Aughinish Alumina Ltd.

Askeaton, Co. Limerick

IE Licence Reg. P0035-06



Annual Environmental Report
2015

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Aughinish Alumina Ltd.

Industrial Emissions Licence
Register No. P0035-06

Annual Environmental Report 2015

March 2016

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1. Introduction

This document comprises the Aughinish Alumina Limited (AAL) Annual Environmental Report (AER).

The report covers the period from the 1st January 2015 to the 31st December 2015 and has been prepared in accordance with the Environmental Protection Agency (EPA) 'Guidance Note on the Annual Environmental Report' and other relevant guidance as provided by the EPA on their website (www.epa.ie).

1.1 Description of the Activity

AAL was granted a revised Industrial Emissions Licence (IE Licence) 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

This IE Licence (Reg. No. P0035-06) supersedes the installation's previous licence (Reg. No. P0035-05), which was issued in 2012.

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 for Guinea in West Africa with the remainder coming from Brazil. The finished product, alumina, is exported for further processing through smelting to aluminium metal.

The production output of the plant in 2015 was 1,897,616 tonnes of alumina (1,974,017 tonnes of alumina hydrate).

1.2 Management Structures

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 IE Licence 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 gained certification of its EMS to the international standard ISO 14001:2004.

Safety, environmental and quality management systems are audited on an on-going basis by a combination of internal audit teams and external certification surveillance audits by our certification body Det Norske Veritas (DNV UK).

1.3 Organisational Structure

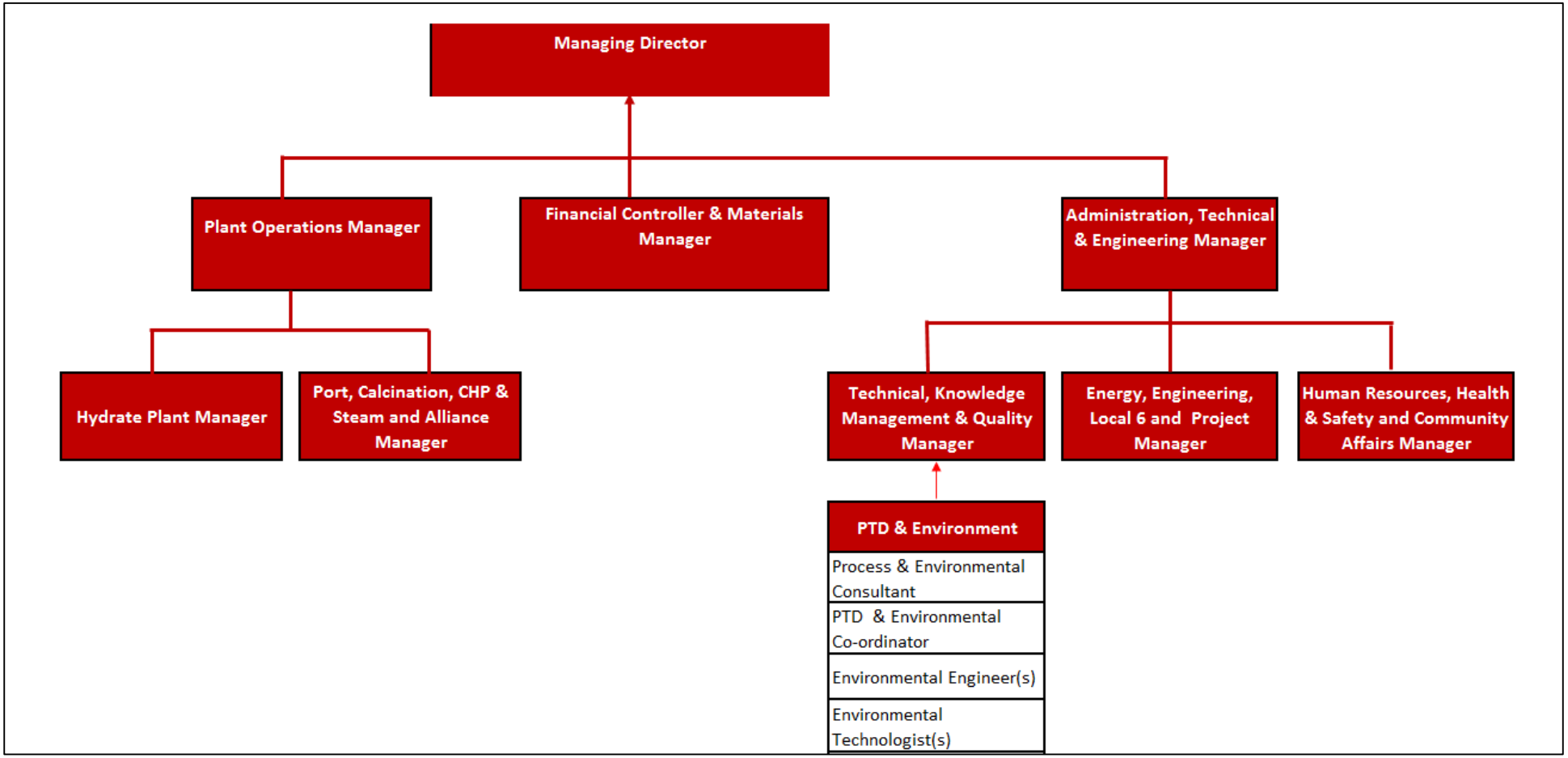
AAL operates a relatively flat management structure with a strong emphasis on team working. The company structure in 2015 is set out in the organogram overleaf and outlines the responsibility for day-to-day management of environmental issues at the plant.

The PTD and Environmental Co-ordinator has overall responsibility for environmental management and reports directly to the Management Team.

The Environmental Co-ordinator is supported in the day-to-day activities by the Environmental Engineer(s), who have responsibility for the maintenance of the Environmental Management System, undertaking specific projects of an environmental nature and evaluating compliance with the IE Licence.

The Environmental Technologists are responsible for environmental monitoring activities including sampling and analysis of all emissions and discharges from the site.

The Contractor Alliance comprises three main contractor companies providing various engineering, operational and maintenance services all of whom are based on-site. As part of contractor induction training, an Environmental Manual is issued to each contractor. This contains information on site environmental requirements and instructions for environmental management and control to ensure compliance with the IE Licence. Contractors are regularly updated through regular training and safety briefings.


Managing Director
Plant Operations Manager
Financial Controller & Materials Manager
Administration, Technical & Engineering Manager
Hydrate Plant Manager
Port, Calcination, CHP & Steam and Alliance Manager
Technical, Knowledge Management & Quality Manager
Energy, Engineering, Local 6 and Project Manager
Human Resources, Health & Safety and Community Affairs Manager
PTD & Environment
Process & Environmental Consultant
PTD & Environmental Co-ordinator
Environmental Engineer(s)
Environmental Technologist(s)

1.4 Environmental Policy

RUSAL
AUGHINISH



Statement of Environmental Policy

Protection of the environment is a high priority for every employee, contractor and director of RUSAL Aughinish. This objective requires our full co-operation in a continuing effort to improve our products and production processes.

The process we employ at RUSAL Aughinish, the 'Bayer Process', is the accepted industrial method for the manufacture of alumina world-wide. Our principal product, smelter grade alumina, is used to manufacture aluminium, a metal with many recognised environmental benefits.

Successful integration of our environmental objectives with our health, safety, quality and cost objectives is required to ensure our competitive position.

We will continue to:

- *Comply with all legal requirements and where appropriate, use more stringent internal standards based on our expertise.*
- *Use world class practices to ensure that we prevent pollution and meet social, economic and environmental demands.*
- *Develop opportunities with suppliers and customers to improve our products and to minimise waste and environmental impacts.*
- *Make effective use of environmental management systems that continually improve our performance consistent with defined goals.*
- *Review our environmental objectives and targets regularly to ensure that these remain both relevant and appropriate to our operations.*
- *Communicate with employees, consumers, communities, businesses and government to achieve greater environmental understanding.*
- *Ensure that RUSAL Aughinish's environmental policy is communicated to all employees and contractors and is made available to the public.*

By fulfilling these objectives, we will have due regard to the environmental expectations of our many stakeholders.

signed:

Seán Garland

Seán Garland MD
January 2016

MANAGEMENT SYSTEM CERTIFICATION
DNV·GL
ISO 9001 · ISO 14001

2. Emissions

AAL implements a comprehensive environmental monitoring programme to assess the significance of emissions from site activities. The programme includes emissions to air, effluent discharges, surface water and waste monitoring. An overview of the results of monitoring conducted during 2015 is presented in this section.

This section also includes an evaluation of compliance with the conditions and schedules of the IE Licence, together with a summary of environmental incidents reported to the Agency during 2015.

Summary information on all emissions, discharges and waste arising from operations at AAL has been submitted to the Agency via the AER/PRTR Annual Environmental Reporting website. Monitoring data, summarised in the following sections, shows continued compliance with IE Licence Conditions and Emission Limit Values (ELV's).

2.1 Emissions to Air

There are 15 IE licensed air emission points at AAL. The primary sources of emissions to air in 2015 were the Gas Boilers (Emission Point Ref. A4-A, A4-B), Combined Heat and Power Plant (CHP) (Emission Point Refs. A3-A and A3-B), Calciners (Emission Point Ref. A2) and HFO Boilers (Emission Point Ref. A1). The gas boilers were installed and commissioned in 2014 and replaced the HFO boilers as primary sources of steam.

The remaining emission sources comprise bag house and cyclone exhausts for control of particulate emissions from materials handling operations and three diesel fired boilers for heating buildings.

2.1.1 HFO Boiler Emissions

HFO Boiler emissions were reduced in 2015 compared with previous years. The HFO boilers are no longer utilised as a primary generators of steam and were only utilised infrequently as back-up to the new gas boilers in 2015. Depending on the parameter, monitoring varies from continuous online monitoring to quarterly analyses as specified in Schedule C1.1 (Control of Emissions to Air) of the IE Licence. A summary of the actual mass emissions for the licensed parameters during the reporting period is tabulated in Table 1 below.

Actual mass emissions of oxides of sulphur (as SO_2), as tabulated below, are generated by calculation, based on the sulphur content of the fuel and the quantity of fuel oil consumed in 2015. Nitrogen oxides mass emissions (as NO_2) are derived from measured NO_2 values, and estimated exhaust gas flow rates. Dust mass emissions from the boilers are calculated from the measured particulate emissions and estimated exhaust gas flow rates. The gas flow rate estimation is based on the quantity of fuel used, as there is a stochiometric relationship between air flow and fuel consumption.

Licensed mass emissions are based on emissions concentration and flow rate at ELV, taking a 365 day operational period.

Table 1 Mass Emissions to Air – HFO Boilers

Emission Point Ref. A1 Boilers	Mass Emission (kg) 2014	Mass Emission (kg) 2015	Licensed Mass Emissions (kg)
Oxides of Sulphur (as SO_2)	571,008	49,618	5,474,299
Nitrogen Oxide (as NO_2)	261,312	20,869	2,415,132
Dust	19,363	2,493	161,009

Emissions of sulphur dioxide, nitrogen oxides and dust from the main site boilers were significantly below licensed mass emission rates permitted for these parameters.

The actual mass emission of SO_2 from the boilers decreased by 91% in 2015 compared to the 2014 figure. Emissions of nitrogen oxides (as NO_2) decreased by 92% and particulates decreased by 87% during the same period.

These significant decreases were due to the replacement of the three HFO boilers with two new more efficient gas boilers as primary sources of steam.

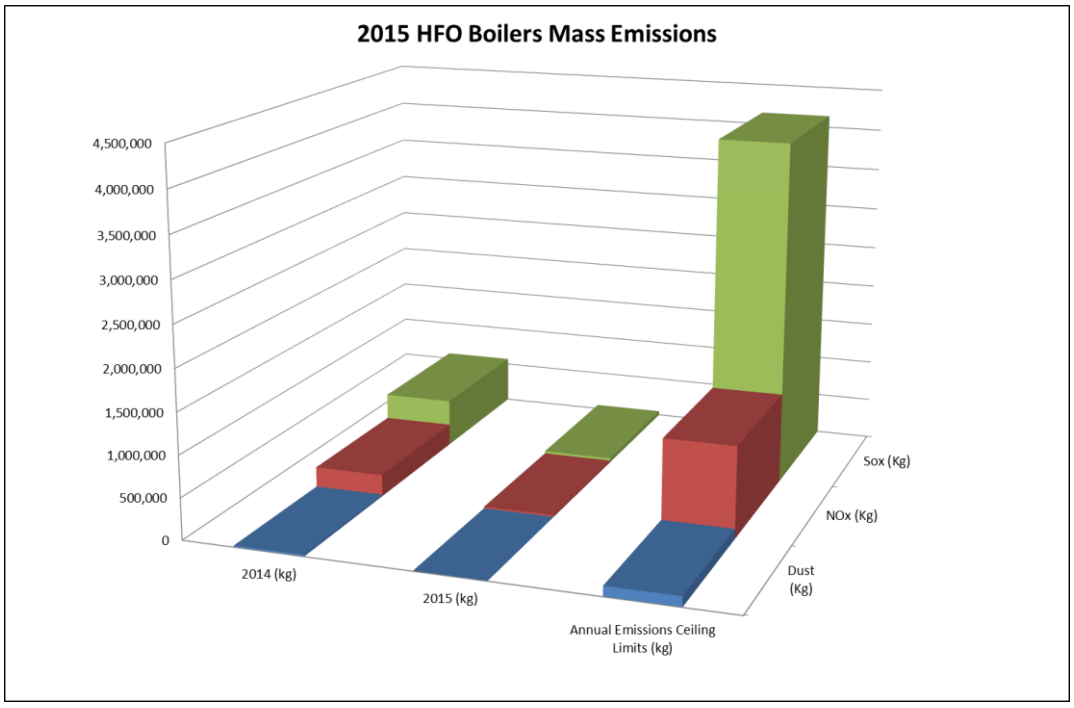


Figure 1 HFO Boiler Mass Emissions 2015

2.1.2 Gas Boiler Emissions

Emissions from the gas boilers are summarised in Table 2 below as actual annual mass emissions (in kgs) for the licensed parameters during the 2015 reporting period. There was an increase in gas boiler emissions in 2015 when compared with 2014 as the gas boilers were in operation for all of 2015 but not all of 2014.

Table 2 Mass Emissions to Air - Gas Boilers

Emission Point Ref. A4-A & A4-B – Gas Boilers	Mass Emission (Kgs) 2014	Mass Emission (Kgs) 2015	Licensed Mass Emissions (Kgs)
Nitrogen Oxides (as NO_2)	37,378	84,024	227,760
Carbon Monoxide	4,611	13,019	227,760

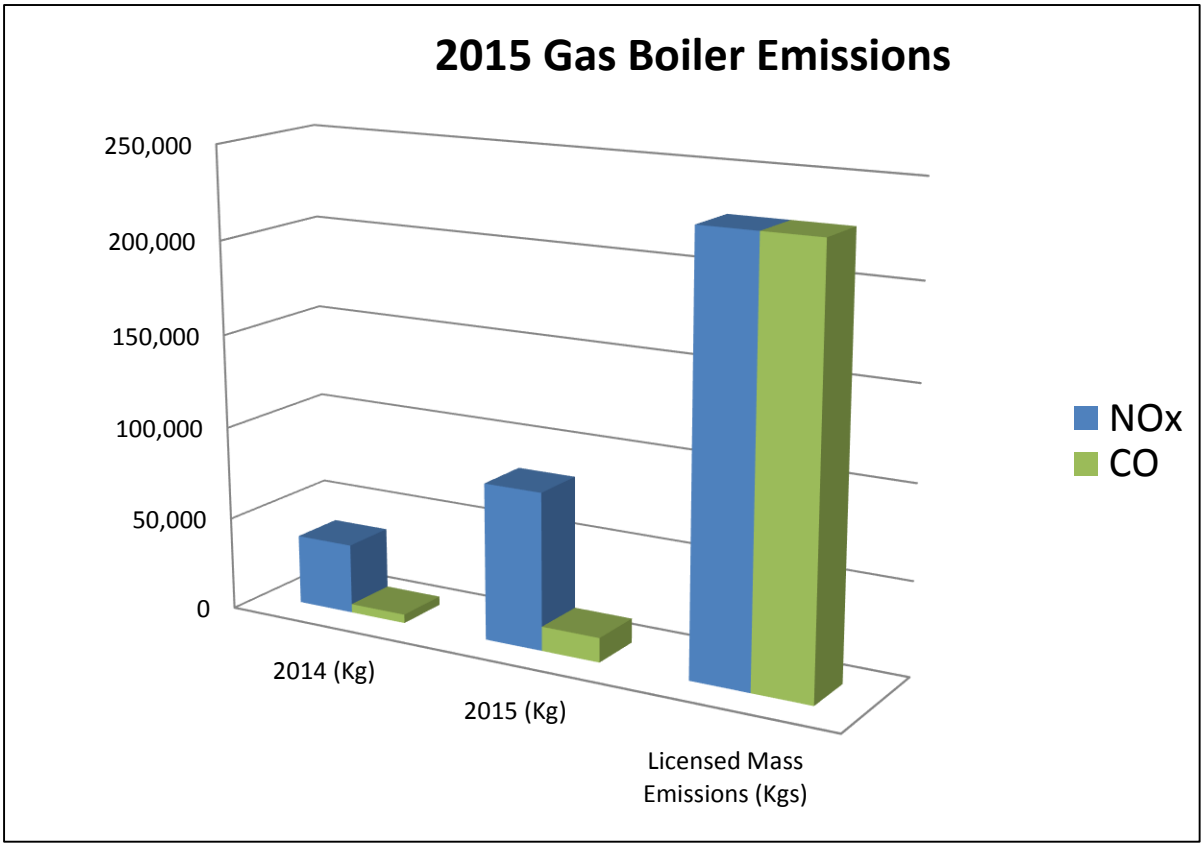


Figure 2 Gas Boiler Mass Emissions 2015

2.1.3 Calciner Emissions

Emissions from the calciners are summarised in Table 3 below as actual annual mass emissions (in kgs) for the licensed parameters during the 2015 reporting period.

The calciners operated on natural gas only in 2015 so there were no emissions of oxides of sulphur. Particulate mass emissions are based on the measured particulates, as monitored as part of the IE Licence requirements, and estimated exhaust gas flow rates.

Table 3 Mass Emissions to Air - Calciners

Emission Point Ref. A2 – Calciner	Mass Emission (Kgs) 2014	Mass Emission (Kgs) 2015	Licensed Mass Emissions (Kgs)
Oxides of Sulphur (as SO_2)	0	0	7,029,024
Particulates	180,568	108,556	235,060
Nitrogen Oxides (as NO_2)	434,790	537,316	878,628

Emissions of sulphur dioxide, particulates and nitrogen oxides from the calciners were significantly below licensed emission rates permitted for these parameters.

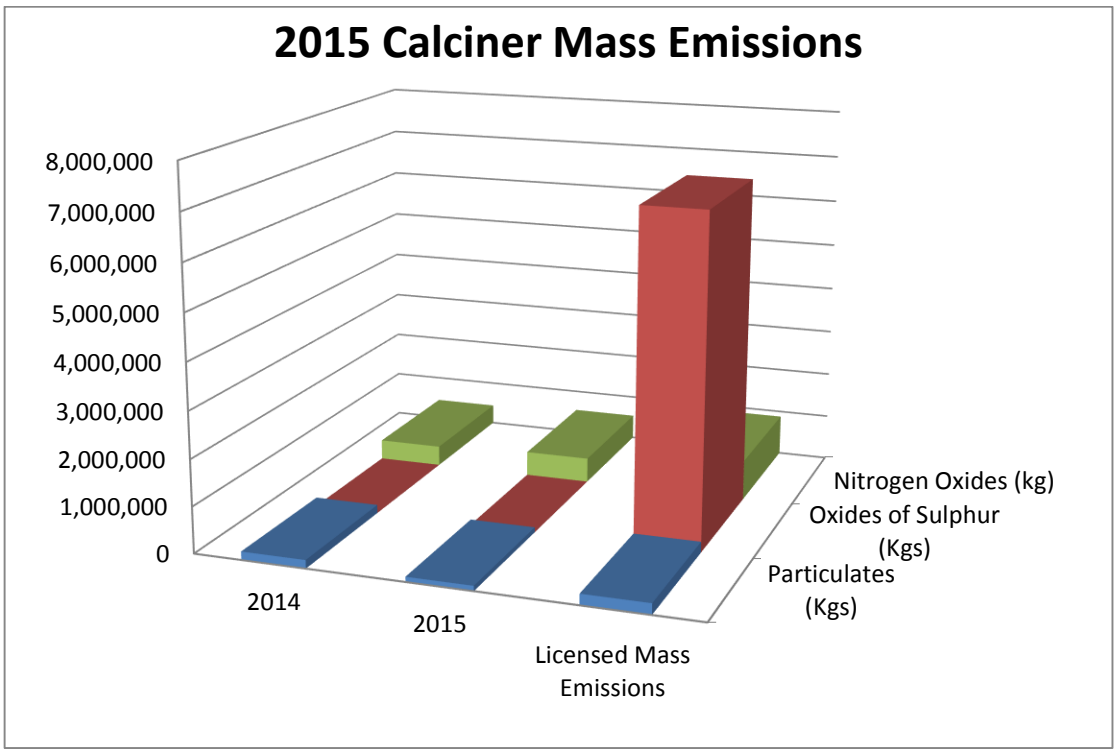


Figure 3 Calciner Mass Emissions 2015

2.1.4 CHP Emissions

Schedule C.1.2 of the IE Licence requires continuous monitoring of oxides of nitrogen (as NO_2). Monitoring of carbon monoxide (CO) became a new requirement in IE Licence P0035-06 issued in July 2014.

The licence requirements for the CHP heat recovery steam generator stack are as outlined below:

- No 24-hour value shall exceed the emission limit value of 75 mg/Nm^3 for Nitrogen Oxides and 100mg/Nm^3 for Carbon Monoxide.
- No hourly value shall exceed twice the ELV.

The NO_2 and CO monitoring results for 2015 is shown in Table 4 below and are significantly below the licensed emission limit values.

Table 4 Mass Emissions to Air - CHP

Emission Point Ref. A3A & A3B – CHP	Mass Emission (Kg) 2014	Mass Emission (Kg) 2015	Licensed Mass Emissions (Kg)
Nitrogen Oxides (as NO_2)	288,853	291,084	946,080
Carbon Monoxide	5,527	19,474	1,261,440

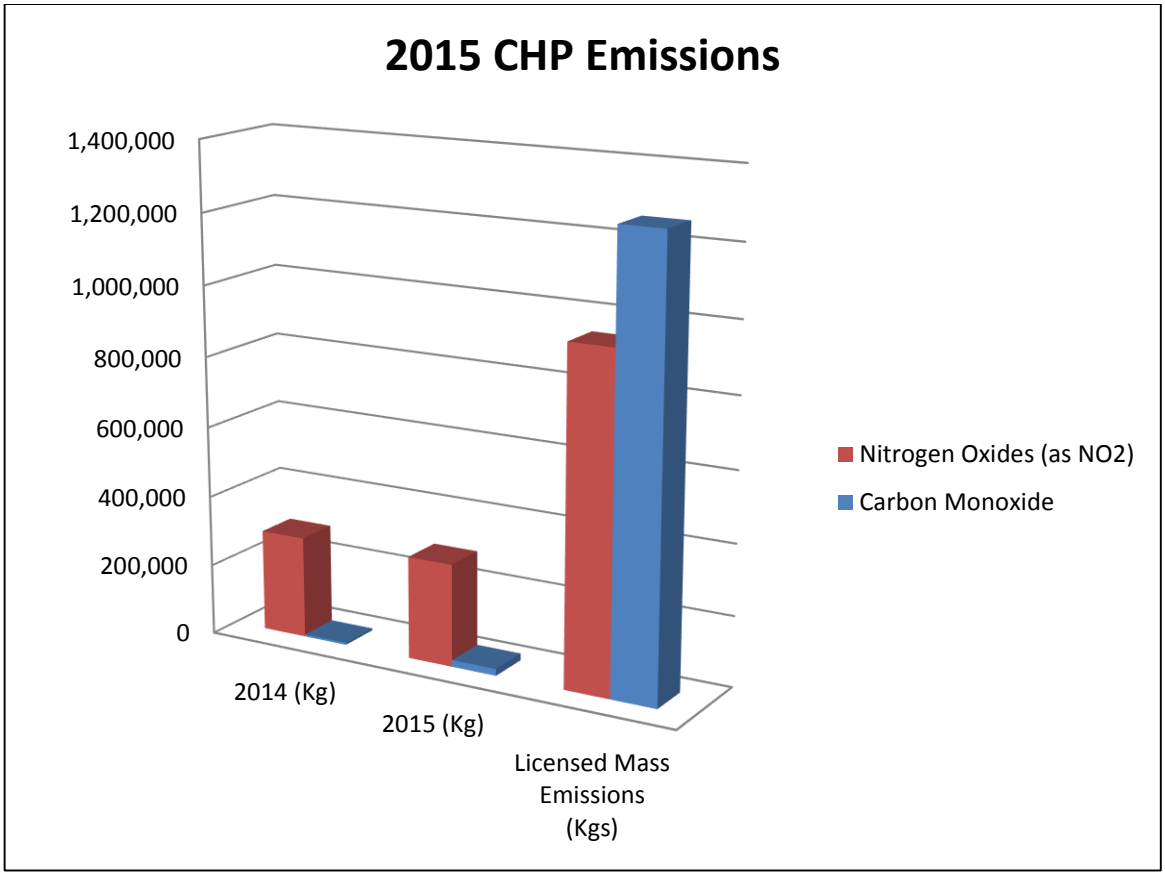


Figure 4 CHP Mass Emissions 2015

2.1.5 Other Emission Points (Dust Collection Units)

There are 9 other licensed process air emission points of which 6 were operational during 2015. These emissions are from dust collection units (DCUs) associated with bauxite and alumina handling and conveying operations at the plant.

Actual mass emissions of particulates from each of the licensed emission points are tabulated below and are based on average quarterly monitoring results and total hours of operation during 2015.

The combined actual annual mass emission of particulates from the licensed emission points was 12,075kg during 2015 which is significantly lower than the permitted annual mass emission for the combined sources of 174,567 kg.

In addition, each individual sample collected during the monitoring periods was significantly below the relevant emission limit value for that source.

Table 5 Summary of Particulate Emissions from Dust Collection Units

Emission Point Ref./Description		Mass Emission 2014(kg)	Mass Emission 2015(kg)	Licensed Emission (kg)
5	Transfer Tower 4 & 5 Exhaust Fan	N/A	N/A	51,757
6	Bauxite Crusher Scrubber Exhaust Fan	3,069	3,683	49,034
8	Transfer Tower 3 Scrubber Exhaust Fan	N/A	N/A	21,535
11	Alumina Loader Dust Fan FA49AL03 Outer	N/A	N/A	20,659
12	Alumina Loader Dust Fan FA49A Inner	1,323	1,610	9,682
16	Alumina Silo 1 Exhaust Fan FA12A017	1,971	2,934	6,570
17	Alumina Silo 2 Exhaust Fan FA12A018	2,031	1,795	6,570
18	Alumina Silo 3 Exhaust Fan FA12A019	1,211	1,412	4,380
19	Alumina Silo 1/2 Exhaust Fan FA12A020	613	642	4,380
Total		**10,218**	**12,075**	**174,567**

2.1.6 Emissions to Air Compliance Summary

Compliance with the relevant emission limit values (ELV's) for emissions to atmosphere is evaluated as follows for all active boilers, calciners and CHP emissions.

HFO Boiler Emissions

The overall annual level of compliance with emission limit values for continuous monitoring of HFO boiler emissions to atmosphere is tabulated below for the 48-hour and the monthly average compliance requirements as specified in Condition 4.1.2 of the IE Licence. The parameters evaluated are sulphur dioxide and nitrogen oxides. It should be noted that Boiler B is no longer in use.

- No monthly mean shall exceed the ELV (750 mg/Nm^3 for NOx and 1700 mg/Nm^3 for SO_2)
- 95% of 48-hour mean values shall not exceed 825 mg/Nm^3 for NOx
- 97% of 48-hour mean values shall not exceed 1,825 mg/Nm^3 for SOx

The evaluation indicates that HFO boiler emissions were fully compliant with both the 48-hour (Table 6) and monthly average (Table 7) emission limits as specified in Condition 4.1.2 of the IE Licence.

Table 6 Evaluation of Compliance with 48-hour Average ELV's – HFO Boilers

Parameter	**Oxides of Sulphur (as SO_2)**		**Nitrogen Oxides (as NO_2)**	
No. Measurement Intervals	**183**		**183**	
Boiler Ref.	**A**	**C**	**A**	**C**
No. of Periods above 1.1 x ELV	0	0	0	0
% of 48-hour periods below 1.1 x ELV	100%	100%	100%	100%
Target % below 1.1 x ELV for compliance	97%	97%	95%	95%
Compliant	**Yes**	**Yes**	**Yes**	**Yes**

Table 7 Evaluation of Compliance with Monthly Average ELV's – HFO Boilers

Parameter	Oxides of Sulphur (as SO_2)		Nitrogen Oxides (as NO_2)	
# Measurement Intervals	**12**		**12**	
Boiler Ref.	**A**	**C**	**A**	**C**
No. of Periods above ELV	0	0	0	0
% of monthly periods below ELV	100%	100%	100%	100%
Target % monthly periods below ELV for compliance	100%	100%	100%	100%
Compliant	**Yes**	**Yes**	**Yes**	**Yes**

Gas Boiler Emissions

For gas boiler overall compliance is assessed in accordance with Condition 4.1.1:

- 100% of validated monthly average values shall not exceed 100mg/Nm^3 for NOx & CO.
- 100% of validated daily average values shall not exceed 110mg/Nm^3 for NOx & CO.
- 95% of validated hourly average values shall not exceed 200mg/Nm^3 for NOx & CO.

The evaluation confirms that gas boiler emissions were fully compliant with all the parameters specified in Condition 4.1.1 of the IE Licence as summarised in Table 8 below.

Table 8 Evaluation of Compliance – Gas Boilers

Parameter	ELV (mg/m^3)	Actual 2015 (mg/m^3)	Comment
A4-A (D Boiler) Monthly average NO_X	100% <100	100% <100	Compliant
A4-A (D-Boiler) Daily average NO_X	100% <110	100% <110	Compliant
A4-A (D Boiler) Hourly average NO_X	95% <200	100% <200	Compliant
A4-B (E Boiler) Monthly average NO_X	100% <100	100% <100	Compliant
A4-B (E-Boiler) Daily average NO_X	100% <110	100% <110	Compliant

A4-B (E-Boiler) Hourly average NO_X	95% <200	100% < 200	Compliant
A4-A (D Boiler) Monthly average CO	100% <100	100% <100	Compliant
A4-A (D-Boiler) Daily average CO	100% <110	100% <110	Compliant
A4-A (D Boiler) Hourly average CO	95% <200	100% <200	Compliant
A4-B (E Boiler) Monthly average CO	100% <100	100% <100	Compliant
A4-B (E-Boiler) Daily average CO	100% <110	100% <110	Compliant
A4-B (E-Boiler) Hourly average CO	95% <200	100% <200	Compliant

Calciner Emissions

The requirements for Calciner particulate emissions as outlined in Condition 4.1.3 of the IE licence are as follows:

- No daily mean value shall exceed the ELV (50 mg/Nm^3)
- No hourly mean shall exceed twice the ELV (100 mg/Nm^3)
- 97% of hourly mean values shall not exceed 1.2 times the ELV (60mg/Nm^3)

An evaluation of the continuous monitoring data for 2015 is summarised in Table 9.

Table 9 Evaluation of Compliance – Calciners

Parameter	ELV (mg/Nm^3)	Actual 2015 (mg/m^3)	Comment
Daily Average Particulates	100% <50	100%<50	Compliant
Hourly Average Particulates	100% <100	100% <100	Compliant
Hourly Average Particulates	97% <60	100% <60	Compliant

In addition, for quarterly non-continuous monitoring of particulates and nitrogen oxides (as NO_2), individual results were fully compliant with the relevant ELV's for calciner emissions.

CHP Emissions

In accordance with Schedule C.1.2, continuous monitoring of Oxides of Nitrogen and Carbon Monoxide was assessed. A summary of evaluation of compliance of CHP emissions is presented in Table 10 below. In all cases, the emissions were compliant with the relevant ELVs.

Table 10 Evaluation of Compliance - CHP 2015

Parameter	ELV (mg/m^3)	Actual 2015 (mg/m^3)	Comment
A3-A (GT1) Monthly average NO_X	100%< 75	100% < 75	Compliant
A3-A (GT1) Daily average NO_X	100%< 82.5	100% < 82.5	Compliant
A3-A (GT1) Hourly average NO_X	100%< 150	100% <150	Compliant
A3-B (GT2) Monthly average NO_X	100%< 75	100% < 75	Compliant
A3-B (GT2) Daily average NO_X	100%< 82.5	100% < 82.5	Compliant
A3-B (GT2) Hourly average NO_X	100%< 150	100% < 150	Compliant
A3-A (GT1) Monthly average CO	100%< 100	100%< 100	Compliant
A3-A (GT1) Daily average CO	100%< 110	100%< 110	Compliant
A3-A (GT1) Hourly average CO	100%< 200	100%< 200	Compliant
A3-B (GT2) Monthly average CO	100%< 100	100%< 100	Compliant
A3-B (GT2) Daily average CO	100%< 110	100%< 110	Compliant
A3-B (GT2) Hourly average CO	100%< 200	100%< 200	Compliant

Dust Collection Units

Other particulate emissions are required to be sampled on a bi-annual basis.

All monitoring results for each of the emission points were fully compliant with the specified emission limit values set out in the IE licence.

2.1.7 EN14181 Compliance Summary

As per the European Directive 2001/80/EC on the emissions into air from large combustion plant (LCPD) and the EPA Guidance document AG3 (Air Guidance Note on the Implementation of I.S. EN 14181), AAL carries out annual monitoring of emissions from the HFO boiler and gas turbine (CHP) continuous emissions measuring systems (CEMS) against Standard Reference Methods (SRMs) so as to validate their accuracy.

In 2015, QAL 2 Testing and Annual Surveillance Testing (AST) was undertaken by RPS Consultants on the CEMS for the primary steam generating sources for the site, as required - D gas boiler, E gas boiler, GT1 and GT2. It should be noted that the CEMs units on GT1 & GT2 were upgraded in 2015 and new QAL2 reports were generated accordingly. The current calibration functions for the relevant CEMS is shown in Table 11 below.

D and E gas boilers replaced A, B and C HFO boilers as primary sources of steam generation since 2014. A and C HFO boilers will be used only as a back-up units for D and E gas boilers, as required.

Table 11: EN14181 CEMS Calibration Functions

Unit	Parameter	Established Calibration Function		Year Established	Next QAL2 Required
		A	B		
A Boiler	NOx	0	0.85	2013	2018
	SOx	2.583	1.202	2013	2018
D Boiler	NOx	0.284	1.026	2015	2020
	CO	-1.335	0.958	2015	2020
E Boiler	NOx	-0.694	0.999	2014	2019
	CO	0.309	0.82	2014	2019
GT1	NOx	1.272	0.9189	2015	2020
	CO	3.042	0.965	2015	2020
GT2	NOx	1.324	1.0085	2015	2020
	CO	3.26	0.9436	2015	2020

2.2 Emissions to Water

AAL has two licensed discharges of treated effluent to the Shannon Estuary as follows:

Table 12 Licensed Discharges to Water

Licence Reference	Receiving Water	Characteristics
W1-1	Shannon Estuary	Treated Industrial (Process) Effluent
Sanitary Effluent	Shannon Estuary	Treated Sanitary Effluent

Discharges of treated industrial (process) and sanitary effluents to the Shannon Estuary are made at an outfall point close to the AAL Marine Terminal. Both discharges are sampled continuously for both flow and pH, and for other parameters at weekly, quarterly and bi-annual frequencies, as specified in Schedules C.2.1 (Control of Emissions to Water) and C.2.2 (Monitoring of Emissions to Water) of the IE Licence.

2.2.1 Process Effluent (W1-1)

Treated process effluent is discharged to the Shannon Estuary at emission point W1-1. Summary monitoring results for 2015 are tabulated in Table 13 below.

Screening for heavy metals, VOC's (Volatile Organic Compounds) and toxicity is also carried out and results are detailed in Sections 2.2.2, 2.2.3 and 2.2.4 respectively.

The data reported in Table 13 is for the 12 months of 2015. Figures for 2014 are included by way of comparison.

It is noted that annual mass emissions for all parameters during the reporting period were within licensed emission limit values (ELV's).

The increase in volume of process effluent discharged in 2015 is due to an increase in rainfall including a number of storms in December. It is also noted that there was no concurrent increase in BOD mass emissions which is indicative of the dilute nature of the increased effluent load which is mainly rainfall.

Table 13 Process Effluent (W1-1) Mass Emissions 2015

Parameters	Mass Emissions (kg) 2014	Mass Emissions (kg) 2015	Licensed Emissions (kg)
Volume (m^3)	5,239,106	5,479,337	10,950,000
BOD	367,373	160,326	861,400
Suspended Solids	68,545	70,318	547,500
Oils Fats & Greases	5,239	5,479	164,250

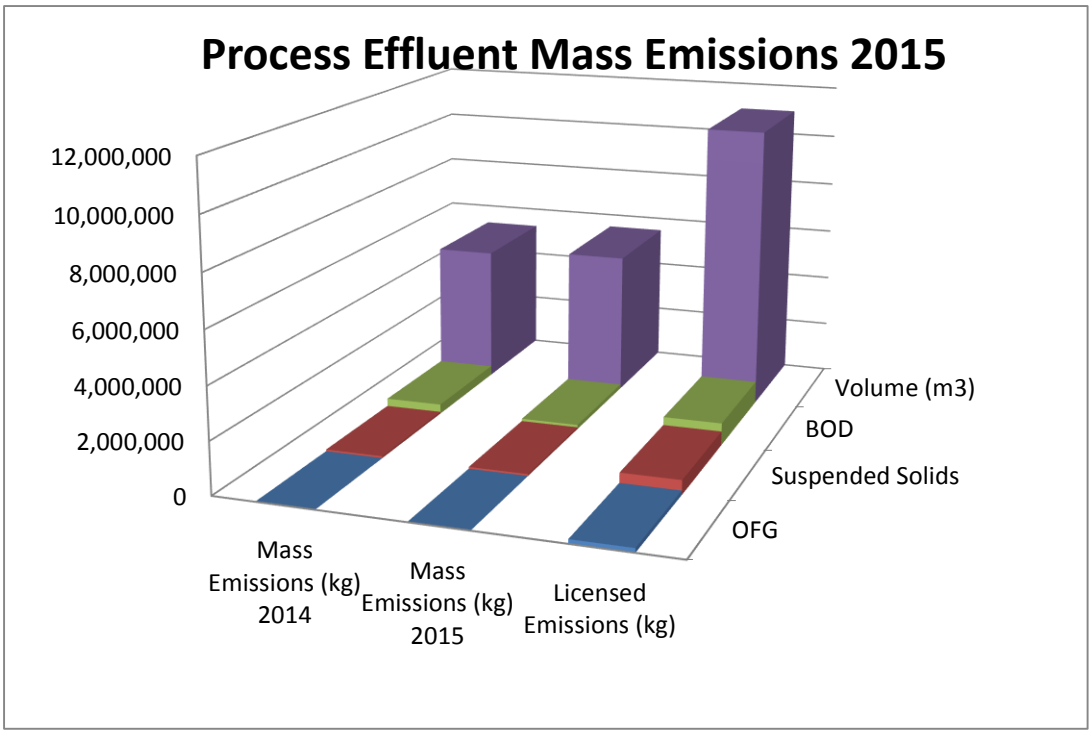


Figure 5 Process Effluent Mass Emissions 2015

2.2.2 Heavy Metal, Aluminium and Soda Analysis

AAL is required to analyse treated process effluent for heavy metals, aluminium and soda under IE Licence Schedule C.2.2 Monitoring of Emissions to Water.

Heavy Metals

Heavy metal analysis of the effluent discharged at emission point W1-1 was undertaken by Fitz Scientific Ltd. on a bi-annual basis during 2015. Analytical results are shown in Table 14 below.

Table 14 Process Effluent (W1-1) - Heavy Metal Analysis 2015

Parameter	Conc. (mg/l)	Conc. (mg/l)
	H1	H2
As	0.042	0.055
Cd	0.0009	0.0009
Cr	0.009	0.004
Cu	0.012	0.024
Hg	0.012	0.006
Ni	0.005	0.009
Pb	0.0002	0.0004
Zn	0.249	0.104
Ti	0.006	0.005
Fe	0.071	0.068

Mg	7.000	0.011

Aluminium & Soda

The results of the analyses for aluminium and soda are detailed in Table 15. The figure provided for each parameter is the average result for the 2015 monthly and quarterly monitoring intervals. 2014 data is provided for comparison.

Table 15 Process Effluent (W1-1) Soda & Aluminium Analysis 2015

Parameter	Units	Annual Average 2014	Annual Average 2015	ELV
Aluminium	mg/l Al	1.51	3.36	Not specified
Soda	g/l Na_2O	2.77	2.72	Not specified

2.2.3 Effluent VOC Screen

Screening of industrial effluent (at W1-1) for VOC's is undertaken biannually as specified in Schedule C.2.2 of the IE Licence. Biannual sampling and analysis was undertaken in April and July 2015. Laboratory analysis was undertaken by Fitz Scientific Ltd. using a modified version of the US EPA Method 524.2, as approved by the Agency (Ref. M35/AP/12).

The VOC concentration in the sample taken in April 2015 was <5 µg/l and the VOC concentration in the July 2015 sample was 75.76 µg/l.

Table 16 Process Effluent (W1-1) - VOC Analysis 2015

Date	Units	Test	Method	Result	ELV
29/04/2015	µg/l	VOC	USEPA 542.2	<5	Not specified
21/07/2015	µg/l	VOC	USEPA 542.2	75.76	Not specified

The VOC results are included as ***Attachment 1***.

2.2.4 Toxicity

Schedule B.2 (Emissions to Water) and Schedule C.2.2 (Monitoring of Emissions to Water) of the IE Licence requires biannual toxicity testing of the treated effluent. The ELV for toxicity is 5 Toxic Units (TU).

Sample of treated effluent (24 hour flow proportional composite sample) was collected and submitted to the Aquatic Services Unit, Environmental Research Institute, Lee Road, Cork for toxicity testing on the 11th May and 23rd August 2015.

The acute toxicity of each sample was analysed on suitable sensitive aquatic indicator species i.e. *Tisbe battagliai* and *Vibrio fischeri*.

The results (see Table 17) show that the both effluent samples were compliant with the ELV for toxicity.

The toxicity testing reports are included as ***Attachment 1***.

Table 17 Process Effluent - Toxicity Testing Results 2015

Test Parameter	May 2015 Results (TU)	August 2015 Results (TU)	ELV (TU)
48h LC_{50} to *Tisbe battagliai*	3.0	1.9	5
30 min EC_{50} to *Vibrio fischeri*	1	1.1	5

Note: Values denoted less than (<) are below the relevant threshold or limit of detection for that test

2.2.5 Sanitary Effluent

Treatment of sanitary effluent is provided for by a proprietary biological effluent treatment plant, which comprises an activated sludge (aeration) stage and a settlement/clarification stage, prior to discharge. The system discharges to the industrial effluent discharge pipeline at a point upstream of the final discharge at W1-1.

Annual mass emissions are tabulated in Table 18 below. 2014 data is provided for comparison.

Table 18 Sanitary Effluent Mass Emissions 2015

Parameter	Mass Emissions (kg) 2014	Mass Emissions (kg) 2015	Licensed Emissions (kg)
Volume (m^3)	21,572	22,038	87,600
BOD	237	187	2,190
Suspended Solids	84	88	3,066

The annual volumetric discharge mass emissions for all parameters were significantly below licence limits for the monitoring period.

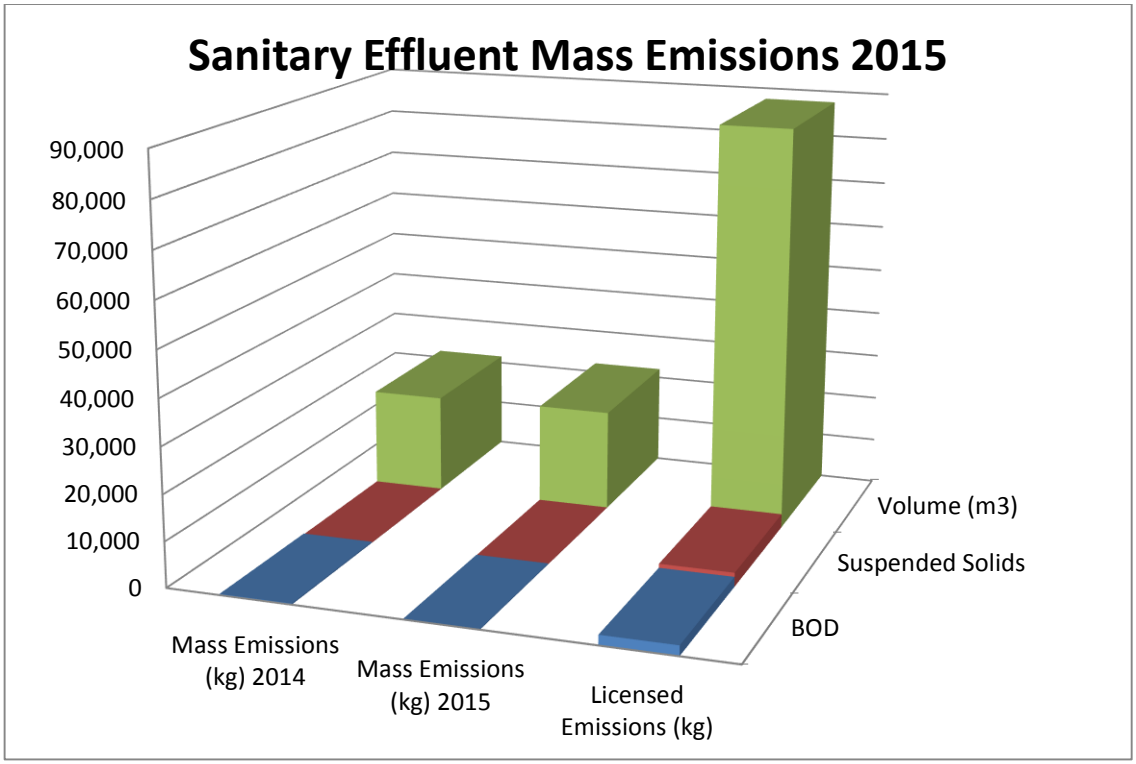


Figure 6 Sanitary Effluent Mass Emissions 2015

2.2.6 Surface Water Monitoring

Monitoring of surface water run-off from the site is undertaken at five discharge locations referred to as Surface Streams (SS).

Monitoring results for each emission point are summarised in Table 19 as the average value for the monitoring period.

Table 19 Results of Surface Water Discharge Monitoring 2015

Emission Point Reference	pH	Conductivity (µS/cm)	Na_2O (g/l)
Frequency	**Monthly**	**Monthly**	**Monthly**
SS 1	8.5	112	0.02
SS 2	8.3	181	0.01
SS 3	8.1	171	0.02
SS 4	8.2	180	0.02
SS 5	8.3	314	0.05

(Note: Results are numerical average of 2015 data)

2.2.7 Surface Water Monitoring at the BRDA

Monitoring of surface water run-off in the area of the existing BRDA is undertaken at three licensed locations – Mangan's Lough, the OPW Channel and Phase 2 West Robertstown Gate.

Results for each emission point are detailed in Table 20 and show the average value over the monitoring period. As the surface water in the area is subject to saline intrusion, the soda and conductivity values are subject to sodium interference owing to the presence of sodium salts in the brackish water.

Table 20 BRDA Surface Water Monitoring Results 2015

Description	pH	Conductivity µS/cm	Soda (Na_2O) g/l
Mangan's Lough	7.6	1,879	0.59
OPW Channel	7.7	2,849	0.69
West Robertstown Gate	7.7	4,190	0.99

(Note: Results are numerical average of 2015 data)

2.2.8 Discharges to Water Compliance Summary

All discharges of treated process wastewater and sanitary effluent during the reporting period complied fully with the relevant emission limit values set out in the IE Licence.

3. Waste Management

The national waste database table, providing a summary of waste arising at the AAL facility has been compiled for the calendar year 2015. The information is tabulated on Tables 21 and 22.

3.1 Waste Quantities 2015

Table 21 Summary Information on Waste Quantities Generated

	2011	**2012**	**2013**	**2014**	**2015**
Total Quantity of waste produced in calendar year (tonnes)	**1,342,802**	**1,305,251**	**1,345,370**	**1,465,781**	**1,509,598**
Quantity of waste disposed of on-site	1,341,342	1,303,765	1,343,879	1,464,306	1,507,468
Quantity of waste disposed of off-site	215	215	243.4	389	751
Quantity of waste recovered on-site	0	0	19.8	0	0
Quantity of waste recovered off-site	1,245	1,270	1,228	1,086	1,379
	2011	**2012**	**2013**	**2014**	**2015**
Quantity of Non-Hazardous waste produced in calendar year (tonnes)	**1,322,599**	**1,289,351**	**1,329,485**	**1,447,040**	**1,490,269**
Quantity of non-hazardous waste disposed of on-site	1,321,264	1,287,957	1,328,123	1,445,765	1,488,267
Quantity of non-hazardous waste disposed of off-site	202	195	221	373	739
Quantity of non-hazardous waste recovered on-site	0	0	0	0	0
Quantity of non-hazardous waste recovered off-site	1,134	1,199	1,141	902	1,263
	2011	**2012**	**2013**	**2014**	**2015**
Quantity of Hazardous waste produced in calendar year (tonnes)	**20,203**	**15,900**	**15,885**	**18,741**	**19,329**
Quantity of hazardous waste disposed of on-site	20,079	15,808	15,756	18,541	19,201
Quantity of hazardous waste disposed of off-site	14	20.5	22.3	16.4	12.5
Quantity of hazardous waste recovered on-site	0	0	19.8	0	0
Quantity of hazardous waste recovered off-site	111	71	87	184	116

The quantities of waste disposed of to the plant Bauxite Residue Disposal Area (BRDA) are estimated using a number of methods:

- Volumes of red mud disposed of to the BRDA are calculated from the annual production figures and the determined mud factor generated by analysis of the bauxite ores used during the reporting period.
- Volumes of salt cake, process scale and other process wastes are based on the number of containers multiplied by typical container net weight.

There was an overall increase of 43,817 tonnes of waste generated on site in 2015 compared to 2014. This increase was attributed primarily to fluctuations in bauxite quality. The quantity of waste disposed off site increased in 2015 compared to 2014 as sanitary effluent sludge was treated off-site for the full year in 2015 compared with part of the year treatment off-site in 2014 following a Licence condition change.

Results of waste analysis carried out by AAL during 2015 are included as ***Attachment 3***.

Table 22 Information on Individual Waste Streams

LoW Code	Haz (Y/N)	Description of Waste	Name of Waste Collection Contractor	Waste Collection Permit No.	Name of Waste Disposal/ Recovery Contractor	Method of Disposal/Recovery	Location of Disposal/ Recovery	Waste Licence/ Permit No.	Quantity (Tonnes/ annum)
15 01 11	Y	Aerosol Cans	John Malone Transport	WCP-LK-543-08b	Rilta Environmental Ltd., Greenogue Business Park, Rathcoole, Co. Dublin	D10 Incineration on land	(b) Off-site Abroad	W0192-03	5.00
17 06 01	Y	Asbestos	John Malone Transport	WCP-LK-543-08b	Rilta Environmental Ltd., Greenogue Business Park, Rathcoole, Co. Dublin	D5 Engineered Landfill	(c) Off-site Abroad	W0192-03	1.1
16 06 01	Y	Batteries	John Malone Transport	WCP-LK-543-08b	Rilta Environmental Ltd. Greenogue Business Park, Rathcoole, Co. Dublin	R4 Recycling/reclamation of metals & metal compounds	(b) Off-site Ireland	W0192-03	10.20
20 01 01	N	Cardboard	Greenstar	WCP-DC-08-1120-01	Greenstar, Dock Road, Limerick	R3 Recycling/reclamation of organic substances which are not used as solvents	(b) Off-site Ireland	W0082-02	17.7
16 05 06	Y	Chemical Waste	Lehane Environmental	WCP-CK-08-0574-02	Rilta Environmental Ltd. Greenogue Business Park, Rathcoole, Co. Dublin	R1 Use as a fuel (other than in direct incineration) or other means to generate energy	(b) Off-site Abroad	W0192-03	10.00
18 01 04	Y	Clinical Waste	SRCL	WCP-DC-09-1178-01	SRCL Ltd., 420-430 Beech Road, Western Industrial Estate, Naas Road, Dublin 12	D9 Physico chemical treatment	(b) Off-site Ireland	W0055-02	0.002
15 02 02	Y	Contaminated Soil	John Malone Transport	WCP-LK-543-08b	Rilta Environmental Ltd. Greenogue Business Park, Rathcoole, Co. Dublin	R13 Accumulation of material intended for any operation numbered R1-R12	(b) Off-site Abroad	W0192-03	7.000

LoW Code	Haz (Y/N)	Description of Waste	Name of Waste Collection Contractor	Waste Collection Permit No.	Name of Waste Disposal/ Recovery Contractor	Method of Disposal/Recovery	Location of Disposal/ Recovery	Waste Licence/ Permit No.	Quantity (Tonnes/ annum)
20 01 99	N	Conveyor Belting	Quarry Plant Supplies	N/A	Pat O'Connor, Quarry Plant Supplies, Straffan, Co. Kildare	R11 Uses of residual materials obtained from any of the operations numbered R1-R10	(b) Off-site Ireland	N/A	7.4
17 04 01	N	Copper	United Metals	WCP-LK-10-657-01	United Metals, Eastway Business Park, Limerick	R4 Recycling/reclamation of metals & metal compounds	(c) Off-site Abroad	WFP-LK-2013-147A-R1	1.8
16 11 04	N	Flue Stack Residue (Refractory Waste)	N/A	N/A	Aughinish Alumina Ltd.	D1 Deposit on, in or under land	Site landfill	P0035-06	62
20 01 21	Y	Fluorescent Bulbs	Irish Lamp Recycling	WCP-DC-08-1115-01	Irish Lamp Recycling, Athy, Co Kildare	R4 Recycling/reclamation of metals & metal compounds	(b) Off-site Ireland	WFP-KE-08-0348-01	9
20 03 01	N	General Waste	Greenstar	WCP-DC-08-1120-01	Greenstar, Dock Road, Limerick	D1 Deposit on, in or under land	(b) Off-site Ireland	W0082-02	169.1
01 03 99	N	Lime Grits/Stone	N/A	N/A	Aughinish Alumina Ltd.	D1 Deposit on, in or under land	Site landfill	P0035-06	7,125
06 04 04	Y	Mercury Liquid	Irish Lamp Recycling	WCP-DC-08-1115-01	Irish Lamp Recycling, Athy, Co Kildare	R4 Recycling/reclamation of metals & metal compounds	(b) Off-site Ireland	WFP-KE-08-0348-01	0.013
15 01 04	N	Metal Containers (empty IBC's & drums)	John Malone Transport	WCP-LK-543-08b	Rilta Environmental Ltd., Greenogue Business Park, Rathcoole, Co. Dublin	R4 Recycling/reclamation of metals & metal compounds	(b) Off-site Ireland	W0192-03	10.2

LoW Code	Haz (Y/N)	Description of Waste	Name of Waste Collection Contractor	Waste Collection Permit No.	Name of Waste Disposal/ Recovery Contractor	Method of Disposal/Recovery	Location of Disposal/ Recovery	Waste Licence/ Permit No.	Quantity (Tonnes/ annum)
16 01 07	Y	Oil Filters	Enva	WCP-DC-08-1116-01	Enva Shannon, Smithstown Industrial Estate, Shannon, Co. Clare	R11 Uses of residual materials obtained from any of the operations numbered R1-R10	(b) Off-site Abroad	W0041-01	0.55
13 08 99	Y	Oily Rags / Oil Dry	John Malone Transport	WCP-LK-543-08b	Rilta Environmental Ltd. Greenogue Business Park, Rathcoole, Co. Dublin	D10 Incineration on land	(b) Off-site Ireland	W0192-03	6.4
20 01 01	N	Paper/Documents	DGD Papers	WCP/LK/021/02b WCP/LK/021/05c WCP/LK/062/02b	DGD Papers Ltd., Bay M1, Raheen Business Park, Limerick	R3 Recycling/reclamation of organic substances which are not used as solvents	(b) Off-site Ireland	WFP-LK-2008-09C	2.0
20 01 39	N	Plastic containers (clean empty IBC's & drums)	John Malone Transport	WCP-LK-543-08b	Rilta Environmental Ltd., Greenogue Business Park, Rathcoole, Co. Dublin	R9 Used oil re-refining or other reuses of previously used oil	(b) Off-site Ireland	W0192-03	38.8
15 01 10	Y	Plastic containers (contaminated empty IBC's & drums)	John Malone Transport	WCP-LK-543-08b	Rilta Environmental Ltd., Greenogue Business Park, Rathcoole, Co. Dublin	R9 Used oil re-refining or other reuses of previously used oil	(b) Off-site Ireland	W0192-03	31.0
20 01 36	N	Printer Toner Cartridges	Condells	N/A	Condells The Office Centre, 9 Roches St., Limerick	R4 Recycling/reclamation of metals & metal compounds	(b) Off-site Ireland	N/A	0.05
01 03 99	N	Process Waste (tank cleanout scale, sludge etc)	N/A	N/A	Aughinish Alumina Ltd.	D1 Deposit on, in or under land	Site landfill	P0035-06	21,869

LoW Code	Haz (Y/N)	Description of Waste	Name of Waste Collection Contractor	Waste Collection Permit No.	Name of Waste Disposal/ Recovery Contractor	Method of Disposal/Recovery	Location of Disposal/ Recovery	Waste Licence/ Permit No.	Quantity (Tonnes/ annum)
01 03 09	N	Red Mud	N/A	N/A	Aughinish Alumina Ltd.	D1 Deposit on, in or under land	Site landfill	P0035-06	1,350,288
01 03 07	Y	Salt Cake	N/A	N/A	Aughinish Alumina Ltd.	D1 Deposit on, in or under land	Site landfill	P0035-06	19,201
01 03 99	N	Sand	N/A	N/A	Aughinish Alumina Ltd.	D1 Deposit on, in or under land	Site landfill	P0035-06	108,923
19 08 05	N	Sanitary Effluent Sludge	Ecojet	WCP-LK-12-685-01	Ecojet Ltd., Bay M1, Raheen Business Park, Raheen, Limerick	D8 Biological Treatment	(b) Off-site Ireland	D0013-01	530.0
17 04 07	N	Steel & Aluminium Scrap Metal	United Metals	WCP-LK-10-657-01	United Metals, Eastway Business Park, Limerick	R4 Recycling/reclamation of metals & metal compounds	(c) Off-site Abroad	WFP-LK-2013-147A-R1	1006.6
20 01 38	N	Timber Reels (used)	Hegarty Metals Recycling	WCP-LK-027-02b	Hegarty Metals Recycling, Ballysimon Rd., Limerick	R11 Uses of residual materials obtained from any of the operations numbered R1-R10	(b) Off-site Ireland	WFP-LKC-11-001-01	8.7
19 12 04	N	Used Hosing & Belting (Rubber)	Greenstar	WCP-DC-08-1120-01	Greenstar, Dock Road, Limerick	R11 Uses of residual materials obtained from any of the operations numbered R1-R10	(b) Off-site Ireland	W0082-02	64.2
20 01 25	N	Vegetable Oils & Greases	Frylite	WCP-DC-10-1297-01	Frylite Dublin Ltd., Unit J1, Ballymount Industrial Estate, Dublin 12	R3 Recycling/reclamation of organic substances which are not used as solvents	(b) Off-site Ireland	WCP-DC-10-1297-01	1.6

LoW Code	Haz (Y/N)	Description of Waste	Name of Waste Collection Contractor	Waste Collection Permit No.	Name of Waste Disposal/ Recovery Contractor	Method of Disposal/Recovery	Location of Disposal/ Recovery	Waste Licence/ Permit No.	Quantity (Tonnes/ annum)
16 02 14	N	Waste Electrical & Electronic Equipment (WEEE)	Greenstar	WCP-DC-08-1120-01	Greenstar, Dock Road, Limerick	R4 Recycling/reclamation of metals & metal compounds	(b) Off-site Ireland	W0082-02	0.002
02 03 99	N	Waste Food	Greenstar	WCP-DC-08-1120-01	Greenstar, Dock Road, Limerick	R3 Recycling/reclamation of organic substances which are not used as solvents	(b) Off-site Ireland	W0082-02	23.4
20 01 38	N	Wood - recycling	Hegarty Metals Recycling	WCP-DC-08-1120-01	Greenstar, Dock Road, Limerick	R3 Recycling/reclamation of organic substances which are not used as solvents	(b) Off-site Ireland	W0082-02	80.7
20 01 38	N	Wood - landfill	Hegarty Metals Recycling	WCP-DC-08-1120-01	Greenstar, Dock Road, Limerick	D1 Deposit on, in or under land	(b) Off-site Ireland	W0082-02	39.8
13 01 13, 13 07 01	Y	Waste Oil	John Malone Transport	WCP-LK-543-08b	Rilta Environmental Ltd., Greenogue Business Park, Rathcoole, Co. Dublin	R9 Used oil re-refining or other reuses of previously used oil	(b) Off-site Ireland	W0192-03	48.0
								TOTAL	**1,509,598.41**

Hazardous Waste

Non Hazardous Waste

4. Monitoring and Enforcement

4.1 Monitoring

The EPA, and their representatives, made 6 separate monitoring visits or inspections during 2015.

- In February 2015, EPA personnel collected samples of treated process effluent and sanitary effluent and inspected one of the site surface water streams. A sample of the surface water discharge at monitoring location SS-5 was also collected.
- In April 2015, EPA representatives audited all air monitoring points to ensure compliance with EPA requirements in terms of safe access and appropriate monitoring points.
- In May 2015, an audit of the internal air emissions monitoring programme was completed by the EPA to verify compliance with ISO17025 standard.
- In July 2015, EPA representatives conducted monitoring of air emissions from calciner emission point reference A2.
- In October, EPA personnel collected samples of treated process effluent and sanitary effluent for analysis.
- In December 2015, an unannounced audit was completed by our EPA Inspector.

All monitoring results received from the EPA were compliant with the relevant emission limit values of the IE licence.

Summarised data from the relevant EPA monitoring reports is tabulated in Table 23 and monitoring results are summarised in Tables 24 and 25.

Table 23 Number of EPA Site Visits 2015

No. of Monitoring Visits	**6**	**No. Exceedances**	**Compliance Rate (%)**
Total No. of Samples	8	0	100%
Parameters Monitored (Water)	13	0	100%
Parameters Monitored (Air)	1	0	100%

Table 24 EPA Industrial Effluent Results (Emission Point Ref. W1-1)

Parameter	**EPA Result Range**	**ELV**
pH	8.1 – 8.2	6 – 9
Solids(mg/l)	<13	50
BOD (mg/l)	42 - 72	2360 (kg/day)

For all results reported by the Agency, results were compliant with the emission limit values as stated in Schedule B.2 of the IE Licence.

Table 25 EPA Sanitary Effluent Results

Parameter	**EPA Result Range**	**ELV**
pH	7.9-8.4	6 – 9
Solids(mg/l)	<4-5	35
BOD (mg/l)	2.9-<6	25

In all cases, sanitary effluent results reported were compliant with the relevant ELV's.

4.2 Third Party Inspections

AAL obtained certification to the international environmental management system (EMS) standard ISO14001 in 2000.

DNV-QA (Det Norske Veritas Quality Assurance) carried out a recertification audit of the system in October 2015. There were no non-conformances recorded.

AAL operates a rigorous internal audit schedule in order to ensure conformance with plant operating systems (production, quality, safety, environmental) and to facilitate the process of continual improvement in those systems.

5. Resource Consumption

5.1 Energy Consumption

Owing to the nature of the Bayer process used at AAL for alumina manufacturing and post extraction processing, energy represents the most economically significant impact to the process.

For this reason, AAL was designed with energy efficiency in mind. Heat recovery and power efficiency are two of the key process efficiency targets that receive close scrutiny.

Overall, energy consumption was similar to previous years. However, there was a significant reduction in HFO use over the last 2 years following the switch from three HFO fuel boilers to two more efficient natural gas boilers as primary sources of steam during 2014.

Table 26 Energy Consumption 2013 – 2015

Source	2013 (MW)	2014 (MW)	2015 (MW)
Heavy Fuel Oil	114.4	50.2	2.7
Power (Electrical)	43.9	44.1	44.2
Diesel	0.5	0.5	0.6
Natural Gas	559.9	631.6	677.9
Total	718.6	726.4	725.4

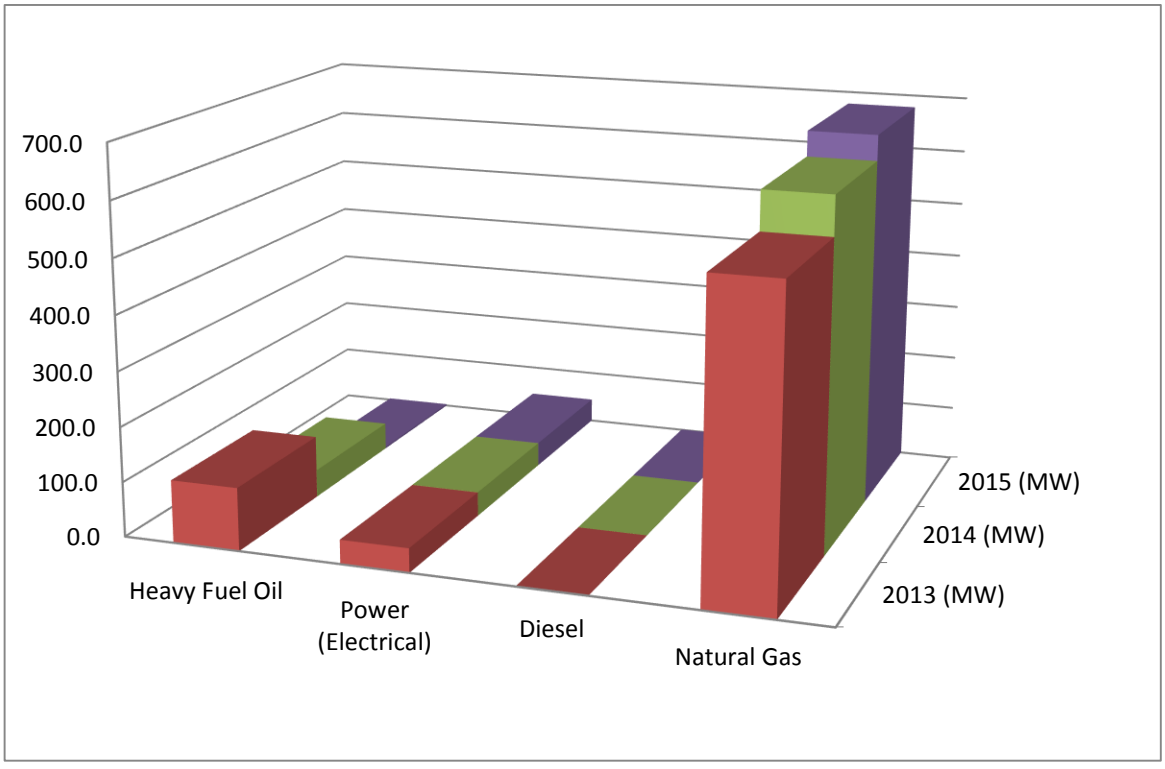


Figure 7 Energy Consumption 2013 – 2015

5.1.1 Energy Efficiency Report 2015

The 2015 energy efficiency report is provided as ***Attachment 3***.

- For the ISO 50001 standard, Internal audit training was completed in September ’15, followed by stage 1 completion in October ’15. Stage 2 (final stage) required to get ISO 50001 accreditidation was achieved in January 2016.

- In 2015, AAL achieved a record total steam efficiency performance of 5.71 GJ/t (previous best was 2014 at 5.82 GJ/t).

- There was a step change since May ’15 due to the 2nd stage heater and flash tank recovery work, less equipment outages that affect steam use and lower ambient heat losses.

- The power efficiency performance result for 2015 was 0.706 GJ/t, which is marginally better than the 0.711 result achieved in 2014. The best ever result of 0.704 was achieved in 2008.

5.2 Water Consumption

AAL receives potable water from Limerick City & County Council for process and domestic uses.

The bulk of the potable water is demineralised in the AAL water treatment plant for use in boiler steam generation. The balance of the potable water is used for process make-up, where process condensate (re-condensed water from the process) supply is not available, and also as domestic water.

AAL does not abstract any groundwater for process or domestic purposes.

Table 27 Water Consumption 2012 - 2015

Year	Total (m^3)	Relative Consumption (m^3/tonne product)
2015	5,177,594	2.62
2014	5,191,722	2.66
2013	5,161,997	2.65
2012	5,182,967	2.69

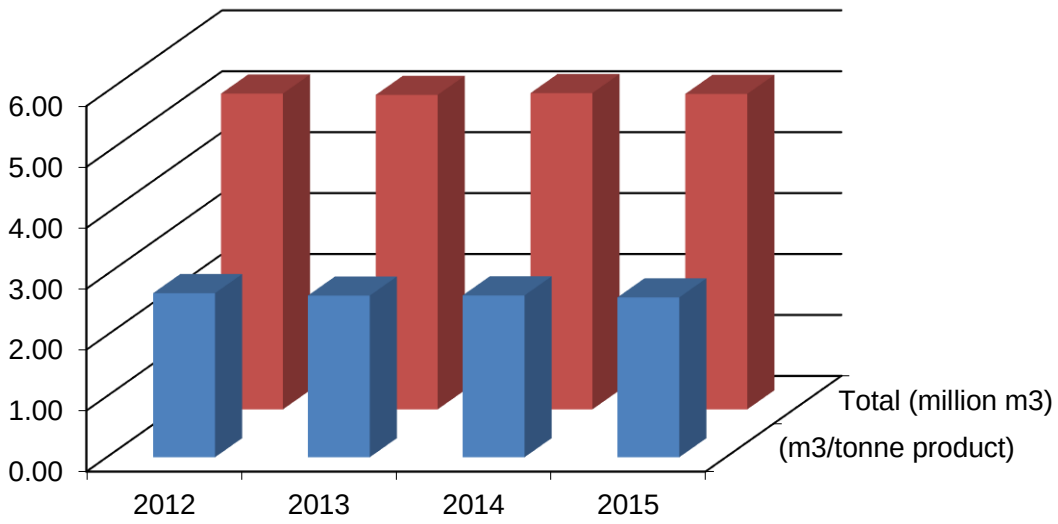


Figure 8 Water Consumption 2012 – 2015

5.3 Raw Materials Efficiency and Waste Reduction

AAL continually strives to improve the efficiency of its processes in order to reduce the raw materials consumed and the waste produced.

Table 28 shows the volumes of raw materials consumed and waste produced for 2014 and 2015. The relative consumption for each parameter is calculated as the volume consumed per tonne of alumina hydrate produced.

Table 28 Raw Material Efficiency & Waste Reduction

Material	2014 Consumption	Relative Consumption (Volume/tonne alumina)	2015 Consumption	Relative Consumption (Volume/tonne alumina)
Alumina Produced (tonnes)	1,955,053	N/A	1,974,017	N/A
Bauxite Ore Consumed (tonnes)	4,495,173	2.3	4,627,457	2.3
Sodium Hydroxide (tonnes)	127,857	0.07	134,444	0.07
Sulphuric Acid (tonnes)	19,349	0.01	18,972	0.01
Heavy Fuel Oil (tonnes)	38,518	0.020	3,710	0.002
Water (m^3)	5,191,722	2.7	5,177,594	2.6
Waste (tonnes)	1,465,781	0.7	1,509,598	0.8
Energy (GJ)	726.4	11.7	725.4	11.6

5.4 Progress on Minimising Water Demand and Volume of Trade Effluent Discharges

AAL continually strives to improve the efficiency of its processes in order to reduce both the quantity of raw water consumed and waste effluent produced.

6. Environmental Incidents and Complaints

AAL has a procedure in place for classification and reporting of environmental incidents. As part of the requirements of the IE Licence, AAL operates, through the plant Environmental Management System, a procedure for logging and responding to any complaints received from the public.

6.1 Category 1 Incidents

There were two Category 1 (minor) incidents notified to the EPA during 2015:

- On Friday 2nd of October at 09:00hrs, a leak of neutralised effluent occurred from the buffer tank for the 35m clarifier, which is part of our effluent treatment system. This caused neutralised effluent to go outside the bunded area. While the majority of the neutralised effluent was contained within the bunded area, approximately 50 m^3 of neutralised effluent was spilled to the ground on a graded area as the leak was being brought under control. The spillage was immediately recovered according to in-house spill response procedures.
- On Tuesday 6th of October, a loss of process hydrate solids occurred from an offline tank as it was being cleaned out for maintenance purposes. The majority of the wet solids were contained within the permanent concrete bund and the engineered permanent spillway plus drain system leading to secondary containment. A portion of solids went outside the bunded area. The solids were immediately recovered according to in-house spill response procedures.

Investigations were completed into both of these incidents, root causes identified and measures agreed to prevent recurrence of these incidents.

6.2 Category 2 – 5 Incidents

There were no Category 2, 3, 4 or 5 (Limited, Serious, Very Serious or Catastrophic) environmental incidents during 2015.

6.3 Complaints

Three complaints were received during 2015. Details are as follows:

- On the 6th & 9th March, two complaints were received by the EPA from a nearby resident regarding dust outfall on their property. The resident was met at his property by AAL personnel and further details were obtained. Both complaints were investigated and following analysis of weather conditions and extensive dust gauge results in and around the residential property and site boundary, it was concluded that the basis for the complaints were not associated with AAL activities. Responses were submitted to the EPA including details of the investigation and the complainant was also contacted.
- On the 8th October, further information response was sought by the EPA regarding a letter addressed to a third party in July 2015 by a member of the public alleging various concerns from AAL. A factual and evidence based response letter was issued by AAL to the EPA outlining our compliant environmental performance which verified no basis for the concerns raised.

7. Environmental Management Programme

This section contains summary information on the AAL Environmental Management Programme (EMP).

A revised Schedule of Objectives and Targets for 2015 is presented in Section 7.2 for Agency approval.

Both the EMP and Schedule of Objectives and Targets fall under the site ISO 14001 Environmental Management System. Accordingly, they are included within a structured system of management review and periodic auditing by both internal auditors and independent third party auditors (DNV).

The Pollution Release and Transfer Register (PRTR), which is a requirement of Condition 6.17 of the IE Licence, has been updated to reflect emissions during the 2015 monitoring period.

7.1 Environmental Management Programme (EMP) Report 2015

The AAL Environmental Management Programme (EMP) is a continuously updated plan showing the status of key environmental improvement programmes being undertaken within the plant and is reviewed as part of the ISO 14001 Environmental Management System (EMS).

Progress in achieving planned objectives and targets during 2015 is summarised in Table 29. It sets out the objectives, associated targets and a comment on progress in meeting those targets.

During 2015, significant progress was achieved in a number of key areas related to operating the BRDA to best practice, upgrade of CEMS, improvement in groundwater quality and bauxite residue neutralisation. In addition, it is noted that significant work is undertaken on an ongoing or recurring basis at the plant in order to continuously maintain and update AAL plant environmental performance.

Table 29 EMP 2015 Report

No.	Objective	Target	Progress
1	**Implement conditions of Industrial Emissions licence**	Review ELV for calciner NOx with EPA	Submission made to EPA
		Submit proposal regarding methodolgy to quantify seepage potential from BRDA	Completed and submitted to the EPA
		Agree pH, conductivity and soda trigger levels in storm water discharges with EPA	Completed and submitted to the EPA. Monitoring ongoing
		Complete fire water retention risk assessment	Commenced. To be completed in Q1, 2016
		Update the Environmental Liabilities Risk Assesment to reflect changes to HFO shipping requirements	Updated and submitted to the EPA
		Review the Plant Closure and Aftercare Plan in light of AMEC feedback and have the costs quantified by a qualified independent consultant	Commenced in 2015. To be completed in Q1, 2016
		Achieve certification of Energy Management System to ISO 50001	Stage I audit completed. Stage II audit due in Jan 2016
2	**Implement relevant BAT conclusions**	Convert existing 50,000 tonne HFO storage tank to caustic storage in accordance with BAT	Complete
		Train relevant personnel on requirements of applicable BREF documents	Complete
3	**Design & operate the BRDA to best practice & implement all new monitoring & reporting requirements set out in Schedule C.7 of IE licence**	Continue to demonstrate sustainability of new vegetation on side slopes of Phase I BRDA.	2015 plan implemented on Phase I side slopes
		Install and commission new effluent line from East Pond to South Pond	Complete
		Conduct flocculant addition trials in 35m clarifier to improve clarity of overflow.	Not required in 2015. Clarfier performance on target.
		Implement dust prevention measures, i.e. fencing and planting on East side of Phase 2 BRDA	Extensive planting programme for 2015 completed

		Continue to develop mud discharge and grading strategy to facilitate thin layer deposition for fast consolidation and slope development for drainage.	Thin layer deposition for Phase I continued in 2015. Slope development continued for Phase II in 2015
		Prepare BRDA Annual Stability Report	Complete
		Update BRDA Operational & Safety Manual	Complete
4	**Implement recommendations of Golder BRDA Breakout Study Report**	Review status of recommendations of revised report issued in 2013	Emergency test exercise completed on 6th March 2015. Updated plan to be issued by Limerick CCC.
5	**Implement recommendations of Residues Solutions Report**	Issue annual update on BRDA rehabilitation work & wetland	Complete
		Continue testing of wetlands for treatment of BRDA leachate and monitor performance	Excellent performance in 2015 – achieving pH < 8 at 50 l/hr feed into December
6	**Implement quality assurance programme for continuous emission monitors (CEMS) on emissions to air to meet requirements of EU Standard EN 14181**	Conduct 'Annual Surveillance Testing' of gas boilers CEMS as required under EN14181	Annual Surveillance Testing complete
		Install new CEMS on gas turbines. Complete quality assurance testing as required under EN 14181.	QAL 2 complete, awaiting final report
		Conduct annual independent cross check of internal air monitoring programme as required by ISO 17025	Exova site monitoring of calciner considered 3rd party cross check
7	**Reduce fugitive emissions**	Continue to progress fugitive alumina dust reduction project in 2015	2015 Capex programme complete
8	**Improve groundwater & surface water quality**	Achieve 100% compliance on Integrity Testing Programme and implement planned repairs for 2015. Include relevant process drains.	Achieved
		Submit groundwater technical screening exercise & risk assessment report to EPA for agreement	Complete
		Close the process caustic balance for 2015.	Complete

7.2 Environmental Objectives and Targets 2016

AAL reviews the plant Environmental Management System on an on-going basis with the aim of updating and refining the Environmental Management Programme (EMP) to take account of progress in meeting objectives and targets.

In addition, new targets are added on the basis of achievement of existing targets and where issues have been identified as requiring a formal and structured EMP approach to drive their implementation.

New targets, which have been added for 2016 are summarised in Table 30. This list highlights only those targets added to the EMP and excludes the significant work involved in on-going programmes and projects to achieve existing targets, the detail of which is set out in the EMP for 2015.

The primary focus of the EMP in achieving significant environmental objectives during 2016 will be the continued implementation of the new IE Licence conditions with regard to the BRDA and plant; to continue the progress in recent years towards improving air emissions by the increased use of natural gas and to agree groundwater quality objectives with the EPA.

Table 30 EMP Objectives and Targets 2016

No.	Objective	Target
1	**Conformance to Industrial Emissions Licence**	Agree 150 mg/Nm^3 ELV for calciner Nox with Agency
		Identify soil monitoring locations for site
		Complete fire water retention risk assessment
		Update the Environmental Liabilities Risk Assesment to reflect Agency comments of 2015
		Complete independent review of the Plant Closure and Aftercare Plan
		Achieve ISO 50001 certification
2	**Design & operate the BRDA to best practice**	Continue vegetation program on side slopes of Phase I BRDA
		Implement 2016 screening programme for Phase I and II
		Implement 2016 rehabilitation programe
		Review sustainability monitoring plan
		Consultation with LCCC on the BRDA External Emergency plan
		Continue Wetlands study for treatment of BRDA leachate
		Issue annual BRDA update in AER to include: Wetlands study, rehabilitation program and BRDA stability report
		Review BRDA Operational & Safety manual
		Develop application of GPS for optimisation of mud farming
		Upgrade of effluent composite samplers
3	**Quality assurance for monitoring of industrial air emissions**	Conduct 'Annual Surveillance Testing' as required under EN14181 on GTs, A/C HFO boilers and D/E gas boilers

No.	Objective	Target
		ISO 17025 independent cross check of internal air monitoring
		Complete QAL2 calibration of calciner 3 CEMS
4	**Continual improvement of ambient air emissions**	Implement alumina dust improvement 2016 project
5	**Continual improvement program for groundwater and surface water**	Achieve 100% compliance on Integrity Testing Programme & implement planned repairs for 2016
		Recovery system upgrade for groundwater
6	**Conduct Caustic Mass Balance**	Close the process caustic balance for 2016
7	**Continual improvement of Environment Management System**	Update Register of Regulations
		Review Register of aspects
		Maintain ISO14001 Certification via internal and external auditing programme

7.3 Pollutant Release and Transfer Register (PRTR)

The Pollutant Release and Transfer Register (PRTR) has been updated to provide further data for the calendar year 2015. Based on the emissions arising from the boilers and calciners, and also emissions which currently appear on the European Pollutant Emission Register (EPER), the following substances are included in the PRTR for 2015;

- Sulphur dioxide (SO_2)
- Oxides of nitrogen (as NO_2)
- Particulate matter
- Carbon dioxide
- Arsenic
- Cadmium
- Chromium
- Copper
- Nickel
- Zinc
- Mercury
- Lead
- Aluminium
- Iron
- Magnesium
- Biological oxygen demand
- Fats, oils and greases
- Suspended solids

Sulphur dioxide mass emissions are based on measured 'S' concentration in HFO multiplied by HFO consumption rate.

Nitrogen dioxide and particulate mass emissions have been calculated based on results of direct stack gas measurement multiplied by calculated stack gas flow rates.

Carbon dioxide and heavy metal emissions have been calculated based on fuel consumption multiplied by the appropriate emission factor.

Emission factors used for calculations Hg, Cr and Cu are based on Ireland specific emission factors for oil fired power plant. All other emission calculations are based on UK NAEI dataset for fuel oil fire power stations.

In line with EPA correspondence, the PRTR is now submitted to the Agency via the AER/PRTR Reporting Website. The PRTR data submitted to the EPA is also shown in **Attachment 4.**

AAL proposes to monitor and report the same parameters for the 2016 PRTR.

7.3.1 Caustic Mass Balance

The mass balance undertaken during 2015, and tabulated below in Table 31, has closed off the input-output cycle and resolved caustic consumption at the plant to -0.04kg caustic (sodium hydroxide) per tonne of alumina hydrate produced. This is likely to be due to slight margins of error in sampling and measurement of caustic concentrations of minor streams which are based on periodic grab samples.

Table 31 Caustic Mass Balance 2015

Element	Units (kg/tH)
Input	
Total Caustic Consumption	68.10
Outputs	
Caustic in Mud	57.36
Caustic in Alumina	4.79
Caustic in Alumina Hydrate Ships	0.20
Caustic in Sand to BRDA	0.49
Caustic in Saltcake to BRDA	3.19
Caustic in process scale from Tank Turnarounds shipped to BRDA	0.79
Caustic in West pond disposal to the BRDA (Storm Water Pond)	1.44
Caustic in treated (neutralized & clarified) industrial effluents to the river	0.00
Caustic recovery to process from the BRDA	-0.12
Total Output	**68.14**
Unaccounted	-0.04

8. Other Reports

This section contains additional information required under the various conditions of the IE Licence.

Generally, where documentation has already been submitted to the Agency, summarised information is provided. Full text reports are included as attachments where relevant.

Monitoring data from annual surveys (noise) together with results from ambient air quality, dust deposition and groundwater monitoring are summarised.

Updates regarding the facility Closure, Restoration and Aftercare Management Plan (CRAMP), the Environmental Liabilities Risk Assessment (ELRA) and the costings and financial provisions associated with both are provided.

The BRDA Status Report in Section 8.10 contains details of the quantities of waste deposited and development works undertaken in the BRDA during the 2015 calendar year.

8.1 Noise Monitoring Programme

AAL is required to carry out an annual noise survey in accordance with IE Licence Conditions 4.5 and 6.16. Schedule B.4 sets out the relevant noise limits at off-site noise sensitive locations (NSL) as:

- Day-time: 55 dB (A) L_{eq}
- Evening-time: 50 dB (A) L_{eq}
- Night-time: 45 dB (A) L_{eq}

A survey of noise levels at boundary and off-site noise sensitive locations was carried out in September 2015. At each monitoring location, day-time, evening-time and night-time measurements were made for the following measurement parameters: LA_{eq}, $LA_{max,}$ $LA_{min,}$ LA_{90} and LA_{10}. Monitoring was undertaken in accordance with the 2012 EPA Revised Noise Survey Guidance Document NG4.

The monitoring results are summarised on Table 32 and 33.

Table 32 Noise Survey Results – Noise Sensitive Locations

Location	Day-time			Evening			Night-time		
	LA_{eq}	LA_{90}	LA_{10}	LA_{eq}	LA_{90}	LA_{10}	LA_{eq}	LA_{90}	LA_{10}
NSL 1	44	42	45	34	30	37	35	30	35
NSL 2	45	34	41	45	33	42	41	34	42
NSL 3	48	35	45	50	41	52	38	21	42
NSL 4	43	37	45	47	39	46	43	38	43
NSL 5	60	34	55	52	34	47	37	24	37

Table 33 Noise Survey Results – Boundary Locations

Location	Day-time			Night-time		
	LA_{eq}	**LA_{90}**	**LA_{10}**	**LA_{eq}**	**LA_{90}**	**LA_{10}**
B 1	53	61	63	62	56	63
B 2	56	55	56	53	52	53
B 3	60	57	61	60	59	60
B 4	49	35	51	42	35	40
B 5	49	36	44	43	41	44
B 6	50	49	52	53	51	54
B 7	38	33	38	40	37	41
B 8	41	37	43	38	35	40
B 9	48	41	51	41	21	40

2015 Noise Survey Report Conclusions

Noise monitoring was conducted in October 2015 at NSLs and boundary locations associated with the Aughinish Alumina Ltd. facility as per IE Licence.

Compliance at NSLs was assessed using the LA_{90} (30 minute) parameter, to remove extraneous (non-site related) influences at these monitoring locations. This parameter best represented the potential noise emissions from AAL at NSLs.

Day-time monitoring results at NSLs were compliant with the IE Licence specified limits of LA_r (30 minute) 55dB. Evening-time monitoring results at NSLs were compliant with the IE Licence specified limits of LA_r (30 minute) 50dB. Night-time monitoring results at NSLs were compliant with the IE Licence specified limits of LA_{eq} (30 minute) 45dB.

No tones or impulsive noise was recorded during the survey periods at NSLs associated with activities at the facility.

Boundary monitoring locations were in line with both historic day and night-time monitoring results. Some variability is recorded at NSL locations however it is noted that results continue to remain in line with both historic day and night-time monitoring results.

Based upon the monitoring conducted in 2015, the Aughinish Alumina Ltd. facility is compliant with the requirements of the IE Licence for noise at NSLs.

The full noise survey report is included as ***Attachment 5***.

8.2 Groundwater Monitoring

AAL undertakes an extensive groundwater monitoring programme. Overall, 87 groundwater monitoring locations have been established with the agreement of the Agency and are routinely monitored in accordance with Schedule C.8 of the IE Licence. The current IE Licence does not specify limit values for groundwater quality.

Monitoring locations can be categorised into the following:

(i) **Estuarine Springs (ES)** are foreshore springs which discharge from the limestone bedrock at the foreshore (ES1 - 16)
(ii) **Plant Observation Wells (POW)** around the process plant (POW1 - 33); the area around the south pond (SPW1 - 6) and the north pond (NPW1 - 3) and the boreholes (BH1 - 4) in the fuel storage tank area.
(iii) **Observation Wells (OW)** around the perimeter of the Phase 1 and Phase 2 BRDA (OW1-45) installed within estuarine alluvium, glacial till and limestone bedrock.

To meet the requirement of Condition 6.15.2 of the IE Licence, an independent groundwater risk screening and technical assessment was undertaken and a report was submitted to the Agency in 2015.

8.2.1 Estuarine Springs

Estuarine springs (referred to as ES's) are locations where the water table level intersects ground level to allow groundwater to directly discharge to the surface. The ES's are therefore accepted as the main indicators of groundwater quality beneath the plant area. Sixteen individual estuarine springs (ES1 - 16) have been identified and are routinely monitored when there is flow.

Table 34 contains a summary of monitoring results for the 2015 reporting period. Reporting is as per Schedule C.6 of the IE Licence.

Table 34 Estuarine Spring Monitoring Results 2015

Emission Point Reference	pH*	Conductivity (µS/cm)	Soda (g/l)
ES 1**	10.9	2,433	0.7
ES 2	7.9	30,085	7.5
ES 3	8.4	16,938	4.0
ES 7**	7.4	2,277	0.4
ES 8	8.8	32,600	7.8
ES 9	8.0	14,023	3.2
ES 10	7.8	9,076	2.1
ES 11	8.2	15,589	3.8
ES 12**	12.3	6,388	1.5
ES 13	8.6	917	0.2
ES 15	8.0	449	0.1
ES 16**	10.5	1,870	0.9

*Numerical average of the data for the reporting period
**Spring recovered for treatment - no direct discharge to estuary

The results show that there has been a gradual and sustained improvement in the quality of the spring discharges and that only three currently have pH >9; ES1, ES12 and ES16. It should be noted that there is no direct discharge to surface water from ES1, ES12 and ES16 as these streams are intercepted and recovered to the effluent plant for treatment.

8.2.2 Plant Observation Wells (POW)

Table 35 contains a summary of plant observation well (POW) groundwater monitoring results for 2015. The table also includes data for those wells located around the north containment pond (NPW) and the south containment pond (SPW).

Monitoring results are reported to the Agency in the quarterly monitoring reports. The values reported here are the average of analytical results returned during the 2015 monitoring period.

Table 35 POW Monitoring Results 2015

POW	pH	Conductivity	Total Alk.	Cl	Fl	Soda	Al	As	Cd	Cr	Cu	Fe	Pb	Mg	Hg	Ni	SO_4	Ti	Zn
Ref.		µS/cm	mg/l $CaCO_3$	mg/l	mg/l	g/l	µg/l	µg/l	µg/l	µg/l	µg/l	µg/l	µg/l	mg/l	µg/l	µg/l	mg/l SO_4	µg/l	µg/l
POW 1	8.9	5,763	92	624	0.5	1.58	235	3.3	0.09	0.7	12.7	271	0.40	21.38	0.2	2.1	1461	0.8	140.9
POW 2	10.1	2,661	112	224	0.5	0.73	5,233	6.2	0.16	0.7	11.9	198	0.94	1.01	0.2	2.7	529	0.8	289.8
POW 3	10.5	2,055	192	147	0.6	0.59	495	12.4	0.1	0.7	9.0	21	0.25	0.87	0.2	1.2	389	4.3	58.7
POW 5	12.5	11,970	4,262	96	2.6	3.2	56,300	156.7	0.6	0.7	15.2	18	0.53	0.2	3.8	20.3	248	3.3	21.4
POW 6	9.3	315	68	16	0.5	0.05	614	1.2	0.1	0.7	10.1	39	0.46	3.4	0.2	0.5	14	2.9	97.4
POW 7	9.4	377	181	6	0.5	0.10	131	0.4	0.1	0.7	9.7	155	0.44	3.5	0.2	0.4	2	0.7	103.9
POW 8	8.1	692	119	53	0.50	0.1	15	0.55	0	0.68	11.3	592	0.53	13.9	0.2	0.5	94	0.7	56.7
POW 9	7.9	518	202	32	0.5	0.05	78	0.5	0.09	1	12.8	111	0.58	5.7	0.2	0.8	6	1.1	133.3
POW 10	7.9	303	130	17	0.5	0.02	221	0.5	0.1	0.68	10.8	93	1.21	2.5	0.2	0.9	2	2.0	129.3
POW 11	11.3	4,785	1,825	41	1.7	0.92	187,450	144	0.5	0.99	22.2	81	24.85	0.5	3.0	3.8	40	1.3	234.3
POW 12	11.1	1,548	673	34	1.3	0.42	26,315	21.8	0.31	1	14.9	56	2.01	0.7	0.7	1.6	25	2.1	125.9
POW 13	9.8	844	363	30	0.5	0.23	5,358	12.1	0.1	0.68	13.0	109	1.34	2.0	0.4	1.7	16	1.1	321.9
POW 14	7.6	926	439	32	0.5	0.14	71	0.8	0.09	1	10.4	1881	0.27	4.6	0.2	1.1	4	0.7	29.5
POW 15	7.5	1,144	532	52	0.5	0.23	31	6.1	0.1	0.68	12.1	5591	0.43	13.2	0.2	0.9	1	1.0	57.2
POW 16	11.2	3,991	2,167	56	1.5	1.22	173,450	214	2.24	4	43.8	1632	39.26	0.8	1.9	18.4	34	9.7	239.1
POW 17	12.8	17,030	5,912	96	7	3.59	194,400	178	0.5	1.1	136.3	65	4.61	0.4	4.1	2.4	76	1.9	179.4
POW 18	12.3	7,248	2,746	51	1.9	1.63	143,245	112	0.4	0.9	18.5	77	1.90	0.20	2.8	3.7	20	1.4	194.9
POW 19	12.0	4,735	2,222	47	1.6	1.21	116,115	118	0.4	0.7	9.2	28	2.80	0.19	2.7	3.5	28	1.0	130.7
POW 20	11.0	1,707	769	35	0.6	0.49	36,840	27.3	0.3	0.7	15.2	232	1.41	0.2055	0.8	1.8	23	1.2	109.7
POW 21	8.1	510	186	37	0.5	0.06	144	0.4	0.09	1	9.2	483	1.22	15.4	0.2	0.4	16	0.7	67.8

Alk. = Alkalinity
Cl = Chloride
Fl = Fluoride

POW	pH	Conductivity	Total Alk.	Cl	Fl	Soda	Al	As	Cd	Cr	Cu	Fe	Pb	Mg	Hg	Ni	SO_4	Ti	Zn
Ref.		µS/cm	mg/l $CaCO_3$	mg/l	mg/l	g/l	µg/l	µg/l	µg/l	µg/l	µg/l	µg/l	µg/l	mg/l	µg/l	µg/l	mg/l SO_4	µg/l	µg/l
POW 22	8.7	339	93	33	0.5	0.05	553	1.2	0.09	0.68	5.7	281	0.40	5.5	0.2	0.4	14	2.0	58.2
POW 23	9.6	519	130	27	0.5	0.11	1,388	4.2	0.12	1.4	10.0	199	0.90	5.8	0.20	1.9	33	3.3	48.1
POW 24	9.0	632	238	46	0.5	0.17	553	6.2	0.09	0.7	7.1	28.2	0.32	4.2	0.2	0.6	16	0.7	45.4
POW 25	8.1	217	83	14	0.5	0.04	192	0.4	0.10	1	8.5	72	0.89	4.4	0.20	1.1	5	0.9	321.8
POW 28	9.0	882	444	27	0.4	0.24	2,491	14	0.5	0.7	13.0	175	0.51	4.17	0.6	3.0	4	0.8	66.7
POW 29	10.2	2,349	1,245	51	1.1	0.75	71,035	70	0.7	1	11.1	459	3.22	2.0	1.1	18.7	19	5.1	117.9
POW 30	10.1	2,430	1,127	42	3.56	0.73	126,994	163	0.51	0.9	46.6	418	3.06	4.6	3.2	20.4	30	3.5	48.4
POW 31	7.9	580	215	32	0.50	0.07	140	1.6	0.09	0.7	12.9	267	1.03	4.3	0.20	0.7	22	0.7	323.9
POW 32	8.2	597	228	32	0.50	0.1	75	2.4	0.10	0.68	10.5	265	0.79	12.0	0.2	1.3	24	0.8	247.3
POW 33	8.0	657	322	65	0.5	0.15	45	1.1	0.1	0.7	8.4	482	0.50	8.8	0.20	0.7	14	0.7	85.1
SPW 1	8.8	2,202	476	31	0.8	0.5	834	577.8	0.1	0.68	5.2	10	0.17	8.8	0.7	3	306	0.7	1.3
SPW 2	10.0	719	344	26	0.5	0.17	9,734	37	0.2	2.4	25.3	403	3.38	8.7	0.4	11.4	23	2.7	115.7
SPW 3	9.2	914	340	29	1.3	0.20	7,463	26.6	0.32	1.21	15.7	343	3.53	3.3	0.494	7	40	2.2	51.0
SPW 4	9.6	663	294	27	0.1	0.16	38,102	41.8	0.2	0.766	12.7	34	1.16	2.1	0.8495	2.7	24	1.1	323.5
SPW 5	8.5	2,285	270	39.2	0.4	0.6	135	4.1	0.1	0.9	11.9	5.3	0.30	12.0	0.4	0.6	576	0.7	78.9
SPW 6	9.6	321	115	13	0.5	0.04	2,553	3.1	0.09	4.3	7.1	111	0.72	1.5	0.2	0.6	33	112.8	45.1
NPW 1	10.0	774	315	22	0.3	0.22	945	4.5	0.1	0.68	10.5	387	0.53	9.1	0.2	1.0	32	2.0	97.5
NPW 2	9.1	1,053	317	49	0.55	0.28	2,584	18.2	0.23	0.68	9.8	798	0.84	3.6	0.5	3.8	100	1.9	51.2
NPW 3	8.1	402	119	30	0.1	0.03	65	0.6	0.1	0.7955	13.9	100	1.05	2.7	0.2	1.2	13	1.0	264.3

Alk. = Alkalinity
Cl = Chloride
Fl = Fluoride

*POW 4, 26 and 27 have been decommissioned

8.2.3 BRDA Observation Wells (OW)

Table 36 contains a summary of summary of BRDA Observation Well (OW) groundwater monitoring results for 2015 as per Schedule C.8 of the IE Licence. The current licence does not set out limit values for groundwater quality.

Monitoring results are reported to the Agency in the quarterly monitoring reports. The values reported here are the average of analytical results returned during the 2015 monitoring period.

In April 1997, OW's 3, 4, 5 and 6 were capped as part of an extension of the original BRDA. OW's 7, 8, 16, 17, 18, 19 and 23 were decommissioned during 2010 as part of the Phase 2 BRDA extension.

Due to the tidal nature of the surrounding environment a number of the wells are subject to saline intrusion and accordingly, the measured electrical conductivity, chloride and soda (Na_2O) values are subject to interference.

A review of the monitoring results for pH in 2015 indicate that pH is below 9 in all BRDA observation wells.

Table 36 BRDA OW Monitoring Results 2015

OW Ref.	pH	Conduct-ivity	Total Alkalinity	Chloride	Fluoride	Soda	Al	As	Cd	Cr	Cu	Fe	Pb	Mg	Hg	Ni	Sulphate	Ti	Zn
		µS/cm	mg/l $CaCO_3$	mg/l	mg/l	g/l	µg/l	µg/l	µg/l	µg/l	µg/l	µg/l	µg/l	mg/l	µg/l	µg/l	mg/l SO_4	µg/l	µg/l
OW 1	7.9	2314	423	233	0.5	0.6	47	3.4	0.1	0.7	11	9	0.3	21	0.2	1.0	1194	0.9	74
OW 2	8.7	2372	377	201	1.2	0.7	2651	8.2	0.1	1.3	15	855	10.6	20	0.2	5.2	1036	4.9	452
OW 9	7.2	14958	723	3297	1.3	4.3	46	33.4	0.2	0.7	13	123	0.7	486	0.2	14.7	1178	14.8	134
OW 10	7.3	29450	131	7733	0.9	6.1	16	76.5	0.1	0.7	12	97	0.6	948	0.2	16.5	1571	34.7	2529
OW 11	7.4	29353	1794	7381	0.6	6.8	19	90.4	0.1	2.6	7	148	0.5	829	0.2	3.3	1009	69.0	81
OW 12	7.9	16317	801	5343	0.4	5.3	40	44.8	0.1	1.1	6	90	0.3	746	0.2	4.9	530	45.1	74
OW 13	7.7	522	209	24	0.5	0.0	34	0.5	0.1	0.7	9	50	0.7	8	0.2	1.1	10	1.0	76
OW 14	7.5	610	237	48	0.5	0.0	56	0.5	0.1	0.7	11	114	1.0	8	0.2	1.7	24	1.8	124
OW 15	7.4	635	282	21	0.1	0.0	15	0.9	0.1	0.7	10	574	0.4	8	0.2	2.4	11	1.1	80
OW 20	7.7	9030	518	644	1.3	0.7	83	10.3	0.1	0.7	13	372	0.6	51	0.2	10.6	380	8.2	18
OW 21	7.2	31425	2314	7785	0.5	7.7	6	97.4	0.1	1.6	23	139	0.3	5921	0.2	3.6	12	64.1	56
OW 22	7.1	19550	580	1274	0.9	1.0	30	12.2	0.3	0.7	19	219	0.9	44	0.2	7.9	426	6.9	123
OW 24	7.2	14355	850	3101	1.0	3.6	11	44.4	0.4	0.7	16	159	0.4	180	0.2	12.7	791	12.2	68
OW 25	7.0	19038	1033	4165	0.7	4.6	19	58.2	0.1	2.5	17	370	0.4	232	0.2	4.8	1306	20.1	97
OW 26	7.5	7878	656	1968	0.8	1.8	15	25.2	0.1	0.7	13	57	0.5	176	0.2	3.3	441	9.9	113
OW 27	7.1	10603	770	2807	0.5	2.9	16	33.3	0.1	0.7	18	146	0.5	161	0.2	6.6	603	9.8	78
OW 28	7.2	15330	717	3834	1.0	4.0	14	51.6	0.1	0.8	22	74	0.5	449	0.2	10.4	786	17.0	96
OW 29	7.3	16715	924	3609	1.1	4.3	8	50.5	0.1	0.8	25	107	0.4	437	0.2	9.6	810	18.7	81
OW 30	7.1	2881	734	348	0.6	0.4	25	9.8	0.1	0.7	13	63	0.5	86	0.2	3.1	423	9.7	98
OW 31	7.1	16790	860	3498	0.4	3.9	20	508.2	0.1	0.7	18	270	0.5	539	0.2	11.2	715	23.1	91

OW Ref.	pH	Conduct-ivity	Total Alkalinity	Chloride	Fluoride	Soda	Al	As	Cd	Cr	Cu	Fe	Pb	Mg	Hg	Ni	Sulphate	Ti	Zn
		µS/cm	mg/l $CaCO_3$	mg/l	mg/l	g/l	µg/l	µg/l	µg/l	µg/l	µg/l	µg/l	µg/l	mg/l	µg/l	µg/l	mg/l SO_4	µg/l	µg/l
OW 32	6.8	32105	677	7732	0.5	8.0	26	2.8	0.2	1.1	31	292	0.3	825	0.2	12.0	2240	64.8	38
OW 33	7.1	17135	624	4482	0.5	4.2	159	7.2	0.1	2.8	20	1793	1.8	369	0.2	7.6	2396	25.8	84
OW 34	7.6	856	277	57	0.5	0.0	42	36.7	0.1	1.6	12	713	0.5	233	0.2	2.2	58	7.8	95
OW 35	7.2	14503	364	4567	0.6	3.2	48	38.3	0.2	0.7	18	1669	1.2	296	0.2	8.7	621	10.8	478
OW 36	7.3	18285	483	4567	0.5	4.0	48	55.7	0.2	0.9	17	627	1.0	431	0.2	9.6	716	18.2	196
OW 37	7.5	787	240	40	0.5	0.0	71	1.2	0.1	0.7	8	126	1.0	17	0.2	1.2	59	1.1	161
OW 38	7.6	643	219	32	0.5	0.0	32	0.8	0.1	0.7	11	69	0.8	8	0.2	1.0	20	0.8	139
OW 39	7.4	813	259	18	0.5	0.0	30	0.7	0.1	0.8	9	32	0.9	21	0.2	1.1	138	1.0	166
OW 40	7.6	652	234	36	0.5	0.0	8	0.9	0.1	0.7	7	11	0.8	17	0.2	0.9	33	1.7	6
OW 41	7.5	660	229	50	0.5	0.0	9	0.6	0.1	0.7	7	25	0.2	11	0.2	1.0	15	0.8	3
OW 42	7.3	826	314	31	0.5	0.0	20	0.9	0.1	0.7	7	15	0.2	10	0.2	1.1	27	0.8	9
OW 43	7.8	2735	212	705	0.5	0.5	9	6.0	0.1	0.7	9	13	0.2	49	0.2	1.2	97	1.1	3
OW 44	7.4	815	301	45	0.5	0.0	14	1.0	0.1	0.7	13	24	0.4	17	0.2	0.9	26	1.0	7
OW 45	7.4	718	242	30	0.5	0.0	13	1.1	0.1	0.7	8	12	0.2	13	0.2	0.8	42	0.7	19

* OW7, 8, 16, 17, 18, 19, 23 were decommissioned in 2010 due to BRDA expansion

8.3 Leak Detection Monitoring System

In accordance with the IE Licence conditions, AAL is required to undertake annual groundwater monitoring for hydrocarbons in four monitoring boreholes (BH1- BH4) located in the underground fuel storage area.

The fuel storage area comprise three steel underground storage tanks (UST's), two of which were used for diesel and one for petrol. The two diesel UST's were decommissioned after Agency approval in 2005.

Low levels of diesel range organic hydrocarbons (DRO) and polycyclic aromatic hydrocarbons (PAH) were detected in groundwater samples taken during 2010. This was believed to be related to historic leaks prior to the decommissioning of the UST's. AAL commenced an in situ remediation programme in late 2010 involving the application of an oxygen release compound (calcium oxyhydroxide) which biodegrades the hydrocarbons and the programme is ongoing.

The results of groundwater monitoring carried 2015 are tabulated in Table 37 below.

Table 37 Borehole Groundwater Monitoring Results 2015

Borehole Ref.	Date	DRO* (μg/l)	PAH* (μg/l)
BH 1	08/09/15	<1	<0.01
BH 2	08/09/15	35,598	<0.01
BH 3	08/09/15	<1	<0.01
BH 4	08/09/15	<1	<0.01

**DRO – Diesel Range Organic hydrocarbons; PAH - Polycyclic Aromatic Hydrocarbons.*

The residual DRO contamination evident in BH 2 is being remediated in situ in recent years. It was noted that there was no contamination detected in BH1 in 2015 which further demonstrates the benefit of the ongoing remediation programme.

8.4 Fugitive Emissions in the AAL Plant Area

AAL undertakes monitoring for fugitive dust emissions at twenty eight locations within the site perimeter.

The dust deposition gauges (labelled DG 1–28) measure deposited particulate material, collected over a 30-day period in accordance with TA Luft/VDI Guidelines 2119 Part 2. In total, there are 19 deposition gauges located around the BRDA to monitor dusting from the landfill area including the Phase 2 BRDA (DG 4–13, 20–28). The remainder are in the plant area.

Dust deposition measures the daily quantity of dust settling over a specified area (m^2) and is expressed as milligrams per square metre per day ($mg/m^2/day$).

Average results for 2015 are summarised in Table 38. Results are presented as mean annual rates for each location, together with the range of monthly data recorded throughout the year.

Table 38 Dust Deposition Rates (mg/m^2/day) in 2015

Deposition Gauge No.	Average Deposition Rate (mg/m2/day)	Range (Min - Max) (mg/m^2/day)	TA Luft Guideline Limit mg/m^2/day
D.G. 1	93	8 - 268	350
D.G. 2	80	9 - 123	350
D.G. 3	79	18 - 184	350
D.G. 4	61	13 - 247	350
D.G. 5	35	5 - 132	350
D.G. 6	47	10 - 140	350
D.G. 7	55	14 - 220	350
D.G. 8	27	7 - 81	350
D.G. 9	28	9 - 70	350
D.G. 10	47	4 - 326	350
D.G. 11	46	5 - 110	350
D.G. 12	26	7 - 101	350
D.G. 13	25	3 - 51	350
D.G. 14	74	7 - 258	350
D.G. 15	36	4 - 199	350
D.G. 16	63	11 - 223	350
D.G. 17	64	9 - 148	350
D.G. 18	96	6 - 287	350
D.G. 19	137	38 - 325	350
D.G. 20	29	6 - 51	350
D.G. 21	29	6 - 109	350
D.G. 22	37	4 - 139	350
D.G. 23	21	4 - 70	350
D.G. 24	32	4 - 121	350
D.G. 25	35	4 - 101	350
D.G. 26	50	14 - 153	350
D.G. 27	28	3 - 91	350
D.G. 28	27	3 - 108	350

8.5 Ambient Air Quality Monitoring

A programme of ambient air quality monitoring (both on-site and off-site) is carried out by AAL in accordance with Conditions 5.8 and 6.18 of the IE Licence.

The parameters monitored as part of the ambient air quality monitoring programme are:

- Sulphur Dioxide
- Deposited Dust
- Particulate Matter below 10 μm (PM_{10})
- Particulate Matter below 2.5 μm ($PM_{2.5}$)

Results from the off-site ambient air quality monitoring programme are reviewed against the Ambient Air Quality and Cleaner Air For Europe (CAFE) Directive 2008/50/EC as transposed into Irish legislation by the Air Quality Standard Regulations 2011 (SI 180/2011). On-site ambient air quality monitoring is also reviewed.

8.5.1 Ambient Air Sulphur Dioxide Monitoring

Ambient sulphur dioxide (SO_2) concentrations are monitored continuously via two SO_2 monitors located at Foynes and Ballysteen, along with passive diffusion tubes placed at 9 locations (including co-location with the continuous monitors).

A summary of the continuous sulphur dioxide results are shown in Table 39. All continuous sulphur dioxide (SO_2) monitoring data was within Air Quality Standard (AQS) Regulations limits for 2015.

Table 39 Ambient Air SO_2 Continuous Monitoring Results (μg/m³)

Continuous SO_2 Monitors	**SO_2 Monitoring Location**		**AQS Limits (μg/m³)**	**Basis of Application of Limit Value**
	Foynes	**Ballysteen**		
Max Hourly Value (μg/m³)	96.6	199.2	**350**	Not to be exceeded more than 24 times in a calendar year
Max Daily Average (μg/m³)	22.4	60.4	**125**	Not to be exceeded more than 3 times in a calendar year
Winter Mean (μg/m³)	5.7	0.3	**20**	1st October to 31st March
# Daily Averages >50μg/m³	0	1	**50**	NAQS Lower Assessment Threshold: 40% of 24-hour limit, not to be exceeded more than 3 times in a calendar year

A summary of the ambient sulphur dioxide diffusion tubes results are tabulated in Table 40, along with a description of their locations. All passive sulphur dioxide (SO_2) monitoring data was within AQS limits for 2015.

Table 40 Ambient Air SO_2 Diffusion Tubes Monthly Results (µg/m³)

Monitoring Location	Annual Mean (µg/m³)	Min Result (µg/m³)	Max Result (µg/m³)	National Air Quality Standard Lower Assessment Threshold
House (1)	0.0	0.0	0.0	<50µg/m³ (Not to be exceeded more than 3 times per year)
House (1A)	0.0	0.0	0.0	
Raw Water Intake (2)	0.0	0.0	0.0	
House (3)	0.0	0.0	0.0	
Water Works (4)	0.0	0.0	0.0	
Foynes (5)	0.6	0.5	1.2	
House (6)	0.4	0.8	0.8	
House (7)	0.6	1.1	1.1	
Aughinish (8)	0.7	0.7	1.0	
Foynes Reservoir (9)	0.5	1.0	1.0	
Foynes Reservoir (9A)	0.0	0.0	0.0	

* Locations shown on ***Attachment 6*** Ambient Air Monitoring Locations Map
**CAFE threshold shown is lower assessment threshold for SO_2 (40% of 24-hour limit value)

8.5.2 Ambient Air Particulate Deposition

Particulate deposition is normally monitored at two off-site locations as part of the ambient air quality monitoring programme. Following Storm Darwin in February 2014, three additional locations were monitored in 2014 & 2015. Table 41 below shows a summary of the results for these monitoring locations during 2015. All values were within the TA Luft guideline limit of 350mg/m²/day.

Table 41 Ambient Air Mean Monthly Particulate Deposition Rates

Site No.	Dust Gauge Ref.	Deposition Rate (mg/m²/day)	Range (mg/m²/day)
3*	29	46	10 - 202
7	30	45	6 - 188
11	31	41	5 - 120
12**	32	34	2 - 174
13	33	17	1 - 68

*Relocated in 2015 away from farmyard roadway to adjacent field to eliminate interference from farm roadway traffic
**Relocated in 2015 from private property to adjacent field (at request of property owner)

8.5.3 Ambient Air $PM_{2.5}$ & PM_{10} Monitoring Ambient Air Particulate Deposition

Monitoring of particulate matter below 2.5µm ($PM_{2.5}$) and below 10µm (PM_{10}) is carried out at 5 locations (2 on-site and 3 off-site) by AAL. The monitoring is carried out using Osiris Continuous Air Sampling Monitors. Table 42 (external) and Table 43 (internal) below show a summary of the results obtained for the 2015 monitoring.

Table 42 External Ambient Air Daily $PM_{2.5}$ & PM_{10} Monitoring Results 2015

Monitoring Location	Foynes	Ballysteen	LCC WTP	CAFE Directive Limits
$PM_{2.5}$ Annual Mean µg/m³	5	6	4	25 µg/m³
PM_{10} Annual Mean µg/m³	9	13	9	40 µg/m³

Table 43 Internal Ambient Air Daily $PM_{2.5}$ & PM_{10} Monitoring Results 2015

Monitoring Location	SW of Plant	NE of Plant
$PM_{2.5}$ Annual Mean µg/m³	12	7
PM_{10} Annual Mean µg/m³	64	16

With reference to Schedule 3 of Air Quality Standard Regulations 2011 regarding location of sampling points, the AQS regulations do not apply to on-site ambient air monitoring.

In summary, 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.

8.6 Bund, Tank and Pipeline Integrity Testing

Condition 6 of the IE Licence (Control and Monitoring) states the requirements for the protection of groundwater from spills, leaks and improper storage. Specifically, Conditions 6.10 and 6.11 deal with the inspection and testing of bunding structures, tanks, underground pipelines and open drains carrying caustic effluent.

8.6.1 Bunds and Tanks

The site has a number of integrity testing and repair programmes.

The integrity testing of all bunding structures and tanks is carried out on an on-going three-year cycle. In total, there are 370 separate items requiring integrity testing at AAL and in 2015 the integrity of 90 bunds, sumps, tanks, underground pipelines and drains was confirmed.

Over the past number of years substantial sections of the drainage network have been upgraded with a steel or stainless steel liner to minimise the risk of groundwater contamination.

8.6.2 Underground Pipelines

All pipelines carrying process effluent are above-ground.

All non-process effluent pipelines (sanitary) were tested in 2013 in accordance with IE Licence Condition 6.10 and are due to be re-tested in 2016.

8.6.3 Process Drains

AAL carried out a detailed risk assessment of open process drains during 2014. The assessment identified a total of 34 sections of open drain that require integrity testing. A proposal was submitted to the Agency in October 2014 and verbal approval to proceed has been received from the EPA inspector. Tests have been scheduled and will be completed over a 3-year period. In 2015, 14 process drains were tested and passed.

8.7 Decommissioning and Residuals Management Plan (DRMP)

Condition 10 of the IE Licence requires that AAL shall maintain a detailed and fully costed Decommissioning and Residuals Management Plan (DRMP), also referred to as a Closure Restoration and Aftercare Plan (CRAMP) which is adequate to assure the Agency that AAL is at all times capable of financing the environmental decommissioning and restoration of the AAL site after closure. The plan must be reviewed annually.

8.7.1 Update of DRMP/CRAMP

A review of the AAL DRMP (CRAMP) was undertaken by AMEC on behalf of the EPA in 2013 and early 2014. It was proposed that the forecast CRAMP cost be increased to provide for a number of more conservative assumptions such as a total of 35 years of post-closure monitoring, an additional 10% allowance for contingencies and to reflect the requirements of the updated guidance from the EPA on Environmental Liability Risk Assessment, Residuals Management Plans and Financial Provision published in 2014.

Following a lengthy consultation and review process involving AAL, AMEC and the EPA, a total estimated cost of **€27,984,656** was formally approved by the the Agency on the 7th May 2014. AAL have engaged independent consultants to conduct a further review of the costings which will be completed in 2016.

8.7.2 Financial Provision

The EPA is updating the form of Financial Provisions that it considers acceptable to underwrite costs identified under DRMP's/CRAMP's and Environmental Liability Risk Assessments. AAL is in detailed discussion with the Agency at present to agree a revised Financial Provision to address the CRAMP cost which is expected to fall due sometime between 2033 and 2055.

8.8 Environmental Liabilities Risk Assessment (ELRA) Review

In accordance with Condition 12.7.2 of the IE Licence, AAL is required to engage an independent consultant to complete a comprehensive and fully costed Environmental Liabilities Risk Assessment (ELRA), at least every three years. The ELRA must address the liabilities from past and present activities on-site and must include those liabilities and costs identified in Condition 10 for execution of the CRAMP.

The ELRA shall be reviewed as necessary to reflect any significant changes on site. Under Condition 12.7.3, AAL is also required to have adequate financial provision in place to cover the identified liabilities in the event of occurrence.

8.8.1 Update of ELRA

During 2014, two new natural gas-fired boilers were commissioned and this has led to cessation of HFO shipments. A revised ELRA was conducted by independent consultants PM Group and submitted to the EPA in February 2015. The cost, calculated in accordance with the EPA Guidance, for unknown liabilities associated with the operational and closure phases of the AAL facility was calculated at **€1,191,873**. This is associated with the potential for a spill or leak from a mobile tanker delivering diesel to the plant.

8.8.2 Financial Provision

The EPA is updating the form of Financial Provisions that it considers acceptable to underwrite costs identified under CRAMPs and Environmental Liability Risk Assessments. AAL will adhere to the requirements of the Agency.

8.8.3 Statement of Measures in Relation to Prevention of Environmental Damage

The measures currently undertaken by AAL in relation to the prevention of environmental damage and possible remedial actions were detailed in the revised CRAMP and ELRA submitted to the EPA.

8.9 Public Information Programme

In accordance with IE Licence Condition 2.2.2.7, AAL maintains a public awareness and information programme. Copies of quarterly monitoring reports and annual environmental reports are retained at the main Reception/Security building at AAL. This documentation can be reviewed by any member of the public at all reasonable times.

AAL held a public meeting with its neighbours on the 10th December 2015. The agenda included:

- Overview of the Alumina Sector
- AAL continuous improvement activities in 2015
- Environmental performance & regulatory visits
- BRDA operation and associated landscaping updates
- A pictoral seasonal review of flora and fauna in Aughinish in 2015

8.10 Annual BRDA (Landfill) Status Report

The Bauxite Residue Disposal Area (BRDA) has been classified as a Category A facility under the Extractive Waste Directive. The basis for this classification is the environmental sensitivity of the Special Area of Conservation lands and estuarine habitats adjacent to the BRDA.

Operational information required under Schedule D of the IE Licence in respect of the BRDA is tabulated in Table 44 below. There are no closed areas within the BRDA and all areas are currently operational.

Table 44 BRDA Operational Status

Parameter	**Details**
Landfill name & Licence number	Aughinish Alumina Ltd. (BRDA) IE Licence Reg. P0035-06
Landfill location	Aughinish Island (National Grid Ref. 127300E, 152200N)
Reporting period	Jan 01 – Dec 31 2015
Owner and/or operator	Aughinish Alumina Ltd.
Area occupied by waste	168.5 hectares (94.5 ha Phase 1 BRDA, 74 ha Phase 2 BRDA)
Tonnage and composition of waste deposited in the preceding year	1,507,468 tonnes (See Table 47)
Methods of depositing	Pumping/Trucking
Time and duration of depositing	24 hours per day, 365 days per year
Total accumulated quantities of waste deposited	**28,375,647** tonnes (Table 48)
Calculated remaining capacity	25,968,278 tonnes (Table 49)
Calculated final capacity of site	54,343,925 tonnes
Year in which final capacity of site is expected to be reached	2032
Stability checks undertaken	See Section 8.10.3 & ***Attachment 8***
Results of monitoring programme	See Section 8.10.3 & ***Attachment 8***
Summary of any monitoring non-compliances and corrective actions taken	No non-compliances in 2015
Summary of any development/remedial works carried out in the preceding year	See Section 8.10.8
Revisions to Landfill Operational Plan	See ***Attachment 7***
Progress on restoration of completed cells	In 2015 the program of amending and vegetating the wide stage 5 - 6 plateau of the North & West sides of BRDA Phase 1 continued

8.10.1 BRDA Waste Composition and Tonnage Data

Information on current and projected waste disposal rates, together with a breakdown of waste types is tabulated below.

Table 45 BRDA Waste Composition & Tonnage 2015

Waste Stream	LoW Code	Jan – Dec 2015 Total (t)	As % of total waste landfilled
Red Mud (dry)	01 03 09	1,350,288	89.57%
Sand	01 03 99	108,923	7.23%
Salt Cake (wet)	01 03 07	19,201	1.27%
Process Waste (wet)	01 03 99	21,869	1.45%
Lime Grits (wet)	01 03 99	7,125	0.47%
Fluestack Residues (dry) 2015 data	16 11 04	62	0.01%
Total Waste		**1,507,468**	**100.00%**

Table 46 Accumulated Quantities of Waste to BRDA 1983 to Dec 2015

Waste Stream	LoW Code	1983 – Dec 2015	As % of total waste landfilled
Red Mud (dry)	01 03 09	25,214,236	88.66%
Salt Cake (wet)	01 03 07	504,989	1.77%
Process Waste (wet) (includes sand)	01 03 99	2,570,061	9.04%
Lime Grits (wet)	01 03 99	140,188	0.49%
Fluestack Residues (dry)	16 11 04	4,799	0.02%
Effluent Sludge A34 Clarifier (dry)*	06 05 03	4,380	0.02%
Total Waste		**28,438,653**	**100%**

(Note1: The data for all residues for 1983 - 1997 other than red mud are estimated based on pro-rata tonnages for the period 1997 to 2000)

* Material no longer generated.

Engineering estimates of the total occupied and remaining capacity of the BRDA have been updated to reflect recorded quantities of waste deposited at the facility during 2015 and take into account the residue deposited in both the Phase 1 BRDA and the Phase 2 BRDA commissioned since 2011 and are tabulated below.

Table 47 Estimated Capacity of BRDA

Period	MOM Note 1	Waste during period (t)	Accumulated waste (t)	Remaining capacity of BRDA (t)
1983-2000	R	9,952,703	9,952,703	9,762,404
2001	R	1,110,916	11,063,619	8,651,488
2002	R	1,111,886	12,175,505	7,539,602
2003	R	1,053,818	13,229,323	6,485,784
2004	R	1,077,940	14,307,263	5,407,844
2005	R	1,224,053	15,531,316	4,183,791
2006	R	1,270,270	16,801,586	2,913,520
2007	R	1,221,369	18,022,955	1,692,151
2008	R	1,240,695	19,263,651	451,455
2009	R	994,993	20,165,917	3,213,230 Note 2
2010	R	1,251,060	21,416,978	1,962,170
2011	R	1,341,079	22,758,056	26,909,500 Note 3
2012	R	1,302,383	24,060,439	25,607,117
2013	R	1,343,516	25,403,955	24,263,601
2014	R	1,464,224	26,868,179	27,475,746 Note 4
2015	R	1,507,468	28,375,647	25,968,278
2016	E	1,512,169	29,887,816	24,456,109

[1] MOM – Method of Measurement; R = Recorded (Measured); E = Engineering Estimate
[2] Increase in capacity of Phase 1 BRDA with increase in height to 32 meters (i.e. going from Stage 7 perimeter lift to Stage 10 perimeter lift) following issue of IPPCL P0035-04 in 2008.
[3] Phase 2 BRDA was commissioned in Aug 2011 increasing the overall capacity from 31st Dec 2011 onwards.
[4] The results of the 2014 laboratory testing as part of the 2014 BRDA Site Investigation indicated increase in consolidated dry density of the insitu accumulated residue, therefore the remaining capacity of the BRDA was increased in 2014.

8.10.2 BRDA Containment Capacity

Containment capacity within the BRDA is developed by rockfill embankments constructed upstream on the hardened residue inside the BRDA perimeter. These embankments are constructed in stages, each stage increasing the elevation of the BRDA by 2 metres. For the Phase 1 BRDA approximately 37% of the Phase 1 BRDA perimeter is currently at Stage 10, 31% of the BRDA perimeter is currently at Stage 9, 32% is at Stage 8. For the Phase 2 BRDA 45% of perimeter is at Stage 0 i.e. the inner wall level, 9% perimeter at Stage 1, 37% at Stage 2 and 9% of perimeter at Stage 3. The current IE Licence and planning permission permits the entire existing Phase 1 and Phase 2 BRDA perimeters to be raised to Stage 10. This extends the lifetime of the BRDA to 2032 at current licensed production rates particularly as the

2014 BRDA Site Investigation recorded that the consolidated dry density of the accumulated residue has increased.

8.10.3 BRDA Monitoring Programme

The 2015 Report on the BRDA monitoring programme is reported in the Golder 2015 Annual (Stability) Review the executive summary of which is included as ***Attachment 8*** in compliance with Schedule C.7. Monitoring of the BRDA geotechnical instrumentation continued in 2015.

Monitoring of environmental conditions at the BRDA is undertaken on a routine basis through the collection of samples of groundwater from observation wells (OW's) and surface waters for analysis. Monitoring results for the 2015 reporting period are detailed in Section 2.2.7 (Surface Waters) and 8.2.3 (Groundwater) of this AER.

There are 28 dust deposition gauges at various locations around the perimeter of the BRDA to determine the rates of dusting from the BRDA. Monitoring results for the 2015 reporting period have been detailed in Section 8.4 (Fugitive Emissions in the AAL Plant Area).

8.10.4 Implementation of Golder Breakout Study Recommendations

The Breakout Study and Risk Assessment for the BRDA was revised in Quarter 1 2013 and submitted to the EPA in accordance with Condition 8.4.30. This was an update of the 2006 study (referred to in Condition 8.4.16 of the IE Licence). The revised report takes account of the improved stability of the BRDA brought about by the implementation of and further advances in 'mud farming'.

The result of mud farming has been to increase the undrained shear strength of the red mud and this has been incorporated in the updated stability analyses for the red mud placed above stages 7/8 in Phase 1 BRDA and all the stages of Phase 2 BRDA. Mud farming has increased the stability of the side slopes significantly on the upper levels of Phase 1, thus reducing the probability of failure and the ability of the material to mobilise. In addition, as the facility is raised, the effective stress (self-weight) on the red mud increases which consolidates stiffens and, in turn, increases the red mud strength.

The study recommended that following procedures/actions be undertaken to alleviate the identified risks or mitigate the consequences:

- Ensure there is no excessive build-up of pore pressures in the foundation or glacial fill materials due to leakage in accordance with the design criteria as outlined in References 3.3 and 3.4;
    - Quarterly monitoring is undertaken by Golder Associates for AAL. Monitoring of the inclinometers, extensometers and piezometers combined with the 2010 Cone Penetration Tests confirm that the BRDA walls are stable at the current elevations and that the BRDA structural integrity is in accordance with the design.
    - 8 No. Piezometers were installed in the estuarine soil around the downstream perimeter of the Phase 1 BRDA in Q1 2015 to measure any pore pressures in the downstream estuarine strata.
- Ensure that the undrained shear strength of the red mud forming the foundations for the upstream raise of the BRDA are monitored in accordance with the design criteria as outlined in the Phase 1 optimisation design and Phase 2 design reports (2005);

  - This is monitored and reported by Golders during CPT testing which was undertaken in 2014.
- Avoid water collecting in the Perimeter Interceptor Channel along Sector E (east side of Phase 2 BRDA) and Sector F (east side of Phase 1 BRDA) by ensuring sufficient gradient in the channel to allow water to migrate to lower sectors of the Perimeter Interceptor Channel;
  - Operational sequence for displacement and drainage of ponded water on east side of Phase 2 BRDA (Sector E) was developed during 2014.
  - A perimeter wall consisting of drainage stone was constructed along Stage 2 wall elevation of the east side of Phase 2 BRDA to facilitate drainage of water along the east perimeter of Phase 2.
  - Pumping of surface water from the east side Phase 2 BRDA is undertaken from a sump within the Stage 2 drainage wall to prevent any water ponding along the east side of Phase 2 BRDA.
  - Drainage of east side of Phase 1 BRDA (Sector F) is totally satisfactory.
- Install and monitor the piezometers, inclinometers and settlement systems in accordance with the recommendations given in References 3.3 and 3.4;
  - Existing instruments are monitored quarterly and additional instruments were installed in Quarter 2 of 2014.
  - In addition 8 piezometers were installed in Quarter 1 of 2015 to monitor pore pressures on the estuarine layer downstream of the Phase 1 BRDA perimeter west and north sides and along the north side of the Storm Water Pond.
  - 4 inclinometers were also installed in Q1 of 2015 to monitor movement under the upper stages of Phase 1 perimeter.
- Provide erosion protection (gabion mattresses) to the outer face of the Outer Perimeter Wall, Storm Water Pond and Liquid Waste Pond in support of the Phase 1 optimisation and Phase 2 designs;
  - Gabion mattresses were installed in 2013 up to elevation 3.5m around the majority of the north and west perimeters of the Phase 1 and Phase 2 BRDA, and this installation was completed in Quarter 1 of 2014.
- Provide a secure mechanism (valve) for isolating and locking closed the intake to the sluice gate valve;
  - A penstock valve was installed in Quarter 3 2014.
- Regularly inspect the integrity of the flood tidal defence berm.(OPW seawall);
  - The wall is inspected periodically for defects.
  - An action plan to repair localised erosion on the OPW seawall approximately 100 metres away from the north side of the Phase 1 BRDA will be co-ordinated with the Office of Public Works and the National Parks and Wildlife Service as well as the Agency during 2016 as the zone of localised repairs is SAC / SPA designated.

Other management measures which are already in place include:

- Visual inspection of the facilities indicates no signs of distress in the walls.
- The outer and inner perimeter walls, the storm water and liquid waste ponds are performing in accordance with the structural design.

8.10.5 Report on Annual BRDA Review

Golder Associates were commissioned by AAL to prepare a annual BRDA review report as required under Schedule C.7 of the IE Licence. The Executive Summary is included as ***Attachment 8***.

The stability assessment summarises the monitoring results from the Casagrande piezometers, the inclinometers / extensometers and visual inspection of the facilities and assesses the stability of the BRDA, the inner and outer perimeter walls forming the perimeter interceptor channel, the storm water and liquid waste ponds.

The Phase 1 BRDA is formed from two facilities, the original Phase 1 BRDA, covering an area of 72 ha and the Phase 1 BRDA extension covering an area of 32 ha. The Phase 1 extension is lined with a HDPE geomembrane while the original Phase 1 relies on the low permeability of the estuarine soils to minimise seepage from the base of the facility, plus the inherent low permeability of the red mud itself. Phase 2 BRDA covers an area of 80 Ha and was commissioned in 2011 and is currently receiving the majority of the red mud generated.

The initial design for the Phase 1 BRDA facility was to provide storage to the year 2009 based on the facility constructed to Stage 7 (elevation 18 m AMSL), which equates to a central elevation of 27.5 m AMSL or 26 m above original ground level. A site investigation and design report was presented to AAL (References 2.1 to 2.4) proposing to raise the facility in three more stages (Stages 8, 9 and 10), resulting in a maximum perimeter elevation of 24 m and a central elevation of 32 m AMSL.

AAL have successfully raised the stack wall for Phase 1 to above Stage 8 and in numerous sections to Stages 9 and a few sections to Stage 10. For Phase 2, they are just commencing the construction of Stage 1.

The key components of the BRDA are:

- Low Permeability Outer Perimeter Embankment Wall;
- Permeable Inner Perimeter Embankment Wall;
- Perimeter Interceptor Channel;
- Composite Lined System Throughout the Phase 1 Extension and Phase 2 BRDA;
- Stage Raises; and
- Upper level bench to reduce the overall side slopes from 6H:1V to 6.3H:1V.

The Phase 1 and the new Phase 2 BRDA are surrounded by a perimeter interceptor channel which is formed by constructing the outer and inner perimeter embankment walls. Surface water collected in the perimeter interceptor channel is pumped back to the plant or into the storm water pond during storm events. The Phase 1 and Phase 2 channels connect on the western section of the facilities. The Phase 1 and Phase 2 facilities are being progressively merged.

Treated water is pumped from the treatment plant and into the liquid waste pond prior to discharge into the River Shannon.

Unlike conventional tailings facilities or water retaining dams, the BRDA retains little to no surface water on the red mud. The red mud is discharged as a paste from several near central discharge points to form a dome which typically has the apex some 6 m to 8 m above the perimeter stack wall elevation. The structure is raised by constructing perimeter walls on the red mud by the upstream method which involves the construction of a series of retaining bunds upstream of the toe of the BRDA facility and so forming a supporting face to the overall structure.

The final elevation of the perimeter stack wall will be 24 m AMSL and the highest elevation of stacked residue will be 32 m AMSL, or some 30 m above ground level.

From the results of the monitoring of the inclinometers, extensometers and piezometers in 2015 in the Phase 1 BRDA together with the previous 2014 CPT testing, it is apparent that the stack wall of the BRDA is stable at the current elevations with a factor of safety above 2 and the facility is performing in accordance with the design.

It is proposed to install 6 surface survey monitoring points along Section F of the Phase 1 BRDA where the dam has been steepened and reinforced to supplement the lateral measurements recorded in the inclinometers 5AIU and 5AIL.

The outer and inner perimeter walls of the Phase 1 and Phase 2 BRDA, the storm water and liquid waste ponds are performing in accordance with the design.

Visual inspection of the facilities indicates no signs of distress in the walls.

8.10.6 Biennial Audit at the BRDA

In January 2013, AAL submitted a proposal to the Agency outlining the scope of the biennial audit and the frequency of the equivalent Safety Evaluation of Existing Dams (SEED) audit to be undertaken at the BRDA. Golder Associates undertake both the Annual Review and the Biennial Independent Audit in accordance with the scope submitted to the Agency.

8.10.7 Revisions to BRDA Operational Plan

The BRDA Operational Plan was updated in October 2015 to ensure that all relevant information is up to date and connected via hyperlinks to the source information in the Business Performance Improvement system and to update the plan layout of the mud farming cells and is included as ***Attachment 7***.

8.10.8 BRDA Development/Remedial Works 2015

The notable developments/works in the BRDA during 2015 were:

- The commencement of the 2.25 raise of downstream walls of the salt cake cell from existing elevation 24.0 to elevation 26.25 to facilitate increased capacity of the cell.
- The installation of drainage stone wall at Stage 2 elevation along the east side of the Phase 2 BRDA to facilitate drainage and to prevent ponding.
- The continuous development of the residue carbonation on site testing and development works continued during 2015 to confirm the range of mud layer thickness and time periods as well as machinery requirements to achieve the optimum reduction in residue causticity to the target pH < 11.5.
- Application of GPS was developed to optimise carbonation at the BRDA.

There were no remedial works required in the BRDA during 2015.

8.10.9 Progress on Closure Planning and Re-vegetation of BRDA

IE Licence Condition 8.4.17 requires that AAL continues to strive to implement the recommendations in the relevant sub-sections of the Residues Solutions Report submitted to the Agency in July 2007. The subsections to be addressed are:

- Closure Planning
- Closure Re-vegetation
- Post-Closure Management

- Alternative Uses of Residue

Successful employment of the mud farming practice on the BRDA promotes carbonation of the red mud within the BRDA resulting in partial neutralisation to a stable pH of < 11.5.

The established closure demonstration trial cell is self-sustaining. In 2015 visual inspections were carried out. ***Attachment 9*** contains details of nutrient and elemental analysis on the closure demonstration cell over a 3 year period from 2013 to 2015.

In 2015, 30% customised organic matter was incorporated to the bauxite residue on stage five of the BRDA and was sown with the following nine salt tolerant grass species (Creeping Bent, Common Bent, Crested Dog's Tail, Sheep's Fescue, Red Fescue, Perennial Rye grass, Salt Marsh Grass, Red Clover, White Clover). The results in 2015 showed that it was possible to establish good grass growth on the BRDA. ***Attachment 10*** contains details of the work conducted by Enrich in 2015 of the restoration works occurring at Stage 5 of the BRDA.

In 2014 AAL joined the BRAVO (Bauxite Residue and Aluminium Valorisation Operations) consortium coordinated by the University of Limerick which focuses on potential re-use of bauxite residue as a valuable raw material for other Industries. The BRAVO consortium has over 30 party members including Industry representatives, SME's and leading Universities and Institutes within Ireland and the EU. A major focus area within this research consortium is being driven by climate change and the requirement for a global reduction of carbon emissions. The cement industry produces approx. 5% of CO_2 emissions globally. Therefore, the use of geopolymers within the production of cement is now an important research area towards reducing CO_2 emissions. In this regard, the BRAVO consortium is researching the application of bauxite residue in the production process of geopolymers.

8.10.10 BRDA Constructed Wetland Project

Bauxite residue from the Bayer process contains residual caustic soda with alkaline leachate of pH > 10.5. The DRMP/CRAMP for the BRDA must address the timeframes required for leachate to reduce to ≤ pH 9.0 so it can be discharged to the receiving environment. A novel approach to ensure that BRDA leachate can be passively treated and made suitable for discharge within a short period (months) of BRDA closure is to incorporate constructed wetland(s) into the CRAMP. Constructed wetlands are gaining global acceptance by regulators in mine closure. However, little research has been conducted into the using wetlands to treat bauxite residue leachate.

In 2012, Aughinish Alumina received funding from its owner Rusal and the International Aluminium Association for a four year study programme investigating the use of a constructed wetland to treat residue leachate. Part one of this study was a two-year (2012-2014) laboratory based investigation of the potential mechanisms that buffer residue pH in wetlands. Parameters included volume and quality of diluting waters, effects of carbonation and soil quality in decreasing pH. Part two of the study is a three year field operation of a constructed wetland within the Aughinish BRDA. An automatic leachate dilution and dosing system feeds the wetland inlet at the target pH and flow-rate. Water inflow and outflow are monitored on a continual basis with soil and herbage analysed seasonally.

In 2013 AAL constructed and commenced operation of a 40 m^2 trial constructed wetlands effluent treatment area in collaboration with the University of Limerick and the International Aluminium Institute. The 40 m^2 plastic lined reed bed is located within the Aughinish BRDA and contains three types of reeds typically found in wetlands ((*Phragmites australis, Typha latifolia* and *Sparganium erectum*). An automatic leachate dilution and dosing system feeds the wetland inlet at the target pH and flow-rate. Within the wetland microbial activity generates CO_2 which carbonates the water and thereby reduces the pH. A discharge pH of < 8.0 has been achieved with efficiency highest in the warmer Spring and Summer months. This research demonstrates that a constructed wetland would be capable to render BRDA leachate suitable for discharge to the environment even if the pH was higher than projected in the AAL CRAMP. The project continued to be a key research topic in 2015. ***Attachment 11*** contains an overview outlining progress made to date throughout 2015. The picture shown in Figure 9 was taken in summer 2015 and shows a thriving wetland system.



Figure 9 Wetland system – summer 2015

8.10.11 BRDA Events 2015

There were zero events related to the BRDA which required notification to the Agency during 2015.

8.10.12 Implementation of Extractive Waste Management Plan

AAL is required under Condition 8.3.1 of the IE Licence to maintain an Extractive Waste Management Plan for the minimisation, treatment, recovery and disposal of extractive waste in accordance with Regulation 5 of the Waste Management (Management of Waste from Extractive Industries) Regulations, 2009. The

Extractive Waste Management Plan was prepared and issued to the Agency in April 2013.

Extractive waste is treated and disposed to the on-site Bauxite Residue Disposal Area (BRDA) according to the Extractive Waste Management Plan. Waste materials suitable for internal road building within the BRDA are recovered for that purpose. Any other wastes for disposal within the BRDA (such as process contaminated pipes) are disposed following Agency approval on a case by case basis. These arrangements are detailed in the Extractive Waste Management Plan.

8.10.13 Emergency Planning for the BRDA

During 2015, AAL continued to consult with representatives of Limerick City and County Council (LCCC) (Fire Service and Environment Department) regarding the External Emergency Plan for the BRDA published in September 2013 as required by Condition 9.4.5 of the IE Licence. The consultation process consisted of written and verbal communication. A successful desk top exercise of the adequacy of the plan took place on-site on the 6th March 2015 and was attended by the Principal Response Agencies (LCCC, the HSE, An Garda Siochana) and the EPA as well as all the relevant personnel from AAL. AAL are awaiting response from LCCC on the updated plan.

8.11 Progress on Bauxite Residue Neutralisation

During 2015 the process of industrial mud farming continued to be implemented in BRDA Phase 1 employing 'thin layer' deposition. In this manner, fresh mud is deposited in layer depths of approximately 40 cms to facilitate fast de-watering and compaction. When a mud cell has been filled during 2 -3 days of operation the fresh mud discharge is moved to a new cell. After a period of 21 - 28 days the cell which has been filled with red mud is ready to be 'amphirolled' to express residual water from the mud and to aid its compaction. Following 10 passes of an amphiroll over a 2 month period the mud reaches a steady state compaction level with the solids concentration increased from 58% to >70%. This is the most important and time-consuming step in mud farming. It is important to speed up this compaction to provide the maximum window for preparing the cell for sealing by grading or subsequent harrowing and the associated carbonation.

Following amphirolling, the mud cells in Phase 1 were levelled and graded using a tracked bulldozer. In the majority of cells, residue carbonation to pH <11.5 was achieved by amphirolling alone. In the remainder of the Phase 1 cells which had been graded, the tractor towed spader machine rotovated the residue layer. Over the course of approximately 10-15 passes of the spader the residual caustic was carbonated and the pH reduced below 11.5.

During 2015 the Phase 2 BRDA area surface continued to be shaped with thicker layers of residue to develop the necessary gradient for thin layer deposition. This slowed down the amphirolling rate and thus industrial scale carbonation was not possible. This area will be developed during 2016 and thin layer mud deposition and carbonation will be implemented.

8.11.1 Testing Methodology to confirm Bauxite Residue Neutralisation

As per the requirements of IE Licence Condition 8.4.20, AAL has documented the test method to be utilised to confirm neutralisation of the bauxite residue by mud farming.

The mud is sampled per cell and analysed for pH until target pH of <11.5 is achieved. Three samples per cell are taken and labelled with cell number, date, location (top, middle, bottom) and no. of passes of equipment (amphiroll, grader or harrow as appropriate). Samples may be taken following amphirolling and if required after harrowing. Once pH < 11.5 is achieved then no further sampling is required. In some instances the target pH is achieved after amphirolling. However, this is dependent on mud quality on deposition, extent of amphirolling and ambient conditions.

The quarterly composite analysis on “farmed red mud” as per condition 8.4.20 is listed in the 4 quarterly waste reports located in **Attachment 2** Waste Analysis 2015.

Attachment 1
Process Effluent VOC & Toxicity Reports

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Report on the Industrial Emissions Licencing (IEL)Testing of the Aughinish W1-1B final effluent on behalf of Aughinish Alumina August 2015

Report prepared by

Aquatic Services Unit,
Environmental Research Institute.
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Cork

Introduction

Toxicity testing was requested by for the final effluent sample at the Aughinish Alumina facility as part of their Industrial Emissions licensing requirements. The sample code for the Aughinish effluent is W1-1 and the IE License number for the effluent is P0035-06. Two aquatic species from different trophic levels were selected for the testing namely the marine copepod (*Tisbe battagliai*) and the bacteria (*Vibrio fischeri*). Testing commenced on August 26th, 2015 and finished on August 28th, 2015.

Methodology

The W1-1B effluent sample was collected on August 23rd, 2015 by Aughinish Alumina personnel and transported by courier service to the Aquatic Services Unit (ASU) laboratory. The effluent sample arrived to the ASU laboratory on August 23rd, 2015 and had temperature of 10.0ºC on arrival; the sample was then immediately placed in a refrigerator at 4 ºC until required for testing.

Tisbe battagliai Bioassay

The *Tisbe* bioassay was carried out following standard methods as described in Environment Agency's Methods for the Examination of Waters and Associated Materials (Environment Agency, 2007). The effluent was tested for toxicity at the following concentrations 4.725, 9.5, 19, 38, and 76% effluent. The salinity of the effluent was adjusted to 30 parts per thousand (ppt) using hypersaline brine to make the sample suitable for testing. Twenty *Tisbe* isolates (animals 6 days old) were tested for each concentration. These animals were added into 4 replicates of five animals per test chamber for each concentration. Testing was carried out in a constant temperature room at a temperature of 20 ºC ± 2 throughout the test. A light regime of 16 hours light/8 hours dark was used throughout the testing period. The test duration was 48 hours. Filtered seawater adjusted to 30 ppt by the addition of distilled water was used as control and dilution water. An additional salt water control comprising of distilled water and hypersaline brine was also tested. A concurrent reference toxicant using zinc sulphate was conducted to assess the sensitivity of the test organisms. The *T. battagliai* were obtained from in house cultures at the ASU.

Vibrio fischeri bacteria bioassay using Microtox system.

The luminescent bacteria *Vibrio fischeri* are used exclusively in the Microtox system. Testing was carried out following the ISO 11348-3 guidelines (ISO, 2007). The concentrations of effluent tested ranged from 6.25% to 80%. Two replicates were used for each concentration tested. A concurrent reference toxicant bioassay was also carried out to determine the health and suitability of the bacteria.

Statistical Analyses

Statistical analyses to generate LC_{50} (Lethal Concentration to cause 50 percent mortality) or EC_{50} (Effective Concentration to cause 50 percent effect) data were performed using the ToxCalc v5.0.32 Environmental Toxicity Data Analysis System, (Tidepool Scientific, 2007). Microtox statistical analyses were carried out using the manufacturers software programme MicrotoxOmni.(Azur Environmental Ltd., 1995)

Results and Discussion

Tisbe battagliai Bioassay

This test was deemed to be valid given that there was greater than 90% survival in the controls indicating that the animals and testing conditions were satisfactory (Environment Agency, 2007). A LC_{50} value of 52.2 % effluent was calculated for this bioassay. This would correspond to a Toxicity Unit (TU) value of 1.9 for the effluent. Results of this bioassay are displayed in Figure 1. A concurrent reference toxicant bioassay using zinc sulphate was carried out alongside the effluent bioassay. This bioassay produced an EC_{50} of 0.426 mg/L of Zinc sulphate, this EC_{50} value is in agreement with previously published data for *Tisbe sp.* (US EPA, 2007) and with ongoing toxicity testing at the ASU. This indicates that the animals were of suitable sensitivity to be used for toxicity testing. Water quality measurements in the test chambers remained within normal limits for the duration of the bioassay. These data are presented in Appendix 2.

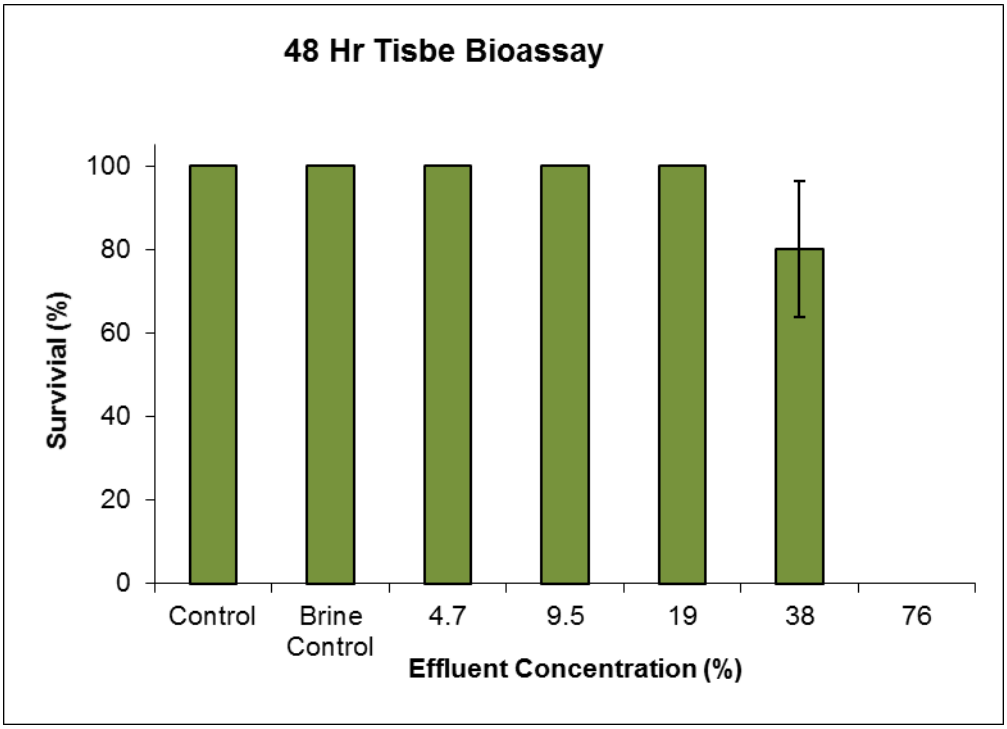


Figure 1 Average survival of *Tisbe battagliai* after 48 hours in a concentration series of the Aughinish Alumina effluent.

Microtox results.

The Microtox bioassay carried out on August 27th, 2015 was deemed to be valid. A reference toxicant test was carried out before actual testing of samples took place to ensure that the bacterium and reagents were suitable for testing. The reference toxicant using zinc sulphate determined an EC_{50} of 8.5 mg/L after 15 minutes exposure. This is within the guideline range of 3-10 mg/L as specified by the Microtox manufacturer (Azur Environmental, 1995). These data are presented in Appendix 2.

A G_L value of 4 was generated for this test. The G_L value is the dilution level at which a waste water effluent causes less than 20% inhibition to the species. Effluent samples with G_L values ranging from 1-10 are considered to have low toxicity, G_L values of 10-100 are considered to be moderate toxicity and G_L values greater than 100 are considered to have high toxicity. This G_L ranking system is based on research carried out on selected effluents (Wang et al., 2002). Exposure to the effluent only produced significant toxicity at the 50 and 80% concentrations. The Microtox test generated an EC^{50} of greater than 94.1% effluent, this would equate to a TU value of 1.1. The data for the Microtox effluent test are presented in Figure 2.

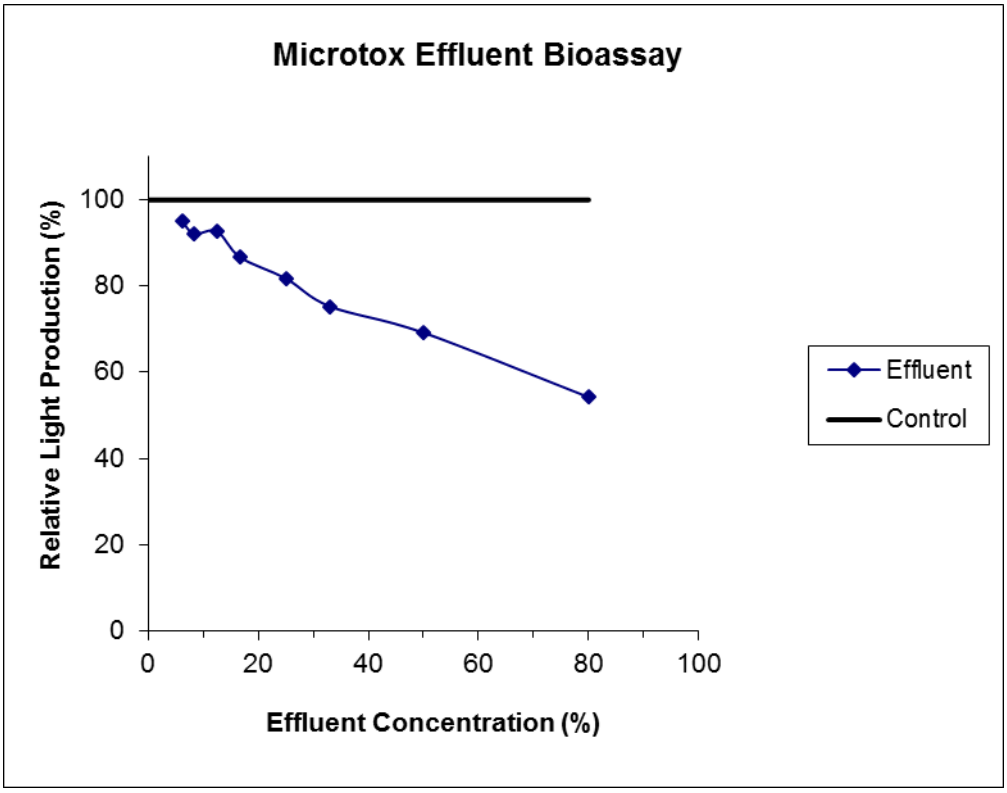


Figure 2 Plot of the Microtox results for the W1-1 effluent sample. Values represent light production relative to the controls. The highest concentration of effluent tested was 80%.

Summary and Conclusions

The marine copepod, *Tisbe battagliai*, was more sensitive to the effluent during this round of testing. The Tisbe bioassay produced a TU value of 1.9, this TU value would be considered low. In the Microtox bioassay, exposure to the W1-1 effluent did have a significant inhibitory effect on light production at the 2 highest concentrations tested. A dose dependent decrease in light production was observed across the concentration series. The Microtox bioassay was less sensitive to the effluent and a TU value of 1.1 was determined during this round of testing. The toxicity of effluents has been classified based on their TU values using the following scale TU<1 (relatively not acutely toxic), TU between 1 and 10 (minor acutely toxic), TU between 10 and 100 (moderately acutely toxic) and TU>100 (very acutely toxic) (Tonkes et al., 1999). Based on this scale, the results from the bioassays performed on the Aughinish Alumina W1-1 final effluent sampled on August 23rd, 2015 indicate that the sample is minor acutely toxic. All of the bioassays performed in the current round of testing were deemed to be valid as they meet all of the criteria as specified in the guidelines.

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Appendix 1- Water Quality Measurements for *Tisbe battagliai* Bioassay

48 Hour Tisbe Bioassay
Aughinish Effluent 26/08/15

Concentration	Survival			D.O (mg/L)			pH			Salinity (ppt)			Temp (°C)		
(%)	0hrs	24hrs	48hrs	0hrs	24hrs	48hrs	0hrs	24hrs	48hrs	0hrs	24hrs	48hrs	0hrs	24hrs	48hrs
Control A	5	5	5	6.8		6.1	8.00		7.89	30		30	19.1	21.3	21.7
Control B	5	5	5												
Control C	5	5	5												
Control D	5	5	5												
Control 2A	5	5	5	6.8		6.1	8.00		7.89	30		30	19.1	21.3	21.7
Control 2B	5	5	5												
Control 2C	5	5	5												
Control 2D	5	5	5												
Brine Control A	5	5	5	6.5		6.5	8.06		7.65	30		31	19.3	21.3	21.7
Brine Control B	5	5	5												
Brine Control C	5	5	5												
Brine Control D	5	5	5												
Brine Control 2A	5	5	5	6.5		6.5	8.06		7.65	30		31	19.3	21.3	21.7
Brine Control 2B	5	5	5												
Brine Control 2C	5	5	5												
Brine Control 2D	5	5	5												
4.725 A	5	5	5	6.6		6.3	8.01		8.22	30		30	19..2	21.3	21.7
4.725 B	5	5	5												
4.725 C	5	5	5												
4.725 D	5	5	5												
9.5 A	5	5	5	6.7		6.6	7.98		8.35	30		30	19.2	21.3	21.7
9.5 B	5	5	5												
9.5 C	5	5	5												
9.5 D	5	5	5												
19 A	5	5	5	6.8		6.5	7.92		8.32	30		30	19.3	21.3	21.7
19 B	5	5	5												
19 C	5	5	5												
19 D	5	5	5												
38 A	5	5	4	6.8		6.5	7.86		8.47	30		30	19.2	21.3	21.7
38 B	5	5	3												
38 C	5	5	4												
38 D	5	5	5												
76 A	5	2	0	6.8		6.2	7.79		8.46	29		30	19.2	21.3	21.7
76 B	5	1	0												
76 C	5	2	0												
76 D	5	2	0												

Notes

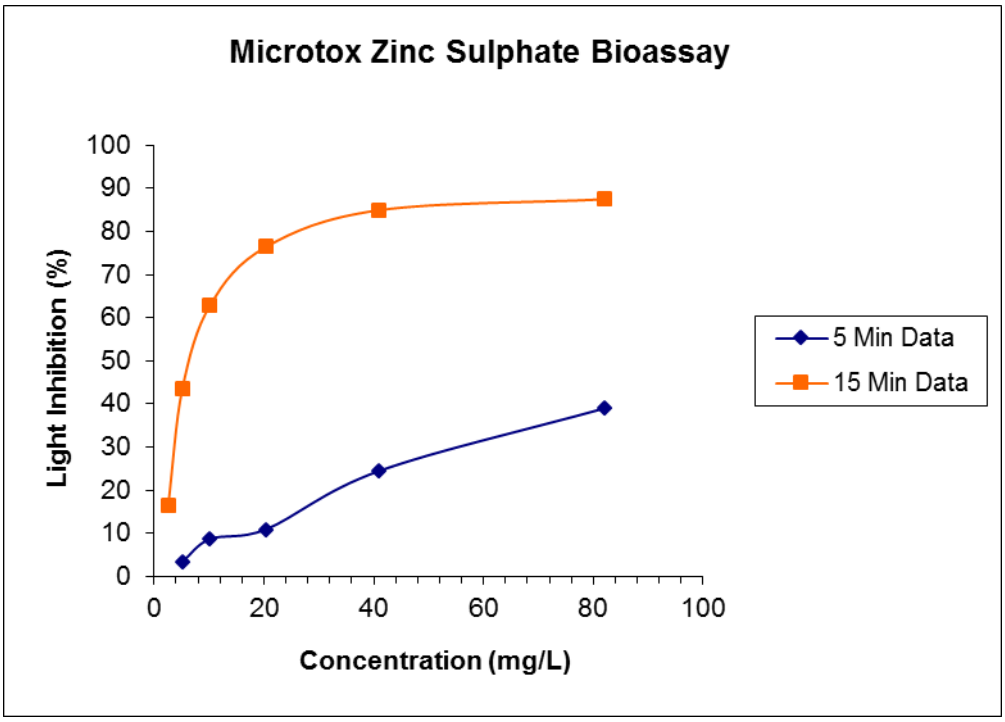
Day 0 Initiated at 17.00 , Animals 6 days old at initiation

24hrs 17.10

48hrs Terminated at 16.20

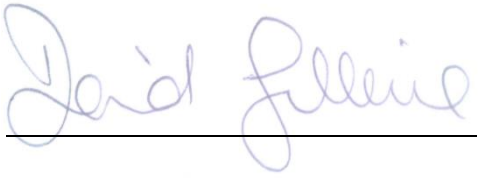
Testing performed by Aquatic Services Unit, ERI Building, Lee Rd., Cork

Appendix 2- Microtox Reference Toxicant Bioassay



Plot of light inhibition relative to the controls versus zinc sulphate concentration after 5 and 15 minutes exposure.

The toxicity testing carried out for this report complies with internationally accepted guidelines. The results of these toxicity tests contained in this report are deemed valid under these guidelines.

Signed: 

David Gillespie MSc (Toxicology)

Report on the IPPC Toxicity Testing of the Aughinish W1-1B final effluent on behalf of Aughinish Alumina May 2015

Report prepared by

Aquatic Services Unit,
Environmental Research Institute.
Lee Road.
Cork

Introduction

Toxicity testing was requested by for the final effluent sample at the Aughinish Alumina facility as part of their IPPC licensing requirements. The sample code for the Aughinish effluent is W1-1 and the EPA IPPC License number for the effluent is P0035-05. Two aquatic species from different trophic levels were selected for the testing namely the marine copepod (*Tisbe battagliai*) and the bacteria (*Vibrio fischeri*). Testing commenced on May 13th, 2015 and finished on May 15th, 2015.

Methodology

The W1-1B effluent sample was collected on May 11th, 2015 by Aughinish Alumina personnel and transported by courier service to the Aquatic Services Unit (ASU) laboratory. The effluent sample arrived to the ASU laboratory on May 12th, 2015 and had temperature of 12.9ºC on arrival; the sample was then immediately placed in a refrigerator at 4 ºC until required for testing.

Tisbe battagliai Bioassay

The *Tisbe* bioassay was carried out following standard methods as described in Environment Agency's Methods for the Examination of Waters and Associated Materials (Environment Agency, 2007). The effluent was tested for toxicity at the following concentrations 6.25, 12.5, 25, 50, and 74% effluent. The salinity of the effluent was adjusted to 30 parts per thousand (ppt) using hypersaline brine to make the sample suitable for testing. Twenty *Tisbe* isolates (animals 6 days old) were tested for each concentration. These animals were added into 4 replicates of five animals per test chamber for each concentration. Testing was carried out in a constant temperature room at a temperature of 20 ºC ± 2 throughout the test. A light regime of 16 hours light/8 hours dark was used throughout the testing period. The test duration was 48 hours. Filtered seawater adjusted to 30 ppt by the addition of distilled water was used as control and dilution water. An additional salt water control comprising of distilled water and hypersaline brine was also tested. A concurrent reference toxicant using zinc sulphate was conducted to assess the sensitivity of the test organisms. The *T. battagliai* were obtained from in house cultures at the ASU.

Vibrio fischeri bacteria bioassay using Microtox system.

The luminescent bacteria *Vibrio fischeri* are used exclusively in the Microtox system. Testing was carried out following the ISO 11348-3 guidelines (ISO, 2007). The concentrations of effluent tested ranged from 6.25% to 80%. Two replicates were used for each concentration tested. A concurrent reference toxicant bioassay was also carried out to determine the health and suitability of the bacteria.

Statistical Analyses

Statistical analyses to generate LC_{50} (Lethal Concentration to cause 50 percent mortality) or EC_{50} (Effective Concentration to cause 50 percent effect) data were performed using the ToxCalc v5.0.32 Environmental Toxicity Data Analysis System, (Tidepool Scientific, 2007). Microtox statistical analyses were carried out using the manufacturers software programme MicrotoxOmni.(Azur Environmental Ltd., 1995)

Results and Discussion

Tisbe battagliai Bioassay

This test was deemed to be valid given that there was greater than 90% survival in the controls indicating that the animals and testing conditions were satisfactory (Environment Agency, 2007). The Lowest observed effect concentration (LOEC) was 50% effluent and a LC_{50} value of 32.9 % effluent was calculated for this bioassay. This would correspond to a Toxicity Unit (TU) value of 3.0 for the effluent. Results of this bioassay are displayed in Figure 1. A concurrent reference toxicant bioassay using zinc sulphate was carried out alongside the effluent bioassay. This bioassay produced an EC_{50} of 0.117 mg/L of Zinc sulphate, this EC_{50} value is in agreement with previously published data for *Tisbe sp.* (US EPA, 2007) and with ongoing toxicity testing at the ASU. This indicates that the animals were of suitable sensitivity to be used for toxicity testing. Water quality measurements in the test chambers remained within normal limits for the duration of the bioassay. These data are presented in Appendix 2.

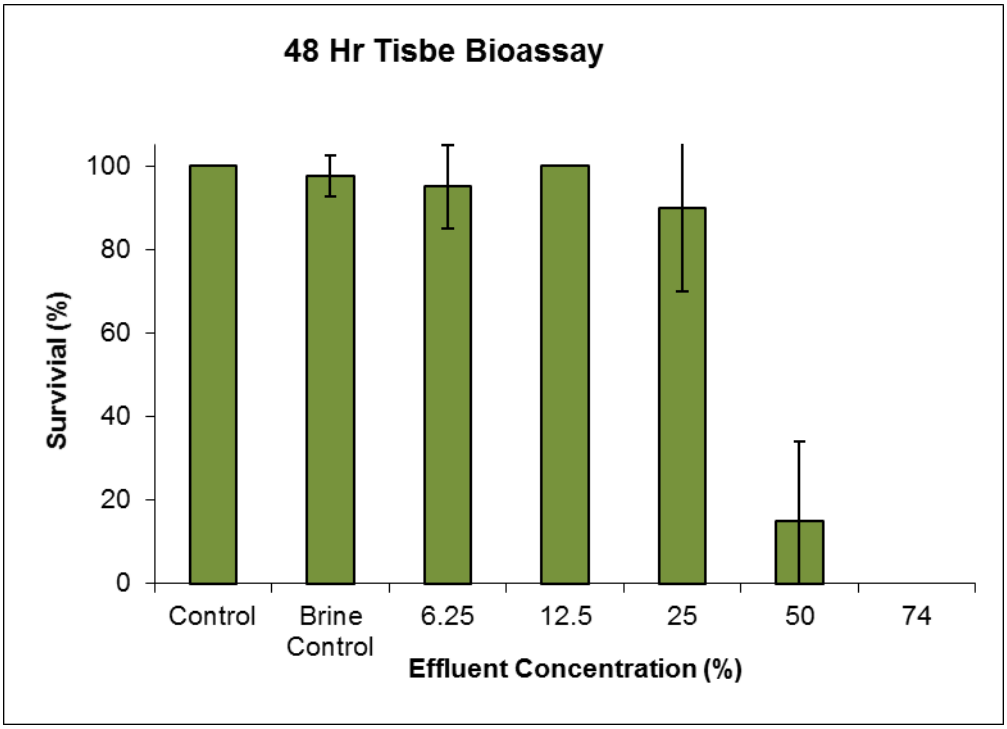


Figure 1 Average survival of *Tisbe battagliai* after 48 hours in a concentration series of the Aughinish Alumina effluent.

Microtox results.

The Microtox bioassay carried out on May 13th, 2015 was deemed to be valid. A reference toxicant test was carried out before actual testing of samples took place to ensure that the bacterium and reagents were suitable for testing. The reference toxicant using zinc sulphate determined an EC_{50} of 5.3 mg/L after 15 minutes exposure. This is within the guideline range of 3-10 mg/L as specified by the Microtox manufacturer (Azur Environmental, 1995). These data are presented in Appendix 2.

A G_L value of 4 was generated for this test. The G_L value is the dilution level at which a waste water effluent causes less than 20% inhibition to the species. Effluent samples with G_L values ranging from 1-10 are considered to have low toxicity, G_L values of 10-100 are considered to be moderate toxicity and G_L values greater than 100 are considered to have high toxicity. This G_L ranking system is based on research carried out on selected effluents (Wang et al., 2002). Exposure to the effluent only produced significant toxicity at the 50 and 80% concentrations. The Microtox test generated an EC^{50} of greater than 100% effluent, this would equate to a TU value of 1. The data for the Microtox effluent test are presented in Figure 2.

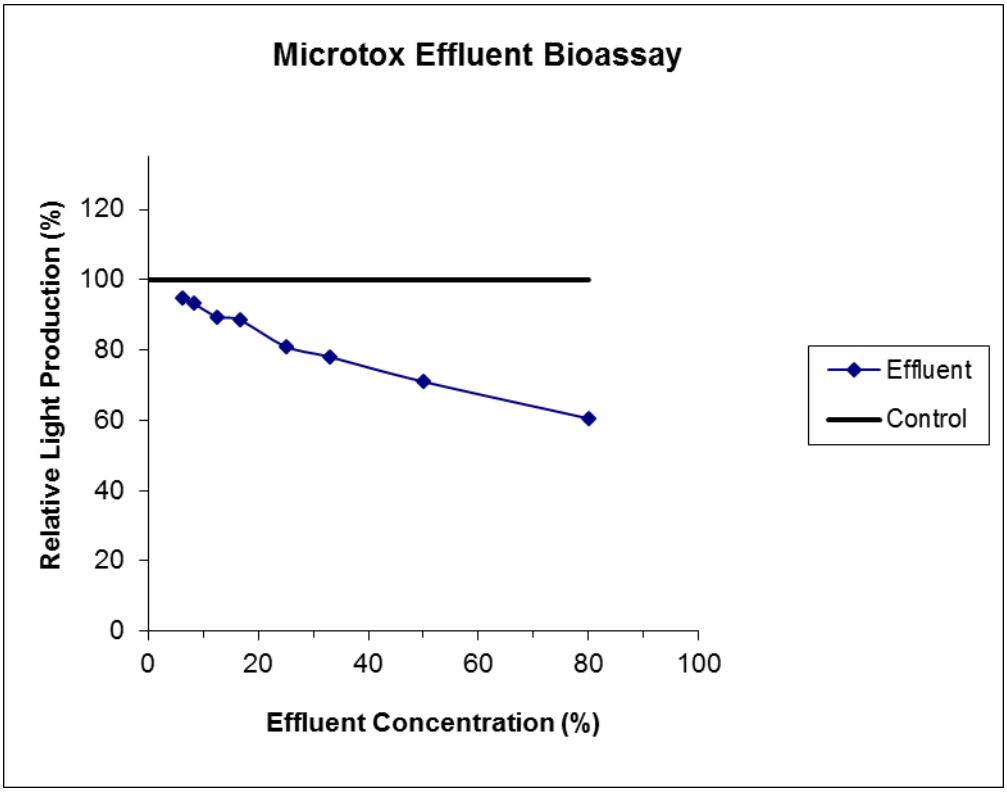


Figure 2 Plot of the Microtox results for the W1-1 effluent sample. Values represent light production relative to the controls. The highest concentration of effluent tested was 80%.

Summary and Conclusions

The marine copepod, *Tisbe battagliai*, was more sensitive to the effluent during this round of testing. The Tisbe bioassay produced a TU value of 3.0, this TU value would be considered low. In the Microtox bioassay, exposure to the W1-1 effluent did have a significant inhibitory effect on light production at the 2 highest concentrations tested. A dose dependent decrease in light production was observed across the concentration series. The Microtox bioassay was less sensitive to the effluent and a TU value of 1 was determined during this round of testing. The toxicity of effluents has been classified based on their TU values using the following scale TU<1 (relatively not acutely toxic), TU between 1 and 10 (minor acutely toxic), TU between 10 and 100 (moderately acutely toxic) and TU>100 (very acutely toxic) (Tonkes et al., 1999). Based on this scale, the results from the bioassays performed on the Aughinish Alumina W1-1 final effluent sampled on May 11th, 2015 indicate that the sample is minor acutely toxic. All of the bioassays performed in the current round of testing were deemed to be valid as they meet all of the criteria as specified in the guidelines.

References

Azur Environmental, 1995. Microtox Acute Basic Test Procedures. Azur Environmental ,. Carlsbad, California, USA.

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Tonkes, M. Graaf, P.J.F., and Jannes, G.,1999. Assessment of Complex Industrial Effluents in the Netherlands using a Whole Effluent Toxicity (or WET) Approach. Water Science and Technology, Vol. 39, No. 10-11, pp 55-61.

U.S EPA, 2007. ECOTOX User Guide: ECOTOXicology Database System. Version 4. http:/www.epa.gov/ecotox.

Wang, C., Yediler, A., Lienert, D., Wang, Z., and Kettrup, A., 2002. Toxicity evaluation of reactive dyestuffs , auxiliaries and selected effluents in the textile finishing industry to luminescent bacteria *Vibrio fischeri*. Chemosphere, 46, pp 339-344

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Appendix 1- Water Quality Measurements for *Tisbe battagliai* Bioassay

48 Hour Tisbe Bioassay
Aughinish Effluent 13/05/15

Concentration	Survival			D.O (mg/L)			pH			Salinity (ppt)			Temp (°C)		
(%)	0hrs	24hrs	48hrs	0hrs	24hrs	48hrs	0hrs	24hrs	48hrs	0hrs	24hrs	48hrs	0hrs	24hrs	48hrs
Control A	5	5	5	7.5		8.1	8.25		7.97	30		30	20.2	20.0	20.5
Control B	5	5	5												
Control C	5	5	5												
Control D	5	5	5												
Control 2A	5	5	5	7.5		8.1	8.25		7.97	30		30	20.2	20.0	20.5
Control 2B	5	5	5												
Control 2C	5	5	5												
Control 2D	5	5	5												
Brine Control A	5	5	5	6.8		8.0	8.21		7.90	29		30	20.4	20.0	20.5
Brine Control B	5	5	5												
Brine Control C	5	5	5												
Brine Control D	5	5	5												
Brine Control 2A	5	5	4	6.8		8.0	8.21		7.90	29		30	20.4	20.0	20.5
Brine Control 2B	5	5	5												
Brine Control 2C	5	5	5												
Brine Control 2D	5	5	5												
6.25 A	5	5	4	8.0		8.0	8.22		8.02	30		30	19.0	20.0	20.5
6.25 B	5	5	5												
6.25 C	5	5	5												
6.25 D	5	5	5												
12.5 A	5	5	5	7.9		7.9	8.16		8.14	30		30	19.7	20.0	20.5
12.5 B	5	5	5												
12.5 C	5	5	5												
12.5 D	5	5	5												
25 A	5	5	5	8.0		7.9	8.04		8.05	30		30	19.2	20.0	20.5
25 B	5	5	5												
25 C	5	5	5												
25 D	5	5	3												
50 A	5	3	1	7.9		7.8	7.91		8.40	30		30	19.0	20.0	20.5
50 B	5	2	2												
50 C	5	0	0												
50 D	5	0	0												
High A	5	0	0	8.2		7.8	7.82		8.57	29		30	20.1	20.0	20.5
High B	5	2	0												
High C	5	0	0												
High D	5	0	0												

Notes

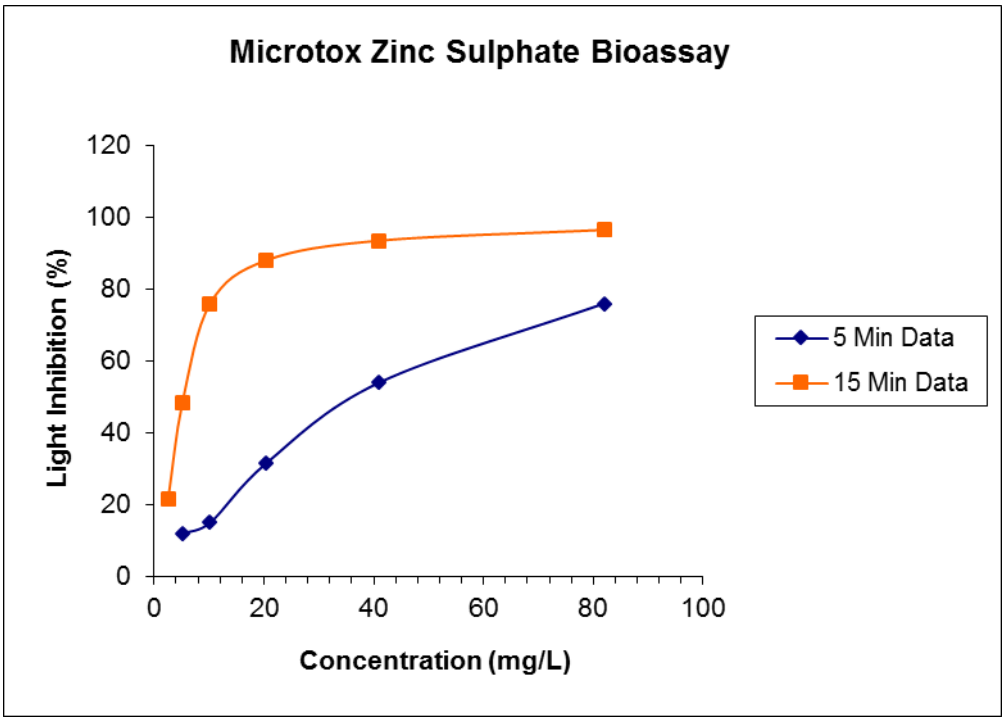
Day 0 Initiated at 13.30 , Animals 6 days old at initiation

24hrs 17.00

48hrs Terminated at 15.20

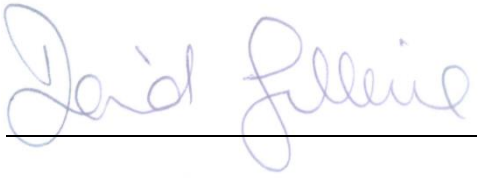
Testing performed by Aquatic Services Unit, ERI Building, Lee Rd., Cork

Appendix 2- Microtox Reference Toxicant Bioassay



Plot of light inhibition relative to the controls versus zinc sulphate concentration after 5 and 15 minutes exposure.

The toxicity testing carried out for this report complies with internationally accepted guidelines. The results of these toxicity tests contained in this report are deemed valid under these guidelines.

Signed: 

David Gillespie MSc (Toxicology)

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Customer	**Sean O' Sullivan** **Aughinish Alumina Ltd** **Auginish Island** **Askeaton** **Co Limerick** **Ireland**	***Lab Report Ref. No.***	**3120/527/03**
		Date of Receipt	**08/05/2015**
		Sampled On	**29/04/2015**
		Date Testing Commenced	**08/05/2015**
		Received or Collected	**Courier : GLS**
		Condition on Receipt	**Acceptable**
Customer PO		***Date of Report***	**22/05/2015**
Customer Ref	**Effluent Composite W1-1 28/04/15**	***Sample Type***	**Trade Effluent**
Ref 2			
Ref 3			

CERTIFICATE OF ANALYSIS

Test Parameter	SOP	Analytical Technique	Result	Units	Acc.
**1,1,1,2-Tetrachloroethane (Industri	154	GCMS	<0.66	ug/L	UKAS
**1,1,1-Trichloroethane (Industrial Eff	154	GCMS	<0.39	ug/L	UKAS
**1,1,2,2-Tetrachloroethane (Industri	154	GCMS	<5.00	ug/L	
**1,1,2-Trichloroethane (Industrial Eff	154	GCMS	<1.26	ug/L	UKAS
**1,1-Dichloroethane (Industrial Eff.)	154	GCMS	<0.51	ug/L	UKAS
**1,1-Dichloroethene (Industrial Eff.)	154	GCMS	<0.50	ug/L	UKAS
**1,1-Dichloropropene (Industrial Eff.)	154	GCMS	<0.39	ug/L	UKAS
**1,2,3-Trichlorobenzene (Industrial	154	GCMS	<0.61	ug/L	UKAS
**1,2,3-Trichloropropane (Industrial E	154	GCMS	<1.31	ug/L	UKAS
**1,2,4-Trichlorobenzene (Industrial	154	GCMS	<0.48	ug/L	UKAS
**1,2,4-Trimethylbenzene (Industrial	154	GCMS	<0.64	ug/L	UKAS
**1,2-Dibromo-3-chloropropane (Indu	154	GCMS	<5.00	ug/L	
**1,2-Dibromoethane (Industrial Eff.)	154	GCMS	<1.04	ug/L	UKAS
**1,2-Dichlorobenzene (Industrial Eff.	154	GCMS	<0.66	ug/L	UKAS
**1,2-Dichloroethane (Industrial Eff.)	154	GCMS	<0.65	ug/L	UKAS
**1,2-Dichloropropane (Industrial Eff.)	154	GCMS	<0.72	ug/L	UKAS
**1,3,5-Trimethylbenzene (Industrial	154	GCMS	<0.59	ug/L	UKAS
**1,3-Dichlorobenzene (Industrial Eff.	154	GCMS	<0.53	ug/L	UKAS
**1,3-Dichloropropane (Industrial Eff.)	154	GCMS	<0.77	ug/L	UKAS
**1,4-Dichlorobenzene (Industrial Eff.	154	GCMS	<1.16	ug/L	UKAS
**2,2-Dichloropropane (Industrial Eff)	154	GCMS	<5.00	ug/L	
**2-Chlorotoluene (Industrial Eff.)	154	GCMS	<0.50	ug/L	UKAS
**4-Chlorotoluene (Industrial Eff.)	154	GCMS	<0.51	ug/L	UKAS
Acetone	328	GC-FID	<0.22	mg/L	

Signed : A Harmon ***Date : 22/05/2015***

Aoife Harmon - Technical Supervisor

UKAS TESTING 2802

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

** : The test result for this parameter may be invalid as it has exceeded the recommended holding time (BS EN ISO 5667-3:2012)
This sample was identified as deviant (BS EN ISO 5667-3:2012) due to [HoldingTime] and the test results may be invalid.

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		Sampled On	**29/04/2015**
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		Received or Collected	**Courier : GLS**
		Condition on Receipt	**Acceptable**
Customer PO		***Date of Report***	**22/05/2015**
Customer Ref	**Effluent Composite W1-1 28/04/15**	***Sample Type***	**Trade Effluent**
Ref 2			
Ref 3			

CERTIFICATE OF ANALYSIS

Test Parameter	SOP	Analytical Technique	Result	Units	Acc.
Acetonitrile	328	GC-FID	<0.33	mg/L	
**Benzene (Industrial Eff.)	154	GCMS	<0.47	ug/L	UKAS
**Bromobenzene (Industrial Eff.)	154	GCMS	<0.60	ug/L	UKAS
**Bromochloromethane (Industrial Eff	154	GCMS	<0.71	ug/L	UKAS
**Bromodichloromethane (Industrial	154	GCMS	<0.62	ug/L	UKAS
**Bromoform (Industrial Eff.)	154	GCMS	<5.00	ug/L	UKAS
**Bromomethane (Industrial Eff.)	154	GCMS	<5.00	ug/L	
**Carbon tetrachloride (Industrial Eff.)	154	GCMS	<5.00	ug/L	UKAS
**Chlorobenzene (Industrial Eff.)	154	GCMS	<0.27	ug/L	UKAS
**Chloroethane (Industrial Eff.)	154	GCMS	<5.00	ug/L	
**Chloroform (Industrial Eff.)	154	GCMS	<0.62	ug/L	UKAS
**Chloromethane (Industrial Eff.)	154	GCMS	<5.00	ug/L	
**cis-1,2-Dichloroethene (Industrial E	154	GCMS	<0.58	ug/L	UKAS
**cis-1,3-Dichloropropene (Industrial	154	GCMS	<0.85	ug/L	UKAS
**Dibromochloromethane (Industrial	154	GCMS	<0.43	ug/L	UKAS
**Dibromomethane (Industrial Eff.)	154	GCMS	<0.88	ug/L	UKAS
**Dichlorodifluoromethane (Industrial	154	GCMS	<5.00	ug/L	
**Dichloromethane (Industrial Eff.)	154	GCMS	<5.00	ug/L	
Ethanol	328	GC-FID	<0.35	mg/L	
**Ethylbenzene (Industrial Eff.)	154	GCMS	<0.45	ug/L	UKAS
**Hexachlorobutadiene (Industrial Eff	154	GCMS	<0.70	ug/L	UKAS
Isopropyl Alcohol	328	GC-FID	<0.34	mg/L	
**Isopropylbenzene (Industrial Eff.)	154	GCMS	<0.36	ug/L	UKAS
**m- & p-Xylene (Industrial Eff.)	154	GCMS	<0.70	ug/L	UKAS

Signed : A Harmon ***Date : 22/05/2015***

Aoife Harmon - Technical Supervisor

UKAS TESTING 2802

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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Results contained in this report relate only to the samples tested (P) : Presumptive Results

** : The test result for this parameter may be invalid as it has exceeded the recommended holding time (BS EN ISO 5667-3:2012)
This sample was identified as deviant (BS EN ISO 5667-3:2012) due to [HoldingTime] and the test results may be invalid.

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		Condition on Receipt	**Acceptable**
Customer PO		***Date of Report***	**22/05/2015**
Customer Ref	**Effluent Composite W1-1 28/04/15**	***Sample Type***	**Trade Effluent**
Ref 2			
Ref 3			

CERTIFICATE OF ANALYSIS

Test Parameter	SOP	Analytical Technique	Result	Units	Acc.
MEK	328	GC-FID	<0.22	mg/L	
Methanol	328	GC-FID	<0.45	mg/L	
**Naphthalene (Industrial Eff.)	154	GCMS	<0.70	ug/L	UKAS
**n-Butylbenzene (Industrial Eff.)	154	GCMS	<0.41	ug/L	UKAS
**n-Propylbenzene (Industrial Eff.)	154	GCMS	<0.31	ug/L	UKAS
**o-Xylene (Industrial Eff.)	154	GCMS	<0.48	ug/L	UKAS
**p-Isopropyltoluene (Industrial Eff.)	154	GCMS	<0.67	ug/L	UKAS
**sec-Butylbenzene (Industrial Eff.)	154	GCMS	<0.34	ug/L	UKAS
**Styrene (Industrial Eff)	154	GCMS	<0.53	ug/L	UKAS
**tert-Butylbenzene (Industrial Eff)	154	GCMS	<0.49	ug/L	UKAS
**Tetrachloroethene (Industrial Eff)	154	GCMS	<0.39	ug/L	UKAS
**Toluene (Industrial Eff)	154	GCMS	<0.54	ug/L	UKAS
**Total Xylene (Industrial Eff)	154	GCMS	<0.70	ug/L	UKAS
**trans-1,2-Dichloroethene (Industrial	154	GCMS	<0.61	ug/L	UKAS
**trans-1,3-Dichloropropene (Industri	154	GCMS	<4.00	ug/L	UKAS
Trichloroethene (Industrial Eff)	154	GCMS	<5.00	ug/L	
**Trichlorofluoromethane (Industrial	154	GCMS	<5.00	ug/L	
**Vinyl chloride (Industrial Eff.)	154	GCMS	<5.00	ug/L	
**Volatile Organic Compounds	154	GCMS	<5	ug/L	

Signed : A Harmon ***Date : 22/05/2015***

Aoife Harmon - Technical Supervisor

UKAS TESTING 2802

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Customer	**Sean O' Sullivan** **Aughinish Alumina Ltd** **Auginish Island** **Askeaton** **Co Limerick** **Ireland**	***Lab Report Ref. No.***	**3120/532/01**
		Date of Receipt	**24/07/2015**
		Sampled On	**21/07/2015**
		Date Testing Commenced	**24/07/2015**
		Received or Collected	**Courier:Nightline**
		Condition on Receipt	**Acceptable**
Customer PO		***Date of Report***	**12/08/2015**
Customer Ref	**W1-1 21/07/15**	***Sample Type***	**Trade Effluent**
Ref 2			
Ref 3			

CERTIFICATE OF ANALYSIS

Test Parameter	SOP	Analytical Technique	Result	Units	Acc.
**1,1,1,2-Tetrachloroethane (Industri	154	GCMS	<0.66	ug/L	UKAS
**1,1,1-Trichloroethane (Industrial Eff	154	GCMS	<0.39	ug/L	UKAS
**1,1,2,2-Tetrachloroethane (Industri	154	GCMS	<5.00	ug/L	
**1,1,2-Trichloroethane (Industrial Eff	154	GCMS	<1.26	ug/L	UKAS
**1,1-Dichloroethane (Industrial Eff.)	154	GCMS	<0.51	ug/L	UKAS
**1,1-Dichloroethene (Industrial Eff.)	154	GCMS	<0.50	ug/L	UKAS
**1,1-Dichloropropene (Industrial Eff.)	154	GCMS	<0.39	ug/L	UKAS
**1,2,3-Trichlorobenzene (Industrial	154	GCMS	<0.61	ug/L	UKAS
**1,2,3-Trichloropropane (Industrial E	154	GCMS	<1.31	ug/L	UKAS
**1,2,4-Trichlorobenzene (Industrial	154	GCMS	<0.48	ug/L	UKAS
**1,2,4-Trimethylbenzene (Industrial	154	GCMS	<0.64	ug/L	UKAS
**1,2-Dibromo-3-chloropropane (Indu	154	GCMS	<5.00	ug/L	
**1,2-Dibromoethane (Industrial Eff.)	154	GCMS	<1.04	ug/L	UKAS
**1,2-Dichlorobenzene (Industrial Eff.	154	GCMS	<0.66	ug/L	UKAS
**1,2-Dichloroethane (Industrial Eff.)	154	GCMS	<0.65	ug/L	UKAS
**1,2-Dichloropropane (Industrial Eff.)	154	GCMS	<0.72	ug/L	UKAS
**1,3,5-Trimethylbenzene (Industrial	154	GCMS	<0.59	ug/L	UKAS
**1,3-Dichlorobenzene (Industrial Eff.	154	GCMS	<0.53	ug/L	UKAS
**1,3-Dichloropropane (Industrial Eff.)	154	GCMS	<0.77	ug/L	UKAS
**1,4-Dichlorobenzene (Industrial Eff.	154	GCMS	<1.16	ug/L	UKAS
**2,2-Dichloropropane (Industrial Eff)	154	GCMS	<5.00	ug/L	
**2-Chlorotoluene (Industrial Eff.)	154	GCMS	<0.50	ug/L	UKAS
**4-Chlorotoluene (Industrial Eff.)	154	GCMS	<0.51	ug/L	UKAS
Acetone	328	GC-FID	<0.22	mg/L	

Signed : A Harmon ***Date : 12/08/2015***

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Customer Ref	**W1-1 21/07/15**	***Sample Type***	**Trade Effluent**
Ref 2			
Ref 3			

CERTIFICATE OF ANALYSIS

Test Parameter	SOP	Analytical Technique	Result	Units	Acc.
Acetonitrile	328	GC-FID	<0.33	mg/L	
**Benzene (Industrial Eff.)	154	GCMS	<0.47	ug/L	UKAS
**Bromobenzene (Industrial Eff.)	154	GCMS	<0.60	ug/L	UKAS
**Bromochloromethane (Industrial Eff	154	GCMS	<0.71	ug/L	UKAS
**Bromodichloromethane (Industrial	154	GCMS	<0.62	ug/L	UKAS
**Bromoform (Industrial Eff.)	154	GCMS	<5.00	ug/L	UKAS
**Bromomethane (Industrial Eff.)	154	GCMS	<5.00	ug/L	
**Carbon tetrachloride (Industrial Eff.)	154	GCMS	<5.00	ug/L	UKAS
**Chlorobenzene (Industrial Eff.)	154	GCMS	<0.27	ug/L	UKAS
**Chloroethane (Industrial Eff.)	154	GCMS	<5.00	ug/L	
**Chloroform (Industrial Eff.)	154	GCMS	75.757	ug/L	UKAS
**Chloromethane (Industrial Eff.)	154	GCMS	<5.00	ug/L	
**cis-1,2-Dichloroethene (Industrial E	154	GCMS	<0.58	ug/L	UKAS
**cis-1,3-Dichloropropene (Industrial	154	GCMS	<0.85	ug/L	UKAS
**Dibromochloromethane (Industrial	154	GCMS	<0.43	ug/L	UKAS
**Dibromomethane (Industrial Eff.)	154	GCMS	<0.88	ug/L	UKAS
**Dichlorodifluoromethane (Industrial	154	GCMS	<5.00	ug/L	
**Dichloromethane (Industrial Eff.)	154	GCMS	<5.00	ug/L	
Ethanol	328	GC-FID	<0.35	mg/L	
**Ethylbenzene (Industrial Eff.)	154	GCMS	<0.45	ug/L	UKAS
**Hexachlorobutadiene (Industrial Eff	154	GCMS	<0.70	ug/L	UKAS
Isopropyl Alcohol	328	GC-FID	<0.34	mg/L	
**Isopropylbenzene (Industrial Eff.)	154	GCMS	<0.36	ug/L	UKAS
**m- & p-Xylene (Industrial Eff.)	154	GCMS	<0.70	ug/L	UKAS

Signed : A Harmon ***Date : 12/08/2015***

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Customer Ref	**W1-1 21/07/15**	***Sample Type***	**Trade Effluent**
Ref 2			
Ref 3			

CERTIFICATE OF ANALYSIS

Test Parameter	SOP	Analytical Technique	Result	Units	Acc.
MEK	328	GC-FID	<0.22	mg/L	
Methanol	328	GC-FID	<0.45	mg/L	
**Naphthalene (Ground Water)	154	GCMS	<0.43	ug/L	UKAS
**n-Butylbenzene (Industrial Eff.)	154	GCMS	<0.41	ug/L	UKAS
**n-Propylbenzene (Potable Water)	154	GCMS	<0.49	ug/L	UKAS
**o-Xylene (Industrial Eff.)	154	GCMS	<0.48	ug/L	UKAS
**p-Isopropyltoluene (Industrial Eff.)	154	GCMS	<0.67	ug/L	UKAS
**sec-Butylbenzene (Industrial Eff.)	154	GCMS	<0.34	ug/L	UKAS
**Styrene (Industrial Eff)	154	GCMS	<0.53	ug/L	UKAS
**tert-Butylbenzene (Industrial Eff)	154	GCMS	<0.49	ug/L	UKAS
**Tetrachloroethene (Industrial Eff)	154	GCMS	<0.39	ug/L	UKAS
**Toluene (Industrial Eff)	154	GCMS	<0.54	ug/L	UKAS
**Total Xylene (Industrial Eff)	154	GCMS	<0.70	ug/L	UKAS
**trans-1,2-Dichloroethene (Industrial	154	GCMS	<0.61	ug/L	UKAS
**trans-1,3-Dichloropropene (Industri	154	GCMS	<4.00	ug/L	UKAS
**Trichloroethene (Industrial Eff)	154	GCMS	<5.00	ug/L	
**Trichlorofluoromethane (Industrial	154	GCMS	<5.00	ug/L	
**Vinyl chloride (Industrial Eff.)	154	GCMS	<5.00	ug/L	
**Volatile Organic Compounds	154	GCMS	75.757	ug/L	

Signed : A Harmon ***Date : 12/08/2015***

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Attachment 2
Waste Analysis

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Waste Analysis

Quarter 1 2015

Emission Point Reference	Description	Date	IEL Limits	pH	Dry matter %	Chloride mg/Kg	Fluoride mg/Kg	Soda mg/Kg	Total Alkalinity mg/Kg $CaCO_3$	Al* mg/Kg	As* mg/Kg	Cd* mg/Kg	Cr* mg/Kg	Cu* mg/Kg	Fe* mg/Kg	Pb* mg/Kg	Mg* mg/Kg	Hg* mg/Kg	Ni* mg/Kg	Ti* mg/Kg	Zn* mg/Kg
C.4 Waste Monitoring	Red Mud**	Jan	N/A	10.8	78	11	31	1784	2718	30012	0.621	< .01	270	5.431	10341	10.245	249.67	< 0.0002	1.491	43	2.455
	Sand	Jan	N/A	12.1	82	68	36	5060	8299	10525	0.828	< .01	129.1	2.434	27373	10.110	167.97	< 0.0002	1.242	121	6.960
	Salt Cake	Jan	N/A	13.2	58	3235	7334	214727	348379	55691	30.23	< .01	0.345	1.13	67.24	< .01	12.26	0.083	1.367	7.65	0.838
				pH	--	Chloride	Fluoride	Soda	Total Alkalinity	Al*	As*	Cd*	Cr*	Cu*	Fe*	Pb*	Mg*	Hg*	Ni*	Ti*	Zn*
						mg/l	mg/l	mg/l	mg/l $CaCO_3$	mg/l	µg/l	µg/l	µg/l	µg/l	µg/l	µg/l	mg/l	µg/l	µg/l	µg/l	µg/l
	Red Mud stack Leachate	Feb	N/A	12.1	--	117	32	3470	7799	2.5	11.98	0.60	7.783	9.998	6.173	< 0.173	< 0.104	3.61	2.9720	2.464	41.54
				pH	Dry matter	Organic matter	N	P	--	Al*	As*	Cd*	Cr*	Cu*	Fe*	Pb*	Mg*	Hg*	Ni*	Ti*	Zn*
					%	%	mg/l	mg/l		µg/l	µg/l	µg/l	µg/l	µg/l	µg/l	µg/l	mg/l	µg/l	µg/l	µg/l	µg/l
	Sanitary Sludge	March	N/A	7.2	0.76	99.8	334.9	46.3	--	327.1	2.813	< 0.14	3.066	54.66	401	1.198	17.94	0.252	13.6	86.1	53.76

***Metal analysis & Sanitary Sludge analysis : Fitz Scientific**

**** Farmed red mud**

Waste Analysis

Quarter 2 2015

Emission Point Reference	Description	Date	IEL Limits	pH	Dry matter %	Chloride mg/Kg	Fluoride mg/Kg	Soda mg/Kg	Total Alkalinity mg/Kg $CaCO_3$	Al* mg/Kg	As* mg/Kg	Cd* mg/Kg	Cr* mg/Kg	Cu* mg/Kg	Fe* mg/Kg	Pb* mg/Kg	Mg* mg/Kg	Hg* mg/Kg	Ni* mg/Kg	Ti* mg/Kg	Zn* mg/Kg
C.4 Waste Monitoring	Red Mud**	May	N/A	11.2	77	31	0.10	2244	3738	33063	0.496	< 0.01	202	5.084	6281	8.691	80.33	< 0.0002	1.019	4460	2.76
	Sand	May	N/A	12.2	83	40	8951	3934	8951	12633	1.38305	< 0.01	106.3	16.891	21762	11.109	66.6	< 0.0002	1.955	1179	9.860
	Salt Cake	May	N/A	13.1	57	4368	0.10	213945	468376	54238	13.72	< 0.01	< 0.01	1.15	19.85	0.01	7.2	0.173	1.244	2.477	2.121
				pH	--	Chloride	Fluoride	Soda	Total Alkalinity	Al*	As*	Cd*	Cr*	Cu*	Fe*	Pb*	Mg*	Hg*	Ni*	Ti*	Zn*
						mg/l	mg/l	mg/l	mg/l $CaCO_3$	mg/l	µg/l	µg/l	µg/l	µg/l	µg/l	µg/l	mg/l	µg/l	µg/l	µg/l	µg/l
	Red Mud stack Leachate	May	N/A	12.0	--	160	0.03	6	9497	15.1	41.81	1.088	19.23	15.61	0.576	<0.173	<0.104	5.472	3.7620	11.61	182.6
				pH	Dry matter	Organic matter	N	P	--	Al*	As*	Cd*	Cr*	Cu*	Fe*	Pb*	Mg*	Hg*	Ni*	Ti*	Zn*
					%	%	mg/l	mg/l		µg/l	µg/l	µg/l	µg/l	µg/l	µg/l	µg/l	mg/l	µg/l	µg/l	µg/l	µg/l
	Sanitary Sludge	May	N/A	7.3	0.46	99.8	227.1	48.0	--	324.27	<0.22	<0.14	1.709	67.184	987	<0.2	17.5	0.545	9..41	82.43	90.6895

***Metal analysis & Sanitary Sludge analysis : Fitz Scientific**

**** Farmed red mud**

Waste Analysis

Quarter 3 2015

Emission Point Reference	Description	Date	IEL Limits	pH	Dry matter %	Chloride mg/Kg	Fluoride mg/Kg	Soda mg/Kg	Total Alkalinity mg/Kg $CaCO_3$	Al* mg/Kg	As* mg/Kg	Cd* mg/Kg	Cr* mg/Kg	Cu* mg/Kg	Fe* mg/Kg	Pb* mg/Kg	Mg* mg/Kg	Hg* mg/Kg	Ni* mg/Kg	Ti* mg/Kg	Zn* mg/Kg
C.4 Waste Monitoring	Red Mud**		N/A	11.4	77	65	0.01	3437	5077	35643	0.234	0.01	248098	2.02884	10505	4.63906	55.3859	0.0002	0.644	1017	0.849875
	Sand		N/A	11.9	82	30	0	3461	5860	14587625	1.16686	0.01	148.2	1.360	52006	6.484	557.955	0.0002	0.628	694	4.714
	Salt Cake		N/A	13.2	58	4585	0.10	225144	6993	58544	28.35	0.01	0.01	0.90	27.65	0.01	4.66295	0.000	1.359	0.892245	1.674
				pH	--	Chloride	Fluoride	Soda	Total Alkalinity	Al*	As*	Cd*	Cr*	Cu*	Fe*	Pb*	Mg*	Hg*	Ni*	Ti*	Zn*
						mg/l	mg/l	mg/l	mg/l $CaCO_3$	mg/l	µg/l	µg/l	µg/l	µg/l	µg/l	µg/l	mg/l	µg/l	µg/l	µg/l	µg/l
	Red Mud stack Leachate		N/A	12.4		158	0.03	2	1199	0.9	382.7	1.328	29.33	51.62	2.535	0.173	0.157	25.21	4.3940	98.36	2.008
				pH	Dry matter	Organic matter	N	P	--	Al*	As*	Cd*	Cr*	Cu*	Fe*	Pb*	Mg*	Hg*	Ni*	Ti*	Zn*
					%	%	mg/l	mg/l		µg/l	µg/l	µg/l	µg/l	µg/l	µg/l	µg/l	mg/l	µg/l	µg/l	µg/l	µg/l
	Sanitary Sludge		N/A	7.2	0.50	99.9	299.6	12.7		40950	9.126	8.459	82.28	5964	31230	66.72	36.66	11.4993	83.23	35.4945	2738

***Metal analysis & Sanitary Sludge analysis : Fitz Scientific**

**** Farmed red mud**

Waste Analysis

Quarter 4 2015

Emission Point Reference	Description	Date	IEL Limits	pH	Dry matter %	Chloride mg/Kg	Fluoride mg/Kg	Soda mg/Kg	Total Alkalinity mg/Kg $CaCO_3$	Al* mg/Kg	As* mg/Kg	Cd* mg/Kg	Cr* mg/Kg	Cu* mg/Kg	Fe* mg/Kg	Pb* mg/Kg	Mg* mg/Kg	Hg* mg/Kg	Ni* mg/Kg	Ti* mg/Kg	Zn* mg/Kg
C.4 Waste Monitoring	Red Mud**	November	N/A	11.2	77	36	63.00	3408	4983	49828	0.135	0.01	227	1.997	11668	4.28	0.0541	0.0005	0.483	128	1.172
	Sand	November	N/A	12.2	82	59	34	4054	6871	22234	0.965184	0.01	287.1	2.283	106006	4.840	0.0332	0.0005	0.818	51	7.479
	Salt Cake	November	N/A	13.2	58	3113	3599.00	217615	31746	45958	93.93	0.01	0.01	0.73	188.46	0.01	0.0091	0.001	0.739	9.425	1.380
				pH	--	Chloride	Fluoride	Soda	Total Alkalinity	Al*	As*	Cd*	Cr*	Cu*	Fe*	Pb*	Mg*	Hg*	Ni*	Ti*	Zn*
						mg/l	mg/l	mg/l	mg/l $CaCO_3$	mg/l	µg/l	µg/l	µg/l	µg/l	µg/l	µg/l	mg/l	µg/l	µg/l	µg/l	µg/l
	Red Mud stack Leachate	November	N/A	12.5	--	88	29.10	3	5709	302.7	<0.96	<0.09	51.03	1.17	2836	<0.38	<0.55	21.11	<0.47	730.6	<4.6
				pH	Dry matter	Organic matter	N	P	--	Al*	As*	Cd*	Cr*	Cu*	Fe*	Pb*	Mg*	Hg*	Ni*	Ti*	Zn*
					%	%	mg/l	mg/l		µg/l	µg/l	µg/l	µg/l	µg/l	µg/l	µg/l	mg/l	µg/l	µg/l	µg/l	µg/l
	Sanitary Sludge		N/A	--	0.42	99.9	234.9	48.1	--	13211.7	<0.22	<0.14	17.769	1773.51	16394	15.05	300	6.755	23.82	132.5	1120.69

***Metal analysis & Sanitary Sludge analysis : Fitz Scientific**

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Attachment 3
Energy Efficiency Report

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ENERGY EFFICIENCY REPORT 2015

RUSAL AUGHINISH

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1. Background

This report summarises the 2015 energy performance for inclusion in the Annual Environmental Report for RUSAL Aughinish. Reports for earlier years were included in previous Environmental Reports

2. Energy Management System

We successfully completed a stage 1 ISO 50001 audit in October 2015 and stage 2 (final) audit in January 2016 and are now certified to ISO 50001 standard.

In addition, the plant again qualified as a high quality CHP site under the UK CHPQA self-assessment scheme. The plant is also certified as high efficiency CHP through the commission for Energy Regulation's scheme.

3. Steam Efficiency

Steam efficiency is reported as the energy in the total steam produced by the plant divided by the hydrate production; GJ/t. The chart below shows steam efficiency data for each year since 2012. 2015 was the best ever performance at 5.71GJ/t (previous best was 5.82GJ/t in 2014). The improvement in significant considering that bauxite quality has deteriorated.

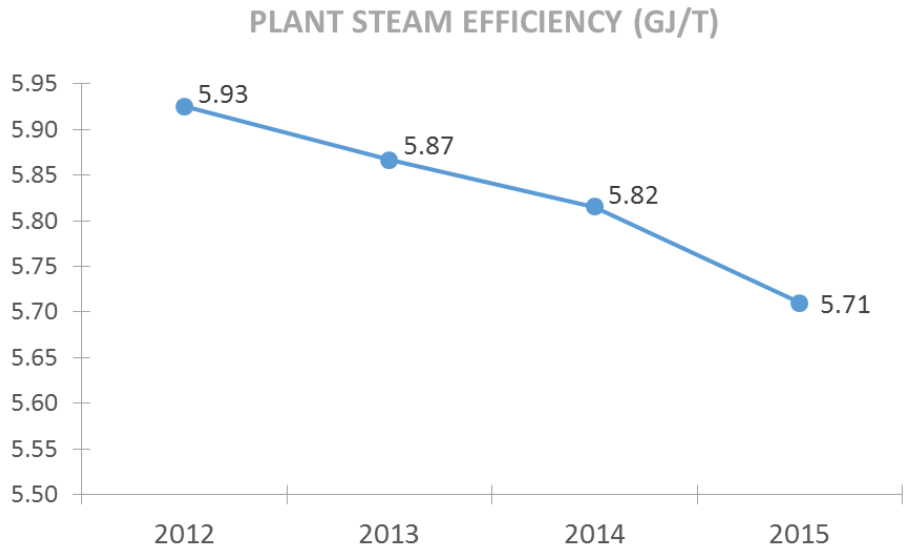


Figure 1 Steam efficiency since 2012 to 2015; best ever performance 2015 @ 5.71GJ/t

The monthly performance for 2015 is shown in the chart below. The monthly target varied in line with expected equipment outages.

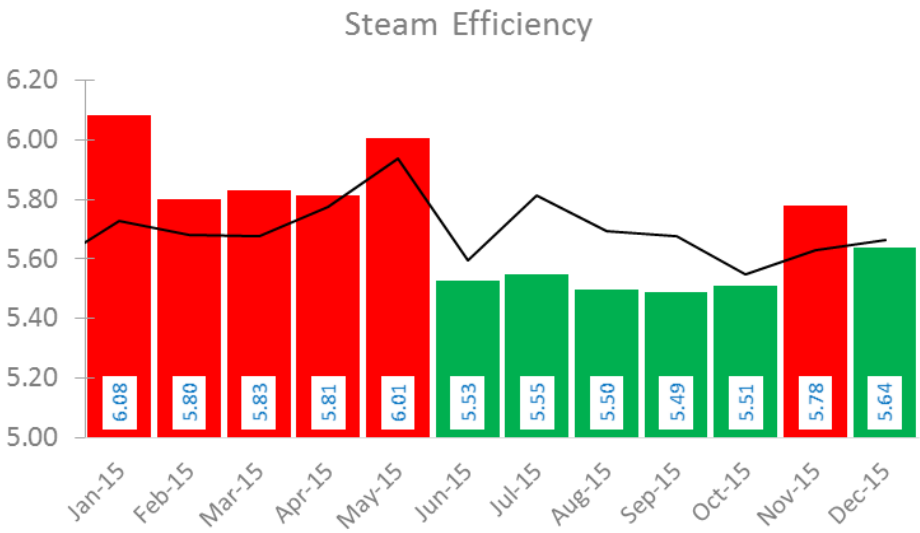


Figure 2 2015 Steam Efficiency month performance year to date

The performance up until June was impacted by higher ambient heat losses and more significantly poor performance of the 2nd stage heaters due to excessive scaling of the vapour supply line and heater shell due to contamination of the steam with slurry residue. This issue was resolved by converting flash tank 2 to bottom entry and by re-tubing all 3 2nd stage heaters.

A new backwash line was installed which has allowed for a lower backwash temperature target. The net effect was higher temperature ex 12C boiler-feed water heater as this heater could take steam from flash tank 3 (higher pressure flash tank).

Heater 7B was manually descaled to improve its performance as was the A chain in vacuum flash. A short section of feed line to the evaporator unit was badly restricted and has now been replaced. This has increased the feed temperature, which resulted in a steam economy improvement for the unit.

4. Power Efficiency

The chart below shows the power efficiency performance for each year since 2005. The 2009 result was excluded as the plant was at minimum production due to poor global economic conditions. The 2015 result was 0.706, which is marginally better than the 0.711 result achieved in 2014. The best ever result of 0.704 was achieved in 2008.

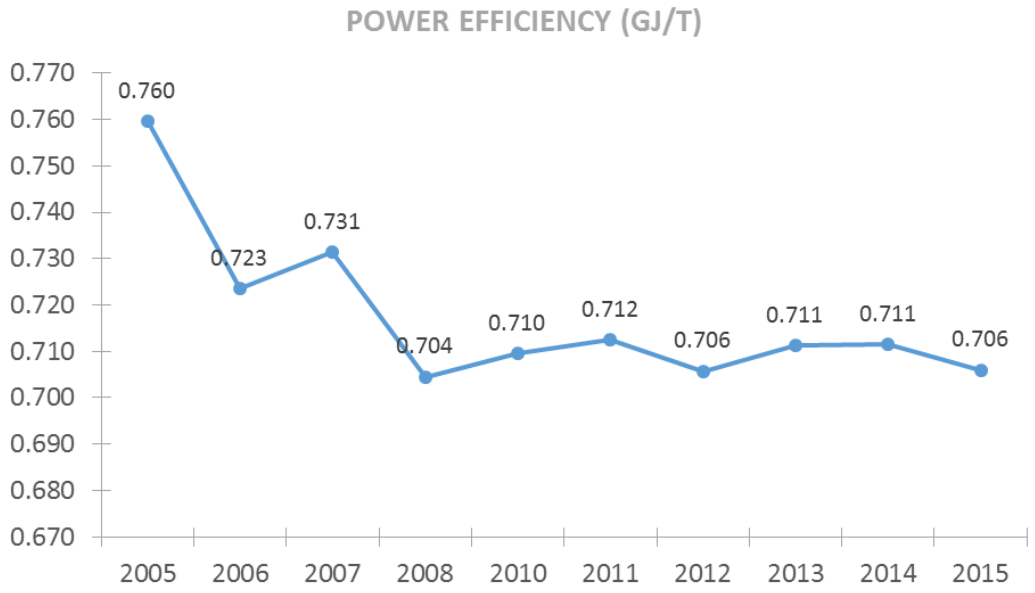


Figure 3 Power Efficiency since 2010

The plant power efficiency for each month of 2015 is shown in the trend below (Annual plant shutdown in May)

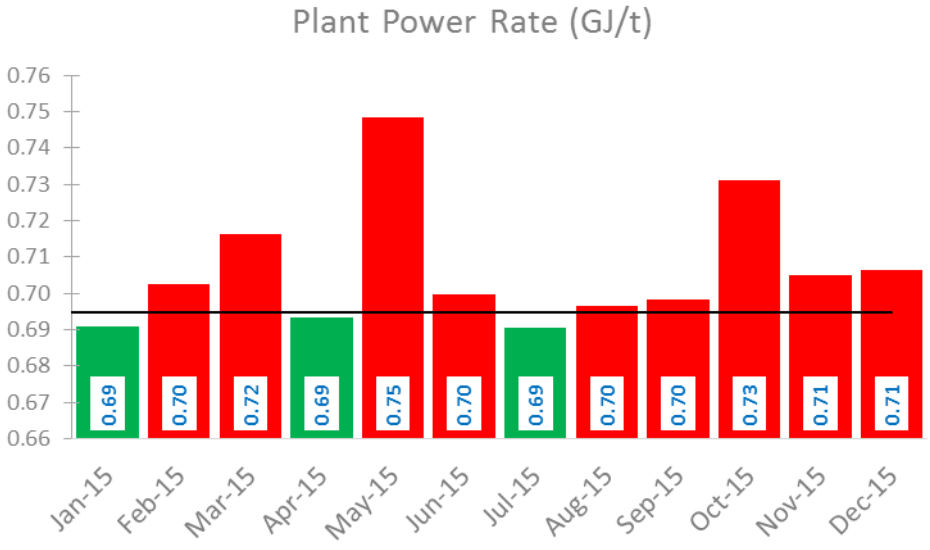


Figure 4 Monthly Power Efficiency results for 2015

5. Energy Programme for 2016

- The main projects affecting heat recovery are:
- Manually descale poorly performing digestion heaters
- Re-tube 7B, 8A, 9C and 12C
- Replace a number of power meters in mud separation area

Attachment 4
PRTR Workbook

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2015

Facility Details

Parent Company Name:	Aughinish Alumina Limited
Facility Name:	Aughinish Alumina Limited
PRTR Identification Number:	P0035
Licence Number:	P0035-06
Address 1:	Aughinish East, Aughinish West,
Address 2:	Island Mac Teige, Glenbane West , and Fawnamore
Address 3:	Askeaton
City/Town/Village:	
Postal Code:	
County:	Limerick
Country:	Ireland
Coordinates of location:	-9.05928 52.6243
River Basin District:	IEGBNISH
Nace Code:	24 4 2
Main Economic Activity:	Aluminium Production
Number of Installations:	1
Number of Employees:	450
No. of Operating Hours in Year:	8760
Production Volume:	1974017
Production Volume Units:	tonnes
Web Address:	
User Feedback:	Reduction in NOx, SOx, Particulates, CO2 and metals emissions due to installation of 2 gas boilers in place of HFO boilers. Increase in waste to BRDA due to bauxite composition. Increase in mixed metals (LoW 170407) for off-site recovery increased due to dismantling and removal of large ship unloader (crane) in 2015. Increase in sludge from treatment of wastewater(LoW 190805) due to full year of treatment off-site in 2015 compared with part of year treatment off-site in 2014 (Licence condition change). Fluctuations in metals in emissions to water were noted relative to 2014 values (both increases and decreases observed for different metals). Increases in mass emissions of zinc and some other metals due to a combination of increases in effluent volumes discharged, atypical biannual results and natural fluctuations in bauxite composition. Data for 2016 to date indicate more typical values for zinc and other metals.
Contact Name:	Louise Clune
Email Address:	Louise.Clune@augh.com
Position:	Environmental Co-ordinator
Telephone:	061 604243
Mobile:	
Fax:	061 604090

Solvents Directive

Waste or IPPC classes of Activity

Action	Description	No.
Major	The production of basic inorganic chemicals, such as:(a) gases, such as ammonia, chlorine or hydrogen chloride, fluorine, or hydrogen fluoride, carbon oxides, sulphur compounds, nitrogen oxides, hydrogen, suphur dioxide, carbonyl chloride,(b) acids, such as chromic acid, hydrofluoric acid, phosphoric acid, nitric acid, hydrochloric acid, sulphuric acid, oleum, sulphurous acids,(c) bases, such as ammonium hydroxide, potassium hydroxide, sodium hydroxide,(d) salts, such as ammonium chloride, potassium chlorate, potassium carbonate, sodium carbonate, perborate, silver nitrate,(e) non-metals, metal oxides or other inorganic compounds such as calcium carbide, silicon, silicon carbide	5.13.0
Minor	The operation of combustion installations with a rated thermal input equal to or greater than 50MW	2.1.0
Minor	The recovery or disposal of waste in a facility, within the meaning of the Waste Management Act, 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.	11.1.0

PRTR Class Activities

No.	Description	PrimaryClass
4(b)	Gases, such as ammonia, chlorine or hydrogen chloride,fluorine or hydrogen fluoride, carbon oxides, sulphur compounds,nitrogen oxides, hydrogen, sulphur dioxide, carbonyl chloride,Acids, such as chromic acid, hydrofluoric acid, phosphoric acid, nitric acid, hydrochloric acid, sulphuric acid, oleum, sulphurous acids,Bases, such as ammonium hydroxide, potassium hydroxide, sodium hydroxide,Salts, such as ammonium chloride, potassium chlorate, potassium carbonate, sodium carbonate, perborate...	TRUE
5(a)	Installations for the recovery or disposal of hazardous waste	FALSE
5(d)	Landfills	FALSE
50.1	General	FALSE

Air - Sector Specific PRTR Pollutants

No.	Annex II	Name	M/C/E	Method Code	Designation or Description	HFO Boiler House (Emission Point Ref. A1)	Calciner Stack (Emission Point Ref. A2)	Gas Turbines (Emission Point Ref. A3-A, A3-B)	Gas Boilers (Emission Point Ref. A4-A, A4-B)	Bauxite Crusher Scrubber Exhaust Fan (6)	Alumina Loader Dust Fan FA49A (12)	Alumina Silo 1 Exhaust Fan FA12A017 (16)	Alumina Silo 2 Exhaust Fan FA12A018 (17)	Alumina Silo 3 Exhaust Fan & Silo 1/2 Exhaust Fan (18 & 19)	A (ACCIDENTAL) KG/Year	F (Fugitive) KG/Year	T (Total) KG/Year
						EMISSION POINT 1	EMISSION POINT 2	EMISSION POINT 3	EMISSION POINT 4	EMISSION POINT 5	EMISSION POINT 6	EMISSION POINT 7	EMISSION POINT 8	EMISSION POINT 9			
	03	Carbon dioxide (CO2)	C	ETS		12503896	308216605	780000757	201225820						0	0	1301947078
	08	Nitrogen oxides (NOx/NO2)	C	OTH	Calculation based on fuel consumption and continuous monitoring by online instruments	84024	537316	291084	84024						0	0	996448
	11	Sulphur oxides (SOx/SO2)	C	OTH	Calculation based on fuel consumption and measured sulphur content of HFO	49618									0	0	49618
	17	Arsenic and compounds (as As)	C	OTH	Calculation based on fuel consumption and emission factor previously submitted to EPA	0.4									0	0	0.4
	18	Cadmium and compounds (as Cd)	C	OTH	Calculation based on fuel consumption and emission factor previously submitted to EPA	0.5									0	0	0.5
	19	Chromium and compounds (as Cr)	C	OTH	Calculation based on fuel consumption and emission factor previously submitted to EPA	0.6									0	0	0.6
	20	Copper and compounds (as Cu)	C	OTH	Calculation based on fuel consumption and emission factor previously submitted to EPA	0.6									0	0	0.6
	21	Mercury and compounds (as Hg)	C	OTH	Calculation based on fuel consumption and emission factor previously submitted to EPA	0.1									0	0	0.1
	22	Nickel and compounds (as Ni)	C	OTH	Calculation based on fuel consumption and emission factor previously submitted to EPA	20.1									0	0	20.1
	23	Lead and compounds (as Pb)	C	OTH	Calculation based on fuel consumption and emission factor previously submitted to EPA	1.1									0	0	1.1
	24	Zinc and compounds (as Zn)	C	OTH	Calculation based on fuel consumption and emission factor previously submitted to EPA	1.6									0	0	1.6
	86	Particulate matter (PM10)	C	OTH	Calculation based on fuel consumption and direct measurement of stack emissions	2493	108556			3683	1610	2934	1795	1412	0	0	122483

Air - Remaining PRTR Pollutants

No Data Available.

Air - SECTION C: REMAINING POLLUTANT EMISSIONS (as required in your Licence requirements)

No Data Available.

PRTR Id: P0035

Water - Sector Specific PRTR Pollutants

No. Annex II	Name	M/C/E	Method Code	Designation or Description	Industrial Effluent (Emission Point Ref. W1-1) EMISSION POINT 1	A (ACCIDENTAL) KG/Year	F (Fugitive) KG/Year	T (Total) KG/Year
17	Arsenic and compounds (as As)	M	OTH	APHA SMEW & WW 3125	265.3	0	0	265.3
18	Cadmium and compounds (as Cd)	M	OTH	APHA SMEW & WW 3126	4.9	0	0	4.9
19	Chromium and compounds (as Cr)	M	OTH	APHA SMEW & WW 3127	36.7	0	0	36.7
20	Copper and compounds (as Cu)	M	OTH	APHA SMEW & WW 3128	99.2	0	0	99.2
21	Mercury and compounds (as Hg)	M	OTH	APHA SMEW & WW 3129	49.2	0	0	49.2
22	Nickel and compounds (as Ni)	M	OTH	APHA SMEW & WW 3130	38.9	0	0	38.9
23	Lead and compounds (as Pb)	M	OTH	APHA SMEW & WW 3131	1.6	0	0	1.6
24	Zinc and compounds (as Zn)	M	OTH	APHA SMEW & WW 3132	965.5	0	0	965.5

Water - Remaining PRTR Pollutants

No Data Available.

Water - SECTION C: REMAINING POLLUTANT EMISSIONS (as required in your Licence requirements)

No. Annex II	Name	M/C/E	Method Code	Designation or Description	EMISSION POINT 1	A (ACCIDENTAL) KG/Year	F (Fugitive) KG/Year	T (Total) KG/Year
240	Suspended Solids	M	OTH	APHA SMEW & WW 2540D	70318	0	0	70318
303	BOD	M	OTH	APHA SMEW & WW 2540D	160326	0	0	160326
314	Fats, Oils and Greases	M	OTH	APHA SMEW & WW 2540D	5479	0	0	5479
320	Magnesium	M	OTH	APHA SMEW & WW 3127	19208	0	0	19208
355	Aluminium	M	OTH	APHA SMEW & WW 3125	18383	0	0	18383
357	Iron	M	OTH	APHA SMEW & WW 3126	379	0	0	379

PRTR Id: P0035

Wastewater - PRTR Pollutants

No Data Available.

Wastewater - Licensed Pollutants

No Data Available.

PRTR Id: P0035

Land - PRTR Pollutants

No Data Available.

Land - Licensed Pollutants

No Data Available.

PRTR Id: P0035

PRTR Treatment & Transfer of Waste

Transfer Destination	List of Waste	Hazardous	Quality T/yea	Description of Waste	Waste Treatment Operation	M/C/E	Method Used	Location of Treatment	Name and Licence/Permit No. of Recoverer/Disposer/Broker	Address of Recoverer/Disposer/Broker	Name and Address of Final Destination i.e. Final Recovery/Disposal Site (Hazardous Waste Only)	Licence/Permit Number of Final Destination i.e. Final Recovery/Disposal Site (Hazardous Waste Only)
To Other Countries	150111	Y	5	Aerosol cans empty	D10	M	Weighed	Abroad	Rilta Environmental Ltd,W0192-03	Greenogue Business Park, Rathcoole, Co. Dublin, Ireland	De-Pack Limited, EAWML/43679, Wymeswold Industrial Estate, Burton on the Wolds, Leicestershire, United Kingdom	Wymeswold Industrial Estate, Burton on the Wolds, Leicestershire, United Kingdom
To Other Countries	170601	Y	1.1	Insulation materials containing asbestos	D5	M	Weighed	Abroad	Rilta Environmental Ltd,W0192-03	Greenogue Business Park, Rathcoole, Co. Dublin, Ireland	GroBenasper Entsorgungsgesellschaft mbh & Co. KG, eg0108, Bimohler Str. 57a, 24623 GroBenaspe, Hamburg, Germany	Bimohler Str. 57a,24623 GroBenaspe, Hamburg, Germany
To Other Countries	160506	Y	10	Chemical Waste	R1	M	Weighed	Abroad	Rilta Environmental Ltd,W0192-03	Greenogue Business Park, Rathcoole, Co. Dublin, Ireland	Recyfuel, Zoning Industriel dEhein, Zoning Industriel dEhein, Engis, B-4480, Belgium	Zoning Industriel dEhein, Zoning Industriel dEhein, Engis, B-4480, Belgium
To Other Countries	150202	Y	7	Contaminated Soil	R13	C	Weighed	Abroad	Rilta Environmental Ltd,W0192-03	Greenogue Business Park, Rathcoole, Co. Dublin, Ireland	Afvalstoffen Terminal Moerdijk (ATM), Vlasweg 12, 4782 PW Moerdijk, The Netherlands	Vlasweg 12, 4782 PW Moerdijk, The Netherlands
To Other Countries	160107	Y	0.55	Oil filters	R11	M	Weighed	Abroad	Enva Shannon,WCP-DC-08-1116-01	Smithstown Industrial Estate, Shannon, Co. Clare, Ireland	Recyfuel, Zoning Industriel dEhein, Zoning Industriel dEhein, Engis, B-4480, Belgium	Zoning Industriel dEhein, Zoning Industriel dEhein, Engis, B-4480, Belgium
To Other Countries	170407	N	1006.6	Mixed metals	R4	M	Weighed	Abroad	United Metals,WCP LK 10 657 01	Eastway Business Park, Ballysimon, Limerick, Ireland		
Within the Country	160601	Y	10.2	Batteries	R4	M	Weighed	Offsite in Ireland	Rilta Environmental Ltd,W0192-03	Greenogue Business Park, Rathcoole, Co. Dublin, Ireland	Rilta Environmental Ltd,W0192-03	Greenogue Business Park, Rathcoole, Co. Dublin, Ireland
Within the Country	130701	Y	48	Waste oil and diesel	R9	M	Volume Calculation	Offsite in Ireland	Rilta Environmental Ltd,W0192-03	Greenogue Business Park, Rathcoole, Co. Dublin, Ireland	Rilta Environmental Ltd, W0192-03	Greenogue Business Park, Rathcoole, Co. Dublin, Ireland
Within the Country	170401	N	1.8	Copper	R4	M	Weighed	Offsite in Ireland	United Metals,WCP LK 10 657 01	Eastway Business Park, Ballysimon, Limerick, Ireland		
Within the Country	130899	Y	6.4	Oily rags/spent oil dry absorbent	D10	C	Weighed	Offsite in Ireland	Rilta Environmental Ltd,W0192-03	Greenogue Business Park, Rathcoole, Co. Dublin, Ireland	Rilta Environmetnal Ltd, W0192-03, Greenogue Business Park, Rathcoole, Co. Dublin, Ireland	Greenogue Business Park, Rathcoole, Co. Dublin, Ireland
Within the Country	150110	Y	31	Plastics (contaminated empty IBC's & drums)	R9	M	Weighed	Offsite in Ireland	Rilta Environmental Ltd,W0192-03	Greenogue Business Park, Rathcoole, Co. Dublin, Ireland	Rilta Environmental Ltd,W0192-03	Greenogue Business Park, Rathcoole, Co. Dublin, Ireland
Within the Country	150104	N	10.2	Metallic packaging/drums/containers	R4	M	Weighed	Offsite in Ireland	Rilta Environmental Ltd,W0192-03	Greenogue Business Park, Rathcoole, Co. Dublin, Ireland		
Within the Country	180104	Y	0.002	Clinical Waste	D9	M	Weighed	Offsite in Ireland	SRCL,W0055-02	420-430 Beech Road, Western Industrial Estate, Naas Road, Dublin 12, Ireland	SRCL,W0055-02	420-430 Beech Road, Western Industrial Estate, Naas Road, Dublin 12, Ireland
Within the Country	191204	N	64.2	Rubber hosing	R11	M	Weighed	Offsite in Ireland	Greenstar,W0082-02	Dock Road, Limerick, Ireland		
Within the Country	200101	N	17.7	Cardboard	R3	M	Weighed	Offsite in Ireland	Greenstar,W0082-02	Dock Road, Limerick, Ireland		
Within the Country	200101	N	2	Paper	R3	M	Weighed	Offsite in Ireland	DGD Papers,WFP-LK-2008-09C	Bay M1, Raheen Business Park, Limerick, Ireland		
Within the Country	200121	Y	9	Fluorescent bulbs	R4	M	Weighed	Offsite in Ireland	Irish Lamp Recycling,WFP-KE-08-0348-01	Athy, Co Kildare, Ireland	Irish Lamp Recycling, WFP-KE-08-0348-01	Athy, Co Kildare, Ireland
Within the Country	200125	N	1.6	Edible oil and fat	R3	E	Volume Calculation	Offsite in Ireland	Frylite Dublin Ltd.,WCP-DC-10-1297-01	Ballymount Industrial Estate, Unit J1, Dublin 12, Ireland		
Within the Country	060404	Y	0.013	Mercury liquid	R4	M	Weighed	Offsite in Ireland	Irish Lamp Recycling,WFP-KE-08-0348-01	Athy, Co Kildare, Ireland	Irish Lamp Recycling, WFP-KE-08-0348-01	Athy, Co Kildare, Ireland
Within the Country	200136	N	0.05	Used printer toner catridges	R4	C	Weighed	Offsite in Ireland	Condells The Office Centre	Roches Street 9, Limerick, Ireland		
Within the Country	200138	N	8.7	Used timber reels	R11	M	Weighed	Offsite in Ireland	Hegarty Metals Recycling,WFP-LKC-11-001-01	Ballysimon Road, Limerick, Ireland		
Within the Country	200138	N	80.7	Wood for recycling	R3	M	Weighed	Offsite in Ireland	Greenstar,W0082-02	Dock Road, Limerick, Ireland		
Within the Country	200138	N	39.8	Wood for landfill	D1	M	Weighed	Offsite in Ireland	Greenstar,W0082-02	Dock Road, Limerick, Ireland		
Within the Country	200139	N	38.8	Plastics (empty IBC's & drums)	R9	M	Weighed	Offsite in Ireland	Rilta Environmental Ltd,W0192-03	Greenogue Business Park, Rathcoole, Co. Dublin, Ireland		
Within the Country	200199	N	7.4	Conveyor belting	R11	M	Weighed	Offsite in Ireland	Quarry Plant Supplies Ltd,None	Straffan, Co Kildare, Ireland		
Within the Country	200301	N	169.1	Mixed municipal waste	D5	M	Weighed	Offsite in Ireland	Greenstar,W0082-02	Dock Road, Limerick, Ireland		
Within the Country	160214	N	0.002	Waste Electronic and Electrical Equipment (WEEE)	R4	M	Weighed	Offsite in Ireland	Greenstar,W0082-02	Dock Road, Limerick, Ireland		
Within the Country	200399	N	23.4	Waste Food	R3	M	Weighed	Offsite in Ireland	Greenstar,W0082-02	Dock Road, Limerick, Ireland		
Within the Country	190805	N	530	sludges from treatment of urban waste water	D8	M	Volume Calculation	Offsite in Ireland	Ecojet Ltd.,WCP LK 12 685 01	Raheen Business Park, Bay M1, Raheen, Limerick, Ireland		
Within the Country	010307	Y	19201	Salt cake	D1	C	Volume Calculation	Onsite of generation	Aughinish Alumina Ltd.,IPPC Licence P0035-06	Aughinish Island, Askeaton, Co Limerick, Ireland	Aughinish Alumina ,IE Licence P0035-06, Aughinish Island, Askeaton, Co. Limerick, Ireland	Aughinish Island,.,Askeaton,Co. Limerick,Ireland
Within the Country	010309	N	108923	Sand (from alumina production)	D1	C	Volume Calculation	Onsite of generation	Aughinish Alumina Ltd.,IPPC Licence P0035-06	Aughinish Island, Askeaton, Co Limerick, Ireland		
Within the Country	010309	N	1350288	Red mud from alumina production other than the wastes mentioned in 01 03 07	D1	C	Volume Calculation	Onsite of generation	Aughinish Alumina Ltd.,IPPC Licence P0035-06	Aughinish Island, Askeaton, Co Limerick, Ireland		
Within the Country	010399	N	7125	Lime grits	D1	C	Volume Calculation	Onsite of generation	Aughinish Alumina Ltd.,IPPC Licence P0035-06	Aughinish Island, Askeaton, Co Limerick, Ireland		
Within the Country	010399	N	21,869	Process wastes (sand, scales, tank cleanout sludges)	D1	C	Volume Calculation	Onsite of generation	Aughinish Alumina Ltd.,IPPC Licence P0035-06	Aughinish Island, Askeaton, Co Limerick, Ireland		
Within the Country	161104	N	62	Flue stack residue - refractory waste	D1	C	Volume Calculation	Onsite of generation	Aughinish Alumina Ltd.,IPPC Licence P0035-06	Aughinish Island, Askeaton, Co Limerick, Ireland		

PRTR Id: P0035

Additional data from Landfill operators

No Data Available.

PRTR Id: P0035

Attachment 5
Noise Survey Report

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Aughinish Alumina Ltd.

Aughinish Island, Askeaton, Co. Limerick.
Industrial Emissions Licence Reg No. P0035-06



Report on

Annual Environmental Noise Survey 2015

November 2015

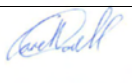
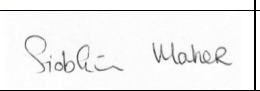
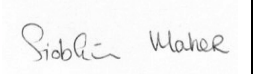
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HEALTH & SAFETY OHSAS 18001:2007 NSAI Certified
QUALITY ISO 9001:2008 NSAI Certified

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LoCall 1890 130 007

OES Consulting
Anfield House, Unit D
Baldonnell Business Park, Dublin 22
www.oes.ie

Control Sheet

Document Title:	Report on Annual Environmental Noise Survey 2015	**Document No.**	R1_101737

Rev	**Description**	**Originator**	**Reviewer**	**Change**	**Date**
00	Draft			Draft	20/11/2015
01	Final			Final	24/11/2015

This report is produced solely for the benefit of Aughinish Alumina Ltd. and no liability is accepted for any reliance placed on it by any other party unless specifically agreed in writing otherwise. This report refers, within the limitations stated, to the condition of the normal operating conditions of the site at the time of the noise compliance site survey. No warranty is given as to the possibility of future changes in the condition of the normal operating conditions of the site.

Aughinish Alumina Ltd.
Aughinish Island, Askeaton, Co. Limerick

Annual Environmental Noise Survey 2015

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Attachments

Attachment 1 Site Location Map Showing Noise Monitoring Locations

Attachment 2 Shannon Airport Met Eireann & AAL Weather Monitoring Data

Attachment 3 Certificates of Calibration

Attachment 4 Photo Log

Attachment 5 Noise Monitoring Report Sheets

Attachment 6 Historic Noise Monitoring Results

1 Introduction

OES Consulting (OES) was commissioned by Aughinish Alumina Ltd. (AAL) to undertake their annual environmental noise assessment at their facility on Aughinish Island, Askeaton, Co. Limerick.

The noise assessment was undertaken in accordance with Conditions and Schedules set out in the Industrial Emissions Licence (IEL) registration number P0035-06. The relevant Conditions and Schedules of the Licence are as follows:

- In accordance with Condition 4.5 of the licence ''*noise from the installation shall not give rise to sound pressure levels ($L_{Aeq,T}$) measured at the specified noise sensitive locations (including those specified in Schedule C.5 Noise Monitoring Locations, of this licence) which exceed the limit value(s).*''

- In accordance with Condition 6.16 of the licence ''*the licensee shall carry out a noise survey of the site operations annually. The survey programme shall be undertaken in accordance with the methodology specified in the 'Guidance Note for Noise: Licence Applications, Surveys and Assessments in Relation to Scheduled Activities (NG4)', as published by the Agency.*''

- In accordance with Schedule B.4 of the licence daytime limits of $L_{Ar\ (30\ minutes)}$ of 55 dB(A), Evening time limits of $L_{Ar(30\ minutes)}$ of 50 dB(A) and Night-time $L_{Aeq\ (15\text{-}30\ minutes)}$ of 45 dB(A) apply. In addition, Schedule B.4 states that "*there shall be no clearly audible tonal component or impulsive component in the noise emission from the activity at any noise sensitive location.*''

- Schedule C.5 Noise Monitoring sets out the monitoring locations, parameters to be measured, measurement frequency, measurement periods, and minimum survey duration as tabulated below:

Location	**Measurement**	**Frequency**
NSL1-NSL5 (incl.) B1-B9 Any other NSL which the Agency deems appropriate.	LAeq(15minute) / LAeq(30 minute) LAr,T (30 minute)	Annually
Period	**Minimum Survey Duration**	
Daytime	4 hour survey with a minimum of 3 sampling periods at each monitoring location. **Note2**	
Evening Time	2 hours survey with a minimum of 1 sampling period at each noise monitoring location.	
Night-Time**Note1**	3 hour survey with a minimum of 2 sampling periods at each noise monitoring location.	
Note1: Night-time measurements should be made between 2300hrs and 0400hrs, Sunday to Thursday, with 2300hrs being the preferred start time. Note2: Sampling period is to be the time period T stated within the relevant licence. Typically this will be either 15 minutes or 30 minutes in duration. This		

applies to day, evening and night time periods.

2 Methodology

The noise survey was undertaken in accordance with the 'Guidance Note for Noise: Licence Applications, Surveys and Assessments in Relation to Scheduled Activities (NG4)' as published by the Environmental Protection Agency in April 2012 and in accordance with the Conditions and Schedules of IEL P0035-06.

The survey was carried out between Wednesday 7th to Friday 9th October 2015 (dates inclusive) and Monday 12th to Tuesday 13th October 2015. The noise survey was undertaken by Mr Gareth Carroll an Environmental Consultant with OES Consulting who has undertaken the Institute of Acoustics (IOA) approved course in environmental noise assessment. This report was reviewed by Siobhan Maher, Member of the Institute of Acoustics (MIOA).

2.1 Measurement Locations

The noise survey was conducted at 9 Boundary Locations (B1 to B9) and 5 Noise Sensitive Locations (NSL1 to NSL5) as shown in Figure 1, Attachment 1 and described in Table 1 below.

Table 1: Noise Monitoring Locations

Monitoring location	GPS Cordinates	Location type	Location relative to Aughinish Alumina Ltd. installation
B1	528276 655432	Boundary	Located on the North-West corner of the jetty where ships are unloaded and loaded.
B2	528807 653808	Boundary	Located at the North East of the facility, close to the cooling towers.
B3	528676 652702	Boundary	Located towards the North side of the main access road.
B4	528153 651916	Boundary	Located to the South of the facility, close to the Nature Trail car-park.
B5	526797 652555	Boundary	Located to the Western corner of the site in the vicinity of the Bauxite Residue Disposal Area (BRDA).
B6	528002 653635	Boundary	Located close to the side access road to the Southwest of the main plant.
B7	526713 652467	Boundary	Located to the Southwest corner of the site.
B8	527668 650952	Boundary	Located to the South of the BRDA Phase II.

Monitoring location	GPS Cordinates	Location type	Location relative to Aughinish Alumina Ltd. installation
B9	528780 651096	Boundary	Located to the Southeast of the BRDA Phase II.
NSL1	529168 652761	Noise sensitive location	Located approximately 600m South East of the facility adjacent Poulaweela Creek.
NSL2	529000 651731	Noise sensitive location	Located approximately 1,200m to the South East of the facility in the vicinity of a residential dwelling.
NSL3	527720 649969	Noise sensitive location	Located approximately 3km to the South of the facility in the townland of Oola.
NSL4	526069 652096	Noise sensitive location	Located approximately 2.6km to the South West. Located at the eastern end of Foynes Port.
NSL5	528805 651209	Noise sensitive location	Located 1.9km directly South of the facility in the vicinity of a residential building.

2.2 Survey Periods

In accordance with IEL P0035-06 and NG4 Guidelines, three sampling periods are required at each noise monitoring location during the daytime, one sampling period is required during the evening period and two sampling periods are required during the night-time surveys. This results in six sampling events at each noise monitoring location over the course of the survey.

Sample periods were 15 minutes for Boundary Locations and 30 minutes for NSLs during the daytime, evening and night-time surveys.

The survey was undertaken during a typical operational production period from Wednesday 7th to Friday 9th October 2015 inclusive and Monday the 12th to Tuesday 13th October 2015, as required for compliance evaluation.

2.3 Weather

Weather conditions were favourable for monitoring of environmental noise. General weather information was sourced from Met Eireann's Shannon Airport Observatory automatic synoptic station. This is shown in Attachment 2. The weather during the daytime surveys was mild to warm (day highs of 14-20°C) and with a calm to light breeze (0 – 4m/s). During the night-time survey the wind regime was very calm with an occasional light breeze. Temperatures dropped to approximately 3-11°C. Conditions were dry for the duration of the monitoring period.

Local weather information was sourced from the AAL weather instrumentation, located on the site. The graphs from these stations are

within Attachment 2. The AAL weather station shows 0.0mm rainfall recorded for the duration of the monitoring period. Temperatures are recorded at a range from 4°C to 18°C and wind speed on site typically 0-4m/s with gusts of 9 m/s at the Bauxite Residue Disposal Area (BRDA). Wind was predominantly from a south to southeast direction, changing on Monday 12th October to a north to northwest direction.

2.4 Instrumentation

All measurements were undertaken using a Type 1 Precision Integrating Sound Level Meter (Cirrus Optimus) and associated hardware (calibrator, tripod) and software. Calibration certificates for the noise meter and calibrator are presented in Attachment 3.

Details of the monitoring equipment and software used are provided in Table 2.

Table 2: Monitoring Equipment

Instrument Type	Manufacturer	Model Number	Serial Number
Sound Level Meter	Cirrus Research plc	CR:171B	G056143
Acoustic Calibrator	Cirrus Research plc	CR:515	55191
Interpretation and Interface Software	Cirrus Research plc	Noise Tools	N/A

The Sound Level Meter and associated software and accessories conform to the following standards:

- IEC 61672-1, Class 1, Group X
- IEC 60651, Type 1, Group X
- IEC 60804, Type 1, Group X
- IEC 61260, IEC 60942, Class 1
- ANSI S1.4 & ANSI S1.4A, Type 1
- ANSI S1.43, Type 1

The Acoustic Calibrator was calibrated to published data as described and recommended by IEC standard Electroacoustic – Sound Calibrators IEC 60942:2003, IEC 90942:1997, BS EN 60942:1998 and BS EN 60942:2003.

2.5 Procedure

The monitoring kit was positioned at each monitoring location. Refer to Attachment 4 for Photolog showing meter locations. Care was taken to ensure that the meter was a minimum distance of 3m from any reflective surface other than the ground, and placed upon a tripod with a microphone height of 1.2-1.5m off the ground as per the requirements of NG4. The sound level meter (SLM) was set to record results for either 15 or 30 minutes as appropriate.

The results were saved to the instrument memory for later analysis. Survey personnel noted all primary noise sources contributing to noise

readings. The noise meter was attended by OES personnel at all times. The survey results were noted onto a Survey Record Sheet immediately following each measurement.

The meter was calibrated before and at the end of each survey period.

2.6 Measurement Parameters

The survey results are presented in terms of the following parameters:

L_{Aeq} is the A-weighted equivalent continuous sound level. It is a type of average and is used to describe a fluctuating noise in terms of a single noise level (or steady sound) over the sample period.

L_{Amax} is the A-weighted instantaneous maximum sound level measured during the sample period.

L_{A10} is the A-weighted sound level that is exceeded for 10% of the sample period time. It is typically used as a descriptor for intermittent high noise level features during a monitoring event such as road traffic.

L_{A90} is the A-weighted sound level that is exceeded for 90% of the sample period. It is typically used as a descriptor for background noise.

In addition to the above, the following definitions may also apply to the report discussion:

$L_{Ar,T}$ The Rated Noise Level is equal to the L_{Aeq} during a specified time interval (T), plus specified adjustments for tonal character and/or impulsiveness of the sound.

The "A" suffix denotes sound levels that have been "A-weighted" in order to account for the non-linear nature of human hearing to sounds of different frequencies.

Tonal sounds are defined as sounds which cover a range of only a few Hz which contains a clearly audible tone, i.e. distinguishable, discrete or continuous noise (whine, hiss, screech, or hum etc.) are referred to as being 'tonal'.

A simplified objective method for determining if tones are present is set out in Annex D of ISO 1996-2:2007(E) Acoustics – Description, measurement and assessment of environmental noise, Part 2: Determination of environmental noise levels.

According to the simplified method, an audible tone is normally defined as being greater than or equal to the following values in both adjacent one third octave bands:

- 15dB in low frequency one third octave bands (25Hz to 125Hz);
- 8dB in middle frequency bands (160Hz to 400Hz), and;

- 5dB in high frequency bands (500Hz to 10,000Hz).

1/3 Octave Analysis is defined as frequency analysis of sound such that the frequency spectrum is subdivided into narrower bands of one–third of an octave each in order to objectively determine if a sound is tonal or not.

All sound levels in this report are expressed in terms of decibels (dB) relative to $2x10^{-5}$ Pa.

3 Noise Monitoring Results

Detailed noise monitoring results for all noise monitoring locations are appended as Attachment 5 of this report. A summary of the survey L_{Aeq}, L_{A90}, L_{A10} and tonal analysis for day, evening and night time measurements are outlined in Tables 3 to 5 below respectively.

Boundary monitoring locations are taken to assess the noise arising from the facility and are useful in assessing potential changes over time compared to historical results.

Table 3: Daytime Noise Monitoring Results Summary

Noise location	Date Time	L_{Aeq}	L_{Amax}	L_{A10}	L_{A90}	Tonal or Impulsive noise* (Y/N)	Was 5dB penalty applied?	L_{AR}	Comments (ex. main noise sources on site, & extraneous noise ex. road traffic)	IEL Limit	Is L_{Ar} compliant with noise limit?
Noise Sensitive Locations - Monitoring Results											
NSL1	12/10/2015 10:02	44	56	45	43	No	No	43	**Facility**. Facility noise audible as constant steady noise source. **Other.** Occasional bird calls and song along the water and within the hedgerow. Car pulls up next to SLM at 11.06am and then drives off. Occasional aircraft descending for landing /take-off from Shannon Airport noticeable.	55	Yes
	12/10/2015 10:32	44	53	45	42	No	No	42		55	Yes
	12/10/2015 11:02	45	60	46	42	No	No	42		55	Yes
NSL2	12/10/2015 11:41	47	72	42	33	Yes~	No	33	**Facility**. Facility noise audible as a faint steady noise event. Individual sources not identifiable. A loud alarm (weekly fire alarm test) could be heard on site for 2 minutes during the initial monitoring round. **Other.** Occasional very faint traffic audible on the N69. Occasional birdsong and call, dog barking in distance, donkey braying nearby and wind induced noise through hedging trees were the prominent local noise sources. Occasional aircraft flying overhead noted during monitoring round. A total of 8 cars passed the SLM during the monitoring period.	55	Yes
	12/10/2015 12:12	43	70	41	34	No	No	34		55	Yes
	12/10/2015 12:42	45	77	40	34	No	No	34		55	Yes
NSL3	12/10/2015 14:59	51	77	44	35	No	No	35	**Facility.** Faint sound of facility when local noise sources are reduced. **Other**. Frequent traffic on the N69 predominant constant noise source. Occasional becoming frequent birdcalls and song along with faint dogs barking in	55	Yes
	12/10/2015 15:29	45	73	43	35	No	No	35		55	Yes

Noise location	Date Time	L_{Aeq}	L_{Amax}	L_{A10}	L_{A90}	Tonal or Impulsive noise* (Y/N)	Was 5dB penalty applied?	L_{AR}	Comments (ex. main noise sources on site, & extraneous noise ex. road traffic)	IEL Limit	Is L_{Ar} compliant with noise limit?
	12/10/2015 16:00	49	75	49	36	No	No	36	distance. Agricultural machinery can be heard in the surrounding area. Neighbour out walking passed meter. At 16.03 car pulls up beside SLM, workers entering housing development and begin laying out pallets and talking loudly. Car leaves at 16.19. A total of six aircraft flew overhead during the monitoring round. Peak noise events include a total of 4 cars passing meter and one tractor.	55	Yes
NSL4	09/10/2015 12:35	46	67	46	38	No	No	38	**Facility**: Faint facility noise audible as a steady distant noise source. Facility noise drowned out occasionally during periods of increased local activities. **Other.** Traffic on N69 is a constant distant noise source. Occasional vehicular movements and associated reversing alarms from Foynes Port. Occasional bird song and call. Maintenance works audible from Foynes Port including a pneumatic drill at 12.59pm. A total of seven aircraft flew overhead during the monitoring period.	55	Yes
	09/10/2015 13:30	44	60	47	38	No	No	38		55	Yes
	13/10/2015 10:57	38	55	41	34	No	No	34		55	Yes
NSL5	12/10/2015 13:17	61	84	56	33	No	No	33	**Facility.** Faint facility noise only audible during times of very low local noise. **Other**. Traffic on N69 a faint, distant noise frequent source. Occasional birdsong and call, dogs barking in distance and wind induced noise through hedging. Neighbour strimming in nearby fields. Frequent intermittent traffic passing SLM on local roads. A total of 62 vehicles passed the SLM over the 1hr 30min period: 72.58% Cars, 19.35% LCV, and 8.06% HCV.	55	Yes
	12/10/2015 13:48	58	82	52	34	No	No	34		55	Yes
	12/10/2015 14:18	60	82	57	35	No	No	35		55	Yes
Boundary Location - Noise Monitoring Results											

Noise location	Date Time	L_{Aeq}	L_{Amax}	L_{A10}	L_{A90}	Tonal or Impulsive noise* (Y/N)	Was 5dB penalty applied?	L_{AR}	Comments (ex. main noise sources on site, & extraneous noise ex. road traffic)	IEL Limit	Is L_{Ar} compliant with noise limit?
B1	09/10/2015 10:00	62	80	62	60	N/A	N/A	N/A	Plant Noise	N/A	N/A
	09/10/2015 10:16	63	72	64	61	N/A	N/A	N/A	Plant Noise	N/A	N/A
	09/10/2015 10:31	63	77	63	61	N/A	N/A	N/A	Plant Noise	N/A	N/A
B2	08/10/2015 10:10	55	59	56	55	N/A	N/A	N/A	Plant Noise	N/A	N/A
	08/10/2015 10:25	56	62	57	55	N/A	N/A	N/A	Plant Noise	N/A	N/A
	08/10/2015 10:40	56	60	56	55	N/A	N/A	N/A	Plant Noise	N/A	N/A
B3	13/10/2015 11:55	60	72	61	58	N/A	N/A	N/A	Plant Noise	N/A	N/A
	13/10/2015 12:10	61	72	63	57	N/A	N/A	N/A	Plant Noise	N/A	N/A
	13/10/2015 12:25	58	75	60	56	N/A	N/A	N/A	Plant Noise	N/A	N/A
B4	08/10/2015 16:42	49	66	53	33	N/A	N/A	N/A	Plant Noise	N/A	N/A
	08/10/2015 16:59	47	65	50	34	N/A	N/A	N/A	Plant Noise	N/A	N/A
	09/10/2015 09:29	50	76	49	38	N/A	N/A	N/A	Plant Noise	N/A	N/A
B5	08/10/2015 12:20	51	69	45	37	N/A	N/A	N/A	Plant Noise	N/A	N/A
	08/10/2015 12:35	41	55	44	36	N/A	N/A	N/A	Plant Noise	N/A	N/A
	08/10/2015 12:51	55	83	44	35	N/A	N/A	N/A	Plant Noise	N/A	N/A
B6	08/10/2015 11:19	50	64	52	49	N/A	N/A	N/A	Plant Noise	N/A	N/A

Noise location	Date Time	L_{Aeq}	L_{Amax}	L_{A10}	L_{A90}	Tonal or Impulsive noise* (Y/N)	Was 5dB penalty applied?	L_{AR}	Comments (ex. main noise sources on site, & extraneous noise ex. road traffic)	IEL Limit	Is L_{Ar} compliant with noise limit?
	08/10/2015 11:34	50	60	52	49	N/A	N/A	N/A	Plant Noise	N/A	N/A
	08/10/2015 11:49	50	60	52	49	N/A	N/A	N/A	Plant Noise	N/A	N/A
B7	08/10/2015 13:52	35	57	36	33	N/A	N/A	N/A	Plant Noise	N/A	N/A
	08/10/2015 14:07	43	65	39	33	N/A	N/A	N/A	Plant Noise	N/A	N/A
	08/10/2015 14:25	37	59	39	33	N/A	N/A	N/A	Plant Noise	N/A	N/A
B8	08/10/2015 14:48	42	61	44	38	N/A	N/A	N/A	Plant Noise	N/A	N/A
	08/10/2015 15:04	42	56	44	36	N/A	N/A	N/A	Plant Noise	N/A	N/A
	08/10/2015 15:19	40	49	42	37	N/A	N/A	N/A	Plant Noise	N/A	N/A
B9	09/10/2015 11:04	48	62	51	41	N/A	N/A	N/A	Plant Noise	N/A	N/A
	09/10/2015 11:19	48	62	51	41	N/A	N/A	N/A	Plant Noise	N/A	N/A
	09/10/2015 11:34	49	65	52	42	N/A	N/A	N/A	Plant Noise	N/A	N/A

*Only tones or impulse noise associated with the Rusal operations are indicated.
~Tone at 8kHz identified at this location. This tone occurred over a 2 minute period of the 30 minutes monitoring event. This tone is associated with the weekly fire alarm and hence no tonal penalty was applied. It is noted that no other tones were identified at this location or any other NSL during the remaining day or night measurements.

Table 4: Evening Noise Monitoring Results Summary

Noise location	Date Time	L_{Aeq}	L_{Amax}	L_{A10}	L_{A90}	Tonal or Impulsive noise* (Y/N)	Was 5dB penalty applied?	L_{AR}	Comments (ex. main noise sources on site, & extraneous noise ex. road traffic)	IEL Limit	Is L_{Ar} compliant with noise limit?
Noise Sensitive Locations - Monitoring Results											
NSL1	08/10/2015 19:48	34	50	37	30	No	No	30	**Facility**. Faint noise from the eastern quarter of the facility audible as steady constant noise source. **Other**. Occasional bird song and call along water and within hedging. Faint distant sound of traffic on local roads and N69. Can hear an offsite alarm sounding in the distance. Occasional aircraft flying overhead noted at 19:48 and 20:09.	50	Yes
NSL2	08/10/2015 20:29	45	72	42	33	No	No	33	**Facility**: Faint facility noise audible when local noises sources were low. Individual sources were not distinct. **Other.** Traffic on N69 steady dominant noise source. Frequent dog barking in the distance, infrequent birdsong and call. Occasional aircraft flew overhead. Occasional traffic in distance on local roads. One car passed the SLM during the monitoring round (peak noise event).	50	Yes
NSL3	08/10/2015 19:01	50	72	52	41	No	No	41	**Facility**: Could not hear facility amongst local background noises. **Other.** Traffic on the N69 a steady dominant noise in the distance. Occasional bird call and song and dog barking in the distance. Intermittent boiler on house next to SLM can be heard throughout the monitoring period. Three cars passed the SLM during the monitoring round (peak noise event).	50	Yes

Noise location	Date Time	L_{Aeq}	L_{Amax}	L_{A10}	L_{A90}	Tonal or Impulsive noise* (Y/N)	Was 5dB penalty applied?	L_{AR}	Comments (ex. main noise sources on site, & extraneous noise ex. road traffic)	IEL Limit	Is L_{Ar} compliant with noise limit?
NSL4	12/10/2015 19:00	47	63	46	39	No	No	39	**Facility.** Facility noise clearly audible as steady source although individual sources indistinct. **Other.** Occasional very faint traffic on N69 audible. Can hear frequent faint sound of water moving from open bay area north of SLM. Occasional bird call and song, faint dog barking in distance and vehicular movements from within Foynes Port.	50	Yes
NSL5	08/10/2015 21:03	52	78	47	34	No	No	34	**Facility.** Faint facility noise only audible during times of very low local noise. Individual sources not distinctive. **Other**. Car traffic on the N69 and traffic on local roads primary sources of noise. Occasional rustling and animal movement of trees and bushes. One aircraft flew overhead at 21.07pm. A total of 4 cars passed the SLM over the 1hr 30min period.	50	Yes
Boundary Location - Noise Monitoring Results											
B1	12/10/2015 19:53	54	75	55	52	N/A	N/A	N/A	Plant Noise	N/A	N/A
B2	12/10/2015 20:17	52	60	53	51	N/A	N/A	N/A	Plant Noise	N/A	N/A
B3	12/10/2015 22:11	60	65	60	59	N/A	N/A	N/A	Plant Noise	N/A	N/A
B4	08/10/2015 22:02	38	65	36	29	N/A	N/A	N/A	Plant Noise	N/A	N/A
B5	12/10/2015 21:04	52	69	51	45	N/A	N/A	N/A	Plant Noise	N/A	N/A
B6	12/10/2015 20:42	54	80	54	51	N/A	N/A	N/A	Plant Noise	N/A	N/A
B7	12/10/2015 21:23	46	64	45	43	N/A	N/A	N/A	Plant Noise	N/A	N/A

Noise location	Date Time	L_{Aeq}	L_{Amax}	L_{A10}	L_{A90}	Tonal or Impulsive noise* (Y/N)	Was 5dB penalty applied?	L_{AR}	Comments (ex. main noise sources on site, & extraneous noise ex. road traffic)	IEL Limit	Is L_{Ar} compliant with noise limit?
B8	12/10/2015 21:42	39	61	41	36	N/A	N/A	N/A	Plant Noise	N/A	N/A
B9	08/10/2015 21:39	45	65	45	33	N/A	N/A	N/A	Plant Noise	N/A	N/A

*Only tones or impulse noise associated with the Rusal operations are indicated.

Table 5: Night-Time Noise Monitoring Results Summary

Noise location	Date/ Time	L_{Aeq}	L_{Amax}	L_{A10}	L_{A90}	Tonal or Impulsive noise* (Y/N)	Comments (ex. main noise sources on site, & extraneous noise ex. road traffic)	IEL Limit	Is L_{Aeq} compliant with noise limit?
Noise Sensitive Locations - Monitoring Results									
NSL1	09/10/2015 02:32	32	53	34	28	No	**Facility**. Faint noise from the eastern quarter of the facility clearly audible as steady constant noise source. Occasional faint reversing alarm in distance. **Other.** Occasional birdcalls from nearby hedging.	45	Yes
	09/10/2015 03:02	38	77	36	31	No		45	Yes
NSL2	08/10/2015 00:09	38	50	41	32	No	**Facility**: Plant noise clearly audible as a constant steady source. Individual sources were not distinct. **Other.** Occasional traffic on N69 audible in the distance. In frequent birdsong and call and occasional faint bleating sheep in the distance. An animal rusting in overgrowth could be heard for the majority of the monitoring period. One car went past the SLM during the monitoring period.	45	Yes
	08/10/2015 00:39	44	71	43	36	No		45	Yes
NSL3	09/10/2015 01:25	38	54	42	21	No	**Facility**. Very faint facility noise when local noises have reduced. **Other.** Traffic on local roads and N69 noted as audible distant noise source. The facility cannot be heard when traffic is passing by. Occasional rustle of leaves in trees in the wind and plastic sheeting flapping on building site. One aircraft flew overhead at 02.20	45	Yes
	09/10/2015 01:55	38	57	42	21	No		45	Yes

Noise location	Date/ Time	L_{Aeq}	L_{Amax}	L_{A10}	L_{A90}	Tonal or Impulsive noise* (Y/N)	Comments (ex. main noise sources on site, & extraneous noise ex. road traffic)	IEL Limit	Is L_{Aeq} compliant with noise limit?
NSL4	12/10/2015 23:00	41	50	43	40	No	**Facility.** Facility noise audible as a steady background noise. **Other.** Occasional birdcalls and faint dog barking in distance. One aircraft flew overhead at 23.38pm.	45	Yes
	12/10/2015 23:30	44	64	42	35	No		45	Yes
NSL5	08/10/2015 01:16	41	63	38	24	No	**Facility.** Facility faintly audible as distant steady noise source. Infrequent distant banging noise from site. **Other**. Occasional traffic passing on N69. Occasional animal movements from surrounding area. Occasional bird calls and song and dogs barking in distance. A total of two cars passed the SLM during the 1hr monitoring period. One aircraft flew overhead at 2.02am.	45	Yes
	08/10/2015 01:46	32	49	36	23	No		45	Yes
Boundary Location - Noise Monitoring Results									
B1	13/10/2015 02:04	60	87	59	54	N/A	Plant Noise	N/A	N/A
	13/10/2015 02:19	64	86	66	57	N/A	Plant Noise	N/A	N/A
B2	13/10/2015 01:21	53	55	53	52	N/A	Plant Noise	N/A	N/A
	13/10/2015 01:38	52	56	53	52	N/A	Plant Noise	N/A	N/A
B3	13/10/2015 00:45	60	63	60	59	N/A	Plant Noise	N/A	N/A
	13/10/2015 01:01	60	73	60	59	N/A	Plant Noise	N/A	N/A
B4	13/10/2015 00:10	40	63	39	34	N/A	Plant Noise	N/A	N/A
	13/10/2015 00:25	43	68	40	35	N/A	Plant Noise	N/A	N/A
B5	13/10/2015 03:21	42	53	44	41	N/A	Plant Noise	N/A	N/A
	13/10/2015 03:37	43	58	44	41	N/A	Plant Noise	N/A	N/A

Noise location	Date/ Time	L_{Aeq}	L_{Amax}	L_{A10}	L_{A90}	Tonal or Impulsive noise* (Y/N)	Comments (ex. main noise sources on site, & extraneous noise ex. road traffic)	IEL Limit	Is L_{Aeq} compliant with noise limit?
B6	13/10/2015 02:43	54	68	55	51	N/A	Plant Noise	N/A	N/A
	13/10/2015 02:59	51	57	52	50	N/A	Plant Noise	N/A	N/A
B7	13/10/2015 03:57	41	57	43	38	N/A	Plant Noise	N/A	N/A
	13/10/2015 04:12	38	51	39	35	N/A	Plant Noise	N/A	N/A
B8	13/10/2015 04:32	37	52	39	35	N/A	Plant Noise	N/A	N/A
	13/10/2015 04:47	39	49	41	35	N/A	Plant Noise	N/A	N/A
B9	09/10/2015 03:37	38	58	40	21	N/A	Plant Noise	N/A	N/A
	09/10/2015 03:52	44	67	40	20	N/A	Plant Noise	N/A	N/A

*Only tones or impulse noise associated with the Rusal operations are indicated.

4 Summary of Noise Survey

A discussion of the noise monitoring measurements taken at the NSLs and Boundary Locations are presented below. Boundary measurements are utilised to identify the noise arising from site activities, changes over time when compared to historic values and are not noise sensitive locations. Historic noise measurements are included in Attachment 6 to which boundary measurements are compared to.

4.1 Noise Sensitive Locations (NSLs)

The discussion of noise measurements at NSLs is split under the three NG4 / IEL periods of day, evening and night for convenience of establishing limit compliance.

From a review of the noise recorded on site, and the notes taken by the acoustician during the survey, the noise arising from plant activities at NSLs, where audible, was a steady noise with little variation in volume. Local noise sources at NSLs were the predominant influence at these monitoring locations. Therefore, as per chapter 7.10 of NG4 '*in instances where extraneous noise sources dominate L_{eq} noise spectra, appropriate consideration should be given to the L_{90} spectrum that may be more representative of site noise emissions alone*'. NSL compliance is rated against the L_{A90} parameter rather than the L_{Aeq}, as this is representative of noise emissions from the facility.

Assessment for tones was completed using the guidance set out in chapter 5.1 of NG4 for positive identification of a tone within a 1/3 octave spectrum. A tone is only recognised where it is attributable to the operations at the AAL facility and is a prominent feature at a NSL.

4.1.1 NSL Daytime Results

AAL's IEL daytime noise limit of 55 dB (L_{Ar}) was not exceeded at any of the NSLs when assessed against the L_{A90} parameter. Facility noise was mostly faint at all locations monitored with the exception of NSL1 where it was just audible.

A tone at 8 kHz was identified on the 1/3 octave chart at monitoring location NSL2 during the first round of daytime monitoring. This tone occurred over a 2 minute period (at 12.00am) at the start of the 30 minute monitoring event. The level was approximately 30 – 35 dB. A high pitched sound was noted coming from north of the monitoring location during the measurement period and was not persistent throughout. It was later identified that this tone was associated with the weekly fire alarm test on site. It is noted that no tones were identified at any other NSL or boundary locations during the day or night monitoring periods. It was therefore determined that no penalty was to be applied at this monitoring location.

Based upon the monitoring data collected, and the interpretation of this data, AAL is in compliance with the daytime limit at all NSLs for noise emissions during the day.

4.1.2 NSL Evening Time Results

The evening monitoring conducted at NSLs were compared to the Schedule B.4 limit of $L_{Ar(30\ minute)}$ of 50dB. This limit was compared to the recorded $L_{A90(30\ minute)}$ measurements as this parameter best represented AAL noise at NSL positions. All NSLs were in compliance with the Evening limit.

No tonal or impulsive noise was subjectively noted or objectively recorded during the evening-time period at NSLs, from the facility. The facility was audible as a faint steady noise source at NSLs, though local noise events including traffic movements, local construction activities and birdcalls were the cause for elevations to the $L_{Aeq,T}$ values recorded.

Based upon the monitoring data collected, and the interpretation of this data, AAL is in compliance with the evening time limit at all NSLs for noise emissions during the evening.

4.1.3 NSL Night-Time Results

During the night-time the facility became more audible. This is attributed to the decreasing sound pressure from other extraneous ambient sources, such as traffic, dwelling house construction and natural sources (wind induced noise) and agricultural activities, although these sources of noise were still present and influencing the overall $L_{Aeq,T}$ results.

AAL IEL night-time noise limit of 45 dB (L_{Aeq}) was compared to the recorded L_{A90} (30 minute) measurements as this parameter best represented AAL noise at NSLs. All NSLs were in compliance with the emission limit value. Noise from the facility was audible at these locations, however acoustic mitigation on site and attenuation due to the separation distance between the facility and the NSLs ensured compliance with licence limits.

Traffic influences were notably reduced overnight, and NSL5, which had shown high L_{AeqT} results during the day, recorded a $L_{Aeq(30\ minute)}$ average of 37dB over the two night-time measurements.

No tonal or impulsive noise from AAL was subjectively noted or objectively recorded during the night-time period at NSLs.

The licence requirement for night-time noise arising from processes onsite, based upon the measurements taken and the observations made during the survey, was therefore complied with.

4.1.4 NSL Historic Results

NSL results during the day show L_{A90} values in line with historic measurements. Some variation with 2014 is present, with large increases of 12dB at NSL1 and a decrease of 8dB at NSL5. Wind direction during the monitoring round at NSL1, although at a low wind speed (0-3m/s), was recorded from a northerly direction and may have influenced the reading when compared to the previous year's results. Wind direction during the monitoring round at NSL5 was recorded from a south to south eastern direction and may also have had influence in reducing the sound level detected at the monitoring point when compared to the previous year's results. It is noted however that overall results remain in line with historic data.

NSL results during the night show L_{A90} values in line with historic measurements. Some variation with 2014 is present, with large decrease of 11dB at NSL1. Wind direction during the monitoring round at NSL1 was recorded from a south eastern direction and may have had influence in reducing the sound level at the monitoring point when compared to the previous year's results. It is noted however that overall results remain in line with historic data.

4.2 Boundary Locations

Boundary measurements are reviewed as $L_{Aeq(15\ minute)}$ and $L_{A90(15\ minute)}$. At boundary locations, influences from external sources was minimal, with the exception of monitoring location B9 which lies in close proximity (less than 30meters) to local roads and (less than 100m) to the National (N69) Road. The $L_{Aeq,T}$ gives an indication of the variable noise on site including short duration activities such as fork-lift and truck movements, alarms, etc. The $L_{A90,T}$ gives a result representative of the continuous noise sources on site, such as the cooling towers along the north eastern boundary of the facility internal production activities and the conveying of material on site through the covered conveyor system.

4.2.1 Boundary Day Results

The daytime arithmetic average $L_{Aeq(15\ minute)}$ recorded at the boundary locations ranged from 38 dB at boundary location B7 to 62 dB at boundary location B1. General noise on site was attributed to the cooling towers along the north eastern boundary of the facility, vehicle movements on site, internal production activities, unloading of bauxite at the jetty and the conveying of material on site through the covered conveyor system.

Boundary results during the day show $L_{Aeq,T}$ values in line with historic measurements. Some variation with 2014 is present, with differences of 4dB at B3, B4, B6 and B8. A large increase is also

noted of 9dB at B2. A significant reduction in noise level was recorded at boundary location B2 in the 2014 monitoring round. An increase in noise levels recorded during the 2015 monitoring round bring the results back in line with data recorded prior to 2014, which suggests that the 2014 recording at B2 was not representative of typical noise at the monitoring location.

Boundary daytime $L_{A90,T}$ values range from 33dB (B7) to 61dB (B1) in 2015.

Boundary $L_{A90,T}$ values are also in line with historic measurements. In the previous monitoring round carried out in 2014 some locations had shown significant variation to 2013 (particularly B1, B2 and B3) and in all three locations values had fallen in the 2014 results when compared to 2013. In the 2015 monitoring round increases in sound pressure levels were recorded at all three of these locations back in line with results obtained in the 2013 monitoring round. A reduction in sound pressure levels at B5 of 4dB and an increase of 4dB at B8 is also noted when compared to 2014 however results continue to remain in line with historic data.

4.2.2 Boundary Evening Results

Evening period noise measurements ranged from a $L_{Aeq(15\ minute)}$ of 38dB at boundary location B4 to a high of 60 dB at boundary location B3. Noise sources on site did not vary from the day to the evening period.

Boundary evening time $L_{A90,T}$ values range from 29dB (B4) to 59dB (B3) in 2015.

4.2.3 Boundary Night-Time Results

The night time arithmetic average $L_{Aeq(15\ minute)}$ recorded at the boundary locations ranged from 38 dB at boundary location B8 to 62 dB at boundary location B1. General external noise sources and activities at the production areas on site were similar to daytime activities.

Boundary results during the night show $L_{Aeq,T}$ values in line with historic measurements. Some variation with 2014 is present, with differences of 4dB at B4 and B6 and 5dB at B8 and B9. A large increase of 18dB is also noted at B3 however this result remains in line with data recorded in 2013.

Boundary night-time $L_{A90,T}$ values range from 21dB (B9) to 59dB (B3) in 2015.

Boundary $L_{A90,T}$ values are also in line with historic measurements. In the previous monitoring round carried out in 2014 some locations had shown significant variation to 2013 (particularly B3, B6 and B8). At B3 and B8 values had fallen significantly in the 2014

results when compared to 2013. At B6 values had increased by 9dB in the 2014 results when compared to the 2013. In the 2015 monitoring round increases in sound pressure levels were recorded at B3 and B8 with results returning back in line with historic results obtained at their respective locations. A reduction in sound pressure levels at B6 of 4dB and B9 of 6dB is also noted when compared to 2014 however results continue to remain in line with historic data.

5 Conclusions

Noise monitoring was conducted in October 2015 at Noise NSLs and boundary locations associated with the Aughinish Alumina Ltd. facility.

It is understood that no noise complaints have been received by the facility since previous noise monitoring was undertaken in 2014.

Compliance at NSLs was assessed using the $L_{A90,(30\ minute)}$ parameter, to remove extraneous (non-site related) influences at these monitoring locations. This parameter best represented the potential noise emissions from AAL at NSLs.

Day-time monitoring results at NSLs were compliant with the Industrial Emissions Licence specified limits of $L_{Ar(30\ minute)}$ 55 dB.

Evening-time monitoring results at NSLs were compliant with the Industrial Emissions Licence specified limits of $L_{Ar(30\ minute)}$ 50 dB.

Night-time monitoring results at NSLs were compliant with the Industrial Emissions Licence specified limits of $L_{Aeq(30\ minute)}$ 45 dB.

No tones or impulsive noise was recorded during the survey periods at NSLs associated with activities at the facility.

Boundary monitoring locations were in line with both historic day and night-time monitoring results.

Some variability is recorded at NSL locations however it is noted that results continue to remain in line with both historic day and night-time monitoring results.

Based upon the monitoring conducted in 2015, the Aughinish Alumina Ltd. facility is compliant with the requirements of the Industrial Emissions Licence for noise at NSLs.

6 References

'Guidance Note for Noise: Licence Applications, Surveys and Assessments in Relation to Scheduled Activities (NG4)' as published by the Environmental Protection Agency in April 2012.

IS0 1996-2:2007(E) Acoustics - Description and Measurement of Environmental Noise

Attachment 1 Site Map



Legend

- Boundary Monitoring Locations (B)
- Noise Sensitive Locations (NSL)

N

RUSAL

OES Consulting 2nd Floor, FBD House, Fels Point, Tralee, Kerry
T: (066) 7128321 F: (066) 7180061 E: info@oes.ie

Client	Aughinish Alumina Ltd (Rusal)
Project	Environmental Noise Survey
Title	Noise Monitoring Locations
Scale	1:30,303
Ref.	11/08/2014
OES Ref.	F1_1017_30
Revision	01
Document Control	By: KG
	Chkd By TQ
	App. By TQ

Ordnance Survey of Ireland
Licence No. EN0059514

Attachment 2 Weather Monitoring Data

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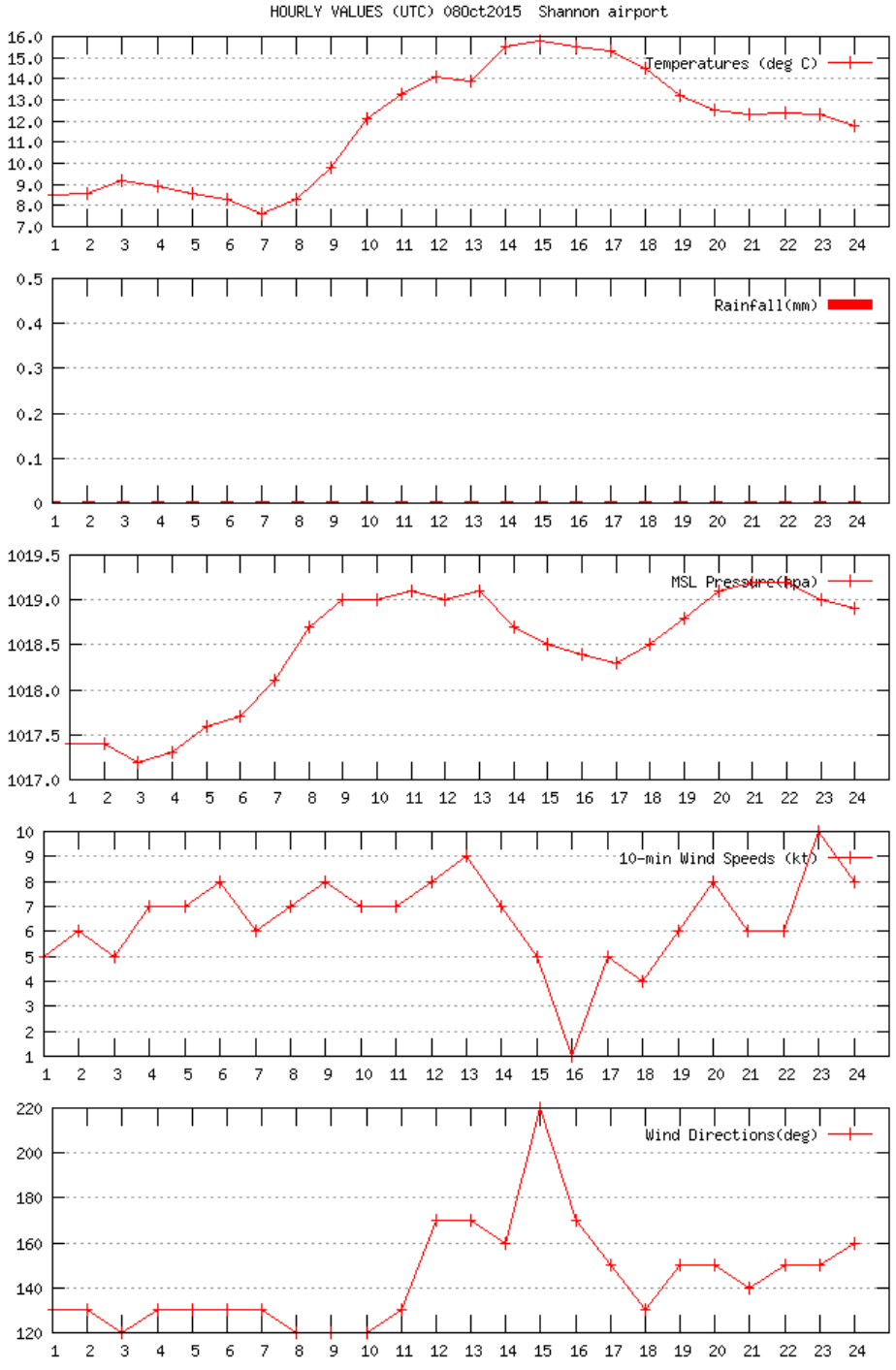
Daily Data

Weather Station Data - From 15/10/2013 to 14/10/2015

Please Select a Station and Date from the menu on the right.

REPORTS FROM SHANNON AIRPORT

Date	Rainfall (mm)	Max Temp (°C)	Min Temp (°C)	Grass Min Temp (°C)	Mean Wind Speed (knots)	Maximum Gust (if >= 34 knots)	Sunshine (hours)
8/10/2015	0.1	16.8	7.5	3.4	6.5		4.3



Print

PLEASE NOTE:
Some stations do not record sunshine amounts and wind speeds.
Gusts are only displayed if 34 knots or more, otherwise blank.
Reports are only available for the past twelve months.
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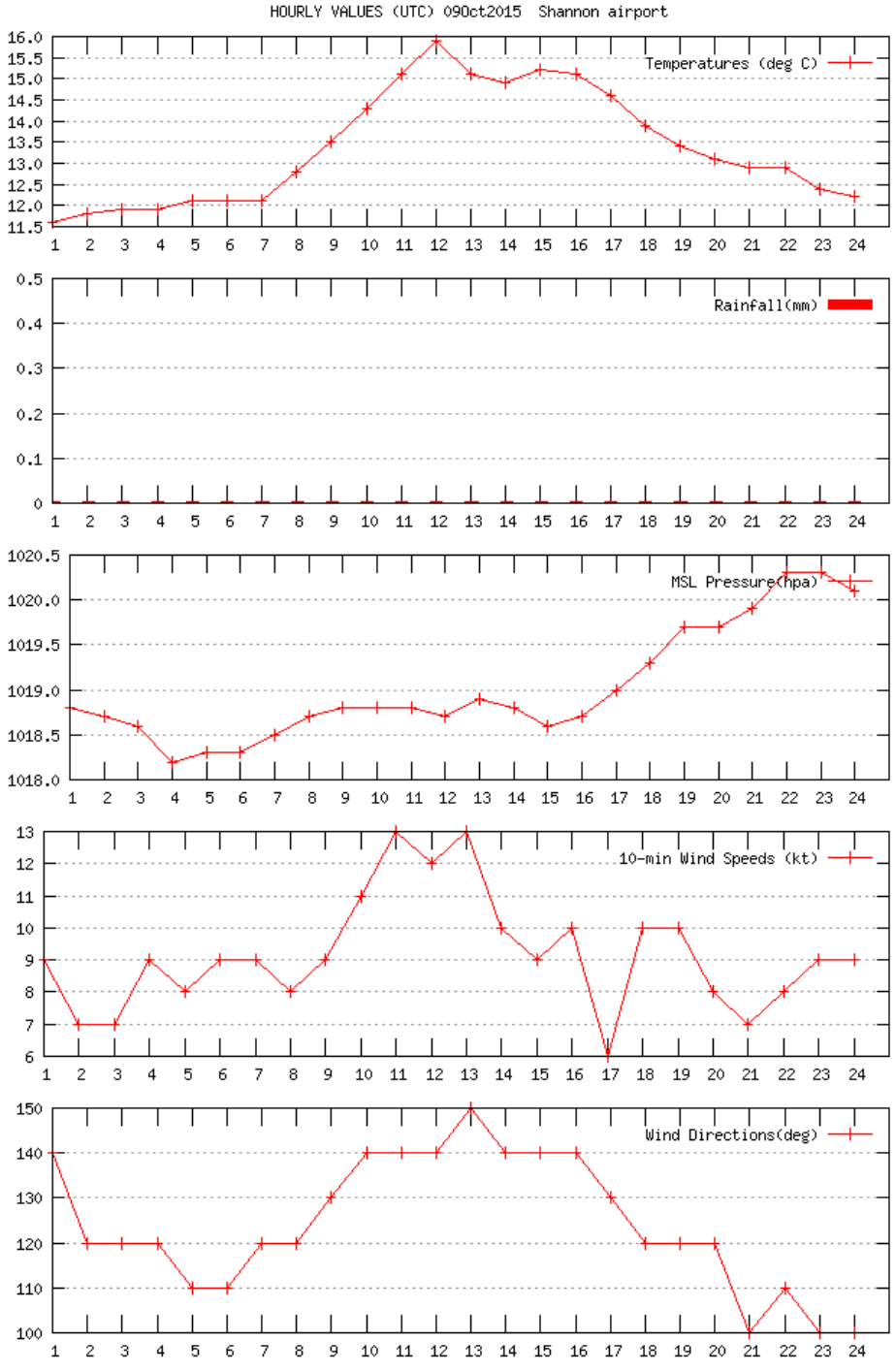
Daily Data

Weather Station Data - From 15/10/2013 to 14/10/2015

Please Select a Station and Date from the menu on the right.

REPORTS FROM SHANNON AIRPORT

Date	Rainfall (mm)	Max Temp (°C)	Min Temp (°C)	Grass Min Temp (°C)	Mean Wind Speed (knots)	Maximum Gust (if >= 34 knots)	Sunshine (hours)
9/10/2015	0	16.2	11.6	9.6	9.2		0



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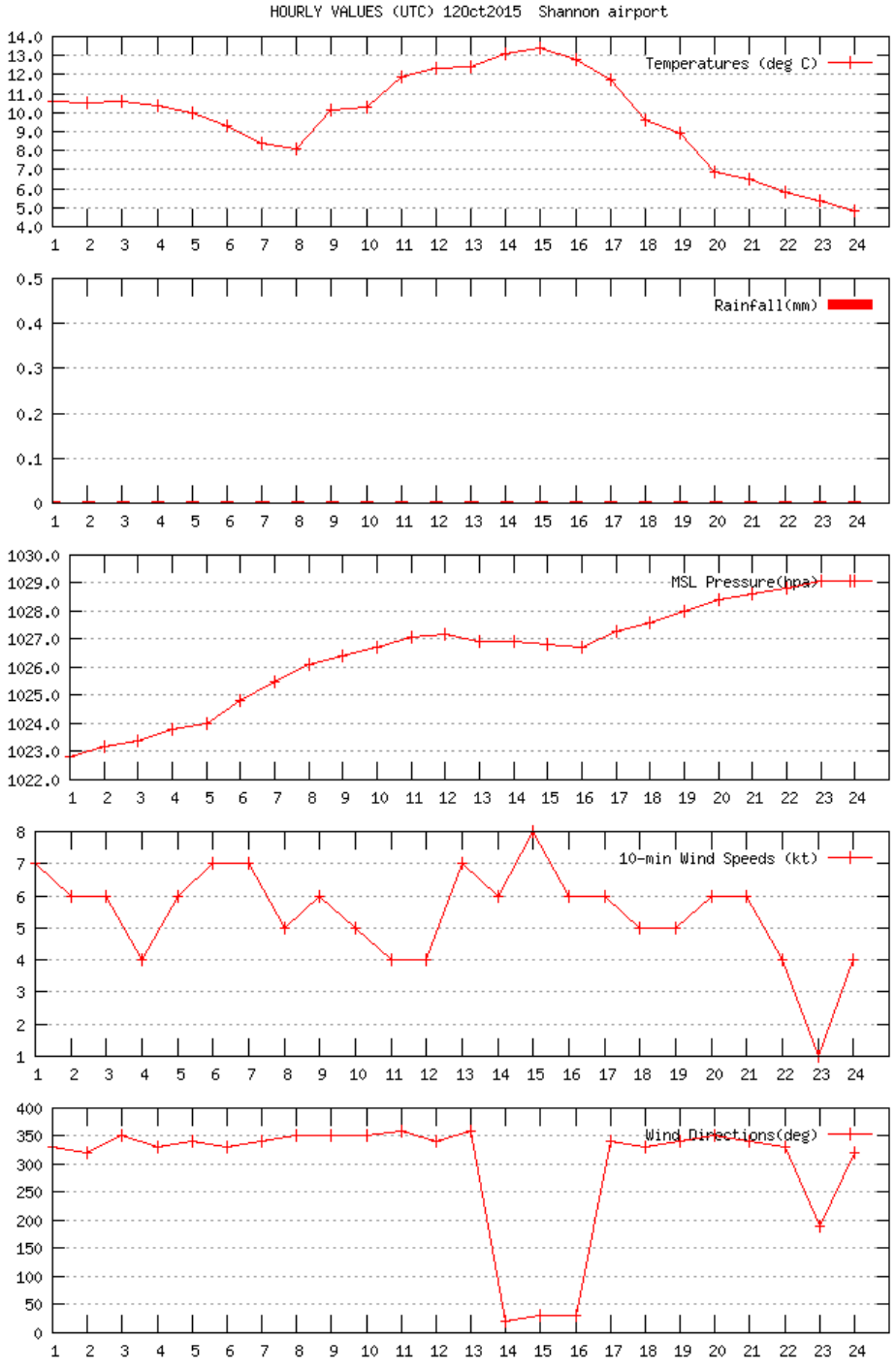
Daily Data

Weather Station Data - From 15/10/2013 to 14/10/2015

Please Select a Station and Date from the menu on the right.

REPORTS FROM SHANNON AIRPORT

Date	Rainfall (mm)	Max Temp (°C)	Min Temp (°C)	Grass Min Temp (°C)	Mean Wind Speed (knots)	Maximum Gust (if >= 34 knots)	Sunshine (hours)
12/10/2015	0	14.1	4.5	0.8	5.5		4.6



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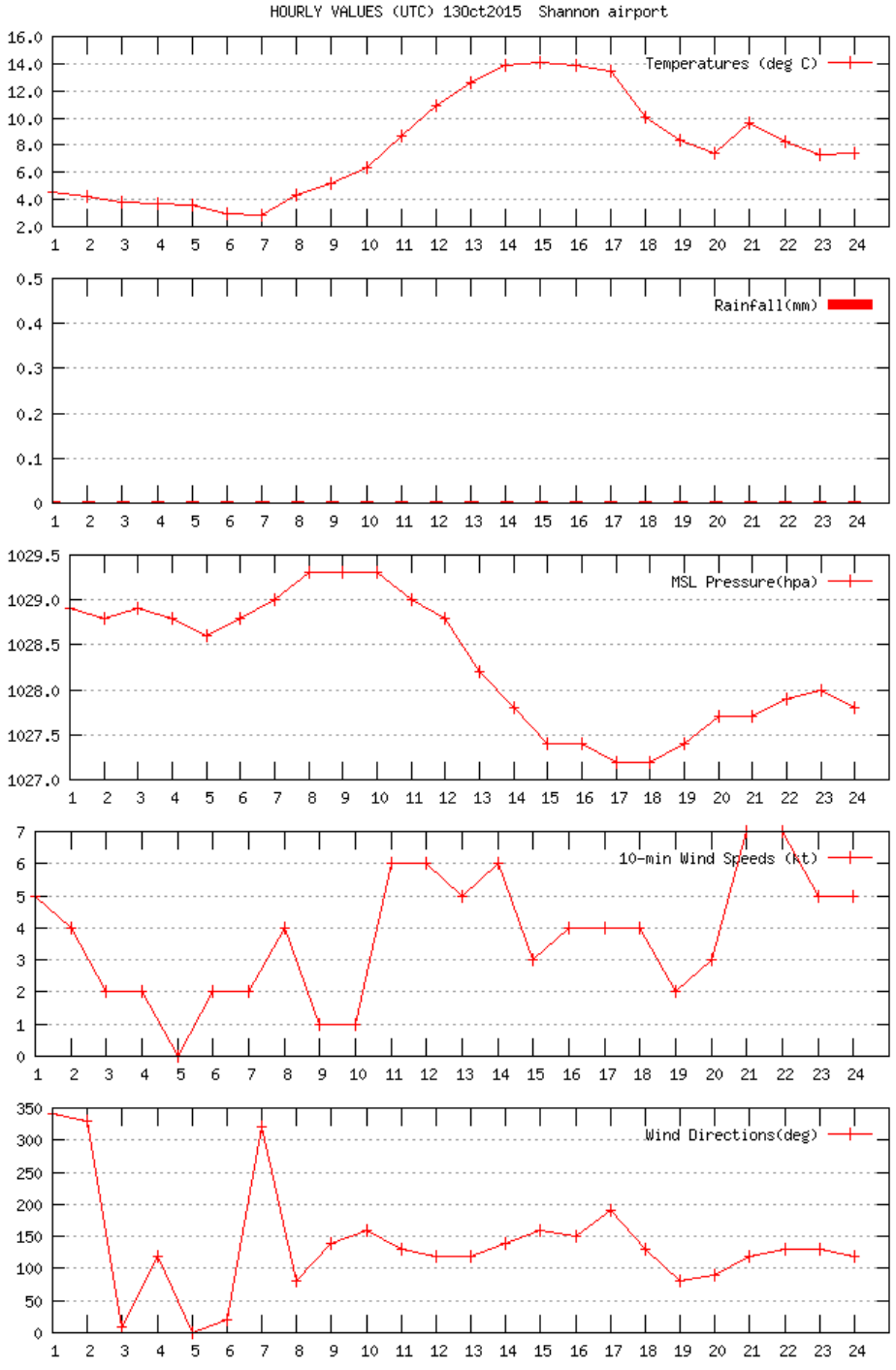
Daily Data

Weather Station Data - From 15/10/2013 to 14/10/2015

Please Select a Station and Date from the menu on the right.

REPORTS FROM SHANNON AIRPORT

Date	Rainfall (mm)	Max Temp (°C)	Min Temp (°C)	Grass Min Temp (°C)	Mean Wind Speed (knots)	Maximum Gust (if >= 34 knots)	Sunshine (hours)
13/10/2015	0	14.3	2.7	0.2	3.8		7.5



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Attachment 3 Calibration Certificates

Certificate of Calibration

Cirrus Research plc
dedicated to noise measurement

Equipment Details

Instrument Manufacturer	Cirrus Research plc
Instrument Type	CR:171B
Description	Sound Level Meter
Serial Number	G056143

Calibration Procedure

The instrument detailed above has been calibrated to the publish test and calibration data as detailed in the instrument hand book, using the techniques recommended in the latest revisions of the International Standards IEC 61672-1:2002, IEC 60651:1979, IEC 60804:2001,IEC 61260:1995, IEC 60942:1997, IEC 61252:1993, ANSI S1.4-1983, ANSI S1.11-1986 and ANSI S1.43-1997 where applicable.
Sound Level Meters: All Calibration procedures were carried out by subsitituting the microphone capsule with a suitable electrical signal, apart from the final acoustic calibration.

Calibration Traceability

The equipment detailed above was calibrated against the calibration laboratory standards held by Cirrus Research plc. These are traceable to International Standards {A.0.6}. The standards are:

Microphone Type	B&K 4192	Serial Number	19207921	Calibration Ref.	S6450
Pistonphone Type	B&K 4220	Serial Number	613843	Calibration Ref.	S6388

Calibrated by T. A. Goodhill

Calibration Date	14 April 2015
Calibration Certificate Number	227734

This Calibration Certificate is valid for 12 months from the date above.

Cirrus Research plc, Acoustic House, Bridlington Road, Hunmanby, North Yorkshire, YO14 0PH
Telephone: +44 (0) 1723 891655 Fax: +44 (0) 1723 891742
Email: sales@cirrusresearch.co.uk

Certificate of Calibration

Cirrus Research plc
dedicated to noise measurement

Certificate Number: **101656**
Date of Issue: **14 April 2015**

Instrument

Manufacturer:	**Cirrus Research plc**	Type:	**Acoustic Calibrator**
Model Number:	**CR:515**	Serial Number:	**55191**

Calibration Procedure

The sound calibrator detailed above has been calibrated to the published data as described in the operating manual and in the half-inch configuration. The procedures and techniques used are as described in IEC 60942:2003 Annex B – Periodic Tests and three determinations of the sound pressure level, frequency and total distortion were made.

The sound pressure level was measured using a WS2F condenser microphone type MK:224 manufactured by Cirrus Research plc.

The results have been corrected to the reference pressure of 101.33 kPa using the manufacturer's data.

Date of Calibration: **13 April 2015**

Calibration Results

Measurement	Level (dB)	Frequency (Hz)	Distortion (% THD + Noise)
1	93.95	1000.1	0.33
2	93.96	1000.1	0.29
3	93.97	1000.1	0.31

Average	**93.96**	**1000.1**	**0.31**
Uncertainty	± 0.13	± 0.1	± 0.10

The reported uncertainties of measurement are expanded by a coverage factor of k=2, providing a 95% confidence level.

Cirrus Research plc, Acoustic House, Bridlington Road
Hunmanby, North Yorkshire, YO14 0PH, United Kingdom
Telephone: 0845 230 2434 **Int**: +44 1723 891655
Email: sales@cirrusresearch.co.uk
Web: www.cirrusresearch.co.uk
UK Registration No. 987160

bsi. ISO 9001 Quality Management FM 531001 ISO 14001 Environmental Management EMS 552104

Cirrus Research plc

Calibration Chart for Electret Microphone

Type: MK:224 **Serial No.:** 204016A

Open Circuit Sensitivity at 1kHz:

-26.3 dB rel.1V/Pa

48.7 mV/Pa

Conditions of Tests:

Barometric Pressure	1027 mBar
Relative Humidity	34 %
Temperature	21 °C

Signature: **Date:** 19/03/2015

Cirrus Research plc
Acoustic House, Hunmanby YO14 0PH UK
www.cirrusresearch.co.uk

Specifications:

Outside Diameter:

13.2mm with protecting grid

12.7mm without protecting grid

Mounting Thread:

11.7mm 60 UNS 2

Ambient Pressure Coefficient:

-0.02 to +0.02 dB/kPa for

±10% pressure change at 250Hz

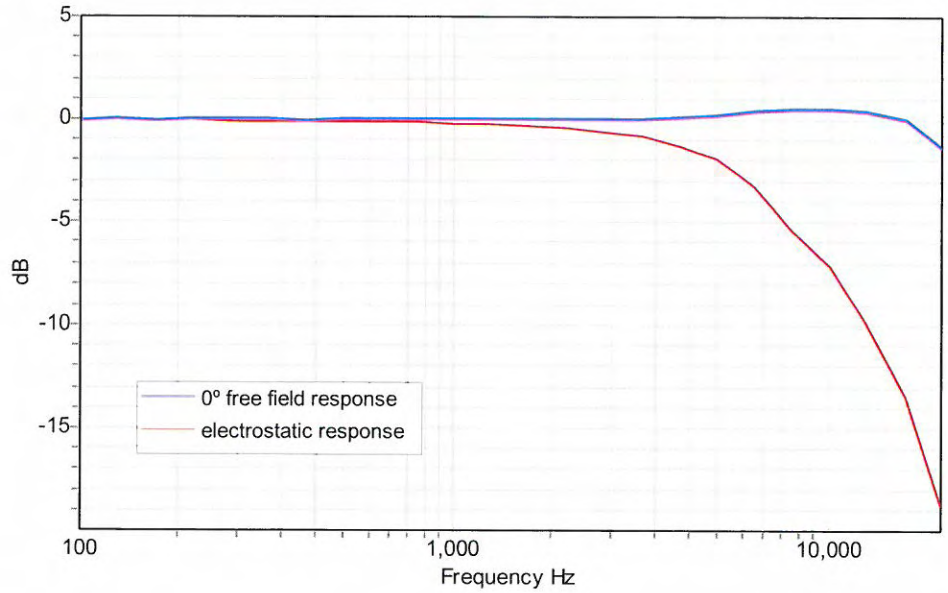
Temperature Coefficient:

-10°C to +50°C

Approx. -0.015dB/k at 250Hz

Dynamic Range:

SPL below which total harmonic distortion is <1%: 130dB



Attachment 4 Photo-log



Plate 1: North of Site on Jetty (B1 Monitoring Location)



Plate 2: Northeast of Facility close to Cooling Towers (B2 Monitoring Location)



Plate 3: South of Facility Security Gates (B3 Monitoring Location)



Plate 4: South of Facility close to car-park for Nature Trail (B4 Monitoring Location)



Plate 5: Northwest of Bauxite Residue Disposal Area (BRDA) (B5 Monitoring Location)



Plate 4: Along Side Access Road, west of main facility (B6 Monitoring Location)



Plate 7: Southwest of the BRDA (B7 Monitoring Location)



Plate 8: South of the BRDA Phase II area (B8 Monitoring Location)



Plate 9: Southeast of the BRDA (B9 Monitoring Location)



Plate 10: Poulaweela Creek , east of facility (NSL1 Monitoring Location)



Plate 11: Southeast of Facility on Local Road (NSL2 Monitoring Location)



Plate 11: Local Road near farm house in Townsland of Oola, South of Facility (NSL3 Monitoring Location)



Plate 13: East of Foynes Port and southwest of main facility (NSL4 Monitoring Location)



Plate 12: Local road junction south of main facility and close to residential properties (NSL5 Monitoring Location)

Attachment 5 Noise Monitoring Report Sheets

Cirrus Research plc

Measurement Summary Report

Name	B1 Day 1
Time	09/10/2015 10:00:45
Duration	00:15:00
Instrument	GO56143, CR:171B

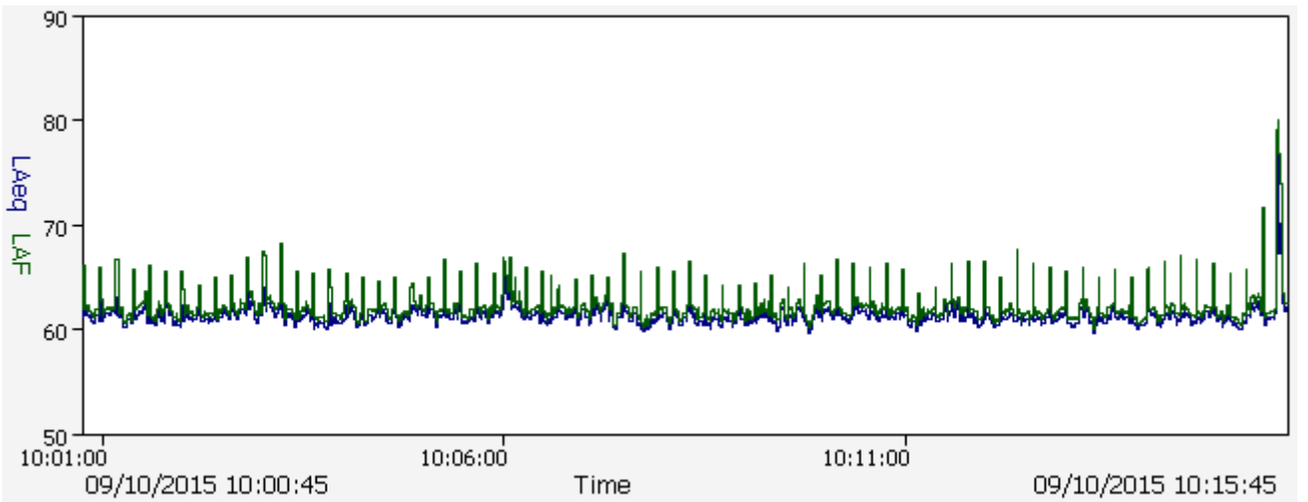
Summary

LAeq	61.6 dB
LAE	91.2 dB
LAFMax	80.1 dB

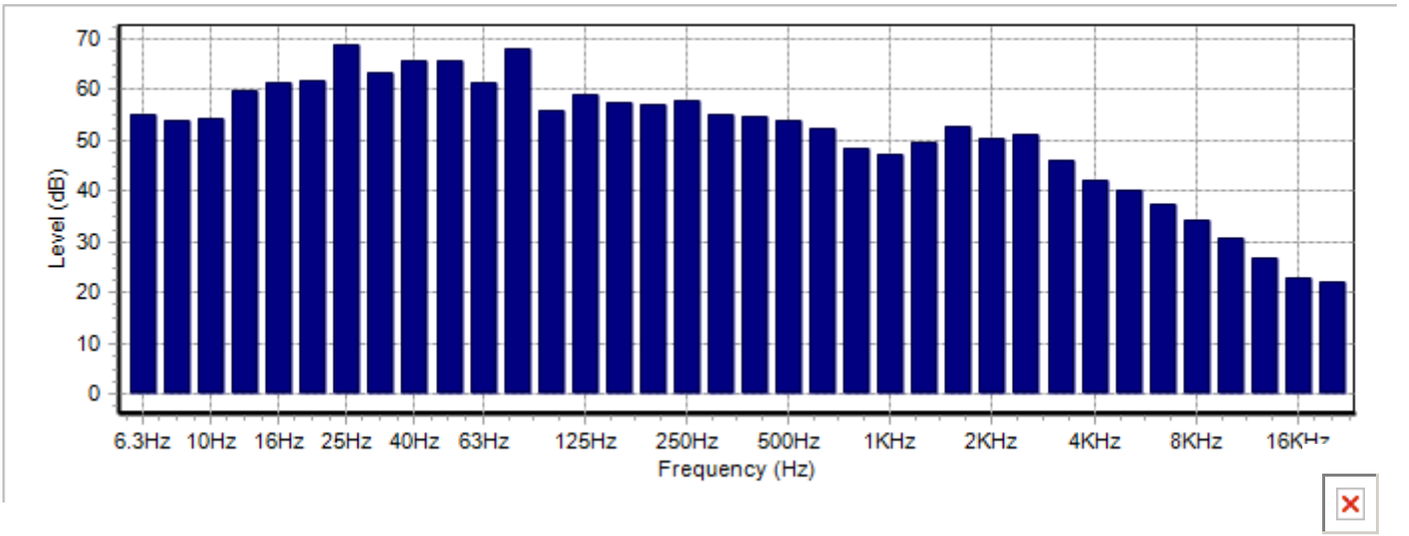
LAF1	65.3 dB
LAF5	62.6 dB
LAF10	62.0 dB
LAF50	61.1 dB
LAF90	60.3 dB
LAF95	60.1 dB
LAF99	59.7 dB

Calibration Information	Person	Place	Project
09/10/2015 09:25:51 -0.51 dB	Gareth Carroll	Rusal Aughinish	1017_37
09/10/2015 12:31:39 -0.34 dB	Graduate Environmental Co...		

Time History



Frequency Bands



Cirrus Research plc

Measurement Summary Report

Name	B1 Day 2
Time	09/10/2015 10:16:21
Duration	00:15:00
Instrument	GO56143, CR:171B

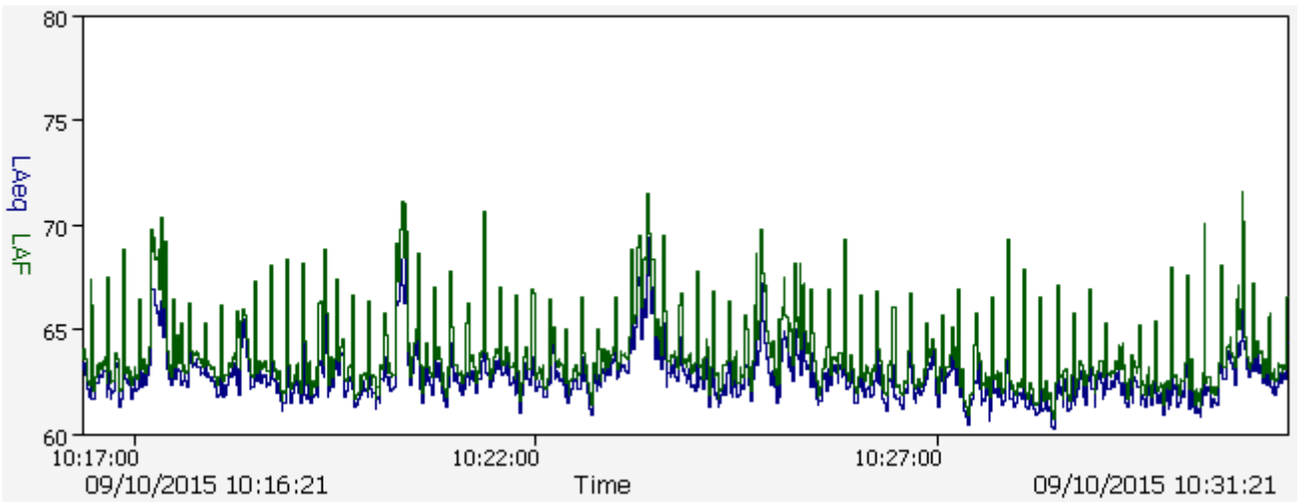
Summary

LAeq	62.9 dB
LAE	92.4 dB
LAFMax	71.6 dB

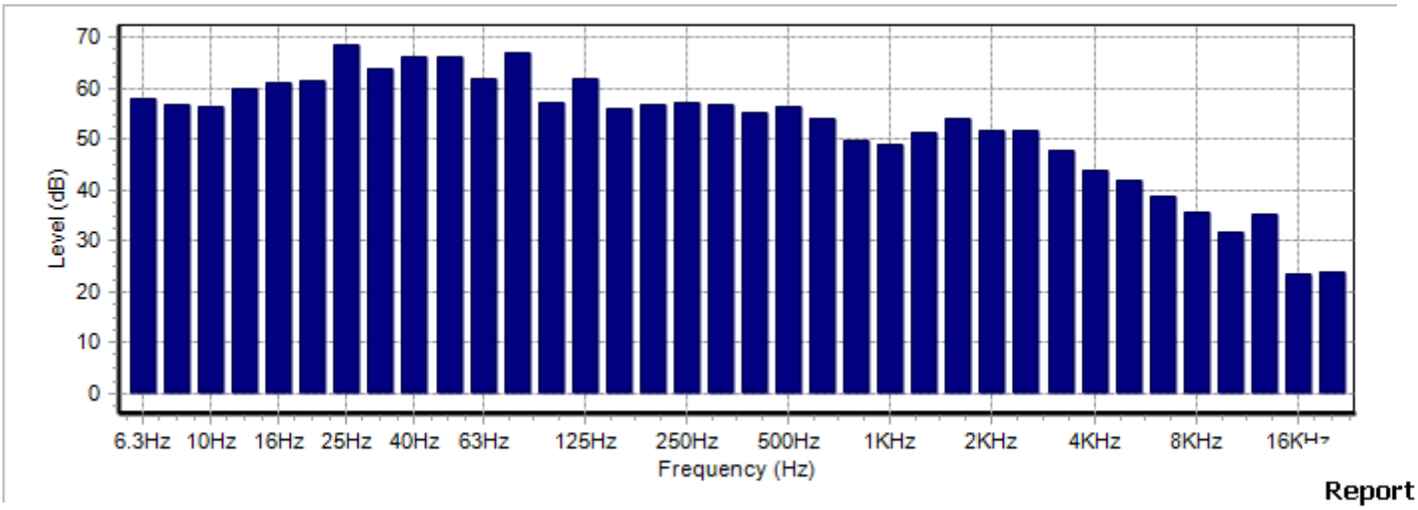
LAF1	67.9 dB
LAF5	65.2 dB
LAF10	63.9 dB
LAF50	62.4 dB
LAF90	61.4 dB
LAF95	61.1 dB
LAF99	60.7 dB

Calibration Information	Person	Place	Project
09/10/2015 09:25:51 -0.51 dB	Gareth Carroll	Rusal Aughinish	1017_37
09/10/2015 12:31:39 -0.34 dB	Graduate Environmental Co...		

Time History



Frequency Bands



Report ID

Cirrus Research plc

Measurement Summary Report

Name	B1 Day 3
Time	09/10/2015 10:31:26
Duration	00:15:00
Instrument	GO56143, CR:171B

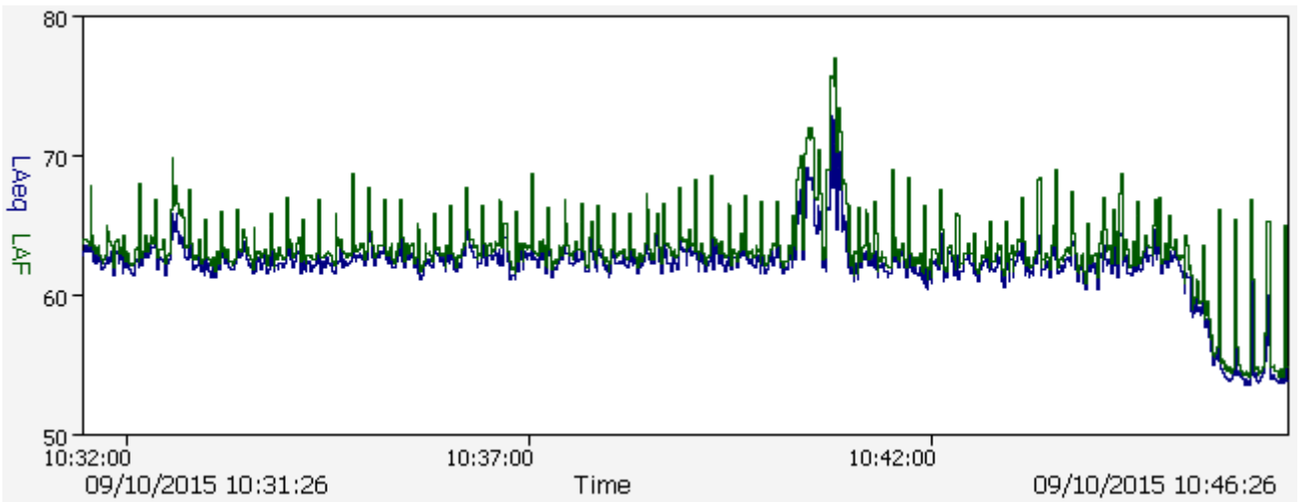
Summary

LAeq	62.6 dB
LAE	92.1 dB
LAFMax	77.0 dB

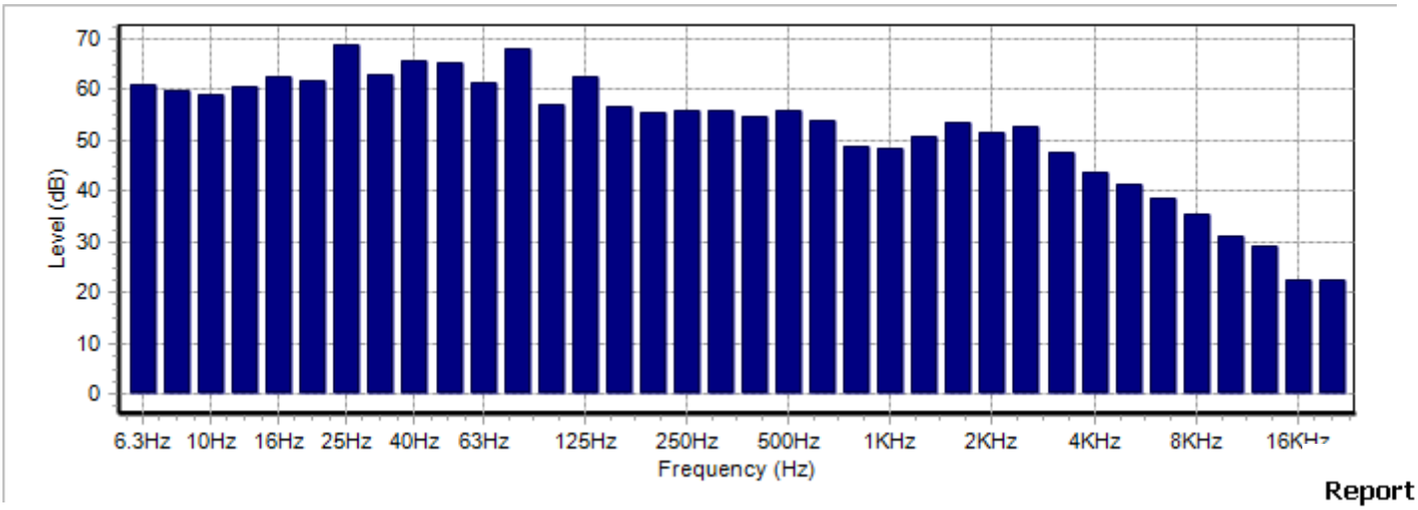
LAF1	68.4 dB
LAF5	64.5 dB
LAF10	63.4 dB
LAF50	62.2 dB
LAF90	60.8 dB
LAF95	54.8 dB
LAF99	53.7 dB

Calibration Information	Person	Place	Project
09/10/2015 09:25:51 -0.51 dB	Gareth Carroll	Rusal Aughinish	1017_37
09/10/2015 12:31:39 -0.34 dB	Graduate Environmental Co...		

Time History



Frequency Bands



Report ID

Cirrus Research plc

Measurement Summary Report

Name	B1 Evening 1
Time	12/10/2015 19:53:53
Duration	00:15:00
Instrument	GO56143, CR:171B

Summary

LAeq	54.2 dB
LAE	83.8 dB
LAFMax	74.6 dB

LAF1	61.5 dB
LAF5	58.0 dB
LAF10	55.1 dB
LAF50	52.6 dB
LAF90	51.5 dB
LAF95	51.2 dB
LAF99	50.7 dB

Calibration Information

12/10/2015 18:52:37 -0.26 dB

12/10/2015 20:40:27 -0.36 dB

Person

Gareth Carroll

Graduate Environmental Co...

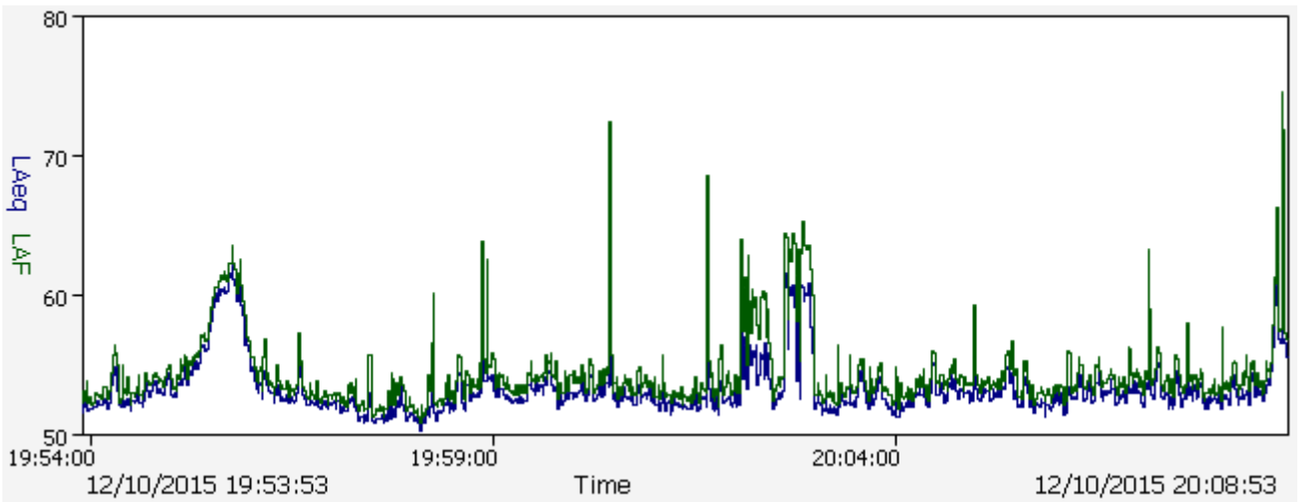
Place

Rusal Aughinish

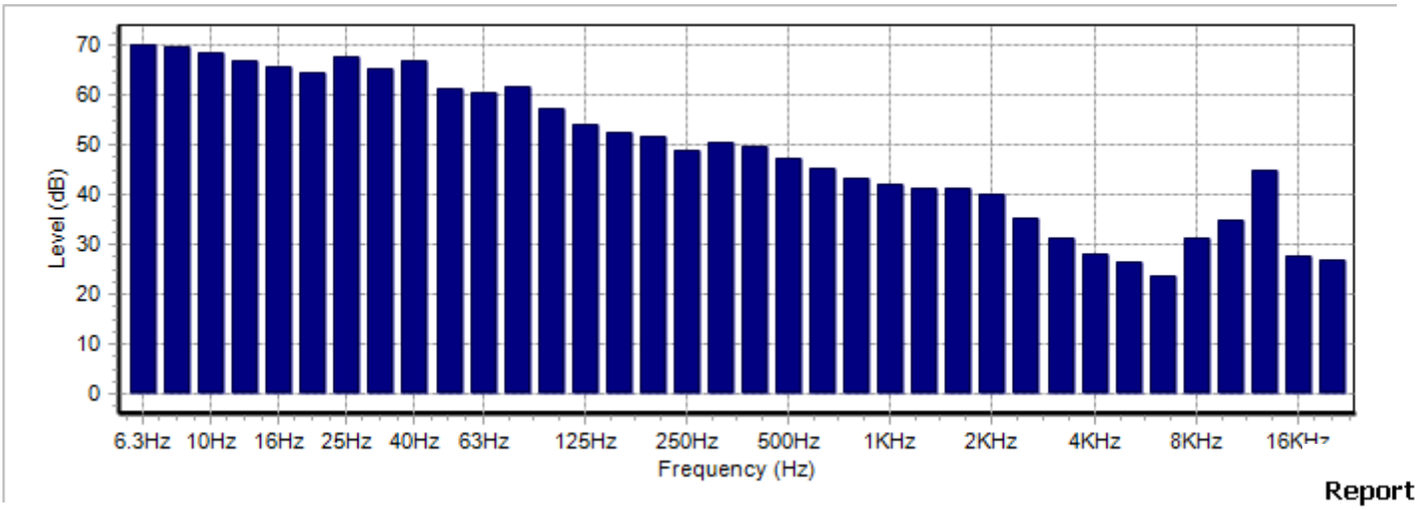
Project

1017_37

Time History



Frequency Bands



Report ID

Cirrus Research plc

Measurement Summary Report

Name	B1 Night 1
Time	13/10/2015 02:04:06
Duration	00:15:09
Instrument	GO56143, CR:171B

Summary

LAeq	59.6 dB
LAE	89.2 dB
LAFMax	87.2 dB

LAF1	67.8 dB
LAF5	62.6 dB
LAF10	59.3 dB
LAF50	54.8 dB
LAF90	54.2 dB
LAF95	54.1 dB
LAF99	53.8 dB

Calibration Information

12/10/2015 22:53:35 -0.34 dB
13/10/2015 10:55:47 -0.80 dB

Person

Gareth Carroll
Graduate Environmental Co...

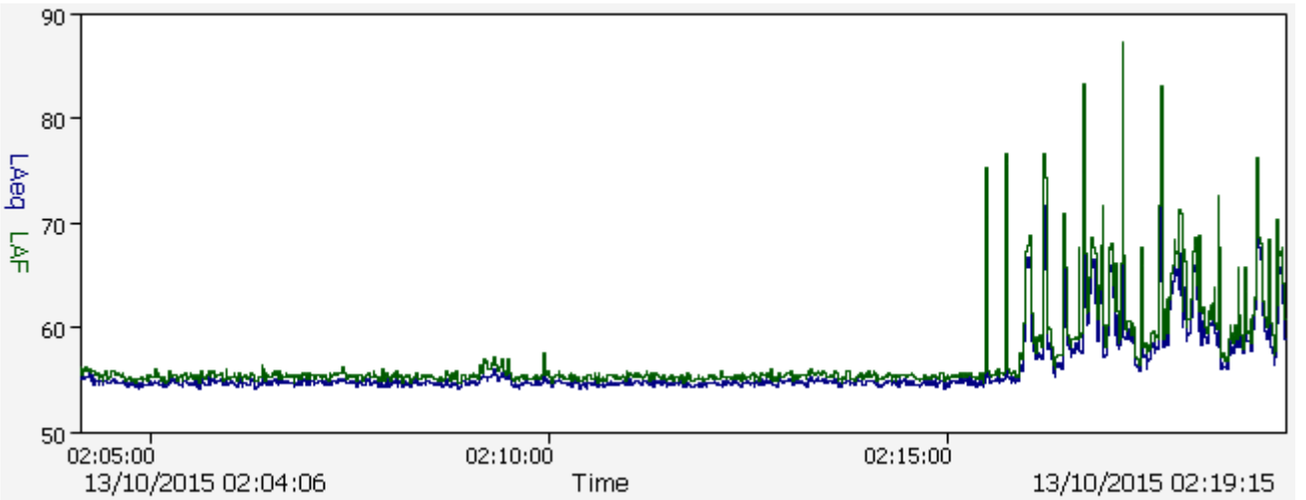
Place

Rusal Aughinish

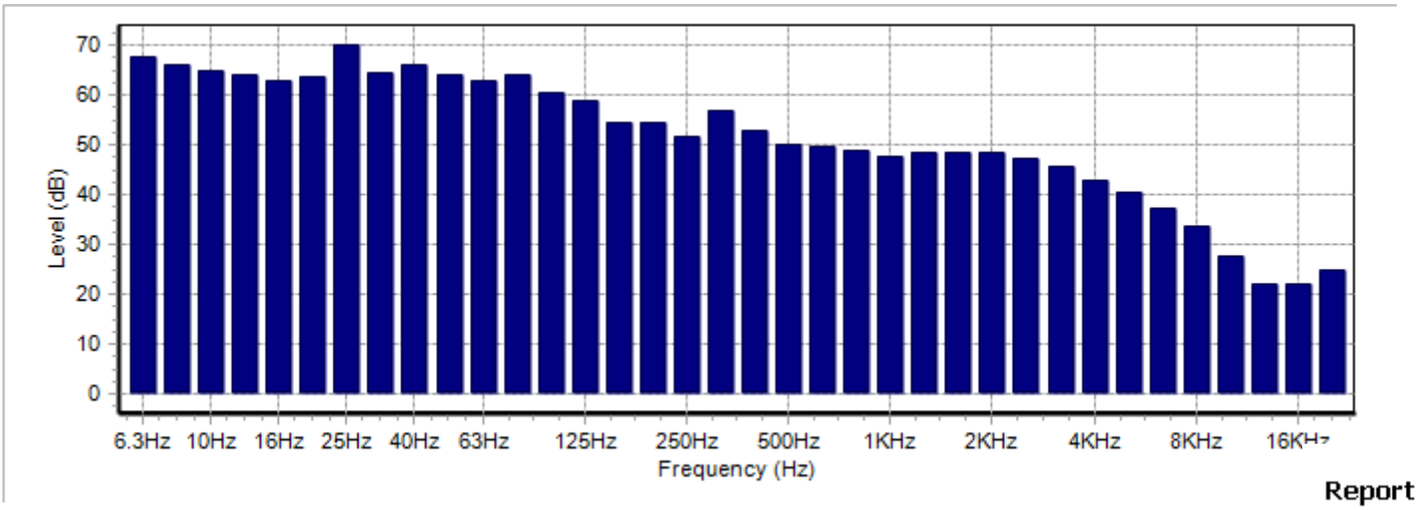
Project

1017_37

Time History



Frequency Bands



Report ID

Cirrus Research plc

Measurement Summary Report

Name	B1 Night 2
Time	13/10/2015 02:19:49
Duration	00:15:00
Instrument	GO56143, CR:171B

Summary

LAeq	64.3 dB
LAE	93.8 dB
LAFMax	85.5 dB

LAF1	74.3 dB
LAF5	67.5 dB
LAF10	65.9 dB
LAF50	59.2 dB
LAF90	56.5 dB
LAF95	55.8 dB
LAF99	55.1 dB

Calibration Information

12/10/2015 22:53:35 -0.34 dB
13/10/2015 10:55:47 -0.80 dB

Person

Gareth Carroll
Graduate Environmental Co...

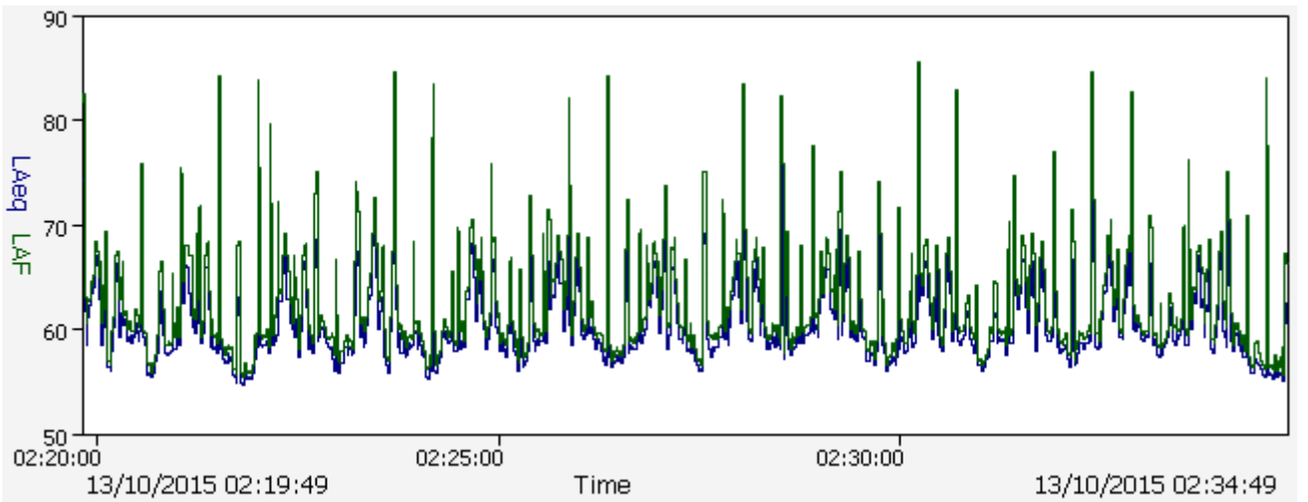
Place

Rusal Aughinish

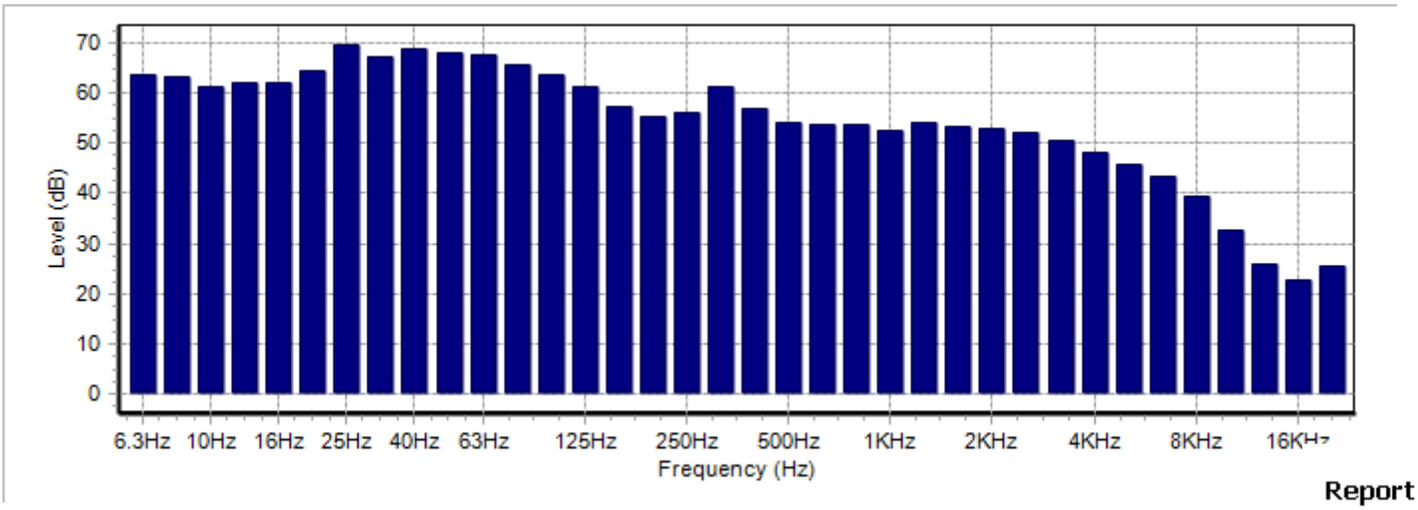
Project

1017_37

Time History



Frequency Bands



Report ID

Cirrus Research plc

Measurement Summary Report

Name	B2 Day 1
Time	08/10/2015 10:10:08
Duration	00:15:00
Instrument	GO56143, CR:171B

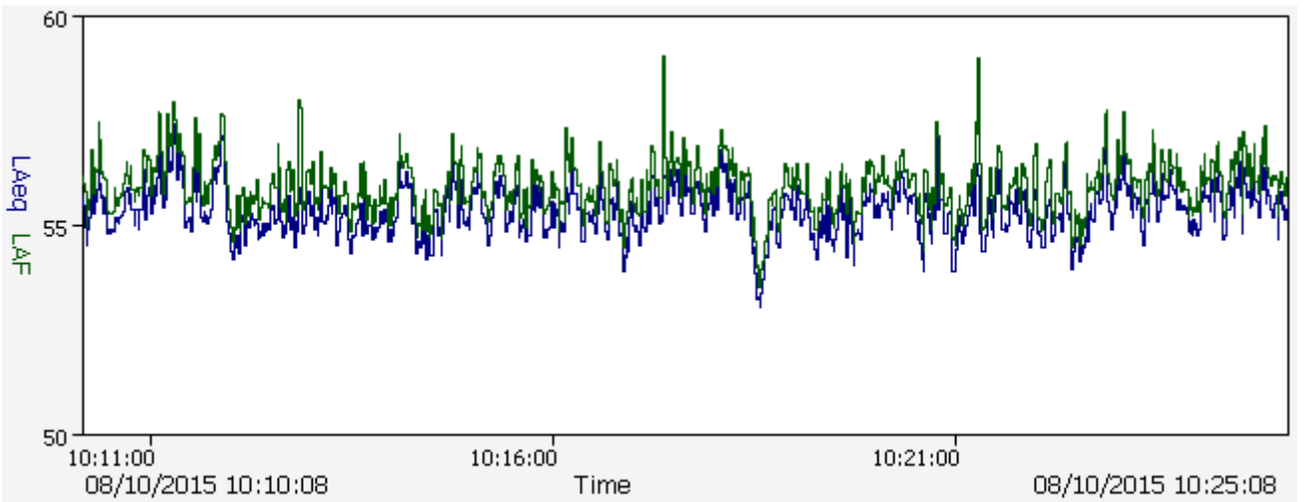
Summary

LAeq	55.4 dB
LAE	84.9 dB
LAFMax	59.0 dB

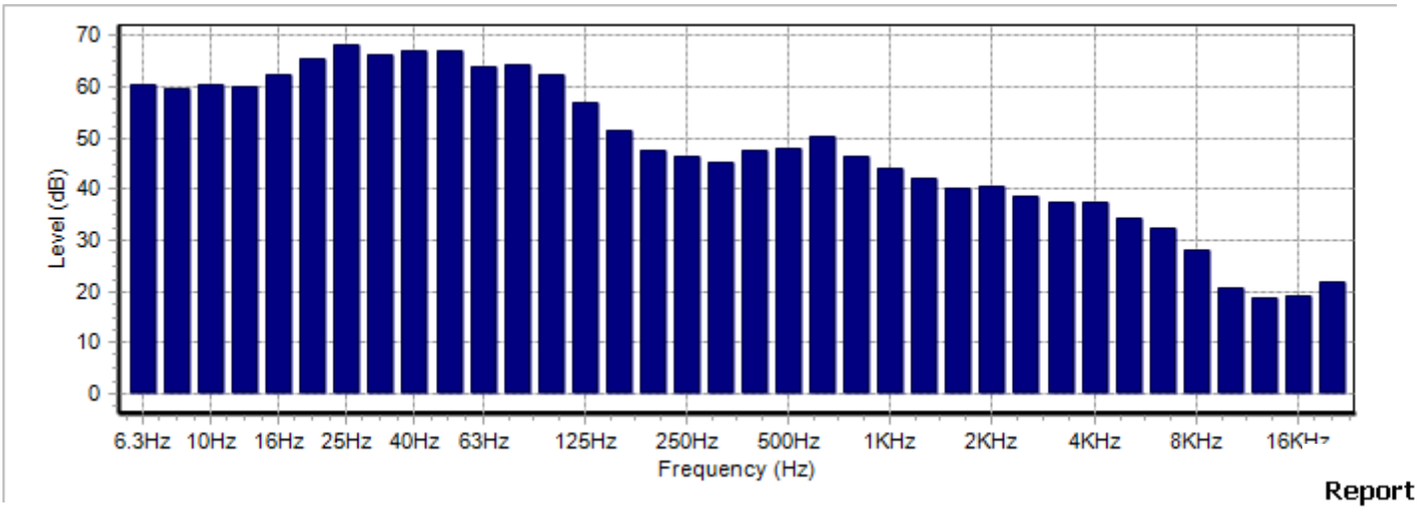
LAF1	56.9 dB
LAF5	56.4 dB
LAF10	56.1 dB
LAF50	55.3 dB
LAF90	54.5 dB
LAF95	54.3 dB
LAF99	53.8 dB

Calibration Information	Person	Place	Project
08/10/2015 10:07:04 -0.55 dB	Gareth Carroll	Rusal Aughinish	1017_37
08/10/2015 11:17:58 -0.34 dB	Graduate Environmental Co...		

Time History



Frequency Bands



Report ID

Cirrus Research plc

Measurement Summary Report

Name	B2 Day 2
Time	08/10/2015 10:25:48
Duration	00:15:00
Instrument	GO56143, CR:171B

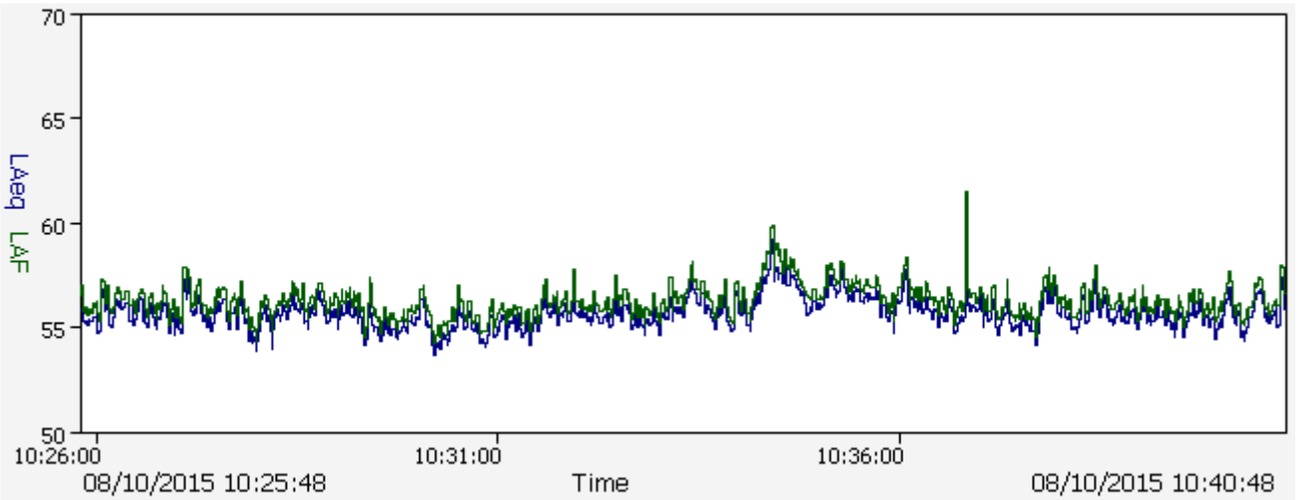
Summary

LAeq	55.7 dB
LAE	85.3 dB
LAFMax	61.5 dB

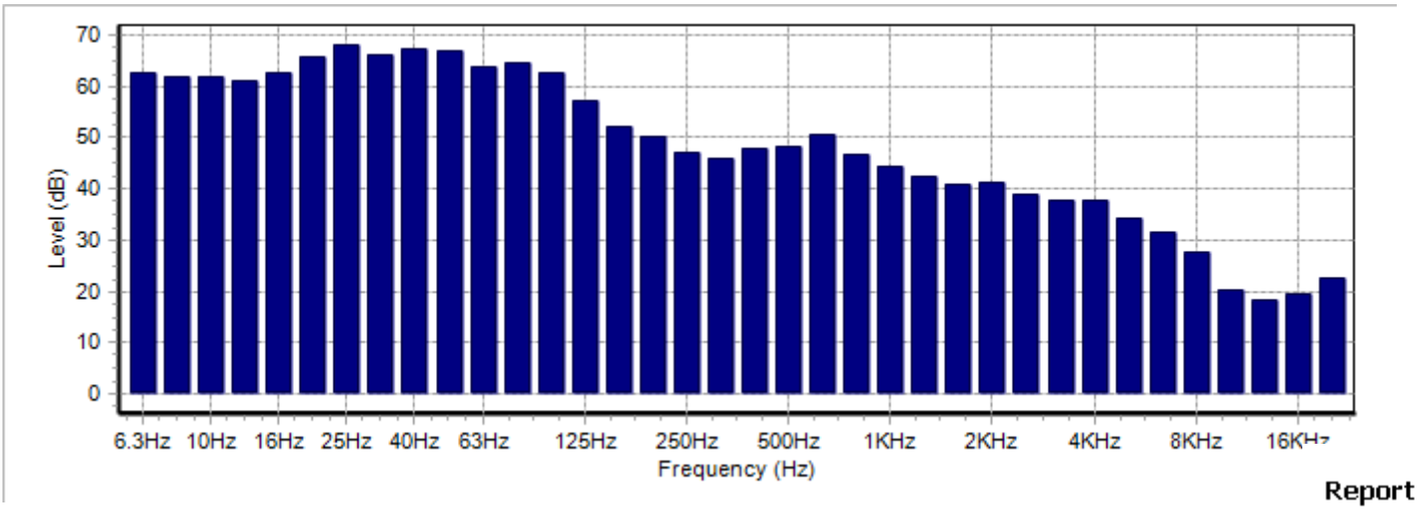
LAF1	57.8 dB
LAF5	57.0 dB
LAF10	56.6 dB
LAF50	55.5 dB
LAF90	54.7 dB
LAF95	54.4 dB
LAF99	54.0 dB

Calibration Information	Person	Place	Project
08/10/2015 10:07:04 -0.55 dB	Gareth Carroll	Rusal Aughinish	1017_37
08/10/2015 11:17:58 -0.34 dB	Graduate Environmental Co...		

Time History



Frequency Bands



Report ID

Cirrus Research plc

Measurement Summary Report

Name	B2 Day 3
Time	08/10/2015 10:40:54
Duration	00:15:00
Instrument	GO56143, CR:171B

Summary

LAeq	55.5 dB
LAE	85.1 dB
LAFMax	60.2 dB

LAF1	57.2 dB
LAF5	56.7 dB
LAF10	56.3 dB
LAF50	55.4 dB
LAF90	54.6 dB
LAF95	54.4 dB
LAF99	54.1 dB

Calibration Information

08/10/2015 10:07:04 -0.55 dB
08/10/2015 11:17:58 -0.34 dB

Person

Gareth Carroll
Graduate Environmental Co...

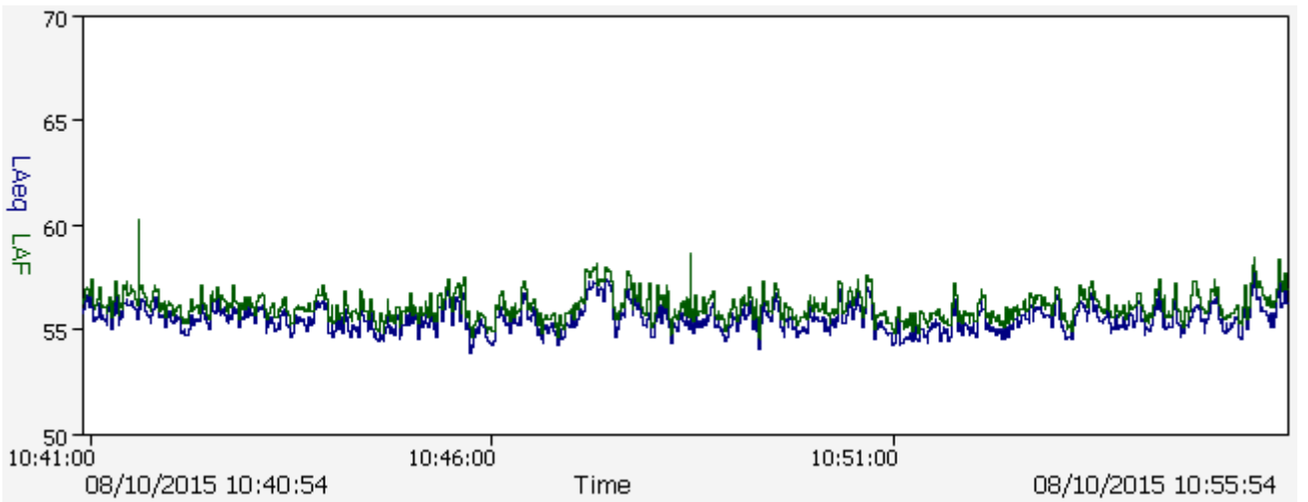
Place

Rusal Aughinish

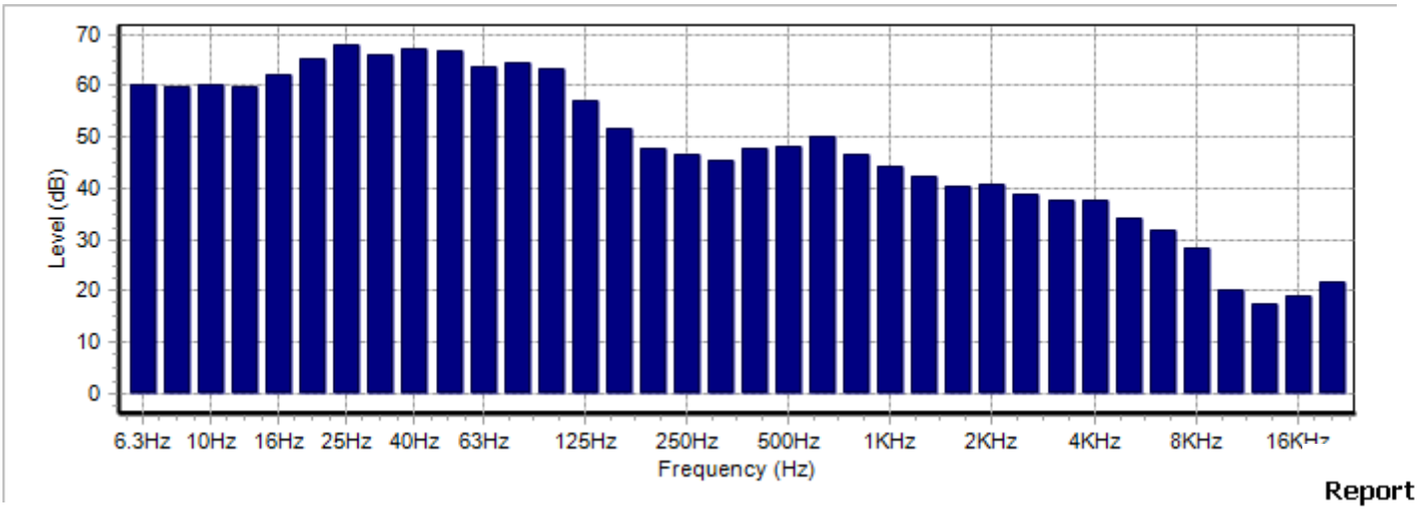
Project

1017_37

Time History



Frequency Bands



Report ID

Cirrus Research plc

Measurement Summary Report

Name	B2 Evening 1
Time	12/10/2015 20:17:12
Duration	00:15:00
Instrument	GO56143, CR:171B

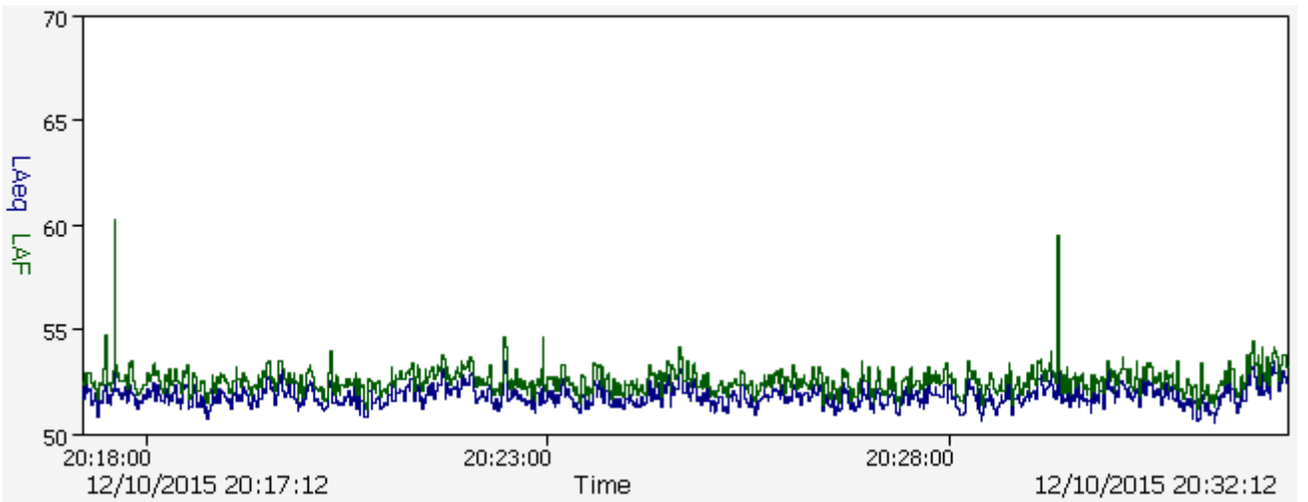
Summary

LAeq	51.8 dB
LAE	81.4 dB
LAFMax	60.2 dB

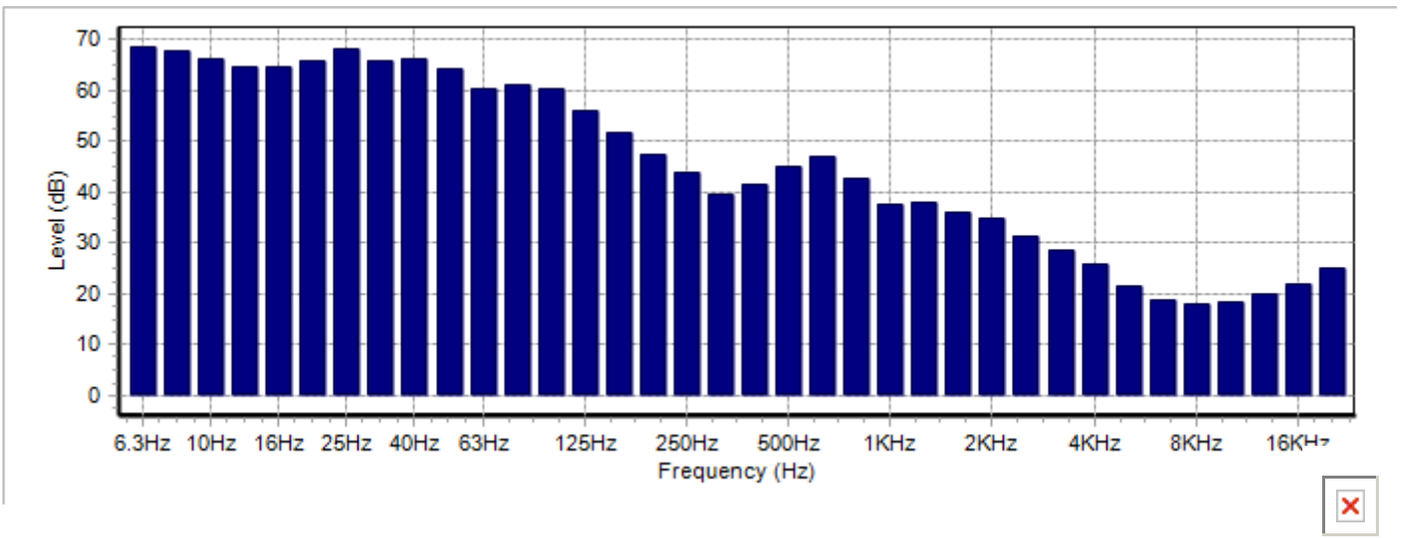
LAF1	53.2 dB
LAF5	52.7 dB
LAF10	52.5 dB
LAF50	51.7 dB
LAF90	51.0 dB
LAF95	50.9 dB
LAF99	50.5 dB

Calibration Information	Person	Place	Project
12/10/2015 18:52:37 -0.26 dB	Gareth Carroll	Rusal Aughinish	1017_37
12/10/2015 20:40:27 -0.36 dB	Graduate Environmental Co...		

Time History



Frequency Bands



Cirrus Research plc

Measurement Summary Report

Name	B2 Night 1
Time	13/10/2015 01:21:09
Duration	00:15:00
Instrument	GO56143, CR:171B

Summary

LAeq	52.7 dB
LAE	82.2 dB
LAFMax	54.7 dB

LAF1	53.8 dB
LAF5	53.4 dB
LAF10	53.2 dB
LAF50	52.6 dB
LAF90	51.9 dB
LAF95	51.7 dB
LAF99	51.4 dB

Calibration Information

12/10/2015 22:53:35 -0.34 dB

13/10/2015 10:55:47 -0.80 dB

Person

Gareth Carroll

Graduate Environmental Co...

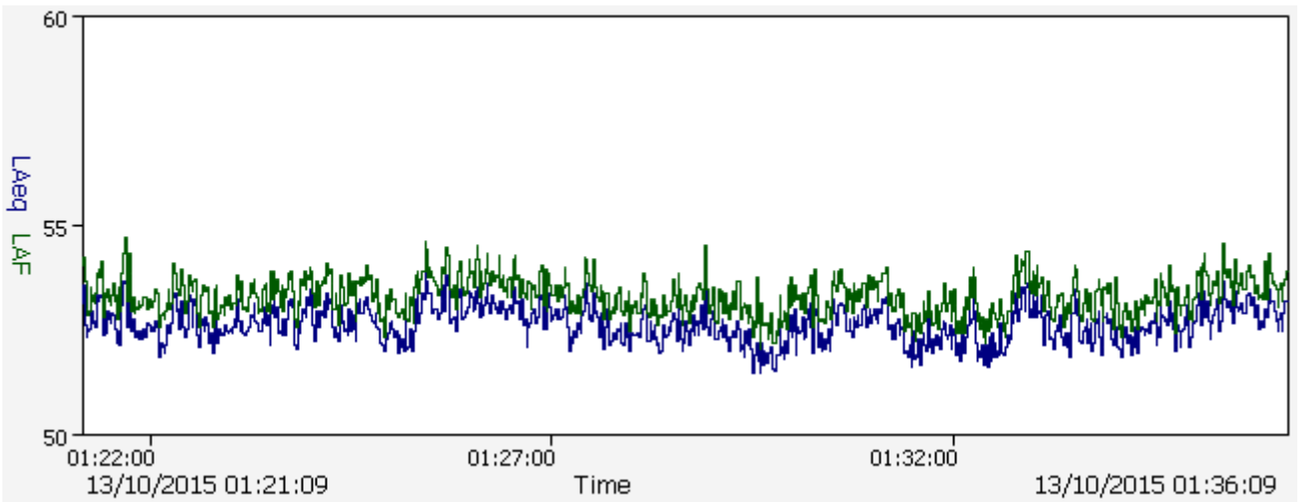
Place

Rusal Aughinish

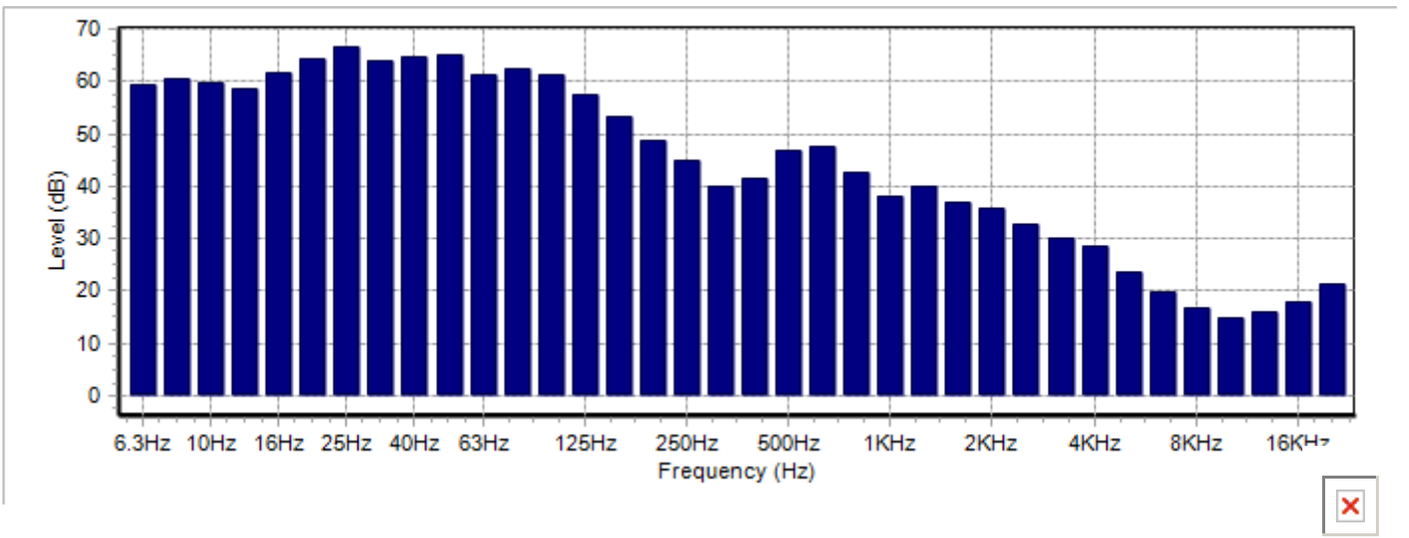
Project

1017_37

Time History



Frequency Bands



Cirrus Research plc

Measurement Summary Report

Name	B2 Night 2
Time	13/10/2015 01:38:40
Duration	00:15:00
Instrument	GO56143, CR:171B

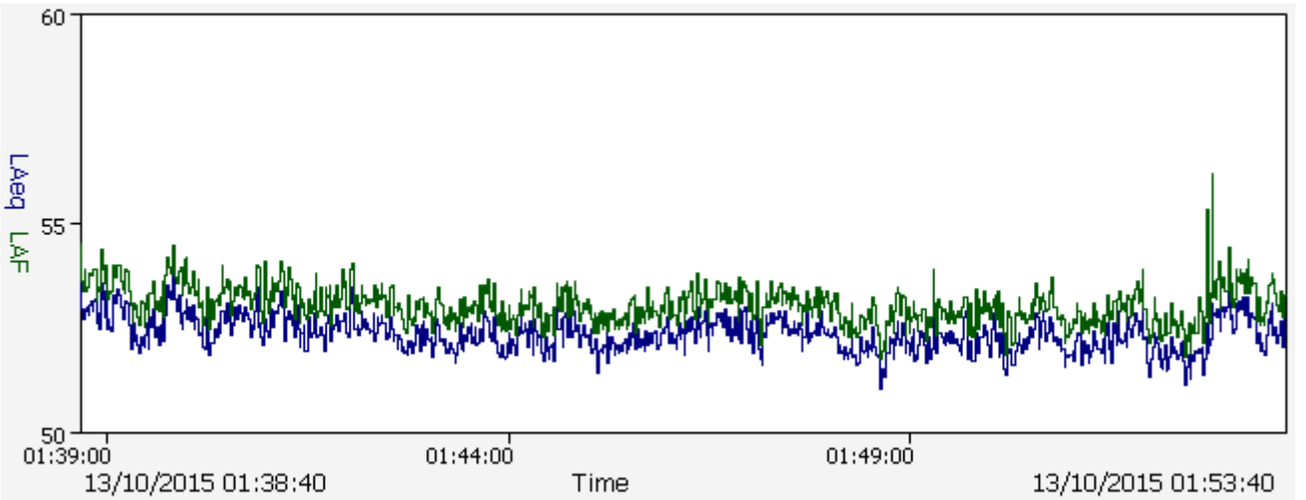
Summary

LAeq	52.4 dB
LAE	81.9 dB
LAFMax	56.2 dB

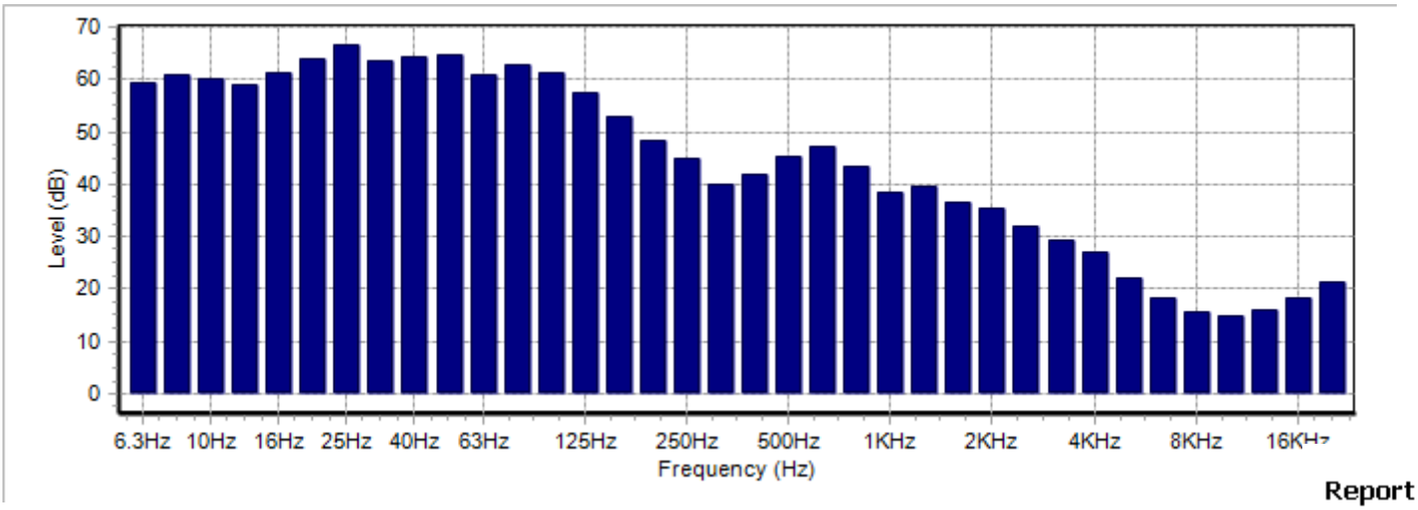
LAF1	53.6 dB
LAF5	53.1 dB
LAF10	52.9 dB
LAF50	52.3 dB
LAF90	51.6 dB
LAF95	51.5 dB
LAF99	51.1 dB

Calibration Information		Person	Place	Project
12/10/2015 22:53:35	-0.34 dB	Gareth Carroll	Rusal Aughinish	1017_37
13/10/2015 10:55:47	-0.80 dB	Graduate Environmental Co...		

Time History



Frequency Bands



Report ID

Cirrus Research plc

Measurement Summary Report

Name	B3 Day 1
Time	13/10/2015 11:55:06
Duration	00:15:00
Instrument	GO56143, CR:171B

Summary

LAeq	59.6 dB
LAE	89.2 dB
LAFMax	72.0 dB

LAF1	65.8 dB
LAF5	63.0 dB
LAF10	61.4 dB
LAF50	58.6 dB
LAF90	57.6 dB
LAF95	57.4 dB
LAF99	57.0 dB

Calibration Information

13/10/2015 10:55:47 -0.80 dB

13/10/2015 12:44:35 -0.44 dB

Person

Gareth Carroll

Graduate Environmental Co...

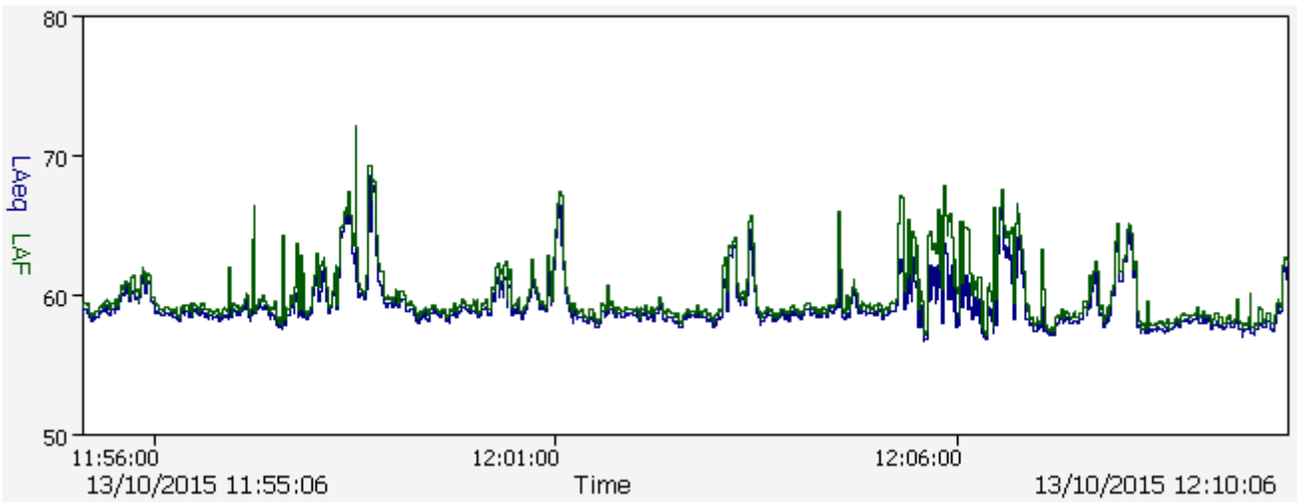
Place

Rusal Aughinish

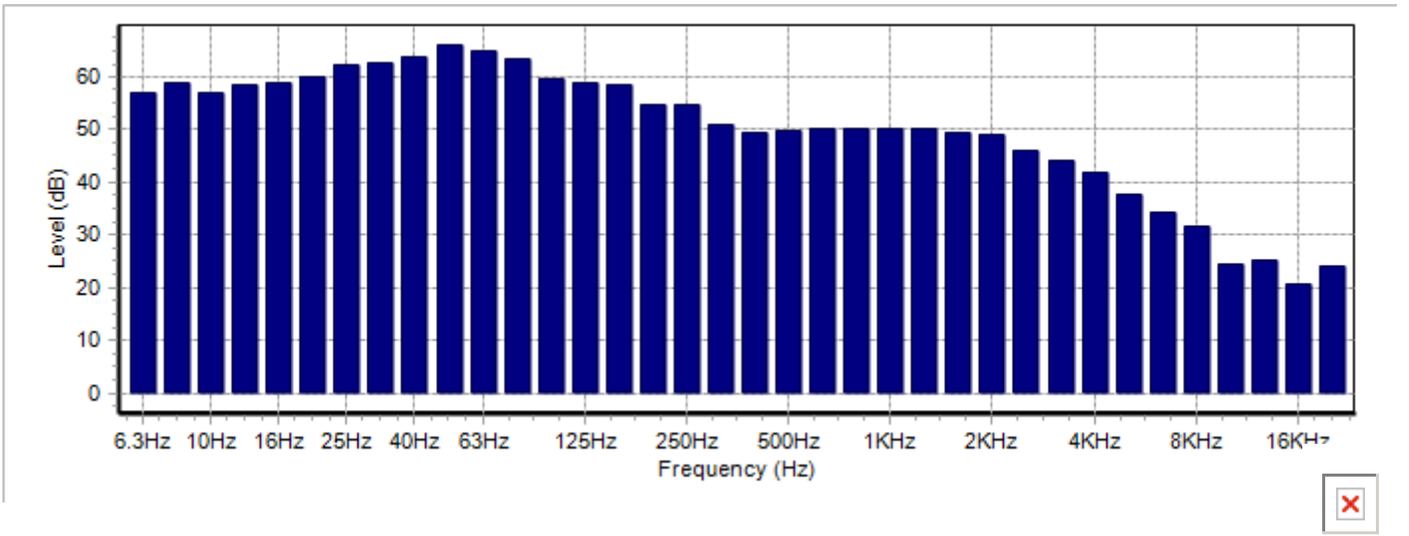
Project

1017_37

Time History



Frequency Bands



Cirrus Research plc

Measurement Summary Report

Name	B3 Day 2
Time	13/10/2015 12:10:16
Duration	00:15:00
Instrument	GO56143, CR:171B

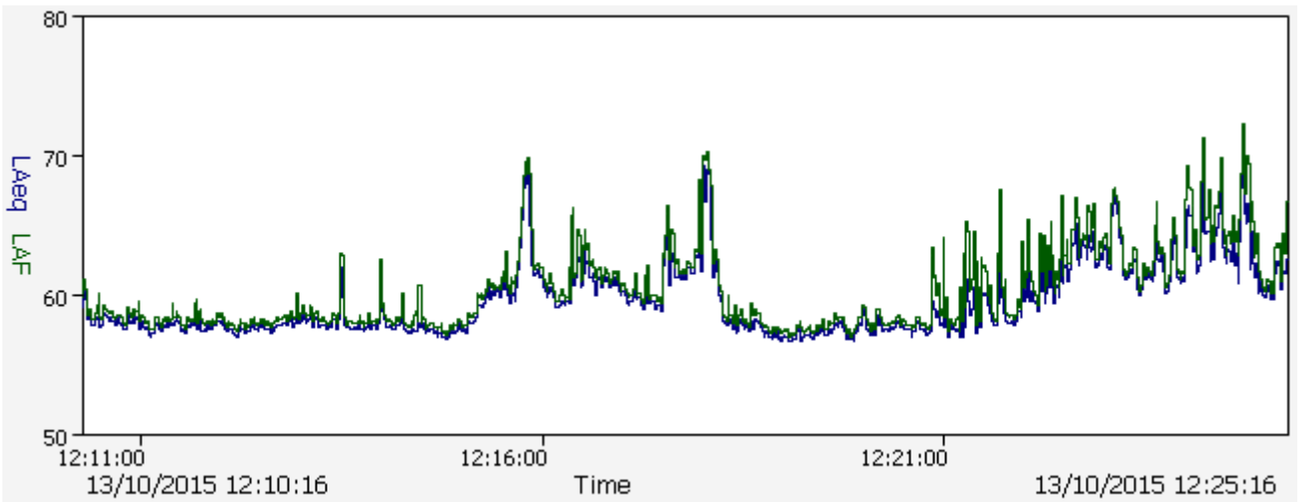
Summary

LAeq	60.5 dB
LAE	90.1 dB
LAFMax	72.3 dB

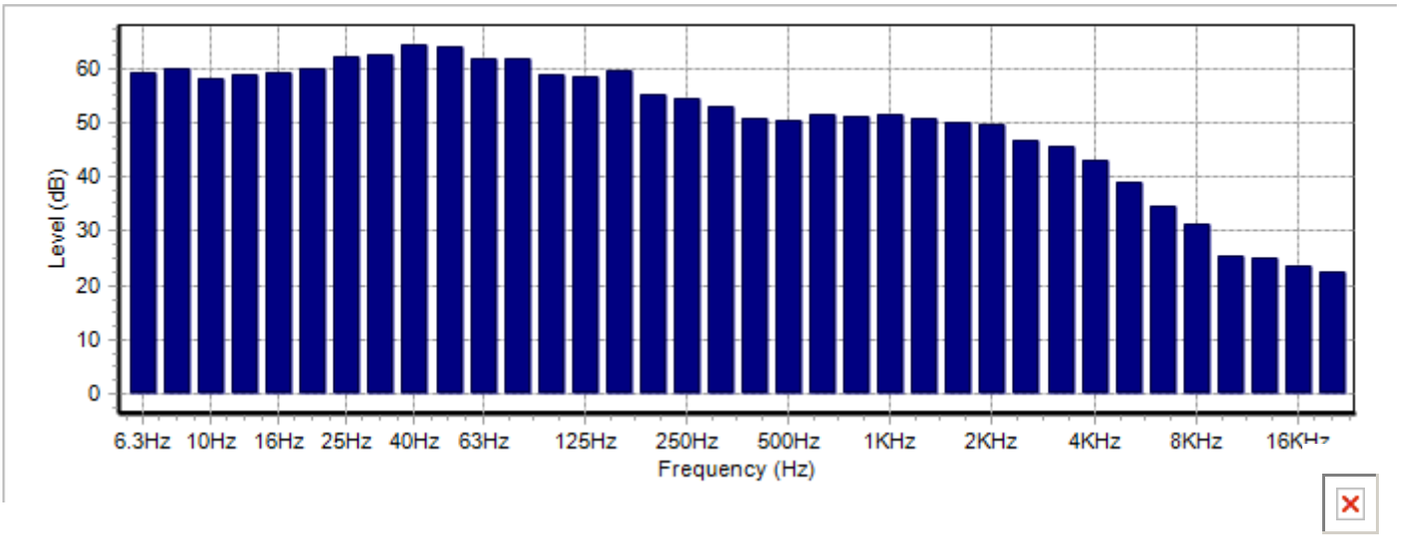
LAF1	68.2 dB
LAF5	64.5 dB
LAF10	62.9 dB
LAF50	58.3 dB
LAF90	57.2 dB
LAF95	56.9 dB
LAF99	56.6 dB

Calibration Information	Person	Place	Project
13/10/2015 10:55:47 -0.80 dB	Gareth Carroll	Rusal Aughinish	1017_37
13/10/2015 12:44:35 -0.44 dB	Graduate Environmental Co...		

Time History



Frequency Bands



Cirrus Research plc

Measurement Summary Report

Name	B3 Day 3
Time	13/10/2015 12:25:22
Duration	00:15:00
Instrument	GO56143, CR:171B

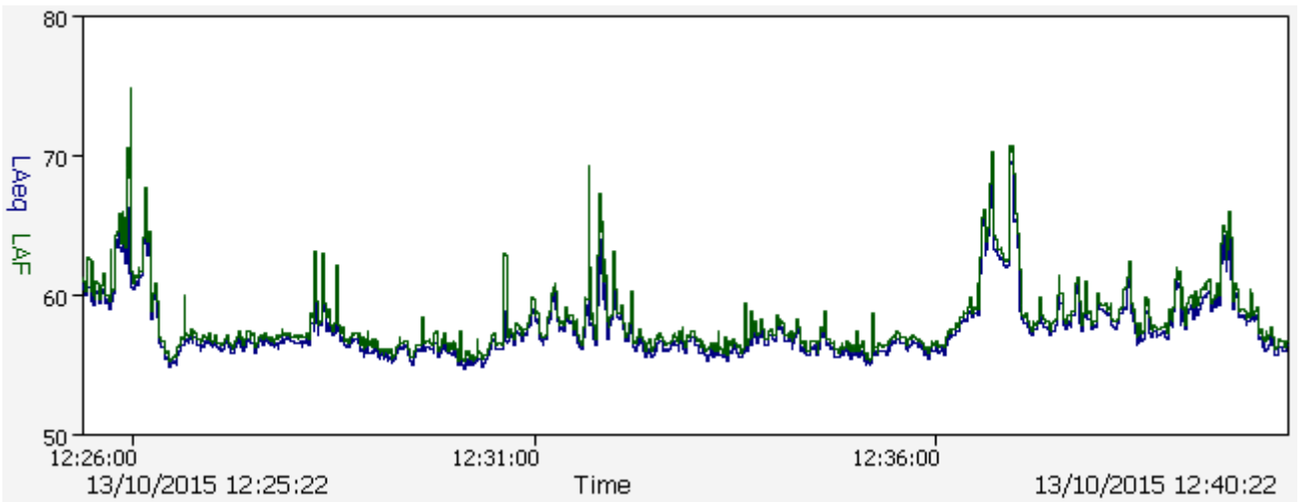
Summary

LAeq	58.4 dB
LAE	88.0 dB
LAFMax	74.8 dB

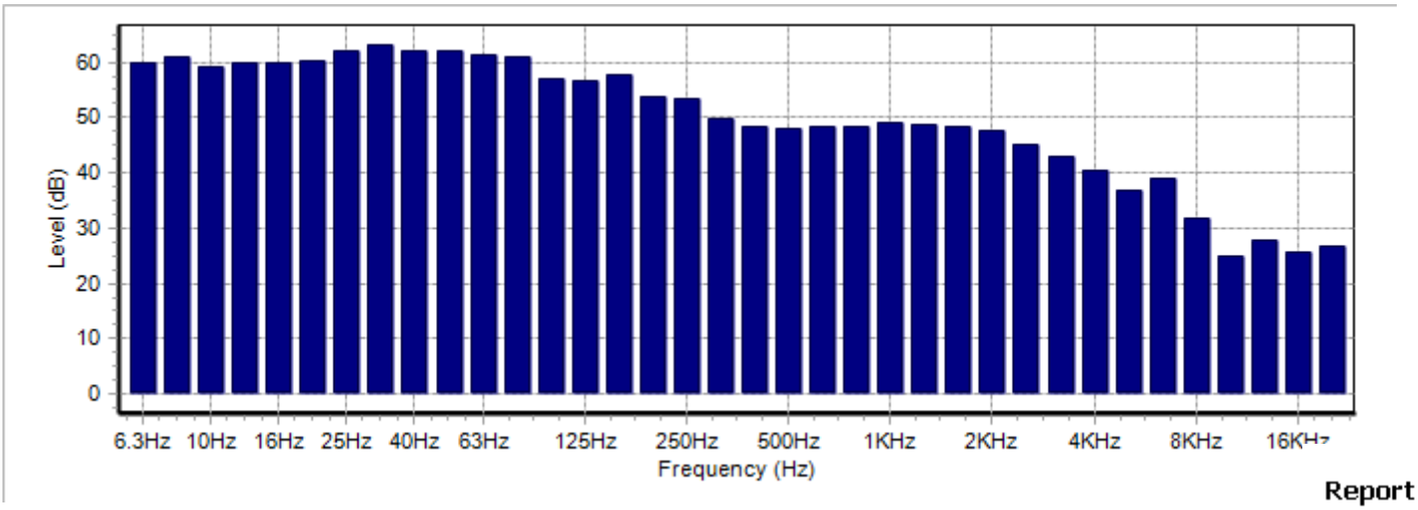
LAF1	65.5 dB
LAF5	62.5 dB
LAF10	60.3 dB
LAF50	56.7 dB
LAF90	55.6 dB
LAF95	55.3 dB
LAF99	54.8 dB

Calibration Information		Person	Place	Project
13/10/2015 10:55:47	-0.80 dB	Gareth Carroll	Rusal Aughinish	1017_37
13/10/2015 12:44:35	-0.44 dB	Graduate Environmental Co...		

Time History



Frequency Bands



Report ID

Cirrus Research plc

Measurement Summary Report

Name	B3 Evening 1
Time	12/10/2015 22:11:31
Duration	00:15:00
Instrument	GO56143, CR:171B

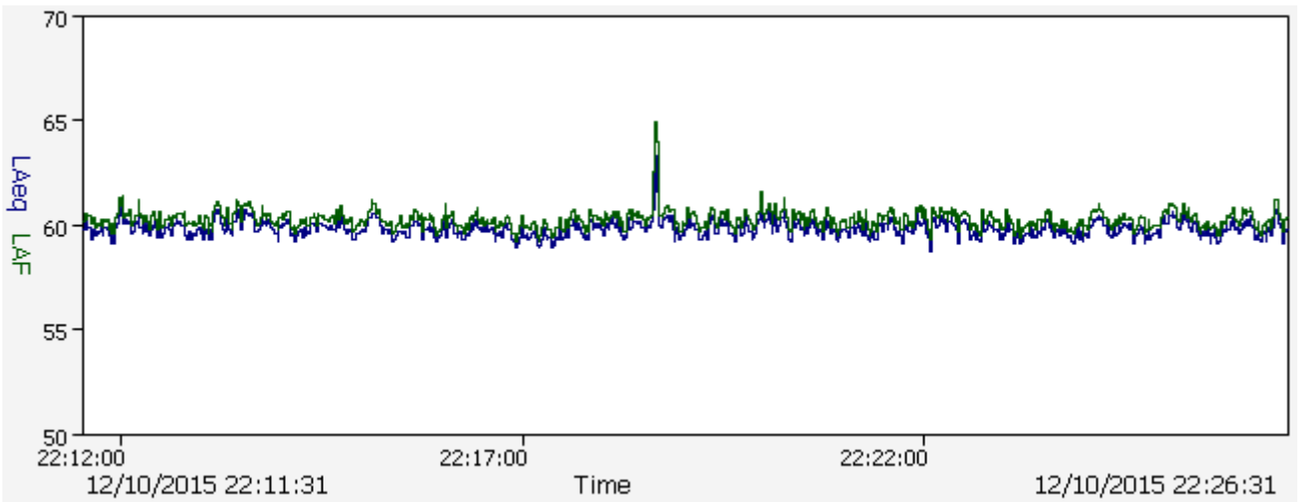
Summary

LAeq	59.8 dB
LAE	89.4 dB
LAFMax	64.9 dB

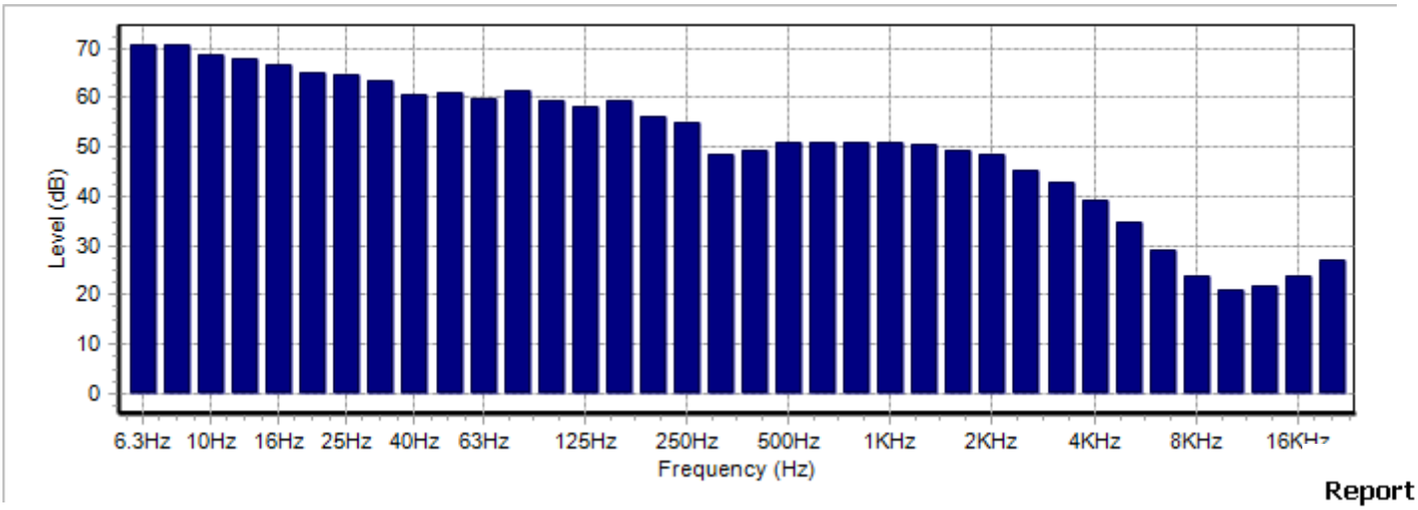
LAF1	60.8 dB
LAF5	60.4 dB
LAF10	60.3 dB
LAF50	59.7 dB
LAF90	59.2 dB
LAF95	59.1 dB
LAF99	58.9 dB

Calibration Information	Person	Place	Project
12/10/2015 20:40:27 -0.36 dB	Gareth Carroll	Rusal Aughinish	1017_37
12/10/2015 22:53:35 -0.34 dB	Graduate Environmental Co...		

Time History



Frequency Bands



Report ID

Cirrus Research plc

Measurement Summary Report

Name	B3 Night 1
Time	13/10/2015 00:45:58
Duration	00:15:00
Instrument	GO56143, CR:171B

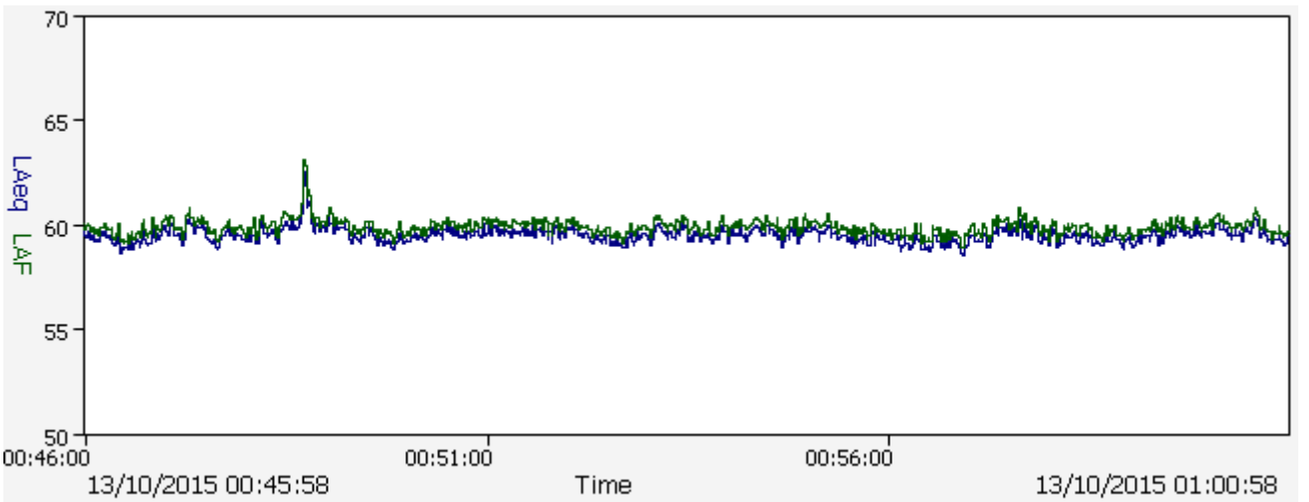
Summary

LAeq	59.5 dB
LAE	89.0 dB
LAFMax	63.1 dB

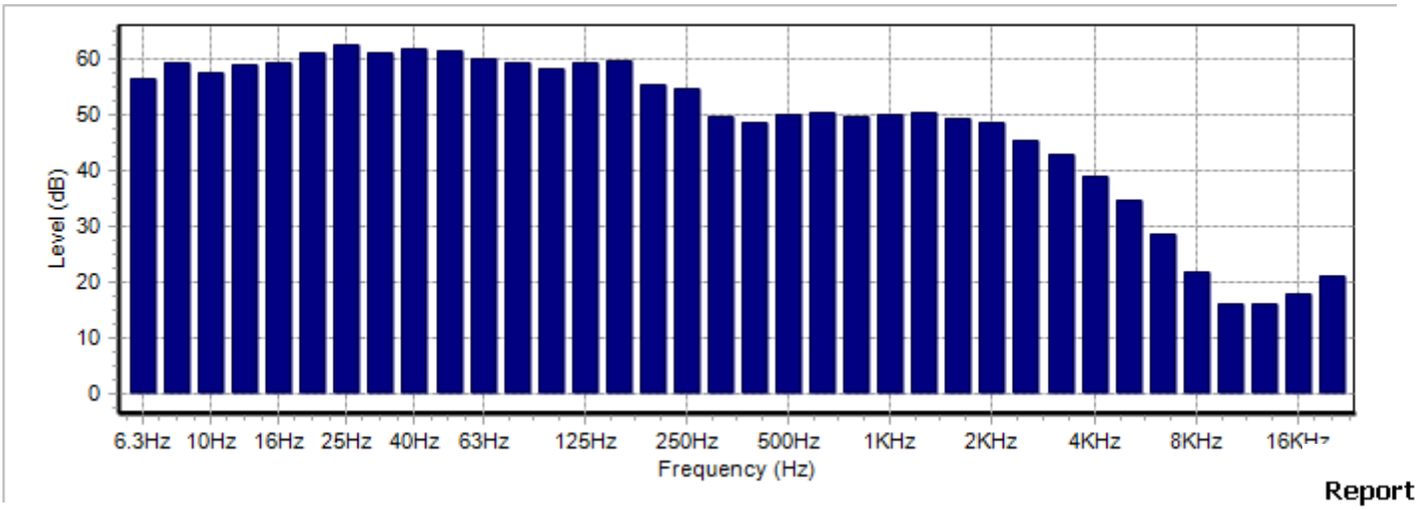
LAF1	60.4 dB
LAF5	60.0 dB
LAF10	59.9 dB
LAF50	59.4 dB
LAF90	59.0 dB
LAF95	58.8 dB
LAF99	58.6 dB

Calibration Information	Person	Place	Project
12/10/2015 22:53:35 -0.34 dB	Gareth Carroll	Rusal Aughinish	1017_37
13/10/2015 10:55:47 -0.80 dB	Graduate Environmental Co...		

Time History



Frequency Bands



Report ID

Cirrus Research plc

Measurement Summary Report

Name	B3 Night 2
Time	13/10/2015 01:01:03
Duration	00:15:00
Instrument	GO56143, CR:171B

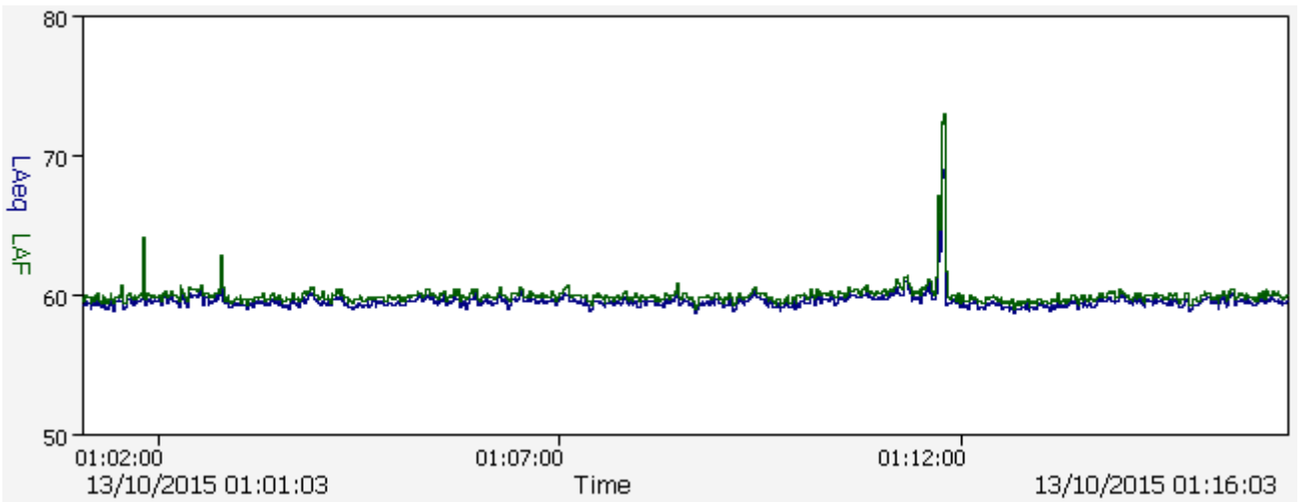
Summary

LAeq	59.6 dB
LAE	89.1 dB
LAFMax	72.9 dB

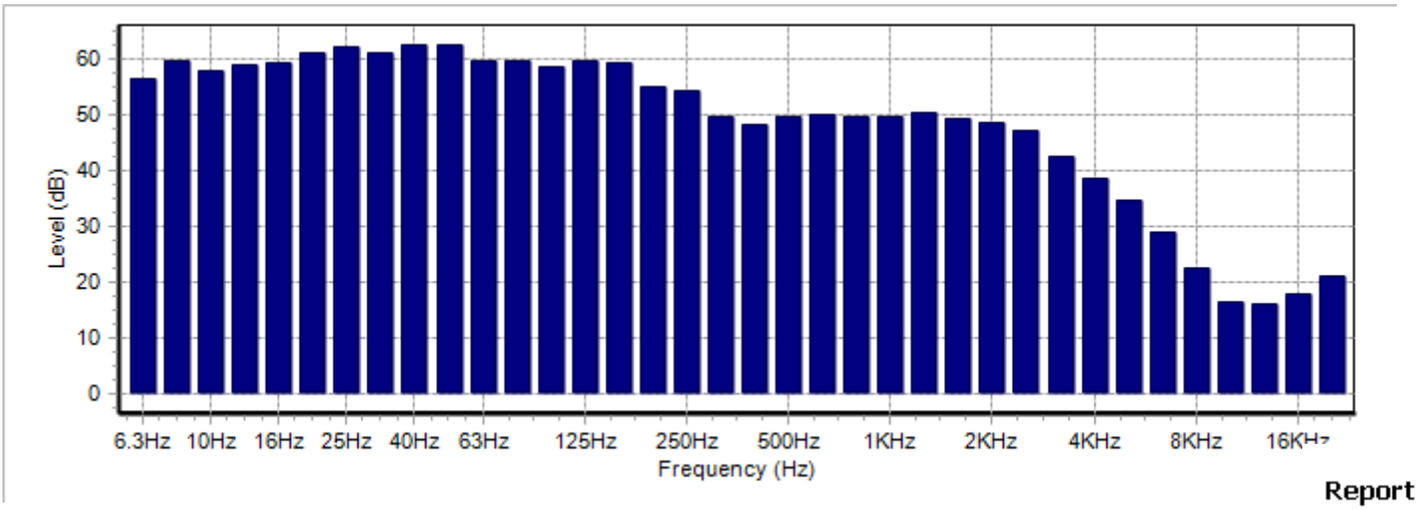
LAF1	60.8 dB
LAF5	60.0 dB
LAF10	59.9 dB
LAF50	59.4 dB
LAF90	59.0 dB
LAF95	58.8 dB
LAF99	58.6 dB

Calibration Information	Person	Place	Project
12/10/2015 22:53:35 -0.34 dB	Gareth Carroll	Rusal Aughinish	1017_37
13/10/2015 10:55:47 -0.80 dB	Graduate Environmental Co...		

Time History



Frequency Bands



Report ID

Cirrus Research plc

Measurement Summary Report

Name	B4 Day 1
Time	08/10/2015 16:42:35
Duration	00:15:00
Instrument	GO56143, CR:171B

Summary

LAeq	49.3 dB
LAE	78.8 dB
LAFMax	66.0 dB

LAF1	60.9 dB
LAF5	57.0 dB
LAF10	53.2 dB
LAF50	40.3 dB
LAF90	33.4 dB
LAF95	32.8 dB
LAF99	32.2 dB

Calibration Information

08/10/2015 16:29:43 -0.25 dB
08/10/2015 18:53:36 -0.14 dB

Person

Gareth Carroll
Graduate Environmental Co...

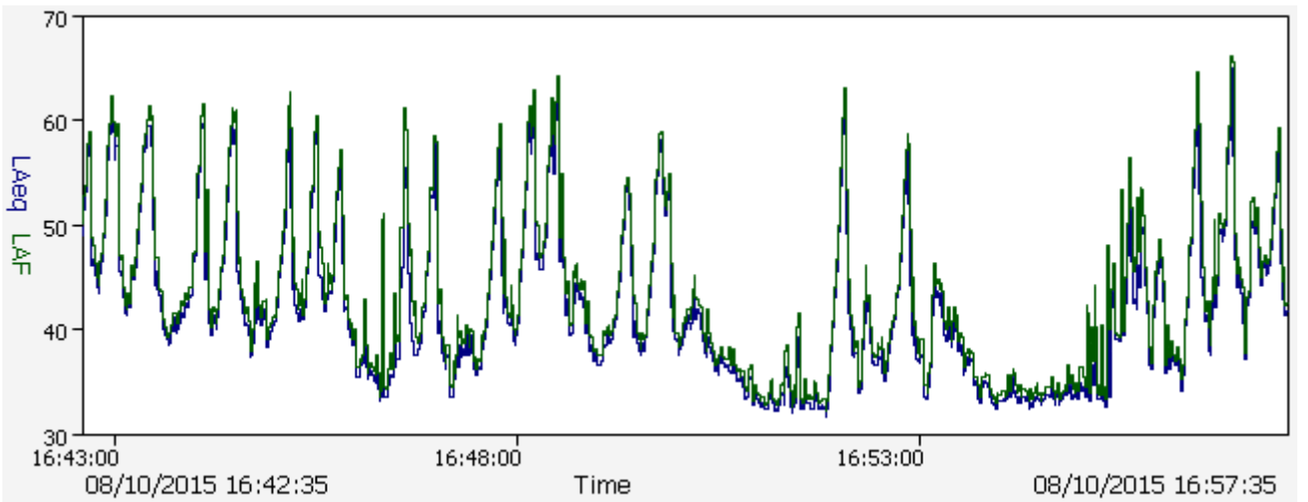
Place

Rusal Aughinish

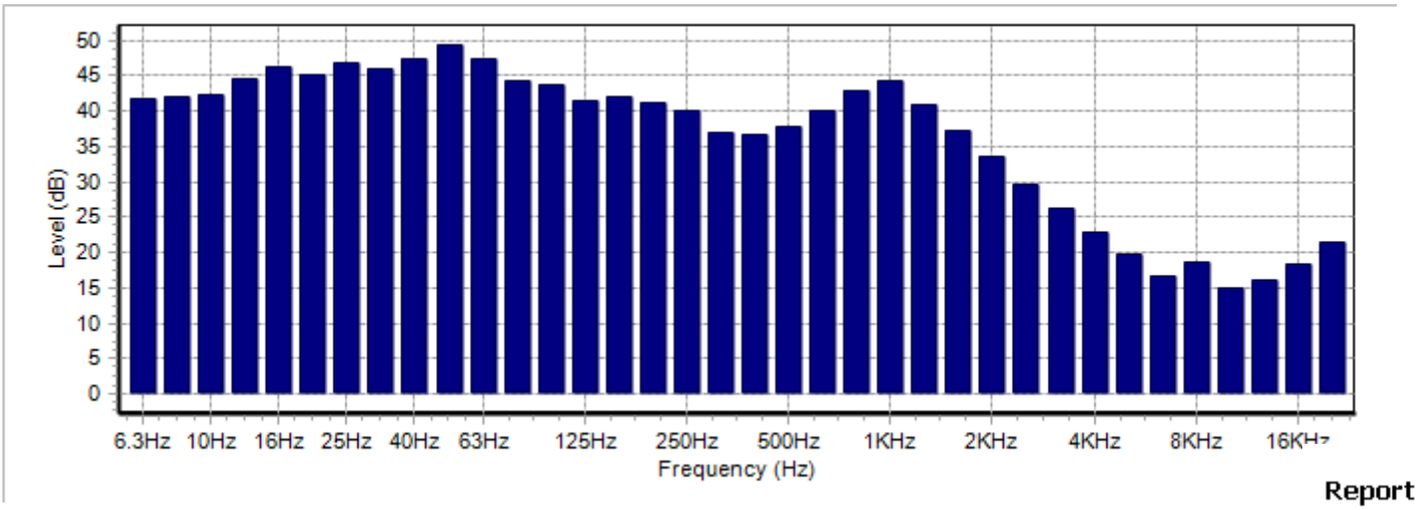
Project

1017_37

Time History



Frequency Bands



Report ID

Cirrus Research plc

Measurement Summary Report

Name	B4 Day 2
Time	08/10/2015 16:59:12
Duration	00:15:00
Instrument	GO56143, CR:171B

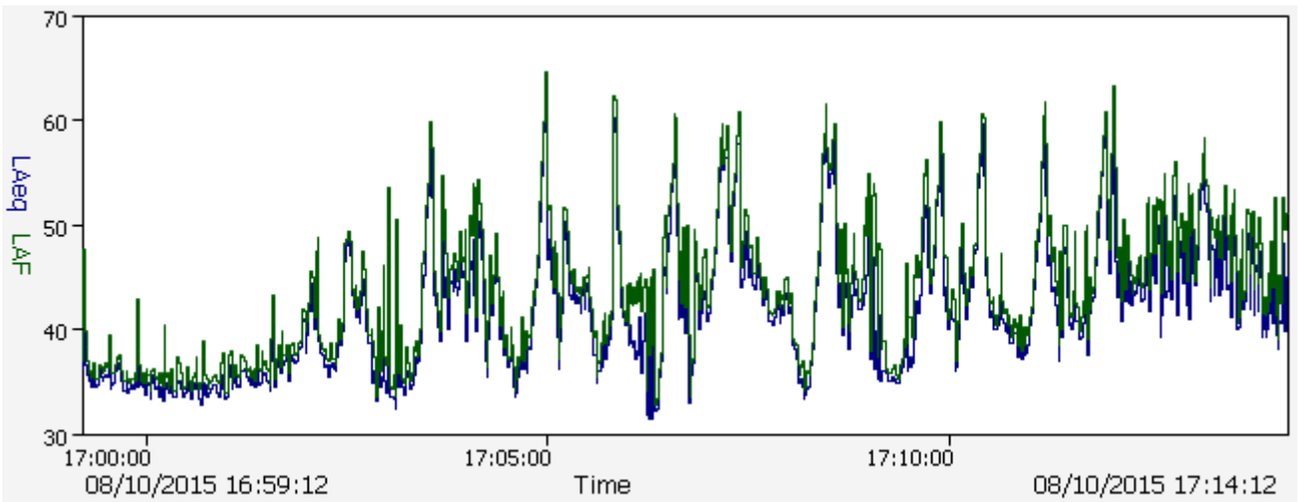
Summary

LAeq	47.3 dB
LAE	76.8 dB
LAFMax	64.6 dB

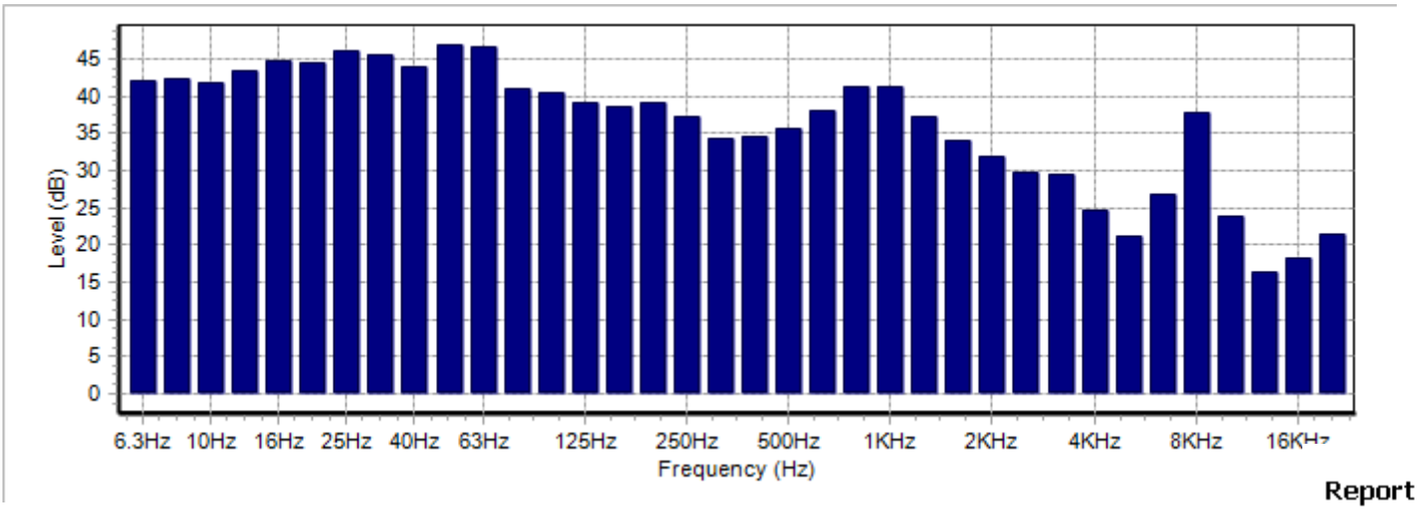
LAF1	58.9 dB
LAF5	54.1 dB
LAF10	50.2 dB
LAF50	40.8 dB
LAF90	34.3 dB
LAF95	33.6 dB
LAF99	32.6 dB

Calibration Information	Person	Place	Project
08/10/2015 16:29:43 -0.25 dB	Gareth Carroll	Rusal Aughinish	1017_37
08/10/2015 18:53:36 -0.14 dB	Graduate Environmental Co...		

Time History



Frequency Bands



Report ID

Cirrus Research plc

Measurement Summary Report

Name	B4 Day 3
Time	09/10/2015 09:29:51
Duration	00:15:00
Instrument	GO56143, CR:171B

Summary

LAeq	49.8 dB
LAE	79.3 dB
LAFMax	75.6 dB

LAF1	60.5 dB
LAF5	52.3 dB
LAF10	48.5 dB
LAF50	41.5 dB
LAF90	37.6 dB
LAF95	36.8 dB
LAF99	35.9 dB

Calibration Information

09/10/2015 09:25:51 -0.51 dB
09/10/2015 12:31:39 -0.34 dB

Person

Gareth Carroll
Graduate Environmental Co...

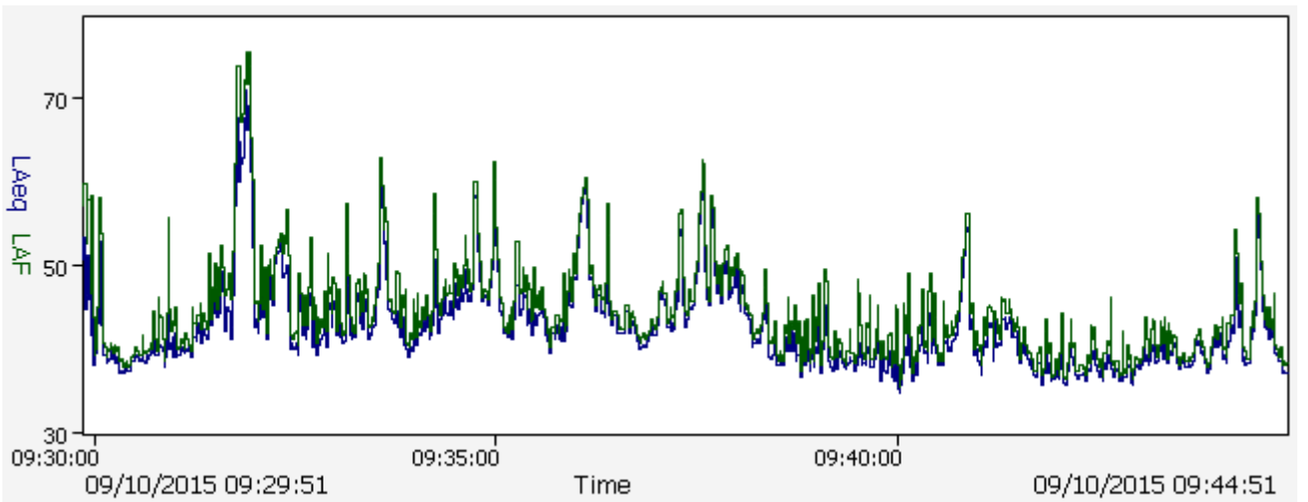
Place

Rusal Aughinish

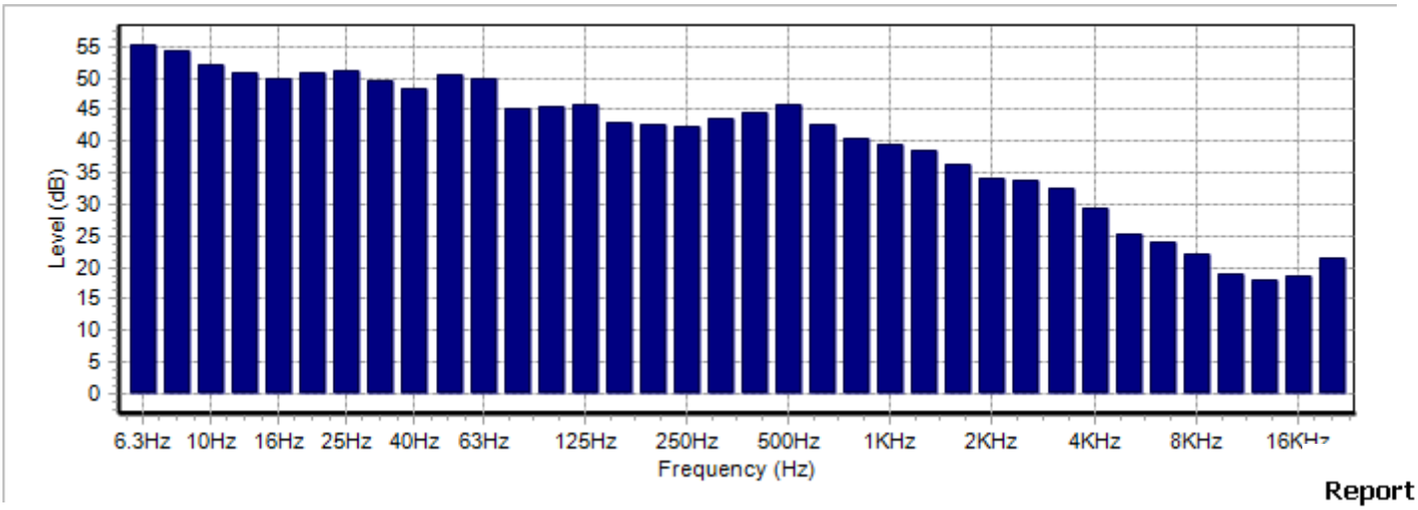
Project

1017_37

Time History



Frequency Bands



Report ID

Cirrus Research plc

Measurement Summary Report

Name	B4 Evening 1
Time	08/10/2015 22:02:57
Duration	00:15:00
Instrument	GO56143, CR:171B

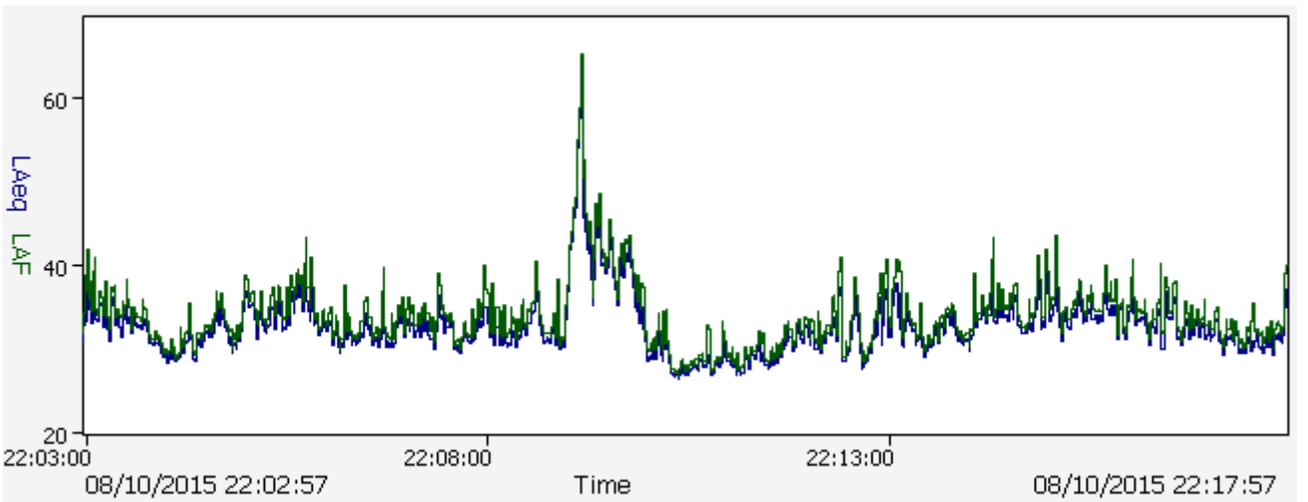
Summary

LAeq	38.0 dB
LAE	67.6 dB
LAFMax	65.4 dB

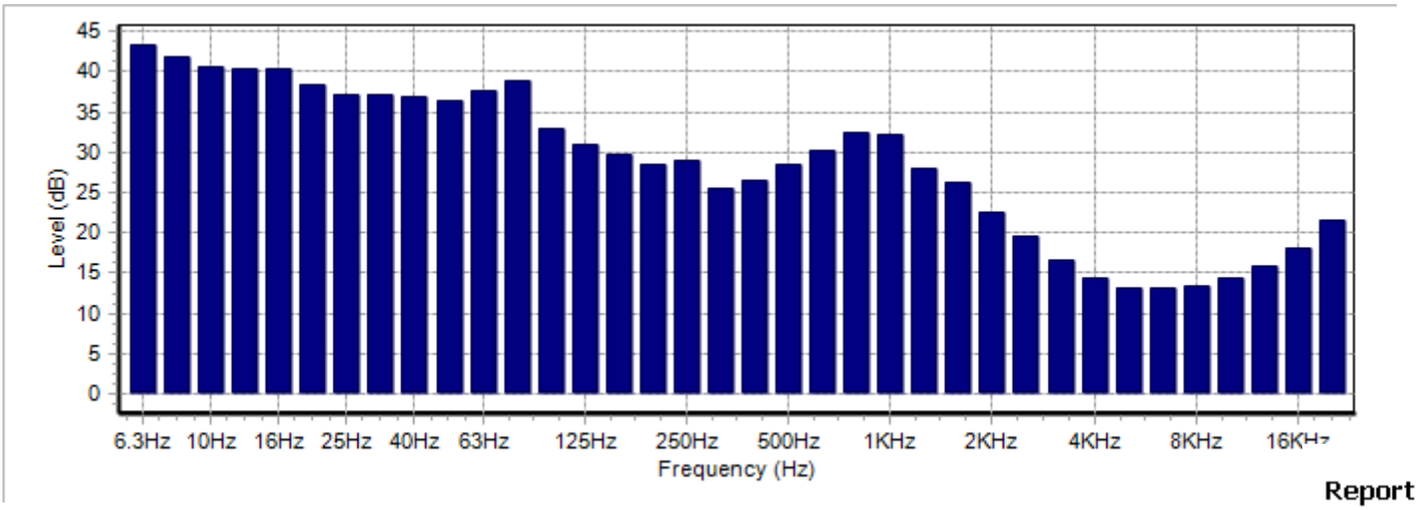
LAF1	46.2 dB
LAF5	39.1 dB
LAF10	36.4 dB
LAF50	32.2 dB
LAF90	29.0 dB
LAF95	28.1 dB
LAF99	27.0 dB

Calibration Information	Person	Place	Project
08/10/2015 20:28:31 -0.22 dB	Gareth Carroll	Rusal Aughinish	1017_37
08/10/2015 22:52:47 -0.32 dB	Graduate Environmental Co...		

Time History



Frequency Bands



Report ID

Cirrus Research plc

Measurement Summary Report

Name	B4 Night 1
Time	13/10/2015 00:10:54
Duration	00:15:00
Instrument	GO56143, CR:171B

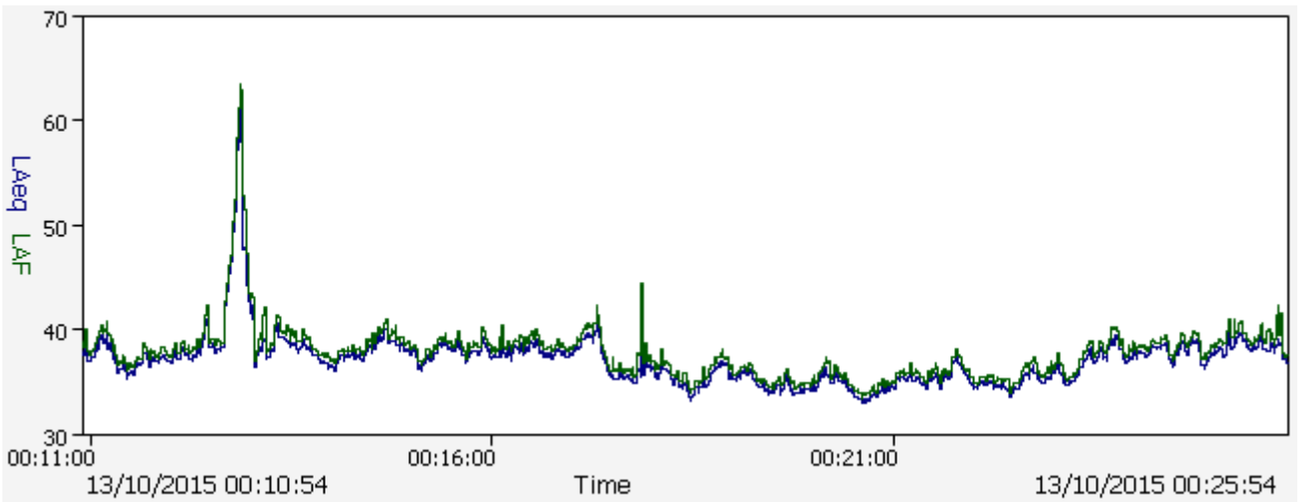
Summary

LAeq	40.1 dB
LAE	69.6 dB
LAFMax	63.4 dB

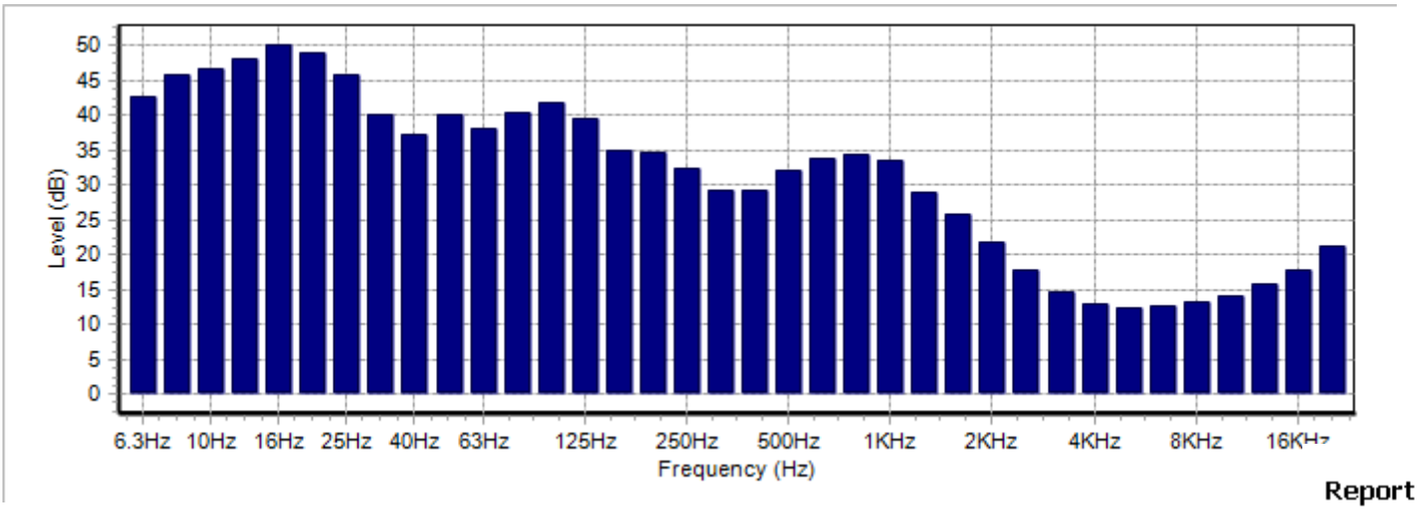
LAF1	47.0 dB
LAF5	39.6 dB
LAF10	38.9 dB
LAF50	37.1 dB
LAF90	34.4 dB
LAF95	34.0 dB
LAF99	33.2 dB

Calibration Information		Person	Place	Project
12/10/2015 22:53:35	-0.34 dB	Gareth Carroll	Rusal Aughinish	1017_37
13/10/2015 10:55:47	-0.80 dB	Graduate Environmental Co...		

Time History



Frequency Bands



Report ID

Cirrus Research plc

Measurement Summary Report

Name	B4 Night 2
Time	13/10/2015 00:25:58
Duration	00:15:00
Instrument	GO56143, CR:171B

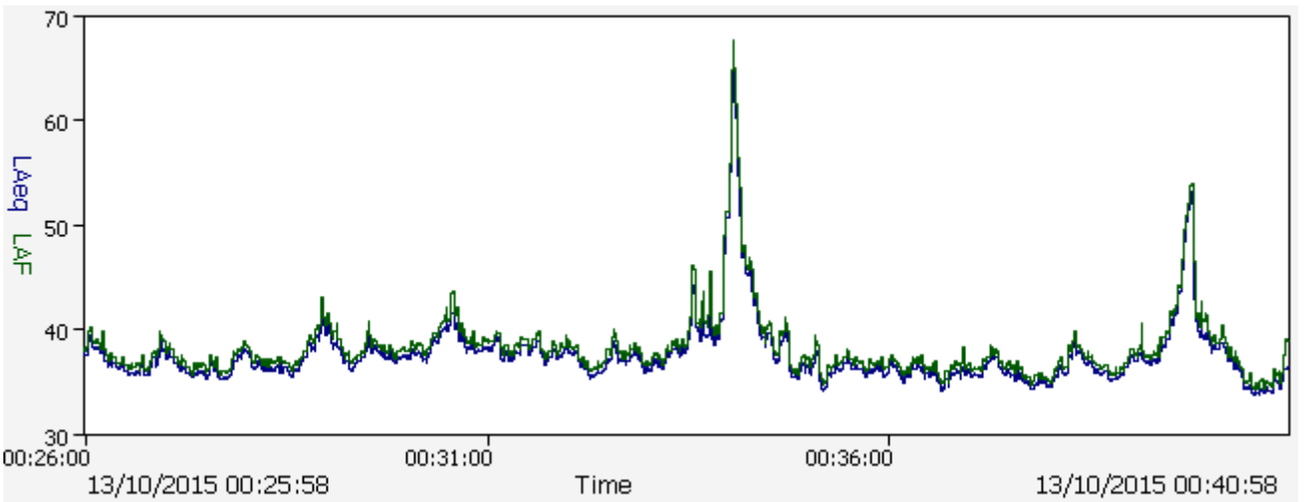
Summary

LAeq	42.7 dB
LAE	72.2 dB
LAFMax	67.7 dB

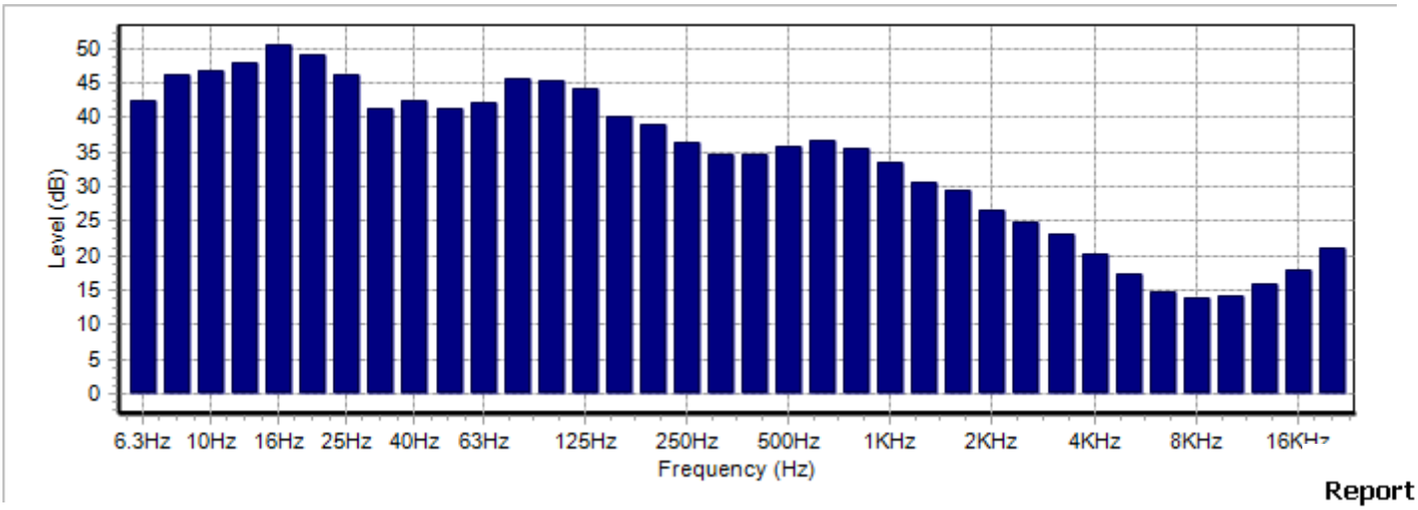
LAF1	52.6 dB
LAF5	41.5 dB
LAF10	39.6 dB
LAF50	36.9 dB
LAF90	35.2 dB
LAF95	34.7 dB
LAF99	33.9 dB

Calibration Information	Person	Place	Project
12/10/2015 22:53:35 -0.34 dB	Gareth Carroll	Rusal Aughinish	1017_37
13/10/2015 10:55:47 -0.80 dB	Graduate Environmental Co...		

Time History



Frequency Bands



Report ID

Cirrus Research plc

Measurement Summary Report

Name	B5 Day 1
Time	08/10/2015 12:20:01
Duration	00:15:00
Instrument	GO56143, CR:171B

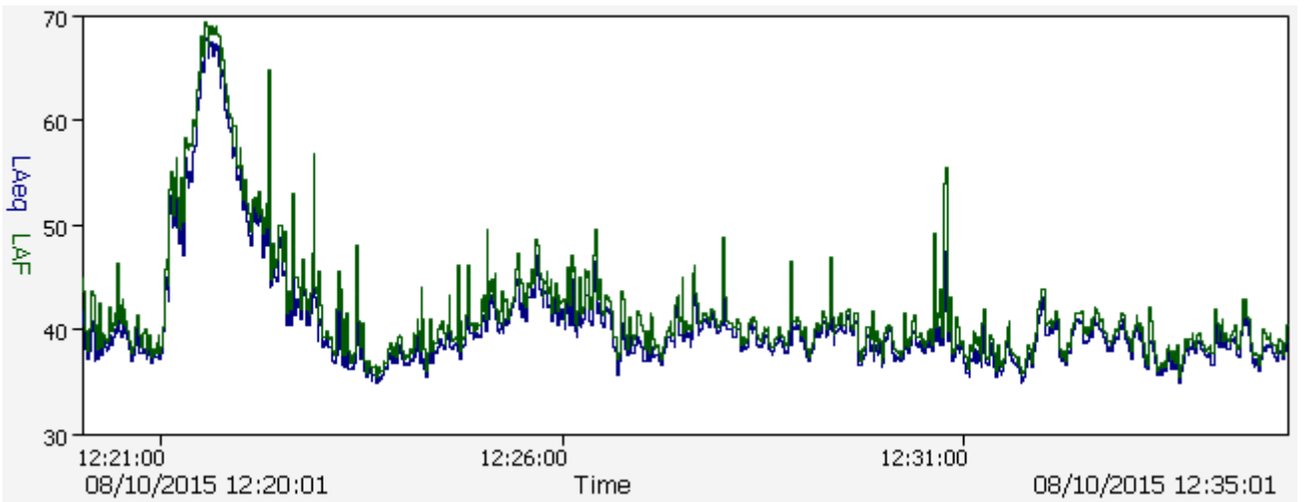
Summary

LAeq	50.6 dB
LAE	80.2 dB
LAFMax	69.3 dB

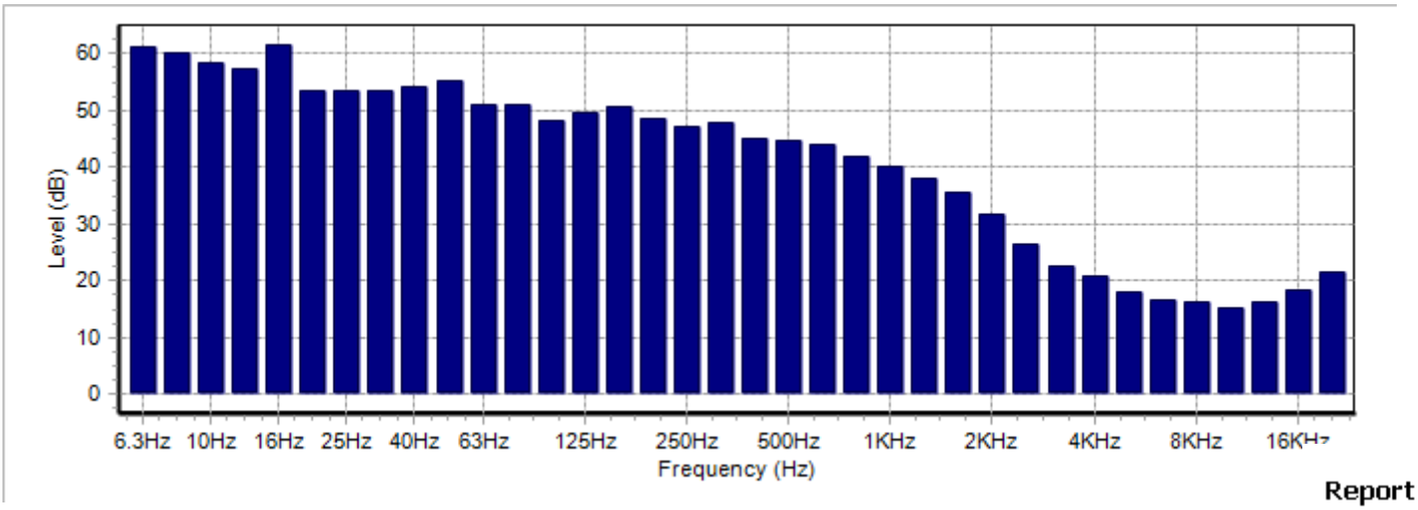
LAF1	65.9 dB
LAF5	52.9 dB
LAF10	45.1 dB
LAF50	38.9 dB
LAF90	36.6 dB
LAF95	36.1 dB
LAF99	35.1 dB

Calibration Information	Person	Place	Project
08/10/2015 11:17:58 -0.34 dB	Gareth Carroll	Rusal Aughinish	1017_37
08/10/2015 13:49:33 -0.26 dB	Graduate Environmental Co...		

Time History



Frequency Bands



Report ID

Cirrus Research plc

Measurement Summary Report

Name	B5 Day 2
Time	08/10/2015 12:35:58
Duration	00:15:00
Instrument	GO56143, CR:171B

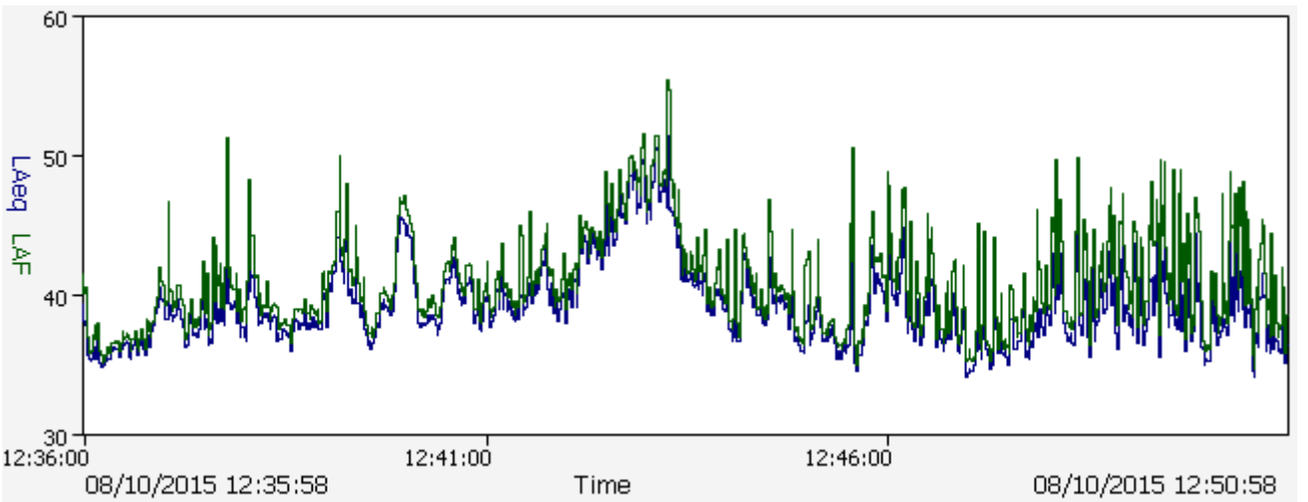
Summary

LAeq	40.6 dB
LAE	70.2 dB
LAFMax	55.3 dB

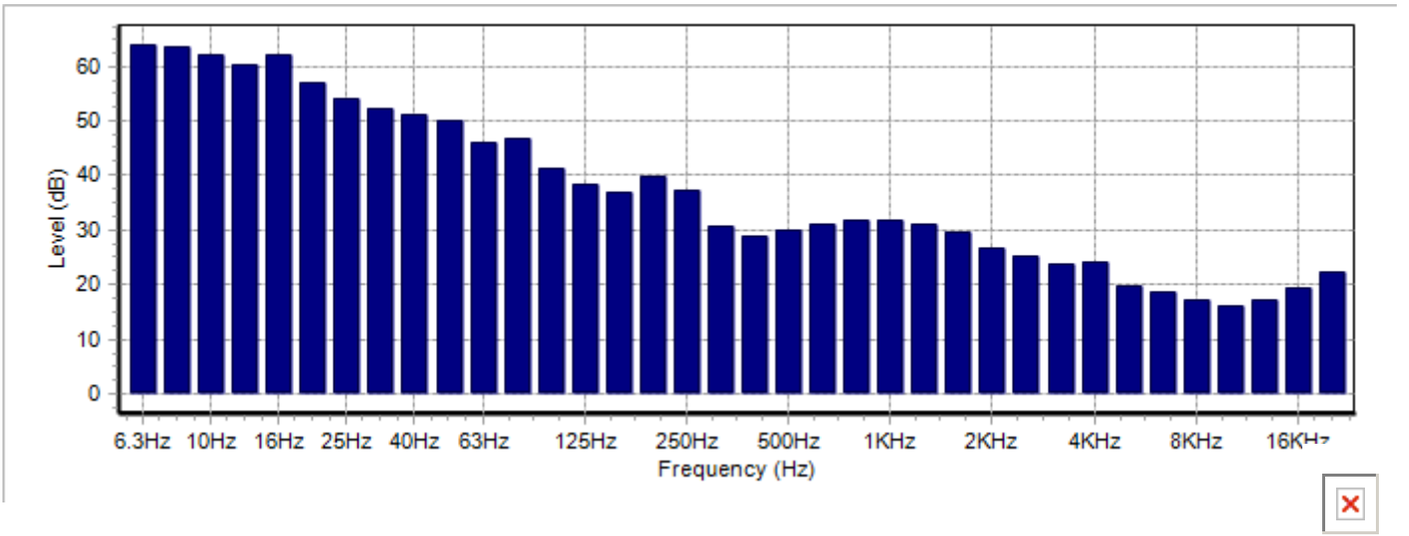
LAF1	48.6 dB
LAF5	45.6 dB
LAF10	43.7 dB
LAF50	38.5 dB
LAF90	35.9 dB
LAF95	35.3 dB
LAF99	34.5 dB

Calibration Information	Person	Place	Project
08/10/2015 11:17:58 -0.34 dB	Gareth Carroll	Rusal Aughinish	1017_37
08/10/2015 13:49:33 -0.26 dB	Graduate Environmental Co...		

Time History



Frequency Bands



Cirrus Research plc

Measurement Summary Report

Name	B5 Day 3
Time	08/10/2015 12:51:27
Duration	00:15:00
Instrument	GO56143, CR:171B

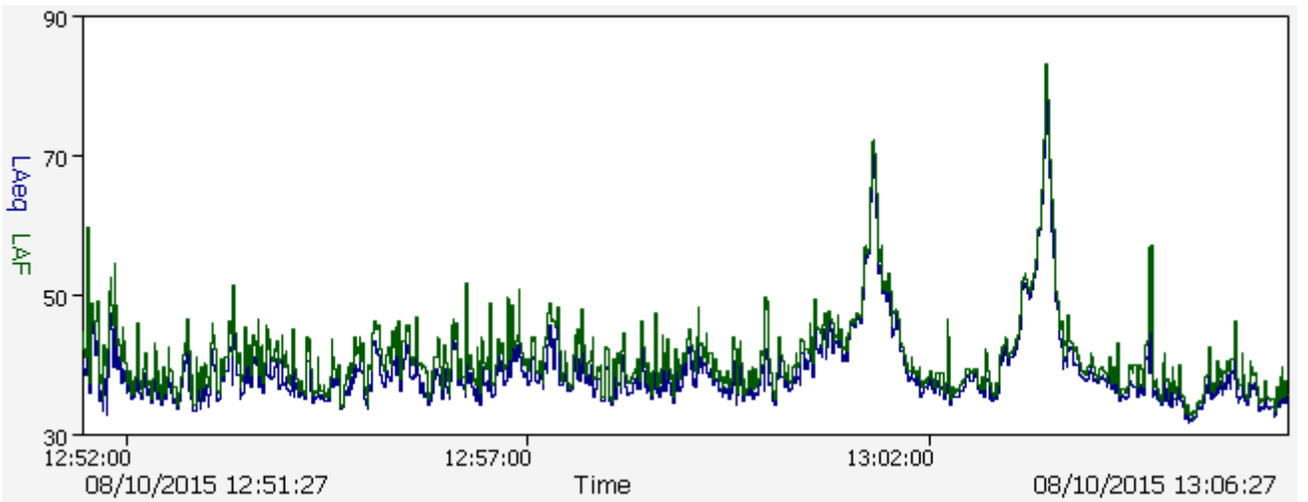
Summary

LAeq	55.2 dB
LAE	84.8 dB
LAFMax	82.9 dB

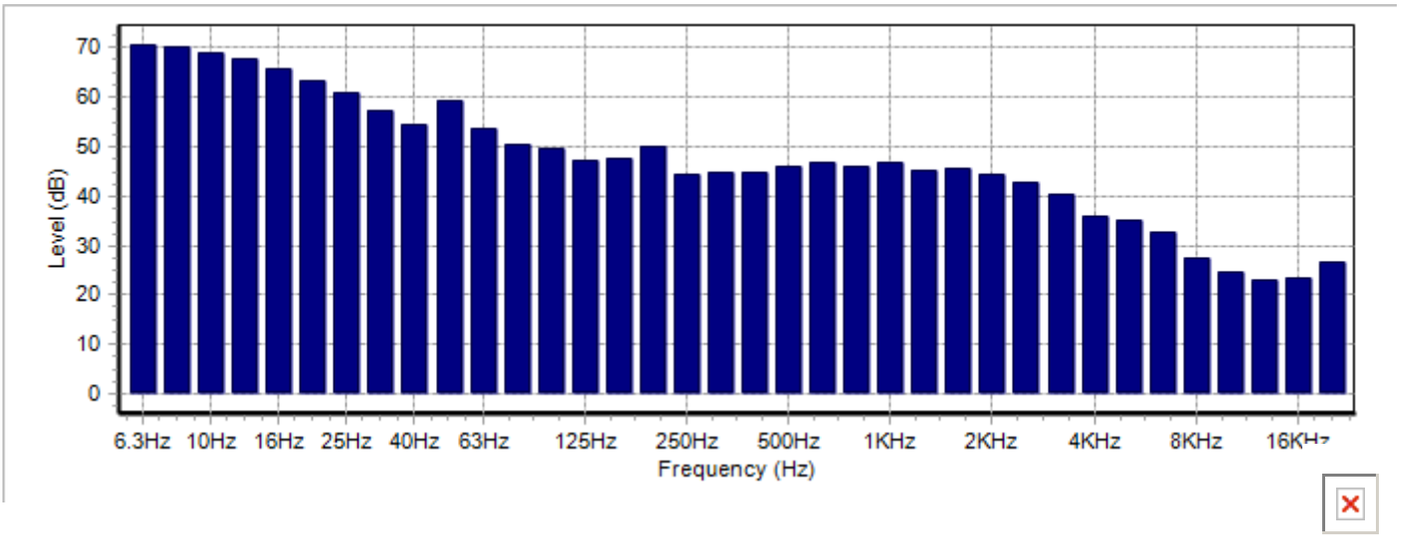
LAF1	64.1 dB
LAF5	49.2 dB
LAF10	44.1 dB
LAF50	37.3 dB
LAF90	34.5 dB
LAF95	33.9 dB
LAF99	32.6 dB

Calibration Information	Person	Place	Project
08/10/2015 11:17:58 -0.34 dB	Gareth Carroll	Rusal Aughinish	1017_37
08/10/2015 13:49:33 -0.26 dB	Graduate Environmental Co...		

Time History



Frequency Bands



Cirrus Research plc

Measurement Summary Report

Name	B5 Evening 1
Time	12/10/2015 21:04:28
Duration	00:15:00
Instrument	GO56143, CR:171B

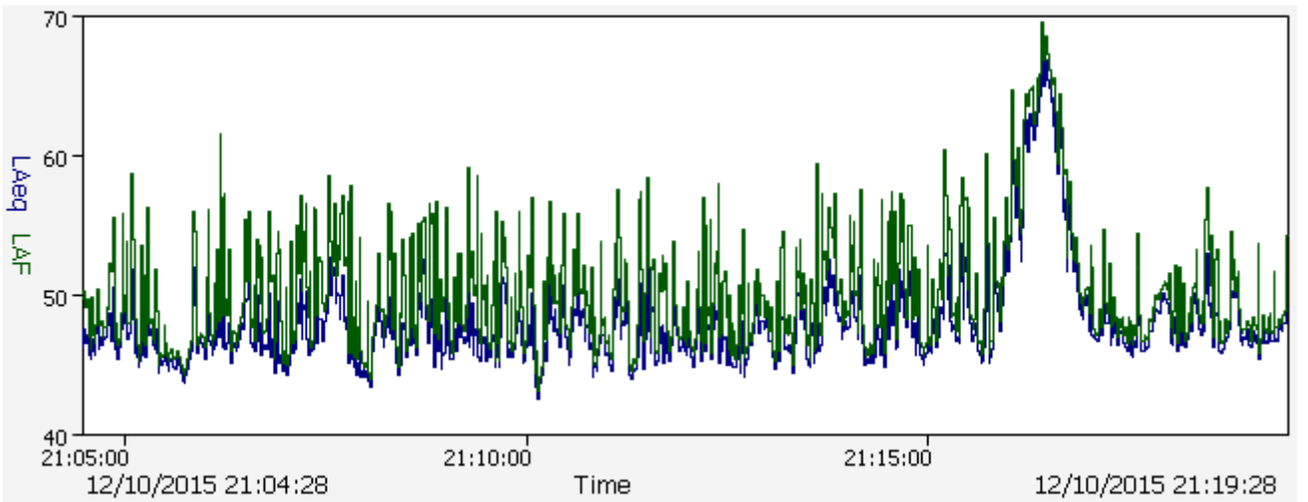
Summary

LAeq	51.5 dB
LAE	81.1 dB
LAFMax	69.5 dB

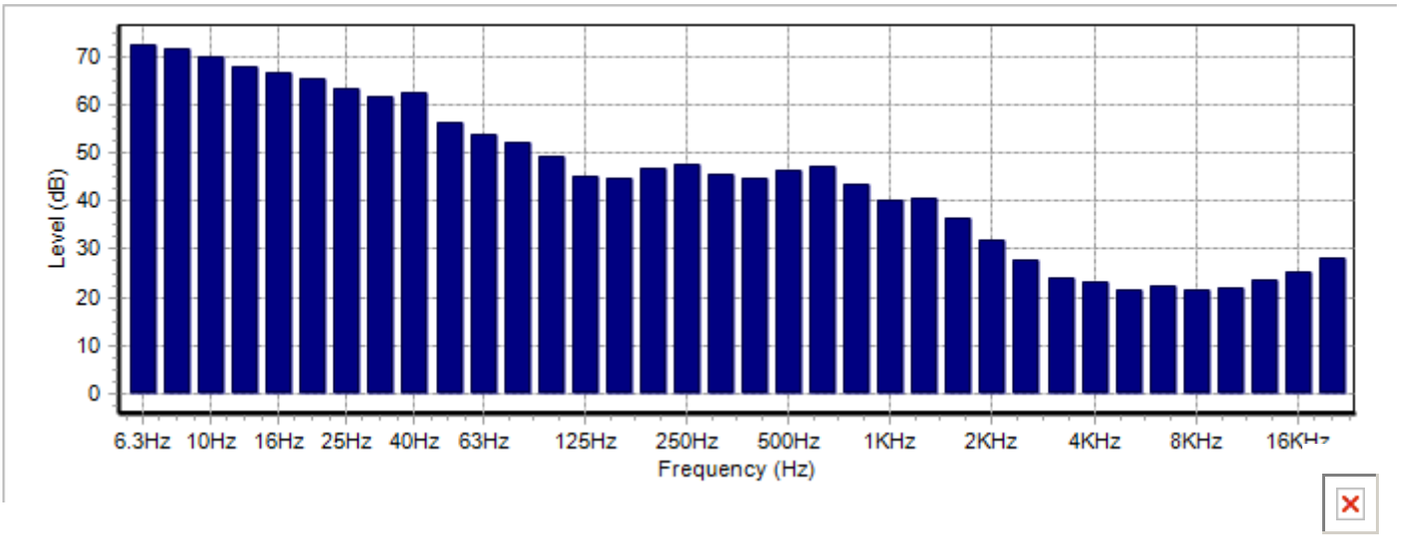
LAF1	64.0 dB
LAF5	55.1 dB
LAF10	51.3 dB
LAF50	46.8 dB
LAF90	44.9 dB
LAF95	44.5 dB
LAF99	43.6 dB

Calibration Information	Person	Place	Project
12/10/2015 20:40:27 -0.36 dB	Gareth Carroll	Rusal Aughinish	1017_37
12/10/2015 22:53:35 -0.34 dB	Graduate Environmental Co...		

Time History



Frequency Bands



Cirrus Research plc

Measurement Summary Report

Name	B5 Night 1
Time	13/10/2015 03:21:19
Duration	00:15:00
Instrument	GO56143, CR:171B

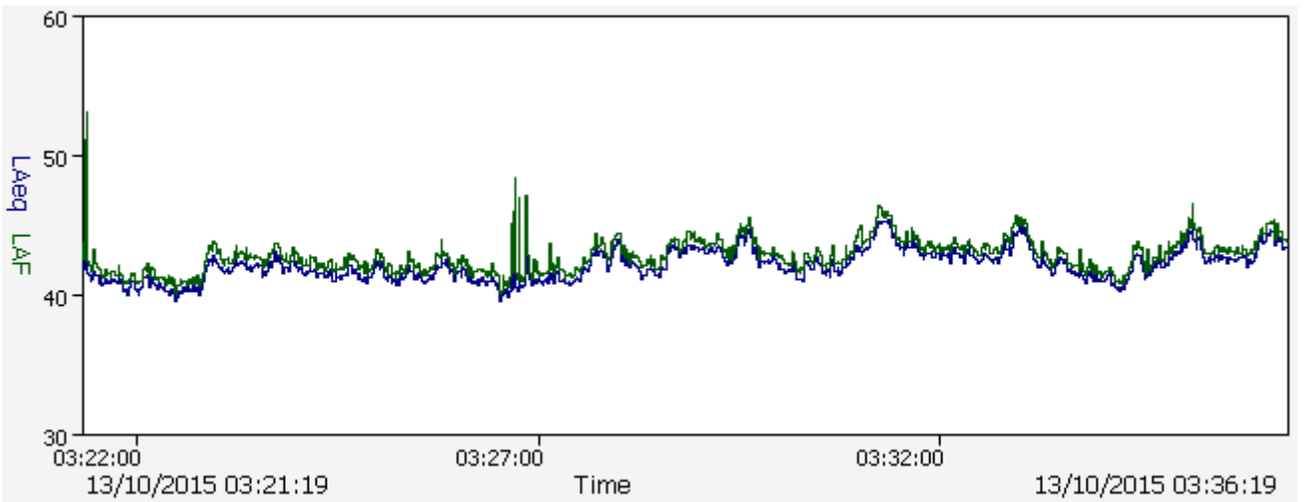
Summary

LAeq	42.2 dB
LAE	71.8 dB
LAFMax	53.0 dB

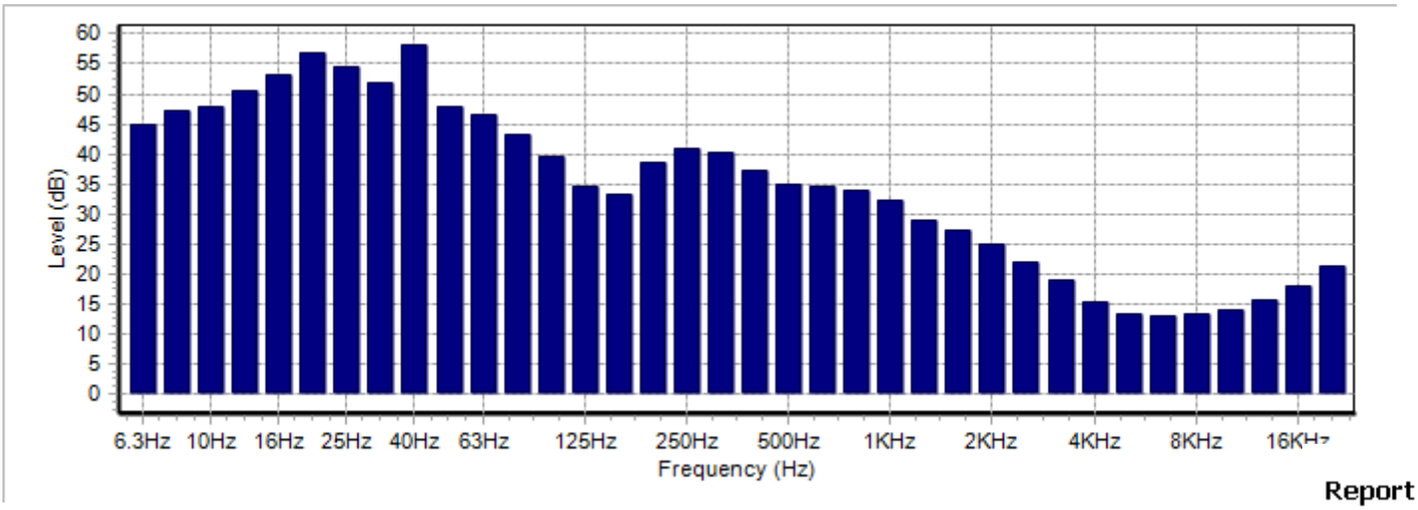
LAF1	45.0 dB
LAF5	44.1 dB
LAF10	43.5 dB
LAF50	41.9 dB
LAF90	40.6 dB
LAF95	40.3 dB
LAF99	39.8 dB

Calibration Information	Person	Place	Project
12/10/2015 22:53:35 -0.34 dB	Gareth Carroll	Rusal Aughinish	1017_37
13/10/2015 10:55:47 -0.80 dB	Graduate Environmental Co...		

Time History



Frequency Bands



Report ID

Cirrus Research plc

Measurement Summary Report

Name	B5 Night 2
Time	13/10/2015 03:37:22
Duration	00:15:00
Instrument	GO56143, CR:171B

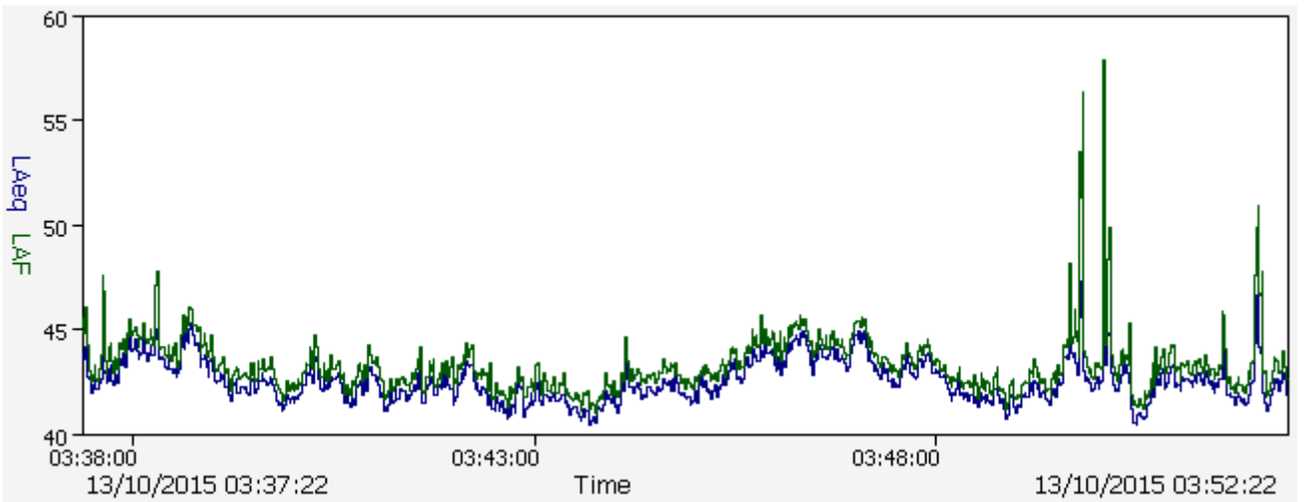
Summary

LAeq	42.7 dB
LAE	72.2 dB
LAFMax	57.8 dB

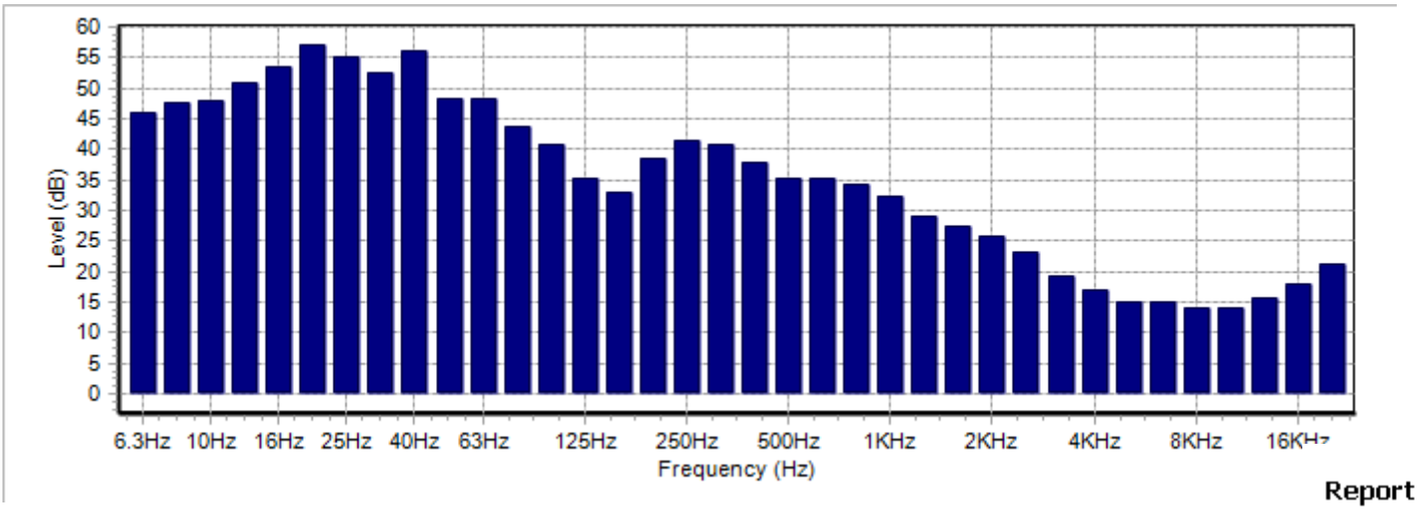
LAF1	45.2 dB
LAF5	44.3 dB
LAF10	43.9 dB
LAF50	42.3 dB
LAF90	41.3 dB
LAF95	41.0 dB
LAF99	40.5 dB

Calibration Information	Person	Place	Project
12/10/2015 22:53:35 -0.34 dB	Gareth Carroll	Rusal Aughinish	1017_37
13/10/2015 10:55:47 -0.80 dB	Graduate Environmental Co...		

Time History



Frequency Bands



Report ID

Cirrus Research plc

Measurement Summary Report

Name	B6 Day 1
Time	08/10/2015 11:19:02
Duration	00:15:00
Instrument	GO56143, CR:171B

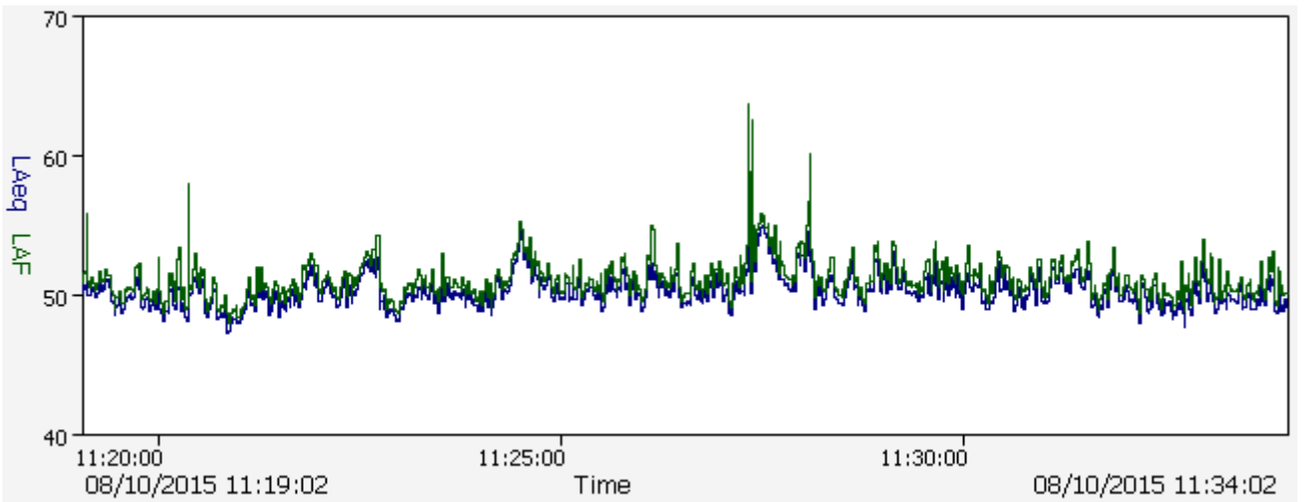
Summary

LAeq	50.5 dB
LAE	80.0 dB
LAFMax	63.6 dB

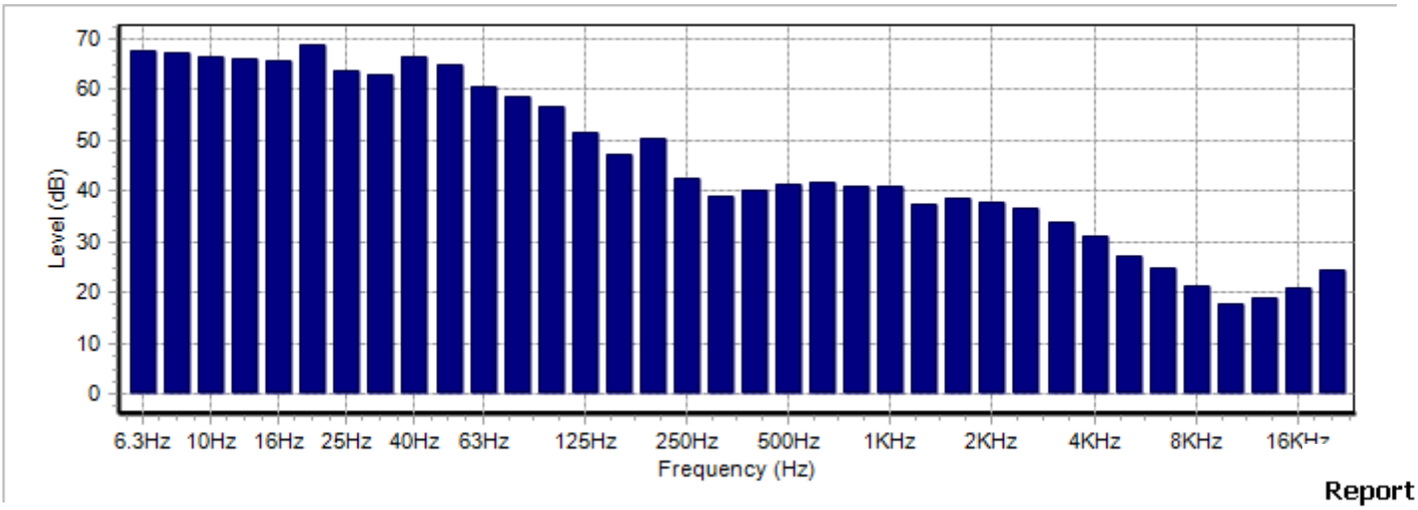
LAF1	54.4 dB
LAF5	52.4 dB
LAF10	51.7 dB
LAF50	50.0 dB
LAF90	48.8 dB
LAF95	48.4 dB
LAF99	47.9 dB

Calibration Information	Person	Place	Project
08/10/2015 11:17:58 -0.34 dB	Gareth Carroll	Rusal Aughinish	1017_37
08/10/2015 13:49:33 -0.26 dB	Graduate Environmental Co...		

Time History



Frequency Bands



Report ID

Cirrus Research plc

Measurement Summary Report

Name	B6 Day 2
Time	08/10/2015 11:34:35
Duration	00:15:00
Instrument	GO56143, CR:171B

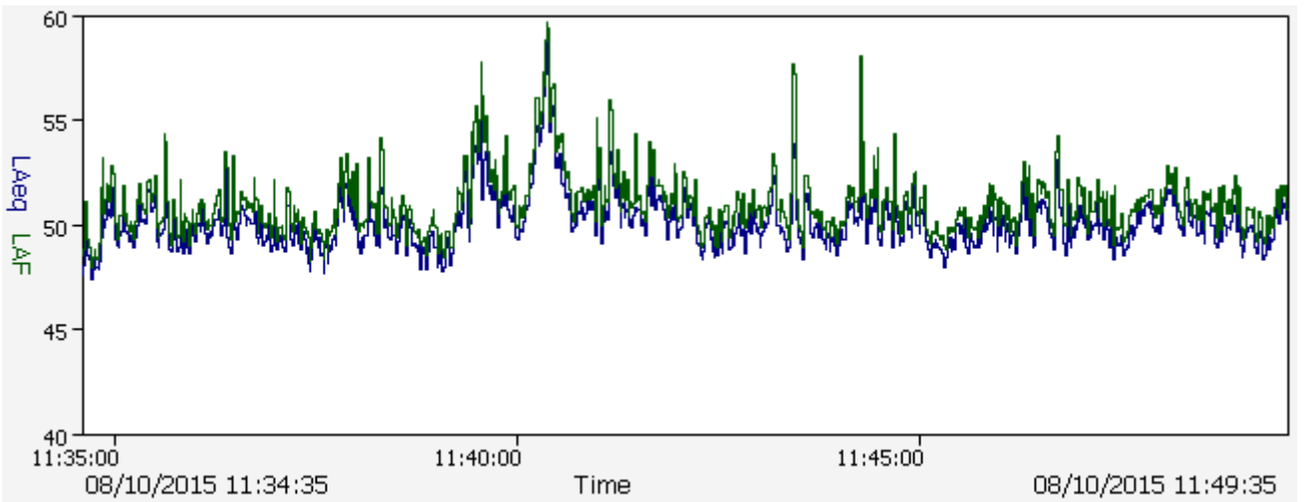
Summary

LAeq	50.4 dB
LAE	79.9 dB
LAFMax	59.7 dB

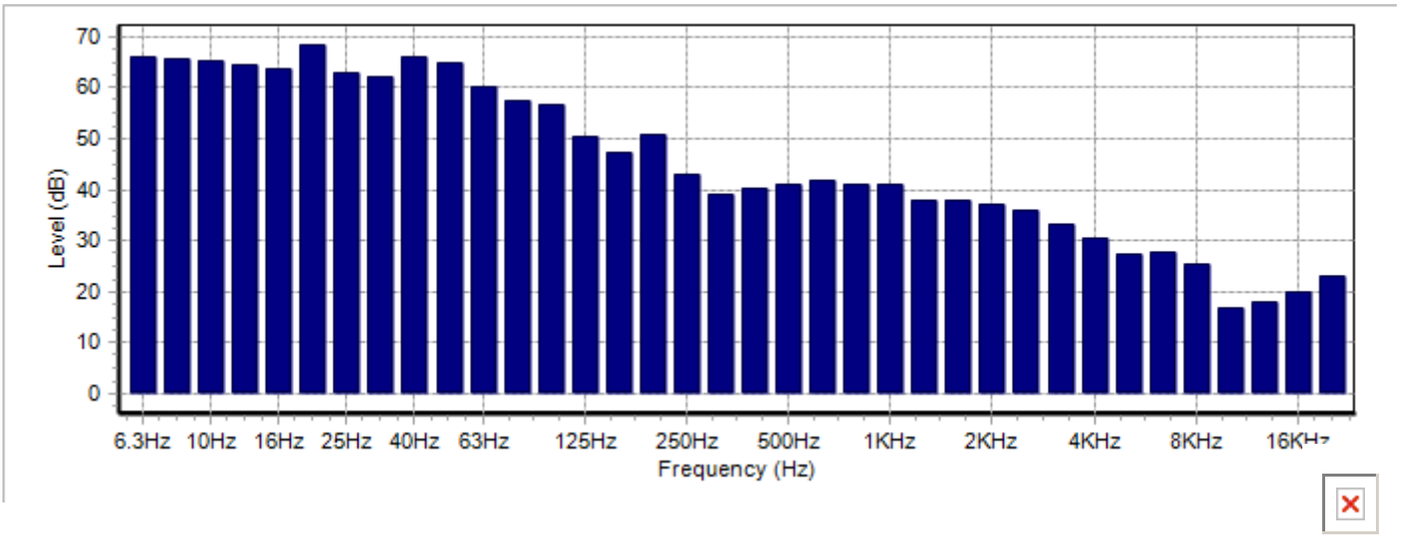
LAF1	55.1 dB
LAF5	52.6 dB
LAF10	51.6 dB
LAF50	49.9 dB
LAF90	48.6 dB
LAF95	48.3 dB
LAF99	47.6 dB

Calibration Information	Person	Place	Project
08/10/2015 11:17:58 -0.34 dB	Gareth Carroll	Rusal Aughinish	1017_37
08/10/2015 13:49:33 -0.26 dB	Graduate Environmental Co...		

Time History



Frequency Bands



Cirrus Research plc

Measurement Summary Report

Name	B6 Day 3
Time	08/10/2015 11:49:42
Duration	00:15:00
Instrument	GO56143, CR:171B

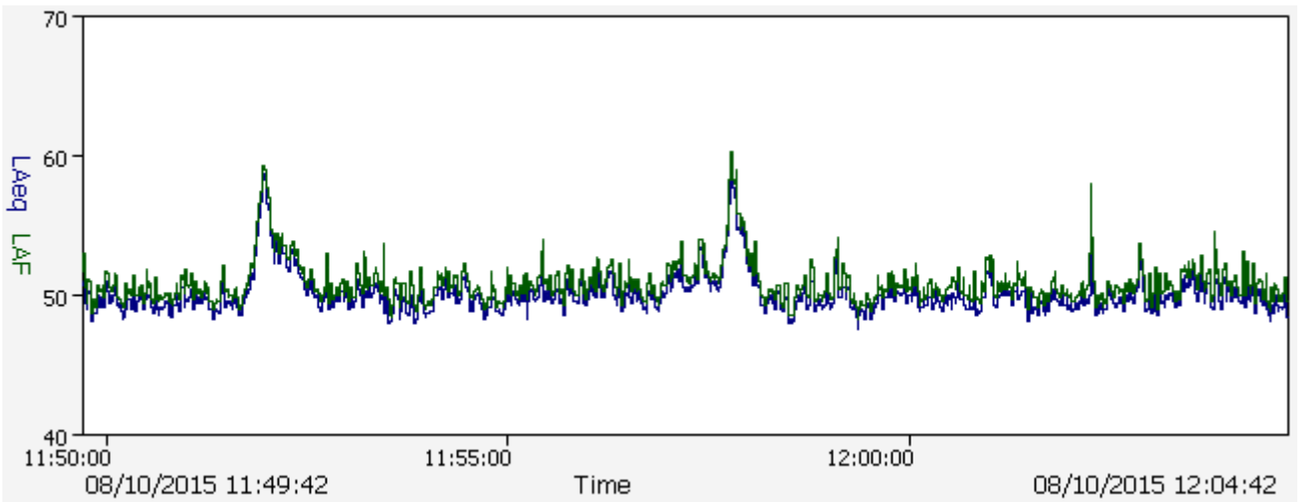
Summary

LAeq	50.4 dB
LAE	79.9 dB
LAFMax	60.3 dB

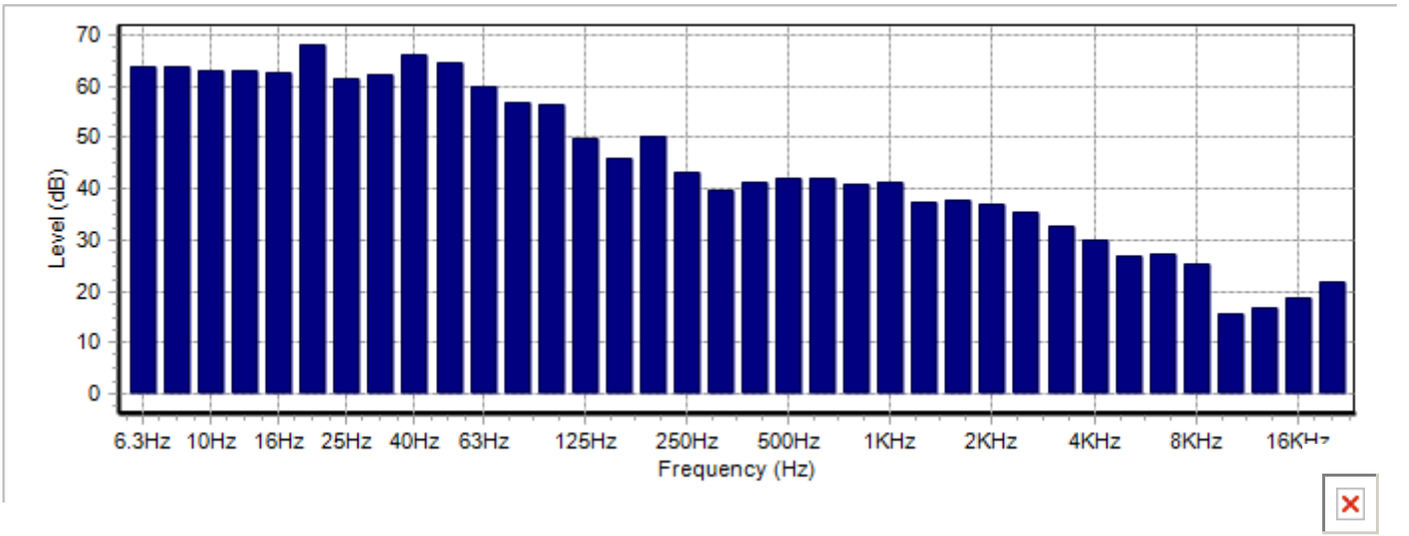
LAF1	56.7 dB
LAF5	52.7 dB
LAF10	51.5 dB
LAF50	49.7 dB
LAF90	48.6 dB
LAF95	48.4 dB
LAF99	47.9 dB

Calibration Information	Person	Place	Project
08/10/2015 11:17:58 -0.34 dB	Gareth Carroll	Rusal Aughinish	1017_37
08/10/2015 13:49:33 -0.26 dB	Graduate Environmental Co...		

Time History



Frequency Bands



Cirrus Research plc

Measurement Summary Report

Name	B6 Evening 1
Time	12/10/2015 20:42:24
Duration	00:15:00
Instrument	GO56143, CR:171B

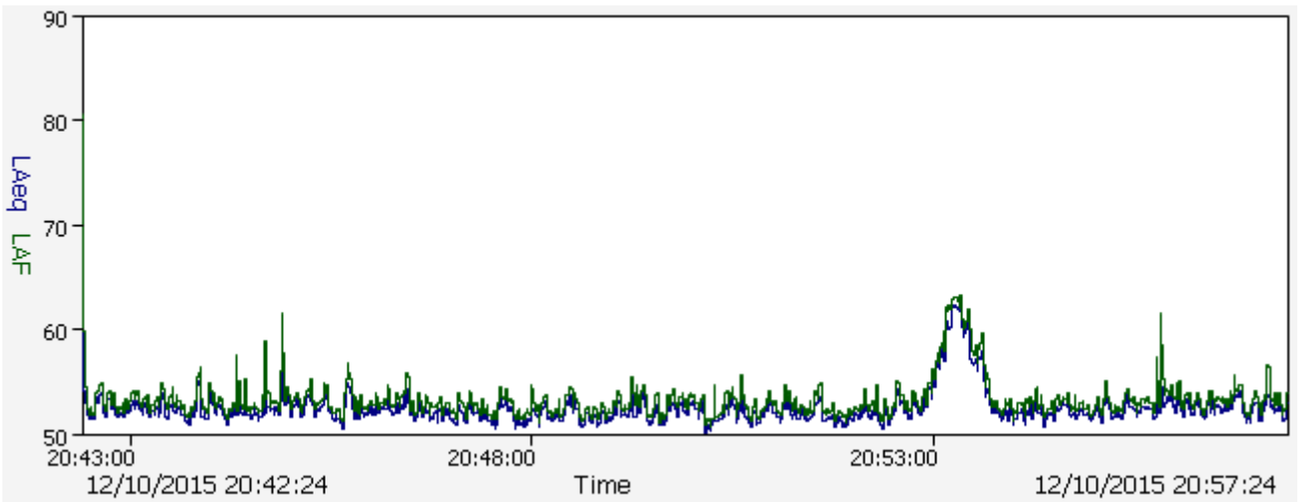
Summary

LAeq	53.5 dB
LAE	83.0 dB
LAFMax	80.5 dB

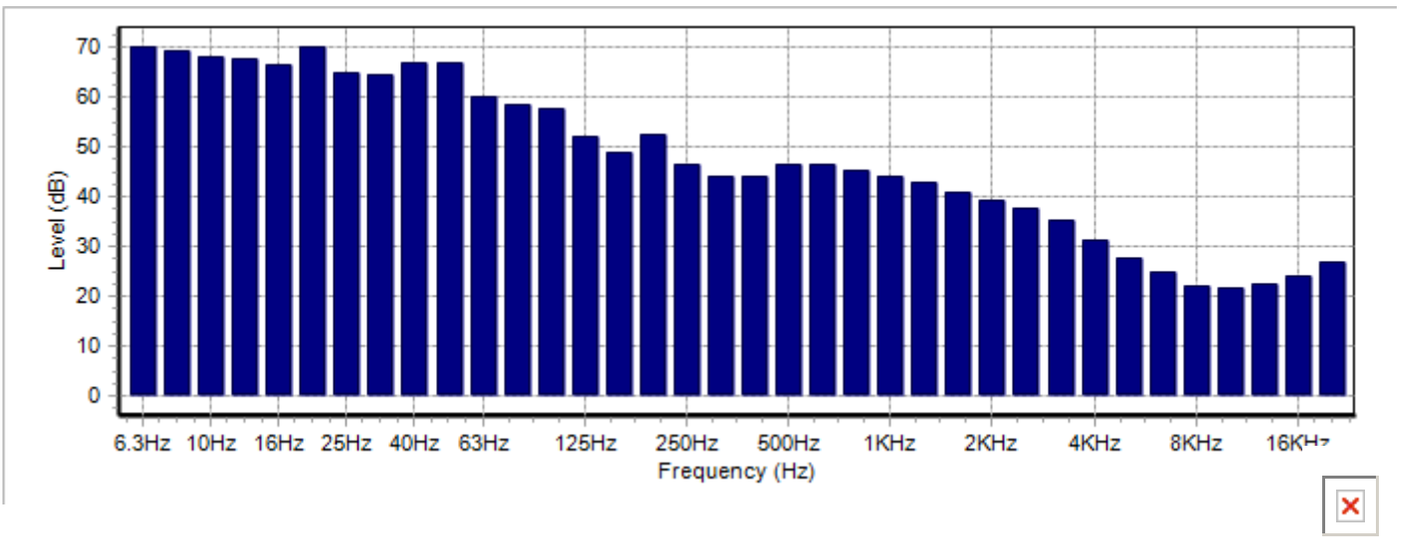
LAF1	61.2 dB
LAF5	54.9 dB
LAF10	53.6 dB
LAF50	52.1 dB
LAF90	51.1 dB
LAF95	50.8 dB
LAF99	50.4 dB

Calibration Information	Person	Place	Project
12/10/2015 20:40:27 -0.36 dB	Gareth Carroll	Rusal Aughinish	1017_37
12/10/2015 22:53:35 -0.34 dB	Graduate Environmental Co...		

Time History



Frequency Bands



Cirrus Research plc

Measurement Summary Report

Name	B6 Night 1
Time	13/10/2015 02:43:59
Duration	00:15:00
Instrument	GO56143, CR:171B

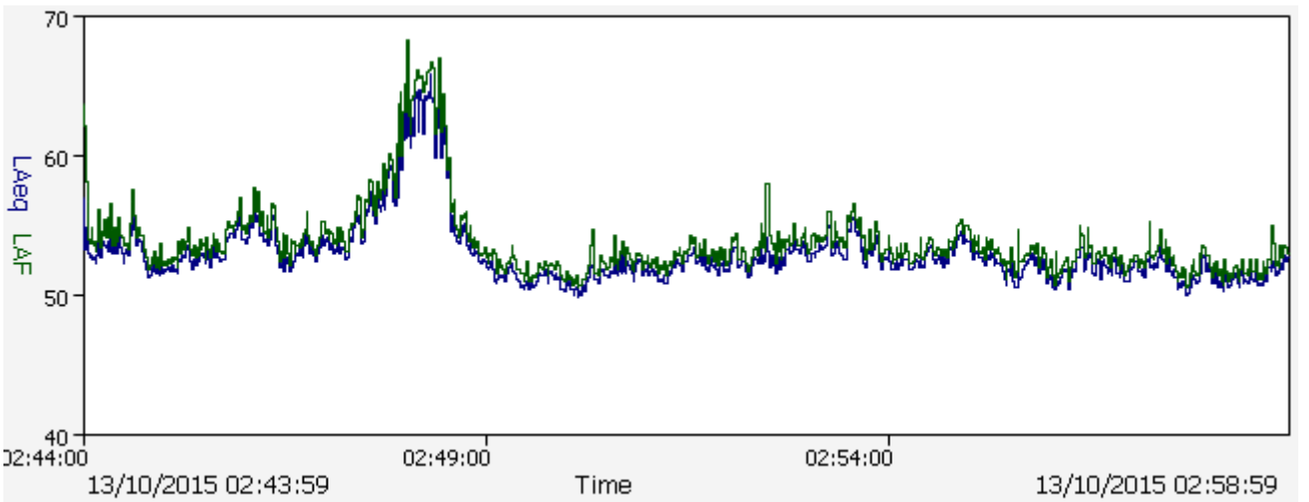
Summary

LAeq	54.2 dB
LAE	83.7 dB
LAFMax	68.2 dB

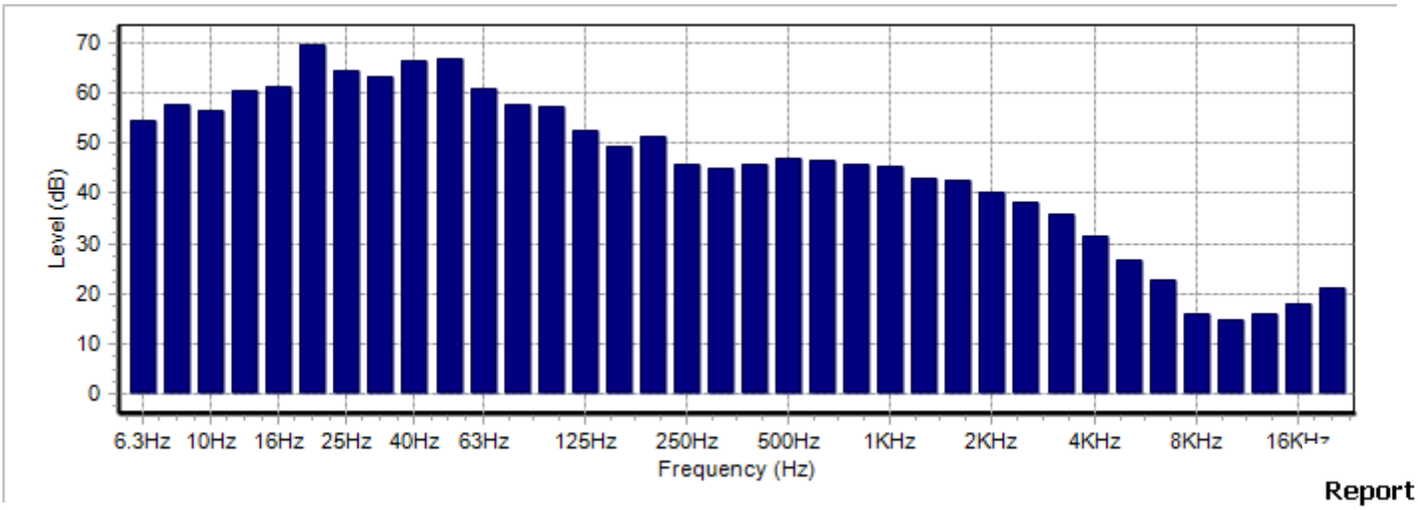
LAF1	64.0 dB
LAF5	57.7 dB
LAF10	54.9 dB
LAF50	52.3 dB
LAF90	50.8 dB
LAF95	50.5 dB
LAF99	50.1 dB

Calibration Information		Person	Place	Project
12/10/2015 22:53:35	-0.34 dB	Gareth Carroll	Rusal Aughinish	1017_37
13/10/2015 10:55:47	-0.80 dB	Graduate Environmental Co...		

Time History



Frequency Bands



Report ID

Cirrus Research plc

Measurement Summary Report

Name	B6 Night 2
Time	13/10/2015 02:59:13
Duration	00:15:00
Instrument	GO56143, CR:171B

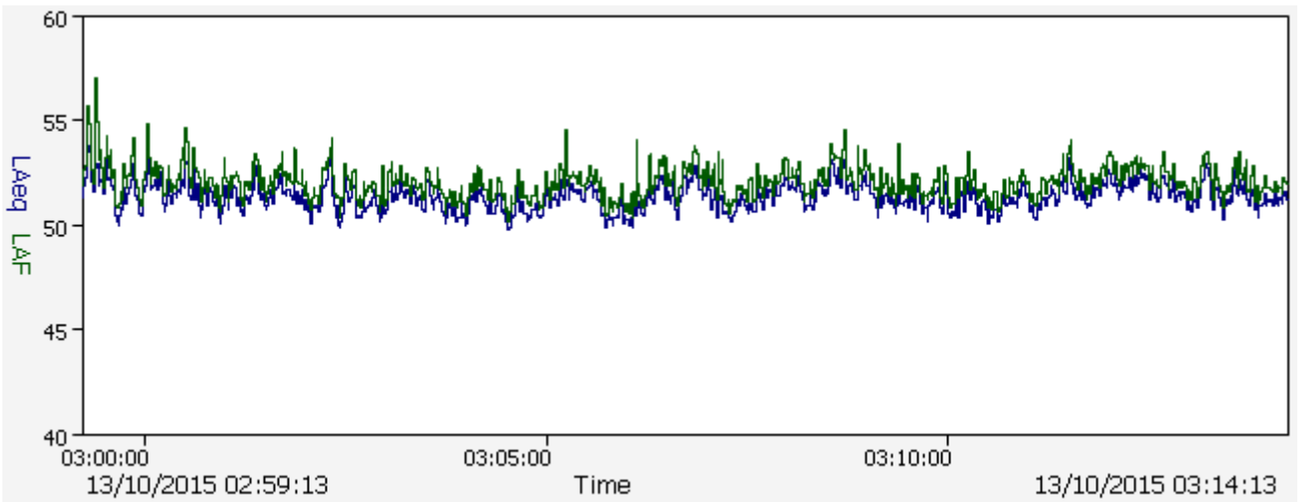
Summary

LAeq	51.4 dB
LAE	80.9 dB
LAFMax	57.0 dB

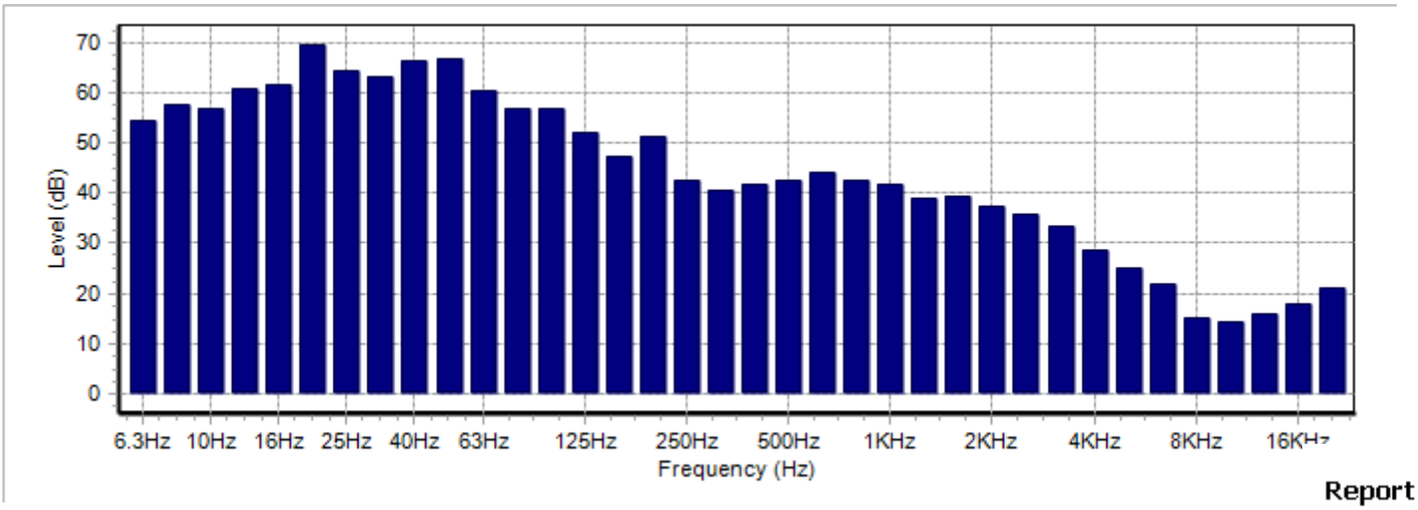
LAF1	53.3 dB
LAF5	52.5 dB
LAF10	52.2 dB
LAF50	51.2 dB
LAF90	50.3 dB
LAF95	50.1 dB
LAF99	49.8 dB

Calibration Information		Person	Place	Project
12/10/2015 22:53:35	-0.34 dB	Gareth Carroll	Rusal Aughinish	1017_37
13/10/2015 10:55:47	-0.80 dB	Graduate Environmental Co...		

Time History



Frequency Bands



Report ID

Cirrus Research plc

Measurement Summary Report

Name	B7 Day 1
Time	08/10/2015 13:52:00
Duration	00:15:00
Instrument	GO56143, CR:171B

Summary

LAeq	35.1 dB
LAE	64.6 dB
LAFMax	56.5 dB

LAF1	41.2 dB
LAF5	37.6 dB
LAF10	36.4 dB
LAF50	33.9 dB
LAF90	32.5 dB
LAF95	32.3 dB
LAF99	31.8 dB

Calibration Information

08/10/2015 13:49:33 -0.26 dB

08/10/2015 16:05:25 -0.46 dB

Person

Gareth Carroll

Graduate Environmental Co...

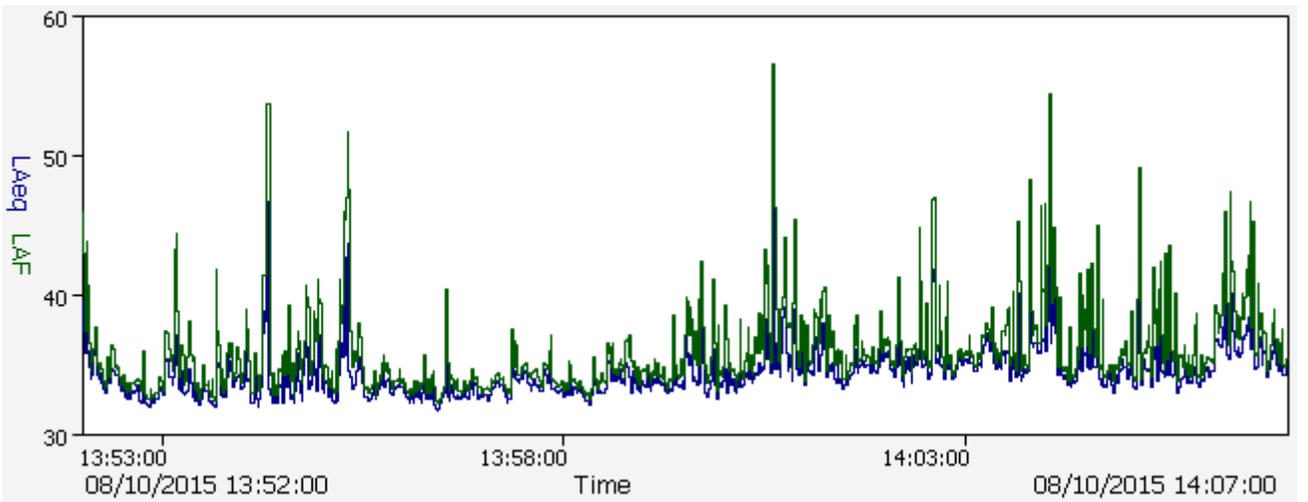
Place

Rusal Aughinish

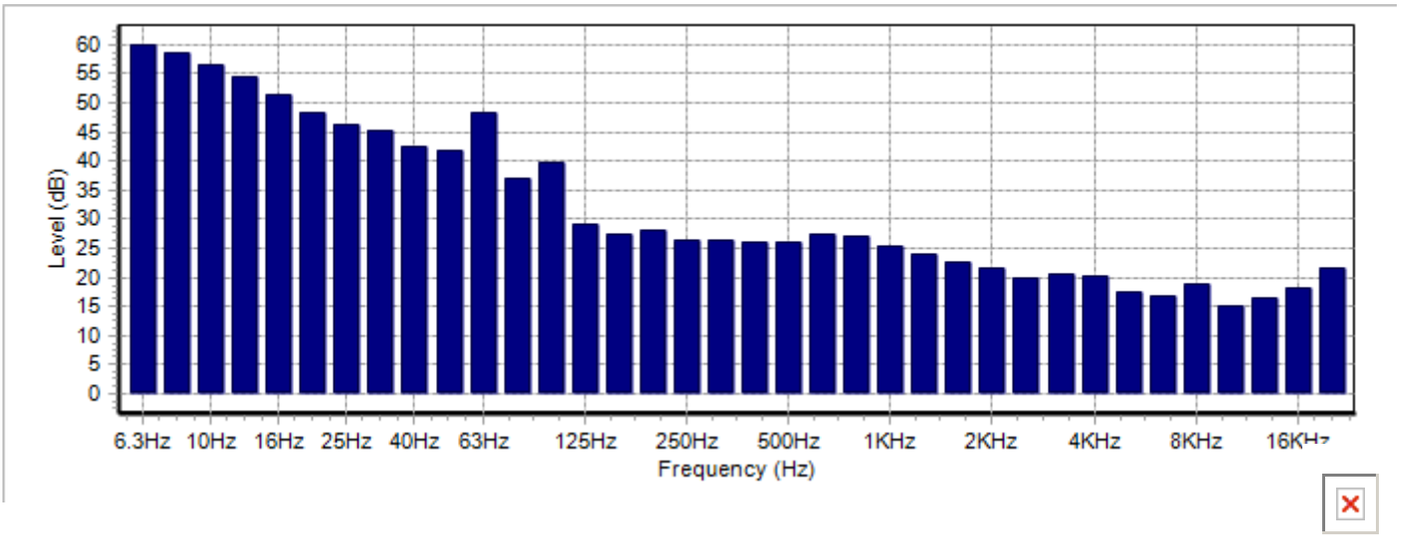
Project

1017_37

Time History



Frequency Bands



Cirrus Research plc

Measurement Summary Report

Name	B7 Day 2
Time	08/10/2015 14:07:09
Duration	00:15:00
Instrument	GO56143, CR:171B

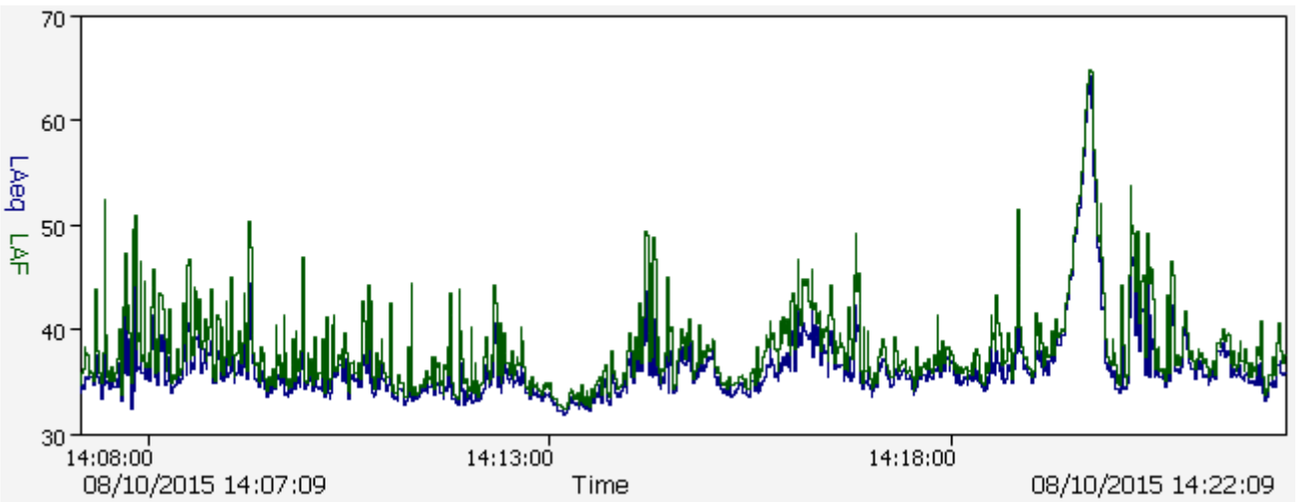
Summary

LAeq	42.6 dB
LAE	72.2 dB
LAFMax	64.8 dB

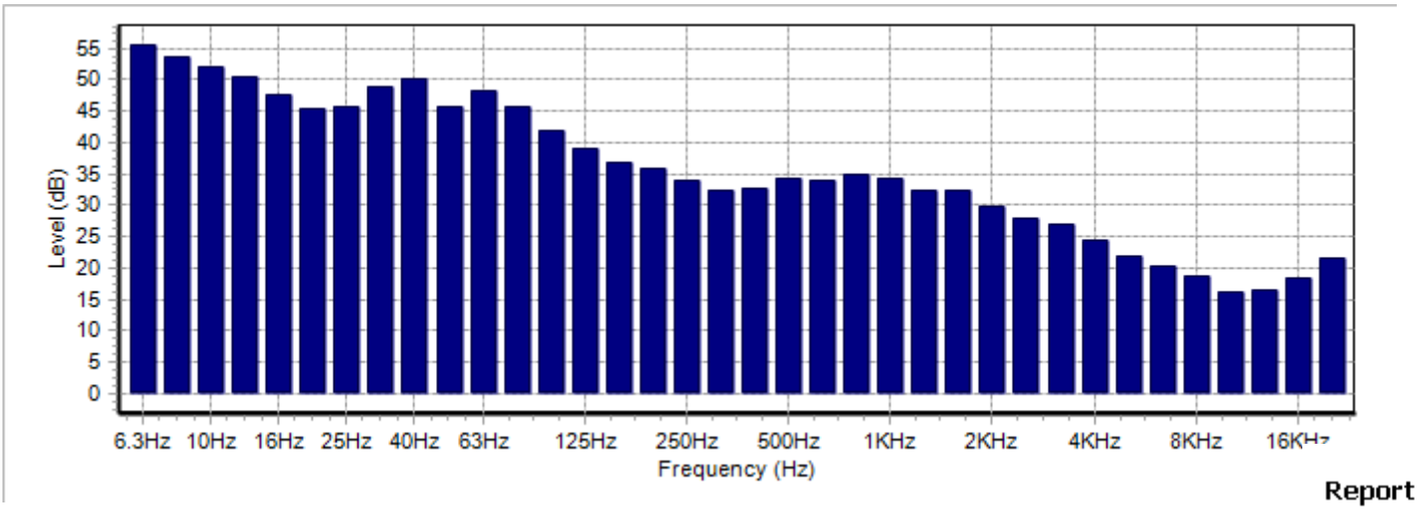
LAF1	53.9 dB
LAF5	42.3 dB
LAF10	39.2 dB
LAF50	35.3 dB
LAF90	33.4 dB
LAF95	33.1 dB
LAF99	32.3 dB

Calibration Information	Person	Place	Project
08/10/2015 13:49:33 -0.26 dB	Gareth Carroll	Rusal Aughinish	1017_37
08/10/2015 16:05:25 -0.46 dB	Graduate Environmental Co...		

Time History



Frequency Bands



Report ID

Cirrus Research plc

Measurement Summary Report

Name	B7 Day 3
Time	08/10/2015 14:25:11
Duration	00:15:00
Instrument	GO56143, CR:171B

Summary

LAeq	36.7 dB
LAE	66.2 dB
LAFMax	58.7 dB

LAF1	43.9 dB
LAF5	40.5 dB
LAF10	38.8 dB
LAF50	34.8 dB
LAF90	33.3 dB
LAF95	32.9 dB
LAF99	32.4 dB

Calibration Information

08/10/2015 13:49:33 -0.26 dB

08/10/2015 16:05:25 -0.46 dB

Person

Gareth Carroll

Graduate Environmental Co...

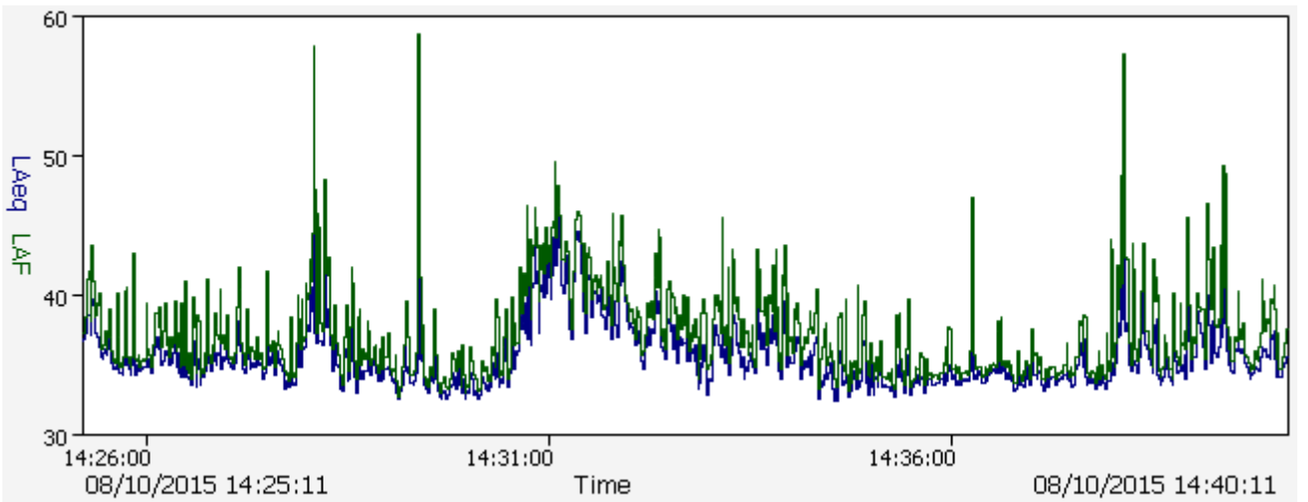
Place

Rusal Aughinish

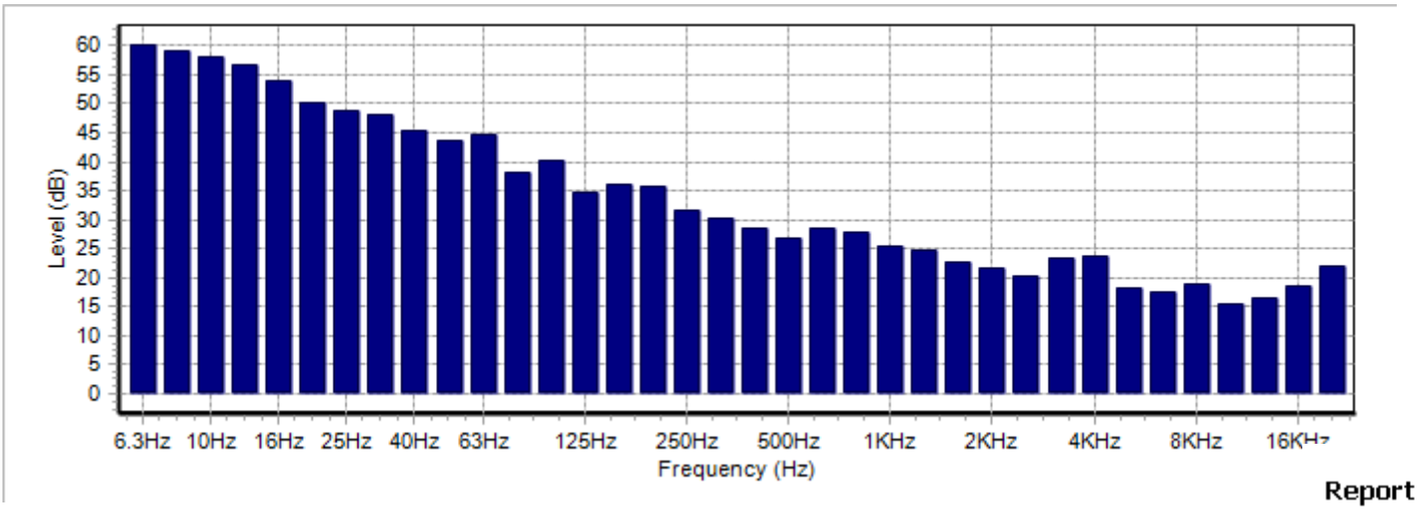
Project

1017_37

Time History



Frequency Bands



Report ID

Cirrus Research plc

Measurement Summary Report

Name	B7 Evening 1
Time	12/10/2015 21:23:28
Duration	00:15:00
Instrument	GO56143, CR:171B

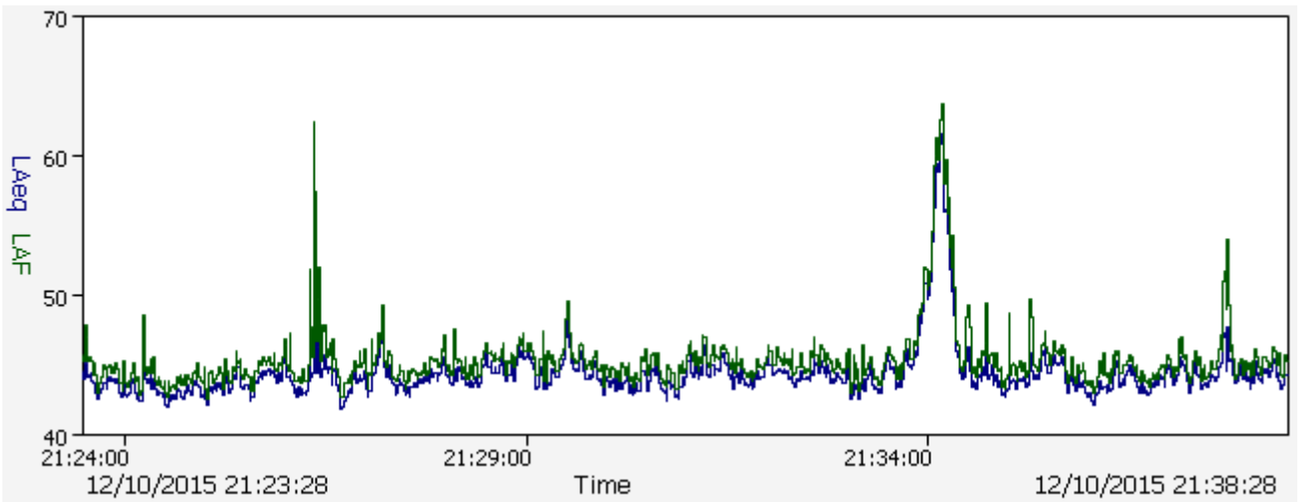
Summary

LAeq	45.7 dB
LAE	75.2 dB
LAFMax	63.7 dB

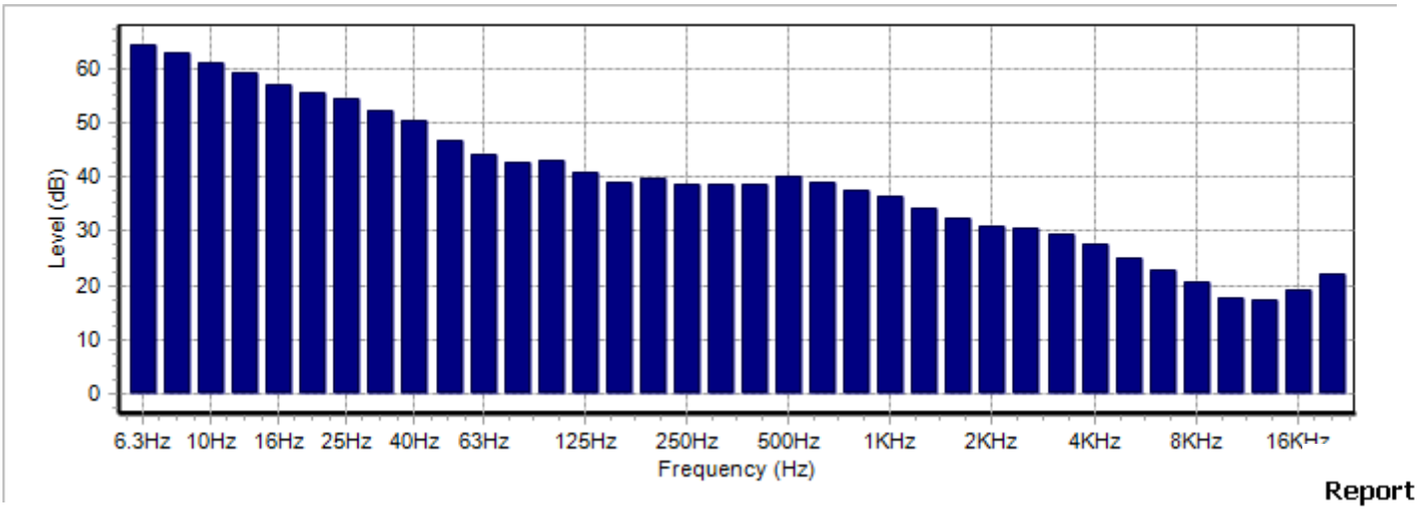
LAF1	55.2 dB
LAF5	46.2 dB
LAF10	45.4 dB
LAF50	43.9 dB
LAF90	42.8 dB
LAF95	42.5 dB
LAF99	42.0 dB

Calibration Information	Person	Place	Project
12/10/2015 20:40:27 -0.36 dB	Gareth Carroll	Rusal Aughinish	1017_37
12/10/2015 22:53:35 -0.34 dB	Graduate Environmental Co...		

Time History



Frequency Bands



Report ID

Cirrus Research plc

Measurement Summary Report

Name	B7 Night 1
Time	13/10/2015 03:57:40
Duration	00:15:00
Instrument	GO56143, CR:171B

Summary

LAeq	41.3 dB
LAE	70.8 dB
LAFMax	56.5 dB

LAF1	44.4 dB
LAF5	43.6 dB
LAF10	43.3 dB
LAF50	41.1 dB
LAF90	37.5 dB
LAF95	37.1 dB
LAF99	36.5 dB

Calibration Information

12/10/2015 22:53:35 -0.34 dB
13/10/2015 10:55:47 -0.80 dB

Person

Gareth Carroll
Graduate Environmental Co...

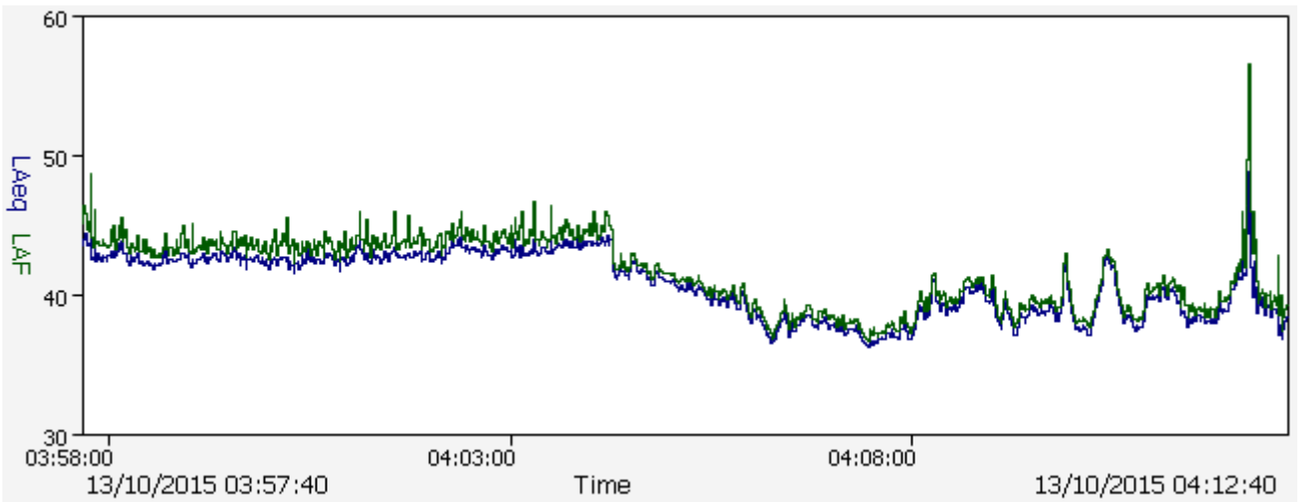
Place

Rusal Aughinish

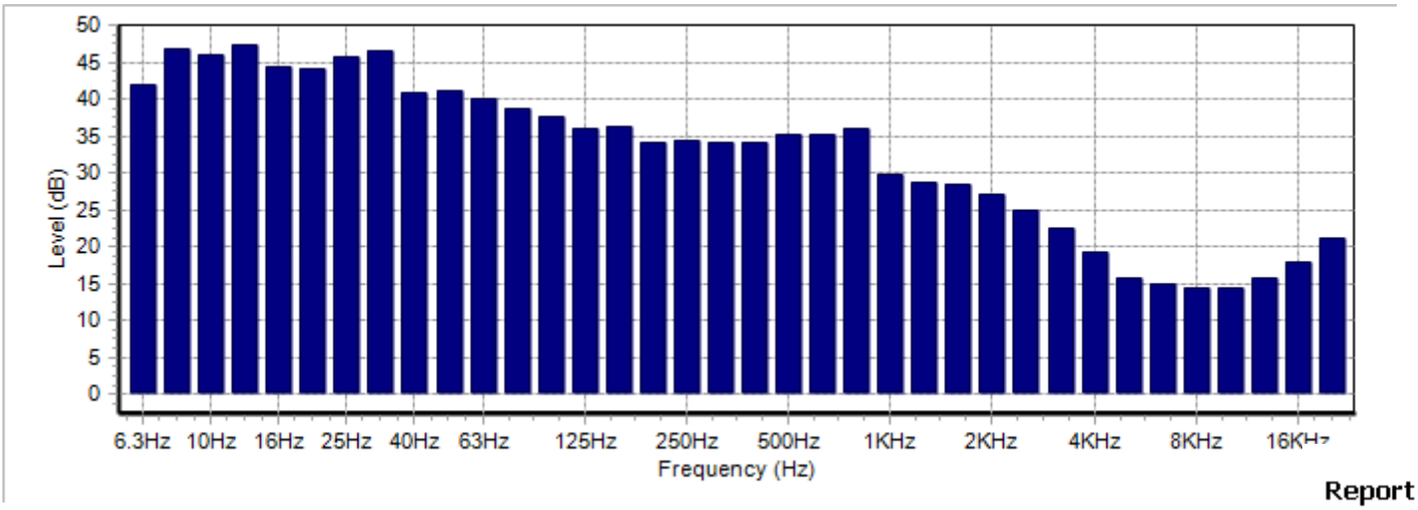
Project

1017_37

Time History



Frequency Bands



Report ID

Cirrus Research plc

Measurement Summary Report

Name	B7 Night 2
Time	13/10/2015 04:12:47
Duration	00:15:00
Instrument	GO56143, CR:171B

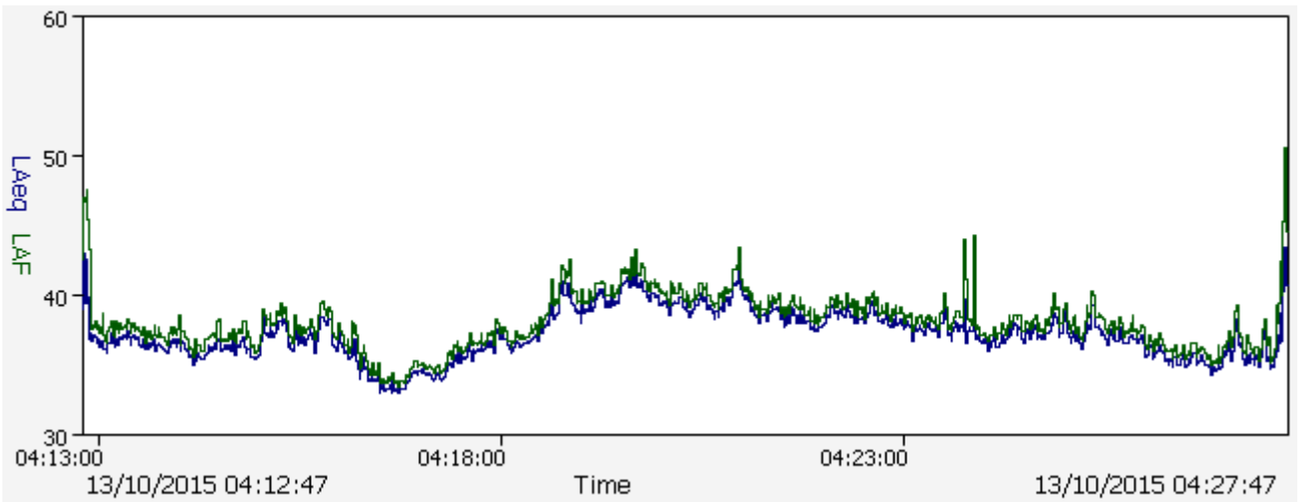
Summary

LAeq	37.5 dB
LAE	67.1 dB
LAFMax	50.5 dB

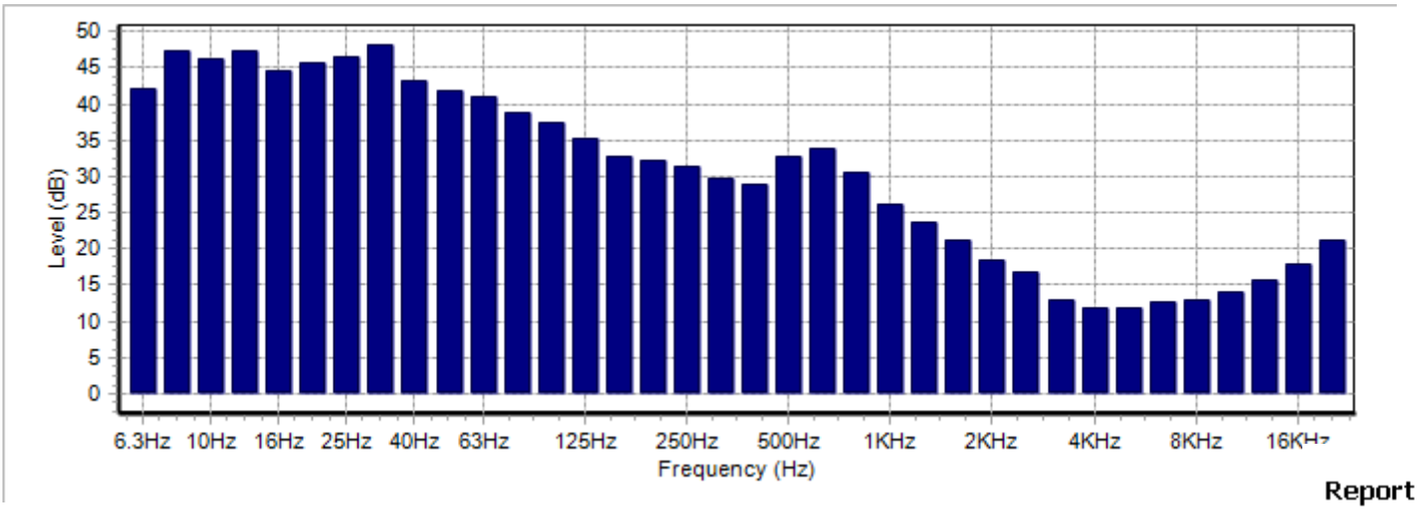
LAF1	41.2 dB
LAF5	40.0 dB
LAF10	39.4 dB
LAF50	37.0 dB
LAF90	34.8 dB
LAF95	34.1 dB
LAF99	33.1 dB

Calibration Information	Person	Place	Project
12/10/2015 22:53:35 -0.34 dB	Gareth Carroll	Rusal Aughinish	1017_37
13/10/2015 10:55:47 -0.80 dB	Graduate Environmental Co...		

Time History



Frequency Bands



Report ID

Cirrus Research plc

Measurement Summary Report

Name	B8 Day 1
Time	08/10/2015 14:48:40
Duration	00:15:00
Instrument	GO56143, CR:171B

Summary

LAeq	42.0 dB
LAE	71.5 dB
LAFMax	60.5 dB

LAF1	48.2 dB
LAF5	45.7 dB
LAF10	44.4 dB
LAF50	40.8 dB
LAF90	38.2 dB
LAF95	37.6 dB
LAF99	36.5 dB

Calibration Information

08/10/2015 13:49:33 -0.26 dB
08/10/2015 16:05:25 -0.46 dB

Person

Gareth Carroll
Graduate Environmental Co...

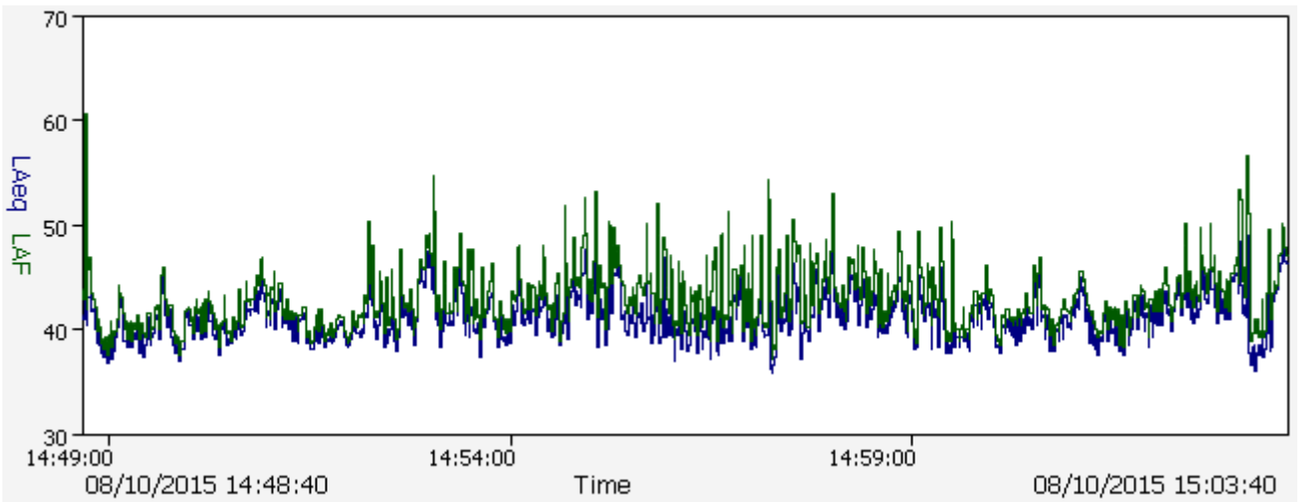
Place

Rusal Aughinish

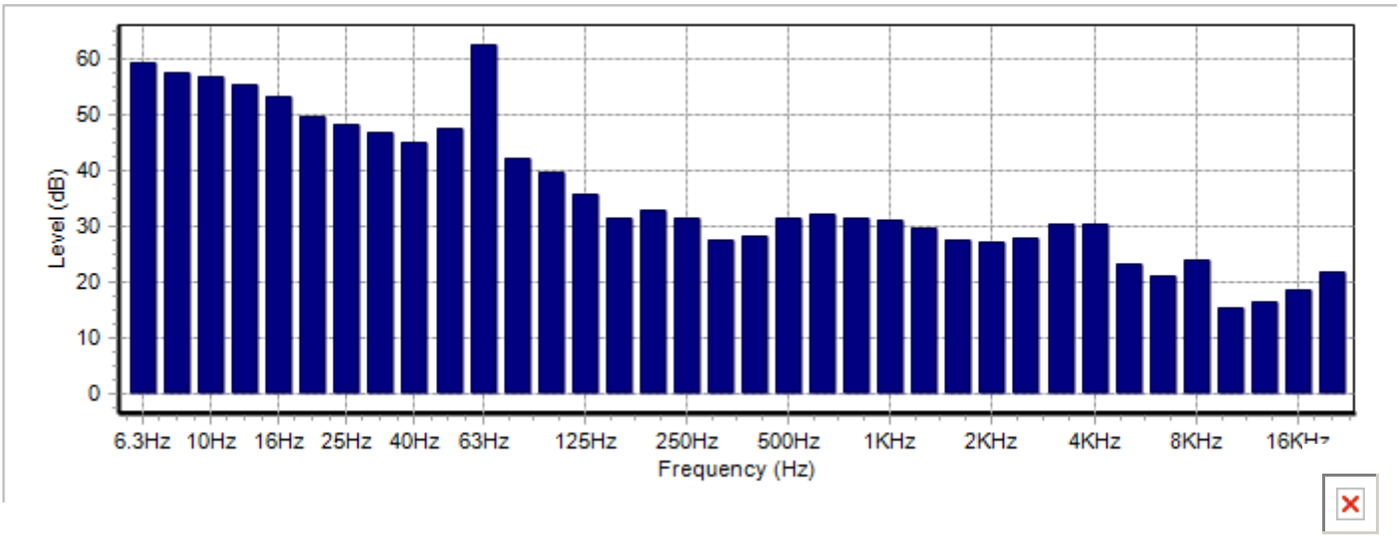
Project

1017_37

Time History



Frequency Bands



Cirrus Research plc

Measurement Summary Report

Name	B8 Day 2
Time	08/10/2015 15:04:07
Duration	00:15:00
Instrument	GO56143, CR:171B

Summary

LAeq	41.7 dB
LAE	71.3 dB
LAFMax	56.1 dB

LAF1	51.8 dB
LAF5	46.1 dB
LAF10	43.8 dB
LAF50	39.2 dB
LAF90	35.5 dB
LAF95	34.5 dB
LAF99	33.2 dB

Calibration Information

08/10/2015 13:49:33 -0.26 dB
08/10/2015 16:05:25 -0.46 dB

Person

Gareth Carroll
Graduate Environmental Co...

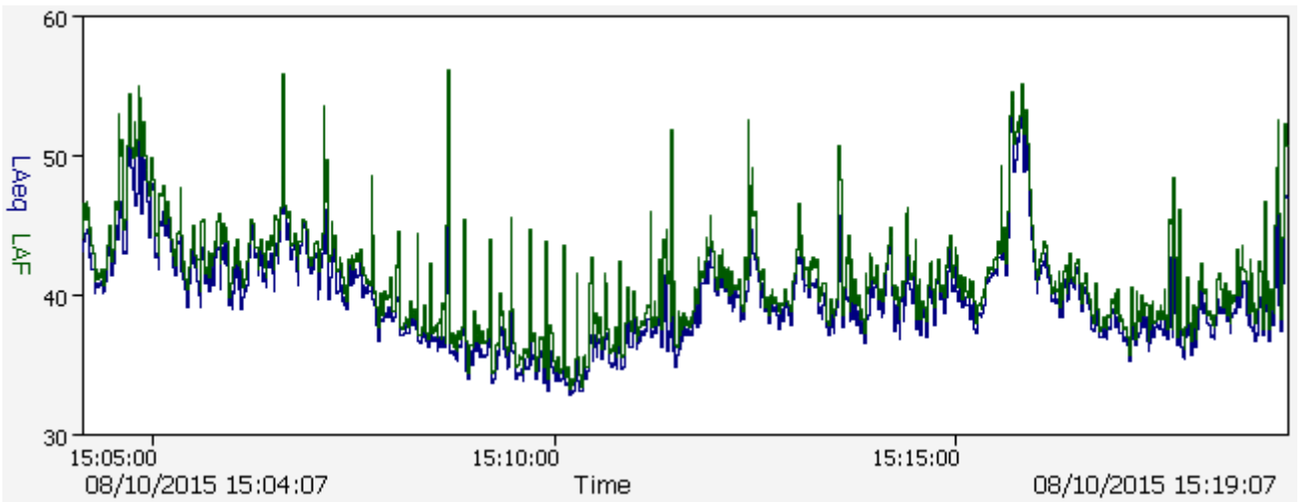
Place

Rusal Aughinish

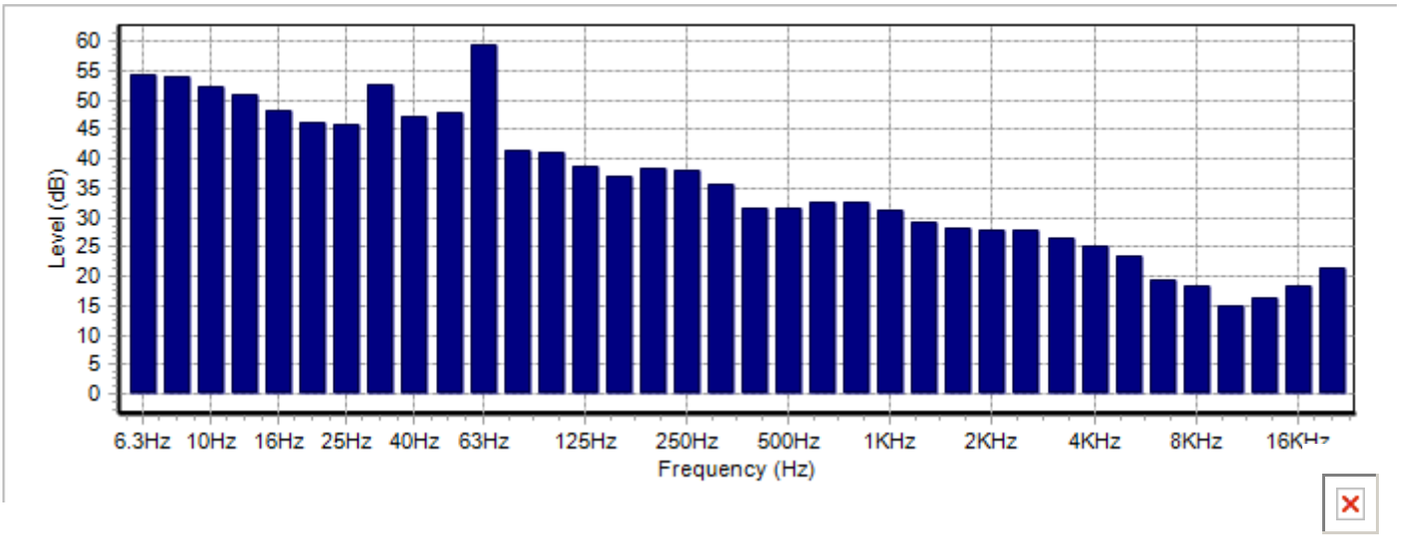
Project

1017_37

Time History



Frequency Bands



Cirrus Research plc

Measurement Summary Report

Name	B8 Day 3
Time	08/10/2015 15:19:27
Duration	00:15:00
Instrument	GO56143, CR:171B

Summary

LAeq	40.2 dB
LAE	69.7 dB
LAFMax	48.7 dB

LAF1	44.4 dB
LAF5	42.7 dB
LAF10	42.1 dB
LAF50	39.7 dB
LAF90	37.2 dB
LAF95	36.5 dB
LAF99	34.8 dB

Calibration Information

08/10/2015 13:49:33 -0.26 dB

08/10/2015 16:05:25 -0.46 dB

Person

Gareth Carroll

Graduate Environmental Co...

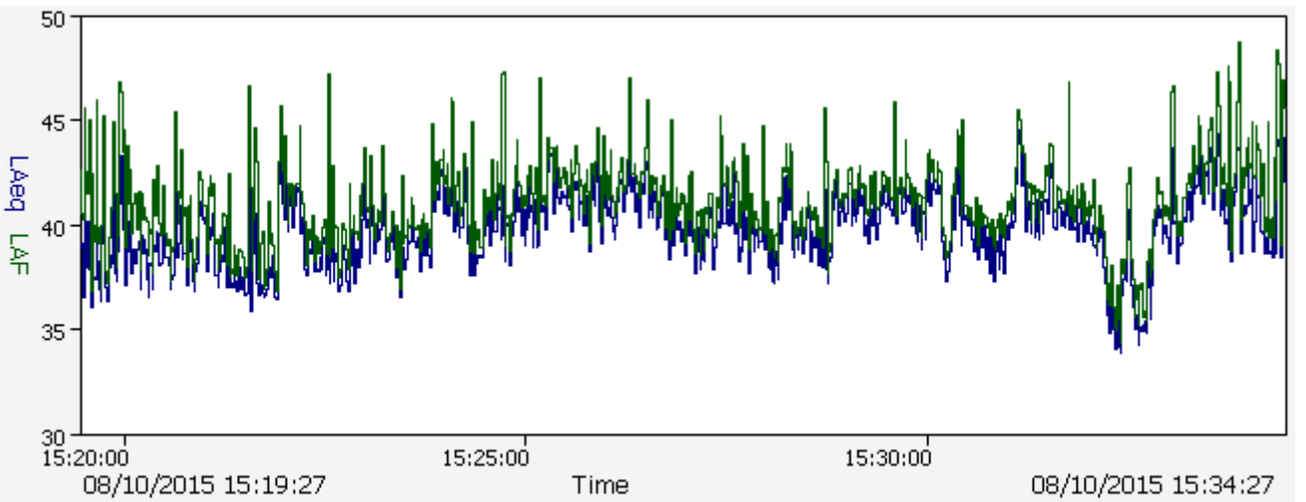
Place

Rusal Aughinish

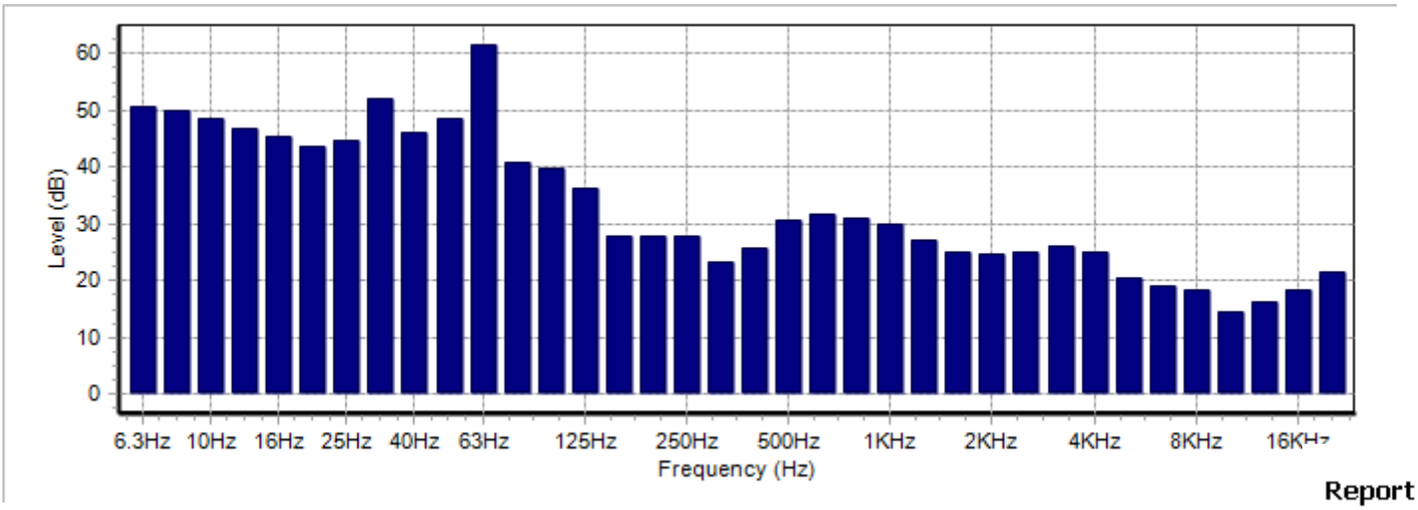
Project

1017_37

Time History



Frequency Bands



Report ID

Cirrus Research plc

Measurement Summary Report

Name	B8 Evening 1
Time	12/10/2015 21:42:39
Duration	00:15:00
Instrument	GO56143, CR:171B

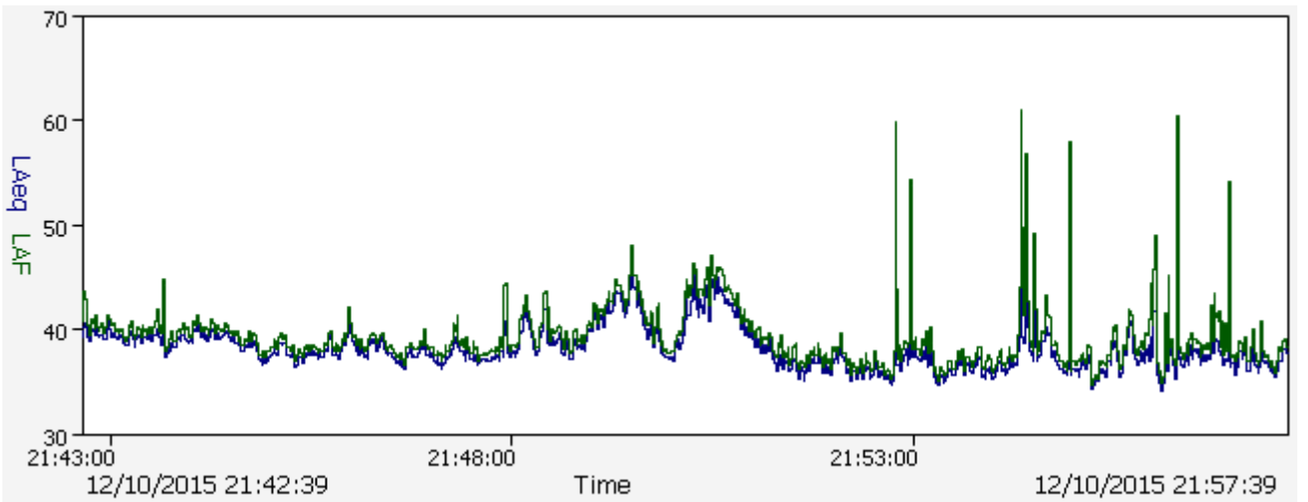
Summary

LAeq	39.2 dB
LAE	68.7 dB
LAFMax	60.9 dB

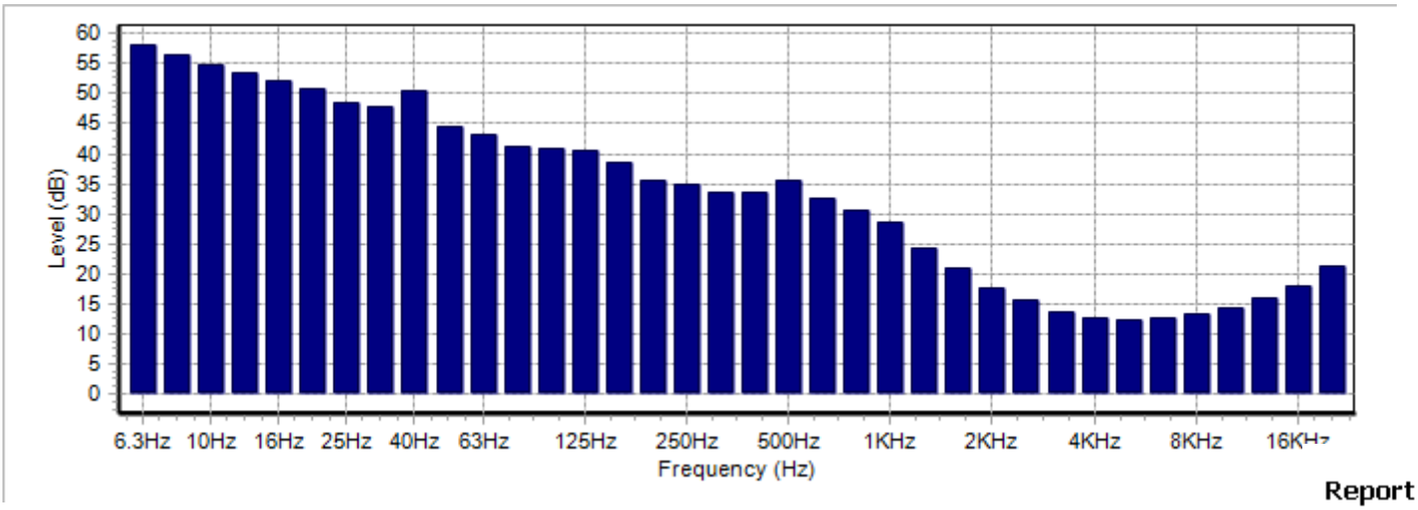
LAF1	44.7 dB
LAF5	42.4 dB
LAF10	40.9 dB
LAF50	37.7 dB
LAF90	35.8 dB
LAF95	35.4 dB
LAF99	34.7 dB

Calibration Information	Person	Place	Project
12/10/2015 20:40:27 -0.36 dB	Gareth Carroll	Rusal Aughinish	1017_37
12/10/2015 22:53:35 -0.34 dB	Graduate Environmental Co...		

Time History



Frequency Bands



Report ID

Cirrus Research plc

Measurement Summary Report

Name	B8 Night 1
Time	13/10/2015 04:32:07
Duration	00:15:00
Instrument	GO56143, CR:171B

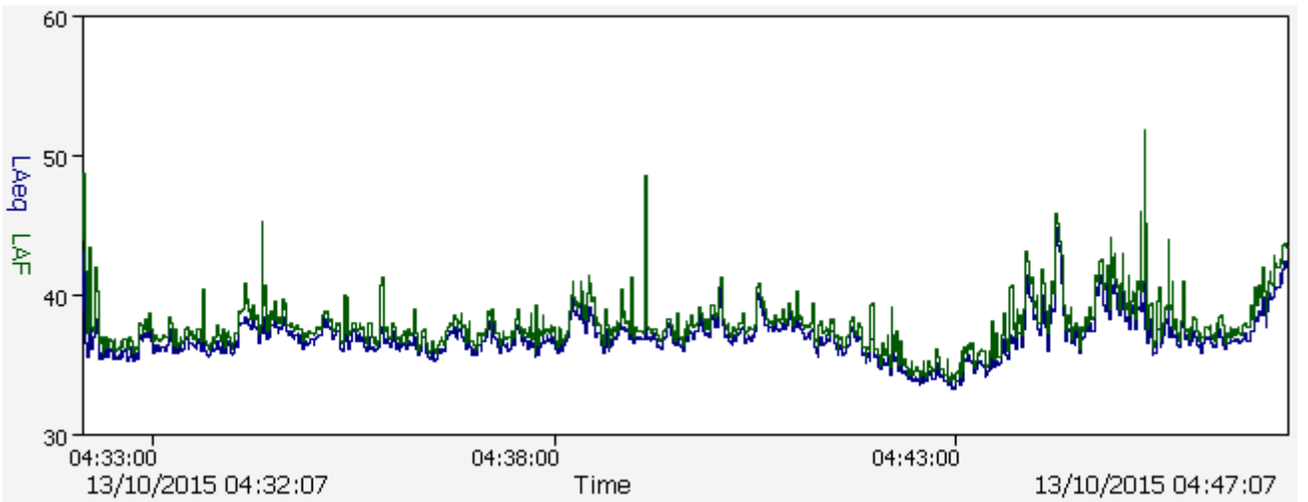
Summary

LAeq	37.2 dB
LAE	66.8 dB
LAFMax	51.8 dB

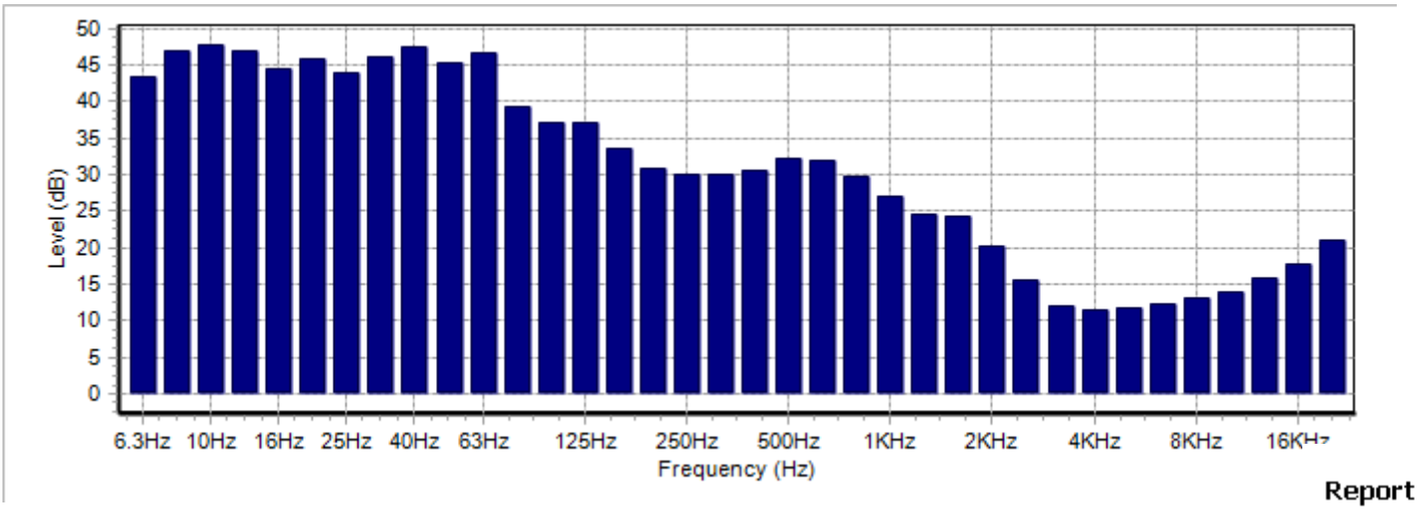
LAF1	42.4 dB
LAF5	39.8 dB
LAF10	38.6 dB
LAF50	36.7 dB
LAF90	35.2 dB
LAF95	34.4 dB
LAF99	33.5 dB

Calibration Information	Person	Place	Project
12/10/2015 22:53:35 -0.34 dB	Gareth Carroll	Rusal Aughinish	1017_37
13/10/2015 10:55:47 -0.80 dB	Graduate Environmental Co...		

Time History



Frequency Bands



Report ID

Cirrus Research plc

Measurement Summary Report

Name	B8 Night 2
Time	13/10/2015 04:47:13
Duration	00:15:00
Instrument	GO56143, CR:171B

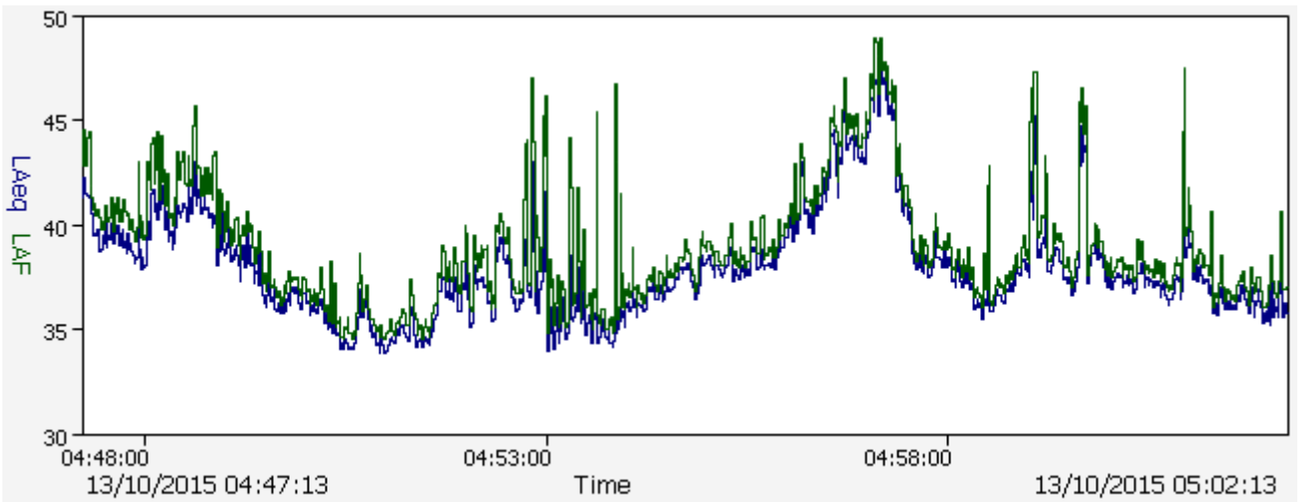
Summary

LAeq	38.9 dB
LAE	68.4 dB
LAFMax	48.9 dB

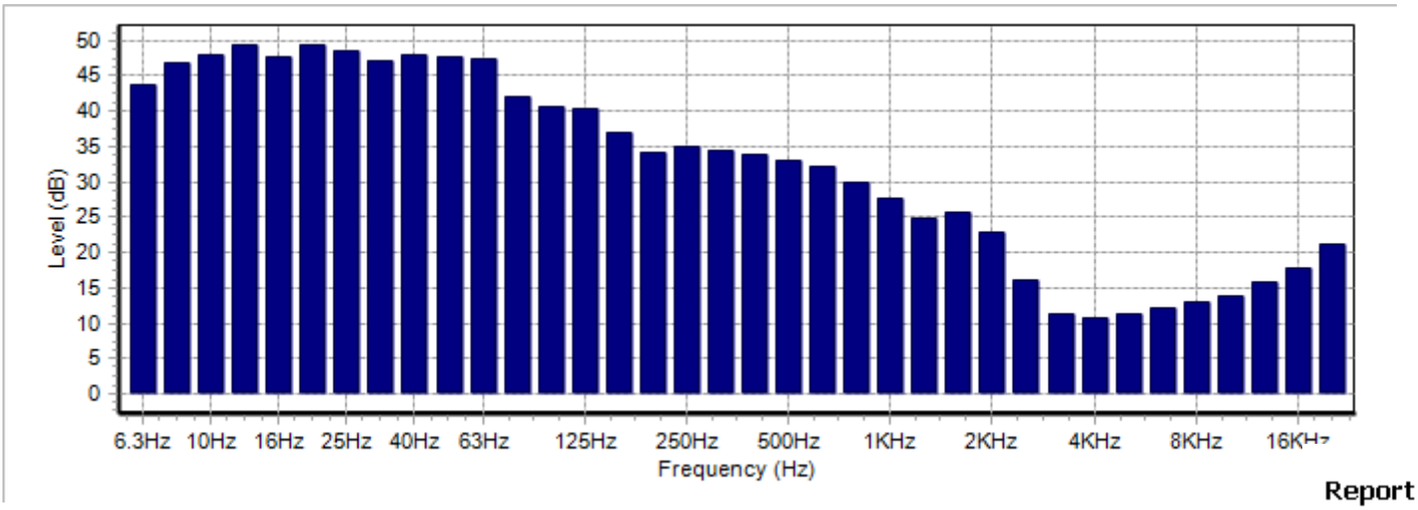
LAF1	46.1 dB
LAF5	43.5 dB
LAF10	41.3 dB
LAF50	37.4 dB
LAF90	35.0 dB
LAF95	34.4 dB
LAF99	33.9 dB

Calibration Information	Person	Place	Project
12/10/2015 22:53:35 -0.34 dB	Gareth Carroll	Rusal Aughinish	1017_37
13/10/2015 10:55:47 -0.80 dB	Graduate Environmental Co...		

Time History



Frequency Bands



Report ID

Cirrus Research plc

Measurement Summary Report

Name	B9 Day 1
Time	09/10/2015 11:04:25
Duration	00:15:00
Instrument	GO56143, CR:171B

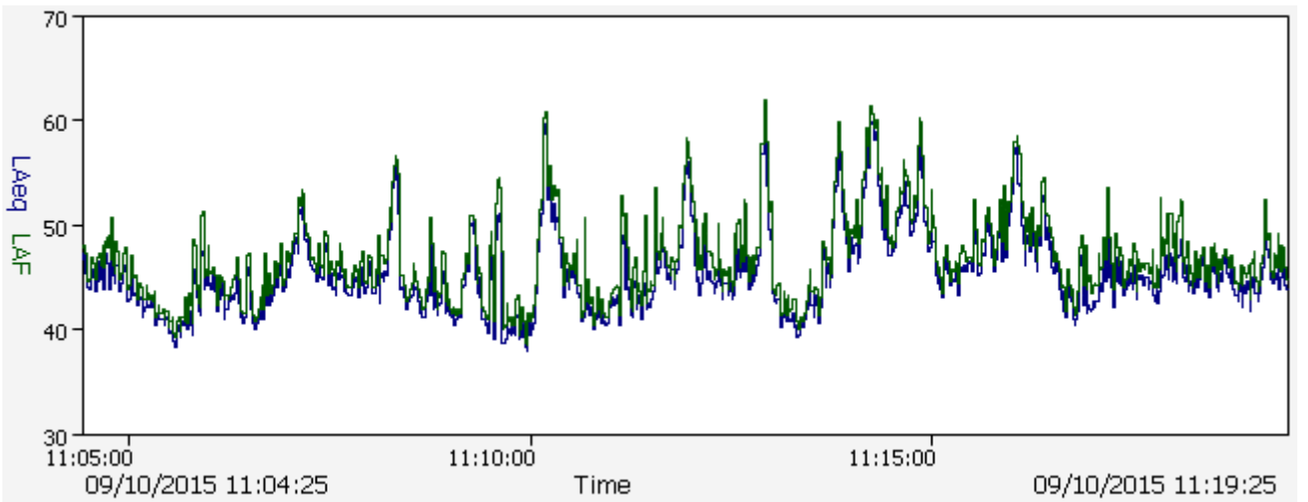
Summary

LAeq	47.9 dB
LAE	77.5 dB
LAFMax	61.9 dB

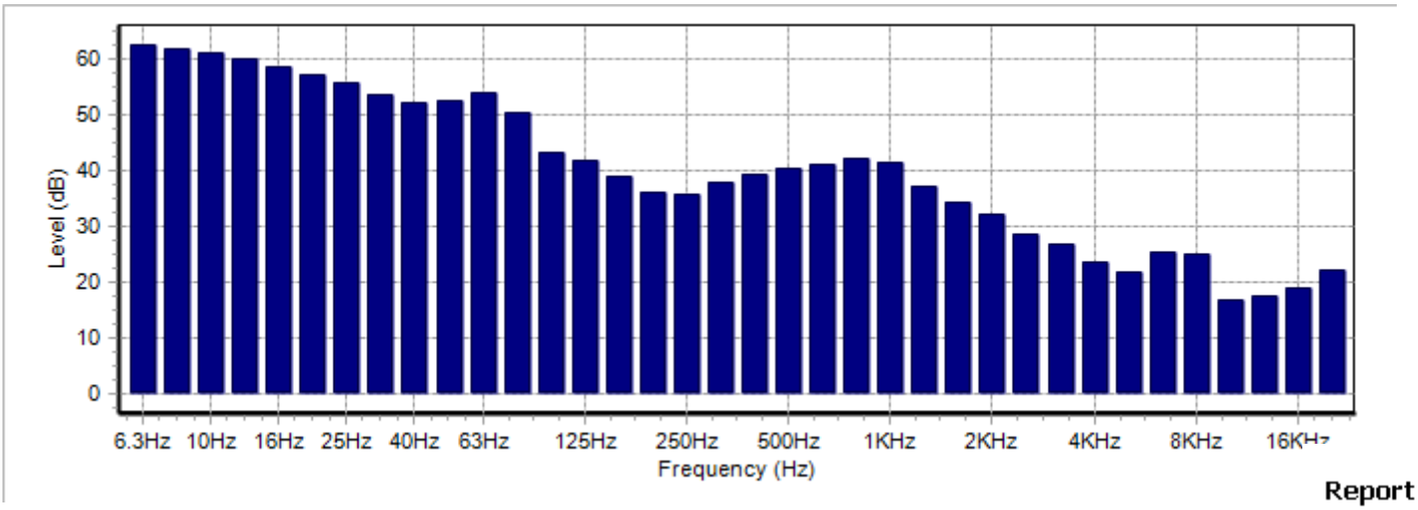
LAF1	58.3 dB
LAF5	53.3 dB
LAF10	50.6 dB
LAF50	44.5 dB
LAF90	40.9 dB
LAF95	40.1 dB
LAF99	38.9 dB

Calibration Information	Person	Place	Project
09/10/2015 09:25:51 -0.51 dB	Gareth Carroll	Rusal Aughinish	1017_37
09/10/2015 12:31:39 -0.34 dB	Graduate Environmental Co...		

Time History



Frequency Bands



Report ID

Cirrus Research plc

Measurement Summary Report

Name	B9 Day 2
Time	09/10/2015 11:19:35
Duration	00:15:00
Instrument	GO56143, CR:171B

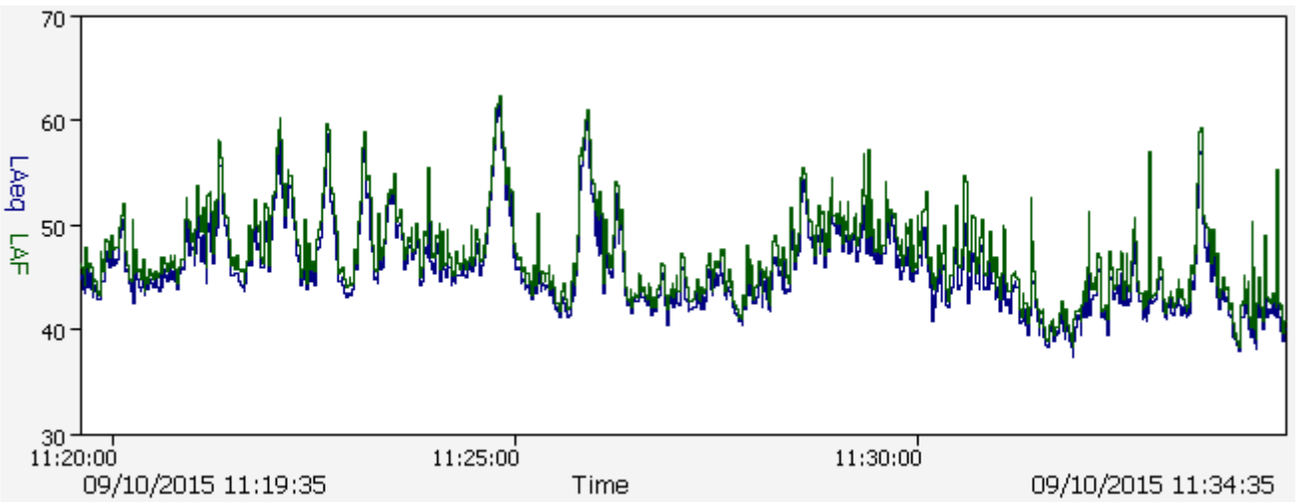
Summary

LAeq	48.3 dB
LAE	77.8 dB
LAFMax	62.3 dB

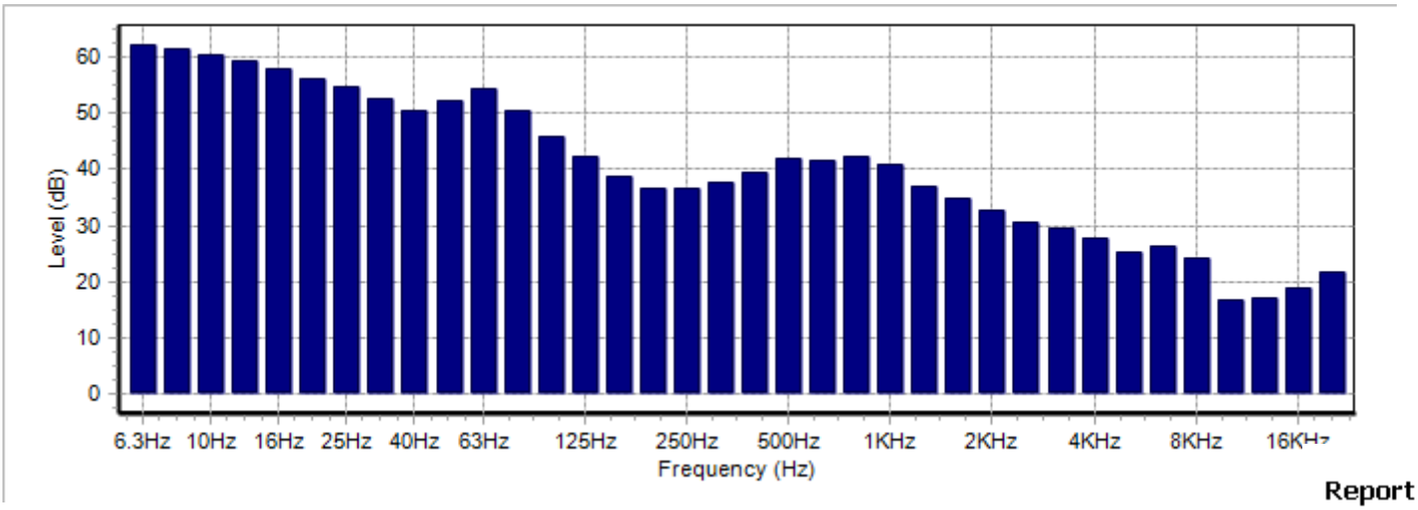
LAF1	58.6 dB
LAF5	53.4 dB
LAF10	51.0 dB
LAF50	45.0 dB
LAF90	41.3 dB
LAF95	40.3 dB
LAF99	38.5 dB

Calibration Information	Person	Place	Project
09/10/2015 09:25:51 -0.51 dB	Gareth Carroll	Rusal Aughinish	1017_37
09/10/2015 12:31:39 -0.34 dB	Graduate Environmental Co...		

Time History



Frequency Bands



Report ID

Cirrus Research plc

Measurement Summary Report

Name	B9 Day 3
Time	09/10/2015 11:34:44
Duration	00:15:00
Instrument	GO56143, CR:171B

Summary

LAeq	49.2 dB
LAE	78.7 dB
LAFMax	64.7 dB

LAF1	58.9 dB
LAF5	54.5 dB
LAF10	52.0 dB
LAF50	45.7 dB
LAF90	41.7 dB
LAF95	40.8 dB
LAF99	39.8 dB

Calibration Information

09/10/2015 09:25:51 -0.51 dB

09/10/2015 12:31:39 -0.34 dB

Person

Gareth Carroll

Graduate Environmental Co...

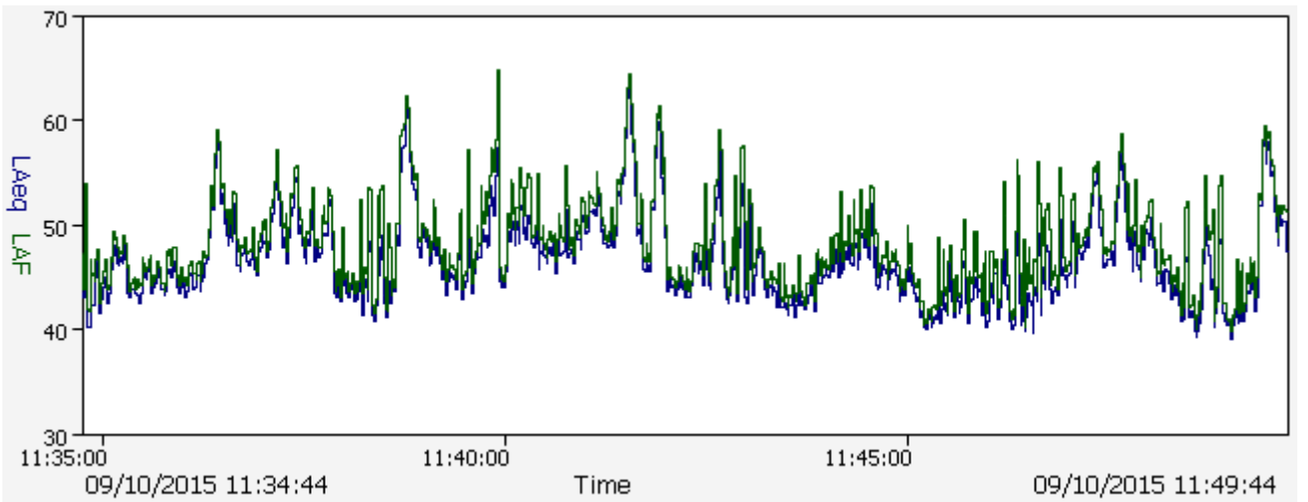
Place

Rusal Aughinish

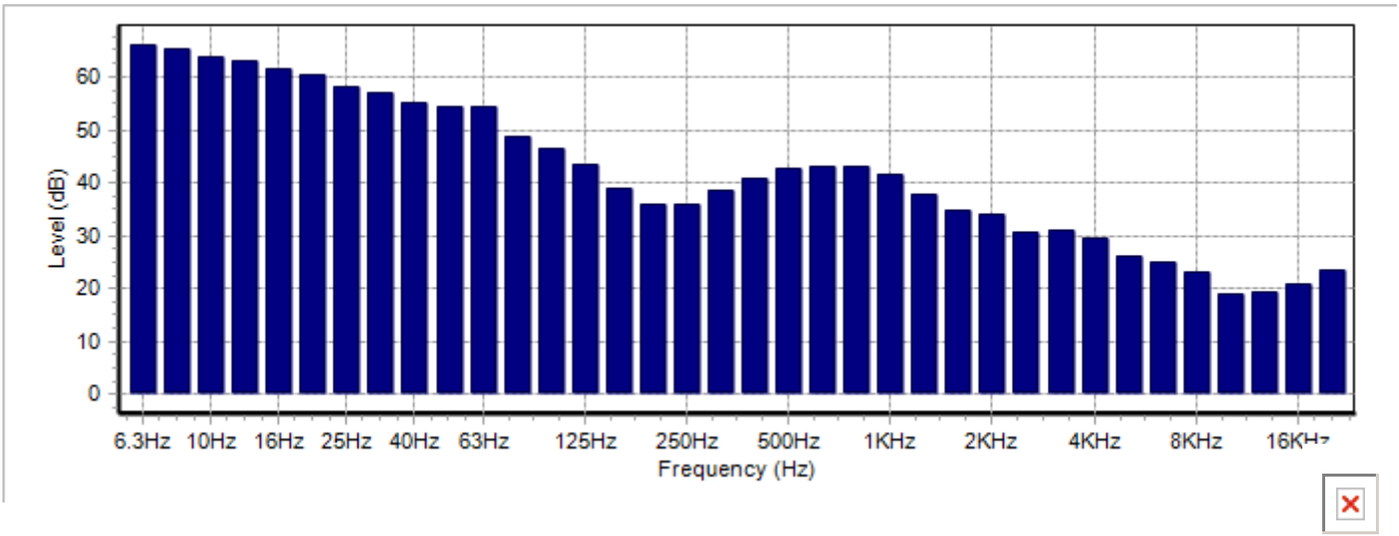
Project

1017_37

Time History



Frequency Bands



Cirrus Research plc

Measurement Summary Report

Name	B9 Evening 1
Time	08/10/2015 21:39:11
Duration	00:15:00
Instrument	GO56143, CR:171B

Summary

LAeq	44.9 dB
LAE	74.4 dB
LAFMax	65.0 dB

LAF1	57.5 dB
LAF5	48.3 dB
LAF10	45.0 dB
LAF50	38.7 dB
LAF90	33.2 dB
LAF95	32.0 dB
LAF99	29.8 dB

Calibration Information

08/10/2015 20:28:31 -0.22 dB

08/10/2015 22:52:47 -0.32 dB

Person

Gareth Carroll

Graduate Environmental Co...

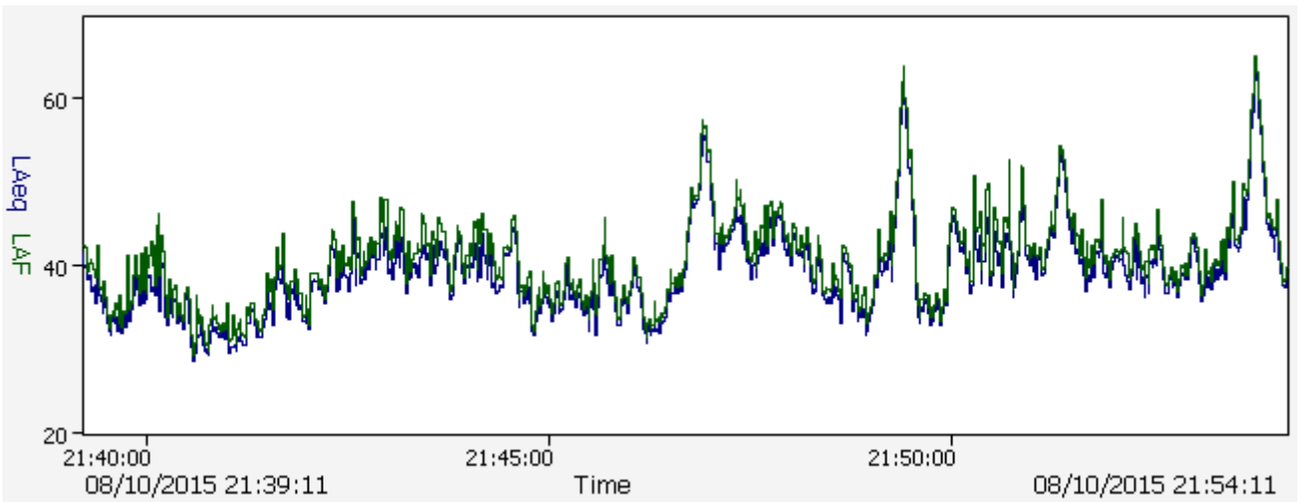
Place

Rusal Aughinish

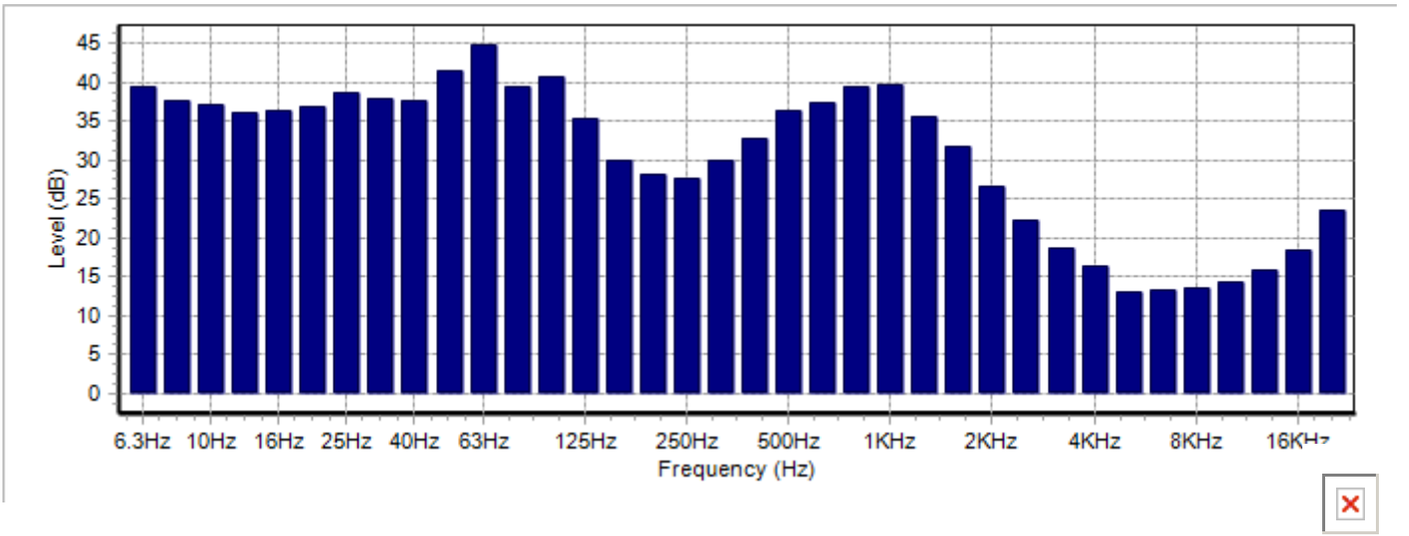
Project

1017_37

Time History



Frequency Bands



Cirrus Research plc

Measurement Summary Report

Name	B9 Night 1
Time	09/10/2015 03:37:36
Duration	00:15:00
Instrument	GO56143, CR:171B

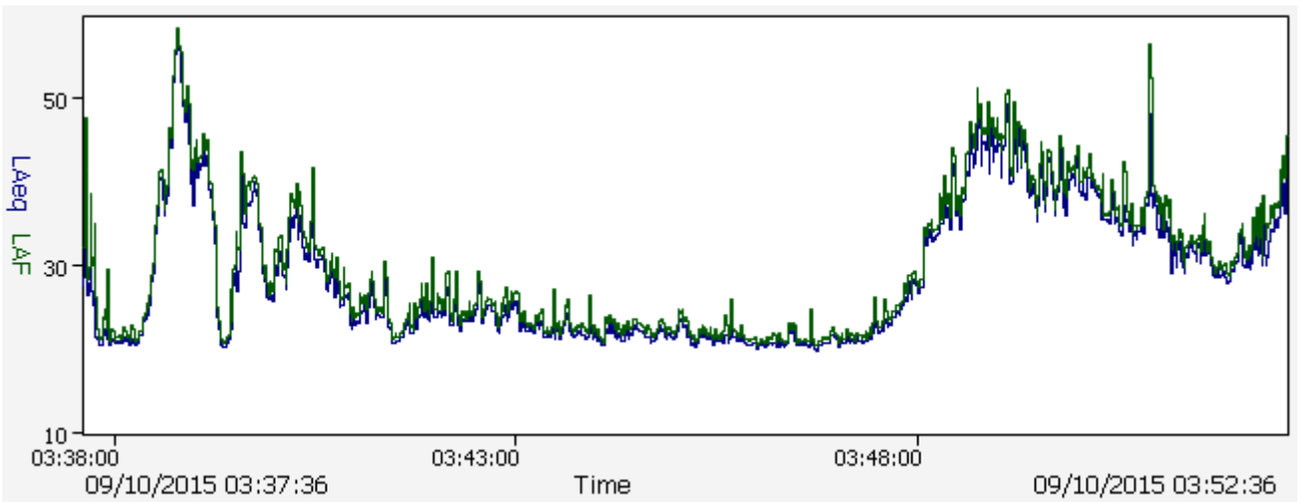
Summary

LAeq	38.3 dB
LAE	67.8 dB
LAFMax	58.4 dB

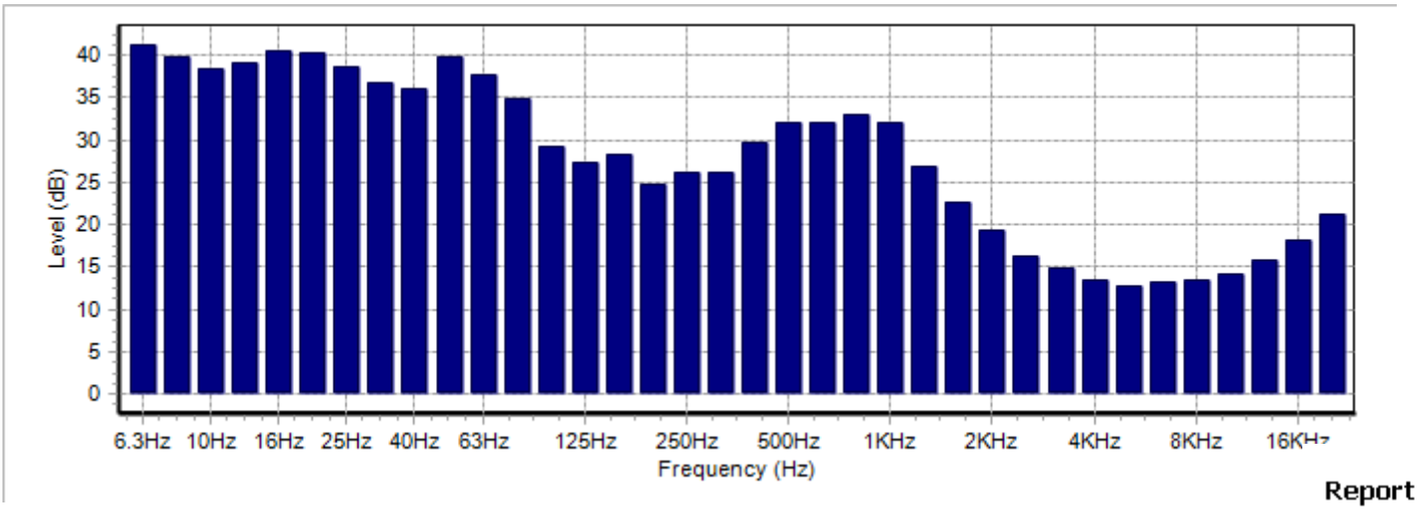
LAF1	49.6 dB
LAF5	43.8 dB
LAF10	40.4 dB
LAF50	25.5 dB
LAF90	20.8 dB
LAF95	20.6 dB
LAF99	20.2 dB

Calibration Information	Person	Place	Project
08/10/2015 22:52:47 -0.32 dB	Gareth Carroll	Rusal Aughinish	1017_37
09/10/2015 09:25:51 -0.51 dB	Graduate Environmental Co...		

Time History



Frequency Bands



Report ID

Cirrus Research plc

Measurement Summary Report

Name	B9 Night 2
Time	09/10/2015 03:52:40
Duration	00:15:00
Instrument	GO56143, CR:171B

Summary

LAeq	44.3 dB
LAE	73.8 dB
LAFMax	67.2 dB

LAF1	57.5 dB
LAF5	43.1 dB
LAF10	40.0 dB
LAF50	27.5 dB
LAF90	20.3 dB
LAF95	20.1 dB
LAF99	20.0 dB

Calibration Information

08/10/2015 22:52:47 -0.32 dB
09/10/2015 09:25:51 -0.51 dB

Person

Gareth Carroll
Graduate Environmental Co...

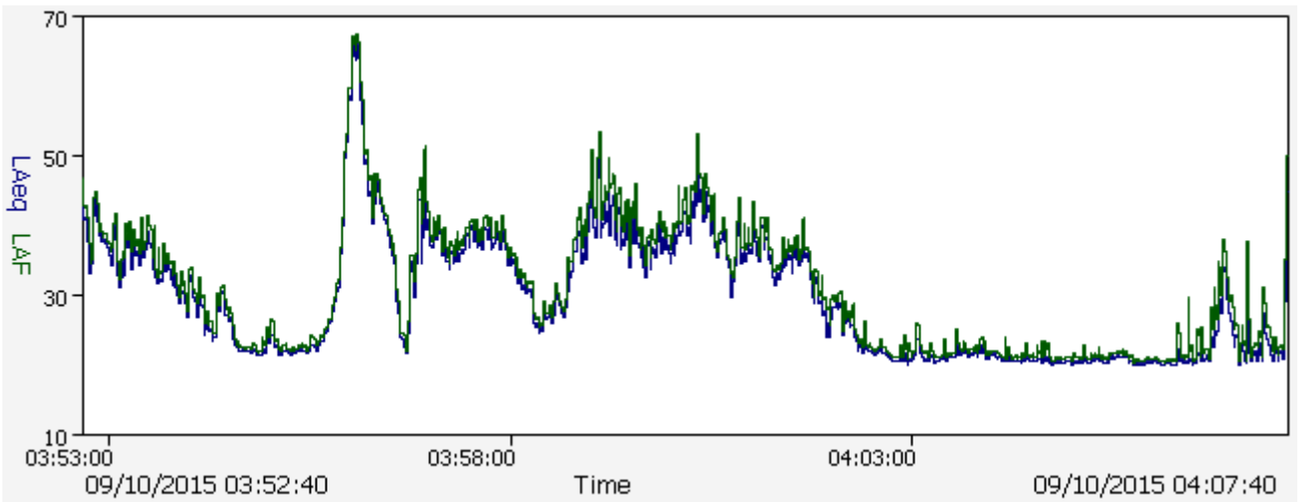
Place

Rusal Aughinish

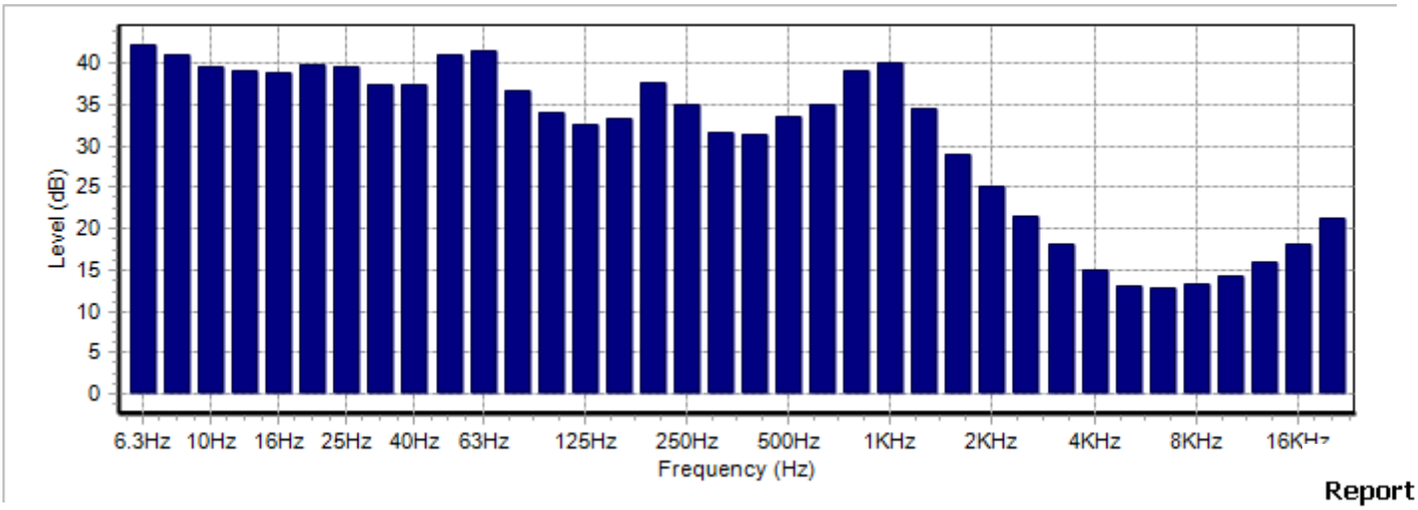
Project

1017_37

Time History



Frequency Bands



Report ID

Cirrus Research plc

Measurement Summary Report

Name	NSL1 Day 1
Time	12/10/2015 10:02:26
Duration	00:30:00
Instrument	GO56143, CR:171B

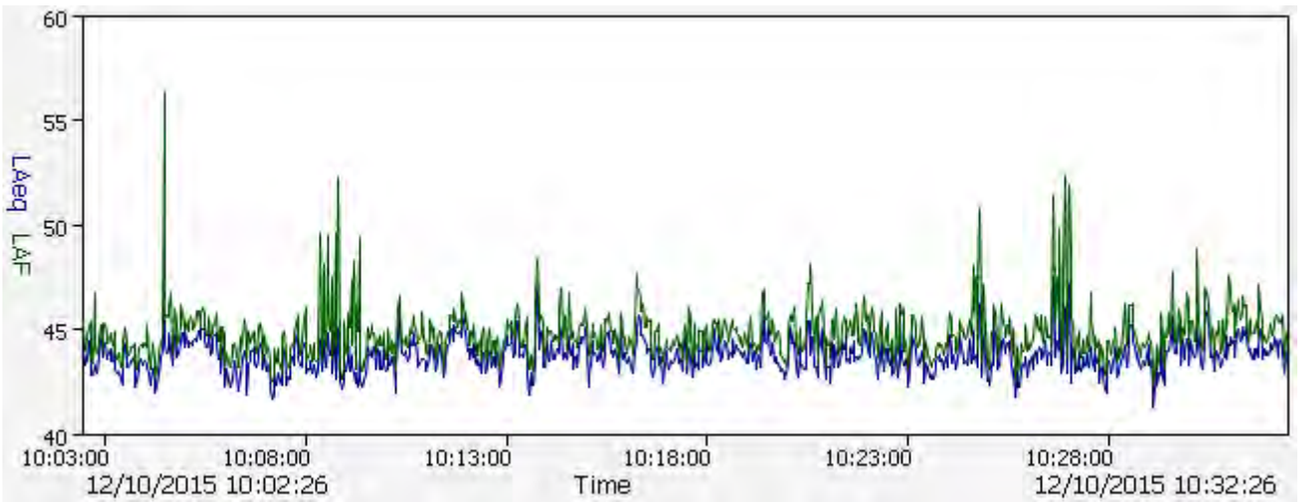
Summary

LAeq	43.8 dB
LAE	76.4 dB
LAFMax	56.3 dB

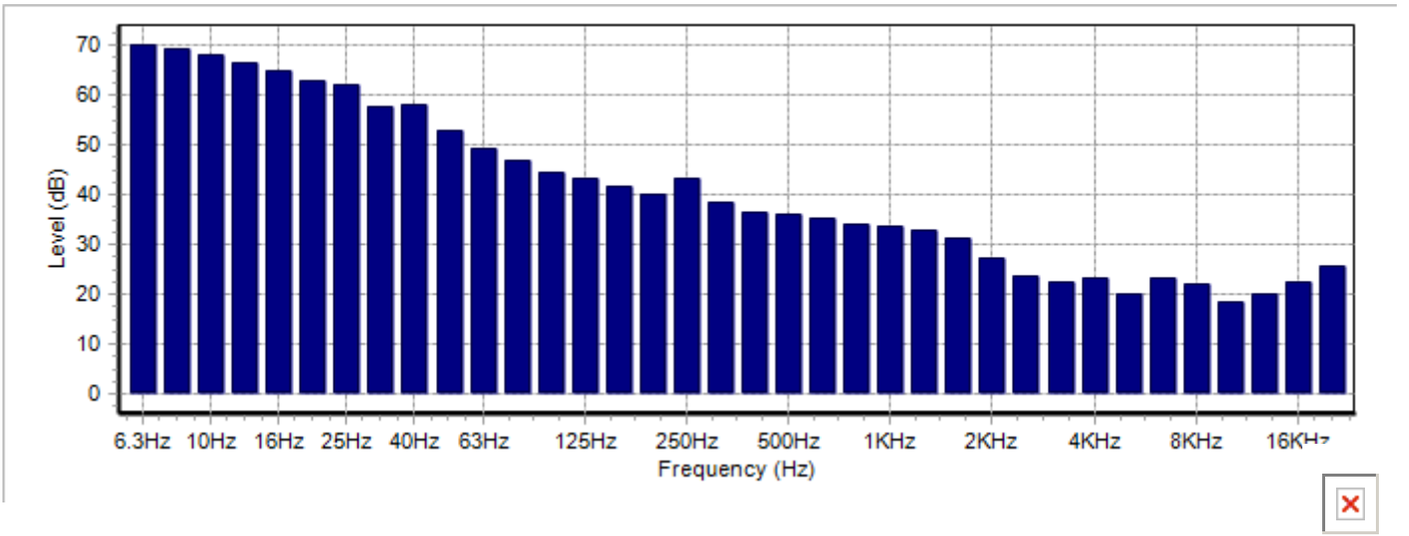
LAF1	46.0 dB
LAF5	45.1 dB
LAF10	44.8 dB
LAF50	43.6 dB
LAF90	42.6 dB
LAF95	42.3 dB
LAF99	41.7 dB

Calibration Information	Person	Place	Project
12/10/2015 09:57:57 -0.21 dB	Gareth Carroll	Rusal Aughinish	1017_37
12/10/2015 11:40:31 -0.30 dB	Graduate Environmental Co...		

Time History



Frequency Bands



Cirrus Research plc

Measurement Summary Report

Name	NSL1 Day 2
Time	12/10/2015 10:32:31
Duration	00:30:00
Instrument	GO56143, CR:171B

Summary

LAeq	43.5 dB
LAE	76.1 dB
LAFMax	53.2 dB

LAF1	46.8 dB
LAF5	45.0 dB
LAF10	44.5 dB
LAF50	43.2 dB
LAF90	42.1 dB
LAF95	41.7 dB
LAF99	41.2 dB

Calibration Information

12/10/2015 09:57:57 -0.21 dB

12/10/2015 11:40:31 -0.30 dB

Person

Gareth Carroll

Graduate Environmental Co...

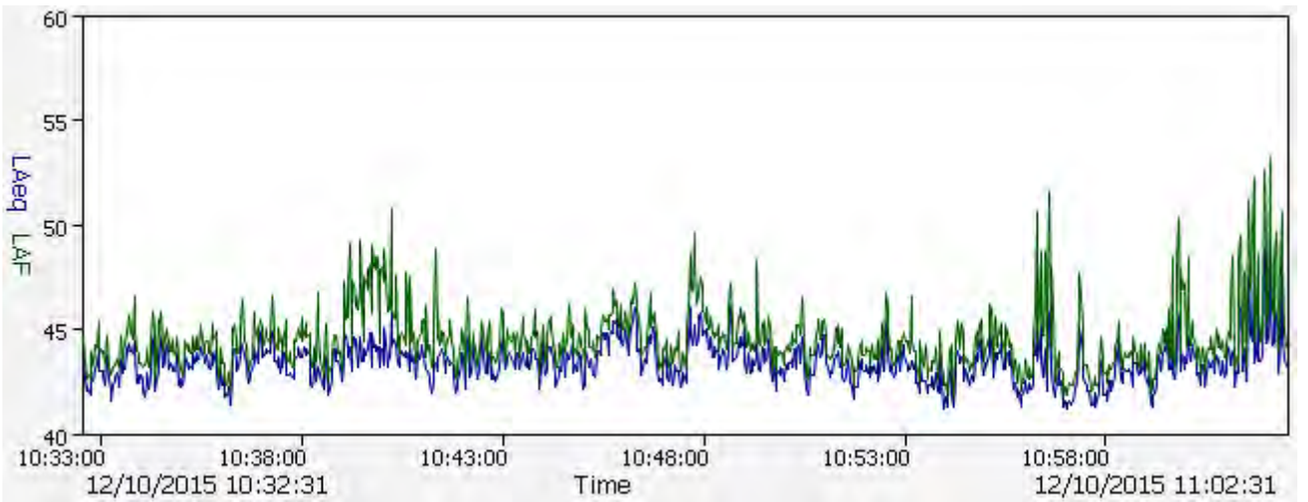
Place

Rusal Aughinish

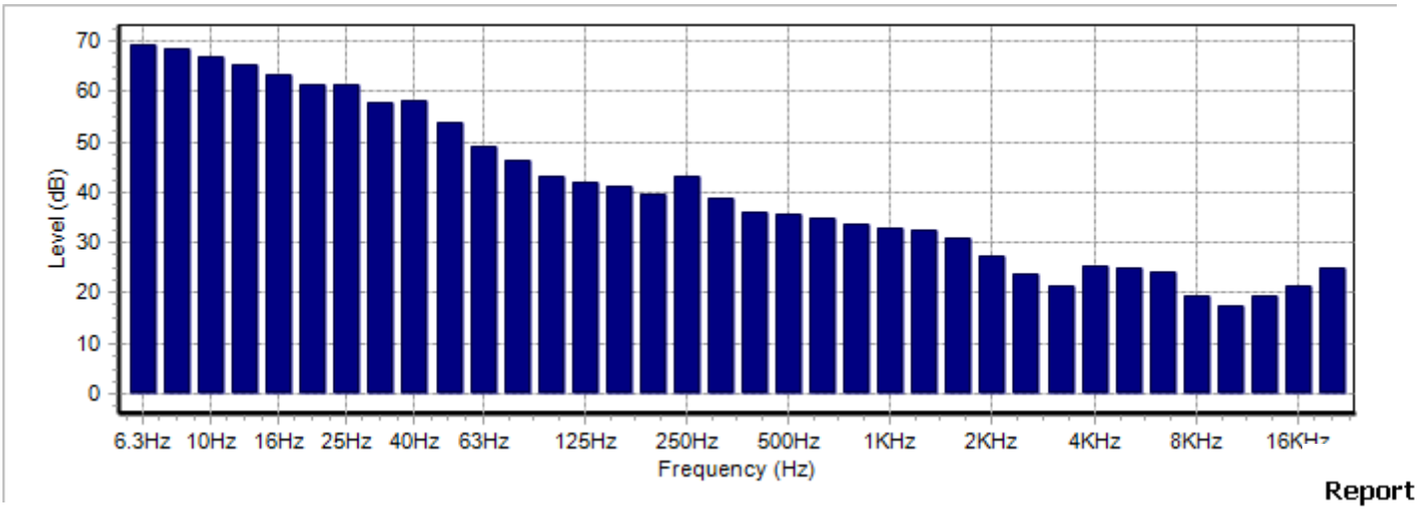
Project

1017_37

Time History



Frequency Bands



Report ID

Cirrus Research plc

Measurement Summary Report

Name	NSL1 Day 3
Time	12/10/2015 11:02:41
Duration	00:30:00
Instrument	GO56143, CR:171B

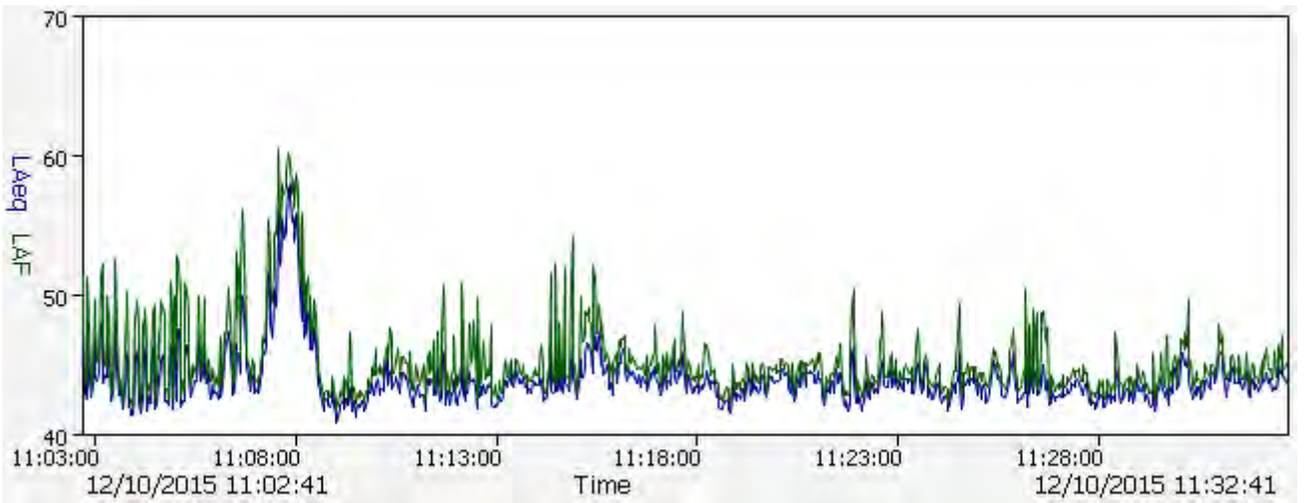
Summary

LAeq	44.9 dB
LAE	77.5 dB
LAFMax	60.4 dB

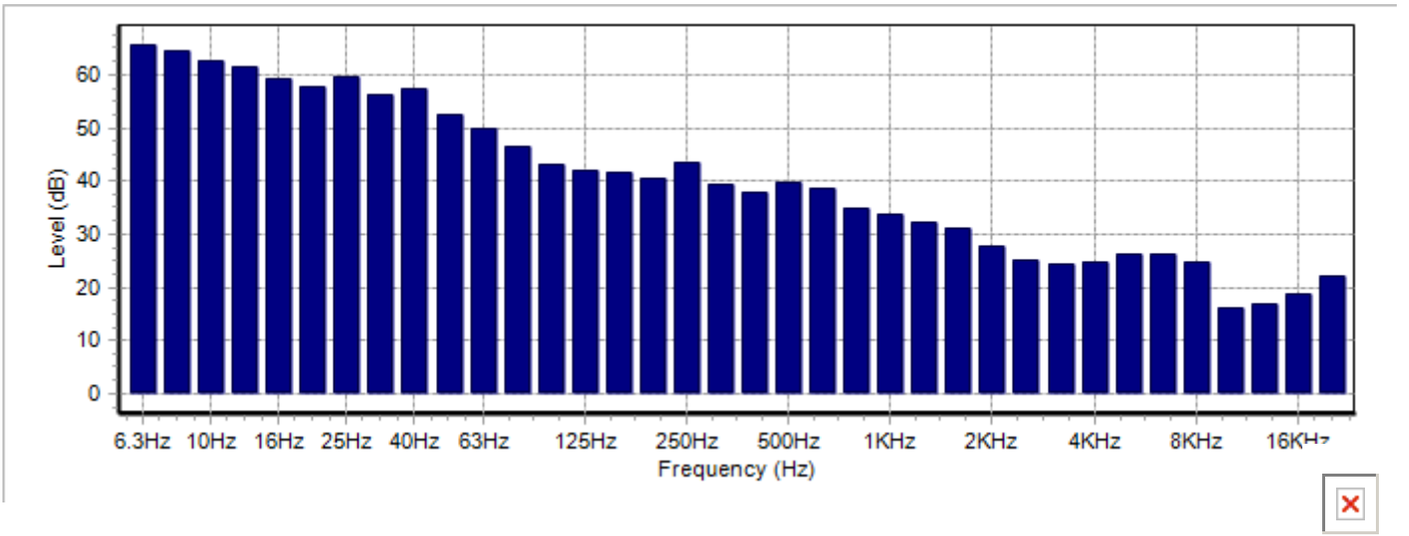
LAF1	54.6 dB
LAF5	47.3 dB
LAF10	45.6 dB
LAF50	43.3 dB
LAF90	42.1 dB
LAF95	41.8 dB
LAF99	41.3 dB

Calibration Information	Person	Place	Project
12/10/2015 09:57:57 -0.21 dB	Gareth Carroll	Rusal Aughinish	1017_37
12/10/2015 11:40:31 -0.30 dB	Graduate Environmental Co...		

Time History



Frequency Bands



Cirrus Research plc

Measurement Summary Report

Name	NSL1 Evening 1
Time	08/10/2015 19:48:04
Duration	00:30:00
Instrument	GO56143, CR:171B

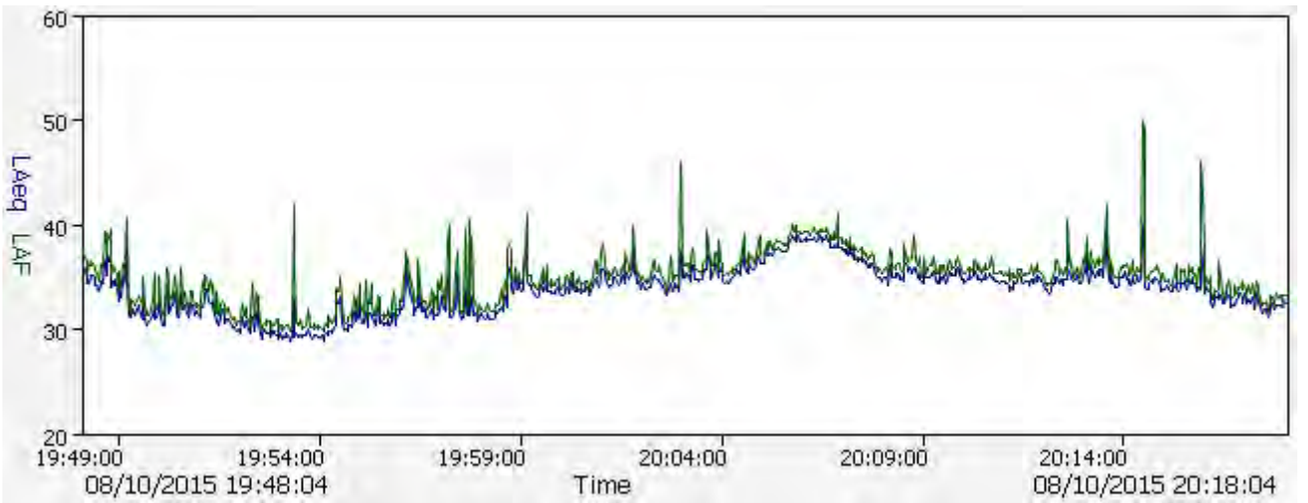
Summary

LAeq	34.4 dB
LAE	66.9 dB
LAFMax	50.0 dB

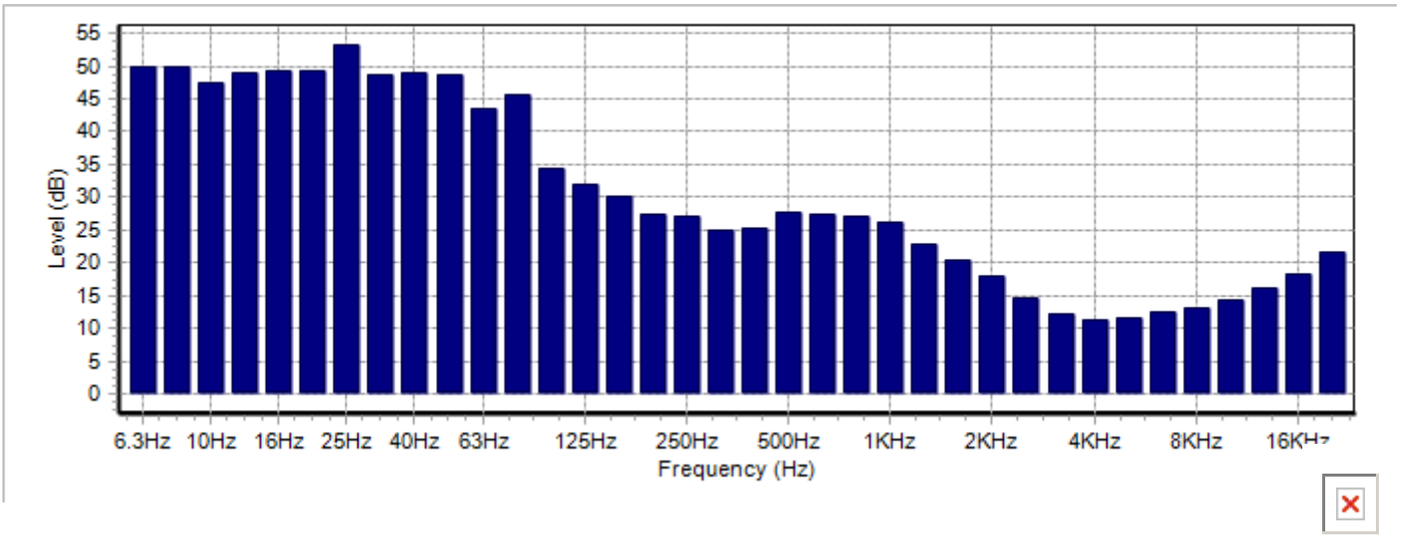
LAF1	38.9 dB
LAF5	37.9 dB
LAF10	36.6 dB
LAF50	34.0 dB
LAF90	30.4 dB
LAF95	29.6 dB
LAF99	28.9 dB

Calibration Information	Person	Place	Project
08/10/2015 18:53:36 -0.14 dB	Gareth Carroll	Rusal Aughinish	1017_37
08/10/2015 20:28:31 -0.22 dB	Graduate Environmental Co...		

Time History



Frequency Bands



Cirrus Research plc

Measurement Summary Report

Name	NSL1 Night 1
Time	09/10/2015 02:32:07
Duration	00:30:00
Instrument	GO56143, CR:171B

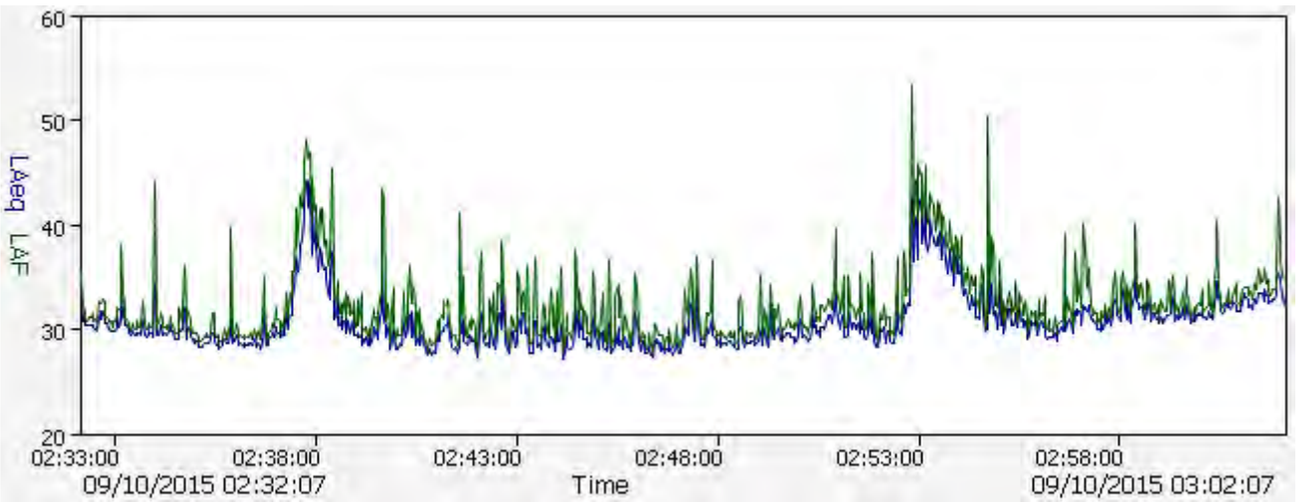
Summary

LAeq	32.0 dB
LAE	64.6 dB
LAFMax	53.2 dB

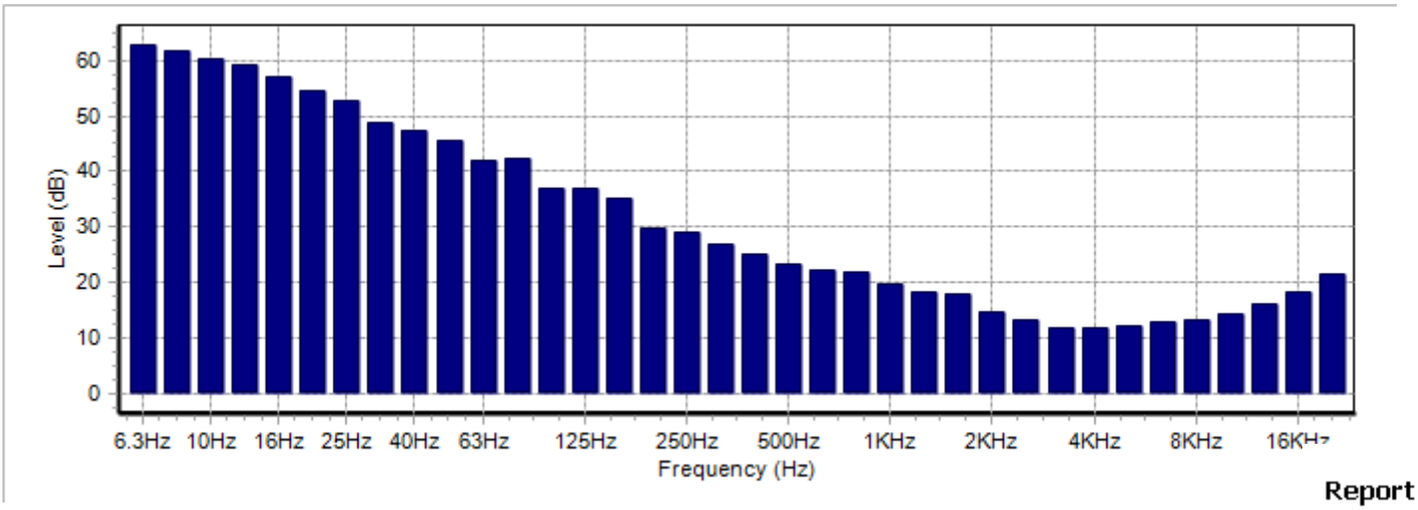
LAF1	41.0 dB
LAF5	36.3 dB
LAF10	33.6 dB
LAF50	29.9 dB
LAF90	28.1 dB
LAF95	27.8 dB
LAF99	27.3 dB

Calibration Information	Person	Place	Project
08/10/2015 22:52:47 -0.32 dB	Gareth Carroll	Rusal Aughinish	1017_37
09/10/2015 09:25:51 -0.51 dB	Graduate Environmental Co...		

Time History



Frequency Bands



Report ID

Cirrus Research plc

Measurement Summary Report

Name	NSL1 Night 2
Time	09/10/2015 03:02:13
Duration	00:30:00
Instrument	GO56143, CR:171B

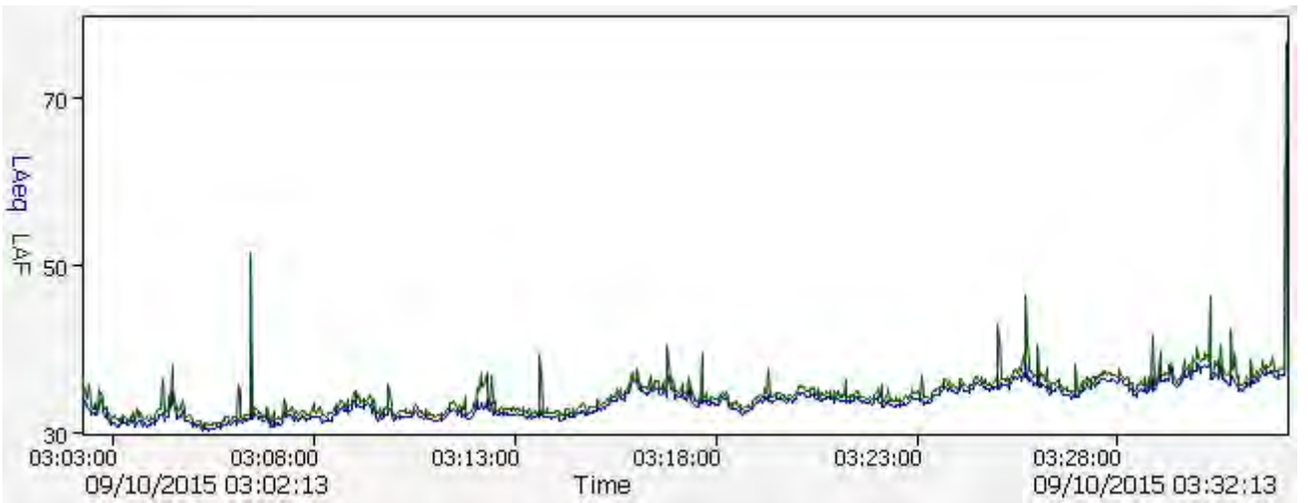
Summary

LAeq	38.2 dB
LAE	70.7 dB
LAFMax	76.8 dB

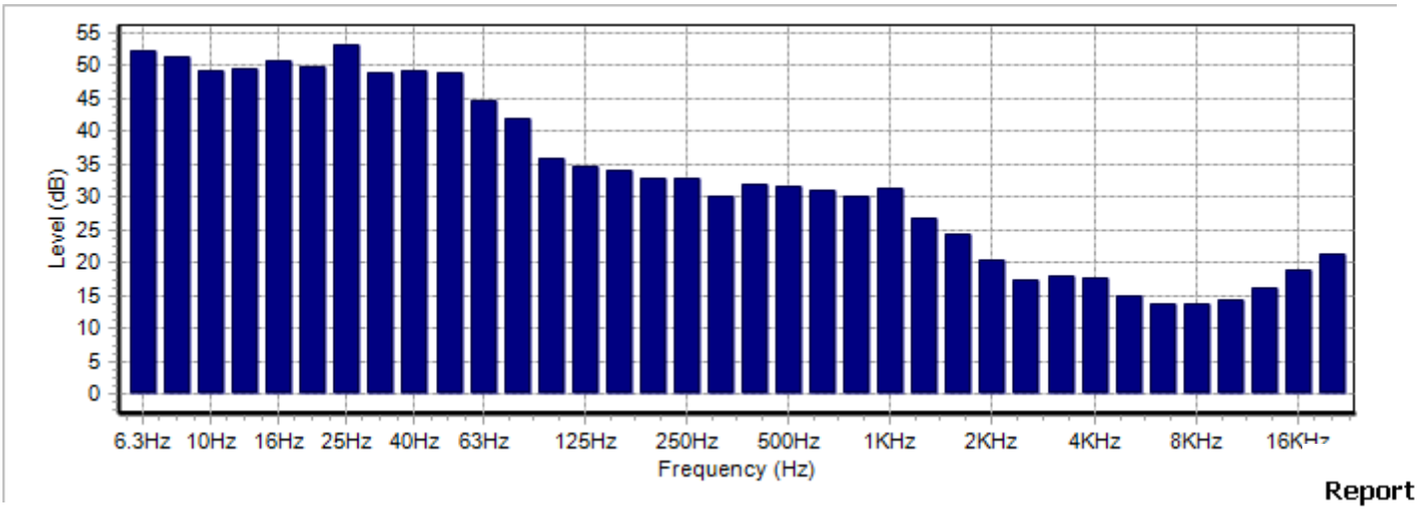
LAF1	38.1 dB
LAF5	36.9 dB
LAF10	36.3 dB
LAF50	33.7 dB
LAF90	31.4 dB
LAF95	31.0 dB
LAF99	30.5 dB

Calibration Information	Person	Place	Project
08/10/2015 22:52:47 -0.32 dB	Gareth Carroll	Rusal Aughinish	1017_37
09/10/2015 09:25:51 -0.51 dB	Graduate Environmental Co...		

Time History



Frequency Bands



Report ID

Cirrus Research plc

Measurement Summary Report

Name	NSL2 Day 1
Time	12/10/2015 11:41:46
Duration	00:30:00
Instrument	GO56143, CR:171B

Summary

LAeq	46.7 dB
LAE	79.2 dB
LAFMax	71.7 dB

LAF1	57.9 dB
LAF5	48.2 dB
LAF10	42.2 dB
LAF50	34.8 dB
LAF90	33.1 dB
LAF95	32.7 dB
LAF99	32.0 dB

Calibration Information

12/10/2015 11:40:31 -0.30 dB
12/10/2015 18:52:37 -0.26 dB

Person

Gareth Carroll
Graduate Environmental Co...

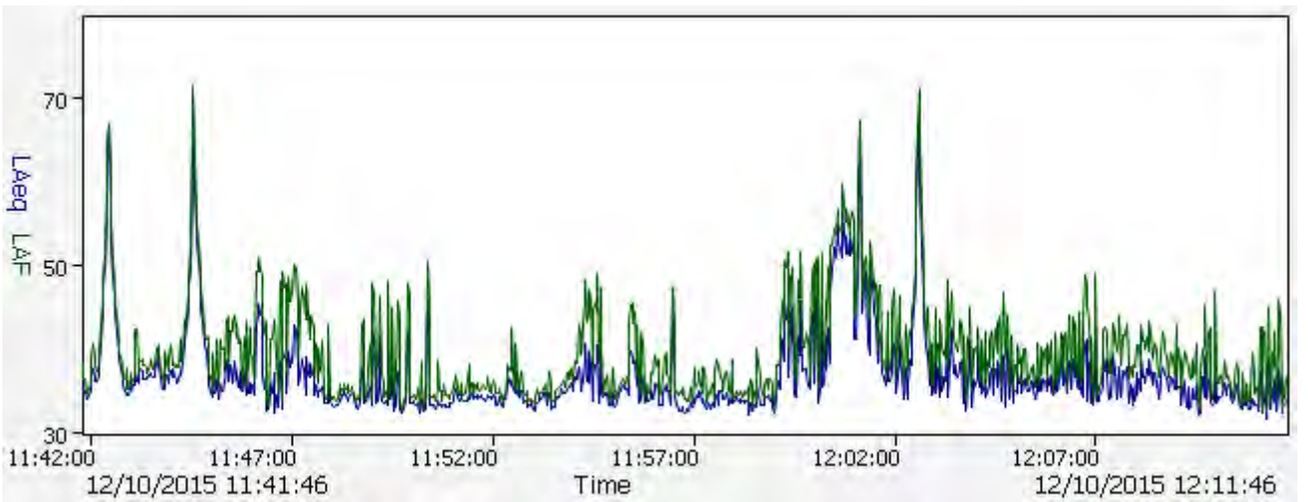
Place

Rusal Aughinish

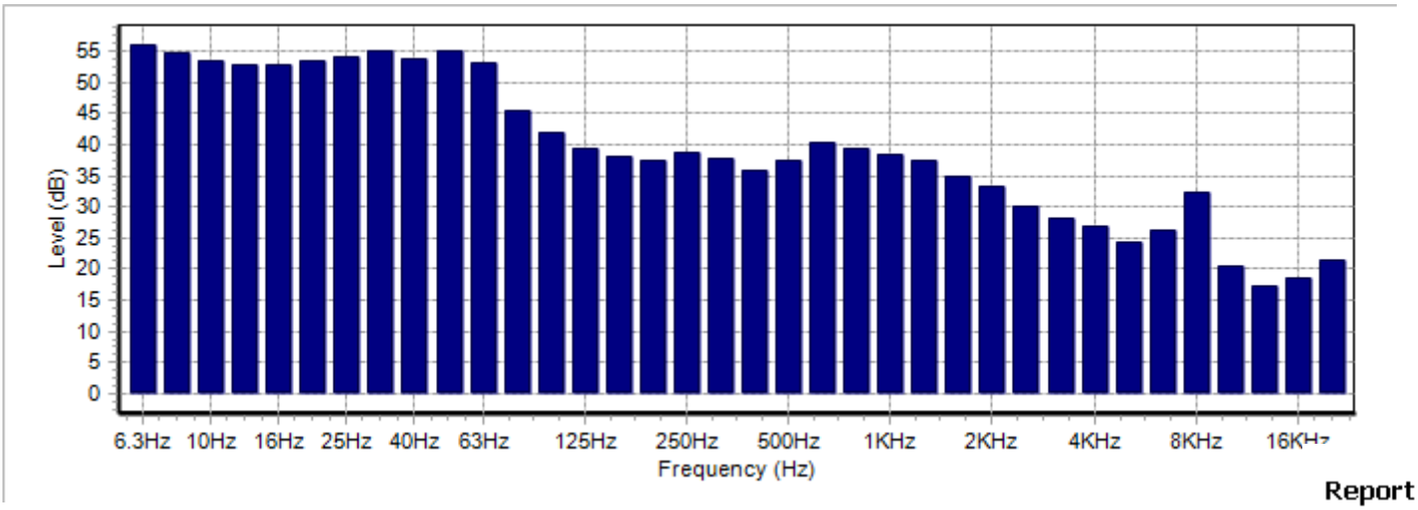
Project

1017_37

Time History



Frequency Bands



Report ID

Cirrus Research plc

Measurement Summary Report

Name	NSL2 Day 2
Time	12/10/2015 12:12:18
Duration	00:30:00
Instrument	GO56143, CR:171B

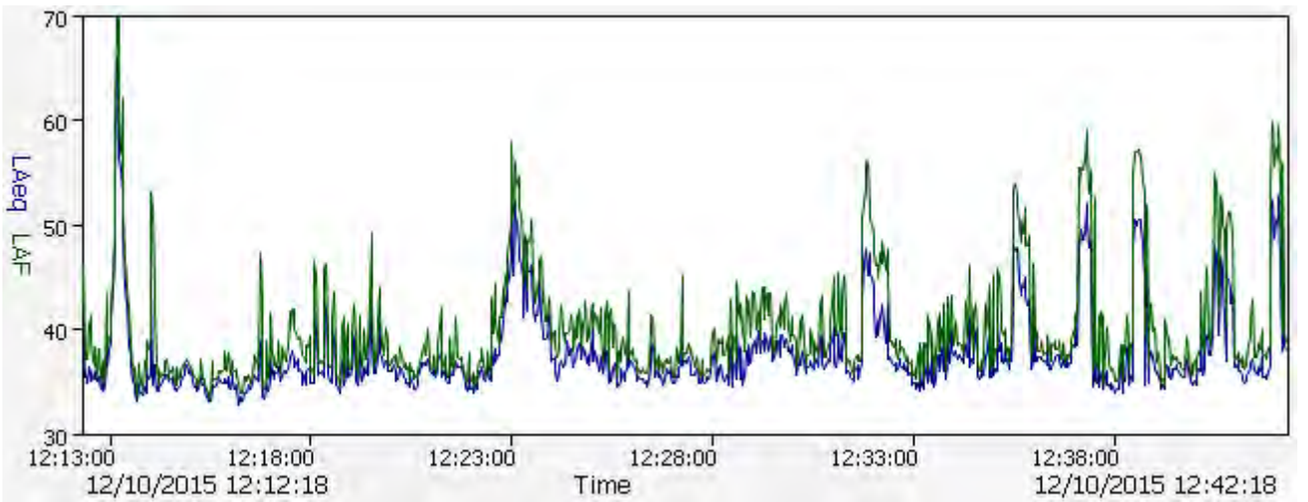
Summary

LAeq	43.1 dB
LAE	75.7 dB
LAFMax	69.8 dB

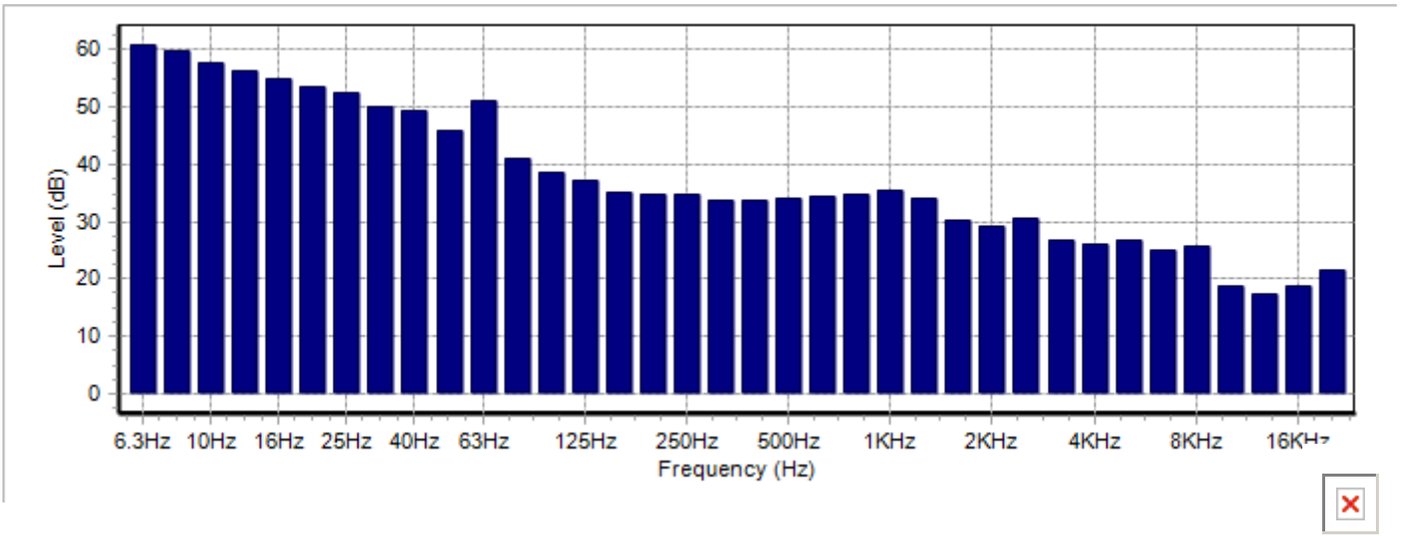
LAF1	53.8 dB
LAF5	44.9 dB
LAF10	40.8 dB
LAF50	36.1 dB
LAF90	34.3 dB
LAF95	33.9 dB
LAF99	33.2 dB

Calibration Information	Person	Place	Project
12/10/2015 11:40:31 -0.30 dB	Gareth Carroll	Rusal Aughinish	1017_37
12/10/2015 18:52:37 -0.26 dB	Graduate Environmental Co...		

Time History



Frequency Bands



Cirrus Research plc

Measurement Summary Report

Name	NSL2 Day 3
Time	12/10/2015 12:42:25
Duration	00:30:00
Instrument	GO56143, CR:171B

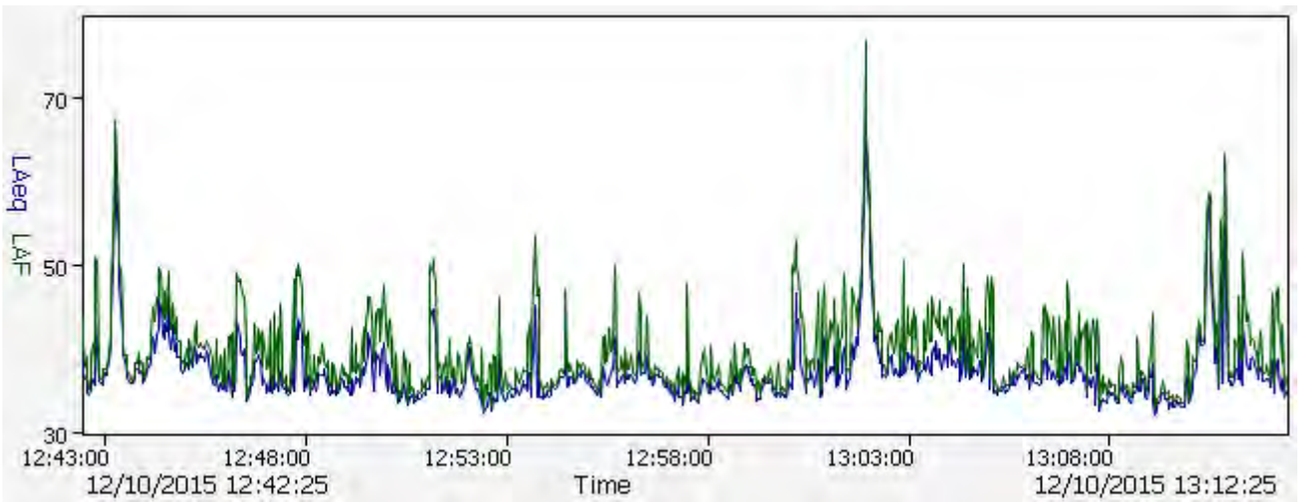
Summary

LAeq	44.6 dB
LAE	77.1 dB
LAFMax	77.0 dB

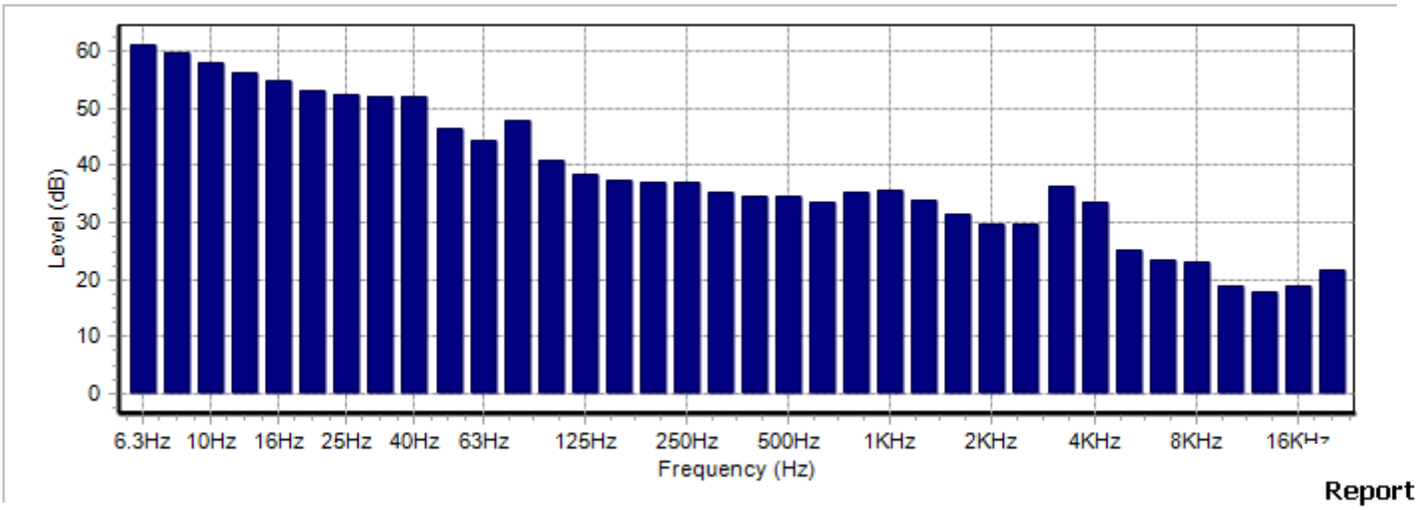
LAF1	55.0 dB
LAF5	43.3 dB
LAF10	40.4 dB
LAF50	36.1 dB
LAF90	34.1 dB
LAF95	33.7 dB
LAF99	32.9 dB

Calibration Information	Person	Place	Project
12/10/2015 11:40:31 -0.30 dB	Gareth Carroll	Rusal Aughinish	1017_37
12/10/2015 18:52:37 -0.26 dB	Graduate Environmental Co...		

Time History



Frequency Bands



Report ID

Cirrus Research plc

Measurement Summary Report

Name	NSL2 Evening 1
Time	08/10/2015 20:29:25
Duration	00:30:00
Instrument	GO56143, CR:171B

Summary

LAeq	45.4 dB
LAE	77.9 dB
LAFMax	72.3 dB

LAF1	53.2 dB
LAF5	44.8 dB
LAF10	41.7 dB
LAF50	37.2 dB
LAF90	32.6 dB
LAF95	31.4 dB
LAF99	29.7 dB

Calibration Information

08/10/2015 20:28:31 -0.22 dB
08/10/2015 22:52:47 -0.32 dB

Person

Gareth Carroll
Graduate Environmental Co...

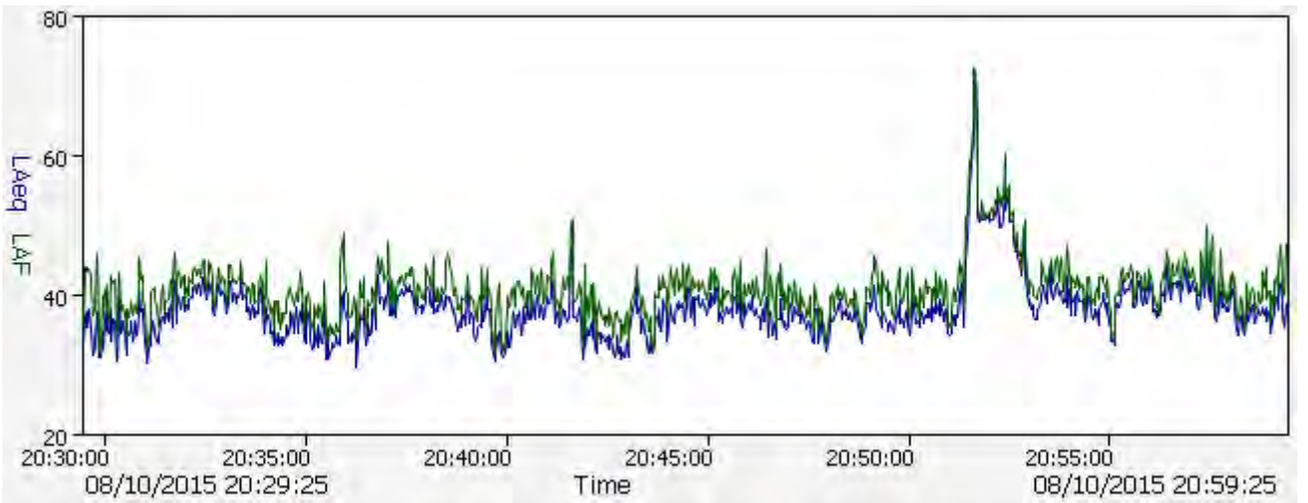
Place

Rusal Aughinish

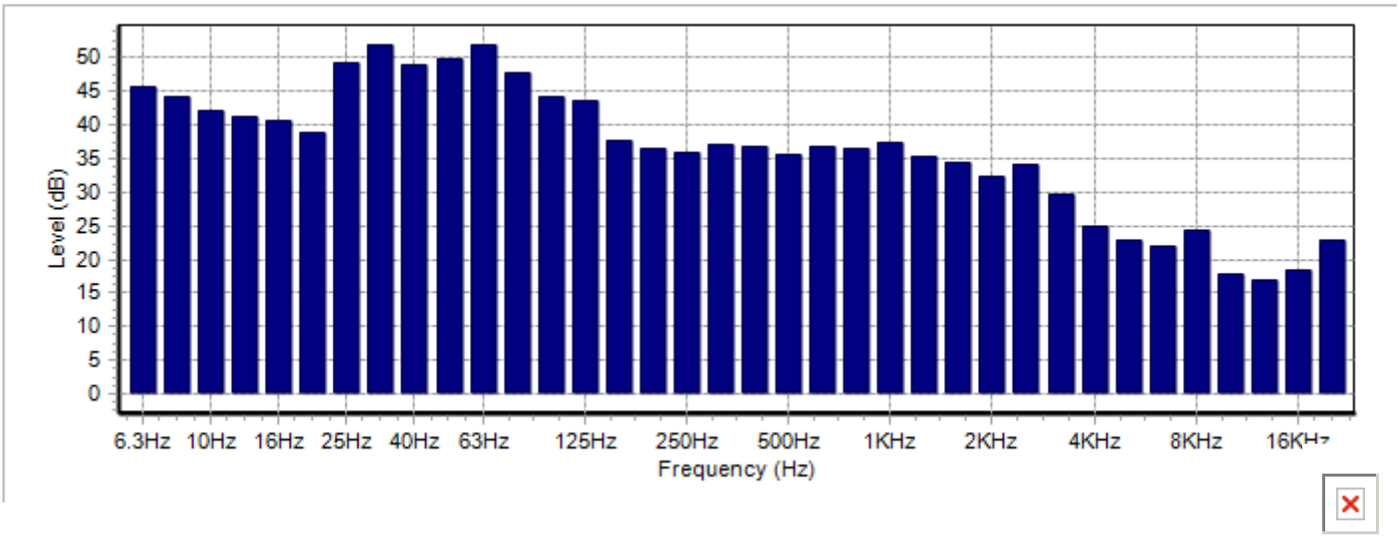
Project

1017_37

Time History



Frequency Bands



Cirrus Research plc

Measurement Summary Report

Name	NSL2 Night 1
Time	08/10/2015 00:09:46
Duration	00:30:00
Instrument	GO56143, CR:171B

Summary

LAeq	37.8 dB
LAE	70.3 dB
LAFMax	49.8 dB

LAF1	42.7 dB
LAF5	41.7 dB
LAF10	40.9 dB
LAF50	37.0 dB
LAF90	32.4 dB
LAF95	31.7 dB
LAF99	31.0 dB

Calibration Information

07/10/2015 23:33:11 -0.29 dB
08/10/2015 10:07:04 -0.55 dB

Person

Gareth Carroll
Graduate Environmental Co...

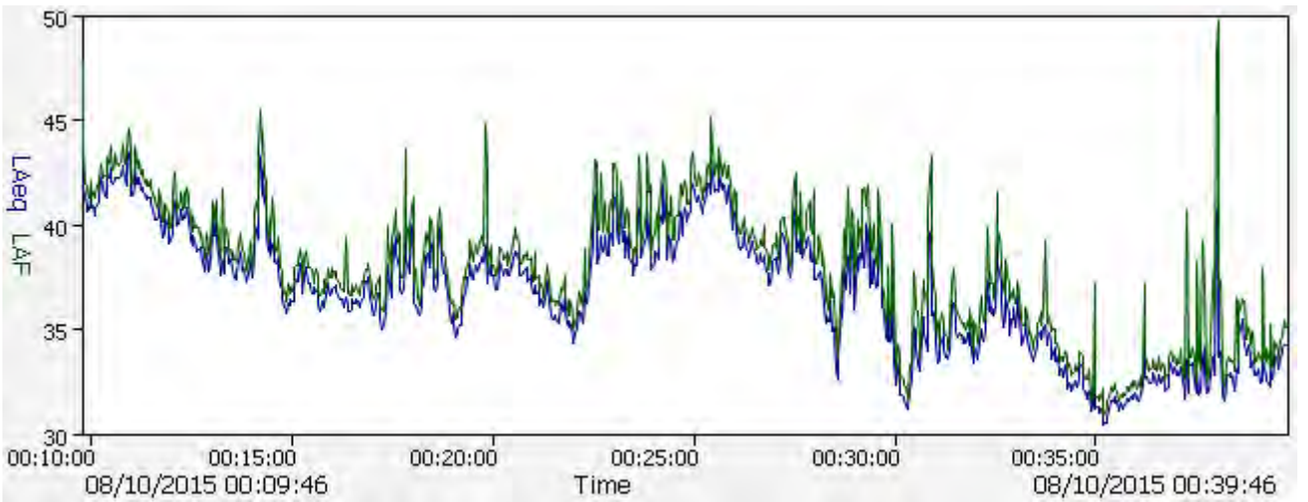
Place

Rusal Aughinish

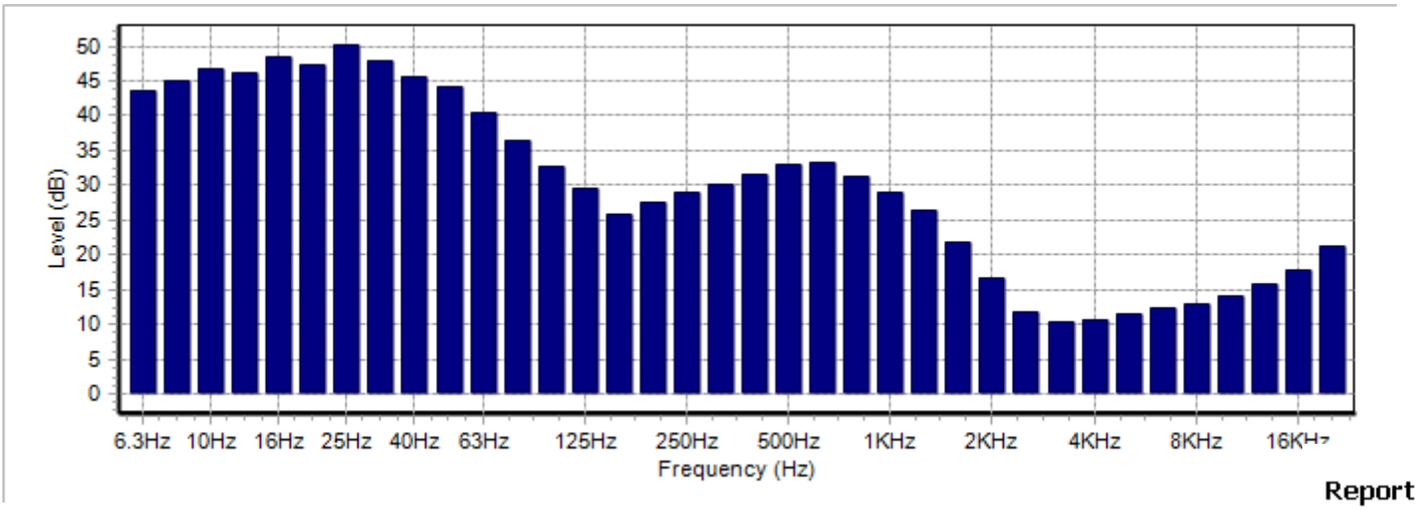
Project

1017_37

Time History



Frequency Bands



Report ID

Cirrus Research plc

Measurement Summary Report

Name	NSL2 Night 2
Time	08/10/2015 00:39:53
Duration	00:30:00
Instrument	GO56143, CR:171B

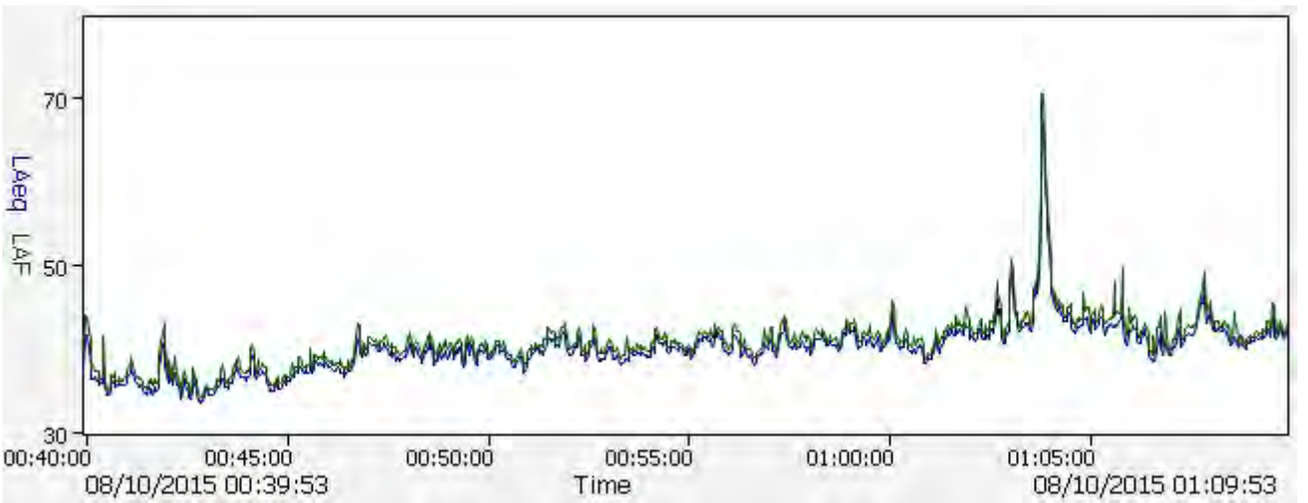
Summary

LAeq	44.2 dB
LAE	76.7 dB
LAFMax	70.5 dB

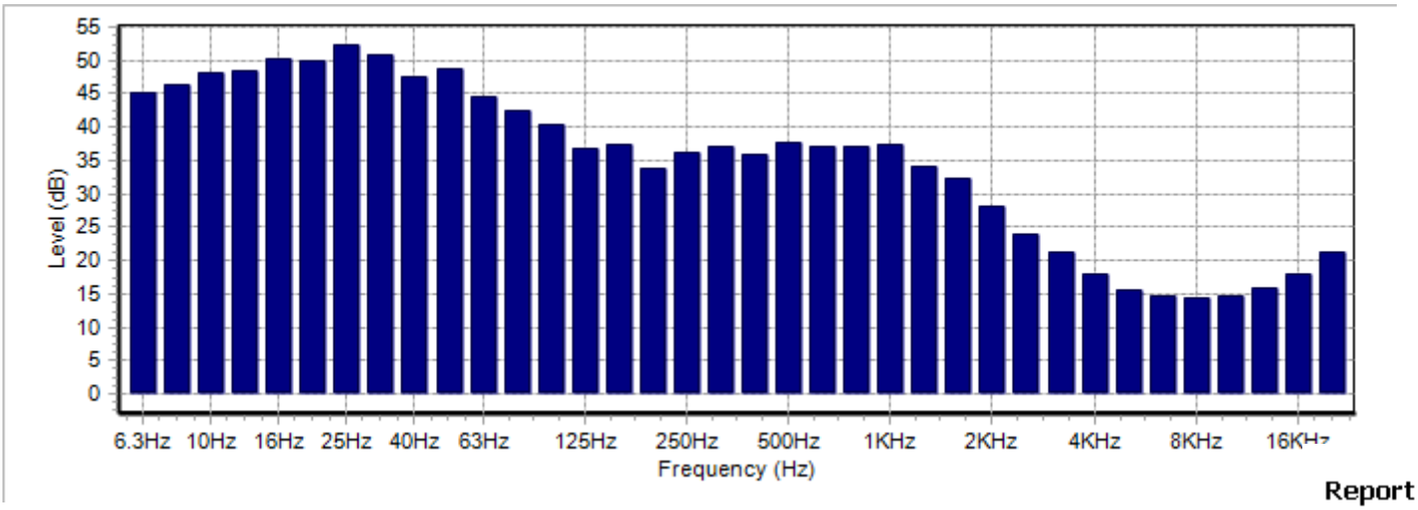
LAF1	49.0 dB
LAF5	44.0 dB
LAF10	42.8 dB
LAF50	40.1 dB
LAF90	36.1 dB
LAF95	35.4 dB
LAF99	34.3 dB

Calibration Information	Person	Place	Project
07/10/2015 23:33:11 -0.29 dB	Gareth Carroll	Rusal Aughinish	1017_37
08/10/2015 10:07:04 -0.55 dB	Graduate Environmental Co...		

Time History



Frequency Bands



Report ID

Cirrus Research plc

Measurement Summary Report

Name	NSL3 Day 1
Time	12/10/2015 14:59:51
Duration	00:30:00
Instrument	GO56143, CR:171B

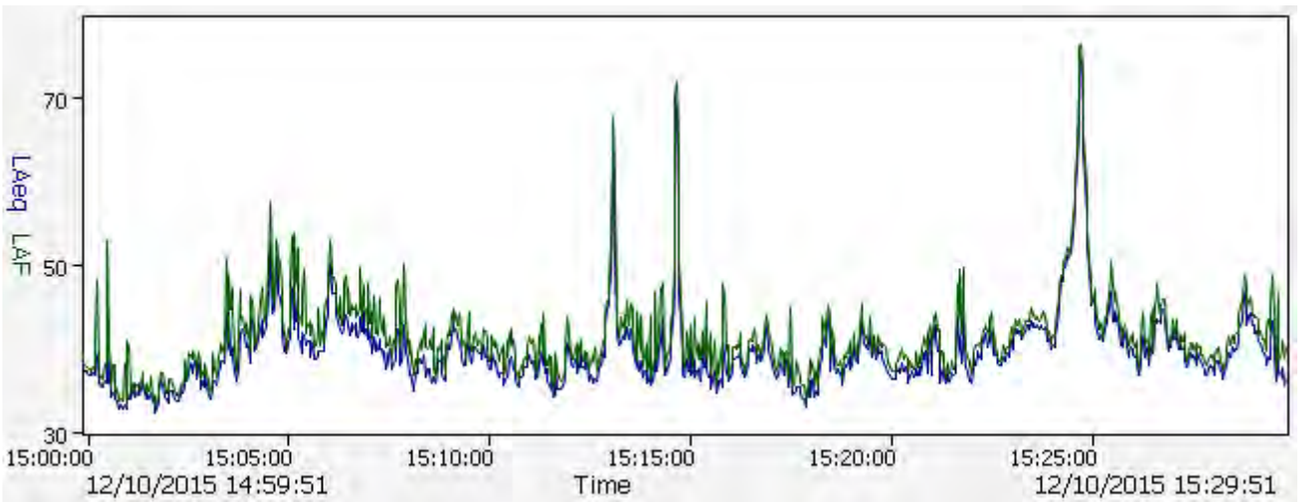
Summary

LAeq	50.9 dB
LAE	83.4 dB
LAFMax	76.5 dB

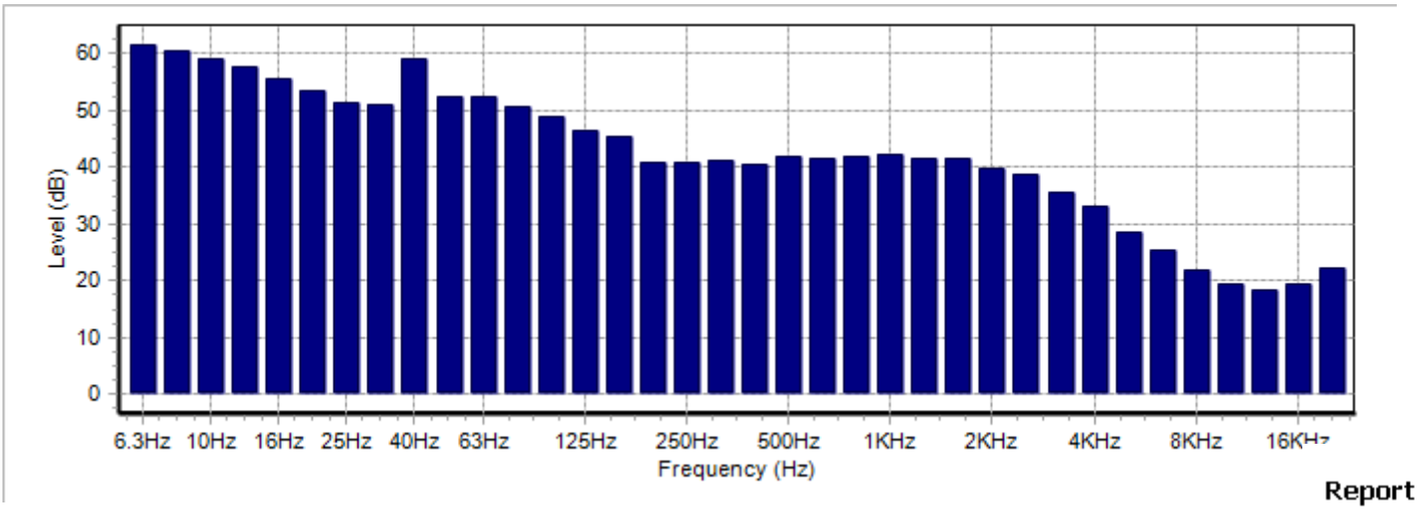
LAF1	60.6 dB
LAF5	46.4 dB
LAF10	43.8 dB
LAF50	38.9 dB
LAF90	35.4 dB
LAF95	34.5 dB
LAF99	33.2 dB

Calibration Information	Person	Place	Project
12/10/2015 11:40:31 -0.30 dB	Gareth Carroll	Rusal Aughinish	1017_37
12/10/2015 18:52:37 -0.26 dB	Graduate Environmental Co...		

Time History



Frequency Bands



Report ID

Cirrus Research plc

Measurement Summary Report

Name	NSL3 Day 2
Time	12/10/2015 15:29:58
Duration	00:30:00
Instrument	GO56143, CR:171B

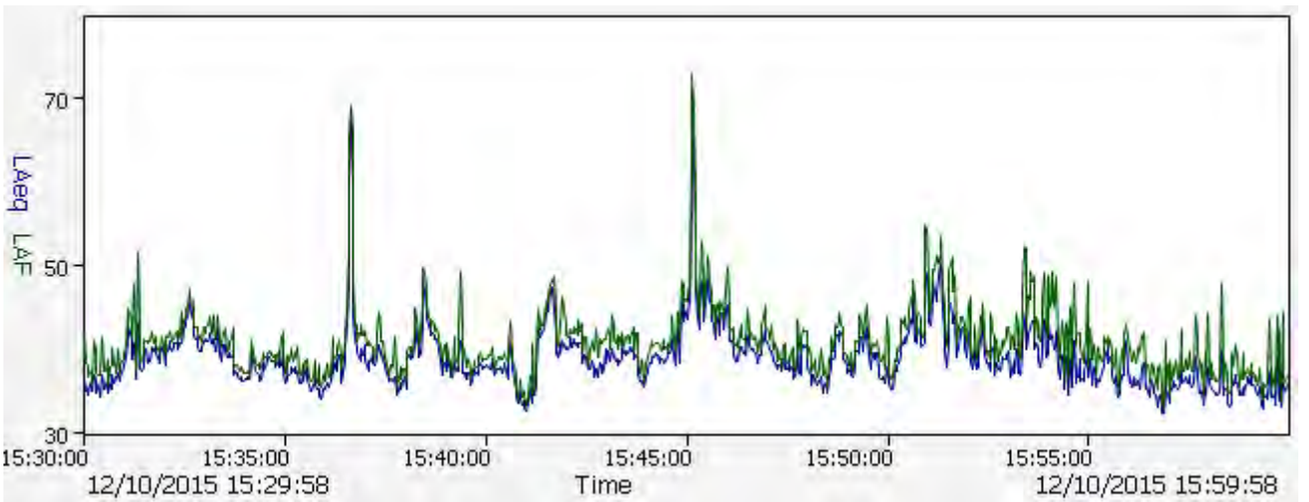
Summary

LAeq	45.4 dB
LAE	78.0 dB
LAFMax	72.9 dB

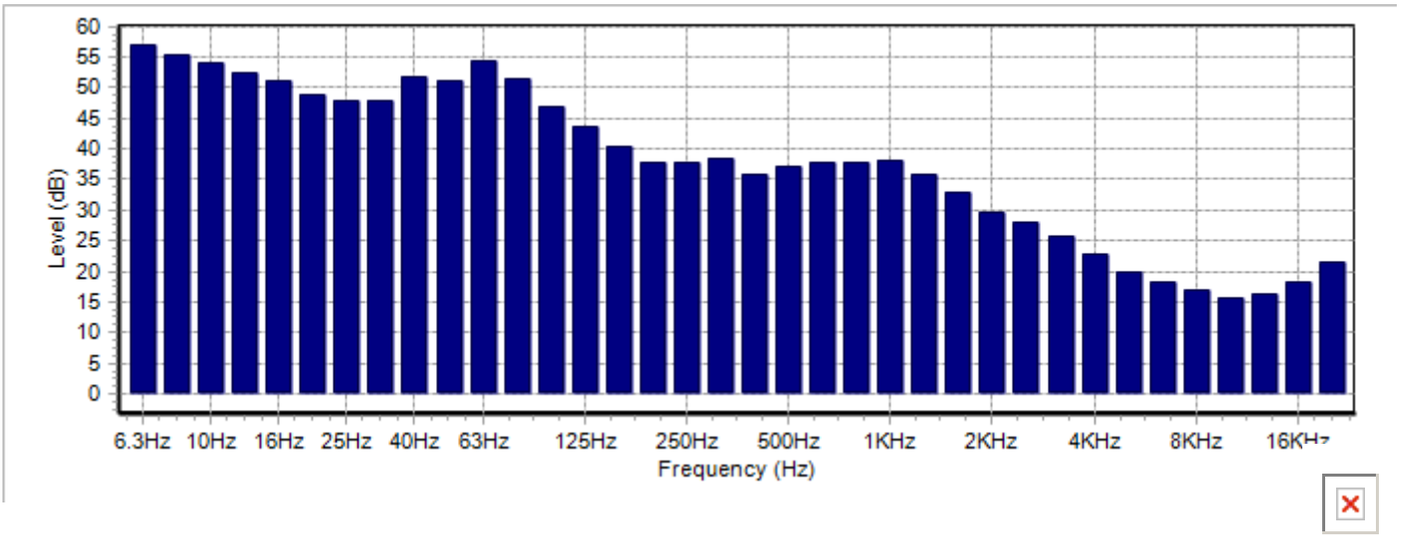
LAF1	50.1 dB
LAF5	44.8 dB
LAF10	42.7 dB
LAF50	38.3 dB
LAF90	34.8 dB
LAF95	34.1 dB
LAF99	33.0 dB

Calibration Information	Person	Place	Project
12/10/2015 11:40:31 -0.30 dB	Gareth Carroll	Rusal Aughinish	1017_37
12/10/2015 18:52:37 -0.26 dB	Graduate Environmental Co...		

Time History



Frequency Bands



Cirrus Research plc

Measurement Summary Report

Name	NSL3 Day 3
Time	12/10/2015 16:00:05
Duration	00:30:00
Instrument	GO56143, CR:171B

Summary

LAeq	49.1 dB
LAE	81.6 dB
LAFMax	75.5 dB

LAF1	60.6 dB
LAF5	54.0 dB
LAF10	49.1 dB
LAF50	40.8 dB
LAF90	36.1 dB
LAF95	35.4 dB
LAF99	34.2 dB

Calibration Information

12/10/2015 11:40:31 -0.30 dB
12/10/2015 18:52:37 -0.26 dB

Person

Gareth Carroll
Graduate Environmental Co...

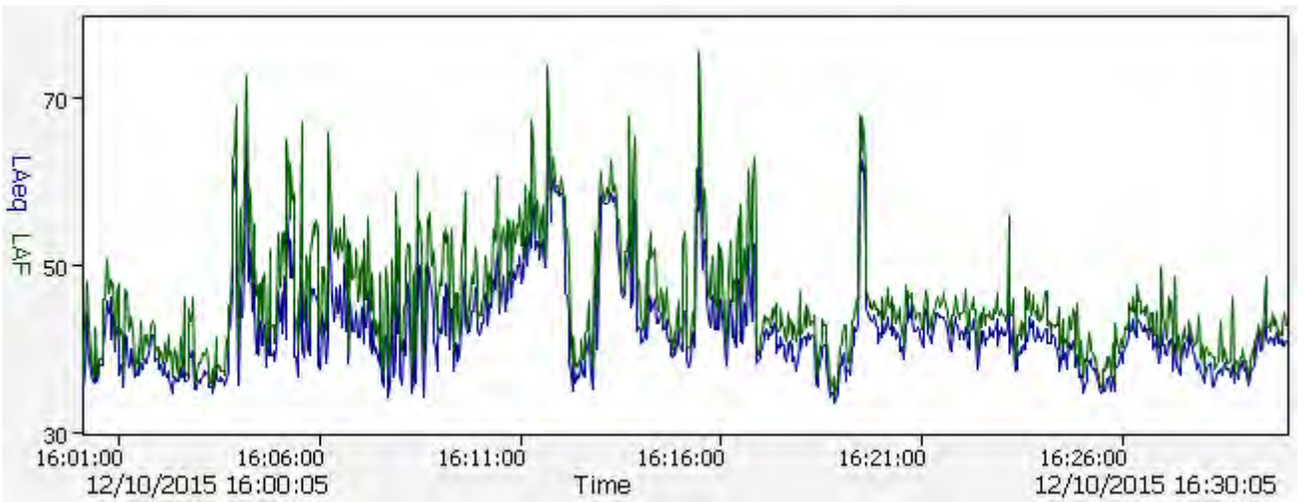
Place

Rusal Aughinish

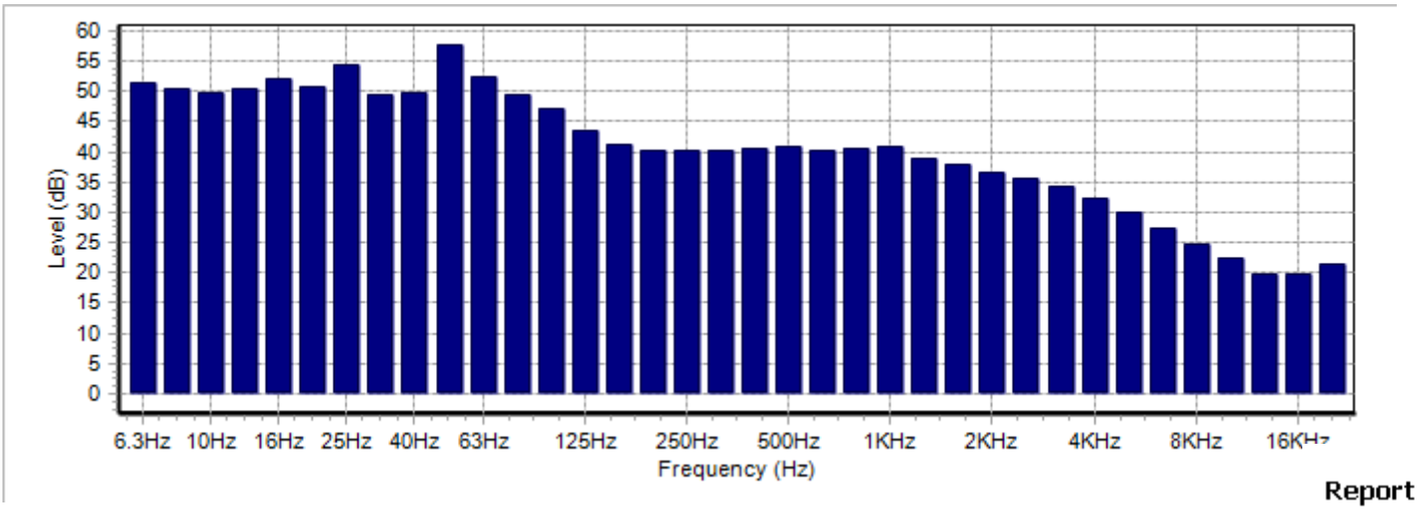
Project

1017_37

Time History



Frequency Bands



Report ID

Cirrus Research plc

Measurement Summary Report

Name	NSL3 Evening 1
Time	08/10/2015 19:01:11
Duration	00:30:00
Instrument	GO56143, CR:171B

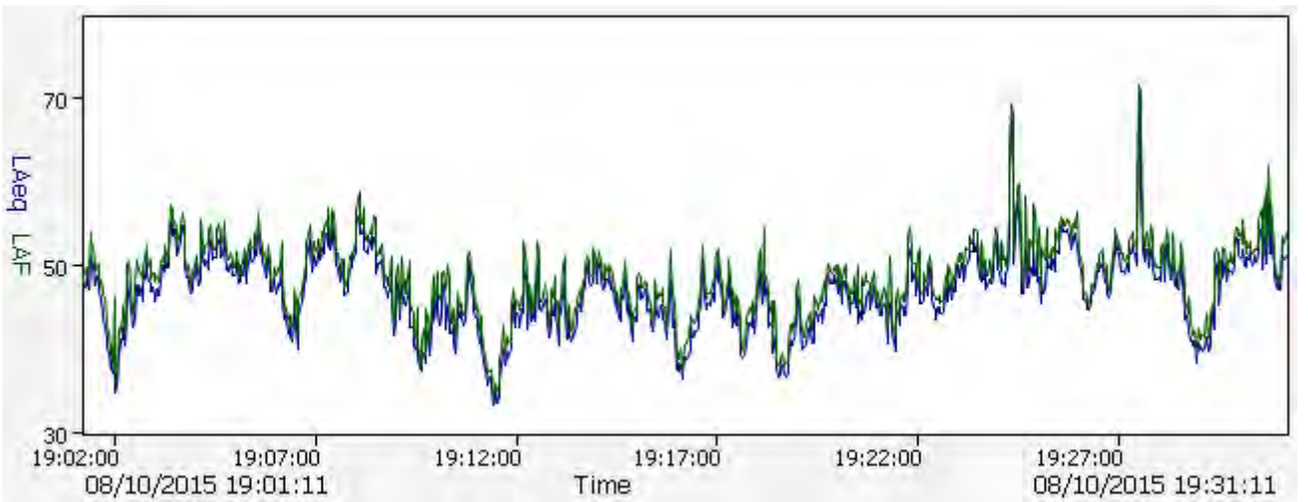
Summary

LAeq	49.9 dB
LAE	82.4 dB
LAFMax	71.7 dB

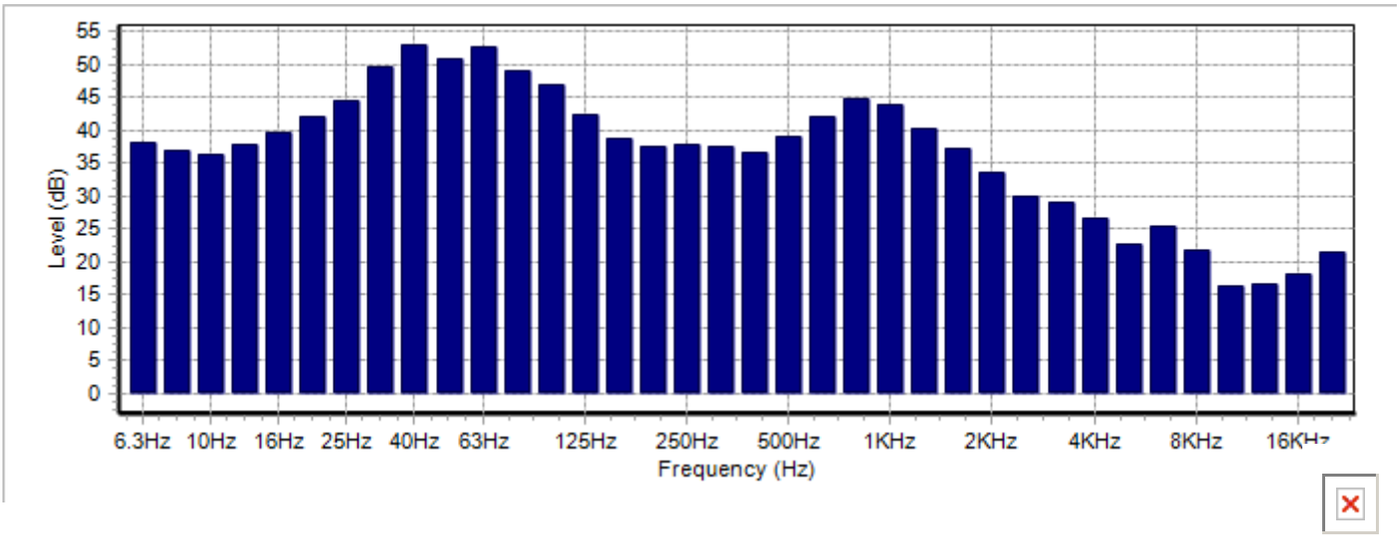
LAF1	56.8 dB
LAF5	53.6 dB
LAF10	52.1 dB
LAF50	47.0 dB
LAF90	40.5 dB
LAF95	38.6 dB
LAF99	35.5 dB

Calibration Information	Person	Place	Project
08/10/2015 18:53:36 -0.14 dB	Gareth Carroll	Rusal Aughinish	1017_37
08/10/2015 20:28:31 -0.22 dB	Graduate Environmental Co...		

Time History



Frequency Bands



Cirrus Research plc

Measurement Summary Report

Name	NSL3 Night 1
Time	09/10/2015 01:25:32
Duration	00:30:00
Instrument	GO56143, CR:171B

Summary

LAeq	38.2 dB
LAE	70.7 dB
LAFMax	54.0 dB

LAF1	49.4 dB
LAF5	45.6 dB
LAF10	42.4 dB
LAF50	27.6 dB
LAF90	20.9 dB
LAF95	20.2 dB
LAF99	20.0 dB

Calibration Information

08/10/2015 22:52:47 -0.32 dB
09/10/2015 09:25:51 -0.51 dB

Person

Gareth Carroll
Graduate Environmental Co...

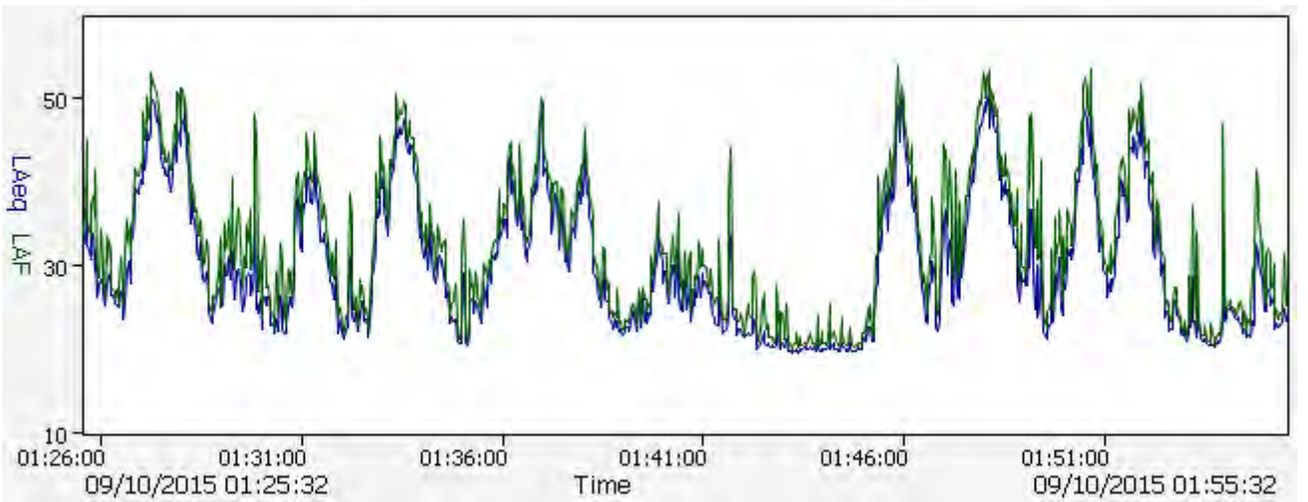
Place

Rusal Aughinish

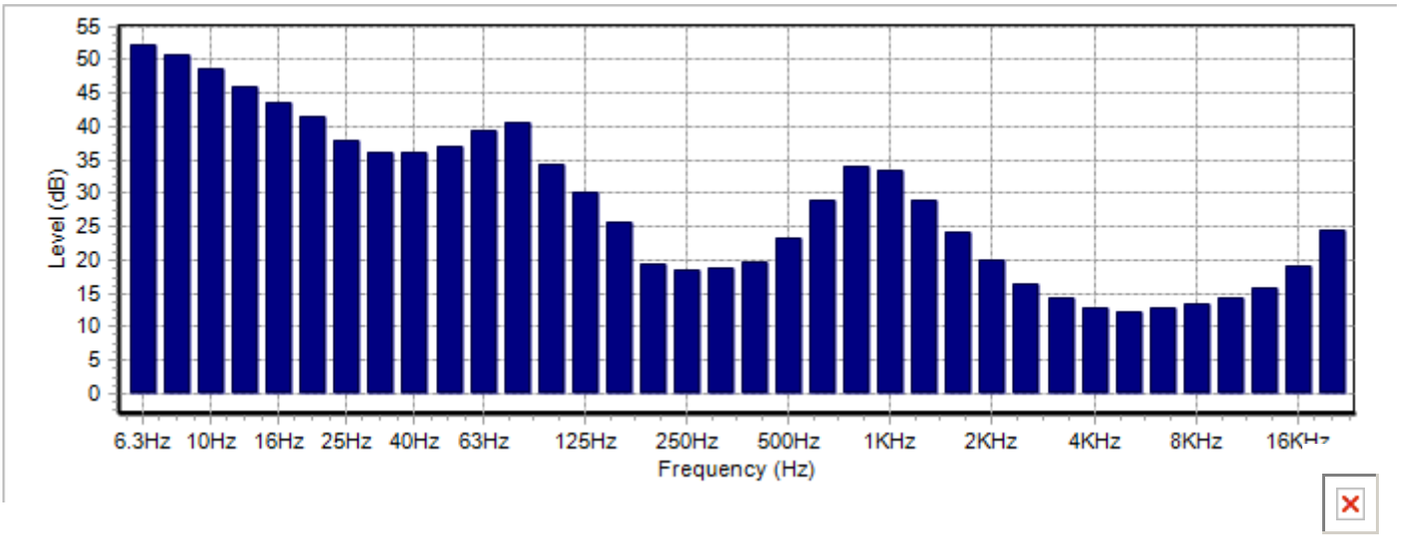
Project

1017_37

Time History



Frequency Bands



Cirrus Research plc

Measurement Summary Report

Name	NSL3 Night 2
Time	09/10/2015 01:55:39
Duration	00:30:00
Instrument	GO56143, CR:171B

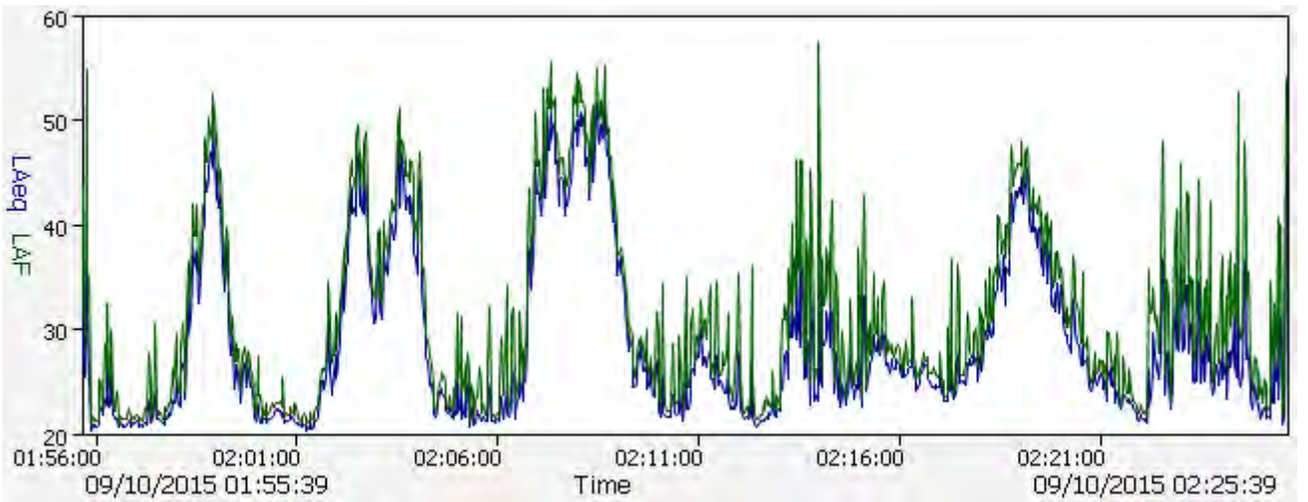
Summary

LAeq	37.9 dB
LAE	70.5 dB
LAFMax	57.4 dB

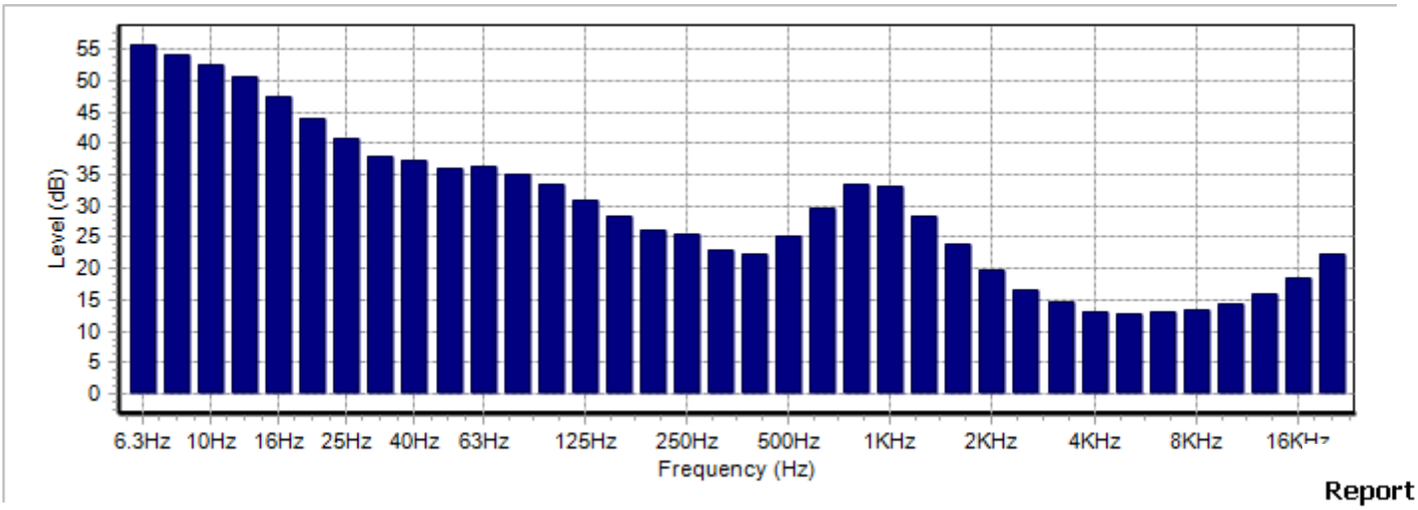
LAF1	50.0 dB
LAF5	45.3 dB
LAF10	41.7 dB
LAF50	25.3 dB
LAF90	21.1 dB
LAF95	20.8 dB
LAF99	20.4 dB

Calibration Information		Person	Place	Project
08/10/2015 22:52:47	-0.32 dB	Gareth Carroll	Rusal Aughinish	1017_37
09/10/2015 09:25:51	-0.51 dB	Graduate Environmental Co...		

Time History



Frequency Bands



Report ID

Cirrus Research plc

Measurement Summary Report

Name	NSL4 Day 1
Time	09/10/2015 12:35:09
Duration	00:30:07
Instrument	GO56143, CR:171B

Summary

LAeq	45.9 dB
LAE	78.5 dB
LAFMax	66.7 dB

LAF1	58.4 dB
LAF5	48.4 dB
LAF10	45.5 dB
LAF50	40.7 dB
LAF90	37.8 dB
LAF95	36.9 dB
LAF99	35.1 dB

Calibration Information

09/10/2015 12:31:39 -0.34 dB

12/10/2015 09:57:57 -0.21 dB

Person

Gareth Carroll

Graduate Environmental Co...

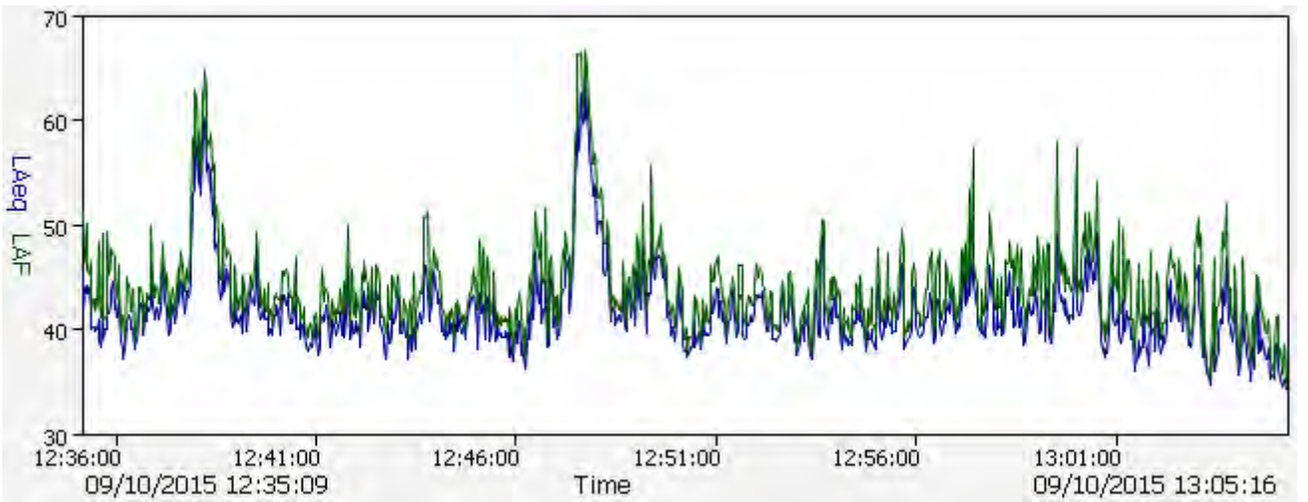
Place

Rusal Aughinish

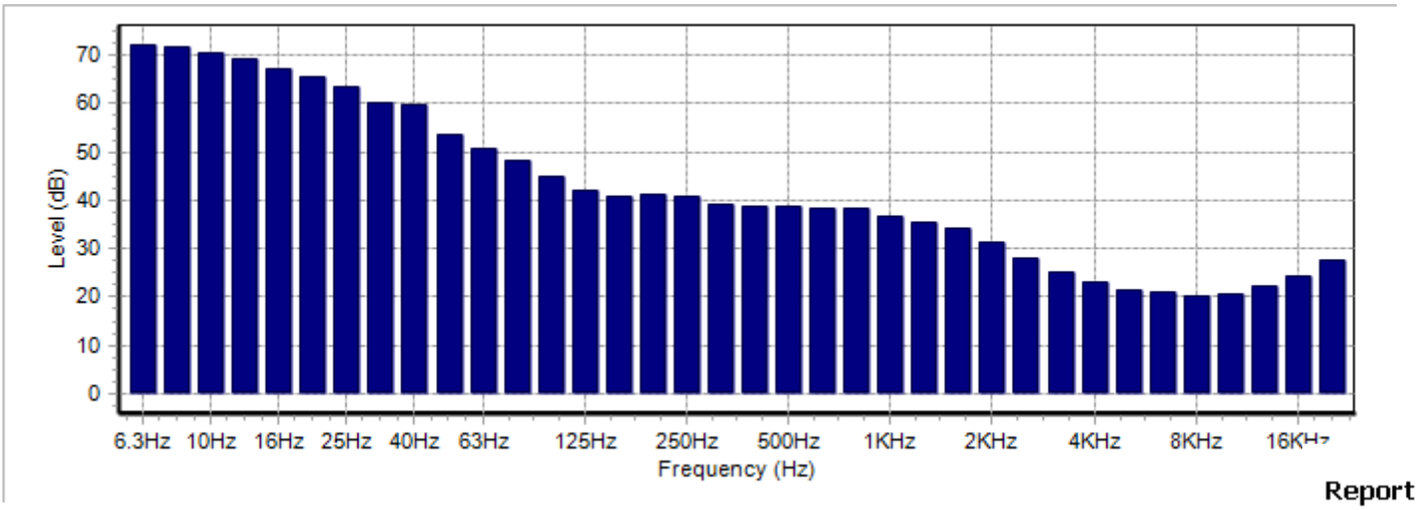
Project

1017_37

Time History



Frequency Bands



Report ID

Cirrus Research plc

Measurement Summary Report

Name	NSL4 Day 2
Time	09/10/2015 13:30:01
Duration	00:30:00
Instrument	GO56143, CR:171B

Summary

LAeq	44.3 dB
LAE	76.8 dB
LAFMax	59.6 dB

LAF1	51.5 dB
LAF5	47.9 dB
LAF10	46.6 dB
LAF50	43.2 dB
LAF90	37.9 dB
LAF95	37.0 dB
LAF99	36.0 dB

Calibration Information

09/10/2015 12:31:39 -0.34 dB

12/10/2015 09:57:57 -0.21 dB

Person

Gareth Carroll

Graduate Environmental Co...

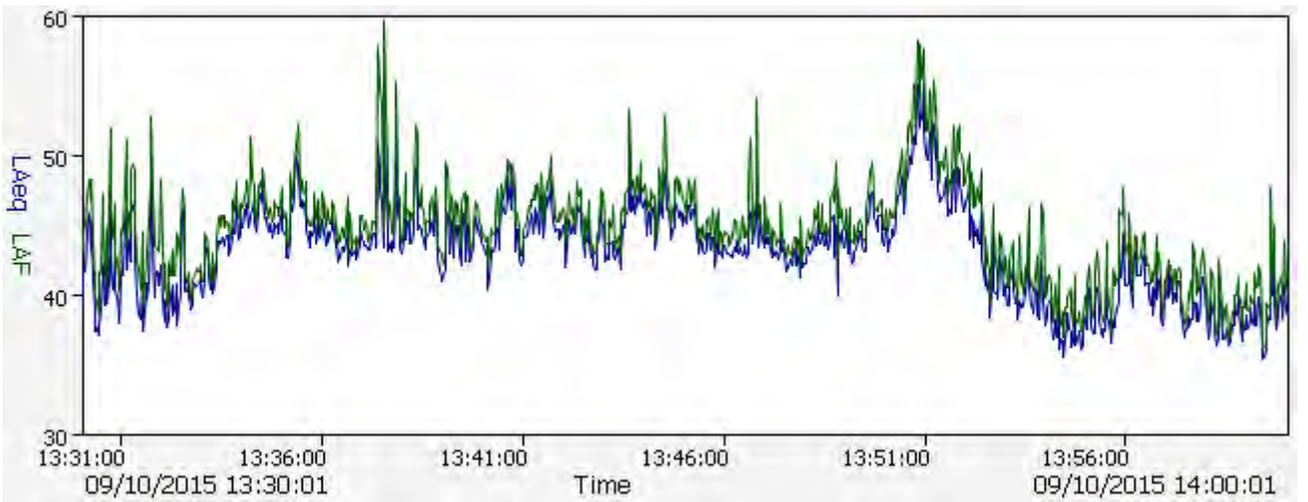
Place

Rusal Aughinish

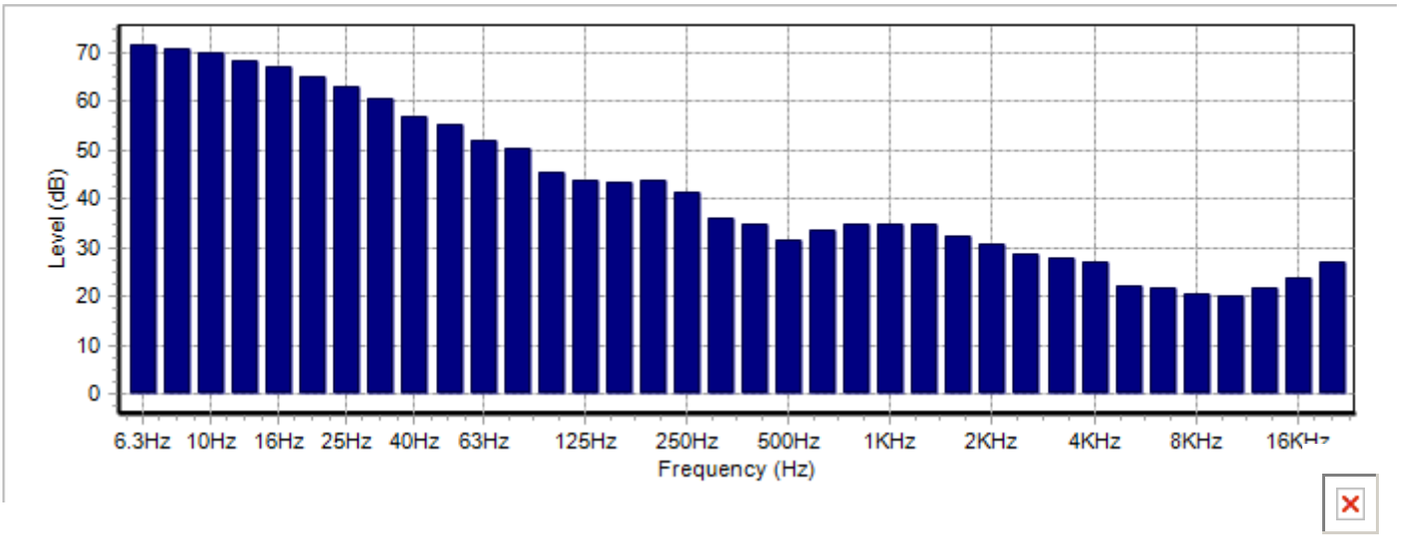
Project

1017_37

Time History



Frequency Bands



Cirrus Research plc

Measurement Summary Report

Name	NSL4 Day 3
Time	13/10/2015 10:57:24
Duration	00:30:00
Instrument	GO56143, CR:171B

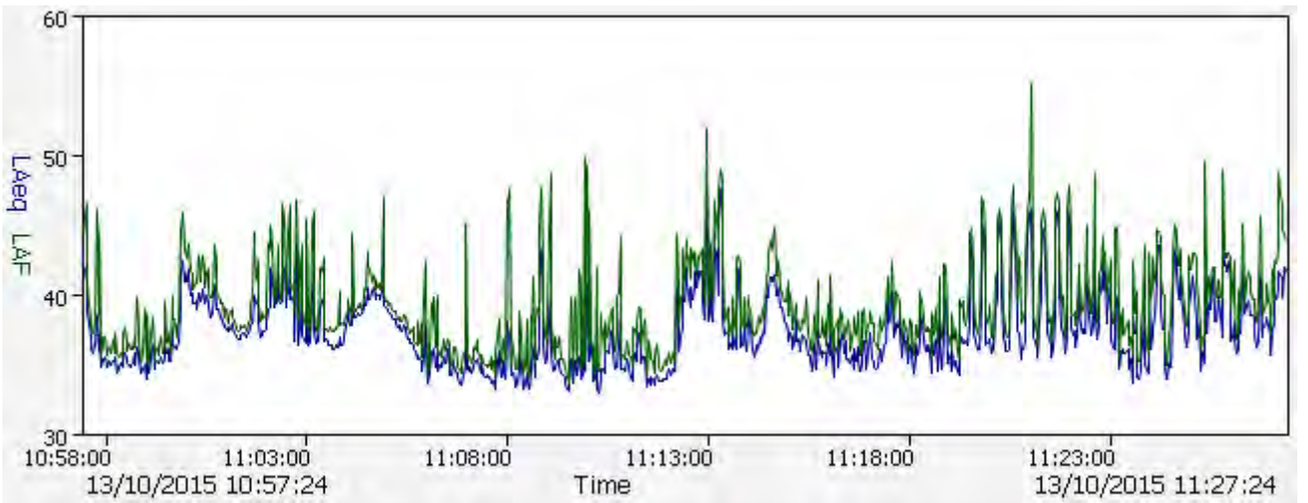
Summary

LAeq	38.3 dB
LAE	70.9 dB
LAFMax	55.1 dB

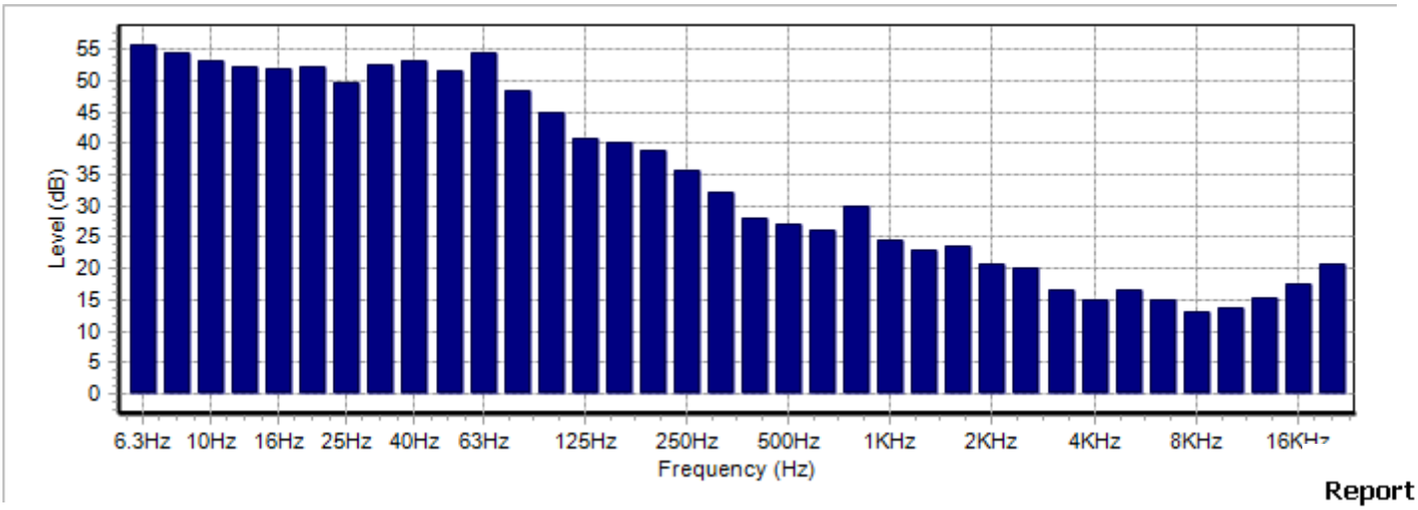
LAF1	45.6 dB
LAF5	42.5 dB
LAF10	40.9 dB
LAF50	36.6 dB
LAF90	34.1 dB
LAF95	33.7 dB
LAF99	33.0 dB

Calibration Information	Person	Place	Project
13/10/2015 10:55:47 -0.80 dB	Gareth Carroll	Rusal Aughinish	1017_37
13/10/2015 12:44:35 -0.44 dB	Graduate Environmental Co...		

Time History



Frequency Bands



Report ID

Cirrus Research plc

Measurement Summary Report

Name	NSL4 Evening 1
Time	12/10/2015 19:00:00
Duration	00:30:00
Instrument	GO56143, CR:171B

Summary

LAeq	47.0 dB
LAE	79.5 dB
LAFMax	63.0 dB

LAF1	59.7 dB
LAF5	53.0 dB
LAF10	45.6 dB
LAF50	41.6 dB
LAF90	39.2 dB
LAF95	38.7 dB
LAF99	37.5 dB

Calibration Information

12/10/2015 18:52:37 -0.26 dB

12/10/2015 20:40:27 -0.36 dB

Person

Gareth Carroll

Graduate Environmental Co...

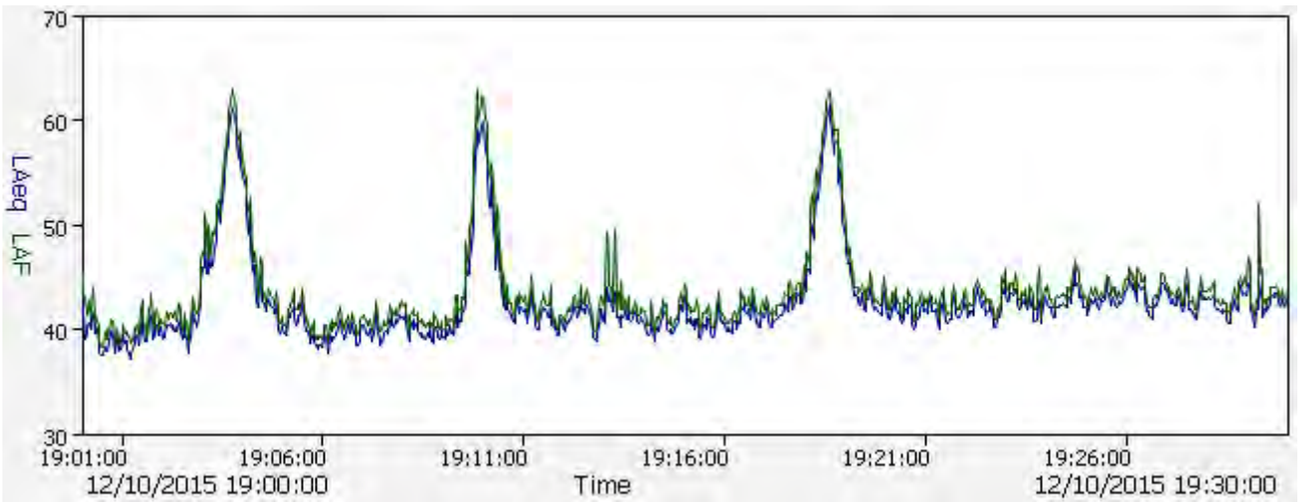
Place

Rusal Aughinish

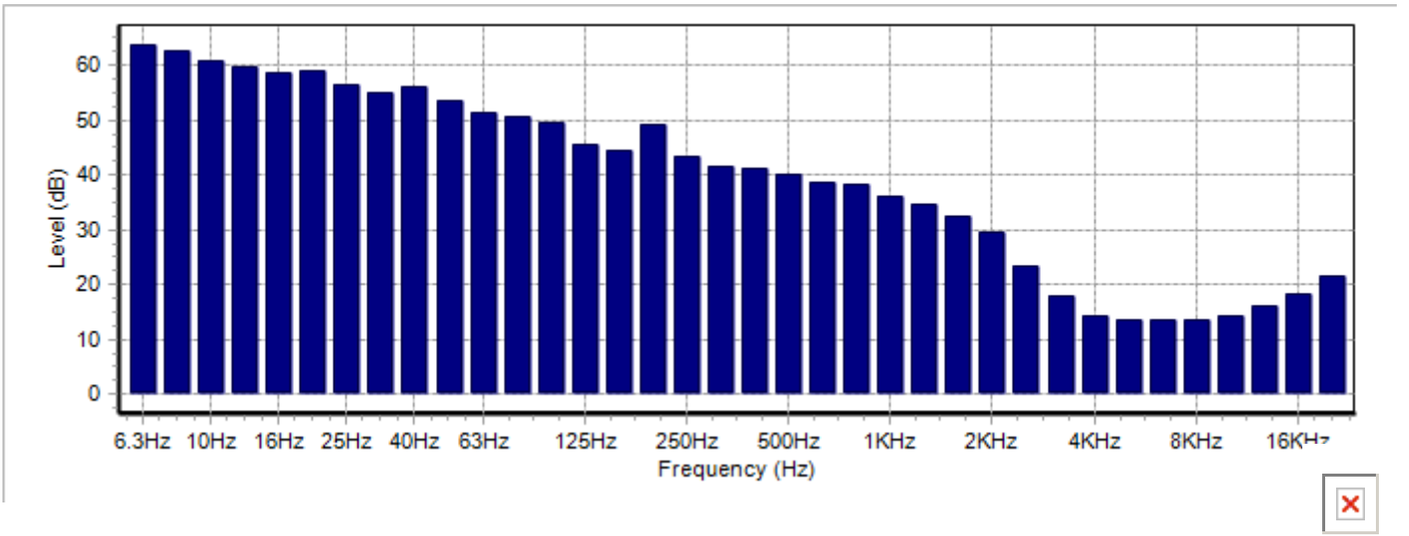
Project

1017_37

Time History



Frequency Bands



Cirrus Research plc

Measurement Summary Report

Name	NSL4 Night 1
Time	12/10/2015 23:00:03
Duration	00:30:00
Instrument	GO56143, CR:171B

Summary

LAeq	41.3 dB
LAE	73.9 dB
LAFMax	50.4 dB

LAF1	45.1 dB
LAF5	43.3 dB
LAF10	42.7 dB
LAF50	41.0 dB
LAF90	39.5 dB
LAF95	39.0 dB
LAF99	38.3 dB

Calibration Information

12/10/2015 22:53:35 -0.34 dB

13/10/2015 10:55:47 -0.80 dB

Person

Gareth Carroll

Graduate Environmental Co...

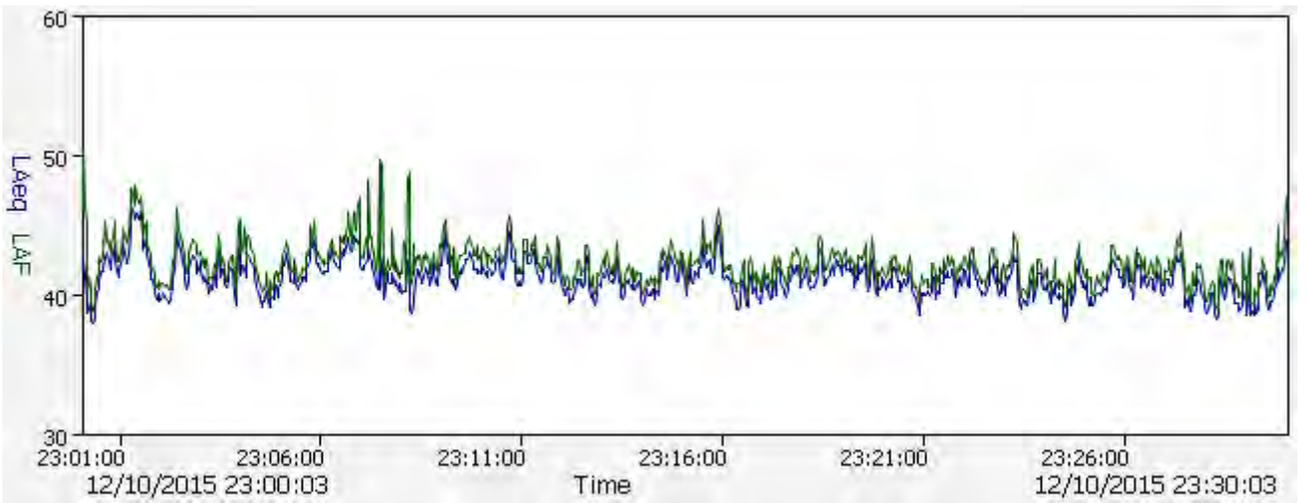
Place

Rusal Aughinish

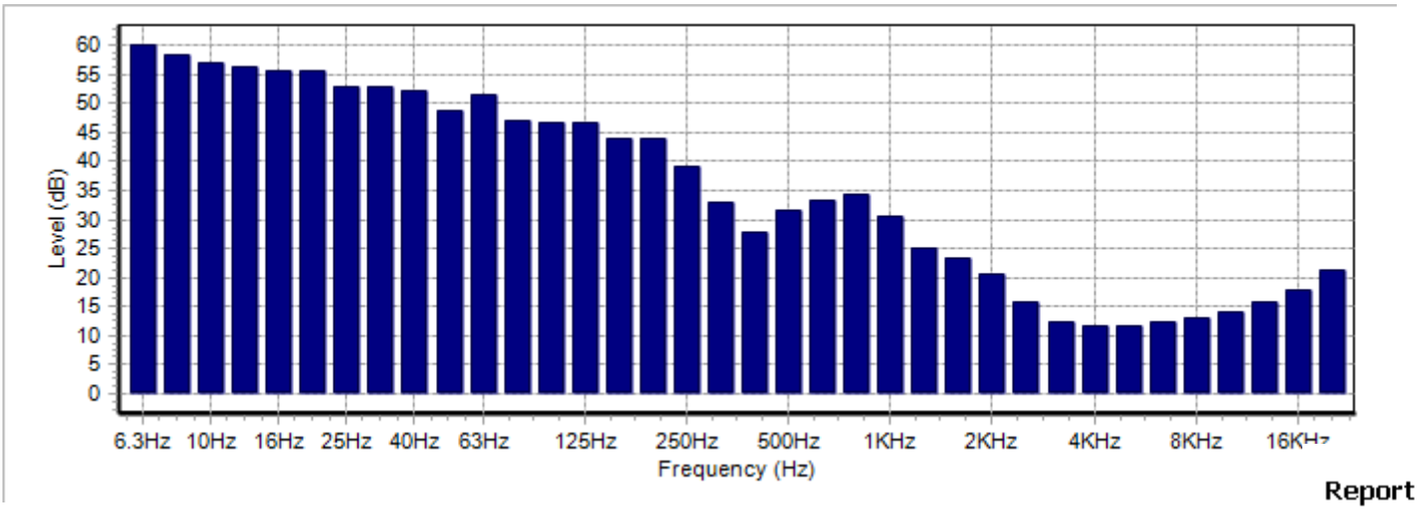
Project

1017_37

Time History



Frequency Bands



Report ID

Cirrus Research plc

Measurement Summary Report

Name	NSL4 Night 2
Time	12/10/2015 23:30:14
Duration	00:30:00
Instrument	GO56143, CR:171B

Summary

LAeq	43.8 dB
LAE	76.3 dB
LAFMax	64.3 dB

LAF1	58.2 dB
LAF5	43.4 dB
LAF10	42.0 dB
LAF50	38.3 dB
LAF90	35.4 dB
LAF95	34.8 dB
LAF99	34.1 dB

Calibration Information

12/10/2015 22:53:35 -0.34 dB

13/10/2015 10:55:47 -0.80 dB

Person

Gareth Carroll

Graduate Environmental Co...

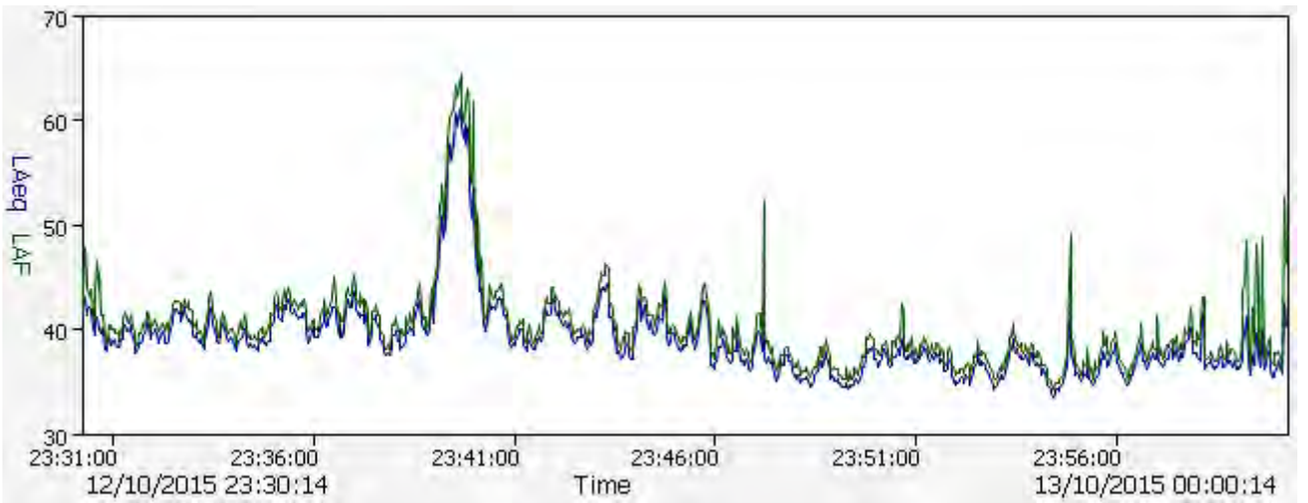
Place

Rusal Aughinish

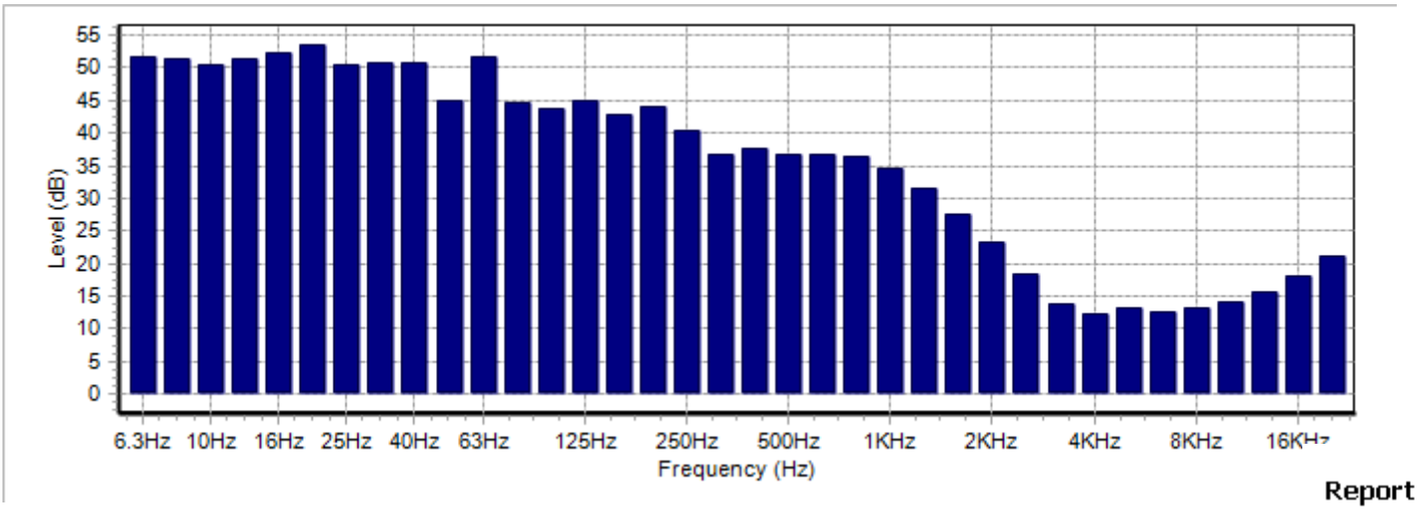
Project

1017_37

Time History



Frequency Bands



Report ID

Cirrus Research plc

Measurement Summary Report

Name	NSL5 Day 1
Time	12/10/2015 13:17:17
Duration	00:30:00
Instrument	GO56143, CR:171B

Summary

LAeq	61.0 dB
LAE	93.6 dB
LAFMax	83.7 dB

LAF1	75.2 dB
LAF5	66.0 dB
LAF10	56.4 dB
LAF50	37.1 dB
LAF90	33.2 dB
LAF95	32.6 dB
LAF99	31.9 dB

Calibration Information

12/10/2015 11:40:31 -0.30 dB

12/10/2015 18:52:37 -0.26 dB

Person

Gareth Carroll

Graduate Environmental Co...

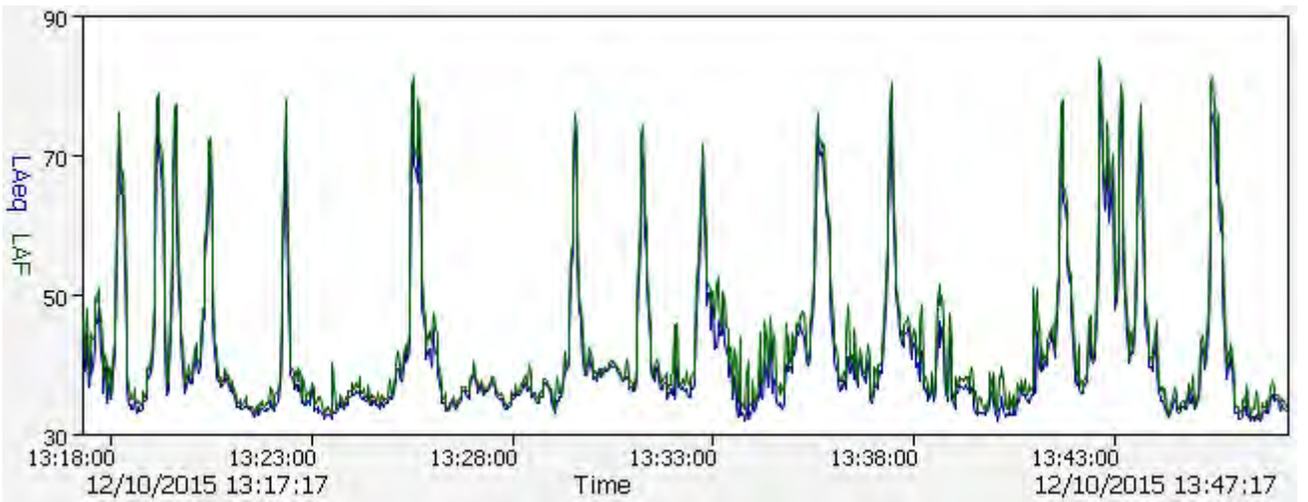
Place

Rusal Aughinish

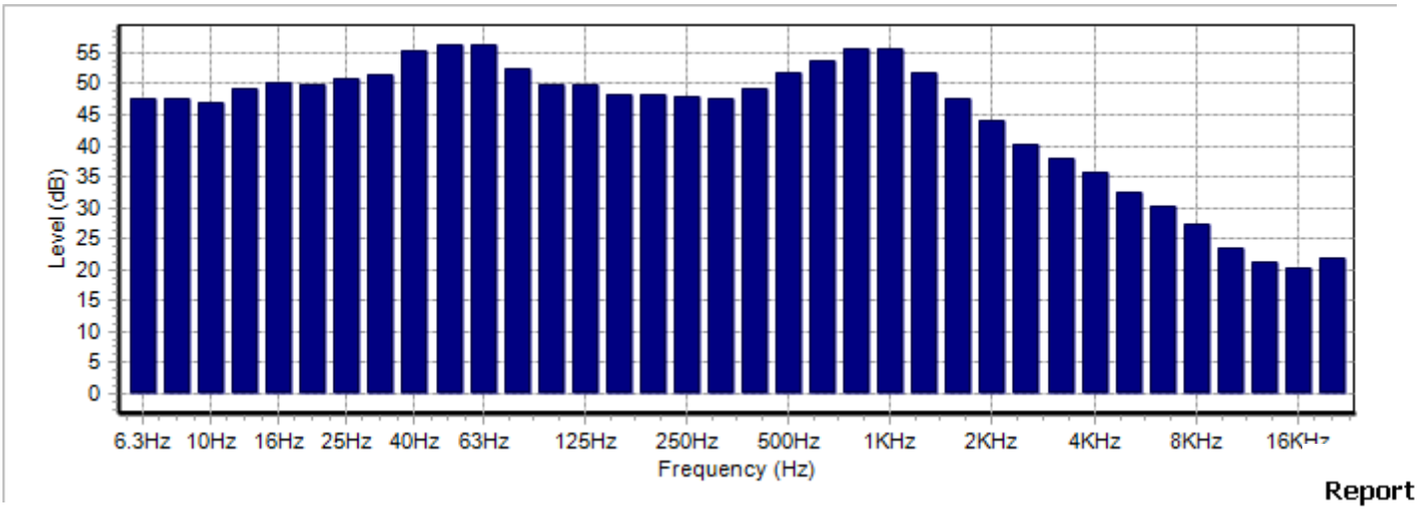
Project

1017_37

Time History



Frequency Bands



Report ID

Cirrus Research plc

Measurement Summary Report

Name	NSL5 Day 2
Time	12/10/2015 13:48:22
Duration	00:30:00
Instrument	GO56143, CR:171B

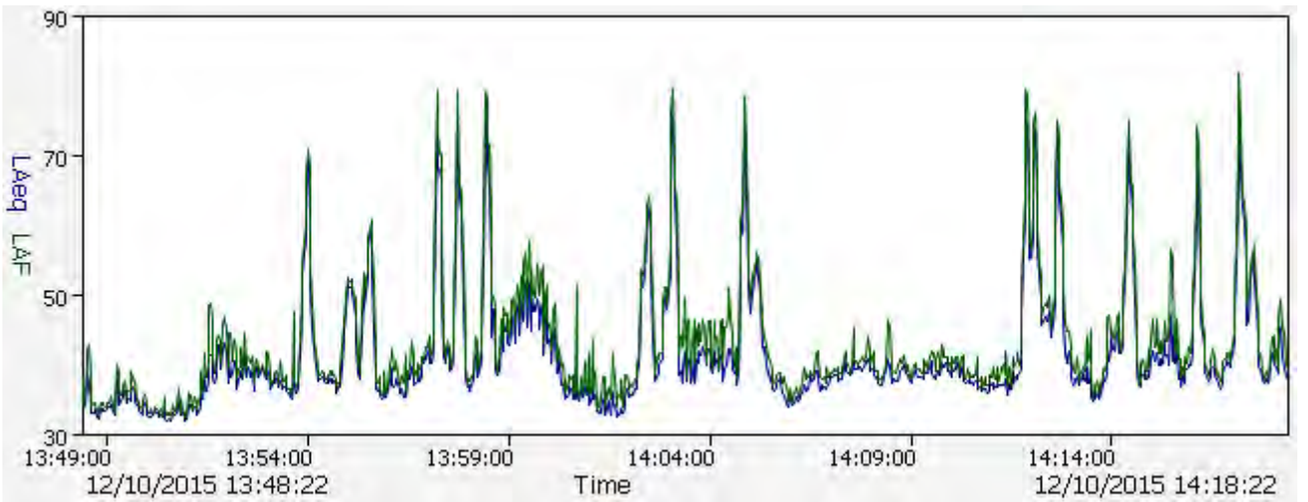
Summary

LAeq	58.2 dB
LAE	90.8 dB
LAFMax	81.9 dB

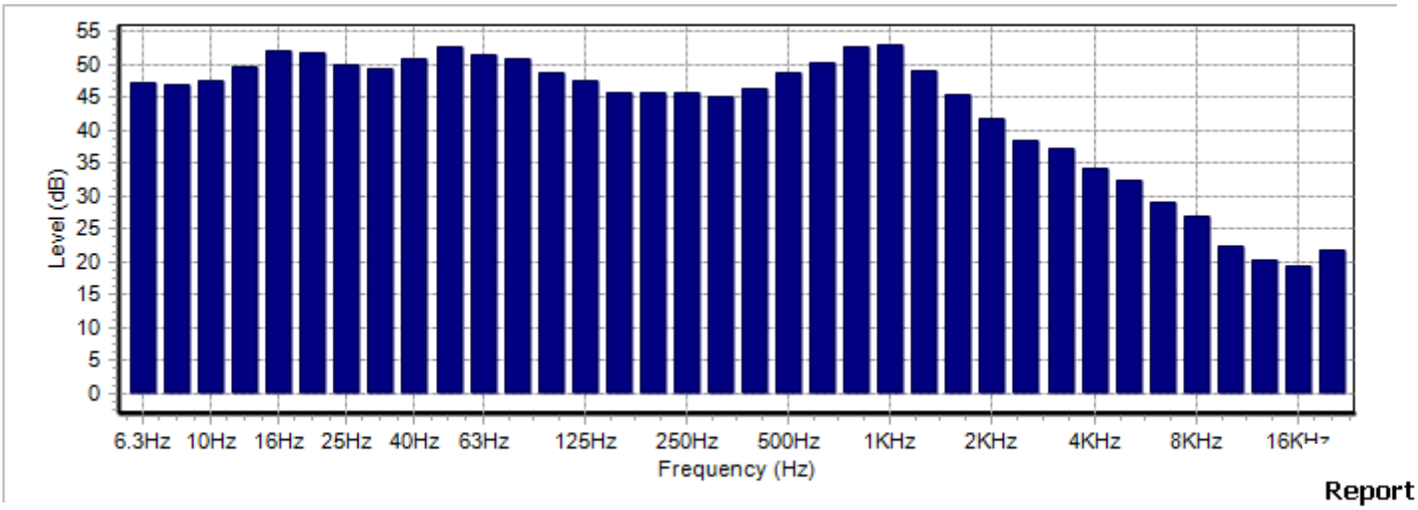
LAF1	72.4 dB
LAF5	60.2 dB
LAF10	51.8 dB
LAF50	38.4 dB
LAF90	34.1 dB
LAF95	33.0 dB
LAF99	32.1 dB

Calibration Information	Person	Place	Project
12/10/2015 11:40:31 -0.30 dB	Gareth Carroll	Rusal Aughinish	1017_37
12/10/2015 18:52:37 -0.26 dB	Graduate Environmental Co...		

Time History



Frequency Bands



Report ID

Cirrus Research plc

Measurement Summary Report

Name	NSL5 Day 3
Time	12/10/2015 14:18:29
Duration	00:30:00
Instrument	GO56143, CR:171B

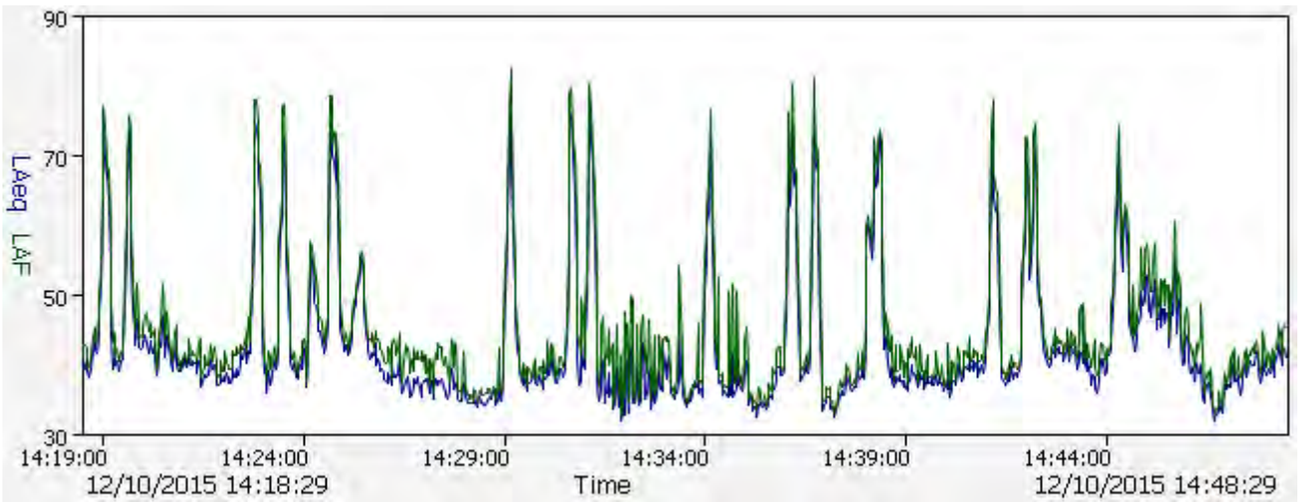
Summary

LAeq	60.3 dB
LAE	92.9 dB
LAFMax	82.3 dB

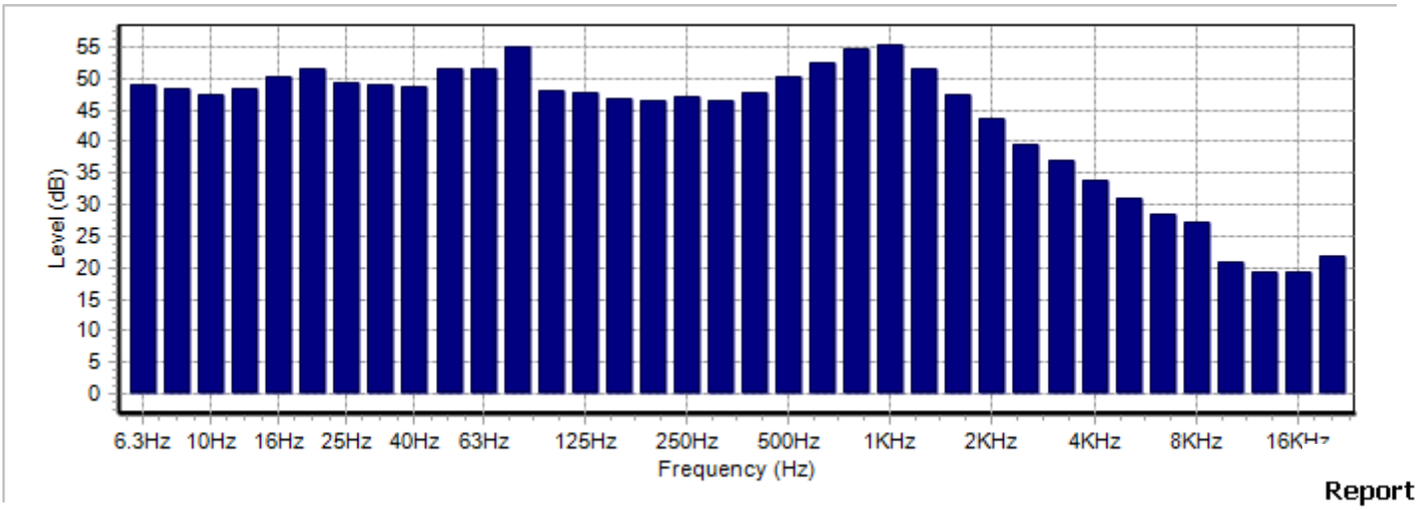
LAF1	74.0 dB
LAF5	66.0 dB
LAF10	56.8 dB
LAF50	39.2 dB
LAF90	34.8 dB
LAF95	34.0 dB
LAF99	32.7 dB

Calibration Information	Person	Place	Project
12/10/2015 11:40:31 -0.30 dB	Gareth Carroll	Rusal Aughinish	1017_37
12/10/2015 18:52:37 -0.26 dB	Graduate Environmental Co...		

Time History



Frequency Bands



Report ID

Cirrus Research plc

Measurement Summary Report

Name	NSL5 Evening 1
Time	08/10/2015 21:03:44
Duration	00:30:00
Instrument	GO56143, CR:171B

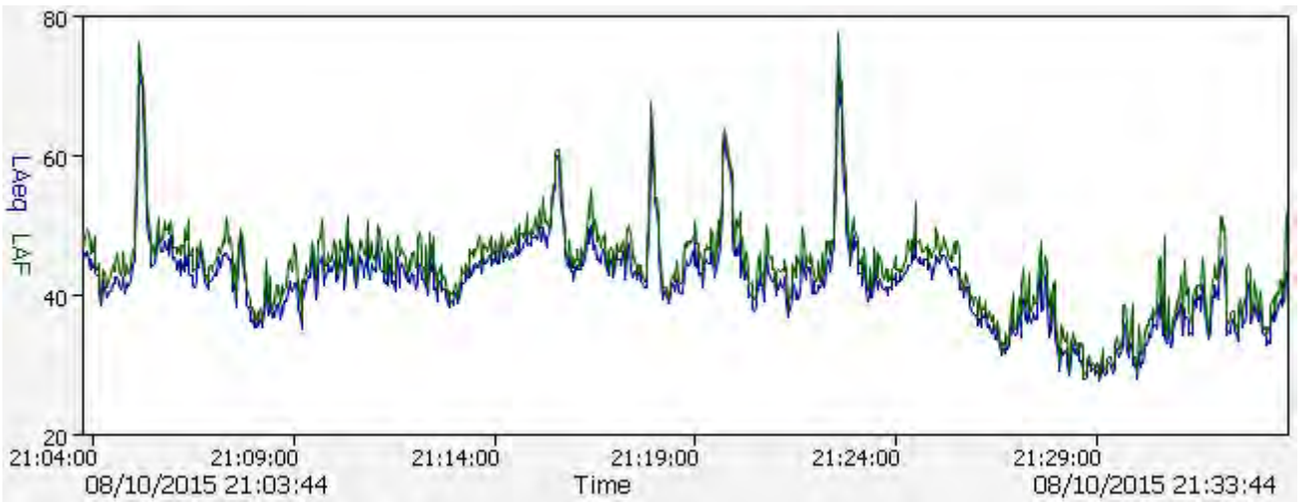
Summary

LAeq	52.2 dB
LAE	84.7 dB
LAFMax	77.7 dB

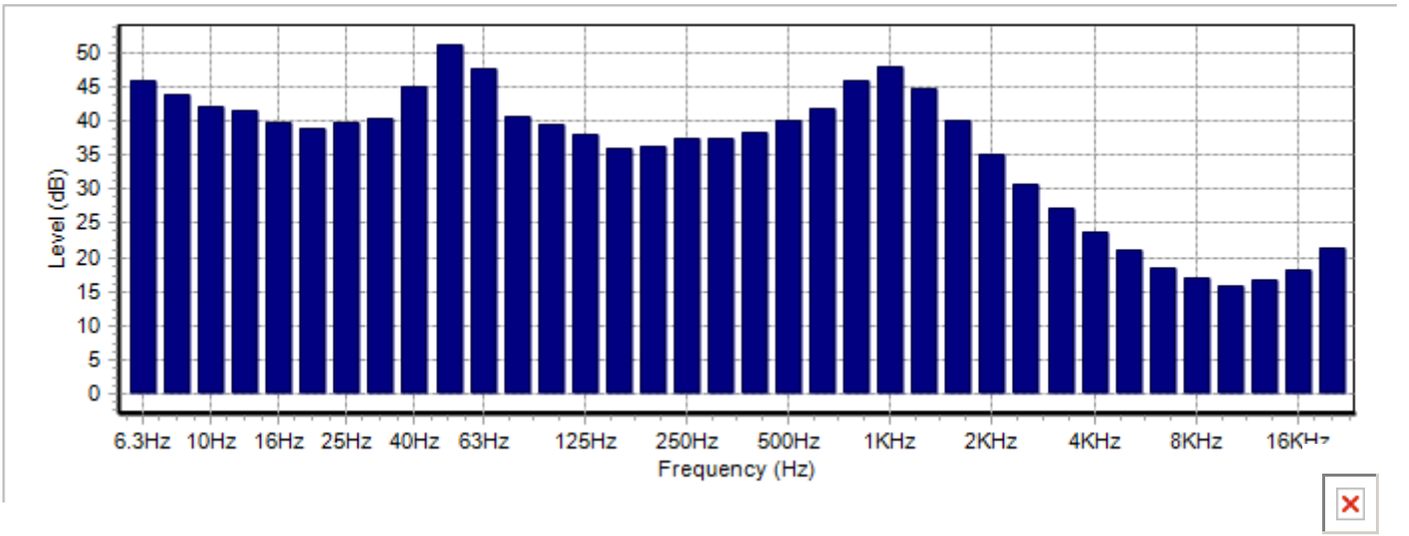
LAF1	64.8 dB
LAF5	50.0 dB
LAF10	47.3 dB
LAF50	41.8 dB
LAF90	33.6 dB
LAF95	31.0 dB
LAF99	28.4 dB

Calibration Information	Person	Place	Project
08/10/2015 20:28:31 -0.22 dB	Gareth Carroll	Rusal Aughinish	1017_37
08/10/2015 22:52:47 -0.32 dB	Graduate Environmental Co...		

Time History



Frequency Bands



Cirrus Research plc

Measurement Summary Report

Name	NSL5 Night 1
Time	08/10/2015 01:16:28
Duration	00:30:00
Instrument	GO56143, CR:171B

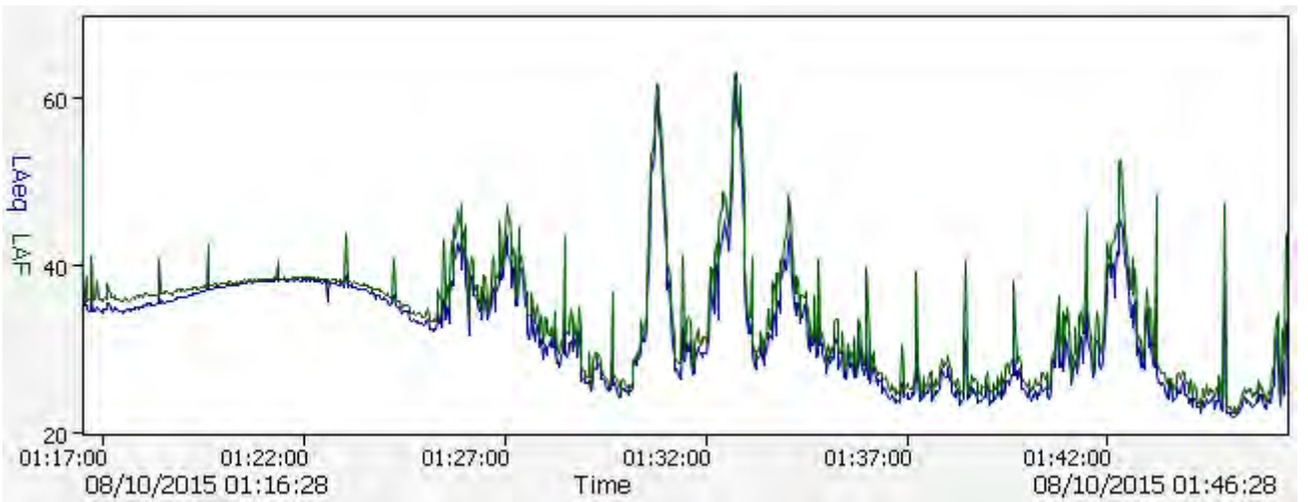
Summary

LAeq	41.3 dB
LAE	73.9 dB
LAFMax	63.1 dB

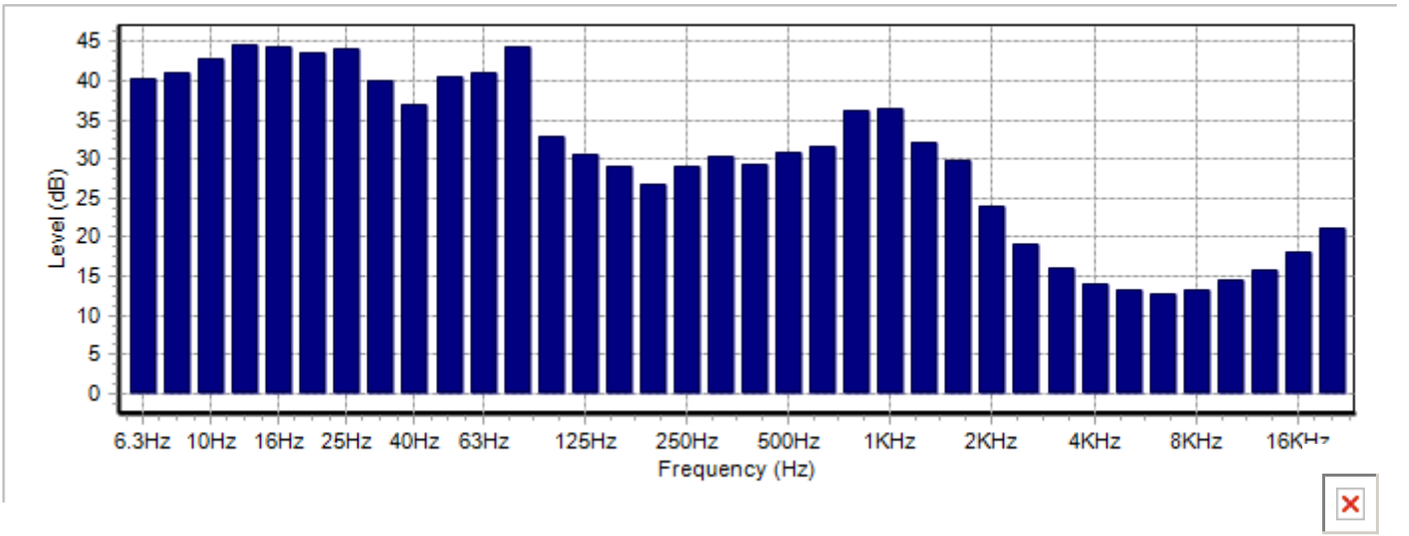
LAF1	56.0 dB
LAF5	41.5 dB
LAF10	38.4 dB
LAF50	31.9 dB
LAF90	24.1 dB
LAF95	23.3 dB
LAF99	22.3 dB

Calibration Information	Person	Place	Project
07/10/2015 23:33:11 -0.29 dB	Gareth Carroll	Rusal Aughinish	1017_37
08/10/2015 10:07:04 -0.55 dB	Graduate Environmental Co...		

Time History



Frequency Bands



Cirrus Research plc

Measurement Summary Report

Name	NSL5 Night 2
Time	08/10/2015 01:46:44
Duration	00:30:00
Instrument	GO56143, CR:171B

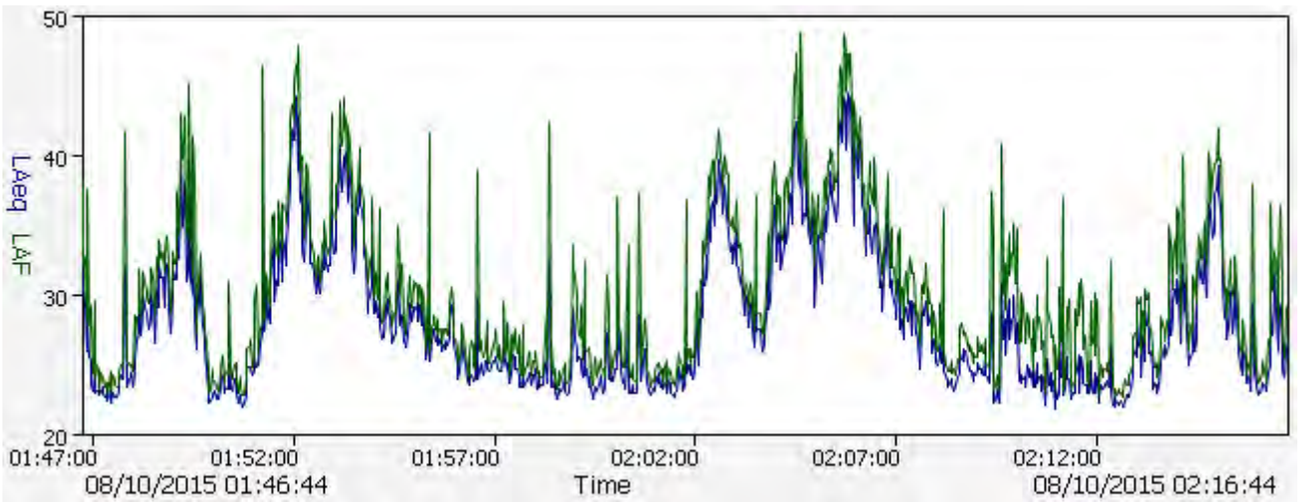
Summary

LAeq	31.9 dB
LAE	64.4 dB
LAFMax	48.8 dB

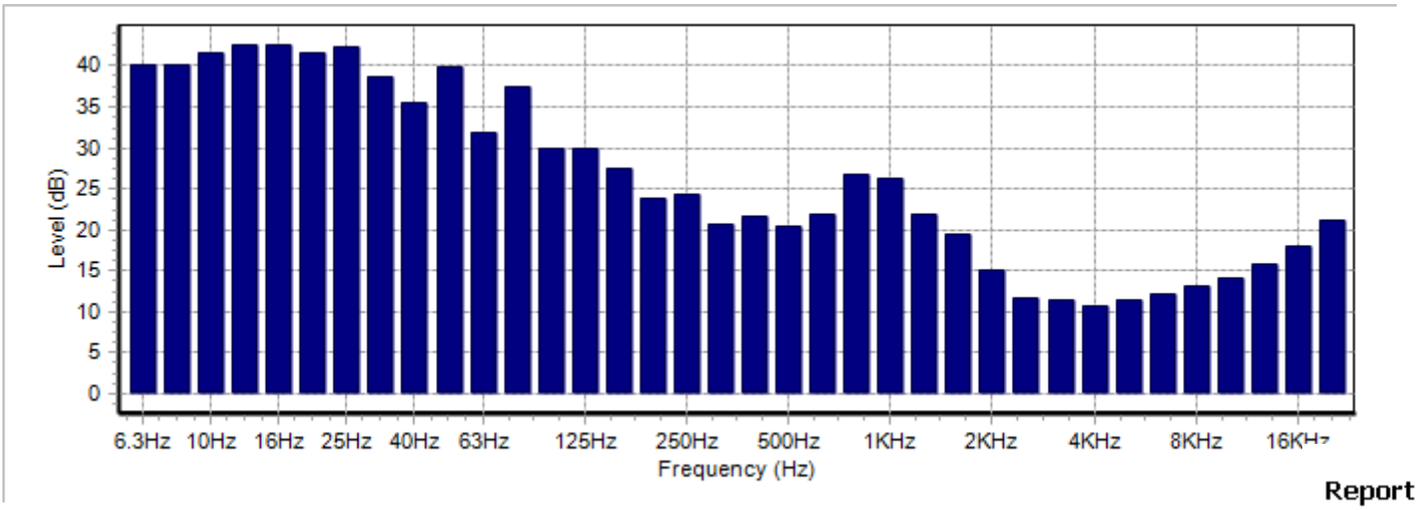
LAF1	42.4 dB
LAF5	38.0 dB
LAF10	35.6 dB
LAF50	26.1 dB
LAF90	22.7 dB
LAF95	22.4 dB
LAF99	21.8 dB

Calibration Information	Person	Place	Project
07/10/2015 23:33:11 -0.29 dB	Gareth Carroll	Rusal Aughinish	1017_37
08/10/2015 10:07:04 -0.55 dB	Graduate Environmental Co...		

Time History



Frequency Bands



Report ID

Attachment 6 Historic Monitoring Noise Results

Daytime Results

Year		2010			2011			2012			2013			2014			2015	
Monitoring location	LAEQ	LA90	LA10	LAEQ	LA90	LA10	LAEQ	LA90	LA10	LAEQ	LA90	LA10	LAEQ	LA90	LA10	LAEQ	LA90	LA10
B1	51	47	52	54	49	56	55	52	55	65	63	66	60	53	61	62	61	63
B2	49	48	51	56	55	57	56	55	57	54	53	56	47	46	48	56	55	56
B3	58	38	55	59	47	60	53	47	56	59	58	60	56	40	52	60	57	62
B4	54	42	52	53	41	48	52	43	52	62	42	64	45	36	47	49	35	51
B5	40	34	42	39	35	42	42	36	45	50	42	53	47	40	46	49	36	44
B6	54	51	56	52	50	54	52	48	54	51	48	53	54	52	56	50	49	52
B7	51	44	53	40	35	42	45	40	47	70	40	60	40	34	40	38	33	38
B8				40	37	41	42	36	45	55	35	51	37	33	39	41	37	43
B9	53	43	53	46	34	50	53	45	55	51	38	56	50	39	52	48	41	51
NSL1	35	31	36	45	42	46	49	46	51	46	44	48	39	30	40	44	42	45
NSL2	53	39	49	53	41	46	53	43	53	44	31	43	43	33	44	45	34	41
NSL3	50	41	52	48	42	48	51	43	51	50	40	48	46	39	49	48	35	45
NSL4	44	39	46	49	40	52	46	41	47	45	39	48	48	39	47	43	37	44
NSL5	49	41	51	54	38	53	53	42	52	59	41	60	67	42	70	60	34	55

Evening Results

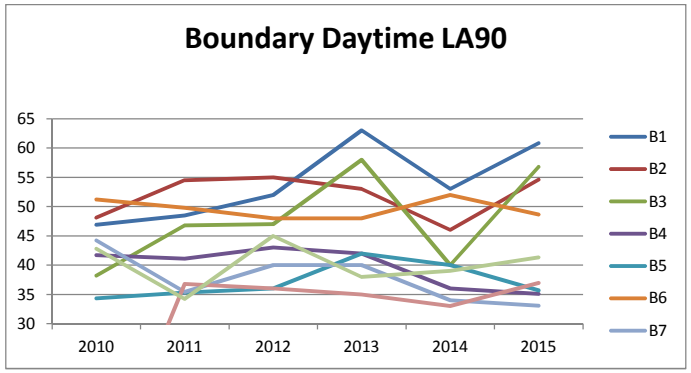
Year		2010			2011			2012			2013			2014			2015	
Monitoring location	LAEQ	LA90	LA10	LAEQ	LA90	LA10	LAEQ	LA90	LA10	LAEQ	LA90	LA10	LAEQ	LA90	LA10	LAEQ	LA90	LA10
B1													62	57	59	54	52	55
B2													50	49	51	52	51	53
B3													46	45	47	60	59	60
B4													42	38	42	38	29	36
B5													42	41	44	52	45	51
B6													59	56	61	54	51	54
B7													37	35	38	46	43	45
B8													35	31	38	39	36	41
B9													45	33	47	45	33	45
NSL1										52	48	52	46	38	48	34	30	37
NSL2										49	39	51	50	35	48	45	33	42
NSL3										43	36	46	44	36	47	50	41	52
NSL4										54	33	52	41	39	42	47	39	46
NSL5										45	35	40	57	31	49	52	34	47

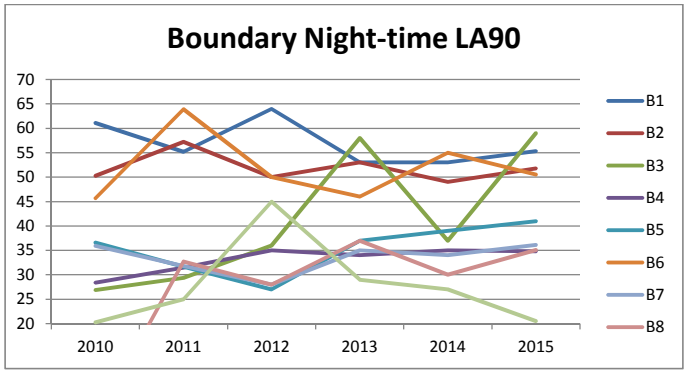
Night time Results

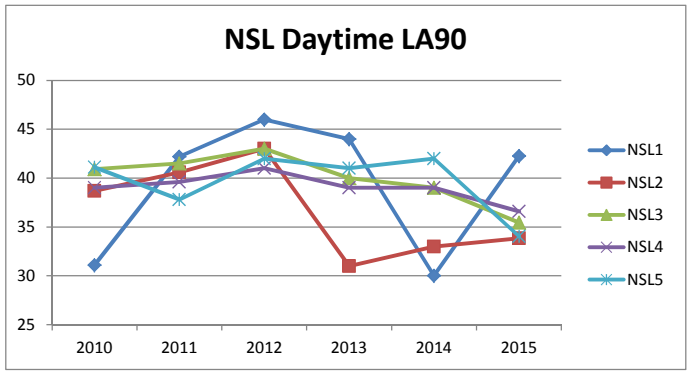
Year		2010			2011			2012			2013			2014			2015	
Monitoring location	LAEQ	LA90	LA10	LAEQ	LA90	LA10	LAEQ	LA90	LA10	LAEQ	LA90	LA10	LAEQ	LA90	LA10	LAEQ	LA90	LA10
B1	63	61	65	58	55	59	66	64	67	56	53	58	59	53	62	62	55	63
B2	51	50	52	58	57	59	51	50	52	53	53	54	50	49	51	53	52	53
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B5	40	37	40	34	32	36	30	27	30	41	37	43	42	39	43	42	41	44
B6	48	46	48	65	64	66	51	50	52	47	46	47	57	55	59	53	51	54
B7	41	36	40	34	32	35	30	28	36	37	35	38	38	34	39	39	36	41
B8				36	33	38	36	28	32	40	37	42	33	30	35	38	35	40
B9	35	20	38	33	25	33	53	45	55	35	29	33	36	27	33	41	21	40
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NSL2	34	23	37	42	30	37	46	34	38	38	36	40	34	31	35	41	34	42
NSL3	36	17	35	46	32	51	37	34	39	38	33	40	29	24	32	38	21	42
NSL4	44	26	37	54	37	45	46	32	37	43	34	41	41	39	42	43	37	42
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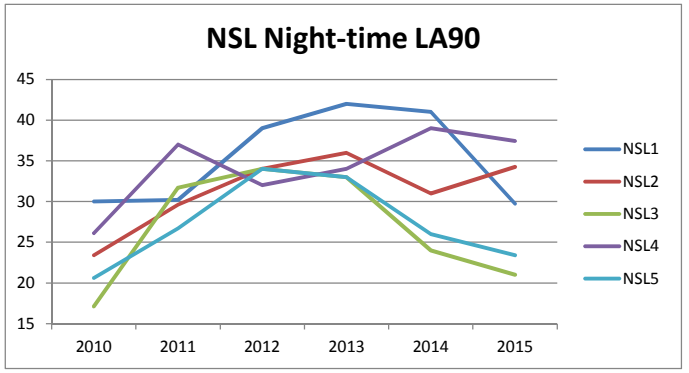
Daytime LA90							
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B2		48	55	55	53	46	55
B3		38	47	47	58	40	57
B4		42	41	43	42	36	35
B5		34	35	36	42	40	36
B6		51	50	48	48	52	49
B7		44	35	40	40	34	33
B8			37	36	35	33	37
B9		43	34	45	38	39	41
NSL1		31	42	46	44	30	42
NSL2		39	41	43	31	33	34
NSL3		41	42	43	40	39	35
NSL4		39	40	41	39	39	37
NSL5		41	38	42	41	42	34
Daytime LAeq							
Year		**2010**	**2011**	**2012**	**2013**	**2014**	**2015**
B1		51	54	55	65	60	62
B2		49	56	56	54	47	56
B3		58	59	53	59	56	60
B4		54	53	52	62	45	49
B5		40	39	42	50	47	49
B6		54	52	52	51	54	50
B7		51	40	45	70	40	38
B8			40	42	55	37	41
B9		53	46	53	51	50	48
NSL1		35	45	49	46	39	44
NSL2		53	53	53	44	43	45
NSL3		50	48	51	50	46	48
NSL4		44	49	46	45	48	43
NSL5		49	54	53	59	67	60
Daytime LA10							
		2010	**2011**	**2012**	**2013**	**2014**	**2015**
B1		52	56	55	66	61	63
B2		51	57	57	56	48	56
B3		55	60	56	60	52	62
B4		52	48	52	64	47	51
B5		42	42	45	53	46	44
B6		56	54	54	53	56	52
B7		53	42	47	60	40	38
B8			41	45	51	39	43
B9		53	50	55	56	52	51
NSL1		36	46	51	48	40	45
NSL2		49	46	53	43	44	41
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NSL5		51	53	52	60	70	55

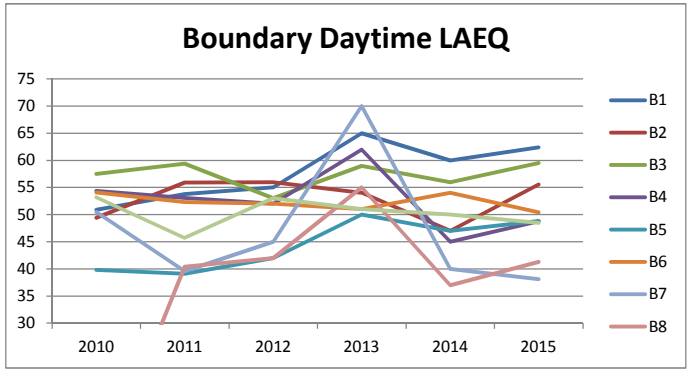
Night-time LAeq							
Year		**2010**	**2011**	**2012**	**2013**	**2014**	**2015**
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B2		51	58	51	53	50	53
B3		48	32	52	59	42	60
B4		38	53	36	36	37	41
B5		40	34	30	41	42	42
B6		48	65	51	47	57	53
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B8			36	36	40	33	38
B9		35	33	53	35	36	41
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NSL2		34	42	46	38	34	41
NSL3		36	46	37	38	29	38
NSL4		44	54	46	43	41	43
NSL5		36	35	39	37	32	37
Night-time LA90							
Year		**2010**	**2011**	**2012**	**2013**	**2014**	**2015**
B1		61	55	64	53	53	55
B2		50	57	50	53	49	52
B3		27	29	36	58	37	59
B4		28	32	35	34	35	35
B5		37	32	27	37	39	41
B6		46	64	50	46	55	51
B7		36	32	28	35	34	36
B8			33	28	37	30	35
B9		20	25	45	29	27	21
NSL1		30	30	39	42	41	30
NSL2		23	30	34	36	31	34
NSL3		17	32	34	33	24	21
NSL4		26	37	32	34	39	37
NSL5		21	27	34	33	26	23
Night-Time LA10							
Year		**2010**	**2011**	**2012**	**2013**	**2014**	**2015**
B1		65	59	67	58	62	63
B2		52	59	52	54	51	53
B3		38	34	41	59	40	60
B4		40	43	37	38	38	39
B5		40	36	30	43	43	44
B6		48	66	52	47	59	54
B7		40	35	36	38	39	41
B8			38	32	42	35	40
B9		38	33	55	33	33	40
NSL1		39	35	43	50	43	35
NSL2		37	37	38	40	35	42
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NSL4		37	45	37	41	42	42
NSL5		38	38	38	36	32	37

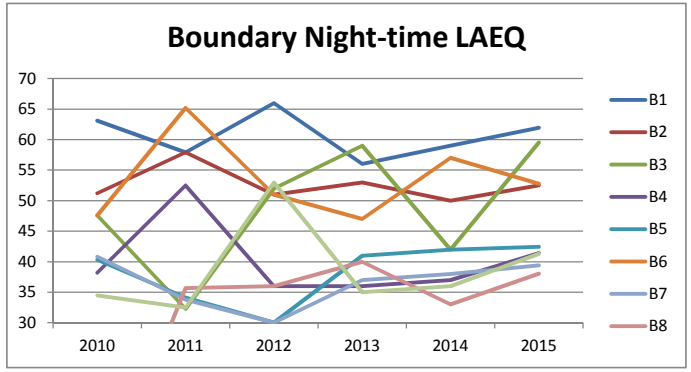

Boundary Daytime LA90
65
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2010
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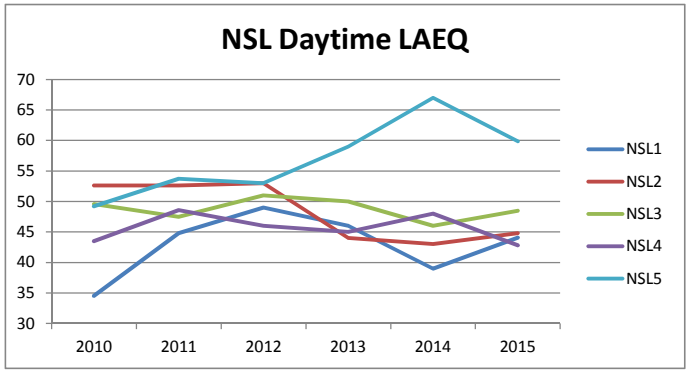

Boundary Night-time LA90
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B1
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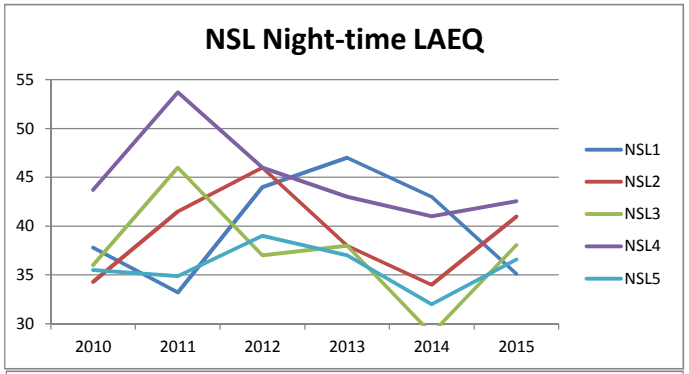

NSL Daytime LA90
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NSL1
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NSL5

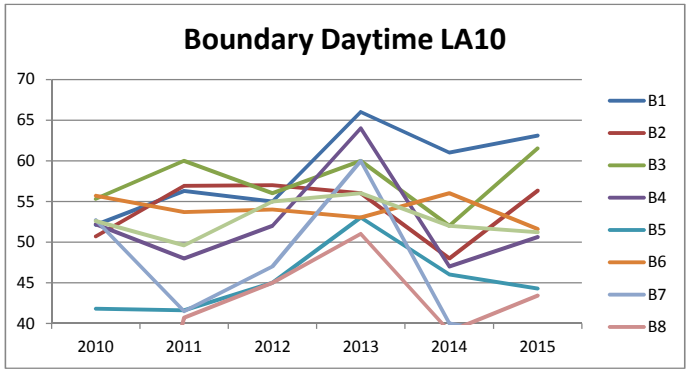

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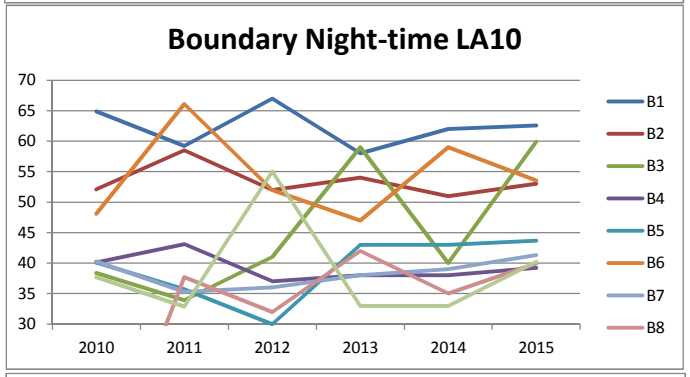

Boundary Daytime LAEQ
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B2
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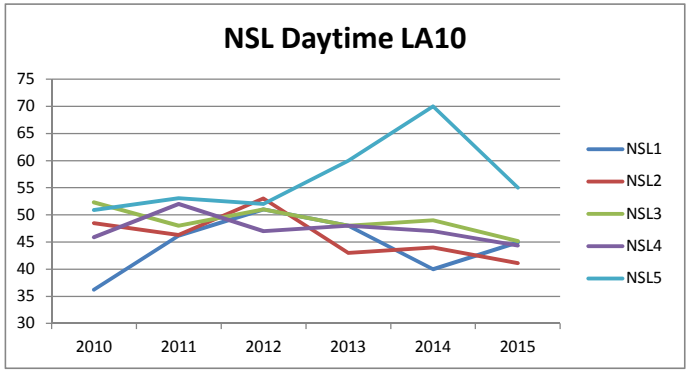

Boundary Night-time LAEQ
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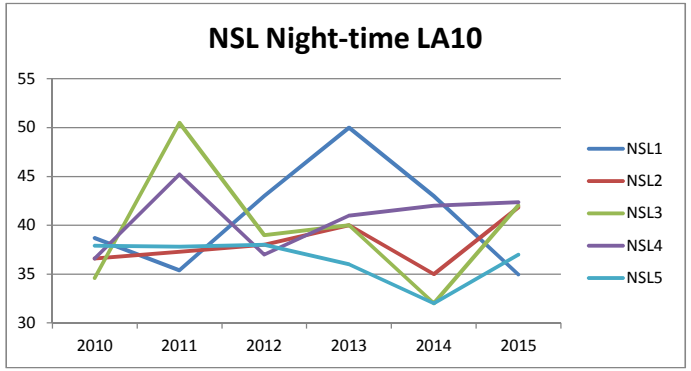

NSL Daytime LAEQ
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NSL Night-time LAEQ
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Boundary Daytime LA10
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Boundary Night-time LA10
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NSL Daytime LA10
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NSL Night-time LA10
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NSL2
NSL3
NSL4
NSL5

Attachment 6
Ambient Air Monitoring Locations

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Parameter	1 Ballysteen (Kennericks)	2 Askeaton (Deel intake)	3 Morgans Nth (Keanes)	4 WTP (LCC)	5 Foynes (LCC Reservoir)	6 Creeves (Morans)	7 Fawnamore (Fitzsimons)	8 A23 North	9 BRDA (P Stack)	10 Foynes Port	11 Cronin	12 Sullivan	13 Ford (DG#33)
PM10 (continuous)	Osiris			Osiris	Partisol (AAL lab) & Osiris			Osiris	Osiris				
PM2.5 (continuous)	Osiris			Osiris	Osiris			Osiris	Osiris				
Deposited dust (monthly)			Dust Gauge (DG#29)				Dust Gauge (DG#30)				Dust Gauge (DG#31)	Dust Gauge (DG#32)	Dust Gauge (DG#33)
Sox (continuous)	Continuous				Continuous								
Sox (monthly)	Diffusion tube x2	Diffusion tube	Diffusion tube	Diffusion tube	Diffusion tube x2	Diffusion tube	Diffusion tube	Diffusion tube	Diffusion tube	Diffusion tube			

Attachment 7
BRDA Operational Plan & Safety Manual

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RUSAL Aughinish

IE Licence P0035-06

Bauxite Residue Disposal Area

Operational Plan and Safety Manual



Prepared by: P O'Loughlin Date: 12.10.04	Approval Date Env Co-ord:	Reference No. BRDA OP001	Issue 1
Revised by: BRDA Eng Kevin McMahon Date 14.10.15	BRDA Eng:		Rev. 7

Bauxite Residue Disposal Area (BRDA)

Operational Plan & Safety Manual

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1. Introduction

The Bauxite Residue Disposal Area (BRDA) is a dedicated extractive waste facility, owned, developed and operated by RUSAL Aughinish Ltd for the permanent disposal of specific bauxite and process residues generated within the alumina extraction plant.

This Operational Plan and Safety Manual is structured to facilitate a clear presentation of relevant information as required by Conditions 8.4.10, 8.4.11 and 8.4.12 of the Industrial Emissions (IE) licence. It includes all relevant data for the effective operation, health and safety management, monitoring long-term planning and aftercare of the BRDA. It demonstrates that the BRDA operations are in accordance with best management practices, the health and safety and environmental policies of RUSAL Aughinish Ltd and the IE Licence.

2. Site Management and Responsibilities

The Technical and Knowledge Management Manager has overall responsibility for the operation of the Bauxite Residue Disposal Area (BRDA). See Rusal Aughinish Organisational Chart'

The BRDA is referred to as Area 54 (A54). The BRDA Operations Engineer has functional and administrative responsibility for the management of the BRDA including the health and safety management of the BRDA.

Placement of trucked residue material within the BRDA is undertaken by Murphy International Ltd. (MIL) under a Site Process Materials Handling (SPMH) Contract.

MIL are also contracted to operate the mud farming equipment to amphiroll and grade the entire pumped residue in the BRDA disposed under the Mud Farming contract.

The BRDA Operations Team has overall responsibility for technical developments in the residue production and the co-ordination of day to day operations and maintenance.

The BRDA Operations Team includes:

- BRDA Operations Engineer.
- BRDA Consultant Engineer
- SPMH & Mud Farming Contractor
- BRDA Site Monitor

The BRDA Consultant Engineer has functional responsibility for all technical developments within the BRDA area and advises the BRDA Operations Team.

The SPMH & Mud Farming Contractor is responsible for all disposal area operations and maintenance as per contract.

The BRDA Site Monitor advises on a daily basis the appropriate residue disposal locations and monitors the capacity of the individual cells within the BRDA and checks the progress of mud deposition and advises on equipment tasks for mud farming activities.

All queries from members of the public are managed by the Human Resources (HR) Manager.

All liaison with and queries from the EPA concerning BRDA aspects are managed by the Environmental Coordinator.

The Aughinish Health and Safety Co-ordinator supports the BRDA health and safety management as per the BRDA Safety Policy and Condition 9.0 of the IE licence (in particular Condition 9.4.2).

2.1 Operation of the BRDA

The day-to-day operation activities of the BRDA are carried out by the SPMH & Mud Farming Contractor. Under this contract, Murphy International Ltd. (the Contractor) has responsibility for the following:

- Collection, transport and placement of all process plant residues at the BRDA.
- Maintenance and organisation of red mud placement operations.
- Reporting of waste quantities deposited to the BRDA to the Environmental Dept.
- Organisation and development of all landfill operations and maintenance, including construction of internal access roads.
- Mud farming by amphirolling and grading of all red mud residue in the cells within the BRDA and the internal and perimeter drainage works associated with surface water drainage from the areas being amphirolled for maximum drying and compaction of the red mud residue.
- Organisation and implementation of all internal storage developments within the BRDA, including perimeter rockfill construction.
- Organisation, implementation and maintenance of environmental protection measures inside the BRDA.

The responsibilities of the BRDA Operations Team include:

1. Patrolling and liaising with the SPMH & Mud Farming Contractor on discharge points to be operated. Assessing the vulnerability of dusting and liaising with contractor on appropriate measures to suppress it.
2. Advising the Local 2 *Control Room Operator (CRO)* to operate the dust suppression sprinkler system with water as and when required.
3. Submitting job tickets for any maintenance work required.
4. Formulation of medium and longer-term operating strategies.
5. The BRDA Operations Team with support from the Engineering Dept. manages the construction of rockfill embankments on the perimeter of the residue disposal areas.

2.2 Control of Mud Quality

The Local 2 (L2) CRO is responsible for monitoring mud slurry throughput and mud line pressure.

The L2 Process Operator (PO) is responsible for sampling, field patrols, filter checks, pump checks, filter washing and mud line pressure control. The L2 PO has responsibility for tasks associated with mud slurry washing, vacuum filtration, mud filter cake reslurrying and mud pumping operations.

The L2 Process Engineer is responsible for monitoring and achieving all long-term trends and process targets in the Mud Filtration Area (Area 34).

2.3 Management of Surface Water Inventory – Water Management

The L2 CRO is responsible for monitoring pond and channels levels, inventory and stream distribution. The CRO records any non-compliance in the L2 Log and reports these to the Shift Plant Facilitator (SPF). The SPF reports any non-compliance in the shift log. The L2 PO is responsible for sampling, field valve set up and field patrols.

2.4 Pond Cleanouts and Inspection

The L2 Process Engineer and Facilitator are responsible for deciding when a clean-out may commence. Pond sludge is pumped to the effluent clarifier for recycling to the plant. The BRDA Operations Team decides where the remaining 'non-pumpable' bauxite residue sludge is disposed in the BRDA.

The Environmental Engineer is responsible for reviewing clean-out operations and to advice on environmental control measures as necessary.

The L2 CRO is responsible for monitoring any condensate flows to the West Pond or its associated drainage trenches. The L2 PO is responsible for monitoring pumping from the Liquid Waste Pond during a normal clean-out. The L2 Environmental Facilitator is responsible for inspection of ponds.

The Engineering Department is responsible for monitoring and overseeing any repairs to the pond liners or concrete.

2.5 Dust Emissions Control

The BRDA Operations Team is responsible for ensuring that no dusting occurs on the BRDA and to take the necessary measures to prevent dusting. These measures include ensuring the sprinkling system is applied appropriately to damp down potential fugitive dust emissions at all times.

The SPMH & Mud Farming Contractor is responsible for the maintenance, filling and operation of all mobile water sprayers and the maintenance and vertical spool lifting of permanently installed sprinkler systems.

The BRDA operation engineer, SPM Management Contractor and BRDA Monitor maintains a watching brief for the meteorological conditions which favour dusting and are responsible for communicating this to the L2 CRO and L2 Equipment Facilitator on a daily basis.

2.6 Emergency Response

In the event of a dusting emergency, any member of the BRDA Operations team detecting the event is responsible for directly notifying the SPF and L2 CRO. Depending on the response required, the SPM Management Contractor has responsibility for requesting assistance, organising all dust suppression resources and ensuring that the BRDA Dusting Prevention and Control (SWM 2026) is implemented.

3. Waste Analysis

3.1 Waste Origin and Composition

All bauxite-derived solid and sludge residues ('Extractive Waste') arising from alumina production at the plant are deposited in the BRDA in accordance with IE Licence conditions. Almost all the solid residue material arises from the initial caustic digestion of the bauxite ore. After exiting the bauxite digesters, the bauxite residue is segregated into two fractions, the fine red mud fraction, representing approximately 93% of the total and the coarse fraction, known as process sand, representing the other 7%.

Together these represent about 97% of the total process residue from the plant. The remaining proportion comprises salt cake; from a salting-out liquor purification process and other process wastes including sand, scale, sludge's and construction and demolition waste. Table 1 below lists the waste types approved by the EPA for placement within the BRDA.

Table 1 Approved Waste Types

Waste Stream	Source	EWC Code
Red Mud	Residue from bauxite processing	01 03 09
Process Sand	Residue from bauxite processing	01 03 99
Salt Cake	By-product of production process	01 03 07
Lime Grits	Lime slaking rejects	01 03 99
Process Scales & Sludge's	Scale & sludge from vessel cleanouts & cleanout of plant effluent storage ponds	01 03 99
*Recovered Concrete Rubble	Construction & demolition. Used for roadway/embankment construction within the BRDA	17 01 01
*Recovered Refractory Material	Calciner & boiler unit maintenance. Used for roadway/embankment construction within the BRDA	16 11 04
*Recovered Miscellaneous Materials	Process contaminated materials. E.g. cooling tower packing and waste insulation. Used for internal roadway construction within BRDA	Depending on type of plastic fill

***In accordance with IE Condition 8.4.29, recovered materials may be deposited in the BRDA.**

The red mud is subject to counter-current washing to reduce the concentration of entrained caustic before being de-watered in vacuum drum filters and pumped as *high density* slurry to the BRDA.

The coarser process sand fraction is delivered to the storage area *by road truck*. Salt cake, lime grits, refractory and scale that are trucked to the BRDA, are confined to specific areas within the existing BRDA.

Accumulated sludge's from process ponds are also deposited within the BRDA.

Table 2 shows the classification of the main process residues disposed of to the BRDA.

Table 2 Process Residues deposited in the BRDA

Waste Stream	European Waste Catalogue Code	Hazardous/ Non-Hazardous (EWC Classification)	Approximate % of Total Residue Deposited
Bauxite Residue (Red Mud & Sand)	01 03 09	Non-Hazardous	88%
Process Waste	01 03 99	Non-Hazardous	9%
Lime Grits	01 03 99	Non-Hazardous	1%
Salt Cake	01 03 07	Hazardous	2%

3.2 Waste Quantities

Data on waste composition and quantities is collected in accordance with IE Licence conditions and is included in Annual Environmental Reports (AER's) to the EPA.

3.3 Physical Properties

The red mud residue is pumped from the Vacuum Filtration area (Local 2) to the BRDA as slurry with solids content of between 55% and 60%. Once the mud has been discharged it begins to dry, with water removal through "bleeding", surface evaporation and mud farming. Samples indicate that after an average 'maturing period' of 3 to 6 months for mud layer of 0.3 to 0.6m thick, a solid's content of around 70% is achieved.

Particle size analyses of red mud indicate that the material is largely silt size, with 90% of the particles smaller than 63 microns and 30% finer than 2 microns. The permeability of the mud is correspondingly very low and has been assessed to be in the range 1 x 10^{-7} to 1 x 10^{-8}m/sec. The specific gravity of the dry mud solids is 3.47.

The process sand is graded medium sand having 95%, 60% and 5% of the particles smaller than 1000, 500 and 100 µm respectively. The permeability of the process sand is estimated to be about 1000 times greater than the permeability of the red mud.

Salt cake is deposited as a 70% solids filter cake.

3.4 Mineral Composition

The principal constituents of the red mud solids (expressed as the oxides) are iron oxide (Fe_2O_3), aluminium oxide (Al_2O_3) and titanium dioxide (TiO_2).

Red mud is analysed as per Schedule C4 of the licence.

Salt cake consists of the organic degradation products from humates in the bauxite, including sodium carbonate, sodium sulphate and sodium oxalate.

4. Operational Principles

The following summarises the key operating principles for the BRDA:

1. The BRDA accepts only those residues described in and permitted by the current IE Licence.

2. The red mud is pumped to the BRDA at optimum solids and deposited in layers to maximise maturing by drying, consolidation and mud farming to optimise overall storage capacity of the BRDA.

3. The approach to the placement of red mud is based on mud farming as described in Section 5 and in SWM 2022. (Link SWM 2022)

4. Storage capacity is developed within the BRDA by construction of rockfill embankments around the BRDA using upstream embankment construction where the underlying red mud supports the upper rockfill embankment.

5. The overall stability of the upstream rockfill core mud retention terraces around the perimeter of the BRDA is determined by routine monitoring of pore pressures in the mud and movement in the inclinometers and by site investigations at frequency determined by the designers to assess by continuous penetration testing the strength of the red mud and underlying estuarine soil.

6. The soda content of the red mud and other residues being deposited is minimised to optimise soda recovery in the plant and to minimise environmental liabilities associated with the BRDA. The soda content of the red mud is further reduced using the mud farming/atmospheric carbonation process.

7. The integrity of all HDPE geomembranes for environmental protection is maintained. No mobile equipment is permitted to contact geomembrane directly.

8. The runoff water is directed to and collected in a perimeter channel and pumped back to the plant for treatment as described in Section 8.0.

9. The surface water inventories in the perimeter channel and adjacent Storm Water Pond (SWP) are minimised to targets listed in SWM 2011 and pumping capacities are maximised as practicably as possible to ensure that there is sufficient operational freeboard for major rainfall events.

10. Water sprinkling dust suppression system is used over the entire red mud and process sand surfaces to prevent dusting.

11. The downstream toe drains, external watercourses and groundwater observation wells are routinely inspected and sampled in accordance with IE conditions.

12. All incidents, whether of an environmental or health and safety nature are reported and investigated to ensure that any necessary remedial action is taken and to prevent any re-occurrence of the incident.

5. Waste Handling and Placement

The BRDA is a dedicated and engineered facility for the placement of specific process residues as detailed below.

5.1 Red Mud

The majority of red mud slurry is pumped from the Mud Filtration Building in A34 to the BRDA at generally greater than 58% solids. A small proportion of low solids red mud slurry, collected from the maintenance turnaround cleaning of the mud settling and washing tanks, is trucked to the BRDA by the Contractor and deposited on existing red mud surfaces.

The red mud including low solids red mud is matured through surface evaporation and the mud farming process as described in section 5.8.

The handling of red mud is covered by section 6.25 of the Waste Management Manual (WM001)
The placement of red mud within the BRDA is controlled by the procedures:
SWM 2022: Area 54A Operation of the BRDA; (Link SWM 2022) and
SWM 2009: Minimise Mud Soda Losses and Maximise Mud Density to the BRDA. (Link SWM 2009)

5.2 Process Sand

Process sand is the quartzite fraction of the bauxite residue. This is washed as effectively as possible to remove all leachable soda and in particular to extract all leachable sodium aluminate which could potentially contain product (refer to SWM 2006 Area 27A Operation). (Link SWM 2006). Process sand is trucked by the Contractor from Area 27 to the BRDA. The handling of process sand is covered by section 6.28 of the Waste Management Manual (WM001)

5.3 Salt Cake

Salt cake is produced in the liquor purification/oxalate removal area of the process plant (A65). The liquor is purified through the precipitation of impurities that occur when the process liquor is concentrated. These impurities are removed as a filter cake, consisting principally of sodium compounds with carbonate, sulphate, oxalate, fluoride and chloride. Salt Cake is trucked from A65 to the BRDA. The handling of salt cake is covered by section 6.27 of the Waste Management Manual (WM001)

Salt cake is classified as a hazardous waste and is deposited within a composite lined cell in the BRDA as per condition 8.4.5 of the IE licence. The design details and construction quality assurance plans for the cell have been agreed with the Agency.

5.4 Lime Grits

These are the insoluble clinker cores of the burnt limestone cobbles dissolved in the lime slaking plant within the process. These are trucked from the process plant to the BRDA by the Contractor and are used as road surfacing materials.

The handling of lime grits is covered under Section 6.15 of the plant Waste Management Manual (WM001)

5.5 Process Scale

Process scale consists of hydrated sodium aluminium silicate sometimes combined with bauxite residues, removed from the interiors of process tanks, vessels and pipes during routine and turnaround maintenance activities in the process plant. All such scales are trucked by the Contractor to the BRDA and deposited on the existing red mud surfaces or on compacted process sand areas.

The handling of scale is covered under Section 6.24 of the plant Waste Management Manual (WM001)

5.6 Transport and Placement of Wastes

The BRDA is operated under the SPM Management Contract by Murphy International Ltd. who has overall responsibility for the collection, transportation, and placement of waste. The contract extends to maintenance and resourcing of all equipment, including vehicles, which operate within the BRDA, including environmental control equipment for dust suppression.

All residues are either pumped or trucked in specified skips or dumpers to the BRDA area. All drivers are trained to ensure that only wastes permitted for disposal in the BRDA should be contained in the designated skips. If other waste streams are contained in the skips these skips will not be removed for disposal. Drivers are also trained on checking and handling of leachate which may arise.

All trucked residues are transported to the BRDA area on a network of internal access roads.

Trucked residues must be deposited on a layer of matured red mud. Process sand may be deposited directly onto red mud surfaces provided mechanical plant is confined to adjacent engineered designed and supervised access roads or the mobile plant is moving on a layer of compacted process sand.

5.7 Relevant Standard Operational Procedures

In addition to the sections of the SPM Management Contract and the Waste Management Manual listed above, the following standard operating procedures (standard work methods) deal with the operation of the BRDA:

Table 3 Relevant SWM's

Procedure Number	Link	Purpose
SWM 2006	Link SWM 2006	Area 27A Operation
SWM 2009	Link SWM 2009	Minimise Mud Soda Losses and Maximise Mud Density
SWM 2017	Link SWM 2011	Water Management
SWM 2017	Link SWM 2017	Pond Cleanouts and Inspections
SWM 2022	Link SWM 2022	Area 54 Operation of the BRDA
SWM 2026	Link SWM 2026	BRDA Dust Prevention and Control

5.8 Mud Farming Process

5.8.1 General Approach

Red mud deposited on the BRDA is processed by "mud farming". Mud is deposited in separate drying bays or cells in the BRDA constructed using mud bunds or nominal boundaries as detailed on 54-G-1130 (see Appendix 1).

A screw-propelled amphirol (photo below) is used to plough the mud in the drying cells on a regular basis to accelerate and improve the natural drying process and densify the residue. This process is also used to maximise the atmospheric carbonation of the red mud residue by increasing the caustic soda / CO_2 interface contact.

This process continues until the increasing density of the mud residue reduces the effectiveness of the amphirol. A low ground pressure swamp dozer is then used to level the drying cell and reconstruct the cell walls.



Plate 1 Amphirol used for mud farming

5.8.2 Operations

The BRDA Mud Farming operation consists of the following tasks:

- Residue Planning
- Filling the Drying Cells
- Drainage Management
- Mud Farming

Each of these systems is described below:

Residue Planning

The Phase 1 and 2 BRDAs have been subdivided into approximately *46* separate drying cells as detailed in the attached drawing 54-G-1130 (Appendix 1). Signs identifying each cell number as detailed on 54-G-1130 have been installed on the perimeter of the BRDA.

Mud is pumped to the drying cells via pipelines connected to the Phase 1 Central Discharge Platform or Phase 2 Southern Platform. A total of 19 separate discharge points have been installed on the pipelines to facilitate the filling of the drying cells in Phase 1 & 2 as detailed on 54-G-1130.

Each discharge point is flushed before a period of non-usage (i.e. > 1 week) to prevent line restrictions and blockages. Mud Points 1 to 10 and 15 to 19 are flushed from the Central Discharge Platform and Southern Discharge Platform respectively using the recycled water. Mud Points 11 to 14 are flushed by injecting process condensate into the suction of the Area 34 Mud Pumps.

The BRDA Operations Team meets weekly and identifies the storage area required for the following week's production and associated mud farming, drainage and maintenance activities.

Outer embankment walls are constructed in a timely manner, to ensure that residue storage area is available on a medium term (quarterly) basis in the BRDA.

A weekly residue plan is issued each week, on BPI, to Local 2 and the SPF's detailing the *mud placement* plan for the week. This plan details mud valve changes and alternatives in the event of pipeline maintenance requirements or valve problems.

Filling the Drying Cells

A 400mm – 500mm deep layer is filled into each drying cell in 200 – 250mm mud layers. A *pipe* is installed on each discharge point to allow the mud to be spread evenly across the cell.

Each cell is inspected in advance by the SPM Management Contractor to identify, repair and raise sprinkler pipes as necessary.

Cell filling is monitored by the BRDA Operations Team from 8am - 4.30pm Mon - Fri.

Cell filling is monitored by the L2 Process Operator and SPF's during the evenings / nights and at the weekends to ensure that filling is occurring according to the weekly residue plan.

Drainage Management

Drainage from the drying cells will initially be assisted by the long reach excavator to free the "bleed" liquor and rainfall from the cell. The Amphirol will then complete an initial plough of the cell.

During this period the excavator will be required to maintain the drainage channels particularly around the embankment walls.

Additional drainage may also be required to eliminate areas of standing water at the perimeter of the BRDA.

Mud Farming

Mud farming commences after mud deposition has ceased, initial drainage completed and the red mud has sufficient stiffness to support the amphirol. A daily inspection of all drying cells is undertaken by the BRDA Site Monitor for BRDA Operations Team.

The amphirol continues to make passes over the mud cells every 3-7 days until the indentations in the mud reduce to < 5 – 10 mm. The cells perimeter walls are then re-built using a low ground pressure bulldozer with perimeter walls approximately 800mm - 900mm in height using mature mud.

Atmospheric Carbonation

If following pH testing of the amphirolled residue indicates that the pH is greater than 11.5, then further atmospheric carbonation of the residue is required. This atmospheric carbonation process commences immediately after the mud farming process has been completed. The mature red mud is initially ploughed to break up the compacted red mud surface. The ploughed red mud is then further reduced in size by harrowing to maximize the exposure of the caustic soda in the mud to atmospheric carbon dioxide.

The mud is then repeatedly harrowed on a daily basis until the pH is gradually reduced from the initial pH until the pH is < 11.5.

In the event of a heavy rain forecast, the mud is rolled to seal the mud surface and prevent water ingress.

Further details are provided in SWM 2022 Area 54 Operation of BRDA.

6. Safety Management

6.1 BRDA Safety Organisation & Structural Stability

The organisational structure including safety responsibilities are set out in Chapter 2 above.

The Plant Health & Safety Policy covers plant wide safety management and includes the requirements of IE Licence Condition 9.4.3.

The Health, Safety and Environmental Security of the BRDA is managed to ensure that:

a. Personnel are protected from particular hazards such as perimeter water filled drains and soft slurry associated with the BRDA
b. That the overall structure of the BRDA is geotechnically stable.

Personnel safety is managed by routine risk assessment of tasks and fixed controls to ensure that all risks are identified in accordance with the Aughinish Safety Management System. For example, there are crash barriers around the main perimeter roads for fall protection, there are life buoys located around open drain perimeters as well as crash barriers in case personnel accidentally fall into ponds. There is specialist mobile plant that can safely travel on soft mud slurry. These Risk Assessments are available. BRDA Risk Assessments

The overall geotechnical stability of the BRDA is examined routinely and reported annually through the Annual BRDA Review in accordance with Schedule C7 of the IE Licence.

It was also reviewed in detail as part of the 2013 “Risk Assessment and Breakout Study” which was an update of the 2006 study (referred to in Condition 8.4.16 of the IE Licence). The revised report was submitted to the EPA in March 2013 in accordance with Condition 8.4.30. The revised report takes account of the improved stability of the BRDA brought about by the implementation of ‘mud farming’ in March 2009. The result of mud farming has been to increase the undrained shear strength of the red mud and this has been incorporated in the updated stability analyses for the red mud placed above stages 7/8 in Phase 1 BRDA and all the stages of Phase 2 BRDA. Mud farming has increased the stability of the side slopes significantly on the upper levels of Phase 1, thus reducing the *already negligibly low* probability of failure and the ability of the material to mobilise. In addition, as the facility is raised, the effective stress (self-weight) on the red mud increases which consolidates stiffens and, in turn, increases the red mud strength.

The most important hazards identified by the risk assessment which indicated negligible to highly improbable risk, are in order of priority:

1) Displacement of alkaline water in the PIC as a result of wave surge without breaching the embankment wall and indirectly displacement of the alkaline untreated water in the SWP and the treated water in the LWP based on a future sea level rise up to year 2200. At present current *sea level the risk of this is much less than stated above.*

2) Slope failure of the containment walls for the SWP, LWP, and the Outer Perimeter Wall under static load conditions;

3) Containment failure from the year 2200 wave surge into the PIC. This negligible to highly improbable risk is not such an important hazard at the current sea level.

The study recommended that following procedures/actions be undertaken to alleviate the identified risks or mitigate the consequences: The recommendations have been actioned as follows

Break-study recommendation	**Implemented by**
Avoid pore pressure build up in the residue	Quarterly monitoring of pore pressure is being undertaken by Golder Associates. No issues to date.
Ensure undrained shear strength of residue is sufficient to support the BRDA structures	Monitor the strength by CPT testing as required by the designers. Major Site Investigation undertaken in 2014. Mud strength more than adequate.
Avoid water collecting in some specific perimeter channels on east side.	Ensure gradient in place to drain specific channels as needed.
Install piezometers and inclinometers to monitor stability.	All instruments installed and monitored quarterly.
Provide erosion protection to outer wall.	Installed around the Phase 1 and Phase 2 Outer walls as required. Will be installed around the base of the SWP and LWP at plant closure.
Secure locking mechanism to be installed to prevent spillage to Robertstown River.	Penstock valve installed in 2014 and operation tested for BRDA Emergency Response exercise in 2015.
Regularly inspect the integrity of the flood tidal defence berm	Currently repairs are being considered for an exposed part of this berm.

Other management measures which are already in place include:

- Visual inspection of the facilities indicates no signs of distress in the walls.
- The outer & inner perimeter walls, the storm water and liquid waste ponds are inspected quarterly and annually are performing in accordance with the design.
- Overflow pipes have been constructed to connect the Phase 2 BRDA perimeter channel to the Phase 1 BRDA perimeter channel.
- Two additional submersible pumps have been installed adjacent to the PIC 1 sump area to pump the Phase 1 PIC back to the Storm Water Pond.
- The original PIC 1 pump has a valve tee connection to facilitate filling of the Storm Water Pond so that with the two new dedicated pumps, there is a large measure of equipment flexibility to discharge water from the PIC to either the SWP or the Effluent treatment plant.
- AAL have their own electricity generating station providing a very reliable supply to the plant and ancillary structures such as the pumps servicing the PIC, SWP and LWP. Electricians provide 24 hour coverage for emergencies resulting from electrical outages or breakdowns.

6.2 Emergency Preparedness Plan

The plant wide Emergency Preparedness Plan and the specific BRDA Emergency Response Procedures have been submitted to the EPA in accordance with Condition 9.4.4. These are an integral part of the overall Plant Safety Management System and are available online via the Aughinish intranet. The External Emergency Plan for the BRDA (EEP) was published by Limerick County Council in September 2013 and is available on their website www.lcc.ie. The adequacy of the external plans will be reviewed annually with the Principal Response Agencies (LCC (Environment and Fire Service), HSE and An Garda Siochana). Further details of the emergency preparedness and response procedures are provided in Chapter 7.

6.3 Classification of BRDA

The BRDA has been classified as a Category A facility under the Extractive Waste Directive. The basis for this classification is the environmental sensitivity of the Special Area of Conservation lands and estuarine habitats adjacent to the BRDA.

6.4 BRDA Dam Wall Design and Construction

Section 6.0 of the 2013 'BRDA Risk Assessment and Breakout Study' submitted to the Agency details the design and construction standards under-pinning the structural integrity of the BRDA.

6.4.1 General

The design of the Phase 1, Phase 1 Extension and Phase 2 BRDA are similar although some modifications were made for the Phase 2 BRDA based on the on-going performance of the facility. The key components of the BRDA are:

- Low Permeability Outer Perimeter Embankment Wall;
- Permeable Inner Perimeter Embankment Wall;
- Perimeter Interceptor Channel;
- Composite Lined System Throughout the Phase 1 Extension and Phase 2 BRDA;
- Stage Raises;
- Upper level bench to reduce the overall side slopes from 6H:1V to 6.3H:1V; and

The storm water pond and liquid waste pond were raised to accommodate runoff from both Phases 1 and 2 BRDA.

The Phase 1 extension and the Phase 2 BRDA has been completely composite lined and surrounded by a perimeter interceptor channel which is formed by constructing the outer and inner perimeter embankment walls. The Phase 1 and Phase 2 channels connect on the western section of the facilities. The Phase 1 and Phase 2 facilities will also be merged in the future.

The ground level within the footprint of the Phase 1 BRDA and varies typically between 0 m AMSL to 14 m AMSL. Phase 2 BRDA varies from 0 m AMSL to 14 m AMSL and therefore future raising and merging of the stack walls will need to accommodate these changes of elevations.

The overall slope is 6.3H:1V consisting of a lower slope of 6H:1V and an upper slope of 6H:1V. An upper level bench, approximately 28m wide separates the two slopes. Where the previous sludge pond was located in the southern section of Phase 1, the wall has been realigned and steepened to approximately 4H:1V and wick drains installed.

Unlike conventional tailings facilities or water retaining dams, the BRDA retains little to no surface water on the red mud. The red mud is discharged as a paste from several near central discharge points to form a dome which typically has the apex some 6m to 8m above the perimeter stack wall elevation. The structure is raised by constructing perimeter walls on the red mud by the upstream method which involves the construction of a series of retaining bunds upstream of the toe of the BRDA facility and so forming a supporting face to the overall structure. As previously stated, the slope of the stack wall or face of the storage facility is 6H:1V for the upper and lower slopes which reduces to an overall slope of 6.3H:1V when the width of the upper level bench has been included.

6.4.2 Outer Perimeter Embankment Wall

This structure forms the outer wall of the Perimeter Interceptor Channel and is the main access road around the facility and is designed with a crest width of 5 m. The upstream and downstream side slopes vary depending on the foundation materials the structure is placed on. The structures founded on the estuarine soils are typically 4H:1V for Phase 1 and 3H:1V for Phase 2. These are found on the northern and western flanks of Phase 1 BRDA and the western and southern flanks of the Phase 2 BRDA. The structures founded on the glacial tills are typically 4H:1V for Phase 1 and 2H:1V for Phase 2. These are found on the southern flank of Phase 1 BRDA and the south eastern flank of Phase 2 BRDA. The Outer Perimeter Dam (Embankment) Wall has been constructed to an elevation of 5m AMSL.

Along the central section of the southern flank of the Phase 2 BRDA, the Outer Perimeter Embankment Wall is constructed in cut with a side slope of 2H:1V and a crest elevation of 5 m AMSL

6.4.3 Inner Perimeter Embankment Wall

This structure forms the inner wall of the Perimeter Interceptor Channel and is constructed with a crest width of approximately 4.5 m. The upstream and downstream side slopes vary depending on the foundation materials the structure is placed on. The structure founded on the estuarine soils and glacial tills has been constructed with upstream and downstream side slopes of 2H:1V. These structures are located on the northern, western and southern flanks. For these cases, the crest elevation is at 4.5 m AMSL.

Along the central section of the southern flank of the Phase 2 BRDA, the Inner Perimeter Embankment Wall has been constructed in a cut and the rockfill embankment wall and founded on glacial till. In this area, the side slopes are constructed at 2H:1V in order to align with the two embankments constructed on the estuarine soils either side of the cut.

Where the Inner Embankment Wall is founded on limestone along the south eastern flank of the Phase 2 BRDA, the side slopes have been steepened to 3H:2V.

6.4.4 Perimeter Interceptor Channel

The Perimeter Interceptor Channel collects all the runoff from the BRDA facility and seepage from the red mud. It is formed by the construction of the Outer and Inner Perimeter Embankment Walls which are discussed above.

For much of its length and for all the northern, western and southern flanks, the Perimeter Interceptor Channel has a top width of 25 m and a minimum base width of 4 m. The storage capacity of the perimeters channels and storm water pond is listed in Water Management SWM Link SWM 2011

6.4.5 Stage Raise

The method of raising the perimeter wall retaining the red mud is by the upstream method which involves constructing on previously deposited red mud. The red mud is farmed and allowed to mature for as long as possible (minimum 3 months) prior to placing the next layer. The success of this method of stage raising is very much dependent on the design of the facility and its on-going performance of red mud dewatering, drying and consolidation which to date is satisfactory and this process has been enhanced since 2009 by the introduction of red mud farming.

The performance of the facility, which is compared to the design criteria, is determined from a comprehensive geotechnical monitoring system within the stack wall together with an intrusive site investigation carried out prior to subsequent raising of the perimeter walls.

6.4.6 Upper Level Bench

The upper level bench is installed when the stack wall is raised to an elevation of 16 m AMSL (Stage 6) after the red mud has been deposited inside the Stage 5 wall at a maximum elevation of 14 m AMSL. The width of the bench is approximately 28m. The bench improves stability of the slope and with suitable drainage measures installed, allows the downstream slopes of the first 5 stage raises to be rehabilitated.

6.5 Salt Cake Cell

Salt cake is classified as a hazardous waste and is deposited within a composite lined cell (geosynthetic clay liner and 2 mm high density polyethylene liner) in the BRDA as per condition 8.4.5 and 8.4.10(v) of the IE licence. The composite lined cell is located on approximately 12 metres of low permeability matured red mud. There is no hydraulic connection between the composite lined cell and the rest of the BRDA . The design details and construction quality assurance plans for the cell have been agreed with the Agency.
The Salt Cake cell was constructed in 2012 and commissioned in 2013.

The Closure Details for the salt cake cell are included in the BRDA part of the overall Plant Decommissioning and Residuals Plan in accordance with IE Licence condition 10.2. In summary a double plastic HDPE liner will be placed over the cell at closure to seal in the salt cake . A drainage layer and subsoil and topsoil will be placed over the plastic liner and the surface will be vegetated with grass.

6.6 Hydrology

No water is stored on the BRDA itself as it is a sloping surface for stack residue. The surface water and leachate is stored in the Perimeter Interceptor Channel. Surface water is also stored in the Storm Water Pond.

6.6.1 Storm Water Pond

The function of the storm water pond (SWP) is to collect storm runoff from the surface of the BRDA via the Perimeter Interceptor Channel and pump the alkaline water to the effluent treatment plants or back to the alumina plant as recycled pond water for various uses.

The volumes retained by the SWP is listed in the Water Management SWM Link SWM 2011

The current crest elevation of the SWP is 6.0 m Above Mean Sea Level (AMSL) on the external wall with the Bird Sanctuary and the internal dividing walls between the SWP and the LWP and between the SWP and central access ramp. The internal wall between the SWP and the PIC is also at an elevation of 6.0 mAMSL.

The SWP was raised and relined in 2007 with a composite lining using a combination of geosynthetic clay liner (GCL) and processed glacial till on the side slopes overlain by 2mm high density polyethylene (HDPE) liner.

The BRDA Water Management SWM Link SWM 2011 developed in accordance with IE Licence Condition 8.4.23 sets targets for water inventory at different times of the year. Adherence to these targets will ensure that sufficient space is available for storm water management in winter months. At the same time they will ensure that sufficient water inventory is available for dust prevention in summer months.

6.7 Environment

Environmental monitoring is undertaken as per Condition 8.4.10(xv) and Schedules C4 (Waste), C2 (Effluent and Surface Water), C6 (Ambient Air) and C8 (Groundwater).

The Environmental Monitoring Programme examines the composition of materials disposed in the BRDA and the treated effluent discharged to the adjacent Shannon Estuary. It also monitors groundwater and surface water quality and dust deposition at strategic locations around the BRDA which have been agreed with the EPA.

Geotechnical and other monitoring of the stability of the BRDA are undertaken as per Schedule C7. This addresses quarterly monitoring of piezometric pressure and movement in the residue. Taken together with site investigations using continuous penetrating testing they characterize the geotechnical stability of the BRDA. All these monitoring data are input to the overall Annual Review undertaken by Golder Associates as required by Schedule C7.

7. Emergency Procedures

The management of emergencies is coordinated by a fully resourced and trained plant security team who are on site 24 hours per day, 365 days per year.

The overall plant Emergency Response Plan and procedures covers activities in the BRDA. The plant Emergency Response Plan deals with emergency preparedness, planning, response and co-ordination in the case of significant emergencies or incidents at the plant. The defined categories of emergency include environmental emergencies and emergencies which may have to potential to lead to environmental

In the event of an emergency, the organisation of safety and emergency response is co-ordinated and located centrally at the security gatehouse. Roles and responsibilities are detailed in the Plant Emergency Response Plan.

Each area of the plant also has specific Emergency Procedures relevant to the area. The emergency procedures addressing the BRDA are:

P007.02.019 BRDA Containment Emergency Response (Link to Procedure)

P007.02.012 Dust Emergency in the BRDA BRDA Dust Emergency

SWM 2026 BRDA Dust Prevention and control (Link SWM 2026)

P007.02.017 BRDA High Wind Procedure (Link to Procedure)

P007.02.018 Severe Frost Conditions (Link to Procedure)

7.1 BRDA Containment Emergency Response

The release of red mud from the red mud has been assessed as negligible to highly improbable. However although assessed in probability as a very unlikely event, the most significant type of emergency at the BRDA would be a release of alkaline water from one of the water retaining structures (such as the Perimeter Channel Embankments, Storm Water Pond or Liquid Waste Pond). In the event of such a failure, elevated pH water and/or mud would carry over into the lands north and west of the BRDA. All of this land is drained by a watercourse known as the OPW Channel which discharges through a single flap valve into the Robertstown River (to prevent reverse flow from river/estuary). In the event of such a failure the area Emergency Procedure P007.02.019 would be activated as well as the Plant Emergency Response Plan. The area Emergency Procedure details the actions to be taken including closing off the *penstock* valve between the OPW Channel and the Robertstown River to contain the spillage. The Plant Emergency Response Plan deals with call out of additional people and resources as well as Notification of the incident/accident to the Principal Response Agencies which may trigger activation of the BRDA External Emergency Plan.

7.2 Dust Control

The main environmental emergency which can arise in the BRDA is dusting. It is classified as an emergency and is subject to formalised emergency response procedures. The BRDA Team has defined responsibilities in the event of dusting. These responsibilities extend from prevention to response through:

- Review of meteorological conditions
- Preventative damping of BRDA
- Maintenance of equipment
- Operation of sprinklers, bowsers
- Resourcing emergency response
- Communication with RUSAL Aughinish personnel in an emergency response
- Ensuring that relevant SWM's and Emergency Response Procedures are followed

Historical evidence shows that incidents of fugitive dust generation occur under the effects of the following:

- Wind speeds in excess of 10 mph
- Freezing (<0C) or very warm (>20C) temperatures
- Dry air-conditions, i.e. low humidity

The primary objective in management of disposal operations at the BRDA is to prevent the formation of conditions where fugitive dust generation can occur.

7.2.1 Dust Prevention and Response Measures

The following fugitive dust prevention and response measures are implemented at the BRDA. Refer to SWM 2026 (Link SWM 2026)

1. Minimise mud flat area exposed to dusting risk by ploughing the mud surfaces via the mud farming process.

2. Keep mud flats in service (i.e. wet) as long as possible to limit areas of potential dusting.

3. Water spray (dust suppression) sprinkler system installed to ensure 100% coverage over red mud areas.

4. Ensure bowser units are available to transport and discharge water from the Liquid Waste Pond (LWP).

5. Bowsers should be left filled at the Liquid Waste Pond outside of normal business hours when BRDA Operations indicate that significant potential for dusting exists. If taken to be used elsewhere on site, must be returned cleaned to the Liquid Waste Pond and filled with water.

8. Surface Water Management and Protection

The BRDA is bounded by the River Shannon, the Robertstown River and Poulaweala Creek. The River Shannon is tidal at RUSAL Aughinish with a range of over 5m (spring tides).

Surface water runoff due to rainfall from the Phase 1 BRDA discharges to Perimeter Interceptor Channel 1 (PIC 1). PIC 1 runs along the entire northern, western and southern perimeter of the Phase 1 BRDA.

Similarly, surface water runoff due to rainfall from the Phase 2 BRDA discharges to Perimeter Interceptor Channel 2 (PIC 2). PIC 2 runs along the western and southern perimeter of the Phase 2 BRDA.

PIC 2 is pumped into PIC 1 using a submersible pump with a capacity of 600m³/hr.

The runoff water is pumped from PIC 1 to the Storm Water Pond (SWP), located in the north-eastern corner of the BRDA (adjacent to the Liquid Waste Pond) via two submersible pumps each with a capacity of 600m³/hr (1,200m³/hr total).

Two pumps are installed in the SWP to recycle surface water to the plant and to the effluent treatment system with a capacity of 450m³/hr each.

Surface water runoff is also recycled to the plant from PIC 1 by a submersible pump with a capacity in excess of 800m³/hr. Surface water is treated in an effluent clarification system before ultimately being discharged to the River Shannon.

Short term heavy rainfall events in the BRDA are accommodated in the Perimeter Interceptor Channels (PIC 1 & PIC 2), Storm Water Pond (SWP) which have the storage capacities listed in Water Management SWM: Link SWM 2011

This design storage capacity is sufficient to ensure a 1 in 200 year rainfall event can be safely managed within the system, while allowing treated effluent discharges to remain within daily flow limits (1,250 m^3/hr, 30,000 m^3/day) as specified in the IE Licence (Schedule B.2).

9. Groundwater Management and Protection

Aughinish Island is hydro-geologically isolated from the mainland and can be regarded as an independent groundwater body.

The BRDA is underlain by two geologically dissimilar components. The northern part of the Phase 1 BRDA is generally underlain by low conductivity estuarine deposits, which are subject to saline intrusion (into the groundwater). The original plant BRDA was developed directly on this material. The eastern part of the Phase 1 BRDA is underlain by limestone bedrock. This section of the BRDA is sealed within 1.0mm and 2.0mm thick HDPE sheets, on 600mm of screened glacial till.

The Phase 2 BRDA is underlain by estuarine deposits on the west side and by limestone bedrock on the eastern side. The Phase 2 BRDA is sealed within 1.5mm and 2.0mm thick HDPE sheets, on a layer of geosynthetic clay liner (GCL).

9.1 Groundwater Seepage Controls

The original northern part of the BRDA was developed over an extensive deposit of low hydraulic conductivity estuarine soil. In addition, the upstream slope of the outer wall around the BRDA and the SWP was sealed with a composite liner consisting of a 750 mm thick compacted glacial till fill covered with a 2.0 mm thick HDPE liner anchored in the estuarine soil along the toe of the Outer wall. In addition, all areas along the toes of the Outer wall where the estuarine soil thickness is less than 4.0 m (applies to the BRDA) or where glacial till or rock outcrop (applies to the SWP) was encountered, were sealed with 2mm thick smooth HDPE liner. All runoff reporting to the open drainage ditch is stored in the Perimeter Interceptor Channel.

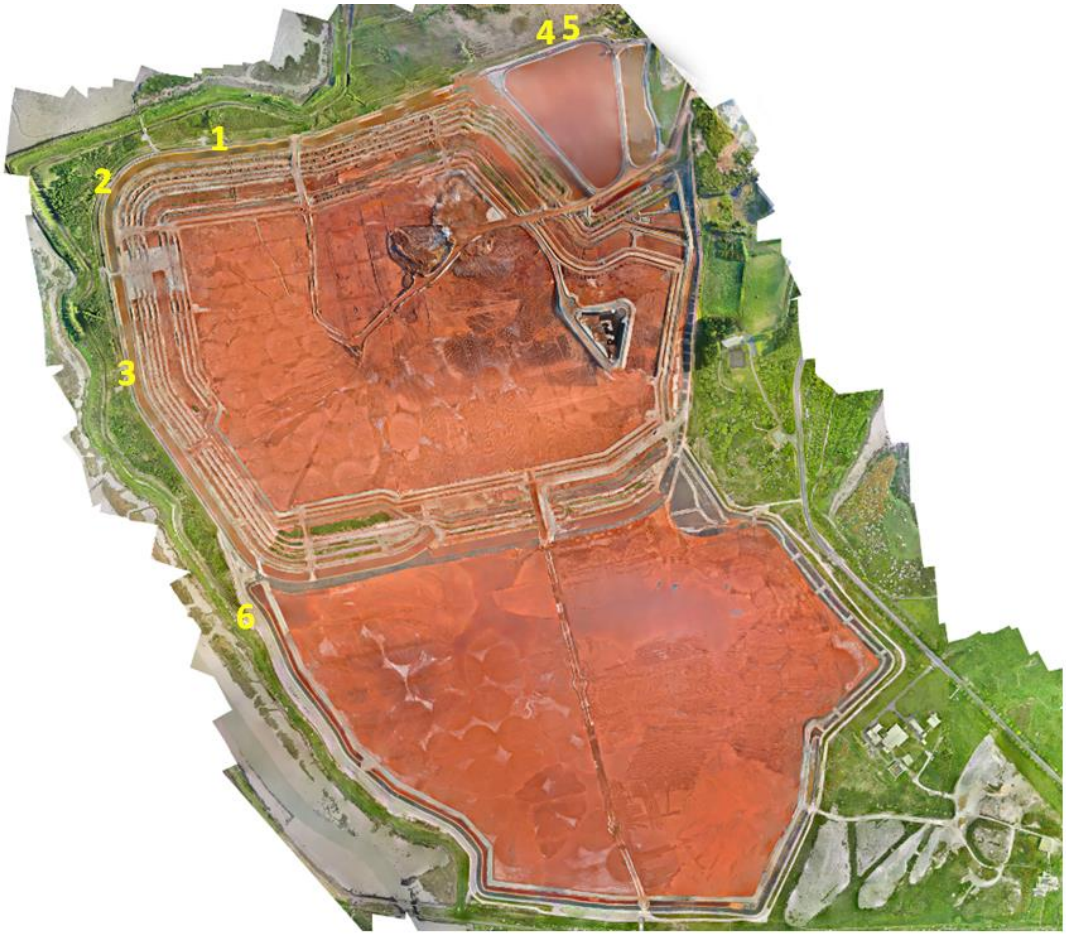
The extended eastern part of the Phase 1 BRDA is sealed with 1.0 and 2.0 mm thick HDPE sheets. Beneath the HDPE sheets, the subgrade consists of a series of mineral varying from 300mm to 600mm thick depending on the subgrade.

9.2 Seepage/Leakage Management and Control

The following seepage and leakage control systems are in place and reported as seepage recovery and monitoring locations as per submission to the EPA in January 2015.

Ref. No. (Fig. 1)	Location	Monitoring parameters	Monitoring Frequency
1	Toe Drain 1 Pumping	pH, Soda, Conductivity	Monthly
2	Toe Drain 2 Pumping	pH, Soda, Conductivity	Monthly
3	Toe Drain 3 Pumping	pH, Soda, Conductivity	Monthly
4	Monitoring Borehole 4 upstream of North East Drain	pH, Soda, Conductivity	Monthly
5	Monitoring Borehole 5 upstream of North East Drain	pH, Soda, Conductivity	Monthly
6	Robertstown Gate	pH, Soda, Conductivity	Monthly

Figure 1: BRDA Proposed Seepage Monitoring Locations



10. Leachate Management and Disposal

The BRDA does not generate leachate in the conventional sense of the term (as applied to waste disposal) due to:

a) The bauxite process residues placed within the BRDA are inorganic and do not degrade.

b) The red mud on placement and maturation has hydraulic conductivity values of the order of 1x10-8 m/sec. Accordingly, recharge and downward movement of liquid into the waste (through precipitation) does not occur.

Although there is no positive leachate collection system in place, bleed water from the red mud is collected in the perimeter channel and returned to the plant for treatment and licensed discharge.

11. Development Programme

All of the principal elements of the Phase 1 and Phase 2 BRDA have been constructed and commissioned in the period 2007 to 2013.
The future development programme for the BRDA consists of

- Routine Stage Raising of the Perimeter Stage Raise walls as per existing design.
- Routine landscaping of the downstream side of future Perimeter stage raise walls as per existing Interim Restoration and Landscaping undertaken in 2013.
- Raising of the existing Salt Cake Cell as per design submitted and agreed with the EPA in 2011.
- Routine Raising of sprinklers and mud discharge pipes in the BRDA as per existing practice.
- Routine raising of the drainage wall on the east side of the Phase 2 BRDA as per Golder Associates design.

12. Life Expectancy

The existing Phase 1 BRDA consists of the original BRDA and the Phase 1 extension, which have been merged since 1999. As the rate of placement is a direct function of production activity, the life expectancy of the BRDA will be reduced with increasing levels of production.

Following the commissioning of the Phase 2 BRDA in 2011, the life expectancy of the combined Phase 1 and 2 BRDAs has been increased by 21 years until mid-year 2032, based on current production levels and residue generation levels. This is reviewed each year as part of the AER. Further details are provided in the AER.

13. Restoration

A Decommissioning and Closure Plan for the site was prepared by SRK Consulting Ltd. and Enviroplan Services Ltd in 1999 – this included proposals for the restoration and aftercare of the BRDA. The Plan was submitted to the Agency as part of the first plant AER in 1999. A revised plan taking into account the Phase 2 extension to the BRDA was submitted in 2005 as part of the application for a revised IE Licence. The plan is updated annually and the most recent update was submitted to the EPA in December 2010.

Based on research undertaken to date, the BRDA perimeter side slopes have been rehabilitated in the interim (2013) and it is proposed that, following final closure of the facility, a surface vegetation cover will be established over the farmed and neutralised residue to ensure physical and chemical stabilisation of the stored bauxite residues.

Establishment of vegetation on the bauxite residues stored at the BRDA has been successfully demonstrated by greenhouse and field trials carried out in conjunction with the University of Limerick. To achieve this, amendment of the red mud residue (using gypsum, compost nutrient, fertilisers and process sand) is required and an

understanding of the basic physical and chemical principles for reclaiming alkaline residues must be established. Considerable attention has been focused on the testing and measures that can be used to ensure appropriate surface soil conditions are present which will promote successful vegetation establishment and surface rehabilitation of the BRDA while controlling costs.

Engineering proposals to address the drainage, seepage, control of storm water and surface run-off from the BRDA both in the interim and following final closure of the facility have been investigated and designed by AAL's consultant Golder Associates.

13.1 Closure and Restoration Programme

Closure will involve utilisation of those techniques that have been proven in operations, or demonstrated in field trials, which have the greatest potential to achieve the performance criteria for air, soil, surface water and groundwater. A key element of this closure plan will be the rehabilitation cover for the BRDA. Because of the variety of residues within the BRDA, there are several different surface treatments which will be necessary in order to ensure that performance criteria are achieved following closure.

The BRDA will be rehabilitated to ensure physical and chemical stabilisation of the red mud. The amended soil (red mud mixed with process sand, gypsum and compost) will be seeded with a grassland seed mixture, and fertiliser applied by broadcast spreader. AAL propose to achieve self-sustaining vegetation cover after a period of five years.

Works will be implemented to ensure that a suitable drainage system is established on the rehabilitated BRDA. Engineered surface water drainage berms will be created to allow for stormwater drainage. Careful supervision will be provided during final mud deposition on the BRDA to ensure the surface topography remains consistent for the construction of a system to direct surface water and lateral seepage safely off the BRDA.

The maintenance of efficient surface water drainage from the BRDA, avoiding as far as possible soil erosion into the perimeter channel, will contribute to the improvement of water quality after closure. With time, it is expected that rainwater flushing and wet-dry cycles in the surface layers of the BRDA, will improve water quality so that runoff and seepage can be discharged without treatment.

13.2 Interim Restoration

As part of the extension of the BRDA, an interim restoration plan was put in place to provide for intermediate cover of the perimeter embankment slopes as the height of the area is increased. This involved the installation in the Phase 1 BRDA of a radial collector drain at 100 metre intervals just below the operating upper stage raise wall, which intercepts and drains surface water from the dome of the BRDA in a controlled manner down to the Perimeter Interceptor Channel. Construction of this drain was completed in 2012 in advance of the Phase 1 landscaping works in 2013. The horizontal benches on each of the Stage Lifts on the north and west sides of the Phase 1 BRDA were graded and shaped in 2013 with a drainage medium and topsoil added and grass and trees were planted . The wide stage 5 to stage 6 bench was also restored and grass was planted. Therefore these 2013 works were the first part of interim restoration of the BRDA.

14. Aftercare Management

14.1 Aftercare Monitoring

Success of surface re-vegetation (which will be critical in meeting requirements for control of fugitive dust and valuable in the limitation of subsurface seepage and the maintenance of geotechnical stability) will be measured on the basis of vegetation and soil biological surveys. These surveys will be conducted annually until Year 5 upon which time it is anticipated that the re-vegetation programme will be deemed successful. Should the five-year objective not be met, AAL will identify the measures that it will undertake to improve the performance of the cover.

At closure, the water sprinkler system will continue for a limited period, particularly throughout any periods of leaching and weathering, until surface rehabilitation by a vegetated surface cover is established. The long-term suppression of fugitive dust will be achieved by the vegetation cover with sufficient density to retain the residue.

Water treatment will no longer be considered necessary when the pH in the Perimeter Interceptor Channel (PIC) is maintained at less than or equal to pH 9 with a Total Suspended Solids (TSS) of less than 50 mg/l for 90% of the samples taken over a 12-month period. Following attainment of water quality objectives for a one-year period without treatment, the water management system will be decommissioned. The PIC and the SWP can then be *modified* (with spillway and sluice constructions) to allow for direct discharge to the Shannon Estuary via the Robertstown River. It is anticipated that this can be achieved within five years post-closure. A trial constructed wetland (reed bed) cell was installed in 2013 with its aim to receive alkaline BRDA leachate and reduce its pH. Implementation of this technique on a larger scale will be considered with a view to future inclusion in the Aughinish closure plan. Monitoring of surface water quality and groundwater quality in the vicinity of the BRDA will continue for a period of up to 30 years post closure.

To monitor geotechnical stability, for five years after the closure of the BRDA, AAL will conduct periodic monitoring of subsoil moisture, to demonstrate that the suction head for the upper subsoil layers is being maintained, or reduced, as a result of the rehabilitation measures.

14.2 Final Land Use

The preferred land-use option for the BRDA, based on current knowledge of the chemistry and biology of the sown grassland cover, is to develop the area for nature conservation. A section of AAL land to the north of the BRDA has already been developed as a Bird Sanctuary, so the development of a nature conservation area is in keeping with AAL land conservation practices. The bird sanctuary management has been featured and reported on by organisations such as the Birdwatch Ireland since its development in 1981.

The choice of end-use is also in line with procedures in the 2009 EU BREF on Tailings Management where it states in Table 4.5 that *'rehabilitation is such that the ultimate land use is optimised and is compatible with the surrounding area and the requirements of*

the local community'.

Lands adjacent to the AAL facility are subject to EU and national environmental designations and the sensitivity of these environmental receptors, particularly in the key areas of surface and groundwater quality, have been taken into account in the design of the BRDA restoration and aftercare process.

15. Environmental Monitoring Programme

RUSAL Aughinish undertakes extensive monitoring of environmental quality (air, water, groundwater, dust and noise) in the vicinity of both the plant and BRDA in accordance with the requirements of our IE.

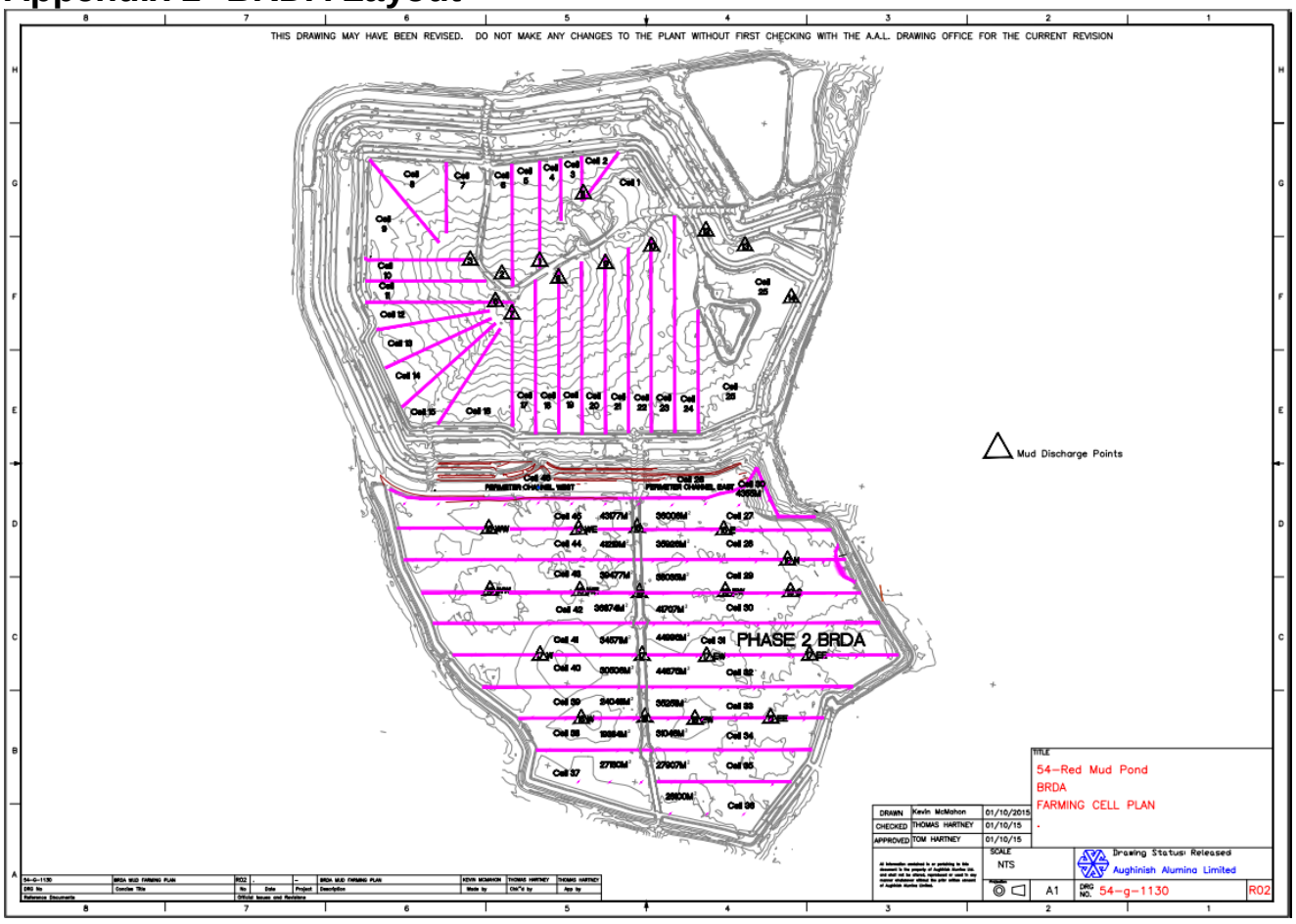
This monitoring, which is undertaken by qualified and experienced Environmental Technicians is detailed in SWM 0003 IEL Compliance and Environmental Performance Monitoring and Reporting. SWM0003

figuEnvironmental Monitoring in the BRDA

Environmental Media	Monitoring Location	Analysis Undertaken	Frequency
Surface Water	OPW Channel Mangans Lough	pH, Conductivity, Soda	Monthly
Groundwater	BRDA Observation Wells (OW's)	pH, Conductivity, Total Alkalinity, Fluoride, Chloride, Soda, Heavy Metals	Quarterly
Air – Fugitive Dust	Dust Gauges at perimeter of BRDA	Dust Deposition	Monthly
Noise	Boundary Locations around BRDA: North Shore (B5), East of East Ridge (B4)	Sound Pressure Level, L_{AEQ}, L_{A10}, L_{A90}	Annually
Waste	Red Mud, Sand, Salt Cake, Leachate	pH, Dry Matter, Alkalinity, Chloride, Fluoride, Soda, Metals	Monthly

In addition to the above, RUSAL Aughinish maintain a weather station between the plant and the BRDA for measurement of wind speed, direction and temperature. This data is fed back to the plant Process Information (PI) System.

Appendix 1 BRDA Layout



Attachment 8
BRDA Annual Review Report

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March 2016

PHASE 1 & 2 BRDA

Phase 1 & 2 BRDA Aughinish 2015 Annual Safety Inspection and Stability Assessment Executive Summary

Submitted to:
Aughinish Alumina Ltd
Aughinish Island
Askeaton
County Limerick
Ireland

REPORT

A world of capabilities delivered locally

Report Number. 1524750.501/A.2

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Golder Associates

Executive Summary

Golder Associates were commissioned by Aughinish Alumina Ltd (AAL) to prepare this report to facilitate licensee compliance with Appendix C7 condition of license P0035-06 namely 'the annual review' for the Bauxite Residue Disposal Area (BRDA). This stability assessment summarises the monitoring results from the Casagrande piezometers, and the inclinometers and extensometers, a visual inspection of the facilities and assesses the stability of the BRDA, the inner and outer perimeter walls forming the perimeter interceptor channel, the storm water and liquid waste ponds.

The Phase 1 BRDA is formed from two facilities, the original Phase 1 BRDA, covering an area of 72 ha and the Phase 1 BRDA extension covering an area of 32 ha. The Phase 1 extension is lined with a HDPE geomembrane while the original Phase 1 relies on the low permeability of the estuarine soils to minimise seepage from the base of the facility, plus the inherent low permeability of the red mud itself. Phase 2 BRDA covers an area of approximately 80 Ha and was commissioned in 2011. It is currently receiving the majority of the red mud generated.

The initial design for the Phase 1 BRDA facility was to provide storage to the year 2009 based on the facility constructed to Stage 7 (elevation 18 m AMSL), which equates to a central elevation of 27.5 m AMSL or 26 m above original ground level. A site investigation and design report was presented to AAL (References 2.1 to 2.4) proposing to raise the facility in three more stages (Stages 8, 9 and 10), resulting in a maximum perimeter elevation of 24 m and a central elevation of 32 m AMSL.

AAL have successfully raised the stack wall for Phase 1 to above Stage 8 and in numerous sections to Stages 9 and a few sections to Stage 10. For Phase 2, they are just commencing the construction of Stage 1.

The key components of the BRDA are:

- Low Permeability Outer Perimeter Embankment Wall;
- Permeable Inner Perimeter Embankment Wall;
- Perimeter Interceptor Channel;
- Composite Lined System Throughout the Phase 1 Extension and Phase 2 BRDA;
- Stage Raises; and
- Upper level bench to reduce the overall side slopes from 6H:1V to 6.3H:1V.

The Phase 1 and the new Phase 2 BRDA are surrounded by a perimeter interceptor channel which is formed by constructing the outer and inner perimeter embankment walls. Surface water collected in the perimeter interceptor channel is pumped back to the plant or into the storm water pond during storm events. The Phase 1 and Phase 2 channels connect on the western section of the facilities. The Phase 1 and Phase 2 facilities are being progressively merged.

Treated water is pumped from the treatment plant into the liquid waste pond prior to discharge into the River Shannon.

Unlike conventional tailings facilities or water retaining dams, the BRDA retains little to no surface water on the red mud surface. The red mud is discharged as a paste from several near central discharge points to form a dome which typically has the apex some 6 m to 8 m above the perimeter stack wall elevation. The structure is raised by constructing perimeter walls on the red mud by the upstream method. This procedure involves the construction of a series of retaining bunds upstream of the toe of the BRDA facility and so forming a supporting face to the overall structure.

The final elevation of the perimeter stack wall will be 24 m AMSL and the highest elevation of stacked residue will be 32 m AMSL, or some 30 m above ground level.

From the results of the monitoring of the inclinometers, extensometers and piezometers in 2015 in the Phase 1 BRDA together with the previous 2014 CPT testing, it is apparent that the stack wall of the BRDA is stable at the current elevations with a factor of safety above 2 and the facility is performing in accordance with the design.

It is proposed to install 6 surface survey monitoring points along Section F of the Phase 1 BRDA where the dam has been steepened and reinforced to supplement the lateral measurements recorded in the inclinometers 5AIU and 5AIL.

The outer and inner perimeter walls of the Phase 1 and Phase 2 BRDA, the storm water and liquid waste ponds are performing in accordance with the design.

Visual inspection of the facilities indicates no signs of distress in the walls.

Where seepages emanating from the Phase 1 BRDA perimeter interceptor channel are intercepted, the flow rate should be monitored to determine any changes in flow rate.

The volume of any red mud retained in the perimeter interceptor channel should be estimated/surveyed and checked against design calculations to ensure sufficient flood storage is available and the freeboard can be maintained. It should be noted that the red mud has the ability to throttle seepage emanating from defects in the geomembrane forming the lining system in the perimeter interceptor channel so it would be preferable to leave some red mud at the base. It would also be difficult to remove the red mud from the channel without potentially damaging the lining.

AAL have their own power generating station providing a very reliable supply to the plant and ancillary structures such as the pumps servicing the PIC, SWP and LWP. Electricians provide 24 hour coverage for emergencies resulting from electrical outages or breakdowns and therefore an overtopping of these structures is extremely unlikely.

Report Signature Page

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Date: March 2016

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Golder Associates

Attachment 9
BRDA Closure Demonstration Cell Area Report

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IE Licence Conditions 8.4.10 & 8.4.17
Residues Solutions Report - Recommendations –

Closure Demonstration Cell Restoration

Based on results and observations from residue research field trials the Closure Demonstration Cell was amended as per the developed restoration technique (ie. process sand, gypsum, organic matter, and fertiliser) in spring 2013 and seeded.

Surface residue (0-15 cm) pH and ESP indicates improvement in residue properties following amendment, seeding and subsequent soil development

Vegetation analysis for first and third year's growth is shown below. As previously found, amendment procedure resulted in sufficient macro nutrient supply and there was no evidence of excessive uptake of elements associated with bauxite residue (e.g aluminium or sodium). Decline is herbage N content observed in the third year is typical of restored sites receiving no further nutrient inputs and is sufficient for the grass sward cover. Other restored residue areas on the BRDA that are 18+ years old exhibit similar N content.
Decline in herbage Na content in the third year has also been previously recorded on restored residue sites and is indicative of further improvement of the residue as a soil medium.

Herbage and soil analysis will continue as per '*Ecological Monitoring of Restoration Success'* programme below.

Table 1. Physico-chemical parameters of surface amended residue

	Surface residue soil (n=5)
pH	8.1
ESP (%)	15

Table 2. Nutrient and elemental analysis for herbage growing in the Closure Demonstration Cell

	Year 1 (n=10)	**Year 3 (n=5)**	**Typical Irish grassland range**
N (%)	2.34	0.42	1 – 5
P (%)	0.38	0.38	0.1 – 0.6
K (%)	3.02	3.3	2.16 - 4.01
Na	0.61	0.22	
Ca (%)	0.36	0.43	0.33 – 0.73
S (%)	0.57	0.52	0.15 – 0.6
Mg (%)	0.18	0.13	0.08 – 0.26
Zn (mg /kg)	20	29	10-14
Al (mg/kg)	86	32	
Cd (mg/kg)	n.d	n.d.	

n.d. – not detected



Figure 1. Soil profile of amended and seeded residue after 3 yrs



Figure 2. Amended and seeded residue area after 3 yrs (constructed wetland demonstration area in foreground)

Ecological Monitoring of Restoration Success

A post-closure monitoring programme has been developed for assessing success of residue restoration in the Closure Plan

This monitoring programme assesses the functioning ability of the restored residue to demonstrate the concept of a self-regulating system. The following 'Completion criteria' will be periodically assessed on the trial cell and future restored areas and, where necessary, management intervention implemented. Key components include;

i. Vegetation establishment, survival and succession
ii. Vegetation productivity, sustained growth and structure development;
iii. Soil fauna colonisation and habitat development;
iv. Ecosystem processes such as soil development and nutrient cycling,
v. Colonisation of specific fauna groups that are involved in these processes
vi. Microbiological studies e.g. colonisation by mycorrhizal fungi and microbial biomass
vii. Ecosystem recovery

Attachment 10
BRDA Restoration Works Report

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Report for

Aughinish Alumina

on

Report of Work Conducted by Enrich in 2015 on Restoration Works on the Bauxite Residue Disposal Area

From:

Enrich Environmental Limited

March 10th, 2016

DOCUMENT CONTROL SHEET

Document Title:	**Report of Work Conducted by Enrich in 2015 on Restoration Works on the Bauxite Residue Disposal Area**					
This Document Comprises:	**DCS**	**TOC**	**Text**	**No of Tables**	**No of Figures**	**No. of Appendices**
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Rev.	**Status**	**Author**	**Reviewed By**	**Approved By**	**Issue Date**
4	Final	E. Bird	P. Foster T. Duggan	P. Foster	10.03.2016

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Table 5: Analysed for Amended (Customised Organic Material) Bauxite Residue
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1. Executive Summary

This report is a review of the work carried out in 2015 under the supervision of Enrich.

In 2015, 30% customised organic matter was incorporated to the bauxite residue on stage five of the bauxite residue storage area (BDRA) and was sown with the following nine salt tolerant grass species (Creeping Bent Common Bent, Crested Dog's Tail, Sheep's Fescue, Red Fescue, Perennial Rye grass, Salt Marsh Grass, Red Clover, White Clover).

The results in 2015 showed that it was possible to establish good grass growth on the BRDA.

Given the lack of soil aggregation and the small particle size of the original bauxite residue, mechanical aeration is required to ensure that the active root zone can get the required oxygen.

The high presence of sodium in the bauxite residues means that this non-essential plant nutrient dominates the soil and occupies all the exchange sites. To address this imbalance the addition of the customised organic matter must contain the cations potassium, magnesium and calcium in order to provide the required nutrients for grass growth.

The following actions are recommended:

- Poor drainage can be a limiting factor and the priority is to ensure that any future works have sufficient drainage.
- Amendments are to be incorporated to a depth of 300mm.
- A grass management plan is required after germination. The grass will require maintenance such as mowing. A mulching mower is recommended as it will evenly distribute the cut grass over the BRDA allowing uniform nutrient recycling.
- The BRDA should be aerated. The purpose of the aeration is to open up the active root zone allowing water and oxygen pass freely.
- Grass and soil analysis to be conducted annually to monitor soil conditions.

2. Introduction

In March 2015 Enrich submitted a 'Proposal to Aughinish Alumina for the Annual Restoration Works on BRDA'.

This report is based on Enrich's work during 2015 on stage five of the BRDA.

Stage five of the BRDA is approximately 3.5 hectares which is sub divided into four areas.

As part of Aughinish Alumina requirements for on-going improvements Enrich will be conducting additional works on new areas of the bauxite residue as well as monitoring the grass growth in stage five.

2.1 Aims

The aims of the work undertaken in 2015 were:

- Phase 1- To get grass to establish on 'stage five of the BRDA'; and
- Phase 2- Monitoring and maintaining grass on 'stage five'.

3. Overview of Work Completed

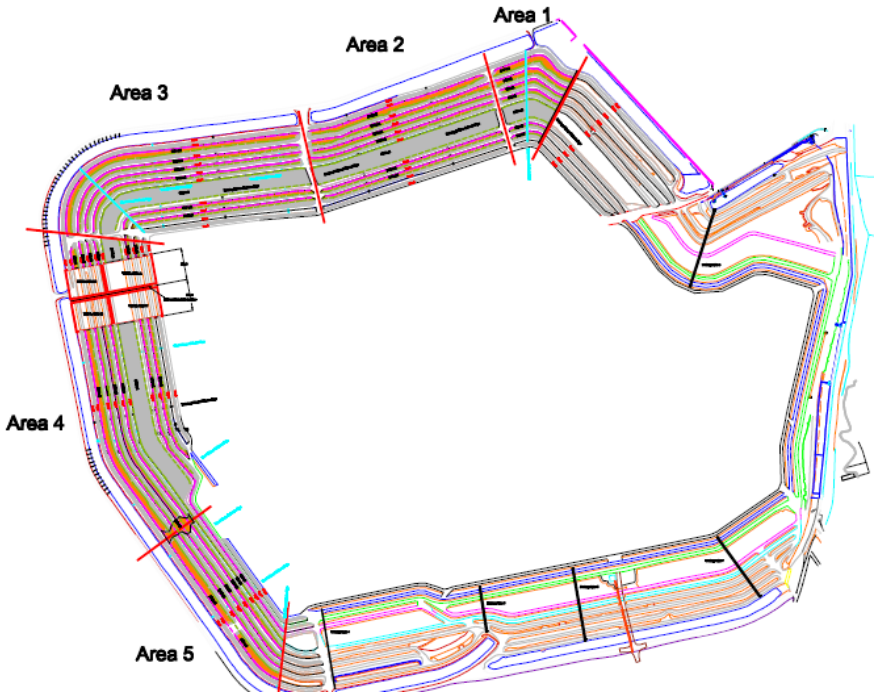


Figure 1: Map of Stage 5 BRDA

3.1 Establishment – Phase 1

Each area of stage five on the BRDA was analysed in 2015 to characterise the bauxite residue. From the results of the characterisation, an inclusion rate of customised organic matter along with an incorporation depth and application method was devised. The organic matter provision was to provide the nutrients for grass establishment.

In order to get customised organic matter into the active root zone, the BRDA was spiked to create channels and organic matter was spread across the surface and brushed into the holes.

A drainage plan consisting of surface drainage channels was designed and installed. The purpose of the drainage system was to remove surface water.

3.2 Monitoring- Phase 2

Stage five is being used to provide a visual demonstration that grass can be established and maintained on the amended bauxite residues.

Table 1: Characterisation of Bauxite Residue

pH	Phosphorus
Electrical Conductivity	Calcium
Sodium	Organic Matter
Magnesium	Potassium
Cation Exchange Capacity	

Table 2: Parameters Analysed in Amended Bauxite Residue

pH	Phosphorus
Electrical Conductivity	Calcium
Sodium	Organic Matter
Magnesium	Potassium
Cation Exchange Capacity	

In order to accurately monitor the natural nutrient recycling both the amended bauxite (Table 2) and the grass (Table 3) were analysed for a range of parameters.

After grass was established, further amended bauxite residue (Table 2) and grass analysis (Table 3) were taken to determine the nutrient status of the grass.

Table 3: Chemical Analysis Conducted on Grass

Cation Exchange Capacity	Potassium
Exchangeable Sodium Percentage	Zinc
Sodium Absorption rate	Sulphur
Phosphorus	Manganese
Magnesium	Copper
Aluminium	Lead
Sodium	Iron

In addition to testing the amended soil, analysis was also conducted on the grass. Leaf analysis is the most accurate method for monitoring plant nutrient levels and detecting any deficiencies. Leaf analysis shows exactly what the plant has successfully absorbed through its root system.

The soil analysis provides information on the levels of nutrients present in the soil, however due to the complex interactions within the soil not all of these are available to the plant.

When leaf and soil analysis are looked at together a clear picture can be ascertained about the nutrient recycling and uptake.

4. Results

Table 4: Initial Characterisation of Bauxite Residue

Reference	Units	Sample 1	Sample 2	Sample 3
pH		8.4	8.3	8.8
Phosphorus	mg/l	24	21	15
Potassium	mg/l	218	160	107
Magnesium	mg/l	22	19	<15
Sodium	mg/l	4255	3841	4281
Calcium	mg/l	3699	3755	2841
Extractable Aluminium	mg/l	80.4	101	115

Table 4 shows the results of the initial characterisation of the bauxite residue.

Table 5: Analysed for Amended (Customised Organic Material) Bauxite Residue

Reference	Units	Sample 1	Sample 2	Sample 3
pH		7.8	7.9	7.8
Phosphorus	mg/l	23	22	56.8
Potassium	mg/l	117	96	333
Magnesium	mg/l	41	31	88
Sodium	mg/l	598	525.4	399.6
Calcium	mg/l	4960.9	5428.7	4659.4
Organic Matter	%	9.4	8.9	14.8
Electrical Conductivity	uS/cm	2413	2297	2484
Cation Exchange Capacity	meq/100g	36.4	38.8	34.6

Table 5 illustrates the reduction of sodium and the increase in calcium levels.

Table 6: Nutrient Analysis Results of Soil Sampled in Areas which had Grass Growth

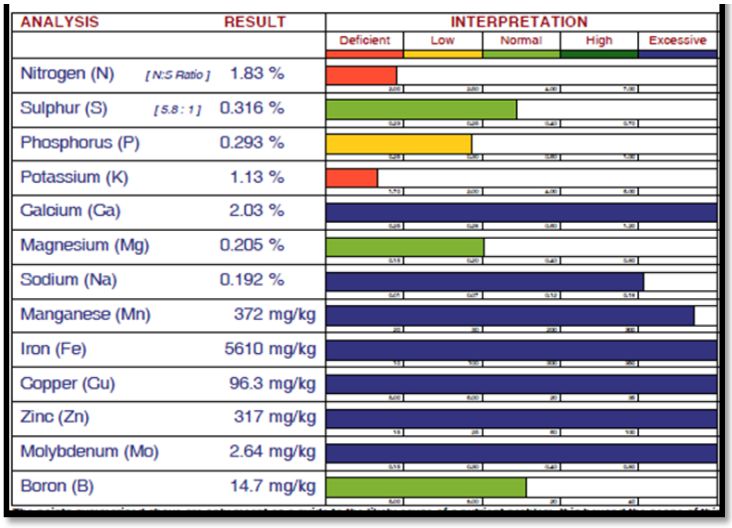
		Grass
Parameter	**Unit**	**Result**
pH		8.1
Phosphorus	mg/l	35.4
Potassium	mg/l	344
Magnesium	mg/l	69
Sodium	mg/l	1920
Calcium	mg/l	5265
Organic Matter	%	11.2
Electrical Conductivity	uS/cm	4084
Cation Exchange Capacity	meq/100g	46.6
SAR*		7.2

**SAR is a measure of sodicity of the soil, the higher the SAR the less suitable the soil is for plant growth. Levels above 13 in soils are considered too high for plant growth.*

SAR is a good indicator of soil health. Table 6 shows that there was a SAR results of 7.2. A result above 13 would have indicated that the soil would not sustain grass growth.

Table 6 shows the results from a sample taken where the grass had grown. From the analysis a benchmark for required conditions for grass growth was established.

Figure 2: Grass Analysis from Areas of Grass Growth



ANALYSIS		RESULT	INTERPRETATION
			Deficient / Low / Normal / High / Excessive
Nitrogen (N)	[N:S Ratio]	1.83 %	
Sulphur (S)	[5.8 : 1]	0.316 %	
Phosphorus (P)		0.293 %	
Potassium (K)		1.13 %	
Calcium (Ca)		2.03 %	
Magnesium (Mg)		0.205 %	
Sodium (Na)		0.192 %	
Manganese (Mn)		372 mg/kg	
Iron (Fe)		5610 mg/kg	
Copper (Cu)		96.3 mg/kg	
Zinc (Zn)		317 mg/kg	
Molybdenum (Mo)		2.64 mg/kg	
Boron (B)		14.7 mg/kg	

The results of leaf analysis of grass is shown in Figure 2. It shows actual nutrient uptake of the plant, physical conditions within the soil have resulted in localised area of nutrient deficiencies.



Figure 3: Grass Growth 28/01/16

5. Discussion

5.1 Overview

In March 2015 Enrich submitted in a 'Proposal to Aughinish Alumina for the Annual Restoration Works on BRDA'. This report is based on Enrich's work since March 2015.

In 2015 under Enrich's direction the following was conducted:

- Customised organic matter was incorporated at a rate of 30% and sown with the following nine salt tolerant grass species:
  - Creeping Bent
  - Common Bent
  - Crested Dog's Tail
  - Sheep's Fescue
  - Red Fescue
  - Perennial Rye grass
  - Salt Marsh Grass
  - Red Clover
  - White Clover
- A drainage plan was designed and implemented.
- A management plan for established grass area was implemented. This involved mowing the grass 2-3 times during the year to return the nutrients to the ground. The ground was aerated as required.

5.2 Discussion of work

Drainage can be a limiting factor to grass growth. As a result of the extremely low permeability of the bauxite residue, water is unable to penetrate to subsurface drainage resulting in a build-up of soluble sodium. There was limited surface drainage due to the insufficient surface gradient. As a result of the low permeability and gradient there is little lateral movement of water. During the summer as water evaporates from the BRDA the soluble sodium concentrates at the surface. During the summer the accumulation of sodium at the surface can lead to the formation of sodium carbonate and sodium bicarbonate. The reverse happens during the winter as the bauxite residue becomes saturated the sodium is washed down through the bauxite residue.

As a result of poor drainage, any soluble sodium is unable to be removed from the bauxite residue. As a result the Sodium Absorption Rate (SAR) will remain a limiting factor for germination. The SAR is a good indicator of soil health. A soil with an SAR >13% will not sustain grass growth. The sodium levels are directly related to the SAR.

As a result of the poor soil structure, the bauxite residue is prone to compaction. Compaction will result in anaerobic conditions and water logging. The incorporation of organic matter will lead to improved structure as a result of soil aggregation

Mechanical aeration is also required to ensure that the active root zone remains aerated. Due to compaction a hard pan can develop resulting in restricted movement of the roots limiting the plants access to vital nutrients.

6. Conclusions

The following are the key conclusions:

- In 2015, nine salt tolerant grass species were sown and grew well. This result shows that it was possible to establish grass on stage five of the BRDA.

- Aeration is required to ensure that the activate root zone remains aerated, due to compaction a hard pan can develop resulting in restricted movement of the roots limiting the plants access to vital nutrients.

7. Recommendations

The following actions are recommended:

- Drainage can be a limiting factor to grass growth and the priority is to ensure that with any future works have sufficient drainage to remove soluble sodium.
- Amendments are to be incorporated to a depth of 300mm.
- A grass management plan is required after germination. The grass will require maintenance such as mowing. A mulching mower is recommended as it will evenly distribute the cut grass over the BRDA allowing uniform nutrient recycling.
- The BRDA should be aerated. The purpose of the aeration is to open up the active root zone allowing water and oxygen pass freely.
- Grass and soil analysis to be conducted annually to monitor soil conditions.

Attachment 11
BRDA Constructed Wetland Overview

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Constructed Wetland – 2015

Overview

Bauxite residue from the Bayer process contains residual caustic soda with alkaline leachate of pH > 10.5. Bauxite Residue Disposal Area (BRDA) closure and aftercare plans must address the timeframes required for leachate to reduce to ≤ pH 9.0 so it can be discharged to the receiving environment. A novel approach to ensure that BRDA leachate can be passively treated and made suitable for discharge within a short period (months) of BRDA closure is to incorporate constructed wetland(s) into the Closure Plan. Constructed wetlands are gaining global acceptance by regulators in mine closure. However, little research has been conducted into the using wetlands to treat bauxite residue leachate.

In 2012 Aughinish Alumina received funding from its owner UC Rusal and the International Aluminium Association for a four year study programme investigating the use of a constructed wetland to treat residue leachate. A three year field operation of a constructed wetland within the Aughinish BRDA is currently being demonstrated. The wetland is fed from an automatic leachate dilution and dosing system at a pre-selected pH and flow-rate. Water inflow and outflow are monitored on a continual basis with soil and herbage analysed seasonally.

In the first year of wetland operation reductions in leachate pH to less than 9 were achieved. Within the wetland, microbial activity generates CO_2 which carbonates the water thereby reducing the pH. A discharge pH of < 9.0 is achievable but lower efficiency of the wetland is observed in winter months due to a decrease in biological activity. Total metal contents observed in soil and herbage was not at phytotoxic levels. Analysis revealed increase in soil pH, electrical conductivity and sodium content over time. Increase in sodium content is attributed to its removal from the residue leachate as a consequence of calcite precipitation within the wetland. The potential for wetland to treat residue leachates of varying composition is now being pursued with Ca deficient waters as feed source for residue leachate generation.

A second phase of the field demonstration commenced in Spring 2015. To determine the effectiveness of wetland technology for low Ca leachate the mixing system was modified to contain de-ionised water for dilution. Dosing to wetland with low Ca content residue leachate commenced in Spring 2015. Results thus far (Figure 1) demonstrate that the constructed wetland can effectively buffer alkalinity of low Ca content residue leachate over the late Spring, Autumn and Winter period without compromising flow rate. A maximum flow rate of 55 l/hr was achieved (Figure 2). As per previous wetland demonstration the component parts of the wetland systems (soil and vegetation) have been periodically sampled and are currently undergoing analysis.

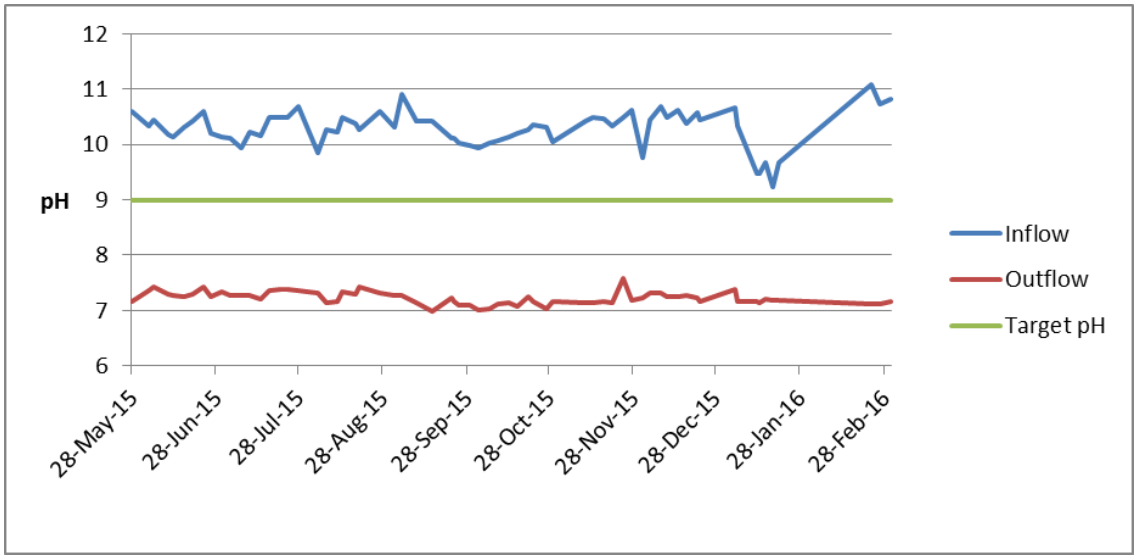


Figure 1. Monthly average pH values of wetland inflow and outflow for bauxite leachate diluted with de-ionised water

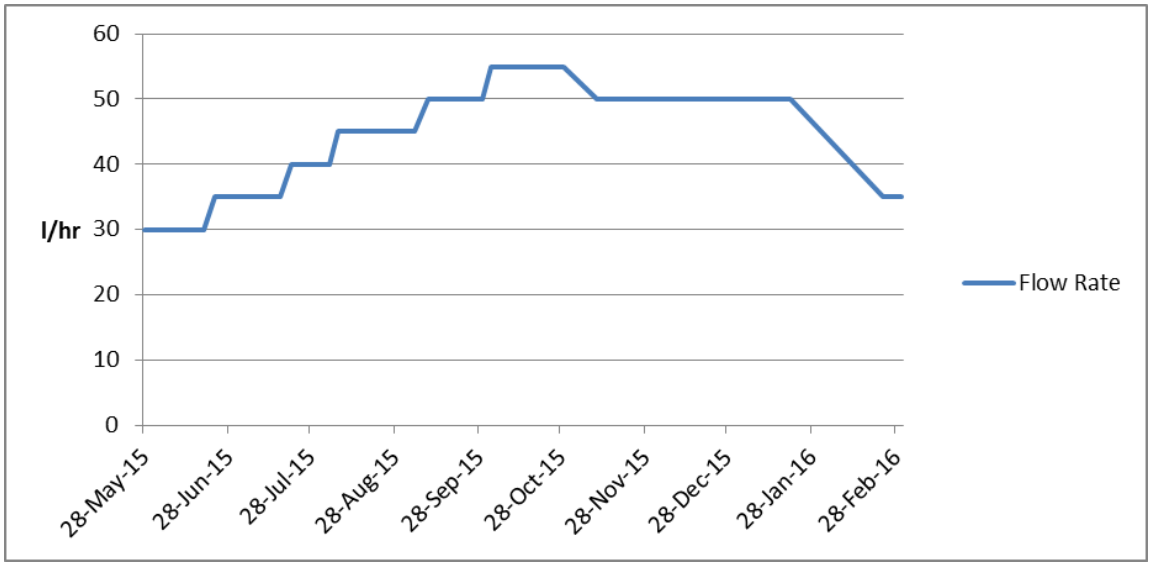


Figure 2. Monthly average flow rates of residue leachate going to constructed wetland

Plant growth trials

In order to determine the effects of bauxite residue leachate on soil properties and plant growth a ten week pot experiment was set up using a range of leachate dilutions. Bauxite residue leachate was diluted as indicated below. Pots were filled with compost and planted with freshly transplanted *Phragmites australis*. Following amendment with nutrient additions pot were then inundated with solutions of the differing pH solutions. After 10 weeks the pots were dismantled and soils were analysed for pH, EC and soluble elements. Plants were separated

into below and above ground portions and new growth determined by root and shoot length. Elemental concentrations of the plant samples are currently being determined.

Treatment	Dilution factor	Solution pH
1	1:40	11.1
2	1:75	10.4
3	1:100	9.9
4	1:200	9.0
5	1:300	8.8
6	1:400	8.5
Control	------	6.9

Results

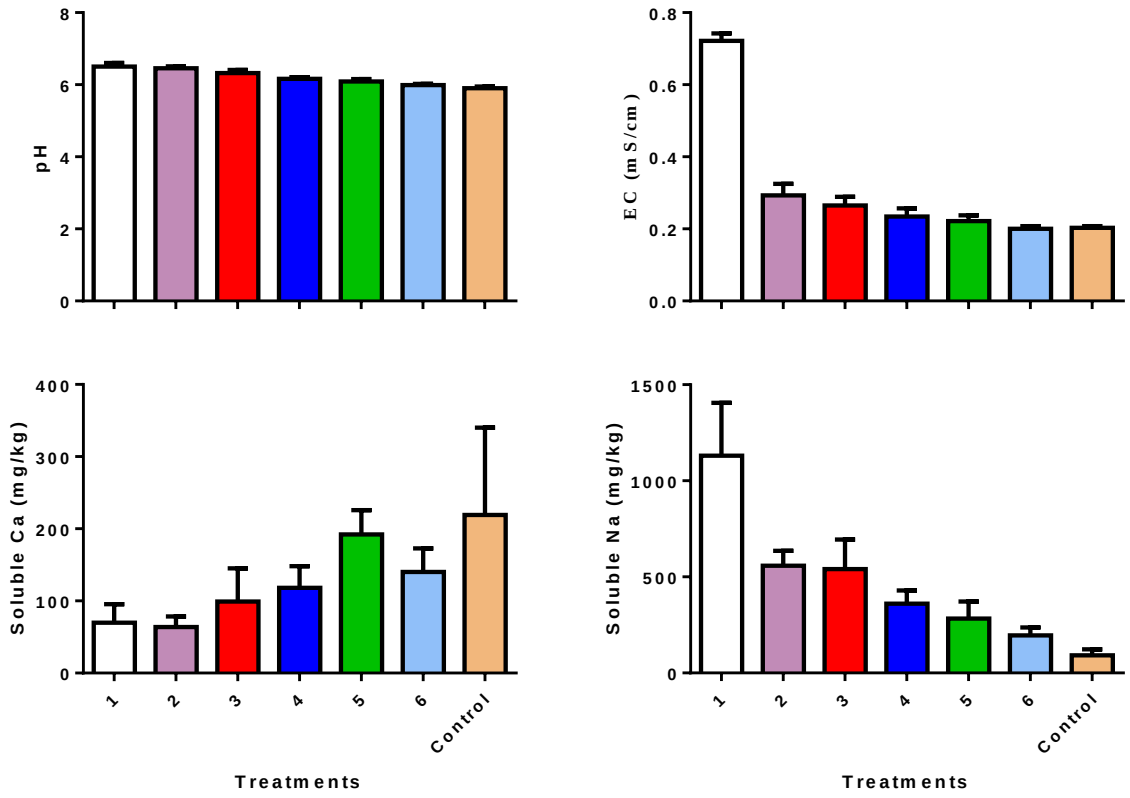


Figure 3. Selected soil physico-chemical parameters after 10 weeks of inundation with residue leachate

Although inundation with residue leachate resulted in an increase in soil pH values for all treatments remained below pH 7. In general, increasing amounts of residue leachate resulted

in decreased soluble Ca in the soil. Conversely, soil EC and Na levels significantly increased with amount of residue leachate per treatment.

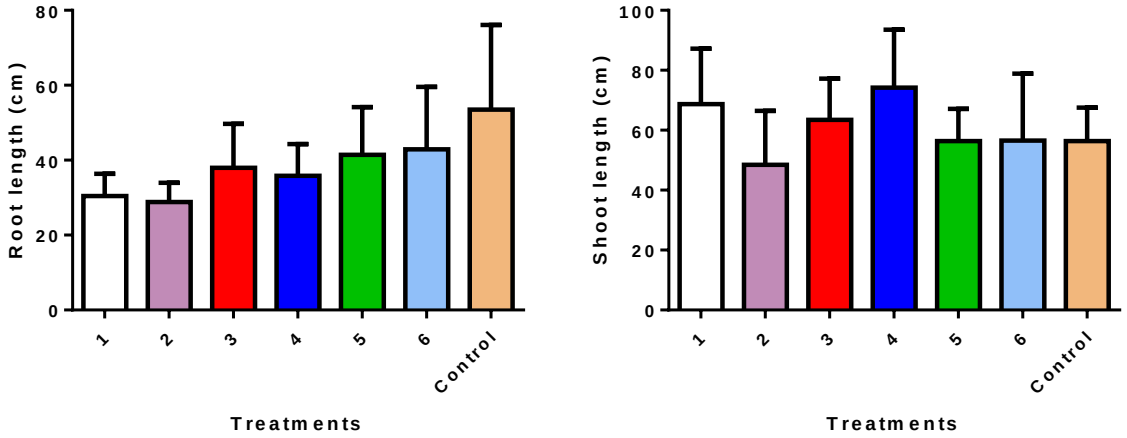


Figure 4. Plant growth as determined by root and shoot length for *Phragmites australis* growing bauxite residue leachate of differing dilution rates

Plant growth in the residue leachate treatments displayed contrasting results. Root length was decreased with increased amount of residue leachate in the treatment. This trend was not repeated for aboveground (shoot) growth. Biomass yield and elemental content are currently being determined to further understand the impact of residue leachate on plant growth within a constructed wetland system receiving bauxite residue leachate.