer.

AERMOD also contains improved algorithms for dealing with low wind speed (near calm) conditions. As a result, AERMOD can produce model estimates for conditions when the wind speed may be less than 1 m/s, but still greater than the instrument threshold.

APPENDIX II

Meteorological Data - AERMET

AERMOD incorporates a meteorological pre-processor AERMET (version 19191)[(11)]. AERMET allows AERMOD to account for changes in the plume behaviour with height. AERMET calculates hourly boundary layer parameters for use by AERMOD, including friction velocity, Monin-Obukhov length, convective velocity scale, convective (CBL) and stable boundary layer (SBL) height and surface heat flux. AERMOD uses this information to calculate concentrations in a manner that accounts for changes in dispersion rate with height, allows for a non-Gaussian plume in convective conditions, and accounts for a dispersion rate that is a continuous function of meteorology.

The AERMET meteorological pre-processor requires the input of surface characteristics, including surface roughness (z_0), Bowen Ratio and albedo by sector and season, as well as hourly observations of wind speed, wind direction, cloud cover, and temperature. A morning sounding from a representative upper air station, latitude, longitude, time zone, and wind speed threshold are also required.

Two files are produced by AERMET for input to the AERMOD dispersion model. The surface file contains observed and calculated surface variables, one record per hour. The profile file contains the observations made at each level of a meteorological tower, if available, or the one-level observations taken from other representative data, one record level per hour.

From the surface characteristics (i.e. surface roughness, albedo and amount of moisture available (Bowen Ratio)) AERMET calculates several boundary layer parameters that are important in the evolution of the boundary layer, which, in turn, influences the dispersion of pollutants. These parameters include the surface friction velocity, which is a measure of the vertical transport of horizontal momentum; the sensible heat flux, which is the vertical transport of heat to/from the surface; the Monin-Obukhov length which is a stability parameter relating the surface friction velocity to the sensible heat flux; the daytime mixed layer height; the nocturnal surface layer height and the convective velocity scale which combines the daytime mixed layer height and the sensible heat flux. These parameters all depend on the underlying surface.

The values of albedo, Bowen Ratio and surface roughness depend on land-use type (e.g., urban, cultivated land etc.) and vary with seasons and wind direction. The assessment of appropriate land-use types was carried out in line with USEPA recommendations[(4)] and using the detailed methodology outlined by the Alaska Department of Environmental Conservation[(13)]. AERMET has also been updated to allow for an adjustment of the surface friction velocity (u*) for low wind speed stable conditions based on the work of Qian and Venkatram (BLM, 2011). Previously, the model had a tendency to over-predict concentrations produced by near-ground sources in stable conditions.

Surface roughness

Surface roughness length is the height above the ground at which the wind speed goes to zero. Surface roughness length is defined by the individual elements on the landscape such as trees and buildings. In order to determine surface roughness length, the USEPA recommends that a representative length be defined for each sector, based on an upwind area-weighted average of the land use within the sector, by using the eight land use categories outlined by the USEPA. The inverse-distance weighted surface roughness length derived from the land use classification within a radius of 1km from Shannon Airport Meteorological Station is shown in Table A1.

Sector	Area Weighted Land Use Classification	Spring	Summer	Autumn	Winter Note 1
270-180	100% Grassland	0.05	0.10	0.01	0.01
180-270	100% Urban	1	1	1	1

(1) Winter defined as periods when surfaces covered permanently by snow whereas autumn is defined as periods when freezing conditions are common, deciduous trees are leafless and no snow is present (Iqbal (1983))(15). Thus for the current location autumn more accurately defines "winter" conditions in Ireland.

Table A1 Surface Roughness based on an inverse distance weighted average of the land use within a 1km radius of Shannon Airport Meteorological Station.

Albedo

Noon-time albedo is the fraction of the incoming solar radiation that is reflected from the ground when the sun is directly overhead. Albedo is used in calculating the hourly net heat balance at the surface for calculating hourly values of Monin-Obuklov length. A 10km x 10km square area is drawn around the meteorological station to determine the albedo based on a simple average for the land use types within the area independent of both distance from the station and the near-field sector. The classification within 10km from Shannon Airport Meteorological Station is shown in Table A2.

Area Weighted Land Use Classification	Spring	Summer	Autumn	Winter Note 1
6% Urban, 49% Grassland, 45% Water	0.151	0.143	0.172	0.172

(1) For the current location autumn more accurately defines "winter" conditions in Ireland.

Table A2 Albedo based on a simple average of the land use within a 10km × 10km grid centred on Shannon Airport Meteorological Station.

Bowen Ratio

The Bowen ratio is a measure of the amount of moisture at the surface of the earth. The presence of moisture affects the heat balance resulting from evaporative cooling which, in turn, affects the Monin-Obukhov length which is used in the formulation of the boundary layer. A 10km x 10km square area is drawn around the meteorological station to determine the Bowen Ratio based on geometric mean of the land use types within the area independent of both distance from the station and the near-field sector. The classification within 10km from Shannon Airport Meteorological Station is shown in Table A3.

Area Weighted Land Use Classification	Spring	Summer	Autumn	Winter Note 1
19% Urban, 81% Grassland	0.301	0.557	0.655	0.655

(1) For the current location autumn more accurately defines "winter" conditions in Ireland.

Table A3 Bowen Ratio based on a geometric mean of the land use within a 10km × 10km grid centred on Shannon Airport Meteorological Station.

Appendix 4

An Assessment of the Dust/PM_{10}/$PM_{2.5}$ from the BRDA at Aughinish Alumina (AWN Consulting 2020)

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AN ASSESSMENT OF THE DUST/PM10/PM2.5 FROM THE BRDA AT AUGHINISH ALUMINA, AUGHINISH, COUNTY LIMERICK IN THE NEARBY ECOLOGICALLY SENSITIVE AREAS

Technical Report Prepared For

Aughinish Alumina Limited
Aughinish Island
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Co. Limerick
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EXECUTIVE SUMMARY

AWN Consulting Limited were commissioned by Aughinish Alumina Ltd to conduct an air quality impact assessment of the Bauxite Residue Disposal Area (BRDA) located on Aughinish Island. The modelling assessment has been undertaken in order to determine the impact of dust / PM_{10} / $PM_{2.5}$ and heavy metal emissions from the BRDA in the nearby ecologically sensitive areas including the Lower River Shannon SAC / River Shannon & River Fergus SPA and Barrigone SAC.

Air dispersion modelling was carried out using the United States Environmental Protection Agency's regulatory model AERMOD (version 19191). The aim of the study was to assess the contribution of emissions of dust, PM_{10} / $PM_{2.5}$ and heavy metals from the BRDA to levels at the site boundary and the surrounding area. Evaluation of the significance of these predicted concentrations and deposition levels was undertaken, including consideration of whether these ground level concentrations are likely to exceed the relevant ambient air quality guideline values in the nearby ecologically sensitive areas including the Lower River Shannon SAC / River Shannon & River Fergus SPA and Barrigone SAC.

In order to estimate the dust/PM_{10}/$PM_{2.5}$ and heavy metal emission rate from the BRDA in Aughinish, a conservative approach was adopted. The approach was to determine realistic dust/PM_{10}/$PM_{2.5}$ and heavy metal emission rates based on validating the output against existing monitoring data and by adopting conservative assumptions wherever possible including:

- The BRDA was assessed firstly based on the assumption of no surface water to suppress dust emissions and secondly based on the assumption of dust abatement. It was also assumed that the BRDA was devoid of all vegetation for both scenarios;

- For calculating the dust emission factor, all precipitation was ignored. Guidance indicates that emission rates should be assumed to be zero during precipitation events and that re-initiation of wind erosion after a precipitation event ranges from 1 to 10 days depending on soil type, season of the year, and rainfall amounts.

The selection of the most appropriate air dispersion modelling methodology for modelling dust emissions in the region of Aughinish was based on guidance by the USEPA. The most appropriate regulatory model for the current application is the AERMOD modelling system which is widely used in all terrain locations. When modelling the emissions of particles from the BRDA in the AERMOD model, the particle size distribution based on mean diameter, mass fraction and particle density from data provided by Aughinish Alumina Ltd was used.

For the purposes of modelling, the meteorological data for the period 2015 - 2019 was used based on data from Shannon Airport.

Dust emission factors were input into AERMOD as a variable emission rate as a function of wind speed. In keeping with the worst-case assumptions, emissions are assumed to occur even if precipitation occurs in that particular modelled hour. The AERMOD air dispersion model predicted dust / PM_{10} concentrations for every hour of the modelled years. A worst-case assumption was also made that $PM_{2.5}$ emission rates were equivalent to PM_{10} emission rates.

The dust deposition validation study undertaken based on the results of the BRDA dust deposition data over the period January 2019 – December 2019 indicated that good agreement was obtained when a year-specific dust abatement efficiency was included in the derivation of the dust emission factor. The dust abatement efficiency was derived by fitting the modelling data to the monitoring data. The abatement efficiency was 98% over the period investigated.

The PM_{10} validation study undertaken based on the results of the Osiris PM_{10} monitoring data in 2019 indicated that good agreement was obtained when a period-specific PM_{10} abatement efficiency was included in the derivation of the dust emission factor. The PM_{10} abatement efficiency was derived by fitting the modelling data to the monitoring data. The abatement efficiency was 98% over the period investigated. This abatement efficiency was also applied to the $PM_{2.5}$ emission rate as they are assumed to be equivalent as a worst-case.

Based on the derived abatement efficiencies, levels are in compliance with the ambient air quality standards for PM_{10} and $PM_{2.5}$ at all receptors within the model.

The annual mean PM_{10} concentration including background peaks at 18.3 $\mu g/m^3$ which is 46% of the limit value whilst the 24-hour PM_{10} concentration including background (as a 90^{th}%ile) peaks at 24.3 $\mu g/m^3$ which is 49% of the limit value at the boundary of the Lower River Shannon SAC / River Shannon & River Fergus SPA and Barrigone SAC.

The annual mean $PM_{2.5}$ concentration including background peaks at 13.5 $\mu g/m^3$ which is 54% of the limit value at the boundary of the Lower River Shannon SAC / River Shannon & River Fergus SPA and Barrigone SAC.

The predicted ground level concentration of each heavy metal has been compared to the relevant ambient air quality standards and guidelines including those from the WHO and EU. All heavy metals are predicted to be within the relevant ambient annual mean air quality standard at the nearby Lower River Shannon SAC / River Shannon & River Fergus SPA and Barrigone SAC based on the derived dust abatement efficiencies and based on the average soil concentrations recorded in 2019.

It has been concluded that the emissions from the BRDA pose no risk to the environment beyond the boundary of the facility in terms of dust, PM_{10}, $PM_{2.5}$, and heavy metals and that all levels remain within the relevant ambient air quality guideline values in the nearby ecologically sensitive areas including the Lower River Shannon SAC / River Shannon & River Fergus SPA and Barrigone SAC.

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1.0 INTRODUCTION

AWN Consulting Limited were commissioned by Aughinish Alumina Ltd to conduct an air quality impact assessment of the Bauxite Residue Disposal Area (BRDA) located on Aughinish Island. The modelling assessment has been undertaken in order to determine the impact of dust / PM_{10} / $PM_{2.5}$ and heavy metal emissions from the BRDA in the nearby ecologically sensitive areas including the Lower River Shannon SAC / River Shannon & River Fergus SPA and Barrigone SAC.

Air dispersion modelling was carried out using the United States Environmental Protection Agency’s regulatory model AERMOD. The aim of the study was to assess the contribution of emissions of dust/PM_{10}/$PM_{2.5}$ and heavy metals from the BRDA to levels at the site boundary and the surrounding area. Evaluation of the significance of these predicted concentrations and deposition levels was undertaken, including consideration of whether these ground level concentrations are likely to exceed the relevant ambient air quality guideline values in the nearby ecologically sensitive areas including the Lower River Shannon SAC / River Shannon & River Fergus SPA and Barrigone SAC.

The BRDA is located in Aughinish Island, County Limerick and is shown below in Figure 1 with the two nearby Osiris air monitoring stations identified. Two other Osiris monitors are located in Foynes and Ballysteen respectively.

This report has assessed the potential dust and PM_{10} / $PM_{2.5}$, and heavy metal impact from the BRDA based on the application of the following methodology:

- Determine the existing baseline air quality environment;
- Specify appropriate limit criteria for dust, PM_{10},$PM_{2.5}$, and heavy metals;
- Model the release of emissions from the BRDA in order to quantify the dust, PM_{10},$PM_{2.5}$, and heavy metal emissions from the area both on- and off-site;
- Compare the predicted emission levels to the adopted criteria.

Figure 1 Location Of Osiris Dust / PM_{10} / $PM_{2.5}$ Monitoring Locations Near Aughinish Alumina BRDA (○ Osiris Monitor)

2.0 METHODOLOGY

2.1 Air Quality Guidance

The air quality assessment has been carried out following procedures described in the publications by the EPA[(1)] and using the methodology outlined in the guidance documents published by the USEPA[(2-4)]. Air quality significance criteria are assessed on the basis of compliance with the appropriate standards or limit values. The applicable standards in Ireland include the Air Quality Standards Regulations 2011, which incorporate EU Directive 2008/50/EC which combines the previous air quality framework and subsequent daughter directives (see Table 1).

With regard to dust deposition, the German TA-Luft standard for dust deposition (non-hazardous dust)[(5)] sets a maximum permissible emission level for dust deposition of 350 mg/(m^2*day) averaged over a one year period at any receptors outside the site boundary.

Pollutant	Regulation [Note 1]	Limit Type	Value
Particulate Matter (as PM_{10})	2008/50/EC	24-hour limit for protection of human health - not to be exceeded more than 35 times/year	50 µg/m^3 PM_{10}
		Annual limit for protection of human health	40 µg/m^3 PM_{10}
$PM_{2.5}$	2008/50/EC	Annual limit for protection of human health	25 µg/m^3 $PM_{2.5}$
Dust Deposition	TA-Luft	Average Daily Dust Deposition At Boundary Of Site	350 mg/m^2/day Total Dust

[Note 1] EU 2008/50/EC – Clean Air For Europe (CAFÉ) Directive replaces the previous Air Framework Directive (1996/30/EC) and daughter directives 1999/30/EC and 2000/69/EC

Table 1 European Union Ambient Air Quality Standard (Based on Directive 2008/50/EC)

In the absence of statutory standards for heavy metals, ambient air quality guidelines can also be derived from occupational exposure limits (OEL). Guidance has issued by the UK Environment Agency entitled "IPPC Environmental Assessment for BAT" (Environment Agency, 2002)[(6)]. The guidance outlines the approach for deriving both short-term and long-term environmental assessment levels (EAL). In relation to the long-term (annual) EAL, this can be derived by applying a factor of 100 to the 8-hour OEL. The factor of 100 allows for both the greater period of exposure and the greater sensitivity of the general population. For short-term (1-hour) exposure, the EAL is derived by applying a factor of 10 to the short term exposure limit (STEL). In this case, only the sensitivity of the general population need be taken into account as there is no need for additional safety factors in terms of the period of exposure. Where STELs are not listed then a value of 3 times the 8-hour time weighted average occupational exposure limit may be used. Predicted GLCs of heavy metals have been compared with the applicable ambient air quality guidelines and standards for the protection of human health as set out in Table 2.

Metal	Long-Term EAL (Annual)	Regulation
Cd	0.005 $\mu g/m^3$	EU(1) / EAL(2)
Ti	40 $\mu g/m^3$	EAL(2)
Inorganic Mercury (as Hg)	1 $\mu g/m^3$ / 0.25 $\mu g/m^3$	WHO(3) / EAL(2)
Al	20 $\mu g/m^3$	EAL(2)
As	0.006 $\mu g/m^3$(1)	EU(1) / EAL(2)
Pb	0.5 $\mu g/m^3$	EU(1)
Cr (except VI)	5.0 $\mu g/m^3$	EAL(2)
Cr (VI)(4)	0.0002 $\mu g/m^3$	EAL(2)
Fe	10 $\mu g/m^3$	EAL(2)
Mg	100 $\mu g/m^3$	EAL(2)
Cu (dust & mists)	10 $\mu g/m^3$	EAL(2)
Zn	50 $\mu g/m^3$	EAL(2)
Ni (inorganic)	0.020 $\mu g/m^3$(1)	EU(1)

(1) Council Directive 2004/107/EC
(2) Environmental Agency (2003) "IPPC H1 - Environmental Assessment & Appraisal of BAT"
(3) WHO (2000) Air Quality Guidelines for Europe

Table 2 Heavy Metal Ambient Air Quality Standards & Guidelines For The Protection of Human Health

3.0 BASELINE AMBIENT AIR DATA

3.1 Ambient Air Quality Monitoring Data

Air quality monitoring programs have been undertaken in recent years by the EPA and Local Authorities(7,8). The most recent annual report on air quality "Air Quality Monitoring Annual Report 2018"(8), details the range and scope of monitoring undertaken throughout Ireland. As part of the implementation of the Framework Directive on Air Quality (1996/62/EC), four air quality zones have been defined in Ireland for air quality management and assessment purposes(8). Dublin is defined as Zone A and Cork as Zone B. Zone C is composed of 23 towns with a population of greater than 15,000. The remainder of the country, which represents rural Ireland but also includes all towns with a population of less than 15,000 is defined as Zone D. In terms of air monitoring, Aughinish is categorised as Zone D(8).

PM_{10}

Long-term PM_{10} monitoring was carried out at the Zone D locations of Castlebar, Claremorris and Kilkitt in 2018. The PM_{10} annual averages for these three locations in 2018 ranged from 9 to 12 μg/m^3(7). The PM_{10} annual average in 2018 for the rural Zone D location of Kilkitt was 9 μg/m^3(7). In addition, data from the Phoenix Park provides a good indication of urban background levels, with an annual average in 2018 of 11 μg/m^3(7). Data from 2014 – 2018 for the four Zone D locations as well as the Phoenix Park (Zone A) showed annual averages ranging from 8 to 29 μg/m^3 (see Table 3). Based on the above information, a conservative estimate of the background rural PM_{10} concentration of 12 μg/m^3 has been used and the maximum 24-hour averaging period was assessed using actual monitoring data for Kilkitt for the year 2018 (see Table 4) and using the methodology outlined below.

Year	Castlebar (μg/m^3)	Claremorris (μg/m^3)	Enniscorthy (μg/m^3)	Kilkitt (μg/m^3)	Phoenix Park (Dublin) (μg/m^3)
2014	12	10	22	9	12
2015	13	10	18	9	12
2016	12	10	17	8	11
2017	11	11	29	8	9
2018	11	12	-	9	11
Average	**12**	**11**	**22**	**9**	**11**

Table 3 Annual Mean PM_{10} Background Concentrations in Zone D Locations 2014 – 2018 (μg/m^3)

Year	Castlebar (μg/m^3)	Claremorris (μg/m^3)	Kilkitt (μg/m^3)
2014	9.5	15.4	21.4
2015	10.2	18.0	22.7
2016	17.4	15.0	20.0
2017	17.3	14.0	19.1
2018	19.9	15.3	19.9
Average	**14.9**	**15.5**	**20.6**

Table 4 90^{th}%ile of 24-Hour PM_{10} Concentrations In Zone D Locations 2014 - 2018 (μg/m^3)

In relation to the annual averages, the ambient background concentration was added directly to the process concentration. However, in relation to the short-term peak concentrations, guidance from the UK DEFRA(6) and EPA(7) advises that for PM_{10} an estimate of the maximum combined pollutant concentration can be obtained as shown below:

PM_{10} - The 90.4th%ile of total 24-hour mean PM_{10} is equal to the maximum of either A or B below:

a) 90.4th%ile of 24-hour mean background PM_{10} + annual mean process contribution PM_{10}

b) 90.4th%ile 24-hour mean process contribution PM_{10} + annual mean background PM_{10}

$PM_{2.5}$

The results of $PM_{2.5}$ monitoring at the Zone D location of Claremorris in 2014-2018(7) indicated an average $PM_{2.5}/PM_{10}$ ratio of between 0.5 - 0.6. Based on this information, a conservative ratio of 0.6 was used to generate a background $PM_{2.5}$ concentration of 7.2 µg/m^3.

Dust Deposition

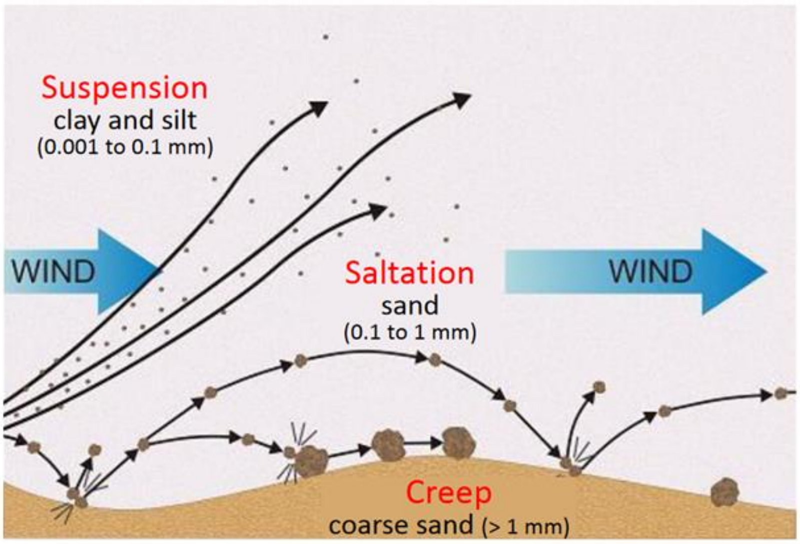
The sources of dust arising from the facility contribute to background levels of dust. Dust is present naturally in the air from a number of sources including weathering of minerals, and pick-up across open land and dust generated from fires. A study by the UK ODPM(9) gives estimates of likely dust deposition levels in specific types of environments. In open country a level of 39 mg/(m^2*day) is typical, rising to 59 mg/(m^2*day) on the outskirts of town and peaking at 127 mg/(m^2*day) for a purely industrial area. A level of 10 mg/(m^2*day) has been applied as the background dust deposition level for the region of the facility in Aughinish, County Limerick based on a review of the lower limit of the values recorded at the facility in recent years.

4.0 DERIVATION OF DUST / PM10 / PM2.5 EMISSION FACTORS

4.1 Dust Emission Research

Dust emissions from wind erosion are dependent on a range of factors including wind velocity, soil moisture, vegetation cover, surface roughness and particle size. A key parameter is the wind threshold velocity which corresponds to the minimum wind speed necessary to initiate the erosion process(10). Once the critical wind threshold velocity is breached, the dust emission flux increases with wind speed. The actual relationship between dust emissions and wind speed (in excess of the threshold velocity) has been the focus of much research over the last 30 years.

Soil movement can be divided into creep (> 1mm) and horizontal flux (between 0.1 – 1mm) which describes most soil movement, also referred to as saltation, and the vertical flux of particles which is generally limited to particles less than 20 microns(11). Research has found that the initial entrainment of dust into the atmosphere occurs due to lifting forces on smaller particles. However, once a few particles begin to move downwind, subsequent entrainment becomes dominating by the impact of the saltating particles(12). The threshold velocities for soil movement occur when the aerodynamic forces are sufficient to dislodge particles from the soil and initiate movement. Experimental studies have shown that there is a minimum friction velocity that will produce motion in particles of diameter of around 100 microns with larger particles requiring greater wind speed while smaller particles require larger pressure fluctuations to initiate movement(11). A schematic of the three main mechanisms for dust movement is shown in Figure 2.



http://cmg.soton.ac.uk/assets/people/gtj104/gallery/saltation-small.JPG

https://extension.arizona.edu/sites/extension.arizona.edu/files/attachments/0920-0950_Walworth_Dust_Conference_2016_Talk_1.pdf

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Figure 2
The three principle mechanisms of dust particle movement

In addition, the relationship between the threshold friction velocity and particle size is non-linear and thus the particle size distribution is also an important factor. A second important factor is the degree of disturbance of the soil. Research from a range of authors has found that the average percent reduction in threshold friction velocity due to disturbance effects is 55% (±25%)[13]. Surfaces with a modest fraction of plant cover have significantly reduced dust emissions. Research from Owens Lake, CA, USA indicates that at 18% plant cover there was a 95% reduction in sand transport rate compared to rates in the absence of vegetation[13].

Over the last few decades many studies on threshold friction velocities and dust erosion formulations have appeared in the literature. Many of the studies report a non-linear relationship typically with the dust emission flux (F) relationship proportional to u_*^3 or u_*^4. Nickling & Gillies[14] conducted experimental measures on vertical dust fluxes in a range of locations using a large portable wind tunnel. The paper presented the results from two mines in Arizona, USA, amongst other locations. The Arizona study[15] outlined threshold friction velocities and roughness heights for 13 sites which have been reproduced in Table 5.

Location	Threshold Friction Velocity (m/s)	Roughness Height (cm)	Threshold Wind Velocity at 10m (m/s)
Mesa – Agricultural Land	0.57	0.0331	16
Glendale – Construction site	0.53	0.0301	15
Maricopa – Agricultural Land	0.58	0.1255	14
Yuma – Disturbed desert	0.32	0.0731	8
Yuma – Agricultural site	0.58	0.0224	17
Algodones – Dunes flats	0.62	0.0166	18
Yuma – Scrub desert	0.39	0.0163	11
Santa Cruz River Tuscon	0.18	0.0204	5
Tuscon – Construction site	0.25	0.0181	7
Ajo – Mine	**0.23**	**0.0176**	**7**
Hayden – Mine	**0.17**	**0.0141**	**5**
Salt River, Mesa	0.22	0.0100	7
Casa Grande – Agricultural Land	0.25	0.0067	8

Table 5 Threshold Friction Velocities – Arizona Sites (USEPA, 1989)[15]

As indicated in Table 5, mines have one of the lowest threshold friction velocities (between 0.17 – 0.23 m/s) which correspond to a threshold wind velocity at 10m of between 5 – 7 m/s. The USEPA in contrast typically assumes a threshold wind speed of between 10 – 25 m/s at 10m[15] depending on the soil material. Initial modelling results indicated that the roughness height (z_0) lead to unrealistically high results.

Alfaro and Gomes[16] study derived empirical emissions flux formulae for particular types of soils. In relation to the silty soils, the empirical formula derived from the studies was :

$$\boldsymbol{F = 2.45x10^{-6}u_*^{3.97}} \quad \textbf{(1)}$$

Where:

F = vertical dust flux
u_{*t} = threshold friction velocity
u_*= friction velocity

The threshold friction velocity was derived using the relationship between threshold friction velocity and aerodynamic roughness length developed by Marticorena[17]:

$$\boldsymbol{u_{*t} = 0.31e^{7.44x(Zo)}} \quad \textbf{(2)}$$

Where:

u_{*t} = threshold friction velocity
Zo= aerodynamic roughness length.

4.2 Dust Emission Rates From The BRDA

In order to estimate the dust emission rate from the BRDA in Aughinish, a conservative approach was adopted. The aim of the approach was to ensure that the dust emission rate was over-estimated by adopting worst-case assumptions wherever possible as outlined below:

- As a first step, the friction velocity for the BRDA was investigated for Phase 1 and Phase 2 with Phase 1 having a higher surface roughness and resultant higher friction velocity. As a worst-case, the surface roughness giving the highest dust emission rate was used in the modelling.

- The BRDA was assumed initially to have no surface water to suppress dust emissions but to consist of a bare soil surface. The finding of this assessment found that the results were generally overly pessimistic and thus additional modelling was undertaken based on water suppression. USEPA AP-42(21) database recommends an abatement efficiency of 84% for water suppression. A site specific abatement efficiency was selected for this study based on a review of the monitoring vs modelling correlations.

- The BRDA soil was assumed to have no additional moisture content.

- It was assumed that the BRDA was devoid of all vegetation.

- For calculating the dust emission factor, all precipitation was ignored. Guidance from the USEPA indicates that emission rates should be assumed to be zero during precipitation events (> 0.2mm) and that re-initiation of wind erosion after a precipitation event ranges from 1 to 10 days depending on soil type, season of the year, and rainfall amounts(15).

- It is assumed that dust emissions may occur every hour of the year including periods of frost and snow.

4.3 Particle Size Distribution

Dust particles have been observed above surfaces during wind erosion events covering a wide range of particle diameters from around 0.1 μm to several hundred μm although only particles less than 20 μm can be transported significant distances(21). Studies have shown that particles less than 20 μm (PM_{20}) that are ejected by sandblasting from coarse soil aggregates do so as a mixture of three log normally distributed populations. These distributions have been found to be essentially independent of the soil texture and mineral composition. In the Alfaro et al (2004)(16) paper the geometric mean diameter (gmd) (and geometric standard deviation (gsd)) of the three populations was defined as 1.5 μm (1.7), 6.7 μm (1.6) and 14.2 μm (1.5).

A paper by the same research team has updated this work (Sow et al (2011)(17)). The analysis was undertaken using field data from Niger, Africa for the same parameters as the earlier work(16) i.e. gmd and gsd. However, the instrumentation in the more recent study had a range of between 0.3 – 20 μm compared to the earlier study which had a range of between 1.2 – 600 μm. Thus, the updated study was better adapted to the sizes of the particles produced in the sandblasting process. The results of the study were broadly in agreement with the earlier study although some variations were noted in the coarse particle size nodes. The results from the study are outlined in Table 6.

	PM2.0	PM5.0	PM10.3
Geometric Mean Diameter (gmd)	2.0	5.0	10.3
Geometric Standard Deviation (gsd)	1.9	1.7	1.5
Average Breakdown (%)	33.0	33.3	33.3

Table 6 Geometric mean diameter and geometric standard deviations of the three log normal distributed populations(17).

The study found that the three particle populations were centred at $PM_{2.0}$, $PM_{5.0}$ and $PM_{10.3}$ with gsd of 1.9, 1.7 and 1.5 respectively. The study also found that the proportion of the three categories emitted depended on the intensity of the wind speeds although on average the three categories emitted essentially in equal proportions(17).

Emission rates have been derived from the site-specific particle size distribution for bauxite residue which is outlined in Tables 7 and 8. Table 7 particle size breakdown was used in the modelling of TSP from the BRDA whilst Table 8 particle size breakdown was used to model PM_{10} / $PM_{2.5}$ from the BRDA.

Particle Size, µm	Percentage In Each Category	Particle Density (kg/m^3)
63	0.20	2.3
34	0.02	2.3
24	0.03	2.3
15	0.04	2.3
9	0.05	2.3
6	0.06	2.3
5	0.10	2.3
1	0.50	2.3

Table 7 Particle Size Breakdown And Density Of Bauxite Residue For The TSP Modelling

Particle Size, µm	Percentage In Each Category	Particle Density (kg/m^3)
10	0.07	2.3
6	0.085	2.3
5	0.14	2.3
1	0.705	2.3

Table 8 Particle Size Breakdown And Density Of Bauxite Residue For The PM_{10} Modelling

5.0 AIR DISPERSION MODELLING ASSESSMENT

The air dispersion modelling input data consists of detailed information on the physical environment (including land use and terrain features), emission rate information and a full meteorological data set for the period of concern. Using this input data, the air dispersion model predicts ground level concentrations for each hour of the modelled meteorological year. The model post-processes the data to identify the location and maximum value of the worst-case ground level concentration in the applicable format for comparison with the relevant limit values. The worst-case concentration is then added to the existing baseline concentration, where relevant, to give the worst-case predicted ambient concentration of the relevant pollutants. The worst-case predicted ambient concentration is then compared with the relevant ambient air quality standard for the protection of human health to assess the significance of the emissions from the emission sources.

5.1 Air Dispersion Modelling Methodology

The United States Environmental Protection Agency (USEPA) approved AERMOD dispersion model has been used to predict the ground level concentrations (GLC) of PM_{10} / $PM_{2.5}$ and heavy metals and dust deposition rates in the ambient environment.

The modelling incorporated the following features:

- A receptor grid was created at which concentrations would be modelled focusing on the nearby ecologically sensitive areas including the Lower River Shannon SAC / River Shannon & River Fergus SPA and Barrigone SAC region near the BRDA giving a total of 482 calculation points for the model.

- Detailed terrain has been mapped into the model using SRTM data with 30m resolution. The site is located in gentle terrain. All terrain features have been mapped in detail into the model using the terrain pre-processor AERMAP(18).

- Hourly-sequenced meteorological information has been used in the model. Meteorological data over the period (Shannon Airport, 2015 - 2019) was used in the model (see Figure 3).

- The source and emission data have been incorporated into the model.

5.2 Terrain

The AERMOD air dispersion model has a terrain pre-processor AERMAP(18) which was used to map the physical environment in detail over the receptor grid. The digital terrain input data used in the AERMAP pre-processor was obtained from SRTM. This data was run to obtain for each receptor point the terrain height and the terrain height scale. The terrain height scale is used in AERMOD to calculate the critical dividing streamline height, H_{crit}, for each receptor. The terrain height scale is derived from the Digital Elevation Model (DEM) files in AERMAP by computing the relief height of the DEM point relative to the height of the receptor and determining the slope. If the slope is less than 10%, the program goes to the next DEM point. If the slope is 10% or greater, the controlling hill height is updated if it is higher than the stored hill height.

In areas of complex terrain, AERMOD models the impact of terrain using the concept of the dividing streamline (H_c). As outlined in the AERMOD model formulation(3) a plume embedded in the flow below H_c tends to remain horizontal; it might go around the hill or impact on it. A plume above H_c will ride over the hill. Associated with this is a tendency for the plume to be depressed toward the terrain surface, for the flow to speed up, and for vertical turbulent intensities to increase.

AERMOD model formulation states that the model "captures the effect of flow above and below the dividing streamline by weighting the plume concentration associated with two possible extreme states of the boundary layer (horizontal plume and terrain-following). The relative weighting of the two states depends on: 1) the degree of atmospheric stability; 2) the wind speed; and 3) the plume height relative to terrain. In stable conditions, the horizontal plume "dominates" and is given greater weight while in neutral and unstable conditions, the plume traveling over the terrain is more heavily weighted"(3).

The terrain in the region of the facility is complex in the sense that the maximum terrain in the modelling domain peaks at 141m which is above the release height of the BRDA. However, in general, the region of the site has gently sloping terrain particularly in the immediate vicinity of the facility.

5.3 Meteorological Data

The selection of the appropriate meteorological data has followed the guidance issued by the USEPA(2). A primary requirement is that the data used should have a data capture of greater than 90% for all parameters. Shannon Airport meteorological station, which is located approximately 15 km north-east of the site, collects data in the correct format and has a data collection of greater than 90%. Long-term hourly observations at Shannon Airport meteorological station provide an indication of the prevailing wind conditions for the region (see Figure 3). Results indicate that the prevailing wind direction is from south to north-westerly in direction over the period 2015 - 2019. The mean wind speed is approximately 4.7 m/s over the period 1981-2010. Calm conditions account for only a small fraction of the time in any one year peaking at 72 hours in 2017 (0.8% of the time). There were also no missing hours over the period 2015 – 2019.

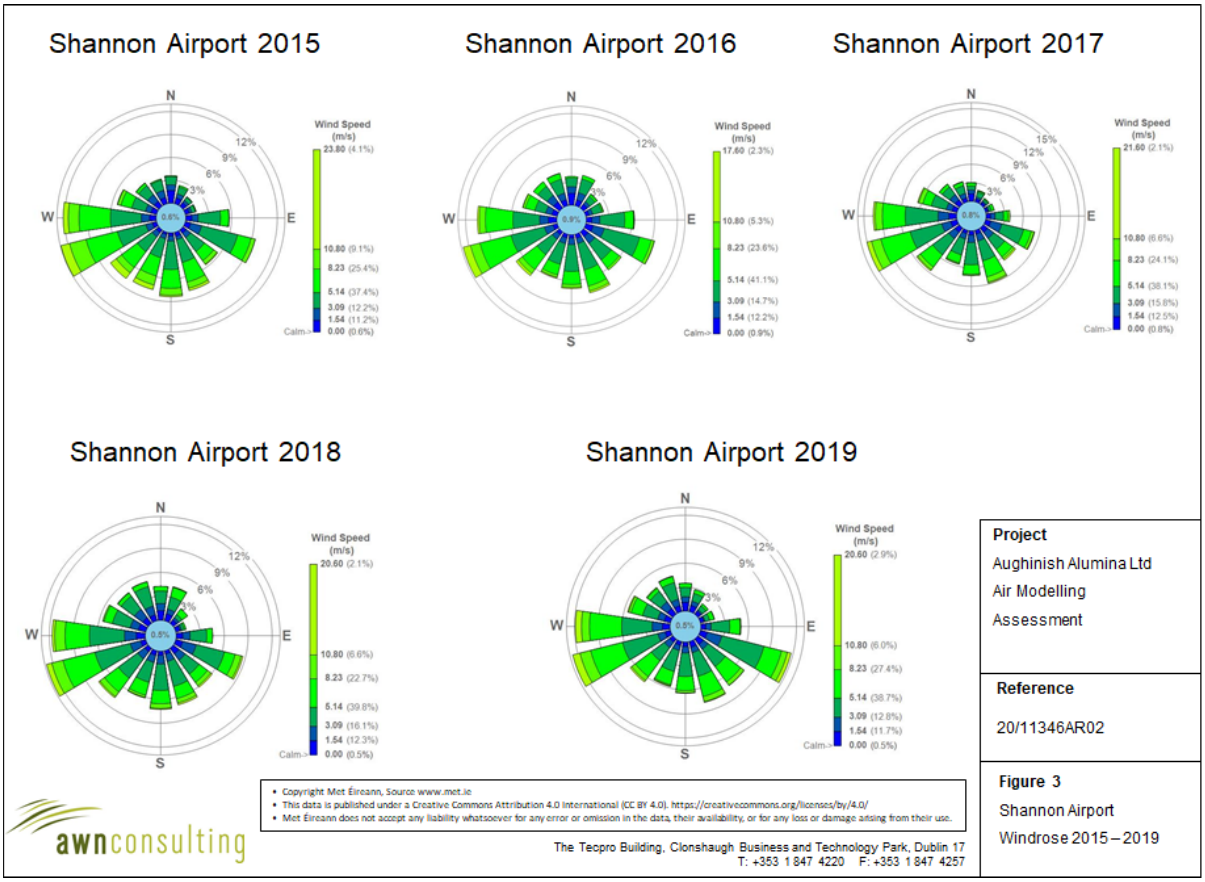

Figure 3
Shannon Airport Windrose 2015 – 2019

5.4 Geophysical Considerations

AERMOD simulates the dispersion process using planetary boundary layer (PBL) scaling theory[3]. PBL depth and the dispersion of pollutants within this layer are influenced by specific surface characteristics such as surface roughness, albedo and the availability of surface moisture. Surface roughness is a measure of the aerodynamic roughness of the surface and is related to the height of the roughness element. Albedo is a measure of the reflectivity of the surface whilst the Bowen ratio is a measure of the availability of surface moisture.

AERMOD incorporates a meteorological pre-processor AERMET[4] to enable the calculation of the appropriate parameters. The AERMET meteorological pre-processor requires the input of surface characteristics, including surface roughness (z_0), Bowen Ratio and albedo by sector and season, as well as hourly observations of wind speed, wind direction, cloud cover, and temperature. The values of albedo, Bowen Ratio and surface roughness depend on land-use type (e.g., urban, cultivated land etc.) and vary with seasons and wind direction. The assessment of appropriate land-use type was carried out to a distance of 10km from the meteorological station for Bowen Ratio and albedo and to a distance of 1km for surface roughness in line with USEPA recommendations[4,19].

In relation to AERMOD, detailed guidance for calculating the relevant surface parameters has been published[19]. The most pertinent features are:

- The surface characteristics should be those of the meteorological site (Shannon Airport) rather than the installation;
- Surface roughness should use a default 1km radius upwind of the meteorological tower and should be based on an inverse-distance weighted geometric mean. If land use varies around the site, the land use should be sub-divided by sectors with a minimum sector size of 30º;
- Bowen ratio and albedo should be based on a 10km grid. The Bowen ratio should be based on an un-weighted geometric mean. The albedo should be based on a simple un-weighted arithmetic mean.

AERMOD has an associated pre-processor, AERSURFACE[19], which has representative values for these parameters depending on land use type. The AERSURFACE pre-processor currently only accepts NLCD92 land use data which covers the USA. Thus, manual input of surface parameters is necessary when modelling in Ireland. Ordnance survey discovery maps (1:50,000) and digital maps such as those provided by the EPA, National Parks and Wildlife Service (NPWS) and Google Earth® are useful in determining the relevant land use in the region of the meteorological station. The Alaska Department of Environmental Conservation has issued a guidance note for the manual calculation of geometric mean for surface roughness and Bowen ratio for use in AERMET[20]. This approach has been applied to the current site.

5.5 AERMOD Modelling Validation Study

The AERMOD air dispersion model was used to predict the ground level concentration of dust/PM_{10}/$PM_{2.5}$ and heavy metals from the BRDA. The modelling was undertaken at the location of the four dust monitoring stations and the modelled results compared to the measured results for 2019. Shannon Airport data for 2019 was used in the modelling assessment.

The emission rate input into the air dispersion model was based on the Alfaro and Gomes[15] study:

$$F = 2.45x10^{-6}u_*^{3.97} \quad (1)$$

Where:

F = vertical dust flux
u_{*t} = threshold friction velocity
u_*= friction velocity

The formula is based on friction velocity, which varies with the local wind speed and thus the dust emission rate will be a function of the wind speed for each hour of the year. Thus, Shannon Airport wind speeds for 2019 were used to derive the hourly emission factors for use in the model. The dust emission rate, based on a site specific abatement efficiency of 98% is shown in Figure 4.

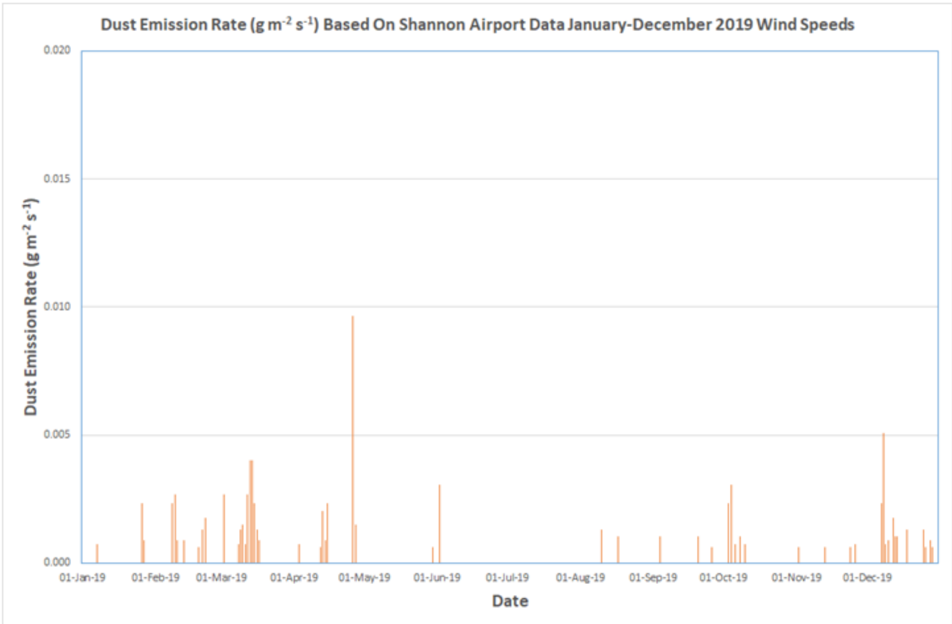

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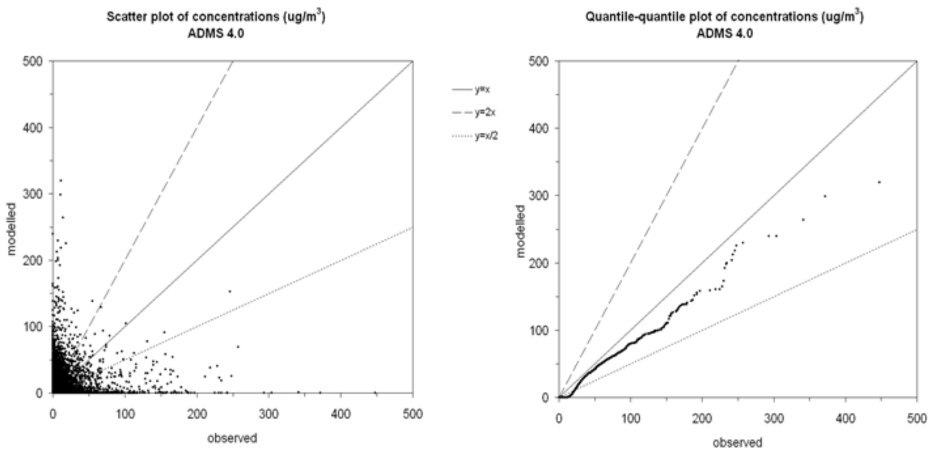
Figure 4
Hourly Dust Emission Factor 2019 (g m^{-2} s^{-1})

The validation study investigated the dust emission rates incorporating the effect of dust suppression on the derived dust emission rates. Based on research by the USEPA[21], an abatement efficiency of 84% has been derived for the use of automated water sprinklers. However, a site specific dust suppression efficiency was derived by adjusting the efficiency to obtain the best fit of the modelled data to the monitored data for each year of the analysis.

The monitoring versus modelling data has been analysed using the approach outlined in the EPA guidance document AG4[1]. As outlined in AG4, due to the uncertainties in wind direction, model comparison studies are not compared paired in space and time (see Figure 5 below). The issue has been addressed in an AERMOD Evaluation Report[22]:

> *"Operational performance of models for predicting compliance with air quality regulations, especially those involving a peak or near peak value at some unspecified time and location can be assessed with quantile-quantile (Q-Q) plots. Q-Q plots, are created by sorting by rank the predicted and the observed concentrations from a set of predictions initially paired in time and space. The*

sorted list of predicted concentrations are then plotted by rank against the observed concentrations also sorted by rank. These concentration pairs are no longer paired in time or location. However, the plot is useful for answering the question, "Over a period of time and over a variety of locations, does the distribution of the model predictions match those of observations?" Scatterplots, which use data paired in time (and / or space), provide a more strict test, answering the question: "At a given time and place, does the magnitude of the model prediction match the observation?" It is the experience of model developers that wind direction uncertainties can and do cause disappointing scatterplot results from what are otherwise well-performing dispersion models. Therefore, the Q-Q plot instead of the scatterplot is a more pragmatic procedure for demonstrating model performance of applied models."



Scatter plots and quantile-quantile plots of ADMS results against observed concentrations (ug/m^3).

1:2 & 2:1 Ratio (agreement within factor of 2)

1:1 Ratio (perfect agreement)

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Figure 5

Quantile – Quantile Plot of Modelled vs Monitored Data

Taken From EPA AG4 (EPA. 2020)

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Thus, in the current validation study, the modelled and monitoring data are not paired in time but ranked from highest to lowest and compared. The dust emission factors derived from the Alfaro & Gomes[(15)] study do not specify the particle size and thus will be dependent on the particle size distribution of the source. For the current study the PM_{10} monitoring results were compared with the PM_{10} modelling results to ascertain the agreement with the monitoring data.

5.6 PM_{10} Validation Study

Figure 6 shows the BRDA PM_{10} monitoring data versus AERMOD PM_{10} modelling data based on Shannon Airport 2019 meteorological data. Results above the 1:1 line indicate that the model is predicting higher levels than the observed data whereas levels below the 1:1 line indicate the reverse. Good agreement is generally deemed to be within a factor of 2 and thus the 1:2 and 2:1 ratios have also been shown as hash lines in the figures.

A direct comparison of the results leads to predicted PM_{10} modelling results, using Shannon Airport 2019 data, significantly greater than the PM_{10} monitoring data. Fitting the monitoring to the modelling data to derive a site-specific abatement efficiency leads to an abatement efficiency of 98% over the period January 2019 - December 2019 as shown in Figure 6.

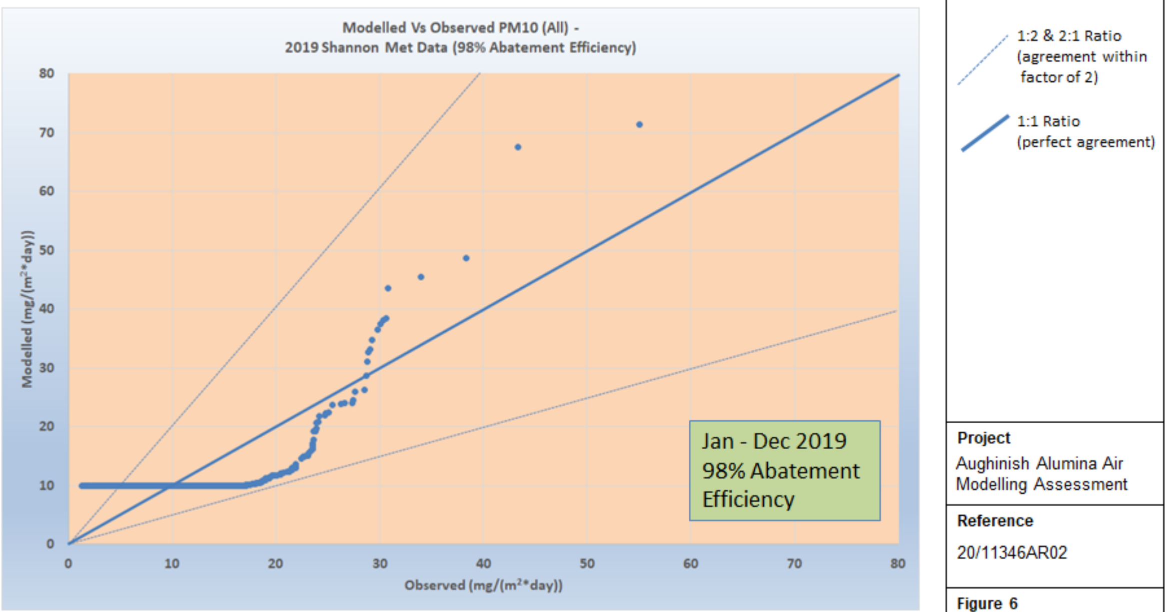

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Figure 6
BRDA Monitoring Data - Aughinish Alumina Ltd
Quantile – Quantile Plot of Modelled PM_{10} vs Monitored PM_{10}
Shannon Airport 2019 Data

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5.7 Dust Deposition Validation Study

Figure 7 shows the BRDA dust deposition monitoring data versus AERMOD dust deposition modelling data based on Shannon Airport meteorological data for the period January 2019 - December 2019. Fitting the monitoring to the modelling data to derive a site-specific abatement efficiency leads to an abatement efficiency of 98% as shown in Figure 7.

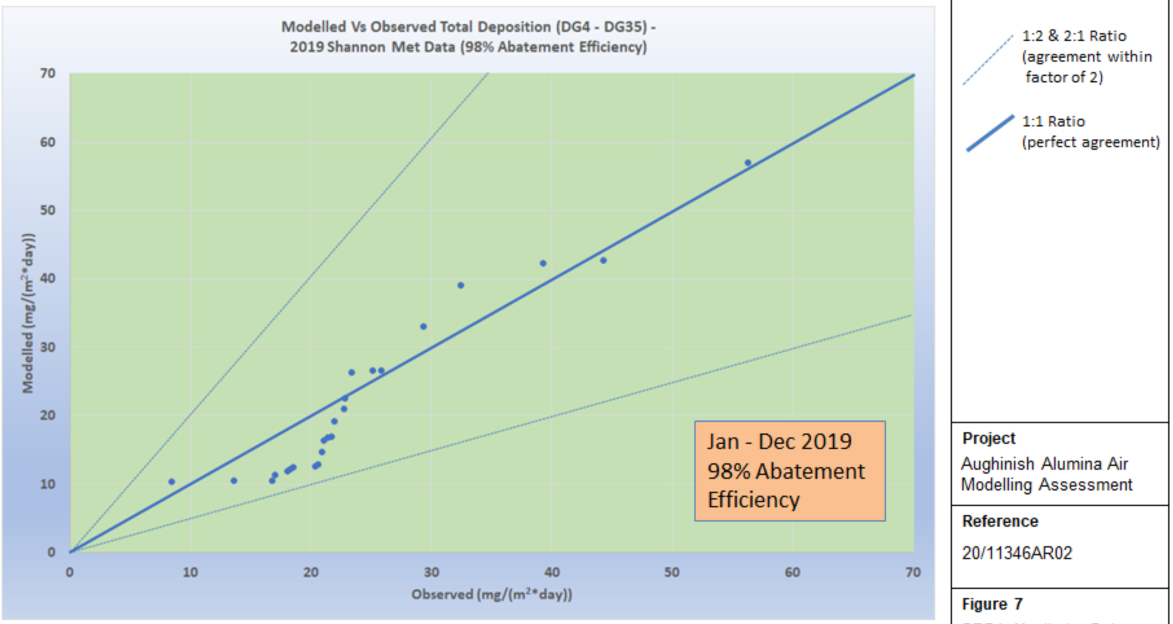

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Figure 7
BRDA Monitoring Data - Aughinish Alumina Ltd

Quantile – Quantile Plot of Modelled Dust Deposition vs Monitored Dust Deposition

Shannon Airport 2019 Data

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6.0 AERMOD AIR DISPERSION MODELLING RESULTS

Predicted Ground Level Concentrations (GLCs) of PM_{10} / $PM_{2.5}$ / heavy metals and dust depostion have been predicted based on the derived dust emission factors for the period (2015 -2019 Shannon Airport). Modelling has been undertaken based on the period-specific abatement efficiencies applied to the derived dust emission factors.

$PM_{2.5}$ modelling has been undertaken on the basis that the $PM_{2.5}$ emission rate is equivalent to the PM_{10} emission rate. The dust emission factor used in the current study is a function of friction velocity only and thus does not take into account the particle size when deriving the emission factor. Only as part of the model inputs does the particle size distribution factor in the analysis and thus $PM_{2.5}$ emission rates will be over-estimated using this methodology. Data from the USEPA(21) indicates that the ratio of $PM_{2.5}$ / PM_{10} is usually 0.15 or less from fugitive sources and thus predicted levels of $PM_{2.5}$ are usually of less concern from fugitive sources than PM_{10}. Thus, the $PM_{2.5}$ results are very conservative and are likely in reality to be significantly lower.

6.1 PM_{10} / $PM_{2.5}$ Modelling Results

The PM_{10} annual mean modelling results are shown in Table 9 for the period 2015 - 2019 (for Shannon Airport). As outlined in Section 3.1, a conservative estimate of the background PM_{10} concentration for Aughinish of 12.0 $\mu g/m^3$ has been used in Table 9 below. In relation to the maximum 24-hour averaging period, real monitoring data for Kilkitt for 2018 (90^{th}%ile of 19.9 $\mu g/m^3$) was used. The background $PM_{2.5}$ concentration for Aughinish of 7.2 $\mu g/m^3$ has been used in Table 9 below.

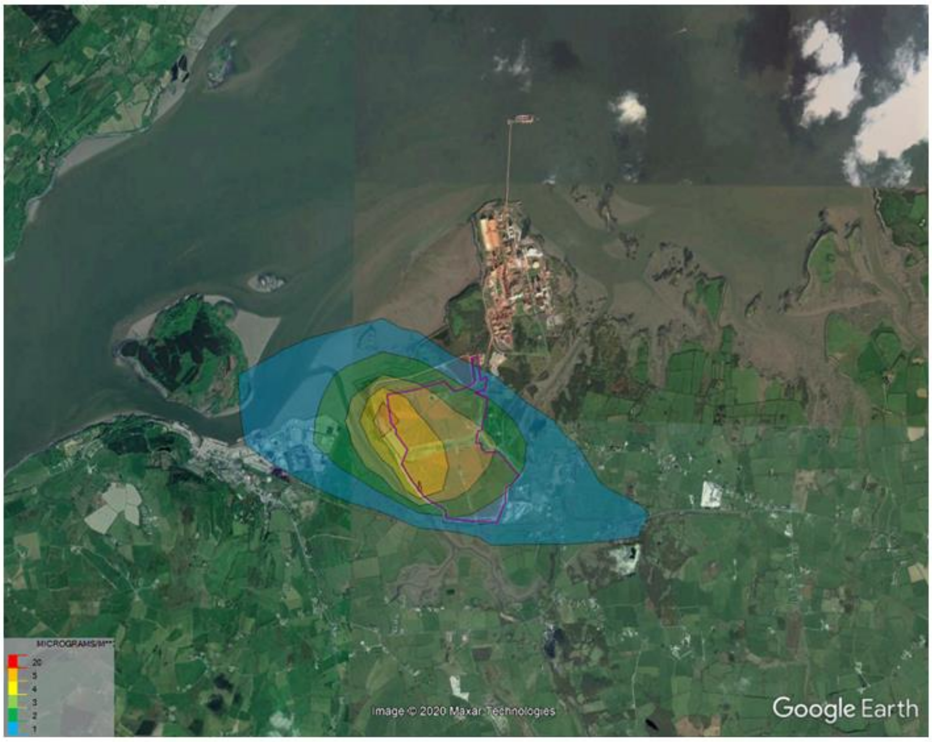
Results indicate that peak concentrations are recorded generally to the north and east of the BRDA boundary with a rapid fall-off in PM_{10} concentration away from the site boundary. Based on the derived abatement efficiencies, levels are in compliance with the ambient air quality standards for PM_{10} at nearby ecologically sensitive areas including the Lower River Shannon SAC / River Shannon & River Fergus SPA and Barrigone SAC as shown in Table 9 and as shown in Figures 8 and 9.

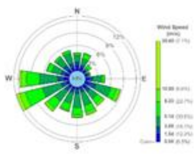
The annual mean PM_{10} concentration peaks at 18.3 $\mu g/m^3$ which is 46% of the limit value whilst the 24-hour PM_{10} concentration (as a 90^{th}%ile) peaks at 24.3 $\mu g/m^3$ which is 49% of the limit value at the boundary of the Lower River Shannon SAC / River Shannon & River Fergus SPA and Barrigone SAC.

The annual mean $PM_{2.5}$ concentration peaks at 13.5 $\mu g/m^3$ which is 54% of the limit value at the boundary of the Lower River Shannon SAC / River Shannon & River Fergus SPA and Barrigone SAC.

Met Data / Year	Receptor	Annual Mean PM_{10}	Max 24-hr PM_{10} (as a 90^{th}%ile)	Annual Mean $PM_{2.5}$
Shannon Airport / 2015	Lower River Shannon SAC / River Shannon & River Fergus SPA and Barrigone SAC	13.2	24.3	8.4
Shannon Airport / 2016		12.6	21.0	7.9
Shannon Airport / 2017		12.8	20.8	8.0
Shannon Airport / 2018		18.3	22.3	13.5
Shannon Airport / 2019		12.9	20.8	8.1
Limit Value		**40**	**50**	**25**

Table 9 PM_{10} / $PM_{2.5}$ Modelling Concentrations For 2015 - 2019 Including Background ($\mu g/m^3$)





Background Mapping from Google Earth

Mean PM_{10} Concentrations (excluding background)

Boundary Of BRDA

Scale

1:50,000

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Figure 8

Mean PM_{10} Concentrations ($\mu g/m^3$) (2018, Shannon Airport data) 98% Abatement Efficiency

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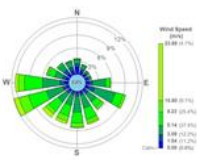

Background Mapping from Google Earth

90^{th}%ile of Maximum PM_{10} Concentrations ($\mu g/m^3$) (excluding background)

Boundary Of BRDA

Scale

1:50,000

N

Project

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Reference

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Figure 9

90^{th}%ile of Maximum PM_{10} Concentrations ($\mu g/m^3$) (2015, Shannon Airport data) 98% Abatement Efficiency

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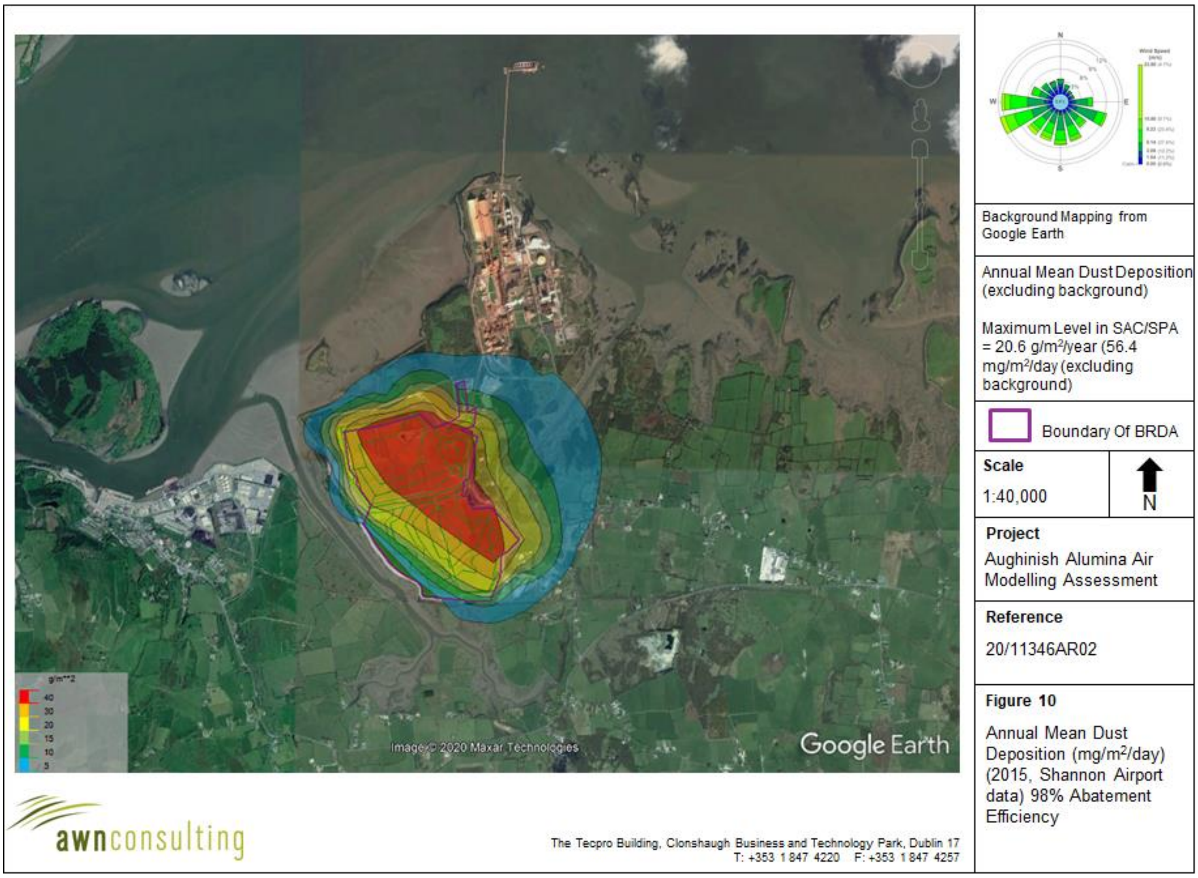
6.2 Dust Deposition Modelling Results

The annual mean dust deposition modelling results are shown in Table 10 for the period 2015 - 2019. Results are presented as Total Deposition which is the sum of dry deposition and wet deposition. Modelling results were also output in terms of these parameters individually. In all cases, dry deposition accounts for at least 99.5% of the reported total deposition result. Thus, the impact of wet deposition on the measured deposition levels is insignificant.

Results indicate that peak deposition levels are recorded to the north and east of the BRDA boundary with a rapid fall-off in TSP deposition levels away from the site boundary. Based on the derived abatement efficiencies, levels are in compliance with the dust nuisance criteria of 350 mg/m^2/day at the nearby Lower River Shannon SAC / River Shannon & River Fergus SPA and Barrigone SAC as outlined in Table 10 and as shown in Figure 10.

Met Data / Year	Receptor	Annual Mean Total Deposition (mg/m^2/day)
Shannon Airport / 2015	Lower River Shannon SAC / River Shannon & River Fergus SPA and Barrigone SAC	61.4
Shannon Airport / 2016		32.8
Shannon Airport / 2017		24.8
Shannon Airport / 2018		39.0
Shannon Airport / 2019		34.1
Limit Value		**350**

Table 10 Total Dust, PM_{10} & $PM_{2.5}$ Modelling Concentrations For The Period 2015 - 2019 Including Background (mg/m^2/day)



6.3 AERMOD Heavy Metal Modelling Results

The emission of heavy metals from the BRDA has been modelled based on the assumption that the percentage of heavy metals identified in the soil sampling of the farmed red mud over the period 2015 – 2019 are also emitted into and dispersed by the atmosphere in the same ratio.

Modelling was based on the average sample results for each heavy metal identified in the soil sampling over this period, as shown in Table 11. The resultant predicted heavy metal concentration is based on the maximum modelling PM_{10} annual mean concentration ratioed to reflect the percentage of heavy metals in the dust.

Table 11 results are based on the derived abatement efficiencies of 98% for PM_{10} using Shannon Airport met data. The results indicate that based on the worst-case reported heavy metal concentration over the period, all heavy metals are in compliance with the relevant ambient annual mean air quality standard.

Shannon Airport	Al*	As*	Cd*	Cr*	Cu*	Fe*	Pb*	Mg*	Hg*	Ni*	Ti*	Zn*
Soil Units	**mg/Kg**	**mg/Kg**	**mg/Kg**	**mg/Kg**	**mg/Kg**	**mg/Kg**	**mg/Kg**	**mg/Kg**	**mg/Kg**	**mg/Kg**	**mg/Kg**	**mg/Kg**
Average Soil Levels	164,191	2.5	1.4	164.1	9.5	10,928	16.2	195.5	0.0	1.9	9480	44.3
Air Modelling Units	**μg/m³**	**ng/m³**	**ng/m³**	**μg/m³**	**μg/m³**	**μg/m³**	**μg/m³**	**μg/m³**	**ng/m³**	**ng/m³**	**μg/m³**	**μg/m³**
Predicted Annual Concentration 2015	0.197	0.003	0.002	2.0E-04	1.1E-05	0.013	1.9E-05	2.3E-04	3.0E-06	2.3E-03	1.1E-02	5.3E-05
Predicted Annual Concentration 2016	0.099	0.002	0.001	9.8E-05	5.7E-06	0.007	9.7E-06	1.2E-04	1.5E-06	1.1E-03	5.7E-03	2.7E-05
Predicted Annual Concentration 2017	0.131	0.002	0.001	1.3E-04	7.6E-06	0.009	1.3E-05	1.6E-04	2.0E-06	1.5E-03	7.6E-03	3.5E-05
Predicted Annual Concentration 2018	1.034	0.016	0.009	1.0E-03	6.0E-05	0.069	1.0E-04	1.2E-03	1.6E-05	1.2E-02	6.0E-02	2.8E-04
Predicted Annual Concentration 2019	0.148	0.002	0.001	1.5E-04	8.6E-06	0.010	1.5E-05	1.8E-04	2.3E-06	1.7E-03	8.5E-03	4.0E-05
Annual Limits	**20**	**6 ng/m³**	**5 ng/m³**	**5**	**10**	**10**	**0.5**	**100**	**250 ng/m³**	**20 ng/m³**	**40**	**50**

Table 11 Heavy Metal Concentrations Based On Shannon Airport 2015 – 2019 (μg/m³) Based On Average Soil Concentration (mg/Kg)

7.0 CONCLUSIONS

The selection of the most appropriate air dispersion modelling methodology for modelling dust (and heavy metal) emissions was based on guidance by the USEPA. The most appropriate regulatory model for the current application is AERMOD which is widely used in all terrains. When modelling the emissions of particles from the BRDA in the AERMOD model, the particle size distribution based on mean diameter, mass fraction and particle density from data provided by Aughinish Alumina Ltd was used.

For the purposes of modelling, the meteorological data for the period 2015 – 2019 was used based on data from Shannon Airport. Onsite data for the same period was checked for consistency in relation to wind speed and direction.

Dust / PM_{10} / $PM_{2.5}$ (and heavy metal) emission factors were input into AERMOD as a variable emission rate as a function of wind speed. In keeping with the worst-case assumptions, emissions are assumed to occur even if precipitation occurs in that particular modelled hour. The AERMOD air dispersion model predicted dust / PM_{10} / $PM_{2.5}$ and heavy metal concentrations and wet and dry deposition fluxes for every hour of the modelled period.

The PM_{10} validation study undertaken based on the results of the BRDA Osiris PM_{10} monitoring data over the period January 2019 – December 2019 indicated that good agreement was obtained when a year-specific PM_{10} abatement efficiency was included in the derivation of the dust emission factor. The PM_{10} abatement efficiency was derived by fitting the modelling data to the monitoring data. The abatement efficiency was 98% over the period investigated.

The dust deposition validation study undertaken based on the results of the BRDA dust deposition data over the period January 2019 – December 2019 indicated that good agreement was obtained when a year-specific dust abatement efficiency was included in the derivation of the dust emission factor. The dust abatement efficiency was derived by fitting the modelling data to the monitoring data. The abatement efficiency was 98% over the period investigated.

Based on the derived abatement efficiencies levels are in compliance with the ambient air quality standards for PM_{10} and $PM_{2.5}$ at the nearby Lower River Shannon SAC / River Shannon & River Fergus SPA and Barrigone SAC.

Based on the derived abatement efficiencies, dust deposition levels are in compliance with the dust nuisance criteria of 133 mg/m^2/year (350 mg/m^2/day) at the nearby Lower River Shannon SAC / River Shannon & River Fergus SPA and Barrigone SAC.

The predicted ground level concentration of each heavy metal has been compared to the relevant ambient air quality standards and guidelines including those from the WHO and EU. All heavy metals are predicted to be within the relevant ambient annual mean air quality standard at the nearby Lower River Shannon SAC / River Shannon & River Fergus SPA and Barrigone SAC based on the derived dust abatement efficiencies and based on the average soil concentrations recorded in 2019.

It has been concluded that the emissions from the BRDA pose no long-term risk to the environment at the nearby Lower River Shannon SAC / River Shannon & River Fergus SPA and Barrigone SAC in terms of dust deposition, PM_{10}, $PM_{2.5}$ and heavy metals.

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APPENDIX 1

Description of the AERMOD Model

The AERMOD dispersion model has been developed in part by the U.S. Environmental Protection Agency (USEPA)[2,3]. The model is a steady-state Gaussian model used to assess pollutant concentrations associated with industrial sources. The model is an enhancement on the Industrial Source Complex-Short Term 3 (ISCST3) model which has been widely used for emissions from industrial sources.

Improvements over the ISCST3 model include the treatment of the vertical distribution of concentration within the plume. ISCST3 assumes a Gaussian distribution in both the horizontal and vertical direction under all weather conditions. AERMOD with PRIME, however, treats the vertical distribution as non-Gaussian under convective (unstable) conditions while maintaining a Gaussian distribution in both the horizontal and vertical direction during stable conditions. This treatment reflects the fact that the plume is skewed upwards under convective conditions due to the greater intensity of turbulence above the plume than below. The result is a more accurate portrayal of actual conditions using the AERMOD model. AERMOD also enhances the turbulence of night-time urban boundary layers thus simulating the influence of the urban heat island.

In contrast to ISCST3, AERMOD is widely applicable in all types of terrain. Differentiation of the simple versus complex terrain is unnecessary with AERMOD. In complex terrain, AERMOD employs the dividing-streamline concept in a simplified simulation of the effects of plume-terrain interactions. In the dividing-streamline concept, flow below this height remains horizontal, and flow above this height tends to rise up and over terrain. Extensive validation studies have found that AERMOD (precursor to AERMOD with PRIME) performs better than ISCST3 for many applications and as well or better than CTDMPLUS for several complex terrain data sets[3].

Due to the proximity to surrounding buildings, the PRIME (Plume Rise Model Enhancements) building downwash algorithm has been incorporated into the model to determine the influence (wake effects) of these buildings on dispersion in each direction considered. The PRIME algorithm takes into account the position of the stack relative to the building in calculating building downwash. In the absence of the building, the plume from the stack will rise due to momentum and/or buoyancy forces. Wind streamlines act on the plume leads to the bending over of the plume as it disperses. However, due to the presence of the building, wind streamlines are disrupted leading to a lowering of the plume centreline.

When there are multiple buildings, the building tier leading to the largest cavity height is used to determine building downwash. The cavity height calculation is an empirical formula based on building height, the length scale (which is a factor of building height & width) and the cavity length (which is based on building width, length and height). As the direction of the wind will lead to the identification of differing dominant tiers, calculations are carried out in intervals of 10 degrees.

In PRIME, the nature of the wind streamline disruption as it passes over the dominant building tier is a function of the exact dimensions of the building and the angle at which the wind approaches the building. Once the streamline encounters the zone of influence of the building, two forces act on the plume. Firstly, the disruption caused by the building leads to increased turbulence and enhances horizontal and vertical dispersion. Secondly, the streamline descends in the lee of the building due to the reduced pressure and drags the plume (or part of) nearer to the ground, leading to higher ground level concentrations. The model calculates the descent of the plume as a function of the building shape and, using a numerical plume rise model, calculates the change in the plume centreline location with distance downwind.

The immediate zone in the lee of the building is termed the cavity or near wake and is characterised by high intensity turbulence and an area of uniform low pressure. Plume mass captured by the cavity region is re-emitted to the far wake as a ground-level volume source. The volume source is located at the base of the lee wall of the building, but is only evaluated near the end of the near wake and beyond. In this region, the disruption caused by the building downwash gradually fades with distance to ambient values downwind of the building.

AERMOD has made substantial improvements in the area of plume growth rates in comparison to ISCST3(3). ISCST3 approximates turbulence using six Pasquill-Gifford-Turner Stability Classes and bases the resulting dispersion curves upon surface release experiments. This treatment, however, cannot explicitly account for turbulence in the formulation. AERMOD is based on the more realistic modern planetary boundary layer (PBL) theory which allows turbulence to vary with height. This use of turbulence-based plume growth with height leads to a substantial advancement over the ISCST3 treatment.

Improvements have also been made in relation to mixing height(3). The treatment of mixing height by ISCST3 is based on a single morning upper air sounding each day. AERMOD, however, calculates mixing height on an hourly basis based on the morning upper air sounding and the surface energy balance, accounting for the solar radiation, cloud cover, reflectivity of the ground and the latent heat due to evaporation from the ground cover. This more advanced formulation provides a more realistic sequence of the diurnal mixing height changes.

AERMOD also has the capability of modelling both unstable (convective) conditions and stable (inversion) conditions. The stability of the atmosphere is defined by the sign of the sensible heat flux. Where the sensible heat flux is positive, the atmosphere is unstable whereas when the sensible heat flux is negative the atmosphere is defined as stable. The sensible heat flux is dependent on the net radiation and the available surface moisture (Bowen Ratio). Under stable (inversion) conditions, AERMOD has specific algorithms to account for plume rise under stable conditions, mechanical mixing heights under stable conditions and vertical and lateral dispersion in the stable boundary layer.

AERMOD also contains improved algorithms for dealing with low wind speed (near calm) conditions. As a result, AERMOD can produce model estimates for conditions when the wind speed may be less than 1 m/s, but still greater than the instrument threshold.

Meteorological Data - AERMET

AERMOD incorporates a meteorological pre-processor AERMET[4]. AERMET allows AERMOD to account for changes in the plume behaviour with height. AERMET calculates hourly boundary layer parameters for use by AERMOD, including friction velocity, Monin-Obukhov length, convective velocity scale, convective (CBL) and stable boundary layer (SBL) height and surface heat flux. AERMOD uses this information to calculate concentrations in a manner that accounts for changes in dispersion rate with height, allows for a non-Gaussian plume in convective conditions, and accounts for a dispersion rate that is a continuous function of meteorology.

The AERMET meteorological preprocessor requires the input of surface characteristics, including surface roughness (z_0), Bowen Ratio and albedo by sector and season, as well as hourly observations of wind speed, wind direction, cloud cover, and temperature. A morning sounding from a representative upper air station, latitude, longitude, time zone, and wind speed threshold are also required.

Two files are produced by AERMET for input to the AERMOD dispersion model. The surface file contains observed and calculated surface variables, one record per hour. The profile file contains the observations made at each level of a meteorological tower, if available, or the one-level observations taken from other representative data, one record level per hour.

From the surface characteristics (i.e. surface roughness, albedo and amount of moisture available (Bowen Ratio)) AERMET calculates several boundary layer parameters that are important in the evolution of the boundary layer, which, in turn, influences the dispersion of pollutants. These parameters include the surface friction velocity, which is a measure of the vertical transport of horizontal momentum; the sensible heat flux, which is the vertical transport of heat to/from the surface; the Monin-Obukhov length which is a stability parameter relating the surface friction velocity to the sensible heat flux; the daytime mixed layer height; the nocturnal surface layer height and the convective velocity scale which combines the daytime mixed layer height and the sensible heat flux. These parameters all depend on the underlying surface.

The values of albedo, Bowen Ratio and surface roughness depend on land-use type (e.g., urban, cultivated land etc) and vary with seasons and wind direction. The assessment of appropriate land-use types was carried out in line with USEPA recommendations[4] and using the detailed methodology outlined by the Alaska Department of Environmental Conservation[20].

Appendix 5

Baseline Water Characterisation Survey Aughinish, Shannon Estuary (Aquafact 2018)

Baseline Water Characterisation Survey
Aughinish, Shannon Estuary

Produced by

AQUAFACT International Services Ltd

On behalf of

Aughinish Alumina Limited

April 2018

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1. Introduction

AQUAFACT International Services Ltd. was commissioned by Aughinish Alumina Ltd to carry out a baseline water characterisation survey around Aughinish Port. The sampling was carried out upstream and downstream of the Aughinish Alumina discharge, which discharged 12,459m^3 of treated effluent that day, with a maximum hourly discharge of 944m^3/hour.

2. Materials & Methods

2.1. Sampling Procedure

On the 4th April 2018, 3 water sampling stations were sampled in the vicinity of the Port. Sampling was carried out in accordance with the EPA Standard Operating Procedure for WFD sampling in transitional and coastal waters. One station was located 500 m upstream of the discharge, a second station was located 500 m downstream and a third station was 1km downstream (See Figure 2.1). Each station was sampled at three depths below surface, mid-water and off bottom. All stations were sampling at mid-ebb, low water and mid-flood. The list of determinands can be seen in Table 2.1. Limits of Detection can be found in Appendix 1.

Samples were collected from a boat using a 1 litre water sampler at the three stations as shown in Figure 2.1. Table 2.2 presents the station coordinates.

Multiple samples were taken at each depth until all required sample containers were filled. The following containers were required for all sampling points:

1. 1 x 250ml bottle for BOD
2. 1 litre plastic (general chemistry),
3. 100ml plastic (metals),
4. 40ml vial (VOCs) &
5. Two 1 litre glass (PAHs & Phenols)

Table 2:1 Determinands.

Determinand	
BOD	Vanadium
COD	Zinc
TOC (water)	Mercury
Antimony	Molybdenum
Arsenic	PAHs note1
Barium	Volatile Organic Compounds note2
Cadmium	BTEX note3
Chromium	Phenols (Total)
Copper	Solids (Total Dissolved)
Lead	Nitrogen (Total)
Nickel	Nitrogen (Total Inorganic)
Selenium	Phosphorus

Note [1] Water GC-MS, Soil GC-MS, Naphthalene, Acenaphthylene, Acenaphthene, Fluorene, Phenanthrene, Anthracene, Fluoranthene, Pyrene, Benz(a)anthracene, Chrysene, Benzo(k)fluoranthene, Benzo(a)pyrene, Indeno(123cd)pyrene, Dibenzo(ah)anthracene, Benzo(ghi)perylene, Coronene

Note [2] 1,1,1,2-Tetrachloroethane, 1,1,1-Trichloroethane, 1,1,2,2-Tetrachloroethane, 1,1,2-Trichloroethane, 1,1-Dichloroethane, 1,1-Dichloroethene, 1,1-Dichloropropene, 1,2,3-Trichlorobenzene, 1,2,3-Trichloropropane, 1,2,4-Trichlorobenzene, 1,2,4-Trimethylbenzene, 1,2-Dibromo-3-chloro-propane, 1,2-Dibromoethane, 1,2-Dichlorobenzene, 1,2-Dichloroethane, 1,2-Dichloropropane, 1,3,5-Trimethylbenzene, 1,3-Dichlorobenzene, 1,3-Dichloropropane, 1,4-Dichlorobenzene, 2,2-Dichloropropane, 2-Chlorotoluene, 4-Chlorotoluene, 4-Isopropyltoluene, , Bromobenzene, Bromochloromethane, Bromodichloromethane, Bromomethane, Bromoform, Carbontetrachloride, Chloroform, Chlorobenzene, Chloroethane, Chloromethane, cis-1,2-Dichloroethene, cis-1,3-Dichloropropene, Dibromochloromethane, Dibromomethane, Dichlorodifluoromethane, Dichloromethane, , Hexachlorobutadiene, Isopropylbenzene, Naphthalene, n-Butylbenzene, , , n- Propylbenzene, sec-Butylbenzene, Styrene, tert-Butylbenzene, Tetrachloroethene, , trans-1,2-Dichloroethene, trans-1,3-Dichloropropene, Trichloroethene, Trichlorofluoromethane, Vinyl Chloride.

Note [3] Benzene, Ethylbenzene, p/m-Xylene~, o-Xylene, Toluene, Xylene (Total)

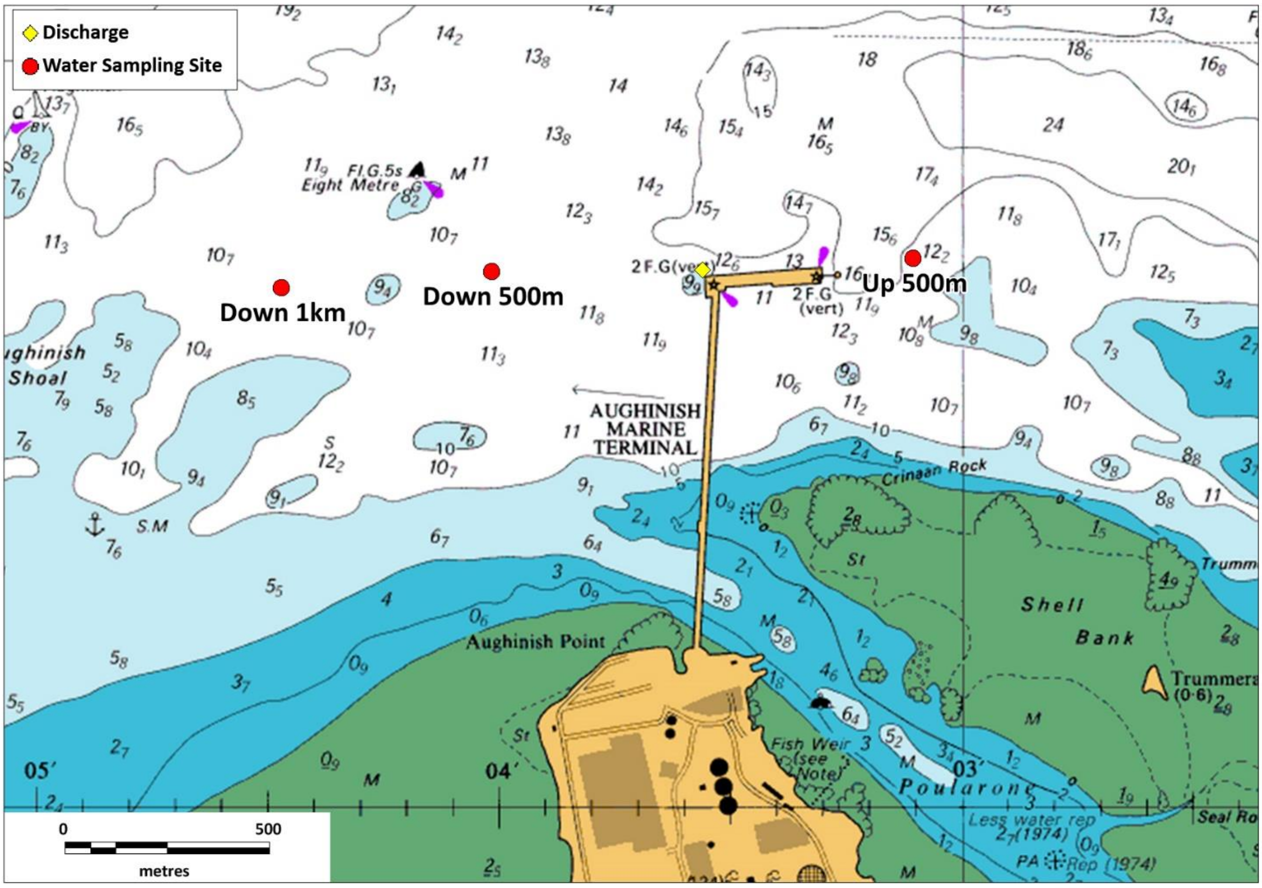

Figure 2.1 Location of chemistry sampling sites

Table 2:2: Coordinates of stations sampled for physical and chemical analysis

Station	Latitude	Longitude	Depth (m)
500m Upstream	52.6457	-9.05242	18
500m Downstream	52.6454	-9.06762	20.1
1km Downstream	52.6451	-9.07522	18.9

2.2. Sample Processing

Once back in the lab, BOD samples were delivered to Glan-Uisce Teo within 24 hours of collection and all other samples were sent to Fitz Scientific in Drogheda.

2.2.1. Chemical Analysis

The following methodologies were employed by the analysing laboratories:

- BOD: BOD_5

- COD: Colorimetry, Standard Method for the Examination of Water and Wastewater 2005, 21st Edition, Method 5220 D.
- TOC: TOC Analyser, British Standard EN 13137:2001- August 2001.
- Metals: ICPMS, Standard Method for the Examination of Water and Wastewater 2005, 21st Edition, Method 3125B. Selenium ICPMS, BS EN 12457-2:2002. Molybdenum ICPMS, Standard Method for the Examination of Water and Wastewater 2005, 21st Edition, Method 3120B.
- Phenols: GCMS, US EPA Method 525.
- Nitrogen (Total): Calculation, Other (Parameter is UKAS accredited if the parameter matrix is industrial effluent).
- Nitrogen (Total Oxidised): Colorimetry, Standard Method for the Examination of Water and Wastewater 2005, 21st Edition, Method 4500-NO3 H" and "SSA Book Series: 5, Methods of Soil Analysis – Extraction of Exchangeable Ammonium and Nitrate and Nitrite 1996.
- Nitrogen (Total Kjeldahl): Digestion/ Distillation/ Titrimetry, Standard Method for the Examination of Water and Wastewater 2005, 21st Edition, Method 4500-Norg.
- VOCs: GCMS, US EPA Method 8260B. Tetrachloroethene (Surface Water) GCMS, US EPA Method 524.
- PAHs: HPLC, Standard Method for the Examination of Water and Wastewater 2005h 21st Edition, Method 6440.

3. Physical / Chemical Results

Appendix 2 and 3 contain the laboratory reports showing the full set of results from Fitz Scientific and Glan-Uisce Teo, respectively. Tables 3:1 - 3:11 present the results from the sample analysis where S = Surface, M= Mid and B = Bottom for sample depth and ME = Mid Ebb, LW = Low Water and MF = Mid Flood for tidal state.

3.1. BOD

Table 3.1 shows the BOD results. BOD was <2.0mg/l at all stations and all depths except at 500m upstream on mid-ebb when BOD was 2.3mg/l at the surface.

Table 3:1: BOD results

Parameter	Tide	500 m Upstream			500 m Downstream			1 km Downstream		
		S	**M**	**B**	**S**	**M**	**B**	**S**	**M**	**B**
BOD (mg/l)	ME	2.3	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0
	LW	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0
	MF	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0

3.2. COD

The COD results can be seen in Table 3.2. Results for mid-ebb ranged from 80 - 110mg/l, with highest levels 500m upstream. Results for low water ranged from 70 - 100 mg/l, with levels increasing slightly across all depths in a downstream direction. Results for mid-flood ranged from 90 - 125 mg/l, with levels highest downstream and at bottom upstream.

Table 3:2: COD results

Parameter	Tide	500 m Upstream			500 m Downstream			1 km Downstream		
		S	**M**	**B**	**S**	**M**	**B**	**S**	**M**	**B**
COD (mg/l)	ME	105	110	100	90	90	85	85	85	80
	LW	70	85	90	75	90	90	90	95	100
	MF	90	95	120	110	120	125	110	115	115

3.3. TOC

Table 3.3 shows the TOC results. Results for mid-ebb ranged from 3.8 - 4.8 mg/l. Results for low water ranged from 3.8 - 4.9 mg/l and results from mid-flood ranged from 3.3 - 4.3 mg/l.

TOC results are consistent upstream and downstream of the discharge.

Table 3:3: TOC results

Parameter	Tide	500 m Upstream			500 m Downstream			1 km Downstream		
		S	M	B	S	M	B	S	M	B
TOC (mg/l)	ME	4.6	3.9	3.8	4.2	4.1	4.2	4.8	4.0	4.1
	LW	4.4	4.2	4.0	4.9	4.1	4.0	4.0	3.8	3.8
	MF	3.9	3.7	3.8	3.6	4.0	4.1	3.5	4.3	3.3

3.4. Phenol

Table 3.4 shows the total phenol results. Phenol was below the Limits of detection (LOD) for all stations except 1km downstream surface sample on the mid-ebb which was 1.03 µg/l.

Table 3:4: Total Phenol results

Parameter	Tide	500 m Upstream			500 m Downstream			1 km Downstream		
		S	M	B	S	M	B	S	M	B
Total Phenols (µg/l)	ME	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	1.03	<0.10	<0.10
	LW	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10
	MF	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10

3.5. Total Dissolved Solids

Table 3.5 shows the total dissolved solid (TDS) results. Values ranged from 1,910 - 2,330 mg/l at mid-ebb, 1,736 – 2,136 mg/l at low water and 2,247 - 2,506 mg/l at mid-flood. Concentrations of TDS vary consistently upstream and downstream of the discharge.

Table 3:5: Total dissolved solids results

Parameter	Tide	500 m Upstream			500 m Downstream			1 km Downstream		
		S	M	B	S	M	B	S	M	B
Total Dissolved Solids (mg/l)	ME	2275	2289	2330	1910	1972	1958	2010	2109	2091
	LW	1736	2120	2136	2043	1896	1938	2072	2116	2093
	MF	2247	2299	2428	2316	2324	2316	2429	2464	2506

3.6. Total Nitrogen

Table 3.6 shows the total nitrogen results. Values ranged from 2 - 3 mg/l at mid-ebb, 2 - 9 mg/l at low water and <1 - 3 mg/l at mid-flood. Total nitrogen was relatively consistent with most sampling points recording 2 - 3 mg/l.

Table 3:6: Metal results and guidance values

Parameter	Tide	500 m Upstream			500 m Downstream			1 km Downstream		
		S	M	B	S	M	B	S	M	B
Total Nitrogen (mg/l)	ME	2	2	2	3	2	3	3	3	3
	LW	3	3	2	3	9	7	7	3	3
	MF	2	2	2	2	3	2	2	<1	2

3.7. Total Inorganic Nitrogen

Tables 3.7 show the total inorganic nitrogen results. Values ranged from 1 - 1.8 mg/l at mid-ebb, 0.4 - 5.6 mg/l at low water and 0.5 - 1.7 mg/l at mid-flood. Total inorganic nitrogen was consistent with similar variation in values upstream and downstream the discharge.

Table 3:7: Total inorganic nitrogen

Parameter	Tide	500 m Upstream			500 m Downstream			1 km Downstream		
		S	M	B	S	M	B	S	M	B
Total Inorganic Nitrogen (mg/l as N)	ME	1	1.2	1.1	1.8	1.7	1.7	1.5	1.4	1.3
	LW	2.5	2	0.4	2	5.6	1.6	1.4	1.2	1.4
	MF	1.7	1	1	0.7	0.6	0.7	0.7	0.6	0.5

3.8. Total Phosphorus

Table 3.8 shows the total phosphorus results. Values ranged from 0.048 - 0.077 mg/l at mid-ebb, 0.052 - 0.083 mg/l at low water and 0.038 - 0.069 mg/l at mid-flood. Total phosphorus levels are consistent upstream and downstream the discharge.

Table 3:8: Total phosphorus results

Parameter	Tide	500 m Upstream			500 m Downstream			1 km Downstream		
		S	M	B	S	M	B	S	M	B
Total Phosphorus (mg/l as P)	ME	0.057	0.071	0.077	0.053	0.057	0.064	0.062	0.064	0.048
	LW	0.083	0.055	0.059	0.071	0.060	0.060	0.054	0.054	0.052
	MF	0.038	0.044	0.069	0.053	0.055	0.048	0.043	0.060	0.058

3.9. Metals

Table 3.9 shows the metal results. Antimony ranged from <3 - 7 µg/l, Arsenic ranged from <1 - 9 µg/l, Barium ranged from 20 - 41 µg/l, all Cadmium results were <1 µg/l, Chromium ranged from 2 - 12 µg/l, Copper ranged from 4 -32 µg/l, Lead ranged from 4 - 21 µg/l, Mercury ranged from <0.03 - 2.14 µg/l, Molybdenum ranged from 6 - 13 µg/l, Nickel ranged from 6 - 27 µg/l, Selenium ranged from <1 - 27 µg/l, Vanadium ranged from 85 - 296 µg/l and Zinc ranged from 91 - 505 µg/l.

Table 3:9: Metal results

Parameter	Tide	500 m Upstream			500 m Downstream			1 km Downstream		
		S	M	B	S	M	B	S	M	B
Antimony (µg/l)	ME	3	<3	<3	<3	<3	<3	<3	<3	<3
	LW	7	5	5	<3	<3	<3	<3	<3	7
	MF	3	4	3	<3	<3	<3	4	3	<3
Arsenic (µg/l)	ME	8	<1	3	4	2	6	4	9	7
	LW	<1	6	<1	4	<1	1	<1	<1	<1

Parameter	Tide	500 m Upstream			500 m Downstream			1 km Downstream		
		S	M	B	S	M	B	S	M	B
	MF	<1	<1	2	<1	1	<1	<1	<1	7
Barium (µg/l)	ME	41	31	35	38	33	35	28	36	37
	LW	26	32	27	31	25	33	30	34	32
	MF	27	35	29	25	26	31	29	20	24
Cadmium (µg/l)	ME	<1	<1	<1	<1	<1	<1	<1	<1	<1
	LW	<1	<1	<1	<1	<1	<1	<1	<1	<1
	MF	<1	<1	<1	<1	<1	<1	<1	<1	<1
Chromium (µg/l)	ME	8	12	8	7	10	7	7	7	8
	LW	3	7	7	5	2	3	8	6	7
	MF	5	10	8	6	9	6	6	9	3
Copper (µg/l)	ME	15	6	25	29	11	10	12	17	29
	LW	17	32	8	14	10	7	8	15	8
	MF	13	11	9	4	11	9	13	12	18
Lead (µg/l)	ME	13	7	13	21	13	7	8	10	12
	LW	6	9	8	13	4	5	5	9	9
	MF	5	11	6	4	5	6	7	4	7
Mercury (µg/l)	ME	0.35	0.16	0.56	<0.03	<0.03	0.17	0.45	<0.03	<0.03
	LW	2.14	1.38	1.31	0.42	0.15	0.37	<0.03	<0.03	1.05
	MF	1.04	1.30	0.92	1.35	0.27	0.29	0.55	0.63	0.45
Molybdenum (µg/l)	ME	10	7	9	7	7	7	8	9	9
	LW	8	10	9	7	6	7	8	9	12
	MF	8	10	8	8	9	8	13	10	10
Nickel (µg/l)	ME	14	16	27	18	13	12	13	13	17
	LW	25	11	14	7	6	9	12	15	8
	MF	7	9	15	8	13	16	9	9	10
Selenium (µg/l)	ME	<1	7	3	1	<1	<1	<1	5	15
	LW	3	<1	<1	1	<1	9	<1	<1	2
	MF	27	8	<1	5	<1	19	6	3	7
Vanadium (µg/l)	ME	243	197	251	216	221	224	204	259	274
	LW	85	171	172	181	165	192	218	262	296
	MF	185	214	181	202	224	232	288	247	269
Zinc (µg/l)	ME	259	222	407	505	326	181	320	271	271
	LW	382	196	155	167	91	138	203	271	221
	MF	122	156	143	96	170	199	156	206	201

3.10. Volatile Organic Compounds

Table 3.10 shows total VOC results. Total VOCs were below limits of detection at all sample points. All individual VOCs were also below limits of detection (See Appendix 2).

Table 3:10: Total VOC results.

Parameter	Tide	500 m Upstream			500 m Downstream			1 km Downstream		
		S	M	B	S	M	B	S	M	B
VOC (µg/l)	ME	<5	<5	<5	<5	<5	<5	<5	<5	<5
	LW	<5	<5	<5	<5	<5	<5	<5	<5	<5
	MF	<5	<5	<5	<5	<5	<5	<5	<5	<5

3.11. BTEX

Table 3.11 shows BTEX results. BTEX results were below limits of detection at all sampling points.

Table 3:11 BTEX results

Parameter	Tide	500 m Upstream			500 m Downstream			1 km Downstream		
		S	**M**	**B**	**S**	**M**	**B**	**S**	**M**	**B**
Benzene (µg/l)	ME	<1	<1	<1	<1	<1	<1	<1	<1	<1
	LW	<1	<1	<1	<1	<1	<1	<1	<1	<1
	MF	<1	<1	<1	<1	<1	<1	<1	<1	<1
Ethylbenzene (µg/l)	ME	<1	<1	<1	<1	<1	<1	<1	<1	<1
	LW	<1	<1	<1	<1	<1	<1	<1	<1	<1
	MF	<1	<1	<1	<1	<1	<1	<1	<1	<1
p/m-Xylene~ (µg/l)	ME	<1	<1	<1	<1	<1	<1	<1	<1	<1
	LW	<1	<1	<1	<1	<1	<1	<1	<1	<1
	MF	<1	<1	<1	<1	<1	<1	<1	<1	<1
o-Xylene (µg/l)	ME	<1	<1	<1	<1	<1	<1	<1	<1	<1
	LW	<1	<1	<1	<1	<1	<1	<1	<1	<1
	MF	<1	<1	<1	<1	<1	<1	<1	<1	<1
Toluene (µg/l)	ME	<1	<1	<1	<1	<1	<1	<1	<1	<1
	LW	<1	<1	<1	<1	<1	<1	<1	<1	<1
	MF	<1	<1	<1	<1	<1	<1	<1	<1	<1
Xylene (Total) (µg/l)	ME	<1	<1	<1	<1	<1	<1	<1	<1	<1
	LW	<1	<1	<1	<1	<1	<1	<1	<1	<1
	MF	<1	<1	<1	<1	<1	<1	<1	<1	<1

4. Discussion/Conclusion

This survey showed no increase in background levels for any of the parameters analysed due to the discharge at Aughinish Alumina, as results showed similar variations upstream and downstream of the discharge.

5. References

EPA (2001) PARAMETERS OF WATER QUALITY Interpretation and Standards. Environmental Protection Agency, Ireland

Appendix 1
Limits of Detection

Parameter	LOD	Units	Parameter	LOD	Units
COD (Surface Water)	10	mg/l	2,2-Dichloropropane (Surface Water)	5	ug/l
BOD (Surface Water)	2	mg/l	2-Chlorotoluene (Surface Water)	1	ug/l
TOC (Surface Water)	0.6	mg/l	4-Chlorotoluene (Surface Water)	1	ug/l
Antimony (Surface Water)	3	ug/l	Benzene (Surface Water)	1	ug/l
Arsenic (Surface Water)	1	ug/l	Bromochloromethane (Surface Water)	1	ug/l
Barium (Surface Water)	1	ug/l	Bromochloromethane (Surface Water)	1	ug/l
Cadmium (Surface Water)	1	ug/l	Bromodichloromethane (Surface Water)	1	ug/l
Chromium (Surface Water)	1	ug/l	Bromoform (Surface Water)	1	ug/l
Copper (Surface Water)	1	ug/l	Carbon tetrachloride (Surface Water)	1	ug/l
Lead (Surface Water)	1	ug/l	Chloroform (Surface Water)	1	ug/l
Nickel (Surface Water)	1	ug/l	Chlorobenzene (Surface Water)	1	ug/l
Selenium (Surface Water)	1	ug/l	Chloroethane (Surface Water)	5	ug/l
Vanadium (Surface Water)	1	ug/l	Bromomethane (Surface Water)	5	ug/l
Zinc (Surface Water)	1	ug/l	Chloromethane (Surface Water)	5	ug/l
Mercury (Surface water)	0.03	ug/l	cis-1,2-Dichloroethene (Surface Water)	1	ug/l
Molybdenum	5	ug/l	cis-1,3-Dichloropropene (Surface Water)	1	ug/l
Phenols (Total)	0.1	ug/l	Dibromochloromethane (Surface Water)	1	ug/l
Solids (Total Dissolved)	5	mg/l	Dibromomethane (Surface Water)	1	ug/l
Nitrogen (Total)	1	mg/l as N	Dichlorodifluoromethane (Surface Water)	5	ug/l
Nitrogen (Total Oxidised)	0.03	mg/l as N	Dichloromethane (Surface Water)	5	ug/l
Nitrogen (Total Kjeldahl)	1	mg/l as N	Ethylbenzene (Surface Water)	1	ug/l
1,1,1,2-Tetrachloroethane (Surface Water)	1	ug/l	Hexachlorobutadiene (Surface Water)	1	ug/l
1,1,1-Trichloroethane (Surface Water)	1	ug/l	Isopropylbenzene (Surface Water)	1	ug/l
1,1,2,2-Tetrachloroethane (Surface Water)	5	ug/l	Naphthalene (Surface Water)	1	ug/l
1,1,2-Trichloroethane (Surface Water)	2	ug/l	n-Butylbenzene (Surface Water)	1	ug/l
1,1-Dichloroethane (Surface Water)	1	ug/l	o-Xylene (Surface Water)	1	ug/l
1,1-Dichloroethene (Surface Water)	1	ug/l	m- + p-Xylene (Surface Water)	1	ug/l
1,1-Dichloropropene (Surface Water)	1	ug/l	n-Propylbenzene (Surface Water)	0.4	ug/l
1,2,3-Trichlorobenzene (Surface Water)	1	ug/l	sec-Butylbenzene (Surface Water)	1	ug/l
1,2,3-Trichloropropane (Surface Water)	0.9	ug/l	Styrene (Surface Water)	1	ug/l
1,2,4-Trichlorobenzene (Surface Water)	1	ug/l	tert-Butylbenzene (Surface Water)	1	ug/l
1,2,4-Trimethylbenzene (Surface Water)	0.6	ug/l	Tetrachloroethene (Surface Water)	1	ug/l
1,2-Dibromo-3-chloropropane (Surface Water)	1	ug/l	Toluene (Surface Water)	1	ug/l

Parameter	LOD	Units	Parameter	LOD	Units
1,2-Dichlorobenzene (Surface Water)	1	ug/l	trans-1,2-Dichloroethene (Surface Water)	1	ug/l
1,2-Dichlorobenzene (Surface Water)	1	ug/l	trans-1,3-Dichloropropene (Surface Water)	1	ug/l
1,2-Dichloroethane (Surface Water)	1	ug/l	Trichloroethene (Surface Water)	1	ug/l
1,2-Dichloropropane (Surface Water)	1	ug/l	Trichlorofluoromethane (Surface Water)	1	ug/l
1,3,5-Trimethylbenzene (Surface Water)	1	ug/l	Vinyl chloride (Surface Water)	1	ug/l
1,3-Dichlorobenzene (Surface Water)	1	ug/l	p-Isopropyltoluene (Surface Water)	1	ug/l
1,3-Dichloropropane (Surface Water)	1	ug/l	PAH (Water)	0.1	ug/l
1,4-Dichlorobenzene (Surface Water)	1	ug/l			

Appendix 2

Fitz Scientific Results

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Customer	Caroline Roche Aqua-Fact International Services Ltd 12 Kilkerrin Park Liosbaun Ind Est Liosbaun Co Galway	*Lab Report Ref. No.*	0529/001/07
		Date of Receipt	06/04/2018
		Sampled On	04/04/2018
		Date Testing Commenced	06/04/2018
		Received or Collected	By Fitz: Paul C
		Condition on Receipt	Acceptable
Customer PO		*Date of Report*	25/04/2018
Customer Ref	UP500-ME-SURF	*Sample Type*	Surface Water
Ref 2			
Ref 3			

CERTIFICATE OF ANALYSIS

Test Parameter	SOP	Analytical Technique	Result	Units	Acc.
1,1,1,2-Tetrachloroethane (Surface	154	GCMS	<1	ug/L	UKAS
1,1,1-Trichloroethane (Surface Water	154	GCMS	<1	ug/L	UKAS
1,1,2,2-Tetrachloroethane (Surface	154	GCMS	<5.0	ug/L	
1,1,2-Trichloroethane (Surface Water	154	GCMS	<2	ug/L	UKAS
1,1-Dichloroethane (Surface Water)	154	GCMS	<1	ug/L	UKAS
1,1-Dichloroethene (Surface Water)	154	GCMS	<1	ug/L	UKAS
1,1-Dichloropropene (Surface Water)	154	GCMS	<1	ug/L	UKAS
1,2,3-Trichlorobenzene (Surface Wat	154	GCMS	<1	ug/L	UKAS
1,2,3-Trichloropropane (Surface Wat	154	GCMS	<0.9	ug/L	UKAS
1,2,4-Trichlorobenzene (Surface Wat	154	GCMS	<0.6	ug/L	UKAS
1,2,4-Trimethylbenzene (Surface Wa	154	GCMS	<1	ug/L	UKAS
1,2-Dibromo-3-chloropropane (Surfac	154	GCMS	<1	ug/L	UKAS
1,2-Dibromoethane (Surface Water)	154	GCMS	<1	ug/L	UKAS
1,2-Dichlorobenzene (Surface Water)	154	GCMS	<1	ug/L	UKAS
1,2-Dichloroethane (Surface Water)	154	GCMS	<1	ug/L	UKAS
1,2-Dichloropropane (Surface Water)	154	GCMS	<1	ug/L	UKAS
1,3,5-Trimethylbenzene (Surface Wa	154	GCMS	<1	ug/L	UKAS
1,3-Dichlorobenzene (Surface Water)	154	GCMS	<1	ug/L	UKAS
1,3-Dichloropropane (Surface Water)	154	GCMS	<1	ug/L	UKAS
1,4-Dichlorobenzene (Surface Water)	154	GCMS	<1	ug/L	UKAS
2,2-Dichloropropane (Surface Water)	154	GCMS	<5.0	ug/L	
2-Chlorotoluene (Surface Water)	154	GCMS	<1	ug/L	UKAS
4-Chlorotoluene (Surface Water)	154	GCMS	<1	ug/L	UKAS
Acenaphthene (GCMS)	200	GCMS	<0.01	ug/L	

Signed : A Harmon

Date : 25/04/2018

Aoife Harmon - Technical Supervisor

Acc. : Accredited Parameters by ISO 17025:2005
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UKAS TESTING 2802

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	Aqua-Fact International Services Ltd	*Date of Receipt*	**06/04/2018**
	12 Kilkerrin Park	*Sampled On*	**04/04/2018**
	Liosbaun Ind Est	*Date Testing Commenced*	**06/04/2018**
	Liosbaun	*Received or Collected*	**By Fitz: Paul C**
	Co Galway	*Condition on Receipt*	**Acceptable**
Customer PO		*Date of Report*	**25/04/2018**
Customer Ref	**UP500-ME-SURF**	*Sample Type*	**Surface Water**
Ref 2			
Ref 3			

CERTIFICATE OF ANALYSIS

Test Parameter	SOP	Analytical Technique	Result	Units	Acc.
Acenaphthylene (GCMS)	200	GCMS	<0.01	ug/L	
Ammonia (Surface Water)	114	Colorimetry	0.37	mg/L as N	UKAS
Anthracene (GCMS)	200	GCMS	<0.01	ug/L	
Antimony (Surface Water)	177	ICPMS	3	ug/L	UKAS
Arsenic (Surface Water)	177	ICPMS	8	ug/L	UKAS
Barium (Surface Water)	177	ICPMS	41	ug/L	UKAS
Benzene (Surface Water)	154	GCMS	<1	ug/L	UKAS
Benzo(a)anthracene (GCMS)	200	GCMS	<0.01	ug/L	
Benzo(a)pyrene (GCMS)	200	GCMS	<0.01	ug/L	
Benzo(g,h,i)perylene (GCMS)	200	GCMS	<0.01	ug/L	
Benzo(k)fluoranthene (GCMS)	200	GCMS	<0.01	ug/L	
Bromobenzene (Surface Water)	154	GCMS	<1	ug/L	UKAS
Bromochloromethane (Surface Water	154	GCMS	<1	ug/L	UKAS
Bromodichloromethane (Surface Wat	154	GCMS	<1	ug/L	UKAS
Bromoform (Surface Water)	154	GCMS	<1	ug/L	UKAS
Bromomethane (Surface Water)	154	GCMS	<5.0	ug/L	
Cadmium (Surface Water)	177	ICPMS	<1	ug/L	UKAS
Carbon tetrachloride (Surface Water)	154	GCMS	<1	ug/L	UKAS
Chlorobenzene (Surface Water)	154	GCMS	<1	ug/L	UKAS
Chloroethane (Surface Water)	154	GCMS	<5.0	ug/L	
Chloroform (Surface Water)	154	GCMS	<1	ug/L	UKAS
Chloromethane (Surface Water)	154	GCMS	<5.0	ug/L	
Chromium (Surface Water)	177	ICPMS	8	ug/L	UKAS
Chrysene (GCMS)	200	GCMS	<0.01	ug/L	

Signed : A Harmon

Date : 25/04/2018

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		Sampled On	04/04/2018
		Date Testing Commenced	06/04/2018
		Received or Collected	By Fitz: Paul C
		Condition on Receipt	Acceptable
Customer PO		*Date of Report*	25/04/2018
Customer Ref	UP500-ME-SURF	*Sample Type*	Surface Water
Ref 2			
Ref 3			

CERTIFICATE OF ANALYSIS

Test Parameter	SOP	Analytical Technique	Result	Units	Acc.
cis-1,2-Dichloroethene (Surface Wat	154	GCMS	<1	ug/L	UKAS
cis-1,3-Dichloropropene (Surface Wa	154	GCMS	<1	ug/L	UKAS
COD (Surface Water)	107	Colorimetry	105	mg/L	UKAS
Copper (Surface Water)	177	ICPMS	15	ug/L	UKAS
Coronene (GCMS)	200	GCMS	<0.01	ug/L	
Dibenzo(a,h)anthracene (GCMS)	200	GCMS	<0.01	ug/L	
Dibromochloromethane (Surface Wat	154	GCMS	<1	ug/L	UKAS
Dibromomethane (Surface Water)	154	GCMS	<1	ug/L	UKAS
Dichlorodifluoromethane (Surface W	154	GCMS	<5.0	ug/L	
Dichloromethane (Surface Water)	154	GCMS	<5.0	ug/L	
Ethylbenzene (Surface Water)	154	GCMS	<1	ug/L	UKAS
Fluoranthene (GCMS)	200	GCMS	<0.01	ug/L	
Fluorene (GCMS)	200	GCMS	<0.01	ug/L	
Hexachlorobutadiene (Surface Water	154	GCMS	<1	ug/L	UKAS
Indeno(1,2,3-cd)pyrene (GCMS)	200	GCMS	<0.01	ug/L	
Isopropylbenzene (Surface Water)	154	GCMS	<1	ug/L	UKAS
Lead (Surface Water)	177	ICPMS	13	ug/L	UKAS
m- & p-Xylene (Surface Water)	154	GCMS	<1	ug/L	UKAS
Mercury (Surface water)	178	ICPMS	0.35	ug/L	UKAS
Molybdenum	226	ICPMS	10	ug/L	
Naphthalene (Surface Water)	154	GCMS	<1	ug/L	UKAS
n-Butylbenzene (Surface Water)	154	GCMS	<1	ug/L	UKAS
Nickel (Surface Water)	177	ICPMS	14	ug/L	UKAS
Nitrogen (Total Kjeldahl)	104	Digestion/ Distillation/ Titrimetr	<1.00	mg/L as N	

Signed : A Harman **Date : 25/04/2018**

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		Sampled On	04/04/2018
		Date Testing Commenced	06/04/2018
		Received or Collected	By Fitz: Paul C
		Condition on Receipt	Acceptable
Customer PO		*Date of Report*	25/04/2018
Customer Ref	UP500-ME-SURF	*Sample Type*	Surface Water
Ref 2			
Ref 3			

CERTIFICATE OF ANALYSIS

Test Parameter	SOP	Analytical Technique	Result	Units	Acc.
Nitrogen (Total Oxidised) (Surface W	151	Colorimetry	1.47	mg/L as N	UKAS
Nitrogen (Total)	0	Calculation	2	mg/L as N	
n-Propylbenzene (Surface Water)	154	GCMS	<1.0	ug/L	UKAS
o-Xylene (Surface Water)	154	GCMS	<1	ug/L	UKAS
Phenanthrene (GCMS)	200	GCMS	<0.01	ug/L	
Phenols (Total)	223	GCMS	<0.10	ug/L	
Phosphorus (Total) Surface Water	166	Colorimetry	0.057	mg/L as P	UKAS
p-Isopropyltoluene (Surface Water)	154	GCMS	<1	ug/L	UKAS
Polyaromatic Hydrocarbons (GCMS)	200	GCMS	<0.01	ug/L	
Pyrene (GCMS)	200	GCMS	<0.01	ug/L	
sec-Butylbenzene (Surface Water)	154	GCMS	<1	ug/L	UKAS
Selenium (Surface Water)	177	ICPMS	<1	ug/L	UKAS
Solids (Total Dissolved)	105	Filtration/ Evaporation @ 180C	22752	mg/L	
Styrene (Surface Water)	154	GCMS	<1	ug/L	UKAS
tert-Butylbenzene (Surface Water)	154	GCMS	<1	ug/L	UKAS
Tetrachloroethene (Surface Water)	154	GCMS	<1	ug/L	UKAS
TOC (Surface Water)	316	TOC Analyser	4.6	mg/L	UKAS
Toluene (Surface Water)	154	GCMS	<1	ug/L	UKAS
Total Inorganic Nitrogen	0	Calculation	1	mg/L	
trans-1,2-Dichloroethene (Surface W	154	GCMS	<1	ug/L	UKAS
trans-1,3-Dichloropropene (Surface	154	GCMS	<1	ug/L	UKAS
Trichloroethene (Surface Water)	154	GCMS	<1.0	ug/L	
Trichlorofluoromethane (Surface Wat	154	GCMS	<1	ug/L	UKAS
Vanadium (Surface Water)	177	ICPMS	243	ug/L	UKAS

Signed : A Harmon

Date : 25/04/2018

Aoife Harmon - Technical Supervisor

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Customer	**Caroline Roche**	*Lab Report Ref. No.*	**0529/001/07**
	Aqua-Fact International Services Ltd	*Date of Receipt*	**06/04/2018**
	12 Kilkerrin Park	*Sampled On*	**04/04/2018**
	Liosbaun Ind Est	*Date Testing Commenced*	**06/04/2018**
	Liosbaun	*Received or Collected*	**By Fitz: Paul C**
	Co Galway	*Condition on Receipt*	**Acceptable**
Customer PO		*Date of Report*	**25/04/2018**
Customer Ref	**UP500-ME-SURF**	*Sample Type*	**Surface Water**
Ref 2			
Ref 3			

CERTIFICATE OF ANALYSIS

Test Parameter	SOP	Analytical Technique	Result	Units	Acc.
Vinyl chloride (Surface Water)	154	GCMS	<1	ug/L	UKAS
Volatile Organic Compounds	154	GCMS	<5.0	ug/L	
Xylene Total (Surface Water)	154	GCMS	<1	ug/L	UKAS
Zinc (Surface Water)	177	ICPMS	259	ug/L	UKAS

Signed : A Harmon

Date : 25/04/2018

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		Date of Receipt	06/04/2018
		Sampled On	04/04/2018
		Date Testing Commenced	06/04/2018
		Received or Collected	By Fitz: Paul C
		Condition on Receipt	Acceptable
Customer PO		*Date of Report*	25/04/2018
Customer Ref	UP500-ME-MID	*Sample Type*	Surface Water
Ref 2			
Ref 3			

CERTIFICATE OF ANALYSIS

Test Parameter	SOP	Analytical Technique	Result	Units	Acc.
1,1,1,2-Tetrachloroethane (Surface	154	GCMS	<1	ug/L	UKAS
1,1,1-Trichloroethane (Surface Water	154	GCMS	<1	ug/L	UKAS
1,1,2,2-Tetrachloroethane (Surface	154	GCMS	<5.0	ug/L	
1,1,2-Trichloroethane (Surface Water	154	GCMS	<2	ug/L	UKAS
1,1-Dichloroethane (Surface Water)	154	GCMS	<1	ug/L	UKAS
1,1-Dichloroethene (Surface Water)	154	GCMS	<1	ug/L	UKAS
1,1-Dichloropropene (Surface Water)	154	GCMS	<1	ug/L	UKAS
1,2,3-Trichlorobenzene (Surface Wat	154	GCMS	<1	ug/L	UKAS
1,2,3-Trichloropropane (Surface Wat	154	GCMS	<0.9	ug/L	UKAS
1,2,4-Trichlorobenzene (Surface Wat	154	GCMS	<0.6	ug/L	UKAS
1,2,4-Trimethylbenzene (Surface Wa	154	GCMS	<1	ug/L	UKAS
1,2-Dibromo-3-chloropropane (Surfac	154	GCMS	<1	ug/L	UKAS
1,2-Dibromoethane (Surface Water)	154	GCMS	<1	ug/L	UKAS
1,2-Dichlorobenzene (Surface Water)	154	GCMS	<1	ug/L	UKAS
1,2-Dichloroethane (Surface Water)	154	GCMS	<1	ug/L	UKAS
1,2-Dichloropropane (Surface Water)	154	GCMS	<1	ug/L	UKAS
1,3,5-Trimethylbenzene (Surface Wa	154	GCMS	<1	ug/L	UKAS
1,3-Dichlorobenzene (Surface Water)	154	GCMS	<1	ug/L	UKAS
1,3-Dichloropropane (Surface Water)	154	GCMS	<1	ug/L	UKAS
1,4-Dichlorobenzene (Surface Water)	154	GCMS	<1	ug/L	UKAS
2,2-Dichloropropane (Surface Water)	154	GCMS	<5.0	ug/L	
2-Chlorotoluene (Surface Water)	154	GCMS	<1	ug/L	UKAS
4-Chlorotoluene (Surface Water)	154	GCMS	<1	ug/L	UKAS
Acenaphthene (GCMS)	200	GCMS	<0.01	ug/L	

Signed : A Harmon

Date : 25/04/2018

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Fitz scientific

Monitoring and Testing Services

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Customer	Caroline Roche	*Lab Report Ref. No.*	0529/001/08
	Aqua-Fact International Services Ltd	*Date of Receipt*	06/04/2018
	12 Kilkerrin Park	*Sampled On*	04/04/2018
	Liosbaun Ind Est	*Date Testing Commenced*	06/04/2018
	Liosbaun	*Received or Collected*	By Fitz: Paul C
	Co Galway	*Condition on Receipt*	Acceptable
Customer PO		*Date of Report*	25/04/2018
Customer Ref	UP500-ME-MID	*Sample Type*	Surface Water
Ref 2			
Ref 3			

CERTIFICATE OF ANALYSIS

Test Parameter	SOP	Analytical Technique	Result	Units	Acc.
Acenaphthylene (GCMS)	200	GCMS	<0.01	ug/L	
Ammonia (Surface Water)	114	Colorimetry	0.36	mg/L as N	UKAS
Anthracene (GCMS)	200	GCMS	<0.01	ug/L	
Antimony (Surface Water)	177	ICPMS	<3	ug/L	UKAS
Arsenic (Surface Water)	177	ICPMS	<1	ug/L	UKAS
Barium (Surface Water)	177	ICPMS	31	ug/L	UKAS
Benzene (Surface Water)	154	GCMS	<1	ug/L	UKAS
Benzo(a)anthracene (GCMS)	200	GCMS	<0.01	ug/L	
Benzo(a)pyrene (GCMS)	200	GCMS	<0.01	ug/L	
Benzo(g,h,i)perylene (GCMS)	200	GCMS	<0.01	ug/L	
Benzo(k)fluoranthene (GCMS)	200	GCMS	<0.01	ug/L	
Bromobenzene (Surface Water)	154	GCMS	<1	ug/L	UKAS
Bromochloromethane (Surface Water	154	GCMS	<1	ug/L	UKAS
Bromodichloromethane (Surface Wat	154	GCMS	<1	ug/L	UKAS
Bromoform (Surface Water)	154	GCMS	<1	ug/L	UKAS
Bromomethane (Surface Water)	154	GCMS	<5.0	ug/L	
Cadmium (Surface Water)	177	ICPMS	<1	ug/L	UKAS
Carbon tetrachloride (Surface Water)	154	GCMS	<1	ug/L	UKAS
Chlorobenzene (Surface Water)	154	GCMS	<1	ug/L	UKAS
Chloroethane (Surface Water)	154	GCMS	<5.0	ug/L	
Chloroform (Surface Water)	154	GCMS	<1	ug/L	UKAS
Chloromethane (Surface Water)	154	GCMS	<5.0	ug/L	
Chromium (Surface Water)	177	ICPMS	12	ug/L	UKAS
Chrysene (GCMS)	200	GCMS	<0.01	ug/L	

Signed : A Harmon **Date : 25/04/2018**

Aoife Harmon - Technical Supervisor

Acc. : Accredited Parameters by ISO 17025:2005
PVL - Parametric Value Limit as per EU (Drinking water) Regulations (SI 122 2014)
For bacterial analysis a result of 0 means none detected in volume examined
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UKAS TESTING 2802

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Customer	Caroline Roche Aqua-Fact International Services Ltd 12 Kilkerrin Park Liosbaun Ind Est Liosbaun Co Galway	*Lab Report Ref. No.*	0529/001/08
		Date of Receipt	06/04/2018
		Sampled On	04/04/2018
		Date Testing Commenced	06/04/2018
		Received or Collected	By Fitz: Paul C
		Condition on Receipt	Acceptable
Customer PO		*Date of Report*	25/04/2018
Customer Ref	UP500-ME-MID	*Sample Type*	Surface Water
Ref 2			
Ref 3			

CERTIFICATE OF ANALYSIS

Test Parameter	SOP	Analytical Technique	Result	Units	Acc.
cis-1,2-Dichloroethene (Surface Wat	154	GCMS	<1	ug/L	UKAS
cis-1,3-Dichloropropene (Surface Wa	154	GCMS	<1	ug/L	UKAS
COD (Surface Water)	107	Colorimetry	110	mg/L	UKAS
Copper (Surface Water)	177	ICPMS	6	ug/L	UKAS
Coronene (GCMS)	200	GCMS	<0.01	ug/L	
Dibenzo(a,h)anthracene (GCMS)	200	GCMS	<0.01	ug/L	
Dibromochloromethane (Surface Wat	154	GCMS	<1	ug/L	UKAS
Dibromomethane (Surface Water)	154	GCMS	<1	ug/L	UKAS
Dichlorodifluoromethane (Surface W	154	GCMS	<5.0	ug/L	
Dichloromethane (Surface Water)	154	GCMS	<5.0	ug/L	
Ethylbenzene (Surface Water)	154	GCMS	<1	ug/L	UKAS
Fluoranthene (GCMS)	200	GCMS	<0.01	ug/L	
Fluorene (GCMS)	200	GCMS	<0.01	ug/L	
Hexachlorobutadiene (Surface Water	154	GCMS	<1	ug/L	UKAS
Indeno(1,2,3-cd)pyrene (GCMS)	200	GCMS	<0.01	ug/L	
Isopropylbenzene (Surface Water)	154	GCMS	<1	ug/L	UKAS
Lead (Surface Water)	177	ICPMS	7	ug/L	UKAS
m- & p-Xylene (Surface Water)	154	GCMS	<1	ug/L	UKAS
Mercury (Surface water)	178	ICPMS	0.16	ug/L	UKAS
Molybdenum	226	ICPMS	7	ug/L	
Naphthalene (Surface Water)	154	GCMS	<1	ug/L	UKAS
n-Butylbenzene (Surface Water)	154	GCMS	<1	ug/L	UKAS
Nickel (Surface Water)	177	ICPMS	16	ug/L	UKAS
Nitrogen (Total Kjeldahl)	104	Digestion/ Distillation/ Titrimetr	<1.00	mg/L as N	

Signed : A Harman

Date : 25/04/2018

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	12 Kilkerrin Park	*Sampled On*	**04/04/2018**
	Liosbaun Ind Est	*Date Testing Commenced*	**06/04/2018**
	Liosbaun	*Received or Collected*	**By Fitz: Paul C**
	Co Galway	*Condition on Receipt*	**Acceptable**
Customer PO		*Date of Report*	**25/04/2018**
Customer Ref	**UP500-ME-MID**	*Sample Type*	**Surface Water**
Ref 2			
Ref 3			

CERTIFICATE OF ANALYSIS

Test Parameter	SOP	Analytical Technique	Result	Units	Acc.
Nitrogen (Total Oxidised) (Surface W	151	Colorimetry	1.45	mg/L as N	UKAS
Nitrogen (Total)	0	Calculation	2	mg/L as N	
n-Propylbenzene (Surface Water)	154	GCMS	<1.0	ug/L	UKAS
o-Xylene (Surface Water)	154	GCMS	<1	ug/L	UKAS
Phenanthrene (GCMS)	200	GCMS	<0.01	ug/L	
Phenols (Total)	223	GCMS	<0.10	ug/L	
Phosphorus (Total) Surface Water	166	Colorimetry	0.071	mg/L as P	UKAS
p-Isopropyltoluene (Surface Water)	154	GCMS	<1	ug/L	UKAS
Polyaromatic Hydrocarbons (GCMS)	200	GCMS	<0.01	ug/L	
Pyrene (GCMS)	200	GCMS	<0.01	ug/L	
sec-Butylbenzene (Surface Water)	154	GCMS	<1	ug/L	UKAS
Selenium (Surface Water)	177	ICPMS	7	ug/L	UKAS
Solids (Total Dissolved)	105	Filtration/ Evaporation @ 180C	22896	mg/L	
Styrene (Surface Water)	154	GCMS	<1	ug/L	UKAS
tert-Butylbenzene (Surface Water)	154	GCMS	<1	ug/L	UKAS
Tetrachloroethene (Surface Water)	154	GCMS	<1	ug/L	UKAS
TOC (Surface Water)	316	TOC Analyser	3.9	mg/L	UKAS
Toluene (Surface Water)	154	GCMS	<1	ug/L	UKAS
Total Inorganic Nitrogen	0	Calculation	1.2	mg/L	
trans-1,2-Dichloroethene (Surface W	154	GCMS	<1	ug/L	UKAS
trans-1,3-Dichloropropene (Surface	154	GCMS	<1	ug/L	UKAS
Trichloroethene (Surface Water)	154	GCMS	<1.0	ug/L	
Trichlorofluoromethane (Surface Wat	154	GCMS	<1	ug/L	UKAS
Vanadium (Surface Water)	177	ICPMS	197	ug/L	UKAS

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	12 Kilkerrin Park	*Sampled On*	**04/04/2018**
	Liosbaun Ind Est	*Date Testing Commenced*	**06/04/2018**
	Liosbaun	*Received or Collected*	**By Fitz: Paul C**
	Co Galway	*Condition on Receipt*	**Acceptable**
Customer PO		*Date of Report*	**25/04/2018**
Customer Ref	**UP500-ME-MID**	*Sample Type*	**Surface Water**
Ref 2			
Ref 3			

CERTIFICATE OF ANALYSIS

Test Parameter	SOP	Analytical Technique	Result	Units	Acc.
Vinyl chloride (Surface Water)	154	GCMS	<1	ug/L	UKAS
Volatile Organic Compounds	154	GCMS	<5.0	ug/L	
Xylene Total (Surface Water)	154	GCMS	<1	ug/L	UKAS
Zinc (Surface Water)	177	ICPMS	222	ug/L	UKAS

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		Date of Receipt	06/04/2018
		Sampled On	04/04/2018
		Date Testing Commenced	06/04/2018
		Received or Collected	By Fitz: Paul C
		Condition on Receipt	Acceptable
Customer PO		*Date of Report*	25/04/2018
Customer Ref	UP500-ME-BOTTOM	*Sample Type*	Surface Water
Ref 2			
Ref 3			

CERTIFICATE OF ANALYSIS

Test Parameter	SOP	Analytical Technique	Result	Units	Acc.
1,1,1,2-Tetrachloroethane (Surface	154	GCMS	<1	ug/L	UKAS
1,1,1-Trichloroethane (Surface Water	154	GCMS	<1	ug/L	UKAS
1,1,2,2-Tetrachloroethane (Surface	154	GCMS	<5.0	ug/L	
1,1,2-Trichloroethane (Surface Water	154	GCMS	<2	ug/L	UKAS
1,1-Dichloroethane (Surface Water)	154	GCMS	<1	ug/L	UKAS
1,1-Dichloroethene (Surface Water)	154	GCMS	<1	ug/L	UKAS
1,1-Dichloropropene (Surface Water)	154	GCMS	<1	ug/L	UKAS
1,2,3-Trichlorobenzene (Surface Wat	154	GCMS	<1	ug/L	UKAS
1,2,3-Trichloropropane (Surface Wat	154	GCMS	<0.9	ug/L	UKAS
1,2,4-Trichlorobenzene (Surface Wat	154	GCMS	<0.6	ug/L	UKAS
1,2,4-Trimethylbenzene (Surface Wa	154	GCMS	<1	ug/L	UKAS
1,2-Dibromo-3-chloropropane (Surfac	154	GCMS	<1	ug/L	UKAS
1,2-Dibromoethane (Surface Water)	154	GCMS	<1	ug/L	UKAS
1,2-Dichlorobenzene (Surface Water)	154	GCMS	<1	ug/L	UKAS
1,2-Dichloroethane (Surface Water)	154	GCMS	<1	ug/L	UKAS
1,2-Dichloropropane (Surface Water)	154	GCMS	<1	ug/L	UKAS
1,3,5-Trimethylbenzene (Surface Wa	154	GCMS	<1	ug/L	UKAS
1,3-Dichlorobenzene (Surface Water)	154	GCMS	<1	ug/L	UKAS
1,3-Dichloropropane (Surface Water)	154	GCMS	<1	ug/L	UKAS
1,4-Dichlorobenzene (Surface Water)	154	GCMS	<1	ug/L	UKAS
2,2-Dichloropropane (Surface Water)	154	GCMS	<5.0	ug/L	
2-Chlorotoluene (Surface Water)	154	GCMS	<1	ug/L	UKAS
4-Chlorotoluene (Surface Water)	154	GCMS	<1	ug/L	UKAS
Acenaphthene (GCMS)	200	GCMS	<0.01	ug/L	

Signed : A Harmon **Date : 25/04/2018**

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		Sampled On	04/04/2018
		Date Testing Commenced	06/04/2018
		Received or Collected	By Fitz: Paul C
		Condition on Receipt	Acceptable
Customer PO		*Date of Report*	25/04/2018
Customer Ref	UP500-ME-BOTTOM	*Sample Type*	Surface Water
Ref 2			
Ref 3			

CERTIFICATE OF ANALYSIS

Test Parameter	SOP	Analytical Technique	Result	Units	Acc.
Acenaphthylene (GCMS)	200	GCMS	<0.01	ug/L	
Ammonia (Surface Water)	114	Colorimetry	0.40	mg/L as N	UKAS
Anthracene (GCMS)	200	GCMS	<0.01	ug/L	
Antimony (Surface Water)	177	ICPMS	<3	ug/L	UKAS
Arsenic (Surface Water)	177	ICPMS	3	ug/L	UKAS
Barium (Surface Water)	177	ICPMS	35	ug/L	UKAS
Benzene (Surface Water)	154	GCMS	<1	ug/L	UKAS
Benzo(a)anthracene (GCMS)	200	GCMS	<0.01	ug/L	
Benzo(a)pyrene (GCMS)	200	GCMS	<0.01	ug/L	
Benzo(g,h,i)perylene (GCMS)	200	GCMS	<0.01	ug/L	
Benzo(k)fluoranthene (GCMS)	200	GCMS	<0.01	ug/L	
Bromobenzene (Surface Water)	154	GCMS	<1	ug/L	UKAS
Bromochloromethane (Surface Water	154	GCMS	<1	ug/L	UKAS
Bromodichloromethane (Surface Wat	154	GCMS	<1	ug/L	UKAS
Bromoform (Surface Water)	154	GCMS	<1	ug/L	UKAS
Bromomethane (Surface Water)	154	GCMS	<5.0	ug/L	
Cadmium (Surface Water)	177	ICPMS	<1	ug/L	UKAS
Carbon tetrachloride (Surface Water)	154	GCMS	<1	ug/L	UKAS
Chlorobenzene (Surface Water)	154	GCMS	<1	ug/L	UKAS
Chloroethane (Surface Water)	154	GCMS	<5.0	ug/L	
Chloroform (Surface Water)	154	GCMS	<1	ug/L	UKAS
Chloromethane (Surface Water)	154	GCMS	<5.0	ug/L	
Chromium (Surface Water)	177	ICPMS	8	ug/L	UKAS
Chrysene (GCMS)	200	GCMS	<0.01	ug/L	

Signed : A Harman

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		Sampled On	04/04/2018
		Date Testing Commenced	06/04/2018
		Received or Collected	By Fitz: Paul C
		Condition on Receipt	Acceptable
Customer PO		*Date of Report*	25/04/2018
Customer Ref	UP500-ME-BOTTOM	*Sample Type*	Surface Water
Ref 2			
Ref 3			

CERTIFICATE OF ANALYSIS

Test Parameter	SOP	Analytical Technique	Result	Units	Acc.
cis-1,2-Dichloroethene (Surface Wat	154	GCMS	<1	ug/L	UKAS
cis-1,3-Dichloropropene (Surface Wa	154	GCMS	<1	ug/L	UKAS
COD (Surface Water)	107	Colorimetry	100	mg/L	UKAS
Copper (Surface Water)	177	ICPMS	25	ug/L	UKAS
Coronene (GCMS)	200	GCMS	<0.01	ug/L	
Dibenzo(a,h)anthracene (GCMS)	200	GCMS	<0.01	ug/L	
Dibromochloromethane (Surface Wat	154	GCMS	<1	ug/L	UKAS
Dibromomethane (Surface Water)	154	GCMS	<1	ug/L	UKAS
Dichlorodifluoromethane (Surface W	154	GCMS	<5.0	ug/L	
Dichloromethane (Surface Water)	154	GCMS	<5.0	ug/L	
Ethylbenzene (Surface Water)	154	GCMS	<1	ug/L	UKAS
Fluoranthene (GCMS)	200	GCMS	<0.01	ug/L	
Fluorene (GCMS)	200	GCMS	<0.01	ug/L	
Hexachlorobutadiene (Surface Water	154	GCMS	<1	ug/L	UKAS
Indeno(1,2,3-cd)pyrene (GCMS)	200	GCMS	<0.01	ug/L	
Isopropylbenzene (Surface Water)	154	GCMS	<1	ug/L	UKAS
Lead (Surface Water)	177	ICPMS	13	ug/L	UKAS
m- & p-Xylene (Surface Water)	154	GCMS	<1	ug/L	UKAS
Mercury (Surface water)	178	ICPMS	0.56	ug/L	UKAS
Molybdenum	226	ICPMS	9	ug/L	
Naphthalene (Surface Water)	154	GCMS	<1	ug/L	UKAS
n-Butylbenzene (Surface Water)	154	GCMS	<1	ug/L	UKAS
Nickel (Surface Water)	177	ICPMS	27	ug/L	UKAS
Nitrogen (Total Kjeldahl)	104	Digestion/ Distillation/ Titrimetr	<1.00	mg/L as N	

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Date : 25/04/2018

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	12 Kilkerrin Park	***Sampled On***	**04/04/2018**
	Liosbaun Ind Est	***Date Testing Commenced***	**06/04/2018**
	Liosbaun	***Received or Collected***	**By Fitz: Paul C**
	Co Galway	***Condition on Receipt***	**Acceptable**
Customer PO		***Date of Report***	**25/04/2018**
Customer Ref	**UP500-ME-BOTTOM**	***Sample Type***	**Surface Water**
Ref 2			
Ref 3			

CERTIFICATE OF ANALYSIS

Test Parameter	SOP	Analytical Technique	Result	Units	Acc.
Nitrogen (Total Oxidised) (Surface W	151	Colorimetry	1.43	mg/L as N	UKAS
Nitrogen (Total)	0	Calculation	2	mg/L as N	
n-Propylbenzene (Surface Water)	154	GCMS	<1.0	ug/L	UKAS
o-Xylene (Surface Water)	154	GCMS	<1	ug/L	UKAS
Phenanthrene (GCMS)	200	GCMS	<0.01	ug/L	
Phenols (Total)	223	GCMS	<0.10	ug/L	
Phosphorus (Total) Surface Water	166	Colorimetry	0.077	mg/L as P	UKAS
p-Isopropyltoluene (Surface Water)	154	GCMS	<1	ug/L	UKAS
Polyaromatic Hydrocarbons (GCMS)	200	GCMS	<0.01	ug/L	
Pyrene (GCMS)	200	GCMS	<0.01	ug/L	
sec-Butylbenzene (Surface Water)	154	GCMS	<1	ug/L	UKAS
Selenium (Surface Water)	177	ICPMS	3	ug/L	UKAS
Solids (Total Dissolved)	105	Filtration/ Evaporation @ 180C	23306	mg/L	
Styrene (Surface Water)	154	GCMS	<1	ug/L	UKAS
tert-Butylbenzene (Surface Water)	154	GCMS	<1	ug/L	UKAS
Tetrachloroethene (Surface Water)	154	GCMS	<1	ug/L	UKAS
TOC (Surface Water)	316	TOC Analyser	3.8	mg/L	UKAS
Toluene (Surface Water)	154	GCMS	<1	ug/L	UKAS
Total Inorganic Nitrogen	0	Calculation	1.1	mg/L	
trans-1,2-Dichloroethene (Surface W	154	GCMS	<1	ug/L	UKAS
trans-1,3-Dichloropropene (Surface	154	GCMS	<1	ug/L	UKAS
Trichloroethene (Surface Water)	154	GCMS	<1.0	ug/L	
Trichlorofluoromethane (Surface Wat	154	GCMS	<1	ug/L	UKAS
Vanadium (Surface Water)	177	ICPMS	251	ug/L	UKAS

Signed : A Harmon ***Date : 25/04/2018***

Aoife Harmon - Technical Supervisor

Acc. : Accredited Parameters by ISO 17025:2005
PVL - Parametric Value Limit as per EU (Drinking water) Regulations (SI 122 2014)
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UKAS TESTING 2802

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Customer	**Caroline Roche**	*Lab Report Ref. No.*	**0529/001/09**
	Aqua-Fact International Services Ltd	*Date of Receipt*	**06/04/2018**
	12 Kilkerrin Park	*Sampled On*	**04/04/2018**
	Liosbaun Ind Est	*Date Testing Commenced*	**06/04/2018**
	Liosbaun	*Received or Collected*	**By Fitz: Paul C**
	Co Galway	*Condition on Receipt*	**Acceptable**
Customer PO		*Date of Report*	**25/04/2018**
Customer Ref	**UP500-ME-BOTTOM**	*Sample Type*	**Surface Water**
Ref 2			
Ref 3			

CERTIFICATE OF ANALYSIS

Test Parameter	SOP	Analytical Technique	Result	Units	Acc.
Vinyl chloride (Surface Water)	154	GCMS	<1	ug/L	UKAS
Volatile Organic Compounds	154	GCMS	<5.0	ug/L	
Xylene Total (Surface Water)	154	GCMS	<1	ug/L	UKAS
Zinc (Surface Water)	177	ICPMS	407	ug/L	UKAS

Signed : A Harman

Date : 25/04/2018

Aoife Harmon - Technical Supervisor

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Customer	Caroline Roche Aqua-Fact International Services Ltd 12 Kilkerrin Park Liosbaun Ind Est Liosbaun Co Galway	*Lab Report Ref. No.*	0529/001/01
		Date of Receipt	06/04/2018
		Sampled On	04/04/2018
		Date Testing Commenced	06/04/2018
		Received or Collected	By Fitz: Paul C
		Condition on Receipt	Acceptable
Customer PO		*Date of Report*	25/04/2018
Customer Ref	UP500-LW-SURF	*Sample Type*	Surface Water
Ref 2			
Ref 3			

CERTIFICATE OF ANALYSIS

Test Parameter	SOP	Analytical Technique	Result	Units	Acc.
1,1,1,2-Tetrachloroethane (Surface	154	GCMS	<1	ug/L	UKAS
1,1,1-Trichloroethane (Surface Water	154	GCMS	<1	ug/L	UKAS
1,1,2,2-Tetrachloroethane (Surface	154	GCMS	<5.0	ug/L	
1,1,2-Trichloroethane (Surface Water	154	GCMS	<2	ug/L	UKAS
1,1-Dichloroethane (Surface Water)	154	GCMS	<1	ug/L	UKAS
1,1-Dichloroethene (Surface Water)	154	GCMS	<1	ug/L	UKAS
1,1-Dichloropropene (Surface Water)	154	GCMS	<1	ug/L	UKAS
1,2,3-Trichlorobenzene (Surface Wat	154	GCMS	<1	ug/L	UKAS
1,2,3-Trichloropropane (Surface Wat	154	GCMS	<0.9	ug/L	UKAS
1,2,4-Trichlorobenzene (Surface Wat	154	GCMS	<0.6	ug/L	UKAS
1,2,4-Trimethylbenzene (Surface Wa	154	GCMS	<1	ug/L	UKAS
1,2-Dibromo-3-chloropropane (Surfac	154	GCMS	<1	ug/L	UKAS
1,2-Dibromoethane (Surface Water)	154	GCMS	<1	ug/L	UKAS
1,2-Dichlorobenzene (Surface Water)	154	GCMS	<1	ug/L	UKAS
1,2-Dichloroethane (Surface Water)	154	GCMS	<1	ug/L	UKAS
1,2-Dichloropropane (Surface Water)	154	GCMS	<1	ug/L	UKAS
1,3,5-Trimethylbenzene (Surface Wa	154	GCMS	<1	ug/L	UKAS
1,3-Dichlorobenzene (Surface Water)	154	GCMS	<1	ug/L	UKAS
1,3-Dichloropropane (Surface Water)	154	GCMS	<1	ug/L	UKAS
1,4-Dichlorobenzene (Surface Water)	154	GCMS	<1	ug/L	UKAS
2,2-Dichloropropane (Surface Water)	154	GCMS	<5.0	ug/L	
2-Chlorotoluene (Surface Water)	154	GCMS	<1	ug/L	UKAS
4-Chlorotoluene (Surface Water)	154	GCMS	<1	ug/L	UKAS
Acenaphthene (GCMS)	200	GCMS	<0.01	ug/L	

Signed : A Harmon

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Customer	Caroline Roche Aqua-Fact International Services Ltd 12 Kilkerrin Park Liosbaun Ind Est Liosbaun Co Galway	*Lab Report Ref. No.*	0529/001/01
		Date of Receipt	06/04/2018
		Sampled On	04/04/2018
		Date Testing Commenced	06/04/2018
		Received or Collected	By Fitz: Paul C
		Condition on Receipt	Acceptable
Customer PO		*Date of Report*	25/04/2018
Customer Ref	UP500-LW-SURF	*Sample Type*	Surface Water
Ref 2			
Ref 3			

CERTIFICATE OF ANALYSIS

Test Parameter	SOP	Analytical Technique	Result	Units	Acc.
Acenaphthylene (GCMS)	200	GCMS	<0.01	ug/L	
Ammonia (Surface Water)	114	Colorimetry	0.34	mg/L as N	UKAS
Anthracene (GCMS)	200	GCMS	<0.01	ug/L	
Antimony (Surface Water)	177	ICPMS	7	ug/L	UKAS
Arsenic (Surface Water)	177	ICPMS	<1	ug/L	UKAS
Barium (Surface Water)	177	ICPMS	26	ug/L	UKAS
Benzene (Surface Water)	154	GCMS	<1	ug/L	UKAS
Benzo(a)anthracene (GCMS)	200	GCMS	<0.01	ug/L	
Benzo(a)pyrene (GCMS)	200	GCMS	<0.01	ug/L	
Benzo(g,h,i)perylene (GCMS)	200	GCMS	<0.01	ug/L	
Benzo(k)fluoranthene (GCMS)	200	GCMS	<0.01	ug/L	
Bromobenzene (Surface Water)	154	GCMS	<1	ug/L	UKAS
Bromochloromethane (Surface Water	154	GCMS	<1	ug/L	UKAS
Bromodichloromethane (Surface Wat	154	GCMS	<1	ug/L	UKAS
Bromoform (Surface Water)	154	GCMS	<1	ug/L	UKAS
Bromomethane (Surface Water)	154	GCMS	<5.0	ug/L	
Cadmium (Surface Water)	177	ICPMS	<1	ug/L	UKAS
Carbon tetrachloride (Surface Water)	154	GCMS	<1	ug/L	UKAS
Chlorobenzene (Surface Water)	154	GCMS	<1	ug/L	UKAS
Chloroethane (Surface Water)	154	GCMS	<5.0	ug/L	
Chloroform (Surface Water)	154	GCMS	<1	ug/L	UKAS
Chloromethane (Surface Water)	154	GCMS	<5.0	ug/L	
Chromium (Surface Water)	177	ICPMS	3	ug/L	UKAS
Chrysene (GCMS)	200	GCMS	<0.01	ug/L	

Signed : A Harmon **Date : 25/04/2018**

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	Aqua-Fact International Services Ltd	*Date of Receipt*	**06/04/2018**
	12 Kilkerrin Park	*Sampled On*	**04/04/2018**
	Liosbaun Ind Est	*Date Testing Commenced*	**06/04/2018**
	Liosbaun	*Received or Collected*	**By Fitz: Paul C**
	Co Galway	*Condition on Receipt*	**Acceptable**
Customer PO		*Date of Report*	**25/04/2018**
Customer Ref	**UP500-LW-SURF**	*Sample Type*	**Surface Water**
Ref 2			
Ref 3			

CERTIFICATE OF ANALYSIS

Test Parameter	SOP	Analytical Technique	Result	Units	Acc.
cis-1,2-Dichloroethene (Surface Wat	154	GCMS	<1	ug/L	UKAS
cis-1,3-Dichloropropene (Surface Wa	154	GCMS	<1	ug/L	UKAS
COD (Surface Water)	107	Colorimetry	70	mg/L	UKAS
Copper (Surface Water)	177	ICPMS	17	ug/L	UKAS
Coronene (GCMS)	200	GCMS	<0.01	ug/L	
Dibenzo(a,h)anthracene (GCMS)	200	GCMS	<0.01	ug/L	
Dibromochloromethane (Surface Wat	154	GCMS	<1	ug/L	UKAS
Dibromomethane (Surface Water)	154	GCMS	<1	ug/L	UKAS
Dichlorodifluoromethane (Surface W	154	GCMS	<5.0	ug/L	
Dichloromethane (Surface Water)	154	GCMS	<5.0	ug/L	
Ethylbenzene (Surface Water)	154	GCMS	<1	ug/L	UKAS
Fluoranthene (GCMS)	200	GCMS	<0.01	ug/L	
Fluorene (GCMS)	200	GCMS	<0.01	ug/L	
Hexachlorobutadiene (Surface Water	154	GCMS	<1	ug/L	UKAS
Indeno(1,2,3-cd)pyrene (GCMS)	200	GCMS	<0.01	ug/L	
Isopropylbenzene (Surface Water)	154	GCMS	<1	ug/L	UKAS
Lead (Surface Water)	177	ICPMS	6	ug/L	UKAS
m- & p-Xylene (Surface Water)	154	GCMS	<1	ug/L	UKAS
Mercury (Surface water)	178	ICPMS	2.14	ug/L	UKAS
Molybdenum	226	ICPMS	8	ug/L	
Naphthalene (Surface Water)	154	GCMS	<1	ug/L	UKAS
n-Butylbenzene (Surface Water)	154	GCMS	<1	ug/L	UKAS
Nickel (Surface Water)	177	ICPMS	25	ug/L	UKAS
Nitrogen (Total Kjeldahl)	104	Digestion/ Distillation/ Titrimetr	<1.00	mg/L as N	

Signed : A Harman

Aoife Harmon - Technical Supervisor

Date : 25/04/2018

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	Liosbaun Ind Est	*Date Testing Commenced*	**06/04/2018**
	Liosbaun	*Received or Collected*	**By Fitz: Paul C**
	Co Galway	*Condition on Receipt*	**Acceptable**
Customer PO		*Date of Report*	**25/04/2018**
Customer Ref	**UP500-LW-SURF**	*Sample Type*	**Surface Water**
Ref 2			
Ref 3			

CERTIFICATE OF ANALYSIS

Test Parameter	SOP	Analytical Technique	Result	Units	Acc.
Nitrogen (Total Oxidised) (Surface W	151	Colorimetry	2.24	mg/L as N	UKAS
Nitrogen (Total)	0	Calculation	3	mg/L as N	
n-Propylbenzene (Surface Water)	154	GCMS	<1.0	ug/L	UKAS
o-Xylene (Surface Water)	154	GCMS	<1	ug/L	UKAS
Phenanthrene (GCMS)	200	GCMS	<0.01	ug/L	
Phenols (Total)	223	GCMS	<0.10	ug/L	
Phosphorus (Total) Surface Water	166	Colorimetry	0.083	mg/L as P	UKAS
p-Isopropyltoluene (Surface Water)	154	GCMS	<1	ug/L	UKAS
Polyaromatic Hydrocarbons (GCMS)	200	GCMS	<0.01	ug/L	
Pyrene (GCMS)	200	GCMS	<0.01	ug/L	
sec-Butylbenzene (Surface Water)	154	GCMS	<1	ug/L	UKAS
Selenium (Surface Water)	177	ICPMS	3	ug/L	UKAS
Solids (Total Dissolved)	105	Filtration/ Evaporation @ 180C	17367	mg/L	
Styrene (Surface Water)	154	GCMS	<1	ug/L	UKAS
tert-Butylbenzene (Surface Water)	154	GCMS	<1	ug/L	UKAS
Tetrachloroethene (Surface Water)	154	GCMS	<1	ug/L	UKAS
TOC (Surface Water)	316	TOC Analyser	4.4	mg/L	UKAS
Toluene (Surface Water)	154	GCMS	<1	ug/L	UKAS
Total Inorganic Nitrogen	0	Calculation	2.5	mg/L	
trans-1,2-Dichloroethene (Surface W	154	GCMS	<1	ug/L	UKAS
trans-1,3-Dichloropropene (Surface	154	GCMS	<1	ug/L	UKAS
Trichloroethene (Surface Water)	154	GCMS	<1.0	ug/L	
Trichlorofluoromethane (Surface Wat	154	GCMS	<1	ug/L	UKAS
Vanadium (Surface Water)	177	ICPMS	85	ug/L	UKAS

Signed : A Harmon ***Date : 25/04/2018***

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	Aqua-Fact International Services Ltd	*Date of Receipt*	**06/04/2018**
	12 Kilkerrin Park	*Sampled On*	**04/04/2018**
	Liosbaun Ind Est	*Date Testing Commenced*	**06/04/2018**
	Liosbaun	*Received or Collected*	**By Fitz: Paul C**
	Co Galway	*Condition on Receipt*	**Acceptable**
Customer PO		*Date of Report*	**25/04/2018**
Customer Ref	**UP500-LW-SURF**	*Sample Type*	**Surface Water**
Ref 2			
Ref 3			

CERTIFICATE OF ANALYSIS

Test Parameter	SOP	Analytical Technique	Result	Units	Acc.
Vinyl chloride (Surface Water)	154	GCMS	<1	ug/L	UKAS
Volatile Organic Compounds	154	GCMS	<5.0	ug/L	
Xylene Total (Surface Water)	154	GCMS	<1	ug/L	UKAS
Zinc (Surface Water)	177	ICPMS	382	ug/L	UKAS

Signed : A Harmon

Aoife Harmon - Technical Supervisor

Date : 25/04/2018

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		Date of Receipt	06/04/2018
		Sampled On	04/04/2018
		Date Testing Commenced	06/04/2018
		Received or Collected	By Fitz: Paul C
		Condition on Receipt	Acceptable
Customer PO		*Date of Report*	25/04/2018
Customer Ref	UP500-LW-MID	*Sample Type*	Surface Water
Ref 2			
Ref 3			

CERTIFICATE OF ANALYSIS

Test Parameter	SOP	Analytical Technique	Result	Units	Acc.
1,1,1,2-Tetrachloroethane (Surface	154	GCMS	<1	ug/L	UKAS
1,1,1-Trichloroethane (Surface Water	154	GCMS	<1	ug/L	UKAS
1,1,2,2-Tetrachloroethane (Surface	154	GCMS	<5.0	ug/L	
1,1,2-Trichloroethane (Surface Water	154	GCMS	<2	ug/L	UKAS
1,1-Dichloroethane (Surface Water)	154	GCMS	<1	ug/L	UKAS
1,1-Dichloroethene (Surface Water)	154	GCMS	<1	ug/L	UKAS
1,1-Dichloropropene (Surface Water)	154	GCMS	<1	ug/L	UKAS
1,2,3-Trichlorobenzene (Surface Wat	154	GCMS	<1	ug/L	UKAS
1,2,3-Trichloropropane (Surface Wat	154	GCMS	<0.9	ug/L	UKAS
1,2,4-Trichlorobenzene (Surface Wat	154	GCMS	<0.6	ug/L	UKAS
1,2,4-Trimethylbenzene (Surface Wa	154	GCMS	<1	ug/L	UKAS
1,2-Dibromo-3-chloropropane (Surfac	154	GCMS	<1	ug/L	UKAS
1,2-Dibromoethane (Surface Water)	154	GCMS	<1	ug/L	UKAS
1,2-Dichlorobenzene (Surface Water)	154	GCMS	<1	ug/L	UKAS
1,2-Dichloroethane (Surface Water)	154	GCMS	<1	ug/L	UKAS
1,2-Dichloropropane (Surface Water)	154	GCMS	<1	ug/L	UKAS
1,3,5-Trimethylbenzene (Surface Wa	154	GCMS	<1	ug/L	UKAS
1,3-Dichlorobenzene (Surface Water)	154	GCMS	<1	ug/L	UKAS
1,3-Dichloropropane (Surface Water)	154	GCMS	<1	ug/L	UKAS
1,4-Dichlorobenzene (Surface Water)	154	GCMS	<1	ug/L	UKAS
2,2-Dichloropropane (Surface Water)	154	GCMS	<5.0	ug/L	
2-Chlorotoluene (Surface Water)	154	GCMS	<1	ug/L	UKAS
4-Chlorotoluene (Surface Water)	154	GCMS	<1	ug/L	UKAS
Acenaphthene (GCMS)	200	GCMS	<0.01	ug/L	

Signed : A Harmon ***Date : 25/04/2018***

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	12 Kilkerrin Park	*Sampled On*	04/04/2018
	Liosbaun Ind Est	*Date Testing Commenced*	06/04/2018
	Liosbaun	*Received or Collected*	By Fitz: Paul C
	Co Galway	*Condition on Receipt*	Acceptable
Customer PO		*Date of Report*	25/04/2018
Customer Ref	UP500-LW-MID	*Sample Type*	Surface Water
Ref 2			
Ref 3			

CERTIFICATE OF ANALYSIS

Test Parameter	SOP	Analytical Technique	Result	Units	Acc.
Acenaphthylene (GCMS)	200	GCMS	<0.01	ug/L	
Ammonia (Surface Water)	114	Colorimetry	0.38	mg/L as N	UKAS
Anthracene (GCMS)	200	GCMS	<0.01	ug/L	
Antimony (Surface Water)	177	ICPMS	5	ug/L	UKAS
Arsenic (Surface Water)	177	ICPMS	6	ug/L	UKAS
Barium (Surface Water)	177	ICPMS	32	ug/L	UKAS
Benzene (Surface Water)	154	GCMS	<1	ug/L	UKAS
Benzo(a)anthracene (GCMS)	200	GCMS	<0.01	ug/L	
Benzo(a)pyrene (GCMS)	200	GCMS	<0.01	ug/L	
Benzo(g,h,i)perylene (GCMS)	200	GCMS	<0.01	ug/L	
Benzo(k)fluoranthene (GCMS)	200	GCMS	<0.01	ug/L	
Bromobenzene (Surface Water)	154	GCMS	<1	ug/L	UKAS
Bromochloromethane (Surface Water	154	GCMS	<1	ug/L	UKAS
Bromodichloromethane (Surface Wat	154	GCMS	<1	ug/L	UKAS
Bromoform (Surface Water)	154	GCMS	<1	ug/L	UKAS
Bromomethane (Surface Water)	154	GCMS	<5.0	ug/L	
Cadmium (Surface Water)	177	ICPMS	<1	ug/L	UKAS
Carbon tetrachloride (Surface Water)	154	GCMS	<1	ug/L	UKAS
Chlorobenzene (Surface Water)	154	GCMS	<1	ug/L	UKAS
Chloroethane (Surface Water)	154	GCMS	<5.0	ug/L	
Chloroform (Surface Water)	154	GCMS	<1	ug/L	UKAS
Chloromethane (Surface Water)	154	GCMS	<5.0	ug/L	
Chromium (Surface Water)	177	ICPMS	7	ug/L	UKAS
Chrysene (GCMS)	200	GCMS	<0.01	ug/L	

Signed : A Harmon

Date : 25/04/2018

Aoife Harmon - Technical Supervisor

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UKAS TESTING 2802

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Customer	Caroline Roche Aqua-Fact International Services Ltd 12 Kilkerrin Park Liosbaun Ind Est Liosbaun Co Galway	*Lab Report Ref. No.*	0529/001/02
		Date of Receipt	06/04/2018
		Sampled On	04/04/2018
		Date Testing Commenced	06/04/2018
		Received or Collected	By Fitz: Paul C
		Condition on Receipt	Acceptable
Customer PO		*Date of Report*	25/04/2018
Customer Ref	UP500-LW-MID	*Sample Type*	Surface Water
Ref 2			
Ref 3			

CERTIFICATE OF ANALYSIS

Test Parameter	SOP	Analytical Technique	Result	Units	Acc.
cis-1,2-Dichloroethene (Surface Wat	154	GCMS	<1	ug/L	UKAS
cis-1,3-Dichloropropene (Surface Wa	154	GCMS	<1	ug/L	UKAS
COD (Surface Water)	107	Colorimetry	85	mg/L	UKAS
Copper (Surface Water)	177	ICPMS	32	ug/L	UKAS
Coronene (GCMS)	200	GCMS	<0.01	ug/L	
Dibenzo(a,h)anthracene (GCMS)	200	GCMS	<0.01	ug/L	
Dibromochloromethane (Surface Wat	154	GCMS	<1	ug/L	UKAS
Dibromomethane (Surface Water)	154	GCMS	<1	ug/L	UKAS
Dichlorodifluoromethane (Surface W	154	GCMS	<5.0	ug/L	
Dichloromethane (Surface Water)	154	GCMS	<5.0	ug/L	
Ethylbenzene (Surface Water)	154	GCMS	<1	ug/L	UKAS
Fluoranthene (GCMS)	200	GCMS	<0.01	ug/L	
Fluorene (GCMS)	200	GCMS	<0.01	ug/L	
Hexachlorobutadiene (Surface Water	154	GCMS	<1	ug/L	UKAS
Indeno(1,2,3-cd)pyrene (GCMS)	200	GCMS	<0.01	ug/L	
Isopropylbenzene (Surface Water)	154	GCMS	<1	ug/L	UKAS
Lead (Surface Water)	177	ICPMS	9	ug/L	UKAS
m- & p-Xylene (Surface Water)	154	GCMS	<1	ug/L	UKAS
Mercury (Surface water)	178	ICPMS	1.38	ug/L	UKAS
Molybdenum	226	ICPMS	10	ug/L	
Naphthalene (Surface Water)	154	GCMS	<1	ug/L	UKAS
n-Butylbenzene (Surface Water)	154	GCMS	<1	ug/L	UKAS
Nickel (Surface Water)	177	ICPMS	11	ug/L	UKAS
Nitrogen (Total Kjeldahl)	104	Digestion/ Distillation/ Titrimetr	<1.00	mg/L as N	

Signed : A Harman

Aoife Harmon - Technical Supervisor

Date : 25/04/2018

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	Aqua-Fact International Services Ltd	*Date of Receipt*	06/04/2018
	12 Kilkerrin Park	*Sampled On*	04/04/2018
	Liosbaun Ind Est	*Date Testing Commenced*	06/04/2018
	Liosbaun	*Received or Collected*	By Fitz: Paul C
	Co Galway	*Condition on Receipt*	Acceptable
Customer PO		*Date of Report*	25/04/2018
Customer Ref	UP500-LW-MID	*Sample Type*	Surface Water
Ref 2			
Ref 3			

CERTIFICATE OF ANALYSIS

Test Parameter	SOP	Analytical Technique	Result	Units	Acc.
Nitrogen (Total Oxidised) (Surface W	151	Colorimetry	1.99	mg/L as N	UKAS
Nitrogen (Total)	0	Calculation	3	mg/L as N	
n-Propylbenzene (Surface Water)	154	GCMS	<1.0	ug/L	UKAS
o-Xylene (Surface Water)	154	GCMS	<1	ug/L	UKAS
Phenanthrene (GCMS)	200	GCMS	<0.01	ug/L	
Phenols (Total)	223	GCMS	<0.10	ug/L	
Phosphorus (Total) Surface Water	166	Colorimetry	0.055	mg/L as P	UKAS
p-Isopropyltoluene (Surface Water)	154	GCMS	<1	ug/L	UKAS
Polyaromatic Hydrocarbons (GCMS)	200	GCMS	<0.01	ug/L	
Pyrene (GCMS)	200	GCMS	<0.01	ug/L	
sec-Butylbenzene (Surface Water)	154	GCMS	<1	ug/L	UKAS
Selenium (Surface Water)	177	ICPMS	<1	ug/L	UKAS
Solids (Total Dissolved)	105	Filtration/ Evaporation @ 180C	21205	mg/L	
Styrene (Surface Water)	154	GCMS	<1	ug/L	UKAS
tert-Butylbenzene (Surface Water)	154	GCMS	<1	ug/L	UKAS
Tetrachloroethene (Surface Water)	154	GCMS	<1	ug/L	UKAS
TOC (Surface Water)	316	TOC Analyser	4.2	mg/L	UKAS
Toluene (Surface Water)	154	GCMS	<1	ug/L	UKAS
Total Inorganic Nitrogen	0	Calculation	2	mg/L	
trans-1,2-Dichloroethene (Surface W	154	GCMS	<1	ug/L	UKAS
trans-1,3-Dichloropropene (Surface	154	GCMS	<1	ug/L	UKAS
Trichloroethene (Surface Water)	154	GCMS	<1.0	ug/L	
Trichlorofluoromethane (Surface Wat	154	GCMS	<1	ug/L	UKAS
Vanadium (Surface Water)	177	ICPMS	171	ug/L	UKAS

Signed : A Harmon ***Date : 25/04/2018***

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	Aqua-Fact International Services Ltd	*Date of Receipt*	**06/04/2018**
	12 Kilkerrin Park	*Sampled On*	**04/04/2018**
	Liosbaun Ind Est	*Date Testing Commenced*	**06/04/2018**
	Liosbaun	*Received or Collected*	**By Fitz: Paul C**
	Co Galway	*Condition on Receipt*	**Acceptable**
Customer PO		*Date of Report*	**25/04/2018**
Customer Ref	**UP500-LW-MID**	*Sample Type*	**Surface Water**
Ref 2			
Ref 3			

CERTIFICATE OF ANALYSIS

Test Parameter	SOP	Analytical Technique	Result	Units	Acc.
Vinyl chloride (Surface Water)	154	GCMS	<1	ug/L	UKAS
Volatile Organic Compounds	154	GCMS	<5.0	ug/L	
Xylene Total (Surface Water)	154	GCMS	<1	ug/L	UKAS
Zinc (Surface Water)	177	ICPMS	196	ug/L	UKAS

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		Sampled On	04/04/2018
		Date Testing Commenced	06/04/2018
		Received or Collected	By Fitz: Paul C
		Condition on Receipt	Acceptable
Customer PO		*Date of Report*	25/04/2018
Customer Ref	UP500-LW-BOTTOM	*Sample Type*	Surface Water
Ref 2			
Ref 3			

CERTIFICATE OF ANALYSIS

Test Parameter	SOP	Analytical Technique	Result	Units	Acc.
1,1,1,2-Tetrachloroethane (Surface	154	GCMS	<1	ug/L	UKAS
1,1,1-Trichloroethane (Surface Water	154	GCMS	<1	ug/L	UKAS
1,1,2,2-Tetrachloroethane (Surface	154	GCMS	<5.0	ug/L	
1,1,2-Trichloroethane (Surface Water	154	GCMS	<2	ug/L	UKAS
1,1-Dichloroethane (Surface Water)	154	GCMS	<1	ug/L	UKAS
1,1-Dichloroethene (Surface Water)	154	GCMS	<1	ug/L	UKAS
1,1-Dichloropropene (Surface Water)	154	GCMS	<1	ug/L	UKAS
1,2,3-Trichlorobenzene (Surface Wat	154	GCMS	<1	ug/L	UKAS
1,2,3-Trichloropropane (Surface Wat	154	GCMS	<0.9	ug/L	UKAS
1,2,4-Trichlorobenzene (Surface Wat	154	GCMS	<0.6	ug/L	UKAS
1,2,4-Trimethylbenzene (Surface Wa	154	GCMS	<1	ug/L	UKAS
1,2-Dibromo-3-chloropropane (Surfac	154	GCMS	<1	ug/L	UKAS
1,2-Dibromoethane (Surface Water)	154	GCMS	<1	ug/L	UKAS
1,2-Dichlorobenzene (Surface Water)	154	GCMS	<1	ug/L	UKAS
1,2-Dichloroethane (Surface Water)	154	GCMS	<1	ug/L	UKAS
1,2-Dichloropropane (Surface Water)	154	GCMS	<1	ug/L	UKAS
1,3,5-Trimethylbenzene (Surface Wa	154	GCMS	<1	ug/L	UKAS
1,3-Dichlorobenzene (Surface Water)	154	GCMS	<1	ug/L	UKAS
1,3-Dichloropropane (Surface Water)	154	GCMS	<1	ug/L	UKAS
1,4-Dichlorobenzene (Surface Water)	154	GCMS	<1	ug/L	UKAS
2,2-Dichloropropane (Surface Water)	154	GCMS	<5.0	ug/L	
2-Chlorotoluene (Surface Water)	154	GCMS	<1	ug/L	UKAS
4-Chlorotoluene (Surface Water)	154	GCMS	<1	ug/L	UKAS
Acenaphthene (GCMS)	200	GCMS	<0.01	ug/L	

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	Liosbaun Ind Est	*Date Testing Commenced*	06/04/2018
	Liosbaun	*Received or Collected*	By Fitz: Paul C
	Co Galway	*Condition on Receipt*	Acceptable
Customer PO		*Date of Report*	25/04/2018
Customer Ref	UP500-LW-BOTTOM	*Sample Type*	Surface Water
Ref 2			
Ref 3			

CERTIFICATE OF ANALYSIS

Test Parameter	SOP	Analytical Technique	Result	Units	Acc.
Acenaphthylene (GCMS)	200	GCMS	<0.01	ug/L	
Ammonia (Surface Water)	114	Colorimetry	0.35	mg/L as N	UKAS
Anthracene (GCMS)	200	GCMS	<0.01	ug/L	
Antimony (Surface Water)	177	ICPMS	5	ug/L	UKAS
Arsenic (Surface Water)	177	ICPMS	<1	ug/L	UKAS
Barium (Surface Water)	177	ICPMS	27	ug/L	UKAS
Benzene (Surface Water)	154	GCMS	<1	ug/L	UKAS
Benzo(a)anthracene (GCMS)	200	GCMS	<0.01	ug/L	
Benzo(a)pyrene (GCMS)	200	GCMS	<0.01	ug/L	
Benzo(g,h,i)perylene (GCMS)	200	GCMS	<0.01	ug/L	
Benzo(k)fluoranthene (GCMS)	200	GCMS	<0.01	ug/L	
Bromobenzene (Surface Water)	154	GCMS	<1	ug/L	UKAS
Bromochloromethane (Surface Water	154	GCMS	<1	ug/L	UKAS
Bromodichloromethane (Surface Wat	154	GCMS	<1	ug/L	UKAS
Bromoform (Surface Water)	154	GCMS	<1	ug/L	UKAS
Bromomethane (Surface Water)	154	GCMS	<5.0	ug/L	
Cadmium (Surface Water)	177	ICPMS	<1	ug/L	UKAS
Carbon tetrachloride (Surface Water)	154	GCMS	<1	ug/L	UKAS
Chlorobenzene (Surface Water)	154	GCMS	<1	ug/L	UKAS
Chloroethane (Surface Water)	154	GCMS	<5.0	ug/L	
Chloroform (Surface Water)	154	GCMS	<1	ug/L	UKAS
Chloromethane (Surface Water)	154	GCMS	<5.0	ug/L	
Chromium (Surface Water)	177	ICPMS	7	ug/L	UKAS
Chrysene (GCMS)	200	GCMS	<0.01	ug/L	

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		Received or Collected	By Fitz: Paul C
		Condition on Receipt	Acceptable
Customer PO		*Date of Report*	25/04/2018
Customer Ref	UP500-LW-BOTTOM	*Sample Type*	Surface Water
Ref 2			
Ref 3			

CERTIFICATE OF ANALYSIS

Test Parameter	SOP	Analytical Technique	Result	Units	Acc.
cis-1,2-Dichloroethene (Surface Wat	154	GCMS	<1	ug/L	UKAS
cis-1,3-Dichloropropene (Surface Wa	154	GCMS	<1	ug/L	UKAS
COD (Surface Water)	107	Colorimetry	90	mg/L	UKAS
Copper (Surface Water)	177	ICPMS	8	ug/L	UKAS
Coronene (GCMS)	200	GCMS	<0.01	ug/L	
Dibenzo(a,h)anthracene (GCMS)	200	GCMS	<0.01	ug/L	
Dibromochloromethane (Surface Wat	154	GCMS	<1	ug/L	UKAS
Dibromomethane (Surface Water)	154	GCMS	<1	ug/L	UKAS
Dichlorodifluoromethane (Surface W	154	GCMS	<5.0	ug/L	
Dichloromethane (Surface Water)	154	GCMS	<5.0	ug/L	
Ethylbenzene (Surface Water)	154	GCMS	<1	ug/L	UKAS
Fluoranthene (GCMS)	200	GCMS	<0.01	ug/L	
Fluorene (GCMS)	200	GCMS	<0.01	ug/L	
Hexachlorobutadiene (Surface Water	154	GCMS	<1	ug/L	UKAS
Indeno(1,2,3-cd)pyrene (GCMS)	200	GCMS	<0.01	ug/L	
Isopropylbenzene (Surface Water)	154	GCMS	<1	ug/L	UKAS
Lead (Surface Water)	177	ICPMS	8	ug/L	UKAS
m- & p-Xylene (Surface Water)	154	GCMS	<1	ug/L	UKAS
Mercury (Surface water)	178	ICPMS	1.31	ug/L	UKAS
Molybdenum	226	ICPMS	9	ug/L	
Naphthalene (Surface Water)	154	GCMS	<1	ug/L	UKAS
n-Butylbenzene (Surface Water)	154	GCMS	<1	ug/L	UKAS
Nickel (Surface Water)	177	ICPMS	14	ug/L	UKAS
Nitrogen (Total Kjeldahl)	104	Digestion/ Distillation/ Titrimetr	<1.00	mg/L as N	

Signed : A Harmon

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		Received or Collected	By Fitz: Paul C
		Condition on Receipt	Acceptable
Customer PO		*Date of Report*	25/04/2018
Customer Ref	UP500-LW-BOTTOM	*Sample Type*	Surface Water
Ref 2			
Ref 3			

CERTIFICATE OF ANALYSIS

Test Parameter	SOP	Analytical Technique	Result	Units	Acc.
Nitrogen (Total Oxidised) (Surface W	151	Colorimetry	1.61	mg/L as N	UKAS
Nitrogen (Total)	0	Calculation	2	mg/L as N	
n-Propylbenzene (Surface Water)	154	GCMS	<1.0	ug/L	UKAS
o-Xylene (Surface Water)	154	GCMS	<1	ug/L	UKAS
Phenanthrene (GCMS)	200	GCMS	<0.01	ug/L	
Phenols (Total)	223	GCMS	<0.10	ug/L	
Phosphorus (Total) Surface Water	166	Colorimetry	0.059	mg/L as P	UKAS
p-Isopropyltoluene (Surface Water)	154	GCMS	<1	ug/L	UKAS
Polyaromatic Hydrocarbons (GCMS)	200	GCMS	<0.01	ug/L	
Pyrene (GCMS)	200	GCMS	<0.01	ug/L	
sec-Butylbenzene (Surface Water)	154	GCMS	<1	ug/L	UKAS
Selenium (Surface Water)	177	ICPMS	<1	ug/L	UKAS
Solids (Total Dissolved)	105	Filtration/ Evaporation @ 180C	21368	mg/L	
Styrene (Surface Water)	154	GCMS	<1	ug/L	UKAS
tert-Butylbenzene (Surface Water)	154	GCMS	<1	ug/L	UKAS
Tetrachloroethene (Surface Water)	154	GCMS	<1	ug/L	UKAS
TOC (Surface Water)	316	TOC Analyser	4.0	mg/L	UKAS
Toluene (Surface Water)	154	GCMS	<1	ug/L	UKAS
Total Inorganic Nitrogen	0	Calculation	0.4	mg/L	
trans-1,2-Dichloroethene (Surface W	154	GCMS	<1	ug/L	UKAS
trans-1,3-Dichloropropene (Surface	154	GCMS	<1	ug/L	UKAS
Trichloroethene (Surface Water)	154	GCMS	<1.0	ug/L	
Trichlorofluoromethane (Surface Wat	154	GCMS	<1	ug/L	UKAS
Vanadium (Surface Water)	177	ICPMS	172	ug/L	UKAS

Signed : A Harmon

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	Aqua-Fact International Services Ltd	*Date of Receipt*	**06/04/2018**
	12 Kilkerrin Park	*Sampled On*	**04/04/2018**
	Liosbaun Ind Est	*Date Testing Commenced*	**06/04/2018**
	Liosbaun	*Received or Collected*	**By Fitz: Paul C**
	Co Galway	*Condition on Receipt*	**Acceptable**
Customer PO		*Date of Report*	**25/04/2018**
Customer Ref	**UP500-LW-BOTTOM**	*Sample Type*	**Surface Water**
Ref 2			
Ref 3			

CERTIFICATE OF ANALYSIS

Test Parameter	SOP	Analytical Technique	Result	Units	Acc.
Vinyl chloride (Surface Water)	154	GCMS	<1	ug/L	UKAS
Volatile Organic Compounds	154	GCMS	<5.0	ug/L	
Xylene Total (Surface Water)	154	GCMS	<1	ug/L	UKAS
Zinc (Surface Water)	177	ICPMS	155	ug/L	UKAS

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Monitoring and Testing Services

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Customer	**Caroline Roche**	***Lab Report Ref. No.***	**0529/001/04**
	Aqua-Fact International Services Ltd	***Date of Receipt***	**06/04/2018**
	12 Kilkerrin Park	***Sampled On***	**04/04/2018**
	Liosbaun Ind Est	***Date Testing Commenced***	**06/04/2018**
	Liosbaun	***Received or Collected***	**By Fitz: Paul C**
	Co Galway	***Condition on Receipt***	**Acceptable**
Customer PO		***Date of Report***	**25/04/2018**
Customer Ref	**UP500-MR-SURF**	***Sample Type***	**Surface Water**
Ref 2			
Ref 3			

CERTIFICATE OF ANALYSIS

Test Parameter	SOP	Analytical Technique	Result	Units	Acc.
1,1,1,2-Tetrachloroethane (Surface	154	GCMS	<1	ug/L	UKAS
1,1,1-Trichloroethane (Surface Water	154	GCMS	<1	ug/L	UKAS
1,1,2,2-Tetrachloroethane (Surface	154	GCMS	<5.0	ug/L	
1,1,2-Trichloroethane (Surface Water	154	GCMS	<2	ug/L	UKAS
1,1-Dichloroethane (Surface Water)	154	GCMS	<1	ug/L	UKAS
1,1-Dichloroethene (Surface Water)	154	GCMS	<1	ug/L	UKAS
1,1-Dichloropropene (Surface Water)	154	GCMS	<1	ug/L	UKAS
1,2,3-Trichlorobenzene (Surface Wat	154	GCMS	<1	ug/L	UKAS
1,2,3-Trichloropropane (Surface Wat	154	GCMS	<0.9	ug/L	UKAS
1,2,4-Trichlorobenzene (Surface Wat	154	GCMS	<0.6	ug/L	UKAS
1,2,4-Trimethylbenzene (Surface Wa	154	GCMS	<1	ug/L	UKAS
1,2-Dibromo-3-chloropropane (Surfac	154	GCMS	<1	ug/L	UKAS
1,2-Dibromoethane (Surface Water)	154	GCMS	<1	ug/L	UKAS
1,2-Dichlorobenzene (Surface Water)	154	GCMS	<1	ug/L	UKAS
1,2-Dichloroethane (Surface Water)	154	GCMS	<1	ug/L	UKAS
1,2-Dichloropropane (Surface Water)	154	GCMS	<1	ug/L	UKAS
1,3,5-Trimethylbenzene (Surface Wa	154	GCMS	<1	ug/L	UKAS
1,3-Dichlorobenzene (Surface Water)	154	GCMS	<1	ug/L	UKAS
1,3-Dichloropropane (Surface Water)	154	GCMS	<1	ug/L	UKAS
1,4-Dichlorobenzene (Surface Water)	154	GCMS	<1	ug/L	UKAS
2,2-Dichloropropane (Surface Water)	154	GCMS	<5.0	ug/L	
2-Chlorotoluene (Surface Water)	154	GCMS	<1	ug/L	UKAS
4-Chlorotoluene (Surface Water)	154	GCMS	<1	ug/L	UKAS
Acenaphthene (GCMS)	200	GCMS	<0.01	ug/L	

Signed : A Harman

Date : 25/04/2018

Aoife Harmon - Technical Supervisor

Acc. : Accredited Parameters by ISO 17025:2005
PVL - Parametric Value Limit as per EU (Drinking water) Regulations (SI 122 2014)
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UKAS TESTING 2802

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	Aqua-Fact International Services Ltd	*Date of Receipt*	06/04/2018
	12 Kilkerrin Park	*Sampled On*	04/04/2018
	Liosbaun Ind Est	*Date Testing Commenced*	06/04/2018
	Liosbaun	*Received or Collected*	By Fitz: Paul C
	Co Galway	*Condition on Receipt*	Acceptable
Customer PO		*Date of Report*	25/04/2018
Customer Ref	UP500-MR-SURF	*Sample Type*	Surface Water
Ref 2			
Ref 3			

CERTIFICATE OF ANALYSIS

Test Parameter	SOP	Analytical Technique	Result	Units	Acc.
Acenaphthylene (GCMS)	200	GCMS	<0.01	ug/L	
Ammonia (Surface Water)	114	Colorimetry	0.37	mg/L as N	UKAS
Anthracene (GCMS)	200	GCMS	<0.01	ug/L	
Antimony (Surface Water)	177	ICPMS	3	ug/L	UKAS
Arsenic (Surface Water)	177	ICPMS	<1	ug/L	UKAS
Barium (Surface Water)	177	ICPMS	27	ug/L	UKAS
Benzene (Surface Water)	154	GCMS	<1	ug/L	UKAS
Benzo(a)anthracene (GCMS)	200	GCMS	<0.01	ug/L	
Benzo(a)pyrene (GCMS)	200	GCMS	<0.01	ug/L	
Benzo(g,h,i)perylene (GCMS)	200	GCMS	<0.01	ug/L	
Benzo(k)fluoranthene (GCMS)	200	GCMS	<0.01	ug/L	
Bromobenzene (Surface Water)	154	GCMS	<1	ug/L	UKAS
Bromochloromethane (Surface Water	154	GCMS	<1	ug/L	UKAS
Bromodichloromethane (Surface Wat	154	GCMS	<1	ug/L	UKAS
Bromoform (Surface Water)	154	GCMS	<1	ug/L	UKAS
Bromomethane (Surface Water)	154	GCMS	<5.0	ug/L	
Cadmium (Surface Water)	177	ICPMS	<1	ug/L	UKAS
Carbon tetrachloride (Surface Water)	154	GCMS	<1	ug/L	UKAS
Chlorobenzene (Surface Water)	154	GCMS	<1	ug/L	UKAS
Chloroethane (Surface Water)	154	GCMS	<5.0	ug/L	
Chloroform (Surface Water)	154	GCMS	<1	ug/L	UKAS
Chloromethane (Surface Water)	154	GCMS	<5.0	ug/L	
Chromium (Surface Water)	177	ICPMS	5	ug/L	UKAS
Chrysene (GCMS)	200	GCMS	<0.01	ug/L	

Signed : A Harmon ***Date : 25/04/2018***

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Customer	Caroline Roche Aqua-Fact International Services Ltd 12 Kilkerrin Park Liosbaun Ind Est Liosbaun Co Galway	*Lab Report Ref. No.*	0529/001/04
		Date of Receipt	06/04/2018
		Sampled On	04/04/2018
		Date Testing Commenced	06/04/2018
		Received or Collected	By Fitz: Paul C
		Condition on Receipt	Acceptable
Customer PO		*Date of Report*	25/04/2018
Customer Ref	UP500-MR-SURF	*Sample Type*	Surface Water
Ref 2			
Ref 3			

CERTIFICATE OF ANALYSIS

Test Parameter	SOP	Analytical Technique	Result	Units	Acc.
cis-1,2-Dichloroethene (Surface Wat	154	GCMS	<1	ug/L	UKAS
cis-1,3-Dichloropropene (Surface Wa	154	GCMS	<1	ug/L	UKAS
COD (Surface Water)	107	Colorimetry	90	mg/L	UKAS
Copper (Surface Water)	177	ICPMS	13	ug/L	UKAS
Coronene (GCMS)	200	GCMS	<0.01	ug/L	
Dibenzo(a,h)anthracene (GCMS)	200	GCMS	<0.01	ug/L	
Dibromochloromethane (Surface Wat	154	GCMS	<1	ug/L	UKAS
Dibromomethane (Surface Water)	154	GCMS	<1	ug/L	UKAS
Dichlorodifluoromethane (Surface W	154	GCMS	<5.0	ug/L	
Dichloromethane (Surface Water)	154	GCMS	<5.0	ug/L	
Ethylbenzene (Surface Water)	154	GCMS	<1	ug/L	UKAS
Fluoranthene (GCMS)	200	GCMS	<0.01	ug/L	
Fluorene (GCMS)	200	GCMS	<0.01	ug/L	
Hexachlorobutadiene (Surface Water	154	GCMS	<1	ug/L	UKAS
Indeno(1,2,3-cd)pyrene (GCMS)	200	GCMS	<0.01	ug/L	
Isopropylbenzene (Surface Water)	154	GCMS	<1	ug/L	UKAS
Lead (Surface Water)	177	ICPMS	5	ug/L	UKAS
m- & p-Xylene (Surface Water)	154	GCMS	<1	ug/L	UKAS
Mercury (Surface water)	178	ICPMS	1.04	ug/L	UKAS
Molybdenum	226	ICPMS	8	ug/L	
Naphthalene (Surface Water)	154	GCMS	<1	ug/L	UKAS
n-Butylbenzene (Surface Water)	154	GCMS	<1	ug/L	UKAS
Nickel (Surface Water)	177	ICPMS	7	ug/L	UKAS
Nitrogen (Total Kjeldahl)	104	Digestion/ Distillation/ Titrimetr	<1.00	mg/L as N	

Signed : A Harmon

Date : 25/04/2018

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	Aqua-Fact International Services Ltd	*Date of Receipt*	**06/04/2018**
	12 Kilkerrin Park	*Sampled On*	**04/04/2018**
	Liosbaun Ind Est	*Date Testing Commenced*	**06/04/2018**
	Liosbaun	*Received or Collected*	**By Fitz: Paul C**
	Co Galway	*Condition on Receipt*	**Acceptable**
Customer PO		*Date of Report*	**25/04/2018**
Customer Ref	**UP500-MR-SURF**	*Sample Type*	**Surface Water**
Ref 2			
Ref 3			

CERTIFICATE OF ANALYSIS

Test Parameter	SOP	Analytical Technique	Result	Units	Acc.
Nitrogen (Total Oxidised) (Surface W	151	Colorimetry	1.43	mg/L as N	UKAS
Nitrogen (Total)	0	Calculation	2	mg/L as N	
n-Propylbenzene (Surface Water)	154	GCMS	<1.0	ug/L	UKAS
o-Xylene (Surface Water)	154	GCMS	<1	ug/L	UKAS
Phenanthrene (GCMS)	200	GCMS	<0.01	ug/L	
Phenols (Total)	223	GCMS	<0.10	ug/L	
Phosphorus (Total) Surface Water	166	Colorimetry	0.038	mg/L as P	UKAS
p-Isopropyltoluene (Surface Water)	154	GCMS	<1	ug/L	UKAS
Polyaromatic Hydrocarbons (GCMS)	200	GCMS	<0.01	ug/L	
Pyrene (GCMS)	200	GCMS	<0.01	ug/L	
sec-Butylbenzene (Surface Water)	154	GCMS	<1	ug/L	UKAS
Selenium (Surface Water)	177	ICPMS	27	ug/L	UKAS
Solids (Total Dissolved)	105	Filtration/ Evaporation @ 180C	22478	mg/L	
Styrene (Surface Water)	154	GCMS	<1	ug/L	UKAS
tert-Butylbenzene (Surface Water)	154	GCMS	<1	ug/L	UKAS
Tetrachloroethene (Surface Water)	154	GCMS	<1	ug/L	UKAS
TOC (Surface Water)	316	TOC Analyser	3.9	mg/L	UKAS
Toluene (Surface Water)	154	GCMS	<1	ug/L	UKAS
Total Inorganic Nitrogen	0	Calculation	1.7	mg/L	
trans-1,2-Dichloroethene (Surface W	154	GCMS	<1	ug/L	UKAS
trans-1,3-Dichloropropene (Surface	154	GCMS	<1	ug/L	UKAS
Trichloroethene (Surface Water)	154	GCMS	<1.0	ug/L	
Trichlorofluoromethane (Surface Wat	154	GCMS	<1	ug/L	UKAS
Vanadium (Surface Water)	177	ICPMS	185	ug/L	UKAS

Signed : A Harmon ***Date : 25/04/2018***

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	12 Kilkerrin Park	*Sampled On*	**04/04/2018**
	Liosbaun Ind Est	*Date Testing Commenced*	**06/04/2018**
	Liosbaun	*Received or Collected*	**By Fitz: Paul C**
	Co Galway	*Condition on Receipt*	**Acceptable**
Customer PO		*Date of Report*	**25/04/2018**
Customer Ref	**UP500-MR-SURF**	*Sample Type*	**Surface Water**
Ref 2			
Ref 3			

CERTIFICATE OF ANALYSIS

Test Parameter	SOP	Analytical Technique	Result	Units	Acc.
Vinyl chloride (Surface Water)	154	GCMS	<1	ug/L	UKAS
Volatile Organic Compounds	154	GCMS	<5.0	ug/L	
Xylene Total (Surface Water)	154	GCMS	<1	ug/L	UKAS
Zinc (Surface Water)	177	ICPMS	122	ug/L	UKAS

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	Aqua-Fact International Services Ltd	*Date of Receipt*	06/04/2018
	12 Kilkerrin Park	*Sampled On*	04/04/2018
	Liosbaun Ind Est	*Date Testing Commenced*	06/04/2018
	Liosbaun	*Received or Collected*	By Fitz: Paul C
	Co Galway	*Condition on Receipt*	Acceptable
Customer PO		*Date of Report*	25/04/2018
Customer Ref	UP500-MF-MID	*Sample Type*	Surface Water
Ref 2			
Ref 3			

CERTIFICATE OF ANALYSIS

Test Parameter	SOP	Analytical Technique	Result	Units	Acc.
1,1,1,2-Tetrachloroethane (Surface	154	GCMS	<1	ug/L	UKAS
1,1,1-Trichloroethane (Surface Water	154	GCMS	<1	ug/L	UKAS
1,1,2,2-Tetrachloroethane (Surface	154	GCMS	<5.0	ug/L	
1,1,2-Trichloroethane (Surface Water	154	GCMS	<2	ug/L	UKAS
1,1-Dichloroethane (Surface Water)	154	GCMS	<1	ug/L	UKAS
1,1-Dichloroethene (Surface Water)	154	GCMS	<1	ug/L	UKAS
1,1-Dichloropropene (Surface Water)	154	GCMS	<1	ug/L	UKAS
1,2,3-Trichlorobenzene (Surface Wat	154	GCMS	<1	ug/L	UKAS
1,2,3-Trichloropropane (Surface Wat	154	GCMS	<0.9	ug/L	UKAS
1,2,4-Trichlorobenzene (Surface Wat	154	GCMS	<0.6	ug/L	UKAS
1,2,4-Trimethylbenzene (Surface Wa	154	GCMS	<1	ug/L	UKAS
1,2-Dibromo-3-chloropropane (Surfac	154	GCMS	<1	ug/L	UKAS
1,2-Dibromoethane (Surface Water)	154	GCMS	<1	ug/L	UKAS
1,2-Dichlorobenzene (Surface Water)	154	GCMS	<1	ug/L	UKAS
1,2-Dichloroethane (Surface Water)	154	GCMS	<1	ug/L	UKAS
1,2-Dichloropropane (Surface Water)	154	GCMS	<1	ug/L	UKAS
1,3,5-Trimethylbenzene (Surface Wa	154	GCMS	<1	ug/L	UKAS
1,3-Dichlorobenzene (Surface Water)	154	GCMS	<1	ug/L	UKAS
1,3-Dichloropropane (Surface Water)	154	GCMS	<1	ug/L	UKAS
1,4-Dichlorobenzene (Surface Water)	154	GCMS	<1	ug/L	UKAS
2,2-Dichloropropane (Surface Water)	154	GCMS	<5.0	ug/L	
2-Chlorotoluene (Surface Water)	154	GCMS	<1	ug/L	UKAS
4-Chlorotoluene (Surface Water)	154	GCMS	<1	ug/L	UKAS
Acenaphthene (GCMS)	200	GCMS	<0.01	ug/L	

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		Date of Receipt	06/04/2018
		Sampled On	04/04/2018
		Date Testing Commenced	06/04/2018
		Received or Collected	By Fitz: Paul C
		Condition on Receipt	Acceptable
Customer PO		*Date of Report*	25/04/2018
Customer Ref	UP500-MF-MID	*Sample Type*	Surface Water
Ref 2			
Ref 3			

CERTIFICATE OF ANALYSIS

Test Parameter	SOP	Analytical Technique	Result	Units	Acc.
Acenaphthylene (GCMS)	200	GCMS	<0.01	ug/L	
Ammonia (Surface Water)	114	Colorimetry	0.34	mg/L as N	UKAS
Anthracene (GCMS)	200	GCMS	<0.01	ug/L	
Antimony (Surface Water)	177	ICPMS	4	ug/L	UKAS
Arsenic (Surface Water)	177	ICPMS	<1	ug/L	UKAS
Barium (Surface Water)	177	ICPMS	35	ug/L	UKAS
Benzene (Surface Water)	154	GCMS	<1	ug/L	UKAS
Benzo(a)anthracene (GCMS)	200	GCMS	<0.01	ug/L	
Benzo(a)pyrene (GCMS)	200	GCMS	<0.01	ug/L	
Benzo(g,h,i)perylene (GCMS)	200	GCMS	<0.01	ug/L	
Benzo(k)fluoranthene (GCMS)	200	GCMS	<0.01	ug/L	
Bromobenzene (Surface Water)	154	GCMS	<1	ug/L	UKAS
Bromochloromethane (Surface Water	154	GCMS	<1	ug/L	UKAS
Bromodichloromethane (Surface Wat	154	GCMS	<1	ug/L	UKAS
Bromoform (Surface Water)	154	GCMS	<1	ug/L	UKAS
Bromomethane (Surface Water)	154	GCMS	<5.0	ug/L	
Cadmium (Surface Water)	177	ICPMS	<1	ug/L	UKAS
Carbon tetrachloride (Surface Water)	154	GCMS	<1	ug/L	UKAS
Chlorobenzene (Surface Water)	154	GCMS	<1	ug/L	UKAS
Chloroethane (Surface Water)	154	GCMS	<5.0	ug/L	
Chloroform (Surface Water)	154	GCMS	<1	ug/L	UKAS
Chloromethane (Surface Water)	154	GCMS	<5.0	ug/L	
Chromium (Surface Water)	177	ICPMS	10	ug/L	UKAS
Chrysene (GCMS)	200	GCMS	<0.01	ug/L	

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		Sampled On	04/04/2018
		Date Testing Commenced	06/04/2018
		Received or Collected	By Fitz: Paul C
		Condition on Receipt	Acceptable
Customer PO		*Date of Report*	25/04/2018
Customer Ref	UP500-MF-MID	*Sample Type*	Surface Water
Ref 2			
Ref 3			

CERTIFICATE OF ANALYSIS

Test Parameter	SOP	Analytical Technique	Result	Units	Acc.
cis-1,2-Dichloroethene (Surface Wat	154	GCMS	<1	ug/L	UKAS
cis-1,3-Dichloropropene (Surface Wa	154	GCMS	<1	ug/L	UKAS
COD (Surface Water)	107	Colorimetry	95	mg/L	UKAS
Copper (Surface Water)	177	ICPMS	11	ug/L	UKAS
Coronene (GCMS)	200	GCMS	<0.01	ug/L	
Dibenzo(a,h)anthracene (GCMS)	200	GCMS	<0.01	ug/L	
Dibromochloromethane (Surface Wat	154	GCMS	<1	ug/L	UKAS
Dibromomethane (Surface Water)	154	GCMS	<1	ug/L	UKAS
Dichlorodifluoromethane (Surface W	154	GCMS	<5.0	ug/L	
Dichloromethane (Surface Water)	154	GCMS	<5.0	ug/L	
Ethylbenzene (Surface Water)	154	GCMS	<1	ug/L	UKAS
Fluoranthene (GCMS)	200	GCMS	<0.01	ug/L	
Fluorene (GCMS)	200	GCMS	<0.01	ug/L	
Hexachlorobutadiene (Surface Water	154	GCMS	<1	ug/L	UKAS
Indeno(1,2,3-cd)pyrene (GCMS)	200	GCMS	<0.01	ug/L	
Isopropylbenzene (Surface Water)	154	GCMS	<1	ug/L	UKAS
Lead (Surface Water)	177	ICPMS	11	ug/L	UKAS
m- & p-Xylene (Surface Water)	154	GCMS	<1	ug/L	UKAS
Mercury (Surface water)	178	ICPMS	1.30	ug/L	UKAS
Molybdenum	226	ICPMS	10	ug/L	
Naphthalene (Surface Water)	154	GCMS	<1	ug/L	UKAS
n-Butylbenzene (Surface Water)	154	GCMS	<1	ug/L	UKAS
Nickel (Surface Water)	177	ICPMS	9	ug/L	UKAS
Nitrogen (Total Kjeldahl)	104	Digestion/ Distillation/ Titrimetr	<1.00	mg/L as N	

Signed : A Harmon **Date : 25/04/2018**

Aoife Harmon - Technical Supervisor

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UKAS TESTING 2802

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Customer	**Caroline Roche**	*Lab Report Ref. No.*	**0529/001/05**
	Aqua-Fact International Services Ltd	*Date of Receipt*	**06/04/2018**
	12 Kilkerrin Park	*Sampled On*	**04/04/2018**
	Liosbaun Ind Est	*Date Testing Commenced*	**06/04/2018**
	Liosbaun	*Received or Collected*	**By Fitz: Paul C**
	Co Galway	*Condition on Receipt*	**Acceptable**
Customer PO		*Date of Report*	**25/04/2018**
Customer Ref	**UP500-MF-MID**	*Sample Type*	**Surface Water**
Ref 2			
Ref 3			

CERTIFICATE OF ANALYSIS

Test Parameter	SOP	Analytical Technique	Result	Units	Acc.
Nitrogen (Total Oxidised) (Surface W	151	Colorimetry	1.41	mg/L as N	UKAS
Nitrogen (Total)	0	Calculation	2	mg/L as N	
n-Propylbenzene (Surface Water)	154	GCMS	<1.0	ug/L	UKAS
o-Xylene (Surface Water)	154	GCMS	<1	ug/L	UKAS
Phenanthrene (GCMS)	200	GCMS	<0.01	ug/L	
Phenols (Total)	223	GCMS	<0.10	ug/L	
Phosphorus (Total) Surface Water	166	Colorimetry	0.044	mg/L as P	UKAS
p-Isopropyltoluene (Surface Water)	154	GCMS	<1	ug/L	UKAS
Polyaromatic Hydrocarbons (GCMS)	200	GCMS	<0.01	ug/L	
Pyrene (GCMS)	200	GCMS	<0.01	ug/L	
sec-Butylbenzene (Surface Water)	154	GCMS	<1	ug/L	UKAS
Selenium (Surface Water)	177	ICPMS	8	ug/L	UKAS
Solids (Total Dissolved)	105	Filtration/ Evaporation @ 180C	22997	mg/L	
Styrene (Surface Water)	154	GCMS	<1	ug/L	UKAS
tert-Butylbenzene (Surface Water)	154	GCMS	<1	ug/L	UKAS
Tetrachloroethene (Surface Water)	154	GCMS	<1	ug/L	UKAS
TOC (Surface Water)	316	TOC Analyser	3.7	mg/L	UKAS
Toluene (Surface Water)	154	GCMS	<1	ug/L	UKAS
Total Inorganic Nitrogen	0	Calculation	1	mg/L	
trans-1,2-Dichloroethene (Surface W	154	GCMS	<1	ug/L	UKAS
trans-1,3-Dichloropropene (Surface	154	GCMS	<1	ug/L	UKAS
Trichloroethene (Surface Water)	154	GCMS	<1.0	ug/L	
Trichlorofluoromethane (Surface Wat	154	GCMS	<1	ug/L	UKAS
Vanadium (Surface Water)	177	ICPMS	214	ug/L	UKAS

Signed : A Harmon

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	Liosbaun Ind Est	*Date Testing Commenced*	**06/04/2018**
	Liosbaun	*Received or Collected*	**By Fitz: Paul C**
	Co Galway	*Condition on Receipt*	**Acceptable**
Customer PO		*Date of Report*	**25/04/2018**
Customer Ref	**UP500-MF-MID**	*Sample Type*	**Surface Water**
Ref 2			
Ref 3			

CERTIFICATE OF ANALYSIS

Test Parameter	SOP	Analytical Technique	Result	Units	Acc.
Vinyl chloride (Surface Water)	154	GCMS	<1	ug/L	UKAS
Volatile Organic Compounds	154	GCMS	<5.0	ug/L	
Xylene Total (Surface Water)	154	GCMS	<1	ug/L	UKAS
Zinc (Surface Water)	177	ICPMS	156	ug/L	UKAS

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Customer	**Caroline Roche**	***Lab Report Ref. No.***	**0529/001/06**
	Aqua-Fact International Services Ltd	***Date of Receipt***	**06/04/2018**
	12 Kilkerrin Park	***Sampled On***	**04/04/2018**
	Liosbaun Ind Est	***Date Testing Commenced***	**06/04/2018**
	Liosbaun	***Received or Collected***	**By Fitz: Paul C**
	Co Galway	***Condition on Receipt***	**Acceptable**
Customer PO		***Date of Report***	**25/04/2018**
Customer Ref	**UP500-MF-BOTTOM**	***Sample Type***	**Surface Water**
Ref 2			
Ref 3			

CERTIFICATE OF ANALYSIS

Test Parameter	SOP	Analytical Technique	Result	Units	Acc.
1,1,1,2-Tetrachloroethane (Surface	154	GCMS	<1	ug/L	UKAS
1,1,1-Trichloroethane (Surface Water	154	GCMS	<1	ug/L	UKAS
1,1,2,2-Tetrachloroethane (Surface	154	GCMS	<5.0	ug/L	
1,1,2-Trichloroethane (Surface Water	154	GCMS	<2	ug/L	UKAS
1,1-Dichloroethane (Surface Water)	154	GCMS	<1	ug/L	UKAS
1,1-Dichloroethene (Surface Water)	154	GCMS	<1	ug/L	UKAS
1,1-Dichloropropene (Surface Water)	154	GCMS	<1	ug/L	UKAS
1,2,3-Trichlorobenzene (Surface Wat	154	GCMS	<1	ug/L	UKAS
1,2,3-Trichloropropane (Surface Wat	154	GCMS	<0.9	ug/L	UKAS
1,2,4-Trichlorobenzene (Surface Wat	154	GCMS	<0.6	ug/L	UKAS
1,2,4-Trimethylbenzene (Surface Wa	154	GCMS	<1	ug/L	UKAS
1,2-Dibromo-3-chloropropane (Surfac	154	GCMS	<1	ug/L	UKAS
1,2-Dibromoethane (Surface Water)	154	GCMS	<1	ug/L	UKAS
1,2-Dichlorobenzene (Surface Water)	154	GCMS	<1	ug/L	UKAS
1,2-Dichloroethane (Surface Water)	154	GCMS	<1	ug/L	UKAS
1,2-Dichloropropane (Surface Water)	154	GCMS	<1	ug/L	UKAS
1,3,5-Trimethylbenzene (Surface Wa	154	GCMS	<1	ug/L	UKAS
1,3-Dichlorobenzene (Surface Water)	154	GCMS	<1	ug/L	UKAS
1,3-Dichloropropane (Surface Water)	154	GCMS	<1	ug/L	UKAS
1,4-Dichlorobenzene (Surface Water)	154	GCMS	<1	ug/L	UKAS
2,2-Dichloropropane (Surface Water)	154	GCMS	<5.0	ug/L	
2-Chlorotoluene (Surface Water)	154	GCMS	<1	ug/L	UKAS
4-Chlorotoluene (Surface Water)	154	GCMS	<1	ug/L	UKAS
Acenaphthene (GCMS)	200	GCMS	<0.01	ug/L	

Signed : A Harman ***Date : 25/04/2018***

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	12 Kilkerrin Park	*Sampled On*	04/04/2018
	Liosbaun Ind Est	*Date Testing Commenced*	06/04/2018
	Liosbaun	*Received or Collected*	By Fitz: Paul C
	Co Galway	*Condition on Receipt*	Acceptable
Customer PO		*Date of Report*	25/04/2018
Customer Ref	UP500-MF-BOTTOM	*Sample Type*	Surface Water
Ref 2			
Ref 3			

CERTIFICATE OF ANALYSIS

Test Parameter	SOP	Analytical Technique	Result	Units	Acc.
Acenaphthylene (GCMS)	200	GCMS	<0.01	ug/L	
Ammonia (Surface Water)	114	Colorimetry	0.36	mg/L as N	UKAS
Anthracene (GCMS)	200	GCMS	<0.01	ug/L	
Antimony (Surface Water)	177	ICPMS	3	ug/L	UKAS
Arsenic (Surface Water)	177	ICPMS	2	ug/L	UKAS
Barium (Surface Water)	177	ICPMS	29	ug/L	UKAS
Benzene (Surface Water)	154	GCMS	<1	ug/L	UKAS
Benzo(a)anthracene (GCMS)	200	GCMS	<0.01	ug/L	
Benzo(a)pyrene (GCMS)	200	GCMS	<0.01	ug/L	
Benzo(g,h,i)perylene (GCMS)	200	GCMS	<0.01	ug/L	
Benzo(k)fluoranthene (GCMS)	200	GCMS	<0.01	ug/L	
Bromobenzene (Surface Water)	154	GCMS	<1	ug/L	UKAS
Bromochloromethane (Surface Water	154	GCMS	<1	ug/L	UKAS
Bromodichloromethane (Surface Wat	154	GCMS	<1	ug/L	UKAS
Bromoform (Surface Water)	154	GCMS	<1	ug/L	UKAS
Bromomethane (Surface Water)	154	GCMS	<5.0	ug/L	
Cadmium (Surface Water)	177	ICPMS	<1	ug/L	UKAS
Carbon tetrachloride (Surface Water)	154	GCMS	<1	ug/L	UKAS
Chlorobenzene (Surface Water)	154	GCMS	<1	ug/L	UKAS
Chloroethane (Surface Water)	154	GCMS	<5.0	ug/L	
Chloroform (Surface Water)	154	GCMS	<1	ug/L	UKAS
Chloromethane (Surface Water)	154	GCMS	<5.0	ug/L	
Chromium (Surface Water)	177	ICPMS	8	ug/L	UKAS
Chrysene (GCMS)	200	GCMS	<0.01	ug/L	

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Date : 25/04/2018

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	12 Kilkerrin Park	*Sampled On*	**04/04/2018**
	Liosbaun Ind Est	*Date Testing Commenced*	**06/04/2018**
	Liosbaun	*Received or Collected*	**By Fitz: Paul C**
	Co Galway	*Condition on Receipt*	**Acceptable**
Customer PO		*Date of Report*	**25/04/2018**
Customer Ref	**UP500-MF-BOTTOM**	*Sample Type*	**Surface Water**
Ref 2			
Ref 3			

CERTIFICATE OF ANALYSIS

Test Parameter	SOP	Analytical Technique	Result	Units	Acc.
cis-1,2-Dichloroethene (Surface Wat	154	GCMS	<1	ug/L	UKAS
cis-1,3-Dichloropropene (Surface Wa	154	GCMS	<1	ug/L	UKAS
COD (Surface Water)	107	Colorimetry	120	mg/L	UKAS
Copper (Surface Water)	177	ICPMS	9	ug/L	UKAS
Coronene (GCMS)	200	GCMS	<0.01	ug/L	
Dibenzo(a,h)anthracene (GCMS)	200	GCMS	<0.01	ug/L	
Dibromochloromethane (Surface Wat	154	GCMS	<1	ug/L	UKAS
Dibromomethane (Surface Water)	154	GCMS	<1	ug/L	UKAS
Dichlorodifluoromethane (Surface W	154	GCMS	<5.0	ug/L	
Dichloromethane (Surface Water)	154	GCMS	<5.0	ug/L	
Ethylbenzene (Surface Water)	154	GCMS	<1	ug/L	UKAS
Fluoranthene (GCMS)	200	GCMS	<0.01	ug/L	
Fluorene (GCMS)	200	GCMS	<0.01	ug/L	
Hexachlorobutadiene (Surface Water	154	GCMS	<1	ug/L	UKAS
Indeno(1,2,3-cd)pyrene (GCMS)	200	GCMS	<0.01	ug/L	
Isopropylbenzene (Surface Water)	154	GCMS	<1	ug/L	UKAS
Lead (Surface Water)	177	ICPMS	6	ug/L	UKAS
m- & p-Xylene (Surface Water)	154	GCMS	<1	ug/L	UKAS
Mercury (Surface water)	178	ICPMS	0.92	ug/L	UKAS
Molybdenum	226	ICPMS	8	ug/L	
Naphthalene (Surface Water)	154	GCMS	<1	ug/L	UKAS
n-Butylbenzene (Surface Water)	154	GCMS	<1	ug/L	UKAS
Nickel (Surface Water)	177	ICPMS	15	ug/L	UKAS
Nitrogen (Total Kjeldahl)	104	Digestion/ Distillation/ Titrimetr	1.12	mg/L as N	

Signed : A Harman

Date : 25/04/2018

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Customer	Caroline Roche Aqua-Fact International Services Ltd 12 Kilkerrin Park Liosbaun Ind Est Liosbaun Co Galway	*Lab Report Ref. No.*	0529/001/06
		Date of Receipt	06/04/2018
		Sampled On	04/04/2018
		Date Testing Commenced	06/04/2018
		Received or Collected	By Fitz: Paul C
		Condition on Receipt	Acceptable
Customer PO		*Date of Report*	25/04/2018
Customer Ref	UP500-MF-BOTTOM	*Sample Type*	Surface Water
Ref 2			
Ref 3			

CERTIFICATE OF ANALYSIS

Test Parameter	SOP	Analytical Technique	Result	Units	Acc.
Nitrogen (Total Oxidised) (Surface W	151	Colorimetry	1.23	mg/L as N	UKAS
Nitrogen (Total)	0	Calculation	2	mg/L as N	
n-Propylbenzene (Surface Water)	154	GCMS	<1.0	ug/L	UKAS
o-Xylene (Surface Water)	154	GCMS	<1	ug/L	UKAS
Phenanthrene (GCMS)	200	GCMS	<0.01	ug/L	
Phenols (Total)	223	GCMS	<0.10	ug/L	
Phosphorus (Total) Surface Water	166	Colorimetry	0.069	mg/L as P	UKAS
p-Isopropyltoluene (Surface Water)	154	GCMS	<1	ug/L	UKAS
Polyaromatic Hydrocarbons (GCMS)	200	GCMS	<0.01	ug/L	
Pyrene (GCMS)	200	GCMS	<0.01	ug/L	
sec-Butylbenzene (Surface Water)	154	GCMS	<1	ug/L	UKAS
Selenium (Surface Water)	177	ICPMS	<1	ug/L	UKAS
Solids (Total Dissolved)	105	Filtration/ Evaporation @ 180C	24288	mg/L	
Styrene (Surface Water)	154	GCMS	<1	ug/L	UKAS
tert-Butylbenzene (Surface Water)	154	GCMS	<1	ug/L	UKAS
Tetrachloroethene (Surface Water)	154	GCMS	<1	ug/L	UKAS
TOC (Surface Water)	316	TOC Analyser	3.8	mg/L	UKAS
Toluene (Surface Water)	154	GCMS	<1	ug/L	UKAS
Total Inorganic Nitrogen	0	Calculation	1	mg/L	
trans-1,2-Dichloroethene (Surface W	154	GCMS	<1	ug/L	UKAS
trans-1,3-Dichloropropene (Surface	154	GCMS	<1	ug/L	UKAS
Trichloroethene (Surface Water)	154	GCMS	<1.0	ug/L	
Trichlorofluoromethane (Surface Wat	154	GCMS	<1	ug/L	UKAS
Vanadium (Surface Water)	177	ICPMS	181	ug/L	UKAS

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Date : 25/04/2018

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	12 Kilkerrin Park	***Sampled On***	**04/04/2018**
	Liosbaun Ind Est	***Date Testing Commenced***	**06/04/2018**
	Liosbaun	***Received or Collected***	**By Fitz: Paul C**
	Co Galway	***Condition on Receipt***	**Acceptable**
Customer PO		***Date of Report***	**25/04/2018**
Customer Ref	**UP500-MF-BOTTOM**	***Sample Type***	**Surface Water**
Ref 2			
Ref 3			

CERTIFICATE OF ANALYSIS

Test Parameter	SOP	Analytical Technique	Result	Units	Acc.
Vinyl chloride (Surface Water)	154	GCMS	<1	ug/L	UKAS
Volatile Organic Compounds	154	GCMS	<5.0	ug/L	
Xylene Total (Surface Water)	154	GCMS	<1	ug/L	UKAS
Zinc (Surface Water)	177	ICPMS	143	ug/L	UKAS

Signed :

Date : 25/04/2018

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Customer	Caroline Roche Aqua-Fact International Services Ltd 12 Kilkerrin Park Liosbaun Ind Est Liosbaun Co Galway	*Lab Report Ref. No.*	0529/001/16
		Date of Receipt	06/04/2018
		Sampled On	04/04/2018
		Date Testing Commenced	06/04/2018
		Received or Collected	By Fitz: Paul C
		Condition on Receipt	Acceptable
Customer PO		*Date of Report*	25/04/2018
Customer Ref	DOWN500-ME-SURF	*Sample Type*	Surface Water
Ref 2			
Ref 3			

CERTIFICATE OF ANALYSIS

Test Parameter	SOP	Analytical Technique	Result	Units	Acc.
1,1,1,2-Tetrachloroethane (Surface	154	GCMS	<1	ug/L	UKAS
1,1,1-Trichloroethane (Surface Water	154	GCMS	<1	ug/L	UKAS
1,1,2,2-Tetrachloroethane (Surface	154	GCMS	<5.0	ug/L	
1,1,2-Trichloroethane (Surface Water	154	GCMS	<2	ug/L	UKAS
1,1-Dichloroethane (Surface Water)	154	GCMS	<1	ug/L	UKAS
1,1-Dichloroethene (Surface Water)	154	GCMS	<1	ug/L	UKAS
1,1-Dichloropropene (Surface Water)	154	GCMS	<1	ug/L	UKAS
1,2,3-Trichlorobenzene (Surface Wat	154	GCMS	<1	ug/L	UKAS
1,2,3-Trichloropropane (Surface Wat	154	GCMS	<0.9	ug/L	UKAS
1,2,4-Trichlorobenzene (Surface Wat	154	GCMS	<0.6	ug/L	UKAS
1,2,4-Trimethylbenzene (Surface Wa	154	GCMS	<1	ug/L	UKAS
1,2-Dibromo-3-chloropropane (Surfac	154	GCMS	<1	ug/L	UKAS
1,2-Dibromoethane (Surface Water)	154	GCMS	<1	ug/L	UKAS
1,2-Dichlorobenzene (Surface Water)	154	GCMS	<1	ug/L	UKAS
1,2-Dichloroethane (Surface Water)	154	GCMS	<1	ug/L	UKAS
1,2-Dichloropropane (Surface Water)	154	GCMS	<1	ug/L	UKAS
1,3,5-Trimethylbenzene (Surface Wa	154	GCMS	<1	ug/L	UKAS
1,3-Dichlorobenzene (Surface Water)	154	GCMS	<1	ug/L	UKAS
1,3-Dichloropropane (Surface Water)	154	GCMS	<1	ug/L	UKAS
1,4-Dichlorobenzene (Surface Water)	154	GCMS	<1	ug/L	UKAS
2,2-Dichloropropane (Surface Water)	154	GCMS	<5.0	ug/L	
2-Chlorotoluene (Surface Water)	154	GCMS	<1	ug/L	UKAS
4-Chlorotoluene (Surface Water)	154	GCMS	<1	ug/L	UKAS
Acenaphthene (GCMS)	200	GCMS	<0.01	ug/L	

Signed : A Harmon

Date : 25/04/2018

Aoife Harmon - Technical Supervisor

Acc. : Accredited Parameters by ISO 17025:2005
PVL - Parametric Value Limit as per EU (Drinking water) Regulations (SI 122 2014)
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UKAS TESTING 2802

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Fitz scientific

Monitoring and Testing Services

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Customer	Caroline Roche Aqua-Fact International Services Ltd 12 Kilkerrin Park Liosbaun Ind Est Liosbaun Co Galway	*Lab Report Ref. No.*	0529/001/16
		Date of Receipt	06/04/2018
		Sampled On	04/04/2018
		Date Testing Commenced	06/04/2018
		Received or Collected	By Fitz: Paul C
		Condition on Receipt	Acceptable
Customer PO		*Date of Report*	25/04/2018
Customer Ref	DOWN500-ME-SURF	*Sample Type*	Surface Water
Ref 2			
Ref 3			

CERTIFICATE OF ANALYSIS

Test Parameter	SOP	Analytical Technique	Result	Units	Acc.
Acenaphthylene (GCMS)	200	GCMS	<0.01	ug/L	
Ammonia (Surface Water)	114	Colorimetry	0.37	mg/L as N	UKAS
Anthracene (GCMS)	200	GCMS	<0.01	ug/L	
Antimony (Surface Water)	177	ICPMS	<3	ug/L	UKAS
Arsenic (Surface Water)	177	ICPMS	4	ug/L	UKAS
Barium (Surface Water)	177	ICPMS	38	ug/L	UKAS
Benzene (Surface Water)	154	GCMS	<1	ug/L	UKAS
Benzo(a)anthracene (GCMS)	200	GCMS	<0.01	ug/L	
Benzo(a)pyrene (GCMS)	200	GCMS	<0.01	ug/L	
Benzo(g,h,i)perylene (GCMS)	200	GCMS	<0.01	ug/L	
Benzo(k)fluoranthene (GCMS)	200	GCMS	<0.01	ug/L	
Bromobenzene (Surface Water)	154	GCMS	<1	ug/L	UKAS
Bromochloromethane (Surface Water	154	GCMS	<1	ug/L	UKAS
Bromodichloromethane (Surface Wat	154	GCMS	<1	ug/L	UKAS
Bromoform (Surface Water)	154	GCMS	<1	ug/L	UKAS
Bromomethane (Surface Water)	154	GCMS	<5.0	ug/L	
Cadmium (Surface Water)	177	ICPMS	<1	ug/L	UKAS
Carbon tetrachloride (Surface Water)	154	GCMS	<1	ug/L	UKAS
Chlorobenzene (Surface Water)	154	GCMS	<1	ug/L	UKAS
Chloroethane (Surface Water)	154	GCMS	<5.0	ug/L	
Chloroform (Surface Water)	154	GCMS	<1	ug/L	UKAS
Chloromethane (Surface Water)	154	GCMS	<5.0	ug/L	
Chromium (Surface Water)	177	ICPMS	7	ug/L	UKAS
Chrysene (GCMS)	200	GCMS	<0.01	ug/L	

Signed : A Harmon

Date : 25/04/2018

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	Aqua-Fact International Services Ltd	*Date of Receipt*	**06/04/2018**
	12 Kilkerrin Park	*Sampled On*	**04/04/2018**
	Liosbaun Ind Est	*Date Testing Commenced*	**06/04/2018**
	Liosbaun	*Received or Collected*	**By Fitz: Paul C**
	Co Galway	*Condition on Receipt*	**Acceptable**
Customer PO		*Date of Report*	**25/04/2018**
Customer Ref	**DOWN500-ME-SURF**	*Sample Type*	**Surface Water**
Ref 2			
Ref 3			

CERTIFICATE OF ANALYSIS

Test Parameter	SOP	Analytical Technique	Result	Units	Acc.
cis-1,2-Dichloroethene (Surface Wat	154	GCMS	<1	ug/L	UKAS
cis-1,3-Dichloropropene (Surface Wa	154	GCMS	<1	ug/L	UKAS
COD (Surface Water)	107	Colorimetry	90	mg/L	UKAS
Copper (Surface Water)	177	ICPMS	29	ug/L	UKAS
Coronene (GCMS)	200	GCMS	<0.01	ug/L	
Dibenzo(a,h)anthracene (GCMS)	200	GCMS	<0.01	ug/L	
Dibromochloromethane (Surface Wat	154	GCMS	<1	ug/L	UKAS
Dibromomethane (Surface Water)	154	GCMS	<1	ug/L	UKAS
Dichlorodifluoromethane (Surface W	154	GCMS	<5.0	ug/L	
Dichloromethane (Surface Water)	154	GCMS	<5.0	ug/L	
Ethylbenzene (Surface Water)	154	GCMS	<1	ug/L	UKAS
Fluoranthene (GCMS)	200	GCMS	<0.01	ug/L	
Fluorene (GCMS)	200	GCMS	<0.01	ug/L	
Hexachlorobutadiene (Surface Water	154	GCMS	<1	ug/L	UKAS
Indeno(1,2,3-cd)pyrene (GCMS)	200	GCMS	<0.01	ug/L	
Isopropylbenzene (Surface Water)	154	GCMS	<1	ug/L	UKAS
Lead (Surface Water)	177	ICPMS	21	ug/L	UKAS
m- & p-Xylene (Surface Water)	154	GCMS	<1	ug/L	UKAS
Mercury (Surface water)	178	ICPMS	<0.03	ug/L	UKAS
Molybdenum	226	ICPMS	7	ug/L	
Naphthalene (Surface Water)	154	GCMS	<1	ug/L	UKAS
n-Butylbenzene (Surface Water)	154	GCMS	<1	ug/L	UKAS
Nickel (Surface Water)	177	ICPMS	18	ug/L	UKAS
Nitrogen (Total Kjeldahl)	104	Digestion/ Distillation/ Titrimetr	<1.00	mg/L as N	

Signed : A Harmon

Date : 25/04/2018

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	Liosbaun	*Received or Collected*	**By Fitz: Paul C**
	Co Galway	*Condition on Receipt*	**Acceptable**
Customer PO		*Date of Report*	**25/04/2018**
Customer Ref	**DOWN500-ME-SURF**	*Sample Type*	**Surface Water**
Ref 2			
Ref 3			

CERTIFICATE OF ANALYSIS

Test Parameter	SOP	Analytical Technique	Result	Units	Acc.
Nitrogen (Total Oxidised) (Surface W	151	Colorimetry	2.40	mg/L as N	UKAS
Nitrogen (Total)	0	Calculation	3	mg/L as N	
n-Propylbenzene (Surface Water)	154	GCMS	<1.0	ug/L	UKAS
o-Xylene (Surface Water)	154	GCMS	<1	ug/L	UKAS
Phenanthrene (GCMS)	200	GCMS	<0.01	ug/L	
Phenols (Total)	223	GCMS	<0.10	ug/L	
Phosphorus (Total) Surface Water	166	Colorimetry	0.053	mg/L as P	UKAS
p-Isopropyltoluene (Surface Water)	154	GCMS	<1	ug/L	UKAS
Polyaromatic Hydrocarbons (GCMS)	200	GCMS	<0.01	ug/L	
Pyrene (GCMS)	200	GCMS	<0.01	ug/L	
sec-Butylbenzene (Surface Water)	154	GCMS	<1	ug/L	UKAS
Selenium (Surface Water)	177	ICPMS	1	ug/L	UKAS
Solids (Total Dissolved)	105	Filtration/ Evaporation @ 180C	19107	mg/L	
Styrene (Surface Water)	154	GCMS	<1	ug/L	UKAS
tert-Butylbenzene (Surface Water)	154	GCMS	<1	ug/L	UKAS
Tetrachloroethene (Surface Water)	154	GCMS	<1	ug/L	UKAS
TOC (Surface Water)	316	TOC Analyser	4.2	mg/L	UKAS
Toluene (Surface Water)	154	GCMS	<1	ug/L	UKAS
Total Inorganic Nitrogen	0	Calculation	1.8	mg/L	
trans-1,2-Dichloroethene (Surface W	154	GCMS	<1	ug/L	UKAS
trans-1,3-Dichloropropene (Surface	154	GCMS	<1	ug/L	UKAS
Trichloroethene (Surface Water)	154	GCMS	<1.0	ug/L	
Trichlorofluoromethane (Surface Wat	154	GCMS	<1	ug/L	UKAS
Vanadium (Surface Water)	177	ICPMS	216	ug/L	UKAS

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	Liosbaun Ind Est	*Date Testing Commenced*	**06/04/2018**
	Liosbaun	*Received or Collected*	**By Fitz: Paul C**
	Co Galway	*Condition on Receipt*	**Acceptable**
Customer PO		*Date of Report*	**25/04/2018**
Customer Ref	**DOWN500-ME-SURF**	*Sample Type*	**Surface Water**
Ref 2			
Ref 3			

CERTIFICATE OF ANALYSIS

Test Parameter	SOP	Analytical Technique	Result	Units	Acc.
Vinyl chloride (Surface Water)	154	GCMS	<1	ug/L	UKAS
Volatile Organic Compounds	154	GCMS	<5.0	ug/L	
Xylene Total (Surface Water)	154	GCMS	<1	ug/L	UKAS
Zinc (Surface Water)	177	ICPMS	505	ug/L	UKAS

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	Liosbaun Ind Est	***Date Testing Commenced***	**06/04/2018**
	Liosbaun	***Received or Collected***	**By Fitz: Paul C**
	Co Galway	***Condition on Receipt***	**Acceptable**
Customer PO		***Date of Report***	**25/04/2018**
Customer Ref	**DOWN500-ME-MID**	***Sample Type***	**Surface Water**
Ref 2			
Ref 3			

CERTIFICATE OF ANALYSIS

Test Parameter	SOP	Analytical Technique	Result	Units	Acc.
1,1,1,2-Tetrachloroethane (Surface	154	GCMS	<1	ug/L	UKAS
1,1,1-Trichloroethane (Surface Water	154	GCMS	<1	ug/L	UKAS
1,1,2,2-Tetrachloroethane (Surface	154	GCMS	<5.0	ug/L	
1,1,2-Trichloroethane (Surface Water	154	GCMS	<2	ug/L	UKAS
1,1-Dichloroethane (Surface Water)	154	GCMS	<1	ug/L	UKAS
1,1-Dichloroethene (Surface Water)	154	GCMS	<1	ug/L	UKAS
1,1-Dichloropropene (Surface Water)	154	GCMS	<1	ug/L	UKAS
1,2,3-Trichlorobenzene (Surface Wat	154	GCMS	<1	ug/L	UKAS
1,2,3-Trichloropropane (Surface Wat	154	GCMS	<0.9	ug/L	UKAS
1,2,4-Trichlorobenzene (Surface Wat	154	GCMS	<0.6	ug/L	UKAS
1,2,4-Trimethylbenzene (Surface Wa	154	GCMS	<1	ug/L	UKAS
1,2-Dibromo-3-chloropropane (Surfac	154	GCMS	<1	ug/L	UKAS
1,2-Dibromoethane (Surface Water)	154	GCMS	<1	ug/L	UKAS
1,2-Dichlorobenzene (Surface Water)	154	GCMS	<1	ug/L	UKAS
1,2-Dichloroethane (Surface Water)	154	GCMS	<1	ug/L	UKAS
1,2-Dichloropropane (Surface Water)	154	GCMS	<1	ug/L	UKAS
1,3,5-Trimethylbenzene (Surface Wa	154	GCMS	<1	ug/L	UKAS
1,3-Dichlorobenzene (Surface Water)	154	GCMS	<1	ug/L	UKAS
1,3-Dichloropropane (Surface Water)	154	GCMS	<1	ug/L	UKAS
1,4-Dichlorobenzene (Surface Water)	154	GCMS	<1	ug/L	UKAS
2,2-Dichloropropane (Surface Water)	154	GCMS	<5.0	ug/L	
2-Chlorotoluene (Surface Water)	154	GCMS	<1	ug/L	UKAS
4-Chlorotoluene (Surface Water)	154	GCMS	<1	ug/L	UKAS
Acenaphthene (GCMS)	200	GCMS	<0.01	ug/L	

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	12 Kilkerrin Park	*Sampled On*	**04/04/2018**
	Liosbaun Ind Est	*Date Testing Commenced*	**06/04/2018**
	Liosbaun	*Received or Collected*	**By Fitz: Paul C**
	Co Galway	*Condition on Receipt*	**Acceptable**
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Customer Ref	**DOWN500-ME-MID**	*Sample Type*	**Surface Water**
Ref 2			
Ref 3			

CERTIFICATE OF ANALYSIS

Test Parameter	SOP	Analytical Technique	Result	Units	Acc.
Acenaphthylene (GCMS)	200	GCMS	<0.01	ug/L	
Ammonia (Surface Water)	114	Colorimetry	0.37	mg/L as N	UKAS
Anthracene (GCMS)	200	GCMS	<0.01	ug/L	
Antimony (Surface Water)	177	ICPMS	<3	ug/L	UKAS
Arsenic (Surface Water)	177	ICPMS	2	ug/L	UKAS
Barium (Surface Water)	177	ICPMS	33	ug/L	UKAS
Benzene (Surface Water)	154	GCMS	<1	ug/L	UKAS
Benzo(a)anthracene (GCMS)	200	GCMS	<0.01	ug/L	
Benzo(a)pyrene (GCMS)	200	GCMS	<0.01	ug/L	
Benzo(g,h,i)perylene (GCMS)	200	GCMS	<0.01	ug/L	
Benzo(k)fluoranthene (GCMS)	200	GCMS	<0.01	ug/L	
Bromobenzene (Surface Water)	154	GCMS	<1	ug/L	UKAS
Bromochloromethane (Surface Water	154	GCMS	<1	ug/L	UKAS
Bromodichloromethane (Surface Wat	154	GCMS	<1	ug/L	UKAS
Bromoform (Surface Water)	154	GCMS	<1	ug/L	UKAS
Bromomethane (Surface Water)	154	GCMS	<5.0	ug/L	
Cadmium (Surface Water)	177	ICPMS	<1	ug/L	UKAS
Carbon tetrachloride (Surface Water)	154	GCMS	<1	ug/L	UKAS
Chlorobenzene (Surface Water)	154	GCMS	<1	ug/L	UKAS
Chloroethane (Surface Water)	154	GCMS	<5.0	ug/L	
Chloroform (Surface Water)	154	GCMS	<1	ug/L	UKAS
Chloromethane (Surface Water)	154	GCMS	<5.0	ug/L	
Chromium (Surface Water)	177	ICPMS	10	ug/L	UKAS
Chrysene (GCMS)	200	GCMS	<0.01	ug/L	

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Customer PO		*Date of Report*	25/04/2018
Customer Ref	DOWN500-ME-MID	*Sample Type*	Surface Water
Ref 2			
Ref 3			

CERTIFICATE OF ANALYSIS

Test Parameter	SOP	Analytical Technique	Result	Units	Acc.
cis-1,2-Dichloroethene (Surface Wat	154	GCMS	<1	ug/L	UKAS
cis-1,3-Dichloropropene (Surface Wa	154	GCMS	<1	ug/L	UKAS
COD (Surface Water)	107	Colorimetry	90	mg/L	UKAS
Copper (Surface Water)	177	ICPMS	11	ug/L	UKAS
Coronene (GCMS)	200	GCMS	<0.01	ug/L	
Dibenzo(a,h)anthracene (GCMS)	200	GCMS	<0.01	ug/L	
Dibromochloromethane (Surface Wat	154	GCMS	<1	ug/L	UKAS
Dibromomethane (Surface Water)	154	GCMS	<1	ug/L	UKAS
Dichlorodifluoromethane (Surface W	154	GCMS	<5.0	ug/L	
Dichloromethane (Surface Water)	154	GCMS	<5.0	ug/L	
Ethylbenzene (Surface Water)	154	GCMS	<1	ug/L	UKAS
Fluoranthene (GCMS)	200	GCMS	<0.01	ug/L	
Fluorene (GCMS)	200	GCMS	<0.01	ug/L	
Hexachlorobutadiene (Surface Water	154	GCMS	<1	ug/L	UKAS
Indeno(1,2,3-cd)pyrene (GCMS)	200	GCMS	<0.01	ug/L	
Isopropylbenzene (Surface Water)	154	GCMS	<1	ug/L	UKAS
Lead (Surface Water)	177	ICPMS	13	ug/L	UKAS
m- & p-Xylene (Surface Water)	154	GCMS	<1	ug/L	UKAS
Mercury (Surface water)	178	ICPMS	<0.03	ug/L	UKAS
Molybdenum	226	ICPMS	7	ug/L	
Naphthalene (Surface Water)	154	GCMS	<1	ug/L	UKAS
n-Butylbenzene (Surface Water)	154	GCMS	<1	ug/L	UKAS
Nickel (Surface Water)	177	ICPMS	13	ug/L	UKAS
Nitrogen (Total Kjeldahl)	104	Digestion/ Distillation/ Titrimetr	<1.00	mg/L as N	

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	Liosbaun	***Received or Collected***	**By Fitz: Paul C**
	Co Galway	***Condition on Receipt***	**Acceptable**
Customer PO		***Date of Report***	**25/04/2018**
Customer Ref	**DOWN500-ME-MID**	***Sample Type***	**Surface Water**
Ref 2			
Ref 3			

CERTIFICATE OF ANALYSIS

Test Parameter	SOP	Analytical Technique	Result	Units	Acc.
Nitrogen (Total Oxidised) (Surface W	151	Colorimetry	1.98	mg/L as N	UKAS
Nitrogen (Total)	0	Calculation	2	mg/L as N	
n-Propylbenzene (Surface Water)	154	GCMS	<1.0	ug/L	UKAS
o-Xylene (Surface Water)	154	GCMS	<1	ug/L	UKAS
Phenanthrene (GCMS)	200	GCMS	<0.01	ug/L	
Phenols (Total)	223	GCMS	<0.10	ug/L	
Phosphorus (Total) Surface Water	166	Colorimetry	0.057	mg/L as P	UKAS
p-Isopropyltoluene (Surface Water)	154	GCMS	<1	ug/L	UKAS
Polyaromatic Hydrocarbons (GCMS)	200	GCMS	<0.01	ug/L	
Pyrene (GCMS)	200	GCMS	<0.01	ug/L	
sec-Butylbenzene (Surface Water)	154	GCMS	<1	ug/L	UKAS
Selenium (Surface Water)	177	ICPMS	<1	ug/L	UKAS
Solids (Total Dissolved)	105	Filtration/ Evaporation @ 180C	19721	mg/L	
Styrene (Surface Water)	154	GCMS	<1	ug/L	UKAS
tert-Butylbenzene (Surface Water)	154	GCMS	<1	ug/L	UKAS
Tetrachloroethene (Surface Water)	154	GCMS	<1	ug/L	UKAS
TOC (Surface Water)	316	TOC Analyser	4.1	mg/L	UKAS
Toluene (Surface Water)	154	GCMS	<1	ug/L	UKAS
Total Inorganic Nitrogen	0	Calculation	1.7	mg/L	
trans-1,2-Dichloroethene (Surface W	154	GCMS	<1	ug/L	UKAS
trans-1,3-Dichloropropene (Surface	154	GCMS	<1	ug/L	UKAS
Trichloroethene (Surface Water)	154	GCMS	<1.0	ug/L	
Trichlorofluoromethane (Surface Wat	154	GCMS	<1	ug/L	UKAS
Vanadium (Surface Water)	177	ICPMS	221	ug/L	UKAS

Signed : A Harman ***Date : 25/04/2018***

Aoife Harmon - Technical Supervisor

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UKAS TESTING 2802

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Customer	**Caroline Roche**	*Lab Report Ref. No.*	**0529/001/17**
	Aqua-Fact International Services Ltd	*Date of Receipt*	**06/04/2018**
	12 Kilkerrin Park	*Sampled On*	**04/04/2018**
	Liosbaun Ind Est	*Date Testing Commenced*	**06/04/2018**
	Liosbaun	*Received or Collected*	**By Fitz: Paul C**
	Co Galway	*Condition on Receipt*	**Acceptable**
Customer PO		*Date of Report*	**25/04/2018**
Customer Ref	**DOWN500-ME-MID**	*Sample Type*	**Surface Water**
Ref 2			
Ref 3			

CERTIFICATE OF ANALYSIS

Test Parameter	SOP	Analytical Technique	Result	Units	Acc.
Vinyl chloride (Surface Water)	154	GCMS	<1	ug/L	UKAS
Volatile Organic Compounds	154	GCMS	<5.0	ug/L	
Xylene Total (Surface Water)	154	GCMS	<1	ug/L	UKAS
Zinc (Surface Water)	177	ICPMS	326	ug/L	UKAS

Signed : A Harmon

Aoife Harmon - Technical Supervisor

Date : 25/04/2018

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Customer	**Caroline Roche**	***Lab Report Ref. No.***	**0529/001/18**
	Aqua-Fact International Services Ltd	***Date of Receipt***	**06/04/2018**
	12 Kilkerrin Park	***Sampled On***	**04/04/2018**
	Liosbaun Ind Est	***Date Testing Commenced***	**06/04/2018**
	Liosbaun	***Received or Collected***	**By Fitz: Paul C**
	Co Galway	***Condition on Receipt***	**Acceptable**
Customer PO		***Date of Report***	**25/04/2018**
Customer Ref	**DOWN500-ME-BOTTOM**	***Sample Type***	**Surface Water**
Ref 2			
Ref 3			

CERTIFICATE OF ANALYSIS

Test Parameter	SOP	Analytical Technique	Result	Units	Acc.
1,1,1,2-Tetrachloroethane (Surface	154	GCMS	<1	ug/L	UKAS
1,1,1-Trichloroethane (Surface Water	154	GCMS	<1	ug/L	UKAS
1,1,2,2-Tetrachloroethane (Surface	154	GCMS	<5.0	ug/L	
1,1,2-Trichloroethane (Surface Water	154	GCMS	<2	ug/L	UKAS
1,1-Dichloroethane (Surface Water)	154	GCMS	<1	ug/L	UKAS
1,1-Dichloroethene (Surface Water)	154	GCMS	<1	ug/L	UKAS
1,1-Dichloropropene (Surface Water)	154	GCMS	<1	ug/L	UKAS
1,2,3-Trichlorobenzene (Surface Wat	154	GCMS	<1	ug/L	UKAS
1,2,3-Trichloropropane (Surface Wat	154	GCMS	<0.9	ug/L	UKAS
1,2,4-Trichlorobenzene (Surface Wat	154	GCMS	<0.6	ug/L	UKAS
1,2,4-Trimethylbenzene (Surface Wa	154	GCMS	<1	ug/L	UKAS
1,2-Dibromo-3-chloropropane (Surfac	154	GCMS	<1	ug/L	UKAS
1,2-Dibromoethane (Surface Water)	154	GCMS	<1	ug/L	UKAS
1,2-Dichlorobenzene (Surface Water)	154	GCMS	<1	ug/L	UKAS
1,2-Dichloroethane (Surface Water)	154	GCMS	<1	ug/L	UKAS
1,2-Dichloropropane (Surface Water)	154	GCMS	<1	ug/L	UKAS
1,3,5-Trimethylbenzene (Surface Wa	154	GCMS	<1	ug/L	UKAS
1,3-Dichlorobenzene (Surface Water)	154	GCMS	<1	ug/L	UKAS
1,3-Dichloropropane (Surface Water)	154	GCMS	<1	ug/L	UKAS
1,4-Dichlorobenzene (Surface Water)	154	GCMS	<1	ug/L	UKAS
2,2-Dichloropropane (Surface Water)	154	GCMS	<5.0	ug/L	
2-Chlorotoluene (Surface Water)	154	GCMS	<1	ug/L	UKAS
4-Chlorotoluene (Surface Water)	154	GCMS	<1	ug/L	UKAS
Acenaphthene (GCMS)	200	GCMS	<0.01	ug/L	

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	Liosbaun Ind Est	***Date Testing Commenced***	**06/04/2018**
	Liosbaun	***Received or Collected***	**By Fitz: Paul C**
	Co Galway	***Condition on Receipt***	**Acceptable**
Customer PO		***Date of Report***	**25/04/2018**
Customer Ref	**DOWN500-ME-BOTTOM**	***Sample Type***	**Surface Water**
Ref 2			
Ref 3			

CERTIFICATE OF ANALYSIS

Test Parameter	SOP	Analytical Technique	Result	Units	Acc.
Acenaphthylene (GCMS)	200	GCMS	<0.01	ug/L	
Ammonia (Surface Water)	114	Colorimetry	0.39	mg/L as N	UKAS
Anthracene (GCMS)	200	GCMS	<0.01	ug/L	
Antimony (Surface Water)	177	ICPMS	<3	ug/L	UKAS
Arsenic (Surface Water)	177	ICPMS	6	ug/L	UKAS
Barium (Surface Water)	177	ICPMS	35	ug/L	UKAS
Benzene (Surface Water)	154	GCMS	<1	ug/L	UKAS
Benzo(a)anthracene (GCMS)	200	GCMS	<0.01	ug/L	
Benzo(a)pyrene (GCMS)	200	GCMS	<0.01	ug/L	
Benzo(g,h,i)perylene (GCMS)	200	GCMS	<0.01	ug/L	
Benzo(k)fluoranthene (GCMS)	200	GCMS	<0.01	ug/L	
Bromobenzene (Surface Water)	154	GCMS	<1	ug/L	UKAS
Bromochloromethane (Surface Water	154	GCMS	<1	ug/L	UKAS
Bromodichloromethane (Surface Wat	154	GCMS	<1	ug/L	UKAS
Bromoform (Surface Water)	154	GCMS	<1	ug/L	UKAS
Bromomethane (Surface Water)	154	GCMS	<5.0	ug/L	
Cadmium (Surface Water)	177	ICPMS	<1	ug/L	UKAS
Carbon tetrachloride (Surface Water)	154	GCMS	<1	ug/L	UKAS
Chlorobenzene (Surface Water)	154	GCMS	<1	ug/L	UKAS
Chloroethane (Surface Water)	154	GCMS	<5.0	ug/L	
Chloroform (Surface Water)	154	GCMS	<1	ug/L	UKAS
Chloromethane (Surface Water)	154	GCMS	<5.0	ug/L	
Chromium (Surface Water)	177	ICPMS	7	ug/L	UKAS
Chrysene (GCMS)	200	GCMS	<0.01	ug/L	

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Customer	Caroline Roche Aqua-Fact International Services Ltd 12 Kilkerrin Park Liosbaun Ind Est Liosbaun Co Galway	*Lab Report Ref. No.*	0529/001/18
		Date of Receipt	06/04/2018
		Sampled On	04/04/2018
		Date Testing Commenced	06/04/2018
		Received or Collected	By Fitz: Paul C
		Condition on Receipt	Acceptable
Customer PO		*Date of Report*	25/04/2018
Customer Ref	DOWN500-ME-BOTTOM	*Sample Type*	Surface Water
Ref 2			
Ref 3			

CERTIFICATE OF ANALYSIS

Test Parameter	SOP	Analytical Technique	Result	Units	Acc.
cis-1,2-Dichloroethene (Surface Wat	154	GCMS	<1	ug/L	UKAS
cis-1,3-Dichloropropene (Surface Wa	154	GCMS	<1	ug/L	UKAS
COD (Surface Water)	107	Colorimetry	85	mg/L	UKAS
Copper (Surface Water)	177	ICPMS	10	ug/L	UKAS
Coronene (GCMS)	200	GCMS	<0.01	ug/L	
Dibenzo(a,h)anthracene (GCMS)	200	GCMS	<0.01	ug/L	
Dibromochloromethane (Surface Wat	154	GCMS	<1	ug/L	UKAS
Dibromomethane (Surface Water)	154	GCMS	<1	ug/L	UKAS
Dichlorodifluoromethane (Surface W	154	GCMS	<5.0	ug/L	
Dichloromethane (Surface Water)	154	GCMS	<5.0	ug/L	
Ethylbenzene (Surface Water)	154	GCMS	<1	ug/L	UKAS
Fluoranthene (GCMS)	200	GCMS	<0.01	ug/L	
Fluorene (GCMS)	200	GCMS	<0.01	ug/L	
Hexachlorobutadiene (Surface Water	154	GCMS	<1	ug/L	UKAS
Indeno(1,2,3-cd)pyrene (GCMS)	200	GCMS	<0.01	ug/L	
Isopropylbenzene (Surface Water)	154	GCMS	<1	ug/L	UKAS
Lead (Surface Water)	177	ICPMS	7	ug/L	UKAS
m- & p-Xylene (Surface Water)	154	GCMS	<1	ug/L	UKAS
Mercury (Surface water)	178	ICPMS	0.17	ug/L	UKAS
Molybdenum	226	ICPMS	7	ug/L	
Naphthalene (Surface Water)	154	GCMS	<1	ug/L	UKAS
n-Butylbenzene (Surface Water)	154	GCMS	<1	ug/L	UKAS
Nickel (Surface Water)	177	ICPMS	12	ug/L	UKAS
Nitrogen (Total Kjeldahl)	104	Digestion/ Distillation/ Titrimetr	<1.00	mg/L as N	

Signed : A Harman

Date : 25/04/2018

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	Aqua-Fact International Services Ltd	***Date of Receipt***	**06/04/2018**
	12 Kilkerrin Park	***Sampled On***	**04/04/2018**
	Liosbaun Ind Est	***Date Testing Commenced***	**06/04/2018**
	Liosbaun	***Received or Collected***	**By Fitz: Paul C**
	Co Galway	***Condition on Receipt***	**Acceptable**
Customer PO		***Date of Report***	**25/04/2018**
Customer Ref	**DOWN500-ME-BOTTOM**	***Sample Type***	**Surface Water**
Ref 2			
Ref 3			

CERTIFICATE OF ANALYSIS

Test Parameter	SOP	Analytical Technique	Result	Units	Acc.
Nitrogen (Total Oxidised) (Surface W	151	Colorimetry	1.97	mg/L as N	UKAS
Nitrogen (Total)	0	Calculation	3	mg/L as N	
n-Propylbenzene (Surface Water)	154	GCMS	<1.0	ug/L	UKAS
o-Xylene (Surface Water)	154	GCMS	<1	ug/L	UKAS
Phenanthrene (GCMS)	200	GCMS	<0.01	ug/L	
Phenols (Total)	223	GCMS	<0.10	ug/L	
Phosphorus (Total) Surface Water	166	Colorimetry	0.064	mg/L as P	UKAS
p-Isopropyltoluene (Surface Water)	154	GCMS	<1	ug/L	UKAS
Polyaromatic Hydrocarbons (GCMS)	200	GCMS	<0.01	ug/L	
Pyrene (GCMS)	200	GCMS	<0.01	ug/L	
sec-Butylbenzene (Surface Water)	154	GCMS	<1	ug/L	UKAS
Selenium (Surface Water)	177	ICPMS	<1	ug/L	UKAS
Solids (Total Dissolved)	105	Filtration/ Evaporation @ 180C	19587	mg/L	
Styrene (Surface Water)	154	GCMS	<1	ug/L	UKAS
tert-Butylbenzene (Surface Water)	154	GCMS	<1	ug/L	UKAS
Tetrachloroethene (Surface Water)	154	GCMS	<1	ug/L	UKAS
TOC (Surface Water)	316	TOC Analyser	4.2	mg/L	UKAS
Toluene (Surface Water)	154	GCMS	<1	ug/L	UKAS
Total Inorganic Nitrogen	0	Calculation	1.7	mg/L	
trans-1,2-Dichloroethene (Surface W	154	GCMS	<1	ug/L	UKAS
trans-1,3-Dichloropropene (Surface	154	GCMS	<1	ug/L	UKAS
Trichloroethene (Surface Water)	154	GCMS	<1.0	ug/L	
Trichlorofluoromethane (Surface Wat	154	GCMS	<1	ug/L	UKAS
Vanadium (Surface Water)	177	ICPMS	224	ug/L	UKAS

Signed : A Harmon ***Date : 25/04/2018***

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Customer	Caroline Roche Aqua-Fact International Services Ltd 12 Kilkerrin Park Liosbaun Ind Est Liosbaun Co Galway	*Lab Report Ref. No.*	0529/001/18
		Date of Receipt	06/04/2018
		Sampled On	04/04/2018
		Date Testing Commenced	06/04/2018
		Received or Collected	By Fitz: Paul C
		Condition on Receipt	Acceptable
Customer PO		*Date of Report*	25/04/2018
Customer Ref	DOWN500-ME-BOTTOM	*Sample Type*	Surface Water
Ref 2			
Ref 3			

CERTIFICATE OF ANALYSIS

Test Parameter	SOP	Analytical Technique	Result	Units	Acc.
Vinyl chloride (Surface Water)	154	GCMS	<1	ug/L	UKAS
Volatile Organic Compounds	154	GCMS	<5.0	ug/L	
Xylene Total (Surface Water)	154	GCMS	<1	ug/L	UKAS
Zinc (Surface Water)	177	ICPMS	181	ug/L	UKAS

Signed : A Harmon

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Customer	**Caroline Roche**	***Lab Report Ref. No.***	**0529/001/10**
	Aqua-Fact International Services Ltd	***Date of Receipt***	**06/04/2018**
	12 Kilkerrin Park	***Sampled On***	**04/04/2018**
	Liosbaun Ind Est	***Date Testing Commenced***	**06/04/2018**
	Liosbaun	***Received or Collected***	**By Fitz: Paul C**
	Co Galway	***Condition on Receipt***	**Acceptable**
Customer PO		***Date of Report***	**25/04/2018**
Customer Ref	**DOWN500-LW-SURF**	***Sample Type***	**Surface Water**
Ref 2			
Ref 3			

CERTIFICATE OF ANALYSIS

Test Parameter	SOP	Analytical Technique	Result	Units	Acc.
1,1,1,2-Tetrachloroethane (Surface	154	GCMS	<1	ug/L	UKAS
1,1,1-Trichloroethane (Surface Water	154	GCMS	<1	ug/L	UKAS
1,1,2,2-Tetrachloroethane (Surface	154	GCMS	<5.0	ug/L	
1,1,2-Trichloroethane (Surface Water	154	GCMS	<2	ug/L	UKAS
1,1-Dichloroethane (Surface Water)	154	GCMS	<1	ug/L	UKAS
1,1-Dichloroethene (Surface Water)	154	GCMS	<1	ug/L	UKAS
1,1-Dichloropropene (Surface Water)	154	GCMS	<1	ug/L	UKAS
1,2,3-Trichlorobenzene (Surface Wat	154	GCMS	<1	ug/L	UKAS
1,2,3-Trichloropropane (Surface Wat	154	GCMS	<0.9	ug/L	UKAS
1,2,4-Trichlorobenzene (Surface Wat	154	GCMS	<0.6	ug/L	UKAS
1,2,4-Trimethylbenzene (Surface Wa	154	GCMS	<1	ug/L	UKAS
1,2-Dibromo-3-chloropropane (Surfac	154	GCMS	<1	ug/L	UKAS
1,2-Dibromoethane (Surface Water)	154	GCMS	<1	ug/L	UKAS
1,2-Dichlorobenzene (Surface Water)	154	GCMS	<1	ug/L	UKAS
1,2-Dichloroethane (Surface Water)	154	GCMS	<1	ug/L	UKAS
1,2-Dichloropropane (Surface Water)	154	GCMS	<1	ug/L	UKAS
1,3,5-Trimethylbenzene (Surface Wa	154	GCMS	<1	ug/L	UKAS
1,3-Dichlorobenzene (Surface Water)	154	GCMS	<1	ug/L	UKAS
1,3-Dichloropropane (Surface Water)	154	GCMS	<1	ug/L	UKAS
1,4-Dichlorobenzene (Surface Water)	154	GCMS	<1	ug/L	UKAS
2,2-Dichloropropane (Surface Water)	154	GCMS	<5.0	ug/L	
2-Chlorotoluene (Surface Water)	154	GCMS	<1	ug/L	UKAS
4-Chlorotoluene (Surface Water)	154	GCMS	<1	ug/L	UKAS
Acenaphthene (GCMS)	200	GCMS	<0.01	ug/L	

Signed : A Harmon ***Date : 25/04/2018***

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	12 Kilkerrin Park	*Sampled On*	**04/04/2018**
	Liosbaun Ind Est	*Date Testing Commenced*	**06/04/2018**
	Liosbaun	*Received or Collected*	**By Fitz: Paul C**
	Co Galway	*Condition on Receipt*	**Acceptable**
Customer PO		*Date of Report*	**25/04/2018**
Customer Ref	**DOWN500-LW-SURF**	*Sample Type*	**Surface Water**
Ref 2			
Ref 3			

CERTIFICATE OF ANALYSIS

Test Parameter	SOP	Analytical Technique	Result	Units	Acc.
Acenaphthylene (GCMS)	200	GCMS	<0.01	ug/L	
Ammonia (Surface Water)	114	Colorimetry	0.35	mg/L as N	UKAS
Anthracene (GCMS)	200	GCMS	<0.01	ug/L	
Antimony (Surface Water)	177	ICPMS	<3	ug/L	UKAS
Arsenic (Surface Water)	177	ICPMS	4	ug/L	UKAS
Barium (Surface Water)	177	ICPMS	31	ug/L	UKAS
Benzene (Surface Water)	154	GCMS	<1	ug/L	UKAS
Benzo(a)anthracene (GCMS)	200	GCMS	<0.01	ug/L	
Benzo(a)pyrene (GCMS)	200	GCMS	<0.01	ug/L	
Benzo(g,h,i)perylene (GCMS)	200	GCMS	<0.01	ug/L	
Benzo(k)fluoranthene (GCMS)	200	GCMS	<0.01	ug/L	
Bromobenzene (Surface Water)	154	GCMS	<1	ug/L	UKAS
Bromochloromethane (Surface Water	154	GCMS	<1	ug/L	UKAS
Bromodichloromethane (Surface Wat	154	GCMS	<1	ug/L	UKAS
Bromoform (Surface Water)	154	GCMS	<1	ug/L	UKAS
Bromomethane (Surface Water)	154	GCMS	<5.0	ug/L	
Cadmium (Surface Water)	177	ICPMS	<1	ug/L	UKAS
Carbon tetrachloride (Surface Water)	154	GCMS	<1	ug/L	UKAS
Chlorobenzene (Surface Water)	154	GCMS	<1	ug/L	UKAS
Chloroethane (Surface Water)	154	GCMS	<5.0	ug/L	
Chloroform (Surface Water)	154	GCMS	<1	ug/L	UKAS
Chloromethane (Surface Water)	154	GCMS	<5.0	ug/L	
Chromium (Surface Water)	177	ICPMS	5	ug/L	UKAS
Chrysene (GCMS)	200	GCMS	<0.01	ug/L	

Signed : A Harmon

Date : 25/04/2018

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UKAS TESTING 2802

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Fitz scientific
Monitoring and Testing Services

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Customer	**Caroline Roche** **Aqua-Fact International Services Ltd** **12 Kilkerrin Park** **Liosbaun Ind Est** **Liosbaun** **Co Galway**	*Lab Report Ref. No.*	**0529/001/10**
		Date of Receipt	**06/04/2018**
		Sampled On	**04/04/2018**
		Date Testing Commenced	**06/04/2018**
		Received or Collected	**By Fitz: Paul C**
		Condition on Receipt	**Acceptable**
Customer PO		*Date of Report*	**25/04/2018**
Customer Ref	**DOWN500-LW-SURF**	*Sample Type*	**Surface Water**
Ref 2			
Ref 3			

CERTIFICATE OF ANALYSIS

Test Parameter	SOP	Analytical Technique	Result	Units	Acc.
cis-1,2-Dichloroethene (Surface Wat	154	GCMS	<1	ug/L	UKAS
cis-1,3-Dichloropropene (Surface Wa	154	GCMS	<1	ug/L	UKAS
COD (Surface Water)	107	Colorimetry	75	mg/L	UKAS
Copper (Surface Water)	177	ICPMS	14	ug/L	UKAS
Coronene (GCMS)	200	GCMS	<0.01	ug/L	
Dibenzo(a,h)anthracene (GCMS)	200	GCMS	<0.01	ug/L	
Dibromochloromethane (Surface Wat	154	GCMS	<1	ug/L	UKAS
Dibromomethane (Surface Water)	154	GCMS	<1	ug/L	UKAS
Dichlorodifluoromethane (Surface W	154	GCMS	<5.0	ug/L	
Dichloromethane (Surface Water)	154	GCMS	<5.0	ug/L	
Ethylbenzene (Surface Water)	154	GCMS	<1	ug/L	UKAS
Fluoranthene (GCMS)	200	GCMS	<0.01	ug/L	
Fluorene (GCMS)	200	GCMS	<0.01	ug/L	
Hexachlorobutadiene (Surface Water	154	GCMS	<1	ug/L	UKAS
Indeno(1,2,3-cd)pyrene (GCMS)	200	GCMS	<0.01	ug/L	
Isopropylbenzene (Surface Water)	154	GCMS	<1	ug/L	UKAS
Lead (Surface Water)	177	ICPMS	13	ug/L	UKAS
m- & p-Xylene (Surface Water)	154	GCMS	<1	ug/L	UKAS
Mercury (Surface water)	178	ICPMS	0.42	ug/L	UKAS
Molybdenum	226	ICPMS	7	ug/L	
Naphthalene (Surface Water)	154	GCMS	<1	ug/L	UKAS
n-Butylbenzene (Surface Water)	154	GCMS	<1	ug/L	UKAS
Nickel (Surface Water)	177	ICPMS	7	ug/L	UKAS
Nitrogen (Total Kjeldahl)	104	Digestion/ Distillation/ Titrimetr	<1.00	mg/L as N	

Signed : A Harmon

Date : 25/04/2018

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	Aqua-Fact International Services Ltd	***Date of Receipt***	**06/04/2018**
	12 Kilkerrin Park	***Sampled On***	**04/04/2018**
	Liosbaun Ind Est	***Date Testing Commenced***	**06/04/2018**
	Liosbaun	***Received or Collected***	**By Fitz: Paul C**
	Co Galway	***Condition on Receipt***	**Acceptable**
Customer PO		***Date of Report***	**25/04/2018**
Customer Ref	**DOWN500-LW-SURF**	***Sample Type***	**Surface Water**
Ref 2			
Ref 3			

CERTIFICATE OF ANALYSIS

Test Parameter	SOP	Analytical Technique	Result	Units	Acc.
Nitrogen (Total Oxidised) (Surface W	151	Colorimetry	2.13	mg/L as N	UKAS
Nitrogen (Total)	0	Calculation	3	mg/L as N	
n-Propylbenzene (Surface Water)	154	GCMS	<1.0	ug/L	UKAS
o-Xylene (Surface Water)	154	GCMS	<1	ug/L	UKAS
Phenanthrene (GCMS)	200	GCMS	<0.01	ug/L	
Phenols (Total)	223	GCMS	<0.10	ug/L	
Phosphorus (Total) Surface Water	166	Colorimetry	0.071	mg/L as P	UKAS
p-Isopropyltoluene (Surface Water)	154	GCMS	<1	ug/L	UKAS
Polyaromatic Hydrocarbons (GCMS)	200	GCMS	<0.01	ug/L	
Pyrene (GCMS)	200	GCMS	<0.01	ug/L	
sec-Butylbenzene (Surface Water)	154	GCMS	<1	ug/L	UKAS
Selenium (Surface Water)	177	ICPMS	1	ug/L	UKAS
Solids (Total Dissolved)	105	Filtration/ Evaporation @ 180C	20431	mg/L	
Styrene (Surface Water)	154	GCMS	<1	ug/L	UKAS
tert-Butylbenzene (Surface Water)	154	GCMS	<1	ug/L	UKAS
Tetrachloroethene (Surface Water)	154	GCMS	<1	ug/L	UKAS
TOC (Surface Water)	316	TOC Analyser	4.9	mg/L	UKAS
Toluene (Surface Water)	154	GCMS	<1	ug/L	UKAS
Total Inorganic Nitrogen	0	Calculation	2	mg/L	
trans-1,2-Dichloroethene (Surface W	154	GCMS	<1	ug/L	UKAS
trans-1,3-Dichloropropene (Surface	154	GCMS	<1	ug/L	UKAS
Trichloroethene (Surface Water)	154	GCMS	<1.0	ug/L	
Trichlorofluoromethane (Surface Wat	154	GCMS	<1	ug/L	UKAS
Vanadium (Surface Water)	177	ICPMS	181	ug/L	UKAS

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	12 Kilkerrin Park	***Sampled On***	**04/04/2018**
	Liosbaun Ind Est	***Date Testing Commenced***	**06/04/2018**
	Liosbaun	***Received or Collected***	**By Fitz: Paul C**
	Co Galway	***Condition on Receipt***	**Acceptable**
Customer PO		***Date of Report***	**25/04/2018**
Customer Ref	**DOWN500-LW-SURF**	***Sample Type***	**Surface Water**
Ref 2			
Ref 3			

CERTIFICATE OF ANALYSIS

Test Parameter	SOP	Analytical Technique	Result	Units	Acc.
Vinyl chloride (Surface Water)	154	GCMS	<1	ug/L	UKAS
Volatile Organic Compounds	154	GCMS	<5.0	ug/L	
Xylene Total (Surface Water)	154	GCMS	<1	ug/L	UKAS
Zinc (Surface Water)	177	ICPMS	167	ug/L	UKAS

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		Date of Receipt	06/04/2018
		Sampled On	04/04/2018
		Date Testing Commenced	06/04/2018
		Received or Collected	By Fitz: Paul C
		Condition on Receipt	Acceptable
Customer PO		*Date of Report*	25/04/2018
Customer Ref	DOWN500-LW-MID	*Sample Type*	Surface Water
Ref 2			
Ref 3			

CERTIFICATE OF ANALYSIS

Test Parameter	SOP	Analytical Technique	Result	Units	Acc.
1,1,1,2-Tetrachloroethane (Surface	154	GCMS	<1	ug/L	UKAS
1,1,1-Trichloroethane (Surface Water	154	GCMS	<1	ug/L	UKAS
1,1,2,2-Tetrachloroethane (Surface	154	GCMS	<5.0	ug/L	
1,1,2-Trichloroethane (Surface Water	154	GCMS	<2	ug/L	UKAS
1,1-Dichloroethane (Surface Water)	154	GCMS	<1	ug/L	UKAS
1,1-Dichloroethene (Surface Water)	154	GCMS	<1	ug/L	UKAS
1,1-Dichloropropene (Surface Water)	154	GCMS	<1	ug/L	UKAS
1,2,3-Trichlorobenzene (Surface Wat	154	GCMS	<1	ug/L	UKAS
1,2,3-Trichloropropane (Surface Wat	154	GCMS	<0.9	ug/L	UKAS
1,2,4-Trichlorobenzene (Surface Wat	154	GCMS	<0.6	ug/L	UKAS
1,2,4-Trimethylbenzene (Surface Wa	154	GCMS	<1	ug/L	UKAS
1,2-Dibromo-3-chloropropane (Surfac	154	GCMS	<1	ug/L	UKAS
1,2-Dibromoethane (Surface Water)	154	GCMS	<1	ug/L	UKAS
1,2-Dichlorobenzene (Surface Water)	154	GCMS	<1	ug/L	UKAS
1,2-Dichloroethane (Surface Water)	154	GCMS	<1	ug/L	UKAS
1,2-Dichloropropane (Surface Water)	154	GCMS	<1	ug/L	UKAS
1,3,5-Trimethylbenzene (Surface Wa	154	GCMS	<1	ug/L	UKAS
1,3-Dichlorobenzene (Surface Water)	154	GCMS	<1	ug/L	UKAS
1,3-Dichloropropane (Surface Water)	154	GCMS	<1	ug/L	UKAS
1,4-Dichlorobenzene (Surface Water)	154	GCMS	<1	ug/L	UKAS
2,2-Dichloropropane (Surface Water)	154	GCMS	<5.0	ug/L	
2-Chlorotoluene (Surface Water)	154	GCMS	<1	ug/L	UKAS
4-Chlorotoluene (Surface Water)	154	GCMS	<1	ug/L	UKAS
Acenaphthene (GCMS)	200	GCMS	<0.01	ug/L	

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		Date of Receipt	06/04/2018
		Sampled On	04/04/2018
		Date Testing Commenced	06/04/2018
		Received or Collected	By Fitz: Paul C
		Condition on Receipt	Acceptable
Customer PO		*Date of Report*	25/04/2018
Customer Ref	DOWN500-LW-MID	*Sample Type*	Surface Water
Ref 2			
Ref 3			

CERTIFICATE OF ANALYSIS

Test Parameter	SOP	Analytical Technique	Result	Units	Acc.
Acenaphthylene (GCMS)	200	GCMS	<0.01	ug/L	
Ammonia (Surface Water)	114	Colorimetry	0.40	mg/L as N	UKAS
Anthracene (GCMS)	200	GCMS	<0.01	ug/L	
Antimony (Surface Water)	177	ICPMS	<3	ug/L	UKAS
Arsenic (Surface Water)	177	ICPMS	<1	ug/L	UKAS
Barium (Surface Water)	177	ICPMS	25	ug/L	UKAS
Benzene (Surface Water)	154	GCMS	<1	ug/L	UKAS
Benzo(a)anthracene (GCMS)	200	GCMS	<0.01	ug/L	
Benzo(a)pyrene (GCMS)	200	GCMS	<0.01	ug/L	
Benzo(g,h,i)perylene (GCMS)	200	GCMS	<0.01	ug/L	
Benzo(k)fluoranthene (GCMS)	200	GCMS	<0.01	ug/L	
Bromobenzene (Surface Water)	154	GCMS	<1	ug/L	UKAS
Bromochloromethane (Surface Water	154	GCMS	<1	ug/L	UKAS
Bromodichloromethane (Surface Wat	154	GCMS	<1	ug/L	UKAS
Bromoform (Surface Water)	154	GCMS	<1	ug/L	UKAS
Bromomethane (Surface Water)	154	GCMS	<5.0	ug/L	
Cadmium (Surface Water)	177	ICPMS	<1	ug/L	UKAS
Carbon tetrachloride (Surface Water)	154	GCMS	<1	ug/L	UKAS
Chlorobenzene (Surface Water)	154	GCMS	<1	ug/L	UKAS
Chloroethane (Surface Water)	154	GCMS	<5.0	ug/L	
Chloroform (Surface Water)	154	GCMS	<1	ug/L	UKAS
Chloromethane (Surface Water)	154	GCMS	<5.0	ug/L	
Chromium (Surface Water)	177	ICPMS	2	ug/L	UKAS
Chrysene (GCMS)	200	GCMS	<0.01	ug/L	

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		Date Testing Commenced	06/04/2018
		Received or Collected	By Fitz: Paul C
		Condition on Receipt	Acceptable
Customer PO		*Date of Report*	25/04/2018
Customer Ref	DOWN500-LW-MID	*Sample Type*	Surface Water
Ref 2			
Ref 3			

CERTIFICATE OF ANALYSIS

Test Parameter	SOP	Analytical Technique	Result	Units	Acc.
cis-1,2-Dichloroethene (Surface Wat	154	GCMS	<1	ug/L	UKAS
cis-1,3-Dichloropropene (Surface Wa	154	GCMS	<1	ug/L	UKAS
COD (Surface Water)	107	Colorimetry	90	mg/L	UKAS
Copper (Surface Water)	177	ICPMS	10	ug/L	UKAS
Coronene (GCMS)	200	GCMS	<0.01	ug/L	
Dibenzo(a,h)anthracene (GCMS)	200	GCMS	<0.01	ug/L	
Dibromochloromethane (Surface Wat	154	GCMS	<1	ug/L	UKAS
Dibromomethane (Surface Water)	154	GCMS	<1	ug/L	UKAS
Dichlorodifluoromethane (Surface W	154	GCMS	<5.0	ug/L	
Dichloromethane (Surface Water)	154	GCMS	<5.0	ug/L	
Ethylbenzene (Surface Water)	154	GCMS	<1	ug/L	UKAS
Fluoranthene (GCMS)	200	GCMS	<0.01	ug/L	
Fluorene (GCMS)	200	GCMS	<0.01	ug/L	
Hexachlorobutadiene (Surface Water	154	GCMS	<1	ug/L	UKAS
Indeno(1,2,3-cd)pyrene (GCMS)	200	GCMS	<0.01	ug/L	
Isopropylbenzene (Surface Water)	154	GCMS	<1	ug/L	UKAS
Lead (Surface Water)	177	ICPMS	4	ug/L	UKAS
m- & p-Xylene (Surface Water)	154	GCMS	<1	ug/L	UKAS
Mercury (Surface water)	178	ICPMS	0.15	ug/L	UKAS
Molybdenum	226	ICPMS	6	ug/L	
Naphthalene (Surface Water)	154	GCMS	<1	ug/L	UKAS
n-Butylbenzene (Surface Water)	154	GCMS	<1	ug/L	UKAS
Nickel (Surface Water)	177	ICPMS	6	ug/L	UKAS
Nitrogen (Total Kjeldahl)	104	Digestion/ Distillation/ Titrimetr	<1.00	mg/L as N	

Signed : A Harman

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	Aqua-Fact International Services Ltd	*Date of Receipt*	**06/04/2018**
	12 Kilkerrin Park	*Sampled On*	**04/04/2018**
	Liosbaun Ind Est	*Date Testing Commenced*	**06/04/2018**
	Liosbaun	*Received or Collected*	**By Fitz: Paul C**
	Co Galway	*Condition on Receipt*	**Acceptable**
Customer PO		*Date of Report*	**25/04/2018**
Customer Ref	**DOWN500-LW-MID**	*Sample Type*	**Surface Water**
Ref 2			
Ref 3			

CERTIFICATE OF ANALYSIS

Test Parameter	SOP	Analytical Technique	Result	Units	Acc.
Nitrogen (Total Oxidised) (Surface W	151	Colorimetry	8.55	mg/L as N	UKAS
Nitrogen (Total)	0	Calculation	9	mg/L as N	
n-Propylbenzene (Surface Water)	154	GCMS	<1.0	ug/L	UKAS
o-Xylene (Surface Water)	154	GCMS	<1	ug/L	UKAS
Phenanthrene (GCMS)	200	GCMS	<0.01	ug/L	
Phenols (Total)	223	GCMS	<0.10	ug/L	
Phosphorus (Total) Surface Water	166	Colorimetry	0.060	mg/L as P	UKAS
p-Isopropyltoluene (Surface Water)	154	GCMS	<1	ug/L	UKAS
Polyaromatic Hydrocarbons (GCMS)	200	GCMS	<0.01	ug/L	
Pyrene (GCMS)	200	GCMS	<0.01	ug/L	
sec-Butylbenzene (Surface Water)	154	GCMS	<1	ug/L	UKAS
Selenium (Surface Water)	177	ICPMS	<1	ug/L	UKAS
Solids (Total Dissolved)	105	Filtration/ Evaporation @ 180C	18962	mg/L	
Styrene (Surface Water)	154	GCMS	<1	ug/L	UKAS
tert-Butylbenzene (Surface Water)	154	GCMS	<1	ug/L	UKAS
Tetrachloroethene (Surface Water)	154	GCMS	<1	ug/L	UKAS
TOC (Surface Water)	316	TOC Analyser	4.1	mg/L	UKAS
Toluene (Surface Water)	154	GCMS	<1	ug/L	UKAS
Total Inorganic Nitrogen	0	Calculation	5.6	mg/L	
trans-1,2-Dichloroethene (Surface W	154	GCMS	<1	ug/L	UKAS
trans-1,3-Dichloropropene (Surface	154	GCMS	<1	ug/L	UKAS
Trichloroethene (Surface Water)	154	GCMS	<1.0	ug/L	
Trichlorofluoromethane (Surface Wat	154	GCMS	<1	ug/L	UKAS
Vanadium (Surface Water)	177	ICPMS	165	ug/L	UKAS

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Customer	**Caroline Roche**	***Lab Report Ref. No.***	**0529/001/11**
	Aqua-Fact International Services Ltd	***Date of Receipt***	**06/04/2018**
	12 Kilkerrin Park	***Sampled On***	**04/04/2018**
	Liosbaun Ind Est	***Date Testing Commenced***	**06/04/2018**
	Liosbaun	***Received or Collected***	**By Fitz: Paul C**
	Co Galway	***Condition on Receipt***	**Acceptable**
Customer PO		***Date of Report***	**25/04/2018**
Customer Ref	**DOWN500-LW-MID**	***Sample Type***	**Surface Water**
Ref 2			
Ref 3			

CERTIFICATE OF ANALYSIS

Test Parameter	SOP	Analytical Technique	Result	Units	Acc.
Vinyl chloride (Surface Water)	154	GCMS	<1	ug/L	UKAS
Volatile Organic Compounds	154	GCMS	<5.0	ug/L	
Xylene Total (Surface Water)	154	GCMS	<1	ug/L	UKAS
Zinc (Surface Water)	177	ICPMS	91	ug/L	UKAS

Signed : A Harmon

Date : 25/04/2018

Aoife Harmon - Technical Supervisor

Acc. : Accredited Parameters by ISO 17025:2005
PVL - Parametric Value Limit as per EU (Drinking water) Regulations (SI 122 2014)
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UKAS TESTING 2802

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Customer	Caroline Roche Aqua-Fact International Services Ltd 12 Kilkerrin Park Liosbaun Ind Est Liosbaun Co Galway	*Lab Report Ref. No.*	0529/001/12
		Date of Receipt	06/04/2018
		Sampled On	04/04/2018
		Date Testing Commenced	06/04/2018
		Received or Collected	By Fitz: Paul C
		Condition on Receipt	Acceptable
Customer PO		*Date of Report*	25/04/2018
Customer Ref	DOWN500-LW-BOTTOM	*Sample Type*	Surface Water
Ref 2			
Ref 3			

CERTIFICATE OF ANALYSIS

Test Parameter	SOP	Analytical Technique	Result	Units	Acc.
1,1,1,2-Tetrachloroethane (Surface	154	GCMS	<1	ug/L	UKAS
1,1,1-Trichloroethane (Surface Water	154	GCMS	<1	ug/L	UKAS
1,1,2,2-Tetrachloroethane (Surface	154	GCMS	<5.0	ug/L	
1,1,2-Trichloroethane (Surface Water	154	GCMS	<2	ug/L	UKAS
1,1-Dichloroethane (Surface Water)	154	GCMS	<1	ug/L	UKAS
1,1-Dichloroethene (Surface Water)	154	GCMS	<1	ug/L	UKAS
1,1-Dichloropropene (Surface Water)	154	GCMS	<1	ug/L	UKAS
1,2,3-Trichlorobenzene (Surface Wat	154	GCMS	<1	ug/L	UKAS
1,2,3-Trichloropropane (Surface Wat	154	GCMS	<0.9	ug/L	UKAS
1,2,4-Trichlorobenzene (Surface Wat	154	GCMS	<0.6	ug/L	UKAS
1,2,4-Trimethylbenzene (Surface Wa	154	GCMS	<1	ug/L	UKAS
1,2-Dibromo-3-chloropropane (Surfac	154	GCMS	<1	ug/L	UKAS
1,2-Dibromoethane (Surface Water)	154	GCMS	<1	ug/L	UKAS
1,2-Dichlorobenzene (Surface Water)	154	GCMS	<1	ug/L	UKAS
1,2-Dichloroethane (Surface Water)	154	GCMS	<1	ug/L	UKAS
1,2-Dichloropropane (Surface Water)	154	GCMS	<1	ug/L	UKAS
1,3,5-Trimethylbenzene (Surface Wa	154	GCMS	<1	ug/L	UKAS
1,3-Dichlorobenzene (Surface Water)	154	GCMS	<1	ug/L	UKAS
1,3-Dichloropropane (Surface Water)	154	GCMS	<1	ug/L	UKAS
1,4-Dichlorobenzene (Surface Water)	154	GCMS	<1	ug/L	UKAS
2,2-Dichloropropane (Surface Water)	154	GCMS	<5.0	ug/L	
2-Chlorotoluene (Surface Water)	154	GCMS	<1	ug/L	UKAS
4-Chlorotoluene (Surface Water)	154	GCMS	<1	ug/L	UKAS
Acenaphthene (GCMS)	200	GCMS	<0.01	ug/L	

Signed : A Harmon

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		Date of Receipt	06/04/2018
		Sampled On	04/04/2018
		Date Testing Commenced	06/04/2018
		Received or Collected	By Fitz: Paul C
		Condition on Receipt	Acceptable
Customer PO		*Date of Report*	25/04/2018
Customer Ref	DOWN500-LW-BOTTOM	*Sample Type*	Surface Water
Ref 2			
Ref 3			

CERTIFICATE OF ANALYSIS

Test Parameter	SOP	Analytical Technique	Result	Units	Acc.
Acenaphthylene (GCMS)	200	GCMS	<0.01	ug/L	
Ammonia (Surface Water)	114	Colorimetry	0.40	mg/L as N	UKAS
Anthracene (GCMS)	200	GCMS	<0.01	ug/L	
Antimony (Surface Water)	177	ICPMS	<3	ug/L	UKAS
Arsenic (Surface Water)	177	ICPMS	1	ug/L	UKAS
Barium (Surface Water)	177	ICPMS	33	ug/L	UKAS
Benzene (Surface Water)	154	GCMS	<1	ug/L	UKAS
Benzo(a)anthracene (GCMS)	200	GCMS	<0.01	ug/L	
Benzo(a)pyrene (GCMS)	200	GCMS	<0.01	ug/L	
Benzo(g,h,i)perylene (GCMS)	200	GCMS	<0.01	ug/L	
Benzo(k)fluoranthene (GCMS)	200	GCMS	<0.01	ug/L	
Bromobenzene (Surface Water)	154	GCMS	<1	ug/L	UKAS
Bromochloromethane (Surface Water	154	GCMS	<1	ug/L	UKAS
Bromodichloromethane (Surface Wat	154	GCMS	<1	ug/L	UKAS
Bromoform (Surface Water)	154	GCMS	<1	ug/L	UKAS
Bromomethane (Surface Water)	154	GCMS	<5.0	ug/L	
Cadmium (Surface Water)	177	ICPMS	<1	ug/L	UKAS
Carbon tetrachloride (Surface Water)	154	GCMS	<1	ug/L	UKAS
Chlorobenzene (Surface Water)	154	GCMS	<1	ug/L	UKAS
Chloroethane (Surface Water)	154	GCMS	<5.0	ug/L	
Chloroform (Surface Water)	154	GCMS	<1	ug/L	UKAS
Chloromethane (Surface Water)	154	GCMS	<5.0	ug/L	
Chromium (Surface Water)	177	ICPMS	3	ug/L	UKAS
Chrysene (GCMS)	200	GCMS	<0.01	ug/L	

Signed : A Harmon

Date : 25/04/2018

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	Liosbaun Ind Est	*Date Testing Commenced*	**06/04/2018**
	Liosbaun	*Received or Collected*	**By Fitz: Paul C**
	Co Galway	*Condition on Receipt*	**Acceptable**
Customer PO		*Date of Report*	**25/04/2018**
Customer Ref	**DOWN500-LW-BOTTOM**	*Sample Type*	**Surface Water**
Ref 2			
Ref 3			

CERTIFICATE OF ANALYSIS

Test Parameter	SOP	Analytical Technique	Result	Units	Acc.
cis-1,2-Dichloroethene (Surface Wat	154	GCMS	<1	ug/L	UKAS
cis-1,3-Dichloropropene (Surface Wa	154	GCMS	<1	ug/L	UKAS
COD (Surface Water)	107	Colorimetry	90	mg/L	UKAS
Copper (Surface Water)	177	ICPMS	7	ug/L	UKAS
Coronene (GCMS)	200	GCMS	<0.01	ug/L	
Dibenzo(a,h)anthracene (GCMS)	200	GCMS	<0.01	ug/L	
Dibromochloromethane (Surface Wat	154	GCMS	<1	ug/L	UKAS
Dibromomethane (Surface Water)	154	GCMS	<1	ug/L	UKAS
Dichlorodifluoromethane (Surface W	154	GCMS	<5.0	ug/L	
Dichloromethane (Surface Water)	154	GCMS	<5.0	ug/L	
Ethylbenzene (Surface Water)	154	GCMS	<1	ug/L	UKAS
Fluoranthene (GCMS)	200	GCMS	<0.01	ug/L	
Fluorene (GCMS)	200	GCMS	<0.01	ug/L	
Hexachlorobutadiene (Surface Water	154	GCMS	<1	ug/L	UKAS
Indeno(1,2,3-cd)pyrene (GCMS)	200	GCMS	<0.01	ug/L	
Isopropylbenzene (Surface Water)	154	GCMS	<1	ug/L	UKAS
Lead (Surface Water)	177	ICPMS	5	ug/L	UKAS
m- & p-Xylene (Surface Water)	154	GCMS	<1	ug/L	UKAS
Mercury (Surface water)	178	ICPMS	0.37	ug/L	UKAS
Molybdenum	226	ICPMS	7	ug/L	
Naphthalene (Surface Water)	154	GCMS	<1	ug/L	UKAS
n-Butylbenzene (Surface Water)	154	GCMS	<1	ug/L	UKAS
Nickel (Surface Water)	177	ICPMS	9	ug/L	UKAS
Nitrogen (Total Kjeldahl)	104	Digestion/ Distillation/ Titrimetr	<1.00	mg/L as N	

Signed : A Harman **Date : 25/04/2018**

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		Date of Receipt	06/04/2018
		Sampled On	04/04/2018
		Date Testing Commenced	06/04/2018
		Received or Collected	By Fitz: Paul C
		Condition on Receipt	Acceptable
Customer PO		*Date of Report*	25/04/2018
Customer Ref	DOWN500-LW-BOTTOM	*Sample Type*	Surface Water
Ref 2			
Ref 3			

CERTIFICATE OF ANALYSIS

Test Parameter	SOP	Analytical Technique	Result	Units	Acc.
Nitrogen (Total Oxidised) (Surface W	151	Colorimetry	6.63	mg/L as N	UKAS
Nitrogen (Total)	0	Calculation	7	mg/L as N	
n-Propylbenzene (Surface Water)	154	GCMS	<1.0	ug/L	UKAS
o-Xylene (Surface Water)	154	GCMS	<1	ug/L	UKAS
Phenanthrene (GCMS)	200	GCMS	<0.01	ug/L	
Phenols (Total)	223	GCMS	<0.10	ug/L	
Phosphorus (Total) Surface Water	166	Colorimetry	0.060	mg/L as P	UKAS
p-Isopropyltoluene (Surface Water)	154	GCMS	<1	ug/L	UKAS
Polyaromatic Hydrocarbons (GCMS)	200	GCMS	<0.01	ug/L	
Pyrene (GCMS)	200	GCMS	<0.01	ug/L	
sec-Butylbenzene (Surface Water)	154	GCMS	<1	ug/L	UKAS
Selenium (Surface Water)	177	ICPMS	9	ug/L	UKAS
Solids (Total Dissolved)	105	Filtration/ Evaporation @ 180C	19386	mg/L	
Styrene (Surface Water)	154	GCMS	<1	ug/L	UKAS
tert-Butylbenzene (Surface Water)	154	GCMS	<1	ug/L	UKAS
Tetrachloroethene (Surface Water)	154	GCMS	<1	ug/L	UKAS
TOC (Surface Water)	316	TOC Analyser	4.0	mg/L	UKAS
Toluene (Surface Water)	154	GCMS	<1	ug/L	UKAS
Total Inorganic Nitrogen	0	Calculation	1.6	mg/L	
trans-1,2-Dichloroethene (Surface W	154	GCMS	<1	ug/L	UKAS
trans-1,3-Dichloropropene (Surface	154	GCMS	<1	ug/L	UKAS
Trichloroethene (Surface Water)	154	GCMS	<1.0	ug/L	
Trichlorofluoromethane (Surface Wat	154	GCMS	<1	ug/L	UKAS
Vanadium (Surface Water)	177	ICPMS	192	ug/L	UKAS

Signed : A Harmon

Date : 25/04/2018

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	12 Kilkerrin Park	*Sampled On*	**04/04/2018**
	Liosbaun Ind Est	*Date Testing Commenced*	**06/04/2018**
	Liosbaun	*Received or Collected*	**By Fitz: Paul C**
	Co Galway	*Condition on Receipt*	**Acceptable**
Customer PO		*Date of Report*	**25/04/2018**
Customer Ref	**DOWN500-LW-BOTTOM**	*Sample Type*	**Surface Water**
Ref 2			
Ref 3			

CERTIFICATE OF ANALYSIS

Test Parameter	SOP	Analytical Technique	Result	Units	Acc.
Vinyl chloride (Surface Water)	154	GCMS	<1	ug/L	UKAS
Volatile Organic Compounds	154	GCMS	<5.0	ug/L	
Xylene Total (Surface Water)	154	GCMS	<1	ug/L	UKAS
Zinc (Surface Water)	177	ICPMS	138	ug/L	UKAS

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	Aqua-Fact International Services Ltd	***Date of Receipt***	**06/04/2018**
	12 Kilkerrin Park	***Sampled On***	**04/04/2018**
	Liosbaun Ind Est	***Date Testing Commenced***	**06/04/2018**
	Liosbaun	***Received or Collected***	**By Fitz: Paul C**
	Co Galway	***Condition on Receipt***	**Acceptable**
Customer PO		***Date of Report***	**25/04/2018**
Customer Ref	**DOWN500-MF-SURF**	***Sample Type***	**Surface Water**
Ref 2			
Ref 3			

CERTIFICATE OF ANALYSIS

Test Parameter	SOP	Analytical Technique	Result	Units	Acc.
1,1,1,2-Tetrachloroethane (Surface	154	GCMS	<1	ug/L	UKAS
1,1,1-Trichloroethane (Surface Water	154	GCMS	<1	ug/L	UKAS
1,1,2,2-Tetrachloroethane (Surface	154	GCMS	<5.0	ug/L	
1,1,2-Trichloroethane (Surface Water	154	GCMS	<2	ug/L	UKAS
1,1-Dichloroethane (Surface Water)	154	GCMS	<1	ug/L	UKAS
1,1-Dichloroethene (Surface Water)	154	GCMS	<1	ug/L	UKAS
1,1-Dichloropropene (Surface Water)	154	GCMS	<1	ug/L	UKAS
1,2,3-Trichlorobenzene (Surface Wat	154	GCMS	<1	ug/L	UKAS
1,2,3-Trichloropropane (Surface Wat	154	GCMS	<0.9	ug/L	UKAS
1,2,4-Trichlorobenzene (Surface Wat	154	GCMS	<0.6	ug/L	UKAS
1,2,4-Trimethylbenzene (Surface Wa	154	GCMS	<1	ug/L	UKAS
1,2-Dibromo-3-chloropropane (Surfac	154	GCMS	<1	ug/L	UKAS
1,2-Dibromoethane (Surface Water)	154	GCMS	<1	ug/L	UKAS
1,2-Dichlorobenzene (Surface Water)	154	GCMS	<1	ug/L	UKAS
1,2-Dichloroethane (Surface Water)	154	GCMS	<1	ug/L	UKAS
1,2-Dichloropropane (Surface Water)	154	GCMS	<1	ug/L	UKAS
1,3,5-Trimethylbenzene (Surface Wa	154	GCMS	<1	ug/L	UKAS
1,3-Dichlorobenzene (Surface Water)	154	GCMS	<1	ug/L	UKAS
1,3-Dichloropropane (Surface Water)	154	GCMS	<1	ug/L	UKAS
1,4-Dichlorobenzene (Surface Water)	154	GCMS	<1	ug/L	UKAS
2,2-Dichloropropane (Surface Water)	154	GCMS	<5.0	ug/L	
2-Chlorotoluene (Surface Water)	154	GCMS	<1	ug/L	UKAS
4-Chlorotoluene (Surface Water)	154	GCMS	<1	ug/L	UKAS
Acenaphthene (GCMS)	200	GCMS	<0.01	ug/L	

Signed : A Harmon ***Date : 25/04/2018***

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		Date Testing Commenced	06/04/2018
		Received or Collected	By Fitz: Paul C
		Condition on Receipt	Acceptable
Customer PO		*Date of Report*	25/04/2018
Customer Ref	DOWN500-MF-SURF	*Sample Type*	Surface Water
Ref 2			
Ref 3			

CERTIFICATE OF ANALYSIS

Test Parameter	SOP	Analytical Technique	Result	Units	Acc.
Acenaphthylene (GCMS)	200	GCMS	<0.01	ug/L	
Ammonia (Surface Water)	114	Colorimetry	0.49	mg/L as N	UKAS
Anthracene (GCMS)	200	GCMS	<0.01	ug/L	
Antimony (Surface Water)	177	ICPMS	<3	ug/L	UKAS
Arsenic (Surface Water)	177	ICPMS	<1	ug/L	UKAS
Barium (Surface Water)	177	ICPMS	25	ug/L	UKAS
Benzene (Surface Water)	154	GCMS	<1	ug/L	UKAS
Benzo(a)anthracene (GCMS)	200	GCMS	<0.01	ug/L	
Benzo(a)pyrene (GCMS)	200	GCMS	<0.01	ug/L	
Benzo(g,h,i)perylene (GCMS)	200	GCMS	<0.01	ug/L	
Benzo(k)fluoranthene (GCMS)	200	GCMS	<0.01	ug/L	
Bromobenzene (Surface Water)	154	GCMS	<1	ug/L	UKAS
Bromochloromethane (Surface Water	154	GCMS	<1	ug/L	UKAS
Bromodichloromethane (Surface Wat	154	GCMS	<1	ug/L	UKAS
Bromoform (Surface Water)	154	GCMS	<1	ug/L	UKAS
Bromomethane (Surface Water)	154	GCMS	<5.0	ug/L	
Cadmium (Surface Water)	177	ICPMS	<1	ug/L	UKAS
Carbon tetrachloride (Surface Water)	154	GCMS	<1	ug/L	UKAS
Chlorobenzene (Surface Water)	154	GCMS	<1	ug/L	UKAS
Chloroethane (Surface Water)	154	GCMS	<5.0	ug/L	
Chloroform (Surface Water)	154	GCMS	<1	ug/L	UKAS
Chloromethane (Surface Water)	154	GCMS	<5.0	ug/L	
Chromium (Surface Water)	177	ICPMS	6	ug/L	UKAS
Chrysene (GCMS)	200	GCMS	<0.01	ug/L	

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		Date of Receipt	06/04/2018
		Sampled On	04/04/2018
		Date Testing Commenced	06/04/2018
		Received or Collected	By Fitz: Paul C
		Condition on Receipt	Acceptable
Customer PO		*Date of Report*	25/04/2018
Customer Ref	DOWN500-MF-SURF	*Sample Type*	Surface Water
Ref 2			
Ref 3			

CERTIFICATE OF ANALYSIS

Test Parameter	SOP	Analytical Technique	Result	Units	Acc.
cis-1,2-Dichloroethene (Surface Wat	154	GCMS	<1	ug/L	UKAS
cis-1,3-Dichloropropene (Surface Wa	154	GCMS	<1	ug/L	UKAS
COD (Surface Water)	107	Colorimetry	110	mg/L	UKAS
Copper (Surface Water)	177	ICPMS	4	ug/L	UKAS
Coronene (GCMS)	200	GCMS	<0.01	ug/L	
Dibenzo(a,h)anthracene (GCMS)	200	GCMS	<0.01	ug/L	
Dibromochloromethane (Surface Wat	154	GCMS	<1	ug/L	UKAS
Dibromomethane (Surface Water)	154	GCMS	<1	ug/L	UKAS
Dichlorodifluoromethane (Surface W	154	GCMS	<5.0	ug/L	
Dichloromethane (Surface Water)	154	GCMS	<5.0	ug/L	
Ethylbenzene (Surface Water)	154	GCMS	<1	ug/L	UKAS
Fluoranthene (GCMS)	200	GCMS	<0.01	ug/L	
Fluorene (GCMS)	200	GCMS	<0.01	ug/L	
Hexachlorobutadiene (Surface Water	154	GCMS	<1	ug/L	UKAS
Indeno(1,2,3-cd)pyrene (GCMS)	200	GCMS	<0.01	ug/L	
Isopropylbenzene (Surface Water)	154	GCMS	<1	ug/L	UKAS
Lead (Surface Water)	177	ICPMS	4	ug/L	UKAS
m- & p-Xylene (Surface Water)	154	GCMS	<1	ug/L	UKAS
Mercury (Surface water)	178	ICPMS	1.35	ug/L	UKAS
Molybdenum	226	ICPMS	8	ug/L	
Naphthalene (Surface Water)	154	GCMS	<1	ug/L	UKAS
n-Butylbenzene (Surface Water)	154	GCMS	<1	ug/L	UKAS
Nickel (Surface Water)	177	ICPMS	8	ug/L	UKAS
Nitrogen (Total Kjeldahl)	104	Digestion/ Distillation/ Titrimetr	<1.00	mg/L as N	

Signed : A Harmon

Date : 25/04/2018

Aoife Harmon - Technical Supervisor

Acc. : Accredited Parameters by ISO 17025:2005
PVL - Parametric Value Limit as per EU (Drinking water) Regulations (SI 122 2014)
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UKAS TESTING 2802

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Customer	**Caroline Roche**	*Lab Report Ref. No.*	**0529/001/13**
	Aqua-Fact International Services Ltd	*Date of Receipt*	**06/04/2018**
	12 Kilkerrin Park	*Sampled On*	**04/04/2018**
	Liosbaun Ind Est	*Date Testing Commenced*	**06/04/2018**
	Liosbaun	*Received or Collected*	**By Fitz: Paul C**
	Co Galway	*Condition on Receipt*	**Acceptable**
Customer PO		*Date of Report*	**25/04/2018**
Customer Ref	**DOWN500-MF-SURF**	*Sample Type*	**Surface Water**
Ref 2			
Ref 3			

CERTIFICATE OF ANALYSIS

Test Parameter	SOP	Analytical Technique	Result	Units	Acc.
Nitrogen (Total Oxidised) (Surface W	151	Colorimetry	1.56	mg/L as N	UKAS
Nitrogen (Total)	0	Calculation	2	mg/L as N	
n-Propylbenzene (Surface Water)	154	GCMS	<1.0	ug/L	UKAS
o-Xylene (Surface Water)	154	GCMS	<1	ug/L	UKAS
Phenanthrene (GCMS)	200	GCMS	<0.01	ug/L	
Phenols (Total)	223	GCMS	<0.10	ug/L	
Phosphorus (Total) Surface Water	166	Colorimetry	0.053	mg/L as P	UKAS
p-Isopropyltoluene (Surface Water)	154	GCMS	<1	ug/L	UKAS
Polyaromatic Hydrocarbons (GCMS)	200	GCMS	<0.01	ug/L	
Pyrene (GCMS)	200	GCMS	<0.01	ug/L	
sec-Butylbenzene (Surface Water)	154	GCMS	<1	ug/L	UKAS
Selenium (Surface Water)	177	ICPMS	5	ug/L	UKAS
Solids (Total Dissolved)	105	Filtration/ Evaporation @ 180C	23163	mg/L	
Styrene (Surface Water)	154	GCMS	<1	ug/L	UKAS
tert-Butylbenzene (Surface Water)	154	GCMS	<1	ug/L	UKAS
Tetrachloroethene (Surface Water)	154	GCMS	<1	ug/L	UKAS
TOC (Surface Water)	316	TOC Analyser	3.6	mg/L	UKAS
Toluene (Surface Water)	154	GCMS	<1	ug/L	UKAS
Total Inorganic Nitrogen	0	Calculation	0.7	mg/L	
trans-1,2-Dichloroethene (Surface W	154	GCMS	<1	ug/L	UKAS
trans-1,3-Dichloropropene (Surface	154	GCMS	<1	ug/L	UKAS
Trichloroethene (Surface Water)	154	GCMS	<1.0	ug/L	
Trichlorofluoromethane (Surface Wat	154	GCMS	<1	ug/L	UKAS
Vanadium (Surface Water)	177	ICPMS	202	ug/L	UKAS

Signed : A Harmon ***Date : 25/04/2018***

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	Aqua-Fact International Services Ltd	*Date of Receipt*	**06/04/2018**
	12 Kilkerrin Park	*Sampled On*	**04/04/2018**
	Liosbaun Ind Est	*Date Testing Commenced*	**06/04/2018**
	Liosbaun	*Received or Collected*	**By Fitz: Paul C**
	Co Galway	*Condition on Receipt*	**Acceptable**
Customer PO		*Date of Report*	**25/04/2018**
Customer Ref	**DOWN500-MF-SURF**	*Sample Type*	**Surface Water**
Ref 2			
Ref 3			

CERTIFICATE OF ANALYSIS

Test Parameter	SOP	Analytical Technique	Result	Units	Acc.
Vinyl chloride (Surface Water)	154	GCMS	<1	ug/L	UKAS
Volatile Organic Compounds	154	GCMS	<5.0	ug/L	
Xylene Total (Surface Water)	154	GCMS	<1	ug/L	UKAS
Zinc (Surface Water)	177	ICPMS	96	ug/L	UKAS

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Customer	Caroline Roche Aqua-Fact International Services Ltd 12 Kilkerrin Park Liosbaun Ind Est Liosbaun Co Galway	*Lab Report Ref. No.*	0529/001/14
		Date of Receipt	06/04/2018
		Sampled On	04/04/2018
		Date Testing Commenced	06/04/2018
		Received or Collected	By Fitz: Paul C
		Condition on Receipt	Acceptable
Customer PO		*Date of Report*	25/04/2018
Customer Ref	DOWN500-MF-MID	*Sample Type*	Surface Water
Ref 2			
Ref 3			

CERTIFICATE OF ANALYSIS

Test Parameter	SOP	Analytical Technique	Result	Units	Acc.
1,1,1,2-Tetrachloroethane (Surface	154	GCMS	<1	ug/L	UKAS
1,1,1-Trichloroethane (Surface Water	154	GCMS	<1	ug/L	UKAS
1,1,2,2-Tetrachloroethane (Surface	154	GCMS	<5.0	ug/L	
1,1,2-Trichloroethane (Surface Water	154	GCMS	<2	ug/L	UKAS
1,1-Dichloroethane (Surface Water)	154	GCMS	<1	ug/L	UKAS
1,1-Dichloroethene (Surface Water)	154	GCMS	<1	ug/L	UKAS
1,1-Dichloropropene (Surface Water)	154	GCMS	<1	ug/L	UKAS
1,2,3-Trichlorobenzene (Surface Wat	154	GCMS	<1	ug/L	UKAS
1,2,3-Trichloropropane (Surface Wat	154	GCMS	<0.9	ug/L	UKAS
1,2,4-Trichlorobenzene (Surface Wat	154	GCMS	<0.6	ug/L	UKAS
1,2,4-Trimethylbenzene (Surface Wa	154	GCMS	<1	ug/L	UKAS
1,2-Dibromo-3-chloropropane (Surfac	154	GCMS	<1	ug/L	UKAS
1,2-Dibromoethane (Surface Water)	154	GCMS	<1	ug/L	UKAS
1,2-Dichlorobenzene (Surface Water)	154	GCMS	<1	ug/L	UKAS
1,2-Dichloroethane (Surface Water)	154	GCMS	<1	ug/L	UKAS
1,2-Dichloropropane (Surface Water)	154	GCMS	<1	ug/L	UKAS
1,3,5-Trimethylbenzene (Surface Wa	154	GCMS	<1	ug/L	UKAS
1,3-Dichlorobenzene (Surface Water)	154	GCMS	<1	ug/L	UKAS
1,3-Dichloropropane (Surface Water)	154	GCMS	<1	ug/L	UKAS
1,4-Dichlorobenzene (Surface Water)	154	GCMS	<1	ug/L	UKAS
2,2-Dichloropropane (Surface Water)	154	GCMS	<5.0	ug/L	
2-Chlorotoluene (Surface Water)	154	GCMS	<1	ug/L	UKAS
4-Chlorotoluene (Surface Water)	154	GCMS	<1	ug/L	UKAS
Acenaphthene (GCMS)	200	GCMS	<0.01	ug/L	

Signed : A Harmon **Date : 25/04/2018**

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Customer	**Caroline Roche**	*Lab Report Ref. No.*	**0529/001/14**
	Aqua-Fact International Services Ltd	*Date of Receipt*	**06/04/2018**
	12 Kilkerrin Park	*Sampled On*	**04/04/2018**
	Liosbaun Ind Est	*Date Testing Commenced*	**06/04/2018**
	Liosbaun	*Received or Collected*	**By Fitz: Paul C**
	Co Galway	*Condition on Receipt*	**Acceptable**
Customer PO		*Date of Report*	**25/04/2018**
Customer Ref	**DOWN500-MF-MID**	*Sample Type*	**Surface Water**
Ref 2			
Ref 3			

CERTIFICATE OF ANALYSIS

Test Parameter	SOP	Analytical Technique	Result	Units	Acc.
Acenaphthylene (GCMS)	200	GCMS	<0.01	ug/L	
Ammonia (Surface Water)	114	Colorimetry	0.43	mg/L as N	UKAS
Anthracene (GCMS)	200	GCMS	<0.01	ug/L	
Antimony (Surface Water)	177	ICPMS	<3	ug/L	UKAS
Arsenic (Surface Water)	177	ICPMS	1	ug/L	UKAS
Barium (Surface Water)	177	ICPMS	26	ug/L	UKAS
Benzene (Surface Water)	154	GCMS	<1	ug/L	UKAS
Benzo(a)anthracene (GCMS)	200	GCMS	<0.01	ug/L	
Benzo(a)pyrene (GCMS)	200	GCMS	<0.01	ug/L	
Benzo(g,h,i)perylene (GCMS)	200	GCMS	<0.01	ug/L	
Benzo(k)fluoranthene (GCMS)	200	GCMS	<0.01	ug/L	
Bromobenzene (Surface Water)	154	GCMS	<1	ug/L	UKAS
Bromochloromethane (Surface Water	154	GCMS	<1	ug/L	UKAS
Bromodichloromethane (Surface Wat	154	GCMS	<1	ug/L	UKAS
Bromoform (Surface Water)	154	GCMS	<1	ug/L	UKAS
Bromomethane (Surface Water)	154	GCMS	<5.0	ug/L	
Cadmium (Surface Water)	177	ICPMS	<1	ug/L	UKAS
Carbon tetrachloride (Surface Water)	154	GCMS	<1	ug/L	UKAS
Chlorobenzene (Surface Water)	154	GCMS	<1	ug/L	UKAS
Chloroethane (Surface Water)	154	GCMS	<5.0	ug/L	
Chloroform (Surface Water)	154	GCMS	<1	ug/L	UKAS
Chloromethane (Surface Water)	154	GCMS	<5.0	ug/L	
Chromium (Surface Water)	177	ICPMS	9	ug/L	UKAS
Chrysene (GCMS)	200	GCMS	<0.01	ug/L	

Signed : A Harman **Date : 25/04/2018**

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	Aqua-Fact International Services Ltd	*Date of Receipt*	**06/04/2018**
	12 Kilkerrin Park	*Sampled On*	**04/04/2018**
	Liosbaun Ind Est	*Date Testing Commenced*	**06/04/2018**
	Liosbaun	*Received or Collected*	**By Fitz: Paul C**
	Co Galway	*Condition on Receipt*	**Acceptable**
Customer PO		*Date of Report*	**25/04/2018**
Customer Ref	**DOWN500-MF-MID**	*Sample Type*	**Surface Water**
Ref 2			
Ref 3			

CERTIFICATE OF ANALYSIS

Test Parameter	SOP	Analytical Technique	Result	Units	Acc.
cis-1,2-Dichloroethene (Surface Wat	154	GCMS	<1	ug/L	UKAS
cis-1,3-Dichloropropene (Surface Wa	154	GCMS	<1	ug/L	UKAS
COD (Surface Water)	107	Colorimetry	120	mg/L	UKAS
Copper (Surface Water)	177	ICPMS	11	ug/L	UKAS
Coronene (GCMS)	200	GCMS	<0.01	ug/L	
Dibenzo(a,h)anthracene (GCMS)	200	GCMS	<0.01	ug/L	
Dibromochloromethane (Surface Wat	154	GCMS	<1	ug/L	UKAS
Dibromomethane (Surface Water)	154	GCMS	<1	ug/L	UKAS
Dichlorodifluoromethane (Surface W	154	GCMS	<5.0	ug/L	
Dichloromethane (Surface Water)	154	GCMS	<5.0	ug/L	
Ethylbenzene (Surface Water)	154	GCMS	<1	ug/L	UKAS
Fluoranthene (GCMS)	200	GCMS	<0.01	ug/L	
Fluorene (GCMS)	200	GCMS	<0.01	ug/L	
Hexachlorobutadiene (Surface Water	154	GCMS	<1	ug/L	UKAS
Indeno(1,2,3-cd)pyrene (GCMS)	200	GCMS	<0.01	ug/L	
Isopropylbenzene (Surface Water)	154	GCMS	<1	ug/L	UKAS
Lead (Surface Water)	177	ICPMS	5	ug/L	UKAS
m- & p-Xylene (Surface Water)	154	GCMS	<1	ug/L	UKAS
Mercury (Surface water)	178	ICPMS	0.27	ug/L	UKAS
Molybdenum	226	ICPMS	9	ug/L	
Naphthalene (Surface Water)	154	GCMS	<1	ug/L	UKAS
n-Butylbenzene (Surface Water)	154	GCMS	<1	ug/L	UKAS
Nickel (Surface Water)	177	ICPMS	13	ug/L	UKAS
Nitrogen (Total Kjeldahl)	104	Digestion/ Distillation/ Titrimetr	<1.00	mg/L as N	

Signed : A Harmon

Date : 25/04/2018

Aoife Harmon - Technical Supervisor

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Customer	Caroline Roche Aqua-Fact International Services Ltd 12 Kilkerrin Park Liosbaun Ind Est Liosbaun Co Galway	*Lab Report Ref. No.*	0529/001/14
		Date of Receipt	06/04/2018
		Sampled On	04/04/2018
		Date Testing Commenced	06/04/2018
		Received or Collected	By Fitz: Paul C
		Condition on Receipt	Acceptable
Customer PO		*Date of Report*	25/04/2018
Customer Ref	DOWN500-MF-MID	*Sample Type*	Surface Water
Ref 2			
Ref 3			

CERTIFICATE OF ANALYSIS

Test Parameter	SOP	Analytical Technique	Result	Units	Acc.
Nitrogen (Total Oxidised) (Surface W	151	Colorimetry	1.97	mg/L as N	UKAS
Nitrogen (Total)	0	Calculation	3	mg/L as N	
n-Propylbenzene (Surface Water)	154	GCMS	<1.0	ug/L	UKAS
o-Xylene (Surface Water)	154	GCMS	<1	ug/L	UKAS
Phenanthrene (GCMS)	200	GCMS	<0.01	ug/L	
Phenols (Total)	223	GCMS	<0.10	ug/L	
Phosphorus (Total) Surface Water	166	Colorimetry	0.055	mg/L as P	UKAS
p-Isopropyltoluene (Surface Water)	154	GCMS	<1	ug/L	UKAS
Polyaromatic Hydrocarbons (GCMS)	200	GCMS	<0.01	ug/L	
Pyrene (GCMS)	200	GCMS	<0.01	ug/L	
sec-Butylbenzene (Surface Water)	154	GCMS	<1	ug/L	UKAS
Selenium (Surface Water)	177	ICPMS	<1	ug/L	UKAS
Solids (Total Dissolved)	105	Filtration/ Evaporation @ 180C	23247	mg/L	
Styrene (Surface Water)	154	GCMS	<1	ug/L	UKAS
tert-Butylbenzene (Surface Water)	154	GCMS	<1	ug/L	UKAS
Tetrachloroethene (Surface Water)	154	GCMS	<1	ug/L	UKAS
TOC (Surface Water)	316	TOC Analyser	4.0	mg/L	UKAS
Toluene (Surface Water)	154	GCMS	<1	ug/L	UKAS
Total Inorganic Nitrogen	0	Calculation	0.6	mg/L	
trans-1,2-Dichloroethene (Surface W	154	GCMS	<1	ug/L	UKAS
trans-1,3-Dichloropropene (Surface	154	GCMS	<1	ug/L	UKAS
Trichloroethene (Surface Water)	154	GCMS	<1.0	ug/L	
Trichlorofluoromethane (Surface Wat	154	GCMS	<1	ug/L	UKAS
Vanadium (Surface Water)	177	ICPMS	224	ug/L	UKAS

Signed : A Harmon

Date : 25/04/2018

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Customer	**Caroline Roche**	*Lab Report Ref. No.*	**0529/001/14**
	Aqua-Fact International Services Ltd	*Date of Receipt*	**06/04/2018**
	12 Kilkerrin Park	*Sampled On*	**04/04/2018**
	Liosbaun Ind Est	*Date Testing Commenced*	**06/04/2018**
	Liosbaun	*Received or Collected*	**By Fitz: Paul C**
	Co Galway	*Condition on Receipt*	**Acceptable**
Customer PO		*Date of Report*	**25/04/2018**
Customer Ref	**DOWN500-MF-MID**	*Sample Type*	**Surface Water**
Ref 2			
Ref 3			

CERTIFICATE OF ANALYSIS

Test Parameter	SOP	Analytical Technique	Result	Units	Acc.
Vinyl chloride (Surface Water)	154	GCMS	<1	ug/L	UKAS
Volatile Organic Compounds	154	GCMS	<5.0	ug/L	
Xylene Total (Surface Water)	154	GCMS	<1	ug/L	UKAS
Zinc (Surface Water)	177	ICPMS	170	ug/L	UKAS

Signed : A Harmon

Aoife Harmon - Technical Supervisor

Date : 25/04/2018

UKAS TESTING 2802

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Customer	**Caroline Roche**	*Lab Report Ref. No.*	**0529/001/15**
	Aqua-Fact International Services Ltd	*Date of Receipt*	**06/04/2018**
	12 Kilkerrin Park	*Sampled On*	**04/04/2018**
	Liosbaun Ind Est	*Date Testing Commenced*	**06/04/2018**
	Liosbaun	*Received or Collected*	**By Fitz: Paul C**
	Co Galway	*Condition on Receipt*	**Acceptable**
Customer PO		*Date of Report*	**25/04/2018**
Customer Ref	**DOWN500-MF-BOTTOM**	*Sample Type*	**Surface Water**
Ref 2			
Ref 3			

CERTIFICATE OF ANALYSIS

Test Parameter	SOP	Analytical Technique	Result	Units	Acc.
1,1,1,2-Tetrachloroethane (Surface	154	GCMS	<1	ug/L	UKAS
1,1,1-Trichloroethane (Surface Water	154	GCMS	<1	ug/L	UKAS
1,1,2,2-Tetrachloroethane (Surface	154	GCMS	<5.0	ug/L	
1,1,2-Trichloroethane (Surface Water	154	GCMS	<2	ug/L	UKAS
1,1-Dichloroethane (Surface Water)	154	GCMS	<1	ug/L	UKAS
1,1-Dichloroethene (Surface Water)	154	GCMS	<1	ug/L	UKAS
1,1-Dichloropropene (Surface Water)	154	GCMS	<1	ug/L	UKAS
1,2,3-Trichlorobenzene (Surface Wat	154	GCMS	<1	ug/L	UKAS
1,2,3-Trichloropropane (Surface Wat	154	GCMS	<0.9	ug/L	UKAS
1,2,4-Trichlorobenzene (Surface Wat	154	GCMS	<0.6	ug/L	UKAS
1,2,4-Trimethylbenzene (Surface Wa	154	GCMS	<1	ug/L	UKAS
1,2-Dibromo-3-chloropropane (Surfac	154	GCMS	<1	ug/L	UKAS
1,2-Dibromoethane (Surface Water)	154	GCMS	<1	ug/L	UKAS
1,2-Dichlorobenzene (Surface Water)	154	GCMS	<1	ug/L	UKAS
1,2-Dichloroethane (Surface Water)	154	GCMS	<1	ug/L	UKAS
1,2-Dichloropropane (Surface Water)	154	GCMS	<1	ug/L	UKAS
1,3,5-Trimethylbenzene (Surface Wa	154	GCMS	<1	ug/L	UKAS
1,3-Dichlorobenzene (Surface Water)	154	GCMS	<1	ug/L	UKAS
1,3-Dichloropropane (Surface Water)	154	GCMS	<1	ug/L	UKAS
1,4-Dichlorobenzene (Surface Water)	154	GCMS	<1	ug/L	UKAS
2,2-Dichloropropane (Surface Water)	154	GCMS	<5.0	ug/L	
2-Chlorotoluene (Surface Water)	154	GCMS	<1	ug/L	UKAS
4-Chlorotoluene (Surface Water)	154	GCMS	<1	ug/L	UKAS
Acenaphthene (GCMS)	200	GCMS	<0.01	ug/L	

Signed : A Harman

Date : 25/04/2018

Aoife Harmon - Technical Supervisor

Acc. : Accredited Parameters by ISO 17025:2005
PVL - Parametric Value Limit as per EU (Drinking water) Regulations (SI 122 2014)
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UKAS TESTING 2802

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Customer	**Caroline Roche**	***Lab Report Ref. No.***	**0529/001/15**
	Aqua-Fact International Services Ltd	***Date of Receipt***	**06/04/2018**
	12 Kilkerrin Park	***Sampled On***	**04/04/2018**
	Liosbaun Ind Est	***Date Testing Commenced***	**06/04/2018**
	Liosbaun	***Received or Collected***	**By Fitz: Paul C**
	Co Galway	***Condition on Receipt***	**Acceptable**
Customer PO		***Date of Report***	**25/04/2018**
Customer Ref	**DOWN500-MF-BOTTOM**	***Sample Type***	**Surface Water**
Ref 2			
Ref 3			

CERTIFICATE OF ANALYSIS

Test Parameter	SOP	Analytical Technique	Result	Units	Acc.
Acenaphthylene (GCMS)	200	GCMS	<0.01	ug/L	
Ammonia (Surface Water)	114	Colorimetry	0.38	mg/L as N	UKAS
Anthracene (GCMS)	200	GCMS	<0.01	ug/L	
Antimony (Surface Water)	177	ICPMS	<3	ug/L	UKAS
Arsenic (Surface Water)	177	ICPMS	<1	ug/L	UKAS
Barium (Surface Water)	177	ICPMS	31	ug/L	UKAS
Benzene (Surface Water)	154	GCMS	<1	ug/L	UKAS
Benzo(a)anthracene (GCMS)	200	GCMS	<0.01	ug/L	
Benzo(a)pyrene (GCMS)	200	GCMS	<0.01	ug/L	
Benzo(g,h,i)perylene (GCMS)	200	GCMS	<0.01	ug/L	
Benzo(k)fluoranthene (GCMS)	200	GCMS	<0.01	ug/L	
Bromobenzene (Surface Water)	154	GCMS	<1	ug/L	UKAS
Bromochloromethane (Surface Water	154	GCMS	<1	ug/L	UKAS
Bromodichloromethane (Surface Wat	154	GCMS	<1	ug/L	UKAS
Bromoform (Surface Water)	154	GCMS	<1	ug/L	UKAS
Bromomethane (Surface Water)	154	GCMS	<5.0	ug/L	
Cadmium (Surface Water)	177	ICPMS	<1	ug/L	UKAS
Carbon tetrachloride (Surface Water)	154	GCMS	<1	ug/L	UKAS
Chlorobenzene (Surface Water)	154	GCMS	<1	ug/L	UKAS
Chloroethane (Surface Water)	154	GCMS	<5.0	ug/L	
Chloroform (Surface Water)	154	GCMS	<1	ug/L	UKAS
Chloromethane (Surface Water)	154	GCMS	<5.0	ug/L	
Chromium (Surface Water)	177	ICPMS	6	ug/L	UKAS
Chrysene (GCMS)	200	GCMS	<0.01	ug/L	

Signed : A Harman ***Date : 25/04/2018***

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	12 Kilkerrin Park	*Sampled On*	**04/04/2018**
	Liosbaun Ind Est	*Date Testing Commenced*	**06/04/2018**
	Liosbaun	*Received or Collected*	**By Fitz: Paul C**
	Co Galway	*Condition on Receipt*	**Acceptable**
Customer PO		*Date of Report*	**25/04/2018**
Customer Ref	**DOWN500-MF-BOTTOM**	*Sample Type*	**Surface Water**
Ref 2			
Ref 3			

CERTIFICATE OF ANALYSIS

Test Parameter	SOP	Analytical Technique	Result	Units	Acc.
cis-1,2-Dichloroethene (Surface Wat	154	GCMS	<1	ug/L	UKAS
cis-1,3-Dichloropropene (Surface Wa	154	GCMS	<1	ug/L	UKAS
COD (Surface Water)	107	Colorimetry	125	mg/L	UKAS
Copper (Surface Water)	177	ICPMS	9	ug/L	UKAS
Coronene (GCMS)	200	GCMS	<0.01	ug/L	
Dibenzo(a,h)anthracene (GCMS)	200	GCMS	<0.01	ug/L	
Dibromochloromethane (Surface Wat	154	GCMS	<1	ug/L	UKAS
Dibromomethane (Surface Water)	154	GCMS	<1	ug/L	UKAS
Dichlorodifluoromethane (Surface W	154	GCMS	<5.0	ug/L	
Dichloromethane (Surface Water)	154	GCMS	<5.0	ug/L	
Ethylbenzene (Surface Water)	154	GCMS	<1	ug/L	UKAS
Fluoranthene (GCMS)	200	GCMS	<0.01	ug/L	
Fluorene (GCMS)	200	GCMS	<0.01	ug/L	
Hexachlorobutadiene (Surface Water	154	GCMS	<1	ug/L	UKAS
Indeno(1,2,3-cd)pyrene (GCMS)	200	GCMS	<0.01	ug/L	
Isopropylbenzene (Surface Water)	154	GCMS	<1	ug/L	UKAS
Lead (Surface Water)	177	ICPMS	6	ug/L	UKAS
m- & p-Xylene (Surface Water)	154	GCMS	<1	ug/L	UKAS
Mercury (Surface water)	178	ICPMS	0.29	ug/L	UKAS
Molybdenum	226	ICPMS	8	ug/L	
Naphthalene (Surface Water)	154	GCMS	<1	ug/L	UKAS
n-Butylbenzene (Surface Water)	154	GCMS	<1	ug/L	UKAS
Nickel (Surface Water)	177	ICPMS	16	ug/L	UKAS
Nitrogen (Total Kjeldahl)	104	Digestion/ Distillation/ Titrimetr	<1.00	mg/L as N	

Signed : A Harman

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Customer	Caroline Roche Aqua-Fact International Services Ltd 12 Kilkerrin Park Liosbaun Ind Est Liosbaun Co Galway	*Lab Report Ref. No.*	0529/001/15
		Date of Receipt	06/04/2018
		Sampled On	04/04/2018
		Date Testing Commenced	06/04/2018
		Received or Collected	By Fitz: Paul C
		Condition on Receipt	Acceptable
Customer PO		*Date of Report*	25/04/2018
Customer Ref	DOWN500-MF-BOTTOM	*Sample Type*	Surface Water
Ref 2			
Ref 3			

CERTIFICATE OF ANALYSIS

Test Parameter	SOP	Analytical Technique	Result	Units	Acc.
Nitrogen (Total Oxidised) (Surface W	151	Colorimetry	1.53	mg/L as N	UKAS
Nitrogen (Total)	0	Calculation	2	mg/L as N	
n-Propylbenzene (Surface Water)	154	GCMS	<1.0	ug/L	UKAS
o-Xylene (Surface Water)	154	GCMS	<1	ug/L	UKAS
Phenanthrene (GCMS)	200	GCMS	<0.01	ug/L	
Phenols (Total)	223	GCMS	<0.10	ug/L	
Phosphorus (Total) Surface Water	166	Colorimetry	0.048	mg/L as P	UKAS
p-Isopropyltoluene (Surface Water)	154	GCMS	<1	ug/L	UKAS
Polyaromatic Hydrocarbons (GCMS)	200	GCMS	<0.01	ug/L	
Pyrene (GCMS)	200	GCMS	<0.01	ug/L	
sec-Butylbenzene (Surface Water)	154	GCMS	<1	ug/L	UKAS
Selenium (Surface Water)	177	ICPMS	19	ug/L	UKAS
Solids (Total Dissolved)	105	Filtration/ Evaporation @ 180C	23169	mg/L	
Styrene (Surface Water)	154	GCMS	<1	ug/L	UKAS
tert-Butylbenzene (Surface Water)	154	GCMS	<1	ug/L	UKAS
Tetrachloroethene (Surface Water)	154	GCMS	<1	ug/L	UKAS
TOC (Surface Water)	316	TOC Analyser	4.1	mg/L	UKAS
Toluene (Surface Water)	154	GCMS	<1	ug/L	UKAS
Total Inorganic Nitrogen	0	Calculation	0.7	mg/L	
trans-1,2-Dichloroethene (Surface W	154	GCMS	<1	ug/L	UKAS
trans-1,3-Dichloropropene (Surface	154	GCMS	<1	ug/L	UKAS
Trichloroethene (Surface Water)	154	GCMS	<1.0	ug/L	
Trichlorofluoromethane (Surface Wat	154	GCMS	<1	ug/L	UKAS
Vanadium (Surface Water)	177	ICPMS	232	ug/L	UKAS

Signed : A Harman ***Date : 25/04/2018***

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Customer	**Caroline Roche**	***Lab Report Ref. No.***	**0529/001/15**
	Aqua-Fact International Services Ltd	***Date of Receipt***	**06/04/2018**
	12 Kilkerrin Park	***Sampled On***	**04/04/2018**
	Liosbaun Ind Est	***Date Testing Commenced***	**06/04/2018**
	Liosbaun	***Received or Collected***	**By Fitz: Paul C**
	Co Galway	***Condition on Receipt***	**Acceptable**
Customer PO		***Date of Report***	**25/04/2018**
Customer Ref	**DOWN500-MF-BOTTOM**	***Sample Type***	**Surface Water**
Ref 2			
Ref 3			

CERTIFICATE OF ANALYSIS

Test Parameter	SOP	Analytical Technique	Result	Units	Acc.
Vinyl chloride (Surface Water)	154	GCMS	<1	ug/L	UKAS
Volatile Organic Compounds	154	GCMS	<5.0	ug/L	
Xylene Total (Surface Water)	154	GCMS	<1	ug/L	UKAS
Zinc (Surface Water)	177	ICPMS	199	ug/L	UKAS

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	Aqua-Fact International Services Ltd	**Date of Receipt**	**06/04/2018**
	12 Kilkerrin Park	**Sampled On**	**04/04/2018**
	Liosbaun Ind Est	**Date Testing Commenced**	**06/04/2018**
	Liosbaun	**Received or Collected**	**By Fitz: Paul C**
	Co Galway	**Condition on Receipt**	**Acceptable**
Customer PO		**Date of Report**	**25/04/2018**
Customer Ref	**DOWN1KM-ME-SURF**	**Sample Type**	**Surface Water**
Ref 2			
Ref 3			

CERTIFICATE OF ANALYSIS

Test Parameter	SOP	Analytical Technique	Result	Units	Acc.
1,1,1,2-Tetrachloroethane (Surface	154	GCMS	<1	ug/L	UKAS
1,1,1-Trichloroethane (Surface Water	154	GCMS	<1	ug/L	UKAS
1,1,2,2-Tetrachloroethane (Surface	154	GCMS	<5.0	ug/L	
1,1,2-Trichloroethane (Surface Water	154	GCMS	<2	ug/L	UKAS
1,1-Dichloroethane (Surface Water)	154	GCMS	<1	ug/L	UKAS
1,1-Dichloroethene (Surface Water)	154	GCMS	<1	ug/L	UKAS
1,1-Dichloropropene (Surface Water)	154	GCMS	<1	ug/L	UKAS
1,2,3-Trichlorobenzene (Surface Wat	154	GCMS	<1	ug/L	UKAS
1,2,3-Trichloropropane (Surface Wat	154	GCMS	<0.9	ug/L	UKAS
1,2,4-Trichlorobenzene (Surface Wat	154	GCMS	<0.6	ug/L	UKAS
1,2,4-Trimethylbenzene (Surface Wa	154	GCMS	<1	ug/L	UKAS
1,2-Dibromo-3-chloropropane (Surfac	154	GCMS	<1	ug/L	UKAS
1,2-Dibromoethane (Surface Water)	154	GCMS	<1	ug/L	UKAS
1,2-Dichlorobenzene (Surface Water)	154	GCMS	<1	ug/L	UKAS
1,2-Dichloroethane (Surface Water)	154	GCMS	<1	ug/L	UKAS
1,2-Dichloropropane (Surface Water)	154	GCMS	<1	ug/L	UKAS
1,3,5-Trimethylbenzene (Surface Wa	154	GCMS	<1	ug/L	UKAS
1,3-Dichlorobenzene (Surface Water)	154	GCMS	<1	ug/L	UKAS
1,3-Dichloropropane (Surface Water)	154	GCMS	<1	ug/L	UKAS
1,4-Dichlorobenzene (Surface Water)	154	GCMS	<1	ug/L	UKAS
2,2-Dichloropropane (Surface Water)	154	GCMS	<5.0	ug/L	
2-Chlorotoluene (Surface Water)	154	GCMS	<1	ug/L	UKAS
4-Chlorotoluene (Surface Water)	154	GCMS	<1	ug/L	UKAS
Acenaphthene (GCMS)	200	GCMS	<0.01	ug/L	

Signed : A Harman

Date : 25/04/2018

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	12 Kilkerrin Park	*Sampled On*	**04/04/2018**
	Liosbaun Ind Est	*Date Testing Commenced*	**06/04/2018**
	Liosbaun	*Received or Collected*	**By Fitz: Paul C**
	Co Galway	*Condition on Receipt*	**Acceptable**
Customer PO		*Date of Report*	**25/04/2018**
Customer Ref	**DOWN1KM-ME-SURF**	*Sample Type*	**Surface Water**
Ref 2			
Ref 3			

CERTIFICATE OF ANALYSIS

Test Parameter	SOP	Analytical Technique	Result	Units	Acc.
Acenaphthylene (GCMS)	200	GCMS	<0.01	ug/L	
Ammonia (Surface Water)	114	Colorimetry	0.36	mg/L as N	UKAS
Anthracene (GCMS)	200	GCMS	<0.01	ug/L	
Antimony (Surface Water)	177	ICPMS	<3	ug/L	UKAS
Arsenic (Surface Water)	177	ICPMS	4	ug/L	UKAS
Barium (Surface Water)	177	ICPMS	28	ug/L	UKAS
Benzene (Surface Water)	154	GCMS	<1	ug/L	UKAS
Benzo(a)anthracene (GCMS)	200	GCMS	<0.01	ug/L	
Benzo(a)pyrene (GCMS)	200	GCMS	<0.01	ug/L	
Benzo(g,h,i)perylene (GCMS)	200	GCMS	<0.01	ug/L	
Benzo(k)fluoranthene (GCMS)	200	GCMS	<0.01	ug/L	
Bromobenzene (Surface Water)	154	GCMS	<1	ug/L	UKAS
Bromochloromethane (Surface Water	154	GCMS	<1	ug/L	UKAS
Bromodichloromethane (Surface Wat	154	GCMS	<1	ug/L	UKAS
Bromoform (Surface Water)	154	GCMS	<1	ug/L	UKAS
Bromomethane (Surface Water)	154	GCMS	<5.0	ug/L	
Cadmium (Surface Water)	177	ICPMS	<1	ug/L	UKAS
Carbon tetrachloride (Surface Water)	154	GCMS	<1	ug/L	UKAS
Chlorobenzene (Surface Water)	154	GCMS	<1	ug/L	UKAS
Chloroethane (Surface Water)	154	GCMS	<5.0	ug/L	
Chloroform (Surface Water)	154	GCMS	<1	ug/L	UKAS
Chloromethane (Surface Water)	154	GCMS	<5.0	ug/L	
Chromium (Surface Water)	177	ICPMS	7	ug/L	UKAS
Chrysene (GCMS)	200	GCMS	<0.01	ug/L	

Signed : A Harmon **Date : 25/04/2018**

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Customer	Caroline Roche Aqua-Fact International Services Ltd 12 Kilkerrin Park Liosbaun Ind Est Liosbaun Co Galway	*Lab Report Ref. No.*	0529/001/25
		Date of Receipt	06/04/2018
		Sampled On	04/04/2018
		Date Testing Commenced	06/04/2018
		Received or Collected	By Fitz: Paul C
		Condition on Receipt	Acceptable
Customer PO		*Date of Report*	25/04/2018
Customer Ref	DOWN1KM-ME-SURF	*Sample Type*	Surface Water
Ref 2			
Ref 3			

CERTIFICATE OF ANALYSIS

Test Parameter	SOP	Analytical Technique	Result	Units	Acc.
cis-1,2-Dichloroethene (Surface Wat	154	GCMS	<1	ug/L	UKAS
cis-1,3-Dichloropropene (Surface Wa	154	GCMS	<1	ug/L	UKAS
COD (Surface Water)	107	Colorimetry	85	mg/L	UKAS
Copper (Surface Water)	177	ICPMS	12	ug/L	UKAS
Coronene (GCMS)	200	GCMS	<0.01	ug/L	
Dibenzo(a,h)anthracene (GCMS)	200	GCMS	<0.01	ug/L	
Dibromochloromethane (Surface Wat	154	GCMS	<1	ug/L	UKAS
Dibromomethane (Surface Water)	154	GCMS	<1	ug/L	UKAS
Dichlorodifluoromethane (Surface W	154	GCMS	<5.0	ug/L	
Dichloromethane (Surface Water)	154	GCMS	<5.0	ug/L	
Ethylbenzene (Surface Water)	154	GCMS	<1	ug/L	UKAS
Fluoranthene (GCMS)	200	GCMS	<0.01	ug/L	
Fluorene (GCMS)	200	GCMS	<0.01	ug/L	
Hexachlorobutadiene (Surface Water	154	GCMS	<1	ug/L	UKAS
Indeno(1,2,3-cd)pyrene (GCMS)	200	GCMS	<0.01	ug/L	
Isopropylbenzene (Surface Water)	154	GCMS	<1	ug/L	UKAS
Lead (Surface Water)	177	ICPMS	8	ug/L	UKAS
m- & p-Xylene (Surface Water)	154	GCMS	<1	ug/L	UKAS
Mercury (Surface water)	178	ICPMS	0.45	ug/L	UKAS
Molybdenum	226	ICPMS	8	ug/L	
Naphthalene (Surface Water)	154	GCMS	<1	ug/L	UKAS
n-Butylbenzene (Surface Water)	154	GCMS	<1	ug/L	UKAS
Nickel (Surface Water)	177	ICPMS	13	ug/L	UKAS
Nitrogen (Total Kjeldahl)	104	Digestion/ Distillation/ Titrimetr	<1.00	mg/L as N	

Signed : A Harmon

Date : 25/04/2018

Aoife Harmon - Technical Supervisor

Acc. : Accredited Parameters by ISO 17025:2005
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UKAS TESTING 2802

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Customer	Caroline Roche Aqua-Fact International Services Ltd 12 Kilkerrin Park Liosbaun Ind Est Liosbaun Co Galway	*Lab Report Ref. No.*	0529/001/25
		Date of Receipt	06/04/2018
		Sampled On	04/04/2018
		Date Testing Commenced	06/04/2018
		Received or Collected	By Fitz: Paul C
		Condition on Receipt	Acceptable
Customer PO		*Date of Report*	25/04/2018
Customer Ref	DOWN1KM-ME-SURF	*Sample Type*	Surface Water
Ref 2			
Ref 3			

CERTIFICATE OF ANALYSIS

Test Parameter	SOP	Analytical Technique	Result	Units	Acc.
Nitrogen (Total Oxidised) (Surface W	151	Colorimetry	1.99	mg/L as N	UKAS
Nitrogen (Total)	0	Calculation	3	mg/L as N	
n-Propylbenzene (Surface Water)	154	GCMS	<1.0	ug/L	UKAS
o-Xylene (Surface Water)	154	GCMS	<1	ug/L	UKAS
Phenanthrene (GCMS)	200	GCMS	<0.01	ug/L	
Phenols (Total)	223	GCMS	1.03	ug/L	
Phosphorus (Total) Surface Water	166	Colorimetry	0.062	mg/L as P	UKAS
p-Isopropyltoluene (Surface Water)	154	GCMS	<1	ug/L	UKAS
Polyaromatic Hydrocarbons (GCMS)	200	GCMS	<0.01	ug/L	
Pyrene (GCMS)	200	GCMS	<0.01	ug/L	
sec-Butylbenzene (Surface Water)	154	GCMS	<1	ug/L	UKAS
Selenium (Surface Water)	177	ICPMS	<1	ug/L	UKAS
Solids (Total Dissolved)	105	Filtration/ Evaporation @ 180C	20108	mg/L	
Styrene (Surface Water)	154	GCMS	<1	ug/L	UKAS
tert-Butylbenzene (Surface Water)	154	GCMS	<1	ug/L	UKAS
Tetrachloroethene (Surface Water)	154	GCMS	<1	ug/L	UKAS
TOC (Surface Water)	316	TOC Analyser	4.8	mg/L	UKAS
Toluene (Surface Water)	154	GCMS	<1	ug/L	UKAS
Total Inorganic Nitrogen	0	Calculation	1.5	mg/L	
trans-1,2-Dichloroethene (Surface W	154	GCMS	<1	ug/L	UKAS
trans-1,3-Dichloropropene (Surface	154	GCMS	<1	ug/L	UKAS
Trichloroethene (Surface Water)	154	GCMS	<1.0	ug/L	
Trichlorofluoromethane (Surface Wat	154	GCMS	<1	ug/L	UKAS
Vanadium (Surface Water)	177	ICPMS	204	ug/L	UKAS

Signed : A Harman

Date : 25/04/2018

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Customer	**Caroline Roche**	*Lab Report Ref. No.*	**0529/001/25**
	Aqua-Fact International Services Ltd	*Date of Receipt*	**06/04/2018**
	12 Kilkerrin Park	*Sampled On*	**04/04/2018**
	Liosbaun Ind Est	*Date Testing Commenced*	**06/04/2018**
	Liosbaun	*Received or Collected*	**By Fitz: Paul C**
	Co Galway	*Condition on Receipt*	**Acceptable**
Customer PO		*Date of Report*	**25/04/2018**
Customer Ref	**DOWN1KM-ME-SURF**	*Sample Type*	**Surface Water**
Ref 2			
Ref 3			

CERTIFICATE OF ANALYSIS

Test Parameter	SOP	Analytical Technique	Result	Units	Acc.
Vinyl chloride (Surface Water)	154	GCMS	<1	ug/L	UKAS
Volatile Organic Compounds	154	GCMS	<5.0	ug/L	
Xylene Total (Surface Water)	154	GCMS	<1	ug/L	UKAS
Zinc (Surface Water)	177	ICPMS	320	ug/L	UKAS

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Customer	**Caroline Roche**	***Lab Report Ref. No.***	**0529/001/26**
	Aqua-Fact International Services Ltd	***Date of Receipt***	**06/04/2018**
	12 Kilkerrin Park	***Sampled On***	**04/04/2018**
	Liosbaun Ind Est	***Date Testing Commenced***	**06/04/2018**
	Liosbaun	***Received or Collected***	**By Fitz: Paul C**
	Co Galway	***Condition on Receipt***	**Acceptable**
Customer PO		***Date of Report***	**25/04/2018**
Customer Ref	**DOWN1KM-ME-MID**	***Sample Type***	**Surface Water**
Ref 2			
Ref 3			

CERTIFICATE OF ANALYSIS

Test Parameter	SOP	Analytical Technique	Result	Units	Acc.
1,1,1,2-Tetrachloroethane (Surface	154	GCMS	<1	ug/L	UKAS
1,1,1-Trichloroethane (Surface Water	154	GCMS	<1	ug/L	UKAS
1,1,2,2-Tetrachloroethane (Surface	154	GCMS	<5.0	ug/L	
1,1,2-Trichloroethane (Surface Water	154	GCMS	<2	ug/L	UKAS
1,1-Dichloroethane (Surface Water)	154	GCMS	<1	ug/L	UKAS
1,1-Dichloroethene (Surface Water)	154	GCMS	<1	ug/L	UKAS
1,1-Dichloropropene (Surface Water)	154	GCMS	<1	ug/L	UKAS
1,2,3-Trichlorobenzene (Surface Wat	154	GCMS	<1	ug/L	UKAS
1,2,3-Trichloropropane (Surface Wat	154	GCMS	<0.9	ug/L	UKAS
1,2,4-Trichlorobenzene (Surface Wat	154	GCMS	<0.6	ug/L	UKAS
1,2,4-Trimethylbenzene (Surface Wa	154	GCMS	<1	ug/L	UKAS
1,2-Dibromo-3-chloropropane (Surfac	154	GCMS	<1	ug/L	UKAS
1,2-Dibromoethane (Surface Water)	154	GCMS	<1	ug/L	UKAS
1,2-Dichlorobenzene (Surface Water)	154	GCMS	<1	ug/L	UKAS
1,2-Dichloroethane (Surface Water)	154	GCMS	<1	ug/L	UKAS
1,2-Dichloropropane (Surface Water)	154	GCMS	<1	ug/L	UKAS
1,3,5-Trimethylbenzene (Surface Wa	154	GCMS	<1	ug/L	UKAS
1,3-Dichlorobenzene (Surface Water)	154	GCMS	<1	ug/L	UKAS
1,3-Dichloropropane (Surface Water)	154	GCMS	<1	ug/L	UKAS
1,4-Dichlorobenzene (Surface Water)	154	GCMS	<1	ug/L	UKAS
2,2-Dichloropropane (Surface Water)	154	GCMS	<5.0	ug/L	
2-Chlorotoluene (Surface Water)	154	GCMS	<1	ug/L	UKAS
4-Chlorotoluene (Surface Water)	154	GCMS	<1	ug/L	UKAS
Acenaphthene (GCMS)	200	GCMS	<0.01	ug/L	

Signed : A Harmon ***Date : 25/04/2018***

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Customer	**Caroline Roche**	*Lab Report Ref. No.*	**0529/001/26**
	Aqua-Fact International Services Ltd	*Date of Receipt*	**06/04/2018**
	12 Kilkerrin Park	*Sampled On*	**04/04/2018**
	Liosbaun Ind Est	*Date Testing Commenced*	**06/04/2018**
	Liosbaun	*Received or Collected*	**By Fitz: Paul C**
	Co Galway	*Condition on Receipt*	**Acceptable**
Customer PO		*Date of Report*	**25/04/2018**
Customer Ref	**DOWN1KM-ME-MID**	*Sample Type*	**Surface Water**
Ref 2			
Ref 3			

CERTIFICATE OF ANALYSIS

Test Parameter	SOP	Analytical Technique	Result	Units	Acc.
Acenaphthylene (GCMS)	200	GCMS	<0.01	ug/L	
Ammonia (Surface Water)	114	Colorimetry	0.42	mg/L as N	UKAS
Anthracene (GCMS)	200	GCMS	<0.01	ug/L	
Antimony (Surface Water)	177	ICPMS	<3	ug/L	UKAS
Arsenic (Surface Water)	177	ICPMS	9	ug/L	UKAS
Barium (Surface Water)	177	ICPMS	36	ug/L	UKAS
Benzene (Surface Water)	154	GCMS	<1	ug/L	UKAS
Benzo(a)anthracene (GCMS)	200	GCMS	<0.01	ug/L	
Benzo(a)pyrene (GCMS)	200	GCMS	<0.01	ug/L	
Benzo(g,h,i)perylene (GCMS)	200	GCMS	<0.01	ug/L	
Benzo(k)fluoranthene (GCMS)	200	GCMS	<0.01	ug/L	
Bromobenzene (Surface Water)	154	GCMS	<1	ug/L	UKAS
Bromochloromethane (Surface Water	154	GCMS	<1	ug/L	UKAS
Bromodichloromethane (Surface Wat	154	GCMS	<1	ug/L	UKAS
Bromoform (Surface Water)	154	GCMS	<1	ug/L	UKAS
Bromomethane (Surface Water)	154	GCMS	<5.0	ug/L	
Cadmium (Surface Water)	177	ICPMS	<1	ug/L	UKAS
Carbon tetrachloride (Surface Water)	154	GCMS	<1	ug/L	UKAS
Chlorobenzene (Surface Water)	154	GCMS	<1	ug/L	UKAS
Chloroethane (Surface Water)	154	GCMS	<5.0	ug/L	
Chloroform (Surface Water)	154	GCMS	<1	ug/L	UKAS
Chloromethane (Surface Water)	154	GCMS	<5.0	ug/L	
Chromium (Surface Water)	177	ICPMS	7	ug/L	UKAS
Chrysene (GCMS)	200	GCMS	<0.01	ug/L	

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Customer	Caroline Roche Aqua-Fact International Services Ltd 12 Kilkerrin Park Liosbaun Ind Est Liosbaun Co Galway	*Lab Report Ref. No.*	0529/001/26
		Date of Receipt	06/04/2018
		Sampled On	04/04/2018
		Date Testing Commenced	06/04/2018
		Received or Collected	By Fitz: Paul C
		Condition on Receipt	Acceptable
Customer PO		*Date of Report*	25/04/2018
Customer Ref	DOWN1KM-ME-MID	*Sample Type*	Surface Water
Ref 2			
Ref 3			

CERTIFICATE OF ANALYSIS

Test Parameter	SOP	Analytical Technique	Result	Units	Acc.
cis-1,2-Dichloroethene (Surface Wat	154	GCMS	<1	ug/L	UKAS
cis-1,3-Dichloropropene (Surface Wa	154	GCMS	<1	ug/L	UKAS
COD (Surface Water)	107	Colorimetry	85	mg/L	UKAS
Copper (Surface Water)	177	ICPMS	17	ug/L	UKAS
Coronene (GCMS)	200	GCMS	<0.01	ug/L	
Dibenzo(a,h)anthracene (GCMS)	200	GCMS	<0.01	ug/L	
Dibromochloromethane (Surface Wat	154	GCMS	<1	ug/L	UKAS
Dibromomethane (Surface Water)	154	GCMS	<1	ug/L	UKAS
Dichlorodifluoromethane (Surface W	154	GCMS	<5.0	ug/L	
Dichloromethane (Surface Water)	154	GCMS	<5.0	ug/L	
Ethylbenzene (Surface Water)	154	GCMS	<1	ug/L	UKAS
Fluoranthene (GCMS)	200	GCMS	<0.01	ug/L	
Fluorene (GCMS)	200	GCMS	<0.01	ug/L	
Hexachlorobutadiene (Surface Water	154	GCMS	<1	ug/L	UKAS
Indeno(1,2,3-cd)pyrene (GCMS)	200	GCMS	<0.01	ug/L	
Isopropylbenzene (Surface Water)	154	GCMS	<1	ug/L	UKAS
Lead (Surface Water)	177	ICPMS	10	ug/L	UKAS
m- & p-Xylene (Surface Water)	154	GCMS	<1	ug/L	UKAS
Mercury (Surface water)	178	ICPMS	<0.03	ug/L	UKAS
Molybdenum	226	ICPMS	9	ug/L	
Naphthalene (Surface Water)	154	GCMS	<1	ug/L	UKAS
n-Butylbenzene (Surface Water)	154	GCMS	<1	ug/L	UKAS
Nickel (Surface Water)	177	ICPMS	13	ug/L	UKAS
Nitrogen (Total Kjeldahl)	104	Digestion/ Distillation/ Titrimetr	<1.00	mg/L as N	

Signed : A Harmon **_Date : 25/04/2018_**

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	Aqua-Fact International Services Ltd	*Date of Receipt*	**06/04/2018**
	12 Kilkerrin Park	*Sampled On*	**04/04/2018**
	Liosbaun Ind Est	*Date Testing Commenced*	**06/04/2018**
	Liosbaun	*Received or Collected*	**By Fitz: Paul C**
	Co Galway	*Condition on Receipt*	**Acceptable**
Customer PO		*Date of Report*	**25/04/2018**
Customer Ref	**DOWN1KM-ME-MID**	*Sample Type*	**Surface Water**
Ref 2			
Ref 3			

CERTIFICATE OF ANALYSIS

Test Parameter	SOP	Analytical Technique	Result	Units	Acc.
Nitrogen (Total Oxidised) (Surface W	151	Colorimetry	2.54	mg/L as N	UKAS
Nitrogen (Total)	0	Calculation	3	mg/L as N	
n-Propylbenzene (Surface Water)	154	GCMS	<1.0	ug/L	UKAS
o-Xylene (Surface Water)	154	GCMS	<1	ug/L	UKAS
Phenanthrene (GCMS)	200	GCMS	<0.01	ug/L	
Phenols (Total)	223	GCMS	<0.10	ug/L	
Phosphorus (Total) Surface Water	166	Colorimetry	0.064	mg/L as P	UKAS
p-Isopropyltoluene (Surface Water)	154	GCMS	<1	ug/L	UKAS
Polyaromatic Hydrocarbons (GCMS)	200	GCMS	<0.01	ug/L	
Pyrene (GCMS)	200	GCMS	<0.01	ug/L	
sec-Butylbenzene (Surface Water)	154	GCMS	<1	ug/L	UKAS
Selenium (Surface Water)	177	ICPMS	5	ug/L	UKAS
Solids (Total Dissolved)	105	Filtration/ Evaporation @ 180C	21095	mg/L	
Styrene (Surface Water)	154	GCMS	<1	ug/L	UKAS
tert-Butylbenzene (Surface Water)	154	GCMS	<1	ug/L	UKAS
Tetrachloroethene (Surface Water)	154	GCMS	<1	ug/L	UKAS
TOC (Surface Water)	316	TOC Analyser	4.0	mg/L	UKAS
Toluene (Surface Water)	154	GCMS	<1	ug/L	UKAS
Total Inorganic Nitrogen	0	Calculation	1.4	mg/L	
trans-1,2-Dichloroethene (Surface W	154	GCMS	<1	ug/L	UKAS
trans-1,3-Dichloropropene (Surface	154	GCMS	<1	ug/L	UKAS
Trichloroethene (Surface Water)	154	GCMS	<1.0	ug/L	
Trichlorofluoromethane (Surface Wat	154	GCMS	<1	ug/L	UKAS
Vanadium (Surface Water)	177	ICPMS	259	ug/L	UKAS

Signed : A Harmon

Date : 25/04/2018

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Customer	Caroline Roche Aqua-Fact International Services Ltd 12 Kilkerrin Park Liosbaun Ind Est Liosbaun Co Galway	*Lab Report Ref. No.*	0529/001/26
		Date of Receipt	06/04/2018
		Sampled On	04/04/2018
		Date Testing Commenced	06/04/2018
		Received or Collected	By Fitz: Paul C
		Condition on Receipt	Acceptable
Customer PO		*Date of Report*	25/04/2018
Customer Ref	DOWN1KM-ME-MID	*Sample Type*	Surface Water
Ref 2			
Ref 3			

CERTIFICATE OF ANALYSIS

Test Parameter	SOP	Analytical Technique	Result	Units	Acc.
Vinyl chloride (Surface Water)	154	GCMS	<1	ug/L	UKAS
Volatile Organic Compounds	154	GCMS	<5.0	ug/L	
Xylene Total (Surface Water)	154	GCMS	<1	ug/L	UKAS
Zinc (Surface Water)	177	ICPMS	271	ug/L	UKAS

Signed : A Harmon

Date : 25/04/2018

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Customer	**Caroline Roche**	***Lab Report Ref. No.***	**0529/001/27**
	Aqua-Fact International Services Ltd	***Date of Receipt***	**06/04/2018**
	12 Kilkerrin Park	***Sampled On***	**04/04/2018**
	Liosbaun Ind Est	***Date Testing Commenced***	**06/04/2018**
	Liosbaun	***Received or Collected***	**By Fitz: Paul C**
	Co Galway	***Condition on Receipt***	**Acceptable**
Customer PO		***Date of Report***	**25/04/2018**
Customer Ref	**DOWN1KM-ME-BOTTOM**	***Sample Type***	**Surface Water**
Ref 2			
Ref 3			

CERTIFICATE OF ANALYSIS

Test Parameter	SOP	Analytical Technique	Result	Units	Acc.
1,1,1,2-Tetrachloroethane (Surface	154	GCMS	<1	ug/L	UKAS
1,1,1-Trichloroethane (Surface Water	154	GCMS	<1	ug/L	UKAS
1,1,2,2-Tetrachloroethane (Surface	154	GCMS	<5.0	ug/L	
1,1,2-Trichloroethane (Surface Water	154	GCMS	<2	ug/L	UKAS
1,1-Dichloroethane (Surface Water)	154	GCMS	<1	ug/L	UKAS
1,1-Dichloroethene (Surface Water)	154	GCMS	<1	ug/L	UKAS
1,1-Dichloropropene (Surface Water)	154	GCMS	<1	ug/L	UKAS
1,2,3-Trichlorobenzene (Surface Wat	154	GCMS	<1	ug/L	UKAS
1,2,3-Trichloropropane (Surface Wat	154	GCMS	<0.9	ug/L	UKAS
1,2,4-Trichlorobenzene (Surface Wat	154	GCMS	<0.6	ug/L	UKAS
1,2,4-Trimethylbenzene (Surface Wa	154	GCMS	<1	ug/L	UKAS
1,2-Dibromo-3-chloropropane (Surfac	154	GCMS	<1	ug/L	UKAS
1,2-Dibromoethane (Surface Water)	154	GCMS	<1	ug/L	UKAS
1,2-Dichlorobenzene (Surface Water)	154	GCMS	<1	ug/L	UKAS
1,2-Dichloroethane (Surface Water)	154	GCMS	<1	ug/L	UKAS
1,2-Dichloropropane (Surface Water)	154	GCMS	<1	ug/L	UKAS
1,3,5-Trimethylbenzene (Surface Wa	154	GCMS	<1	ug/L	UKAS
1,3-Dichlorobenzene (Surface Water)	154	GCMS	<1	ug/L	UKAS
1,3-Dichloropropane (Surface Water)	154	GCMS	<1	ug/L	UKAS
1,4-Dichlorobenzene (Surface Water)	154	GCMS	<1	ug/L	UKAS
2,2-Dichloropropane (Surface Water)	154	GCMS	<5.0	ug/L	
2-Chlorotoluene (Surface Water)	154	GCMS	<1	ug/L	UKAS
4-Chlorotoluene (Surface Water)	154	GCMS	<1	ug/L	UKAS
Acenaphthene (GCMS)	200	GCMS	<0.01	ug/L	

Signed : A Harmon ***Date : 25/04/2018***

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UKAS TESTING 2802

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Customer	**Caroline Roche**	*Lab Report Ref. No.*	**0529/001/27**
	Aqua-Fact International Services Ltd	*Date of Receipt*	**06/04/2018**
	12 Kilkerrin Park	*Sampled On*	**04/04/2018**
	Liosbaun Ind Est	*Date Testing Commenced*	**06/04/2018**
	Liosbaun	*Received or Collected*	**By Fitz: Paul C**
	Co Galway	*Condition on Receipt*	**Acceptable**
Customer PO		*Date of Report*	**25/04/2018**
Customer Ref	**DOWN1KM-ME-BOTTOM**	*Sample Type*	**Surface Water**
Ref 2			
Ref 3			

CERTIFICATE OF ANALYSIS

Test Parameter	SOP	Analytical Technique	Result	Units	Acc.
Acenaphthylene (GCMS)	200	GCMS	<0.01	ug/L	
Ammonia (Surface Water)	114	Colorimetry	0.42	mg/L as N	UKAS
Anthracene (GCMS)	200	GCMS	<0.01	ug/L	
Antimony (Surface Water)	177	ICPMS	<3	ug/L	UKAS
Arsenic (Surface Water)	177	ICPMS	7	ug/L	UKAS
Barium (Surface Water)	177	ICPMS	37	ug/L	UKAS
Benzene (Surface Water)	154	GCMS	<1	ug/L	UKAS
Benzo(a)anthracene (GCMS)	200	GCMS	<0.01	ug/L	
Benzo(a)pyrene (GCMS)	200	GCMS	<0.01	ug/L	
Benzo(g,h,i)perylene (GCMS)	200	GCMS	<0.01	ug/L	
Benzo(k)fluoranthene (GCMS)	200	GCMS	<0.01	ug/L	
Bromobenzene (Surface Water)	154	GCMS	<1	ug/L	UKAS
Bromochloromethane (Surface Water	154	GCMS	<1	ug/L	UKAS
Bromodichloromethane (Surface Wat	154	GCMS	<1	ug/L	UKAS
Bromoform (Surface Water)	154	GCMS	<1	ug/L	UKAS
Bromomethane (Surface Water)	154	GCMS	<5.0	ug/L	
Cadmium (Surface Water)	177	ICPMS	<1	ug/L	UKAS
Carbon tetrachloride (Surface Water)	154	GCMS	<1	ug/L	UKAS
Chlorobenzene (Surface Water)	154	GCMS	<1	ug/L	UKAS
Chloroethane (Surface Water)	154	GCMS	<5.0	ug/L	
Chloroform (Surface Water)	154	GCMS	<1	ug/L	UKAS
Chloromethane (Surface Water)	154	GCMS	<5.0	ug/L	
Chromium (Surface Water)	177	ICPMS	8	ug/L	UKAS
Chrysene (GCMS)	200	GCMS	<0.01	ug/L	

Signed : A Harmon **Date : 25/04/2018**

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	Co Galway	*Condition on Receipt*	**Acceptable**
Customer PO		*Date of Report*	**25/04/2018**
Customer Ref	**DOWN1KM-ME-BOTTOM**	*Sample Type*	**Surface Water**
Ref 2			
Ref 3			

CERTIFICATE OF ANALYSIS

Test Parameter	SOP	Analytical Technique	Result	Units	Acc.
cis-1,2-Dichloroethene (Surface Wat	154	GCMS	<1	ug/L	UKAS
cis-1,3-Dichloropropene (Surface Wa	154	GCMS	<1	ug/L	UKAS
COD (Surface Water)	107	Colorimetry	80	mg/L	UKAS
Copper (Surface Water)	177	ICPMS	29	ug/L	UKAS
Coronene (GCMS)	200	GCMS	<0.01	ug/L	
Dibenzo(a,h)anthracene (GCMS)	200	GCMS	<0.01	ug/L	
Dibromochloromethane (Surface Wat	154	GCMS	<1	ug/L	UKAS
Dibromomethane (Surface Water)	154	GCMS	<1	ug/L	UKAS
Dichlorodifluoromethane (Surface W	154	GCMS	<5.0	ug/L	
Dichloromethane (Surface Water)	154	GCMS	<5.0	ug/L	
Ethylbenzene (Surface Water)	154	GCMS	<1	ug/L	UKAS
Fluoranthene (GCMS)	200	GCMS	<0.01	ug/L	
Fluorene (GCMS)	200	GCMS	<0.01	ug/L	
Hexachlorobutadiene (Surface Water	154	GCMS	<1	ug/L	UKAS
Indeno(1,2,3-cd)pyrene (GCMS)	200	GCMS	<0.01	ug/L	
Isopropylbenzene (Surface Water)	154	GCMS	<1	ug/L	UKAS
Lead (Surface Water)	177	ICPMS	12	ug/L	UKAS
m- & p-Xylene (Surface Water)	154	GCMS	<1	ug/L	UKAS
Mercury (Surface water)	178	ICPMS	<0.03	ug/L	UKAS
Molybdenum	226	ICPMS	9	ug/L	
Naphthalene (Surface Water)	154	GCMS	<1	ug/L	UKAS
n-Butylbenzene (Surface Water)	154	GCMS	<1	ug/L	UKAS
Nickel (Surface Water)	177	ICPMS	17	ug/L	UKAS
Nitrogen (Total Kjeldahl)	104	Digestion/ Distillation/ Titrimetr	<1.00	mg/L as N	

Signed : A Harmon ***Date : 25/04/2018***

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Customer Ref	**DOWN1KM-ME-BOTTOM**	*Sample Type*	**Surface Water**
Ref 2			
Ref 3			

CERTIFICATE OF ANALYSIS

Test Parameter	SOP	Analytical Technique	Result	Units	Acc.
Nitrogen (Total Oxidised) (Surface W	151	Colorimetry	1.93	mg/L as N	UKAS
Nitrogen (Total)	0	Calculation	3	mg/L as N	
n-Propylbenzene (Surface Water)	154	GCMS	<1.0	ug/L	UKAS
o-Xylene (Surface Water)	154	GCMS	<1	ug/L	UKAS
Phenanthrene (GCMS)	200	GCMS	<0.01	ug/L	
Phenols (Total)	223	GCMS	<0.10	ug/L	
Phosphorus (Total) Surface Water	166	Colorimetry	0.048	mg/L as P	UKAS
p-Isopropyltoluene (Surface Water)	154	GCMS	<1	ug/L	UKAS
Polyaromatic Hydrocarbons (GCMS)	200	GCMS	<0.01	ug/L	
Pyrene (GCMS)	200	GCMS	<0.01	ug/L	
sec-Butylbenzene (Surface Water)	154	GCMS	<1	ug/L	UKAS
Selenium (Surface Water)	177	ICPMS	15	ug/L	UKAS
Solids (Total Dissolved)	105	Filtration/ Evaporation @ 180C	20918	mg/L	
Styrene (Surface Water)	154	GCMS	<1	ug/L	UKAS
tert-Butylbenzene (Surface Water)	154	GCMS	<1	ug/L	UKAS
Tetrachloroethene (Surface Water)	154	GCMS	<1	ug/L	UKAS
TOC (Surface Water)	316	TOC Analyser	4.1	mg/L	UKAS
Toluene (Surface Water)	154	GCMS	<1	ug/L	UKAS
Total Inorganic Nitrogen	0	Calculation	1.3	mg/L	
trans-1,2-Dichloroethene (Surface W	154	GCMS	<1	ug/L	UKAS
trans-1,3-Dichloropropene (Surface	154	GCMS	<1	ug/L	UKAS
Trichloroethene (Surface Water)	154	GCMS	<1.0	ug/L	
Trichlorofluoromethane (Surface Wat	154	GCMS	<1	ug/L	UKAS
Vanadium (Surface Water)	177	ICPMS	274	ug/L	UKAS

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Customer Ref	**DOWN1KM-ME-BOTTOM**	*Sample Type*	**Surface Water**
Ref 2			
Ref 3			

CERTIFICATE OF ANALYSIS

Test Parameter	SOP	Analytical Technique	Result	Units	Acc.
Vinyl chloride (Surface Water)	154	GCMS	<1	ug/L	UKAS
Volatile Organic Compounds	154	GCMS	<5.0	ug/L	
Xylene Total (Surface Water)	154	GCMS	<1	ug/L	UKAS
Zinc (Surface Water)	177	ICPMS	271	ug/L	UKAS

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	Liosbaun	*Received or Collected*	**By Fitz: Paul C**
	Co Galway	*Condition on Receipt*	**Acceptable**
Customer PO		*Date of Report*	**25/04/2018**
Customer Ref	**DOWN1KM-LW-SURD**	*Sample Type*	**Surface Water**
Ref 2			
Ref 3			

CERTIFICATE OF ANALYSIS

Test Parameter	SOP	Analytical Technique	Result	Units	Acc.
1,1,1,2-Tetrachloroethane (Surface	154	GCMS	<1	ug/L	UKAS
1,1,1-Trichloroethane (Surface Water	154	GCMS	<1	ug/L	UKAS
1,1,2,2-Tetrachloroethane (Surface	154	GCMS	<5.0	ug/L	
1,1,2-Trichloroethane (Surface Water	154	GCMS	<2	ug/L	UKAS
1,1-Dichloroethane (Surface Water)	154	GCMS	<1	ug/L	UKAS
1,1-Dichloroethene (Surface Water)	154	GCMS	<1	ug/L	UKAS
1,1-Dichloropropene (Surface Water)	154	GCMS	<1	ug/L	UKAS
1,2,3-Trichlorobenzene (Surface Wat	154	GCMS	<1	ug/L	UKAS
1,2,3-Trichloropropane (Surface Wat	154	GCMS	<0.9	ug/L	UKAS
1,2,4-Trichlorobenzene (Surface Wat	154	GCMS	<0.6	ug/L	UKAS
1,2,4-Trimethylbenzene (Surface Wa	154	GCMS	<1	ug/L	UKAS
1,2-Dibromo-3-chloropropane (Surfac	154	GCMS	<1	ug/L	UKAS
1,2-Dibromoethane (Surface Water)	154	GCMS	<1	ug/L	UKAS
1,2-Dichlorobenzene (Surface Water)	154	GCMS	<1	ug/L	UKAS
1,2-Dichloroethane (Surface Water)	154	GCMS	<1	ug/L	UKAS
1,2-Dichloropropane (Surface Water)	154	GCMS	<1	ug/L	UKAS
1,3,5-Trimethylbenzene (Surface Wa	154	GCMS	<1	ug/L	UKAS
1,3-Dichlorobenzene (Surface Water)	154	GCMS	<1	ug/L	UKAS
1,3-Dichloropropane (Surface Water)	154	GCMS	<1	ug/L	UKAS
1,4-Dichlorobenzene (Surface Water)	154	GCMS	<1	ug/L	UKAS
2,2-Dichloropropane (Surface Water)	154	GCMS	<5.0	ug/L	
2-Chlorotoluene (Surface Water)	154	GCMS	<1	ug/L	UKAS
4-Chlorotoluene (Surface Water)	154	GCMS	<1	ug/L	UKAS
Acenaphthene (GCMS)	200	GCMS	<0.01	ug/L	

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Customer Ref	**DOWN1KM-LW-SURD**	*Sample Type*	**Surface Water**
Ref 2			
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CERTIFICATE OF ANALYSIS

Test Parameter	SOP	Analytical Technique	Result	Units	Acc.
Acenaphthylene (GCMS)	200	GCMS	<0.01	ug/L	
Ammonia (Surface Water)	114	Colorimetry	0.48	mg/L as N	UKAS
Anthracene (GCMS)	200	GCMS	<0.01	ug/L	
Antimony (Surface Water)	177	ICPMS	<3	ug/L	UKAS
Arsenic (Surface Water)	177	ICPMS	<1	ug/L	UKAS
Barium (Surface Water)	177	ICPMS	30	ug/L	UKAS
Benzene (Surface Water)	154	GCMS	<1	ug/L	UKAS
Benzo(a)anthracene (GCMS)	200	GCMS	<0.01	ug/L	
Benzo(a)pyrene (GCMS)	200	GCMS	<0.01	ug/L	
Benzo(g,h,i)perylene (GCMS)	200	GCMS	<0.01	ug/L	
Benzo(k)fluoranthene (GCMS)	200	GCMS	<0.01	ug/L	
Bromobenzene (Surface Water)	154	GCMS	<1	ug/L	UKAS
Bromochloromethane (Surface Water	154	GCMS	<1	ug/L	UKAS
Bromodichloromethane (Surface Wat	154	GCMS	<1	ug/L	UKAS
Bromoform (Surface Water)	154	GCMS	<1	ug/L	UKAS
Bromomethane (Surface Water)	154	GCMS	<5.0	ug/L	
Cadmium (Surface Water)	177	ICPMS	<1	ug/L	UKAS
Carbon tetrachloride (Surface Water)	154	GCMS	<1	ug/L	UKAS
Chlorobenzene (Surface Water)	154	GCMS	<1	ug/L	UKAS
Chloroethane (Surface Water)	154	GCMS	<5.0	ug/L	
Chloroform (Surface Water)	154	GCMS	<1	ug/L	UKAS
Chloromethane (Surface Water)	154	GCMS	<5.0	ug/L	
Chromium (Surface Water)	177	ICPMS	8	ug/L	UKAS
Chrysene (GCMS)	200	GCMS	<0.01	ug/L	

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Ref 2			
Ref 3			

CERTIFICATE OF ANALYSIS

Test Parameter	SOP	Analytical Technique	Result	Units	Acc.
cis-1,2-Dichloroethene (Surface Wat	154	GCMS	<1	ug/L	UKAS
cis-1,3-Dichloropropene (Surface Wa	154	GCMS	<1	ug/L	UKAS
COD (Surface Water)	107	Colorimetry	90	mg/L	UKAS
Copper (Surface Water)	177	ICPMS	8	ug/L	UKAS
Coronene (GCMS)	200	GCMS	<0.01	ug/L	
Dibenzo(a,h)anthracene (GCMS)	200	GCMS	<0.01	ug/L	
Dibromochloromethane (Surface Wat	154	GCMS	<1	ug/L	UKAS
Dibromomethane (Surface Water)	154	GCMS	<1	ug/L	UKAS
Dichlorodifluoromethane (Surface W	154	GCMS	<5.0	ug/L	
Dichloromethane (Surface Water)	154	GCMS	<5.0	ug/L	
Ethylbenzene (Surface Water)	154	GCMS	<1	ug/L	UKAS
Fluoranthene (GCMS)	200	GCMS	<0.01	ug/L	
Fluorene (GCMS)	200	GCMS	<0.01	ug/L	
Hexachlorobutadiene (Surface Water	154	GCMS	<1	ug/L	UKAS
Indeno(1,2,3-cd)pyrene (GCMS)	200	GCMS	<0.01	ug/L	
Isopropylbenzene (Surface Water)	154	GCMS	<1	ug/L	UKAS
Lead (Surface Water)	177	ICPMS	5	ug/L	UKAS
m- & p-Xylene (Surface Water)	154	GCMS	<1	ug/L	UKAS
Mercury (Surface water)	178	ICPMS	<0.03	ug/L	UKAS
Molybdenum	226	ICPMS	8	ug/L	
Naphthalene (Surface Water)	154	GCMS	<1	ug/L	UKAS
n-Butylbenzene (Surface Water)	154	GCMS	<1	ug/L	UKAS
Nickel (Surface Water)	177	ICPMS	12	ug/L	UKAS
Nitrogen (Total Kjeldahl)	104	Digestion/ Distillation/ Titrimetr	<1.00	mg/L as N	

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Customer Ref	**DOWN1KM-LW-SURD**	*Sample Type*	**Surface Water**
Ref 2			
Ref 3			

CERTIFICATE OF ANALYSIS

Test Parameter	SOP	Analytical Technique	Result	Units	Acc.
Nitrogen (Total Oxidised) (Surface W	151	Colorimetry	5.97	mg/L as N	UKAS
Nitrogen (Total)	0	Calculation	7	mg/L as N	
n-Propylbenzene (Surface Water)	154	GCMS	<1.0	ug/L	UKAS
o-Xylene (Surface Water)	154	GCMS	<1	ug/L	UKAS
Phenanthrene (GCMS)	200	GCMS	<0.01	ug/L	
Phenols (Total)	223	GCMS	<0.10	ug/L	
Phosphorus (Total) Surface Water	166	Colorimetry	0.054	mg/L as P	UKAS
p-Isopropyltoluene (Surface Water)	154	GCMS	<1	ug/L	UKAS
Polyaromatic Hydrocarbons (GCMS)	200	GCMS	<0.01	ug/L	
Pyrene (GCMS)	200	GCMS	<0.01	ug/L	
sec-Butylbenzene (Surface Water)	154	GCMS	<1	ug/L	UKAS
Selenium (Surface Water)	177	ICPMS	<1	ug/L	UKAS
Solids (Total Dissolved)	105	Filtration/ Evaporation @ 180C	20721	mg/L	
Styrene (Surface Water)	154	GCMS	<1	ug/L	UKAS
tert-Butylbenzene (Surface Water)	154	GCMS	<1	ug/L	UKAS
Tetrachloroethene (Surface Water)	154	GCMS	<1	ug/L	UKAS
TOC (Surface Water)	316	TOC Analyser	4.0	mg/L	UKAS
Toluene (Surface Water)	154	GCMS	<1	ug/L	UKAS
Total Inorganic Nitrogen	0	Calculation	1.4	mg/L	
trans-1,2-Dichloroethene (Surface W	154	GCMS	<1	ug/L	UKAS
trans-1,3-Dichloropropene (Surface	154	GCMS	<1	ug/L	UKAS
Trichloroethene (Surface Water)	154	GCMS	<1.0	ug/L	
Trichlorofluoromethane (Surface Wat	154	GCMS	<1	ug/L	UKAS
Vanadium (Surface Water)	177	ICPMS	218	ug/L	UKAS

Signed : A Harmon

Date : 25/04/2018

Aoife Harmon - Technical Supervisor

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UKAS TESTING 2802

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Customer	Caroline Roche	*Lab Report Ref. No.*	0529/001/19
	Aqua-Fact International Services Ltd	*Date of Receipt*	06/04/2018
	12 Kilkerrin Park	*Sampled On*	04/04/2018
	Liosbaun Ind Est	*Date Testing Commenced*	06/04/2018
	Liosbaun	*Received or Collected*	By Fitz: Paul C
	Co Galway	*Condition on Receipt*	Acceptable
Customer PO		*Date of Report*	25/04/2018
Customer Ref	DOWN1KM-LW-SURD	*Sample Type*	Surface Water
Ref 2			
Ref 3			

CERTIFICATE OF ANALYSIS

Test Parameter	SOP	Analytical Technique	Result	Units	Acc.
Vinyl chloride (Surface Water)	154	GCMS	<1	ug/L	UKAS
Volatile Organic Compounds	154	GCMS	<5.0	ug/L	
Xylene Total (Surface Water)	154	GCMS	<1	ug/L	UKAS
Zinc (Surface Water)	177	ICPMS	203	ug/L	UKAS

Signed : A Harmon ***Date : 25/04/2018***

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	12 Kilkerrin Park	*Sampled On*	**04/04/2018**
	Liosbaun Ind Est	*Date Testing Commenced*	**06/04/2018**
	Liosbaun	*Received or Collected*	**By Fitz: Paul C**
	Co Galway	*Condition on Receipt*	**Acceptable**
Customer PO		*Date of Report*	**25/04/2018**
Customer Ref	**DOWN1KM-LW-MID**	*Sample Type*	**Surface Water**
Ref 2			
Ref 3			

CERTIFICATE OF ANALYSIS

Test Parameter	SOP	Analytical Technique	Result	Units	Acc.
1,1,1,2-Tetrachloroethane (Surface	154	GCMS	<1	ug/L	UKAS
1,1,1-Trichloroethane (Surface Water	154	GCMS	<1	ug/L	UKAS
1,1,2,2-Tetrachloroethane (Surface	154	GCMS	<5.0	ug/L	
1,1,2-Trichloroethane (Surface Water	154	GCMS	<2	ug/L	UKAS
1,1-Dichloroethane (Surface Water)	154	GCMS	<1	ug/L	UKAS
1,1-Dichloroethene (Surface Water)	154	GCMS	<1	ug/L	UKAS
1,1-Dichloropropene (Surface Water)	154	GCMS	<1	ug/L	UKAS
1,2,3-Trichlorobenzene (Surface Wat	154	GCMS	<1	ug/L	UKAS
1,2,3-Trichloropropane (Surface Wat	154	GCMS	<0.9	ug/L	UKAS
1,2,4-Trichlorobenzene (Surface Wat	154	GCMS	<0.6	ug/L	UKAS
1,2,4-Trimethylbenzene (Surface Wa	154	GCMS	<1	ug/L	UKAS
1,2-Dibromo-3-chloropropane (Surfac	154	GCMS	<1	ug/L	UKAS
1,2-Dibromoethane (Surface Water)	154	GCMS	<1	ug/L	UKAS
1,2-Dichlorobenzene (Surface Water)	154	GCMS	<1	ug/L	UKAS
1,2-Dichloroethane (Surface Water)	154	GCMS	<1	ug/L	UKAS
1,2-Dichloropropane (Surface Water)	154	GCMS	<1	ug/L	UKAS
1,3,5-Trimethylbenzene (Surface Wa	154	GCMS	<1	ug/L	UKAS
1,3-Dichlorobenzene (Surface Water)	154	GCMS	<1	ug/L	UKAS
1,3-Dichloropropane (Surface Water)	154	GCMS	<1	ug/L	UKAS
1,4-Dichlorobenzene (Surface Water)	154	GCMS	<1	ug/L	UKAS
2,2-Dichloropropane (Surface Water)	154	GCMS	<5.0	ug/L	
2-Chlorotoluene (Surface Water)	154	GCMS	<1	ug/L	UKAS
4-Chlorotoluene (Surface Water)	154	GCMS	<1	ug/L	UKAS
Acenaphthene (GCMS)	200	GCMS	<0.01	ug/L	

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	Liosbaun Ind Est	***Date Testing Commenced***	**06/04/2018**
	Liosbaun	***Received or Collected***	**By Fitz: Paul C**
	Co Galway	***Condition on Receipt***	**Acceptable**
Customer PO		***Date of Report***	**25/04/2018**
Customer Ref	**DOWN1KM-LW-MID**	***Sample Type***	**Surface Water**
Ref 2			
Ref 3			

CERTIFICATE OF ANALYSIS

Test Parameter	SOP	Analytical Technique	Result	Units	Acc.
Acenaphthylene (GCMS)	200	GCMS	<0.01	ug/L	
Ammonia (Surface Water)	114	Colorimetry	0.43	mg/L as N	UKAS
Anthracene (GCMS)	200	GCMS	<0.01	ug/L	
Antimony (Surface Water)	177	ICPMS	<3	ug/L	UKAS
Arsenic (Surface Water)	177	ICPMS	<1	ug/L	UKAS
Barium (Surface Water)	177	ICPMS	34	ug/L	UKAS
Benzene (Surface Water)	154	GCMS	<1	ug/L	UKAS
Benzo(a)anthracene (GCMS)	200	GCMS	<0.01	ug/L	
Benzo(a)pyrene (GCMS)	200	GCMS	<0.01	ug/L	
Benzo(g,h,i)perylene (GCMS)	200	GCMS	<0.01	ug/L	
Benzo(k)fluoranthene (GCMS)	200	GCMS	<0.01	ug/L	
Bromobenzene (Surface Water)	154	GCMS	<1	ug/L	UKAS
Bromochloromethane (Surface Water	154	GCMS	<1	ug/L	UKAS
Bromodichloromethane (Surface Wat	154	GCMS	<1	ug/L	UKAS
Bromoform (Surface Water)	154	GCMS	<1	ug/L	UKAS
Bromomethane (Surface Water)	154	GCMS	<5.0	ug/L	
Cadmium (Surface Water)	177	ICPMS	<1	ug/L	UKAS
Carbon tetrachloride (Surface Water)	154	GCMS	<1	ug/L	UKAS
Chlorobenzene (Surface Water)	154	GCMS	<1	ug/L	UKAS
Chloroethane (Surface Water)	154	GCMS	<5.0	ug/L	
Chloroform (Surface Water)	154	GCMS	<1	ug/L	UKAS
Chloromethane (Surface Water)	154	GCMS	<5.0	ug/L	
Chromium (Surface Water)	177	ICPMS	6	ug/L	UKAS
Chrysene (GCMS)	200	GCMS	<0.01	ug/L	

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	12 Kilkerrin Park	*Sampled On*	**04/04/2018**
	Liosbaun Ind Est	*Date Testing Commenced*	**06/04/2018**
	Liosbaun	*Received or Collected*	**By Fitz: Paul C**
	Co Galway	*Condition on Receipt*	**Acceptable**
Customer PO		*Date of Report*	**25/04/2018**
Customer Ref	**DOWN1KM-LW-MID**	*Sample Type*	**Surface Water**
Ref 2			
Ref 3			

CERTIFICATE OF ANALYSIS

Test Parameter	SOP	Analytical Technique	Result	Units	Acc.
cis-1,2-Dichloroethene (Surface Wat	154	GCMS	<1	ug/L	UKAS
cis-1,3-Dichloropropene (Surface Wa	154	GCMS	<1	ug/L	UKAS
COD (Surface Water)	107	Colorimetry	95	mg/L	UKAS
Copper (Surface Water)	177	ICPMS	15	ug/L	UKAS
Coronene (GCMS)	200	GCMS	<0.01	ug/L	
Dibenzo(a,h)anthracene (GCMS)	200	GCMS	<0.01	ug/L	
Dibromochloromethane (Surface Wat	154	GCMS	<1	ug/L	UKAS
Dibromomethane (Surface Water)	154	GCMS	<1	ug/L	UKAS
Dichlorodifluoromethane (Surface W	154	GCMS	<5.0	ug/L	
Dichloromethane (Surface Water)	154	GCMS	<5.0	ug/L	
Ethylbenzene (Surface Water)	154	GCMS	<1	ug/L	UKAS
Fluoranthene (GCMS)	200	GCMS	<0.01	ug/L	
Fluorene (GCMS)	200	GCMS	<0.01	ug/L	
Hexachlorobutadiene (Surface Water	154	GCMS	<1	ug/L	UKAS
Indeno(1,2,3-cd)pyrene (GCMS)	200	GCMS	<0.01	ug/L	
Isopropylbenzene (Surface Water)	154	GCMS	<1	ug/L	UKAS
Lead (Surface Water)	177	ICPMS	9	ug/L	UKAS
m- & p-Xylene (Surface Water)	154	GCMS	<1	ug/L	UKAS
Mercury (Surface water)	178	ICPMS	<0.03	ug/L	UKAS
Molybdenum	226	ICPMS	9	ug/L	
Naphthalene (Surface Water)	154	GCMS	<1	ug/L	UKAS
n-Butylbenzene (Surface Water)	154	GCMS	<1	ug/L	UKAS
Nickel (Surface Water)	177	ICPMS	15	ug/L	UKAS
Nitrogen (Total Kjeldahl)	104	Digestion/ Distillation/ Titrimetr	<1.00	mg/L as N	

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	Liosbaun	*Received or Collected*	**By Fitz: Paul C**
	Co Galway	*Condition on Receipt*	**Acceptable**
Customer PO		*Date of Report*	**25/04/2018**
Customer Ref	**DOWN1KM-LW-MID**	*Sample Type*	**Surface Water**
Ref 2			
Ref 3			

CERTIFICATE OF ANALYSIS

Test Parameter	SOP	Analytical Technique	Result	Units	Acc.
Nitrogen (Total Oxidised) (Surface W	151	Colorimetry	1.79	mg/L as N	UKAS
Nitrogen (Total)	0	Calculation	3	mg/L as N	
n-Propylbenzene (Surface Water)	154	GCMS	<1.0	ug/L	UKAS
o-Xylene (Surface Water)	154	GCMS	<1	ug/L	UKAS
Phenanthrene (GCMS)	200	GCMS	<0.01	ug/L	
Phenols (Total)	223	GCMS	<0.10	ug/L	
Phosphorus (Total) Surface Water	166	Colorimetry	0.054	mg/L as P	UKAS
p-Isopropyltoluene (Surface Water)	154	GCMS	<1	ug/L	UKAS
Polyaromatic Hydrocarbons (GCMS)	200	GCMS	<0.01	ug/L	
Pyrene (GCMS)	200	GCMS	<0.01	ug/L	
sec-Butylbenzene (Surface Water)	154	GCMS	<1	ug/L	UKAS
Selenium (Surface Water)	177	ICPMS	<1	ug/L	UKAS
Solids (Total Dissolved)	105	Filtration/ Evaporation @ 180C	21162	mg/L	
Styrene (Surface Water)	154	GCMS	<1	ug/L	UKAS
tert-Butylbenzene (Surface Water)	154	GCMS	<1	ug/L	UKAS
Tetrachloroethene (Surface Water)	154	GCMS	<1	ug/L	UKAS
TOC (Surface Water)	316	TOC Analyser	3.8	mg/L	UKAS
Toluene (Surface Water)	154	GCMS	<1	ug/L	UKAS
Total Inorganic Nitrogen	0	Calculation	1.2	mg/L	
trans-1,2-Dichloroethene (Surface W	154	GCMS	<1	ug/L	UKAS
trans-1,3-Dichloropropene (Surface	154	GCMS	<1	ug/L	UKAS
Trichloroethene (Surface Water)	154	GCMS	<1.0	ug/L	
Trichlorofluoromethane (Surface Wat	154	GCMS	<1	ug/L	UKAS
Vanadium (Surface Water)	177	ICPMS	262	ug/L	UKAS

Signed : A Harmon ***Date : 25/04/2018***

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	Liosbaun Ind Est	*Date Testing Commenced*	**06/04/2018**
	Liosbaun	*Received or Collected*	**By Fitz: Paul C**
	Co Galway	*Condition on Receipt*	**Acceptable**
Customer PO		*Date of Report*	**25/04/2018**
Customer Ref	**DOWN1KM-LW-MID**	*Sample Type*	**Surface Water**
Ref 2			
Ref 3			

CERTIFICATE OF ANALYSIS

Test Parameter	SOP	Analytical Technique	Result	Units	Acc.
Vinyl chloride (Surface Water)	154	GCMS	<1	ug/L	UKAS
Volatile Organic Compounds	154	GCMS	<5.0	ug/L	
Xylene Total (Surface Water)	154	GCMS	<1	ug/L	UKAS
Zinc (Surface Water)	177	ICPMS	271	ug/L	UKAS

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		Date of Receipt	06/04/2018
		Sampled On	04/04/2018
		Date Testing Commenced	06/04/2018
		Received or Collected	By Fitz: Paul C
		Condition on Receipt	Acceptable
Customer PO		*Date of Report*	25/04/2018
Customer Ref	DOWN1KM-LW-BOTTOM	*Sample Type*	Surface Water
Ref 2			
Ref 3			

CERTIFICATE OF ANALYSIS

Test Parameter	SOP	Analytical Technique	Result	Units	Acc.
1,1,1,2-Tetrachloroethane (Surface	154	GCMS	<1	ug/L	UKAS
1,1,1-Trichloroethane (Surface Water	154	GCMS	<1	ug/L	UKAS
1,1,2,2-Tetrachloroethane (Surface	154	GCMS	<5.0	ug/L	
1,1,2-Trichloroethane (Surface Water	154	GCMS	<2	ug/L	UKAS
1,1-Dichloroethane (Surface Water)	154	GCMS	<1	ug/L	UKAS
1,1-Dichloroethene (Surface Water)	154	GCMS	<1	ug/L	UKAS
1,1-Dichloropropene (Surface Water)	154	GCMS	<1	ug/L	UKAS
1,2,3-Trichlorobenzene (Surface Wat	154	GCMS	<1	ug/L	UKAS
1,2,3-Trichloropropane (Surface Wat	154	GCMS	<0.9	ug/L	UKAS
1,2,4-Trichlorobenzene (Surface Wat	154	GCMS	<0.6	ug/L	UKAS
1,2,4-Trimethylbenzene (Surface Wa	154	GCMS	<1	ug/L	UKAS
1,2-Dibromo-3-chloropropane (Surfac	154	GCMS	<1	ug/L	UKAS
1,2-Dibromoethane (Surface Water)	154	GCMS	<1	ug/L	UKAS
1,2-Dichlorobenzene (Surface Water)	154	GCMS	<1	ug/L	UKAS
1,2-Dichloroethane (Surface Water)	154	GCMS	<1	ug/L	UKAS
1,2-Dichloropropane (Surface Water)	154	GCMS	<1	ug/L	UKAS
1,3,5-Trimethylbenzene (Surface Wa	154	GCMS	<1	ug/L	UKAS
1,3-Dichlorobenzene (Surface Water)	154	GCMS	<1	ug/L	UKAS
1,3-Dichloropropane (Surface Water)	154	GCMS	<1	ug/L	UKAS
1,4-Dichlorobenzene (Surface Water)	154	GCMS	<1	ug/L	UKAS
2,2-Dichloropropane (Surface Water)	154	GCMS	<5.0	ug/L	
2-Chlorotoluene (Surface Water)	154	GCMS	<1	ug/L	UKAS
4-Chlorotoluene (Surface Water)	154	GCMS	<1	ug/L	UKAS
Acenaphthene (GCMS)	200	GCMS	<0.01	ug/L	

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	Liosbaun Ind Est	*Date Testing Commenced*	**06/04/2018**
	Liosbaun	*Received or Collected*	**By Fitz: Paul C**
	Co Galway	*Condition on Receipt*	**Acceptable**
Customer PO		*Date of Report*	**25/04/2018**
Customer Ref	**DOWN1KM-LW-BOTTOM**	*Sample Type*	**Surface Water**
Ref 2			
Ref 3			

CERTIFICATE OF ANALYSIS

Test Parameter	SOP	Analytical Technique	Result	Units	Acc.
Acenaphthylene (GCMS)	200	GCMS	<0.01	ug/L	
Ammonia (Surface Water)	114	Colorimetry	0.39	mg/L as N	UKAS
Anthracene (GCMS)	200	GCMS	<0.01	ug/L	
Antimony (Surface Water)	177	ICPMS	7	ug/L	UKAS
Arsenic (Surface Water)	177	ICPMS	<1	ug/L	UKAS
Barium (Surface Water)	177	ICPMS	32	ug/L	UKAS
Benzene (Surface Water)	154	GCMS	<1	ug/L	UKAS
Benzo(a)anthracene (GCMS)	200	GCMS	<0.01	ug/L	
Benzo(a)pyrene (GCMS)	200	GCMS	<0.01	ug/L	
Benzo(g,h,i)perylene (GCMS)	200	GCMS	<0.01	ug/L	
Benzo(k)fluoranthene (GCMS)	200	GCMS	<0.01	ug/L	
Bromobenzene (Surface Water)	154	GCMS	<1	ug/L	UKAS
Bromochloromethane (Surface Water	154	GCMS	<1	ug/L	UKAS
Bromodichloromethane (Surface Wat	154	GCMS	<1	ug/L	UKAS
Bromoform (Surface Water)	154	GCMS	<1	ug/L	UKAS
Bromomethane (Surface Water)	154	GCMS	<5.0	ug/L	
Cadmium (Surface Water)	177	ICPMS	<1	ug/L	UKAS
Carbon tetrachloride (Surface Water)	154	GCMS	<1	ug/L	UKAS
Chlorobenzene (Surface Water)	154	GCMS	<1	ug/L	UKAS
Chloroethane (Surface Water)	154	GCMS	<5.0	ug/L	
Chloroform (Surface Water)	154	GCMS	<1	ug/L	UKAS
Chloromethane (Surface Water)	154	GCMS	<5.0	ug/L	
Chromium (Surface Water)	177	ICPMS	7	ug/L	UKAS
Chrysene (GCMS)	200	GCMS	<0.01	ug/L	

Signed : A Harman

Date : 25/04/2018

Aoife Harmon - Technical Supervisor

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UKAS TESTING 2802

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Customer	Caroline Roche Aqua-Fact International Services Ltd 12 Kilkerrin Park Liosbaun Ind Est Liosbaun Co Galway	*Lab Report Ref. No.*	0529/001/21
		Date of Receipt	06/04/2018
		Sampled On	04/04/2018
		Date Testing Commenced	06/04/2018
		Received or Collected	By Fitz: Paul C
		Condition on Receipt	Acceptable
Customer PO		*Date of Report*	25/04/2018
Customer Ref	DOWN1KM-LW-BOTTOM	*Sample Type*	Surface Water
Ref 2			
Ref 3			

CERTIFICATE OF ANALYSIS

Test Parameter	SOP	Analytical Technique	Result	Units	Acc.
cis-1,2-Dichloroethene (Surface Wat	154	GCMS	<1	ug/L	UKAS
cis-1,3-Dichloropropene (Surface Wa	154	GCMS	<1	ug/L	UKAS
COD (Surface Water)	107	Colorimetry	100	mg/L	UKAS
Copper (Surface Water)	177	ICPMS	8	ug/L	UKAS
Coronene (GCMS)	200	GCMS	<0.01	ug/L	
Dibenzo(a,h)anthracene (GCMS)	200	GCMS	<0.01	ug/L	
Dibromochloromethane (Surface Wat	154	GCMS	<1	ug/L	UKAS
Dibromomethane (Surface Water)	154	GCMS	<1	ug/L	UKAS
Dichlorodifluoromethane (Surface W	154	GCMS	<5.0	ug/L	
Dichloromethane (Surface Water)	154	GCMS	<5.0	ug/L	
Ethylbenzene (Surface Water)	154	GCMS	<1	ug/L	UKAS
Fluoranthene (GCMS)	200	GCMS	<0.01	ug/L	
Fluorene (GCMS)	200	GCMS	<0.01	ug/L	
Hexachlorobutadiene (Surface Water	154	GCMS	<1	ug/L	UKAS
Indeno(1,2,3-cd)pyrene (GCMS)	200	GCMS	<0.01	ug/L	
Isopropylbenzene (Surface Water)	154	GCMS	<1	ug/L	UKAS
Lead (Surface Water)	177	ICPMS	9	ug/L	UKAS
m- & p-Xylene (Surface Water)	154	GCMS	<1	ug/L	UKAS
Mercury (Surface water)	178	ICPMS	1.05	ug/L	UKAS
Molybdenum	226	ICPMS	12	ug/L	
Naphthalene (Surface Water)	154	GCMS	<1	ug/L	UKAS
n-Butylbenzene (Surface Water)	154	GCMS	<1	ug/L	UKAS
Nickel (Surface Water)	177	ICPMS	8	ug/L	UKAS
Nitrogen (Total Kjeldahl)	104	Digestion/ Distillation/ Titrimetr	<1.00	mg/L as N	

Signed : A Harmon

Aoife Harmon - Technical Supervisor

Date : 25/04/2018

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	Aqua-Fact International Services Ltd	*Date of Receipt*	**06/04/2018**
	12 Kilkerrin Park	*Sampled On*	**04/04/2018**
	Liosbaun Ind Est	*Date Testing Commenced*	**06/04/2018**
	Liosbaun	*Received or Collected*	**By Fitz: Paul C**
	Co Galway	*Condition on Receipt*	**Acceptable**
Customer PO		*Date of Report*	**25/04/2018**
Customer Ref	**DOWN1KM-LW-BOTTOM**	*Sample Type*	**Surface Water**
Ref 2			
Ref 3			

CERTIFICATE OF ANALYSIS

Test Parameter	SOP	Analytical Technique	Result	Units	Acc.
Nitrogen (Total Oxidised) (Surface W	151	Colorimetry	1.85	mg/L as N	UKAS
Nitrogen (Total)	0	Calculation	3	mg/L as N	
n-Propylbenzene (Surface Water)	154	GCMS	<1.0	ug/L	UKAS
o-Xylene (Surface Water)	154	GCMS	<1	ug/L	UKAS
Phenanthrene (GCMS)	200	GCMS	<0.01	ug/L	
Phenols (Total)	223	GCMS	<0.10	ug/L	
Phosphorus (Total) Surface Water	166	Colorimetry	0.052	mg/L as P	UKAS
p-Isopropyltoluene (Surface Water)	154	GCMS	<1	ug/L	UKAS
Polyaromatic Hydrocarbons (GCMS)	200	GCMS	<0.01	ug/L	
Pyrene (GCMS)	200	GCMS	<0.01	ug/L	
sec-Butylbenzene (Surface Water)	154	GCMS	<1	ug/L	UKAS
Selenium (Surface Water)	177	ICPMS	2	ug/L	UKAS
Solids (Total Dissolved)	105	Filtration/ Evaporation @ 180C	20938	mg/L	
Styrene (Surface Water)	154	GCMS	<1	ug/L	UKAS
tert-Butylbenzene (Surface Water)	154	GCMS	<1	ug/L	UKAS
Tetrachloroethene (Surface Water)	154	GCMS	<1	ug/L	UKAS
TOC (Surface Water)	316	TOC Analyser	3.8	mg/L	UKAS
Toluene (Surface Water)	154	GCMS	<1	ug/L	UKAS
Total Inorganic Nitrogen	0	Calculation	1.4	mg/L	
trans-1,2-Dichloroethene (Surface W	154	GCMS	<1	ug/L	UKAS
trans-1,3-Dichloropropene (Surface	154	GCMS	<1	ug/L	UKAS
Trichloroethene (Surface Water)	154	GCMS	<1.0	ug/L	
Trichlorofluoromethane (Surface Wat	154	GCMS	<1	ug/L	UKAS
Vanadium (Surface Water)	177	ICPMS	296	ug/L	UKAS

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UKAS TESTING 2802

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	Liosbaun Ind Est	*Date Testing Commenced*	**06/04/2018**
	Liosbaun	*Received or Collected*	**By Fitz: Paul C**
	Co Galway	*Condition on Receipt*	**Acceptable**
Customer PO		*Date of Report*	**25/04/2018**
Customer Ref	**DOWN1KM-LW-BOTTOM**	*Sample Type*	**Surface Water**
Ref 2			
Ref 3			

CERTIFICATE OF ANALYSIS

Test Parameter	SOP	Analytical Technique	Result	Units	Acc.
Vinyl chloride (Surface Water)	154	GCMS	<1	ug/L	UKAS
Volatile Organic Compounds	154	GCMS	<5.0	ug/L	
Xylene Total (Surface Water)	154	GCMS	<1	ug/L	UKAS
Zinc (Surface Water)	177	ICPMS	221	ug/L	UKAS

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		Date of Receipt	06/04/2018
		Sampled On	04/04/2018
		Date Testing Commenced	06/04/2018
		Received or Collected	By Fitz: Paul C
		Condition on Receipt	Acceptable
Customer PO		*Date of Report*	25/04/2018
Customer Ref	DOWN1KM-MF-SURF	*Sample Type*	Surface Water
Ref 2			
Ref 3			

CERTIFICATE OF ANALYSIS

Test Parameter	SOP	Analytical Technique	Result	Units	Acc.
1,1,1,2-Tetrachloroethane (Surface	154	GCMS	<1	ug/L	UKAS
1,1,1-Trichloroethane (Surface Water	154	GCMS	<1	ug/L	UKAS
1,1,2,2-Tetrachloroethane (Surface	154	GCMS	<5.0	ug/L	
1,1,2-Trichloroethane (Surface Water	154	GCMS	<2	ug/L	UKAS
1,1-Dichloroethane (Surface Water)	154	GCMS	<1	ug/L	UKAS
1,1-Dichloroethene (Surface Water)	154	GCMS	<1	ug/L	UKAS
1,1-Dichloropropene (Surface Water)	154	GCMS	<1	ug/L	UKAS
1,2,3-Trichlorobenzene (Surface Wat	154	GCMS	<1	ug/L	UKAS
1,2,3-Trichloropropane (Surface Wat	154	GCMS	<0.9	ug/L	UKAS
1,2,4-Trichlorobenzene (Surface Wat	154	GCMS	<0.6	ug/L	UKAS
1,2,4-Trimethylbenzene (Surface Wa	154	GCMS	<1	ug/L	UKAS
1,2-Dibromo-3-chloropropane (Surfac	154	GCMS	<1	ug/L	UKAS
1,2-Dibromoethane (Surface Water)	154	GCMS	<1	ug/L	UKAS
1,2-Dichlorobenzene (Surface Water)	154	GCMS	<1	ug/L	UKAS
1,2-Dichloroethane (Surface Water)	154	GCMS	<1	ug/L	UKAS
1,2-Dichloropropane (Surface Water)	154	GCMS	<1	ug/L	UKAS
1,3,5-Trimethylbenzene (Surface Wa	154	GCMS	<1	ug/L	UKAS
1,3-Dichlorobenzene (Surface Water)	154	GCMS	<1	ug/L	UKAS
1,3-Dichloropropane (Surface Water)	154	GCMS	<1	ug/L	UKAS
1,4-Dichlorobenzene (Surface Water)	154	GCMS	<1	ug/L	UKAS
2,2-Dichloropropane (Surface Water)	154	GCMS	<5.0	ug/L	
2-Chlorotoluene (Surface Water)	154	GCMS	<1	ug/L	UKAS
4-Chlorotoluene (Surface Water)	154	GCMS	<1	ug/L	UKAS
Acenaphthene (GCMS)	200	GCMS	<0.01	ug/L	

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	Aqua-Fact International Services Ltd	*Date of Receipt*	**06/04/2018**
	12 Kilkerrin Park	*Sampled On*	**04/04/2018**
	Liosbaun Ind Est	*Date Testing Commenced*	**06/04/2018**
	Liosbaun	*Received or Collected*	**By Fitz: Paul C**
	Co Galway	*Condition on Receipt*	**Acceptable**
Customer PO		*Date of Report*	**25/04/2018**
Customer Ref	**DOWN1KM-MF-SURF**	*Sample Type*	**Surface Water**
Ref 2			
Ref 3			

CERTIFICATE OF ANALYSIS

Test Parameter	SOP	Analytical Technique	Result	Units	Acc.
Acenaphthylene (GCMS)	200	GCMS	<0.01	ug/L	
Ammonia (Surface Water)	114	Colorimetry	0.37	mg/L as N	UKAS
Anthracene (GCMS)	200	GCMS	<0.01	ug/L	
Antimony (Surface Water)	177	ICPMS	4	ug/L	UKAS
Arsenic (Surface Water)	177	ICPMS	<1	ug/L	UKAS
Barium (Surface Water)	177	ICPMS	29	ug/L	UKAS
Benzene (Surface Water)	154	GCMS	<1	ug/L	UKAS
Benzo(a)anthracene (GCMS)	200	GCMS	<0.01	ug/L	
Benzo(a)pyrene (GCMS)	200	GCMS	<0.01	ug/L	
Benzo(g,h,i)perylene (GCMS)	200	GCMS	<0.01	ug/L	
Benzo(k)fluoranthene (GCMS)	200	GCMS	<0.01	ug/L	
Bromobenzene (Surface Water)	154	GCMS	<1	ug/L	UKAS
Bromochloromethane (Surface Water	154	GCMS	<1	ug/L	UKAS
Bromodichloromethane (Surface Wat	154	GCMS	<1	ug/L	UKAS
Bromoform (Surface Water)	154	GCMS	<1	ug/L	UKAS
Bromomethane (Surface Water)	154	GCMS	<5.0	ug/L	
Cadmium (Surface Water)	177	ICPMS	<1	ug/L	UKAS
Carbon tetrachloride (Surface Water)	154	GCMS	<1	ug/L	UKAS
Chlorobenzene (Surface Water)	154	GCMS	<1	ug/L	UKAS
Chloroethane (Surface Water)	154	GCMS	<5.0	ug/L	
Chloroform (Surface Water)	154	GCMS	<1	ug/L	UKAS
Chloromethane (Surface Water)	154	GCMS	<5.0	ug/L	
Chromium (Surface Water)	177	ICPMS	6	ug/L	UKAS
Chrysene (GCMS)	200	GCMS	<0.01	ug/L	

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	12 Kilkerrin Park	*Sampled On*	**04/04/2018**
	Liosbaun Ind Est	*Date Testing Commenced*	**06/04/2018**
	Liosbaun	*Received or Collected*	**By Fitz: Paul C**
	Co Galway	*Condition on Receipt*	**Acceptable**
Customer PO		*Date of Report*	**25/04/2018**
Customer Ref	**DOWN1KM-MF-SURF**	*Sample Type*	**Surface Water**
Ref 2			
Ref 3			

CERTIFICATE OF ANALYSIS

Test Parameter	SOP	Analytical Technique	Result	Units	Acc.
cis-1,2-Dichloroethene (Surface Wat	154	GCMS	<1	ug/L	UKAS
cis-1,3-Dichloropropene (Surface Wa	154	GCMS	<1	ug/L	UKAS
COD (Surface Water)	107	Colorimetry	110	mg/L	UKAS
Copper (Surface Water)	177	ICPMS	13	ug/L	UKAS
Coronene (GCMS)	200	GCMS	<0.01	ug/L	
Dibenzo(a,h)anthracene (GCMS)	200	GCMS	<0.01	ug/L	
Dibromochloromethane (Surface Wat	154	GCMS	<1	ug/L	UKAS
Dibromomethane (Surface Water)	154	GCMS	<1	ug/L	UKAS
Dichlorodifluoromethane (Surface W	154	GCMS	<5.0	ug/L	
Dichloromethane (Surface Water)	154	GCMS	<5.0	ug/L	
Ethylbenzene (Surface Water)	154	GCMS	<1	ug/L	UKAS
Fluoranthene (GCMS)	200	GCMS	<0.01	ug/L	
Fluorene (GCMS)	200	GCMS	<0.01	ug/L	
Hexachlorobutadiene (Surface Water	154	GCMS	<1	ug/L	UKAS
Indeno(1,2,3-cd)pyrene (GCMS)	200	GCMS	<0.01	ug/L	
Isopropylbenzene (Surface Water)	154	GCMS	<1	ug/L	UKAS
Lead (Surface Water)	177	ICPMS	7	ug/L	UKAS
m- & p-Xylene (Surface Water)	154	GCMS	<1	ug/L	UKAS
Mercury (Surface water)	178	ICPMS	0.55	ug/L	UKAS
Molybdenum	226	ICPMS	13	ug/L	
Naphthalene (Surface Water)	154	GCMS	<1	ug/L	UKAS
n-Butylbenzene (Surface Water)	154	GCMS	<1	ug/L	UKAS
Nickel (Surface Water)	177	ICPMS	9	ug/L	UKAS
Nitrogen (Total Kjeldahl)	104	Digestion/ Distillation/ Titrimetr	<1.00	mg/L as N	

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	12 Kilkerrin Park	**Sampled On**	**04/04/2018**
	Liosbaun Ind Est	**Date Testing Commenced**	**06/04/2018**
	Liosbaun	**Received or Collected**	**By Fitz: Paul C**
	Co Galway	**Condition on Receipt**	**Acceptable**
Customer PO		**Date of Report**	**25/04/2018**
Customer Ref	**DOWN1KM-MF-SURF**	**Sample Type**	**Surface Water**
Ref 2			
Ref 3			

CERTIFICATE OF ANALYSIS

Test Parameter	SOP	Analytical Technique	Result	Units	Acc.
Nitrogen (Total Oxidised) (Surface W	151	Colorimetry	1.40	mg/L as N	UKAS
Nitrogen (Total)	0	Calculation	2	mg/L as N	
n-Propylbenzene (Surface Water)	154	GCMS	<1.0	ug/L	UKAS
o-Xylene (Surface Water)	154	GCMS	<1	ug/L	UKAS
Phenanthrene (GCMS)	200	GCMS	<0.01	ug/L	
Phenols (Total)	223	GCMS	<0.10	ug/L	
Phosphorus (Total) Surface Water	166	Colorimetry	0.043	mg/L as P	UKAS
p-Isopropyltoluene (Surface Water)	154	GCMS	<1	ug/L	UKAS
Polyaromatic Hydrocarbons (GCMS)	200	GCMS	<0.01	ug/L	
Pyrene (GCMS)	200	GCMS	<0.01	ug/L	
sec-Butylbenzene (Surface Water)	154	GCMS	<1	ug/L	UKAS
Selenium (Surface Water)	177	ICPMS	6	ug/L	UKAS
Solids (Total Dissolved)	105	Filtration/ Evaporation @ 180C	24296	mg/L	
Styrene (Surface Water)	154	GCMS	<1	ug/L	UKAS
tert-Butylbenzene (Surface Water)	154	GCMS	<1	ug/L	UKAS
Tetrachloroethene (Surface Water)	154	GCMS	<1	ug/L	UKAS
TOC (Surface Water)	316	TOC Analyser	3.5	mg/L	UKAS
Toluene (Surface Water)	154	GCMS	<1	ug/L	UKAS
Total Inorganic Nitrogen	0	Calculation	0.7	mg/L	
trans-1,2-Dichloroethene (Surface W	154	GCMS	<1	ug/L	UKAS
trans-1,3-Dichloropropene (Surface	154	GCMS	<1	ug/L	UKAS
Trichloroethene (Surface Water)	154	GCMS	<1.0	ug/L	
Trichlorofluoromethane (Surface Wat	154	GCMS	<1	ug/L	UKAS
Vanadium (Surface Water)	177	ICPMS	288	ug/L	UKAS

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Customer	**Caroline Roche**	*Lab Report Ref. No.*	**0529/001/22**
	Aqua-Fact International Services Ltd	*Date of Receipt*	**06/04/2018**
	12 Kilkerrin Park	*Sampled On*	**04/04/2018**
	Liosbaun Ind Est	*Date Testing Commenced*	**06/04/2018**
	Liosbaun	*Received or Collected*	**By Fitz: Paul C**
	Co Galway	*Condition on Receipt*	**Acceptable**
Customer PO		*Date of Report*	**25/04/2018**
Customer Ref	**DOWN1KM-MF-SURF**	*Sample Type*	**Surface Water**
Ref 2			
Ref 3			

CERTIFICATE OF ANALYSIS

Test Parameter	SOP	Analytical Technique	Result	Units	Acc.
Vinyl chloride (Surface Water)	154	GCMS	<1	ug/L	UKAS
Volatile Organic Compounds	154	GCMS	<5.0	ug/L	
Xylene Total (Surface Water)	154	GCMS	<1	ug/L	UKAS
Zinc (Surface Water)	177	ICPMS	156	ug/L	UKAS

Signed : A Harmon

Aoife Harmon - Technical Supervisor

Date : 25/04/2018

Acc. : Accredited Parameters by ISO 17025:2005
PVL - Parametric Value Limit as per EU (Drinking water) Regulations (SI 122 2014)
For bacterial analysis a result of 0 means none detected in volume examined
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UKAS TESTING 2802

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Customer	Caroline Roche	*Lab Report Ref. No.*	0529/001/23
	Aqua-Fact International Services Ltd	*Date of Receipt*	06/04/2018
	12 Kilkerrin Park	*Sampled On*	04/04/2018
	Liosbaun Ind Est	*Date Testing Commenced*	06/04/2018
	Liosbaun	*Received or Collected*	By Fitz: Paul C
	Co Galway	*Condition on Receipt*	Acceptable
Customer PO		*Date of Report*	25/04/2018
Customer Ref	DOWN1KM-MF-MID	*Sample Type*	Surface Water
Ref 2			
Ref 3			

CERTIFICATE OF ANALYSIS

Test Parameter	SOP	Analytical Technique	Result	Units	Acc.
1,1,1,2-Tetrachloroethane (Surface	154	GCMS	<1	ug/L	UKAS
1,1,1-Trichloroethane (Surface Water	154	GCMS	<1	ug/L	UKAS
1,1,2,2-Tetrachloroethane (Surface	154	GCMS	<5.0	ug/L	
1,1,2-Trichloroethane (Surface Water	154	GCMS	<2	ug/L	UKAS
1,1-Dichloroethane (Surface Water)	154	GCMS	<1	ug/L	UKAS
1,1-Dichloroethene (Surface Water)	154	GCMS	<1	ug/L	UKAS
1,1-Dichloropropene (Surface Water)	154	GCMS	<1	ug/L	UKAS
1,2,3-Trichlorobenzene (Surface Wat	154	GCMS	<1	ug/L	UKAS
1,2,3-Trichloropropane (Surface Wat	154	GCMS	<0.9	ug/L	UKAS
1,2,4-Trichlorobenzene (Surface Wat	154	GCMS	<0.6	ug/L	UKAS
1,2,4-Trimethylbenzene (Surface Wa	154	GCMS	<1	ug/L	UKAS
1,2-Dibromo-3-chloropropane (Surfac	154	GCMS	<1	ug/L	UKAS
1,2-Dibromoethane (Surface Water)	154	GCMS	<1	ug/L	UKAS
1,2-Dichlorobenzene (Surface Water)	154	GCMS	<1	ug/L	UKAS
1,2-Dichloroethane (Surface Water)	154	GCMS	<1	ug/L	UKAS
1,2-Dichloropropane (Surface Water)	154	GCMS	<1	ug/L	UKAS
1,3,5-Trimethylbenzene (Surface Wa	154	GCMS	<1	ug/L	UKAS
1,3-Dichlorobenzene (Surface Water)	154	GCMS	<1	ug/L	UKAS
1,3-Dichloropropane (Surface Water)	154	GCMS	<1	ug/L	UKAS
1,4-Dichlorobenzene (Surface Water)	154	GCMS	<1	ug/L	UKAS
2,2-Dichloropropane (Surface Water)	154	GCMS	<5.0	ug/L	
2-Chlorotoluene (Surface Water)	154	GCMS	<1	ug/L	UKAS
4-Chlorotoluene (Surface Water)	154	GCMS	<1	ug/L	UKAS
Acenaphthene (GCMS)	200	GCMS	<0.01	ug/L	

Signed : A Harmon **Date : 25/04/2018**

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Customer	Caroline Roche Aqua-Fact International Services Ltd 12 Kilkerrin Park Liosbaun Ind Est Liosbaun Co Galway	*Lab Report Ref. No.*	0529/001/23
		Date of Receipt	06/04/2018
		Sampled On	04/04/2018
		Date Testing Commenced	06/04/2018
		Received or Collected	By Fitz: Paul C
		Condition on Receipt	Acceptable
Customer PO		*Date of Report*	25/04/2018
Customer Ref	DOWN1KM-MF-MID	*Sample Type*	Surface Water
Ref 2			
Ref 3			

CERTIFICATE OF ANALYSIS

Test Parameter	SOP	Analytical Technique	Result	Units	Acc.
Acenaphthylene (GCMS)	200	GCMS	<0.01	ug/L	
Ammonia (Surface Water)	114	Colorimetry	0.37	mg/L as N	UKAS
Anthracene (GCMS)	200	GCMS	<0.01	ug/L	
Antimony (Surface Water)	177	ICPMS	3	ug/L	UKAS
Arsenic (Surface Water)	177	ICPMS	<1	ug/L	UKAS
Barium (Surface Water)	177	ICPMS	20	ug/L	UKAS
Benzene (Surface Water)	154	GCMS	<1	ug/L	UKAS
Benzo(a)anthracene (GCMS)	200	GCMS	<0.01	ug/L	
Benzo(a)pyrene (GCMS)	200	GCMS	<0.01	ug/L	
Benzo(g,h,i)perylene (GCMS)	200	GCMS	<0.01	ug/L	
Benzo(k)fluoranthene (GCMS)	200	GCMS	<0.01	ug/L	
Bromobenzene (Surface Water)	154	GCMS	<1	ug/L	UKAS
Bromochloromethane (Surface Water	154	GCMS	<1	ug/L	UKAS
Bromodichloromethane (Surface Wat	154	GCMS	<1	ug/L	UKAS
Bromoform (Surface Water)	154	GCMS	<1	ug/L	UKAS
Bromomethane (Surface Water)	154	GCMS	<5.0	ug/L	
Cadmium (Surface Water)	177	ICPMS	<1	ug/L	UKAS
Carbon tetrachloride (Surface Water)	154	GCMS	<1	ug/L	UKAS
Chlorobenzene (Surface Water)	154	GCMS	<1	ug/L	UKAS
Chloroethane (Surface Water)	154	GCMS	<5.0	ug/L	
Chloroform (Surface Water)	154	GCMS	<1	ug/L	UKAS
Chloromethane (Surface Water)	154	GCMS	<5.0	ug/L	
Chromium (Surface Water)	177	ICPMS	9	ug/L	UKAS
Chrysene (GCMS)	200	GCMS	<0.01	ug/L	

Signed : A Harmon

Date : 25/04/2018

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	12 Kilkerrin Park	***Sampled On***	**04/04/2018**
	Liosbaun Ind Est	***Date Testing Commenced***	**06/04/2018**
	Liosbaun	***Received or Collected***	**By Fitz: Paul C**
	Co Galway	***Condition on Receipt***	**Acceptable**
Customer PO		***Date of Report***	**25/04/2018**
Customer Ref	**DOWN1KM-MF-MID**	***Sample Type***	**Surface Water**
Ref 2			
Ref 3			

CERTIFICATE OF ANALYSIS

Test Parameter	SOP	Analytical Technique	Result	Units	Acc.
cis-1,2-Dichloroethene (Surface Wat	154	GCMS	<1	ug/L	UKAS
cis-1,3-Dichloropropene (Surface Wa	154	GCMS	<1	ug/L	UKAS
COD (Surface Water)	107	Colorimetry	115	mg/L	UKAS
Copper (Surface Water)	177	ICPMS	12	ug/L	UKAS
Coronene (GCMS)	200	GCMS	<0.01	ug/L	
Dibenzo(a,h)anthracene (GCMS)	200	GCMS	<0.01	ug/L	
Dibromochloromethane (Surface Wat	154	GCMS	<1	ug/L	UKAS
Dibromomethane (Surface Water)	154	GCMS	<1	ug/L	UKAS
Dichlorodifluoromethane (Surface W	154	GCMS	<5.0	ug/L	
Dichloromethane (Surface Water)	154	GCMS	<5.0	ug/L	
Ethylbenzene (Surface Water)	154	GCMS	<1	ug/L	UKAS
Fluoranthene (GCMS)	200	GCMS	<0.01	ug/L	
Fluorene (GCMS)	200	GCMS	<0.01	ug/L	
Hexachlorobutadiene (Surface Water	154	GCMS	<1	ug/L	UKAS
Indeno(1,2,3-cd)pyrene (GCMS)	200	GCMS	<0.01	ug/L	
Isopropylbenzene (Surface Water)	154	GCMS	<1	ug/L	UKAS
Lead (Surface Water)	177	ICPMS	4	ug/L	UKAS
m- & p-Xylene (Surface Water)	154	GCMS	<1	ug/L	UKAS
Mercury (Surface water)	178	ICPMS	0.63	ug/L	UKAS
Molybdenum	226	ICPMS	10	ug/L	
Naphthalene (Surface Water)	154	GCMS	<1	ug/L	UKAS
n-Butylbenzene (Surface Water)	154	GCMS	<1	ug/L	UKAS
Nickel (Surface Water)	177	ICPMS	9	ug/L	UKAS
Nitrogen (Total Kjeldahl)	104	Digestion/ Distillation/ Titrimetr	<1.00	mg/L as N	

Signed : A Harman ***Date : 25/04/2018***

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	12 Kilkerrin Park	**Sampled On**	**04/04/2018**
	Liosbaun Ind Est	**Date Testing Commenced**	**06/04/2018**
	Liosbaun	**Received or Collected**	**By Fitz: Paul C**
	Co Galway	**Condition on Receipt**	**Acceptable**
Customer PO		**Date of Report**	**25/04/2018**
Customer Ref	**DOWN1KM-MF-MID**	**Sample Type**	**Surface Water**
Ref 2			
Ref 3			

CERTIFICATE OF ANALYSIS

Test Parameter	SOP	Analytical Technique	Result	Units	Acc.
Nitrogen (Total Oxidised) (Surface W	151	Colorimetry	<0.08	mg/L as N	UKAS
Nitrogen (Total)	0	Calculation	<1	mg/L as N	
n-Propylbenzene (Surface Water)	154	GCMS	<1.0	ug/L	UKAS
o-Xylene (Surface Water)	154	GCMS	<1	ug/L	UKAS
Phenanthrene (GCMS)	200	GCMS	<0.01	ug/L	
Phenols (Total)	223	GCMS	<0.10	ug/L	
Phosphorus (Total) Surface Water	166	Colorimetry	0.060	mg/L as P	UKAS
p-Isopropyltoluene (Surface Water)	154	GCMS	<1	ug/L	UKAS
Polyaromatic Hydrocarbons (GCMS)	200	GCMS	<0.01	ug/L	
Pyrene (GCMS)	200	GCMS	<0.01	ug/L	
sec-Butylbenzene (Surface Water)	154	GCMS	<1	ug/L	UKAS
Selenium (Surface Water)	177	ICPMS	3	ug/L	UKAS
Solids (Total Dissolved)	105	Filtration/ Evaporation @ 180C	24644	mg/L	
Styrene (Surface Water)	154	GCMS	<1	ug/L	UKAS
tert-Butylbenzene (Surface Water)	154	GCMS	<1	ug/L	UKAS
Tetrachloroethene (Surface Water)	154	GCMS	<1	ug/L	UKAS
TOC (Surface Water)	316	TOC Analyser	4.3	mg/L	UKAS
Toluene (Surface Water)	154	GCMS	<1	ug/L	UKAS
Total Inorganic Nitrogen	0	Calculation	0.6	mg/L	
trans-1,2-Dichloroethene (Surface W	154	GCMS	<1	ug/L	UKAS
trans-1,3-Dichloropropene (Surface	154	GCMS	<1	ug/L	UKAS
Trichloroethene (Surface Water)	154	GCMS	<1.0	ug/L	
Trichlorofluoromethane (Surface Wat	154	GCMS	<1	ug/L	UKAS
Vanadium (Surface Water)	177	ICPMS	247	ug/L	UKAS

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Customer	Caroline Roche Aqua-Fact International Services Ltd 12 Kilkerrin Park Liosbaun Ind Est Liosbaun Co Galway	*Lab Report Ref. No.*	0529/001/23
		Date of Receipt	06/04/2018
		Sampled On	04/04/2018
		Date Testing Commenced	06/04/2018
		Received or Collected	By Fitz: Paul C
		Condition on Receipt	Acceptable
Customer PO		*Date of Report*	25/04/2018
Customer Ref	DOWN1KM-MF-MID	*Sample Type*	Surface Water
Ref 2			
Ref 3			

CERTIFICATE OF ANALYSIS

Test Parameter	SOP	Analytical Technique	Result	Units	Acc.
Vinyl chloride (Surface Water)	154	GCMS	<1	ug/L	UKAS
Volatile Organic Compounds	154	GCMS	<5.0	ug/L	
Xylene Total (Surface Water)	154	GCMS	<1	ug/L	UKAS
Zinc (Surface Water)	177	ICPMS	206	ug/L	UKAS

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	Aqua-Fact International Services Ltd	*Date of Receipt*	**06/04/2018**
	12 Kilkerrin Park	*Sampled On*	**04/04/2018**
	Liosbaun Ind Est	*Date Testing Commenced*	**06/04/2018**
	Liosbaun	*Received or Collected*	**By Fitz: Paul C**
	Co Galway	*Condition on Receipt*	**Acceptable**
Customer PO		*Date of Report*	**25/04/2018**
Customer Ref	**DOWN1KM-MF-BOTTOM**	*Sample Type*	**Surface Water**
Ref 2			
Ref 3			

CERTIFICATE OF ANALYSIS

Test Parameter	SOP	Analytical Technique	Result	Units	Acc.
1,1,1,2-Tetrachloroethane (Surface	154	GCMS	<1	ug/L	UKAS
1,1,1-Trichloroethane (Surface Water	154	GCMS	<1	ug/L	UKAS
1,1,2,2-Tetrachloroethane (Surface	154	GCMS	<5.0	ug/L	
1,1,2-Trichloroethane (Surface Water	154	GCMS	<2	ug/L	UKAS
1,1-Dichloroethane (Surface Water)	154	GCMS	<1	ug/L	UKAS
1,1-Dichloroethene (Surface Water)	154	GCMS	<1	ug/L	UKAS
1,1-Dichloropropene (Surface Water)	154	GCMS	<1	ug/L	UKAS
1,2,3-Trichlorobenzene (Surface Wat	154	GCMS	<1	ug/L	UKAS
1,2,3-Trichloropropane (Surface Wat	154	GCMS	<0.9	ug/L	UKAS
1,2,4-Trichlorobenzene (Surface Wat	154	GCMS	<0.6	ug/L	UKAS
1,2,4-Trimethylbenzene (Surface Wa	154	GCMS	<1	ug/L	UKAS
1,2-Dibromo-3-chloropropane (Surfac	154	GCMS	<1	ug/L	UKAS
1,2-Dibromoethane (Surface Water)	154	GCMS	<1	ug/L	UKAS
1,2-Dichlorobenzene (Surface Water)	154	GCMS	<1	ug/L	UKAS
1,2-Dichloroethane (Surface Water)	154	GCMS	<1	ug/L	UKAS
1,2-Dichloropropane (Surface Water)	154	GCMS	<1	ug/L	UKAS
1,3,5-Trimethylbenzene (Surface Wa	154	GCMS	<1	ug/L	UKAS
1,3-Dichlorobenzene (Surface Water)	154	GCMS	<1	ug/L	UKAS
1,3-Dichloropropane (Surface Water)	154	GCMS	<1	ug/L	UKAS
1,4-Dichlorobenzene (Surface Water)	154	GCMS	<1	ug/L	UKAS
2,2-Dichloropropane (Surface Water)	154	GCMS	<5.0	ug/L	
2-Chlorotoluene (Surface Water)	154	GCMS	<1	ug/L	UKAS
4-Chlorotoluene (Surface Water)	154	GCMS	<1	ug/L	UKAS
Acenaphthene (GCMS)	200	GCMS	<0.01	ug/L	

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	12 Kilkerrin Park	*Sampled On*	**04/04/2018**
	Liosbaun Ind Est	*Date Testing Commenced*	**06/04/2018**
	Liosbaun	*Received or Collected*	**By Fitz: Paul C**
	Co Galway	*Condition on Receipt*	**Acceptable**
Customer PO		*Date of Report*	**25/04/2018**
Customer Ref	**DOWN1KM-MF-BOTTOM**	*Sample Type*	**Surface Water**
Ref 2			
Ref 3			

CERTIFICATE OF ANALYSIS

Test Parameter	SOP	Analytical Technique	Result	Units	Acc.
Acenaphthylene (GCMS)	200	GCMS	<0.01	ug/L	
Ammonia (Surface Water)	114	Colorimetry	0.30	mg/L as N	UKAS
Anthracene (GCMS)	200	GCMS	<0.01	ug/L	
Antimony (Surface Water)	177	ICPMS	<3	ug/L	UKAS
Arsenic (Surface Water)	177	ICPMS	7	ug/L	UKAS
Barium (Surface Water)	177	ICPMS	24	ug/L	UKAS
Benzene (Surface Water)	154	GCMS	<1	ug/L	UKAS
Benzo(a)anthracene (GCMS)	200	GCMS	<0.01	ug/L	
Benzo(a)pyrene (GCMS)	200	GCMS	<0.01	ug/L	
Benzo(g,h,i)perylene (GCMS)	200	GCMS	<0.01	ug/L	
Benzo(k)fluoranthene (GCMS)	200	GCMS	<0.01	ug/L	
Bromobenzene (Surface Water)	154	GCMS	<1	ug/L	UKAS
Bromochloromethane (Surface Water	154	GCMS	<1	ug/L	UKAS
Bromodichloromethane (Surface Wat	154	GCMS	<1	ug/L	UKAS
Bromoform (Surface Water)	154	GCMS	<1	ug/L	UKAS
Bromomethane (Surface Water)	154	GCMS	<5.0	ug/L	
Cadmium (Surface Water)	177	ICPMS	<1	ug/L	UKAS
Carbon tetrachloride (Surface Water)	154	GCMS	<1	ug/L	UKAS
Chlorobenzene (Surface Water)	154	GCMS	<1	ug/L	UKAS
Chloroethane (Surface Water)	154	GCMS	<5.0	ug/L	
Chloroform (Surface Water)	154	GCMS	<1	ug/L	UKAS
Chloromethane (Surface Water)	154	GCMS	<5.0	ug/L	
Chromium (Surface Water)	177	ICPMS	3	ug/L	UKAS
Chrysene (GCMS)	200	GCMS	<0.01	ug/L	

Signed : A Harmon

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		Date of Receipt	06/04/2018
		Sampled On	04/04/2018
		Date Testing Commenced	06/04/2018
		Received or Collected	By Fitz: Paul C
		Condition on Receipt	Acceptable
Customer PO		*Date of Report*	25/04/2018
Customer Ref	DOWN1KM-MF-BOTTOM	*Sample Type*	Surface Water
Ref 2			
Ref 3			

CERTIFICATE OF ANALYSIS

Test Parameter	SOP	Analytical Technique	Result	Units	Acc.
cis-1,2-Dichloroethene (Surface Wat	154	GCMS	<1	ug/L	UKAS
cis-1,3-Dichloropropene (Surface Wa	154	GCMS	<1	ug/L	UKAS
COD (Surface Water)	107	Colorimetry	115	mg/L	UKAS
Copper (Surface Water)	177	ICPMS	18	ug/L	UKAS
Coronene (GCMS)	200	GCMS	<0.01	ug/L	
Dibenzo(a,h)anthracene (GCMS)	200	GCMS	<0.01	ug/L	
Dibromochloromethane (Surface Wat	154	GCMS	<1	ug/L	UKAS
Dibromomethane (Surface Water)	154	GCMS	<1	ug/L	UKAS
Dichlorodifluoromethane (Surface W	154	GCMS	<5.0	ug/L	
Dichloromethane (Surface Water)	154	GCMS	<5.0	ug/L	
Ethylbenzene (Surface Water)	154	GCMS	<1	ug/L	UKAS
Fluoranthene (GCMS)	200	GCMS	<0.01	ug/L	
Fluorene (GCMS)	200	GCMS	<0.01	ug/L	
Hexachlorobutadiene (Surface Water	154	GCMS	<1	ug/L	UKAS
Indeno(1,2,3-cd)pyrene (GCMS)	200	GCMS	<0.01	ug/L	
Isopropylbenzene (Surface Water)	154	GCMS	<1	ug/L	UKAS
Lead (Surface Water)	177	ICPMS	7	ug/L	UKAS
m- & p-Xylene (Surface Water)	154	GCMS	<1	ug/L	UKAS
Mercury (Surface water)	178	ICPMS	0.45	ug/L	UKAS
Molybdenum	226	ICPMS	10	ug/L	
Naphthalene (Surface Water)	154	GCMS	<1	ug/L	UKAS
n-Butylbenzene (Surface Water)	154	GCMS	<1	ug/L	UKAS
Nickel (Surface Water)	177	ICPMS	10	ug/L	UKAS
Nitrogen (Total Kjeldahl)	104	Digestion/ Distillation/ Titrimetr	<1.00	mg/L as N	

Signed : A Harman

Date : 25/04/2018

Aoife Harmon - Technical Supervisor

Acc. : Accredited Parameters by ISO 17025:2005
PVL - Parametric Value Limit as per EU (Drinking water) Regulations (SI 122 2014)
For bacterial analysis a result of 0 means none detected in volume examined
All organic results are analysed as received and all results are corrected for dry weight at 104 C
Results shall not be reproduced, except in full, without the approval of Fitz Scientific
Results contained in this report relate only to the samples tested (P) : Presumptive Results

UKAS TESTING 2802

** : The test result for this parameter may be invalid as it has exceeded the recommended holding time (BS EN ISO 5667-3:2012)

Fitz scientific

Monitoring and Testing Services

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email info@fitzsci.ie

A copy of this certificate is available on www.fitzsci.ie

Customer	Caroline Roche Aqua-Fact International Services Ltd 12 Kilkerrin Park Liosbaun Ind Est Liosbaun Co Galway	*Lab Report Ref. No.*	0529/001/24
		Date of Receipt	06/04/2018
		Sampled On	04/04/2018
		Date Testing Commenced	06/04/2018
		Received or Collected	By Fitz: Paul C
		Condition on Receipt	Acceptable
Customer PO		*Date of Report*	25/04/2018
Customer Ref	DOWN1KM-MF-BOTTOM	*Sample Type*	Surface Water
Ref 2			
Ref 3			

CERTIFICATE OF ANALYSIS

Test Parameter	SOP	Analytical Technique	Result	Units	Acc.
Nitrogen (Total Oxidised) (Surface W	151	Colorimetry	1.28	mg/L as N	UKAS
Nitrogen (Total)	0	Calculation	2	mg/L as N	
n-Propylbenzene (Surface Water)	154	GCMS	<1.0	ug/L	UKAS
o-Xylene (Surface Water)	154	GCMS	<1	ug/L	UKAS
Phenanthrene (GCMS)	200	GCMS	<0.01	ug/L	
Phenols (Total)	223	GCMS	<0.10	ug/L	
Phosphorus (Total) Surface Water	166	Colorimetry	0.058	mg/L as P	UKAS
p-Isopropyltoluene (Surface Water)	154	GCMS	<1	ug/L	UKAS
Polyaromatic Hydrocarbons (GCMS)	200	GCMS	<0.01	ug/L	
Pyrene (GCMS)	200	GCMS	<0.01	ug/L	
sec-Butylbenzene (Surface Water)	154	GCMS	<1	ug/L	UKAS
Selenium (Surface Water)	177	ICPMS	7	ug/L	UKAS
Solids (Total Dissolved)	105	Filtration/ Evaporation @ 180C	25062	mg/L	
Styrene (Surface Water)	154	GCMS	<1	ug/L	UKAS
tert-Butylbenzene (Surface Water)	154	GCMS	<1	ug/L	UKAS
Tetrachloroethene (Surface Water)	154	GCMS	<1	ug/L	UKAS
TOC (Surface Water)	316	TOC Analyser	3.3	mg/L	UKAS
Toluene (Surface Water)	154	GCMS	<1	ug/L	UKAS
Total Inorganic Nitrogen	0	Calculation	0.5	mg/L	
trans-1,2-Dichloroethene (Surface W	154	GCMS	<1	ug/L	UKAS
trans-1,3-Dichloropropene (Surface	154	GCMS	<1	ug/L	UKAS
Trichloroethene (Surface Water)	154	GCMS	<1.0	ug/L	
Trichlorofluoromethane (Surface Wat	154	GCMS	<1	ug/L	UKAS
Vanadium (Surface Water)	177	ICPMS	269	ug/L	UKAS

Signed : A Harmon

Date : 25/04/2018

Aoife Harmon - Technical Supervisor

Acc. : Accredited Parameters by ISO 17025:2005
PVL - Parametric Value Limit as per EU (Drinking water) Regulations (SI 122 2014)
For bacterial analysis a result of 0 means none detected in volume examined
All organic results are analysed as received and all results are corrected for dry weight at 104 C
Results shall not be reproduced, except in full, without the approval of Fitz Scientific
Results contained in this report relate only to the samples tested (P) : Presumptive Results

UKAS TESTING 2802

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Customer	**Caroline Roche**	*Lab Report Ref. No.*	**0529/001/24**
	Aqua-Fact International Services Ltd	*Date of Receipt*	**06/04/2018**
	12 Kilkerrin Park	*Sampled On*	**04/04/2018**
	Liosbaun Ind Est	*Date Testing Commenced*	**06/04/2018**
	Liosbaun	*Received or Collected*	**By Fitz: Paul C**
	Co Galway	*Condition on Receipt*	**Acceptable**
Customer PO		*Date of Report*	**25/04/2018**
Customer Ref	**DOWN1KM-MF-BOTTOM**	*Sample Type*	**Surface Water**
Ref 2			
Ref 3			

CERTIFICATE OF ANALYSIS

Test Parameter	SOP	Analytical Technique	Result	Units	Acc.
Vinyl chloride (Surface Water)	154	GCMS	<1	ug/L	UKAS
Volatile Organic Compounds	154	GCMS	<5.0	ug/L	
Xylene Total (Surface Water)	154	GCMS	<1	ug/L	UKAS
Zinc (Surface Water)	177	ICPMS	201	ug/L	UKAS

Signed : A Harmon

Aoife Harmon - Technical Supervisor

Date : 25/04/2018

Acc. : Accredited Parameters by ISO 17025:2005
PVL - Parametric Value Limit as per EU (Drinking water) Regulations (SI 122 2014)
For bacterial analysis a result of 0 means none detected in volume examined
All organic results are analysed as received and all results are corrected for dry weight at 104 C
Results shall not be reproduced, except in full, without the approval of Fitz Scientific
Results contained in this report relate only to the samples tested (P) : Presumptive Results

UKAS TESTING 2802

** : The test result for this parameter may be invalid as it has exceeded the recommended holding time (BS EN ISO 5667-3:2012)

Appendix 3
Glan-Uisce Teo Results

HENSEY GLAN-UISCE TEO.
Coismeigmore, Furbo, Co. Galway
Phone 091-592174 e-mail : maryhensey@glan-uisce.ie

ENVIRONMENTAL MONITORING REPORT

Aquafact International Ltd.,
Liosbaun Industrial Estate,
GALWAY

Samples delivered: 5th April 2018

Table 1.

Date received	Site	Sample	BOD mg/l
05.04.18	Up 500m	LW surface	<2.0
05.04.18	Up 500m	LW middle	<2.0
05.04.18	Up 500m	LW bottom	<2.0
05.04.18	Up 500m	ME surface	2.3
05.04.18	Up 500m	ME middle	<2.0
05.04.18	Up 500m	ME bottom	<2.0
05.04.18	Up 500m	MF surface	<2.0
05.04.18	Up 500m	MF middle	<2.0
05.04.18	Up 500m	MF bottom	<2.0
05.04.18	Down 500m	LW surface	<2.0
05.04.18	Down 500m	LW middle	<2.0
05.04.18	Down 500m	LW bottom	<2.0
05.04.18	Down 500m	ME surface	<2.0
05.04.18	Down 500m	ME middle	<2.0
05.04.18	Down 500m	ME bottom	<2.0
05.04.18	Down 500m	MF surface	<2.0
05.04.18	Down 500m	MF middle	<2.0
05.04.18	Down 500m	MF bottom	<2.0
05.04.18	Down 1Km	LW surface	<2.0
05.04.18	Down 1Km	LW middle	<2.0
05.04.18	Down 1Km	LW bottom	<2.0
05.04.18	Down 1Km	ME surface	<2.0
05.04.18	Down 1Km	ME middle	<2.0
05.04.18	Down 1Km	ME bottom	<2.0
05.04.18	Down 1Km	MF surface	<2.0
05.04.18	Down 1Km	MF middle	<2.0
05.04.18	Down 1Km	MF bottom	<2.0

Test methods: The following methods were used for sample analysis:

BOD: Method No. 4 Revision No. 13

DATE: 10.04.18

SIGNED. Mary Hensey
Mary Hensey M.Sc.
MANAGER

This report relates only to the samples tested.
This report must not be reproduced, except in full, without the approval of Hensey Glan-Uisce Teo.

ilac-MRA

ISO 17025
INAB
ACCREDITED
TESTING
DETAILED IN SCOPE REG NO.047T

Appendix 6

Baseline Water Characterisation Survey Aughinish, Shannon Estuary (Aquafact 2019)

Baseline Water Characterisation Survey
Aughinish, Shannon Estuary

Produced by

AQUAFACT International Services Ltd

On behalf of

Aughinish Alumina Limited

March 2019

AQUAFACT INTERNATIONAL SERVICES LTD.,
12 KILKERRIN PARK, LIOSBAUN, TUAM RD.,
GALWAY.
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Report Approval Sheet

Client	Aughinish Alumina Limited
Report Title	Baseline Water Characterisation Survey Aughinish, Shannon Estuary
Job Number	1526
Report Status	Final
Issue Date	19.3.2019

Rev	Status	Issue Date	Document File Name	Author (s)	Approved by:
1	Draft	14.3.19	JN1526 Aughinish Water Quality DRAFT	Hugh O'Sullivan	Caroline Roche
1	Final	19.3.19	JN1526 Aughinish Water Quality FINAL	Hugh O'Sullivan	Caroline Roche

AQUAFACT

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1. Introduction

AQUAFACT International Services Ltd. was commissioned by Aughinish Alumina Ltd. to carry out a baseline water characterisation survey around Aughinish Port. The sampling was carried out upstream and downstream of the Aughinish Alumina discharge, which discharged 12,212m^3 of treated effluent that day, with a maximum hourly discharge of 954m^3/hour.

.

2. Materials & Methods

2.1. Sampling Procedure

On the 20th February 2019, 3 water sampling stations were sampled in the vicinity of the Port. Sampling was carried out in accordance with the EPA Standard Operating Procedure for WFD sampling in transitional and coastal waters. The first station was located 500 m upstream of the discharge, a second station was located 500 m downstream and a third station was 1km downstream (See Figure 2.1). Each station was sampled at three depths; below surface, mid-water and off bottom. All stations were sampled at mid-ebb, low water and mid-flood with low water at 12:36 and high water at 19:00. The list of determinands can be seen in Table 2.1. Limits of Detection can be found in Appendix 1.

Samples were collected from a boat using a 1 litre water sampler at the three stations as shown in Figure 2.1. Table 2.2 presents the station coordinates.

Multiple samples were taken at each depth until all required sample containers were filled. The following containers were required for all sampling points:

1. 1 x 1l bottle for BOD
2. 1 litre plastic (general chemistry),
3. 100ml plastic (metals),
4. 40ml vial (VOCs) &
5. Two 1 litre glass (PAHs & Phenols)

Table 2:1 Determinands.

Determinand	
BOD	Vanadium
COD	Zinc
TOC (water)	Mercury
Antimony	Molybdenum
Arsenic	PAHs note1
Barium	Volatile Organic Compounds note2
Cadmium	BTEX note3
Chromium	Phenols (Total)
Copper	Solids (Total Dissolved)
Lead	Nitrogen (Total)
Nickel	Nitrogen (Total Inorganic)
Selenium	Phosphorus

Note [1] Water GC-MS, Soil GC-MS, Naphthalene, Acenaphthylene, Acenaphthene, Fluorene, Phenanthrene, Anthracene, Fluoranthene, Pyrene, Benz(a)anthracene, Chrysene, Benzo(k)fluoranthene, Benzo(a)pyrene, Indeno(123cd)pyrene, Dibenzo(ah)anthracene, Benzo(ghi)perylene, Coronene

Note [2] 1,1,1,2-Tetrachloroethane, 1,1,1-Trichloroethane, 1,1,2,2-Tetrachloroethane, 1,1,2-Trichloroethane, 1,1-Dichloroethane, 1,1-Dichloroethene, 1,1-Dichloropropene, 1,2,3-Trichlorobenzene, 1,2,3-Trichloropropane, 1,2,4-Trichlorobenzene, 1,2,4-Trimethylbenzene, 1,2-Dibromo-3-chloro-propane, 1,2-Dibromoethane, 1,2-Dichlorobenzene, 1,2-Dichloroethane, 1,2-Dichloropropane, 1,3,5-Trimethylbenzene, 1,3-Dichlorobenzene, 1,3-Dichloropropane, 1,4-Dichlorobenzene, 2,2-Dichloropropane, 2-Chlorotoluene, 4-Chlorotoluene, 4-Isopropyltoluene, , Bromobenzene, Bromochloromethane, Bromodichloromethane, Bromomethane, Bromoform, Carbontetrachloride, Chloroform, Chlorobenzene, Chloroethane, Chloromethane, cis-1,2-Dichloroethene, cis-1,3-Dichloropropene, Dibromochloromethane, Dibromomethane, Dichlorodifluoromethane, Dichloromethane, , Hexachlorobutadiene, Isopropylbenzene, Naphthalene, n-Butylbenzene, , , n- Propylbenzene, sec-Butylbenzene, Styrene, tert-Butylbenzene, Tetrachloroethene, , trans-1,2-Dichloroethene, trans-1,3-Dichloropropene, Trichloroethene, Trichlorofluoromethane, Vinyl Chloride.

Note [3] Benzene, Ethylbenzene, p/m-Xylene~, o-Xylene, Toluene, Xylene (Total)

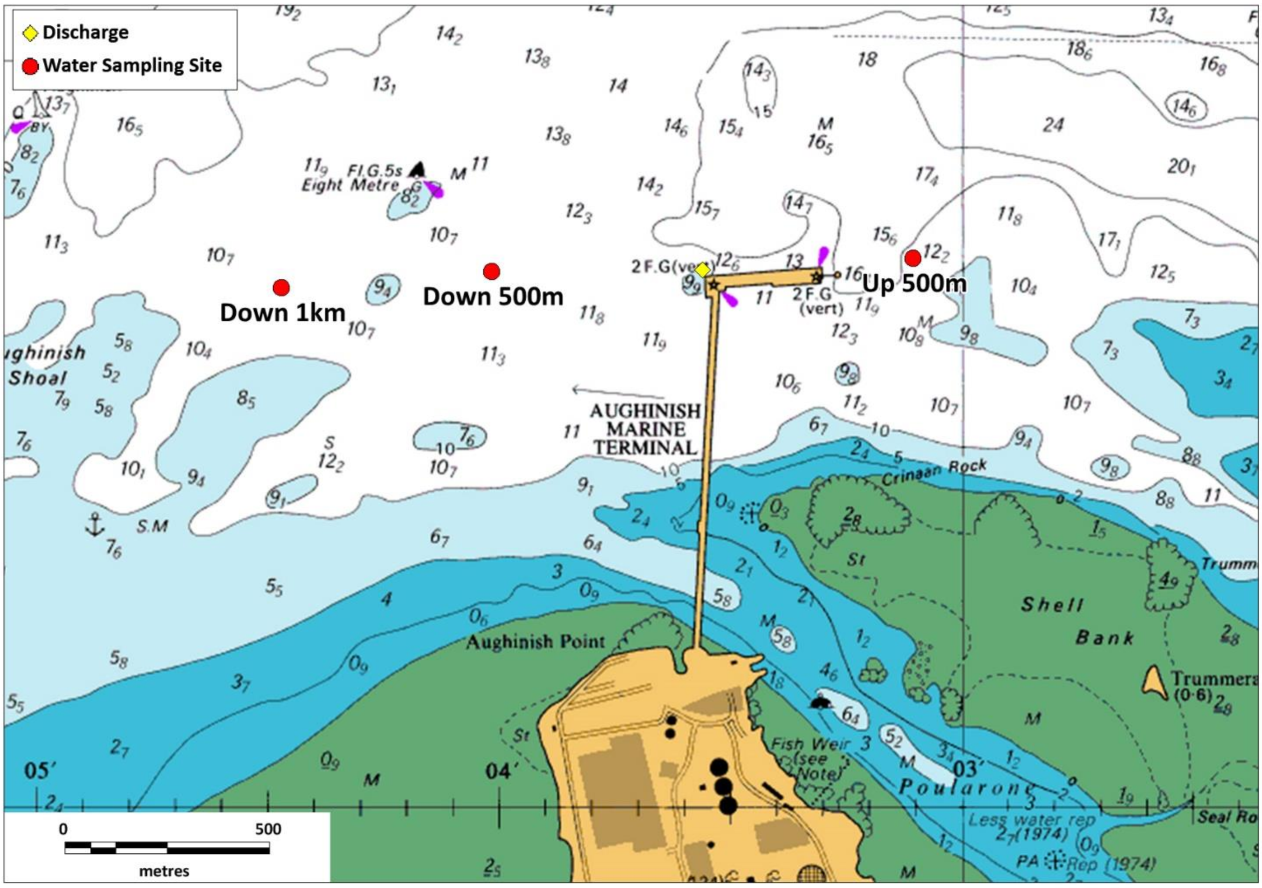

Figure 2.1 Location of chemistry sampling sites

Table 2:2: Coordinates of stations sampled for physical and chemical analysis

Station	Latitude	Longitude	Depth (m)
500m Upstream	52.6457	-9.05242	13
500m Downstream	52.6454	-9.06762	11
1km Downstream	52.6451	-9.07522	10

2.2. Sample Processing

Once back in the lab, BOD samples were delivered to Complete Laboratory Solutions (CLS) within 24 hours of collection and all other samples were sent to Fitz Scientific in Drogheda.

2.2.1. Chemical Analysis

The following methodologies were employed by the analysing laboratories:

- BOD: BOD_5

- COD: Colorimetry, Standard Method for the Examination of Water and Wastewater 2005, 21st Edition, Method 5220 D.
- TOC: TOC Analyser, British Standard EN 13137:2001- August 2001.
- Metals: ICPMS, Standard Method for the Examination of Water and Wastewater 2005, 21st Edition, Method 3125B. Selenium ICPMS, BS EN 12457-2:2002. Molybdenum ICPMS, Standard Method for the Examination of Water and Wastewater 2005, 21st Edition, Method 3120B.
- Phenols: GCMS, US EPA Method 525.
- Nitrogen (Total): Calculation, Other (Parameter is UKAS accredited if the parameter matrix is industrial effluent).
- Nitrogen (Total Oxidised): Colorimetry, Standard Method for the Examination of Water and Wastewater 2005, 21st Edition, Method 4500-NO3 H" and "SSA Book Series: 5, Methods of Soil Analysis – Extraction of Exchangeable Ammonium and Nitrate and Nitrite 1996.
- Nitrogen (Total Kjeldahl): Digestion/ Distillation/ Titrimetry, Standard Method for the Examination of Water and Wastewater 2005, 21st Edition, Method 4500-Norg.
- VOCs: GCMS, US EPA Method 8260B. Tetrachloroethene (Surface Water) GCMS, US EPA Method 524.
- PAHs: HPLC, Standard Method for the Examination of Water and Wastewater 2005h 21st Edition, Method 6440.

3. Physical / Chemical Results

Appendices 2 and 3 contain the laboratory reports showing the full set of results from Fitz Scientific and CLS, respectively. Tables 3.1 to 3.11 present the results from the sample analysis where S = Surface, M= Middle and B = Bottom for sample depth and ME = Mid Ebb, LW = Low Water and MF = Mid Flood for tidal state.

3.1. BOD

Table 3.1 shows the BOD results. BOD was <1.0mg/l at all stations and all depths.

Table 3:1: BOD results

Parameter	Tide	500 m Upstream			500 m Downstream			1 km Downstream		
		S	M	B	S	M	B	S	M	B
BOD (mg/l)	ME	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
	LW	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
	MF	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0

3.2. COD

The COD results can be seen in Table 3.2. Results for mid-ebb ranged from <5 - 132mg/l, with highest levels 500m downstream. Results for low water ranged from 83 - 141 mg/l, with levels increasing slightly across all depths in a downstream direction. Results for mid-flood ranged from 769 - 1270 mg/l, with levels highest downstream.

Table 3:2: COD results

Parameter	Tide	500 m Upstream			500 m Downstream			1 km Downstream		
		S	M	B	S	M	B	S	M	B
COD (mg/l)	ME	119	<5	117	126	125	132	122	131	126
	LW	84	83	122	99	113	141	120	114	125
	MF	769	857	935	1054	1124	1097	1138	1270	1182

3.3. TOC

Table 3.3 shows the TOC results. Results for mid-ebb ranged from 5.3 – 5.7 mg/l. Results for low water ranged from 5.3 – 6.2 mg/l and results from mid-flood ranged from 4.0 – 5.0 mg/l. TOC results are consistent upstream and downstream of the discharge.

Table 3:3: TOC results

Parameter	Tide	500 m Upstream			500 m Downstream			1 km Downstream		
		S	M	B	S	M	B	S	M	B
TOC (mg/l)	ME	5.7	5.7	5.5	5.4	5.3	5.5	5.5	5.2	5.3
	LW	6.2	6.2	5.5	5.7	5.8	5.3	5.6	5.6	5.5
	MF	5.0	4.7	4.8	4.3	4.3	4.3	4.2	4.0	4.2

3.4. Phenol

Table 3.4 shows the total phenol results. Phenol was below the Limits of detection (LOD) for all stations.

Table 3:4: Total Phenol results

Parameter	Tide	500 m Upstream			500 m Downstream			1 km Downstream		
		S	M	B	S	M	B	S	M	B
Total Phenols (µg/l)	ME	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10
	LW	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10
	MF	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10

3.5. Total Dissolved Solids

Table 3.5 shows the Total Dissolved Solid (TDS) results. Values ranged from 12,833 – 14,045 mg/l at mid-ebb, 10,510 – 15,682mg/l at low water and 16,289 – 20,083 mg/l at mid-flood. Concentrations of TDS vary consistently upstream and downstream of the discharge.

Table 3:5: Total dissolved solids results

Parameter	Tide	500 m Upstream			500 m Downstream			1 km Downstream		
		S	M	B	S	M	B	S	M	B
Total Dissolved Solids (mg/l)	ME	13130	13443	12833	13501	14045	13825	13125	13928	13585
	LW	10510	10883	13257	12286	12615	14083	12814	12647	15682
	MF	16289	17391	17558	19089	18873	19174	19198	20083	19584

3.6. Total Nitrogen

Table 3.6 shows the total nitrogen results. Values ranged from 2.16 – 3.02 mg/l at mid-ebb, 2.17 – 2.74 mg/l at low water and 2.16 – 3.01 mg/l at mid-flood. Total nitrogen was relatively consistent with most sampling points recording 2 - 3 mg/l.

Table 3:6: Total nitrogen results

Parameter	Tide	500 m Upstream			500 m Downstream			1 km Downstream		
		S	M	B	S	M	B	S	M	B
Total Nitrogen (mg/l)	ME	2.48	2.16	2.37	2.45	2.72	2.73	2.75	3.02	2.94
	LW	2.25	2.26	2.46	2.2	2.17	2.46	2.47	2.74	2.44
	MF	2.16	3.01	2.44	2.68	2.78	2.42	2.43	2.73	2.72

3.7. Total Inorganic Nitrogen

Tables 3.7 show the total inorganic nitrogen results. Values ranged from 1.5 - 1.6 mg/l at mid-ebb, 1.5 - 1.7 mg/l at low water and 1.5 - 1.6 mg/l at mid-flood. Total inorganic nitrogen was consistent with similar variation in values upstream and downstream of the discharge.

Table 3:7: Total inorganic nitrogen

Parameter	Tide	500 m Upstream			500 m Downstream			1 km Downstream		
		S	M	B	S	M	B	S	M	B
Total Inorganic Nitrogen (mg/l as N)	ME	1.6	1.6	1.5	1.5	1.6	1.6	1.6	1.6	1.5
	LW	1.7	1.6	1.6	1.6	1.6	1.6	1.6	1.6	1.5
	MF	1.6	1.6	1.5	1.5	1.6	1.5	1.5	1.6	1.5

3.8. Total Phosphorus

Table 3.8 shows the total phosphorus results. Values ranged from 0.082 - 0.115 mg/l at mid-ebb, 0.080 - 0.113 mg/l at low water and 0.054 - 0.121 mg/l at mid-flood. Total phosphorus levels are consistent upstream and downstream of the discharge.

Table 3:8: Total phosphorus results

Parameter	Tide	500 m Upstream			500 m Downstream			1 km Downstream		
		S	M	B	S	M	B	S	M	B
Total Phosphorus (mg/l as P)	ME	0.101	0.098	0.111	0.089	0.086	0.115	0.101	0.082	0.099
	LW	0.113	0.083	0.086	0.080	0.097	0.113	0.090	0.084	0.092
	MF	0.108	0.078	0.121	0.054	0.082	0.084	0.064	0.070	0.081

3.9. Metals

Table 3.9 shows the metal results. Antimony ranged from 61 - 123 µg/l, Arsenic ranged from 63 - 126 µg/l, Barium ranged from 60 - 122 µg/l, Cadmium results ranged from 63 - 126 µg/l, Chromium ranged from 63 - 125 µg/l, Copper ranged from 62 -116 µg/l, Lead ranged from 63 - 125 µg/l, Mercury results were <0.03 µg/l, Molybdenum ranged from 5 - 55 µg/l, Nickel ranged from 63 - 125 µg/l, Selenium ranged from 63 - 126 µg/l, Vanadium ranged from 63 - 126 µg/l and Zinc ranged from 20 - 82 µg/l.

Table 3:9: Metal results

Parameter	Tide	500 m Upstream			500 m Downstream			1 km Downstream		
		S	M	B	S	M	B	S	M	B
Antimony (µg/l)	ME	79	76	79	83	84	87	80	82	86
	LW	61	77	75	79	87	87	72	70	82
	MF	90	93	123	111	101	91	92	107	106
Arsenic (µg/l)	ME	81	78	82	85	86	89	82	84	88
	LW	63	79	77	81	89	89	74	73	84
	MF	92	95	126	113	103	93	95	109	108
Barium (µg/l)	ME	78	75	78	82	83	86	79	81	85
	LW	60	76	74	78	86	86	71	69	81
	MF	89	92	122	110	106	89	91	106	105
Cadmium (µg/l)	ME	81	78	82	85	87	89	82	84	89
	LW	63	79	77	81	89	89	74	73	84
	MF	92	95	126	113	104	93	95	109	108
Chromium (µg/l)	ME	81	78	81	85	86	89	82	84	88
	LW	63	79	77	81	89	89	74	72	84
	MF	92	95	125	113	103	92	94	109	108

Parameter	Tide	500 m Upstream			500 m Downstream			1 km Downstream		
		S	M	B	S	M	B	S	M	B
Copper (µg/l)	ME	71	68	72	75	76	79	72	74	78
	LW	53	69	67	71	79	79	64	62	74
	MF	82	85	116	103	93	83	85	99	98
Lead (µg/l)*	ME	80	77	81	85	86	89	82	83	88
	LW	63	78	77	80	89	89	73	72	84
	MF	92	94	125	113	103	92	94	109	108
Mercury (µg/l)	ME	<0.03	<0.03	<0.03	<0.03	<0.03	<0.03	<0.03	<0.03	<0.03
	LW	<0.03	<0.03	<0.03	<0.03	<0.03	<0.03	<0.03	<0.03	<0.03
	MF	<0.03	<0.03	<0.03	<0.03	<0.03	<0.03	<0.03	<0.03	<0.03
Molybdenum (µg/l)	ME	5	5	5	5	<5	6	8	6	6
	LW	47	9	55	<5	5	6	<5	14	6
	MF	9	11	8	8	<5	<5	27	14	9
Nickel (µg/l)*	ME	80	77	81	85	86	89	82	83	88
	LW	63	78	77	80	89	89	74	72	84
	MF	92	94	125	113	103	92	94	109	108
Selenium (µg/l)	ME	81	78	82	85	86	89	82	84	88
	LW	63	79	77	81	89	89	74	73	84
	MF	92	95	126	113	103	93	95	109	108
Vanadium (µg/l)	ME	81	78	82	85	87	89	82	84	89
	LW	63	79	77	81	89	89	74	73	84
	MF	92	95	126	113	104	93	95	109	108
Zinc (µg/l)	ME	37	34	38	42	43	46	39	40	45
	LW	20	35	34	37	46	46	30	29	41
	MF	49	51	82	70	60	49	51	66	65

* While these values show as identical in this table, when the decimal places are included they are different

3.10. Volatile Organic Compounds

Table 3.10 shows total VOC results. Total VOCs were below limits of detection at all sample points. All individual VOCs were also below limits of detection (See Appendix 2).

Table 3:10: Total VOC results

Parameter	Tide	500 m Upstream			500 m Downstream			1 km Downstream		
		S	M	B	S	M	B	S	M	B
VOC (µg/l)	ME	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0
	LW	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0
	MF	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0

3.11. BTEX

Table 3.11 shows BTEX results. BTEX results were below limits of detection at all sampling points.

Table 3:11 BTEX results

Parameter	Tide	500 m Upstream			500 m Downstream			1 km Downstream		
		S	**M**	**B**	**S**	**M**	**B**	**S**	**M**	**B**
Benzene (µg/l)	ME	<1	<1	<1	<1	<1	<1	<1	<1	<1
	LW	<1	<1	<1	<1	<1	<1	<1	<1	<1
	MF	<1	<1	<1	<1	<1	<1	<1	<1	<1
Ethylbenzene (µg/l)	ME	<1	<1	<1	<1	<1	<1	<1	<1	<1
	LW	<1	<1	<1	<1	<1	<1	<1	<1	<1
	MF	<1	<1	<1	<1	<1	<1	<1	<1	<1
p/m-Xylene~ (µg/l)	ME	<1	<1	<1	<1	<1	<1	<1	<1	<1
	LW	<1	<1	<1	<1	<1	<1	<1	<1	<1
	MF	<1	<1	<1	<1	<1	<1	<1	<1	<1
o-Xylene (µg/l)	ME	<1	<1	<1	<1	<1	<1	<1	<1	<1
	LW	<1	<1	<1	<1	<1	<1	<1	<1	<1
	MF	<1	<1	<1	<1	<1	<1	<1	<1	<1
Toluene (µg/l)	ME	<1	<1	<1	<1	<1	<1	<1	<1	<1
	LW	<1	<1	<1	<1	<1	<1	<1	<1	<1
	MF	<1	<1	<1	<1	<1	<1	<1	<1	<1
Xylene (Total) (µg/l)	ME	<1	<1	<1	<1	<1	<1	<1	<1	<1
	LW	<1	<1	<1	<1	<1	<1	<1	<1	<1
	MF	<1	<1	<1	<1	<1	<1	<1	<1	<1

4. Discussion/Conclusion

This survey showed no increase in background levels for any of the parameters analysed due to the discharge at Aughinish Alumina, as results showed similar variations upstream and downstream of the discharge.

5. References

EPA (2001) Parameters of Water Quality Interpretation and Standards. Environmental Protection Agency, Ireland

Appendix 1
Limits of Detection

Parameter	LOD	Units	Parameter	LOD	Units
COD (Surface Water)	10	mg/l	2,2-Dichloropropane (Surface Water)	5	ug/l
BOD (Surface Water)	1	mg/l	2-Chlorotoluene (Surface Water)	1	ug/l
TOC (Surface Water)	0.6	mg/l	4-Chlorotoluene (Surface Water)	1	ug/l
Antimony (Surface Water)	3	ug/l	Benzene (Surface Water)	1	ug/l
Arsenic (Surface Water)	1	ug/l	Bromochloromethane (Surface Water)	1	ug/l
Barium (Surface Water)	2	ug/l	Bromochloromethane (Surface Water)	1	ug/l
Cadmium (Surface Water)	1	ug/l	Bromodichloromethane (Surface Water)	1	ug/l
Chromium (Surface Water)	1	ug/l	Bromoform (Surface Water)	1	ug/l
Copper (Surface Water)	2	ug/l	Carbon tetrachloride (Surface Water)	1	ug/l
Lead (Surface Water)	1	ug/l	Chloroform (Surface Water)	1	ug/l
Nickel (Surface Water)	1	ug/l	Chlorobenzene (Surface Water)	1	ug/l
Selenium (Surface Water)	1	ug/l	Chloroethane (Surface Water)	5	ug/l
Vanadium (Surface Water)	1	ug/l	Bromomethane (Surface Water)	5	ug/l
Zinc (Surface Water)	2	ug/l	Chloromethane (Surface Water)	5	ug/l
Mercury (Surface water)	0.05	ug/l	cis-1,2-Dichloroethene (Surface Water)	1	ug/l
Molybdenum	5	ug/l	cis-1,3-Dichloropropene (Surface Water)	1	ug/l
Phenols (Total)	0.1	ug/l	Dibromochloromethane (Surface Water)	1	ug/l
Solids (Total Dissolved)	5	mg/l	Dibromomethane (Surface Water)	1	ug/l
Nitrogen (Total)	1	mg/l as N	Dichlorodifluoromethane (Surface Water)	5	ug/l
Nitrogen (Total Oxidised)	0.03	mg/l as N	Dichloromethane (Surface Water)	5	ug/l
Nitrogen (Total Kjeldahl)	1	mg/l as N	Ethylbenzene (Surface Water)	1	ug/l
1,1,1,2-Tetrachloroethane (Surface Water)	1	ug/l	Hexachlorobutadiene (Surface Water)	1	ug/l
1,1,1-Trichloroethane (Surface Water)	1	ug/l	Isopropylbenzene (Surface Water)	1	ug/l
1,1,2,2-Tetrachloroethane (Surface Water)	5	ug/l	Naphthalene (Surface Water)	1	ug/l
1,1,2-Trichloroethane (Surface Water)	2	ug/l	n-Butylbenzene (Surface Water)	1	ug/l
1,1-Dichloroethane (Surface Water)	1	ug/l	o-Xylene (Surface Water)	1	ug/l
1,1-Dichloroethene (Surface Water)	1	ug/l	m- + p-Xylene (Surface Water)	1	ug/l
1,1-Dichloropropene (Surface Water)	1	ug/l	n-Propylbenzene (Surface Water)	0.4	ug/l
1,2,3-Trichlorobenzene (Surface Water)	1	ug/l	sec-Butylbenzene (Surface Water)	1	ug/l
1,2,3-Trichloropropane (Surface Water)	0.9	ug/l	Styrene (Surface Water)	1	ug/l
1,2,4-Trichlorobenzene (Surface Water)	1	ug/l	tert-Butylbenzene (Surface Water)	1	ug/l
1,2,4-Trimethylbenzene (Surface Water)	0.6	ug/l	Tetrachloroethene (Surface Water)	1	ug/l
1,2-Dibromo-3-chloropropane (Surface Water)	1	ug/l	Toluene (Surface Water)	1	ug/l

Parameter	LOD	Units	Parameter	LOD	Units
1,2-Dichlorobenzene (Surface Water)	1	ug/l	trans-1,2-Dichloroethene (Surface Water)	1	ug/l
1,2-Dichlorobenzene (Surface Water)	1	ug/l	trans-1,3-Dichloropropene (Surface Water)	1	ug/l
1,2-Dichloroethane (Surface Water)	1	ug/l	Trichloroethene (Surface Water)	1	ug/l
1,2-Dichloropropane (Surface Water)	1	ug/l	Trichlorofluoromethane (Surface Water)	1	ug/l
1,3,5-Trimethylbenzene (Surface Water)	1	ug/l	Vinyl chloride (Surface Water)	1	ug/l
1,3-Dichlorobenzene (Surface Water)	1	ug/l	p-Isopropyltoluene (Surface Water)	1	ug/l
1,3-Dichloropropane (Surface Water)	1	ug/l	PAH (Water)	0.1	ug/l
1,4-Dichlorobenzene (Surface Water)	1	ug/l			

Appendix 2

Fitz Scientific Results

Fitz scientific

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Customer	**Caroline Roche**	***Lab Report Ref. No.***	**0529/002/07**
	Aqua-Fact International Services Ltd	***Date of Receipt***	**21/02/2019**
	12 Kilkerrin Park	***Sampled On***	**20/02/2019**
	Liosbaun Ind Est	***Date Testing Commenced***	**21/02/2019**
	Liosbaun	***Received or Collected***	**By Fitz: Pick up DS**
	Co Galway	***Condition on Receipt***	**Acceptable**
Customer PO	**JN1526**	***Date of Report***	**12/03/2019**
Customer Ref	**UP500-ME-Surface**	***Sample Type***	**Surface Water**
Ref 2	**20/02/19 10:20**		
Ref 3			

CERTIFICATE OF ANALYSIS

Test Parameter	SOP	Analytical Technique	Result	Units	Acc.
1,1,1,2-Tetrachloroethane (Surface	154	GCMS	<1	ug/L	UKAS
1,1,1-Trichloroethane (Surface Water	154	GCMS	<1	ug/L	UKAS
1,1,2,2-Tetrachloroethane (Surface	154	GCMS	<5.0	ug/L	
1,1,2-Trichloroethane (Surface Water	154	GCMS	<2	ug/L	UKAS
1,1-Dichloroethane (Surface Water)	154	GCMS	<1	ug/L	UKAS
1,1-Dichloroethene (Surface Water)	154	GCMS	<1	ug/L	UKAS
1,1-Dichloropropene (Surface Water)	154	GCMS	<1	ug/L	UKAS
1,2,3-Trichlorobenzene (Surface Wat	154	GCMS	<1	ug/L	UKAS
1,2,3-Trichloropropane (Surface Wat	154	GCMS	<0.9	ug/L	UKAS
1,2,4-Trichlorobenzene (Surface Wat	154	GCMS	<0.6	ug/L	UKAS
1,2,4-Trimethylbenzene (Surface Wa	154	GCMS	<1	ug/L	UKAS
1,2-Dibromo-3-chloropropane (Surfac	154	GCMS	<1	ug/L	UKAS
1,2-Dibromoethane (Surface Water)	154	GCMS	<1	ug/L	UKAS
1,2-Dichlorobenzene (Surface Water)	154	GCMS	<1	ug/L	UKAS
1,2-Dichloroethane (Surface Water)	154	GCMS	<1	ug/L	UKAS
1,2-Dichloropropane (Surface Water)	154	GCMS	<1	ug/L	UKAS
1,3,5-Trimethylbenzene (Surface Wa	154	GCMS	<1	ug/L	UKAS
1,3-Dichlorobenzene (Surface Water)	154	GCMS	<1	ug/L	UKAS
1,3-Dichloropropane (Surface Water)	154	GCMS	<1	ug/L	UKAS
1,4-Dichlorobenzene (Surface Water)	154	GCMS	<1	ug/L	UKAS
2,2-Dichloropropane (Surface Water)	154	GCMS	<5.0	ug/L	
2-Chlorotoluene (Surface Water)	154	GCMS	<1	ug/L	UKAS
4-Chlorotoluene (Surface Water)	154	GCMS	<1	ug/L	UKAS
Acenaphthene (GCMS)	200	GCMS	<0.01	ug/L	

Signed : A Harman ***Date : 12/03/2019***

Aoife Harmon - Technical Supervisor

Acc. : Accredited Parameters by ISO 17025:2005
PVL - Parametric Value Limit as per EU (Drinking water) Regulations (SI 122 2014)
For bacterial analysis a result of 0 means none detected in volume examined
All organic results are analysed as received and all results are corrected for dry weight at 104 C
Results shall not be reproduced, except in full, without the approval of Fitz Scientific
Results contained in this report relate only to the samples tested (P) : Presumptive Results

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Customer Ref	**UP500-ME-Surface**	***Sample Type***	**Surface Water**
Ref 2	**20/02/19 10:20**		
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Test Parameter	SOP	Analytical Technique	Result	Units	Acc.
Acenaphthylene (GCMS)	200	GCMS	<0.01	ug/L	
Ammonia (Surface Water)	114	Colorimetry	0.23	mg/L as N	UKAS
Anthracene (GCMS)	200	GCMS	<0.01	ug/L	
Antimony (Surface Water)	177	ICPMS	79	ug/L	UKAS
Arsenic (Surface Water)	177	ICPMS	81	ug/L	UKAS
Barium (Surface Water)	177	ICPMS	78	ug/L	UKAS
Benzene (Surface Water)	154	GCMS	<1	ug/L	UKAS
Benzo(a)anthracene (GCMS)	200	GCMS	<0.01	ug/L	
Benzo(a)pyrene (GCMS)	200	GCMS	<0.01	ug/L	
Benzo(g,h,i)perylene (GCMS)	200	GCMS	<0.01	ug/L	
Benzo(k)fluoranthene (GCMS)	200	GCMS	<0.01	ug/L	
Bromobenzene (Surface Water)	154	GCMS	<1	ug/L	UKAS
Bromochloromethane (Surface Water	154	GCMS	<1	ug/L	UKAS
Bromodichloromethane (Surface Wat	154	GCMS	<1	ug/L	UKAS
Bromoform (Surface Water)	154	GCMS	<1	ug/L	UKAS
Bromomethane (Surface Water)	154	GCMS	<5.0	ug/L	
Cadmium (Surface Water)	177	ICPMS	81	ug/L	UKAS
Carbon tetrachloride (Surface Water)	154	GCMS	<1	ug/L	UKAS
Chlorobenzene (Surface Water)	154	GCMS	<1	ug/L	UKAS
Chloroethane (Surface Water)	154	GCMS	<5.0	ug/L	
Chloroform (Surface Water)	154	GCMS	<1	ug/L	UKAS
Chloromethane (Surface Water)	154	GCMS	<5.0	ug/L	
Chromium (Surface Water)	177	ICPMS	81	ug/L	UKAS
Chrysene (GCMS)	200	GCMS	<0.01	ug/L	

Signed : A Harman

Date : 12/03/2019

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Customer Ref	**UP500-ME-Surface**	*Sample Type*	**Surface Water**
Ref 2	**20/02/19 10:20**		
Ref 3			

CERTIFICATE OF ANALYSIS

Test Parameter	SOP	Analytical Technique	Result	Units	Acc.
cis-1,2-Dichloroethene (Surface Wat	154	GCMS	<1	ug/L	UKAS
cis-1,3-Dichloropropene (Surface Wa	154	GCMS	<1	ug/L	UKAS
COD (Surface Water)	107	Colorimetry	119	mg/L	UKAS
Copper (Surface Water)	177	ICPMS	71	ug/L	UKAS
Coronene (GCMS)	200	GCMS	<0.01	ug/L	
Dibenzo(a,h)anthracene (GCMS)	200	GCMS	<0.01	ug/L	
Dibromochloromethane (Surface Wat	154	GCMS	<1	ug/L	UKAS
Dibromomethane (Surface Water)	154	GCMS	<1	ug/L	UKAS
Dichlorodifluoromethane (Surface W	154	GCMS	<5.0	ug/L	
Dichloromethane (Surface Water)	154	GCMS	<5.0	ug/L	
Ethylbenzene (Surface Water)	154	GCMS	<1	ug/L	UKAS
Fluoranthene (GCMS)	200	GCMS	<0.01	ug/L	
Fluorene (GCMS)	200	GCMS	<0.01	ug/L	
Hexachlorobutadiene (Surface Water	154	GCMS	<1	ug/L	UKAS
Indeno(1,2,3-cd)pyrene (GCMS)	200	GCMS	<0.01	ug/L	
Isopropylbenzene (Surface Water)	154	GCMS	<1	ug/L	UKAS
Lead (Surface Water)	177	ICPMS	80	ug/L	UKAS
m- & p-Xylene (Surface Water)	154	GCMS	<1	ug/L	UKAS
Mercury (Surface water)	178	ICPMS	<0.03	ug/L	UKAS
Molybdenum	226	ICPMS	5	ug/L	
Naphthalene (Surface Water)	154	GCMS	<1	ug/L	UKAS
n-Butylbenzene (Surface Water)	154	GCMS	<1	ug/L	UKAS
Nickel (Surface Water)	177	ICPMS	80	ug/L	UKAS
Nitrogen (Total Kjeldahl)	104	Digestion/ Distillation/ Titrimetr	1.12	mg/L as N	

Signed : A Harmon ***Date : 12/03/2019***

Aoife Harmon - Technical Supervisor

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	Co Galway	*Condition on Receipt*	**Acceptable**
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Customer Ref	**UP500-ME-Surface**	*Sample Type*	**Surface Water**
Ref 2	**20/02/19 10:20**		
Ref 3			

CERTIFICATE OF ANALYSIS

Test Parameter	SOP	Analytical Technique	Result	Units	Acc.
Nitrogen (Total Oxidised) (Surface W	151	Colorimetry	1.36	mg/L as N	UKAS
Nitrogen (Total)	0	Calculation	2.48	mg/L as N	
n-Propylbenzene (Surface Water)	154	GCMS	<1.0	ug/L	UKAS
o-Xylene (Surface Water)	154	GCMS	<1	ug/L	UKAS
Phenanthrene (GCMS)	200	GCMS	<0.01	ug/L	
Phenols (Total)	223	GCMS	<0.10	ug/L	
Phosphorus (Total) Surface Water	166	Colorimetry	0.101	mg/L as P	UKAS
p-Isopropyltoluene (Surface Water)	154	GCMS	<1	ug/L	UKAS
Polyaromatic Hydrocarbons (GCMS)	200	GCMS	<0.01	ug/L	
Pyrene (GCMS)	200	GCMS	<0.01	ug/L	
sec-Butylbenzene (Surface Water)	154	GCMS	<1	ug/L	UKAS
Selenium (Surface Water)	177	ICPMS	81	ug/L	UKAS
Solids (Total Dissolved)	105	Filtration/ Evaporation @ 180C	13130	mg/L	
Styrene (Surface Water)	154	GCMS	<1	ug/L	UKAS
tert-Butylbenzene (Surface Water)	154	GCMS	<1	ug/L	UKAS
Tetrachloroethene (Surface Water)	154	GCMS	<1	ug/L	UKAS
TOC (Surface Water)	316	TOC Analyser	5.7	mg/L	UKAS
Toluene (Surface Water)	154	GCMS	<1	ug/L	UKAS
Total Inorganic Nitrogen	0	Calculation	1.6	mg/L	
trans-1,2-Dichloroethene (Surface W	154	GCMS	<1	ug/L	UKAS
trans-1,3-Dichloropropene (Surface	154	GCMS	<1	ug/L	UKAS
Trichloroethene (Surface Water)	154	GCMS	<1.0	ug/L	
Trichlorofluoromethane (Surface Wat	154	GCMS	<1	ug/L	UKAS
Vanadium (Surface Water)	177	ICPMS	81	ug/L	UKAS

Signed : A Harmon ***Date : 12/03/2019***

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Customer	**Caroline Roche**	***Lab Report Ref. No.***	**0529/002/07**
	Aqua-Fact International Services Ltd	***Date of Receipt***	**21/02/2019**
	12 Kilkerrin Park	***Sampled On***	**20/02/2019**
	Liosbaun Ind Est	***Date Testing Commenced***	**21/02/2019**
	Liosbaun	***Received or Collected***	**By Fitz: Pick up DS**
	Co Galway	***Condition on Receipt***	**Acceptable**
Customer PO	**JN1526**	***Date of Report***	**12/03/2019**
Customer Ref	**UP500-ME-Surface**	***Sample Type***	**Surface Water**
Ref 2	**20/02/19 10:20**		
Ref 3			

CERTIFICATE OF ANALYSIS

Test Parameter	SOP	Analytical Technique	Result	Units	Acc.
Vinyl chloride (Surface Water)	154	GCMS	<1	ug/L	UKAS
Volatile Organic Compounds	154	GCMS	<5.0	ug/L	
Xylene Total (Surface Water)	154	GCMS	<1	ug/L	UKAS
Zinc (Surface Water)	177	ICPMS	37	ug/L	UKAS

Signed : A Harmon

Aoife Harmon - Technical Supervisor

Date : 12/03/2019

Acc. : Accredited Parameters by ISO 17025:2005
PVL - Parametric Value Limit as per EU (Drinking water) Regulations (SI 122 2014)
For bacterial analysis a result of 0 means none detected in volume examined
All organic results are analysed as received and all results are corrected for dry weight at 104 C
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Results contained in this report relate only to the samples tested (P) : Presumptive Results

ilac-MRA UKAS TESTING 2802

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Customer	**Caroline Roche**	***Lab Report Ref. No.***	**0529/002/08**
	Aqua-Fact International Services Ltd	***Date of Receipt***	**21/02/2019**
	12 Kilkerrin Park	***Sampled On***	**20/02/2019**
	Liosbaun Ind Est	***Date Testing Commenced***	**21/02/2019**
	Liosbaun	***Received or Collected***	**By Fitz: Pick up DS**
	Co Galway	***Condition on Receipt***	**Acceptable**
Customer PO	**JN1526**	***Date of Report***	**12/03/2019**
Customer Ref	**UP500-ME-Middle**	***Sample Type***	**Surface Water**
Ref 2	**20/02/19 10:25**		
Ref 3			

CERTIFICATE OF ANALYSIS

Test Parameter	SOP	Analytical Technique	Result	Units	Acc.
1,1,1,2-Tetrachloroethane (Surface	154	GCMS	<1	ug/L	UKAS
1,1,1-Trichloroethane (Surface Water	154	GCMS	<1	ug/L	UKAS
1,1,2,2-Tetrachloroethane (Surface	154	GCMS	<5.0	ug/L	
1,1,2-Trichloroethane (Surface Water	154	GCMS	<2	ug/L	UKAS
1,1-Dichloroethane (Surface Water)	154	GCMS	<1	ug/L	UKAS
1,1-Dichloroethene (Surface Water)	154	GCMS	<1	ug/L	UKAS
1,1-Dichloropropene (Surface Water)	154	GCMS	<1	ug/L	UKAS
1,2,3-Trichlorobenzene (Surface Wat	154	GCMS	<1	ug/L	UKAS
1,2,3-Trichloropropane (Surface Wat	154	GCMS	<0.9	ug/L	UKAS
1,2,4-Trichlorobenzene (Surface Wat	154	GCMS	<0.6	ug/L	UKAS
1,2,4-Trimethylbenzene (Surface Wa	154	GCMS	<1	ug/L	UKAS
1,2-Dibromo-3-chloropropane (Surfac	154	GCMS	<1	ug/L	UKAS
1,2-Dibromoethane (Surface Water)	154	GCMS	<1	ug/L	UKAS
1,2-Dichlorobenzene (Surface Water)	154	GCMS	<1	ug/L	UKAS
1,2-Dichloroethane (Surface Water)	154	GCMS	<1	ug/L	UKAS
1,2-Dichloropropane (Surface Water)	154	GCMS	<1	ug/L	UKAS
1,3,5-Trimethylbenzene (Surface Wa	154	GCMS	<1	ug/L	UKAS
1,3-Dichlorobenzene (Surface Water)	154	GCMS	<1	ug/L	UKAS
1,3-Dichloropropane (Surface Water)	154	GCMS	<1	ug/L	UKAS
1,4-Dichlorobenzene (Surface Water)	154	GCMS	<1	ug/L	UKAS
2,2-Dichloropropane (Surface Water)	154	GCMS	<5.0	ug/L	
2-Chlorotoluene (Surface Water)	154	GCMS	<1	ug/L	UKAS
4-Chlorotoluene (Surface Water)	154	GCMS	<1	ug/L	UKAS
Acenaphthene (GCMS)	200	GCMS	<0.01	ug/L	

Signed : A Harmon ***Date : 12/03/2019***

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	12 Kilkerrin Park	***Sampled On***	**20/02/2019**
	Liosbaun Ind Est	***Date Testing Commenced***	**21/02/2019**
	Liosbaun	***Received or Collected***	**By Fitz: Pick up DS**
	Co Galway	***Condition on Receipt***	**Acceptable**
Customer PO	**JN1526**	***Date of Report***	**12/03/2019**
Customer Ref	**UP500-ME-Middle**	***Sample Type***	**Surface Water**
Ref 2	**20/02/19 10:25**		
Ref 3			

CERTIFICATE OF ANALYSIS

Test Parameter	SOP	Analytical Technique	Result	Units	Acc.
Acenaphthylene (GCMS)	200	GCMS	<0.01	ug/L	
Ammonia (Surface Water)	114	Colorimetry	0.25	mg/L as N	UKAS
Anthracene (GCMS)	200	GCMS	<0.01	ug/L	
Antimony (Surface Water)	177	ICPMS	76	ug/L	UKAS
Arsenic (Surface Water)	177	ICPMS	78	ug/L	UKAS
Barium (Surface Water)	177	ICPMS	75	ug/L	UKAS
Benzene (Surface Water)	154	GCMS	<1	ug/L	UKAS
Benzo(a)anthracene (GCMS)	200	GCMS	<0.01	ug/L	
Benzo(a)pyrene (GCMS)	200	GCMS	<0.01	ug/L	
Benzo(g,h,i)perylene (GCMS)	200	GCMS	<0.01	ug/L	
Benzo(k)fluoranthene (GCMS)	200	GCMS	<0.01	ug/L	
Bromobenzene (Surface Water)	154	GCMS	<1	ug/L	UKAS
Bromochloromethane (Surface Water	154	GCMS	<1	ug/L	UKAS
Bromodichloromethane (Surface Wat	154	GCMS	<1	ug/L	UKAS
Bromoform (Surface Water)	154	GCMS	<1	ug/L	UKAS
Bromomethane (Surface Water)	154	GCMS	<5.0	ug/L	
Cadmium (Surface Water)	177	ICPMS	78	ug/L	UKAS
Carbon tetrachloride (Surface Water)	154	GCMS	<1	ug/L	UKAS
Chlorobenzene (Surface Water)	154	GCMS	<1	ug/L	UKAS
Chloroethane (Surface Water)	154	GCMS	<5.0	ug/L	
Chloroform (Surface Water)	154	GCMS	<1	ug/L	UKAS
Chloromethane (Surface Water)	154	GCMS	<5.0	ug/L	
Chromium (Surface Water)	177	ICPMS	78	ug/L	UKAS
Chrysene (GCMS)	200	GCMS	<0.01	ug/L	

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	Liosbaun Ind Est	***Date Testing Commenced***	**21/02/2019**
	Liosbaun	***Received or Collected***	**By Fitz: Pick up DS**
	Co Galway	***Condition on Receipt***	**Acceptable**
Customer PO	**JN1526**	***Date of Report***	**12/03/2019**
Customer Ref	**UP500-ME-Middle**	***Sample Type***	**Surface Water**
Ref 2	**20/02/19 10:25**		
Ref 3			

CERTIFICATE OF ANALYSIS

Test Parameter	SOP	Analytical Technique	Result	Units	Acc.
cis-1,2-Dichloroethene (Surface Wat	154	GCMS	<1	ug/L	UKAS
cis-1,3-Dichloropropene (Surface Wa	154	GCMS	<1	ug/L	UKAS
COD (Surface Water)	107	Colorimetry	<5	mg/L	UKAS
Copper (Surface Water)	177	ICPMS	68	ug/L	UKAS
Coronene (GCMS)	200	GCMS	<0.01	ug/L	
Dibenzo(a,h)anthracene (GCMS)	200	GCMS	<0.01	ug/L	
Dibromochloromethane (Surface Wat	154	GCMS	<1	ug/L	UKAS
Dibromomethane (Surface Water)	154	GCMS	<1	ug/L	UKAS
Dichlorodifluoromethane (Surface W	154	GCMS	<5.0	ug/L	
Dichloromethane (Surface Water)	154	GCMS	<5.0	ug/L	
Ethylbenzene (Surface Water)	154	GCMS	<1	ug/L	UKAS
Fluoranthene (GCMS)	200	GCMS	<0.01	ug/L	
Fluorene (GCMS)	200	GCMS	<0.01	ug/L	
Hexachlorobutadiene (Surface Water	154	GCMS	<1	ug/L	UKAS
Indeno(1,2,3-cd)pyrene (GCMS)	200	GCMS	<0.01	ug/L	
Isopropylbenzene (Surface Water)	154	GCMS	<1	ug/L	UKAS
Lead (Surface Water)	177	ICPMS	77	ug/L	UKAS
m- & p-Xylene (Surface Water)	154	GCMS	<1	ug/L	UKAS
Mercury (Surface water)	178	ICPMS	<0.03	ug/L	UKAS
Molybdenum	226	ICPMS	5	ug/L	
Naphthalene (Surface Water)	154	GCMS	<1	ug/L	UKAS
n-Butylbenzene (Surface Water)	154	GCMS	<1	ug/L	UKAS
Nickel (Surface Water)	177	ICPMS	77	ug/L	UKAS
Nitrogen (Total Kjeldahl)	104	Digestion/ Distillation/ Titrimetr	<1.00	mg/L as N	

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Customer	Caroline Roche	*Lab Report Ref. No.*	0529/002/08
	Aqua-Fact International Services Ltd	*Date of Receipt*	21/02/2019
	12 Kilkerrin Park	*Sampled On*	20/02/2019
	Liosbaun Ind Est	*Date Testing Commenced*	21/02/2019
	Liosbaun	*Received or Collected*	By Fitz: Pick up DS
	Co Galway	*Condition on Receipt*	Acceptable
Customer PO	JN1526	*Date of Report*	12/03/2019
Customer Ref	UP500-ME-Middle	*Sample Type*	Surface Water
Ref 2	20/02/19 10:25		
Ref 3			

CERTIFICATE OF ANALYSIS

Test Parameter	SOP	Analytical Technique	Result	Units	Acc.
Nitrogen (Total Oxidised) (Surface W	151	Colorimetry	1.32	mg/L as N	UKAS
Nitrogen (Total)	0	Calculation	2.16	mg/L as N	
n-Propylbenzene (Surface Water)	154	GCMS	<1.0	ug/L	UKAS
o-Xylene (Surface Water)	154	GCMS	<1	ug/L	UKAS
Phenanthrene (GCMS)	200	GCMS	<0.01	ug/L	
Phenols (Total)	223	GCMS	<0.10	ug/L	
Phosphorus (Total) Surface Water	166	Colorimetry	0.098	mg/L as P	UKAS
p-Isopropyltoluene (Surface Water)	154	GCMS	<1	ug/L	UKAS
Polyaromatic Hydrocarbons (GCMS)	200	GCMS	<0.01	ug/L	
Pyrene (GCMS)	200	GCMS	<0.01	ug/L	
sec-Butylbenzene (Surface Water)	154	GCMS	<1	ug/L	UKAS
Selenium (Surface Water)	177	ICPMS	78	ug/L	UKAS
Solids (Total Dissolved)	105	Filtration/ Evaporation @ 180C	13443	mg/L	
Styrene (Surface Water)	154	GCMS	<1	ug/L	UKAS
tert-Butylbenzene (Surface Water)	154	GCMS	<1	ug/L	UKAS
Tetrachloroethene (Surface Water)	154	GCMS	<1	ug/L	UKAS
TOC (Surface Water)	316	TOC Analyser	5.7	mg/L	UKAS
Toluene (Surface Water)	154	GCMS	<1	ug/L	UKAS
Total Inorganic Nitrogen	0	Calculation	1.6	mg/L	
trans-1,2-Dichloroethene (Surface W	154	GCMS	<1	ug/L	UKAS
trans-1,3-Dichloropropene (Surface	154	GCMS	<1	ug/L	UKAS
Trichloroethene (Surface Water)	154	GCMS	<1.0	ug/L	
Trichlorofluoromethane (Surface Wat	154	GCMS	<1	ug/L	UKAS
Vanadium (Surface Water)	177	ICPMS	78	ug/L	UKAS

Signed : A Harmon **Date : 12/03/2019**

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Customer	**Caroline Roche**	***Lab Report Ref. No.***	**0529/002/08**
	Aqua-Fact International Services Ltd	***Date of Receipt***	**21/02/2019**
	12 Kilkerrin Park	***Sampled On***	**20/02/2019**
	Liosbaun Ind Est	***Date Testing Commenced***	**21/02/2019**
	Liosbaun	***Received or Collected***	**By Fitz: Pick up DS**
	Co Galway	***Condition on Receipt***	**Acceptable**
Customer PO	**JN1526**	***Date of Report***	**12/03/2019**
Customer Ref	**UP500-ME-Middle**	***Sample Type***	**Surface Water**
Ref 2	**20/02/19 10:25**		
Ref 3			

CERTIFICATE OF ANALYSIS

Test Parameter	SOP	Analytical Technique	Result	Units	Acc.
Vinyl chloride (Surface Water)	154	GCMS	<1	ug/L	UKAS
Volatile Organic Compounds	154	GCMS	<5.0	ug/L	
Xylene Total (Surface Water)	154	GCMS	<1	ug/L	UKAS
Zinc (Surface Water)	177	ICPMS	34	ug/L	UKAS

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Customer	Caroline Roche	*Lab Report Ref. No.*	0529/002/09
	Aqua-Fact International Services Ltd	*Date of Receipt*	21/02/2019
	12 Kilkerrin Park	*Sampled On*	20/02/2019
	Liosbaun Ind Est	*Date Testing Commenced*	21/02/2019
	Liosbaun	*Received or Collected*	By Fitz: Pick up DS
	Co Galway	*Condition on Receipt*	Acceptable
Customer PO	JN1526	*Date of Report*	12/03/2019
Customer Ref	UP500-ME-Bottom	*Sample Type*	Surface Water
Ref 2	20/02/19 10:30		
Ref 3			

CERTIFICATE OF ANALYSIS

Test Parameter	SOP	Analytical Technique	Result	Units	Acc.
1,1,1,2-Tetrachloroethane (Surface	154	GCMS	<1	ug/L	UKAS
1,1,1-Trichloroethane (Surface Water	154	GCMS	<1	ug/L	UKAS
1,1,2,2-Tetrachloroethane (Surface	154	GCMS	<5.0	ug/L	
1,1,2-Trichloroethane (Surface Water	154	GCMS	<2	ug/L	UKAS
1,1-Dichloroethane (Surface Water)	154	GCMS	<1	ug/L	UKAS
1,1-Dichloroethene (Surface Water)	154	GCMS	<1	ug/L	UKAS
1,1-Dichloropropene (Surface Water)	154	GCMS	<1	ug/L	UKAS
1,2,3-Trichlorobenzene (Surface Wat	154	GCMS	<1	ug/L	UKAS
1,2,3-Trichloropropane (Surface Wat	154	GCMS	<0.9	ug/L	UKAS
1,2,4-Trichlorobenzene (Surface Wat	154	GCMS	<0.6	ug/L	UKAS
1,2,4-Trimethylbenzene (Surface Wa	154	GCMS	<1	ug/L	UKAS
1,2-Dibromo-3-chloropropane (Surfac	154	GCMS	<1	ug/L	UKAS
1,2-Dibromoethane (Surface Water)	154	GCMS	<1	ug/L	UKAS
1,2-Dichlorobenzene (Surface Water)	154	GCMS	<1	ug/L	UKAS
1,2-Dichloroethane (Surface Water)	154	GCMS	<1	ug/L	UKAS
1,2-Dichloropropane (Surface Water)	154	GCMS	<1	ug/L	UKAS
1,3,5-Trimethylbenzene (Surface Wa	154	GCMS	<1	ug/L	UKAS
1,3-Dichlorobenzene (Surface Water)	154	GCMS	<1	ug/L	UKAS
1,3-Dichloropropane (Surface Water)	154	GCMS	<1	ug/L	UKAS
1,4-Dichlorobenzene (Surface Water)	154	GCMS	<1	ug/L	UKAS
2,2-Dichloropropane (Surface Water)	154	GCMS	<5.0	ug/L	
2-Chlorotoluene (Surface Water)	154	GCMS	<1	ug/L	UKAS
4-Chlorotoluene (Surface Water)	154	GCMS	<1	ug/L	UKAS
Acenaphthene (GCMS)	200	GCMS	<0.01	ug/L	

Signed : A Harmon ***Date : 12/03/2019***

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	Aqua-Fact International Services Ltd	***Date of Receipt***	**21/02/2019**
	12 Kilkerrin Park	***Sampled On***	**20/02/2019**
	Liosbaun Ind Est	***Date Testing Commenced***	**21/02/2019**
	Liosbaun	***Received or Collected***	**By Fitz: Pick up DS**
	Co Galway	***Condition on Receipt***	**Acceptable**
Customer PO	**JN1526**	***Date of Report***	**12/03/2019**
Customer Ref	**UP500-ME-Bottom**	***Sample Type***	**Surface Water**
Ref 2	**20/02/19 10:30**		
Ref 3			

CERTIFICATE OF ANALYSIS

Test Parameter	SOP	Analytical Technique	Result	Units	Acc.
Acenaphthylene (GCMS)	200	GCMS	<0.01	ug/L	
Ammonia (Surface Water)	114	Colorimetry	0.22	mg/L as N	UKAS
Anthracene (GCMS)	200	GCMS	<0.01	ug/L	
Antimony (Surface Water)	177	ICPMS	79	ug/L	UKAS
Arsenic (Surface Water)	177	ICPMS	82	ug/L	UKAS
Barium (Surface Water)	177	ICPMS	78	ug/L	UKAS
Benzene (Surface Water)	154	GCMS	<1	ug/L	UKAS
Benzo(a)anthracene (GCMS)	200	GCMS	<0.01	ug/L	
Benzo(a)pyrene (GCMS)	200	GCMS	<0.01	ug/L	
Benzo(g,h,i)perylene (GCMS)	200	GCMS	<0.01	ug/L	
Benzo(k)fluoranthene (GCMS)	200	GCMS	<0.01	ug/L	
Bromobenzene (Surface Water)	154	GCMS	<1	ug/L	UKAS
Bromochloromethane (Surface Water	154	GCMS	<1	ug/L	UKAS
Bromodichloromethane (Surface Wat	154	GCMS	<1	ug/L	UKAS
Bromoform (Surface Water)	154	GCMS	<1	ug/L	UKAS
Bromomethane (Surface Water)	154	GCMS	<5.0	ug/L	
Cadmium (Surface Water)	177	ICPMS	82	ug/L	UKAS
Carbon tetrachloride (Surface Water)	154	GCMS	<1	ug/L	UKAS
Chlorobenzene (Surface Water)	154	GCMS	<1	ug/L	UKAS
Chloroethane (Surface Water)	154	GCMS	<5.0	ug/L	
Chloroform (Surface Water)	154	GCMS	<1	ug/L	UKAS
Chloromethane (Surface Water)	154	GCMS	<5.0	ug/L	
Chromium (Surface Water)	177	ICPMS	81	ug/L	UKAS
Chrysene (GCMS)	200	GCMS	<0.01	ug/L	

Signed : A Harman ***Date : 12/03/2019***

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ilac-MRA UKAS TESTING 2802

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Monitoring and Testing Services

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Customer	**Caroline Roche**	***Lab Report Ref. No.***	**0529/002/09**
	Aqua-Fact International Services Ltd	***Date of Receipt***	**21/02/2019**
	12 Kilkerrin Park	***Sampled On***	**20/02/2019**
	Liosbaun Ind Est	***Date Testing Commenced***	**21/02/2019**
	Liosbaun	***Received or Collected***	**By Fitz: Pick up DS**
	Co Galway	***Condition on Receipt***	**Acceptable**
Customer PO	**JN1526**	***Date of Report***	**12/03/2019**
Customer Ref	**UP500-ME-Bottom**	***Sample Type***	**Surface Water**
Ref 2	**20/02/19 10:30**		
Ref 3			

CERTIFICATE OF ANALYSIS

Test Parameter	SOP	Analytical Technique	Result	Units	Acc.
cis-1,2-Dichloroethene (Surface Wat	154	GCMS	<1	ug/L	UKAS
cis-1,3-Dichloropropene (Surface Wa	154	GCMS	<1	ug/L	UKAS
COD (Surface Water)	107	Colorimetry	117	mg/L	UKAS
Copper (Surface Water)	177	ICPMS	72	ug/L	UKAS
Coronene (GCMS)	200	GCMS	<0.01	ug/L	
Dibenzo(a,h)anthracene (GCMS)	200	GCMS	<0.01	ug/L	
Dibromochloromethane (Surface Wat	154	GCMS	<1	ug/L	UKAS
Dibromomethane (Surface Water)	154	GCMS	<1	ug/L	UKAS
Dichlorodifluoromethane (Surface W	154	GCMS	<5.0	ug/L	
Dichloromethane (Surface Water)	154	GCMS	<5.0	ug/L	
Ethylbenzene (Surface Water)	154	GCMS	<1	ug/L	UKAS
Fluoranthene (GCMS)	200	GCMS	<0.01	ug/L	
Fluorene (GCMS)	200	GCMS	<0.01	ug/L	
Hexachlorobutadiene (Surface Water	154	GCMS	<1	ug/L	UKAS
Indeno(1,2,3-cd)pyrene (GCMS)	200	GCMS	<0.01	ug/L	
Isopropylbenzene (Surface Water)	154	GCMS	<1	ug/L	UKAS
Lead (Surface Water)	177	ICPMS	81	ug/L	UKAS
m- & p-Xylene (Surface Water)	154	GCMS	<1	ug/L	UKAS
Mercury (Surface water)	178	ICPMS	<0.03	ug/L	UKAS
Molybdenum	226	ICPMS	5	ug/L	
Naphthalene (Surface Water)	154	GCMS	<1	ug/L	UKAS
n-Butylbenzene (Surface Water)	154	GCMS	<1	ug/L	UKAS
Nickel (Surface Water)	177	ICPMS	81	ug/L	UKAS
Nitrogen (Total Kjeldahl)	104	Digestion/ Distillation/ Titrimetr	1.12	mg/L as N	

Signed : A Harmon

Date : 12/03/2019

Aoife Harmon - Technical Supervisor

Acc. : Accredited Parameters by ISO 17025:2005
PVL - Parametric Value Limit as per EU (Drinking water) Regulations (SI 122 2014)
For bacterial analysis a result of 0 means none detected in volume examined
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	Co Galway	*Condition on Receipt*	**Acceptable**
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Customer Ref	**UP500-ME-Bottom**	*Sample Type*	**Surface Water**
Ref 2	**20/02/19 10:30**		
Ref 3			

CERTIFICATE OF ANALYSIS

Test Parameter	SOP	Analytical Technique	Result	Units	Acc.
Nitrogen (Total Oxidised) (Surface W	151	Colorimetry	1.25	mg/L as N	UKAS
Nitrogen (Total)	0	Calculation	2.37	mg/L as N	
n-Propylbenzene (Surface Water)	154	GCMS	<1.0	ug/L	UKAS
o-Xylene (Surface Water)	154	GCMS	<1	ug/L	UKAS
Phenanthrene (GCMS)	200	GCMS	<0.01	ug/L	
Phenols (Total)	223	GCMS	<0.10	ug/L	
Phosphorus (Total) Surface Water	166	Colorimetry	0.111	mg/L as P	UKAS
p-Isopropyltoluene (Surface Water)	154	GCMS	<1	ug/L	UKAS
Polyaromatic Hydrocarbons (GCMS)	200	GCMS	<0.01	ug/L	
Pyrene (GCMS)	200	GCMS	<0.01	ug/L	
sec-Butylbenzene (Surface Water)	154	GCMS	<1	ug/L	UKAS
Selenium (Surface Water)	177	ICPMS	82	ug/L	UKAS
Solids (Total Dissolved)	105	Filtration/ Evaporation @ 180C	12833	mg/L	
Styrene (Surface Water)	154	GCMS	<1	ug/L	UKAS
tert-Butylbenzene (Surface Water)	154	GCMS	<1	ug/L	UKAS
Tetrachloroethene (Surface Water)	154	GCMS	<1	ug/L	UKAS
TOC (Surface Water)	316	TOC Analyser	5.5	mg/L	UKAS
Toluene (Surface Water)	154	GCMS	<1	ug/L	UKAS
Total Inorganic Nitrogen	0	Calculation	1.5	mg/L	
trans-1,2-Dichloroethene (Surface W	154	GCMS	<1	ug/L	UKAS
trans-1,3-Dichloropropene (Surface	154	GCMS	<1	ug/L	UKAS
Trichloroethene (Surface Water)	154	GCMS	<1.0	ug/L	
Trichlorofluoromethane (Surface Wat	154	GCMS	<1	ug/L	UKAS
Vanadium (Surface Water)	177	ICPMS	82	ug/L	UKAS

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	Co Galway	***Condition on Receipt***	**Acceptable**
Customer PO	**JN1526**	***Date of Report***	**12/03/2019**
Customer Ref	**UP500-ME-Bottom**	***Sample Type***	**Surface Water**
Ref 2	**20/02/19 10:30**		
Ref 3			

CERTIFICATE OF ANALYSIS

Test Parameter	SOP	Analytical Technique	Result	Units	Acc.
Vinyl chloride (Surface Water)	154	GCMS	<1	ug/L	UKAS
Volatile Organic Compounds	154	GCMS	<5.0	ug/L	
Xylene Total (Surface Water)	154	GCMS	<1	ug/L	UKAS
Zinc (Surface Water)	177	ICPMS	38	ug/L	UKAS

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	Aqua-Fact International Services Ltd	***Date of Receipt***	**21/02/2019**
	12 Kilkerrin Park	***Sampled On***	**20/02/2019**
	Liosbaun Ind Est	***Date Testing Commenced***	**21/02/2019**
	Liosbaun	***Received or Collected***	**By Fitz: Pick up DS**
	Co Galway	***Condition on Receipt***	**Acceptable**
Customer PO	**JN1526**	***Date of Report***	**12/03/2019**
Customer Ref	**Up500-LW-Surface**	***Sample Type***	**Surface Water**
Ref 2	**20/02/19 12:41**		
Ref 3			

CERTIFICATE OF ANALYSIS

Test Parameter	SOP	Analytical Technique	Result	Units	Acc.
1,1,1,2-Tetrachloroethane (Surface	154	GCMS	<1	ug/L	UKAS
1,1,1-Trichloroethane (Surface Water	154	GCMS	<1	ug/L	UKAS
1,1,2,2-Tetrachloroethane (Surface	154	GCMS	<5.0	ug/L	
1,1,2-Trichloroethane (Surface Water	154	GCMS	<2	ug/L	UKAS
1,1-Dichloroethane (Surface Water)	154	GCMS	<1	ug/L	UKAS
1,1-Dichloroethene (Surface Water)	154	GCMS	<1	ug/L	UKAS
1,1-Dichloropropene (Surface Water)	154	GCMS	<1	ug/L	UKAS
1,2,3-Trichlorobenzene (Surface Wat	154	GCMS	<1	ug/L	UKAS
1,2,3-Trichloropropane (Surface Wat	154	GCMS	<0.9	ug/L	UKAS
1,2,4-Trichlorobenzene (Surface Wat	154	GCMS	<0.6	ug/L	UKAS
1,2,4-Trimethylbenzene (Surface Wa	154	GCMS	<1	ug/L	UKAS
1,2-Dibromo-3-chloropropane (Surfac	154	GCMS	<1	ug/L	UKAS
1,2-Dibromoethane (Surface Water)	154	GCMS	<1	ug/L	UKAS
1,2-Dichlorobenzene (Surface Water)	154	GCMS	<1	ug/L	UKAS
1,2-Dichloroethane (Surface Water)	154	GCMS	<1	ug/L	UKAS
1,2-Dichloropropane (Surface Water)	154	GCMS	<1	ug/L	UKAS
1,3,5-Trimethylbenzene (Surface Wa	154	GCMS	<1	ug/L	UKAS
1,3-Dichlorobenzene (Surface Water)	154	GCMS	<1	ug/L	UKAS
1,3-Dichloropropane (Surface Water)	154	GCMS	<1	ug/L	UKAS
1,4-Dichlorobenzene (Surface Water)	154	GCMS	<1	ug/L	UKAS
2,2-Dichloropropane (Surface Water)	154	GCMS	<5.0	ug/L	
2-Chlorotoluene (Surface Water)	154	GCMS	<1	ug/L	UKAS
4-Chlorotoluene (Surface Water)	154	GCMS	<1	ug/L	UKAS
Acenaphthene (GCMS)	200	GCMS	<0.01	ug/L	

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Customer Ref	**Up500-LW-Surface**	***Sample Type***	**Surface Water**
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CERTIFICATE OF ANALYSIS

Test Parameter	SOP	Analytical Technique	Result	Units	Acc.
Acenaphthylene (GCMS)	200	GCMS	<0.01	ug/L	
Ammonia (Surface Water)	114	Colorimetry	0.31	mg/L as N	UKAS
Anthracene (GCMS)	200	GCMS	<0.01	ug/L	
Antimony (Surface Water)	177	ICPMS	61	ug/L	UKAS
Arsenic (Surface Water)	177	ICPMS	63	ug/L	UKAS
Barium (Surface Water)	177	ICPMS	60	ug/L	UKAS
Benzene (Surface Water)	154	GCMS	<1	ug/L	UKAS
Benzo(a)anthracene (GCMS)	200	GCMS	<0.01	ug/L	
Benzo(a)pyrene (GCMS)	200	GCMS	<0.01	ug/L	
Benzo(g,h,i)perylene (GCMS)	200	GCMS	<0.01	ug/L	
Benzo(k)fluoranthene (GCMS)	200	GCMS	<0.01	ug/L	
Bromobenzene (Surface Water)	154	GCMS	<1	ug/L	UKAS
Bromochloromethane (Surface Water	154	GCMS	<1	ug/L	UKAS
Bromodichloromethane (Surface Wat	154	GCMS	<1	ug/L	UKAS
Bromoform (Surface Water)	154	GCMS	<1	ug/L	UKAS
Bromomethane (Surface Water)	154	GCMS	<5.0	ug/L	
Cadmium (Surface Water)	177	ICPMS	63	ug/L	UKAS
Carbon tetrachloride (Surface Water)	154	GCMS	<1	ug/L	UKAS
Chlorobenzene (Surface Water)	154	GCMS	<1	ug/L	UKAS
Chloroethane (Surface Water)	154	GCMS	<5.0	ug/L	
Chloroform (Surface Water)	154	GCMS	<1	ug/L	UKAS
Chloromethane (Surface Water)	154	GCMS	<5.0	ug/L	
Chromium (Surface Water)	177	ICPMS	63	ug/L	UKAS
Chrysene (GCMS)	200	GCMS	<0.01	ug/L	

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	Co Galway	*Condition on Receipt*	**Acceptable**
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Customer Ref	**Up500-LW-Surface**	*Sample Type*	**Surface Water**
Ref 2	**20/02/19 12:41**		
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CERTIFICATE OF ANALYSIS

Test Parameter	SOP	Analytical Technique	Result	Units	Acc.
cis-1,2-Dichloroethene (Surface Wat	154	GCMS	<1	ug/L	UKAS
cis-1,3-Dichloropropene (Surface Wa	154	GCMS	<1	ug/L	UKAS
COD (Surface Water)	107	Colorimetry	84	mg/L	UKAS
Copper (Surface Water)	177	ICPMS	53	ug/L	UKAS
Coronene (GCMS)	200	GCMS	<0.01	ug/L	
Dibenzo(a,h)anthracene (GCMS)	200	GCMS	<0.01	ug/L	
Dibromochloromethane (Surface Wat	154	GCMS	<1	ug/L	UKAS
Dibromomethane (Surface Water)	154	GCMS	<1	ug/L	UKAS
Dichlorodifluoromethane (Surface W	154	GCMS	<5.0	ug/L	
Dichloromethane (Surface Water)	154	GCMS	<5.0	ug/L	
Ethylbenzene (Surface Water)	154	GCMS	<1	ug/L	UKAS
Fluoranthene (GCMS)	200	GCMS	<0.01	ug/L	
Fluorene (GCMS)	200	GCMS	<0.01	ug/L	
Hexachlorobutadiene (Surface Water	154	GCMS	<1	ug/L	UKAS
Indeno(1,2,3-cd)pyrene (GCMS)	200	GCMS	<0.01	ug/L	
Isopropylbenzene (Surface Water)	154	GCMS	<1	ug/L	UKAS
Lead (Surface Water)	177	ICPMS	63	ug/L	UKAS
m- & p-Xylene (Surface Water)	154	GCMS	<1	ug/L	UKAS
Mercury (Surface water)	178	ICPMS	<0.03	ug/L	UKAS
Molybdenum	226	ICPMS	47	ug/L	
Naphthalene (Surface Water)	154	GCMS	<1	ug/L	UKAS
n-Butylbenzene (Surface Water)	154	GCMS	<1	ug/L	UKAS
Nickel (Surface Water)	177	ICPMS	63	ug/L	UKAS
Nitrogen (Total Kjeldahl)	104	Digestion/ Distillation/ Titrimetr	<1.00	mg/L as N	

Signed : A Harman ***Date : 12/03/2019***

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Test Parameter	SOP	Analytical Technique	Result	Units	Acc.
Nitrogen (Total Oxidised) (Surface W	151	Colorimetry	1.41	mg/L as N	UKAS
Nitrogen (Total)	0	Calculation	2.25	mg/L as N	
n-Propylbenzene (Surface Water)	154	GCMS	<1.0	ug/L	UKAS
o-Xylene (Surface Water)	154	GCMS	<1	ug/L	UKAS
Phenanthrene (GCMS)	200	GCMS	<0.01	ug/L	
Phenols (Total)	223	GCMS	<0.10	ug/L	
Phosphorus (Total) Surface Water	166	Colorimetry	0.113	mg/L as P	UKAS
p-Isopropyltoluene (Surface Water)	154	GCMS	<1	ug/L	UKAS
Polyaromatic Hydrocarbons (GCMS)	200	GCMS	<0.01	ug/L	
Pyrene (GCMS)	200	GCMS	<0.01	ug/L	
sec-Butylbenzene (Surface Water)	154	GCMS	<1	ug/L	UKAS
Selenium (Surface Water)	177	ICPMS	63	ug/L	UKAS
Solids (Total Dissolved)	105	Filtration/ Evaporation @ 180C	10510	mg/L	
Styrene (Surface Water)	154	GCMS	<1	ug/L	UKAS
tert-Butylbenzene (Surface Water)	154	GCMS	<1	ug/L	UKAS
Tetrachloroethene (Surface Water)	154	GCMS	<1	ug/L	UKAS
TOC (Surface Water)	316	TOC Analyser	6.2	mg/L	UKAS
Toluene (Surface Water)	154	GCMS	<1	ug/L	UKAS
Total Inorganic Nitrogen	0	Calculation	1.7	mg/L	
trans-1,2-Dichloroethene (Surface W	154	GCMS	<1	ug/L	UKAS
trans-1,3-Dichloropropene (Surface	154	GCMS	<1	ug/L	UKAS
Trichloroethene (Surface Water)	154	GCMS	<1.0	ug/L	
Trichlorofluoromethane (Surface Wat	154	GCMS	<1	ug/L	UKAS
Vanadium (Surface Water)	177	ICPMS	63	ug/L	UKAS

Signed : A Harmon ***Date : 12/03/2019***

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Customer	Caroline Roche Aqua-Fact International Services Ltd 12 Kilkerrin Park Liosbaun Ind Est Liosbaun Co Galway	*Lab Report Ref. No.*	0529/002/01
		Date of Receipt	21/02/2019
		Sampled On	20/02/2019
		Date Testing Commenced	21/02/2019
		Received or Collected	By Fitz: Pick up DS
		Condition on Receipt	Acceptable
Customer PO	JN1526	*Date of Report*	12/03/2019
Customer Ref	Up500-LW-Surface	*Sample Type*	Surface Water
Ref 2	20/02/19 12:41		
Ref 3			

CERTIFICATE OF ANALYSIS

Test Parameter	SOP	Analytical Technique	Result	Units	Acc.
Vinyl chloride (Surface Water)	154	GCMS	<1	ug/L	UKAS
Volatile Organic Compounds	154	GCMS	<5.0	ug/L	
Xylene Total (Surface Water)	154	GCMS	<1	ug/L	UKAS
Zinc (Surface Water)	177	ICPMS	20	ug/L	UKAS

Signed : A Harmon
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Date : 12/03/2019

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UKAS TESTING 2802

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Customer	**Caroline Roche**	***Lab Report Ref. No.***	**0529/002/02**
	Aqua-Fact International Services Ltd	***Date of Receipt***	**21/02/2019**
	12 Kilkerrin Park	***Sampled On***	**20/02/2019**
	Liosbaun Ind Est	***Date Testing Commenced***	**21/02/2019**
	Liosbaun	***Received or Collected***	**By Fitz: Pick up DS**
	Co Galway	***Condition on Receipt***	**Acceptable**
Customer PO	**JN1526**	***Date of Report***	**12/03/2019**
Customer Ref	**Up500-LW-Middle**	***Sample Type***	**Surface Water**
Ref 2	**20/02/19 12:46**		
Ref 3			

CERTIFICATE OF ANALYSIS

Test Parameter	SOP	Analytical Technique	Result	Units	Acc.
1,1,1,2-Tetrachloroethane (Surface	154	GCMS	<1	ug/L	UKAS
1,1,1-Trichloroethane (Surface Water	154	GCMS	<1	ug/L	UKAS
1,1,2,2-Tetrachloroethane (Surface	154	GCMS	<5.0	ug/L	
1,1,2-Trichloroethane (Surface Water	154	GCMS	<2	ug/L	UKAS
1,1-Dichloroethane (Surface Water)	154	GCMS	<1	ug/L	UKAS
1,1-Dichloroethene (Surface Water)	154	GCMS	<1	ug/L	UKAS
1,1-Dichloropropene (Surface Water)	154	GCMS	<1	ug/L	UKAS
1,2,3-Trichlorobenzene (Surface Wat	154	GCMS	<1	ug/L	UKAS
1,2,3-Trichloropropane (Surface Wat	154	GCMS	<0.9	ug/L	UKAS
1,2,4-Trichlorobenzene (Surface Wat	154	GCMS	<0.6	ug/L	UKAS
1,2,4-Trimethylbenzene (Surface Wa	154	GCMS	<1	ug/L	UKAS
1,2-Dibromo-3-chloropropane (Surfac	154	GCMS	<1	ug/L	UKAS
1,2-Dibromoethane (Surface Water)	154	GCMS	<1	ug/L	UKAS
1,2-Dichlorobenzene (Surface Water)	154	GCMS	<1	ug/L	UKAS
1,2-Dichloroethane (Surface Water)	154	GCMS	<1	ug/L	UKAS
1,2-Dichloropropane (Surface Water)	154	GCMS	<1	ug/L	UKAS
1,3,5-Trimethylbenzene (Surface Wa	154	GCMS	<1	ug/L	UKAS
1,3-Dichlorobenzene (Surface Water)	154	GCMS	<1	ug/L	UKAS
1,3-Dichloropropane (Surface Water)	154	GCMS	<1	ug/L	UKAS
1,4-Dichlorobenzene (Surface Water)	154	GCMS	<1	ug/L	UKAS
2,2-Dichloropropane (Surface Water)	154	GCMS	<5.0	ug/L	
2-Chlorotoluene (Surface Water)	154	GCMS	<1	ug/L	UKAS
4-Chlorotoluene (Surface Water)	154	GCMS	<1	ug/L	UKAS
Acenaphthene (GCMS)	200	GCMS	<0.01	ug/L	

Signed : A Harmon ***Date : 12/03/2019***

Aoife Harmon - Technical Supervisor

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ilac-MRA UKAS TESTING 2802

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		Date of Receipt	21/02/2019
		Sampled On	20/02/2019
		Date Testing Commenced	21/02/2019
		Received or Collected	By Fitz: Pick up DS
		Condition on Receipt	Acceptable
Customer PO	JN1526	*Date of Report*	12/03/2019
Customer Ref	Up500-LW-Middle	*Sample Type*	Surface Water
Ref 2	20/02/19 12:46		
Ref 3			

CERTIFICATE OF ANALYSIS

Test Parameter	SOP	Analytical Technique	Result	Units	Acc.
Acenaphthylene (GCMS)	200	GCMS	<0.01	ug/L	
Ammonia (Surface Water)	114	Colorimetry	0.21	mg/L as N	UKAS
Anthracene (GCMS)	200	GCMS	<0.01	ug/L	
Antimony (Surface Water)	177	ICPMS	77	ug/L	UKAS
Arsenic (Surface Water)	177	ICPMS	79	ug/L	UKAS
Barium (Surface Water)	177	ICPMS	76	ug/L	UKAS
Benzene (Surface Water)	154	GCMS	<1	ug/L	UKAS
Benzo(a)anthracene (GCMS)	200	GCMS	<0.01	ug/L	
Benzo(a)pyrene (GCMS)	200	GCMS	<0.01	ug/L	
Benzo(g,h,i)perylene (GCMS)	200	GCMS	<0.01	ug/L	
Benzo(k)fluoranthene (GCMS)	200	GCMS	<0.01	ug/L	
Bromobenzene (Surface Water)	154	GCMS	<1	ug/L	UKAS
Bromochloromethane (Surface Water	154	GCMS	<1	ug/L	UKAS
Bromodichloromethane (Surface Wat	154	GCMS	<1	ug/L	UKAS
Bromoform (Surface Water)	154	GCMS	<1	ug/L	UKAS
Bromomethane (Surface Water)	154	GCMS	<5.0	ug/L	
Cadmium (Surface Water)	177	ICPMS	79	ug/L	UKAS
Carbon tetrachloride (Surface Water)	154	GCMS	<1	ug/L	UKAS
Chlorobenzene (Surface Water)	154	GCMS	<1	ug/L	UKAS
Chloroethane (Surface Water)	154	GCMS	<5.0	ug/L	
Chloroform (Surface Water)	154	GCMS	<1	ug/L	UKAS
Chloromethane (Surface Water)	154	GCMS	<5.0	ug/L	
Chromium (Surface Water)	177	ICPMS	79	ug/L	UKAS
Chrysene (GCMS)	200	GCMS	<0.01	ug/L	

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	Liosbaun	***Received or Collected***	**By Fitz: Pick up DS**
	Co Galway	***Condition on Receipt***	**Acceptable**
Customer PO	**JN1526**	***Date of Report***	**12/03/2019**
Customer Ref	**Up500-LW-Middle**	***Sample Type***	**Surface Water**
Ref 2	**20/02/19 12:46**		
Ref 3			

CERTIFICATE OF ANALYSIS

Test Parameter	SOP	Analytical Technique	Result	Units	Acc.
cis-1,2-Dichloroethene (Surface Wat	154	GCMS	<1	ug/L	UKAS
cis-1,3-Dichloropropene (Surface Wa	154	GCMS	<1	ug/L	UKAS
COD (Surface Water)	107	Colorimetry	83	mg/L	UKAS
Copper (Surface Water)	177	ICPMS	69	ug/L	UKAS
Coronene (GCMS)	200	GCMS	<0.01	ug/L	
Dibenzo(a,h)anthracene (GCMS)	200	GCMS	<0.01	ug/L	
Dibromochloromethane (Surface Wat	154	GCMS	<1	ug/L	UKAS
Dibromomethane (Surface Water)	154	GCMS	<1	ug/L	UKAS
Dichlorodifluoromethane (Surface W	154	GCMS	<5.0	ug/L	
Dichloromethane (Surface Water)	154	GCMS	<5.0	ug/L	
Ethylbenzene (Surface Water)	154	GCMS	<1	ug/L	UKAS
Fluoranthene (GCMS)	200	GCMS	<0.01	ug/L	
Fluorene (GCMS)	200	GCMS	<0.01	ug/L	
Hexachlorobutadiene (Surface Water	154	GCMS	<1	ug/L	UKAS
Indeno(1,2,3-cd)pyrene (GCMS)	200	GCMS	<0.01	ug/L	
Isopropylbenzene (Surface Water)	154	GCMS	<1	ug/L	UKAS
Lead (Surface Water)	177	ICPMS	78	ug/L	UKAS
m- & p-Xylene (Surface Water)	154	GCMS	<1	ug/L	UKAS
Mercury (Surface water)	178	ICPMS	<0.03	ug/L	UKAS
Molybdenum	226	ICPMS	9	ug/L	
Naphthalene (Surface Water)	154	GCMS	<1	ug/L	UKAS
n-Butylbenzene (Surface Water)	154	GCMS	<1	ug/L	UKAS
Nickel (Surface Water)	177	ICPMS	78	ug/L	UKAS
Nitrogen (Total Kjeldahl)	104	Digestion/ Distillation/ Titrimetr	<1.00	mg/L as N	

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Customer Ref	Up500-LW-Middle	**Sample Type**	Surface Water
Ref 2	20/02/19 12:46		
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CERTIFICATE OF ANALYSIS

Test Parameter	SOP	Analytical Technique	Result	Units	Acc.
Nitrogen (Total Oxidised) (Surface W	151	Colorimetry	1.42	mg/L as N	UKAS
Nitrogen (Total)	0	Calculation	2.26	mg/L as N	
n-Propylbenzene (Surface Water)	154	GCMS	<1.0	ug/L	UKAS
o-Xylene (Surface Water)	154	GCMS	<1	ug/L	UKAS
Phenanthrene (GCMS)	200	GCMS	<0.01	ug/L	
Phenols (Total)	223	GCMS	<0.10	ug/L	
Phosphorus (Total) Surface Water	166	Colorimetry	0.083	mg/L as P	UKAS
p-Isopropyltoluene (Surface Water)	154	GCMS	<1	ug/L	UKAS
Polyaromatic Hydrocarbons (GCMS)	200	GCMS	<0.01	ug/L	
Pyrene (GCMS)	200	GCMS	<0.01	ug/L	
sec-Butylbenzene (Surface Water)	154	GCMS	<1	ug/L	UKAS
Selenium (Surface Water)	177	ICPMS	79	ug/L	UKAS
Solids (Total Dissolved)	105	Filtration/ Evaporation @ 180C	10883	mg/L	
Styrene (Surface Water)	154	GCMS	<1	ug/L	UKAS
tert-Butylbenzene (Surface Water)	154	GCMS	<1	ug/L	UKAS
Tetrachloroethene (Surface Water)	154	GCMS	<1	ug/L	UKAS
TOC (Surface Water)	316	TOC Analyser	6.2	mg/L	UKAS
Toluene (Surface Water)	154	GCMS	<1	ug/L	UKAS
Total Inorganic Nitrogen	0	Calculation	1.6	mg/L	
trans-1,2-Dichloroethene (Surface W	154	GCMS	<1	ug/L	UKAS
trans-1,3-Dichloropropene (Surface	154	GCMS	<1	ug/L	UKAS
Trichloroethene (Surface Water)	154	GCMS	<1.0	ug/L	
Trichlorofluoromethane (Surface Wat	154	GCMS	<1	ug/L	UKAS
Vanadium (Surface Water)	177	ICPMS	79	ug/L	UKAS

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Customer Ref	**Up500-LW-Middle**	*Sample Type*	**Surface Water**
Ref 2	**20/02/19 12:46**		
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CERTIFICATE OF ANALYSIS

Test Parameter	SOP	Analytical Technique	Result	Units	Acc.
Vinyl chloride (Surface Water)	154	GCMS	<1	ug/L	UKAS
Volatile Organic Compounds	154	GCMS	<5.0	ug/L	
Xylene Total (Surface Water)	154	GCMS	<1	ug/L	UKAS
Zinc (Surface Water)	177	ICPMS	35	ug/L	UKAS

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	Liosbaun	***Received or Collected***	**By Fitz: Pick up DS**
	Co Galway	***Condition on Receipt***	**Acceptable**
Customer PO	**JN1526**	***Date of Report***	**12/03/2019**
Customer Ref	**Up500-LW-Bottom**	***Sample Type***	**Surface Water**
Ref 2	**20/02/19 12:51**		
Ref 3			

CERTIFICATE OF ANALYSIS

Test Parameter	SOP	Analytical Technique	Result	Units	Acc.
1,1,1,2-Tetrachloroethane (Surface	154	GCMS	<1	ug/L	UKAS
1,1,1-Trichloroethane (Surface Water	154	GCMS	<1	ug/L	UKAS
1,1,2,2-Tetrachloroethane (Surface	154	GCMS	<5.0	ug/L	
1,1,2-Trichloroethane (Surface Water	154	GCMS	<2	ug/L	UKAS
1,1-Dichloroethane (Surface Water)	154	GCMS	<1	ug/L	UKAS
1,1-Dichloroethene (Surface Water)	154	GCMS	<1	ug/L	UKAS
1,1-Dichloropropene (Surface Water)	154	GCMS	<1	ug/L	UKAS
1,2,3-Trichlorobenzene (Surface Wat	154	GCMS	<1	ug/L	UKAS
1,2,3-Trichloropropane (Surface Wat	154	GCMS	<0.9	ug/L	UKAS
1,2,4-Trichlorobenzene (Surface Wat	154	GCMS	<0.6	ug/L	UKAS
1,2,4-Trimethylbenzene (Surface Wa	154	GCMS	<1	ug/L	UKAS
1,2-Dibromo-3-chloropropane (Surfac	154	GCMS	<1	ug/L	UKAS
1,2-Dibromoethane (Surface Water)	154	GCMS	<1	ug/L	UKAS
1,2-Dichlorobenzene (Surface Water)	154	GCMS	<1	ug/L	UKAS
1,2-Dichloroethane (Surface Water)	154	GCMS	<1	ug/L	UKAS
1,2-Dichloropropane (Surface Water)	154	GCMS	<1	ug/L	UKAS
1,3,5-Trimethylbenzene (Surface Wa	154	GCMS	<1	ug/L	UKAS
1,3-Dichlorobenzene (Surface Water)	154	GCMS	<1	ug/L	UKAS
1,3-Dichloropropane (Surface Water)	154	GCMS	<1	ug/L	UKAS
1,4-Dichlorobenzene (Surface Water)	154	GCMS	<1	ug/L	UKAS
2,2-Dichloropropane (Surface Water)	154	GCMS	<5.0	ug/L	
2-Chlorotoluene (Surface Water)	154	GCMS	<1	ug/L	UKAS
4-Chlorotoluene (Surface Water)	154	GCMS	<1	ug/L	UKAS
Acenaphthene (GCMS)	200	GCMS	<0.01	ug/L	

Signed : A Harmon ***Date : 12/03/2019***

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	Liosbaun Ind Est	*Date Testing Commenced*	**21/02/2019**
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Customer Ref	**Up500-LW-Bottom**	*Sample Type*	**Surface Water**
Ref 2	**20/02/19 12:51**		
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CERTIFICATE OF ANALYSIS

Test Parameter	SOP	Analytical Technique	Result	Units	Acc.
Acenaphthylene (GCMS)	200	GCMS	<0.01	ug/L	
Ammonia (Surface Water)	114	Colorimetry	0.27	mg/L as N	UKAS
Anthracene (GCMS)	200	GCMS	<0.01	ug/L	
Antimony (Surface Water)	177	ICPMS	75	ug/L	UKAS
Arsenic (Surface Water)	177	ICPMS	77	ug/L	UKAS
Barium (Surface Water)	177	ICPMS	74	ug/L	UKAS
Benzene (Surface Water)	154	GCMS	<1	ug/L	UKAS
Benzo(a)anthracene (GCMS)	200	GCMS	<0.01	ug/L	
Benzo(a)pyrene (GCMS)	200	GCMS	<0.01	ug/L	
Benzo(g,h,i)perylene (GCMS)	200	GCMS	<0.01	ug/L	
Benzo(k)fluoranthene (GCMS)	200	GCMS	<0.01	ug/L	
Bromobenzene (Surface Water)	154	GCMS	<1	ug/L	UKAS
Bromochloromethane (Surface Water	154	GCMS	<1	ug/L	UKAS
Bromodichloromethane (Surface Wat	154	GCMS	<1	ug/L	UKAS
Bromoform (Surface Water)	154	GCMS	<1	ug/L	UKAS
Bromomethane (Surface Water)	154	GCMS	<5.0	ug/L	
Cadmium (Surface Water)	177	ICPMS	77	ug/L	UKAS
Carbon tetrachloride (Surface Water)	154	GCMS	<1	ug/L	UKAS
Chlorobenzene (Surface Water)	154	GCMS	<1	ug/L	UKAS
Chloroethane (Surface Water)	154	GCMS	<5.0	ug/L	
Chloroform (Surface Water)	154	GCMS	<1	ug/L	UKAS
Chloromethane (Surface Water)	154	GCMS	<5.0	ug/L	
Chromium (Surface Water)	177	ICPMS	77	ug/L	UKAS
Chrysene (GCMS)	200	GCMS	<0.01	ug/L	

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Customer Ref	**Up500-LW-Bottom**	***Sample Type***	**Surface Water**
Ref 2	**20/02/19 12:51**		
Ref 3			

CERTIFICATE OF ANALYSIS

Test Parameter	SOP	Analytical Technique	Result	Units	Acc.
cis-1,2-Dichloroethene (Surface Wat	154	GCMS	<1	ug/L	UKAS
cis-1,3-Dichloropropene (Surface Wa	154	GCMS	<1	ug/L	UKAS
COD (Surface Water)	107	Colorimetry	122	mg/L	UKAS
Copper (Surface Water)	177	ICPMS	67	ug/L	UKAS
Coronene (GCMS)	200	GCMS	<0.01	ug/L	
Dibenzo(a,h)anthracene (GCMS)	200	GCMS	<0.01	ug/L	
Dibromochloromethane (Surface Wat	154	GCMS	<1	ug/L	UKAS
Dibromomethane (Surface Water)	154	GCMS	<1	ug/L	UKAS
Dichlorodifluoromethane (Surface W	154	GCMS	<5.0	ug/L	
Dichloromethane (Surface Water)	154	GCMS	<5.0	ug/L	
Ethylbenzene (Surface Water)	154	GCMS	<1	ug/L	UKAS
Fluoranthene (GCMS)	200	GCMS	<0.01	ug/L	
Fluorene (GCMS)	200	GCMS	<0.01	ug/L	
Hexachlorobutadiene (Surface Water	154	GCMS	<1	ug/L	UKAS
Indeno(1,2,3-cd)pyrene (GCMS)	200	GCMS	<0.01	ug/L	
Isopropylbenzene (Surface Water)	154	GCMS	<1	ug/L	UKAS
Lead (Surface Water)	177	ICPMS	77	ug/L	UKAS
m- & p-Xylene (Surface Water)	154	GCMS	<1	ug/L	UKAS
Mercury (Surface water)	178	ICPMS	<0.03	ug/L	UKAS
Molybdenum	226	ICPMS	55	ug/L	
Naphthalene (Surface Water)	154	GCMS	<1	ug/L	UKAS
n-Butylbenzene (Surface Water)	154	GCMS	<1	ug/L	UKAS
Nickel (Surface Water)	177	ICPMS	77	ug/L	UKAS
Nitrogen (Total Kjeldahl)	104	Digestion/ Distillation/ Titrimetr	1.12	mg/L as N	

Signed : A Harmon ***Date : 12/03/2019***

Aoife Harmon - Technical Supervisor

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ilac-MRA UKAS TESTING 2802

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Customer	**Caroline Roche**	***Lab Report Ref. No.***	**0529/002/03**
	Aqua-Fact International Services Ltd	***Date of Receipt***	**21/02/2019**
	12 Kilkerrin Park	***Sampled On***	**20/02/2019**
	Liosbaun Ind Est	***Date Testing Commenced***	**21/02/2019**
	Liosbaun	***Received or Collected***	**By Fitz: Pick up DS**
	Co Galway	***Condition on Receipt***	**Acceptable**
Customer PO	**JN1526**	***Date of Report***	**12/03/2019**
Customer Ref	**Up500-LW-Bottom**	***Sample Type***	**Surface Water**
Ref 2	**20/02/19 12:51**		
Ref 3			

CERTIFICATE OF ANALYSIS

Test Parameter	SOP	Analytical Technique	Result	Units	Acc.
Nitrogen (Total Oxidised) (Surface W	151	Colorimetry	1.34	mg/L as N	UKAS
Nitrogen (Total)	0	Calculation	2.46	mg/L as N	
n-Propylbenzene (Surface Water)	154	GCMS	<1.0	ug/L	UKAS
o-Xylene (Surface Water)	154	GCMS	<1	ug/L	UKAS
Phenanthrene (GCMS)	200	GCMS	<0.01	ug/L	
Phenols (Total)	223	GCMS	<0.10	ug/L	
Phosphorus (Total) Surface Water	166	Colorimetry	0.086	mg/L as P	UKAS
p-Isopropyltoluene (Surface Water)	154	GCMS	<1	ug/L	UKAS
Polyaromatic Hydrocarbons (GCMS)	200	GCMS	<0.01	ug/L	
Pyrene (GCMS)	200	GCMS	<0.01	ug/L	
sec-Butylbenzene (Surface Water)	154	GCMS	<1	ug/L	UKAS
Selenium (Surface Water)	177	ICPMS	77	ug/L	UKAS
Solids (Total Dissolved)	105	Filtration/ Evaporation @ 180C	13257	mg/L	
Styrene (Surface Water)	154	GCMS	<1	ug/L	UKAS
tert-Butylbenzene (Surface Water)	154	GCMS	<1	ug/L	UKAS
Tetrachloroethene (Surface Water)	154	GCMS	<1	ug/L	UKAS
TOC (Surface Water)	316	TOC Analyser	5.5	mg/L	UKAS
Toluene (Surface Water)	154	GCMS	<1	ug/L	UKAS
Total Inorganic Nitrogen	0	Calculation	1.6	mg/L	
trans-1,2-Dichloroethene (Surface W	154	GCMS	<1	ug/L	UKAS
trans-1,3-Dichloropropene (Surface	154	GCMS	<1	ug/L	UKAS
Trichloroethene (Surface Water)	154	GCMS	<1.0	ug/L	
Trichlorofluoromethane (Surface Wat	154	GCMS	<1	ug/L	UKAS
Vanadium (Surface Water)	177	ICPMS	77	ug/L	UKAS

Signed : A Harman ***Date : 12/03/2019***

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	Liosbaun Ind Est	***Date Testing Commenced***	**21/02/2019**
	Liosbaun	***Received or Collected***	**By Fitz: Pick up DS**
	Co Galway	***Condition on Receipt***	**Acceptable**
Customer PO	**JN1526**	***Date of Report***	**12/03/2019**
Customer Ref	**Up500-LW-Bottom**	***Sample Type***	**Surface Water**
Ref 2	**20/02/19 12:51**		
Ref 3			

CERTIFICATE OF ANALYSIS

Test Parameter	SOP	Analytical Technique	Result	Units	Acc.
Vinyl chloride (Surface Water)	154	GCMS	<1	ug/L	UKAS
Volatile Organic Compounds	154	GCMS	<5.0	ug/L	
Xylene Total (Surface Water)	154	GCMS	<1	ug/L	UKAS
Zinc (Surface Water)	177	ICPMS	34	ug/L	UKAS

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Customer	**Caroline Roche**	***Lab Report Ref. No.***	**0529/002/04**
	Aqua-Fact International Services Ltd	***Date of Receipt***	**21/02/2019**
	12 Kilkerrin Park	***Sampled On***	**20/02/2019**
	Liosbaun Ind Est	***Date Testing Commenced***	**21/02/2019**
	Liosbaun	***Received or Collected***	**By Fitz: Pick up DS**
	Co Galway	***Condition on Receipt***	**Acceptable**
Customer PO	**JN1526**	***Date of Report***	**12/03/2019**
Customer Ref	**UP500-MF-Surface**	***Sample Type***	**Surface Water**
Ref 2	**20/02/19 16:00**		
Ref 3			

CERTIFICATE OF ANALYSIS

Test Parameter	SOP	Analytical Technique	Result	Units	Acc.
1,1,1,2-Tetrachloroethane (Surface	154	GCMS	<1	ug/L	UKAS
1,1,1-Trichloroethane (Surface Water	154	GCMS	<1	ug/L	UKAS
1,1,2,2-Tetrachloroethane (Surface	154	GCMS	<5.0	ug/L	
1,1,2-Trichloroethane (Surface Water	154	GCMS	<2	ug/L	UKAS
1,1-Dichloroethane (Surface Water)	154	GCMS	<1	ug/L	UKAS
1,1-Dichloroethene (Surface Water)	154	GCMS	<1	ug/L	UKAS
1,1-Dichloropropene (Surface Water)	154	GCMS	<1	ug/L	UKAS
1,2,3-Trichlorobenzene (Surface Wat	154	GCMS	<1	ug/L	UKAS
1,2,3-Trichloropropane (Surface Wat	154	GCMS	<0.9	ug/L	UKAS
1,2,4-Trichlorobenzene (Surface Wat	154	GCMS	<0.6	ug/L	UKAS
1,2,4-Trimethylbenzene (Surface Wa	154	GCMS	<1	ug/L	UKAS
1,2-Dibromo-3-chloropropane (Surfac	154	GCMS	<1	ug/L	UKAS
1,2-Dibromoethane (Surface Water)	154	GCMS	<1	ug/L	UKAS
1,2-Dichlorobenzene (Surface Water)	154	GCMS	<1	ug/L	UKAS
1,2-Dichloroethane (Surface Water)	154	GCMS	<1	ug/L	UKAS
1,2-Dichloropropane (Surface Water)	154	GCMS	<1	ug/L	UKAS
1,3,5-Trimethylbenzene (Surface Wa	154	GCMS	<1	ug/L	UKAS
1,3-Dichlorobenzene (Surface Water)	154	GCMS	<1	ug/L	UKAS
1,3-Dichloropropane (Surface Water)	154	GCMS	<1	ug/L	UKAS
1,4-Dichlorobenzene (Surface Water)	154	GCMS	<1	ug/L	UKAS
2,2-Dichloropropane (Surface Water)	154	GCMS	<5.0	ug/L	
2-Chlorotoluene (Surface Water)	154	GCMS	<1	ug/L	UKAS
4-Chlorotoluene (Surface Water)	154	GCMS	<1	ug/L	UKAS
Acenaphthene (GCMS)	200	GCMS	<0.01	ug/L	

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	12 Kilkerrin Park	*Sampled On*	**20/02/2019**
	Liosbaun Ind Est	*Date Testing Commenced*	**21/02/2019**
	Liosbaun	*Received or Collected*	**By Fitz: Pick up DS**
	Co Galway	*Condition on Receipt*	**Acceptable**
Customer PO	**JN1526**	*Date of Report*	**12/03/2019**
Customer Ref	**UP500-MF-Surface**	*Sample Type*	**Surface Water**
Ref 2	**20/02/19 16:00**		
Ref 3			

CERTIFICATE OF ANALYSIS

Test Parameter	SOP	Analytical Technique	Result	Units	Acc.
Acenaphthylene (GCMS)	200	GCMS	<0.01	ug/L	
Ammonia (Surface Water)	114	Colorimetry	0.25	mg/L as N	UKAS
Anthracene (GCMS)	200	GCMS	<0.01	ug/L	
Antimony (Surface Water)	177	ICPMS	90	ug/L	UKAS
Arsenic (Surface Water)	177	ICPMS	92	ug/L	UKAS
Barium (Surface Water)	177	ICPMS	89	ug/L	UKAS
Benzene (Surface Water)	154	GCMS	<1	ug/L	UKAS
Benzo(a)anthracene (GCMS)	200	GCMS	<0.01	ug/L	
Benzo(a)pyrene (GCMS)	200	GCMS	<0.01	ug/L	
Benzo(g,h,i)perylene (GCMS)	200	GCMS	<0.01	ug/L	
Benzo(k)fluoranthene (GCMS)	200	GCMS	<0.01	ug/L	
Bromobenzene (Surface Water)	154	GCMS	<1	ug/L	UKAS
Bromochloromethane (Surface Water	154	GCMS	<1	ug/L	UKAS
Bromodichloromethane (Surface Wat	154	GCMS	<1	ug/L	UKAS
Bromoform (Surface Water)	154	GCMS	<1	ug/L	UKAS
Bromomethane (Surface Water)	154	GCMS	<5.0	ug/L	
Cadmium (Surface Water)	177	ICPMS	92	ug/L	UKAS
Carbon tetrachloride (Surface Water)	154	GCMS	<1	ug/L	UKAS
Chlorobenzene (Surface Water)	154	GCMS	<1	ug/L	UKAS
Chloroethane (Surface Water)	154	GCMS	<5.0	ug/L	
Chloroform (Surface Water)	154	GCMS	<1	ug/L	UKAS
Chloromethane (Surface Water)	154	GCMS	<5.0	ug/L	
Chromium (Surface Water)	177	ICPMS	92	ug/L	UKAS
Chrysene (GCMS)	200	GCMS	<0.01	ug/L	

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	Liosbaun	***Received or Collected***	**By Fitz: Pick up DS**
	Co Galway	***Condition on Receipt***	**Acceptable**
Customer PO	**JN1526**	***Date of Report***	**12/03/2019**
Customer Ref	**UP500-MF-Surface**	***Sample Type***	**Surface Water**
Ref 2	**20/02/19 16:00**		
Ref 3			

CERTIFICATE OF ANALYSIS

Test Parameter	SOP	Analytical Technique	Result	Units	Acc.
cis-1,2-Dichloroethene (Surface Wat	154	GCMS	<1	ug/L	UKAS
cis-1,3-Dichloropropene (Surface Wa	154	GCMS	<1	ug/L	UKAS
COD (Surface Water)	107	Colorimetry	769	mg/L	UKAS
Copper (Surface Water)	177	ICPMS	82	ug/L	UKAS
Coronene (GCMS)	200	GCMS	<0.01	ug/L	
Dibenzo(a,h)anthracene (GCMS)	200	GCMS	<0.01	ug/L	
Dibromochloromethane (Surface Wat	154	GCMS	<1	ug/L	UKAS
Dibromomethane (Surface Water)	154	GCMS	<1	ug/L	UKAS
Dichlorodifluoromethane (Surface W	154	GCMS	<5.0	ug/L	
Dichloromethane (Surface Water)	154	GCMS	<5.0	ug/L	
Ethylbenzene (Surface Water)	154	GCMS	<1	ug/L	UKAS
Fluoranthene (GCMS)	200	GCMS	<0.01	ug/L	
Fluorene (GCMS)	200	GCMS	<0.01	ug/L	
Hexachlorobutadiene (Surface Water	154	GCMS	<1	ug/L	UKAS
Indeno(1,2,3-cd)pyrene (GCMS)	200	GCMS	<0.01	ug/L	
Isopropylbenzene (Surface Water)	154	GCMS	<1	ug/L	UKAS
Lead (Surface Water)	177	ICPMS	92	ug/L	UKAS
m- & p-Xylene (Surface Water)	154	GCMS	<1	ug/L	UKAS
Mercury (Surface water)	178	ICPMS	<0.03	ug/L	UKAS
Molybdenum	226	ICPMS	9	ug/L	
Naphthalene (Surface Water)	154	GCMS	<1	ug/L	UKAS
n-Butylbenzene (Surface Water)	154	GCMS	<1	ug/L	UKAS
Nickel (Surface Water)	177	ICPMS	92	ug/L	UKAS
Nitrogen (Total Kjeldahl)	104	Digestion/ Distillation/ Titrimetr	<1.00	mg/L as N	

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	12 Kilkerrin Park	***Sampled On***	**20/02/2019**
	Liosbaun Ind Est	***Date Testing Commenced***	**21/02/2019**
	Liosbaun	***Received or Collected***	**By Fitz: Pick up DS**
	Co Galway	***Condition on Receipt***	**Acceptable**
Customer PO	**JN1526**	***Date of Report***	**12/03/2019**
Customer Ref	**UP500-MF-Surface**	***Sample Type***	**Surface Water**
Ref 2	**20/02/19 16:00**		
Ref 3			

CERTIFICATE OF ANALYSIS

Test Parameter	SOP	Analytical Technique	Result	Units	Acc.
Nitrogen (Total Oxidised) (Surface W	151	Colorimetry	1.32	mg/L as N	UKAS
Nitrogen (Total)	0	Calculation	2.16	mg/L as N	
n-Propylbenzene (Surface Water)	154	GCMS	<1.0	ug/L	UKAS
o-Xylene (Surface Water)	154	GCMS	<1	ug/L	UKAS
Phenanthrene (GCMS)	200	GCMS	<0.01	ug/L	
Phenols (Total)	223	GCMS	<0.10	ug/L	
Phosphorus (Total) Surface Water	166	Colorimetry	0.108	mg/L as P	UKAS
p-Isopropyltoluene (Surface Water)	154	GCMS	<1	ug/L	UKAS
Polyaromatic Hydrocarbons (GCMS)	200	GCMS	<0.01	ug/L	
Pyrene (GCMS)	200	GCMS	<0.01	ug/L	
sec-Butylbenzene (Surface Water)	154	GCMS	<1	ug/L	UKAS
Selenium (Surface Water)	177	ICPMS	92	ug/L	UKAS
Solids (Total Dissolved)	105	Filtration/ Evaporation @ 180C	16289	mg/L	
Styrene (Surface Water)	154	GCMS	<1	ug/L	UKAS
tert-Butylbenzene (Surface Water)	154	GCMS	<1	ug/L	UKAS
Tetrachloroethene (Surface Water)	154	GCMS	<1	ug/L	UKAS
TOC (Surface Water)	316	TOC Analyser	5.0	mg/L	UKAS
Toluene (Surface Water)	154	GCMS	<1	ug/L	UKAS
Total Inorganic Nitrogen	0	Calculation	1.6	mg/L	
trans-1,2-Dichloroethene (Surface W	154	GCMS	<1	ug/L	UKAS
trans-1,3-Dichloropropene (Surface	154	GCMS	<1	ug/L	UKAS
Trichloroethene (Surface Water)	154	GCMS	<1.0	ug/L	
Trichlorofluoromethane (Surface Wat	154	GCMS	<1	ug/L	UKAS
Vanadium (Surface Water)	177	ICPMS	92	ug/L	UKAS

Signed : A Harman ***Date : 12/03/2019***

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Customer	**Caroline Roche** **Aqua-Fact International Services Ltd** **12 Kilkerrin Park** **Liosbaun Ind Est** **Liosbaun** **Co Galway**	*Lab Report Ref. No.*	**0529/002/04**
		Date of Receipt	**21/02/2019**
		Sampled On	**20/02/2019**
		Date Testing Commenced	**21/02/2019**
		Received or Collected	**By Fitz: Pick up DS**
		Condition on Receipt	**Acceptable**
Customer PO	**JN1526**	*Date of Report*	**12/03/2019**
Customer Ref	**UP500-MF-Surface**	*Sample Type*	**Surface Water**
Ref 2	**20/02/19 16:00**		
Ref 3			

CERTIFICATE OF ANALYSIS

Test Parameter	SOP	Analytical Technique	Result	Units	Acc.
Vinyl chloride (Surface Water)	154	GCMS	<1	ug/L	UKAS
Volatile Organic Compounds	154	GCMS	<5.0	ug/L	
Xylene Total (Surface Water)	154	GCMS	<1	ug/L	UKAS
Zinc (Surface Water)	177	ICPMS	49	ug/L	UKAS

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Customer	Caroline Roche Aqua-Fact International Services Ltd 12 Kilkerrin Park Liosbaun Ind Est Liosbaun Co Galway	*Lab Report Ref. No.*	0529/002/05
		Date of Receipt	21/02/2019
		Sampled On	20/02/2019
		Date Testing Commenced	21/02/2019
		Received or Collected	By Fitz: Pick up DS
		Condition on Receipt	Acceptable
Customer PO	JN1526	*Date of Report*	12/03/2019
Customer Ref	UP500-MF-Middle	*Sample Type*	Surface Water
Ref 2	20/02/19 16:05		
Ref 3			

CERTIFICATE OF ANALYSIS

Test Parameter	SOP	Analytical Technique	Result	Units	Acc.
1,1,1,2-Tetrachloroethane (Surface	154	GCMS	<1	ug/L	UKAS
1,1,1-Trichloroethane (Surface Water	154	GCMS	<1	ug/L	UKAS
1,1,2,2-Tetrachloroethane (Surface	154	GCMS	<5.0	ug/L	
1,1,2-Trichloroethane (Surface Water	154	GCMS	<2	ug/L	UKAS
1,1-Dichloroethane (Surface Water)	154	GCMS	<1	ug/L	UKAS
1,1-Dichloroethene (Surface Water)	154	GCMS	<1	ug/L	UKAS
1,1-Dichloropropene (Surface Water)	154	GCMS	<1	ug/L	UKAS
1,2,3-Trichlorobenzene (Surface Wat	154	GCMS	<1	ug/L	UKAS
1,2,3-Trichloropropane (Surface Wat	154	GCMS	<0.9	ug/L	UKAS
1,2,4-Trichlorobenzene (Surface Wat	154	GCMS	<0.6	ug/L	UKAS
1,2,4-Trimethylbenzene (Surface Wa	154	GCMS	<1	ug/L	UKAS
1,2-Dibromo-3-chloropropane (Surfac	154	GCMS	<1	ug/L	UKAS
1,2-Dibromoethane (Surface Water)	154	GCMS	<1	ug/L	UKAS
1,2-Dichlorobenzene (Surface Water)	154	GCMS	<1	ug/L	UKAS
1,2-Dichloroethane (Surface Water)	154	GCMS	<1	ug/L	UKAS
1,2-Dichloropropane (Surface Water)	154	GCMS	<1	ug/L	UKAS
1,3,5-Trimethylbenzene (Surface Wa	154	GCMS	<1	ug/L	UKAS
1,3-Dichlorobenzene (Surface Water)	154	GCMS	<1	ug/L	UKAS
1,3-Dichloropropane (Surface Water)	154	GCMS	<1	ug/L	UKAS
1,4-Dichlorobenzene (Surface Water)	154	GCMS	<1	ug/L	UKAS
2,2-Dichloropropane (Surface Water)	154	GCMS	<5.0	ug/L	
2-Chlorotoluene (Surface Water)	154	GCMS	<1	ug/L	UKAS
4-Chlorotoluene (Surface Water)	154	GCMS	<1	ug/L	UKAS
Acenaphthene (GCMS)	200	GCMS	<0.01	ug/L	

Signed : A Harmon

Date : 12/03/2019

Aoife Harmon - Technical Supervisor

Acc. : Accredited Parameters by ISO 17025:2005
PVL - Parametric Value Limit as per EU (Drinking water) Regulations (SI 122 2014)
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ilac-MRA UKAS TESTING 2802

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Customer	**Caroline Roche**	***Lab Report Ref. No.***	**0529/002/05**
	Aqua-Fact International Services Ltd	***Date of Receipt***	**21/02/2019**
	12 Kilkerrin Park	***Sampled On***	**20/02/2019**
	Liosbaun Ind Est	***Date Testing Commenced***	**21/02/2019**
	Liosbaun	***Received or Collected***	**By Fitz: Pick up DS**
	Co Galway	***Condition on Receipt***	**Acceptable**
Customer PO	**JN1526**	***Date of Report***	**12/03/2019**
Customer Ref	**UP500-MF-Middle**	***Sample Type***	**Surface Water**
Ref 2	**20/02/19 16:05**		
Ref 3			

CERTIFICATE OF ANALYSIS

Test Parameter	SOP	Analytical Technique	Result	Units	Acc.
Acenaphthylene (GCMS)	200	GCMS	<0.01	ug/L	
Ammonia (Surface Water)	114	Colorimetry	0.22	mg/L as N	UKAS
Anthracene (GCMS)	200	GCMS	<0.01	ug/L	
Antimony (Surface Water)	177	ICPMS	93	ug/L	UKAS
Arsenic (Surface Water)	177	ICPMS	95	ug/L	UKAS
Barium (Surface Water)	177	ICPMS	92	ug/L	UKAS
Benzene (Surface Water)	154	GCMS	<1	ug/L	UKAS
Benzo(a)anthracene (GCMS)	200	GCMS	<0.01	ug/L	
Benzo(a)pyrene (GCMS)	200	GCMS	<0.01	ug/L	
Benzo(g,h,i)perylene (GCMS)	200	GCMS	<0.01	ug/L	
Benzo(k)fluoranthene (GCMS)	200	GCMS	<0.01	ug/L	
Bromobenzene (Surface Water)	154	GCMS	<1	ug/L	UKAS
Bromochloromethane (Surface Water	154	GCMS	<1	ug/L	UKAS
Bromodichloromethane (Surface Wat	154	GCMS	<1	ug/L	UKAS
Bromoform (Surface Water)	154	GCMS	<1	ug/L	UKAS
Bromomethane (Surface Water)	154	GCMS	<5.0	ug/L	
Cadmium (Surface Water)	177	ICPMS	95	ug/L	UKAS
Carbon tetrachloride (Surface Water)	154	GCMS	<1	ug/L	UKAS
Chlorobenzene (Surface Water)	154	GCMS	<1	ug/L	UKAS
Chloroethane (Surface Water)	154	GCMS	<5.0	ug/L	
Chloroform (Surface Water)	154	GCMS	<1	ug/L	UKAS
Chloromethane (Surface Water)	154	GCMS	<5.0	ug/L	
Chromium (Surface Water)	177	ICPMS	95	ug/L	UKAS
Chrysene (GCMS)	200	GCMS	<0.01	ug/L	

Signed : A Harman ***Date : 12/03/2019***

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	Liosbaun Ind Est	***Date Testing Commenced***	**21/02/2019**
	Liosbaun	***Received or Collected***	**By Fitz: Pick up DS**
	Co Galway	***Condition on Receipt***	**Acceptable**
Customer PO	**JN1526**	***Date of Report***	**12/03/2019**
Customer Ref	**UP500-MF-Middle**	***Sample Type***	**Surface Water**
Ref 2	**20/02/19 16:05**		
Ref 3			

CERTIFICATE OF ANALYSIS

Test Parameter	SOP	Analytical Technique	Result	Units	Acc.
cis-1,2-Dichloroethene (Surface Wat	154	GCMS	<1	ug/L	UKAS
cis-1,3-Dichloropropene (Surface Wa	154	GCMS	<1	ug/L	UKAS
COD (Surface Water)	107	Colorimetry	857	mg/L	UKAS
Copper (Surface Water)	177	ICPMS	85	ug/L	UKAS
Coronene (GCMS)	200	GCMS	<0.01	ug/L	
Dibenzo(a,h)anthracene (GCMS)	200	GCMS	<0.01	ug/L	
Dibromochloromethane (Surface Wat	154	GCMS	<1	ug/L	UKAS
Dibromomethane (Surface Water)	154	GCMS	<1	ug/L	UKAS
Dichlorodifluoromethane (Surface W	154	GCMS	<5.0	ug/L	
Dichloromethane (Surface Water)	154	GCMS	<5.0	ug/L	
Ethylbenzene (Surface Water)	154	GCMS	<1	ug/L	UKAS
Fluoranthene (GCMS)	200	GCMS	<0.01	ug/L	
Fluorene (GCMS)	200	GCMS	<0.01	ug/L	
Hexachlorobutadiene (Surface Water	154	GCMS	<1	ug/L	UKAS
Indeno(1,2,3-cd)pyrene (GCMS)	200	GCMS	<0.01	ug/L	
Isopropylbenzene (Surface Water)	154	GCMS	<1	ug/L	UKAS
Lead (Surface Water)	177	ICPMS	94	ug/L	UKAS
m- & p-Xylene (Surface Water)	154	GCMS	<1	ug/L	UKAS
Mercury (Surface water)	178	ICPMS	<0.03	ug/L	UKAS
Molybdenum	226	ICPMS	11	ug/L	
Naphthalene (Surface Water)	154	GCMS	<1	ug/L	UKAS
n-Butylbenzene (Surface Water)	154	GCMS	<1	ug/L	UKAS
Nickel (Surface Water)	177	ICPMS	94	ug/L	UKAS
Nitrogen (Total Kjeldahl)	104	Digestion/ Distillation/ Titrimetr	1.68	mg/L as N	

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	Liosbaun Ind Est	***Date Testing Commenced***	**21/02/2019**
	Liosbaun	***Received or Collected***	**By Fitz: Pick up DS**
	Co Galway	***Condition on Receipt***	**Acceptable**
Customer PO	**JN1526**	***Date of Report***	**12/03/2019**
Customer Ref	**UP500-MF-Middle**	***Sample Type***	**Surface Water**
Ref 2	**20/02/19 16:05**		
Ref 3			

CERTIFICATE OF ANALYSIS

Test Parameter	SOP	Analytical Technique	Result	Units	Acc.
Nitrogen (Total Oxidised) (Surface W	151	Colorimetry	1.33	mg/L as N	UKAS
Nitrogen (Total)	0	Calculation	3.01	mg/L as N	
n-Propylbenzene (Surface Water)	154	GCMS	<1.0	ug/L	UKAS
o-Xylene (Surface Water)	154	GCMS	<1	ug/L	UKAS
Phenanthrene (GCMS)	200	GCMS	<0.01	ug/L	
Phenols (Total)	223	GCMS	<0.10	ug/L	
Phosphorus (Total) Surface Water	166	Colorimetry	0.078	mg/L as P	UKAS
p-Isopropyltoluene (Surface Water)	154	GCMS	<1	ug/L	UKAS
Polyaromatic Hydrocarbons (GCMS)	200	GCMS	<0.01	ug/L	
Pyrene (GCMS)	200	GCMS	<0.01	ug/L	
sec-Butylbenzene (Surface Water)	154	GCMS	<1	ug/L	UKAS
Selenium (Surface Water)	177	ICPMS	95	ug/L	UKAS
Solids (Total Dissolved)	105	Filtration/ Evaporation @ 180C	17391	mg/L	
Styrene (Surface Water)	154	GCMS	<1	ug/L	UKAS
tert-Butylbenzene (Surface Water)	154	GCMS	<1	ug/L	UKAS
Tetrachloroethene (Surface Water)	154	GCMS	<1	ug/L	UKAS
TOC (Surface Water)	316	TOC Analyser	4.7	mg/L	UKAS
Toluene (Surface Water)	154	GCMS	<1	ug/L	UKAS
Total Inorganic Nitrogen	0	Calculation	1.6	mg/L	
trans-1,2-Dichloroethene (Surface W	154	GCMS	<1	ug/L	UKAS
trans-1,3-Dichloropropene (Surface	154	GCMS	<1	ug/L	UKAS
Trichloroethene (Surface Water)	154	GCMS	<1.0	ug/L	
Trichlorofluoromethane (Surface Wat	154	GCMS	<1	ug/L	UKAS
Vanadium (Surface Water)	177	ICPMS	95	ug/L	UKAS

Signed : A Harman ***Date : 12/03/2019***

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Customer	**Caroline Roche** **Aqua-Fact International Services Ltd** **12 Kilkerrin Park** **Liosbaun Ind Est** **Liosbaun** **Co Galway**	*Lab Report Ref. No.*	**0529/002/05**
		Date of Receipt	**21/02/2019**
		Sampled On	**20/02/2019**
		Date Testing Commenced	**21/02/2019**
		Received or Collected	**By Fitz: Pick up DS**
		Condition on Receipt	**Acceptable**
Customer PO	**JN1526**	*Date of Report*	**12/03/2019**
Customer Ref	**UP500-MF-Middle**	*Sample Type*	**Surface Water**
Ref 2	**20/02/19 16:05**		
Ref 3			

CERTIFICATE OF ANALYSIS

Test Parameter	SOP	Analytical Technique	Result	Units	Acc.
Vinyl chloride (Surface Water)	154	GCMS	<1	ug/L	UKAS
Volatile Organic Compounds	154	GCMS	<5.0	ug/L	
Xylene Total (Surface Water)	154	GCMS	<1	ug/L	UKAS
Zinc (Surface Water)	177	ICPMS	51	ug/L	UKAS

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Customer	Caroline Roche	*Lab Report Ref. No.*	0529/002/06
	Aqua-Fact International Services Ltd	*Date of Receipt*	21/02/2019
	12 Kilkerrin Park	*Sampled On*	20/02/2019
	Liosbaun Ind Est	*Date Testing Commenced*	21/02/2019
	Liosbaun	*Received or Collected*	By Fitz: Pick up DS
	Co Galway	*Condition on Receipt*	Acceptable
Customer PO	JN1526	*Date of Report*	12/03/2019
Customer Ref	UP500-MF-Bottom	*Sample Type*	Surface Water
Ref 2	20/02/19 16:10		
Ref 3			

CERTIFICATE OF ANALYSIS

Test Parameter	SOP	Analytical Technique	Result	Units	Acc.
1,1,1,2-Tetrachloroethane (Surface	154	GCMS	<1	ug/L	UKAS
1,1,1-Trichloroethane (Surface Water	154	GCMS	<1	ug/L	UKAS
1,1,2,2-Tetrachloroethane (Surface	154	GCMS	<5.0	ug/L	
1,1,2-Trichloroethane (Surface Water	154	GCMS	<2	ug/L	UKAS
1,1-Dichloroethane (Surface Water)	154	GCMS	<1	ug/L	UKAS
1,1-Dichloroethene (Surface Water)	154	GCMS	<1	ug/L	UKAS
1,1-Dichloropropene (Surface Water)	154	GCMS	<1	ug/L	UKAS
1,2,3-Trichlorobenzene (Surface Wat	154	GCMS	<1	ug/L	UKAS
1,2,3-Trichloropropane (Surface Wat	154	GCMS	<0.9	ug/L	UKAS
1,2,4-Trichlorobenzene (Surface Wat	154	GCMS	<0.6	ug/L	UKAS
1,2,4-Trimethylbenzene (Surface Wa	154	GCMS	<1	ug/L	UKAS
1,2-Dibromo-3-chloropropane (Surfac	154	GCMS	<1	ug/L	UKAS
1,2-Dibromoethane (Surface Water)	154	GCMS	<1	ug/L	UKAS
1,2-Dichlorobenzene (Surface Water)	154	GCMS	<1	ug/L	UKAS
1,2-Dichloroethane (Surface Water)	154	GCMS	<1	ug/L	UKAS
1,2-Dichloropropane (Surface Water)	154	GCMS	<1	ug/L	UKAS
1,3,5-Trimethylbenzene (Surface Wa	154	GCMS	<1	ug/L	UKAS
1,3-Dichlorobenzene (Surface Water)	154	GCMS	<1	ug/L	UKAS
1,3-Dichloropropane (Surface Water)	154	GCMS	<1	ug/L	UKAS
1,4-Dichlorobenzene (Surface Water)	154	GCMS	<1	ug/L	UKAS
2,2-Dichloropropane (Surface Water)	154	GCMS	<5.0	ug/L	
2-Chlorotoluene (Surface Water)	154	GCMS	<1	ug/L	UKAS
4-Chlorotoluene (Surface Water)	154	GCMS	<1	ug/L	UKAS
Acenaphthene (GCMS)	200	GCMS	<0.01	ug/L	

Signed : A Harman **Date : 12/03/2019**

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	12 Kilkerrin Park	**Sampled On**	**20/02/2019**
	Liosbaun Ind Est	**Date Testing Commenced**	**21/02/2019**
	Liosbaun	**Received or Collected**	**By Fitz: Pick up DS**
	Co Galway	**Condition on Receipt**	**Acceptable**
Customer PO	**JN1526**	**Date of Report**	**12/03/2019**
Customer Ref	**UP500-MF-Bottom**	**Sample Type**	**Surface Water**
Ref 2	**20/02/19 16:10**		
Ref 3			

CERTIFICATE OF ANALYSIS

Test Parameter	SOP	Analytical Technique	Result	Units	Acc.
Acenaphthylene (GCMS)	200	GCMS	<0.01	ug/L	
Ammonia (Surface Water)	114	Colorimetry	0.20	mg/L as N	UKAS
Anthracene (GCMS)	200	GCMS	<0.01	ug/L	
Antimony (Surface Water)	177	ICPMS	123	ug/L	UKAS
Arsenic (Surface Water)	177	ICPMS	126	ug/L	UKAS
Barium (Surface Water)	177	ICPMS	122	ug/L	UKAS
Benzene (Surface Water)	154	GCMS	<1	ug/L	UKAS
Benzo(a)anthracene (GCMS)	200	GCMS	<0.01	ug/L	
Benzo(a)pyrene (GCMS)	200	GCMS	<0.01	ug/L	
Benzo(g,h,i)perylene (GCMS)	200	GCMS	<0.01	ug/L	
Benzo(k)fluoranthene (GCMS)	200	GCMS	<0.01	ug/L	
Bromobenzene (Surface Water)	154	GCMS	<1	ug/L	UKAS
Bromochloromethane (Surface Water	154	GCMS	<1	ug/L	UKAS
Bromodichloromethane (Surface Wat	154	GCMS	<1	ug/L	UKAS
Bromoform (Surface Water)	154	GCMS	<1	ug/L	UKAS
Bromomethane (Surface Water)	154	GCMS	<5.0	ug/L	
Cadmium (Surface Water)	177	ICPMS	126	ug/L	UKAS
Carbon tetrachloride (Surface Water)	154	GCMS	<1	ug/L	UKAS
Chlorobenzene (Surface Water)	154	GCMS	<1	ug/L	UKAS
Chloroethane (Surface Water)	154	GCMS	<5.0	ug/L	
Chloroform (Surface Water)	154	GCMS	<1	ug/L	UKAS
Chloromethane (Surface Water)	154	GCMS	<5.0	ug/L	
Chromium (Surface Water)	177	ICPMS	125	ug/L	UKAS
Chrysene (GCMS)	200	GCMS	<0.01	ug/L	

Signed : A Harmon **Date : 12/03/2019**

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	Aqua-Fact International Services Ltd	*Date of Receipt*	**21/02/2019**
	12 Kilkerrin Park	*Sampled On*	**20/02/2019**
	Liosbaun Ind Est	*Date Testing Commenced*	**21/02/2019**
	Liosbaun	*Received or Collected*	**By Fitz: Pick up DS**
	Co Galway	*Condition on Receipt*	**Acceptable**
Customer PO	**JN1526**	*Date of Report*	**12/03/2019**
Customer Ref	**UP500-MF-Bottom**	*Sample Type*	**Surface Water**
Ref 2	**20/02/19 16:10**		
Ref 3			

CERTIFICATE OF ANALYSIS

Test Parameter	SOP	Analytical Technique	Result	Units	Acc.
cis-1,2-Dichloroethene (Surface Wat	154	GCMS	<1	ug/L	UKAS
cis-1,3-Dichloropropene (Surface Wa	154	GCMS	<1	ug/L	UKAS
COD (Surface Water)	107	Colorimetry	935	mg/L	UKAS
Copper (Surface Water)	177	ICPMS	116	ug/L	UKAS
Coronene (GCMS)	200	GCMS	<0.01	ug/L	
Dibenzo(a,h)anthracene (GCMS)	200	GCMS	<0.01	ug/L	
Dibromochloromethane (Surface Wat	154	GCMS	<1	ug/L	UKAS
Dibromomethane (Surface Water)	154	GCMS	<1	ug/L	UKAS
Dichlorodifluoromethane (Surface W	154	GCMS	<5.0	ug/L	
Dichloromethane (Surface Water)	154	GCMS	<5.0	ug/L	
Ethylbenzene (Surface Water)	154	GCMS	<1	ug/L	UKAS
Fluoranthene (GCMS)	200	GCMS	<0.01	ug/L	
Fluorene (GCMS)	200	GCMS	<0.01	ug/L	
Hexachlorobutadiene (Surface Water	154	GCMS	<1	ug/L	UKAS
Indeno(1,2,3-cd)pyrene (GCMS)	200	GCMS	<0.01	ug/L	
Isopropylbenzene (Surface Water)	154	GCMS	<1	ug/L	UKAS
Lead (Surface Water)	177	ICPMS	125	ug/L	UKAS
m- & p-Xylene (Surface Water)	154	GCMS	<1	ug/L	UKAS
Mercury (Surface water)	178	ICPMS	<0.03	ug/L	UKAS
Molybdenum	226	ICPMS	8	ug/L	
Naphthalene (Surface Water)	154	GCMS	<1	ug/L	UKAS
n-Butylbenzene (Surface Water)	154	GCMS	<1	ug/L	UKAS
Nickel (Surface Water)	177	ICPMS	125	ug/L	UKAS
Nitrogen (Total Kjeldahl)	104	Digestion/ Distillation/ Titrimetr	1.12	mg/L as N	

Signed : A Harmon ***Date : 12/03/2019***

Aoife Harmon - Technical Supervisor

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ilac-MRA UKAS TESTING 2802

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Customer	**Caroline Roche**	***Lab Report Ref. No.***	**0529/002/06**
	Aqua-Fact International Services Ltd	***Date of Receipt***	**21/02/2019**
	12 Kilkerrin Park	***Sampled On***	**20/02/2019**
	Liosbaun Ind Est	***Date Testing Commenced***	**21/02/2019**
	Liosbaun	***Received or Collected***	**By Fitz: Pick up DS**
	Co Galway	***Condition on Receipt***	**Acceptable**
Customer PO	**JN1526**	***Date of Report***	**12/03/2019**
Customer Ref	**UP500-MF-Bottom**	***Sample Type***	**Surface Water**
Ref 2	**20/02/19 16:10**		
Ref 3			

CERTIFICATE OF ANALYSIS

Test Parameter	SOP	Analytical Technique	Result	Units	Acc.
Nitrogen (Total Oxidised) (Surface W	151	Colorimetry	1.32	mg/L as N	UKAS
Nitrogen (Total)	0	Calculation	2.44	mg/L as N	
n-Propylbenzene (Surface Water)	154	GCMS	<1.0	ug/L	UKAS
o-Xylene (Surface Water)	154	GCMS	<1	ug/L	UKAS
Phenanthrene (GCMS)	200	GCMS	<0.01	ug/L	
Phenols (Total)	223	GCMS	<0.10	ug/L	
Phosphorus (Total) Surface Water	166	Colorimetry	0.121	mg/L as P	UKAS
p-Isopropyltoluene (Surface Water)	154	GCMS	<1	ug/L	UKAS
Polyaromatic Hydrocarbons (GCMS)	200	GCMS	<0.01	ug/L	
Pyrene (GCMS)	200	GCMS	<0.01	ug/L	
sec-Butylbenzene (Surface Water)	154	GCMS	<1	ug/L	UKAS
Selenium (Surface Water)	177	ICPMS	126	ug/L	UKAS
Solids (Total Dissolved)	105	Filtration/ Evaporation @ 180C	17558	mg/L	
Styrene (Surface Water)	154	GCMS	<1	ug/L	UKAS
tert-Butylbenzene (Surface Water)	154	GCMS	<1	ug/L	UKAS
Tetrachloroethene (Surface Water)	154	GCMS	<1	ug/L	UKAS
TOC (Surface Water)	316	TOC Analyser	4.8	mg/L	UKAS
Toluene (Surface Water)	154	GCMS	<1	ug/L	UKAS
Total Inorganic Nitrogen	0	Calculation	1.5	mg/L	
trans-1,2-Dichloroethene (Surface W	154	GCMS	<1	ug/L	UKAS
trans-1,3-Dichloropropene (Surface	154	GCMS	<1	ug/L	UKAS
Trichloroethene (Surface Water)	154	GCMS	<1.0	ug/L	
Trichlorofluoromethane (Surface Wat	154	GCMS	<1	ug/L	UKAS
Vanadium (Surface Water)	177	ICPMS	126	ug/L	UKAS

Signed : A Harman

Date : 12/03/2019

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	12 Kilkerrin Park	*Sampled On*	**20/02/2019**
	Liosbaun Ind Est	*Date Testing Commenced*	**21/02/2019**
	Liosbaun	*Received or Collected*	**By Fitz: Pick up DS**
	Co Galway	*Condition on Receipt*	**Acceptable**
Customer PO	**JN1526**	*Date of Report*	**12/03/2019**
Customer Ref	**UP500-MF-Bottom**	*Sample Type*	**Surface Water**
Ref 2	**20/02/19 16:10**		
Ref 3			

CERTIFICATE OF ANALYSIS

Test Parameter	SOP	Analytical Technique	Result	Units	Acc.
Vinyl chloride (Surface Water)	154	GCMS	<1	ug/L	UKAS
Volatile Organic Compounds	154	GCMS	<5.0	ug/L	
Xylene Total (Surface Water)	154	GCMS	<1	ug/L	UKAS
Zinc (Surface Water)	177	ICPMS	82	ug/L	UKAS

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Customer	**Caroline Roche**	***Lab Report Ref. No.***	**0529/002/16**
	Aqua-Fact International Services Ltd	***Date of Receipt***	**21/02/2019**
	12 Kilkerrin Park	***Sampled On***	**20/02/2019**
	Liosbaun Ind Est	***Date Testing Commenced***	**21/02/2019**
	Liosbaun	***Received or Collected***	**By Fitz: Pick up DS**
	Co Galway	***Condition on Receipt***	**Acceptable**
Customer PO	**JN1526**	***Date of Report***	**12/03/2019**
Customer Ref	**DOWN500-ME-Surface**	***Sample Type***	**Surface Water**
Ref 2	**20/02/19 11:00**		
Ref 3			

CERTIFICATE OF ANALYSIS

Test Parameter	SOP	Analytical Technique	Result	Units	Acc.
1,1,1,2-Tetrachloroethane (Surface	154	GCMS	<1	ug/L	UKAS
1,1,1-Trichloroethane (Surface Water	154	GCMS	<1	ug/L	UKAS
1,1,2,2-Tetrachloroethane (Surface	154	GCMS	<5.0	ug/L	
1,1,2-Trichloroethane (Surface Water	154	GCMS	<2	ug/L	UKAS
1,1-Dichloroethane (Surface Water)	154	GCMS	<1	ug/L	UKAS
1,1-Dichloroethene (Surface Water)	154	GCMS	<1	ug/L	UKAS
1,1-Dichloropropene (Surface Water)	154	GCMS	<1	ug/L	UKAS
1,2,3-Trichlorobenzene (Surface Wat	154	GCMS	<1	ug/L	UKAS
1,2,3-Trichloropropane (Surface Wat	154	GCMS	<0.9	ug/L	UKAS
1,2,4-Trichlorobenzene (Surface Wat	154	GCMS	<0.6	ug/L	UKAS
1,2,4-Trimethylbenzene (Surface Wa	154	GCMS	<1	ug/L	UKAS
1,2-Dibromo-3-chloropropane (Surfac	154	GCMS	<1	ug/L	UKAS
1,2-Dibromoethane (Surface Water)	154	GCMS	<1	ug/L	UKAS
1,2-Dichlorobenzene (Surface Water)	154	GCMS	<1	ug/L	UKAS
1,2-Dichloroethane (Surface Water)	154	GCMS	<1	ug/L	UKAS
1,2-Dichloropropane (Surface Water)	154	GCMS	<1	ug/L	UKAS
1,3,5-Trimethylbenzene (Surface Wa	154	GCMS	<1	ug/L	UKAS
1,3-Dichlorobenzene (Surface Water)	154	GCMS	<1	ug/L	UKAS
1,3-Dichloropropane (Surface Water)	154	GCMS	<1	ug/L	UKAS
1,4-Dichlorobenzene (Surface Water)	154	GCMS	<1	ug/L	UKAS
2,2-Dichloropropane (Surface Water)	154	GCMS	<5.0	ug/L	
2-Chlorotoluene (Surface Water)	154	GCMS	<1	ug/L	UKAS
4-Chlorotoluene (Surface Water)	154	GCMS	<1	ug/L	UKAS
Acenaphthene (GCMS)	200	GCMS	<0.01	ug/L	

Signed : A Harman ***Date : 12/03/2019***

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Customer	Caroline Roche Aqua-Fact International Services Ltd 12 Kilkerrin Park Liosbaun Ind Est Liosbaun Co Galway	*Lab Report Ref. No.*	0529/002/16
		Date of Receipt	21/02/2019
		Sampled On	20/02/2019
		Date Testing Commenced	21/02/2019
		Received or Collected	By Fitz: Pick up DS
		Condition on Receipt	Acceptable
Customer PO	JN1526	*Date of Report*	12/03/2019
Customer Ref	DOWN500-ME-Surface	*Sample Type*	Surface Water
Ref 2	20/02/19 11:00		
Ref 3			

CERTIFICATE OF ANALYSIS

Test Parameter	SOP	Analytical Technique	Result	Units	Acc.
Acenaphthylene (GCMS)	200	GCMS	<0.01	ug/L	
Ammonia (Surface Water)	114	Colorimetry	0.21	mg/L as N	UKAS
Anthracene (GCMS)	200	GCMS	<0.01	ug/L	
Antimony (Surface Water)	177	ICPMS	83	ug/L	UKAS
Arsenic (Surface Water)	177	ICPMS	85	ug/L	UKAS
Barium (Surface Water)	177	ICPMS	82	ug/L	UKAS
Benzene (Surface Water)	154	GCMS	<1	ug/L	UKAS
Benzo(a)anthracene (GCMS)	200	GCMS	<0.01	ug/L	
Benzo(a)pyrene (GCMS)	200	GCMS	<0.01	ug/L	
Benzo(g,h,i)perylene (GCMS)	200	GCMS	<0.01	ug/L	
Benzo(k)fluoranthene (GCMS)	200	GCMS	<0.01	ug/L	
Bromobenzene (Surface Water)	154	GCMS	<1	ug/L	UKAS
Bromochloromethane (Surface Water	154	GCMS	<1	ug/L	UKAS
Bromodichloromethane (Surface Wat	154	GCMS	<1	ug/L	UKAS
Bromoform (Surface Water)	154	GCMS	<1	ug/L	UKAS
Bromomethane (Surface Water)	154	GCMS	<5.0	ug/L	
Cadmium (Surface Water)	177	ICPMS	85	ug/L	UKAS
Carbon tetrachloride (Surface Water)	154	GCMS	<1	ug/L	UKAS
Chlorobenzene (Surface Water)	154	GCMS	<1	ug/L	UKAS
Chloroethane (Surface Water)	154	GCMS	<5.0	ug/L	
Chloroform (Surface Water)	154	GCMS	<1	ug/L	UKAS
Chloromethane (Surface Water)	154	GCMS	<5.0	ug/L	
Chromium (Surface Water)	177	ICPMS	85	ug/L	UKAS
Chrysene (GCMS)	200	GCMS	<0.01	ug/L	

Signed : A Harman

Date : 12/03/2019

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Customer	Caroline Roche Aqua-Fact International Services Ltd 12 Kilkerrin Park Liosbaun Ind Est Liosbaun Co Galway	*Lab Report Ref. No.*	0529/002/16
		Date of Receipt	21/02/2019
		Sampled On	20/02/2019
		Date Testing Commenced	21/02/2019
		Received or Collected	By Fitz: Pick up DS
		Condition on Receipt	Acceptable
Customer PO	JN1526	*Date of Report*	12/03/2019
Customer Ref	DOWN500-ME-Surface	*Sample Type*	Surface Water
Ref 2	20/02/19 11:00		
Ref 3			

CERTIFICATE OF ANALYSIS

Test Parameter	SOP	Analytical Technique	Result	Units	Acc.
cis-1,2-Dichloroethene (Surface Wat	154	GCMS	<1	ug/L	UKAS
cis-1,3-Dichloropropene (Surface Wa	154	GCMS	<1	ug/L	UKAS
COD (Surface Water)	107	Colorimetry	126	mg/L	UKAS
Copper (Surface Water)	177	ICPMS	75	ug/L	UKAS
Coronene (GCMS)	200	GCMS	<0.01	ug/L	
Dibenzo(a,h)anthracene (GCMS)	200	GCMS	<0.01	ug/L	
Dibromochloromethane (Surface Wat	154	GCMS	<1	ug/L	UKAS
Dibromomethane (Surface Water)	154	GCMS	<1	ug/L	UKAS
Dichlorodifluoromethane (Surface W	154	GCMS	<5.0	ug/L	
Dichloromethane (Surface Water)	154	GCMS	<5.0	ug/L	
Ethylbenzene (Surface Water)	154	GCMS	<1	ug/L	UKAS
Fluoranthene (GCMS)	200	GCMS	<0.01	ug/L	
Fluorene (GCMS)	200	GCMS	<0.01	ug/L	
Hexachlorobutadiene (Surface Water	154	GCMS	<1	ug/L	UKAS
Indeno(1,2,3-cd)pyrene (GCMS)	200	GCMS	<0.01	ug/L	
Isopropylbenzene (Surface Water)	154	GCMS	<1	ug/L	UKAS
Lead (Surface Water)	177	ICPMS	85	ug/L	UKAS
m- & p-Xylene (Surface Water)	154	GCMS	<1	ug/L	UKAS
Mercury (Surface water)	178	ICPMS	<0.03	ug/L	UKAS
Molybdenum	226	ICPMS	5	ug/L	
Naphthalene (Surface Water)	154	GCMS	<1	ug/L	UKAS
n-Butylbenzene (Surface Water)	154	GCMS	<1	ug/L	UKAS
Nickel (Surface Water)	177	ICPMS	85	ug/L	UKAS
Nitrogen (Total Kjeldahl)	104	Digestion/ Distillation/ Titrimetr	1.12	mg/L as N	

Signed : A Harmon

Date : 12/03/2019

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	Aqua-Fact International Services Ltd	*Date of Receipt*	**21/02/2019**
	12 Kilkerrin Park	*Sampled On*	**20/02/2019**
	Liosbaun Ind Est	*Date Testing Commenced*	**21/02/2019**
	Liosbaun	*Received or Collected*	**By Fitz: Pick up DS**
	Co Galway	*Condition on Receipt*	**Acceptable**
Customer PO	**JN1526**	*Date of Report*	**12/03/2019**
Customer Ref	**DOWN500-ME-Surface**	*Sample Type*	**Surface Water**
Ref 2	**20/02/19 11:00**		
Ref 3			

CERTIFICATE OF ANALYSIS

Test Parameter	SOP	Analytical Technique	Result	Units	Acc.
Nitrogen (Total Oxidised) (Surface W	151	Colorimetry	1.33	mg/L as N	UKAS
Nitrogen (Total)	0	Calculation	2.45	mg/L as N	
n-Propylbenzene (Surface Water)	154	GCMS	<1.0	ug/L	UKAS
o-Xylene (Surface Water)	154	GCMS	<1	ug/L	UKAS
Phenanthrene (GCMS)	200	GCMS	<0.01	ug/L	
Phenols (Total)	223	GCMS	<0.10	ug/L	
Phosphorus (Total) Surface Water	166	Colorimetry	0.089	mg/L as P	UKAS
p-Isopropyltoluene (Surface Water)	154	GCMS	<1	ug/L	UKAS
Polyaromatic Hydrocarbons (GCMS)	200	GCMS	<0.01	ug/L	
Pyrene (GCMS)	200	GCMS	<0.01	ug/L	
sec-Butylbenzene (Surface Water)	154	GCMS	<1	ug/L	UKAS
Selenium (Surface Water)	177	ICPMS	85	ug/L	UKAS
Solids (Total Dissolved)	105	Filtration/ Evaporation @ 180C	13501	mg/L	
Styrene (Surface Water)	154	GCMS	<1	ug/L	UKAS
tert-Butylbenzene (Surface Water)	154	GCMS	<1	ug/L	UKAS
Tetrachloroethene (Surface Water)	154	GCMS	<1	ug/L	UKAS
TOC (Surface Water)	316	TOC Analyser	5.4	mg/L	UKAS
Toluene (Surface Water)	154	GCMS	<1	ug/L	UKAS
Total Inorganic Nitrogen	0	Calculation	1.5	mg/L	
trans-1,2-Dichloroethene (Surface W	154	GCMS	<1	ug/L	UKAS
trans-1,3-Dichloropropene (Surface	154	GCMS	<1	ug/L	UKAS
Trichloroethene (Surface Water)	154	GCMS	<1.0	ug/L	
Trichlorofluoromethane (Surface Wat	154	GCMS	<1	ug/L	UKAS
Vanadium (Surface Water)	177	ICPMS	85	ug/L	UKAS

Signed : A Harman ***Date : 12/03/2019***

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	Aqua-Fact International Services Ltd	***Date of Receipt***	**21/02/2019**
	12 Kilkerrin Park	***Sampled On***	**20/02/2019**
	Liosbaun Ind Est	***Date Testing Commenced***	**21/02/2019**
	Liosbaun	***Received or Collected***	**By Fitz: Pick up DS**
	Co Galway	***Condition on Receipt***	**Acceptable**
Customer PO	**JN1526**	***Date of Report***	**12/03/2019**
Customer Ref	**DOWN500-ME-Surface**	***Sample Type***	**Surface Water**
Ref 2	**20/02/19 11:00**		
Ref 3			

CERTIFICATE OF ANALYSIS

Test Parameter	SOP	Analytical Technique	Result	Units	Acc.
Vinyl chloride (Surface Water)	154	GCMS	<1	ug/L	UKAS
Volatile Organic Compounds	154	GCMS	<5.0	ug/L	
Xylene Total (Surface Water)	154	GCMS	<1	ug/L	UKAS
Zinc (Surface Water)	177	ICPMS	42	ug/L	UKAS

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Customer	Caroline Roche Aqua-Fact International Services Ltd 12 Kilkerrin Park Liosbaun Ind Est Liosbaun Co Galway	*Lab Report Ref. No.*	0529/002/17
		Date of Receipt	21/02/2019
		Sampled On	20/02/2019
		Date Testing Commenced	21/02/2019
		Received or Collected	By Fitz: Pick up DS
		Condition on Receipt	Acceptable
Customer PO	JN1526	*Date of Report*	12/03/2019
Customer Ref	DOWN500-ME-Middle	*Sample Type*	Surface Water
Ref 2	20/02/19 11:05		
Ref 3			

CERTIFICATE OF ANALYSIS

Test Parameter	SOP	Analytical Technique	Result	Units	Acc.
1,1,1,2-Tetrachloroethane (Surface	154	GCMS	<1	ug/L	UKAS
1,1,1-Trichloroethane (Surface Water	154	GCMS	<1	ug/L	UKAS
1,1,2,2-Tetrachloroethane (Surface	154	GCMS	<5.0	ug/L	
1,1,2-Trichloroethane (Surface Water	154	GCMS	<2	ug/L	UKAS
1,1-Dichloroethane (Surface Water)	154	GCMS	<1	ug/L	UKAS
1,1-Dichloroethene (Surface Water)	154	GCMS	<1	ug/L	UKAS
1,1-Dichloropropene (Surface Water)	154	GCMS	<1	ug/L	UKAS
1,2,3-Trichlorobenzene (Surface Wat	154	GCMS	<1	ug/L	UKAS
1,2,3-Trichloropropane (Surface Wat	154	GCMS	<0.9	ug/L	UKAS
1,2,4-Trichlorobenzene (Surface Wat	154	GCMS	<0.6	ug/L	UKAS
1,2,4-Trimethylbenzene (Surface Wa	154	GCMS	<1	ug/L	UKAS
1,2-Dibromo-3-chloropropane (Surfac	154	GCMS	<1	ug/L	UKAS
1,2-Dibromoethane (Surface Water)	154	GCMS	<1	ug/L	UKAS
1,2-Dichlorobenzene (Surface Water)	154	GCMS	<1	ug/L	UKAS
1,2-Dichloroethane (Surface Water)	154	GCMS	<1	ug/L	UKAS
1,2-Dichloropropane (Surface Water)	154	GCMS	<1	ug/L	UKAS
1,3,5-Trimethylbenzene (Surface Wa	154	GCMS	<1	ug/L	UKAS
1,3-Dichlorobenzene (Surface Water)	154	GCMS	<1	ug/L	UKAS
1,3-Dichloropropane (Surface Water)	154	GCMS	<1	ug/L	UKAS
1,4-Dichlorobenzene (Surface Water)	154	GCMS	<1	ug/L	UKAS
2,2-Dichloropropane (Surface Water)	154	GCMS	<5.0	ug/L	
2-Chlorotoluene (Surface Water)	154	GCMS	<1	ug/L	UKAS
4-Chlorotoluene (Surface Water)	154	GCMS	<1	ug/L	UKAS
Acenaphthene (GCMS)	200	GCMS	<0.01	ug/L	

Signed : A Harman ***Date : 12/03/2019***

Aoife Harmon - Technical Supervisor

Acc. : Accredited Parameters by ISO 17025:2005
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ilac-MRA UKAS TESTING 2802

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Monitoring and Testing Services

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Customer	**Caroline Roche**	***Lab Report Ref. No.***	**0529/002/17**
	Aqua-Fact International Services Ltd	***Date of Receipt***	**21/02/2019**
	12 Kilkerrin Park	***Sampled On***	**20/02/2019**
	Liosbaun Ind Est	***Date Testing Commenced***	**21/02/2019**
	Liosbaun	***Received or Collected***	**By Fitz: Pick up DS**
	Co Galway	***Condition on Receipt***	**Acceptable**
Customer PO	**JN1526**	***Date of Report***	**12/03/2019**
Customer Ref	**DOWN500-ME-Middle**	***Sample Type***	**Surface Water**
Ref 2	**20/02/19 11:05**		
Ref 3			

CERTIFICATE OF ANALYSIS

Test Parameter	SOP	Analytical Technique	Result	Units	Acc.
Acenaphthylene (GCMS)	200	GCMS	<0.01	ug/L	
Ammonia (Surface Water)	114	Colorimetry	0.25	mg/L as N	UKAS
Anthracene (GCMS)	200	GCMS	<0.01	ug/L	
Antimony (Surface Water)	177	ICPMS	84	ug/L	UKAS
Arsenic (Surface Water)	177	ICPMS	86	ug/L	UKAS
Barium (Surface Water)	177	ICPMS	83	ug/L	UKAS
Benzene (Surface Water)	154	GCMS	<1	ug/L	UKAS
Benzo(a)anthracene (GCMS)	200	GCMS	<0.01	ug/L	
Benzo(a)pyrene (GCMS)	200	GCMS	<0.01	ug/L	
Benzo(g,h,i)perylene (GCMS)	200	GCMS	<0.01	ug/L	
Benzo(k)fluoranthene (GCMS)	200	GCMS	<0.01	ug/L	
Bromobenzene (Surface Water)	154	GCMS	<1	ug/L	UKAS
Bromochloromethane (Surface Water	154	GCMS	<1	ug/L	UKAS
Bromodichloromethane (Surface Wat	154	GCMS	<1	ug/L	UKAS
Bromoform (Surface Water)	154	GCMS	<1	ug/L	UKAS
Bromomethane (Surface Water)	154	GCMS	<5.0	ug/L	
Cadmium (Surface Water)	177	ICPMS	87	ug/L	UKAS
Carbon tetrachloride (Surface Water)	154	GCMS	<1	ug/L	UKAS
Chlorobenzene (Surface Water)	154	GCMS	<1	ug/L	UKAS
Chloroethane (Surface Water)	154	GCMS	<5.0	ug/L	
Chloroform (Surface Water)	154	GCMS	<1	ug/L	UKAS
Chloromethane (Surface Water)	154	GCMS	<5.0	ug/L	
Chromium (Surface Water)	177	ICPMS	86	ug/L	UKAS
Chrysene (GCMS)	200	GCMS	<0.01	ug/L	

Signed : A Harman

Date : 12/03/2019

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Customer Ref	**DOWN500-ME-Middle**	***Sample Type***	**Surface Water**
Ref 2	**20/02/19 11:05**		
Ref 3			

CERTIFICATE OF ANALYSIS

Test Parameter	SOP	Analytical Technique	Result	Units	Acc.
cis-1,2-Dichloroethene (Surface Wat	154	GCMS	<1	ug/L	UKAS
cis-1,3-Dichloropropene (Surface Wa	154	GCMS	<1	ug/L	UKAS
COD (Surface Water)	107	Colorimetry	125	mg/L	UKAS
Copper (Surface Water)	177	ICPMS	76	ug/L	UKAS
Coronene (GCMS)	200	GCMS	<0.01	ug/L	
Dibenzo(a,h)anthracene (GCMS)	200	GCMS	<0.01	ug/L	
Dibromochloromethane (Surface Wat	154	GCMS	<1	ug/L	UKAS
Dibromomethane (Surface Water)	154	GCMS	<1	ug/L	UKAS
Dichlorodifluoromethane (Surface W	154	GCMS	<5.0	ug/L	
Dichloromethane (Surface Water)	154	GCMS	<5.0	ug/L	
Ethylbenzene (Surface Water)	154	GCMS	<1	ug/L	UKAS
Fluoranthene (GCMS)	200	GCMS	<0.01	ug/L	
Fluorene (GCMS)	200	GCMS	<0.01	ug/L	
Hexachlorobutadiene (Surface Water	154	GCMS	<1	ug/L	UKAS
Indeno(1,2,3-cd)pyrene (GCMS)	200	GCMS	<0.01	ug/L	
Isopropylbenzene (Surface Water)	154	GCMS	<1	ug/L	UKAS
Lead (Surface Water)	177	ICPMS	86	ug/L	UKAS
m- & p-Xylene (Surface Water)	154	GCMS	<1	ug/L	UKAS
Mercury (Surface water)	178	ICPMS	<0.03	ug/L	UKAS
Molybdenum	226	ICPMS	<5	ug/L	
Naphthalene (Surface Water)	154	GCMS	<1	ug/L	UKAS
n-Butylbenzene (Surface Water)	154	GCMS	<1	ug/L	UKAS
Nickel (Surface Water)	177	ICPMS	86	ug/L	UKAS
Nitrogen (Total Kjeldahl)	104	Digestion/ Distillation/ Titrimetr	1.40	mg/L as N	

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Customer Ref	**DOWN500-ME-Middle**	***Sample Type***	**Surface Water**
Ref 2	**20/02/19 11:05**		
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CERTIFICATE OF ANALYSIS

Test Parameter	SOP	Analytical Technique	Result	Units	Acc.
Nitrogen (Total Oxidised) (Surface W	151	Colorimetry	1.32	mg/L as N	UKAS
Nitrogen (Total)	0	Calculation	2.72	mg/L as N	
n-Propylbenzene (Surface Water)	154	GCMS	<1.0	ug/L	UKAS
o-Xylene (Surface Water)	154	GCMS	<1	ug/L	UKAS
Phenanthrene (GCMS)	200	GCMS	<0.01	ug/L	
Phenols (Total)	223	GCMS	<0.10	ug/L	
Phosphorus (Total) Surface Water	166	Colorimetry	0.086	mg/L as P	UKAS
p-Isopropyltoluene (Surface Water)	154	GCMS	<1	ug/L	UKAS
Polyaromatic Hydrocarbons (GCMS)	200	GCMS	<0.01	ug/L	
Pyrene (GCMS)	200	GCMS	<0.01	ug/L	
sec-Butylbenzene (Surface Water)	154	GCMS	<1	ug/L	UKAS
Selenium (Surface Water)	177	ICPMS	86	ug/L	UKAS
Solids (Total Dissolved)	105	Filtration/ Evaporation @ 180C	14045	mg/L	
Styrene (Surface Water)	154	GCMS	<1	ug/L	UKAS
tert-Butylbenzene (Surface Water)	154	GCMS	<1	ug/L	UKAS
Tetrachloroethene (Surface Water)	154	GCMS	<1	ug/L	UKAS
TOC (Surface Water)	316	TOC Analyser	5.3	mg/L	UKAS
Toluene (Surface Water)	154	GCMS	<1	ug/L	UKAS
Total Inorganic Nitrogen	0	Calculation	1.6	mg/L	
trans-1,2-Dichloroethene (Surface W	154	GCMS	<1	ug/L	UKAS
trans-1,3-Dichloropropene (Surface	154	GCMS	<1	ug/L	UKAS
Trichloroethene (Surface Water)	154	GCMS	<1.0	ug/L	
Trichlorofluoromethane (Surface Wat	154	GCMS	<1	ug/L	UKAS
Vanadium (Surface Water)	177	ICPMS	87	ug/L	UKAS

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Customer Ref	**DOWN500-ME-Middle**	***Sample Type***	**Surface Water**
Ref 2	**20/02/19 11:05**		
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CERTIFICATE OF ANALYSIS

Test Parameter	SOP	Analytical Technique	Result	Units	Acc.
Vinyl chloride (Surface Water)	154	GCMS	<1	ug/L	UKAS
Volatile Organic Compounds	154	GCMS	<5.0	ug/L	
Xylene Total (Surface Water)	154	GCMS	<1	ug/L	UKAS
Zinc (Surface Water)	177	ICPMS	43	ug/L	UKAS

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	Liosbaun Ind Est	*Date Testing Commenced*	**21/02/2019**
	Liosbaun	*Received or Collected*	**By Fitz: Pick up DS**
	Co Galway	*Condition on Receipt*	**Acceptable**
Customer PO	**JN1526**	*Date of Report*	**12/03/2019**
Customer Ref	**DOWN500 - ME- Bottom**	*Sample Type*	**Surface Water**
Ref 2	**20/02/19 11:10**		
Ref 3			

CERTIFICATE OF ANALYSIS

Test Parameter	SOP	Analytical Technique	Result	Units	Acc.
1,1,1,2-Tetrachloroethane (Surface	154	GCMS	<1	ug/L	UKAS
1,1,1-Trichloroethane (Surface Water	154	GCMS	<1	ug/L	UKAS
1,1,2,2-Tetrachloroethane (Surface	154	GCMS	<5.0	ug/L	
1,1,2-Trichloroethane (Surface Water	154	GCMS	<2	ug/L	UKAS
1,1-Dichloroethane (Surface Water)	154	GCMS	<1	ug/L	UKAS
1,1-Dichloroethene (Surface Water)	154	GCMS	<1	ug/L	UKAS
1,1-Dichloropropene (Surface Water)	154	GCMS	<1	ug/L	UKAS
1,2,3-Trichlorobenzene (Surface Wat	154	GCMS	<1	ug/L	UKAS
1,2,3-Trichloropropane (Surface Wat	154	GCMS	<0.9	ug/L	UKAS
1,2,4-Trichlorobenzene (Surface Wat	154	GCMS	<0.6	ug/L	UKAS
1,2,4-Trimethylbenzene (Surface Wa	154	GCMS	<1	ug/L	UKAS
1,2-Dibromo-3-chloropropane (Surfac	154	GCMS	<1	ug/L	UKAS
1,2-Dibromoethane (Surface Water)	154	GCMS	<1	ug/L	UKAS
1,2-Dichlorobenzene (Surface Water)	154	GCMS	<1	ug/L	UKAS
1,2-Dichloroethane (Surface Water)	154	GCMS	<1	ug/L	UKAS
1,2-Dichloropropane (Surface Water)	154	GCMS	<1	ug/L	UKAS
1,3,5-Trimethylbenzene (Surface Wa	154	GCMS	<1	ug/L	UKAS
1,3-Dichlorobenzene (Surface Water)	154	GCMS	<1	ug/L	UKAS
1,3-Dichloropropane (Surface Water)	154	GCMS	<1	ug/L	UKAS
1,4-Dichlorobenzene (Surface Water)	154	GCMS	<1	ug/L	UKAS
2,2-Dichloropropane (Surface Water)	154	GCMS	<5.0	ug/L	
2-Chlorotoluene (Surface Water)	154	GCMS	<1	ug/L	UKAS
4-Chlorotoluene (Surface Water)	154	GCMS	<1	ug/L	UKAS
Acenaphthene (GCMS)	200	GCMS	<0.01	ug/L	

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CERTIFICATE OF ANALYSIS

Test Parameter	SOP	Analytical Technique	Result	Units	Acc.
Acenaphthylene (GCMS)	200	GCMS	<0.01	ug/L	
Ammonia (Surface Water)	114	Colorimetry	0.23	mg/L as N	UKAS
Anthracene (GCMS)	200	GCMS	<0.01	ug/L	
Antimony (Surface Water)	177	ICPMS	87	ug/L	UKAS
Arsenic (Surface Water)	177	ICPMS	89	ug/L	UKAS
Barium (Surface Water)	177	ICPMS	86	ug/L	UKAS
Benzene (Surface Water)	154	GCMS	<1	ug/L	UKAS
Benzo(a)anthracene (GCMS)	200	GCMS	<0.01	ug/L	
Benzo(a)pyrene (GCMS)	200	GCMS	<0.01	ug/L	
Benzo(g,h,i)perylene (GCMS)	200	GCMS	<0.01	ug/L	
Benzo(k)fluoranthene (GCMS)	200	GCMS	<0.01	ug/L	
Bromobenzene (Surface Water)	154	GCMS	<1	ug/L	UKAS
Bromochloromethane (Surface Water	154	GCMS	<1	ug/L	UKAS
Bromodichloromethane (Surface Wat	154	GCMS	<1	ug/L	UKAS
Bromoform (Surface Water)	154	GCMS	<1	ug/L	UKAS
Bromomethane (Surface Water)	154	GCMS	<5.0	ug/L	
Cadmium (Surface Water)	177	ICPMS	89	ug/L	UKAS
Carbon tetrachloride (Surface Water)	154	GCMS	<1	ug/L	UKAS
Chlorobenzene (Surface Water)	154	GCMS	<1	ug/L	UKAS
Chloroethane (Surface Water)	154	GCMS	<5.0	ug/L	
Chloroform (Surface Water)	154	GCMS	<1	ug/L	UKAS
Chloromethane (Surface Water)	154	GCMS	<5.0	ug/L	
Chromium (Surface Water)	177	ICPMS	89	ug/L	UKAS
Chrysene (GCMS)	200	GCMS	<0.01	ug/L	

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Customer Ref	DOWN500 - ME- Bottom	*Sample Type*	Surface Water
Ref 2	20/02/19 11:10		
Ref 3			

CERTIFICATE OF ANALYSIS

Test Parameter	SOP	Analytical Technique	Result	Units	Acc.
cis-1,2-Dichloroethene (Surface Wat	154	GCMS	<1	ug/L	UKAS
cis-1,3-Dichloropropene (Surface Wa	154	GCMS	<1	ug/L	UKAS
COD (Surface Water)	107	Colorimetry	132	mg/L	UKAS
Copper (Surface Water)	177	ICPMS	79	ug/L	UKAS
Coronene (GCMS)	200	GCMS	<0.01	ug/L	
Dibenzo(a,h)anthracene (GCMS)	200	GCMS	<0.01	ug/L	
Dibromochloromethane (Surface Wat	154	GCMS	<1	ug/L	UKAS
Dibromomethane (Surface Water)	154	GCMS	<1	ug/L	UKAS
Dichlorodifluoromethane (Surface W	154	GCMS	<5.0	ug/L	
Dichloromethane (Surface Water)	154	GCMS	<5.0	ug/L	
Ethylbenzene (Surface Water)	154	GCMS	<1	ug/L	UKAS
Fluoranthene (GCMS)	200	GCMS	<0.01	ug/L	
Fluorene (GCMS)	200	GCMS	<0.01	ug/L	
Hexachlorobutadiene (Surface Water	154	GCMS	<1	ug/L	UKAS
Indeno(1,2,3-cd)pyrene (GCMS)	200	GCMS	<0.01	ug/L	
Isopropylbenzene (Surface Water)	154	GCMS	<1	ug/L	UKAS
Lead (Surface Water)	177	ICPMS	89	ug/L	UKAS
m- & p-Xylene (Surface Water)	154	GCMS	<1	ug/L	UKAS
Mercury (Surface water)	178	ICPMS	<0.03	ug/L	UKAS
Molybdenum	226	ICPMS	6	ug/L	
Naphthalene (Surface Water)	154	GCMS	<1	ug/L	UKAS
n-Butylbenzene (Surface Water)	154	GCMS	<1	ug/L	UKAS
Nickel (Surface Water)	177	ICPMS	89	ug/L	UKAS
Nitrogen (Total Kjeldahl)	104	Digestion/ Distillation/ Titrimetr	1.40	mg/L as N	

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Customer	**Caroline Roche**	*Lab Report Ref. No.*	**0529/002/18**
	Aqua-Fact International Services Ltd	*Date of Receipt*	**21/02/2019**
	12 Kilkerrin Park	*Sampled On*	**20/02/2019**
	Liosbaun Ind Est	*Date Testing Commenced*	**21/02/2019**
	Liosbaun	*Received or Collected*	**By Fitz: Pick up DS**
	Co Galway	*Condition on Receipt*	**Acceptable**
Customer PO	**JN1526**	*Date of Report*	**12/03/2019**
Customer Ref	**DOWN500 - ME- Bottom**	*Sample Type*	**Surface Water**
Ref 2	**20/02/19 11:10**		
Ref 3			

CERTIFICATE OF ANALYSIS

Test Parameter	SOP	Analytical Technique	Result	Units	Acc.
Nitrogen (Total Oxidised) (Surface W	151	Colorimetry	1.33	mg/L as N	UKAS
Nitrogen (Total)	0	Calculation	2.73	mg/L as N	
n-Propylbenzene (Surface Water)	154	GCMS	<1.0	ug/L	UKAS
o-Xylene (Surface Water)	154	GCMS	<1	ug/L	UKAS
Phenanthrene (GCMS)	200	GCMS	<0.01	ug/L	
Phenols (Total)	223	GCMS	<0.10	ug/L	
Phosphorus (Total) Surface Water	166	Colorimetry	0.115	mg/L as P	UKAS
p-Isopropyltoluene (Surface Water)	154	GCMS	<1	ug/L	UKAS
Polyaromatic Hydrocarbons (GCMS)	200	GCMS	<0.01	ug/L	
Pyrene (GCMS)	200	GCMS	<0.01	ug/L	
sec-Butylbenzene (Surface Water)	154	GCMS	<1	ug/L	UKAS
Selenium (Surface Water)	177	ICPMS	89	ug/L	UKAS
Solids (Total Dissolved)	105	Filtration/ Evaporation @ 180C	13825	mg/L	
Styrene (Surface Water)	154	GCMS	<1	ug/L	UKAS
tert-Butylbenzene (Surface Water)	154	GCMS	<1	ug/L	UKAS
Tetrachloroethene (Surface Water)	154	GCMS	<1	ug/L	UKAS
TOC (Surface Water)	316	TOC Analyser	5.5	mg/L	UKAS
Toluene (Surface Water)	154	GCMS	<1	ug/L	UKAS
Total Inorganic Nitrogen	0	Calculation	1.6	mg/L	
trans-1,2-Dichloroethene (Surface W	154	GCMS	<1	ug/L	UKAS
trans-1,3-Dichloropropene (Surface	154	GCMS	<1	ug/L	UKAS
Trichloroethene (Surface Water)	154	GCMS	<1.0	ug/L	
Trichlorofluoromethane (Surface Wat	154	GCMS	<1	ug/L	UKAS
Vanadium (Surface Water)	177	ICPMS	89	ug/L	UKAS

Signed : A Harmon **Date : 12/03/2019**

Aoife Harmon - Technical Supervisor

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ilac-MRA UKAS TESTING 2802

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	Aqua-Fact International Services Ltd	*Date of Receipt*	**21/02/2019**
	12 Kilkerrin Park	*Sampled On*	**20/02/2019**
	Liosbaun Ind Est	*Date Testing Commenced*	**21/02/2019**
	Liosbaun	*Received or Collected*	**By Fitz: Pick up DS**
	Co Galway	*Condition on Receipt*	**Acceptable**
Customer PO	**JN1526**	*Date of Report*	**12/03/2019**
Customer Ref	**DOWN500 - ME- Bottom**	*Sample Type*	**Surface Water**
Ref 2	**20/02/19 11:10**		
Ref 3			

CERTIFICATE OF ANALYSIS

Test Parameter	SOP	Analytical Technique	Result	Units	Acc.
Vinyl chloride (Surface Water)	154	GCMS	<1	ug/L	UKAS
Volatile Organic Compounds	154	GCMS	<5.0	ug/L	
Xylene Total (Surface Water)	154	GCMS	<1	ug/L	UKAS
Zinc (Surface Water)	177	ICPMS	46	ug/L	UKAS

Signed : A Harmon

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Customer	Caroline Roche Aqua-Fact International Services Ltd 12 Kilkerrin Park Liosbaun Ind Est Liosbaun Co Galway	*Lab Report Ref. No.*	0529/002/10
		Date of Receipt	21/02/2019
		Sampled On	20/02/2019
		Date Testing Commenced	21/02/2019
		Received or Collected	By Fitz: Pick up DS
		Condition on Receipt	Acceptable
Customer PO	JN1526	*Date of Report*	12/03/2019
Customer Ref	DOWN500-LW-Surface	*Sample Type*	Surface Water
Ref 2	20/02/19 13:00		
Ref 3			

CERTIFICATE OF ANALYSIS

Test Parameter	SOP	Analytical Technique	Result	Units	Acc.
1,1,1,2-Tetrachloroethane (Surface	154	GCMS	<1	ug/L	UKAS
1,1,1-Trichloroethane (Surface Water	154	GCMS	<1	ug/L	UKAS
1,1,2,2-Tetrachloroethane (Surface	154	GCMS	<5.0	ug/L	
1,1,2-Trichloroethane (Surface Water	154	GCMS	<2	ug/L	UKAS
1,1-Dichloroethane (Surface Water)	154	GCMS	<1	ug/L	UKAS
1,1-Dichloroethene (Surface Water)	154	GCMS	<1	ug/L	UKAS
1,1-Dichloropropene (Surface Water)	154	GCMS	<1	ug/L	UKAS
1,2,3-Trichlorobenzene (Surface Wat	154	GCMS	<1	ug/L	UKAS
1,2,3-Trichloropropane (Surface Wat	154	GCMS	<0.9	ug/L	UKAS
1,2,4-Trichlorobenzene (Surface Wat	154	GCMS	<0.6	ug/L	UKAS
1,2,4-Trimethylbenzene (Surface Wa	154	GCMS	<1	ug/L	UKAS
1,2-Dibromo-3-chloropropane (Surfac	154	GCMS	<1	ug/L	UKAS
1,2-Dibromoethane (Surface Water)	154	GCMS	<1	ug/L	UKAS
1,2-Dichlorobenzene (Surface Water)	154	GCMS	<1	ug/L	UKAS
1,2-Dichloroethane (Surface Water)	154	GCMS	<1	ug/L	UKAS
1,2-Dichloropropane (Surface Water)	154	GCMS	<1	ug/L	UKAS
1,3,5-Trimethylbenzene (Surface Wa	154	GCMS	<1	ug/L	UKAS
1,3-Dichlorobenzene (Surface Water)	154	GCMS	<1	ug/L	UKAS
1,3-Dichloropropane (Surface Water)	154	GCMS	<1	ug/L	UKAS
1,4-Dichlorobenzene (Surface Water)	154	GCMS	<1	ug/L	UKAS
2,2-Dichloropropane (Surface Water)	154	GCMS	<5.0	ug/L	
2-Chlorotoluene (Surface Water)	154	GCMS	<1	ug/L	UKAS
4-Chlorotoluene (Surface Water)	154	GCMS	<1	ug/L	UKAS
Acenaphthene (GCMS)	200	GCMS	<0.01	ug/L	

Signed : A Harman ***Date : 12/03/2019***

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	Aqua-Fact International Services Ltd	***Date of Receipt***	**21/02/2019**
	12 Kilkerrin Park	***Sampled On***	**20/02/2019**
	Liosbaun Ind Est	***Date Testing Commenced***	**21/02/2019**
	Liosbaun	***Received or Collected***	**By Fitz: Pick up DS**
	Co Galway	***Condition on Receipt***	**Acceptable**
Customer PO	**JN1526**	***Date of Report***	**12/03/2019**
Customer Ref	**DOWN500-LW-Surface**	***Sample Type***	**Surface Water**
Ref 2	**20/02/19 13:00**		
Ref 3			

CERTIFICATE OF ANALYSIS

Test Parameter	SOP	Analytical Technique	Result	Units	Acc.
Acenaphthylene (GCMS)	200	GCMS	<0.01	ug/L	
Ammonia (Surface Water)	114	Colorimetry	0.23	mg/L as N	UKAS
Anthracene (GCMS)	200	GCMS	<0.01	ug/L	
Antimony (Surface Water)	177	ICPMS	79	ug/L	UKAS
Arsenic (Surface Water)	177	ICPMS	81	ug/L	UKAS
Barium (Surface Water)	177	ICPMS	78	ug/L	UKAS
Benzene (Surface Water)	154	GCMS	<1	ug/L	UKAS
Benzo(a)anthracene (GCMS)	200	GCMS	<0.01	ug/L	
Benzo(a)pyrene (GCMS)	200	GCMS	<0.01	ug/L	
Benzo(g,h,i)perylene (GCMS)	200	GCMS	<0.01	ug/L	
Benzo(k)fluoranthene (GCMS)	200	GCMS	<0.01	ug/L	
Bromobenzene (Surface Water)	154	GCMS	<1	ug/L	UKAS
Bromochloromethane (Surface Water	154	GCMS	<1	ug/L	UKAS
Bromodichloromethane (Surface Wat	154	GCMS	<1	ug/L	UKAS
Bromoform (Surface Water)	154	GCMS	<1	ug/L	UKAS
Bromomethane (Surface Water)	154	GCMS	<5.0	ug/L	
Cadmium (Surface Water)	177	ICPMS	81	ug/L	UKAS
Carbon tetrachloride (Surface Water)	154	GCMS	<1	ug/L	UKAS
Chlorobenzene (Surface Water)	154	GCMS	<1	ug/L	UKAS
Chloroethane (Surface Water)	154	GCMS	<5.0	ug/L	
Chloroform (Surface Water)	154	GCMS	<1	ug/L	UKAS
Chloromethane (Surface Water)	154	GCMS	<5.0	ug/L	
Chromium (Surface Water)	177	ICPMS	81	ug/L	UKAS
Chrysene (GCMS)	200	GCMS	<0.01	ug/L	

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	Aqua-Fact International Services Ltd	*Date of Receipt*	**21/02/2019**
	12 Kilkerrin Park	*Sampled On*	**20/02/2019**
	Liosbaun Ind Est	*Date Testing Commenced*	**21/02/2019**
	Liosbaun	*Received or Collected*	**By Fitz: Pick up DS**
	Co Galway	*Condition on Receipt*	**Acceptable**
Customer PO	**JN1526**	*Date of Report*	**12/03/2019**
Customer Ref	**DOWN500-LW-Surface**	*Sample Type*	**Surface Water**
Ref 2	**20/02/19 13:00**		
Ref 3			

CERTIFICATE OF ANALYSIS

Test Parameter	SOP	Analytical Technique	Result	Units	Acc.
cis-1,2-Dichloroethene (Surface Wat	154	GCMS	<1	ug/L	UKAS
cis-1,3-Dichloropropene (Surface Wa	154	GCMS	<1	ug/L	UKAS
COD (Surface Water)	107	Colorimetry	99	mg/L	UKAS
Copper (Surface Water)	177	ICPMS	71	ug/L	UKAS
Coronene (GCMS)	200	GCMS	<0.01	ug/L	
Dibenzo(a,h)anthracene (GCMS)	200	GCMS	<0.01	ug/L	
Dibromochloromethane (Surface Wat	154	GCMS	<1	ug/L	UKAS
Dibromomethane (Surface Water)	154	GCMS	<1	ug/L	UKAS
Dichlorodifluoromethane (Surface W	154	GCMS	<5.0	ug/L	
Dichloromethane (Surface Water)	154	GCMS	<5.0	ug/L	
Ethylbenzene (Surface Water)	154	GCMS	<1	ug/L	UKAS
Fluoranthene (GCMS)	200	GCMS	<0.01	ug/L	
Fluorene (GCMS)	200	GCMS	<0.01	ug/L	
Hexachlorobutadiene (Surface Water	154	GCMS	<1	ug/L	UKAS
Indeno(1,2,3-cd)pyrene (GCMS)	200	GCMS	<0.01	ug/L	
Isopropylbenzene (Surface Water)	154	GCMS	<1	ug/L	UKAS
Lead (Surface Water)	177	ICPMS	80	ug/L	UKAS
m- & p-Xylene (Surface Water)	154	GCMS	<1	ug/L	UKAS
Mercury (Surface water)	178	ICPMS	<0.03	ug/L	UKAS
Molybdenum	226	ICPMS	<5	ug/L	
Naphthalene (Surface Water)	154	GCMS	<1	ug/L	UKAS
n-Butylbenzene (Surface Water)	154	GCMS	<1	ug/L	UKAS
Nickel (Surface Water)	177	ICPMS	80	ug/L	UKAS
Nitrogen (Total Kjeldahl)	104	Digestion/ Distillation/ Titrimetr	<1.00	mg/L as N	

Signed : A Harmon ***Date : 12/03/2019***

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	12 Kilkerrin Park	***Sampled On***	**20/02/2019**
	Liosbaun Ind Est	***Date Testing Commenced***	**21/02/2019**
	Liosbaun	***Received or Collected***	**By Fitz: Pick up DS**
	Co Galway	***Condition on Receipt***	**Acceptable**
Customer PO	**JN1526**	***Date of Report***	**12/03/2019**
Customer Ref	**DOWN500-LW-Surface**	***Sample Type***	**Surface Water**
Ref 2	**20/02/19 13:00**		
Ref 3			

CERTIFICATE OF ANALYSIS

Test Parameter	SOP	Analytical Technique	Result	Units	Acc.
Nitrogen (Total Oxidised) (Surface W	151	Colorimetry	1.36	mg/L as N	UKAS
Nitrogen (Total)	0	Calculation	2.2	mg/L as N	
n-Propylbenzene (Surface Water)	154	GCMS	<1.0	ug/L	UKAS
o-Xylene (Surface Water)	154	GCMS	<1	ug/L	UKAS
Phenanthrene (GCMS)	200	GCMS	<0.01	ug/L	
Phenols (Total)	223	GCMS	<0.10	ug/L	
Phosphorus (Total) Surface Water	166	Colorimetry	0.080	mg/L as P	UKAS
p-Isopropyltoluene (Surface Water)	154	GCMS	<1	ug/L	UKAS
Polyaromatic Hydrocarbons (GCMS)	200	GCMS	<0.01	ug/L	
Pyrene (GCMS)	200	GCMS	<0.01	ug/L	
sec-Butylbenzene (Surface Water)	154	GCMS	<1	ug/L	UKAS
Selenium (Surface Water)	177	ICPMS	81	ug/L	UKAS
Solids (Total Dissolved)	105	Filtration/ Evaporation @ 180C	12286	mg/L	
Styrene (Surface Water)	154	GCMS	<1	ug/L	UKAS
tert-Butylbenzene (Surface Water)	154	GCMS	<1	ug/L	UKAS
Tetrachloroethene (Surface Water)	154	GCMS	<1	ug/L	UKAS
TOC (Surface Water)	316	TOC Analyser	5.7	mg/L	UKAS
Toluene (Surface Water)	154	GCMS	<1	ug/L	UKAS
Total Inorganic Nitrogen	0	Calculation	1.6	mg/L	
trans-1,2-Dichloroethene (Surface W	154	GCMS	<1	ug/L	UKAS
trans-1,3-Dichloropropene (Surface	154	GCMS	<1	ug/L	UKAS
Trichloroethene (Surface Water)	154	GCMS	<1.0	ug/L	
Trichlorofluoromethane (Surface Wat	154	GCMS	<1	ug/L	UKAS
Vanadium (Surface Water)	177	ICPMS	81	ug/L	UKAS

Signed : A Harmon ***Date : 12/03/2019***

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Customer	**Caroline Roche**	*Lab Report Ref. No.*	**0529/002/10**
	Aqua-Fact International Services Ltd	*Date of Receipt*	**21/02/2019**
	12 Kilkerrin Park	*Sampled On*	**20/02/2019**
	Liosbaun Ind Est	*Date Testing Commenced*	**21/02/2019**
	Liosbaun	*Received or Collected*	**By Fitz: Pick up DS**
	Co Galway	*Condition on Receipt*	**Acceptable**
Customer PO	**JN1526**	*Date of Report*	**12/03/2019**
Customer Ref	**DOWN500-LW-Surface**	*Sample Type*	**Surface Water**
Ref 2	**20/02/19 13:00**		
Ref 3			

CERTIFICATE OF ANALYSIS

Test Parameter	SOP	Analytical Technique	Result	Units	Acc.
Vinyl chloride (Surface Water)	154	GCMS	<1	ug/L	UKAS
Volatile Organic Compounds	154	GCMS	<5.0	ug/L	
Xylene Total (Surface Water)	154	GCMS	<1	ug/L	UKAS
Zinc (Surface Water)	177	ICPMS	37	ug/L	UKAS

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Customer	**Caroline Roche**	***Lab Report Ref. No.***	**0529/002/11**
	Aqua-Fact International Services Ltd	***Date of Receipt***	**21/02/2019**
	12 Kilkerrin Park	***Sampled On***	**20/02/2019**
	Liosbaun Ind Est	***Date Testing Commenced***	**21/02/2019**
	Liosbaun	***Received or Collected***	**By Fitz: Pick up DS**
	Co Galway	***Condition on Receipt***	**Acceptable**
Customer PO	**JN1526**	***Date of Report***	**12/03/2019**
Customer Ref	**DOWN500-LW-Middle**	***Sample Type***	**Surface Water**
Ref 2	**20/02/19 13:05**		
Ref 3			

CERTIFICATE OF ANALYSIS

Test Parameter	SOP	Analytical Technique	Result	Units	Acc.
1,1,1,2-Tetrachloroethane (Surface	154	GCMS	<1	ug/L	UKAS
1,1,1-Trichloroethane (Surface Water	154	GCMS	<1	ug/L	UKAS
1,1,2,2-Tetrachloroethane (Surface	154	GCMS	<5.0	ug/L	
1,1,2-Trichloroethane (Surface Water	154	GCMS	<2	ug/L	UKAS
1,1-Dichloroethane (Surface Water)	154	GCMS	<1	ug/L	UKAS
1,1-Dichloroethene (Surface Water)	154	GCMS	<1	ug/L	UKAS
1,1-Dichloropropene (Surface Water)	154	GCMS	<1	ug/L	UKAS
1,2,3-Trichlorobenzene (Surface Wat	154	GCMS	<1	ug/L	UKAS
1,2,3-Trichloropropane (Surface Wat	154	GCMS	<0.9	ug/L	UKAS
1,2,4-Trichlorobenzene (Surface Wat	154	GCMS	<0.6	ug/L	UKAS
1,2,4-Trimethylbenzene (Surface Wa	154	GCMS	<1	ug/L	UKAS
1,2-Dibromo-3-chloropropane (Surfac	154	GCMS	<1	ug/L	UKAS
1,2-Dibromoethane (Surface Water)	154	GCMS	<1	ug/L	UKAS
1,2-Dichlorobenzene (Surface Water)	154	GCMS	<1	ug/L	UKAS
1,2-Dichloroethane (Surface Water)	154	GCMS	<1	ug/L	UKAS
1,2-Dichloropropane (Surface Water)	154	GCMS	<1	ug/L	UKAS
1,3,5-Trimethylbenzene (Surface Wa	154	GCMS	<1	ug/L	UKAS
1,3-Dichlorobenzene (Surface Water)	154	GCMS	<1	ug/L	UKAS
1,3-Dichloropropane (Surface Water)	154	GCMS	<1	ug/L	UKAS
1,4-Dichlorobenzene (Surface Water)	154	GCMS	<1	ug/L	UKAS
2,2-Dichloropropane (Surface Water)	154	GCMS	<5.0	ug/L	
2-Chlorotoluene (Surface Water)	154	GCMS	<1	ug/L	UKAS
4-Chlorotoluene (Surface Water)	154	GCMS	<1	ug/L	UKAS
Acenaphthene (GCMS)	200	GCMS	<0.01	ug/L	

Signed : A Harmon ***Date : 12/03/2019***

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ilac-MRA UKAS TESTING 2802

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Customer	Caroline Roche Aqua-Fact International Services Ltd 12 Kilkerrin Park Liosbaun Ind Est Liosbaun Co Galway	*Lab Report Ref. No.*	0529/002/11
		Date of Receipt	21/02/2019
		Sampled On	20/02/2019
		Date Testing Commenced	21/02/2019
		Received or Collected	By Fitz: Pick up DS
		Condition on Receipt	Acceptable
Customer PO	JN1526	*Date of Report*	12/03/2019
Customer Ref	DOWN500-LW-Middle	*Sample Type*	Surface Water
Ref 2	20/02/19 13:05		
Ref 3			

CERTIFICATE OF ANALYSIS

Test Parameter	SOP	Analytical Technique	Result	Units	Acc.
Acenaphthylene (GCMS)	200	GCMS	<0.01	ug/L	
Ammonia (Surface Water)	114	Colorimetry	0.24	mg/L as N	UKAS
Anthracene (GCMS)	200	GCMS	<0.01	ug/L	
Antimony (Surface Water)	177	ICPMS	87	ug/L	UKAS
Arsenic (Surface Water)	177	ICPMS	89	ug/L	UKAS
Barium (Surface Water)	177	ICPMS	86	ug/L	UKAS
Benzene (Surface Water)	154	GCMS	<1	ug/L	UKAS
Benzo(a)anthracene (GCMS)	200	GCMS	<0.01	ug/L	
Benzo(a)pyrene (GCMS)	200	GCMS	<0.01	ug/L	
Benzo(g,h,i)perylene (GCMS)	200	GCMS	<0.01	ug/L	
Benzo(k)fluoranthene (GCMS)	200	GCMS	<0.01	ug/L	
Bromobenzene (Surface Water)	154	GCMS	<1	ug/L	UKAS
Bromochloromethane (Surface Water	154	GCMS	<1	ug/L	UKAS
Bromodichloromethane (Surface Wat	154	GCMS	<1	ug/L	UKAS
Bromoform (Surface Water)	154	GCMS	<1	ug/L	UKAS
Bromomethane (Surface Water)	154	GCMS	<5.0	ug/L	
Cadmium (Surface Water)	177	ICPMS	89	ug/L	UKAS
Carbon tetrachloride (Surface Water)	154	GCMS	<1	ug/L	UKAS
Chlorobenzene (Surface Water)	154	GCMS	<1	ug/L	UKAS
Chloroethane (Surface Water)	154	GCMS	<5.0	ug/L	
Chloroform (Surface Water)	154	GCMS	<1	ug/L	UKAS
Chloromethane (Surface Water)	154	GCMS	<5.0	ug/L	
Chromium (Surface Water)	177	ICPMS	89	ug/L	UKAS
Chrysene (GCMS)	200	GCMS	<0.01	ug/L	

Signed : A Harman

Date : 12/03/2019

Aoife Harmon - Technical Supervisor

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ilac-MRA UKAS TESTING 2802

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Customer	**Caroline Roche Aqua-Fact International Services Ltd 12 Kilkerrin Park Liosbaun Ind Est Liosbaun Co Galway**	*Lab Report Ref. No.*	**0529/002/11**
		Date of Receipt	**21/02/2019**
		Sampled On	**20/02/2019**
		Date Testing Commenced	**21/02/2019**
		Received or Collected	**By Fitz: Pick up DS**
		Condition on Receipt	**Acceptable**
Customer PO	**JN1526**	*Date of Report*	**12/03/2019**
Customer Ref	**DOWN500-LW-Middle**	*Sample Type*	**Surface Water**
Ref 2	**20/02/19 13:05**		
Ref 3			

CERTIFICATE OF ANALYSIS

Test Parameter	SOP	Analytical Technique	Result	Units	Acc.
cis-1,2-Dichloroethene (Surface Wat	154	GCMS	<1	ug/L	UKAS
cis-1,3-Dichloropropene (Surface Wa	154	GCMS	<1	ug/L	UKAS
COD (Surface Water)	107	Colorimetry	113	mg/L	UKAS
Copper (Surface Water)	177	ICPMS	79	ug/L	UKAS
Coronene (GCMS)	200	GCMS	<0.01	ug/L	
Dibenzo(a,h)anthracene (GCMS)	200	GCMS	<0.01	ug/L	
Dibromochloromethane (Surface Wat	154	GCMS	<1	ug/L	UKAS
Dibromomethane (Surface Water)	154	GCMS	<1	ug/L	UKAS
Dichlorodifluoromethane (Surface W	154	GCMS	<5.0	ug/L	
Dichloromethane (Surface Water)	154	GCMS	<5.0	ug/L	
Ethylbenzene (Surface Water)	154	GCMS	<1	ug/L	UKAS
Fluoranthene (GCMS)	200	GCMS	<0.01	ug/L	
Fluorene (GCMS)	200	GCMS	<0.01	ug/L	
Hexachlorobutadiene (Surface Water	154	GCMS	<1	ug/L	UKAS
Indeno(1,2,3-cd)pyrene (GCMS)	200	GCMS	<0.01	ug/L	
Isopropylbenzene (Surface Water)	154	GCMS	<1	ug/L	UKAS
Lead (Surface Water)	177	ICPMS	89	ug/L	UKAS
m- & p-Xylene (Surface Water)	154	GCMS	<1	ug/L	UKAS
Mercury (Surface water)	178	ICPMS	0.28	ug/L	UKAS
Molybdenum	226	ICPMS	5	ug/L	
Naphthalene (Surface Water)	154	GCMS	<1	ug/L	UKAS
n-Butylbenzene (Surface Water)	154	GCMS	<1	ug/L	UKAS
Nickel (Surface Water)	177	ICPMS	89	ug/L	UKAS
Nitrogen (Total Kjeldahl)	104	Digestion/ Distillation/ Titrimetr	<1.00	mg/L as N	

Signed : A Harmon ***Date : 12/03/2019***

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	Aqua-Fact International Services Ltd	*Date of Receipt*	**21/02/2019**
	12 Kilkerrin Park	*Sampled On*	**20/02/2019**
	Liosbaun Ind Est	*Date Testing Commenced*	**21/02/2019**
	Liosbaun	*Received or Collected*	**By Fitz: Pick up DS**
	Co Galway	*Condition on Receipt*	**Acceptable**
Customer PO	**JN1526**	*Date of Report*	**12/03/2019**
Customer Ref	**DOWN500-LW-Middle**	*Sample Type*	**Surface Water**
Ref 2	**20/02/19 13:05**		
Ref 3			

CERTIFICATE OF ANALYSIS

Test Parameter	SOP	Analytical Technique	Result	Units	Acc.
Nitrogen (Total Oxidised) (Surface W	151	Colorimetry	1.33	mg/L as N	UKAS
Nitrogen (Total)	0	Calculation	2.17	mg/L as N	
n-Propylbenzene (Surface Water)	154	GCMS	<1.0	ug/L	UKAS
o-Xylene (Surface Water)	154	GCMS	<1	ug/L	UKAS
Phenanthrene (GCMS)	200	GCMS	<0.01	ug/L	
Phenols (Total)	223	GCMS	<0.10	ug/L	
Phosphorus (Total) Surface Water	166	Colorimetry	0.097	mg/L as P	UKAS
p-Isopropyltoluene (Surface Water)	154	GCMS	<1	ug/L	UKAS
Polyaromatic Hydrocarbons (GCMS)	200	GCMS	<0.01	ug/L	
Pyrene (GCMS)	200	GCMS	<0.01	ug/L	
sec-Butylbenzene (Surface Water)	154	GCMS	<1	ug/L	UKAS
Selenium (Surface Water)	177	ICPMS	89	ug/L	UKAS
Solids (Total Dissolved)	105	Filtration/ Evaporation @ 180C	12615	mg/L	
Styrene (Surface Water)	154	GCMS	<1	ug/L	UKAS
tert-Butylbenzene (Surface Water)	154	GCMS	<1	ug/L	UKAS
Tetrachloroethene (Surface Water)	154	GCMS	<1	ug/L	UKAS
TOC (Surface Water)	316	TOC Analyser	5.8	mg/L	UKAS
Toluene (Surface Water)	154	GCMS	<1	ug/L	UKAS
Total Inorganic Nitrogen	0	Calculation	1.6	mg/L	
trans-1,2-Dichloroethene (Surface W	154	GCMS	<1	ug/L	UKAS
trans-1,3-Dichloropropene (Surface	154	GCMS	<1	ug/L	UKAS
Trichloroethene (Surface Water)	154	GCMS	<1.0	ug/L	
Trichlorofluoromethane (Surface Wat	154	GCMS	<1	ug/L	UKAS
Vanadium (Surface Water)	177	ICPMS	89	ug/L	UKAS

Signed : A Harmon ***Date : 12/03/2019***

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Customer	Caroline Roche Aqua-Fact International Services Ltd 12 Kilkerrin Park Liosbaun Ind Est Liosbaun Co Galway	**Lab Report Ref. No.**	0529/002/11
		Date of Receipt	21/02/2019
		Sampled On	20/02/2019
		Date Testing Commenced	21/02/2019
		Received or Collected	By Fitz: Pick up DS
		Condition on Receipt	Acceptable
Customer PO	JN1526	**Date of Report**	12/03/2019
Customer Ref	DOWN500-LW-Middle	**Sample Type**	Surface Water
Ref 2	20/02/19 13:05		
Ref 3			

CERTIFICATE OF ANALYSIS

Test Parameter	SOP	Analytical Technique	Result	Units	Acc.
Vinyl chloride (Surface Water)	154	GCMS	<1	ug/L	UKAS
Volatile Organic Compounds	154	GCMS	<5.0	ug/L	
Xylene Total (Surface Water)	154	GCMS	<1	ug/L	UKAS
Zinc (Surface Water)	177	ICPMS	46	ug/L	UKAS

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	Aqua-Fact International Services Ltd	*Date of Receipt*	**21/02/2019**
	12 Kilkerrin Park	*Sampled On*	**20/02/2019**
	Liosbaun Ind Est	*Date Testing Commenced*	**21/02/2019**
	Liosbaun	*Received or Collected*	**By Fitz: Pick up DS**
	Co Galway	*Condition on Receipt*	**Acceptable**
Customer PO	**JN1526**	*Date of Report*	**12/03/2019**
Customer Ref	**DOWN500-LW-Bottom**	*Sample Type*	**Surface Water**
Ref 2	**20/02/19 13:10**		
Ref 3			

CERTIFICATE OF ANALYSIS

Test Parameter	SOP	Analytical Technique	Result	Units	Acc.
1,1,1,2-Tetrachloroethane (Surface	154	GCMS	<1	ug/L	UKAS
1,1,1-Trichloroethane (Surface Water	154	GCMS	<1	ug/L	UKAS
1,1,2,2-Tetrachloroethane (Surface	154	GCMS	<5.0	ug/L	
1,1,2-Trichloroethane (Surface Water	154	GCMS	<2	ug/L	UKAS
1,1-Dichloroethane (Surface Water)	154	GCMS	<1	ug/L	UKAS
1,1-Dichloroethene (Surface Water)	154	GCMS	<1	ug/L	UKAS
1,1-Dichloropropene (Surface Water)	154	GCMS	<1	ug/L	UKAS
1,2,3-Trichlorobenzene (Surface Wat	154	GCMS	<1	ug/L	UKAS
1,2,3-Trichloropropane (Surface Wat	154	GCMS	<0.9	ug/L	UKAS
1,2,4-Trichlorobenzene (Surface Wat	154	GCMS	<0.6	ug/L	UKAS
1,2,4-Trimethylbenzene (Surface Wa	154	GCMS	<1	ug/L	UKAS
1,2-Dibromo-3-chloropropane (Surfac	154	GCMS	<1	ug/L	UKAS
1,2-Dibromoethane (Surface Water)	154	GCMS	<1	ug/L	UKAS
1,2-Dichlorobenzene (Surface Water)	154	GCMS	<1	ug/L	UKAS
1,2-Dichloroethane (Surface Water)	154	GCMS	<1	ug/L	UKAS
1,2-Dichloropropane (Surface Water)	154	GCMS	<1	ug/L	UKAS
1,3,5-Trimethylbenzene (Surface Wa	154	GCMS	<1	ug/L	UKAS
1,3-Dichlorobenzene (Surface Water)	154	GCMS	<1	ug/L	UKAS
1,3-Dichloropropane (Surface Water)	154	GCMS	<1	ug/L	UKAS
1,4-Dichlorobenzene (Surface Water)	154	GCMS	<1	ug/L	UKAS
2,2-Dichloropropane (Surface Water)	154	GCMS	<5.0	ug/L	
2-Chlorotoluene (Surface Water)	154	GCMS	<1	ug/L	UKAS
4-Chlorotoluene (Surface Water)	154	GCMS	<1	ug/L	UKAS
Acenaphthene (GCMS)	200	GCMS	<0.01	ug/L	

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	Aqua-Fact International Services Ltd	*Date of Receipt*	**21/02/2019**
	12 Kilkerrin Park	*Sampled On*	**20/02/2019**
	Liosbaun Ind Est	*Date Testing Commenced*	**21/02/2019**
	Liosbaun	*Received or Collected*	**By Fitz: Pick up DS**
	Co Galway	*Condition on Receipt*	**Acceptable**
Customer PO	**JN1526**	*Date of Report*	**12/03/2019**
Customer Ref	**DOWN500-LW-Bottom**	*Sample Type*	**Surface Water**
Ref 2	**20/02/19 13:10**		
Ref 3			

CERTIFICATE OF ANALYSIS

Test Parameter	SOP	Analytical Technique	Result	Units	Acc.
Acenaphthylene (GCMS)	200	GCMS	<0.01	ug/L	
Ammonia (Surface Water)	114	Colorimetry	0.21	mg/L as N	UKAS
Anthracene (GCMS)	200	GCMS	<0.01	ug/L	
Antimony (Surface Water)	177	ICPMS	87	ug/L	UKAS
Arsenic (Surface Water)	177	ICPMS	89	ug/L	UKAS
Barium (Surface Water)	177	ICPMS	86	ug/L	UKAS
Benzene (Surface Water)	154	GCMS	<1	ug/L	UKAS
Benzo(a)anthracene (GCMS)	200	GCMS	<0.01	ug/L	
Benzo(a)pyrene (GCMS)	200	GCMS	<0.01	ug/L	
Benzo(g,h,i)perylene (GCMS)	200	GCMS	<0.01	ug/L	
Benzo(k)fluoranthene (GCMS)	200	GCMS	<0.01	ug/L	
Bromobenzene (Surface Water)	154	GCMS	<1	ug/L	UKAS
Bromochloromethane (Surface Water	154	GCMS	<1	ug/L	UKAS
Bromodichloromethane (Surface Wat	154	GCMS	<1	ug/L	UKAS
Bromoform (Surface Water)	154	GCMS	<1	ug/L	UKAS
Bromomethane (Surface Water)	154	GCMS	<5.0	ug/L	
Cadmium (Surface Water)	177	ICPMS	89	ug/L	UKAS
Carbon tetrachloride (Surface Water)	154	GCMS	<1	ug/L	UKAS
Chlorobenzene (Surface Water)	154	GCMS	<1	ug/L	UKAS
Chloroethane (Surface Water)	154	GCMS	<5.0	ug/L	
Chloroform (Surface Water)	154	GCMS	<1	ug/L	UKAS
Chloromethane (Surface Water)	154	GCMS	<5.0	ug/L	
Chromium (Surface Water)	177	ICPMS	89	ug/L	UKAS
Chrysene (GCMS)	200	GCMS	<0.01	ug/L	

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	Aqua-Fact International Services Ltd	*Date of Receipt*	**21/02/2019**
	12 Kilkerrin Park	*Sampled On*	**20/02/2019**
	Liosbaun Ind Est	*Date Testing Commenced*	**21/02/2019**
	Liosbaun	*Received or Collected*	**By Fitz: Pick up DS**
	Co Galway	*Condition on Receipt*	**Acceptable**
Customer PO	**JN1526**	*Date of Report*	**12/03/2019**
Customer Ref	**DOWN500-LW-Bottom**	*Sample Type*	**Surface Water**
Ref 2	**20/02/19 13:10**		
Ref 3			

CERTIFICATE OF ANALYSIS

Test Parameter	SOP	Analytical Technique	Result	Units	Acc.
cis-1,2-Dichloroethene (Surface Wat	154	GCMS	<1	ug/L	UKAS
cis-1,3-Dichloropropene (Surface Wa	154	GCMS	<1	ug/L	UKAS
COD (Surface Water)	107	Colorimetry	141	mg/L	UKAS
Copper (Surface Water)	177	ICPMS	79	ug/L	UKAS
Coronene (GCMS)	200	GCMS	<0.01	ug/L	
Dibenzo(a,h)anthracene (GCMS)	200	GCMS	<0.01	ug/L	
Dibromochloromethane (Surface Wat	154	GCMS	<1	ug/L	UKAS
Dibromomethane (Surface Water)	154	GCMS	<1	ug/L	UKAS
Dichlorodifluoromethane (Surface W	154	GCMS	<5.0	ug/L	
Dichloromethane (Surface Water)	154	GCMS	<5.0	ug/L	
Ethylbenzene (Surface Water)	154	GCMS	<1	ug/L	UKAS
Fluoranthene (GCMS)	200	GCMS	<0.01	ug/L	
Fluorene (GCMS)	200	GCMS	<0.01	ug/L	
Hexachlorobutadiene (Surface Water	154	GCMS	<1	ug/L	UKAS
Indeno(1,2,3-cd)pyrene (GCMS)	200	GCMS	<0.01	ug/L	
Isopropylbenzene (Surface Water)	154	GCMS	<1	ug/L	UKAS
Lead (Surface Water)	177	ICPMS	89	ug/L	UKAS
m- & p-Xylene (Surface Water)	154	GCMS	<1	ug/L	UKAS
Mercury (Surface water)	178	ICPMS	<0.03	ug/L	UKAS
Molybdenum	226	ICPMS	6	ug/L	
Naphthalene (Surface Water)	154	GCMS	<1	ug/L	UKAS
n-Butylbenzene (Surface Water)	154	GCMS	<1	ug/L	UKAS
Nickel (Surface Water)	177	ICPMS	89	ug/L	UKAS
Nitrogen (Total Kjeldahl)	104	Digestion/ Distillation/ Titrimetr	1.12	mg/L as N	

Signed : A Harmon

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Customer	**Caroline Roche**	**Lab Report Ref. No.**	**0529/002/12**
	Aqua-Fact International Services Ltd	**Date of Receipt**	**21/02/2019**
	12 Kilkerrin Park	**Sampled On**	**20/02/2019**
	Liosbaun Ind Est	**Date Testing Commenced**	**21/02/2019**
	Liosbaun	**Received or Collected**	**By Fitz: Pick up DS**
	Co Galway	**Condition on Receipt**	**Acceptable**
Customer PO	**JN1526**	**Date of Report**	**12/03/2019**
Customer Ref	**DOWN500-LW-Bottom**	**Sample Type**	**Surface Water**
Ref 2	**20/02/19 13:10**		
Ref 3			

CERTIFICATE OF ANALYSIS

Test Parameter	SOP	Analytical Technique	Result	Units	Acc.
Nitrogen (Total Oxidised) (Surface W	151	Colorimetry	1.34	mg/L as N	UKAS
Nitrogen (Total)	0	Calculation	2.46	mg/L as N	
n-Propylbenzene (Surface Water)	154	GCMS	<1.0	ug/L	UKAS
o-Xylene (Surface Water)	154	GCMS	<1	ug/L	UKAS
Phenanthrene (GCMS)	200	GCMS	<0.01	ug/L	
Phenols (Total)	223	GCMS	<0.10	ug/L	
Phosphorus (Total) Surface Water	166	Colorimetry	0.113	mg/L as P	UKAS
p-Isopropyltoluene (Surface Water)	154	GCMS	<1	ug/L	UKAS
Polyaromatic Hydrocarbons (GCMS)	200	GCMS	<0.01	ug/L	
Pyrene (GCMS)	200	GCMS	<0.01	ug/L	
sec-Butylbenzene (Surface Water)	154	GCMS	<1	ug/L	UKAS
Selenium (Surface Water)	177	ICPMS	89	ug/L	UKAS
Solids (Total Dissolved)	105	Filtration/ Evaporation @ 180C	14083	mg/L	
Styrene (Surface Water)	154	GCMS	<1	ug/L	UKAS
tert-Butylbenzene (Surface Water)	154	GCMS	<1	ug/L	UKAS
Tetrachloroethene (Surface Water)	154	GCMS	<1	ug/L	UKAS
TOC (Surface Water)	316	TOC Analyser	5.3	mg/L	UKAS
Toluene (Surface Water)	154	GCMS	<1	ug/L	UKAS
Total Inorganic Nitrogen	0	Calculation	1.6	mg/L	
trans-1,2-Dichloroethene (Surface W	154	GCMS	<1	ug/L	UKAS
trans-1,3-Dichloropropene (Surface	154	GCMS	<1	ug/L	UKAS
Trichloroethene (Surface Water)	154	GCMS	<1.0	ug/L	
Trichlorofluoromethane (Surface Wat	154	GCMS	<1	ug/L	UKAS
Vanadium (Surface Water)	177	ICPMS	89	ug/L	UKAS

Signed : A Harman **Date : 12/03/2019**

Aoife Harmon - Technical Supervisor

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ilac-MRA UKAS TESTING 2802

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Monitoring and Testing Services

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Customer	**Caroline Roche**	*Lab Report Ref. No.*	**0529/002/12**
	Aqua-Fact International Services Ltd	*Date of Receipt*	**21/02/2019**
	12 Kilkerrin Park	*Sampled On*	**20/02/2019**
	Liosbaun Ind Est	*Date Testing Commenced*	**21/02/2019**
	Liosbaun	*Received or Collected*	**By Fitz: Pick up DS**
	Co Galway	*Condition on Receipt*	**Acceptable**
Customer PO	**JN1526**	*Date of Report*	**12/03/2019**
Customer Ref	**DOWN500-LW-Bottom**	*Sample Type*	**Surface Water**
Ref 2	**20/02/19 13:10**		
Ref 3			

CERTIFICATE OF ANALYSIS

Test Parameter	SOP	Analytical Technique	Result	Units	Acc.
Vinyl chloride (Surface Water)	154	GCMS	<1	ug/L	UKAS
Volatile Organic Compounds	154	GCMS	<5.0	ug/L	
Xylene Total (Surface Water)	154	GCMS	<1	ug/L	UKAS
Zinc (Surface Water)	177	ICPMS	46	ug/L	UKAS

Signed : A Harmon

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2802

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	Aqua-Fact International Services Ltd	*Date of Receipt*	**21/02/2019**
	12 Kilkerrin Park	*Sampled On*	**20/02/2019**
	Liosbaun Ind Est	*Date Testing Commenced*	**21/02/2019**
	Liosbaun	*Received or Collected*	**By Fitz: Pick up DS**
	Co Galway	*Condition on Receipt*	**Acceptable**
Customer PO	**JN1526**	*Date of Report*	**12/03/2019**
Customer Ref	**DOWN500-MF-Surface**	*Sample Type*	**Surface Water**
Ref 2	**20/02/19 16:25**		
Ref 3			

CERTIFICATE OF ANALYSIS

Test Parameter	SOP	Analytical Technique	Result	Units	Acc.
1,1,1,2-Tetrachloroethane (Surface	154	GCMS	<1	ug/L	UKAS
1,1,1-Trichloroethane (Surface Water	154	GCMS	<1	ug/L	UKAS
1,1,2,2-Tetrachloroethane (Surface	154	GCMS	<5.0	ug/L	
1,1,2-Trichloroethane (Surface Water	154	GCMS	<2	ug/L	UKAS
1,1-Dichloroethane (Surface Water)	154	GCMS	<1	ug/L	UKAS
1,1-Dichloroethene (Surface Water)	154	GCMS	<1	ug/L	UKAS
1,1-Dichloropropene (Surface Water)	154	GCMS	<1	ug/L	UKAS
1,2,3-Trichlorobenzene (Surface Wat	154	GCMS	<1	ug/L	UKAS
1,2,3-Trichloropropane (Surface Wat	154	GCMS	<0.9	ug/L	UKAS
1,2,4-Trichlorobenzene (Surface Wat	154	GCMS	<0.6	ug/L	UKAS
1,2,4-Trimethylbenzene (Surface Wa	154	GCMS	<1	ug/L	UKAS
1,2-Dibromo-3-chloropropane (Surfac	154	GCMS	<1	ug/L	UKAS
1,2-Dibromoethane (Surface Water)	154	GCMS	<1	ug/L	UKAS
1,2-Dichlorobenzene (Surface Water)	154	GCMS	<1	ug/L	UKAS
1,2-Dichloroethane (Surface Water)	154	GCMS	<1	ug/L	UKAS
1,2-Dichloropropane (Surface Water)	154	GCMS	<1	ug/L	UKAS
1,3,5-Trimethylbenzene (Surface Wa	154	GCMS	<1	ug/L	UKAS
1,3-Dichlorobenzene (Surface Water)	154	GCMS	<1	ug/L	UKAS
1,3-Dichloropropane (Surface Water)	154	GCMS	<1	ug/L	UKAS
1,4-Dichlorobenzene (Surface Water)	154	GCMS	<1	ug/L	UKAS
2,2-Dichloropropane (Surface Water)	154	GCMS	<5.0	ug/L	
2-Chlorotoluene (Surface Water)	154	GCMS	<1	ug/L	UKAS
4-Chlorotoluene (Surface Water)	154	GCMS	<1	ug/L	UKAS
Acenaphthene (GCMS)	200	GCMS	<0.01	ug/L	

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	Liosbaun Ind Est	*Date Testing Commenced*	**21/02/2019**
	Liosbaun	*Received or Collected*	**By Fitz: Pick up DS**
	Co Galway	*Condition on Receipt*	**Acceptable**
Customer PO	**JN1526**	*Date of Report*	**12/03/2019**
Customer Ref	**DOWN500-MF-Surface**	*Sample Type*	**Surface Water**
Ref 2	**20/02/19 16:25**		
Ref 3			

CERTIFICATE OF ANALYSIS

Test Parameter	SOP	Analytical Technique	Result	Units	Acc.
Acenaphthylene (GCMS)	200	GCMS	<0.01	ug/L	
Ammonia (Surface Water)	114	Colorimetry	0.20	mg/L as N	UKAS
Anthracene (GCMS)	200	GCMS	<0.01	ug/L	
Antimony (Surface Water)	177	ICPMS	111	ug/L	UKAS
Arsenic (Surface Water)	177	ICPMS	113	ug/L	UKAS
Barium (Surface Water)	177	ICPMS	110	ug/L	UKAS
Benzene (Surface Water)	154	GCMS	<1	ug/L	UKAS
Benzo(a)anthracene (GCMS)	200	GCMS	<0.01	ug/L	
Benzo(a)pyrene (GCMS)	200	GCMS	<0.01	ug/L	
Benzo(g,h,i)perylene (GCMS)	200	GCMS	<0.01	ug/L	
Benzo(k)fluoranthene (GCMS)	200	GCMS	<0.01	ug/L	
Bromobenzene (Surface Water)	154	GCMS	<1	ug/L	UKAS
Bromochloromethane (Surface Water	154	GCMS	<1	ug/L	UKAS
Bromodichloromethane (Surface Wat	154	GCMS	<1	ug/L	UKAS
Bromoform (Surface Water)	154	GCMS	<1	ug/L	UKAS
Bromomethane (Surface Water)	154	GCMS	<5.0	ug/L	
Cadmium (Surface Water)	177	ICPMS	113	ug/L	UKAS
Carbon tetrachloride (Surface Water)	154	GCMS	<1	ug/L	UKAS
Chlorobenzene (Surface Water)	154	GCMS	<1	ug/L	UKAS
Chloroethane (Surface Water)	154	GCMS	<5.0	ug/L	
Chloroform (Surface Water)	154	GCMS	<1	ug/L	UKAS
Chloromethane (Surface Water)	154	GCMS	<5.0	ug/L	
Chromium (Surface Water)	177	ICPMS	113	ug/L	UKAS
Chrysene (GCMS)	200	GCMS	<0.01	ug/L	

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	Aqua-Fact International Services Ltd	*Date of Receipt*	**21/02/2019**
	12 Kilkerrin Park	*Sampled On*	**20/02/2019**
	Liosbaun Ind Est	*Date Testing Commenced*	**21/02/2019**
	Liosbaun	*Received or Collected*	**By Fitz: Pick up DS**
	Co Galway	*Condition on Receipt*	**Acceptable**
Customer PO	**JN1526**	*Date of Report*	**12/03/2019**
Customer Ref	**DOWN500-MF-Surface**	*Sample Type*	**Surface Water**
Ref 2	**20/02/19 16:25**		
Ref 3			

CERTIFICATE OF ANALYSIS

Test Parameter	SOP	Analytical Technique	Result	Units	Acc.
cis-1,2-Dichloroethene (Surface Wat	154	GCMS	<1	ug/L	UKAS
cis-1,3-Dichloropropene (Surface Wa	154	GCMS	<1	ug/L	UKAS
COD (Surface Water)	107	Colorimetry	1054	mg/L	UKAS
Copper (Surface Water)	177	ICPMS	103	ug/L	UKAS
Coronene (GCMS)	200	GCMS	<0.01	ug/L	
Dibenzo(a,h)anthracene (GCMS)	200	GCMS	<0.01	ug/L	
Dibromochloromethane (Surface Wat	154	GCMS	<1	ug/L	UKAS
Dibromomethane (Surface Water)	154	GCMS	<1	ug/L	UKAS
Dichlorodifluoromethane (Surface W	154	GCMS	<5.0	ug/L	
Dichloromethane (Surface Water)	154	GCMS	<5.0	ug/L	
Ethylbenzene (Surface Water)	154	GCMS	<1	ug/L	UKAS
Fluoranthene (GCMS)	200	GCMS	<0.01	ug/L	
Fluorene (GCMS)	200	GCMS	<0.01	ug/L	
Hexachlorobutadiene (Surface Water	154	GCMS	<1	ug/L	UKAS
Indeno(1,2,3-cd)pyrene (GCMS)	200	GCMS	<0.01	ug/L	
Isopropylbenzene (Surface Water)	154	GCMS	<1	ug/L	UKAS
Lead (Surface Water)	177	ICPMS	113	ug/L	UKAS
m- & p-Xylene (Surface Water)	154	GCMS	<1	ug/L	UKAS
Mercury (Surface water)	178	ICPMS	<0.03	ug/L	UKAS
Molybdenum	226	ICPMS	8	ug/L	
Naphthalene (Surface Water)	154	GCMS	<1	ug/L	UKAS
n-Butylbenzene (Surface Water)	154	GCMS	<1	ug/L	UKAS
Nickel (Surface Water)	177	ICPMS	113	ug/L	UKAS
Nitrogen (Total Kjeldahl)	104	Digestion/ Distillation/ Titrimetr	1.40	mg/L as N	

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Customer	Caroline Roche Aqua-Fact International Services Ltd 12 Kilkerrin Park Liosbaun Ind Est Liosbaun Co Galway	*Lab Report Ref. No.*	0529/002/13
		Date of Receipt	21/02/2019
		Sampled On	20/02/2019
		Date Testing Commenced	21/02/2019
		Received or Collected	By Fitz: Pick up DS
		Condition on Receipt	Acceptable
Customer PO	JN1526	*Date of Report*	12/03/2019
Customer Ref	DOWN500-MF-Surface	*Sample Type*	Surface Water
Ref 2	20/02/19 16:25		
Ref 3			

CERTIFICATE OF ANALYSIS

Test Parameter	SOP	Analytical Technique	Result	Units	Acc.
Nitrogen (Total Oxidised) (Surface W	151	Colorimetry	1.28	mg/L as N	UKAS
Nitrogen (Total)	0	Calculation	2.68	mg/L as N	
n-Propylbenzene (Surface Water)	154	GCMS	<1.0	ug/L	UKAS
o-Xylene (Surface Water)	154	GCMS	<1	ug/L	UKAS
Phenanthrene (GCMS)	200	GCMS	<0.01	ug/L	
Phenols (Total)	223	GCMS	<0.10	ug/L	
Phosphorus (Total) Surface Water	166	Colorimetry	0.054	mg/L as P	UKAS
p-Isopropyltoluene (Surface Water)	154	GCMS	<1	ug/L	UKAS
Polyaromatic Hydrocarbons (GCMS)	200	GCMS	<0.01	ug/L	
Pyrene (GCMS)	200	GCMS	<0.01	ug/L	
sec-Butylbenzene (Surface Water)	154	GCMS	<1	ug/L	UKAS
Selenium (Surface Water)	177	ICPMS	113	ug/L	UKAS
Solids (Total Dissolved)	105	Filtration/ Evaporation @ 180C	19089	mg/L	
Styrene (Surface Water)	154	GCMS	<1	ug/L	UKAS
tert-Butylbenzene (Surface Water)	154	GCMS	<1	ug/L	UKAS
Tetrachloroethene (Surface Water)	154	GCMS	<1	ug/L	UKAS
TOC (Surface Water)	316	TOC Analyser	4.3	mg/L	UKAS
Toluene (Surface Water)	154	GCMS	<1	ug/L	UKAS
Total Inorganic Nitrogen	0	Calculation	1.5	mg/L	
trans-1,2-Dichloroethene (Surface W	154	GCMS	<1	ug/L	UKAS
trans-1,3-Dichloropropene (Surface	154	GCMS	<1	ug/L	UKAS
Trichloroethene (Surface Water)	154	GCMS	<1.0	ug/L	
Trichlorofluoromethane (Surface Wat	154	GCMS	<1	ug/L	UKAS
Vanadium (Surface Water)	177	ICPMS	113	ug/L	UKAS

Signed : A Harman ***Date : 12/03/2019***

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	12 Kilkerrin Park	*Sampled On*	**20/02/2019**
	Liosbaun Ind Est	*Date Testing Commenced*	**21/02/2019**
	Liosbaun	*Received or Collected*	**By Fitz: Pick up DS**
	Co Galway	*Condition on Receipt*	**Acceptable**
Customer PO	**JN1526**	*Date of Report*	**12/03/2019**
Customer Ref	**DOWN500-MF-Surface**	*Sample Type*	**Surface Water**
Ref 2	**20/02/19 16:25**		
Ref 3			

CERTIFICATE OF ANALYSIS

Test Parameter	SOP	Analytical Technique	Result	Units	Acc.
Vinyl chloride (Surface Water)	154	GCMS	<1	ug/L	UKAS
Volatile Organic Compounds	154	GCMS	<5.0	ug/L	
Xylene Total (Surface Water)	154	GCMS	<1	ug/L	UKAS
Zinc (Surface Water)	177	ICPMS	70	ug/L	UKAS

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	Aqua-Fact International Services Ltd	*Date of Receipt*	**21/02/2019**
	12 Kilkerrin Park	*Sampled On*	**20/02/2019**
	Liosbaun Ind Est	*Date Testing Commenced*	**21/02/2019**
	Liosbaun	*Received or Collected*	**By Fitz: Pick up DS**
	Co Galway	*Condition on Receipt*	**Acceptable**
Customer PO	**JN1526**	*Date of Report*	**12/03/2019**
Customer Ref	**DOWN500-MF-Middle**	*Sample Type*	**Surface Water**
Ref 2	**20/02/19 16:30**		
Ref 3			

CERTIFICATE OF ANALYSIS

Test Parameter	SOP	Analytical Technique	Result	Units	Acc.
1,1,1,2-Tetrachloroethane (Surface	154	GCMS	<1	ug/L	UKAS
1,1,1-Trichloroethane (Surface Water	154	GCMS	<1	ug/L	UKAS
1,1,2,2-Tetrachloroethane (Surface	154	GCMS	<5.0	ug/L	
1,1,2-Trichloroethane (Surface Water	154	GCMS	<2	ug/L	UKAS
1,1-Dichloroethane (Surface Water)	154	GCMS	<1	ug/L	UKAS
1,1-Dichloroethene (Surface Water)	154	GCMS	<1	ug/L	UKAS
1,1-Dichloropropene (Surface Water)	154	GCMS	<1	ug/L	UKAS
1,2,3-Trichlorobenzene (Surface Wat	154	GCMS	<1	ug/L	UKAS
1,2,3-Trichloropropane (Surface Wat	154	GCMS	<0.9	ug/L	UKAS
1,2,4-Trichlorobenzene (Surface Wat	154	GCMS	<0.6	ug/L	UKAS
1,2,4-Trimethylbenzene (Surface Wa	154	GCMS	<1	ug/L	UKAS
1,2-Dibromo-3-chloropropane (Surfac	154	GCMS	<1	ug/L	UKAS
1,2-Dibromoethane (Surface Water)	154	GCMS	<1	ug/L	UKAS
1,2-Dichlorobenzene (Surface Water)	154	GCMS	<1	ug/L	UKAS
1,2-Dichloroethane (Surface Water)	154	GCMS	<1	ug/L	UKAS
1,2-Dichloropropane (Surface Water)	154	GCMS	<1	ug/L	UKAS
1,3,5-Trimethylbenzene (Surface Wa	154	GCMS	<1	ug/L	UKAS
1,3-Dichlorobenzene (Surface Water)	154	GCMS	<1	ug/L	UKAS
1,3-Dichloropropane (Surface Water)	154	GCMS	<1	ug/L	UKAS
1,4-Dichlorobenzene (Surface Water)	154	GCMS	<1	ug/L	UKAS
2,2-Dichloropropane (Surface Water)	154	GCMS	<5.0	ug/L	
2-Chlorotoluene (Surface Water)	154	GCMS	<1	ug/L	UKAS
4-Chlorotoluene (Surface Water)	154	GCMS	<1	ug/L	UKAS
Acenaphthene (GCMS)	200	GCMS	<0.01	ug/L	

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	12 Kilkerrin Park	*Sampled On*	**20/02/2019**
	Liosbaun Ind Est	*Date Testing Commenced*	**21/02/2019**
	Liosbaun	*Received or Collected*	**By Fitz: Pick up DS**
	Co Galway	*Condition on Receipt*	**Acceptable**
Customer PO	**JN1526**	*Date of Report*	**12/03/2019**
Customer Ref	**DOWN500-MF-Middle**	*Sample Type*	**Surface Water**
Ref 2	**20/02/19 16:30**		
Ref 3			

CERTIFICATE OF ANALYSIS

Test Parameter	SOP	Analytical Technique	Result	Units	Acc.
Acenaphthylene (GCMS)	200	GCMS	<0.01	ug/L	
Ammonia (Surface Water)	114	Colorimetry	0.22	mg/L as N	UKAS
Anthracene (GCMS)	200	GCMS	<0.01	ug/L	
Antimony (Surface Water)	177	ICPMS	101	ug/L	UKAS
Arsenic (Surface Water)	177	ICPMS	103	ug/L	UKAS
Barium (Surface Water)	177	ICPMS	100	ug/L	UKAS
Benzene (Surface Water)	154	GCMS	<1	ug/L	UKAS
Benzo(a)anthracene (GCMS)	200	GCMS	<0.01	ug/L	
Benzo(a)pyrene (GCMS)	200	GCMS	<0.01	ug/L	
Benzo(g,h,i)perylene (GCMS)	200	GCMS	<0.01	ug/L	
Benzo(k)fluoranthene (GCMS)	200	GCMS	<0.01	ug/L	
Bromobenzene (Surface Water)	154	GCMS	<1	ug/L	UKAS
Bromochloromethane (Surface Water	154	GCMS	<1	ug/L	UKAS
Bromodichloromethane (Surface Wat	154	GCMS	<1	ug/L	UKAS
Bromoform (Surface Water)	154	GCMS	<1	ug/L	UKAS
Bromomethane (Surface Water)	154	GCMS	<5.0	ug/L	
Cadmium (Surface Water)	177	ICPMS	104	ug/L	UKAS
Carbon tetrachloride (Surface Water)	154	GCMS	<1	ug/L	UKAS
Chlorobenzene (Surface Water)	154	GCMS	<1	ug/L	UKAS
Chloroethane (Surface Water)	154	GCMS	<5.0	ug/L	
Chloroform (Surface Water)	154	GCMS	<1	ug/L	UKAS
Chloromethane (Surface Water)	154	GCMS	<5.0	ug/L	
Chromium (Surface Water)	177	ICPMS	103	ug/L	UKAS
Chrysene (GCMS)	200	GCMS	<0.01	ug/L	

Signed : A Harmon

Date : 12/03/2019

Aoife Harmon - Technical Supervisor

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ilac-MRA UKAS TESTING 2802

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Customer	**Caroline Roche**	*Lab Report Ref. No.*	**0529/002/14**
	Aqua-Fact International Services Ltd	*Date of Receipt*	**21/02/2019**
	12 Kilkerrin Park	*Sampled On*	**20/02/2019**
	Liosbaun Ind Est	*Date Testing Commenced*	**21/02/2019**
	Liosbaun	*Received or Collected*	**By Fitz: Pick up DS**
	Co Galway	*Condition on Receipt*	**Acceptable**
Customer PO	**JN1526**	*Date of Report*	**12/03/2019**
Customer Ref	**DOWN500-MF-Middle**	*Sample Type*	**Surface Water**
Ref 2	**20/02/19 16:30**		
Ref 3			

CERTIFICATE OF ANALYSIS

Test Parameter	SOP	Analytical Technique	Result	Units	Acc.
cis-1,2-Dichloroethene (Surface Wat	154	GCMS	<1	ug/L	UKAS
cis-1,3-Dichloropropene (Surface Wa	154	GCMS	<1	ug/L	UKAS
COD (Surface Water)	107	Colorimetry	1124	mg/L	UKAS
Copper (Surface Water)	177	ICPMS	93	ug/L	UKAS
Coronene (GCMS)	200	GCMS	<0.01	ug/L	
Dibenzo(a,h)anthracene (GCMS)	200	GCMS	<0.01	ug/L	
Dibromochloromethane (Surface Wat	154	GCMS	<1	ug/L	UKAS
Dibromomethane (Surface Water)	154	GCMS	<1	ug/L	UKAS
Dichlorodifluoromethane (Surface W	154	GCMS	<5.0	ug/L	
Dichloromethane (Surface Water)	154	GCMS	<5.0	ug/L	
Ethylbenzene (Surface Water)	154	GCMS	<1	ug/L	UKAS
Fluoranthene (GCMS)	200	GCMS	<0.01	ug/L	
Fluorene (GCMS)	200	GCMS	<0.01	ug/L	
Hexachlorobutadiene (Surface Water	154	GCMS	<1	ug/L	UKAS
Indeno(1,2,3-cd)pyrene (GCMS)	200	GCMS	<0.01	ug/L	
Isopropylbenzene (Surface Water)	154	GCMS	<1	ug/L	UKAS
Lead (Surface Water)	177	ICPMS	103	ug/L	UKAS
m- & p-Xylene (Surface Water)	154	GCMS	<1	ug/L	UKAS
Mercury (Surface water)	178	ICPMS	<0.03	ug/L	UKAS
Molybdenum	226	ICPMS	<5	ug/L	
Naphthalene (Surface Water)	154	GCMS	<1	ug/L	UKAS
n-Butylbenzene (Surface Water)	154	GCMS	<1	ug/L	UKAS
Nickel (Surface Water)	177	ICPMS	103	ug/L	UKAS
Nitrogen (Total Kjeldahl)	104	Digestion/ Distillation/ Titrimetr	1.40	mg/L as N	

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Customer Ref	**DOWN500-MF-Middle**	***Sample Type***	**Surface Water**
Ref 2	**20/02/19 16:30**		
Ref 3			

CERTIFICATE OF ANALYSIS

Test Parameter	SOP	Analytical Technique	Result	Units	Acc.
Nitrogen (Total Oxidised) (Surface W	151	Colorimetry	1.38	mg/L as N	UKAS
Nitrogen (Total)	0	Calculation	2.78	mg/L as N	
n-Propylbenzene (Surface Water)	154	GCMS	<1.0	ug/L	UKAS
o-Xylene (Surface Water)	154	GCMS	<1	ug/L	UKAS
Phenanthrene (GCMS)	200	GCMS	<0.01	ug/L	
Phenols (Total)	223	GCMS	<0.10	ug/L	
Phosphorus (Total) Surface Water	166	Colorimetry	0.082	mg/L as P	UKAS
p-Isopropyltoluene (Surface Water)	154	GCMS	<1	ug/L	UKAS
Polyaromatic Hydrocarbons (GCMS)	200	GCMS	<0.01	ug/L	
Pyrene (GCMS)	200	GCMS	<0.01	ug/L	
sec-Butylbenzene (Surface Water)	154	GCMS	<1	ug/L	UKAS
Selenium (Surface Water)	177	ICPMS	103	ug/L	UKAS
Solids (Total Dissolved)	105	Filtration/ Evaporation @ 180C	18873	mg/L	
Styrene (Surface Water)	154	GCMS	<1	ug/L	UKAS
tert-Butylbenzene (Surface Water)	154	GCMS	<1	ug/L	UKAS
Tetrachloroethene (Surface Water)	154	GCMS	<1	ug/L	UKAS
TOC (Surface Water)	316	TOC Analyser	4.3	mg/L	UKAS
Toluene (Surface Water)	154	GCMS	<1	ug/L	UKAS
Total Inorganic Nitrogen	0	Calculation	1.6	mg/L	
trans-1,2-Dichloroethene (Surface W	154	GCMS	<1	ug/L	UKAS
trans-1,3-Dichloropropene (Surface	154	GCMS	<1	ug/L	UKAS
Trichloroethene (Surface Water)	154	GCMS	<1.0	ug/L	
Trichlorofluoromethane (Surface Wat	154	GCMS	<1	ug/L	UKAS
Vanadium (Surface Water)	177	ICPMS	104	ug/L	UKAS

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Customer PO	**JN1526**	***Date of Report***	**12/03/2019**
Customer Ref	**DOWN500-MF-Middle**	***Sample Type***	**Surface Water**
Ref 2	**20/02/19 16:30**		
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CERTIFICATE OF ANALYSIS

Test Parameter	SOP	Analytical Technique	Result	Units	Acc.
Vinyl chloride (Surface Water)	154	GCMS	<1	ug/L	UKAS
Volatile Organic Compounds	154	GCMS	<5.0	ug/L	
Xylene Total (Surface Water)	154	GCMS	<1	ug/L	UKAS
Zinc (Surface Water)	177	ICPMS	60	ug/L	UKAS

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	Liosbaun	***Received or Collected***	**By Fitz: Pick up DS**
	Co Galway	***Condition on Receipt***	**Acceptable**
Customer PO	**JN1526**	***Date of Report***	**12/03/2019**
Customer Ref	**DOWN500-MF-Bottom**	***Sample Type***	**Surface Water**
Ref 2	**20/02/19 16:35**		
Ref 3			

CERTIFICATE OF ANALYSIS

Test Parameter	SOP	Analytical Technique	Result	Units	Acc.
1,1,1,2-Tetrachloroethane (Surface	154	GCMS	<1	ug/L	UKAS
1,1,1-Trichloroethane (Surface Water	154	GCMS	<1	ug/L	UKAS
1,1,2,2-Tetrachloroethane (Surface	154	GCMS	<5.0	ug/L	
1,1,2-Trichloroethane (Surface Water	154	GCMS	<2	ug/L	UKAS
1,1-Dichloroethane (Surface Water)	154	GCMS	<1	ug/L	UKAS
1,1-Dichloroethene (Surface Water)	154	GCMS	<1	ug/L	UKAS
1,1-Dichloropropene (Surface Water)	154	GCMS	<1	ug/L	UKAS
1,2,3-Trichlorobenzene (Surface Wat	154	GCMS	<1	ug/L	UKAS
1,2,3-Trichloropropane (Surface Wat	154	GCMS	<0.9	ug/L	UKAS
1,2,4-Trichlorobenzene (Surface Wat	154	GCMS	<0.6	ug/L	UKAS
1,2,4-Trimethylbenzene (Surface Wa	154	GCMS	<1	ug/L	UKAS
1,2-Dibromo-3-chloropropane (Surfac	154	GCMS	<1	ug/L	UKAS
1,2-Dibromoethane (Surface Water)	154	GCMS	<1	ug/L	UKAS
1,2-Dichlorobenzene (Surface Water)	154	GCMS	<1	ug/L	UKAS
1,2-Dichloroethane (Surface Water)	154	GCMS	<1	ug/L	UKAS
1,2-Dichloropropane (Surface Water)	154	GCMS	<1	ug/L	UKAS
1,3,5-Trimethylbenzene (Surface Wa	154	GCMS	<1	ug/L	UKAS
1,3-Dichlorobenzene (Surface Water)	154	GCMS	<1	ug/L	UKAS
1,3-Dichloropropane (Surface Water)	154	GCMS	<1	ug/L	UKAS
1,4-Dichlorobenzene (Surface Water)	154	GCMS	<1	ug/L	UKAS
2,2-Dichloropropane (Surface Water)	154	GCMS	<5.0	ug/L	
2-Chlorotoluene (Surface Water)	154	GCMS	<1	ug/L	UKAS
4-Chlorotoluene (Surface Water)	154	GCMS	<1	ug/L	UKAS
Acenaphthene (GCMS)	200	GCMS	<0.01	ug/L	

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CERTIFICATE OF ANALYSIS

Test Parameter	SOP	Analytical Technique	Result	Units	Acc.
Acenaphthylene (GCMS)	200	GCMS	<0.01	ug/L	
Ammonia (Surface Water)	114	Colorimetry	0.19	mg/L as N	UKAS
Anthracene (GCMS)	200	GCMS	<0.01	ug/L	
Antimony (Surface Water)	177	ICPMS	91	ug/L	UKAS
Arsenic (Surface Water)	177	ICPMS	93	ug/L	UKAS
Barium (Surface Water)	177	ICPMS	89	ug/L	UKAS
Benzene (Surface Water)	154	GCMS	<1	ug/L	UKAS
Benzo(a)anthracene (GCMS)	200	GCMS	<0.01	ug/L	
Benzo(a)pyrene (GCMS)	200	GCMS	<0.01	ug/L	
Benzo(g,h,i)perylene (GCMS)	200	GCMS	<0.01	ug/L	
Benzo(k)fluoranthene (GCMS)	200	GCMS	<0.01	ug/L	
Bromobenzene (Surface Water)	154	GCMS	<1	ug/L	UKAS
Bromochloromethane (Surface Water	154	GCMS	<1	ug/L	UKAS
Bromodichloromethane (Surface Wat	154	GCMS	<1	ug/L	UKAS
Bromoform (Surface Water)	154	GCMS	<1	ug/L	UKAS
Bromomethane (Surface Water)	154	GCMS	<5.0	ug/L	
Cadmium (Surface Water)	177	ICPMS	93	ug/L	UKAS
Carbon tetrachloride (Surface Water)	154	GCMS	<1	ug/L	UKAS
Chlorobenzene (Surface Water)	154	GCMS	<1	ug/L	UKAS
Chloroethane (Surface Water)	154	GCMS	<5.0	ug/L	
Chloroform (Surface Water)	154	GCMS	<1	ug/L	UKAS
Chloromethane (Surface Water)	154	GCMS	<5.0	ug/L	
Chromium (Surface Water)	177	ICPMS	92	ug/L	UKAS
Chrysene (GCMS)	200	GCMS	<0.01	ug/L	

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CERTIFICATE OF ANALYSIS

Test Parameter	SOP	Analytical Technique	Result	Units	Acc.
cis-1,2-Dichloroethene (Surface Wat	154	GCMS	<1	ug/L	UKAS
cis-1,3-Dichloropropene (Surface Wa	154	GCMS	<1	ug/L	UKAS
COD (Surface Water)	107	Colorimetry	1097	mg/L	UKAS
Copper (Surface Water)	177	ICPMS	83	ug/L	UKAS
Coronene (GCMS)	200	GCMS	<0.01	ug/L	
Dibenzo(a,h)anthracene (GCMS)	200	GCMS	<0.01	ug/L	
Dibromochloromethane (Surface Wat	154	GCMS	<1	ug/L	UKAS
Dibromomethane (Surface Water)	154	GCMS	<1	ug/L	UKAS
Dichlorodifluoromethane (Surface W	154	GCMS	<5.0	ug/L	
Dichloromethane (Surface Water)	154	GCMS	<5.0	ug/L	
Ethylbenzene (Surface Water)	154	GCMS	<1	ug/L	UKAS
Fluoranthene (GCMS)	200	GCMS	<0.01	ug/L	
Fluorene (GCMS)	200	GCMS	<0.01	ug/L	
Hexachlorobutadiene (Surface Water	154	GCMS	<1	ug/L	UKAS
Indeno(1,2,3-cd)pyrene (GCMS)	200	GCMS	<0.01	ug/L	
Isopropylbenzene (Surface Water)	154	GCMS	<1	ug/L	UKAS
Lead (Surface Water)	177	ICPMS	92	ug/L	UKAS
m- & p-Xylene (Surface Water)	154	GCMS	<1	ug/L	UKAS
Mercury (Surface water)	178	ICPMS	<0.03	ug/L	UKAS
Molybdenum	226	ICPMS	<5	ug/L	
Naphthalene (Surface Water)	154	GCMS	<1	ug/L	UKAS
n-Butylbenzene (Surface Water)	154	GCMS	<1	ug/L	UKAS
Nickel (Surface Water)	177	ICPMS	92	ug/L	UKAS
Nitrogen (Total Kjeldahl)	104	Digestion/ Distillation/ Titrimetr	1.12	mg/L as N	

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	Co Galway	*Condition on Receipt*	**Acceptable**
Customer PO	**JN1526**	*Date of Report*	**12/03/2019**
Customer Ref	**DOWN500-MF-Bottom**	*Sample Type*	**Surface Water**
Ref 2	**20/02/19 16:35**		
Ref 3			

CERTIFICATE OF ANALYSIS

Test Parameter	SOP	Analytical Technique	Result	Units	Acc.
Nitrogen (Total Oxidised) (Surface W	151	Colorimetry	1.30	mg/L as N	UKAS
Nitrogen (Total)	0	Calculation	2.42	mg/L as N	
n-Propylbenzene (Surface Water)	154	GCMS	<1.0	ug/L	UKAS
o-Xylene (Surface Water)	154	GCMS	<1	ug/L	UKAS
Phenanthrene (GCMS)	200	GCMS	<0.01	ug/L	
Phenols (Total)	223	GCMS	<0.10	ug/L	
Phosphorus (Total) Surface Water	166	Colorimetry	0.084	mg/L as P	UKAS
p-Isopropyltoluene (Surface Water)	154	GCMS	<1	ug/L	UKAS
Polyaromatic Hydrocarbons (GCMS)	200	GCMS	<0.01	ug/L	
Pyrene (GCMS)	200	GCMS	<0.01	ug/L	
sec-Butylbenzene (Surface Water)	154	GCMS	<1	ug/L	UKAS
Selenium (Surface Water)	177	ICPMS	93	ug/L	UKAS
Solids (Total Dissolved)	105	Filtration/ Evaporation @ 180C	19174	mg/L	
Styrene (Surface Water)	154	GCMS	<1	ug/L	UKAS
tert-Butylbenzene (Surface Water)	154	GCMS	<1	ug/L	UKAS
Tetrachloroethene (Surface Water)	154	GCMS	<1	ug/L	UKAS
TOC (Surface Water)	316	TOC Analyser	4.3	mg/L	UKAS
Toluene (Surface Water)	154	GCMS	<1	ug/L	UKAS
Total Inorganic Nitrogen	0	Calculation	1.5	mg/L	
trans-1,2-Dichloroethene (Surface W	154	GCMS	<1	ug/L	UKAS
trans-1,3-Dichloropropene (Surface	154	GCMS	<1	ug/L	UKAS
Trichloroethene (Surface Water)	154	GCMS	<1.0	ug/L	
Trichlorofluoromethane (Surface Wat	154	GCMS	<1	ug/L	UKAS
Vanadium (Surface Water)	177	ICPMS	93	ug/L	UKAS

Signed : A Harman ***Date : 12/03/2019***

Aoife Harmon - Technical Supervisor

Acc. : Accredited Parameters by ISO 17025:2005
PVL - Parametric Value Limit as per EU (Drinking water) Regulations (SI 122 2014)
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ilac-MRA UKAS TESTING 2802

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Customer	Caroline Roche Aqua-Fact International Services Ltd 12 Kilkerrin Park Liosbaun Ind Est Liosbaun Co Galway	*Lab Report Ref. No.*	0529/002/15
		Date of Receipt	21/02/2019
		Sampled On	20/02/2019
		Date Testing Commenced	21/02/2019
		Received or Collected	By Fitz: Pick up DS
		Condition on Receipt	Acceptable
Customer PO	JN1526	*Date of Report*	12/03/2019
Customer Ref	DOWN500-MF-Bottom	*Sample Type*	Surface Water
Ref 2	20/02/19 16:35		
Ref 3			

CERTIFICATE OF ANALYSIS

Test Parameter	SOP	Analytical Technique	Result	Units	Acc.
Vinyl chloride (Surface Water)	154	GCMS	<1	ug/L	UKAS
Volatile Organic Compounds	154	GCMS	<5.0	ug/L	
Xylene Total (Surface Water)	154	GCMS	<1	ug/L	UKAS
Zinc (Surface Water)	177	ICPMS	49	ug/L	UKAS

Signed : A Harmon

Date : 12/03/2019

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Customer	**Caroline Roche**	**Lab Report Ref. No.**	**0529/002/24**
	Aqua-Fact International Services Ltd	**Date of Receipt**	**21/02/2019**
	12 Kilkerrin Park	**Sampled On**	**20/02/2019**
	Liosbaun Ind Est	**Date Testing Commenced**	**21/02/2019**
	Liosbaun	**Received or Collected**	**By Fitz: Pick up DS**
	Co Galway	**Condition on Receipt**	**Acceptable**
Customer PO	**JN1526**	**Date of Report**	**12/03/2019**
Customer Ref	**DOWN 1km- ME- Surface**	**Sample Type**	**Surface Water**
Ref 2	**20/02/19 11:22**		
Ref 3			

CERTIFICATE OF ANALYSIS

Test Parameter	SOP	Analytical Technique	Result	Units	Acc.
1,1,1,2-Tetrachloroethane (Surface	154	GCMS	<1	ug/L	UKAS
1,1,1-Trichloroethane (Surface Water	154	GCMS	<1	ug/L	UKAS
1,1,2,2-Tetrachloroethane (Surface	154	GCMS	<5.0	ug/L	
1,1,2-Trichloroethane (Surface Water	154	GCMS	<2	ug/L	UKAS
1,1-Dichloroethane (Surface Water)	154	GCMS	<1	ug/L	UKAS
1,1-Dichloroethene (Surface Water)	154	GCMS	<1	ug/L	UKAS
1,1-Dichloropropene (Surface Water)	154	GCMS	<1	ug/L	UKAS
1,2,3-Trichlorobenzene (Surface Wat	154	GCMS	<1	ug/L	UKAS
1,2,3-Trichloropropane (Surface Wat	154	GCMS	<0.9	ug/L	UKAS
1,2,4-Trichlorobenzene (Surface Wat	154	GCMS	<0.6	ug/L	UKAS
1,2,4-Trimethylbenzene (Surface Wa	154	GCMS	<1	ug/L	UKAS
1,2-Dibromo-3-chloropropane (Surfac	154	GCMS	<1	ug/L	UKAS
1,2-Dibromoethane (Surface Water)	154	GCMS	<1	ug/L	UKAS
1,2-Dichlorobenzene (Surface Water)	154	GCMS	<1	ug/L	UKAS
1,2-Dichloroethane (Surface Water)	154	GCMS	<1	ug/L	UKAS
1,2-Dichloropropane (Surface Water)	154	GCMS	<1	ug/L	UKAS
1,3,5-Trimethylbenzene (Surface Wa	154	GCMS	<1	ug/L	UKAS
1,3-Dichlorobenzene (Surface Water)	154	GCMS	<1	ug/L	UKAS
1,3-Dichloropropane (Surface Water)	154	GCMS	<1	ug/L	UKAS
1,4-Dichlorobenzene (Surface Water)	154	GCMS	<1	ug/L	UKAS
2,2-Dichloropropane (Surface Water)	154	GCMS	<5.0	ug/L	
2-Chlorotoluene (Surface Water)	154	GCMS	<1	ug/L	UKAS
4-Chlorotoluene (Surface Water)	154	GCMS	<1	ug/L	UKAS
Acenaphthene (GCMS)	200	GCMS	<0.01	ug/L	

Signed : A Harmon **Date : 12/03/2019**

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	Aqua-Fact International Services Ltd	***Date of Receipt***	**21/02/2019**
	12 Kilkerrin Park	***Sampled On***	**20/02/2019**
	Liosbaun Ind Est	***Date Testing Commenced***	**21/02/2019**
	Liosbaun	***Received or Collected***	**By Fitz: Pick up DS**
	Co Galway	***Condition on Receipt***	**Acceptable**
Customer PO	**JN1526**	***Date of Report***	**12/03/2019**
Customer Ref	**DOWN 1km- ME- Surface**	***Sample Type***	**Surface Water**
Ref 2	**20/02/19 11:22**		
Ref 3			

CERTIFICATE OF ANALYSIS

Test Parameter	SOP	Analytical Technique	Result	Units	Acc.
Acenaphthylene (GCMS)	200	GCMS	<0.01	ug/L	
Ammonia (Surface Water)	114	Colorimetry	0.23	mg/L as N	UKAS
Anthracene (GCMS)	200	GCMS	<0.01	ug/L	
Antimony (Surface Water)	177	ICPMS	80	ug/L	UKAS
Arsenic (Surface Water)	177	ICPMS	82	ug/L	UKAS
Barium (Surface Water)	177	ICPMS	79	ug/L	UKAS
Benzene (Surface Water)	154	GCMS	<1	ug/L	UKAS
Benzo(a)anthracene (GCMS)	200	GCMS	<0.01	ug/L	
Benzo(a)pyrene (GCMS)	200	GCMS	<0.01	ug/L	
Benzo(g,h,i)perylene (GCMS)	200	GCMS	<0.01	ug/L	
Benzo(k)fluoranthene (GCMS)	200	GCMS	<0.01	ug/L	
Bromobenzene (Surface Water)	154	GCMS	<1	ug/L	UKAS
Bromochloromethane (Surface Water	154	GCMS	<1	ug/L	UKAS
Bromodichloromethane (Surface Wat	154	GCMS	<1	ug/L	UKAS
Bromoform (Surface Water)	154	GCMS	<1	ug/L	UKAS
Bromomethane (Surface Water)	154	GCMS	<5.0	ug/L	
Cadmium (Surface Water)	177	ICPMS	82	ug/L	UKAS
Carbon tetrachloride (Surface Water)	154	GCMS	<1	ug/L	UKAS
Chlorobenzene (Surface Water)	154	GCMS	<1	ug/L	UKAS
Chloroethane (Surface Water)	154	GCMS	<5.0	ug/L	
Chloroform (Surface Water)	154	GCMS	<1	ug/L	UKAS
Chloromethane (Surface Water)	154	GCMS	<5.0	ug/L	
Chromium (Surface Water)	177	ICPMS	82	ug/L	UKAS
Chrysene (GCMS)	200	GCMS	<0.01	ug/L	

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Customer	Caroline Roche Aqua-Fact International Services Ltd 12 Kilkerrin Park Liosbaun Ind Est Liosbaun Co Galway	*Lab Report Ref. No.*	0529/002/24
		Date of Receipt	21/02/2019
		Sampled On	20/02/2019
		Date Testing Commenced	21/02/2019
		Received or Collected	By Fitz: Pick up DS
		Condition on Receipt	Acceptable
Customer PO	JN1526	*Date of Report*	12/03/2019
Customer Ref	DOWN 1km- ME- Surface	*Sample Type*	Surface Water
Ref 2	20/02/19 11:22		
Ref 3			

CERTIFICATE OF ANALYSIS

Test Parameter	SOP	Analytical Technique	Result	Units	Acc.
cis-1,2-Dichloroethene (Surface Wat	154	GCMS	<1	ug/L	UKAS
cis-1,3-Dichloropropene (Surface Wa	154	GCMS	<1	ug/L	UKAS
COD (Surface Water)	107	Colorimetry	122	mg/L	UKAS
Copper (Surface Water)	177	ICPMS	72	ug/L	UKAS
Coronene (GCMS)	200	GCMS	<0.01	ug/L	
Dibenzo(a,h)anthracene (GCMS)	200	GCMS	<0.01	ug/L	
Dibromochloromethane (Surface Wat	154	GCMS	<1	ug/L	UKAS
Dibromomethane (Surface Water)	154	GCMS	<1	ug/L	UKAS
Dichlorodifluoromethane (Surface W	154	GCMS	<5.0	ug/L	
Dichloromethane (Surface Water)	154	GCMS	<5.0	ug/L	
Ethylbenzene (Surface Water)	154	GCMS	<1	ug/L	UKAS
Fluoranthene (GCMS)	200	GCMS	<0.01	ug/L	
Fluorene (GCMS)	200	GCMS	<0.01	ug/L	
Hexachlorobutadiene (Surface Water	154	GCMS	<1	ug/L	UKAS
Indeno(1,2,3-cd)pyrene (GCMS)	200	GCMS	<0.01	ug/L	
Isopropylbenzene (Surface Water)	154	GCMS	<1	ug/L	UKAS
Lead (Surface Water)	177	ICPMS	82	ug/L	UKAS
m- & p-Xylene (Surface Water)	154	GCMS	<1	ug/L	UKAS
Mercury (Surface water)	178	ICPMS	<0.03	ug/L	UKAS
Molybdenum	226	ICPMS	8	ug/L	
Naphthalene (Surface Water)	154	GCMS	<1	ug/L	UKAS
n-Butylbenzene (Surface Water)	154	GCMS	<1	ug/L	UKAS
Nickel (Surface Water)	177	ICPMS	82	ug/L	UKAS
Nitrogen (Total Kjeldahl)	104	Digestion/ Distillation/ Titrimetr	1.40	mg/L as N	

Signed : A Harmon

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	Aqua-Fact International Services Ltd	**Date of Receipt**	**21/02/2019**
	12 Kilkerrin Park	**Sampled On**	**20/02/2019**
	Liosbaun Ind Est	**Date Testing Commenced**	**21/02/2019**
	Liosbaun	**Received or Collected**	**By Fitz: Pick up DS**
	Co Galway	**Condition on Receipt**	**Acceptable**
Customer PO	**JN1526**	**Date of Report**	**12/03/2019**
Customer Ref	**DOWN 1km- ME- Surface**	**Sample Type**	**Surface Water**
Ref 2	**20/02/19 11:22**		
Ref 3			

CERTIFICATE OF ANALYSIS

Test Parameter	SOP	Analytical Technique	Result	Units	Acc.
Nitrogen (Total Oxidised) (Surface W	151	Colorimetry	1.35	mg/L as N	UKAS
Nitrogen (Total)	0	Calculation	2.75	mg/L as N	
n-Propylbenzene (Surface Water)	154	GCMS	<1.0	ug/L	UKAS
o-Xylene (Surface Water)	154	GCMS	<1	ug/L	UKAS
Phenanthrene (GCMS)	200	GCMS	<0.01	ug/L	
Phenols (Total)	223	GCMS	<0.10	ug/L	
Phosphorus (Total) Surface Water	166	Colorimetry	0.101	mg/L as P	UKAS
p-Isopropyltoluene (Surface Water)	154	GCMS	<1	ug/L	UKAS
Polyaromatic Hydrocarbons (GCMS)	200	GCMS	<0.01	ug/L	
Pyrene (GCMS)	200	GCMS	<0.01	ug/L	
sec-Butylbenzene (Surface Water)	154	GCMS	<1	ug/L	UKAS
Selenium (Surface Water)	177	ICPMS	82	ug/L	UKAS
Solids (Total Dissolved)	105	Filtration/ Evaporation @ 180C	13125	mg/L	
Styrene (Surface Water)	154	GCMS	<1	ug/L	UKAS
tert-Butylbenzene (Surface Water)	154	GCMS	<1	ug/L	UKAS
Tetrachloroethene (Surface Water)	154	GCMS	<1	ug/L	UKAS
TOC (Surface Water)	316	TOC Analyser	5.5	mg/L	UKAS
Toluene (Surface Water)	154	GCMS	<1	ug/L	UKAS
Total Inorganic Nitrogen	0	Calculation	1.6	mg/L	
trans-1,2-Dichloroethene (Surface W	154	GCMS	<1	ug/L	UKAS
trans-1,3-Dichloropropene (Surface	154	GCMS	<1	ug/L	UKAS
Trichloroethene (Surface Water)	154	GCMS	<1.0	ug/L	
Trichlorofluoromethane (Surface Wat	154	GCMS	<1	ug/L	UKAS
Vanadium (Surface Water)	177	ICPMS	82	ug/L	UKAS

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	Aqua-Fact International Services Ltd	***Date of Receipt***	**21/02/2019**
	12 Kilkerrin Park	***Sampled On***	**20/02/2019**
	Liosbaun Ind Est	***Date Testing Commenced***	**21/02/2019**
	Liosbaun	***Received or Collected***	**By Fitz: Pick up DS**
	Co Galway	***Condition on Receipt***	**Acceptable**
Customer PO	**JN1526**	***Date of Report***	**12/03/2019**
Customer Ref	**DOWN 1km- ME- Surface**	***Sample Type***	**Surface Water**
Ref 2	**20/02/19 11:22**		
Ref 3			

CERTIFICATE OF ANALYSIS

Test Parameter	SOP	Analytical Technique	Result	Units	Acc.
Vinyl chloride (Surface Water)	154	GCMS	<1	ug/L	UKAS
Volatile Organic Compounds	154	GCMS	<5.0	ug/L	
Xylene Total (Surface Water)	154	GCMS	<1	ug/L	UKAS
Zinc (Surface Water)	177	ICPMS	39	ug/L	UKAS

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		Date of Receipt	21/02/2019
		Sampled On	20/02/2019
		Date Testing Commenced	21/02/2019
		Received or Collected	By Fitz: Pick up DS
		Condition on Receipt	Acceptable
Customer PO	JN1526	*Date of Report*	12/03/2019
Customer Ref	DOWN 1km- ME- Middle	*Sample Type*	Surface Water
Ref 2	20/02/19 11:27		
Ref 3			

CERTIFICATE OF ANALYSIS

Test Parameter	SOP	Analytical Technique	Result	Units	Acc.
1,1,1,2-Tetrachloroethane (Surface	154	GCMS	<1	ug/L	UKAS
1,1,1-Trichloroethane (Surface Water	154	GCMS	<1	ug/L	UKAS
1,1,2,2-Tetrachloroethane (Surface	154	GCMS	<5.0	ug/L	
1,1,2-Trichloroethane (Surface Water	154	GCMS	<2	ug/L	UKAS
1,1-Dichloroethane (Surface Water)	154	GCMS	<1	ug/L	UKAS
1,1-Dichloroethene (Surface Water)	154	GCMS	<1	ug/L	UKAS
1,1-Dichloropropene (Surface Water)	154	GCMS	<1	ug/L	UKAS
1,2,3-Trichlorobenzene (Surface Wat	154	GCMS	<1	ug/L	UKAS
1,2,3-Trichloropropane (Surface Wat	154	GCMS	<0.9	ug/L	UKAS
1,2,4-Trichlorobenzene (Surface Wat	154	GCMS	<0.6	ug/L	UKAS
1,2,4-Trimethylbenzene (Surface Wa	154	GCMS	<1	ug/L	UKAS
1,2-Dibromo-3-chloropropane (Surfac	154	GCMS	<1	ug/L	UKAS
1,2-Dibromoethane (Surface Water)	154	GCMS	<1	ug/L	UKAS
1,2-Dichlorobenzene (Surface Water)	154	GCMS	<1	ug/L	UKAS
1,2-Dichloroethane (Surface Water)	154	GCMS	<1	ug/L	UKAS
1,2-Dichloropropane (Surface Water)	154	GCMS	<1	ug/L	UKAS
1,3,5-Trimethylbenzene (Surface Wa	154	GCMS	<1	ug/L	UKAS
1,3-Dichlorobenzene (Surface Water)	154	GCMS	<1	ug/L	UKAS
1,3-Dichloropropane (Surface Water)	154	GCMS	<1	ug/L	UKAS
1,4-Dichlorobenzene (Surface Water)	154	GCMS	<1	ug/L	UKAS
2,2-Dichloropropane (Surface Water)	154	GCMS	<5.0	ug/L	
2-Chlorotoluene (Surface Water)	154	GCMS	<1	ug/L	UKAS
4-Chlorotoluene (Surface Water)	154	GCMS	<1	ug/L	UKAS
Acenaphthene (GCMS)	200	GCMS	<0.01	ug/L	

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	Aqua-Fact International Services Ltd	***Date of Receipt***	**21/02/2019**
	12 Kilkerrin Park	***Sampled On***	**20/02/2019**
	Liosbaun Ind Est	***Date Testing Commenced***	**21/02/2019**
	Liosbaun	***Received or Collected***	**By Fitz: Pick up DS**
	Co Galway	***Condition on Receipt***	**Acceptable**
Customer PO	**JN1526**	***Date of Report***	**12/03/2019**
Customer Ref	**DOWN 1km- ME- Middle**	***Sample Type***	**Surface Water**
Ref 2	**20/02/19 11:27**		
Ref 3			

CERTIFICATE OF ANALYSIS

Test Parameter	SOP	Analytical Technique	Result	Units	Acc.
Acenaphthylene (GCMS)	200	GCMS	<0.01	ug/L	
Ammonia (Surface Water)	114	Colorimetry	0.21	mg/L as N	UKAS
Anthracene (GCMS)	200	GCMS	<0.01	ug/L	
Antimony (Surface Water)	177	ICPMS	82	ug/L	UKAS
Arsenic (Surface Water)	177	ICPMS	84	ug/L	UKAS
Barium (Surface Water)	177	ICPMS	81	ug/L	UKAS
Benzene (Surface Water)	154	GCMS	<1	ug/L	UKAS
Benzo(a)anthracene (GCMS)	200	GCMS	<0.01	ug/L	
Benzo(a)pyrene (GCMS)	200	GCMS	<0.01	ug/L	
Benzo(g,h,i)perylene (GCMS)	200	GCMS	<0.01	ug/L	
Benzo(k)fluoranthene (GCMS)	200	GCMS	<0.01	ug/L	
Bromobenzene (Surface Water)	154	GCMS	<1	ug/L	UKAS
Bromochloromethane (Surface Water	154	GCMS	<1	ug/L	UKAS
Bromodichloromethane (Surface Wat	154	GCMS	<1	ug/L	UKAS
Bromoform (Surface Water)	154	GCMS	<1	ug/L	UKAS
Bromomethane (Surface Water)	154	GCMS	<5.0	ug/L	
Cadmium (Surface Water)	177	ICPMS	84	ug/L	UKAS
Carbon tetrachloride (Surface Water)	154	GCMS	<1	ug/L	UKAS
Chlorobenzene (Surface Water)	154	GCMS	<1	ug/L	UKAS
Chloroethane (Surface Water)	154	GCMS	<5.0	ug/L	
Chloroform (Surface Water)	154	GCMS	<1	ug/L	UKAS
Chloromethane (Surface Water)	154	GCMS	<5.0	ug/L	
Chromium (Surface Water)	177	ICPMS	84	ug/L	UKAS
Chrysene (GCMS)	200	GCMS	<0.01	ug/L	

Signed : A Harman

Date : 12/03/2019

Aoife Harmon - Technical Supervisor

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ilac-MRA UKAS TESTING 2802

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Customer	Caroline Roche Aqua-Fact International Services Ltd 12 Kilkerrin Park Liosbaun Ind Est Liosbaun Co Galway	*Lab Report Ref. No.*	0529/002/25
		Date of Receipt	21/02/2019
		Sampled On	20/02/2019
		Date Testing Commenced	21/02/2019
		Received or Collected	By Fitz: Pick up DS
		Condition on Receipt	Acceptable
Customer PO	JN1526	*Date of Report*	12/03/2019
Customer Ref	DOWN 1km- ME- Middle	*Sample Type*	Surface Water
Ref 2	20/02/19 11:27		
Ref 3			

CERTIFICATE OF ANALYSIS

Test Parameter	SOP	Analytical Technique	Result	Units	Acc.
cis-1,2-Dichloroethene (Surface Wat	154	GCMS	<1	ug/L	UKAS
cis-1,3-Dichloropropene (Surface Wa	154	GCMS	<1	ug/L	UKAS
COD (Surface Water)	107	Colorimetry	131	mg/L	UKAS
Copper (Surface Water)	177	ICPMS	74	ug/L	UKAS
Coronene (GCMS)	200	GCMS	<0.01	ug/L	
Dibenzo(a,h)anthracene (GCMS)	200	GCMS	<0.01	ug/L	
Dibromochloromethane (Surface Wat	154	GCMS	<1	ug/L	UKAS
Dibromomethane (Surface Water)	154	GCMS	<1	ug/L	UKAS
Dichlorodifluoromethane (Surface W	154	GCMS	<5.0	ug/L	
Dichloromethane (Surface Water)	154	GCMS	<5.0	ug/L	
Ethylbenzene (Surface Water)	154	GCMS	<1	ug/L	UKAS
Fluoranthene (GCMS)	200	GCMS	<0.01	ug/L	
Fluorene (GCMS)	200	GCMS	<0.01	ug/L	
Hexachlorobutadiene (Surface Water	154	GCMS	<1	ug/L	UKAS
Indeno(1,2,3-cd)pyrene (GCMS)	200	GCMS	<0.01	ug/L	
Isopropylbenzene (Surface Water)	154	GCMS	<1	ug/L	UKAS
Lead (Surface Water)	177	ICPMS	83	ug/L	UKAS
m- & p-Xylene (Surface Water)	154	GCMS	<1	ug/L	UKAS
Mercury (Surface water)	178	ICPMS	<0.03	ug/L	UKAS
Molybdenum	226	ICPMS	6	ug/L	
Naphthalene (Surface Water)	154	GCMS	<1	ug/L	UKAS
n-Butylbenzene (Surface Water)	154	GCMS	<1	ug/L	UKAS
Nickel (Surface Water)	177	ICPMS	83	ug/L	UKAS
Nitrogen (Total Kjeldahl)	104	Digestion/ Distillation/ Titrimetr	1.68	mg/L as N	

Signed : A Harmon ***Date : 12/03/2019***

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	Aqua-Fact International Services Ltd	**Date of Receipt**	**21/02/2019**
	12 Kilkerrin Park	**Sampled On**	**20/02/2019**
	Liosbaun Ind Est	**Date Testing Commenced**	**21/02/2019**
	Liosbaun	**Received or Collected**	**By Fitz: Pick up DS**
	Co Galway	**Condition on Receipt**	**Acceptable**
Customer PO	**JN1526**	**Date of Report**	**12/03/2019**
Customer Ref	**DOWN 1km- ME- Middle**	**Sample Type**	**Surface Water**
Ref 2	**20/02/19 11:27**		
Ref 3			

CERTIFICATE OF ANALYSIS

Test Parameter	SOP	Analytical Technique	Result	Units	Acc.
Nitrogen (Total Oxidised) (Surface W	151	Colorimetry	1.34	mg/L as N	UKAS
Nitrogen (Total)	0	Calculation	3.02	mg/L as N	
n-Propylbenzene (Surface Water)	154	GCMS	<1.0	ug/L	UKAS
o-Xylene (Surface Water)	154	GCMS	<1	ug/L	UKAS
Phenanthrene (GCMS)	200	GCMS	<0.01	ug/L	
Phenols (Total)	223	GCMS	<0.10	ug/L	
Phosphorus (Total) Surface Water	166	Colorimetry	0.082	mg/L as P	UKAS
p-Isopropyltoluene (Surface Water)	154	GCMS	<1	ug/L	UKAS
Polyaromatic Hydrocarbons (GCMS)	200	GCMS	<0.01	ug/L	
Pyrene (GCMS)	200	GCMS	<0.01	ug/L	
sec-Butylbenzene (Surface Water)	154	GCMS	<1	ug/L	UKAS
Selenium (Surface Water)	177	ICPMS	84	ug/L	UKAS
Solids (Total Dissolved)	105	Filtration/ Evaporation @ 180C	13928	mg/L	
Styrene (Surface Water)	154	GCMS	<1	ug/L	UKAS
tert-Butylbenzene (Surface Water)	154	GCMS	<1	ug/L	UKAS
Tetrachloroethene (Surface Water)	154	GCMS	<1	ug/L	UKAS
TOC (Surface Water)	316	TOC Analyser	5.2	mg/L	UKAS
Toluene (Surface Water)	154	GCMS	<1	ug/L	UKAS
Total Inorganic Nitrogen	0	Calculation	1.6	mg/L	
trans-1,2-Dichloroethene (Surface W	154	GCMS	<1	ug/L	UKAS
trans-1,3-Dichloropropene (Surface	154	GCMS	<1	ug/L	UKAS
Trichloroethene (Surface Water)	154	GCMS	<1.0	ug/L	
Trichlorofluoromethane (Surface Wat	154	GCMS	<1	ug/L	UKAS
Vanadium (Surface Water)	177	ICPMS	84	ug/L	UKAS

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		Sampled On	20/02/2019
		Date Testing Commenced	21/02/2019
		Received or Collected	By Fitz: Pick up DS
		Condition on Receipt	Acceptable
Customer PO	JN1526	*Date of Report*	12/03/2019
Customer Ref	DOWN 1km- ME- Middle	*Sample Type*	Surface Water
Ref 2	20/02/19 11:27		
Ref 3			

CERTIFICATE OF ANALYSIS

Test Parameter	SOP	Analytical Technique	Result	Units	Acc.
Vinyl chloride (Surface Water)	154	GCMS	<1	ug/L	UKAS
Volatile Organic Compounds	154	GCMS	<5.0	ug/L	
Xylene Total (Surface Water)	154	GCMS	<1	ug/L	UKAS
Zinc (Surface Water)	177	ICPMS	40	ug/L	UKAS

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	Aqua-Fact International Services Ltd	*Date of Receipt*	21/02/2019
	12 Kilkerrin Park	*Sampled On*	20/02/2019
	Liosbaun Ind Est	*Date Testing Commenced*	21/02/2019
	Liosbaun	*Received or Collected*	By Fitz: Pick up DS
	Co Galway	*Condition on Receipt*	Acceptable
Customer PO	JN1526	*Date of Report*	12/03/2019
Customer Ref	DOWN 1km- ME- Bottom	*Sample Type*	Surface Water
Ref 2	20/02/19 11:32		
Ref 3			

CERTIFICATE OF ANALYSIS

Test Parameter	SOP	Analytical Technique	Result	Units	Acc.
1,1,1,2-Tetrachloroethane (Surface	154	GCMS	<1	ug/L	UKAS
1,1,1-Trichloroethane (Surface Water	154	GCMS	<1	ug/L	UKAS
1,1,2,2-Tetrachloroethane (Surface	154	GCMS	<5.0	ug/L	
1,1,2-Trichloroethane (Surface Water	154	GCMS	<2	ug/L	UKAS
1,1-Dichloroethane (Surface Water)	154	GCMS	<1	ug/L	UKAS
1,1-Dichloroethene (Surface Water)	154	GCMS	<1	ug/L	UKAS
1,1-Dichloropropene (Surface Water)	154	GCMS	<1	ug/L	UKAS
1,2,3-Trichlorobenzene (Surface Wat	154	GCMS	<1	ug/L	UKAS
1,2,3-Trichloropropane (Surface Wat	154	GCMS	<0.9	ug/L	UKAS
1,2,4-Trichlorobenzene (Surface Wat	154	GCMS	<0.6	ug/L	UKAS
1,2,4-Trimethylbenzene (Surface Wa	154	GCMS	<1	ug/L	UKAS
1,2-Dibromo-3-chloropropane (Surfac	154	GCMS	<1	ug/L	UKAS
1,2-Dibromoethane (Surface Water)	154	GCMS	<1	ug/L	UKAS
1,2-Dichlorobenzene (Surface Water)	154	GCMS	<1	ug/L	UKAS
1,2-Dichloroethane (Surface Water)	154	GCMS	<1	ug/L	UKAS
1,2-Dichloropropane (Surface Water)	154	GCMS	<1	ug/L	UKAS
1,3,5-Trimethylbenzene (Surface Wa	154	GCMS	<1	ug/L	UKAS
1,3-Dichlorobenzene (Surface Water)	154	GCMS	<1	ug/L	UKAS
1,3-Dichloropropane (Surface Water)	154	GCMS	<1	ug/L	UKAS
1,4-Dichlorobenzene (Surface Water)	154	GCMS	<1	ug/L	UKAS
2,2-Dichloropropane (Surface Water)	154	GCMS	<5.0	ug/L	
2-Chlorotoluene (Surface Water)	154	GCMS	<1	ug/L	UKAS
4-Chlorotoluene (Surface Water)	154	GCMS	<1	ug/L	UKAS
Acenaphthene (GCMS)	200	GCMS	<0.01	ug/L	

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	Liosbaun Ind Est	*Date Testing Commenced*	**21/02/2019**
	Liosbaun	*Received or Collected*	**By Fitz: Pick up DS**
	Co Galway	*Condition on Receipt*	**Acceptable**
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Customer Ref	**DOWN 1km- ME- Bottom**	*Sample Type*	**Surface Water**
Ref 2	**20/02/19 11:32**		
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CERTIFICATE OF ANALYSIS

Test Parameter	SOP	Analytical Technique	Result	Units	Acc.
Acenaphthylene (GCMS)	200	GCMS	<0.01	ug/L	
Ammonia (Surface Water)	114	Colorimetry	0.20	mg/L as N	UKAS
Anthracene (GCMS)	200	GCMS	<0.01	ug/L	
Antimony (Surface Water)	177	ICPMS	86	ug/L	UKAS
Arsenic (Surface Water)	177	ICPMS	88	ug/L	UKAS
Barium (Surface Water)	177	ICPMS	85	ug/L	UKAS
Benzene (Surface Water)	154	GCMS	<1	ug/L	UKAS
Benzo(a)anthracene (GCMS)	200	GCMS	<0.01	ug/L	
Benzo(a)pyrene (GCMS)	200	GCMS	<0.01	ug/L	
Benzo(g,h,i)perylene (GCMS)	200	GCMS	<0.01	ug/L	
Benzo(k)fluoranthene (GCMS)	200	GCMS	<0.01	ug/L	
Bromobenzene (Surface Water)	154	GCMS	<1	ug/L	UKAS
Bromochloromethane (Surface Water	154	GCMS	<1	ug/L	UKAS
Bromodichloromethane (Surface Wat	154	GCMS	<1	ug/L	UKAS
Bromoform (Surface Water)	154	GCMS	<1	ug/L	UKAS
Bromomethane (Surface Water)	154	GCMS	<5.0	ug/L	
Cadmium (Surface Water)	177	ICPMS	89	ug/L	UKAS
Carbon tetrachloride (Surface Water)	154	GCMS	<1	ug/L	UKAS
Chlorobenzene (Surface Water)	154	GCMS	<1	ug/L	UKAS
Chloroethane (Surface Water)	154	GCMS	<5.0	ug/L	
Chloroform (Surface Water)	154	GCMS	<1	ug/L	UKAS
Chloromethane (Surface Water)	154	GCMS	<5.0	ug/L	
Chromium (Surface Water)	177	ICPMS	88	ug/L	UKAS
Chrysene (GCMS)	200	GCMS	<0.01	ug/L	

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	Liosbaun Ind Est	*Date Testing Commenced*	**21/02/2019**
	Liosbaun	*Received or Collected*	**By Fitz: Pick up DS**
	Co Galway	*Condition on Receipt*	**Acceptable**
Customer PO	**JN1526**	*Date of Report*	**12/03/2019**
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Ref 2	**20/02/19 11:32**		
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CERTIFICATE OF ANALYSIS

Test Parameter	SOP	Analytical Technique	Result	Units	Acc.
cis-1,2-Dichloroethene (Surface Wat	154	GCMS	<1	ug/L	UKAS
cis-1,3-Dichloropropene (Surface Wa	154	GCMS	<1	ug/L	UKAS
COD (Surface Water)	107	Colorimetry	126	mg/L	UKAS
Copper (Surface Water)	177	ICPMS	78	ug/L	UKAS
Coronene (GCMS)	200	GCMS	<0.01	ug/L	
Dibenzo(a,h)anthracene (GCMS)	200	GCMS	<0.01	ug/L	
Dibromochloromethane (Surface Wat	154	GCMS	<1	ug/L	UKAS
Dibromomethane (Surface Water)	154	GCMS	<1	ug/L	UKAS
Dichlorodifluoromethane (Surface W	154	GCMS	<5.0	ug/L	
Dichloromethane (Surface Water)	154	GCMS	<5.0	ug/L	
Ethylbenzene (Surface Water)	154	GCMS	<1	ug/L	UKAS
Fluoranthene (GCMS)	200	GCMS	<0.01	ug/L	
Fluorene (GCMS)	200	GCMS	<0.01	ug/L	
Hexachlorobutadiene (Surface Water	154	GCMS	<1	ug/L	UKAS
Indeno(1,2,3-cd)pyrene (GCMS)	200	GCMS	<0.01	ug/L	
Isopropylbenzene (Surface Water)	154	GCMS	<1	ug/L	UKAS
Lead (Surface Water)	177	ICPMS	88	ug/L	UKAS
m- & p-Xylene (Surface Water)	154	GCMS	<1	ug/L	UKAS
Mercury (Surface water)	178	ICPMS	<0.03	ug/L	UKAS
Molybdenum	226	ICPMS	6	ug/L	
Naphthalene (Surface Water)	154	GCMS	<1	ug/L	UKAS
n-Butylbenzene (Surface Water)	154	GCMS	<1	ug/L	UKAS
Nickel (Surface Water)	177	ICPMS	88	ug/L	UKAS
Nitrogen (Total Kjeldahl)	104	Digestion/ Distillation/ Titrimetr	1.68	mg/L as N	

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	12 Kilkerrin Park	*Sampled On*	**20/02/2019**
	Liosbaun Ind Est	*Date Testing Commenced*	**21/02/2019**
	Liosbaun	*Received or Collected*	**By Fitz: Pick up DS**
	Co Galway	*Condition on Receipt*	**Acceptable**
Customer PO	**JN1526**	*Date of Report*	**12/03/2019**
Customer Ref	**DOWN 1km- ME- Bottom**	*Sample Type*	**Surface Water**
Ref 2	**20/02/19 11:32**		
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CERTIFICATE OF ANALYSIS

Test Parameter	SOP	Analytical Technique	Result	Units	Acc.
Nitrogen (Total Oxidised) (Surface W	151	Colorimetry	1.26	mg/L as N	UKAS
Nitrogen (Total)	0	Calculation	2.94	mg/L as N	
n-Propylbenzene (Surface Water)	154	GCMS	<1.0	ug/L	UKAS
o-Xylene (Surface Water)	154	GCMS	<1	ug/L	UKAS
Phenanthrene (GCMS)	200	GCMS	<0.01	ug/L	
Phenols (Total)	223	GCMS	<0.10	ug/L	
Phosphorus (Total) Surface Water	166	Colorimetry	0.099	mg/L as P	UKAS
p-Isopropyltoluene (Surface Water)	154	GCMS	<1	ug/L	UKAS
Polyaromatic Hydrocarbons (GCMS)	200	GCMS	<0.01	ug/L	
Pyrene (GCMS)	200	GCMS	<0.01	ug/L	
sec-Butylbenzene (Surface Water)	154	GCMS	<1	ug/L	UKAS
Selenium (Surface Water)	177	ICPMS	88	ug/L	UKAS
Solids (Total Dissolved)	105	Filtration/ Evaporation @ 180C	13585	mg/L	
Styrene (Surface Water)	154	GCMS	<1	ug/L	UKAS
tert-Butylbenzene (Surface Water)	154	GCMS	<1	ug/L	UKAS
Tetrachloroethene (Surface Water)	154	GCMS	<1	ug/L	UKAS
TOC (Surface Water)	316	TOC Analyser	5.3	mg/L	UKAS
Toluene (Surface Water)	154	GCMS	<1	ug/L	UKAS
Total Inorganic Nitrogen	0	Calculation	1.5	mg/L	
trans-1,2-Dichloroethene (Surface W	154	GCMS	<1	ug/L	UKAS
trans-1,3-Dichloropropene (Surface	154	GCMS	<1	ug/L	UKAS
Trichloroethene (Surface Water)	154	GCMS	<1.0	ug/L	
Trichlorofluoromethane (Surface Wat	154	GCMS	<1	ug/L	UKAS
Vanadium (Surface Water)	177	ICPMS	89	ug/L	UKAS

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	12 Kilkerrin Park	***Sampled On***	**20/02/2019**
	Liosbaun Ind Est	***Date Testing Commenced***	**21/02/2019**
	Liosbaun	***Received or Collected***	**By Fitz: Pick up DS**
	Co Galway	***Condition on Receipt***	**Acceptable**
Customer PO	**JN1526**	***Date of Report***	**12/03/2019**
Customer Ref	**DOWN 1km- ME- Bottom**	***Sample Type***	**Surface Water**
Ref 2	**20/02/19 11:32**		
Ref 3			

CERTIFICATE OF ANALYSIS

Test Parameter	SOP	Analytical Technique	Result	Units	Acc.
Vinyl chloride (Surface Water)	154	GCMS	<1	ug/L	UKAS
Volatile Organic Compounds	154	GCMS	<5.0	ug/L	
Xylene Total (Surface Water)	154	GCMS	<1	ug/L	UKAS
Zinc (Surface Water)	177	ICPMS	45	ug/L	UKAS

Signed : A Harmon

Aoife Harmon - Technical Supervisor

Date : 12/03/2019

Acc. : Accredited Parameters by ISO 17025:2005
PVL - Parametric Value Limit as per EU (Drinking water) Regulations (SI 122 2014)
For bacterial analysis a result of 0 means none detected in volume examined
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ilac-MRA UKAS TESTING 2802

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Customer	**Caroline Roche**	*Lab Report Ref. No.*	**0529/002/19**
	Aqua-Fact International Services Ltd	*Date of Receipt*	**21/02/2019**
	12 Kilkerrin Park	*Sampled On*	**20/02/2019**
	Liosbaun Ind Est	*Date Testing Commenced*	**21/02/2019**
	Liosbaun	*Received or Collected*	**By Fitz: Pick up DS**
	Co Galway	*Condition on Receipt*	**Acceptable**
Customer PO	**JN1526**	*Date of Report*	**12/03/2019**
Customer Ref	**DOWN 1KM - LW - Surface**	*Sample Type*	**Surface Water**
Ref 2	**20/02/19 13:25**		
Ref 3			

CERTIFICATE OF ANALYSIS

Test Parameter	SOP	Analytical Technique	Result	Units	Acc.
1,1,1,2-Tetrachloroethane (Surface	154	GCMS	<1	ug/L	UKAS
1,1,1-Trichloroethane (Surface Water	154	GCMS	<1	ug/L	UKAS
1,1,2,2-Tetrachloroethane (Surface	154	GCMS	<5.0	ug/L	
1,1,2-Trichloroethane (Surface Water	154	GCMS	<2	ug/L	UKAS
1,1-Dichloroethane (Surface Water)	154	GCMS	<1	ug/L	UKAS
1,1-Dichloroethene (Surface Water)	154	GCMS	<1	ug/L	UKAS
1,1-Dichloropropene (Surface Water)	154	GCMS	<1	ug/L	UKAS
1,2,3-Trichlorobenzene (Surface Wat	154	GCMS	<1	ug/L	UKAS
1,2,3-Trichloropropane (Surface Wat	154	GCMS	<0.9	ug/L	UKAS
1,2,4-Trichlorobenzene (Surface Wat	154	GCMS	<0.6	ug/L	UKAS
1,2,4-Trimethylbenzene (Surface Wa	154	GCMS	<1	ug/L	UKAS
1,2-Dibromo-3-chloropropane (Surfac	154	GCMS	<1	ug/L	UKAS
1,2-Dibromoethane (Surface Water)	154	GCMS	<1	ug/L	UKAS
1,2-Dichlorobenzene (Surface Water)	154	GCMS	<1	ug/L	UKAS
1,2-Dichloroethane (Surface Water)	154	GCMS	<1	ug/L	UKAS
1,2-Dichloropropane (Surface Water)	154	GCMS	<1	ug/L	UKAS
1,3,5-Trimethylbenzene (Surface Wa	154	GCMS	<1	ug/L	UKAS
1,3-Dichlorobenzene (Surface Water)	154	GCMS	<1	ug/L	UKAS
1,3-Dichloropropane (Surface Water)	154	GCMS	<1	ug/L	UKAS
1,4-Dichlorobenzene (Surface Water)	154	GCMS	<1	ug/L	UKAS
2,2-Dichloropropane (Surface Water)	154	GCMS	<5.0	ug/L	
2-Chlorotoluene (Surface Water)	154	GCMS	<1	ug/L	UKAS
4-Chlorotoluene (Surface Water)	154	GCMS	<1	ug/L	UKAS
Acenaphthene (GCMS)	200	GCMS	<0.01	ug/L	

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Customer	**Caroline Roche** **Aqua-Fact International Services Ltd** **12 Kilkerrin Park** **Liosbaun Ind Est** **Liosbaun** **Co Galway**	*Lab Report Ref. No.*	**0529/002/19**
		Date of Receipt	**21/02/2019**
		Sampled On	**20/02/2019**
		Date Testing Commenced	**21/02/2019**
		Received or Collected	**By Fitz: Pick up DS**
		Condition on Receipt	**Acceptable**
Customer PO	**JN1526**	*Date of Report*	**12/03/2019**
Customer Ref	**DOWN 1KM - LW - Surface**	*Sample Type*	**Surface Water**
Ref 2	**20/02/19 13:25**		
Ref 3			

CERTIFICATE OF ANALYSIS

Test Parameter	SOP	Analytical Technique	Result	Units	Acc.
Acenaphthylene (GCMS)	200	GCMS	<0.01	ug/L	
Ammonia (Surface Water)	114	Colorimetry	0.23	mg/L as N	UKAS
Anthracene (GCMS)	200	GCMS	<0.01	ug/L	
Antimony (Surface Water)	177	ICPMS	72	ug/L	UKAS
Arsenic (Surface Water)	177	ICPMS	74	ug/L	UKAS
Barium (Surface Water)	177	ICPMS	71	ug/L	UKAS
Benzene (Surface Water)	154	GCMS	<1	ug/L	UKAS
Benzo(a)anthracene (GCMS)	200	GCMS	<0.01	ug/L	
Benzo(a)pyrene (GCMS)	200	GCMS	<0.01	ug/L	
Benzo(g,h,i)perylene (GCMS)	200	GCMS	<0.01	ug/L	
Benzo(k)fluoranthene (GCMS)	200	GCMS	<0.01	ug/L	
Bromobenzene (Surface Water)	154	GCMS	<1	ug/L	UKAS
Bromochloromethane (Surface Water	154	GCMS	<1	ug/L	UKAS
Bromodichloromethane (Surface Wat	154	GCMS	<1	ug/L	UKAS
Bromoform (Surface Water)	154	GCMS	<1	ug/L	UKAS
Bromomethane (Surface Water)	154	GCMS	<5.0	ug/L	
Cadmium (Surface Water)	177	ICPMS	74	ug/L	UKAS
Carbon tetrachloride (Surface Water)	154	GCMS	<1	ug/L	UKAS
Chlorobenzene (Surface Water)	154	GCMS	<1	ug/L	UKAS
Chloroethane (Surface Water)	154	GCMS	<5.0	ug/L	
Chloroform (Surface Water)	154	GCMS	<1	ug/L	UKAS
Chloromethane (Surface Water)	154	GCMS	<5.0	ug/L	
Chromium (Surface Water)	177	ICPMS	74	ug/L	UKAS
Chrysene (GCMS)	200	GCMS	<0.01	ug/L	

Signed : A Harman

Date : 12/03/2019

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		Date of Receipt	21/02/2019
		Sampled On	20/02/2019
		Date Testing Commenced	21/02/2019
		Received or Collected	By Fitz: Pick up DS
		Condition on Receipt	Acceptable
Customer PO	JN1526	*Date of Report*	12/03/2019
Customer Ref	DOWN 1KM - LW - Surface	*Sample Type*	Surface Water
Ref 2	20/02/19 13:25		
Ref 3			

CERTIFICATE OF ANALYSIS

Test Parameter	SOP	Analytical Technique	Result	Units	Acc.
cis-1,2-Dichloroethene (Surface Wat	154	GCMS	<1	ug/L	UKAS
cis-1,3-Dichloropropene (Surface Wa	154	GCMS	<1	ug/L	UKAS
COD (Surface Water)	107	Colorimetry	120	mg/L	UKAS
Copper (Surface Water)	177	ICPMS	64	ug/L	UKAS
Coronene (GCMS)	200	GCMS	<0.01	ug/L	
Dibenzo(a,h)anthracene (GCMS)	200	GCMS	<0.01	ug/L	
Dibromochloromethane (Surface Wat	154	GCMS	<1	ug/L	UKAS
Dibromomethane (Surface Water)	154	GCMS	<1	ug/L	UKAS
Dichlorodifluoromethane (Surface W	154	GCMS	<5.0	ug/L	
Dichloromethane (Surface Water)	154	GCMS	<5.0	ug/L	
Ethylbenzene (Surface Water)	154	GCMS	<1	ug/L	UKAS
Fluoranthene (GCMS)	200	GCMS	<0.01	ug/L	
Fluorene (GCMS)	200	GCMS	<0.01	ug/L	
Hexachlorobutadiene (Surface Water	154	GCMS	<1	ug/L	UKAS
Indeno(1,2,3-cd)pyrene (GCMS)	200	GCMS	<0.01	ug/L	
Isopropylbenzene (Surface Water)	154	GCMS	<1	ug/L	UKAS
Lead (Surface Water)	177	ICPMS	73	ug/L	UKAS
m- & p-Xylene (Surface Water)	154	GCMS	<1	ug/L	UKAS
Mercury (Surface water)	178	ICPMS	<0.03	ug/L	UKAS
Molybdenum	226	ICPMS	<5	ug/L	
Naphthalene (Surface Water)	154	GCMS	<1	ug/L	UKAS
n-Butylbenzene (Surface Water)	154	GCMS	<1	ug/L	UKAS
Nickel (Surface Water)	177	ICPMS	74	ug/L	UKAS
Nitrogen (Total Kjeldahl)	104	Digestion/ Distillation/ Titrimetr	1.12	mg/L as N	

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Customer	**Caroline Roche** **Aqua-Fact International Services Ltd** **12 Kilkerrin Park** **Liosbaun Ind Est** **Liosbaun** **Co Galway**	*Lab Report Ref. No.*	**0529/002/19**
		Date of Receipt	**21/02/2019**
		Sampled On	**20/02/2019**
		Date Testing Commenced	**21/02/2019**
		Received or Collected	**By Fitz: Pick up DS**
		Condition on Receipt	**Acceptable**
Customer PO	**JN1526**	*Date of Report*	**12/03/2019**
Customer Ref	**DOWN 1KM - LW - Surface**	*Sample Type*	**Surface Water**
Ref 2	**20/02/19 13:25**		
Ref 3			

CERTIFICATE OF ANALYSIS

Test Parameter	SOP	Analytical Technique	Result	Units	Acc.
Nitrogen (Total Oxidised) (Surface W	151	Colorimetry	1.35	mg/L as N	UKAS
Nitrogen (Total)	0	Calculation	2.47	mg/L as N	
n-Propylbenzene (Surface Water)	154	GCMS	<1.0	ug/L	UKAS
o-Xylene (Surface Water)	154	GCMS	<1	ug/L	UKAS
Phenanthrene (GCMS)	200	GCMS	<0.01	ug/L	
Phenols (Total)	223	GCMS	<0.10	ug/L	
Phosphorus (Total) Surface Water	166	Colorimetry	0.090	mg/L as P	UKAS
p-Isopropyltoluene (Surface Water)	154	GCMS	<1	ug/L	UKAS
Polyaromatic Hydrocarbons (GCMS)	200	GCMS	<0.01	ug/L	
Pyrene (GCMS)	200	GCMS	<0.01	ug/L	
sec-Butylbenzene (Surface Water)	154	GCMS	<1	ug/L	UKAS
Selenium (Surface Water)	177	ICPMS	74	ug/L	UKAS
Solids (Total Dissolved)	105	Filtration/ Evaporation @ 180C	12814	mg/L	
Styrene (Surface Water)	154	GCMS	<1	ug/L	UKAS
tert-Butylbenzene (Surface Water)	154	GCMS	<1	ug/L	UKAS
Tetrachloroethene (Surface Water)	154	GCMS	<1	ug/L	UKAS
TOC (Surface Water)	316	TOC Analyser	5.6	mg/L	UKAS
Toluene (Surface Water)	154	GCMS	<1	ug/L	UKAS
Total Inorganic Nitrogen	0	Calculation	1.6	mg/L	
trans-1,2-Dichloroethene (Surface W	154	GCMS	<1	ug/L	UKAS
trans-1,3-Dichloropropene (Surface	154	GCMS	<1	ug/L	UKAS
Trichloroethene (Surface Water)	154	GCMS	<1.0	ug/L	
Trichlorofluoromethane (Surface Wat	154	GCMS	<1	ug/L	UKAS
Vanadium (Surface Water)	177	ICPMS	74	ug/L	UKAS

Signed : A Harman **Date : 12/03/2019**

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Customer	Caroline Roche Aqua-Fact International Services Ltd 12 Kilkerrin Park Liosbaun Ind Est Liosbaun Co Galway	**Lab Report Ref. No.**	0529/002/19
		Date of Receipt	21/02/2019
		Sampled On	20/02/2019
		Date Testing Commenced	21/02/2019
		Received or Collected	By Fitz: Pick up DS
		Condition on Receipt	Acceptable
Customer PO	JN1526	**Date of Report**	12/03/2019
Customer Ref	DOWN 1KM - LW - Surface	**Sample Type**	Surface Water
Ref 2	20/02/19 13:25		
Ref 3			

CERTIFICATE OF ANALYSIS

Test Parameter	SOP	Analytical Technique	Result	Units	Acc.
Vinyl chloride (Surface Water)	154	GCMS	<1	ug/L	UKAS
Volatile Organic Compounds	154	GCMS	<5.0	ug/L	
Xylene Total (Surface Water)	154	GCMS	<1	ug/L	UKAS
Zinc (Surface Water)	177	ICPMS	30	ug/L	UKAS

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	Aqua-Fact International Services Ltd	***Date of Receipt***	**21/02/2019**
	12 Kilkerrin Park	***Sampled On***	**20/02/2019**
	Liosbaun Ind Est	***Date Testing Commenced***	**21/02/2019**
	Liosbaun	***Received or Collected***	**By Fitz: Pick up DS**
	Co Galway	***Condition on Receipt***	**Acceptable**
Customer PO	**JN1526**	***Date of Report***	**12/03/2019**
Customer Ref	**DOWN 1km- LW- Middle**	***Sample Type***	**Surface Water**
Ref 2	**20/02/19 13:30**		
Ref 3			

CERTIFICATE OF ANALYSIS

Test Parameter	SOP	Analytical Technique	Result	Units	Acc.
1,1,1,2-Tetrachloroethane (Surface	154	GCMS	<1	ug/L	UKAS
1,1,1-Trichloroethane (Surface Water	154	GCMS	<1	ug/L	UKAS
1,1,2,2-Tetrachloroethane (Surface	154	GCMS	<5.0	ug/L	
1,1,2-Trichloroethane (Surface Water	154	GCMS	<2	ug/L	UKAS
1,1-Dichloroethane (Surface Water)	154	GCMS	<1	ug/L	UKAS
1,1-Dichloroethene (Surface Water)	154	GCMS	<1	ug/L	UKAS
1,1-Dichloropropene (Surface Water)	154	GCMS	<1	ug/L	UKAS
1,2,3-Trichlorobenzene (Surface Wat	154	GCMS	<1	ug/L	UKAS
1,2,3-Trichloropropane (Surface Wat	154	GCMS	<0.9	ug/L	UKAS
1,2,4-Trichlorobenzene (Surface Wat	154	GCMS	<0.6	ug/L	UKAS
1,2,4-Trimethylbenzene (Surface Wa	154	GCMS	<1	ug/L	UKAS
1,2-Dibromo-3-chloropropane (Surfac	154	GCMS	<1	ug/L	UKAS
1,2-Dibromoethane (Surface Water)	154	GCMS	<1	ug/L	UKAS
1,2-Dichlorobenzene (Surface Water)	154	GCMS	<1	ug/L	UKAS
1,2-Dichloroethane (Surface Water)	154	GCMS	<1	ug/L	UKAS
1,2-Dichloropropane (Surface Water)	154	GCMS	<1	ug/L	UKAS
1,3,5-Trimethylbenzene (Surface Wa	154	GCMS	<1	ug/L	UKAS
1,3-Dichlorobenzene (Surface Water)	154	GCMS	<1	ug/L	UKAS
1,3-Dichloropropane (Surface Water)	154	GCMS	<1	ug/L	UKAS
1,4-Dichlorobenzene (Surface Water)	154	GCMS	<1	ug/L	UKAS
2,2-Dichloropropane (Surface Water)	154	GCMS	<5.0	ug/L	
2-Chlorotoluene (Surface Water)	154	GCMS	<1	ug/L	UKAS
4-Chlorotoluene (Surface Water)	154	GCMS	<1	ug/L	UKAS
Acenaphthene (GCMS)	200	GCMS	<0.01	ug/L	

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	Aqua-Fact International Services Ltd	***Date of Receipt***	**21/02/2019**
	12 Kilkerrin Park	***Sampled On***	**20/02/2019**
	Liosbaun Ind Est	***Date Testing Commenced***	**21/02/2019**
	Liosbaun	***Received or Collected***	**By Fitz: Pick up DS**
	Co Galway	***Condition on Receipt***	**Acceptable**
Customer PO	**JN1526**	***Date of Report***	**12/03/2019**
Customer Ref	**DOWN 1km- LW- Middle**	***Sample Type***	**Surface Water**
Ref 2	**20/02/19 13:30**		
Ref 3			

CERTIFICATE OF ANALYSIS

Test Parameter	SOP	Analytical Technique	Result	Units	Acc.
Acenaphthylene (GCMS)	200	GCMS	<0.01	ug/L	
Ammonia (Surface Water)	114	Colorimetry	0.22	mg/L as N	UKAS
Anthracene (GCMS)	200	GCMS	<0.01	ug/L	
Antimony (Surface Water)	177	ICPMS	70	ug/L	UKAS
Arsenic (Surface Water)	177	ICPMS	73	ug/L	UKAS
Barium (Surface Water)	177	ICPMS	69	ug/L	UKAS
Benzene (Surface Water)	154	GCMS	<1	ug/L	UKAS
Benzo(a)anthracene (GCMS)	200	GCMS	<0.01	ug/L	
Benzo(a)pyrene (GCMS)	200	GCMS	<0.01	ug/L	
Benzo(g,h,i)perylene (GCMS)	200	GCMS	<0.01	ug/L	
Benzo(k)fluoranthene (GCMS)	200	GCMS	<0.01	ug/L	
Bromobenzene (Surface Water)	154	GCMS	<1	ug/L	UKAS
Bromochloromethane (Surface Water	154	GCMS	<1	ug/L	UKAS
Bromodichloromethane (Surface Wat	154	GCMS	<1	ug/L	UKAS
Bromoform (Surface Water)	154	GCMS	<1	ug/L	UKAS
Bromomethane (Surface Water)	154	GCMS	<5.0	ug/L	
Cadmium (Surface Water)	177	ICPMS	73	ug/L	UKAS
Carbon tetrachloride (Surface Water)	154	GCMS	<1	ug/L	UKAS
Chlorobenzene (Surface Water)	154	GCMS	<1	ug/L	UKAS
Chloroethane (Surface Water)	154	GCMS	<5.0	ug/L	
Chloroform (Surface Water)	154	GCMS	<1	ug/L	UKAS
Chloromethane (Surface Water)	154	GCMS	<5.0	ug/L	
Chromium (Surface Water)	177	ICPMS	72	ug/L	UKAS
Chrysene (GCMS)	200	GCMS	<0.01	ug/L	

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Customer	**Caroline Roche**	*Lab Report Ref. No.*	**0529/002/27**
	Aqua-Fact International Services Ltd	*Date of Receipt*	**21/02/2019**
	12 Kilkerrin Park	*Sampled On*	**20/02/2019**
	Liosbaun Ind Est	*Date Testing Commenced*	**21/02/2019**
	Liosbaun	*Received or Collected*	**By Fitz: Pick up DS**
	Co Galway	*Condition on Receipt*	**Acceptable**
Customer PO	**JN1526**	*Date of Report*	**12/03/2019**
Customer Ref	**DOWN 1km- LW- Middle**	*Sample Type*	**Surface Water**
Ref 2	**20/02/19 13:30**		
Ref 3			

CERTIFICATE OF ANALYSIS

Test Parameter	SOP	Analytical Technique	Result	Units	Acc.
cis-1,2-Dichloroethene (Surface Wat	154	GCMS	<1	ug/L	UKAS
cis-1,3-Dichloropropene (Surface Wa	154	GCMS	<1	ug/L	UKAS
COD (Surface Water)	107	Colorimetry	114	mg/L	UKAS
Copper (Surface Water)	177	ICPMS	62	ug/L	UKAS
Coronene (GCMS)	200	GCMS	<0.01	ug/L	
Dibenzo(a,h)anthracene (GCMS)	200	GCMS	<0.01	ug/L	
Dibromochloromethane (Surface Wat	154	GCMS	<1	ug/L	UKAS
Dibromomethane (Surface Water)	154	GCMS	<1	ug/L	UKAS
Dichlorodifluoromethane (Surface W	154	GCMS	<5.0	ug/L	
Dichloromethane (Surface Water)	154	GCMS	<5.0	ug/L	
Ethylbenzene (Surface Water)	154	GCMS	<1	ug/L	UKAS
Fluoranthene (GCMS)	200	GCMS	<0.01	ug/L	
Fluorene (GCMS)	200	GCMS	<0.01	ug/L	
Hexachlorobutadiene (Surface Water	154	GCMS	<1	ug/L	UKAS
Indeno(1,2,3-cd)pyrene (GCMS)	200	GCMS	<0.01	ug/L	
Isopropylbenzene (Surface Water)	154	GCMS	<1	ug/L	UKAS
Lead (Surface Water)	177	ICPMS	72	ug/L	UKAS
m- & p-Xylene (Surface Water)	154	GCMS	<1	ug/L	UKAS
Mercury (Surface water)	178	ICPMS	<0.03	ug/L	UKAS
Molybdenum	226	ICPMS	14	ug/L	
Naphthalene (Surface Water)	154	GCMS	<1	ug/L	UKAS
n-Butylbenzene (Surface Water)	154	GCMS	<1	ug/L	UKAS
Nickel (Surface Water)	177	ICPMS	72	ug/L	UKAS
Nitrogen (Total Kjeldahl)	104	Digestion/ Distillation/ Titrimetr	1.40	mg/L as N	

Signed : A Harmon ***Date : 12/03/2019***

Aoife Harmon - Technical Supervisor

Acc. : Accredited Parameters by ISO 17025:2005
PVL - Parametric Value Limit as per EU (Drinking water) Regulations (SI 122 2014)
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ilac-MRA UKAS TESTING 2802

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Customer PO	**JN1526**	**Date of Report**	**12/03/2019**
Customer Ref	**DOWN 1km- LW- Middle**	**Sample Type**	**Surface Water**
Ref 2	**20/02/19 13:30**		
Ref 3			

CERTIFICATE OF ANALYSIS

Test Parameter	SOP	Analytical Technique	Result	Units	Acc.
Nitrogen (Total Oxidised) (Surface W	151	Colorimetry	1.34	mg/L as N	UKAS
Nitrogen (Total)	0	Calculation	2.74	mg/L as N	
n-Propylbenzene (Surface Water)	154	GCMS	<1.0	ug/L	UKAS
o-Xylene (Surface Water)	154	GCMS	<1	ug/L	UKAS
Phenanthrene (GCMS)	200	GCMS	<0.01	ug/L	
Phenols (Total)	223	GCMS	<0.10	ug/L	
Phosphorus (Total) Surface Water	166	Colorimetry	0.084	mg/L as P	UKAS
p-Isopropyltoluene (Surface Water)	154	GCMS	<1	ug/L	UKAS
Polyaromatic Hydrocarbons (GCMS)	200	GCMS	<0.01	ug/L	
Pyrene (GCMS)	200	GCMS	<0.01	ug/L	
sec-Butylbenzene (Surface Water)	154	GCMS	<1	ug/L	UKAS
Selenium (Surface Water)	177	ICPMS	73	ug/L	UKAS
Solids (Total Dissolved)	105	Filtration/ Evaporation @ 180C	12647	mg/L	
Styrene (Surface Water)	154	GCMS	<1	ug/L	UKAS
tert-Butylbenzene (Surface Water)	154	GCMS	<1	ug/L	UKAS
Tetrachloroethene (Surface Water)	154	GCMS	<1	ug/L	UKAS
TOC (Surface Water)	316	TOC Analyser	5.6	mg/L	UKAS
Toluene (Surface Water)	154	GCMS	<1	ug/L	UKAS
Total Inorganic Nitrogen	0	Calculation	1.6	mg/L	
trans-1,2-Dichloroethene (Surface W	154	GCMS	<1	ug/L	UKAS
trans-1,3-Dichloropropene (Surface	154	GCMS	<1	ug/L	UKAS
Trichloroethene (Surface Water)	154	GCMS	<1.0	ug/L	
Trichlorofluoromethane (Surface Wat	154	GCMS	<1	ug/L	UKAS
Vanadium (Surface Water)	177	ICPMS	73	ug/L	UKAS

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Customer Ref	**DOWN 1km- LW- Middle**	*Sample Type*	**Surface Water**
Ref 2	**20/02/19 13:30**		
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CERTIFICATE OF ANALYSIS

Test Parameter	SOP	Analytical Technique	Result	Units	Acc.
Vinyl chloride (Surface Water)	154	GCMS	<1	ug/L	UKAS
Volatile Organic Compounds	154	GCMS	<5.0	ug/L	
Xylene Total (Surface Water)	154	GCMS	<1	ug/L	UKAS
Zinc (Surface Water)	177	ICPMS	29	ug/L	UKAS

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	Liosbaun	***Received or Collected***	**By Fitz: Pick up DS**
	Co Galway	***Condition on Receipt***	**Acceptable**
Customer PO	**JN1526**	***Date of Report***	**12/03/2019**
Customer Ref	**DOWN 1km- LW- Bottom**	***Sample Type***	**Surface Water**
Ref 2	**20/02/19 13:35**		
Ref 3			

CERTIFICATE OF ANALYSIS

Test Parameter	SOP	Analytical Technique	Result	Units	Acc.
1,1,1,2-Tetrachloroethane (Surface	154	GCMS	<1	ug/L	UKAS
1,1,1-Trichloroethane (Surface Water	154	GCMS	<1	ug/L	UKAS
1,1,2,2-Tetrachloroethane (Surface	154	GCMS	<5.0	ug/L	
1,1,2-Trichloroethane (Surface Water	154	GCMS	<2	ug/L	UKAS
1,1-Dichloroethane (Surface Water)	154	GCMS	<1	ug/L	UKAS
1,1-Dichloroethene (Surface Water)	154	GCMS	<1	ug/L	UKAS
1,1-Dichloropropene (Surface Water)	154	GCMS	<1	ug/L	UKAS
1,2,3-Trichlorobenzene (Surface Wat	154	GCMS	<1	ug/L	UKAS
1,2,3-Trichloropropane (Surface Wat	154	GCMS	<0.9	ug/L	UKAS
1,2,4-Trichlorobenzene (Surface Wat	154	GCMS	<0.6	ug/L	UKAS
1,2,4-Trimethylbenzene (Surface Wa	154	GCMS	<1	ug/L	UKAS
1,2-Dibromo-3-chloropropane (Surfac	154	GCMS	<1	ug/L	UKAS
1,2-Dibromoethane (Surface Water)	154	GCMS	<1	ug/L	UKAS
1,2-Dichlorobenzene (Surface Water)	154	GCMS	<1	ug/L	UKAS
1,2-Dichloroethane (Surface Water)	154	GCMS	<1	ug/L	UKAS
1,2-Dichloropropane (Surface Water)	154	GCMS	<1	ug/L	UKAS
1,3,5-Trimethylbenzene (Surface Wa	154	GCMS	<1	ug/L	UKAS
1,3-Dichlorobenzene (Surface Water)	154	GCMS	<1	ug/L	UKAS
1,3-Dichloropropane (Surface Water)	154	GCMS	<1	ug/L	UKAS
1,4-Dichlorobenzene (Surface Water)	154	GCMS	<1	ug/L	UKAS
2,2-Dichloropropane (Surface Water)	154	GCMS	<5.0	ug/L	
2-Chlorotoluene (Surface Water)	154	GCMS	<1	ug/L	UKAS
4-Chlorotoluene (Surface Water)	154	GCMS	<1	ug/L	UKAS
Acenaphthene (GCMS)	200	GCMS	<0.01	ug/L	

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	Liosbaun Ind Est	*Date Testing Commenced*	**21/02/2019**
	Liosbaun	*Received or Collected*	**By Fitz: Pick up DS**
	Co Galway	*Condition on Receipt*	**Acceptable**
Customer PO	**JN1526**	*Date of Report*	**12/03/2019**
Customer Ref	**DOWN 1km- LW- Bottom**	*Sample Type*	**Surface Water**
Ref 2	**20/02/19 13:35**		
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CERTIFICATE OF ANALYSIS

Test Parameter	SOP	Analytical Technique	Result	Units	Acc.
Acenaphthylene (GCMS)	200	GCMS	<0.01	ug/L	
Ammonia (Surface Water)	114	Colorimetry	0.22	mg/L as N	UKAS
Anthracene (GCMS)	200	GCMS	<0.01	ug/L	
Antimony (Surface Water)	177	ICPMS	82	ug/L	UKAS
Arsenic (Surface Water)	177	ICPMS	84	ug/L	UKAS
Barium (Surface Water)	177	ICPMS	81	ug/L	UKAS
Benzene (Surface Water)	154	GCMS	<1	ug/L	UKAS
Benzo(a)anthracene (GCMS)	200	GCMS	<0.01	ug/L	
Benzo(a)pyrene (GCMS)	200	GCMS	<0.01	ug/L	
Benzo(g,h,i)perylene (GCMS)	200	GCMS	<0.01	ug/L	
Benzo(k)fluoranthene (GCMS)	200	GCMS	<0.01	ug/L	
Bromobenzene (Surface Water)	154	GCMS	<1	ug/L	UKAS
Bromochloromethane (Surface Water	154	GCMS	<1	ug/L	UKAS
Bromodichloromethane (Surface Wat	154	GCMS	<1	ug/L	UKAS
Bromoform (Surface Water)	154	GCMS	<1	ug/L	UKAS
Bromomethane (Surface Water)	154	GCMS	<5.0	ug/L	
Cadmium (Surface Water)	177	ICPMS	84	ug/L	UKAS
Carbon tetrachloride (Surface Water)	154	GCMS	<1	ug/L	UKAS
Chlorobenzene (Surface Water)	154	GCMS	<1	ug/L	UKAS
Chloroethane (Surface Water)	154	GCMS	<5.0	ug/L	
Chloroform (Surface Water)	154	GCMS	<1	ug/L	UKAS
Chloromethane (Surface Water)	154	GCMS	<5.0	ug/L	
Chromium (Surface Water)	177	ICPMS	84	ug/L	UKAS
Chrysene (GCMS)	200	GCMS	<0.01	ug/L	

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Customer	Caroline Roche Aqua-Fact International Services Ltd 12 Kilkerrin Park Liosbaun Ind Est Liosbaun Co Galway	*Lab Report Ref. No.*	0529/002/20
		Date of Receipt	21/02/2019
		Sampled On	20/02/2019
		Date Testing Commenced	21/02/2019
		Received or Collected	By Fitz: Pick up DS
		Condition on Receipt	Acceptable
Customer PO	JN1526	*Date of Report*	12/03/2019
Customer Ref	DOWN 1km- LW- Bottom	*Sample Type*	Surface Water
Ref 2	20/02/19 13:35		
Ref 3			

CERTIFICATE OF ANALYSIS

Test Parameter	SOP	Analytical Technique	Result	Units	Acc.
cis-1,2-Dichloroethene (Surface Wat	154	GCMS	<1	ug/L	UKAS
cis-1,3-Dichloropropene (Surface Wa	154	GCMS	<1	ug/L	UKAS
COD (Surface Water)	107	Colorimetry	125	mg/L	UKAS
Copper (Surface Water)	177	ICPMS	74	ug/L	UKAS
Coronene (GCMS)	200	GCMS	<0.01	ug/L	
Dibenzo(a,h)anthracene (GCMS)	200	GCMS	<0.01	ug/L	
Dibromochloromethane (Surface Wat	154	GCMS	<1	ug/L	UKAS
Dibromomethane (Surface Water)	154	GCMS	<1	ug/L	UKAS
Dichlorodifluoromethane (Surface W	154	GCMS	<5.0	ug/L	
Dichloromethane (Surface Water)	154	GCMS	<5.0	ug/L	
Ethylbenzene (Surface Water)	154	GCMS	<1	ug/L	UKAS
Fluoranthene (GCMS)	200	GCMS	<0.01	ug/L	
Fluorene (GCMS)	200	GCMS	<0.01	ug/L	
Hexachlorobutadiene (Surface Water	154	GCMS	<1	ug/L	UKAS
Indeno(1,2,3-cd)pyrene (GCMS)	200	GCMS	<0.01	ug/L	
Isopropylbenzene (Surface Water)	154	GCMS	<1	ug/L	UKAS
Lead (Surface Water)	177	ICPMS	84	ug/L	UKAS
m- & p-Xylene (Surface Water)	154	GCMS	<1	ug/L	UKAS
Mercury (Surface water)	178	ICPMS	<0.03	ug/L	UKAS
Molybdenum	226	ICPMS	6	ug/L	
Naphthalene (Surface Water)	154	GCMS	<1	ug/L	UKAS
n-Butylbenzene (Surface Water)	154	GCMS	<1	ug/L	UKAS
Nickel (Surface Water)	177	ICPMS	84	ug/L	UKAS
Nitrogen (Total Kjeldahl)	104	Digestion/ Distillation/ Titrimetr	1.12	mg/L as N	

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Test Parameter	SOP	Analytical Technique	Result	Units	Acc.
Nitrogen (Total Oxidised) (Surface W	151	Colorimetry	1.32	mg/L as N	UKAS
Nitrogen (Total)	0	Calculation	2.44	mg/L as N	
n-Propylbenzene (Surface Water)	154	GCMS	<1.0	ug/L	UKAS
o-Xylene (Surface Water)	154	GCMS	<1	ug/L	UKAS
Phenanthrene (GCMS)	200	GCMS	<0.01	ug/L	
Phenols (Total)	223	GCMS	<0.10	ug/L	
Phosphorus (Total) Surface Water	166	Colorimetry	0.092	mg/L as P	UKAS
p-Isopropyltoluene (Surface Water)	154	GCMS	<1	ug/L	UKAS
Polyaromatic Hydrocarbons (GCMS)	200	GCMS	<0.01	ug/L	
Pyrene (GCMS)	200	GCMS	<0.01	ug/L	
sec-Butylbenzene (Surface Water)	154	GCMS	<1	ug/L	UKAS
Selenium (Surface Water)	177	ICPMS	84	ug/L	UKAS
Solids (Total Dissolved)	105	Filtration/ Evaporation @ 180C	13682	mg/L	
Styrene (Surface Water)	154	GCMS	<1	ug/L	UKAS
tert-Butylbenzene (Surface Water)	154	GCMS	<1	ug/L	UKAS
Tetrachloroethene (Surface Water)	154	GCMS	<1	ug/L	UKAS
TOC (Surface Water)	316	TOC Analyser	5.5	mg/L	UKAS
Toluene (Surface Water)	154	GCMS	<1	ug/L	UKAS
Total Inorganic Nitrogen	0	Calculation	1.5	mg/L	
trans-1,2-Dichloroethene (Surface W	154	GCMS	<1	ug/L	UKAS
trans-1,3-Dichloropropene (Surface	154	GCMS	<1	ug/L	UKAS
Trichloroethene (Surface Water)	154	GCMS	<1.0	ug/L	
Trichlorofluoromethane (Surface Wat	154	GCMS	<1	ug/L	UKAS
Vanadium (Surface Water)	177	ICPMS	84	ug/L	UKAS

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	Co Galway	***Condition on Receipt***	**Acceptable**
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Customer Ref	**DOWN 1km- LW- Bottom**	***Sample Type***	**Surface Water**
Ref 2	**20/02/19 13:35**		
Ref 3			

CERTIFICATE OF ANALYSIS

Test Parameter	SOP	Analytical Technique	Result	Units	Acc.
Vinyl chloride (Surface Water)	154	GCMS	<1	ug/L	UKAS
Volatile Organic Compounds	154	GCMS	<5.0	ug/L	
Xylene Total (Surface Water)	154	GCMS	<1	ug/L	UKAS
Zinc (Surface Water)	177	ICPMS	41	ug/L	UKAS

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Monitoring and Testing Services

Unit 35,
Boyne Business Park,
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A copy of this certificate is available on www.fitzsci.ie

Customer	**Caroline Roche**	***Lab Report Ref. No.***	**0529/002/21**
	Aqua-Fact International Services Ltd	***Date of Receipt***	**21/02/2019**
	12 Kilkerrin Park	***Sampled On***	**20/02/2019**
	Liosbaun Ind Est	***Date Testing Commenced***	**21/02/2019**
	Liosbaun	***Received or Collected***	**By Fitz: Pick up DS**
	Co Galway	***Condition on Receipt***	**Acceptable**
Customer PO	**JN1526**	***Date of Report***	**12/03/2019**
Customer Ref	**DOWN 1km-MF-Surface**	***Sample Type***	**Surface Water**
Ref 2	**20/02/19 16:45**		
Ref 3			

CERTIFICATE OF ANALYSIS

Test Parameter	SOP	Analytical Technique	Result	Units	Acc.
1,1,1,2-Tetrachloroethane (Surface	154	GCMS	<1	ug/L	UKAS
1,1,1-Trichloroethane (Surface Water	154	GCMS	<1	ug/L	UKAS
1,1,2,2-Tetrachloroethane (Surface	154	GCMS	<5.0	ug/L	
1,1,2-Trichloroethane (Surface Water	154	GCMS	<2	ug/L	UKAS
1,1-Dichloroethane (Surface Water)	154	GCMS	<1	ug/L	UKAS
1,1-Dichloroethene (Surface Water)	154	GCMS	<1	ug/L	UKAS
1,1-Dichloropropene (Surface Water)	154	GCMS	<1	ug/L	UKAS
1,2,3-Trichlorobenzene (Surface Wat	154	GCMS	<1	ug/L	UKAS
1,2,3-Trichloropropane (Surface Wat	154	GCMS	<0.9	ug/L	UKAS
1,2,4-Trichlorobenzene (Surface Wat	154	GCMS	<0.6	ug/L	UKAS
1,2,4-Trimethylbenzene (Surface Wa	154	GCMS	<1	ug/L	UKAS
1,2-Dibromo-3-chloropropane (Surfac	154	GCMS	<1	ug/L	UKAS
1,2-Dibromoethane (Surface Water)	154	GCMS	<1	ug/L	UKAS
1,2-Dichlorobenzene (Surface Water)	154	GCMS	<1	ug/L	UKAS
1,2-Dichloroethane (Surface Water)	154	GCMS	<1	ug/L	UKAS
1,2-Dichloropropane (Surface Water)	154	GCMS	<1	ug/L	UKAS
1,3,5-Trimethylbenzene (Surface Wa	154	GCMS	<1	ug/L	UKAS
1,3-Dichlorobenzene (Surface Water)	154	GCMS	<1	ug/L	UKAS
1,3-Dichloropropane (Surface Water)	154	GCMS	<1	ug/L	UKAS
1,4-Dichlorobenzene (Surface Water)	154	GCMS	<1	ug/L	UKAS
2,2-Dichloropropane (Surface Water)	154	GCMS	<5.0	ug/L	
2-Chlorotoluene (Surface Water)	154	GCMS	<1	ug/L	UKAS
4-Chlorotoluene (Surface Water)	154	GCMS	<1	ug/L	UKAS
Acenaphthene (GCMS)	200	GCMS	<0.01	ug/L	

Signed : A Harmon ***Date : 12/03/2019***

Aoife Harmon - Technical Supervisor

Acc. : Accredited Parameters by ISO 17025:2005
PVL - Parametric Value Limit as per EU (Drinking water) Regulations (SI 122 2014)
For bacterial analysis a result of 0 means none detected in volume examined
All organic results are analysed as received and all results are corrected for dry weight at 104 C
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ilac-MRA UKAS TESTING 2802

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Test Parameter	SOP	Analytical Technique	Result	Units	Acc.
Acenaphthylene (GCMS)	200	GCMS	<0.01	ug/L	
Ammonia (Surface Water)	114	Colorimetry	0.22	mg/L as N	UKAS
Anthracene (GCMS)	200	GCMS	<0.01	ug/L	
Antimony (Surface Water)	177	ICPMS	92	ug/L	UKAS
Arsenic (Surface Water)	177	ICPMS	95	ug/L	UKAS
Barium (Surface Water)	177	ICPMS	91	ug/L	UKAS
Benzene (Surface Water)	154	GCMS	<1	ug/L	UKAS
Benzo(a)anthracene (GCMS)	200	GCMS	<0.01	ug/L	
Benzo(a)pyrene (GCMS)	200	GCMS	<0.01	ug/L	
Benzo(g,h,i)perylene (GCMS)	200	GCMS	<0.01	ug/L	
Benzo(k)fluoranthene (GCMS)	200	GCMS	<0.01	ug/L	
Bromobenzene (Surface Water)	154	GCMS	<1	ug/L	UKAS
Bromochloromethane (Surface Water	154	GCMS	<1	ug/L	UKAS
Bromodichloromethane (Surface Wat	154	GCMS	<1	ug/L	UKAS
Bromoform (Surface Water)	154	GCMS	<1	ug/L	UKAS
Bromomethane (Surface Water)	154	GCMS	<5.0	ug/L	
Cadmium (Surface Water)	177	ICPMS	95	ug/L	UKAS
Carbon tetrachloride (Surface Water)	154	GCMS	<1	ug/L	UKAS
Chlorobenzene (Surface Water)	154	GCMS	<1	ug/L	UKAS
Chloroethane (Surface Water)	154	GCMS	<5.0	ug/L	
Chloroform (Surface Water)	154	GCMS	<1	ug/L	UKAS
Chloromethane (Surface Water)	154	GCMS	<5.0	ug/L	
Chromium (Surface Water)	177	ICPMS	94	ug/L	UKAS
Chrysene (GCMS)	200	GCMS	<0.01	ug/L	

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Test Parameter	SOP	Analytical Technique	Result	Units	Acc.
cis-1,2-Dichloroethene (Surface Wat	154	GCMS	<1	ug/L	UKAS
cis-1,3-Dichloropropene (Surface Wa	154	GCMS	<1	ug/L	UKAS
COD (Surface Water)	107	Colorimetry	1138	mg/L	UKAS
Copper (Surface Water)	177	ICPMS	85	ug/L	UKAS
Coronene (GCMS)	200	GCMS	<0.01	ug/L	
Dibenzo(a,h)anthracene (GCMS)	200	GCMS	<0.01	ug/L	
Dibromochloromethane (Surface Wat	154	GCMS	<1	ug/L	UKAS
Dibromomethane (Surface Water)	154	GCMS	<1	ug/L	UKAS
Dichlorodifluoromethane (Surface W	154	GCMS	<5.0	ug/L	
Dichloromethane (Surface Water)	154	GCMS	<5.0	ug/L	
Ethylbenzene (Surface Water)	154	GCMS	<1	ug/L	UKAS
Fluoranthene (GCMS)	200	GCMS	<0.01	ug/L	
Fluorene (GCMS)	200	GCMS	<0.01	ug/L	
Hexachlorobutadiene (Surface Water	154	GCMS	<1	ug/L	UKAS
Indeno(1,2,3-cd)pyrene (GCMS)	200	GCMS	<0.01	ug/L	
Isopropylbenzene (Surface Water)	154	GCMS	<1	ug/L	UKAS
Lead (Surface Water)	177	ICPMS	94	ug/L	UKAS
m- & p-Xylene (Surface Water)	154	GCMS	<1	ug/L	UKAS
Mercury (Surface water)	178	ICPMS	<0.03	ug/L	UKAS
Molybdenum	226	ICPMS	27	ug/L	
Naphthalene (Surface Water)	154	GCMS	<1	ug/L	UKAS
n-Butylbenzene (Surface Water)	154	GCMS	<1	ug/L	UKAS
Nickel (Surface Water)	177	ICPMS	94	ug/L	UKAS
Nitrogen (Total Kjeldahl)	104	Digestion/ Distillation/ Titrimetr	1.12	mg/L as N	

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Test Parameter	SOP	Analytical Technique	Result	Units	Acc.
Nitrogen (Total Oxidised) (Surface W	151	Colorimetry	1.31	mg/L as N	UKAS
Nitrogen (Total)	0	Calculation	2.43	mg/L as N	
n-Propylbenzene (Surface Water)	154	GCMS	<1.0	ug/L	UKAS
o-Xylene (Surface Water)	154	GCMS	<1	ug/L	UKAS
Phenanthrene (GCMS)	200	GCMS	<0.01	ug/L	
Phenols (Total)	223	GCMS	<0.10	ug/L	
Phosphorus (Total) Surface Water	166	Colorimetry	0.064	mg/L as P	UKAS
p-Isopropyltoluene (Surface Water)	154	GCMS	<1	ug/L	UKAS
Polyaromatic Hydrocarbons (GCMS)	200	GCMS	<0.01	ug/L	
Pyrene (GCMS)	200	GCMS	<0.01	ug/L	
sec-Butylbenzene (Surface Water)	154	GCMS	<1	ug/L	UKAS
Selenium (Surface Water)	177	ICPMS	95	ug/L	UKAS
Solids (Total Dissolved)	105	Filtration/ Evaporation @ 180C	19198	mg/L	
Styrene (Surface Water)	154	GCMS	<1	ug/L	UKAS
tert-Butylbenzene (Surface Water)	154	GCMS	<1	ug/L	UKAS
Tetrachloroethene (Surface Water)	154	GCMS	<1	ug/L	UKAS
TOC (Surface Water)	316	TOC Analyser	4.2	mg/L	UKAS
Toluene (Surface Water)	154	GCMS	<1	ug/L	UKAS
Total Inorganic Nitrogen	0	Calculation	1.5	mg/L	
trans-1,2-Dichloroethene (Surface W	154	GCMS	<1	ug/L	UKAS
trans-1,3-Dichloropropene (Surface	154	GCMS	<1	ug/L	UKAS
Trichloroethene (Surface Water)	154	GCMS	<1.0	ug/L	
Trichlorofluoromethane (Surface Wat	154	GCMS	<1	ug/L	UKAS
Vanadium (Surface Water)	177	ICPMS	95	ug/L	UKAS

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Customer	Caroline Roche Aqua-Fact International Services Ltd 12 Kilkerrin Park Liosbaun Ind Est Liosbaun Co Galway	*Lab Report Ref. No.*	0529/002/21
		Date of Receipt	21/02/2019
		Sampled On	20/02/2019
		Date Testing Commenced	21/02/2019
		Received or Collected	By Fitz: Pick up DS
		Condition on Receipt	Acceptable
Customer PO	JN1526	*Date of Report*	12/03/2019
Customer Ref	DOWN 1km-MF-Surface	*Sample Type*	Surface Water
Ref 2	20/02/19 16:45		
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CERTIFICATE OF ANALYSIS

Test Parameter	SOP	Analytical Technique	Result	Units	Acc.
Vinyl chloride (Surface Water)	154	GCMS	<1	ug/L	UKAS
Volatile Organic Compounds	154	GCMS	<5.0	ug/L	
Xylene Total (Surface Water)	154	GCMS	<1	ug/L	UKAS
Zinc (Surface Water)	177	ICPMS	51	ug/L	UKAS

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		Sampled On	20/02/2019
		Date Testing Commenced	21/02/2019
		Received or Collected	By Fitz: Pick up DS
		Condition on Receipt	Acceptable
Customer PO	JN1526	*Date of Report*	12/03/2019
Customer Ref	DOWN 1km- MF- Middle	*Sample Type*	Surface Water
Ref 2	20/02/19 16:50		
Ref 3			

CERTIFICATE OF ANALYSIS

Test Parameter	SOP	Analytical Technique	Result	Units	Acc.
1,1,1,2-Tetrachloroethane (Surface	154	GCMS	<1	ug/L	UKAS
1,1,1-Trichloroethane (Surface Water	154	GCMS	<1	ug/L	UKAS
1,1,2,2-Tetrachloroethane (Surface	154	GCMS	<5.0	ug/L	
1,1,2-Trichloroethane (Surface Water	154	GCMS	<2	ug/L	UKAS
1,1-Dichloroethane (Surface Water)	154	GCMS	<1	ug/L	UKAS
1,1-Dichloroethene (Surface Water)	154	GCMS	<1	ug/L	UKAS
1,1-Dichloropropene (Surface Water)	154	GCMS	<1	ug/L	UKAS
1,2,3-Trichlorobenzene (Surface Wat	154	GCMS	<1	ug/L	UKAS
1,2,3-Trichloropropane (Surface Wat	154	GCMS	<0.9	ug/L	UKAS
1,2,4-Trichlorobenzene (Surface Wat	154	GCMS	<0.6	ug/L	UKAS
1,2,4-Trimethylbenzene (Surface Wa	154	GCMS	<1	ug/L	UKAS
1,2-Dibromo-3-chloropropane (Surfac	154	GCMS	<1	ug/L	UKAS
1,2-Dibromoethane (Surface Water)	154	GCMS	<1	ug/L	UKAS
1,2-Dichlorobenzene (Surface Water)	154	GCMS	<1	ug/L	UKAS
1,2-Dichloroethane (Surface Water)	154	GCMS	<1	ug/L	UKAS
1,2-Dichloropropane (Surface Water)	154	GCMS	<1	ug/L	UKAS
1,3,5-Trimethylbenzene (Surface Wa	154	GCMS	<1	ug/L	UKAS
1,3-Dichlorobenzene (Surface Water)	154	GCMS	<1	ug/L	UKAS
1,3-Dichloropropane (Surface Water)	154	GCMS	<1	ug/L	UKAS
1,4-Dichlorobenzene (Surface Water)	154	GCMS	<1	ug/L	UKAS
2,2-Dichloropropane (Surface Water)	154	GCMS	<5.0	ug/L	
2-Chlorotoluene (Surface Water)	154	GCMS	<1	ug/L	UKAS
4-Chlorotoluene (Surface Water)	154	GCMS	<1	ug/L	UKAS
Acenaphthene (GCMS)	200	GCMS	<0.01	ug/L	

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Test Parameter	SOP	Analytical Technique	Result	Units	Acc.
Acenaphthylene (GCMS)	200	GCMS	<0.01	ug/L	
Ammonia (Surface Water)	114	Colorimetry	0.24	mg/L as N	UKAS
Anthracene (GCMS)	200	GCMS	<0.01	ug/L	
Antimony (Surface Water)	177	ICPMS	107	ug/L	UKAS
Arsenic (Surface Water)	177	ICPMS	109	ug/L	UKAS
Barium (Surface Water)	177	ICPMS	106	ug/L	UKAS
Benzene (Surface Water)	154	GCMS	<1	ug/L	UKAS
Benzo(a)anthracene (GCMS)	200	GCMS	<0.01	ug/L	
Benzo(a)pyrene (GCMS)	200	GCMS	<0.01	ug/L	
Benzo(g,h,i)perylene (GCMS)	200	GCMS	<0.01	ug/L	
Benzo(k)fluoranthene (GCMS)	200	GCMS	<0.01	ug/L	
Bromobenzene (Surface Water)	154	GCMS	<1	ug/L	UKAS
Bromochloromethane (Surface Water	154	GCMS	<1	ug/L	UKAS
Bromodichloromethane (Surface Wat	154	GCMS	<1	ug/L	UKAS
Bromoform (Surface Water)	154	GCMS	<1	ug/L	UKAS
Bromomethane (Surface Water)	154	GCMS	<5.0	ug/L	
Cadmium (Surface Water)	177	ICPMS	109	ug/L	UKAS
Carbon tetrachloride (Surface Water)	154	GCMS	<1	ug/L	UKAS
Chlorobenzene (Surface Water)	154	GCMS	<1	ug/L	UKAS
Chloroethane (Surface Water)	154	GCMS	<5.0	ug/L	
Chloroform (Surface Water)	154	GCMS	<1	ug/L	UKAS
Chloromethane (Surface Water)	154	GCMS	<5.0	ug/L	
Chromium (Surface Water)	177	ICPMS	109	ug/L	UKAS
Chrysene (GCMS)	200	GCMS	<0.01	ug/L	

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	Co Galway	*Condition on Receipt*	Acceptable
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Customer Ref	DOWN 1km- MF- Middle	*Sample Type*	Surface Water
Ref 2	20/02/19 16:50		
Ref 3			

CERTIFICATE OF ANALYSIS

Test Parameter	SOP	Analytical Technique	Result	Units	Acc.
cis-1,2-Dichloroethene (Surface Wat	154	GCMS	<1	ug/L	UKAS
cis-1,3-Dichloropropene (Surface Wa	154	GCMS	<1	ug/L	UKAS
COD (Surface Water)	107	Colorimetry	1270	mg/L	UKAS
Copper (Surface Water)	177	ICPMS	99	ug/L	UKAS
Coronene (GCMS)	200	GCMS	<0.01	ug/L	
Dibenzo(a,h)anthracene (GCMS)	200	GCMS	<0.01	ug/L	
Dibromochloromethane (Surface Wat	154	GCMS	<1	ug/L	UKAS
Dibromomethane (Surface Water)	154	GCMS	<1	ug/L	UKAS
Dichlorodifluoromethane (Surface W	154	GCMS	<5.0	ug/L	
Dichloromethane (Surface Water)	154	GCMS	<5.0	ug/L	
Ethylbenzene (Surface Water)	154	GCMS	<1	ug/L	UKAS
Fluoranthene (GCMS)	200	GCMS	<0.01	ug/L	
Fluorene (GCMS)	200	GCMS	<0.01	ug/L	
Hexachlorobutadiene (Surface Water	154	GCMS	<1	ug/L	UKAS
Indeno(1,2,3-cd)pyrene (GCMS)	200	GCMS	<0.01	ug/L	
Isopropylbenzene (Surface Water)	154	GCMS	<1	ug/L	UKAS
Lead (Surface Water)	177	ICPMS	109	ug/L	UKAS
m- & p-Xylene (Surface Water)	154	GCMS	<1	ug/L	UKAS
Mercury (Surface water)	178	ICPMS	<0.03	ug/L	UKAS
Molybdenum	226	ICPMS	14	ug/L	
Naphthalene (Surface Water)	154	GCMS	<1	ug/L	UKAS
n-Butylbenzene (Surface Water)	154	GCMS	<1	ug/L	UKAS
Nickel (Surface Water)	177	ICPMS	109	ug/L	UKAS
Nitrogen (Total Kjeldahl)	104	Digestion/ Distillation/ Titrimetr	1.40	mg/L as N	

Signed : A Harmon **_Date : 12/03/2019_**

Aoife Harmon - Technical Supervisor

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ilac-MRA UKAS TESTING 2802

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Customer	**Caroline Roche**	***Lab Report Ref. No.***	**0529/002/22**
	Aqua-Fact International Services Ltd	***Date of Receipt***	**21/02/2019**
	12 Kilkerrin Park	***Sampled On***	**20/02/2019**
	Liosbaun Ind Est	***Date Testing Commenced***	**21/02/2019**
	Liosbaun	***Received or Collected***	**By Fitz: Pick up DS**
	Co Galway	***Condition on Receipt***	**Acceptable**
Customer PO	**JN1526**	***Date of Report***	**12/03/2019**
Customer Ref	**DOWN 1km- MF- Middle**	***Sample Type***	**Surface Water**
Ref 2	**20/02/19 16:50**		
Ref 3			

CERTIFICATE OF ANALYSIS

Test Parameter	SOP	Analytical Technique	Result	Units	Acc.
Nitrogen (Total Oxidised) (Surface W	151	Colorimetry	1.33	mg/L as N	UKAS
Nitrogen (Total)	0	Calculation	2.73	mg/L as N	
n-Propylbenzene (Surface Water)	154	GCMS	<1.0	ug/L	UKAS
o-Xylene (Surface Water)	154	GCMS	<1	ug/L	UKAS
Phenanthrene (GCMS)	200	GCMS	<0.01	ug/L	
Phenols (Total)	223	GCMS	<0.10	ug/L	
Phosphorus (Total) Surface Water	166	Colorimetry	0.070	mg/L as P	UKAS
p-Isopropyltoluene (Surface Water)	154	GCMS	<1	ug/L	UKAS
Polyaromatic Hydrocarbons (GCMS)	200	GCMS	<0.01	ug/L	
Pyrene (GCMS)	200	GCMS	<0.01	ug/L	
sec-Butylbenzene (Surface Water)	154	GCMS	<1	ug/L	UKAS
Selenium (Surface Water)	177	ICPMS	109	ug/L	UKAS
Solids (Total Dissolved)	105	Filtration/ Evaporation @ 180C	20083	mg/L	
Styrene (Surface Water)	154	GCMS	<1	ug/L	UKAS
tert-Butylbenzene (Surface Water)	154	GCMS	<1	ug/L	UKAS
Tetrachloroethene (Surface Water)	154	GCMS	<1	ug/L	UKAS
TOC (Surface Water)	316	TOC Analyser	4.0	mg/L	UKAS
Toluene (Surface Water)	154	GCMS	<1	ug/L	UKAS
Total Inorganic Nitrogen	0	Calculation	1.6	mg/L	
trans-1,2-Dichloroethene (Surface W	154	GCMS	<1	ug/L	UKAS
trans-1,3-Dichloropropene (Surface	154	GCMS	<1	ug/L	UKAS
Trichloroethene (Surface Water)	154	GCMS	<1.0	ug/L	
Trichlorofluoromethane (Surface Wat	154	GCMS	<1	ug/L	UKAS
Vanadium (Surface Water)	177	ICPMS	109	ug/L	UKAS

Signed : A Harmon ***Date : 12/03/2019***

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	Liosbaun Ind Est	*Date Testing Commenced*	21/02/2019
	Liosbaun	*Received or Collected*	By Fitz: Pick up DS
	Co Galway	*Condition on Receipt*	Acceptable
Customer PO	JN1526	*Date of Report*	12/03/2019
Customer Ref	DOWN 1km- MF- Middle	*Sample Type*	Surface Water
Ref 2	20/02/19 16:50		
Ref 3			

CERTIFICATE OF ANALYSIS

Test Parameter	SOP	Analytical Technique	Result	Units	Acc.
Vinyl chloride (Surface Water)	154	GCMS	<1	ug/L	UKAS
Volatile Organic Compounds	154	GCMS	<5.0	ug/L	
Xylene Total (Surface Water)	154	GCMS	<1	ug/L	UKAS
Zinc (Surface Water)	177	ICPMS	66	ug/L	UKAS

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	Liosbaun	*Received or Collected*	**By Fitz: Pick up DS**
	Co Galway	*Condition on Receipt*	**Acceptable**
Customer PO	**JN1526**	*Date of Report*	**12/03/2019**
Customer Ref	**DOWN 1km- MF- Bottom**	*Sample Type*	**Surface Water**
Ref 2	**20/02/19 16:55**		
Ref 3			

CERTIFICATE OF ANALYSIS

Test Parameter	SOP	Analytical Technique	Result	Units	Acc.
1,1,1,2-Tetrachloroethane (Surface	154	GCMS	<1	ug/L	UKAS
1,1,1-Trichloroethane (Surface Water	154	GCMS	<1	ug/L	UKAS
1,1,2,2-Tetrachloroethane (Surface	154	GCMS	<5.0	ug/L	
1,1,2-Trichloroethane (Surface Water	154	GCMS	<2	ug/L	UKAS
1,1-Dichloroethane (Surface Water)	154	GCMS	<1	ug/L	UKAS
1,1-Dichloroethene (Surface Water)	154	GCMS	<1	ug/L	UKAS
1,1-Dichloropropene (Surface Water)	154	GCMS	<1	ug/L	UKAS
1,2,3-Trichlorobenzene (Surface Wat	154	GCMS	<1	ug/L	UKAS
1,2,3-Trichloropropane (Surface Wat	154	GCMS	<0.9	ug/L	UKAS
1,2,4-Trichlorobenzene (Surface Wat	154	GCMS	<0.6	ug/L	UKAS
1,2,4-Trimethylbenzene (Surface Wa	154	GCMS	<1	ug/L	UKAS
1,2-Dibromo-3-chloropropane (Surfac	154	GCMS	<1	ug/L	UKAS
1,2-Dibromoethane (Surface Water)	154	GCMS	<1	ug/L	UKAS
1,2-Dichlorobenzene (Surface Water)	154	GCMS	<1	ug/L	UKAS
1,2-Dichloroethane (Surface Water)	154	GCMS	<1	ug/L	UKAS
1,2-Dichloropropane (Surface Water)	154	GCMS	<1	ug/L	UKAS
1,3,5-Trimethylbenzene (Surface Wa	154	GCMS	<1	ug/L	UKAS
1,3-Dichlorobenzene (Surface Water)	154	GCMS	<1	ug/L	UKAS
1,3-Dichloropropane (Surface Water)	154	GCMS	<1	ug/L	UKAS
1,4-Dichlorobenzene (Surface Water)	154	GCMS	<1	ug/L	UKAS
2,2-Dichloropropane (Surface Water)	154	GCMS	<5.0	ug/L	
2-Chlorotoluene (Surface Water)	154	GCMS	<1	ug/L	UKAS
4-Chlorotoluene (Surface Water)	154	GCMS	<1	ug/L	UKAS
Acenaphthene (GCMS)	200	GCMS	<0.01	ug/L	

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	12 Kilkerrin Park	*Sampled On*	**20/02/2019**
	Liosbaun Ind Est	*Date Testing Commenced*	**21/02/2019**
	Liosbaun	*Received or Collected*	**By Fitz: Pick up DS**
	Co Galway	*Condition on Receipt*	**Acceptable**
Customer PO	**JN1526**	*Date of Report*	**12/03/2019**
Customer Ref	**DOWN 1km- MF- Bottom**	*Sample Type*	**Surface Water**
Ref 2	**20/02/19 16:55**		
Ref 3			

CERTIFICATE OF ANALYSIS

Test Parameter	SOP	Analytical Technique	Result	Units	Acc.
Acenaphthylene (GCMS)	200	GCMS	<0.01	ug/L	
Ammonia (Surface Water)	114	Colorimetry	0.22	mg/L as N	UKAS
Anthracene (GCMS)	200	GCMS	<0.01	ug/L	
Antimony (Surface Water)	177	ICPMS	106	ug/L	UKAS
Arsenic (Surface Water)	177	ICPMS	108	ug/L	UKAS
Barium (Surface Water)	177	ICPMS	105	ug/L	UKAS
Benzene (Surface Water)	154	GCMS	<1	ug/L	UKAS
Benzo(a)anthracene (GCMS)	200	GCMS	<0.01	ug/L	
Benzo(a)pyrene (GCMS)	200	GCMS	<0.01	ug/L	
Benzo(g,h,i)perylene (GCMS)	200	GCMS	<0.01	ug/L	
Benzo(k)fluoranthene (GCMS)	200	GCMS	<0.01	ug/L	
Bromobenzene (Surface Water)	154	GCMS	<1	ug/L	UKAS
Bromochloromethane (Surface Water	154	GCMS	<1	ug/L	UKAS
Bromodichloromethane (Surface Wat	154	GCMS	<1	ug/L	UKAS
Bromoform (Surface Water)	154	GCMS	<1	ug/L	UKAS
Bromomethane (Surface Water)	154	GCMS	<5.0	ug/L	
Cadmium (Surface Water)	177	ICPMS	108	ug/L	UKAS
Carbon tetrachloride (Surface Water)	154	GCMS	<1	ug/L	UKAS
Chlorobenzene (Surface Water)	154	GCMS	<1	ug/L	UKAS
Chloroethane (Surface Water)	154	GCMS	<5.0	ug/L	
Chloroform (Surface Water)	154	GCMS	<1	ug/L	UKAS
Chloromethane (Surface Water)	154	GCMS	<5.0	ug/L	
Chromium (Surface Water)	177	ICPMS	108	ug/L	UKAS
Chrysene (GCMS)	200	GCMS	<0.01	ug/L	

Signed : A Harman

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	Aqua-Fact International Services Ltd	***Date of Receipt***	**21/02/2019**
	12 Kilkerrin Park	***Sampled On***	**20/02/2019**
	Liosbaun Ind Est	***Date Testing Commenced***	**21/02/2019**
	Liosbaun	***Received or Collected***	**By Fitz: Pick up DS**
	Co Galway	***Condition on Receipt***	**Acceptable**
Customer PO	**JN1526**	***Date of Report***	**12/03/2019**
Customer Ref	**DOWN 1km- MF- Bottom**	***Sample Type***	**Surface Water**
Ref 2	**20/02/19 16:55**		
Ref 3			

CERTIFICATE OF ANALYSIS

Test Parameter	SOP	Analytical Technique	Result	Units	Acc.
cis-1,2-Dichloroethene (Surface Wat	154	GCMS	<1	ug/L	UKAS
cis-1,3-Dichloropropene (Surface Wa	154	GCMS	<1	ug/L	UKAS
COD (Surface Water)	107	Colorimetry	1182	mg/L	UKAS
Copper (Surface Water)	177	ICPMS	98	ug/L	UKAS
Coronene (GCMS)	200	GCMS	<0.01	ug/L	
Dibenzo(a,h)anthracene (GCMS)	200	GCMS	<0.01	ug/L	
Dibromochloromethane (Surface Wat	154	GCMS	<1	ug/L	UKAS
Dibromomethane (Surface Water)	154	GCMS	<1	ug/L	UKAS
Dichlorodifluoromethane (Surface W	154	GCMS	<5.0	ug/L	
Dichloromethane (Surface Water)	154	GCMS	<5.0	ug/L	
Ethylbenzene (Surface Water)	154	GCMS	<1	ug/L	UKAS
Fluoranthene (GCMS)	200	GCMS	<0.01	ug/L	
Fluorene (GCMS)	200	GCMS	<0.01	ug/L	
Hexachlorobutadiene (Surface Water	154	GCMS	<1	ug/L	UKAS
Indeno(1,2,3-cd)pyrene (GCMS)	200	GCMS	<0.01	ug/L	
Isopropylbenzene (Surface Water)	154	GCMS	<1	ug/L	UKAS
Lead (Surface Water)	177	ICPMS	108	ug/L	UKAS
m- & p-Xylene (Surface Water)	154	GCMS	<1	ug/L	UKAS
Mercury (Surface water)	178	ICPMS	<0.03	ug/L	UKAS
Molybdenum	226	ICPMS	9	ug/L	
Naphthalene (Surface Water)	154	GCMS	<1	ug/L	UKAS
n-Butylbenzene (Surface Water)	154	GCMS	<1	ug/L	UKAS
Nickel (Surface Water)	177	ICPMS	108	ug/L	UKAS
Nitrogen (Total Kjeldahl)	104	Digestion/ Distillation/ Titrimetr	1.40	mg/L as N	

Signed : A Harmon ***Date : 12/03/2019***

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Test Parameter	SOP	Analytical Technique	Result	Units	Acc.
Nitrogen (Total Oxidised) (Surface W	151	Colorimetry	1.32	mg/L as N	UKAS
Nitrogen (Total)	0	Calculation	2.72	mg/L as N	
n-Propylbenzene (Surface Water)	154	GCMS	<1.0	ug/L	UKAS
o-Xylene (Surface Water)	154	GCMS	<1	ug/L	UKAS
Phenanthrene (GCMS)	200	GCMS	<0.01	ug/L	
Phenols (Total)	223	GCMS	<0.10	ug/L	
Phosphorus (Total) Surface Water	166	Colorimetry	0.081	mg/L as P	UKAS
p-Isopropyltoluene (Surface Water)	154	GCMS	<1	ug/L	UKAS
Polyaromatic Hydrocarbons (GCMS)	200	GCMS	<0.01	ug/L	
Pyrene (GCMS)	200	GCMS	<0.01	ug/L	
sec-Butylbenzene (Surface Water)	154	GCMS	<1	ug/L	UKAS
Selenium (Surface Water)	177	ICPMS	108	ug/L	UKAS
Solids (Total Dissolved)	105	Filtration/ Evaporation @ 180C	19584	mg/L	
Styrene (Surface Water)	154	GCMS	<1	ug/L	UKAS
tert-Butylbenzene (Surface Water)	154	GCMS	<1	ug/L	UKAS
Tetrachloroethene (Surface Water)	154	GCMS	<1	ug/L	UKAS
TOC (Surface Water)	316	TOC Analyser	4.2	mg/L	UKAS
Toluene (Surface Water)	154	GCMS	<1	ug/L	UKAS
Total Inorganic Nitrogen	0	Calculation	1.5	mg/L	
trans-1,2-Dichloroethene (Surface W	154	GCMS	<1	ug/L	UKAS
trans-1,3-Dichloropropene (Surface	154	GCMS	<1	ug/L	UKAS
Trichloroethene (Surface Water)	154	GCMS	<1.0	ug/L	
Trichlorofluoromethane (Surface Wat	154	GCMS	<1	ug/L	UKAS
Vanadium (Surface Water)	177	ICPMS	108	ug/L	UKAS

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	Liosbaun Ind Est	***Date Testing Commenced***	**21/02/2019**
	Liosbaun	***Received or Collected***	**By Fitz: Pick up DS**
	Co Galway	***Condition on Receipt***	**Acceptable**
Customer PO	**JN1526**	***Date of Report***	**12/03/2019**
Customer Ref	**DOWN 1km- MF- Bottom**	***Sample Type***	**Surface Water**
Ref 2	**20/02/19 16:55**		
Ref 3			

CERTIFICATE OF ANALYSIS

Test Parameter	SOP	Analytical Technique	Result	Units	Acc.
Vinyl chloride (Surface Water)	154	GCMS	<1	ug/L	UKAS
Volatile Organic Compounds	154	GCMS	<5.0	ug/L	
Xylene Total (Surface Water)	154	GCMS	<1	ug/L	UKAS
Zinc (Surface Water)	177	ICPMS	65	ug/L	UKAS

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Appendix 3
CLS Results

Complete Laboratory Solutions
[Tel] 091 574355
[Fax] 091 574356
[Email] services@cls.ie
[web] www.cls.ie

CERTIFICATE OF ANALYSIS

Client :	Brendan O'Connor Aquafact Kilkerrin Park, Liosbaun Tuam Road Galway	Report No.	: 383201
		Date of Receipt	: 21/02/2019
		Start Date of Analysis	: 21/02/2019
		Date of Report	: 27/02/2019
		Order Number	: JN1526
		Sample taken by	: Client

Lab No	Sample Description	Test	Ref.	Result	Units
933117	Up 500- MF - SURFACE	BOD	I, R	<1	mg/l
933118	Up 500- MF - MIDDLE	BOD	I, R	<1	mg/l
933119	Up 500- MF - BOTTOM	BOD	I, R	<1	mg/l
933120	Up 500- LW -SURFACE	BOD	I, R	<1	mg/l
933121	Up 500- LW -MIDDLE	BOD	I, R	<1	mg/l
933122	Up 500- LW -BOTTOM	BOD	I, R	<1	mg/l
933124	Up 500- ME -SURFACE	BOD	I, R	<1	mg/l
933125	Up 500- ME -MIDDLE	BOD	I, R	<1	mg/l
933126	Up 500- ME -BOTTOM	BOD	I, R	<1	mg/l
933127	DOWN 500- MF -SURFACE	BOD	I, R	<1	mg/l
933128	DOWN 500- MF -MIDDLE	BOD	I, R	<1	mg/l
933129	DOWN 500- MF -BOTTOM	BOD	I, R	<1	mg/l
933130	DOWN 500- LW -SURFACE	BOD	I, R	<1	mg/l
933131	DOWN 500- LW -MIDDLE	BOD	I, R	<1	mg/l
933132	DOWN 500- LW BOTTOM	BOD	I, R	<1	mg/l
933133	DOWN 500-ME-SURFACE	BOD	I, R	<1	mg/l
933134	DOWN 500-ME-MIDDLE	BOD	I, R	<1	mg/l
933135	DOWN 500-ME-BOTTOM	BOD	I, R	<1	mg/l
933136	DOWN 1KM-MF-SURFACE	BOD	I, R	<1	mg/l
933137	DOWN 1KM-MF-MIDDLE	BOD	I, R	<1	mg/l
933138	DOWN 1KM-MF-BOTTOM	BOD	I, R	<1	mg/l
933139	DOWN 1KM-LW- SURFACE	BOD	I, R	<1	mg/l
933140	DOWN 1KM-LW- MIDDLE	BOD	I, R	<1	mg/l
933141	DOWN 1KM-LW- BOTTOM	BOD	I, R	<1	mg/l
933142	DOWN 1KM-ME- SURFACE	BOD	I, R	<1	mg/l
933143	DOWN 1KM-ME- MIDDLE	BOD	I, R	<1	mg/l
933144	DOWN 1KM-ME- BOTTOM	BOD	I, R	<1	mg/l

ISO 17025 INAB ACCREDITED TESTING DETAILED IN SCOPE REG NO.108T

Approved by: Barbara Lee

Barbara Lee
Environmental Scientist

See below for test specifications and accreditation status.
This report only relates to items tested and shall not be reproduced but in full with the permission of CLS.
est. is an estimated count.

Complete Laboratory Solutions,
Ros Muc, Connemara,
Co. Galway

Complete Laboratory Solutions,
MedPharma Division,
Unit 3a, Small Business Park, Mervue, Galway

Symbol Reference - I:17025 accredited; S:Subcontracted; R:Analysis carried out in Ros Muc; M:Analysis carried out in MedPharma

Complete Laboratory Solutions
[Tel] 091 574355
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In-House Test	Specification	17025	GMP/FDA*	ISO**
BOD	CLS 12	Yes	No	Yes

*Analysis carried out in a GMP approved, FDA inspected facility (MedPharma site only).
**Laboratory Analysis, Sampling, Food Safety Monitoring and Analysts on Contract are all ISO 9001 certified.

Lab No	Sample ID	Sample Condition on Receipt	Sampling Date
933117	Up 500- MF - SURFACE	Good condition	20/02/2019
933118	Up 500- MF - MIDDLE	Good condition	20/02/2019
933119	Up 500- MF - BOTTOM	Good condition	20/02/2019
933120	Up 500- LW -SURFACE	Good condition	20/02/2019
933121	Up 500- LW -MIDDLE	Good condition	20/02/2019
933122	Up 500- LW -BOTTOM	Good condition	20/02/2019
933124	Up 500- ME -SURFACE	Good condition	20/02/2019
933125	Up 500- ME -MIDDLE	Good condition	20/02/2019
933126	Up 500- ME -BOTTOM	Good condition	20/02/2019
933127	DOWN 500- MF -SURFACE	Good condition	20/02/2019
933128	DOWN 500- MF -MIDDLE	Good condition	20/02/2019
933129	DOWN 500- MF -BOTTOM	Good condition	20/02/2019
933130	DOWN 500- LW -SURFACE	Good condition	20/02/2019
933131	DOWN 500- LW -MIDDLE	Good condition	20/02/2019
933132	DOWN 500- LW BOTTOM	Good condition	20/02/2019
933133	DOWN 500-ME-SURFACE	Good condition	20/02/2019
933134	DOWN 500-ME-MIDDLE	Good condition	20/02/2019
933135	DOWN 500-ME-BOTTOM	Good condition	20/02/2019
933136	DOWN 1KM-MF-SURFACE	Good condition	20/02/2019
933137	DOWN 1KM-MF-MIDDLE	Good condition	20/02/2019
933138	DOWN 1KM-MF-BOTTOM	Good condition	20/02/2019
933139	DOWN 1KM-LW- SURFACE	Good condition	20/02/2019
933140	DOWN 1KM-LW- MIDDLE	Good condition	20/02/2019
933141	DOWN 1KM-LW- BOTTOM	Good condition	20/02/2019
933142	DOWN 1KM-ME- SURFACE	Good condition	20/02/2019
933143	DOWN 1KM-ME- MIDDLE	Good condition	20/02/2019
933144	DOWN 1KM-ME- BOTTOM	Good condition	20/02/2019

Complete Laboratory Solutions,
Ros Muc, Connemara,
Co. Galway

Complete Laboratory Solutions,
MedPharma Division,
Unit 3a, Small Business Park, Mervue, Galway

Symbol Reference - I:17025 accredited; S:Subcontracted; R:Analysis carried out in Ros Muc; M:Analysis carried out in MedPharma

Appendix 7

Marine Sediment Characterisation Aughinish Port Dredging and Disposal Operations (Aquafact 2018)

Marine Sediment Characterisation
Aughinish Port
Dredging and Disposal Operations

Produced by

AQUAFACT International Services Ltd

On behalf of

Aughinish Alumina Limited

April 2018

AQUAFACT INTERNATIONAL SERVICES LTD.,
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1. Introduction

In July 2016, Aughinish Alumina Ltd were granted a Dumping at Sea Permit (S0026-01) for the disposal of dredge material from around their jetty. There is a requirement under Condition 4.5 of Permit S0026-01 that sediment monitoring is carried out in 2018. AQUAFACT International Services Ltd. was commissioned by Aughinish Alumina Ltd to carry out the sediment monitoring survey around Aughinish Port.

2. Materials & Methods

2.1. Sampling Procedure

On the 14th December 2017, 3 sediment stations were sampled for physical and chemical analysis as per Condition 4.5 of Permit No. S0026-01 (Appendix 1). The analysis required can be seen in Table 2.1. In addition, in 2017, two additional metals (Iron and Titanium) were added to the list in order to extend the monitoring to align those metals reported for bauxite residue in quarterly monitoring reports to the EPA (Appendix 2).

Table 2:1 Determinands.

Determinand	
Total organic carbon	Lead
Granulometry	Arsenic
Mercury	Cadmium
Zinc	Dibutyltin
Nickel	Tributyltin
Copper	Lindane
Chromium	HCB
Aluminium	PCB 7
Manganese	PAH
Lithium	TEH

Samples were taken from the edge of the pier. Figure 2.1 shows the station locations and Table 2.2 shows the station coordinates. Samples were collected within 10m of the coordinates shown.

One grab sample was taken at each of the stations and the samples were divided as follows:

1. Into labelled 1l plastic bags for water content, density and sediment grain size analysis.

For Chemical analysis by SOCOTEC:

2. Into 500ml Plastic bag
3. Into 120ml amber glass
4. Into sediment tin.

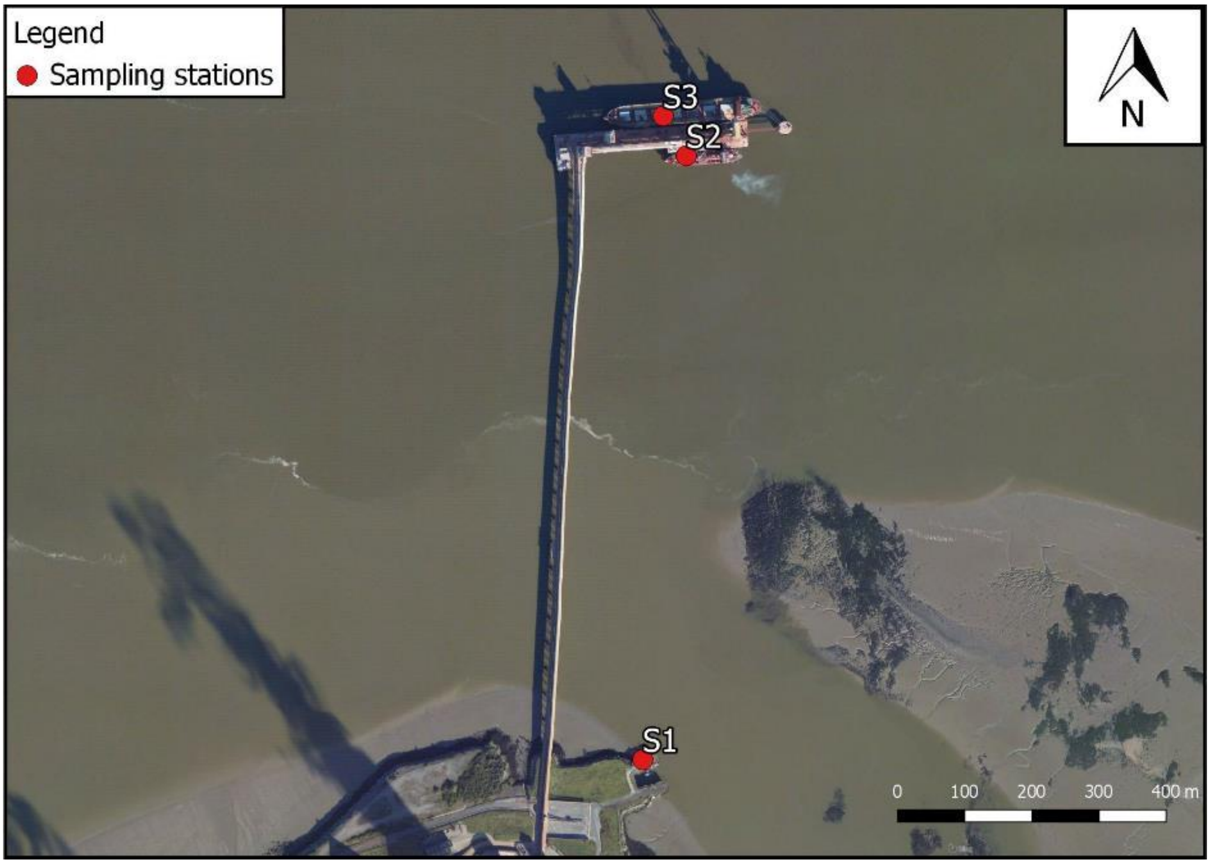

Figure 2.1: Location of chemistry sampling sites

Table 2:2: Coordinates of stations sampled for physical and chemical analysis.

Station	Latitude	Longitude	Depth (m)
S1	52.63699	-9.05784	1.5
S2	52.64505	-9.05688	11
S3	52.64558	-9.05739	13

2.2. Sample Processing

Once back in the lab, all sediment samples for the analysis of organics and contaminants were sent to the SOCOTEC Laboratories in Burton on Trent. AQUAFACT carried out the particle size analysis, moisture and density content as described below.

2.2.1. Particle Size Analysis (PSA)

AQUAFACT carried out the PSA analysis in-house using the following methodology:

1. Approximately 100g of dried sediment (previously washed in distilled water and dried) was weighed out and placed in a labelled 1L glass beaker to which 100ml of a 6 percent hydrogen peroxide solution was added. This was allowed to stand overnight in a fume hood.
2. The beaker was placed on a hot plate and heated gently. Small quantities of hydrogen peroxide were added to the beaker until there was no further reaction. This peroxide treatment removed any organic material from the sediment which can interfere with grain size determination.
3. The beaker was then emptied of sediment and rinsed into a 63µm sieve. This was then washed with distilled water to remove any residual hydrogen peroxide. The sample retained on the sieve was then carefully washed back into the glass beaker up to a volume of approximately 250ml of distilled water.
4. 10ml of sodium hexametaphosphate solution was added to the beaker and this solution was stirred for ten minutes and then allowed to stand overnight. This treatment helped to dissociate the clay particles from one another.
5. The beaker with the sediment and sodium hexametaphosphate solution was washed and rinsed into a 63µm sieve. The retained sample was carefully washed from the sieve into a labelled aluminium tray and placed in an oven for drying at 100ºC for 24 hours.
6. The dried sediment was then passed through a Wentworth series of analytical sieves (>8,000 to 63µm; single phi units). The weight of material retained in each sieve was weighed and recorded. The material which passed through the 63µm sieve was also weighed and the value added to the value measured in Point 5 (above).
7. The total silt/clay fraction was determined by subtracting all weighed fractions from the initial starting weight of sediment as the less than 63µm fraction was lost during the various washing stages.
8. The following range of particle sizes: <63µm, 63<125µm, 125<250µm, 250<500µm,

500<1000μm, 1000<2000μm, 2000<4000μm and 4000<8000μm were reported.

2.2.2. Moisture Content & Density

Moisture content was taken as the percentage weight difference between the wet and dried sediment. Sediment density was calculated by placing a fixed volume (100 ml) of sediment in a volumetric cylinder and weighing the contents.

2.2.3. Chemical Analysis

The following methodologies were employed by SOCOTEC Burton-upon-Trent:

- Total Organic Carbon analysis: carbonate removal and sulphurous acid/combustion at 800°C/NDIR.
- Carbonate content analysis: acid based titration to preset pH.
- Total Hydrocarbons: (GCFID) Documented in-house method using marine specification by GC-FID.
- Organotins: Documented in-house method OGSNSED
- Metal analysis: using HF boric extraction followed by ICPMS (As, Cd, Cu, Pb and Hg) and by ICPOES (Al, Fe, Li, Mn, Cr, Ni, Zn and Ti).
- OCP & PCB analysis: Documented in-house method using GCQQQ.
- PAH analysis: Documented in-house method using DTI specification by GC-MS.

All tests were carried out on the <2mm fraction.

The Limits of detection can be seen in Table 2.3.

Table 2:3: Limits of Detection

Parameter	Unit	LOD
Hydrocarbons	μg/kg	1
Mercury	mg/kg	0.01
Aluminium	mg/kg	10
Arsenic	mg/kg	1
Cadmium	mg/kg	0.1
Chromium	mg/kg	1.5
Copper	mg/kg	2
Lead	mg/kg	2
Lithium	mg/kg	0.5
Nickel	mg/kg	1
Zinc	mg/kg	1
OCP	μg/kg	0.1
PAH	μg/kg	1

Parameter	Unit	LOD
PCBs	µg/kg	0.08
DBT/TBT	mg/kg	0.001

3. Physical / Chemical Results

Appendix 3 contains the laboratory report showing the full set of results from SOCOTEC. AQUAFACT can confirm that all results have been reconfirmed by the laboratory.

3.1. Parameter Code 1

Table 3.1 shows the visual inspection information, which includes colour and sediment type.

Table 3:1: Visual Inspection

Station	Description
S1	Light brown surface/ black anoxic below <5mm, Sandy mud
S2	Light brown surface/ black anoxic below <5mm, Sandy mud
S3	Light brown surface/ black anoxic below <5mm, Sandy mud

3.2. Parameter Code 2

The water content and density results can be seen in Table 3.2. Values ranged from 1.45 (S3) to 1.73g/ml (S2) for density and from 25.6 (S3) to 39.2% (S1) for moisture content.

Table 3:2: Moisture content and density

Station	Density (g/ml)	Moisture Content (%)
S1	1.63	39.2
S2	1.73	34
S3	1.45	25.6

3.3. Parameter Code 3

Table 3.3 shows the granulometry results broken down into % gravel (>2mm), sand (<2mm >63μm) and mud (<63μm). Gravel ranged from 6.7 (S1) to 14.3% (S3), sand ranged from 43.8 (S1) to 54.7% (S3) and silt-clay ranged from 31.2 (S3) to 49.5% (S1).

Table 3:3: Granulometry results

Station	% Gravel (>2mm)	% Sand (<2mm - > 63μm	% Silt-Clay (<63μm)
S1	6.7	43.8	49.5
S2	9.1	52.4	38.6
S3	14.3	54.7	31.2

3.4. Parameter Code 4

3.4.1. Code 4a

Table 3.4 shows the total organic carbon results. Values ranged from 0.99 (S2) to 1.44% (S1).

Table 3:4: Total organic carbon results

Station	800°C/NDIR
S1	1.44
S2	0.99
S3	1.31

3.4.2. Code 4c

Table 3.5 shows the metal results, along with the upper and lower guidance values for Annex I metals (Cronin *et al.,* 2006). Cadmium, Chromium, Copper and Mercury were all below the lower level guidance values. Nickel was above the lower level guidance values at all stations. Arsenic was below the lower guidance level at Station 2, the remaining two stations were above the lower level guidance values. Zinc was above the upper level guidance values at station 2, but below the lower level guidance values at the remaining stations.

Table 3:5: Metal results and guidance values.

Determinand		Lower Action Limit	Upper Action Limit	S1	S2	S3
Hg	**mg/kg**	**0.2**	**0.7**	0.05	0.03	0.03
Al	**mg/kg**	**N/A**	**N/A**	34800	31500	55300
As	**mg/kg**	**9***	**70#**	12.2	7.9	11.2
Cd	**mg/kg**	**0.7**	**4.2**	0.4	0.7	0.4
Cr	**mg/kg**	**120**	**370**	46.9	44.8	105
Cu	**mg/kg**	**40**	**110^**	22.8	32.1	19.5
Li	**mg/kg**	**N/A**	**N/A**	24.6	19.7	23.4
Ni	**mg/kg**	**21**	**60**	26.9	21.7	22.7
Zn	**mg/kg**	**160**	**410**	107	652	74.4
Fe	**mg/kg**	**N/A**	**N/A**	34600	22700	30900
Mn	**mg/kg**	**N/A**	**N/A**	843	710	807
Titanium	**mg/kg**	**N/A**	**N/A**	1390	1390	2730

Exceeds Lower Limit	Exceeds Upper Limit

* ERL (rounded up) – No background Irish data

In some locations natural levels of arsenic will exceed this value and in such instances this guidance value will not be appropriate.

^ PEL as ERM considered high.

3.4.3. Code 4d

Tables 3.6 and 3.7 show the organochlorines including ɣ-HCH (Lindane) and PCB results, along with the upper and lower guidance values for Annex I organochlorines and PCBs (Cronin *et al.,* 2006). All PCBs are below the lower guidance level. HCB and ɣ-HCH were below the lower guidance level at all stations.

Table 3:6: Organochlorine results.

Determinand		Lower Action Limit	Upper Action Limit	S1	S2	S3
DDE-pp	**ug/kg**	**N/A**	**N/A**	0.11	0.13	<0.1
DDD-pp	**ug/kg**	**N/A**	**N/A**	0.1	0.11	<0.1
DDT-pp	**ug/kg**	**N/A**	**N/A**	<0.1	<0.1	<0.1
Dieldrin	**ug/kg**	**N/A**	**N/A**	0.1	<0.1	<0.1
HCH Alpha	**ug/kg**	**N/A**	**N/A**	<0.1	<0.1	<0.1
HCH Gamma	**ug/kg**	**0.3**	**1**	<0.1	<0.1	<0.1
HCB	**ug/kg**	**0.3**	**1**	0.16	0.1	<0.1

Exceeds Lower Limit	Exceeds Upper Limit

Table 3:7: PCB Results.

Determinand		Lower Action Limit	Upper Action Limit	S1	S2	S3
PCB 028	**ug/kg**	**1**	**180**	0.3	0.24	0.2
PCB 052	**ug/kg**	**1**	**180**	0.3	0.32	0.2
PCB 101	**ug/kg**	**1**	**180**	0.12	0.13	0.1
PCB 118	**ug/kg**	**1**	**180**	<0.08	<0.08	<0.08
PCB 138	**ug/kg**	**1**	**180**	0.08	<0.08	<0.08
PCB 153	**ug/kg**	**1**	**180**	<0.08	<0.08	<0.08
PCB 180	**ug/kg**	**1**	**180**	<0.08	<0.08	<0.08

Exceeds Lower Limit	Exceeds Upper Limit

3.4.4. Code 4e

Table 3.8 shows the total extractable hydrocarbon results, along with the lower guidance values for Hydrocarbons (Cronin *et al.,* 2006). Values ranged from 43.24 (S1) to 54.313mg/kg (S3). All were below the lower guidance level

Table 3:8: Total extractable hydrocarbon results.

Determinand		Lower Action Limit	S1	S2	S3
Hydrocarbons	**mg/kg**	**1000**	43.24	45.521	54.313

3.4.5. Code 4f

Table 3.9 shows the dibutyl and tributyl tin results, along with the Annex I upper and lower guidance values for sum of DBT and TBT (Cronin *et al.,* 2006). Sum of DBT and TBT was below the lower limit for all stations.

Table 3:9: Dibutyl and tributyl tin results.

Determinand		Lower Action Limit	Upper Action Limit	S1	S2	S3
DBT	**mg/kg**	**N/A**	**N/A**	<0.001	<0.005	<0.001
TBT	**mg/kg**	**N/A**	**N/A**	<0.001	<0.005	<0.001
∑DBT &TBT	**mg/kg**	**0.1**	**0.5**	<0.002	<0.01	<0.002

Exceeds Lower Limit	Exceeds Upper Limit

3.4.6. Code 4g

Table 3.10 shows the PAH results and Annex I lower guidance values for sum of 16 PAH's. Sum of 16 PAH's was below the lower limit for all stations.

Table 3:10: PAH results.

Determinand		Lower Action Limit	S1	S2	S3
PAH Acenaphthene	**ug/kg**	**N/A**	3.20	11.30	3.60
PAH Acenaphthylene	**ug/kg**	**N/A**	2.90	1.80	1.30
PAH Anthracene	**ug/kg**	**N/A**	7.40	8.60	5.50
PAH Benzo a anthracene	**ug/kg**	**N/A**	24.60	24.80	17.40
PAH Benzo (a) pyrene	**ug/kg**	**N/A**	24.1	24.4	16.5
PAH Benzo b fluoranthene	**ug/kg**	**N/A**	32.2	30.7	26.6
PAH Benzo ghi perylene	**ug/kg**	**N/A**	19.9	19.9	17.2
PAH Benzo k fluoranthene	**ug/kg**	**N/A**	14.3	14.4	10.9
PAH Chrysene	**ug/kg**	**N/A**	29.9	28.6	22.8
PAH Dibenzo a,h anthracene	**ug/kg**	**N/A**	3.6	3.6	3.1
PAH Fluoranthene	**ug/kg**	**N/A**	44.8	52.9	34.8
PAH Fluorene	**ug/kg**	**N/A**	5.8	7.7	4.9
PAH Indeno 1,2,3 – cd pyrene	**ug/kg**	**N/A**	21.2	21.8	17.4
PAH Naphthalene	**ug/kg**	**N/A**	6.4	16.3	5.3
PAH Phenanthrene	**ug/kg**	**N/A**	24.0	27.1	17.7
PAH Pyrene	**ug/kg**	**N/A**	36.8	44.8	29.2
∑ 16 PAH	**ug/kg**	**4000**	301.10	338.70	234.20

Exceeds Lower Limit	Exceeds Upper Limit

4. Discussion/Conclusion

The sediments analysed were below the lower Irish action limits for organochlorines, PCBs, total extractable hydrocarbons, organotins and ∑16 PAH's. Arsenic was above the lower Irish action limit at two of the three stations sampled, Nickel was above the lower Irish action limit at all three stations and Zinc was above the upper Irish action limit at one out of the three stations sampled. All other metals were below the lower Irish action limit.

The following interpretation of the results has been provided by Rick Boelens at the request of AQUAFACT International Services Ltd. Appendix 4 contains Mr. Boelens interpretation reports.

Rick Boelens has an honours degree in zoology from Trinity College Dublin. He has a background in aquatic biology and toxicology and has 40 years experience in the investigation, assessment and management of freshwater and marine environments. He has worked in Canada[1], Ireland and the UK for state agencies and later as a consultant to industry, local and national government and to specialised UN agencies. He has represented Ireland at EU technical meetings, the OSPAR and London Conventions and served on various international advisory groups including ICES-ACMP[2] and GESAMP[3]. He has been a visiting professor at the World Maritime University in Malmö. He has served as Irish Sea Science Coordinator for the Irish and UK governments and as manager of the team that prepared Ireland's first comprehensive marine quality status report (1999). Recently, he has been independent editor of the UNEP[4]/UNESCO-IOC[5] Assessment of Assessments (towards a new global process for marine environmental assessment), Chairman of a GESAMP task team on Pollution in the Open Ocean and mid-term evaluator of the IMO[6]/UNDP-GEF[7] GloBallast project which assists developing countries with implementation of the IMO Ballast Water Management Convention. He is Chairman and founder member of the Lough Derg Science Group that studies environmental aspects of the Shannon River and surrounding areas. In 2016, he was chairman of a GESAMP task team established to update a report (GESAMP Reports & Studies No.79) on pollution of the open ocean; the report will contribute to the GEF Transboundary Waters Assessment

[1] Ontario Ministry of Environment
[2] Advisory Committee on Marine Pollution of the International Council for Exploration of the Sea
[3] UN Group of Experts on the Scientific Aspects of Marine Protection
[4] United Nations Environment Programme
[5] Intergovernmental Oceanographic Commission of UNESCO
[6] International Maritime Organization
[7] Global Environment Facility (UN funding agency)

Programme (TWAP). Rick is also a co-author of the 'Guidelines for the assessment of dredge material for disposal in Irish waters (Cronin *et al.,* 2006).

It should be noted that the assessment of estuarine sediments representative of small (highly localised) areas is difficult without reference to the wider distribution of sediment types in the estuary. Grain sizes, organic fractions and salinities are particularly important in regulating concentrations of contaminants. Thus, with the data and time available an *in-depth* assessment of the samples is not presently possible.

ZINC Levels of zinc in sediment samples from Irish inshore waters are typically <300 mg/kg with the majority <100mg/kg. Higher values tend to be associated with acid mine drainage or the transport of metalliferous ores[8]. The current Irish Action Level for Zn in sediments to be dredged is >410 mg/kg[9].

The levels of zinc in Samples 1 and 3 are well within expected background levels and of no biological concern.

The level of Zn in sediment at Station 2 (652 mg/kg) is above the expected background range for Irish waters and indicates some form of contamination. As this exceeds the Irish action level of 410 mg/kg, possible sources should be identified. Common sources of zinc in ports and navigation channels are sacrificial anodes on hulls, antifouling paints and galvanized objects and structures. Considering the much lower value recorded at the adjacent Station 3 (74.4 mg/kg), it is likely that the contamination at Station 2 is extremely localised and the amount of contaminated material to be dredged may be small; this can only be confirmed by further sampling. Additional sampling was carried out in April 2018 at Station 2 and throughout the wider Inner Berth area and values at Station 2 ranged from 15.1 to 19.5mg/kg, considerabley lower than the 652mg/kg recorded in December 2017. Values throughout the remainder of the site were all below the lower action limit with the exception of 1 sample which was above the lower action limit (206mg/kg). Appendix 5 provides a summary report on the additional sampling. The results of this survey show no evidence of the previously high levels of Zn contamination at Station 2 or in the wider dredge area.

Zinc is an essential element for many marine organisms and, as such, is readily bioaccumulated. According to Canadian sediment quality guidelines, sediment concentrations of zinc above 124

[8] Marine Institute (1999). Ireland's Marine and Coastal areas and Adjacent Seas: an Environmental Assessment, 388p.

[9] Margot Cronin, Evin McGovern, Terry McMahon & Rick Boelens (2006). *Guidelines for the Assessment of Dredge Material for Disposal in Irish Waters.* Marine Institute, Marine Environment and Health Series, No. 24, 56pp.

mg/kg can pose a hazard to sediment-dwelling organisms. A recent UK report[10] has suggested that levels <130 mg/kg should not be of concern while those >600 mg/kg (reduced from 800 mg/kg) are unsuitable for disposal at sea. Intermediate values warrant further investigation.

It is the opinion of Mr. Boelens that providing it can be confirmed that the quantity of sediment to be dredged from Station 2 is small (e.g. <500m^3), the risk to marine life from disposal at a dispersive site in the estuary would be minor.

IRON concentrations ranged from 30,000-35,000 mg/kg approximately. Estuarine sediments tend to be rich in iron of geological origin and mean concentrations of 20,000 mg/kg or more are not uncommon, especially in and around salt marshes (UK Marine SAC Org.), without biological damage. A similar sediment characterisation study by Shannon Foynes Port Company in 2008 recorded Fe levels from 19000 to 27700 mg/kg at Foynes Harbour, 22800 mg/kg at Ted Russel Dock and from 29600 to 35800 mg/kg in the approach channel to Limerick Docks (mean 26980mg/kg) (Permit Details S0009-02 http://www.epa.ie/terminalfour/DaS/DaS-view.jsp?regno=S0009-02). A study of heavy metal concentrations in the Thames Estuary showed Fe values ranging from 21,711 to 52,900 mg/kg (Attrill & Thomes, 1995). The same study also compared Fe mean values from other Baltic and UK/European estuaries which ranged from 14,816 to 45,683mg/kg.

It is the opinion of Mr. Boelens that dredging of the sediments at the sample site, and their disposal at a suitable dispersive site, should have little or no environmental consequence.

TITANIUM is present in most igneous rocks and in sediments derived from them. It has no known biological role and the human body can withstand large doses. No environmental effects have been reported. It is seldom routinely monitored and comparative data for sediments would be difficult to locate. It is the opinion of Mr. Boelens that the levels of titanium in the sediments in question (1300-2700 mg/kg approx.) are of no biological significance.

5. References

Attrill, M.J. & Thomes, R.M. (1995) Heavy Metal concentrations in sediment from the Thames Estuary, UK. Marine Pollution Bulletin, Vol. 30, No. 11, pp. 742-744, 1995.

[10] MMO (2015). *High Level Review of Current UK Action Level Guidance.* A report produced for the Marine Management Organisation, pp 73. MMO Project No: 1053.

Cronin, M., McGovern, E., McMahon, T. & R. Boelens. 2006. Guidelines for the assessment of dredge material for disposal in Irish waters. Marine Environmental and Health Series, No. 24, 2006.

Appendix 1
Extracts from Dumping at Sea Permit

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

DUMPING AT SEA PERMIT

Permit Register Number:	**S0026-01**
Permit Holder:	**Aughinish Alumina Limited**
Location of Dumping:	**Jetty at Aughinish Alumina Limited**

Condition 4. Control and Monitoring

4.5 Sediment chemistry and grain size analysis

4.5.1 The permit holder shall carry out chemical and granulometric analysis of sediments within the dumping sites in 2018, 2021 and 2024 in accordance with *Schedule C.1.2: Sediment Monitoring* of this permit. A report on this analysis shall be submitted to the Agency within 1 month of completion of the analysis.

4.5.2 Following submission of the results of the monitoring specified in Condition 4.5.1, plough dredging may not proceed without the written agreement of the Agency.

SCHEDULE C: Monitoring

C.1 Monitoring at Dumping Site [Note 1]

Note 1: The frequency, methods and scope of monitoring, sampling and analyses may be amended in accordance with Condition 4.3.

C.1.1 Bathymetry Monitoring

Parameters	Monitoring Frequency/Time	Monitoring Locations	Analysis Method/Technique
Bathymetry & concurrent tide observations	• Within one week prior to the commencement of each dumping campaign. • Within one week following completion of each dumping campaign.	Dumping Sites A, B and C	**High resolution bathymetric survey & concurrent tidal height measurements.**

C.1.2 Sediment Monitoring

Parameters	Monitoring Frequency/Time	Monitoring Locations	Analysis Method/Technique
Sediment analysis: Total organic carbon Granulometry [Note 1] Mercury Zinc Nickel Copper Chromium Aluminium Manganese Lithium Lead Arsenic Cadmium Dibutyltin Tributyltin y-HCH (Lindane) HCB PCB 7 [Note 2] PAH [Note 3] TEH	**• 2018 • 2021 • 2024**	**Grab samples of surface sediments to be taken at: Locations to be agreed with the Agency prior to dumping in 2018, 2021 & 2024.**	Standard method [Note 4]

Note 1: Monitoring of granulometry shall include but not be limited to the following fractions: >2 mm, <2 mm, >63 µm and <63 µm.

Note 2: ICES 7 polychlorinated biphenyls: PCB 028/052/101/138/153/180/118.

Note 3: PAHs: Naphthalene, Acenaphthylene, Acenaphthene, Fluorene,Phenanthrene, Anthracene, Fluoranthene, Pyrene, Benzo(a)anthracene, Chrysene, Benzo(b)fluoranthene, Benzo(k)fluoranthene, Benzo(a)pyrene, Dibenzo(ah)anthracene, Benzo(ghi)perylene, Indeno(123-cd)pyrene.

Note 4: Sampling and analyses shall be conducted in accordance with the analytical and quality requirements set out in: *M. Cronin et al. 2006. Guidelines for the Assessment of Dredge Material for Disposal in Irish Waters. Marine Environment & Health Series, No. 24. Marine Institute.*

Ca

Appendix 2

Permit S0026-01 Additional Metals for Analysis

Amendment

RUSAL

AUGHINISH ALUMINA LIMITED

(Registered in Ireland No.59982)

9th November 2017

Mr. Pol O'Seasnain,
Inspector,
Office of Environmental Enforcement,
Environmental Protection Agency,
Regional Inspectorate,
Inniscarra,
Co. Cork

Re: Condition 4.3 of DaS Permit S0026-01

Dear Mr. O'Seasnain,

In accordance with Condition 4.3 of DaS Permit S0026-0, Aughinish Alumina (AAL) wish to seek approval for a change to the scope of sediment characterisation. During a meeting held with the Agency on 21st June 2017 it was requested that AAL submit a proposal to extend the monitoring parameters for sediment characterisation, in particular metals.

AAL propose to extend the monitoring parameters to align with those metals which are reported for bauxite residue in quarterly monitoring reports to the Agency. Those metals which are not covered by the existing Schedule C1.2 but which are monitored for in bauxite residue are Iron and Titanium. Therefore, we propose that both Iron and Titania are monitored for in future sediment characterisation.

Regards,

Louise Clune

Louise Clune
Environment Coordinator

Aughinish Alumina Limited, Aughinish Island, Askeaton, Co Limerick, V94 V8F7 – Ireland
Tel. +353 (0)61 604000 – Fax +353(0)61 604242 – www.rusal.com
DIRECTORS: D A Clancy, S Garland, M Samoylov, A Shylak, O. Smirnova, O Stasev, K Strunnikov, I Usacheva
Reg. in Ireland No.59982. Reg. Office: Aughinish Island, Askeaton, Co Limerick, Ireland

Appendix 3
SOCOTEC Laboratory Report
December 2017

Our Ref: EFS/181668 (Ver. 1)
Your Ref: JN1461

March 28, 2018

Environmental Chemistry
SOCOTEC UK Limited
Bretby Business Park
Ashby Road
Burton-on-Trent
Staffordshire
DE15 0YZ

Telephone: 01283 554400
Facsimile: 01283 554422

Caroline Roche
Aquafact International Services Ltd
12 Kikerrn Park
Tuam Road
Galway City
Ireland

For the attention of Caroline Roche

Dear Caroline Roche

Sample Analysis - Aughinish Das

Samples from the above site have been analysed in accordance with the schedule supplied.
The sample details and the results of analyses for these samples are given in the appended report.

An invoice for this work will follow under a separate cover.

The samples will be kept until the agreed date when they will be discarded. Please call 01283 554547 for an extension of this date.
Please be aware that our policy for the retention of paper based laboratory records and analysis reports is 6 years.

The work was carried out in accordance with SOCOTEC UK Limited (Multi-Sector Services) Standard Terms and Conditions of Contract.

If I can be of any further assistance please do not hesitate to contact me.

Yours sincerely

for SOCOTEC UK Limited

JMColbourne

J Colbourne
Project Co-ordinator
01283 554565

TEST REPORT

1252

Report No. EFS/181668 (Ver. 1)

Aquafact International Services Ltd
12 Kikerrn Park
Tuam Road
Galway City
Ireland

Site: Aughinish Das

The 6 samples described in this report were registered for analysis by SOCOTEC UK Limited on 19-Dec-2017. This report supersedes any versions previously issued by the laboratory.

The analysis was completed by: 28-Mar-2018

Tests where the accreditation is set to N or No, and any individual data items marked with a * are not UKAS accredited.
Opinions and interpretations expressed herein are outside the scope of UKAS accreditation.

The following tables are contained in this report:

On behalf of
SOCOTEC UK Lim[ited] T Barnes
Tim Barnes Operations Director
Energy & Waste Services

Date of Issue: 28-Mar-2018

Tests marked '^' have been subcontracted to another laboratory.

Where samples have been flagged as deviant on the Analytical and Deviating Sample Overview, for any reason, the data may not be representative of the sample at the point of sampling and the validity of the data may be affected.
SOCOTEC UK Limited accepts no responsibility for any sampling not carried out by our personnel.

Where individual results are flagged see report notes for status.

LAB ID Number CL/	Client Sample Description	Sample Date	Arsenic (HF-MS)	Copper (HF-MS)	Lead (HF-MS)	Aluminium(Sediments HF-OES)	Iron(Sediments HF-OES)	Manganese(Sediments HF-OES)	Nickel(Sediments HF-OES)	Zinc(Sediments HF-OES)	PAH by MS Dti	Total Organic Carbon (Sediment)	Carbonate %	Cadmium (HF-MS)	Chromium(Sediments HF-OES)	Lithium(Sediments HF-OES)	Titanium(Sediments HF-OES)	Dibutyl Tin (Sediments)
		Units :	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	µg/kg	% M/M	%	mg/kg	mg/kg	mg/kg	mg/kg	ug Sn/kg
		Method Codes :	ICPMSSED	ICPMSSED	ICPMSSED	ICPSED	ICPSED	ICPSED	ICPSED	ICPSED	PAHSED	WSLM59	ANC	ICPMSSED	ICPSED	ICPSED	ICPSED	OGSNSED
		Method Reporting Limits :	1	2	2	10	10	1	1	1	1	0.02	0.12	0.1	1.5	0.5	5	1
		UKAS Accredited :	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	No	No	No	No	No	No
1787793	1	14-Dec-17	12.2	22.8	19	34800	34600	843	26.9	107	Req	1.44	17.76	0.4	46.9	24.6	1390	<1
1787794	2	14-Dec-17	7.9	32.1	46.9	31500	22700	710	21.7	652	Req	0.99	18.00	0.7	44.8	19.7	1390	<5
1787795	3	14-Dec-17	11.2	19.5	23.8	55300	30900	807	22.7	74.4	Req	1.31	13.68	0.4	105	23.4	2730	<1
1787796	CRM	14-Dec-17	34.2 §	77.8 §	97.6 §	74600 §	63800 §	1480 §	62.9 §	421 §	Req §	3.1847 §		1.9	292	60.2		774
1787797	QC Blank		<1 §	<2 §	<2 §	<10 §	<10 §	<1 §	<1 §	<1 §	Req §	<0.02 §		<0.1	<1.5	<0.5	<6	<1
1787798	Reference Material (% Recovery)		93 §	90 §	85 §	99 §	100 §	101 §	99 §	101 §	Req §	101 §	98	102	99	103	99	87

SOCOTEC

Bretby Business Park, Ashby Road

Burton-on-Trent, Staffordshire, DE15 0YZ

Tel +44 (0) 1283 554400

Fax +44 (0) 1283 554422

Client Name Aquafact International Services Ltd

Contact Caroline Roche

Aughinish Das

Sample Analysis

Date Printed	19-Jan-2018
Report Number	EFS/181668
Table Number	1

Where individual results are flagged see report notes for status.

LAB ID Number CL/	Client Sample Description	Sample Date	Tributyl Tin (Sediments)	Organochlorine Pesticides (Marine Sediments)	PCB- 7 Congeners (Marine Sediments)	Mercury (Tot.MS)	TPH GCFID (Si)+Sats
		Units :	ug Sn/kg	µg/kg	µg/kg	mg/kg	µg/kg
		Method Codes :	OGSNSED	PCBMS3Q	PCBMS3Q	TMMS1	TPHSED
		Method Reporting Limits :	1	0.08	0.08	0.01	10
		UKAS Accredited :	No	No	No	No	No
1787793	1	14-Dec-17	<1	Req	Req	0.05	Req
1787794	2	14-Dec-17	<5	Req	Req	0.03	Req
1787795	3	14-Dec-17	<1	Req	Req	0.03	Req
1787796	CRM	14-Dec-17	460	Req	Req	0.05	Req
1787797	QC Blank		<1	Req	Req	<0.01	Req
1787798	Reference Material (% Recovery)		86	Req	Req	94	Req

SOCOTEC

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Client Name	**Aquafact International Services Ltd**
Contact	Caroline Roche

Aughinish Das

Sample Analysis

Date Printed	**19-Jan-2018**
Report Number	**EFS/181668**
Table Number	**1**

Polychlorinated Biphenyls (congeners)

Customer and Site Details:	Aquafact International Services Ltd: Aughinish Das	**Matrix:**	Soil
Job Number:	S18_1668	**Date Booked in:**	19-Dec-17
QC Batch Number:	180001	**Date Extracted:**	16-Dec-17
Directory:	181217PCB.TQ1	**Date Analysed:**	18-Dec-17
Method:	Ultrasonic		

Compounds marked * are not UKAS or MCerts accredited

		Concentration, (µg/kg)						
Sample ID	**Customer ID**	**PCB28***	**PCB52***	**PCB101***	**PCB118***	**PCB153***	**PCB138***	**PCB180***
CL1787793	1	0.30	0.30	0.12	<0.08	<0.08	0.08	<0.08
CL1787794	2	0.24	0.32	0.13	<0.08	<0.08	<0.08	<0.08
CL1787795	3	0.20	0.20	0.10	<0.08	<0.08	<0.08	<0.08
CL1787796	CRM	2.03	4.10	4.17	2.31	3.41	4.39	2.22
CL1787797	QC Blank	<0.08	<0.08	<0.08	<0.08	<0.08	<0.08	<0.08
CL1787798	Reference Material (% Recovery)	77	108	100	94	99	107	100

Where individual results are flagged see report notes for status.

Organochlorine Pesticides

Customer and Site Details:	Aquafact International Services Ltd: Aughinish Das	**Matrix:**	Sediment
Job Number:	S18_1668	**Date Booked in:**	19-Dec-17
QC Batch Number:	180001	**Date Extracted:**	02-Jan-18
Directory:	181217.TQ1	**Date Analysed:**	05-Jan-18
Method:	Ultrasonic	**UKAS Accredited:**	No

Compounds marked * are not UKAS or MCerts accredited

Sample ID :	CL1787793	CL1787794	CL1787795	CL1787796	CL1787797
Client ID :	1	2	3	CRM	QC Blank
Compound	**Concentration (µg/kg)**				
alpha-HCH	<0.10	<0.10	<0.10	0.01	<0.10
Hexachlorobenzene	0.16	0.10	<0.10	8.37	<0.10
gamma-HCH	<0.10	<0.10	<0.10	0.03	<0.10
p,p'-DDE	0.11	0.13	<0.10	3.03	<0.10
Dieldrin	0.10	<0.10	<0.10	0.55	<0.10
p,p'-DDD	0.10	0.11	<0.10	5.14	<0.10
p,p'-DDT	<0.10	<0.10	<0.10	0.28	<0.10

Where individual results are flagged see report notes for status.

Organochlorine Pesticides

Customer and Site Details:	Aquafact International Services Ltd: Aughinish Das	**Matrix:**	Sediment
Job Number:	S18_1668	**Date Booked in:**	19-Dec-17
QC Batch Number:	180001	**Date Extracted:**	02-Jan-18
Directory:	181217.TQ1	**Date Analysed:**	05-Jan-18
Method:	Ultrasonic	**UKAS Accredited:**	No

Compounds marked * are not UKAS or MCerts accredited

Sample ID :	CL1787798				
Client ID :	erence Material (% Recovery)				
Compound	**Concentration (µg/kg)**				
alpha-HCH	105				
Hexachlorobenzene	108				
gamma-HCH	109				
p,p'-DDE	109				
Dieldrin	101				
p,p'-DDD	114				
p,p'-DDT	124				

Where individual results are flagged see report notes for status.

Polyaromatic Hydrocarbon Concentrations (ng/g dry weight basis) UKAS accredited?: Yes

		Sample ID :	CL1787797	CL1787798	CL1787793	CL1787794	CL1787795	CL1787796
		Station :	QC Blank	e Material (% R	1	2	3	1941b
PAH Fraction	***# PAH***	***Mass***						
Naphthalene *	1	128	<1	117.4	6.4	16.3	5.3	590.0
C1 Naphthalenes *	2	142	<1	114.1	9.3	9.9	9.6	317.0
C2 Naphthalenes *		156	<1	N.D	11.5	10.0	10.5	224.9
C3 Naphthalenes *		170	<1	N.D	9.8	9.6	10.5	173.3
C4 Naphthalenes *		184	<1	N.D	6.9	6.6	7.5	116.8
Sum Naphthalenes *			0	116	44	52	43	1422
Phenanthrene / Anthracene	2	178	<1	110.7	31.4	35.7	23.2	503.3
C1 178 *		192	<1	N.D	21.0	24.1	20.0	315.0
C2 178 *		206	<1	N.D	21.3	21.2	22.3	246.4
C3 178 *		220	<1	N.D	18.6	16.4	15.4	190.3
Sum 178 *			0	111	92.2	97.4	81.0	1254.9
Dibenzothiophene		184	<1	112	3.0	3.0	2.2	44.0
C1 Dibenzothiophenes *		198	<1	N.D	4.0	4.4	4.0	71.6
C2 Dibenzothiophenes *		212	<1	N.D	5.7	7.0	7.1	84.7
C3 Dibenzothiophenes *		226	<1	N.D	3.5	7.9	4.3	62.5
Sum Dibenzothiophenes *			0	112	16.2	22.3	17.5	262.7
Fluoranthene / pyrene	2	202	<1	109	81.6	97.7	64.1	1060.0
C1 202 *		216	<1	N.D	29.2	31.6	27.1	259.6
C2 202 *		230	<1	N.D	21.7	22.4	20.2	200.2
C3 202 *		244	<1	N.D	14.4	10.9	12.8	97.2
Sum 202 *			0	109	147.0	162.7	124.1	1616.9
Benzoanthracene / Chrysene	2	228	<1	110	54.5	53.4	40.2	655.6
C1 228 *		242	<1	N.D	28.0	24.5	21.9	275.7
C2 228 *		256	<1	N.D	17.7	12.6	13.3	151.0
Sum 228 *			0	110	100.2	90.5	75.4	1082.4
Benzofluoranthenes / benzopyrenes	4	252	<1	102	94.8	93.0	73.0	1252.0
C1 252 *		266	<1	N.D	37.8	31.5	27.5	338.9
C2 252 *		280	<1	N.D	16.6	10.8	14.4	219.5
Sum 252 *			0	102	149.2	135.3	114.9	1810.5
Dibenzoanthracene / Indenopyrene / Benzoperylene	3	276	<1	106	44.7	45.2	37.7	598.0
C1 276 *		290	<1	N.D	13.1	12.6	6.1	138.1
C2 276 *		304	<1	N.D	3.6	3.0	3.3	46.4
Sum 276 *			0	106	61.4	60.9	47.1	782.4
Sum of all fractions *			0	109	610.0	621.5	503.5	8231.9
Sum of NPD fraction *			0	113	152.3	172.1	141.9	2939.7
NPD / 4-6 ring PAH ratio *			#DIV/0!	0.26	0.33	0.38	0.39	0.56

Polyaromatic Hydrocarbon Concentrations (ng/g dry weight basis) UKAS accredited?: Yes

EPA 16 PAHs Compounds marked with a * are reported not UKAS.

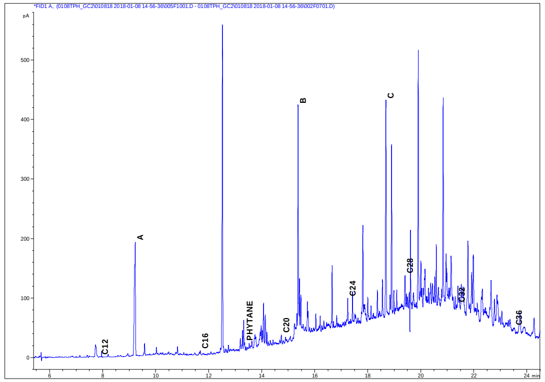
	Sample ID :	CL1787797	CL1787798	CL1787793	CL1787794	CL1787795	CL1787796
	Station :	QC Blank	:e Material (% R	1	2	3	1941b
PAH	***Mass***						
Naphthalene *	128	<1	117.4	6.4	16.3	5.3	590.0
Acenaphthylene	152	<1	116.9	2.9	1.8	1.3	55.3
Acenaphthene	154	<1	119.7	3.2	11.3	3.6	40.5
Fluorene	166	<1	116.0	5.8	7.7	4.9	58.3
Phenanthrene	178	<1	113.9	24.0	27.1	17.7	368.2
Dibenzothiophene	184	<1	112.2	3.0	3.0	2.2	44.0
Anthracene	178	<1	107.5	7.4	8.6	5.5	135.1
Fluoranthene	202	<1	109.6	44.8	52.9	34.8	597.1
Pyrene	202	<1	108.0	36.8	44.8	29.2	462.9
Benzo[a]anthracene	228	<1	107.6	24.6	24.8	17.4	265.6
Chrysene	228	<1	111.7	29.9	28.6	22.8	390.0
Benzo[b]fluoranthene	252	<1	96.4	32.2	30.7	26.6	471.0
Benzo[k]fluoranthene	252	<1	95.3	14.3	14.4	10.9	219.8
Benzo[e]pyrene	252	<1	110.9	24.2	23.5	18.9	322.6
Benzo[a]pyrene	252	<1	105.6	24.1	24.4	16.5	238.6
Perylene *	252	<1	113.8	62.4	136.9	119.2	253.0
Indeno[123,cd]pyrene	276	<1	104.0	21.2	21.8	17.4	311.5
Dibenzo[a,h]anthracene	278	<1	105.5	3.6	3.6	3.1	63.0
Benzo[ghi]perylene	276	<1	107.6	19.9	19.9	17.2	223.5

As the method uses surrogate standards to correct for losses, the RM results are reported as percentage trueness, not reco

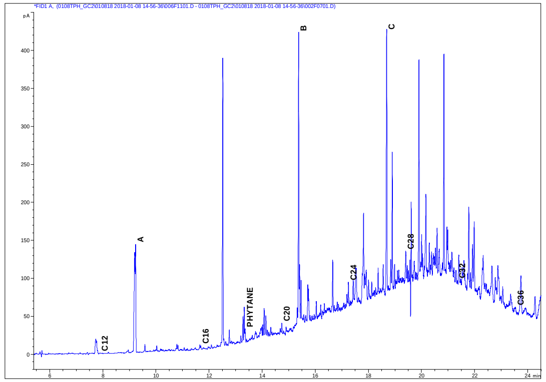
n-alkanes (ng/g) **UKAS accredited?: No** As the method uses surrogate standards to correct for losses, the RM results are reported as percentage trueness, not recovery.

Sample ID :	CL1787797	CL1787798	CL1787793	CL1787794	CL1787795
Station :	QC Blank	nce Material (% Re	1	2	3
Alkane					
nC10	<1	102.9	<1	<1	28.6
nC11	<1	<0.04	1.5	2.9	5.8
nC12	<1	109.1	2.7	3.0	3.9
nC13	<1	<0.04	7.4	6.5	5.7
nC14	<1	101.4	3.4	2.7	4.2
nC15	<1	<0.04	14.7	9.7	11.2
nC16	<1	97.3	10.7	7.1	6.7
nC17	<1	<0.04	889.8	562.6	1,785.1
pristane	<1	<0.04	14.9	7.7	14.8
nC18	<1	119.0	36.6	37.0	30.3
phytane	<1	<0.04	16.4	24.4	21.8
nC19	<1	<0.04	105.0	47.9	82.3
nC20	<1	105.5	22.4	15.7	20.2
nC21	<1	<0.04	66.0	81.6	63.0
nC22	<1	108.2	29.3	22.5	34.4
nC23	<1	<0.04	126.1	74.6	112.0
nC24	<1	110.4	46.2	35.0	44.3
nC25	<1	<0.04	214.2	98.8	183.0
nC26	<1	107.3	59.9	44.5	64.7
nC27	<1	<0.04	381.8	213.1	330.2
nC28	<1	109.1	81.3	40.4	53.6
nC29	<1	<0.04	613.4	390.3	552.1
nC30	<1	108.9	43.2	28.1	41.8
nC31	<1	<0.04	482.7	386.8	475.2
nC32	<1	112.3	28.6	19.6	26.4
nC33	<1	<0.04	169.0	141.1	170.2
nC34	<1	112.0	33.1	30.9	46.7
nC35	<1	1.4	48.6	49.1	53.4
nC36	<1	119.8	16.1	2.9	4.8
nC37	<1	3.1	65.5	47.0	63.9
Total Oil (ug/kg)	30.7	0.0	43,240.8	45,521.2	54,313.6
Total n alkanes	0	1,528	3,599	2,402	4,304
Carbon Preference Index	#DIV/0!	0.00	7.71	7.30	9.48
Pristane	<1	<0.04	15	8	15
Phytane	<1	<0.04	16	24	22
Pristane / phytane ratio			0.9	0.3	0.7

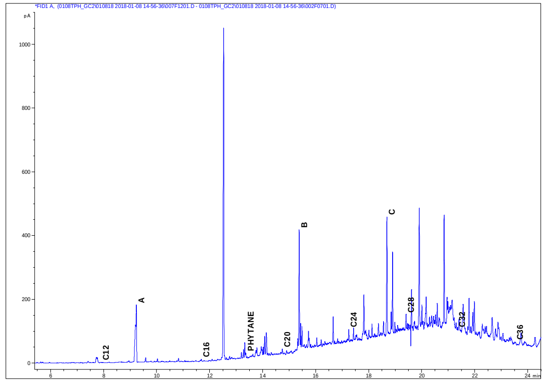
Note: sample data are blank corrected



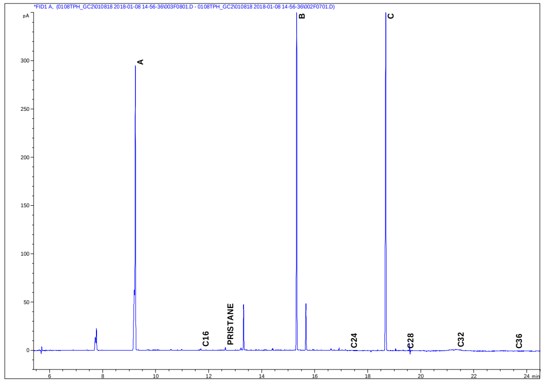
Sample ID: CL/1787793
Station: 1



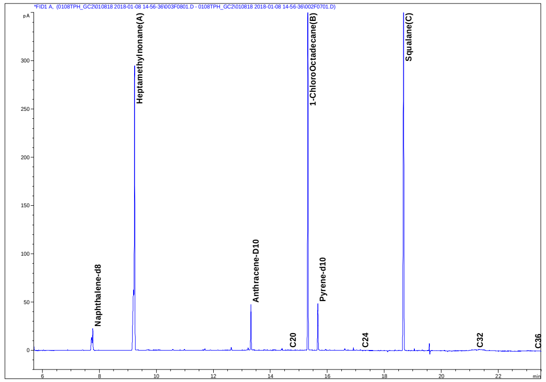
Sample ID: CL/1787794
Station: 2



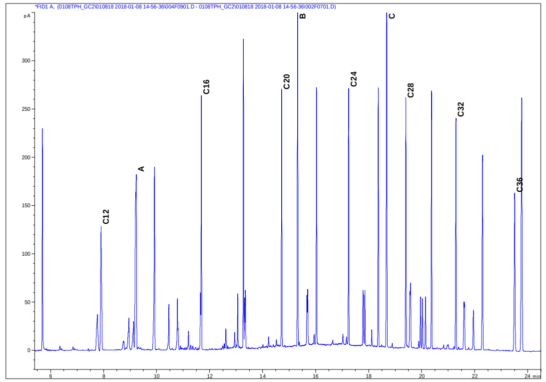
Sample ID: CL/1787795
Station: 3



Sample ID: CL/1787797
Station: QC Blank



Sample ID: CL/1787797
Station: QC Blank Labelled



Sample ID: CL/1787798
Station: Reference Material (% Recovery)

Analytical and Deviating Sample Overview

Customer **Aquafact International Services Ltd**
Site **Aughinish Das**
Report No **S181668**

Consignment No S71343
Date Logged 19-Dec-2017
In-House Report Due 11-Jan-2018

Please note the results for any subcontracted analysis (identified with a '^') is likely to take up to an additional five working days.

ID Number	Description	Sampled	Carbonate %	Report C	Arsenic (HF-MS)	Cadmium (HF-MS)	Copper (HF-MS)	Lead (HF-MS)	Aluminium(Sediments HF-OES)	Chromium(Sediments HF-OES)	Iron(Sediments HF-OES)	Lithium(Sediments HF-OES)	Manganese(Sediments HF-OES)	Nickel(Sediments HF-OES)	Titanium(Sediments HF-OES)	Zinc(Sediments HF-OES)	Dibutyl Tin (Sediments)	Tributyl Tin (Sediments)	PAH by MS Dti	Organochlorine Pesticides (Marine Sediments)	PCB- 7 Congeners (Marine Sediments)	Mercury (Tot.MS)	TPH GCFID (Si)+Sats	Total Organic Carbon (Sediment)
		MethodID	ANC	CustServ	ICPMSSED				ICPSED								OGSNSED		PAHSED	PCBMS3Q		TMMS1	TPHSED	WSLM59
																								•
CL/1787793	1	14/12/17																						
CL/1787794	2	14/12/17																						
CL/1787795	3	14/12/17																						
CL/1787796	CRM	14/12/17																						
CL/1787797	QC Blank																							
CL/1787798	Reference Material (% Recovery)																							

Note: We will endeavour to prioritise samples to complete analysis within holding time; however any delay could result in samples becoming deviant whilst being processed in the laboratory.

If sampling dates are missing or matrices unclassified then results will not be ISO 17025 accredited. Please contact us as soon as possible to provide missing information in order to reinstate accreditation.

Deviating Sample Key	
A	The sample was received in an inappropriate container for this analysis
B	The sample was received without the correct preservation for this analysis
C	Headspace present in the sample container
D	The sampling date was not supplied so holding time may be compromised - applicable to all analysis
E	Sample processing did not commence within the appropriate holding time
F	Sample processing did not commence within the appropriate handling time

Requested Analysis Key	
	Analysis Required
	Analysis dependant upon trigger result - **Note: due date may be affected if triggered**
	No analysis scheduled
^	Analysis Subcontracted - **Note: due date may vary**

Where individual results are flagged see report notes for status.

The integrity of data for samples/analysis that have been categorised as Deviating may be compromised. Data may not be representative of the sample at the time of sampling.

Additional Report Notes

Method Code	Sample ID	The following information should be taken into consideration when using the data contained within this report
OGSNSED	CL1787794	The matrix of this sample has been found to interfere with the result for this test. The sample has therefore been diluted, but in doing so, the detection limit for this test has been elevated.
OGSNSED	CL1787795	Due to matrix interference, the Surrogate recovery for this Test is below the required QMS specification. This has been confirmed by repeating the analysis. All other Laboratory Process Controls meet the requirements of the QMS unless otherwise stated. These circumstances should be taken into consideration when utilising the data.
PAHSED	CL1787793 to CL1787796	The Primary process control data associated with this Test has not wholly met the requirements of the Laboratory Quality Management System QMS with one or more target analytes falling outside acceptable limits. However the remaining data gives the Laboratory confidence that the test has performed satisfactorily and that the validity of the data may not have been significantly affected. However in line with our QMS policy we have removed accreditation, where applicable, from the affected analytes (Naphthalene) . These circumstances should be taken into consideration when utilising the data.
PAHSED	CL1787793 to CL1787796	Chrysene is known to coelute with Triphenylene and these peaks can not be resolved. It is believed Triphenylene is present in these samples therefore it is suggested that the Chrysene results should be taken as a Chrysene (inc. Triphenylene).This should be taken into consideration when utilising the data.

Method Descriptions

Matrix	MethodID	Analysis Basis	Method Description
Soil	ANC	Oven Dried @ < 35°C	Quantitative digestion with Hydrochloric Acid back titration with 1M Sodium Hydroxide to pH 7
Soil	ICPMSSED	Oven Dried @ < 35°C	Determination of Metals in Marine and Esturine Sediments by Hydrofluoric Acid digestion followed by ICPMS
Soil	ICPSED	Oven Dried @ < 35°C	Determination of total Metals in samples by Hydrofluoric and Boric Acid digestion followed by ICPOES
Soil	OGSNSED	As Received	Determination of Organo-tin compounds using sonic extraction in methanol , derivatiseation with Sodium Tetraethylborate and GCMS quantitation (SIM mode).
Soil	PAHSED	As Received	Determination of Polyaromatic Hydrocarbons in Sediments by Methanol/Dichloromethane ultrasonic extraction GC-MS quantification
Soil	PCBMS3Q	As Received	Determination of Polychlorinated Biphenyl (PCB) congeners by hexane/acetone extraction followed by GCECD detection
Soil	TMMS1	Oven Dried @ < 35°C	Determination of total Metals in sediment samples by Nitric Acid and Hydrogen Peroxide digestion followed by ICPMS detection
Soil	TPHSED	As Received	Determination of methanol/dichloromethane extractable Hydrocarbons in Marine & Esturine Sediments with GCFID detection including quantitation of Aliphatic fractions.
Soil	WSLM59	Oven Dried @ < 35°C	Determination of Organic Carbon in soil using sulphurous Acid digestion followed by high temperature combustion and IR detection

Where individual results are flagged see report notes for status.

Report Notes

Generic Notes

Soil/Solid Analysis

Unless stated otherwise,
- Results expressed as mg/kg have been calculated on the basis indicated in the Method Description table.
  All results on MCERTS reports are reported on a 105ºC dry weight basis with the exception of pH and conductivity.
- Sulphate analysis not conducted in accordance with BS1377
- Water Soluble Sulphate is on a 2:1 water:soil extract

Waters Analysis
Unless stated otherwise results are expressed as mg/l
Nil: Where "Nil" has been entered against Total Alkalinity or Total Acidity this indicates that a measurement was not required due to the inherent pH of the sample.

Oil analysis specific

Unless stated otherwise,
- Results are expressed as mg/kg
- SG is expressed as g/cm^3@ 15^oC

Gas (Tedlar bag) Analysis

Unless stated otherwise, results are expressed as ug/l

Asbestos Analysis

CH Denotes Chrysotile
CR Denotes Crocidolite
AM Denotes Amosite
TR Denotes Tremolite
AC Denotes Actinolite
AN Denotes Anthophylite
NAIIS No Asbestos Identified in Sample
NADIS No Asbestos Detected In Sample

Symbol Reference

^ Sub-contracted analysis.
$$ Unable to analyse due to the nature of the sample
¶ Samples submitted for this analyte were not preserved on site in accordance with laboratory protocols.
This may have resulted in deterioration of the sample(s) during transit to the laboratory.
Consequently the reported data may not represent the concentration of the target analyte present in the sample at the time of sampling
¥ Results for guidance only due to possible interference
& Blank corrected result
I.S Insufficient sample to complete requested analysis
I.S(g) Insufficient sample to re-analyse, results for guidance only
Intf Unable to analyse due to interferences
N.D Not determined
N.Det Not detected
N.F No Flow
NS Information Not Supplied
Req Analysis requested, see attached sheets for results
Þ Raised detection limit due to nature of the sample
***** All accreditation has been removed by the laboratory for this result
‡ MCERTS accreditation has been removed for this result
§ accreditation has been removed for this result as it is a non-accredited matrix

Note: The Laboratory may only claim that data is accredited when all of the requirements of our Quality System have been met. Where these requirements have not been met the laboratory may elect to include the data in its final report and remove the accreditation from individual data items if it believes that the validity of the data has not been affected. If further details are required of the circumstances which have led to the removal of accreditation then please do not hesitate to contact the laboratory.

Sample Descriptions

Client : Aquafact International Services Ltd
Site : Aughinish Das
Report Number : S18_1668

Note: major constituent in upper case

Lab ID Number	Client ID	Description
CL/1787793	1	MARINE SEDIMENTS
CL/1787794	2	MARINE SEDIMENTS
CL/1787795	3	MARINE SEDIMENTS
CL/1787796	CRM	QUALITY CONTROL SAMPLE
CL/1787797	QC Blank	QUALITY CONTROL SAMPLE
CL/1787798	Reference Material (% Recovery)	QUALITY CONTROL SAMPLE

Appendix 4
Interpretation of Results

April 3rd 2018

Rick Boelens

Advisor, Water Environment

Castlelough

Portroe Nenagh

Co. Tipperary E45 ND91

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T:06723700 M:0857804780

ZINC in marine sediment

I have been requested by Aquafact International Services Ltd of Galway to comment on the levels of zinc found in 3 samples of sediment collected from the Shannon Estuary in December 2017, as follows:

Stn.	Sample No.	Zn mg/kg
1	S1787793	107
2	S1787794	652
3	S1787795	74.4

Samples 2 and 3 were taken at the offshore extremity of a c.0.8 km marine terminal (commercial jetty) whereas Sample 1 was taken from shallow water close to where the jetty meets the shoreline.

First, it must be noted that the assessment of estuarine sediments representative of small (highly localised) areas is difficult without reference to the wider distribution of sediment types in the estuary. Grain sizes, organic fractions and salinities are particularly important in regulating concentrations of contaminants. Thus, with the data and time available an *in-depth* assessment of the samples is not presently possible.

Levels of zinc in sediment samples from Irish inshore waters are typically <300 mg/kg with the majority <100mg/kg. Higher values tend to be associated with acid mine drainage or the transport of metalliferous ores[1]. The current Irish Action Level for Zn in sediments to be dredged is >410 mg/kg[2].

The levels of zinc in Samples 1 and 3 are well within expected background levels and of no biological concern.

The level of Zn in sediment at Station 2 (652 mg/kg) is above the expected background range for Irish waters and indicates some form of contamination. As this exceeds the Irish action level of 410 mg/kg, possible sources should be identified. Common sources of zinc in ports and navigation channels are sacrificial anodes on hulls, antifouling paints and galvanized objects and structures. Considering the much lower value recorded at the adjacent Station 3 (74.4 mg/kg), it is likely that the contamination at Station 2 is extremely localised and the amount of contaminated material to be dredged may be small; this can only be confirmed by further sampling.

Zinc is an essential element for many marine organisms and, as such, is readily bioaccumulated. According to Canadian sediment quality guidelines, sediment concentrations of zinc above 124 mg/kg can pose a hazard to sediment-dwelling organisms. A recent UK report[3] has suggested that levels <130 mg/kg should not be of concern while those >600 mg/kg (reduced from 800 mg/kg) are unsuitable for disposal at sea. Intermediate values warrant further investigation.

In my opinion, providing it can be confirmed that the quantity of sediment to be dredged from Station 2 is small (e.g. <500m^3), the risk to marine life from disposal at a dispersive site in the estuary would be minor.

RGVB
3.4.2018

[1] Marine Institute (1999). Ireland's Marine and Coastal areas and Adjacent Seas: an Environmental Assessment, 388p.

[2] Margot Cronin, Evin McGovern, Terry McMahon & Rick Boelens (2006). *Guidelines for the Assessment of Dredge Material for Disposal in Irish Waters.* Marine Institute, Marine Environment and Health Series, No. 24, 56pp.

[3] MMO (2015). *High Level Review of Current UK Action Level Guidance.* A report produced for the Marine Management Organisation, pp 73. MMO Project No: 1053.

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March 29th 2018

Comments on metal levels in sediment at a Shannon Estuary shipping terminal

This note is in reference to the environmental significance of the levels of iron (Fe) and titanium (Ti) in samples of sediment taken in proximity to a jetty used to unload commercial quantities of bauxite. Such samples are taken routinely prior to dredging operations.

The samples in question were collected on 14.12.2017 and designated as follows:

S1787793
S1787794
S1787795

To preface my remarks, it must be noted that the assessment of estuarine sediments representative of small (highly localised) areas is difficult without reference to the wider distribution of sediment types in the estuary. Grain sizes, organic fractions and salinities are particularly important in regulating concentrations of contaminants. Thus, with the data and time available an *in-depth* assessment of the samples is not presently possible.

IRON concentrations ranged from 30,000-35,000 mg/kg approximately.. Estuarine sediments tend to be rich in iron of geological origin and mean concentrations of 20,000 mg/kg or more are not uncommon, especially in and around salt marshes (UK Marine SAC Org.), without biological damage. In my opinion, dredging of the sediments at the sample site, and their disposal at a suitable dispersive site, should have little or no environmental consequence.

Titanium is present in most igneous rocks and in sediments derived from them. It has no known biological role and the human body can withstand large doses. No environmental effects have been reported. It is seldom routinely monitored and comparative data for sediments would be difficult to locate. In my opinion, the levels of titanium in the sediments in question (1300-2700 mg/kg approx.) are of no biological significance.

RGVB: 29.03.2018

Appendix 5
Additional Sampling for Zinc (April 2018)

The level of Zinc (Zn) in sediment at Station 2 (652 mg/kg) in December 2017 was above the expected background range for Irish waters and indicated some form of contamination. Additional sampling was carried out on the 4th April 2018 to determine how localised the elevated Zn levels were at Station 2 and to determine Zn levels at 4 additional sites within the wider Inner Berth Dredge Area (C).

All sampling and analysis followed the methodologies outlined in Section 2 of the main report.

Figure 1 shows the location of the 5 stations that were identified for Zn analysis within the Inner Berth Dredge Area. Station 2 corresponds with the Station 2 tat was sampled in December 2017. Table 1 shows the station coordinates. Samples were collected within 10m of the coordinates shown.

Figure 1. Stations sampled for Zn analysis on April 4th 2018.

Table 1. Station coordinates.

Station	Longitude	Latitude
S1	-9.0579	52.64494
S2	-9.05688	52.64505
S3	-9.05604	52.64505
S4	-9.05531	52.64507
S5	-9.05455	52.64509

The intention was to collect 5 separate samples for Zn analysis at Station 2 and 1 sample at each of the remaining 4 stations. However, due to the hard coarse nature of the sediments at Station 2 only 2 out of the intended 5 samples could be collected. No sample could be collected at Station 3 due to the hard coarse nature of the seabed. Sediments were collected at Stations 1, 4 and 5. Station 1 consisted of fines with some coarse gravel and Stations 4 and 5 were soft mud. The hard coarse nature of the seabed at Stations 2 and 3 is not surprising given the scouring effect of the vessels on the seabed when mooring alongside the pier.

Table 2 shows the Zn results from the 5 stations analysed (The lab report can be seen in Appendix 5-1.).

Table2. Zn results from Inner Berth Dredge Area C April 2018

Station	Lower Action Limit	Upper Action Limit	Zinc (mg/kg)
Aughinish S1	160 mg/kg	410 mg/kg	206
Aughinish S2			15.1
Aughinish S2(D)			19.5
Aughinish S4			77.2
Aughinish S5			150

Exceeds Lower Limit	Exceeds Upper Limit

The results from Station 1 exceeded the lower action limit only (206mg/kg). The results from Station 2 ranged from 15.1 to 19.5 mg/kg and were considerable lower than the 652mg/kg recorded in December 2017. Values from Stations 4 and 5 (77.2 - 150mg/kg) were higher than at Station 2 but still below the lower limit. The lowest values at Station 2 are not surprising given the hard coarse nature of the seabed. Contaminants have an affinity for fine sediments and the coarse hard nature of the seabed at Station 2 on this occasion explains the low values recoded here.

The results from this survey show no evidence of the previously high levels of Zn contamination at Station 2 or in the wider dredge area.

Appendix 5-1
SOCOTEC Laboratory Report
April 2018

Certificate of Analysis

Issuing Laboratory SOCOTEC, Marine Department, Specialist Chemistry, Etwall House, Bretby Business Park, Ashby Road, Bretby, Burton-upon-Trent DE15 0YZ

Test Report ID	MAR00024	
Issue Version	1	
Customer	Aquafact International Services Ltd, 12 Kilkerrin Park, Liosbaun, Tuam Rd, Galway, H91 FW7V	
Customer Reference	JN1461 Aughinish	
Date Sampled	04-Apr-18	
Date Received	09-Apr-18	
Date Reported	24-Apr-18	
Condition of samples	Cold	Satisfactory

M. Hubbard

Authorised by: Marya Hubbard

Position: Laboratory Manager

Any additional opinions or interpretations found in this report, are outside the scope of UKAS accreditation.

Certificate of Analysis

Issuing Laboratory SOCOTEC, Marine Department, Specialist Chemistry, Etwall House, Bretby Business Park, Ashby Road, Bretby, Burton-upon-Trent DE15 0YZ

SOCOTEC

Test Report ID	MAR00024
Issue Version	1
Customer Reference	JN1461 Aughinish

		Analyte	**Zinc**
		Accreditation	UKAS
		Method No	SOCOTEC Env Chem*
		Limit of Detection	1
		Units	mg/kg
Client Reference	**SOCOTEC Ref**	**Date Analysed**	N/A
Aughinish S2	MAR00024.001	**Sediment**	15.1
Aughinish S4	MAR00024.002	**Sediment**	77.2
Aughinish S1	MAR00024.003	**Sediment**	206
Aughinish S5	MAR00024.004	**Sediment**	150
Aughinish S2(D)	MAR00024.005	**Sediment**	19.5
CRM 2702			417
Reference Material (% Recovery)			100
QC Blank			<1

Certificate of Analysis

Issuing Laboratory SOCOTEC, Marine Department, Specialist Chemistry, Etwall House, Bretby Business Park, Ashby Road, Bretby, Burton-upon-Trent DE15 0YZ

SOCOTEC

Test Report ID	MAR00024
Issue Version	1
Customer Reference	JN1461 Aughinish

REPORT NOTES

Method Code	Sample ID	The following information should be taken into consideration when using the data contained within this report
SOCOTEC Env Chem*	MAR00024.001-005	Analysis was conducted by an internal SOCOTEC laboratory. UKAS accredited analysis by this laboratory is under UKAS number 1252.

DEVIATING SAMPLE STATEMENT

Devaiation Code	Devation Definition	Sample ID	Deviation Details. The following information should be taken into consideration when using the data contained within this report
D1	Holding Time Exceeded	N/A	N/A
D2	Handling Time Exceeded	N/A	N/A
D3	12/04/2018	N/A	N/A
D4	Sample Contaminated through Sampling	N/A	N/A
D5	Inappropriate Container/Packaging	N/A	N/A
D6	Damaged in Transit	N/A	N/A
D7	Insufficient Quantity of Sample	N/A	N/A
D8	Inappropriate Headspace	N/A	N/A
D9	Retained at Incorrect Temperature	N/A	N/A
D10	Lack of Date & Time of Sampling	N/A	N/A
D11	Insufficient Sample Details	N/A	N/A

Certificate of Analysis

Issuing Laboratory SOCOTEC, Marine Department, Specialist Chemistry, Etwall House, Bretby Business Park, Ashby Road, Bretby, Burton-upon-Trent DE15 0YZ

Test Report ID	MAR00024
Issue Version	1
Customer Reference	JN1461 Aughinish

Method	Sample and Fraction Size	Method Summary
ICPSED	Air Dried and Ground	Determination of total Metals in samples by Hydrofluoric and Boric Acid digestion followed by ICPOES

Appendix 8

Aughinish Sediment Analysis (Aquafact 2020)

Aughinish Sediment Analysis

Produced by

AQUAFACT International Services Ltd

On behalf of

Aughinish Alumina Ltd.

February 2020

AQUAFACT INTERNATIONAL SERVICES Ltd
12 KILKERRIN PARK, LIOSBAUN,
GALWAY
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Report Approval Sheet

Client	Aughinish Alumina Ltd.
Report Title	Aughinish Sediment Analysis
Job Number	JN1580
Report Status	Final
Issue Date	21/02/2020

Rev	Status	Issue Date	Document File Name	Author (s)	Approved by:
1	Final	21/02/20	JN1580 Aughinish Sediment Analysis	Kevin Mc Caffrey	Mark Costelloe

AQUAFACT

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1. Introduction

AQUAFACT International Services Ltd. was commissioned by the Aughinish Alumina Ltd. to carry out sediment analysis for heavy metals and total organic carbon (TOC) in the area surrounding the facility.

2. Materials & Methods

2.1. Sampling Procedure

On the 29th and 31st of January 2020, 23 sediment stations were sampled for chemical analysis. Sampling in the estuary near the Aughinish pier was carried out from a Shannon Work Boats vessel and samples were taken using a Van Veen grab (0.025m^2). The remaining samples were taken from the shore using a stainless steel trowel. At each station a 500ml plastic container was filled with sediment.

Figure 2.1 Sampling Points

Table 2.1: Coordinates for all sampling points.

Station	Longitude (WGS84)	Latitude (WGS84)
1	-9.0560	52.6338
2	-9.0491	52.6291
3	-9.0482	52.6253
4	-9.0471	52.6247
5	-9.0452	52.6240
6	-9.0534	52.6190
7	-9.0515	52.6183
8	-9.0497	52.6172
9	-9.0731	52.6063
10	-9.0744	52.6054
12	-9.0760	52.6082
13	-9.0776	52.6075
15	-9.0800	52.6108
16	-9.0810	52.6101
18	-9.0833	52.6151
19	-9.0855	52.6137
21	-9.0857	52.6188
23	-9.0899	52.6159
26	-9.0447	52.6451
27	-9.0603	52.6452
28	-9.0682	52.6452
29	-9.0759	52.6451
30	-9.0813	52.6372

2.2. Sample Processing

Once back in the lab, all sediment samples for the analysis of organics and heavy metals were sent to the SOCOTEC Laboritories in Burton on Trent.

3. Results

The results from all stations sampled can be seen in Table 3.1 below. See Appendix 1 for full SOCOTEC report

Table 3.1: Results of Heavy metal and TOC analysis.

Station	Arsenic	Cadmium	Chromium	Copper	Lead	Nickel	Zinc	Aluminium	Lithium	Mercury	Total Organic Carbon
Units	mg/Kg	mg/Kg	mg/Kg	mg/Kg	mg/Kg	mg/Kg	mg/Kg	mg/Kg	mg/Kg	mg/Kg	mg/Kg
S1	15.1	1.0	34.9	10.9	22.4	19.4	85.8	31600	25.4	0.07	1.28
S2	14.2	1.1	49.8	10.4	25.8	27.0	95.2	43100	35.7	0.07	1.82
S3	15.5	1.2	40.4	37.3	21.6	22.0	73.0	34000	29.2	0.05	1.35
S4	16.9	1.0	48.6	11.5	24.1	25.9	86.6	41500	34.8	0.04	1.69
S5	16.2	1.9	57.1	15.7	29.2	49.4	108.1	63300	41.5	0.09	8.20
S6	16.6	1.3	55.7	8.9	35.4	29.8	94.9	45500	37.9	0.05	2.28
S7	15.9	1.1	44.6	10.0	24.1	24.0	83.3	36100	29.4	0.02	1.62
S8	13.2	2.0	18.7	12.4	29.5	16.9	122	18100	16.1	0.10	>25.0
S9	17.3	1.1	39.8	10.4	16.6	21.4	62.9	33400	26.6	0.02	1.03
S10	15.0	0.9	50.8	10.6	29.3	27.1	86.4	43000	37.1	0.03	1.54
S12	22.4	1.2	47.1	10.2	24.6	23.9	75.3	38600	31.3	0.03	1.43
S13	16.3	1.4	48.4	10.9	22.7	26.2	81.4	39200	33.3	0.03	1.91
S15	18.4	1.4	40.3	8.2	18.9	21.0	64.9	32100	26.7	0.02	1.00

Station	Arsenic	Cadmium	Chromium	Copper	Lead	Nickel	Zinc	Aluminium	Lithium	Mercury	Total Organic Carbon
S16	21.5	1.7	52.8	11.1	25.7	27.2	195	42700	35.6	0.04	2.14
S18	20.1	1.3	47.9	6.8	23.1	25.0	85.3	38300	32.3	0.04	2.00
S19	18.0	2.1	38.4	8.6	15.9	20.1	60.9	31800	25.8	0.03	0.97
S21	17.5	1.7	31.3	7.4	13.1	16.8	54.3	26100	22.0	0.02	0.91
S23	18.2	1.9	41.4	9.7	17.7	21.9	68.8	32400	25.6	0.02	1.24
S26	16.5	1.3	44.9	9.6	20.4	24	76.6	36800	28.8	0.03	1.54
S27	9.9	0.6	36.0	9.6	17.1	19.6	65.7	27900	25.3	0.04	1.07
S28	11.0	0.5	31.5	8.1	15.0	16.4	55.1	25400	23.6	0.03	0.89
S29	12.6	0.5	33.2	8.5	16.9	17.4	60.9	26300	24.3	0.02	1.01
S30	16.3	<0.1	15.2	4.9	14.4	9.0	40.6	11800	12.2	0.01	0.46

Appendix 1
SOCOTEC Report

Certificate of Analysis

Issuing Laboratory SOCOTEC, Marine Department, Specialist Chemistry, Etwall House, Bretby Business Park, Ashby Road, Bretby, Burton-upon-Trent DE15 0YZ

SOCOTEC

Test Report ID	MAR00568
Issue Version	1
Customer	Aquafact International Services Ltd, 12 Kilkerrin Park, Liosbaun, Tuam Rd, Galway, H91 FW7V
Customer Reference	Aughinish Sediments
Date Sampled	28-30-Jan-20
Date Received	04-Feb-20
Date Reported	18-Feb-20
Condition of samples	Cold Satisfactory

Authorised by: Marya Hubbard

Position: Laboratory Manager

Any additional opinions or interpretations found in this report, are outside the scope of UKAS accreditation.

Certificate of Analysis

Issuing Laboratory SOCOTEC, Marine Department, Specialist Chemistry, Etwall House, Bretby Business Park, Ashby Road, Bretby, Burton-upon-Trent DE15 0YZ

SOCOTEC

Test Report ID MAR00568
Issue Version 1
Customer Reference Aughinish Sediments

		Units	mg/Kg (Dry Weight)	mg/Kg (Dry Weight)	mg/Kg (Dry Weight)	mg/Kg (Dry Weight)	mg/Kg (Dry Weight)	mg/Kg (Dry Weight)	mg/Kg (Dry Weight)
		Method No	SOCOTEC Env Chem*	SOCOTEC Env Chem*	SOCOTEC Env Chem*	SOCOTEC Env Chem*	SOCOTEC Env Chem*	SOCOTEC Env Chem*	SOCOTEC Env Chem*
		Limit of Detection	1	0.1	0.5	2	2	0.5	3
		Accreditation	UKAS	N	N	UKAS	UKAS	N	N
Client Reference:	**SOCOTEC Ref:**	**Matrix**	**Arsenic (HF-MS)**	**Cadmium (HF-MS)**	**Chromium (HF-MS)**	**Copper (HF-MS)**	**Lead (HF-MS)**	**Nickel (HF-MS)**	**Zinc (HF-MS)**
S1	MAR00568.001	Sediment	15.1	1.0	34.9	10.9	22.4	19.4	85.8
S2	MAR00568.002	Sediment	14.2	1.1	49.8	10.4	25.8	27.0	95.2
S3	MAR00568.003	Sediment	15.5	1.2	40.4	37.3	21.6	22.0	73.0
S4	MAR00568.004	Sediment	16.9	1.0	48.6	11.5	24.1	25.9	86.6
S5	MAR00568.005	Sediment	16.2	1.9	57.1	15.7	29.2	49.4	108.1
S6	MAR00568.006	Sediment	16.6	1.3	55.7	8.9	35.4	29.8	94.9
S7	MAR00568.007	Sediment	15.9	1.1	44.6	10.0	24.1	24.0	83.3
S8	MAR00568.008	Sediment	13.2	2.0	18.7	12.4	29.5	16.9	122
S9	MAR00568.009	Sediment	17.3	1.1	39.8	10.4	16.6	21.4	62.9
S10	MAR00568.010	Sediment	15.0	0.9	50.8	10.6	29.3	27.1	86.4
S12	MAR00568.011	Sediment	22.4	1.2	47.1	10.2	24.6	23.9	75.3
S13	MAR00568.012	Sediment	16.3	1.4	48.4	10.9	22.7	26.2	81.4
S15	MAR00568.013	Sediment	18.4	1.4	40.3	8.2	18.9	21.0	64.9
S16	MAR00568.014	Sediment	21.5	1.7	52.8	11.1	25.7	27.2	195
S18	MAR00568.015	Sediment	20.1	1.3	47.9	6.8	23.1	25.0	85.3
S19	MAR00568.016	Sediment	18.0	2.1	38.4	8.6	15.9	20.1	60.9
S21	MAR00568.017	Sediment	17.5	1.7	31.3	7.4	13.1	16.8	54.3
S23	MAR00568.018	Sediment	18.2	1.9	41.4	9.7	17.7	21.9	68.8
S26	MAR00568.019	Sediment	16.5	1.3	44.9	9.6	20.4	24	76.6
Certified Reference Material 2702 (% Recovery)			103	101~	97~	101	97	98~	99~
QC Blank			<1	<0.1	<0.5	<2	<2	<0.5	<3

* See Report Notes
~ Indicates result is for an In-house Reference Material as
no Certified Reference Materials are avaliable.

Certificate of Analysis

Issuing Laboratory SOCOTEC, Marine Department, Specialist Chemistry, Etwall House, Bretby Business Park, Ashby Road, Bretby, Burton-upon-Trent DE15 0YZ

SOCOTEC

Test Report ID	MAR00568
Issue Version	1
Customer Reference	Aughinish Sediments

		Units	mg/Kg (Dry Weight)	mg/Kg (Dry Weight)	mg/Kg (Dry Weight)	mg/Kg (Dry Weight)
		Method No	SOCOTEC Env Chem*	SOCOTEC Env Chem*	SOCOTEC Env Chem*	SOCOTEC Env Chem*
		Limit of Detection	10	0.5	0.01	0.02
		Accreditation	UKAS	N	N	UKAS
Client Reference:	**SOCOTEC Ref:**	**Matrix**	**Aluminium(HF-OES)**	**Lithium(HF-OES)**	**Mercury (Tot.MS)**	**Total Organic Carbon**
S1	MAR00568.001	Sediment	31600	25.4	0.07	1.28
S2	MAR00568.002	Sediment	43100	35.7	0.07	1.82
S3	MAR00568.003	Sediment	34000	29.2	0.05	1.35
S4	MAR00568.004	Sediment	41500	34.8	0.04	1.69
S5	MAR00568.005	Sediment	63300	41.5	0.09	8.20
S6	MAR00568.006	Sediment	45500	37.9	0.05	2.28
S7	MAR00568.007	Sediment	36100	29.4	0.02	1.62
S8	MAR00568.008	Sediment	18100	16.1	0.10	>25.0
S9	MAR00568.009	Sediment	33400	26.6	0.02	1.03
S10	MAR00568.010	Sediment	43000	37.1	0.03	1.54
S12	MAR00568.011	Sediment	38600	31.3	0.03	1.43
S13	MAR00568.012	Sediment	39200	33.3	0.03	1.91
S15	MAR00568.013	Sediment	32100	26.7	0.02	1.00
S16	MAR00568.014	Sediment	42700	35.6	0.04	2.14
S18	MAR00568.015	Sediment	38300	32.3	0.04	2.00
S19	MAR00568.016	Sediment	31800	25.8	0.03	0.97
S21	MAR00568.017	Sediment	26100	22.0	0.02	0.91
S23	MAR00568.018	Sediment	32400	25.6	0.02	1.24
S26	MAR00568.019	Sediment	36800	28.8	0.03	1.54
Certified Reference Material 2702 (% Recovery)			108	123	101~	101~
QC Blank			<10	<0.5	<0.01	<0.02

* See Report Notes

~ Indicates result is for an In-house Reference Material as no Certified Reference Materials are avaliable.

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SOCOTEC

Test Report ID	MAR00568
Issue Version	1
Customer Reference	Aughinish Sediments

		Units	mg/Kg (Dry Weight)	mg/Kg (Dry Weight)	mg/Kg (Dry Weight)	mg/Kg (Dry Weight)	mg/Kg (Dry Weight)	mg/Kg (Dry Weight)	mg/Kg (Dry Weight)
		Method No	SOCOTEC Env Chem*	SOCOTEC Env Chem*	SOCOTEC Env Chem*	SOCOTEC Env Chem*	SOCOTEC Env Chem*	SOCOTEC Env Chem*	SOCOTEC Env Chem*
		Limit of Detection	1	0.1	0.5	2	2	0.5	3
		Accreditation	UKAS	N	N	UKAS	UKAS	N	N
Client Reference:	**SOCOTEC Ref:**	**Matrix**	**Arsenic (HF-MS)**	**Cadmium (HF-MS)**	**Chromium (HF-MS)**	**Copper (HF-MS)**	**Lead (HF-MS)**	**Nickel (HF-MS)**	**Zinc (HF-MS)**
S27	MAR00568.020	Sediment	9.9	0.6	36.0	9.6	17.1	19.6	65.7
S28	MAR00568.021	Sediment	11.0	0.5	31.5	8.1	15.0	16.4	55.1
S29	MAR00568.022	Sediment	12.6	0.5	33.2	8.5	16.9	17.4	60.9
S30	MAR00568.023	Sediment	16.3	<0.1	15.2	4.9	14.4	9.0	40.6
Certified Reference Material 2702 (% Recovery)			98	101~	97~	102	96	98~	99~
QC Blank			<1	<0.1	<0.5	<2	<2	<0.5	<3

* See Report Notes

~ Indicates result is for an In-house Reference Material as no Certified Reference Materials are avaliable.

Certificate of Analysis

Issuing Laboratory SOCOTEC, Marine Department, Specialist Chemistry, Etwall House, Bretby Business Park, Ashby Road, Bretby, Burton-upon-Trent DE15 0YZ

SOCOTEC

Test Report ID	MAR00568
Issue Version	1
Customer Reference	Aughinish Sediments

		Units	mg/Kg (Dry Weight)	mg/Kg (Dry Weight)	mg/Kg (Dry Weight)	mg/Kg (Dry Weight)
		Method No	SOCOTEC Env Chem*	SOCOTEC Env Chem*	SOCOTEC Env Chem*	SOCOTEC Env Chem*
		Limit of Detection	10	0.5	0.01	0.02
		Accreditation	UKAS	N	N	UKAS
Client Reference:	**SOCOTEC Ref:**	**Matrix**	**Aluminium(HF-OES)**	**Lithium(HF-OES)**	**Mercury (Tot.MS)**	**Total Organic Carbon**
S27	MAR00568.020	Sediment	27900	25.3	0.04	1.07
S28	MAR00568.021	Sediment	25400	23.6	0.03	0.89
S29	MAR00568.022	Sediment	26300	24.3	0.02	1.01
S30	MAR00568.023	Sediment	11800	12.2	0.01	0.46
Certified Reference Material 2702 (% Recovery)			109	145	102~	96~
QC Blank			<10	<0.5	<0.01	<0.02

* See Report Notes

~ Indicates result is for an In-house Reference Material as no Certified Reference Materials are avaliable.

Certificate of Analysis

Issuing Laboratory SOCOTEC, Marine Department, Specialist Chemistry, Etwall House, Bretby Business Park, Ashby Road, Bretby, Burton-upon-Trent DE15 0YZ

SOCOTEC

Test Report ID	MAR00568
Issue Version	1
Customer Reference	Aughinish Sediments

REPORT NOTES

Method Code	Sample ID	The following information should be taken into consideration when using the data contained within this report
SOCOTEC Env Chem*	MAR00586.001-023	Analysis was conducted by an internal SOCOTEC laboratory. UKAS accredited analysis by this laboratory is under UKAS number 1252.

DEVIATING SAMPLE STATEMENT

Deviation Code	Deviation Definition	Sample ID	Deviation Details. The following information should be taken into consideration when using the data contained within this report
D1	Holding Time Exceeded	N/A	N/A
D2	Handling Time Exceeded	N/A	N/A
D3	Sample Contaminated through Damaged Packaging	N/A	N/A
D4	Sample Contaminated through Sampling	N/A	N/A
D5	Inappropriate Container/Packaging	N/A	N/A
D6	Damaged in Transit	N/A	N/A
D7	Insufficient Quantity of Sample	N/A	N/A
D8	Inappropriate Headspace	N/A	N/A
D9	Retained at Incorrect Temperature	N/A	N/A
D10	Lack of Date & Time of Sampling	N/A	N/A
D11	Insufficient Sample Details	N/A	N/A
D12	Sample integrity compromised or not suitable for analysis	N/A	N/A

Certificate of Analysis

Issuing Laboratory SOCOTEC, Marine Department, Specialist Chemistry, Etwall House, Bretby Business Park, Ashby Road, Bretby, Burton-upon-Trent DE15 0YZ

Test Report ID	MAR00568
Issue Version	1
Customer Reference	Aughinish Sediments

Method	Sample and Fraction Size	Method Summary
Metals	Air dried and ground	HF/Boric acid extraction followed by ICP analysis.
Total Organic Carbon (TOC)	Air dried and ground	Carbonate removal and sulphurous acid/combustion at 1600°C/NDIR.

Appendix 9

Ambient Light Survey at Aughinish Alumina (PM Group 2020)

Aughinish Alumina Light Survey

Aughinish Alumina Ltd
IE0310294-44-RP-0001, Issue: C

Issue date: 27 Mar 2020

Document Sign Off

Aughinish Alumina Light Survey

Aughinish Alumina Ltd
IE0310294-44-RP-0001, Issue C

File No:IE0310294.44.010

CURRENT ISSUE					
Issue No: C	Date: 27 Mar 2020	Reason for issue: Information			
Sign Off	Originator	Checker	Reviewer	Approver	Customer Approval (if required)
Print Name	Stephen Byrne	MARTIN.MCQUADE		ORLA.DUGGAN	
Signature	Authorised Electronically				
Date	27/03/2020	27 Mar 2020		27 Mar 2020	

PREVIOUS ISSUES							
Issue No	Date	Originator	Checker	Reviewer	Approver	Customer	Reason for issue
A	04/03/2020	Stephen Byrne	Martin Mcquade		Orla Duggan	AAL	Information
B	24/03/2020	Stephen Byrne	Martin Mcquade		Orla Duggan	AAL	Information

Contents

1 Introduction

1.1 General

In order to inform a Natura Impact Statement, Aughinish Alumina Ltd. (AAL) has requested that PM Group undertake a lux level survey at specified locations throughout the facility, in close proximity to designated sites.

A total number of 45 points were surveyed, over the duration of two nights. 18 No. points were measured within the operational plant and 27 No. points were measured around the site perimeter, including 2 No. points on the jetty.

The Lux levels were measured using a calibrated Hagner EC1 Lux Meter. Please refer to the calibration certificate for this lux meter, which can be found in Attachment 1.

This revision of the document (Issue C) has been issued to address a clerical error in Table 1, at line items 12, 41 and 44.

2 Light Survey

The light survey was performed over two nights, Wednesday 26th February and Thursday 27th February 2020. All measurements were taken during the hours of darkness. The weather conditions consisted of high-clouds and light rain on Wednesday 26th February and clear skies with scattered high clouds on Thursday 27th February.

The light survey consisted of conducting lux level measurements at specified locations. The points at which the lux level readings were recorded are shown in Appendix A of this document.

The lux levels were measured at a height of 1.2m above ground level, and where applicable, the lux levels were recorded in between light sources i.e. street lighting and/or facility lighting.

Global Positioning System (GPS) co-ordinates were also recorded at each location. The measured lux levels and their associated GPS co-ordinates are presented in Table 1.

3 Light Survey Results – Point Values

Table 1: Illuminance Levels Results and Corresponding GPS Co-Ordinates

Measurement Point Reference	Lux Levels	Latitude	Longitude
No.1	28 lx	52.62596	-9.06032
No.2	15 lx	52.62596	-9.05828
No.3	9 lx	52.62616	-9.05529
No.4	6 lx	52.62833	-9.05604
No.5	20 lx	52.63054	-9.05704
No.6	5 lx	52.62718	-9.05876
No.7	7 lx	52.63013	-9.05970
No.8	1 lx	52.63143	-9.05079
No.9	7 lx	52.63261	-9.06076
No.10	7 lx	52.63583	-9.06032
No.11	11 lx	52.64102	-9.05980
No.12	32 lx	52.64531	-9.05952
No.13	0.2 lx	52.63617	-9.06458
No.14	0 lx	52.63291	-9.06423
No.15	0 lx	52.63009	-9.06365
No.16	0.2 lx	52.62654	-9.06345
No.17	0.1 lx	52.62332	-9.06258
No.18	7 lx	52.62159	-9.06643
No.19	0 lx	52.62055	-9.07188
No.20	0 lx	52.61950	-9.07723
No.21	0 lx	52.61915	-9.08482
No.22	0 lx	52.61915	-9.08482
No.23	0.1 lx	52.61689	-9.08212
No.24	0.1 lx	52.61414	-9.08111
No.25	0.1 lx	52.61107	-9.07797
No.26	0.2 lx	52.60859	-9.07527
No.27	0.2 lx	52.60665	-9.07138
No.28	0.3 lx	52.60513	-9.06668
No.29	0.6 lx	52.60510	-9.06162
No.30	1.2 lx	52.60844	-9.05999
No.31	0.9 lx	52.61120	-9.05993

Measurement Point Reference	Lux Levels	Latitude	Longitude
No.32	0.2 lx	52.61361	-9.06401
No.33	0.5 lx	52.61643	-9.06361
No.34	0.6 lx	52.62009	-9.06362
No.35	0.1 lx	52.61325	-9.05999
No.36	0 lx	52.61601	-9.05888
No.37	0 lx	52.61856	-9.05583
No.38	0.1 lx	52.62091	-9.05154
No 39	0 lx	52.62416	-9.04965
No.40	0.1 lx	52.63047	-9.05049
No.41	0.2 lx	52.62708	-9.04969
No.42	8 lx	52.62712	-9.05318
No.43	4 lx	52.62952	-9.05417
No.44	0.4 lx	52.63296	-9.05503
No.45	0.5 lx	52.63550	-9.05838

Appendix A
Light Survey Results - Locations

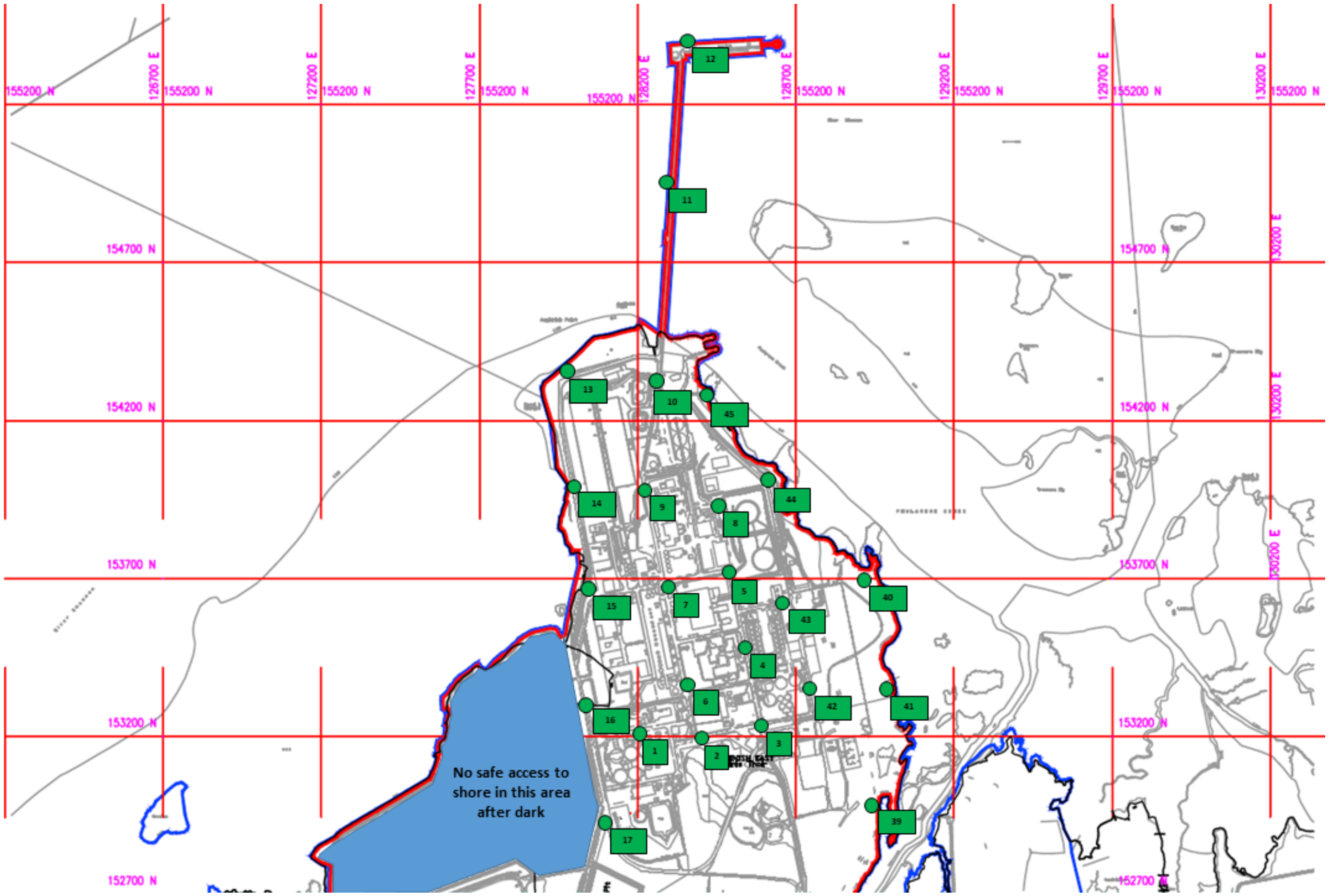

Figure 1: Measurement Locations at AAL Site - North

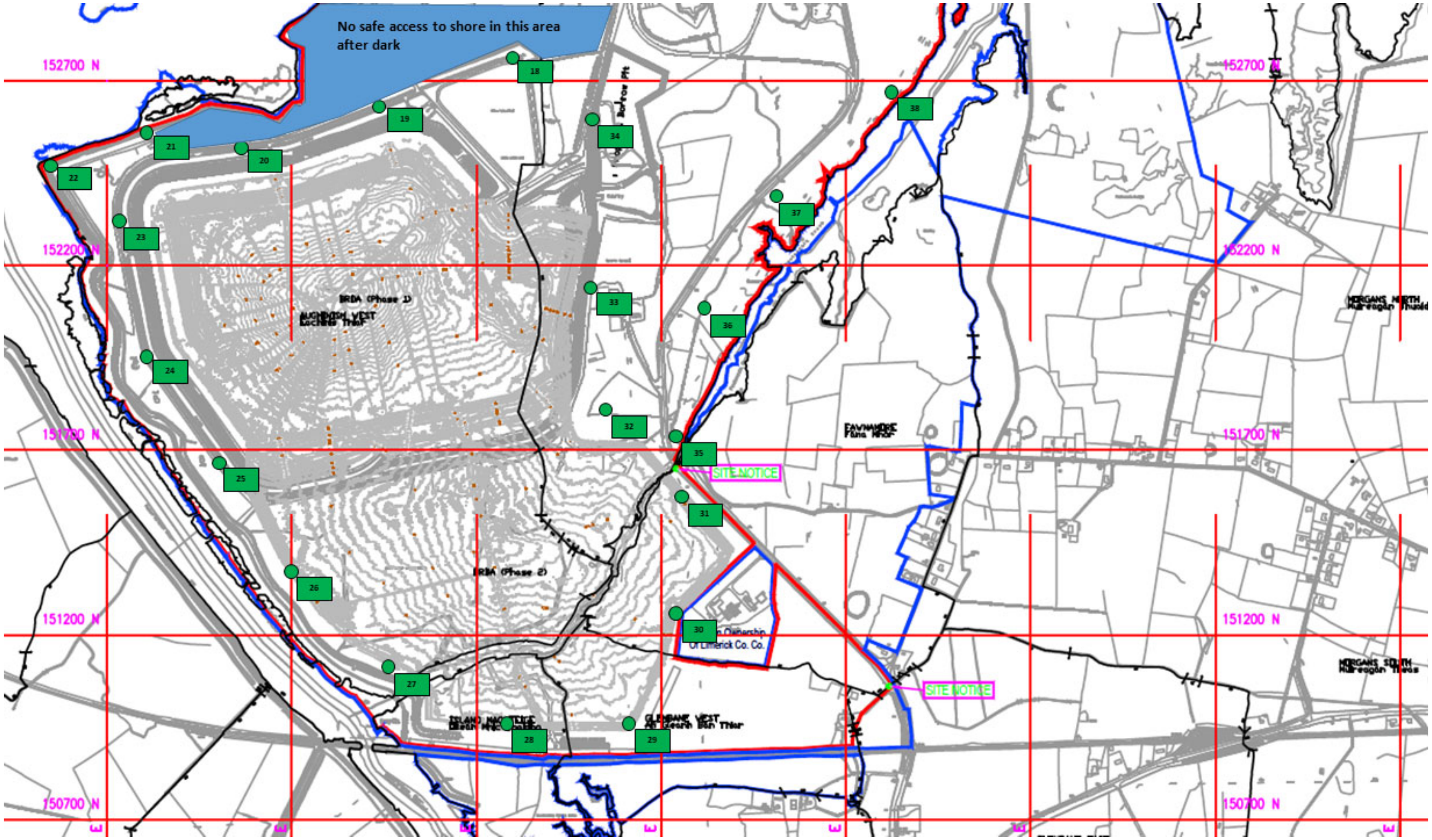

Figure 2: Measurement Locations at AAL – South

Attachment 1
Lux Meter Calibration Certificate

B. Hagner AB

BOX 2256
SE-169 02 SOLNA
SWEDEN

Vistors address: Lövgatan 58, Solna

TELEPHONE: 08-83 61 50
FAX: 08-83 93 57
E-MAIL: hagner@hagner.se
INTERNET: www.hagner.se
BANKGIRO: 838-1618
BANK: Skandinaviska Enskilda Banken

Calibration Certificate

for Hagner digital luxmeter EC1 No.56800

We hereby certify that the above instrument has been calibrated in our laboratory in Solna, Sweden at the date given below. The instrument has been calibrated against "Standard light A". References used are MTt9F006158-K02, traceable to RISE Research Institutes of Sweden, and secondary reference 52132. Calibration accuracy ± 3%.

Solna 2019-11-07
B Hagner AB

Elie Bouyaji

Elie Bouyaji

Appendix B

Conceptual Site Model (CSM)

Aughinish Alumina

Conceptual Site Model

BRDA Waste Facility

80946

NOVEMBER 2021

RSK GENERAL NOTES

Project No.: 80946

Title: Conceptual Site Model

Client: Aughinish Alumina

Date: 26th November 2021

Office: Helsby

Status: Final

Author	Andrew Bendell	**Technical reviewer**	David Watson
Signature		Signature	
Date:	26.11.2021	Date:	26.11.2021

RSK Environment Ltd (RSK) has prepared this report for the sole use of the client, showing reasonable skill and care, for the intended purposes as stated in the agreement under which this work was completed. The report may not be relied upon by any other party without the express agreement of the client and RSK. No other warranty, expressed or implied, is made as to the professional advice included in this report.

Where any data supplied by the client or from other sources have been used, it has been assumed that the information is correct. No responsibility can be accepted by RSK for inaccuracies in the data supplied by any other party. The conclusions and recommendations in this report are based on the assumption that all relevant information has been supplied by those bodies from whom it was requested.

No part of this report may be copied or duplicated without the express permission of RSK and the party for whom it was prepared.

Where field investigations have been carried out, these have been restricted to a level of detail required to achieve the stated objectives of the work.

This work has been undertaken in accordance with the quality management system of RSK Environment Ltd.

Abbreviations & Definitions

Abbreviation	Definition
CSM	Conceptual Site Model
IEH	Institute of Environmental Health
S-P-R	Source-pathway-receptor
UKEA	Contaminated Land Act for Assessing Ecological Risk
EPA	Environmental Protection Agency
CLR	Contaminated Land Report
EU	European Union
GAC	Generic Assessment Critera
QRA	Quantitative Risk Assessment
WWTP	Waste Water Treatment Plant

CONTENTS

FIGURES

TABLES

1 INTRODUCTION

1.1 Background

Aughinish Alumina plans to increase the lifetime of their operations at Aughinish by expanding the capacity of the BRDA waste facility. As part of their preparations for the expansion, Aughinish made a request to RSK Environment Ltd to provide a conceptual site model (CSM) for their site, identifying potential pathways for pollutants to enter the environment from their current operations. RSK engaged the assistance of the Institute of Environmental Health (IEH) to produce the CSM.

This report provides the CSM, including an explanation of the theory used in producing this type of model, and the various sources and pathways for pollutants which have been investigated for the Aughinish site. For each source and/or pathway, discussion and explanation is provided regarding the possibility and reality that pollutants may/ may not be entering the environment.

1.2 Theoretical considerations - Using a conceptual model

The conceptual model looks at the source(s), pathways and receptors for input into the environment from all sources. It should consider the source, i.e., where the pollution can come from. The next step is to think about how the pollution can travel through the environment - the pathway. This should be as comprehensive as possible and not just the obvious pathways of air, land and water, there are many more such as dispersal by animals and people. Finally, it should consider the receptor of the pollution, who or what could be affected, these being environmental receptor(s), the protected habitat etc. When using this model, it should be considered that for each source that there are usually multiple pathways and receptors. In addition, some receptors may eventually act as additional pathways so the chain can continue past a basic source, pathway, receptor model**.**

1.3 Applying the model

This model is used ultimately to implement controls or mitigation practices. The best place to put controls in place is at the source, if the contribution can be reduced in anyway? Assuming that source itself cannot be controlled is there any control that could be placed on for example, how to intercept the pollutant from reaching the environment and travelling through the pathway to the receptor. If everything has been done to stop the pollutant from entering the environment, the receptors can be considered. This approach can be used to consider the possible receptors, having identified the primary source for example of those pollutants likely to impact on overall water quality.

If it is known where pollution can go and what it can affect, measures can be put into place to prevent the pollutant from getting into the pathways identified and/ or to protect the receptors. Using this principle in reverse may also help to assist in identifying where the pollution may have originated from and help polluters identify the necessary steps to remediate.

Overall, the source, pathway, receptor model can be used when assessing environmental risk and controls to maximise environmental performance.

2 AUGHINISH ALUMINA CONCEPTUAL SITE MODEL

2.1 Identification and mapping of potential pathways of release to the environment

The conceptual site model (CSM) considers all the major priority pathways for entry of potential contaminant sources from the manufacturing site (and all associated activities) into the environment from the point of manufacturing to point of likely impact. We have used risk-based methodologies to consider the source-pathway-receptor (S-P-R) model for deriving a system CSM for assessing likely pathways and subsequently quantifying priority pathways (corridors or routes) through which pollutants or chemicals of concern may enter the environment from industrial activities, and the potential impacts on environmental health. We know that pollutants can enter the environment through numerous routes (pathways), with common points of entry into the environment being via licensed emissions points and fugitive emissions. Different entry routes to the environment may occur via accidental or improper disposal of waste.

2.2 Source – Pathway – Receptor(s)

The principle of risk assessment starts with an understanding of the likely hazard that the particular substance of concern poses to the end receptors of interest – in the Aughinish case we are interested in the impacts or effects of the manufacturing process on levels of pollutants in the immediate environment and their subsequent impact on environmental health. To understand this, we must consider all the likely sources of a particular contaminant at the site (the specific sources), the pathways through which they may travel (including sinks and reservoirs) and the ultimate linkages to any end receptors, ideally in a quantified manner. Although such models are largely qualitative. The pathways can typically be mapped qualitatively and then the significance of each can be determined through the collation of evidence. This process contributes understanding of the levels of risk likely to be driven or encountered by a particular pathway to the receptor of interest or concern. In this study, the actual substance that is the hazard - is any product that may be entering the environment in either a controlled or fugitive manner.

2.3 Pollutant linkages

The determination of the impacts of the sources can be mapped by using the concept of pollutant linkages in which a contaminant (in the case of Aughiunish, heavy metals are being considered) and a receptor are linked by means of a pathway. The three essential elements to defining the likely risk or significance of a pathway are defined by:

- The contaminant - a substance that is released to the environment which has the potential to cause harm or pollute the receiving environment;
- A receptor - in general terms, something that could be adversely affected by a contaminant; in our case, an ecological system such as a benthic marine system;
- The pathway - a route or means by which a receptor can be exposed to, or affected by, the source.

Each of these elements can exist independently; they create a risk only where they are linked together so that a particular contaminant affects a particular receptor through a particular pathway. This combination of contaminant-pathway-receptor is described as an S-P-R pollutant linkage. At any individual site there may be a single pollutant linkage or many, and each will need to be identified and assessed independently of others to assess the level of risk. Within the context of this work, it must first be established that a contaminant pathway and receptor are present and constitute a significant pollutant linkage before identifying a site as contributing to any environmental burden of heavy metals. On the basis that it is likely that significant harm is being caused to an end receptor as a consequence of the exposure pathway being realised, it also holds true that without a pollutant linkage there is limited risk, even if a source of contamination is present.

2.4 Risk Assessment

During the risk assessment, we should determine whether a particular practice or exposure pathway appears to provide a likely or significant link (or corridor) to an actual receptor (ecosystem) within the S-P-R model (in accordance with the definitions above). It is a structured decision-making approach that when adopted in circumstances where there is uncertainty, enables different pathways to be evaluated and ranked in order to prioritise particular hazards. This also then offers the opportunity to suggest critical points for control, or indeed understand which potential pathways should/ could be interrupted.

Risk assessment distinguishes between the concepts of hazard and risk as follows:

- Hazard is an attribute or situation that in particular circumstances could lead to harm, and;
- Risk is a combination of the probability, or frequency, of occurrence of a defined hazard and the magnitude of the consequences of the occurrence (i.e., how likely is the hazard, and how bad would it be if the pathway was realised).

Particular features of a risk assessment include the need for formulation and development of a conceptual model for a site or a situation which supports the identification and assessment of particular or specific pollutant linkages. A conceptual model represents the characteristics of the site in diagrammatical or written form and shows the possible relationships between the source contaminants, pathways and receptors. The risk assessment process can be a highly detailed process and the approach can fit within a tiered hierarchical assessment structure. Generally, an increasing level of detail is required for a specific site when progressing through the risk assessment tiers.

The process can be exited partway through; this may arise, for example, when enough is known about the potential risk to complete the process or move to a higher tier of a framework that requires more data. That said, there is an established risk assessment process as used under Part IIA of the contaminated land act for assessing ecological risk (UKEA)[1], however, there is currently no specific policy in Ireland and therefore no similar legislation in place. The process, however, follows a prescriptive hierarchical risk-based approach that is equally applicable to the assessment of habitats under control of other

[1] An ecological risk assessment framework for contaminants in soil. Science Report – SC070009/SR1. UK Environment Agency, 2008

regulatory frameworks such as by way of example, the Habitats Directive. The Environmental Protection Agency (EPA) has produced similar guidance on the management of contaminated land and risks to groundwater using a risk-based assessment of known or suspected contamination under the Environmental Liability Regulations[2]. The risk-based process adopted here enables decision making to take place and facilitates regulatory acceptance of any proposed decisions to be agreed. This approach is broadly in line with the EPA's Code of Practice (Environmental Risk Assessment for Unregulated Waste Disposal Sites (2007[3])).

The risk assessment methodology follows a staged (tiered) approach, designed to ensure that key elements are addressed in succession and when or only as needed. The first stage is site characterisation and assessment resulting in the development of a conceptual site model; the CSM. This critical element of the methodology underpins the whole process through the establishment and use of a Conceptual Site Model (CSM) and is produced at Step 1– Preliminary Site Assessment which is then updated, based on additional information and data, throughout the whole process. (Further guidance on the development and use of CSMs is provided in Chapter 3 of the COP (EPA, 2007).

As documented previously, the CSM describes the potential sources of contamination at a site, the migration pathways it may follow and the receptors it could impact upon. If a complete source–pathway–receptor scenarios exist then there is a potential pollutant linkage that needs to be characterised and assessed (via a formal risk assessment). The Habitats Directive is equally applicable as a regulatory driver (Council Directive 92/43/EEC)[4] designed to protect and conserve natural habitats and wild fauna and flora and to promote the maintenance of biodiversity, taking account of economic, social, cultural and regional requirements. It forms the cornerstone of Europe's nature conservation policy alongside the Birds Directive and establishes the EU wide Natura 2000 ecological network of protected areas, safeguarded against potentially damaging developments.

Typically, a preliminary risk assessment is undertaken at the start of the process - this develops an initial conceptual model of the site and attempts to establish whether or not there are potentially unacceptable risks and what further action(s), if any, is appropriate. A generic quantitative risk assessment then establishes whether generic assessment criteria (GAC) and assumptions are appropriate for assessing the risks and, if so, to apply those to establish whether there are actual or potential unacceptable risks. GAC criteria derived using largely generic assumptions about the characteristics and behaviour of sources, pathways and receptors have been established for a range of contaminant scenarios. Most risk assumptions are conservative and fit a limited yet defined range of conditions. The process also determines whether further, more detailed, risk assessment is required. A detailed quantitative risk assessment (QRA) may be undertaken to establish and use more detailed site-specific information to set criteria or to decide whether there are any unacceptable risks. Traditionally, for other risk scenarios, such an approach has been the sole method for the quantitative assessment of risks, or it may be used to refine early assessments using generic assessment criteria.

[2] Environmental Liability Regulations Guidance Document, Environmental Protection Agency 2011

[3] CODE OF PRACTICE Environmental Risk Assessment for Unregulated Waste Disposal Sites, Environmental Protection Agency 2007 (ISBN 1-84095-226-1)

[4] Council Directive 92/43/EEC on the Conservation of natural habitats and of wild fauna and flora

The standardised risk assessment methodology as described above applies to any hazard evaluation in terms of addressing the level of risk posed by a particular contaminant. In the current situation, the hazard – i.e., the possible occurrence of chemicals in waste streams that may be emitted to the environment is assessed in terms of pathways being realised to environmental receptors. Once pathways are identified then risk mitigation may be possible to reduce further the enhancement of impacts (or harm if occurring) through, for example, the development of a detailed site-specific risk assessment which may set values for concentrations of chemicals above which there is an unacceptable risk to the wider environment.

The risk framework does not anticipate that many scenarios will progress through all the tiers of the risk assessment. It is quite likely, as in this case, that the potential pathways can be identified, mapped and considered as to the likelihood that they may realise a pollution link to a defined receptor. If that were the case, then next steps might include the generation of further information to complete an empirical risk assessment if warranted as directed by the outcomes of the CSM. Other options may need to be considered if a potential risk was identified or determined to be unacceptable. It may be, as is the case in this instance, that no unacceptable risk(s) has been identified. Therefore, the risk assessor can exit from the tiered process at the soonest stage (not progressing beyond the CSM, or Tier 1) as deemed appropriate. If that were not to be the case, the assessor would work though the higher tiers to gather more data to support next actions. Future consideration for managing any identified risks would be driven by the CSM to consider.

The following examples of activities reflect actions (as likely defined by the CSM) to address any ongoing risk (if that were the case):

- A framework for the identification of future risk management processes focusing on any future development or identified gaps in knowledge and addressing a decision-making process;
- Provision of sufficient underpinning technical understanding of the issue to support the risk assessment process necessary to complete a particular activity or achieve a desired decision;
- Guidance on the generation of data to fill data or evidence gaps resulting from the CSM assessment (not applicable in this case), including developing more detailed technical guidance on any flagged particular aspect of the risk management process.

Having established the S-P-R outlines, these can be viewed as a conceptual site model (CSM) - essentially a representation which sets out the critical pollutant linkages of concern for a particular pollution problem (see example in Figure 2-1). This visualisation tool provides a clear understanding of what needs to be done to achieve any risk mitigation by setting management goals. The CSM can be used to drive investigations and manage or control point sources of pollution; it is a representation of the primary pathways by which a source is linked to a receptor, and it sets out a clear and transparent structure to visualise and assist in understanding data or knowledge gaps and associated uncertainties. Once established, the CSM can be an integral part of an assessment framework to develop actions or recommendations. It will identify potential primary sources of contamination at the site, potential chemicals of concern, and the receptors or media (soil, water, and air) affected. It can also be used to quantify how any identified sources may be migrating from the source through the media and the primary pathways responsible. To develop a site specific CSM a set of data are required, such as historical records, nature of the underlying geology, etc. In the absence of such detailed information at this stage the conceptual model remains very much as theoretical approach highlighting potential pathways.

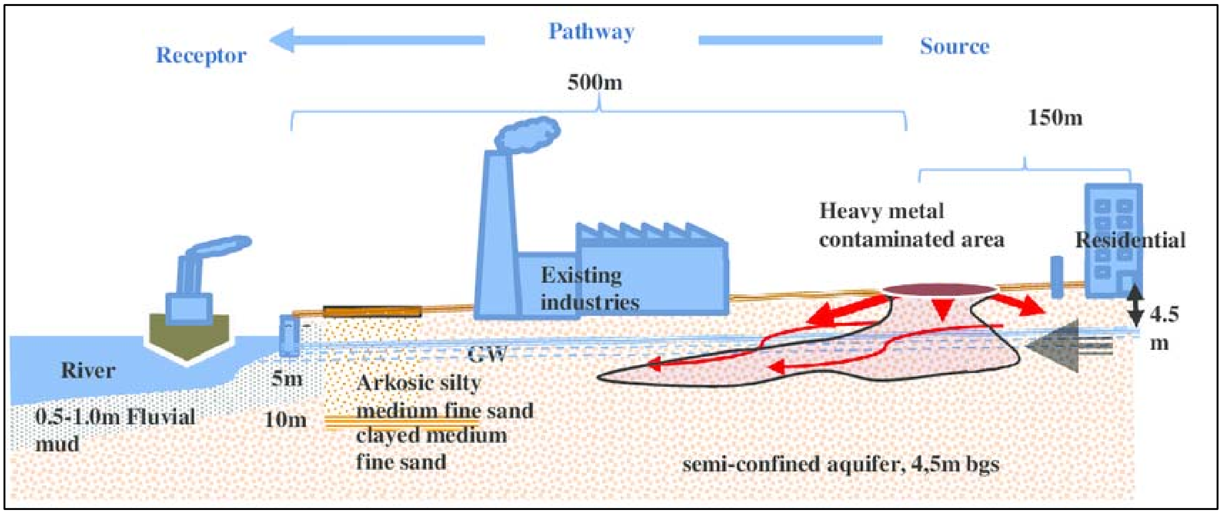

Figure 2-1 A fictitious example of a conceptual site model based around the source–pathway–receptor approach to considering potential sources of chemicals to environmental receptors.

Table 2-1 summarises the sources and pathways for the environmental receptors of concern for potential chemical sources emanating from the manufacturing and associated plant activities at the Aughinish plant.

Table 2-1 Summary S-P-R "conceptual" site model for the Aughinish plant based on available information.

Note that whilst this CSM is a generic consideration of possible pathways; the focus has been very much on the likely pathways to the terrestrial/ marine environments. It must be stressed that this is a list of possible pathways, listing them here does not imply that these pathways are in anyway actually realised.

Source	Pathway	Secondary pathway	Tertiary pathway	Receptor	Likelihood of pathway being realised (evidence from Natura Impact Statement - IEL Application P0035-07)
Chemicals contained in manufacturing waste water streams enter directly or indirectly to the domestic sewage waste/treatment without additional processing	Waste water streams enters the waste water treatment plant and are discharged to the environment Spread of chemicals into the local environment	Processed water from the WWTPs enters river/ estuary/ marine environment Sludge from the waste water treatment plant applied to soil/ agricultural sites enters through run-off Horizontal spread of fugitive emissions (dusts, wind-blown particles move through the environment	Water irrigation/ingestion Uptake into crops/ or association with food ingestion	Direct exposure via ingestion of contaminated drinking/ irrigation water by animals Consumption of contaminated food by animals on or offsite Exposure to environment that acts as a source, sink and pathway to other receptors Deposition in the environment	Appendix 2 Assimilative Capacity Assessment of Effluent Discharge from Aughinish Alumina Appendix 5 Baseline Water characterisation Survey Aughinish, Shannon Estuary (2018) Appendix 6 Baseline Water characterisation Survey Aughinish, Shannon Estuary (2019) Appendix 7 Marine Sediment characterisation Aughinish Port (2018) Appendix 8 Aughinish Sediment Analysis (2020) Appendix 3 Determination of the Air Emissions from the Aughinish Alumina facility, Co. Limerick Appendix 4 An Assessment of the Dust/PM10/PM2.5 from the BRDA at Aughinish Alumina

Source	Pathway	Secondary pathway	Tertiary pathway	Receptor	Likelihood of pathway being realised (evidence from Natura Impact Statement - IEL Application P0035-07)
Chemicals contained in manufacturing waste water streams directly disposed to the domestic sewage with ineffective treatment	Waste water streams enter waste water treatment plant and are discharged to wider environment	Processed water from the WWTPs enters river/ estuary Sludge from the waste water treatment plant applied to soil/ agricultural sites or enters river directly	Water irrigation/ingestion Uptake into crops	Direct exposure via ingestion of contaminated drinking/ irrigation water by animals in the environment Exposure via swimming or food chain transfer from contaminated waters to marine biota Consumption of contaminated food by animals, bioaccumulation, magnification through food chains Exposure to environment that acts as a source, sink and pathway to other receptors	No discharge to domestic sewage Appendix 2 Assimilative Capacity Assessment of Effluent Discharge from Aughinish Alumina Appendix 5 Baseline Water characterisation Survey Aughinish, Shannon Estuary (2018) Appendix 6 Baseline Water Characterisation Survey Aughinish, Shannon Estuary (2019)
Chemicals contained in manufacturing solid waste streams disposed to land	Leachate from landfills enters groundwater or surface waters enters environment	Spread of chemicals through the freshwater/ marine environment	Uptake by animals/ plants, passage into other water bodies, leading to the environment	Direct exposure via drinking contaminated water Consumption of contaminated food by animals in the environment Exposure to environment that acts as a source, sink and	No direct disposal to land.

Source	Pathway	Secondary pathway	Tertiary pathway	Receptor	Likelihood of pathway being realised (evidence from Natura Impact Statement - IEL Application P0035-07)
				pathway to other receptors such as groundwater	
Chemicals contained in emission to air (e.g., dusts, salt cake cell, BRDA phase 1 and 2)	Direct inhalation by animals/ humans Ingestion by preening birds/ animals visiting/ moving through the site Transmission by vehicle activities Deposition into the marine/ terrestrial environment at distance from the site (windblown fugitive emissions) Wash off from the site and puddling leading to secondary sources for dust upon drying and entering into the environment	Spread of chemicals through the terrestrial/ marine environment Sinks/ sources and environmental reservoirs	Uptake by animals/ plants, deposited into receiving marine environments, bound to soils or sediments and redistributed/ resuspended in water column ultimately deposited into the environment	Direct exposure via ingestion by marine biota/ or via food chain Direct and indirect exposure via receiving environment	Appendix 4 An Assessment of the Dust/PM10/PM2.5 from the BRDA at Aughinish Alumina No evidence of pathway being realised via terrestrial deposition to land from air.
Animals/ birds wildlife	Ingestion of particles through preening birds/ animals visiting/ moving through the site	Spread of chemicals through the environment	Movement of wildlife between site and receptor	Direct exposure via ingestion by biota/ or food chain in the environment	

Source	Pathway	Secondary pathway	Tertiary pathway	Receptor	Likelihood of pathway being realised (evidence from Natura Impact Statement - IEL Application P0035-07)
Animals drinking from puddles on site	Direct drinking by birds' other wildlife from puddles occurring at the site Wash off from the site and puddling leading to secondary sources for dust upon drying	Ingestion of prey items	Movement by birds etc. between site and receptor	Biota and eco-receptors. Indirect exposure via ingestion by biota/ or food chain within the environment	
Excess Rainfall and non-bunded wash off (rainfall) from the site; and accompany solid/ soil rain- wash out	Uncontrolled emissions enter controlled waters or via fugitive discharges to the environment	Wash off from the site/ puddling leading to secondary sources for dust upon drying		Biota and eco-receptors. Direct exposure via ingestion by biota/ or food chain within the environment	Only rainfall which falls on North end of the site is discharged as surface water after a stone trap. In process areas all rainfall is diverted for treatment before disposal at W1-1 Appendix 2 Assimilative Capacity Assessment of Effluent Discharge from Aughinish Alumina Appendix 5 Baseline Water characterisation Survey Aughinish, Shannon Estuary (2018) Appendix 6 Baseline Water characterisation Survey Aughinish, Shannon Estuary (2019)

2.5 Pathways for release of pollutants into the environment

The potential for chemicals (heavy metals) from the plants current and future activities to impact on the health of the environment - through environmental exposure routes remains very unlikely given the comprehensive qualitative and often quantitative (see information provided above) review of evidence.

Overall, manufacturing process control and emissions from the plant from a qualitative and where determined, a quantitative perspective, would indicate that there are no concerns in relation to likely consequences of widespread environmental contamination derived from the plant's activities. There are no obvious evidence gaps.

There has been significant effort to identify and quantify likely sources of chemicals, elucidate their pathways, and determine their presence in waste waters and / or in other environmental matrices.

Based on the plant activities and consideration of the wider likely or potential pathways or exposure scenarios, the main pathways by which chemicals could leave the site are via:

- Direct/ or fugitive discharges into water, or onto the land;
- Fugitive emissions to the surrounding environment including soils and waters.

The initial distribution and fate of chemicals in the environment is largely dependent on their entry pathway(s) into the environment and their subsequent metabolism and/or transformation. However, once released into the environment, the fate of the heavy metals in terms of toxicity and bioavailability will depend on their physicochemical properties (e.g., molecular structure, size, shape, form, solubility speciation etc.) and a variety of environmental factors (e.g., climatic conditions, soil types and hydrological effects). In addition, sorption properties of metals to organic and other substrates with varying degrees of mineralisation/ binding / transformation by both abiotic or biological processes, will also determine how they partition into different environmental compartments and therefore how toxic they are likely to be. Heavy metals released into the environment will not degrade. However, both bioavailability and toxicity are influenced (amongst other things) by the temperature, moisture, pH and ionic strength of the environment and the composition of the receiving environment. The methodology used to determine the concentration of heavy metals in the surrounding marine sediments used an extraction methodology that would best reflect the bioavailable concentrations (in the sediment), and hence the likely most toxic to resident marine biota (see methodology section). Other determinations have extracted heavy metals from dust and soils using very aggressive procedures to determine the total concentrations in the samples. Overall, there is no evidence heavy metal concentrations exceeding guideline levels in the surrounding marine sediments or soil concentrations.

3 CONCLUSIONS

The CSM has highlighted the potential pathways that could connect activities at the plant and the immediate aquatic and terrestrial environments. A further confirmatory study to collect additional marine sediment data was undertaken in May 2021 (Appendix 1) to assess the significance of any potential releases from the plant on the possible elevation of heavy metals concentrations in marine sediments in the immediate vicinity of the plant. The sampling data from the study indicated that no pathways are being realised that may impact on sediment metal concentrations in the immediate marine environment. The data showed that metal sediment concentrations were around the typical background concentrations for the marine environment in Ireland, and therefore additional studies were not recommended on the basis that no pathway for the Aughinish activity producing a negative impact on the designated prey species of intertidal feeding birds in the SPA designated habitat. Similar studies of metals concentrations in the terrestrial soils in the vicinity of the Aughinish plant (Appendix 2) also confirmed that metals levels in the soils were typical for the area and that no linkage (pathway) between any potential source metals at the plant and their deposition into the local terrestrial environment could be discerned.

APPENDIX 1 - PATHWAYS FOR THE RELEASE OF HEAVY METALS INTO THE ENVIRONMENT – MARINE SEDIMENTS

Pathways for release of heavy metals into the environment – marine sediments

Background

The potential for heavy metals, particularly from the plant activities, to impact on the health of the environment - through environmental exposure routes, has been considered through both a comprehensive review of qualitative and quantitative evidence and an additional confirmatory determination of heavy metals in marine sediments collected in the vicinity of the plant (the CSM). In aquatic systems, metal bioavailability depends on local water and sediment characteristics, and therefore, the risks are site-specific. Environmental quality standards (EQS) are typically used to manage the risks of metals in aquatic environments. In its simplest form an EQS represents a total concentration of a given metal in water or sediment that has been compared against a pre-set acceptable threshold level. However, comparing total concentration is of limited value as the toxicity of a heavy metal is dictated largely by its biological availability and so it is important that metal bioavailability is considered in any evaluation of heavy metal concentrations. Scientific advances have been made in metal bioavailability assessment, including passive samplers and computational models, such as biotic ligand models (BLM). However, very few standards have been derived for environmental monitoring and in particular for marine sediments.

The USA has implemented site-specific environmental risk assessment for water and sediment phases, and they have already implemented metal mixture toxicity evaluation. The European Union is promoting the use of bioavailability and BLMs in ecological risk assessment (ERA), but metal mixture toxicity and sediment phase are still mostly neglected. The total metal concentrations discussed in this section have been determined using an analytical method that best reflects the bioavailable total concentrations (in the sediment), and hence the fraction that is most likely to be toxic to resident marine biota (see methodology section below).

Typically for sediments two generally accepted criteria are used to assess the toxicological significance of a given sediment metal concentration and all are based on total concentrations; namely the:

- Background Assessment Concentration (BAC); and the,
- Effects Range Low (ERL).

BACs were developed within the Oslo and Paris Commission framework with scientific advice from the International Council for the Exploration of the Sea. Mean metal concentrations in sediments significantly below the BAC are said to be near background. ERLs were developed by the United States Environmental Protection Agency (US-EPA) for assessing the ecological significance of marine sediment concentrations. Concentrations below the ERL rarely cause adverse effects in marine organisms. Table A1-1 shows the BACs and ERLs that are available for the following metals in marine sediments.

Table A1-1: List of BACS and ERLs for metal concentrations in marine sediments above which effects may be seen (mg/kg)

Metal	BAC	ERL
Arsenic	25	8.2
Cadmium	0.31	1.2
Chromium	81	81
Copper	27	34
Mercury	0.07	0.15
Nickel	36	21
Lead	38	47
Zinc	122	150

In addition, Cronin et al. (2006) produced guidelines for the assessment of dredged material for disposal in Irish Waters (Cronin et al., 2006). The guidance document was developed to provide an integrated assessment of the ecological risk associated with the disposal of sediments and considers the bioaccumulation and toxicity potential of a given metal concentration in a sediment. Table A1-2 presents the upper and lower limits for a range of heavy metals. The guidelines set two Action Levels (as per the requirement of the OSPAR guidelines, 2004); the lower level (Level 1) defines a concentration (i.e., a guidance value) of a contaminant in sediment below which biological effects are not anticipated. The upper level (Level 2) defines a contaminant concentration above which biological effects are anticipated to occur. The more sediment concentrations exceeding the upper limit values for the corresponding parameter the more likely the material will cause biological effects.

Table A1-2: Lower and Upper Sediment Action Limits (mg/kg) (Cronin et al., 2006)

Parameter	Lower Action Limit	Upper Action Limit
Mercury (Hg)	0.2	0.7
Aluminium (Al)	N/A	N/A
Arsenic (As)	9	70
Cadmium (Cd)	0.7	4.2
Cobalt (Co)	N/A	N/A
Chromium (Cr)	120	370
Copper (Cu)	40	110
Lithium (Li)	N/A	N/A
Nickel (Ni)	21	60
Zinc (Zn)	160	410

The following narrative summarises the data for the latest round of marine sediment metal determinations (sediment collected in May 2021) and builds on those previously reported in the Natura Impact Statement - IEL Application P0035-07.

Heavy metals in marine sediments

Pollution by heavy metals can lead to significant impacts on marine benthic communities through either direct toxic effects or changes in ecosystem dynamics.

It should be noted that the assessment of estuarine sediments representative of small (highly localised) areas is difficult without reference to the wider distribution of sediment types in the estuary. Grain sizes, organic fractions and salinities are particularly important in regulating concentrations of heavy metals and these may fluctuate daily. The mere determination of a heavy metal concentration at a locality provides no real insight into likely toxicity or bioavailability. Suspended solids and both natural and anthropogenic materials, in the water body of the River Shannon will affect the formation of metal complexes, metal speciation and complexation and metal/ligand interactions and hence bioavailability and toxicity. Once heavy metals are bound to particles in the water column they tend to settle out in depositional areas of the estuary.

Marine Sediment Sampling and Analysis – Methodology and Approach

Sediment samples were collected from a number of shoreline locations in the vicinity of the Aughinish plant. These are shown in the map (Figure A1-1) below.

Figure A1-1: The locations of the sediment samples taken for heavy metal analysis.

Stations were selected to provide representative coverage of the intertidal areas of the Shannon Estuary both up and down tide and on both shorelines of the estuary; where there was the potential for contaminants to disperse and accumulate in the sediments. A greater frequency of sampling locations was selected in the creeks and on the main estuary shorelines in closest proximity to the Aughinish plant and hence closest to areas of potential for pathway impacts.

The sampling locations shown above correspond to the shorelines at the following eight locations:

Shannon Golf Course, Rinemolgan Pier, Poulaweela Creek, Robertstown River, Foynes foreshore, Carrowbane Pier, Rinealon Bay and a further site, more remote from the Aughinish plant near Foynes.

The locations are shown at the position of the uppermost point on each sampling transect close to Mean High Water Springs (MHWS) in Table A1-3:

Table A1-3: The location, identifier and coordinates of the sediment samples collected for analysis

Location	Identifier	Location (Decimal Degrees)	
Shannon Golf Course	1	52.6873757	-8.9381621
Rinemolgan Pier	2	52.6604693	-8.9484469
Poulaweela Creek	3	52.6223086	-9.0476347
Robertstown River	4	52.6056273	-9.0749154
Foynes	5	52.6157899	-9.0910371
Carrowbane Pier	6	52.5934516	-9.222985
Rinealon Bay	7	52.6220253	-9.1759664
Shannon/Foynes	8	52.62658	-9.07107

Sampling was undertaken between the 5th and 7th May 2021 for all sites with the exception of the additional site near Foynes (site 8), which was sampled on the 25th May. These dates corresponded with spring tidal cycles to allow good access to sample the shorelines on foot with maximum exposure or by Rigid Inflatable Boat (RIB) with safe water depth from which to sample.

Samples were taken from three sampling stations at each of the eight locations. The three sampling stations corresponding to upper, middle and lower intertidal shoreline levels. The uppermost stations were sampled close to the point of MHWS, while lower stations were taken at a point close to MLWS. Mid shoreline locations were collected from a point that was considered to be halfway between the two at the respective locations based on the spring tidal conditions that were prevalent at the time of the sampling. Sampled stations were named A, B, or C depending on their height on the shore (A being the highest).

Sediment samples were collected using either a 0.025 m^2 grab or 0.01m^2 core sampler (grab used from RIB, and core used for upper shore locations sampled on foot), with samples retained and sieved over a 0.5 mm mesh. These samples were retained and stored for possible analysis of sediment infauna. In addition, sub samples were taken from the surface sediments for a range of physicochemical parameters. These were sampled using a solvent washed plastic scoop and then stored in appropriate plastic containers frozen for subsequent transfer for analysis in the UK. The samples were transferred under cold conditions and under Chain-of-Custody to the UKAS accredited Socotec analytical laboratory to be analysed for a suite of metals, particle size determination and total organic content (TOC). The samples were received at the laboratory on the 14th June 2021 and reported on 30th June 2021.

The following analytical methods were used at the Socotec laboratory for the analysis of the samples – all analyses were UKAS accredited with the exception of aluminium in sediments and particle size distribution:

- Samples for the analysis of the heavy metal suite were air-dried and ground. This material was then analysed using Aqua-regia digestion followed by Inductively-Coupled Plasma (ICP-MS) analysis for the following metals – the minimum reportable values (MRV) (analytical detection limits) are shown in Table A1-4 below for each analyte in mg/kg:

Table A1-4: Minimum reportable values (MRV) (detection limits) for the heavy metals determined in the collected sediment samples

Analyte	MRV
Cadmium	0.04 mg/kg
Cobalt	0.5 mg/kg
Copper	0.5 mg/kg
Lead	0.5 mg/kg
Mercury	0.01 mg/kg
Nickel	0.5 mg/kg
Chromium	0.5 mg/kg
Zinc	2 mg/kg
Aluminium	10 mg/kg

- Samples for the analysis of Total Organic Content (TOC) were initially air dried and ground and then analysed by carbonate removal and addition of sulphurous acid and combustion at 1600°C and analysed using Non-Dispersive Infrared Spectroscopy (NDIR). The MRV was 0.02 % M/M.
- Analysis for particle size analysis was undertaken on the wet sediment as collected. Analysis was by both wet and dry sieving and laser diffraction.

Summary of findings for the determined marine sediment heavy metal concentrations

The free metal ion speciation of heavy metals typically determines bioavailability and hence toxicity to organisms. The data collected for the sediments samples during the May 2021 survey showed no exceedances of any recognised marine sediment standard (Table A1-2).

Cadmium

Cadmium is a non-essential metal and inherently toxic. Cadmium can adsorb to sediments and is often associated with total organic carbon and the May 2021 data (see Appendix A1 Figure A1-1) indicates a correlation between cadmium concentration and both TOC and the silt fraction of the sediment. The concentrations determined in the sampled sediments in the vicinity of the plant are below any action levels.

Cobalt

No reliable acute or chronic toxicity data for the marine sediment compartment for cobalt exist in either the open literature or grey literature (non-peer reviewed information). Because of the apparent observed decreased sensitivity of marine water-column dwelling organisms versus freshwater water-column dwelling organisms, it has been decided by ECHA to use the freshwater $PNEC_{sediment,\ freshwater}$ as an environmentally conservative approach that would be protective of the marine environment. The freshwater value for the EC50 for freshwater sediment is 1703 mg/kg. The results of the samples collected in May 2021 are significantly below this value. Cobalt appears poorly correlated to sediment size fraction or TOC (Figure A1-2) but correlates well with total aluminium concentration.

Copper

Cu^{2+} is the most environmentally relevant species of copper. It is recognised that free Cu^{2+} ions are the most active copper species and cause environmental effects, whereas total Cu concentrations in aqueous media are not directly related to ecological effects. The ecotoxicity of copper is caused by the soluble copper ions. For this reason, it is possible to read-across from ecotoxicity and environmental fate studies conducted with all soluble copper compounds. Copper can exist naturally in water as either dissolved (as Cu^{2+}) or complexed with organic matter or suspended particles our results (Figure A1-3) showed a poor correlation with both. Copper can also be absorbed to bottom sediments. The concentration of these forms of complexes is dependent upon several other factors such as pH, salinity, hardness and alkalinity. The total concentrations of copper determined in the sediments was low, so no significant impacts on marine sediment dwelling species are anticipated.

Lead

Much of the lead in the marine environment is absorbed onto sediment and suspended particles thereby reducing its availability to marine organisms. Sediments form a sink for lead in the marine environment. The data for Pb in this study show a trend in association with sediment and organic material (Figure A1-4). The determined concentrations for lead are significantly lower than the effects level (see Table A1-1).

Mercury

Dissolved mercury has a strong affinity for organic matter and suspended solids and consequently it will bind to these particles in the water column and may ultimately accumulate in sediments. The May 2021 sediment data show a highly variable association to both sediment fraction size and organic carbon (Figure A1-5). Once in the sediments, mercury can undergo methylation to produce methylmercury. The No Observable Effect Concentration (NOEC) for marine sediment for mercury is set at 930 mg/kg. One of the samples exceeded the BAC (0.07 mg/kg) at 0.11 mg/kg but is well below the NOEC value.

Nickel

Nickel toxicity can vary considerably among marine sediments particularly with different physico-chemical characteristics, with no strong correlation evident with TOC or silt, however concentration of nickel and total aluminium do correlate well (Figure A1-6). Consequently, bioavailability models have been developed to directly compare sediment toxicity and to generate sediment threshold values, e.g., $PNEC_{sed}$. In order to understand nickel toxicity, it is important to estimate site-specific bioavailable nickel PNEC values. The availability of sediment physico-chemistry data, such as acid volatile sulphide (AVS) content, allows site-specific nickel PNEC values to be calculated and a more accurate site-specific risk characterisation to be conducted. Five of the May, 2021 sediment samples approached or just exceeded the ERL (Effects Range Low) of 21 mg/kg for nickel. However, the ERL determination for nickel is below the OSPAR Background Concentration (BAC) of 36 mg/kg. Therefore, respectively, nickel concentrations are only assessed against the BAC (36 mg/kg) and only one sample exceeded this value at 44.9 mg/kg. This concentration, however, is still significantly lower than the PNEC sediment value (for marine waters) of 109 mg/kg.

Chromium

In the hexavalent state chromium can occur in water with a low organic content. In its trivalent form chromium will form insoluble compounds. The solubility of chromium III in seawater varies with salinity, and the main removal process is adsorption to suspended materials. Cr IV, in particular is not adsorbed by sediments. Our analysis determined total chromium but the plot of total chromium against the percentage of fine material in the sediments (Figure A1-7) demonstrated little correlation between sediment and total chromium concentrations. The concentrations of metals determined in the marine sediments sampled are significantly lower than the recognised sediment standards. No significant effects on habitats or species are predicted. It is worthy of note that the ERL for chromium equals the BAC; and therefore, chromium concentrations should only be assessed against the ERL.

Zinc

In an estuarine environment, zinc is absorbed to suspended materials in the water column. In low salinity areas within an estuary absorbed zinc can be mobilised from particles by microbial degradation of organic matter. In seawater, zinc is normally dissolved as either organic or inorganic complexes. The May 2021 sample data indicated a positive correlation between zinc and both TOC and the fine sediment fraction (Figure A1-8). The determined concentrations of total zinc in several sampled sediment locations exceeded the Probable Effects Concentration (PEL) of 271 mg/kg, the BAC (122 mg/kg) and the ERL (150 mg/kg). However, total zinc concentration is not necessarily a determinant of actual bioavailable and hence toxicity of zinc. It has been shown that concentrations of total zinc in sediments above 124 mg/kg can pose a hazard to sediment living organisms (Canadian Council of Resource and Environmental Ministers, 1987). ECHA, additionally undertook an assessment to calculate a Marine $PNEC_{add,\ sediment}$. The assessment for zinc identified only two long-term chronic toxicity studies. However, using partitioning coefficients and a robust aquatic toxicity database approach provided ECHA a reliable derivation for the marine benthic compartment. The resulting value that is considered protective for EU marine ecosystems is 56.5 mg/kg. From the sampling locations, two samples from different locations had a total zinc sediment concentration of 244 and 268 mg/kg, respectively, one sample (T4, upper shore) had a concentration of 458 mg/kg and one sample (T3 mid-shore) had a zinc concentration of 634 mg/kg. These isolated sediment concentrations may indicate that as zinc can accumulate in sediments that a risk to sediment dwelling organisms may exist at these locations. It is recognised, however, that concentrations of zinc in sediment samples from Irish inshore waters are typically <300 mg/kg with the majority <100mg/kg (Nag *et al*., 2022), a situation generally reflected in the May 2021 samples. The current Irish Action Level for Zn in sediments to be dredged is >410 mg/kg (Table A1-2).

The December 2017 sampling programme also recorded a single high level for zinc of 652 mg/kg. It is very likely that this May 2021 value is an isolated occurrence. Concentrations throughout the remainder of the locations sampled are all below the threshold ERL.

Aluminium

Aluminium is more stable in the solid than aqueous phase and in the marine environment tends to be absorbed on the surrounding sediments. This acts as a sink for aluminium for biota but only a small portion is bioavailable, which is turn is controlled by pH conditions with aluminium toxicity being higher at lower pHs. Aluminium is most toxic at pH 5.5 – 6 and least toxic around pH 7. The buffering capacity of seawater ensures that aluminium remains in its original chemical form and therefore no significant impacts on the designated areas in the wider hinterland of the AAL facility are predicted from the levels recorded. From Figure A1-9 it can be seen that there is no significant correlation between aluminium concentration and either TOC or silt levels in this area of the Shannon.

Summary

The range and concentrations of heavy metals detected in the marine sediments sampled from the eight transects during May 2021 and reported in Table A1-5 are generally low or typical of background levels. This quantitative overview of determined sediment metal concentrations has indicated that the manufacturing activities and controlled emissions from the plant appear to have little effect on marine sediment heavy metal concentrations in the vicinity of the site.

Table A1-5: Summary total metal concentrations determined for each sampling location. The yellow shading highlights those locations where the indicated sediment metal concentration (mg/kg) may approach an indicated limit (e.g., BAC, PEL, or ERL), the amber shading where limits are exceeded and the red shading where limits are significantly exceeded.

		Units	mg/Kg (Dry Weight)							mg/Kg (Dry Weight)	
		Method No	SOCOTEC Env Chem*							SOCOTEC Env Chem*	
		Limit of Detection	0.04	0.5	0.5	0.5	0.01	0.5	0.5	2	10
		Accreditation	UKAS	UKAS	UKAS	UKAS	UKAS	UKAS	UKAS	UKAS	None
Client Reference:	**SOCOTEC Ref:**	**Matrix**	**Cadmium as Cd**	**Cobalt as Co**	**Copper as Cu**	**Lead as Pb**	**Mercury as Hg**	**Nickel as Ni**	**otal Chromium as C**	**Zinc as Zn**	**Aluminium as Al**
Background Assessment Concentration (BAC)			**0.31**	-	**27**	**38**	**0.07**	**36**	**81**	**122**	-
Probable Effects Level (PEL)				-	**108**	**112**		**43**	**160**	**271**	
Effects Range Low (ERL)			**1.2**		**34**	**47**	**0.15**	**21**	**81**	**150**	-
(T1-U) 1a	MAR01031.001	Sediment	0.19	9.50	14.7	12.6	0.07	24.9	20.9	61.50	12300
(T1-M) 1b	MAR01031.002	Sediment	0.32	7.70	13.1	18.5	0.07	21.3	22.1	268.9	10200
(T1-L) 1c	MAR01031.003	Sediment	0.29	6.70	11.6	16.0	0.06	18.0	18.0	109.2	9240
(T2-U) 2a	MAR01031.004	Sediment	0.21	4.50	12.6	10.4	0.05	12.1	11.5	129.5	5420
(T2-M) 2b	MAR01031.005	Sediment	0.33	7.00	11.2	17.5	0.07	18.6	18.4	145.7	8760
(T2-L) 2c	MAR01031.006	Sediment	0.27	5.30	10.0	11.9	0.05	14.3	14.4	244.8	7400
(T3-U) 3a	MAR01031.007	Sediment	0.25	3.90	9.70	11.4	0.10	11.1	9.20	186.3	4840
(T3-M) 3b	MAR01031.008	Sediment	0.30	7.20	14.5	17.4	0.10	19.9	19.0	634.5	8870
(T3-L) 3c	MAR01031.009	Sediment	0.27	7.30	8.90	14.2	0.06	20.4	22.1	63.70	10300
(T4-U) 4a	MAR01031.010	Sediment	0.35	7.50	14.8	19.6	0.11	21.6	22.0	458.8	10300
(T4-M) 4b	MAR01031.011	Sediment	0.26	7.10	11.5	15.8	0.07	20.1	21.2	63.20	9450
(T4-L) 4c	MAR01031.012	Sediment	0.32	6.50	12.3	17.2	0.07	17.5	17.5	73.90	8370
(T5-U) 5a	MAR01031.013	Sediment	0.27	6.60	10.8	14.2	0.05	18.6	19.6	54.00	9200
(T5-M) 5b	MAR01031.014	Sediment	0.33	6.90	13.4	15.4	0.06	18.9	19.3	65.00	9020
(T5-L) 5c	MAR01031.015	Sediment	0.35	7.10	11.1	16.8	0.06	19.2	19.0	65.30	8900
(T6-U) 6a	MAR01031.016	Sediment	0.25	5.60	8.00	14.3	0.05	15.7	14.7	54.60	6770
(T6-M) 6b	MAR01031.017	Sediment	0.28	4.70	5.80	9.30	0.09	12.5	12.3	42.40	5510
(T6-L) 6c	MAR01031.018	Sediment	0.28	5.20	7.60	10.7	0.06	13.9	13.2	45.60	6040
(T7-U) 7a	MAR01031.019	Sediment	0.12	13.1	24.0	17.7	0.04	44.9	30.2	92.30	18000
(T7-M) 7b	MAR01031.020	Sediment	0.28	7.00	9.00	16.2	0.06	19.4	18.8	61.80	8340
(T7-L) 7c	MAR01031.021	Sediment	0.26	5.70	6.40	12.0	0.04	14.8	15.0	47.80	6830
(T8-U) 8a	MAR01031.022	Sediment	0.29	6.40	7.50	14.0	0.04	17.4	17.5	58.70	7980
(T8-M) 8b	MAR01031.023	Sediment	0.25	4.60	5.30	9.60	0.03	11.8	11.6	57.60	5390
(T8-L) 8c	MAR01031.024	Sediment	0.26	4.50	5.10	10.1	0.08	11.1	10.9	46.60	4880
Certified Reference Material SETOC 774 (% Recovery)			102	100	101	99	104	97	96	99	95
QC Blank			<0.04	<0.5	<0.5	<0.5	<0.01	<0.5	<0.5	<2	<10

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OSPAR/ICES Workshop on the evaluation and update of Background Reference Concentrations (BRCs) and Ecotoxicological Assessment Criteria (EACs) and how these assessment tools should be used in assessing contaminants in water, sediment, and biota. The Hague, 9-13 February 2004. ISBN 1-904426-52-2.

APPENDIX A1: Graphical presentation of the sampled sediments and associated heavy metal data (taken from Table A1-5)

The following section presents three plots for each heavy metal. The first is the plot of total sediment metal concentration for each sampling point against the Total Organic Carbon (TOC) content. The second is the total sediment metal concentration for each sampling point plotted against the silt fraction (<63 μm), and the third plot for each sequence is the plot of total sediment metal concentration for each sampling point plotted against the total aluminium concentration for the same point (apart from a plot of Al/ Al).

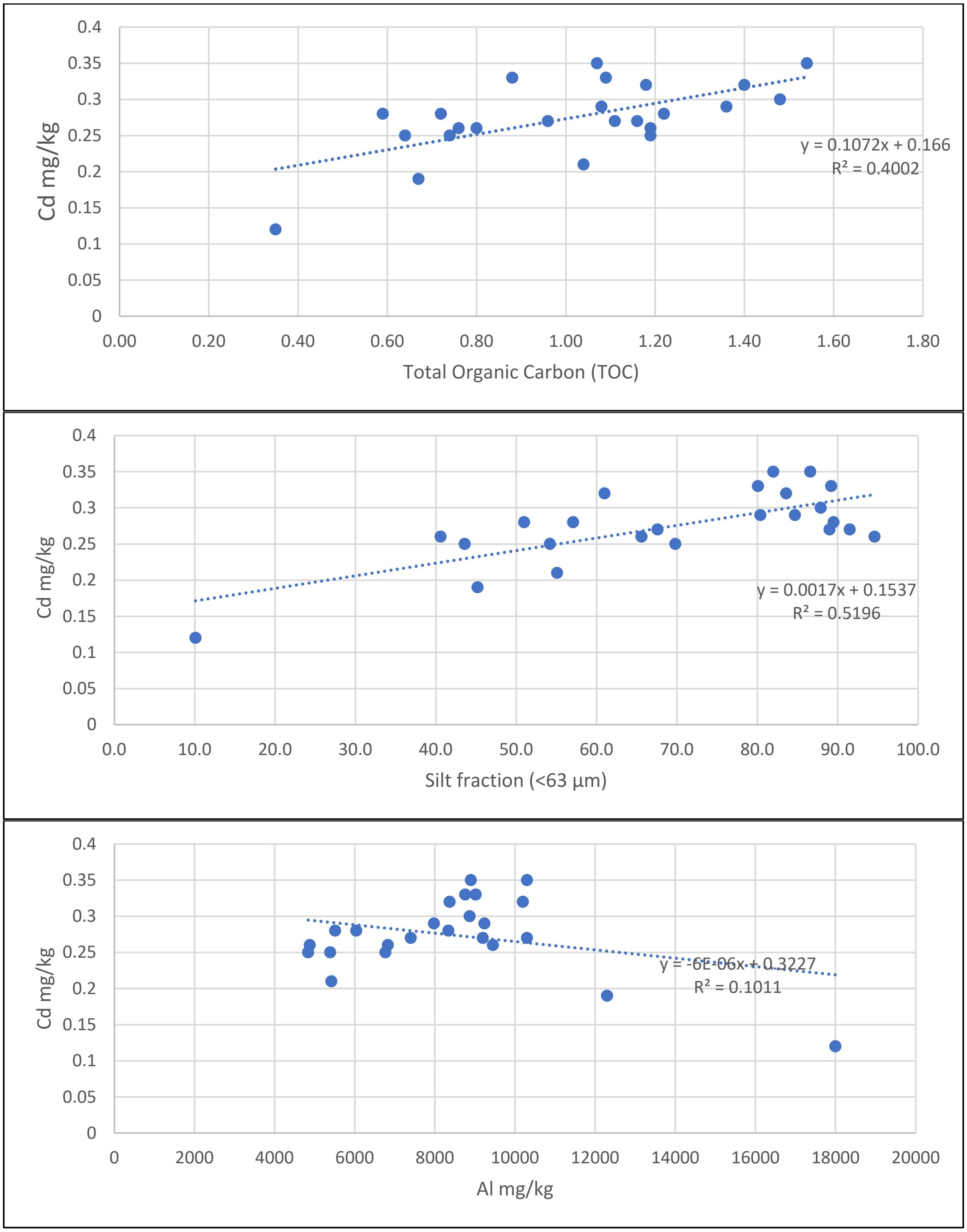

Figure A1-1: Cadmium a) plot of total sediment metal concentration for each sampling point against the Total Organic Carbon (TOC) content b) the total sediment metal concentration for each sampling point plotted against the silt fraction (<63 µm) and c) total sediment metal concentration for each sampling point plotted against the total aluminium concentration for the same sampling point.

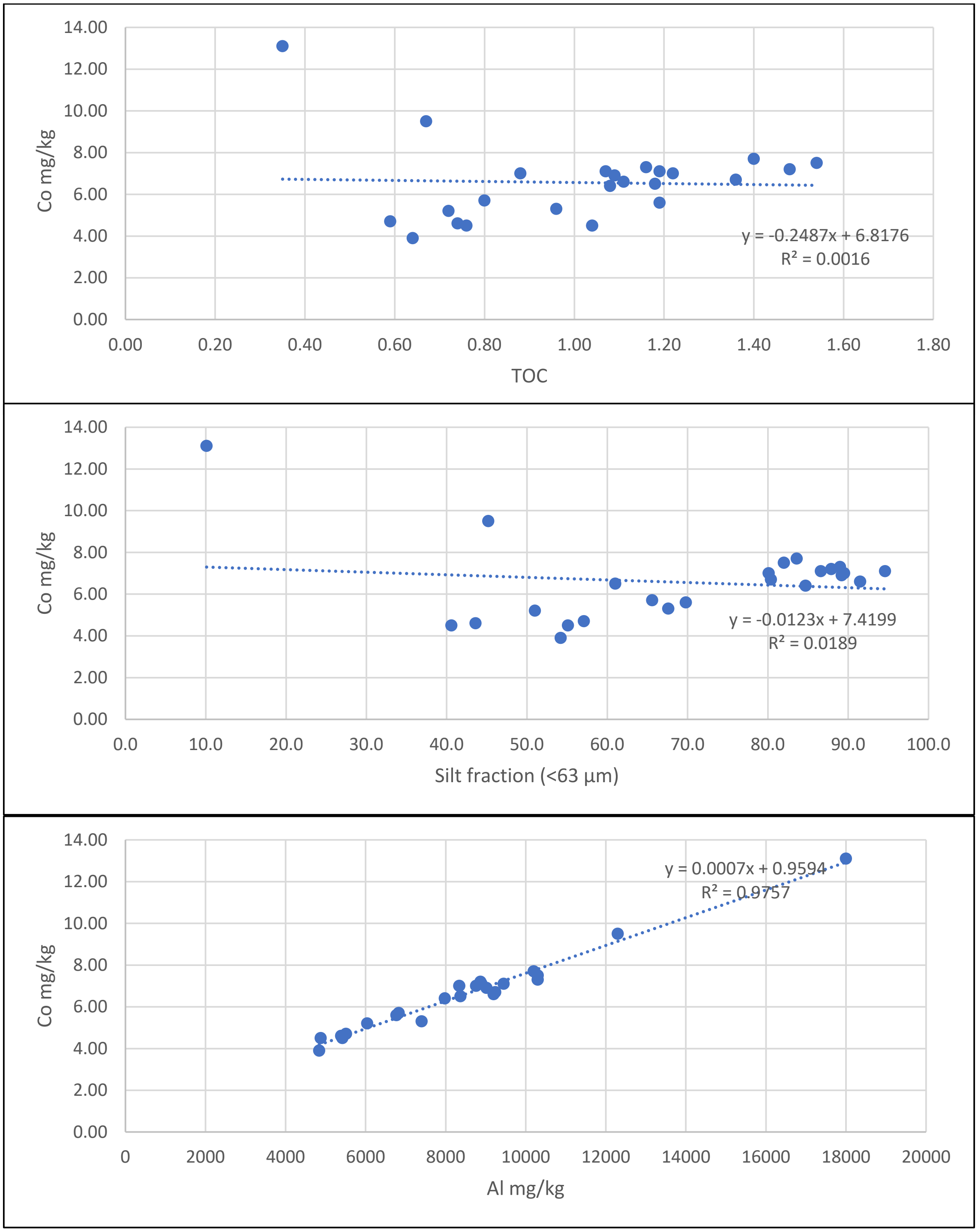

Figure A1-2: Cobalt a) plot of total sediment metal concentration for each sampling point against the Total Organic Carbon (TOC) content b) the total sediment metal concentration for each sampling point plotted against the silt fraction (<63 µm) and c) total sediment metal concentration for each sampling point plotted against the total aluminium concentration for the same sampling point.

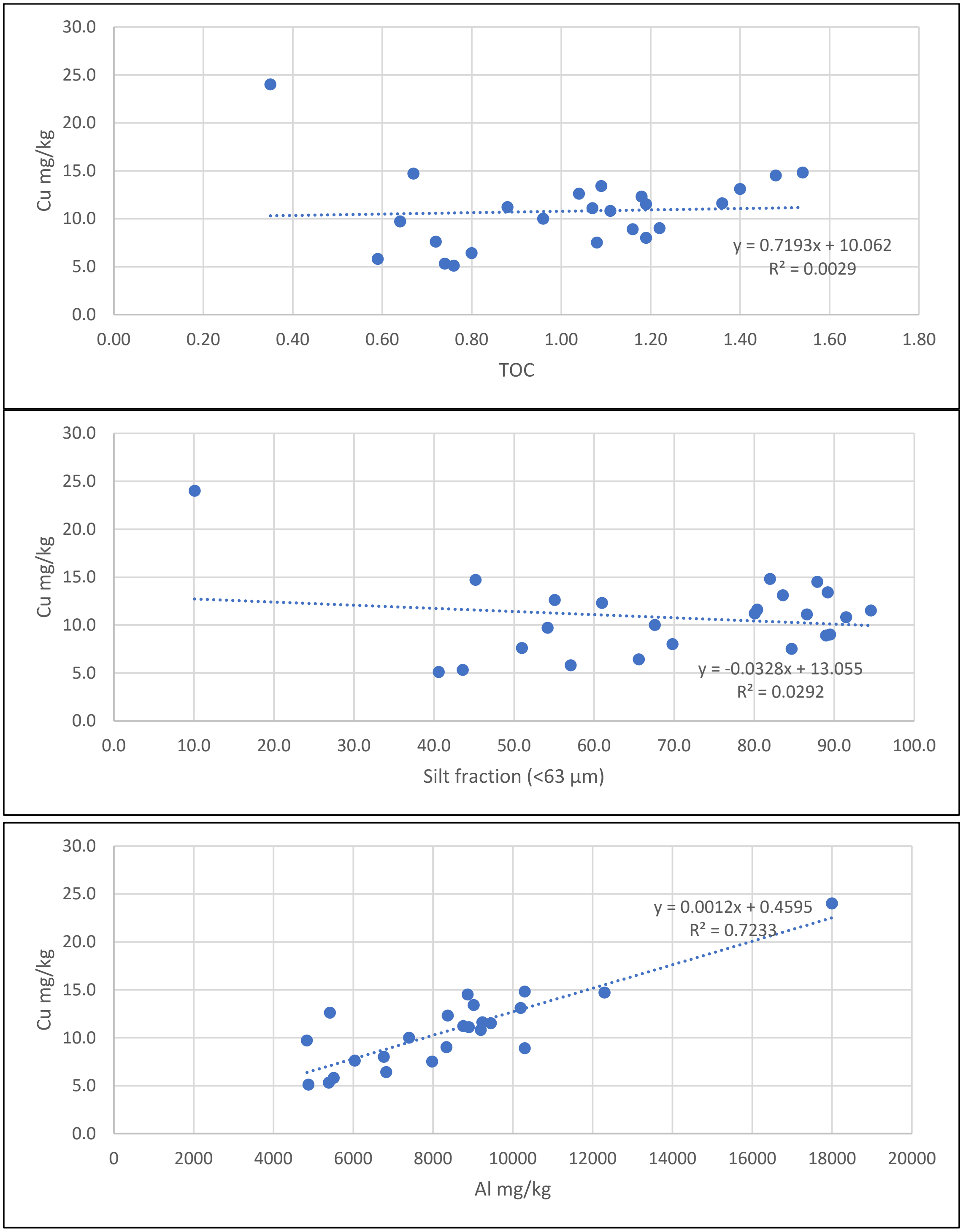

Figure A1-3: Copper a) plot of total sediment metal concentration for each sampling point against the Total Organic Carbon (TOC) content b) the total sediment metal concentration for each sampling point plotted against the silt fraction (<63 µm) and c) total sediment metal concentration for each sampling point plotted against the total aluminium concentration for the same sampling point.

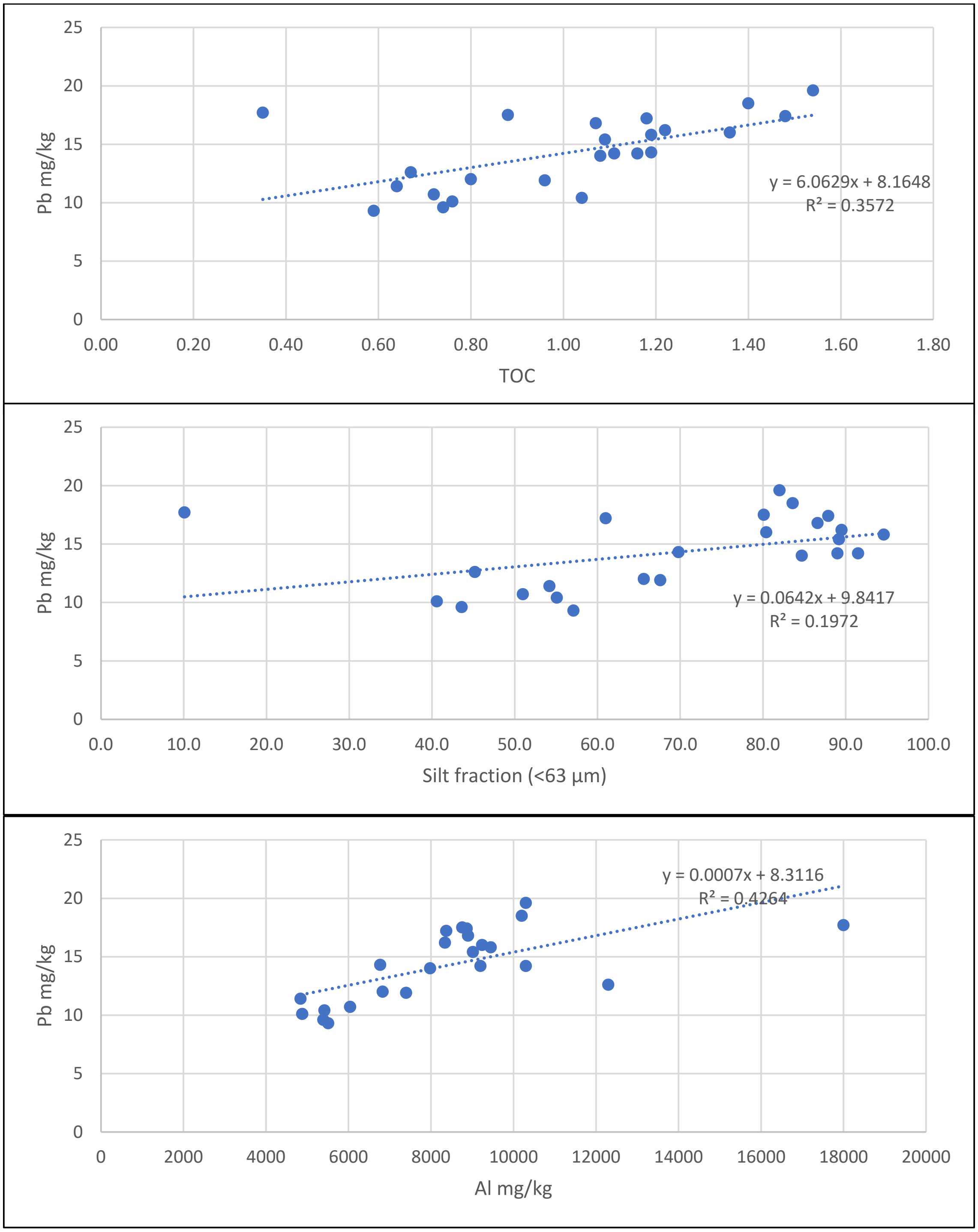

Figure A1-4: Lead a) plot of total sediment metal concentration for each sampling point against the Total Organic Carbon (TOC) content b) the total sediment metal concentration for each sampling point plotted against the silt fraction (<63 µm) and c) total sediment metal concentration for each sampling point plotted against the total aluminium concentration for the same sampling point.

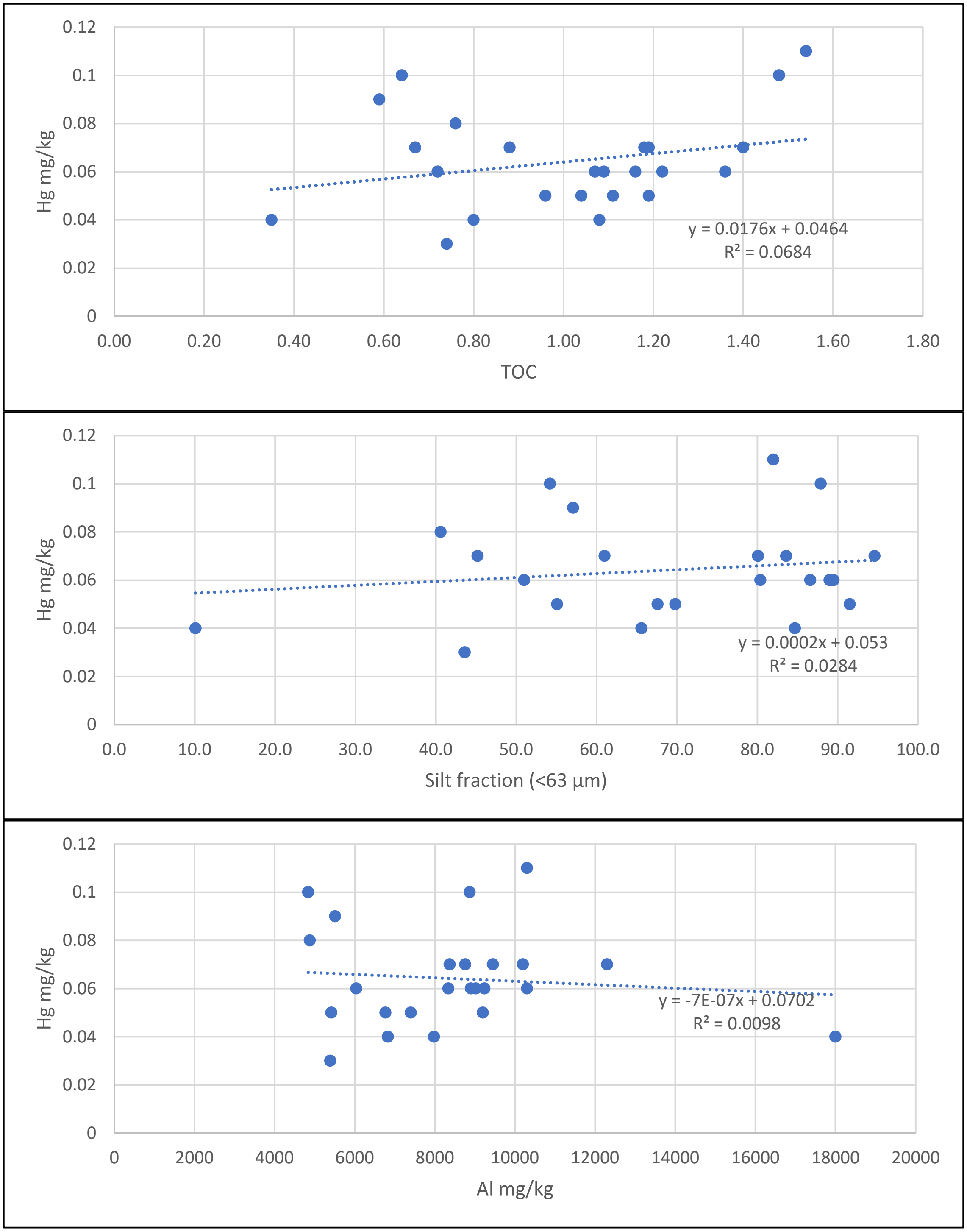

Figure A1-5: Mercury a) plot of total sediment metal concentration for each sampling point against the Total Organic Carbon (TOC) content b) the total sediment metal concentration for each sampling point plotted against the silt fraction (<63 µm) and c) total sediment metal concentration for each sampling point plotted against the total aluminium concentration for the same sampling point.

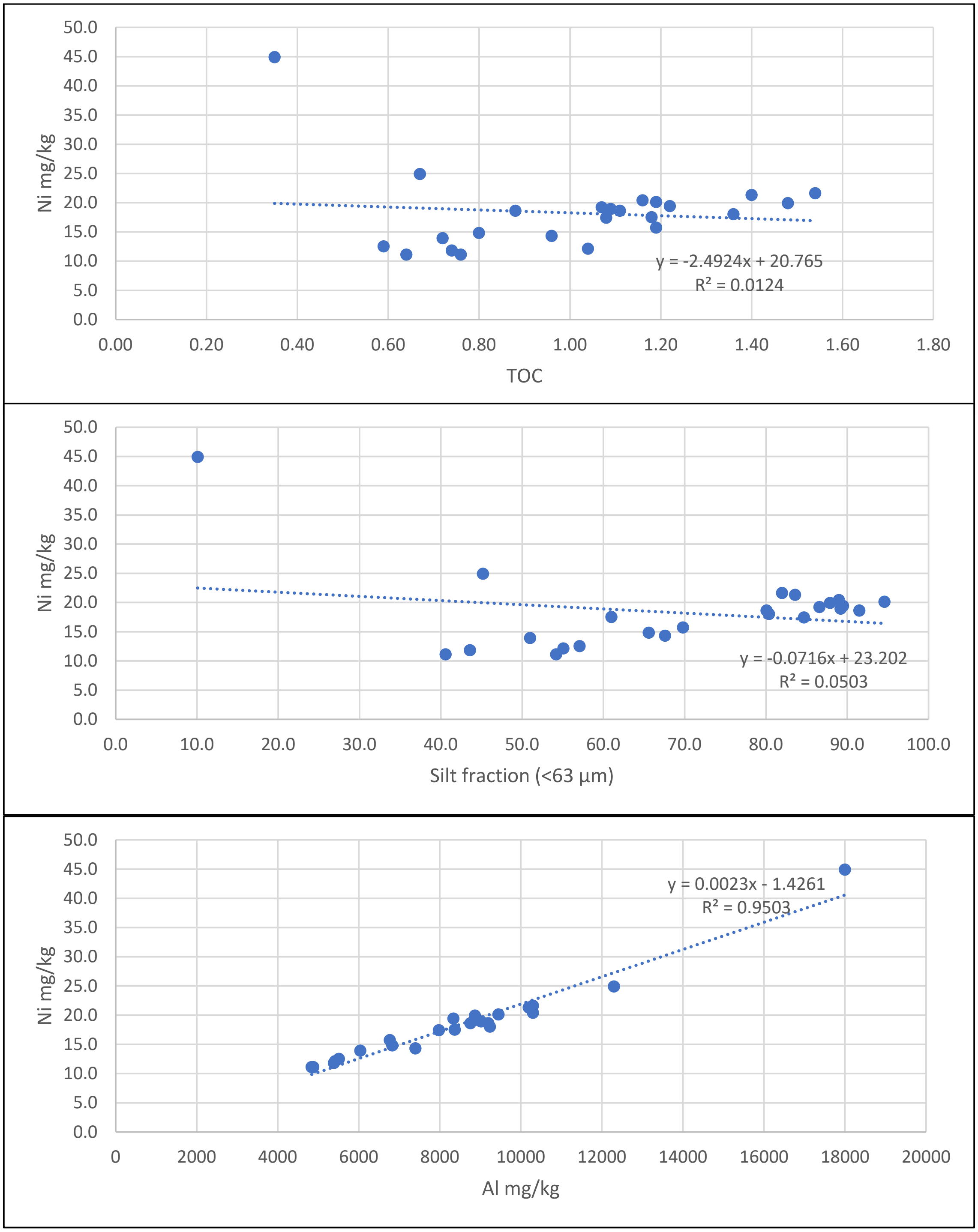

Figure A1-6: Nickel a) plot of total sediment metal concentration for each sampling point against the Total Organic Carbon (TOC) content b) the total sediment metal concentration for each sampling point plotted against the silt fraction (<63 µm) and c) total sediment metal concentration for each sampling point plotted against the total aluminium concentration for the same sampling point.

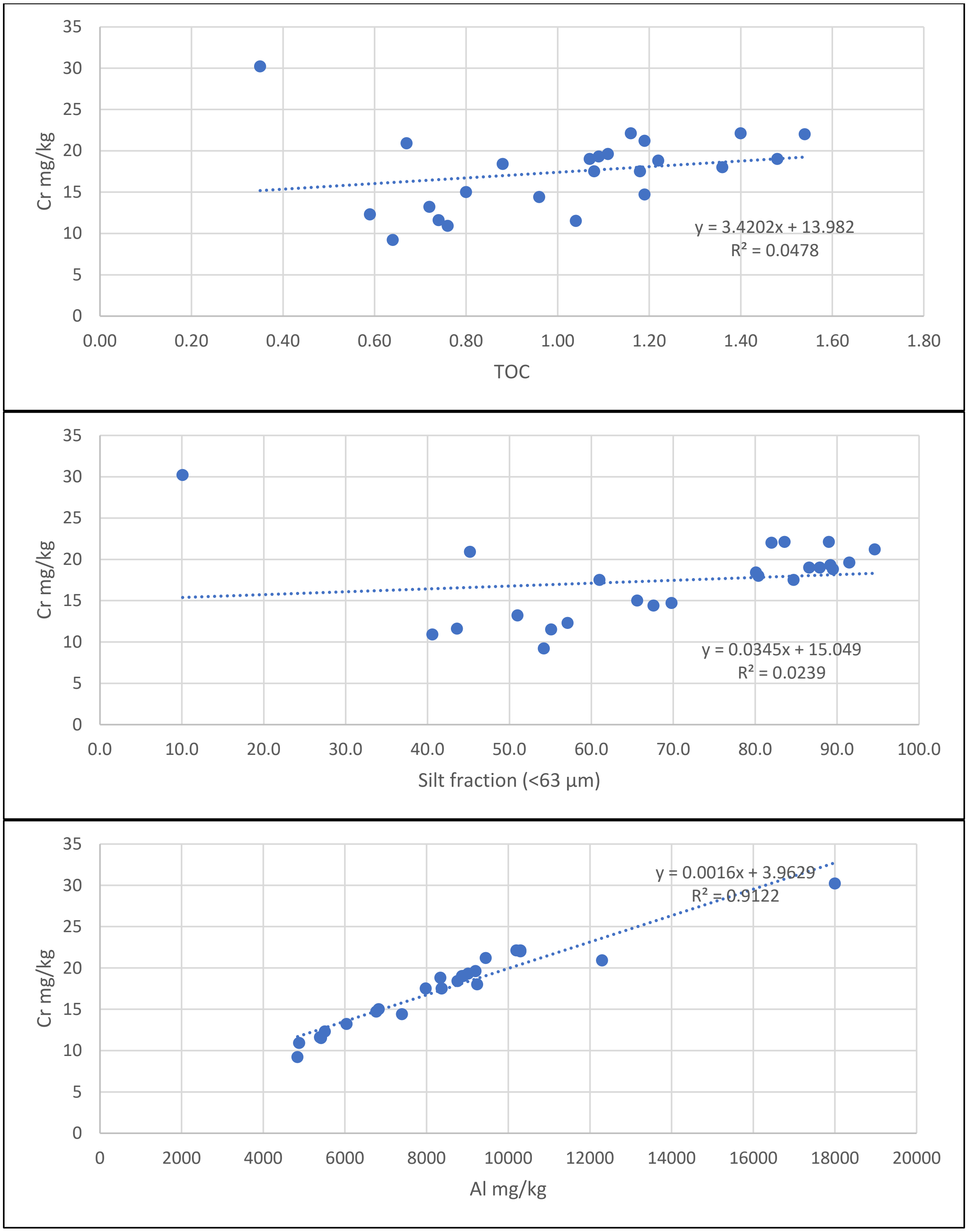

Figure A1-7: Chromium a) plot of total sediment metal concentration for each sampling point against the Total Organic Carbon (TOC) content b) the total sediment metal concentration for each sampling point plotted against the silt fraction (<63 µm) and c) total sediment metal concentration for each sampling point plotted against the total aluminium concentration for the same sampling point.

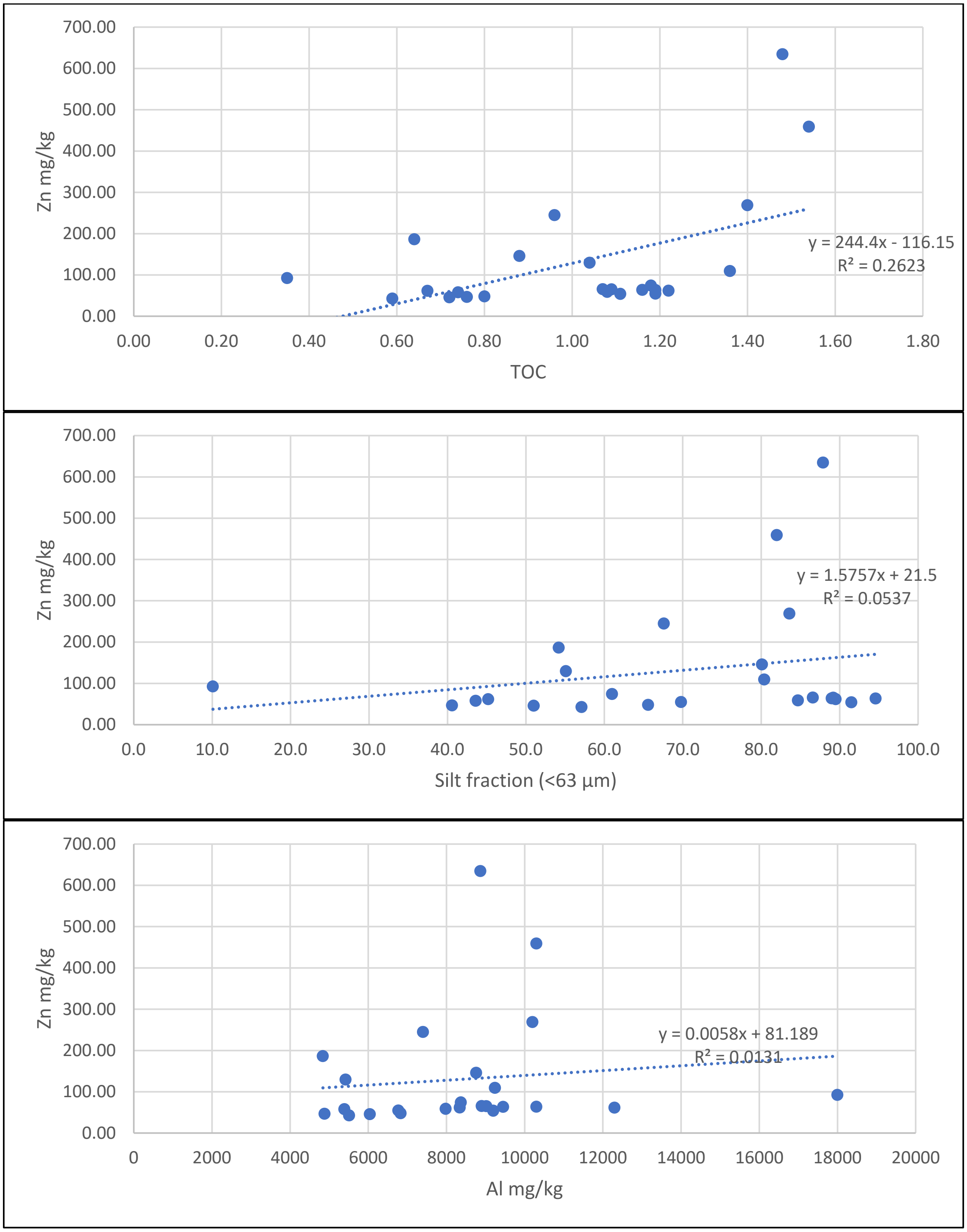

Figure A1-8: Zinc a) plot of total sediment metal concentration for each sampling point against the Total Organic Carbon (TOC) content b) the total sediment metal concentration for each sampling point plotted against the silt fraction (<63 µm) and c) total sediment metal concentration for each sampling point plotted against the total aluminium concentration for the same sampling point.

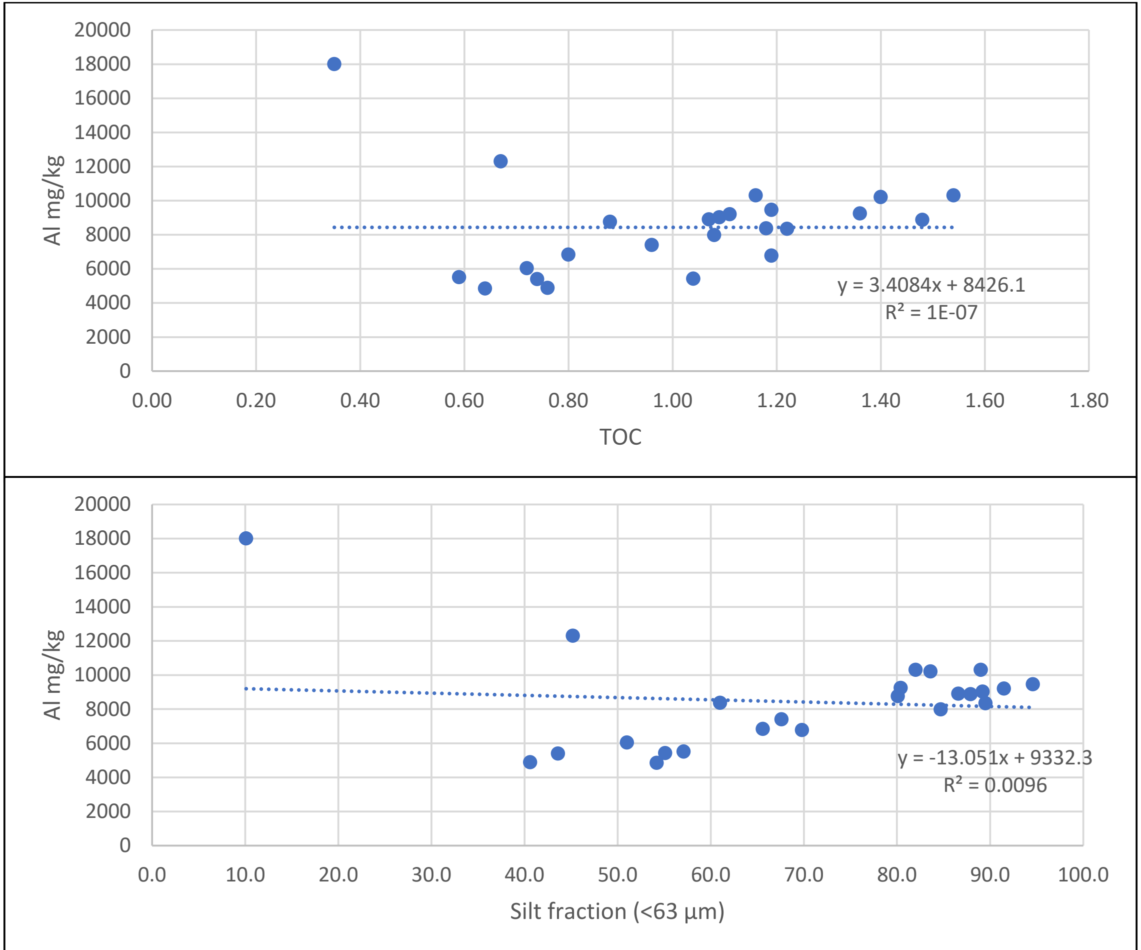

Figure A1-9: Aluminium a) plot of total sediment metal concentration for each sampling point against the Total Organic Carbon (TOC) content b) the total sediment metal concentration for each sampling point plotted against the silt fraction (<63 µm)

APPENDIX 2 – PATHWAYS FOR THE RELEASE OF HEAVY METALS INTO THE ENVIRONMENT - TERRESTRIAL SOILS

Pathways for release of heavy metals into the environment – terrestrial soils

Background

The potential for heavy metals from Aughinish plant activities to impact on the health of the environment through environmental exposure routes, has been considered through a comprehensive review of available qualitative and quantitative evidence and data. Following the derivation of a conceptual site model, a possible pathway of heavy metals to soils from deposition of suspended particles contained in aerial emissions was recognised. This section considers the pathway of heavy metals potentially deposited in the vicinity of the plant and compares determined soil heavy metal concentrations against established soil quality criteria (or soil screening values) that are protective of both environmental and human health.

No additional samples were taken and the following consideration of the heavy metal concentrations determined in soils is based on soils collected from the plant during a previous sampling regime (2017) and used to inform whether a potential pathway is being realized. To avoid repetition, the original report comprehensively details the sampling locations, and the sampling and analytical methodologies. The original samples were collected to inform a pre-operational baseline and accompanied by a recommendation to re-sample at 5 yearly intervals (2022). A screen grab of Table 2 of this report[5] is repeated here (see Table A2-1 below).

Table A2-1: Soil Sampling Summary Statistics (7 samples) – Aughinish Alumina Ltd, 2016/2017

Parameter	Units	Minimum	Maximum	Mean*	Median*
pH	pH units	7.69	8.44	8.1	8.12
Total Sulphate	mg/kg	218	909	507	468
Aluminium	mg/kg	1,893	16,060	10,628	12,630
Arsenic	mg/kg	3.4	19.4	11.0	9
Cadmium	mg/kg	<0.1	2.3	0.94	0.8
Lead	mg/kg	<5	21	16	16
Mercury	mg/kg	<0.1	<0.1	<0.1	<0.1
Nickel	mg/kg	8.1	59.8	32	34.1
Sodium	mg/kg	154	602	257	189
Extractable Petroleum Hydrocarbons (EPH, C8-C40)	mg/kg	not detected			
Gasoline Range Organics (GRO)	µg/kg	not detected			
Nonyl phenol ethoxylates	mg/kg	not detected			
sVOCs	µg/kg	not detected			

*values below detection were not considered for mean and median concentrations

Soil Guideline Values (SGVs)

In soils systems as in sediments, metal bioavailability depends on local conditions including pH, underlying geology, a range of biotic and abiotic factors and a range of soil characteristics, and therefore, the risks are site-specific. Environmental quality standards (EQS) for soils are termed soil guideline values (SGVs) and are typically used to manage the risks of metals in terrestrial environments. However, comparing total concentration is of limited value as the toxicity of a heavy

[5] Soil Quality Monitoring Report, Aughinish, Co. Limerick, Report No. 1663245 R02A0 Golder Associates, July 2017

metal in a soil is dictated largely by its biological availability and so it is important that metal bioavailability is considered in any evaluation of heavy metal concentrations. That said, Soil Guideline Values (SGV) and their supporting technical guidance have been developed to and are intended to assist professionals in the assessment of the long-term risks to health from human and environmental exposure to heavy metal contamination in soil. There are often different SGVs according to particular land-use (residential, allotments, commercial) because people use land differently and this affects who and how people may be exposed to soil contamination. Soil Guideline Values have been used as 'trigger values' for screening-out low risk areas of land contamination often during remediation projects. SGVs give an indication of the representative average levels of heavy metals in a soil below which the long-term health risks are likely to be minimal. Exceeding an SGV does not mean that a risk is necessarily present or remediation necessary, although in many cases some further investigation and evaluation of the risk may be carried out; such as, attempting to determine the soluble or bioavailable concentrations.

The term SGV is very generic and different approaches, methodologies and derivations have been re-invented by different organisations and national governments. Therefore, there are a wide range of available SGVs and the appropriateness of their use needs to be defined at the onset as often they are not representative of a particular site that may be under investigation. Several SGVs do not assess risk to human health or short-term and acute exposures and others are not acceptable for ecological receptors. SGVs are available only for a limited number of chemical substances.

Professionals and regulators that are required to assess the risks to health from potential land contamination are not obligated to use a particular SGV approach and alternative approaches do exist, but these must satisfy any legislative requirements; one such approach is the CLEA model[6][7], (see footnote for technical background to the model and the underlying assumptions used to predict exposure for three standard land use scenarios (residential, allotments and commercial)). It is recognised that the EPA have adopted the use of the CLEA model for the determination of human health impacts of contaminated land. In our comparison we have selected to use the Dutch intervention values as in this case they address both human and environmental health concerns simultaneously; the UK CLEA S4U values are the default for human health, but do not apply to protection of environmental receptors, only to the protection of human health. The later section on Comparison of determined soils against SGVs provides a recommendation on choice of SGV for this study.

Background soil concentrations

An excellent compilation of pre-existing collated information on heavy metals in soils, plants and food that is largely relevant to Ireland has been produced by McGrath and Fleming (2007)[8]. This document provides an overview of the geochemical profile of Irish soils alongside likely inputs and measurements on typical background soil metal concentrations. In addition, the Tellus survey is a national programme to gather geochemical and geophysical data across Ireland and provides significant information on background concentration is soils across Ireland[9]. Other studies have also sought to define the upper limits of natural background concentrations (NBCs) using the upper

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[6] Human health toxicological assessment of contaminants in soil (Science Report Final SC050021/SR2) (PDF, 718KB)

[7] Updated technical background to the CLEA model (Science Report Final SC050021/SR3) (PDF, 1.60MB)

[8] Heavy Metals in Irish Soils, David McGrath & Garrett A. Fleming 2007; https://www.teagasc.ie/media/website/publications/2011/Trace_Elements.pdf

[9] https://www.gsi.ie/en-ie/programmes-and-projects/tellus/Pages/default.aspx as described by the Part 2A contaminated land statutory guidance

95 per cent confidence limit of the 95th percentile of measured normal background concentrations for a range of priority hazardous heavy metals to best define the upper limit of ‘normal’ levels of contaminants in a soil . These derived “normal” values (see Table A2-2) are not a legal planning or risk assessment tool but provide a contextual basis for comparison with the soil samples collected from the plant vicinity (Table A1-1).

The background soil concentrations indicated in Table 1 are in good alignment and not exceeded for the heavy metals determined in the vicinity of the plant (viz. arsenic, cadmium, lead, mercury, and nickel) presented in Table A2-1.

Table A2-2: A summary of measured “normal” background concentrations (NBCs) for several hazardous heavy metals studied by Ander et al. 2013[10] studied in English soils (unless otherwise stated). All concentrations in the table below are in mg/kg.

As	DOMAIN				
	Principal	Mineralisation	Ironstone		
	32 (41,509)	290 (187)	220 (437)		
BaP	DOMAIN (Great Britain)				
	Principal	Urban			
	0.5 (371)	3.6 (32)			
Cd	DOMAIN				
	Principal	Min. Grp. 1	Min. Grp. 2	Urban	Chalk (south)
	1.0 (4,418)	17 (224)	2.9 (95)	2.1 (9,308)	2.5 (265)
Cu	DOMAIN				
	Principal	Mineralisation	Urban		
	62 (34,504)	340 (153)	190 (7,475)		
Hg	DOMAIN				
	Principal	Urban			
	0.5 (1,126)	1.9 (512)			
Ni	DOMAIN				
	Principal	Ironstone (Ni)	Peak District	Basic	Ultrabasic
	42 (41,768)	230 (117)	120 (221)	* (23)	* (4)
Pb	DOMAIN				
	Principal	Mineralisation	Urban		
	180 (34,257)	2,400 (347)	820 (7,529)		

[10] Ander, EL, Johnson CC, Cave, MR, Palumbo-Roe, B, Nathanail, P and Lark, RM Methodology for the determination of normal background concentrations of contaminants in English soil. *Science of The Total Environment*, Volumes 454–455, 1 June 2013, Pages 604-618

Comparison of determined soils against SGVs

As stated above the choice of a soil guideline value against which to compare determined soil heavy metal concentrations remains a matter of choice as policy permits a range of soil intervention values and indicative levels for serious contamination and other target values. The Dutch government uses a risk-based approach in environmental policy (Ministry of Housing, Spatial Planning and the Environment (VROM), Lower House of Parliament, parliamentary proceedings 1988-1989, 21 137, no. 5) and has developed a set of soil intervention and accompanying target values for soil as given in Table A2-3. These target and intervention values for soil metals also depend on the concentration of organic substances and clay.

The key reason for comparing the plant soil data against these Dutch soil intervention values is that exceedance of these values will likely indicate when the functional properties of a soil for both human and environmental health is seriously impaired or threatened. They are representative of the level of contamination above which there is a likelihood of serious soil contamination and are based on extensive studies by the National Institute for Public Health and Environmental Protection (RIVM, report numbers 725201001 to 725201008 inclusive, report numbers 715810004, 715810008 to 715810010 inclusive, report numbers 711701003 to 711701005 inclusive) of both human and ecotoxicological effects of heavy metal soil contaminants. These Dutch Intervention values are one of the few SGVs that addresses both human and environmental health simultaneously and are widely recognised and accepted across regulatory bodies in Europe.

Human toxicological effects have been quantified in the form of concentrations in the soil above which the so-called maximum permissible risk (MPR) for humans may be exceeded. For non-carcinogenic substances this corresponds to the Tolerable Daily Intake (TDI). Ecotoxicological effects are quantified in the form of concentrations in the soil above which 50% of the potentially present species and processes may experience negative effects. The ultimate intervention values for soil and sediment are based on an integration of the human and ecotoxicological effects. In principle the most critical effects are definitive.

Table A2-3 presents these intervention values for the listed heavy metals adopted by the Dutch Legislature. The intervention values for soil remediation are used to assess whether heavy metal concentrations in soils poses a serious threat to public and environmental health. A comparison of the soil heavy metal determinations shown in Table A2-1 from the Aughinish plant locality indicates that the recorded heavy metal concentrations in all soil samples are below the thresholds above which the functionality of the soil for human or ecological health is considered seriously compromised or impaired.

Table A2-3: Dutch target values (also referred to as A-value or reference value) and intervention values (also referred to as C-value) for selected heavy metals in soil (mg/kg dry matter). (Source: Dutch Ministry of Housing, Spatial Planning and Environment. The Hague, The Netherlands).

Metal	Target value	Intervention value
Arsenic	29	55
Barium	200	625
Cadmium	0.8	12
Chromium	100	380
Cobalt	20	240
Copper	36	190
Mercury	0.3	10
Lead	85	530
Molybdenum	10	200
Nickel	35	210
Zinc	140	720

Summary

The range and concentrations of heavy metals detected in the soils sampled from the seven locations in 2017 and reported in Table A2-2 are generally typical of soil background heavy metal concentrations in Ireland. This quantitative overview of determined soil metal concentrations has indicated that the manufacturing activities and controlled emissions from the plant appear to have little/ if any effect on soil heavy metal concentrations and hence on environmental or human health in the vicinity of the site when compared to the widely accepted Dutch Intervention values. In terms of our source- pathway – receptor model there appears to be no linkage (pathway) between any potential source metals at the plant and their deposition into the local environment.