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30 May 2019

Commercial-in-Confidence

Kirstie Richards
Partner
K&L Gates on behalf of AGL Macquarie
Level 31, 1 O'Connell Street
Sydney NSW 2000, Australia

Dear Kirstie

PRIVILEGED AND CONFIDENTIAL Bayswater Power Station - Fly Ash Characterisation Report

1.0 Introduction

AGL Macquarie Pty Limited (AGL Macquarie) has requested AECOM Australia Pty Ltd (AECOM) to conduct run of plant fly ash sampling and analysis for the purposes of coal ash characterisation in accordance with the requirements of the *Coal Ash Order 2014* (Coal Ash Order) made under the *Protection of the Environment Operations (Waste) Regulation 2014*. The fly ash is to be beneficially reused as an engineering material (cementitious mixes) only. This characterisation report does not cover any other potential beneficial reuse of the fly ash.

Characterisation sampling occurred in January/February 2019.

2.0 Objectives

The objectives of the sampling plan and the proposed works were to:

- Outline the required sampling and sample collection locations;
- Describe the procedures for sampling, sample preparation, sample storage and transport to the analytical laboratory and sample analysis, as well as the reporting requirements;
- Carry out sampling analysis as per the sampling plan for the purposes of coal ash characterisation; and
- Document compliance with the requirements of the Coal Ash Order.

3.0 Sample Collection

Sampling was conducted on a daily basis from 19 January 2019 to 7 February 2019 (resulting in a total of 20 composite samples) in accordance with AS 1141.3.1 – 2012 and the following site specific requirements:

- At least five sampling increments with minimum mass of 1kg (as per AS 1141.3.1 Sect 6.3 Table 1) were collected from the Silo A offtake valve or bag house quad boxes over a period of time that represented >30 tonnes of fly ash production and over a minimum one hour period to form each composite sample.
- Each increment was weighed on site to confirm that the minimum increment mass has been achieved.
- Each increment was collected in a sealed plastic bag and labelled with date, time, location and sampler's name.
- Sample increments were returned to AECOM Singleton for mixing and division into composite samples and preparation for laboratory delivery.

4.0 Characterisation Analysis Results

Fly ash characterisation composite samples were analysed at ALS NATA accredited laboratory. Average and maximum analyte results are presented in **Table 1**. Testing procedures were in accordance with or equivalent to those specified in Clauses 4.7 and 4.8 of the Coal Ash Order. A results summary (**Table 2**) and certificates of analysis have been attached.

Table 1 Characterisation Sample Analysis Results and Compliance with Limits in Columns 2 and 4 of Table 1 to the Coal Ash Order

Column 1 of Table 1 of the Coal Ash Order	**Column 2 of Table 1 of the Coal Ash Order**	**Column 4 of Table 1 of the Coal Ash Order**	**Average Characterisation Sample Analyte Concentration** (mg/kg)[2]	**Absolute Maximum Sample Analyte Concentration (mg/kg)**	**Average Characterisation Sample Analyte Compliance (Yes / No)**	**Absolute Maximum Concentration Compliance (Yes/No)**
Analyte	**Maximum Average Concentration for Characterisation** (mg/kg)	**Absolute Maximum Concentration** (mg/kg)				
Arsenic	*10*	*20*	5.1	6	Yes	Yes
Boron	*75*	*150 (engineering uses)*	<50	<50	Yes	Yes
Cadmium	*0.5*	*1*	<0.4	<0.4	Yes	Yes
Chromium	*25*	*50*	4.9	7	Yes	Yes
Copper	*20*	*40*	5.1	6	Yes	Yes
Lead	*25*	*50*	5.2	6	Yes	Yes
Molybdenum	*10*	*20*	3.9	5	Yes	Yes
Nickel	*25*	*50*	2.8	4	Yes	Yes
Selenium	*10*	*20*	<5	<5	Yes	Yes
Zinc	*35*	*70*	12.6	16	Yes	Yes
Mercury	*0.5*	*1*	0.06	0.14	Yes	Yes
Electrical Conductivity[1]	*NA*	*NA (engineering uses)*	373 µS/cm	463 µS/cm	NA	NA
pH in cementitious mixes	*NA*	*NA*	NA	NA	NA	NA

[1]Note: while thresholds are not provided for electrical conductivity this must be tested and a record kept of the results.

[2] For the purposes of calculating the average analyte concentration, results below the Limit of Reporting (LOR) have been evaluated at the respective LORs. If all results were below the LOR for a particular analyte the <LOR result has been presented as the average.

5.0 Compliance

The average analyte concentrations of the twenty characterisation fly ash samples collected at Bayswater Power Station from 19 January 2019 to 7 February 2019 were below the maximum average concentrations as per Table 1, Column 2 of the Coal Ash Order. Individual analyte results from all fly ash characterisation samples were below the absolute maximum concentrations for all analytes as per Table 1 Column 4 of the Coal Ash Order. As such the results of the fly ash characterisation testing program comply with the requirements of the Coal Ash Order for beneficial reuse as an engineering material (cementitious mixes).

Yours faithfully

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encl: Analysis Results Summary
Certificates of Analysis
Sampling Plan
cc: Morgana Gidley-Baird - AGL Macquarie
Summer Steward - AGL Macquarie

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Table 2 Fly Ash Characterisation Analysis Results Summary

Analyte	19-Jan-19	20-Jan-19	21-Jan-19	22-Jan-19	23-Jan-19	24-Jan-19	25-Jan-19	26-Jan-19	27-Jan-19	28-Jan-19
Arsenic (mg/kg)	<5	<5	<5	<5	<5	6	<5	<5	<5	5
Boron (mg/kg)	<50	<50	<50	<50	<50	<50	<50	<50	<50	<50
Cadmium (mg/kg)	<0.4	<0.4	<0.4	<0.4	<0.4	<0.4	<0.4	<0.4	<0.4	<0.4
Chromium (mg/kg)	5	5	5	5	5	6	3	3	6	6
Copper (mg/kg)	<5	<5	<5	<5	<5	6	<5	<5	<5	<5
Lead (mg/kg)	<5	5	<5	<5	<5	6	<5	<5	6	<5
Molybdenum (mg/kg)	5	4	4	4	4	4	2	<2	4	5
Nickel (mg/kg)	2	3	2	3	4	4	<2	<2	4	4
Selenium (mg/kg)	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5
Zinc (mg/kg)	11	14	11	14	13	16	<5	<5	15	14
Mercury (mg/kg)	0.05	0.05	0.06	0.07	0.06	0.06	0.06	0.05	0.07	0.08
Electrical Conductivity (µS/cm)	287	276	349	400	284	366	355	240	309	427
Analyte	**29-Jan-19**	**30-Jan-19**	**31-Jan-19**	**01-Feb-19**	**02-Feb-19**	**03-Feb-19**	**04-Feb-19**	**05-Feb-19**	**06-Feb-19**	**07-Feb-19**
Arsenic (mg/kg)	5	<5	<5	<5	<5	6	5	<5	<5	<5
Boron (mg/kg)	<50	<50	<50	<50	<50	<50	<50	<50	<50	<50
Cadmium (mg/kg)	<0.4	<0.4	<0.4	<0.4	<0.4	<0.4	<0.4	<0.4	<0.4	<0.4
Chromium (mg/kg)	6	4	7	6	5	4	5	2	4	5
Copper (mg/kg)	<5	<5	5	5	<5	<5	<5	<5	<5	<5
Lead (mg/kg)	<5	<5	6	6	<5	<5	<5	<5	<5	<5
Molybdenum (mg/kg)	4	4	4	4	4	4	4	4	4	4
Nickel (mg/kg)	3	<2	4	4	2	<2	<2	<2	<2	<2
Selenium (mg/kg)	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5
Zinc (mg/kg)	13	9	15	16	13	<5	7	<5	<5	8
Mercury (mg/kg)	0.06	0.04	0.05	0.08	0.08	0.06	0.05	0.05	0.06	0.14
Electrical Conductivity (µS/cm)	463	267	361	279	272	390	432	348	384	373

ALS Environmental

CERTIFICATE OF ANALYSIS

Work Order	: **ES1909166**	Page	: 1 of 10
Client	: **AECOM Australia Pty Ltd**	Laboratory	: Environmental Division Sydney
Contact	: MS SARAH BROWN	Contact	: Brenda Hong
Address	: PO BOX 3148 SINGLETON NSW, AUSTRALIA 2330	Address	: 277-289 Woodpark Road Smithfield NSW Australia 2164
Telephone	: +61 02 6575 9000	Telephone	: +61 2 8784 8555
Project	: 60580964 PRIVILEGED AND CONFIDENTIAL -60580964 AGL A03847	Date Samples Received	: 26-Mar-2019 16:51
Order number	: 74645	Date Analysis Commenced	: 27-Mar-2019
C-O-C number	: A0384	Issue Date	: 28-Mar-2019 20:22
Sampler	: ----		
Site	: ----		
Quote number	: EN/004/16		
No. of samples received	: 40		
No. of samples analysed	: 40		

Accreditation No. 825
Accredited for compliance with
ISO/IEC 17025 - Testing

This report supersedes any previous report(s) with this reference. Results apply to the sample(s) as submitted. This document shall not be reproduced, except in full.

This Certificate of Analysis contains the following information:

- General Comments
- Analytical Results

Additional information pertinent to this report will be found in the following separate attachments: Quality Control Report, QA/QC Compliance Assessment to assist with Quality Review and Sample Receipt Notification.

Signatories

This document has been electronically signed by the authorized signatories below. Electronic signing is carried out in compliance with procedures specified in 21 CFR Part 11.

Signatories	*Position*	*Accreditation Category*
Ivan Taylor	Analyst	Sydney Inorganics, Smithfield, NSW

General Comments

The analytical procedures used by the Environmental Division have been developed from established internationally recognized procedures such as those published by the USEPA, APHA, AS and NEPM. In house developed procedures are employed in the absence of documented standards or by client request.

Where moisture determination has been performed, results are reported on a dry weight basis.

Where a reported less than (<) result is higher than the LOR, this may be due to primary sample extract/digestate dilution and/or insufficient sample for analysis.

Where the LOR of a reported result differs from standard LOR, this may be due to high moisture content, insufficient sample (reduced weight employed) or matrix interference.

When sampling time information is not provided by the client, sampling dates are shown without a time component. In these instances, the time component has been assumed by the laboratory for processing purposes.

Where a result is required to meet compliance limits the associated uncertainty must be considered. Refer to the ALS Contact for details.

Key : CAS Number = CAS registry number from database maintained by Chemical Abstracts Services. The Chemical Abstracts Service is a division of the American Chemical Society.
LOR = Limit of reporting
^ = This result is computed from individual analyte detections at or above the level of reporting
ø = ALS is not NATA accredited for these tests.
~ = Indicates an estimated value.

Analytical Results

Sub-Matrix: FLY ASH (Matrix: SOIL)				Client sample ID	20190119FA-01 FLY ASH	20190120FA-01 FLY ASH	20190121FA-01 FLY ASH	20190122FA-01 FLY ASH	20190123FA-01 FLY ASH
				Client sampling date / time	19-Jan-2019 00:00	20-Jan-2019 00:00	21-Jan-2019 00:00	22-Jan-2019 00:00	23-Jan-2019 00:00
Compound	CAS Number	LOR	Unit		ES1909166-001	ES1909166-002	ES1909166-003	ES1909166-004	ES1909166-005
					Result	Result	Result	Result	Result
EA055: Moisture Content (Dried @ 105-110°C)									
Moisture Content	----	0.1	%		**0.1**	<0.1	<0.1	**0.1**	<0.1
EG005(ED093)T-MW: Total Metals by nitric acid microwave digestion / ICP-AES									
Arsenic	7440-38-2	5	mg/kg		<5	<5	<5	<5	<5
Boron	7440-42-8	50	mg/kg		<50	<50	<50	<50	<50
Cadmium	7440-43-9	0.4	mg/kg		<0.4	<0.4	<0.4	<0.4	<0.4
Chromium	7440-47-3	2	mg/kg		**5**	**5**	**5**	**5**	**5**
Copper	7440-50-8	5	mg/kg		<5	<5	<5	<5	<5
Lead	7439-92-1	5	mg/kg		<5	**5**	<5	<5	<5
Molybdenum	7439-98-7	2	mg/kg		**5**	**4**	**4**	**4**	**4**
Nickel	7440-02-0	2	mg/kg		**2**	**3**	**2**	**3**	**4**
Selenium	7782-49-2	5	mg/kg		<5	<5	<5	<5	<5
Zinc	7440-66-6	5	mg/kg		**11**	**14**	**11**	**14**	**13**

Analytical Results

Sub-Matrix: **FLY ASH** (Matrix: **SOIL**)

Compound	CAS Number	LOR	Unit	Client sample ID	20190124FA-01 FLY ASH	20190125FA-01 FLY ASH	20190126FA-01 FLY ASH	20190127FA-01 FLY ASH	20190128FA-01 FLY ASH
				Client sampling date / time	24-Jan-2019 00:00	25-Jan-2019 00:00	26-Jan-2019 00:00	27-Jan-2019 00:00	28-Jan-2019 00:00
					ES1909166-006	ES1909166-007	ES1909166-008	ES1909166-009	ES1909166-010
					Result	Result	Result	Result	Result
EA055: Moisture Content (Dried @ 105-110°C)									
Moisture Content	----	0.1	%		**0.2**	<0.1	<0.1	<0.1	<0.1
EG005(ED093)T-MW: Total Metals by nitric acid microwave digestion / ICP-AES									
Arsenic	7440-38-2	5	mg/kg		**6**	<5	<5	<5	**5**
Boron	7440-42-8	50	mg/kg		<50	<50	<50	<50	<50
Cadmium	7440-43-9	0.4	mg/kg		<0.4	<0.4	<0.4	<0.4	<0.4
Chromium	7440-47-3	2	mg/kg		**6**	**3**	**3**	**6**	**6**
Copper	7440-50-8	5	mg/kg		**6**	<5	<5	<5	<5
Lead	7439-92-1	5	mg/kg		**6**	<5	<5	**6**	<5
Molybdenum	7439-98-7	2	mg/kg		**4**	**2**	<2	**4**	**5**
Nickel	7440-02-0	2	mg/kg		**4**	<2	<2	**4**	**4**
Selenium	7782-49-2	5	mg/kg		<5	<5	<5	<5	<5
Zinc	7440-66-6	5	mg/kg		**16**	<5	<5	**15**	**14**

Analytical Results

Sub-Matrix: FLY ASH (Matrix: SOIL)				Client sample ID	20190129FA-01 FLY ASH	20190130FA-01 FLY ASH	20190131FA-01 FLY ASH	20190201FA-01 FLY ASH	20190202FA-01 FLY ASH
				Client sampling date / time	29-Jan-2019 00:00	30-Jan-2019 00:00	31-Jan-2019 00:00	01-Feb-2019 00:00	02-Feb-2019 00:00
Compound	CAS Number	LOR	Unit		ES1909166-011	ES1909166-012	ES1909166-013	ES1909166-014	ES1909166-015
					Result	Result	Result	Result	Result
EA055: Moisture Content (Dried @ 105-110°C)									
Moisture Content	----	0.1	%		<0.1	<0.1	**0.2**	**0.3**	<0.1
EG005(ED093)T-MW: Total Metals by nitric acid microwave digestion / ICP-AES									
Arsenic	7440-38-2	5	mg/kg		**5**	<5	<5	<5	<5
Boron	7440-42-8	50	mg/kg		<50	<50	<50	<50	<50
Cadmium	7440-43-9	0.4	mg/kg		<0.4	<0.4	<0.4	<0.4	<0.4
Chromium	7440-47-3	2	mg/kg		**6**	**4**	**7**	**6**	**5**
Copper	7440-50-8	5	mg/kg		<5	<5	**5**	**5**	<5
Lead	7439-92-1	5	mg/kg		<5	<5	**6**	**6**	<5
Molybdenum	7439-98-7	2	mg/kg		**4**	**4**	**4**	**4**	**4**
Nickel	7440-02-0	2	mg/kg		**3**	<2	**4**	**4**	**2**
Selenium	7782-49-2	5	mg/kg		<5	<5	<5	<5	<5
Zinc	7440-66-6	5	mg/kg		**13**	**9**	**15**	**16**	**13**

Analytical Results

Sub-Matrix: **FLY ASH**
(Matrix: **SOIL**)

Compound	CAS Number	LOR	Unit	Client sample ID	20190203FA-01 FLY ASH	20190204FA-01 FLY ASH	20190205FA-01 FLY ASH	20190206FA-01 FLY ASH	20190207FA-01 FLY ASH
				Client sampling date / time	03-Feb-2019 00:00	04-Feb-2019 00:00	05-Feb-2019 00:00	06-Feb-2019 00:00	07-Feb-2019 00:00
					ES1909166-016	ES1909166-017	ES1909166-018	ES1909166-019	ES1909166-020
					Result	Result	Result	Result	Result
EA055: Moisture Content (Dried @ 105-110°C)									
Moisture Content	----	0.1	%		<0.1	<0.1	<0.1	<0.1	<0.1
EG005(ED093)T-MW: Total Metals by nitric acid microwave digestion / ICP-AES									
Arsenic	7440-38-2	5	mg/kg		**6**	**5**	<5	<5	<5
Boron	7440-42-8	50	mg/kg		<50	<50	<50	<50	<50
Cadmium	7440-43-9	0.4	mg/kg		<0.4	<0.4	<0.4	<0.4	<0.4
Chromium	7440-47-3	2	mg/kg		**4**	**5**	**2**	**4**	**5**
Copper	7440-50-8	5	mg/kg		<5	<5	<5	<5	<5
Lead	7439-92-1	5	mg/kg		<5	<5	<5	<5	<5
Molybdenum	7439-98-7	2	mg/kg		**4**	**4**	**4**	**4**	**4**
Nickel	7440-02-0	2	mg/kg		<2	<2	<2	<2	<2
Selenium	7782-49-2	5	mg/kg		<5	<5	<5	<5	<5
Zinc	7440-66-6	5	mg/kg		<5	**7**	<5	<5	**8**

Analytical Results

Sub-Matrix: **FLY ASH** (Matrix: **SOIL**)

Compound	CAS Number	LOR	Unit	Client sample ID	20190119BA-01 BOTTOM ASH	20190120BA-01 BOTTOM ASH	20190121BA-01 BOTTOM ASH	20190122BA-01 BOTTOM ASH	20190123BA-01 BOTTOM ASH
				Client sampling date / time	19-Jan-2019 00:00	20-Jan-2019 00:00	21-Jan-2019 00:00	22-Jan-2019 00:00	23-Jan-2019 00:00
					ES1909166-021	ES1909166-022	ES1909166-023	ES1909166-024	ES1909166-025
					Result	Result	Result	Result	Result
EA055: Moisture Content (Dried @ 105-110°C)									
Moisture Content	----	0.1	%		**27.6**	**27.2**	**25.3**	**25.2**	**23.5**
EG005(ED093)T-MW: Total Metals by nitric acid microwave digestion / ICP-AES									
Arsenic	7440-38-2	5	mg/kg		<5	<5	<5	<5	<5
Boron	7440-42-8	50	mg/kg		<50	<50	<50	<50	<50
Cadmium	7440-43-9	0.4	mg/kg		<0.4	<0.4	<0.4	<0.4	<0.4
Chromium	7440-47-3	2	mg/kg		<2	<2	<2	<2	<2
Copper	7440-50-8	5	mg/kg		**8**	**7**	<5	<5	<5
Lead	7439-92-1	5	mg/kg		<5	<5	<5	<5	<5
Molybdenum	7439-98-7	2	mg/kg		<2	<2	<2	<2	<2
Nickel	7440-02-0	2	mg/kg		<2	<2	<2	<2	<2
Selenium	7782-49-2	5	mg/kg		<5	<5	<5	<5	<5
Zinc	7440-66-6	5	mg/kg		<5	<5	<5	<5	<5

Analytical Results

Sub-Matrix: **FLY ASH** (Matrix: **SOIL**)

Compound	CAS Number	LOR	Unit	Client sample ID	20190124BA-01 BOTTOM ASH	20190125BA-01 BOTTOM ASH	20190126BA-01 BOTTOM ASH	20190127BA-01 BOTTOM ASH	20190128BA-01 BOTTOM ASH
				Client sampling date / time	24-Jan-2019 00:00	25-Jan-2019 00:00	26-Jan-2019 00:00	27-Jan-2019 00:00	28-Jan-2019 00:00
					ES1909166-026	ES1909166-027	ES1909166-028	ES1909166-029	ES1909166-030
					Result	Result	Result	Result	Result
EA055: Moisture Content (Dried @ 105-110°C)									
Moisture Content	----	0.1	%		**22.6**	**26.2**	**17.9**	**20.8**	**17.7**
EG005(ED093)T-MW: Total Metals by nitric acid microwave digestion / ICP-AES									
Arsenic	7440-38-2	5	mg/kg		<5	<5	<5	<5	<5
Boron	7440-42-8	50	mg/kg		<50	<50	<50	<50	<50
Cadmium	7440-43-9	0.4	mg/kg		<0.4	<0.4	<0.4	<0.4	<0.4
Chromium	7440-47-3	2	mg/kg		<2	<2	<2	<2	<2
Copper	7440-50-8	5	mg/kg		<5	<5	<5	<5	<5
Lead	7439-92-1	5	mg/kg		<5	**9**	<5	<5	<5
Molybdenum	7439-98-7	2	mg/kg		<2	<2	<2	<2	<2
Nickel	7440-02-0	2	mg/kg		<2	<2	<2	<2	<2
Selenium	7782-49-2	5	mg/kg		<5	<5	<5	<5	<5
Zinc	7440-66-6	5	mg/kg		<5	<5	**6**	<5	<5

Analytical Results

Sub-Matrix: **FLY ASH** (Matrix: **SOIL**)

Compound	CAS Number	LOR	Unit	Client sample ID	20190129BA-01 BOTTOM ASH	20190130BA-01 BOTTOM ASH	20190131BA-01 BOTTOM ASH	20190201BA-01 BOTTOM ASH	20190202BA-01 BOTTOM ASH
				Client sampling date / time	29-Jan-2019 00:00	30-Jan-2019 00:00	31-Jan-2019 00:00	01-Feb-2019 00:00	02-Feb-2019 00:00
					ES1909166-031	ES1909166-032	ES1909166-033	ES1909166-034	ES1909166-035
					Result	Result	Result	Result	Result
EA055: Moisture Content (Dried @ 105-110°C)									
Moisture Content	----	0.1	%		**20.2**	**14.3**	**21.7**	**21.0**	**20.2**
EG005(ED093)T-MW: Total Metals by nitric acid microwave digestion / ICP-AES									
Arsenic	7440-38-2	5	mg/kg		<5	<5	<5	<5	<5
Boron	7440-42-8	50	mg/kg		<50	<50	<50	<50	<50
Cadmium	7440-43-9	0.4	mg/kg		**0.6**	<0.4	<0.4	<0.4	<0.4
Chromium	7440-47-3	2	mg/kg		<2	**2**	<2	**4**	<2
Copper	7440-50-8	5	mg/kg		<5	**8**	**6**	<5	<5
Lead	7439-92-1	5	mg/kg		<5	<5	<5	<5	<5
Molybdenum	7439-98-7	2	mg/kg		<2	<2	<2	**2**	<2
Nickel	7440-02-0	2	mg/kg		<2	**10**	<2	**10**	<2
Selenium	7782-49-2	5	mg/kg		<5	<5	<5	<5	<5
Zinc	7440-66-6	5	mg/kg		<5	<5	<5	<5	<5

Analytical Results

Sub-Matrix: **FLY ASH** (Matrix: **SOIL**)

Compound	CAS Number	LOR	Unit	Client sample ID	20190203BA-01 BOTTOM ASH	20190204BA-01 BOTTOM ASH	20190205BA-01 BOTTOM ASH	20190206BA-01 BOTTOM ASH	20190207BA-01 BOTTOM ASH
				Client sampling date / time	03-Feb-2019 00:00	04-Feb-2019 00:00	05-Feb-2019 00:00	06-Feb-2019 00:00	07-Feb-2019 00:00
					ES1909166-036	ES1909166-037	ES1909166-038	ES1909166-039	ES1909166-040
					Result	Result	Result	Result	Result
EA055: Moisture Content (Dried @ 105-110°C)									
Moisture Content	----	0.1	%		**22.1**	**19.5**	**21.3**	**23.9**	**23.7**
EG005(ED093)T-MW: Total Metals by nitric acid microwave digestion / ICP-AES									
Arsenic	7440-38-2	5	mg/kg		<5	<5	<5	<5	<5
Boron	7440-42-8	50	mg/kg		<50	<50	<50	<50	<50
Cadmium	7440-43-9	0.4	mg/kg		<0.4	<0.4	<0.4	<0.4	<0.4
Chromium	7440-47-3	2	mg/kg		<2	<2	**5**	<2	<2
Copper	7440-50-8	5	mg/kg		<5	<5	**10**	**8**	<5
Lead	7439-92-1	5	mg/kg		<5	<5	<5	<5	<5
Molybdenum	7439-98-7	2	mg/kg		<2	<2	**2**	<2	<2
Nickel	7440-02-0	2	mg/kg		<2	<2	**3**	<2	<2
Selenium	7782-49-2	5	mg/kg		<5	<5	<5	<5	<5
Zinc	7440-66-6	5	mg/kg		<5	<5	**5**	<5	**8**

Fly Ash Sampling Plan

Coal Ash Order (2014) Characterisation and Routine Sampling

Fly Ash Sampling Plan

Coal Ash Order (2014) Characterisation and Routine Sampling

Client: AGL Macquarie Pty Ltd

ABN: 18 167 859 494

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Quality Information

Document Fly Ash Sampling Plan

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Date 13-May-2019

Prepared by Ralph Brown

Reviewed by Brad Eismen

Revision History

Rev	Revision Date	Details	Authorised	
			Name/Position	Signature
A	08-May-2019	Draft - fly ash plan extracted from previous combined fly ash cenosphere sampling plan.	Chad Whitburn Compliance Services Team Leader	
0	13-May-2019	Final	Chad Whitburn Compliance Services Team Leader	

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1.0 Introduction

1.1 Background

As a part of operations at Bayswater and Liddell Power Stations, coal ash is produced on a continuous basis as part of the coal combustion process undertaken during the generation of electricity. Combustion within the boiler furnaces at the Power Stations produces two types of ash. Heavier course ash particles fall to the bottom of the boiler and are referred to as 'bottom ash'. Lighter fine ash particles remain suspended in the combustion flue gas and are referred to as 'fly ash'. In addition, Cenospheres are also formed during the combustion process. Cenospheres are light weight hollow ceramic microspheres that typically form part of the fly ash produced.

Some of the fly ash generated from Bayswater Power Station are supplied to a number of commercial operators (the Coal Ash Companies). The Coal Ash Companies then supply the fly ash to third parties for beneficial reuse as an engineering material (cementitious mixes).

As a generator of coal ash which is supplied to third parties for such uses, AGL Macquarie Pty Limited (AGL Macquarie) is required to comply with the *Coal Ash Order 2014* (Coal Ash Order) made under the *Protection of the Environment Operations (Waste) Regulation 2014.* The Coal Ash Order commenced on 24 November 2014.

K&L Gates on behalf of AGL Macquarie has requested AECOM to conduct run of plant fly ash sampling and analysis for the purposes of coal ash characterisation and ongoing routine sampling and analysis in accordance with the requirements of the Coal Ash Order.

It is noted that characterisation sampling, as generally described in this plan, occurred in January and February 2019 and followed an earlier draft coal ash sampling plan.

1.2 Objectives

The objectives of this sampling plan and the proposed works are to:

- Outline the required sampling and sample collection locations;
- Describe the procedures for sampling, sample preparation, sample storage and transport to the analytical laboratory and sample analysis, as well as the reporting requirements; and
- Document compliance with the requirements of the Coal Ash Order.

2.0 Fly Ash Characterisation Sampling Plan

2.1 Material to be sampled

The majority of fly ash generated at Bayswater Station is transported to the Ravensworth voids or the Bayswater Ash Dam for onsite disposal. However, a portion of run of plant fly ash is siloed at Bayswater Power Station in one of two silos located at the Ravensworth Fly Ash Plant, being Silo A and Silo B. Silos A and B are operated in turn as both a duty and a standby silo, with the duty silo changing over as required for maintenance. Fly ash from the duty silo (being either Silo A or Silo B) is loaded from an enclosed delivery system into sealed trucks for offsite use in cementitious mixes or combined with water for pumping to the onsite ash dam. The dry material is powdery with approximate nominal size of <0.2mm.

2.2 Purpose of sampling

As the fly ash from Silos A and B is used by the Coal Ash Companies as an engineering material and is generated as part of a continuous process it is a requirement of the Coal Ash Order to conduct a coal ash characterisation study. At least 20 fly ash composite samples will be collected and analysed over twenty days.

2.3 Lot size

For the purposes of the characterisation the sampling lot is considered to be a minimum of one truck load i.e. ~30 tonnes. Sampling will be conducted over a period of time that will meet the following two conditions:

- Sampling conducted over a minimum one hour time period per day; and
- At least 30 tonnes of fly ash is produced over the sampling period.

As per Clause 4.3.1 of the Coal Ash Order each composite sample must be taken from a batch not previously sampled for the purposes of characterisation. To meet this requirement characterisation samples will be collected on a daily basis for at least twenty days.

2.4 Sampling procedure

The techniques outlined in AS 1141.3.1 – 2012 are not directly applicable to sampling Bayswater Power Station fly ash, which is in an enclosed delivery system. However, the principles of collecting sampling increments and combining to form a composite sample will still apply. Several locations may be utilised to collect fly ash samples; however the offtake valve sampling system at Silo A or Silo B at the Bayswater Ash Plant are the preferred sampling points (with the silo to be sampled dependent on which of Silo A or Silo B is operating as the duty silo at the relevant time). Ash passing through this location represents ash from all generating units and is the source of ash for the truck loading plant. If the preferred location is not available then, in consultation with the site engineer, alternative sampling points may be used e.g. fly ash quad boxes below each generating unit. Alternative sampling locations must represent all site fly ash production (likely multiple locations).

- At least five sampling increments with minimum mass of 1kg (as per AS 1141.3.1 Sect 6.3 Table 1) will be collected from the offtake valve over a period of time that represents >30 tonnes of fly ash production and over a minimum one hour period. Each increment will be collected in a sealed plastic bag and labelled with date, time, location and sampler's name.
- The bagged and sealed sampling increments will be stored in a plastic bucket with sealable lid and labelled as above.

2.5 Records

A field sampling record will be kept to record the date and time of collection, plant fly ash production rate and the mass of each sampling increment and the corresponding lot number. An example Fly Ash field sheet is shown in **Appendix A**.

2.6 Sampling location

The fly ash sampling locations are at the Bayswater Power Station fly ash plant, Silo A and Silo B, and are identified in **Figures 2, 3** and **4**. Fly ash may not be available from this location due to plant maintenance or breakdowns. In this case, alternative locations may be sourced in consultation with site engineers.

Figure 1 Bayswater Power Station – Fly Ash Truck Loading Facility Location

Figure 2 Bayswater Power Station – Fly Ash Truck Loading Facility Silo A and Silo B

Figure 3 Bayswater Power Station – Silo A Fly Ash Sampling Point (a similar sampling point is located at Silo B)

2.7 Sample mixing and division

Sample increments will be weighed on site to confirm that the minimum increment mass has been achieved. Sample increments will be returned to AECOM Singleton for mixing and division and preparation for laboratory delivery. A clean concrete surface will be prepared for the mixing and division of samples by cone and quartering with a minimum composite sample mass of 5kg (as per AS 1141.3.1 – 2012 Sect 6.4.3). Further sample mixing and division may be performed to meet laboratory sample size requirements (as per AS 1141.3.1 – 2012 Appendix A). Samples divided out for specific testing will be referred to as sub-samples. The remaining sample will be stored in a sealable plastic bucket for three weeks.

The sealed laboratory samples (or sub-samples) will be despatched to ALS, Newcastle. AECOM chain of custody procedures will be followed.

2.8 Reporting

Following the receipt of final laboratory reports, a report in accordance with Clause 4.10 of the Coal As Order will be developed and include:

- A copy of this sampling plan;
- A compliance statement including:
  - A comparison of average analyte results to the concentrations in Table 1 - Column 2 of the Coal Ash Order.
  - A comparison of individual analyte results to the concentrations in Table 1 - Column 4 of the Coal Ash Order; and

- A copy of the laboratory reports.

2.9 Characterisation analysis requirements

As per the Coal Ash Order, fly ash characterisation composite samples will be analysed at ALS NATA accredited laboratory for the following analytes:

- Mercury
- Cadmium
- Lead
- Arsenic
- Boron
- Chromium
- Copper
- Molybdenum
- Nickel
- Selenium
- Zinc
- Electrical Conductivity

Testing procedures will be in accordance with or equivalent to those specified in Clauses 4.7 and 4.8 of the Coal Ash Order (sections attached for reference in **Appendix B**).

Characterisation fly ash composite sample analysis results may also be used for ongoing routine monitoring results.

2.10 Laboratory Quality Assurance and Quality Control

ALS NATA accredited laboratory provides Laboratory Control Samples (LCS), Method Blanks (MB), Matrix Spikes (MS), Laboratory Duplicates (Dups) and Surrogates (where applicable), at frequencies at or above the NEPC (2013) guidelines (ASC NEPM).

2.11 Ongoing Coal Ash Characterisation

The Coal Ash Order requires that where coal ash is produced as part of a continuous process and is used for engineering purposes characterisation must be conducted again during the two year period following commencement of the continuous process. The samples collected for characterisation purposes may also be treated as a sample collected and tested for the purpose of routine sampling as contemplated by clause 4.3.2 of the Coal Ash Order.

3.0 Routine Coal Ash Sampling Plan

3.1 Material to be sampled

As noted at section 2.1, the majority of fly ash generated at Bayswater Station is transported to the Ravensworth voids or the Bayswater Ash Dam for onsite disposal. However, a portion of run of plant fly ash is siloed at Bayswater Power Station in one of two silos located at the Ravensworth Fly Ash Plant, being Silo A and Silo B. Silos A and B are operated in turn as both a duty and a standby silo, with the duty silo changing over as required for maintenance. Fly ash from the duty silo (being either Silo A or Silo B) is loaded from an enclosed delivery system into sealed trucks for offsite use in cementitious mixes or combined with water for pumping to the onsite ash dam. The dry material is powdery with approximate nominal size of <0.2mm.

3.2 Purpose of sampling

As fly ash from Silos A and B is used as an engineering material by the Coal Ash Companies and is generated as part of a continuous process, it is a requirement of the Coal Ash Order to conduct ongoing routine monitoring.

3.3 Estimated production and sampling requirements

As fly ash production at Bayswater Power Station is considered to be a continuous process and the material is used for engineering purposes the following section of the Coal Ash Order is relevant to establishing the routine sampling requirements:

- Clause 4.3.2 (engineering application – generation by continuous process)

Estimated production tonnages and relevant sampling frequencies as per the requirements of the Coal Ash Order are presented in **Table 1.**

Table 1 Bayswater Fly Ash Production and Sampling Requirements

Application	Approximate Tonnage per Annum	Minimum Routine Sampling
Engineering	200,000 t	Five composite samples per three months

The five composite samples will be collected over 5 different sampling events in accordance with the sampling procedure specified in 3.1.5 below over the three month period (at intervals of approximately 18 days).

3.4 Lot size

For the purposes of routine sampling a lot is considered to be a minimum of one truck load i.e. ~30 tonnes and composite sampling will be conducted over a period of time that represents production greater than 30 tonnes.

3.5 Sampling procedure

Sampling techniques outlined in AS 1141.3.1 – 2012 are not directly applicable to the Bayswater Power Station fly ash situation which is an enclosed delivery system. However, the principles of collecting sampling increments and combining to form a composite sample will still apply. Several locations may be utilised to take fly ash samples, however, the offtake valve sampling system at either Silo A or Silo B at the Bayswater Ash Plant is the preferred sampling point (with the silo to be sampled depending on which of Silo A or Silo B is operating as the duty silo at the relevant time). Ash passing through these Silos represents ash from all generating units and are the sources of ash for the truck loading plants. If either of the preferred locations are not available then, in consultation with the site engineer, alternative sampling points may be used e.g. fly ash quad boxes below each generating unit. Alternative sampling locations must represent all site fly ash production (likely multiple locations).

The routine fly ash sampling procedure will be as follows:

- At least five sampling increments with minimum mass of 1kg (as per AS 1141.3.1 Sect 6.3 Table 1) will be collected from the offtake valve over a period of time that represents >30 tonnes of fly ash production and over a minimum one hour period;
- Each increment will be collected in a sealed plastic bag and labelled with the date and time;
- The bagged and sealed sampling increments will be stored in a plastic bucket with sealable lid and labelled as above; and
- Each of the sampling increments will be combined to form a single composite sample for analysis.

3.6 Records

A field sampling record will be kept to record the date and time of collection, plant fly ash production rate and the mass of each sampling increment and the corresponding lot number. An example Fly Ash field sheet is shown in **Appendix A**.

3.7 Sampling location

The fly ash sampling locations are at the Bayswater Power Station fly ash plant, Silos A and B, and are identified in **Figures 6, 7** and **8**. Fly ash may not be available from this location due to plant maintenance or breakdowns. In this case, alternative locations may be sourced in consultation with site engineers. Alternative sampling locations must represent all station fly ash production and may require multiple sampling locations.

Figure 4 Bayswater Power Station – Fly Ash Truck Loading Facility Location

Figure 5 Bayswater Power Station – Fly Ash Truck Loading Facility Silos A and B

Figure 6 Bayswater Power Station - Silo A Sampling Point (similar sample point at Silo B)

3.7.1 Sample mixing and division

Sample increments will be weighed on site to confirm that the minimum increment mass has been achieved. Sample increments will be returned to AECOM Singleton for mixing and division and preparation for laboratory delivery. A clean surface will be prepared for the mixing and division of samples by cone and quartering with a minimum composite sample mass of 5kg (as per AS 1141.3.1 – 2012 Sect 6.4.3). Further sample mixing and division may be performed to meet laboratory sample size requirements (as per AS 1141.3.1 – 2012 Appendix A). Samples divided out for specific testing will be referred to as sub-samples. The remaining sample will be stored in a sealable plastic bucket for three weeks.

The sealed laboratory samples (or sub-samples) will be despatched to ALS NATA accredited laboratory, Newcastle. AECOM chain of custody procedures will be followed.

3.8 Routine Monitoring Analysis Requirements

Routine fly ash composite samples will be tested for the analytes specified in Table 1, Column 3 of the Coal Ash Order. Samples will be analysed at ALS NATA accredited laboratory for the following analytes:

- Cadmium
- Lead
- Chromium
- Nickel
- Selenium
- Zinc
- Electrical Conductivity

Routine fly ash composite sample analysis results may be used for ongoing characterisation. In this case, routine monitoring composite samples that will form part of the characterisation will be analysed for the full suite of analysis as specified in Table 1, Column 1 of the Coal Ash Order (see Section 2.4). Testing procedures will be in accordance with or equivalent to those specified in Clauses 4.7 and 4.8 of the Coal Ash Order (sections attached for reference in **Appendix B**).

3.9 Laboratory Quality Assurance and Quality Control

ALS NATA accredited laboratory provides Laboratory Control Samples (LCS), Method Blanks (MB), Matrix Spikes (MS), Laboratory Duplicates (Dups) and Surrogates (where applicable), at frequencies at or above the ASC NEPM.

Also, one inter-laboratory and one intra-laboratory field duplicate fly ash sample will be taken once per three month period and analysed for a full suite of analysis (as per Section 3.8). The inter-laboratory duplicate will be sent to another NATA accredited laboratory for analysis.

3.10 Reporting

Following the receipt of final laboratory reports, a report in accordance with Clause 4.10 of the Coal As Order will be developed and include:

- A copy of this sampling plan;
- The estimated quantities of fly ash represented by the samples collected;
- A compliance statement including:
    - A comparison of average analyte results to the concentrations in Table 1 - Column 3 of the Coal Ash Order.
    - A comparison of individual analyte results to the concentrations in Table 1 - Column 4 of the Coal Ash Order; and
- A copy of the laboratory reports.

AGL Macquarie will be notified as soon as practicable after the receipt of non-complying results so that AGL Macquarie can comply with clauses 4.5 and 4.6 of the Coal Ash Order.

Additional record keeping will include a list of the name and address of each person/company to whom coal ash was supplied and the quantity supplied (responsibility of AGL Macquarie).

4.0 Compliance with Clauses 4.5 and 4.6 of the Coal Ash Order

The following measures will be taken to ensure compliance with Clauses 4.5 and 4.6 of the Coal Ash Order:

- AGL Macquarie will not supply fly ash to the Coal Ash Companies from the time on which samples are collected in each sampling event until receiving confirmation that the laboratory results comply with the limits in Table 1 of the Coal Ash Order. Rather, all coal ash generated in the period between the samples being collected and confirmation being obtained that the laboratory results comply with the limits in Table 1 of the Coal Ash Order will be either stored pending confirmation or diverted to the onsite ash dams and ash voids.
- Routine sampling will be conducted over the 3 month period as shown in **Figure 7** below to provide representative concentrations over the entire 3 month period:
  - Composite samples will be collected over the 3 month production period at approximately 18 day intervals.
  - Each composite sample will be made up of 5 sub-samples collected over the one hour period as described in Sections 2.4 and 3.5.
  - Samples will be submitted to the laboratory as soon as practicable.
  - Please refer to the **Figure 7** below for details of proposed indicative timing for the 5 sampling events for routine sampling of fly ash over the three month period. It is noted that the 18 day period between sampling is approximate only.
- If any given result does not comply with the limits in Table 1 of the Coal Ash Order the following will be conducted:
  - The results will be reviewed to investigate the cause of the apparent exceedance of the limits specified in Table 1 of the Coal Ash Order. If, as part of this investigation, a laboratory error is suspected, the laboratory will be contacted, asked to confirm the results and rerun the sample with the exceedance. In addition, two composite samples of the material in question will be collected and analysed on a rapid turnaround to confirm the reliability of the results.
  - If the analysing laboratory confirms that an error was responsible for the non-complying result and repeat analysis results comply with the limits in Table 1 of the Coal Ash Order, coal ash supplies will resume to the Coal Ash Companies. Note that the highest of all repeat analysis results, confirmed as valid by the laboratory, will be taken as the final result for each analyte retested.
  - If the laboratory confirms its original result or additional composite analysis results do not comply with the limits in Table 1 of the Coal Ash Order then the relevant coal ash will continue to be diverted to the onsite ash dams and ash voids and an investigation into coal ash quality will be carried out. The investigation will include, but not be limited to, changes to coal supply or quality; adherence to the sampling plan during sample collection and preparation; and laboratory error.
  - In order to ensure compliance with clauses 4.5 and 4.6 of the Coal Ash Order, supplies to the Coal Ash Companies will be resumed only after obtaining analysis results which comply with the limits in Table 1 of the Coal Ash Order from a further two composite samples.

  AGL Macquarie must also notify the EPA within 7 days of becoming aware that it has not complied with any requirement in clause 4.1 to 4.8 of the Coal Ash Order.

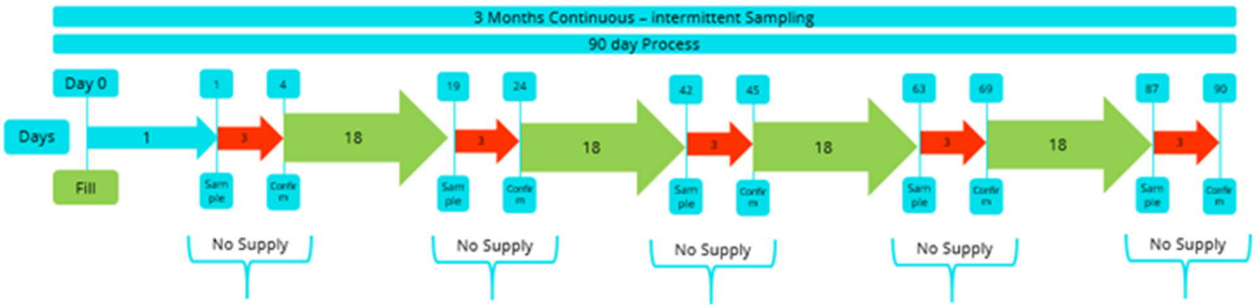

Figure 7 Indicative routine fly ash sampling flow chart

5.0 Safety

The following hazards and controls, while not being limited to, should be considered when developing a safe work method statement (SWMS) for fly ash sampling:

Table 2 Fly Ash Sampling - Hazards and Controls

Hazard	Controls
Mobile plant	Notify all parties in the work area of your intention to sample
	Stay with contractor escort
	Park in designated area
Stairs	Three points of contact
	Eyes on path
Dust	PPE – P2 respirator
Noise	PPE – Hearing protection

6.0 References

National Environmental Protection Council (NEPC), 2013. National Environment Protection (Assessment of Site Contamination) Measure 1999, as amended in 2013.

NSW EPA, 2014. Resource Recovery Order under Part 9, Clause 93 of the Protection of the Environment Operations (Waste) Regulation 2014, the coal ash order 2014.

SAI Global, 2012. AS 1141.3.1—2012, Methods for sampling and testing aggregates, Method 3.1: Sampling—Aggregates.

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Appendix A

Sampling Records

Appendix A Sampling Records

AECOM

Fly Ash Sampling Field Sheet

Client: AGL Project No.: 60580964 Sampled by:

Date Collected: Collection Start Time: Collection Stop Time:

Sampling Lot Number	Date	Time	Increment Mass (kg)	Comments
				Plant production rate (tph):
				Plant production rate (tph):
				Plant production rate (tph):
				Plant production rate (tph):
				Plant production rate (tph):
				Plant production rate (tph):
				Plant production rate (tph):

Initials…………………………………………

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Appendix B

Test Methods

Appendix B Test Methods

4.5.1. The concentration or other value of that attribute of any sample collected and tested as part of the characterisation or the routine or one-off sampling of the coal ash exceeds the absolute maximum concentration or other value listed in Column 4 of Table 1, or

4.5.2. The average concentration or other value of that attribute from the characterisation or one-off sampling of the coal ash (based on the arithmetic mean) exceeds the maximum average concentration or other value listed in Column 2 of Table 1, or

4.5.3. The average concentration or other value of that attribute from the routine sampling of the coal ash (based on the arithmetic mean) exceeds the maximum average concentration or other value listed in Column 3 of Table 1.

4.6. The absolute maximum concentration or other value of that attribute in any coal ash supplied under this order must not exceed the absolute maximum concentration or other value listed in Column 4 of Table 1.

Table 1

Column 1	Column 2	Column 3	Column 4
Chemicals and other attributes	**Maximum average concentration for characterisation** (mg/kg 'dry weight' unless otherwise specified)	**Maximum average concentration for routine testing** (mg/kg 'dry weight' unless otherwise specified)	**Absolute maximum concentration** (mg/kg 'dry weight' unless otherwise specified)
1. Mercury	0.5	Not required	1
2. Cadmium	0.5	0.5	1
3. Lead	25	25	50
4. Arsenic	10	Not required	20
5. Boron	75	Not required	150 for engineering uses 60 for soil amendment
6. Chromium (total)	25	25	50
7. Copper	20	Not required	40
8. Molybdenum	10	Not required	20
9. Nickel	25	25	50
10. Selenium	10	10	20
11. Zinc	35	35	70
12. Electrical Conductivity[1]	NA	NA	NA for engineering uses 4dS/m for soil amendment
13. pH* in non-cementitious mixes[2]	7 to 12.5	7 to 12.5	6 to 13
14. pH in cementitious mixes	NA	NA	NA

[1]Note: while thresholds are not provided for electrical conductivity this must be tested and a record kept of the results.

[2]Note: The ranges given for pH are for the minimum and maximum acceptable pH values in the coal ash.

Test methods

4.7. The generator must ensure that any testing of samples required by this order is undertaken by analytical laboratories accredited by the National Association of Testing Authorities (NATA), or equivalent.

4.8. The generator must ensure that the chemicals and other attributes (listed in Column 1 of Table 1) in the coal ash it supplies are tested in accordance with the test methods specified below or other equivalent analytical methods. Where an equivalent analytical method is used the detection limit must be equal to or less than that nominated for the given method below.

4.8.1. Test method for measuring the mercury concentration:

4.8.1.1 Analysis using USEPA SW-846 Method 7471B Mercury in solid or semisolid waste (manual cold vapour technique), or an equivalent analytical method with a detection limit < 20% of the stated maximum average concentration in Table 1, Column 2 (i.e. < 0.1 mg/kg dry weight).

4.8.1.2 Report as mg/kg dry weight.

4.8.2. Test methods for measuring chemicals 2 - 11:

4.8.2.1 Sample preparation by digesting using USEPA SW-846 Method 3051A Microwave assisted acid digestion of sediments, sludges, soils, and oils.

4.8.2.2 Analysis using USEPA SW-846 Method 6010C Inductively coupled plasma - atomic emission spectrometry, or an equivalent analytical method with a detection limit < 10% of stated maximum average concentration in Table 1, Column 2 (i.e. 2.5 mg/kg dry weight for lead).

4.8.2.3 Report as mg/kg dry weight.

4.8.3. Test methods for measuring the electrical conductivity and pH:

4.8.3.1 Sample preparation by mixing 1 part coal ash with 5 parts distilled water.

4.8.3.2 Analysis using Method 103 (pH) and 104 (Electrical Conductivity) in Schedule B (3): Guideline on Laboratory Analysis of Potentially Contaminated Soils, National Environment Protection (Assessment of Site Contamination) Measure 1999 (or an equivalent analytical method).

4.8.3.3 Report electrical conductivity in deciSiemens per metre (dS/m).

4.8.4. Test method for measuring boron in coal ash for land application as a soil amendment:

4.8.4.1 Water soluble boron using a calcium chloride extractable method 12C1 or 12C2 in Rayment, G.E. and Lyons D.J. 2011 Soil Chemical Methods - Australasia, CSIRO Publishing (or an equivalent analytical method with a detection limit for water soluble boron <10% of the stated absolute maximum).

4.8.4.2 Report as mg/kg dry weight.

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31 May 2019

Commercial-in-Confidence

Kirstie Richards
Partner
K&L Gates on behalf of AGL Macquarie
Level 31, 1 O'Connell Street
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Dear Kirstie

PRIVILEGED AND CONFIDENTIAL Bayswater Power Station - Bottom Ash Characterisation Report

1.0 Introduction

AGL Macquarie Pty Limited (AGL Macquarie) has requested AECOM Australia Pty Ltd (AECOM) to conduct run of plant bottom ash sampling and analysis for the purposes of coal ash characterisation in accordance with the requirements of the Coal Ash Order 2014 (Coal Ash Order) made under the Protection of the Environment Operations (Waste) Regulation 2014. The bottom ash is to be beneficially reused as an engineering material (cementitious and non-cementitious mixes) only. This characterisation report does not cover any other potential beneficial reuse of the bottom ash, including as a soil amendment for the growing of vegetation.

Characterisation sampling occurred in January/February 2019.

2.0 Objectives

The objectives of the sampling plan and the proposed works were to:

- Outline the required sampling and sample collection locations;
- Describe the procedures for sampling, sample preparation, sample storage and transport to the analytical laboratory and sample analysis, as well as the reporting requirements;
- Carry out sampling analysis as per the sampling plan for the purposes of coal ash characterisation; and
- Document compliance with the requirements of the Coal Ash Order.

3.0 Sample Collection

Characterisation stockpiles were formed from fresh bottom ash material on a daily basis for the purposes of sampling for the characterisation program. After sampling, the material was removed to allow room for a fresh, discreet stockpile to be formed. Sampling from the characterisation stockpiles was conducted on a daily basis from 19 January 2019 to 7 February 2019 (resulting in a total of 20 composite samples) in accordance with AS 1141.3.1 – 2012 and the following site specific requirements:

- At least five sampling increments with minimum mass of 3kg (as per AS 1141.3.1 Sect 6.3

  Table 1) were collected from the perimeter of the stockpile to form each composite sample.
- For each sampling increment surface material to a depth of > 200mm was removed. A sampling shield was inserted above the sampling area to prevent loose material falling into the sampling area. Sample increments were taken at intervals up the stockpile face to account for the effects of layering in the stockpile.
- The sampling shovel was square edged (as per AS 1141.3.1 – 2012 Sect 4.3) with sides sufficiently high to prevent loss of material from the sides.
- Increments were collected in plastic pales with sealable lids.
- All of the sampling increments were combined to form a single composite sample with minimum mass of 15kg for analysis.

4.0 Characterisation Analysis Results

Bottom ash characterisation composite samples were analysed at ALS NATA accredited laboratory. Average and maximum analyte results are presented in **Table 1**. Testing procedures were in accordance with or equivalent to those specified in Clauses 4.7 and 4.8 of the Coal Ash Order. A results summary (**Table 2**) and certificates of analysis have been attached.

Table 1 Characterisation Sample Analysis Results and Compliance with Limits in Columns 2 and 4 of Table 1 to the Coal Ash Order

Column 1 of Table 1 of the Coal Ash Order	Column 2 of Table 1 of the Coal Ash Order	Column 4 of Table 1 of the Coal Ash Order	Average[2] Characterisation Sample Analyte Concentration (mg/kg)	Absolute Maximum Sample Analyte Concentration (mg/kg)	Average Characterisation Sample Analyte Compliance (Yes / No)	Absolute Maximum Concentration Compliance (Yes/No)
Analyte	**Maximum Average Concentration for Characterisation (mg/kg)**	**Absolute Maximum Concentration (mg/kg)**				
Arsenic	*10*	*20*	<5	<5	Yes	Yes
Boron	*75*	150 (engineering uses)	<50	<50	Yes	Yes
Cadmium	*0.5*	*1*	0.4	0.6	Yes	Yes
Chromium	*25*	*50*	2.3	5	Yes	Yes
Copper	*20*	*40*	5.9	10	Yes	Yes
Lead	*25*	*50*	5.2	9	Yes	Yes
Molybdenum	*10*	*20*	2.0	2	Yes	Yes
Nickel	*25*	*50*	2.9	10	Yes	Yes
Selenium	*10*	*20*	<5	<5	Yes	Yes
Zinc	*35*	*70*	5.2	8	Yes	Yes
Mercury	*0.5*	*1*	0.02	0.17	Yes	Yes
Electrical Conductivity[1]	*NA*	NA (engineering uses)	294 µS/cm	321 µS/cm	NA	NA
pH in non-cementitious mixes (pH units)	*7 to 12.5*	*6 to 13*	NA	Max pH – 9.2 Min pH - 8.7	Yes	Yes

[1]Note: while thresholds are not provided for electrical conductivity this must be tested and a record kept of the results.

[2] For the purposes of calculating the average analyte concentration, results below the Limit of Reporting (LOR) have been evaluated at the respective LORs. If all results were below the LOR for a particular analyte the <LOR result has been presented as the average.

5.0 Compliance

The average analyte concentrations of the twenty characterisation bottom ash samples collected at Bayswater Power Station from 19 January 2019 to 7 February 2019 were below the maximum average concentrations as per Table 1, Column 2 of the Coal Ash Order. Individual analyte results from all bottom ash characterisation samples were below the absolute maximum concentrations for all analytes as per Table 1 Column 4 of the Coal Ash Order. As such the results of the bottom ash characterisation testing program comply with the requirements of the Coal Ash Order for beneficial reuse as an engineering material (cementitious and non-cementitious mixes).

Yours faithfully

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encl: Analysis Results Summary
Certificates of Analysis
Sampling Plan
cc: Morgana Gidley-Baird - AGL Macquarie
Summer Steward - AGL Macquarie

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Table 2 Bottom Ash Characterisation Analysis Results Summary

Analyte	19-Jan-19	20-Jan-19	21-Jan-19	22-Jan-19	23-Jan-19	24-Jan-19	25-Jan-19	26-Jan-19	27-Jan-19	28-Jan-19
Arsenic (mg/kg)	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5
Boron (mg/kg)	<50	<50	<50	<50	<50	<50	<50	<50	<50	<50
Cadmium (mg/kg)	<0.4	<0.4	<0.4	<0.4	<0.4	<0.4	<0.4	<0.4	<0.4	<0.4
Chromium (mg/kg)	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2
Copper (mg/kg)	8	7	<5	<5	<5	<5	<5	<5	<5	<5
Lead (mg/kg)	<5	<5	<5	<5	<5	<5	9	<5	<5	<5
Molybdenum (mg/kg)	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2
Nickel (mg/kg)	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2
Selenium (mg/kg)	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5
Zinc (mg/kg)	<5	<5	<5	<5	<5	<5	<5	6	<5	<5
Mercury (mg/kg)	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	0.07	<0.01	<0.01	<0.01
Electrical Conductivity (µS/cm)	302	312	265	247	313	284	289	265	109	280
pH (pH units)	8.8	8.8	8.9	9.0	8.7	9.1	9.1	9.1	9.2	9.2
Analyte	**29-Jan-19**	**30-Jan-19**	**31-Jan-19**	**01-Feb-19**	**02-Feb-19**	**03-Feb-19**	**04-Feb-19**	**05-Feb-19**	**06-Feb-19**	**07-Feb-19**
Arsenic (mg/kg)	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5
Boron (mg/kg)	<50	<50	<50	<50	<50	<50	<50	<50	<50	<50
Cadmium (mg/kg)	0.6	<0.4	<0.4	<0.4	<0.4	<0.4	<0.4	<0.4	<0.4	<0.4
Chromium (mg/kg)	<2	2	<2	4	<2	<2	<2	5	<2	<2
Copper (mg/kg)	<5	8	6	<5	<5	<5	<5	10	8	<5
Lead (mg/kg)	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5
Molybdenum (mg/kg)	<2	<2	<2	2	<2	<2	<2	2	<2	<2
Nickel (mg/kg)	<2	10	<2	10	<2	<2	<2	3	<2	<2
Selenium (mg/kg)	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5
Zinc (mg/kg)	<5	<5	<5	<5	<5	<5	<5	5	<5	8
Mercury (mg/kg)	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	0.17
Electrical Conductivity (µS/cm)	226	220	216	228	217	232	229	208	321	294
pH (pH units)	9.0	9.0	9.0	8.9	9.1	8.9	9.2	9.0	9.2	9.1

ALS Environmental

CERTIFICATE OF ANALYSIS

Work Order	: **ES1909166**	Page	: 1 of 10
Client	: **AECOM Australia Pty Ltd**	Laboratory	: Environmental Division Sydney
Contact	: MS SARAH BROWN	Contact	: Brenda Hong
Address	: PO BOX 3148 SINGLETON NSW, AUSTRALIA 2330	Address	: 277-289 Woodpark Road Smithfield NSW Australia 2164
Telephone	: +61 02 6575 9000	Telephone	: +61 2 8784 8555
Project	: 60580964 PRIVILEGED AND CONFIDENTIAL -60580964 AGL A03847	Date Samples Received	: 26-Mar-2019 16:51
Order number	: 74645	Date Analysis Commenced	: 27-Mar-2019
C-O-C number	: A0384	Issue Date	: 28-Mar-2019 20:22
Sampler	: ----		
Site	: ----		
Quote number	: EN/004/16		
No. of samples received	: 40		
No. of samples analysed	: 40		

Accreditation No. 825
Accredited for compliance with
ISO/IEC 17025 - Testing

This report supersedes any previous report(s) with this reference. Results apply to the sample(s) as submitted. This document shall not be reproduced, except in full.

This Certificate of Analysis contains the following information:

- General Comments
- Analytical Results

Additional information pertinent to this report will be found in the following separate attachments: Quality Control Report, QA/QC Compliance Assessment to assist with Quality Review and Sample Receipt Notification.

Signatories

This document has been electronically signed by the authorized signatories below. Electronic signing is carried out in compliance with procedures specified in 21 CFR Part 11.

Signatories	*Position*	*Accreditation Category*
Ivan Taylor	Analyst	Sydney Inorganics, Smithfield, NSW

General Comments

The analytical procedures used by the Environmental Division have been developed from established internationally recognized procedures such as those published by the USEPA, APHA, AS and NEPM. In house developed procedures are employed in the absence of documented standards or by client request.

Where moisture determination has been performed, results are reported on a dry weight basis.

Where a reported less than (<) result is higher than the LOR, this may be due to primary sample extract/digestate dilution and/or insufficient sample for analysis.

Where the LOR of a reported result differs from standard LOR, this may be due to high moisture content, insufficient sample (reduced weight employed) or matrix interference.

When sampling time information is not provided by the client, sampling dates are shown without a time component. In these instances, the time component has been assumed by the laboratory for processing purposes.

Where a result is required to meet compliance limits the associated uncertainty must be considered. Refer to the ALS Contact for details.

Key : CAS Number = CAS registry number from database maintained by Chemical Abstracts Services. The Chemical Abstracts Service is a division of the American Chemical Society.
LOR = Limit of reporting
^ = This result is computed from individual analyte detections at or above the level of reporting
ø = ALS is not NATA accredited for these tests.
~ = Indicates an estimated value.

Analytical Results

Sub-Matrix: FLY ASH (Matrix: SOIL)				Client sample ID	20190119FA-01 FLY ASH	20190120FA-01 FLY ASH	20190121FA-01 FLY ASH	20190122FA-01 FLY ASH	20190123FA-01 FLY ASH
				Client sampling date / time	19-Jan-2019 00:00	20-Jan-2019 00:00	21-Jan-2019 00:00	22-Jan-2019 00:00	23-Jan-2019 00:00
Compound	CAS Number	LOR	Unit		ES1909166-001	ES1909166-002	ES1909166-003	ES1909166-004	ES1909166-005
					Result	Result	Result	Result	Result
EA055: Moisture Content (Dried @ 105-110°C)									
Moisture Content	----	0.1	%		**0.1**	<0.1	<0.1	**0.1**	<0.1
EG005(ED093)T-MW: Total Metals by nitric acid microwave digestion / ICP-AES									
Arsenic	7440-38-2	5	mg/kg		<5	<5	<5	<5	<5
Boron	7440-42-8	50	mg/kg		<50	<50	<50	<50	<50
Cadmium	7440-43-9	0.4	mg/kg		<0.4	<0.4	<0.4	<0.4	<0.4
Chromium	7440-47-3	2	mg/kg		**5**	**5**	**5**	**5**	**5**
Copper	7440-50-8	5	mg/kg		<5	<5	<5	<5	<5
Lead	7439-92-1	5	mg/kg		<5	**5**	<5	<5	<5
Molybdenum	7439-98-7	2	mg/kg		**5**	**4**	**4**	**4**	**4**
Nickel	7440-02-0	2	mg/kg		**2**	**3**	**2**	**3**	**4**
Selenium	7782-49-2	5	mg/kg		<5	<5	<5	<5	<5
Zinc	7440-66-6	5	mg/kg		**11**	**14**	**11**	**14**	**13**

Analytical Results

Sub-Matrix: **FLY ASH** (Matrix: **SOIL**)

Compound	CAS Number	LOR	Unit	Client sample ID	20190124FA-01 FLY ASH	20190125FA-01 FLY ASH	20190126FA-01 FLY ASH	20190127FA-01 FLY ASH	20190128FA-01 FLY ASH
				Client sampling date / time	24-Jan-2019 00:00	25-Jan-2019 00:00	26-Jan-2019 00:00	27-Jan-2019 00:00	28-Jan-2019 00:00
					ES1909166-006	ES1909166-007	ES1909166-008	ES1909166-009	ES1909166-010
					Result	Result	Result	Result	Result
EA055: Moisture Content (Dried @ 105-110°C)									
Moisture Content	----	0.1	%		**0.2**	<0.1	<0.1	<0.1	<0.1
EG005(ED093)T-MW: Total Metals by nitric acid microwave digestion / ICP-AES									
Arsenic	7440-38-2	5	mg/kg		**6**	<5	<5	<5	**5**
Boron	7440-42-8	50	mg/kg		<50	<50	<50	<50	<50
Cadmium	7440-43-9	0.4	mg/kg		<0.4	<0.4	<0.4	<0.4	<0.4
Chromium	7440-47-3	2	mg/kg		**6**	**3**	**3**	**6**	**6**
Copper	7440-50-8	5	mg/kg		**6**	<5	<5	<5	<5
Lead	7439-92-1	5	mg/kg		**6**	<5	<5	**6**	<5
Molybdenum	7439-98-7	2	mg/kg		**4**	**2**	<2	**4**	**5**
Nickel	7440-02-0	2	mg/kg		**4**	<2	<2	**4**	**4**
Selenium	7782-49-2	5	mg/kg		<5	<5	<5	<5	<5
Zinc	7440-66-6	5	mg/kg		**16**	<5	<5	**15**	**14**

Analytical Results

Sub-Matrix: FLY ASH (Matrix: SOIL)				Client sample ID	20190129FA-01 FLY ASH	20190130FA-01 FLY ASH	20190131FA-01 FLY ASH	20190201FA-01 FLY ASH	20190202FA-01 FLY ASH
				Client sampling date / time	29-Jan-2019 00:00	30-Jan-2019 00:00	31-Jan-2019 00:00	01-Feb-2019 00:00	02-Feb-2019 00:00
Compound	CAS Number	LOR	Unit		ES1909166-011	ES1909166-012	ES1909166-013	ES1909166-014	ES1909166-015
					Result	Result	Result	Result	Result
EA055: Moisture Content (Dried @ 105-110°C)									
Moisture Content	----	0.1	%		<0.1	<0.1	**0.2**	**0.3**	<0.1
EG005(ED093)T-MW: Total Metals by nitric acid microwave digestion / ICP-AES									
Arsenic	7440-38-2	5	mg/kg		**5**	<5	<5	<5	<5
Boron	7440-42-8	50	mg/kg		<50	<50	<50	<50	<50
Cadmium	7440-43-9	0.4	mg/kg		<0.4	<0.4	<0.4	<0.4	<0.4
Chromium	7440-47-3	2	mg/kg		**6**	**4**	**7**	**6**	**5**
Copper	7440-50-8	5	mg/kg		<5	<5	**5**	**5**	<5
Lead	7439-92-1	5	mg/kg		<5	<5	**6**	**6**	<5
Molybdenum	7439-98-7	2	mg/kg		**4**	**4**	**4**	**4**	**4**
Nickel	7440-02-0	2	mg/kg		**3**	<2	**4**	**4**	**2**
Selenium	7782-49-2	5	mg/kg		<5	<5	<5	<5	<5
Zinc	7440-66-6	5	mg/kg		**13**	**9**	**15**	**16**	**13**

Analytical Results

Sub-Matrix: **FLY ASH**
(Matrix: **SOIL**)

Compound	CAS Number	LOR	Unit	Client sample ID	20190203FA-01 FLY ASH	20190204FA-01 FLY ASH	20190205FA-01 FLY ASH	20190206FA-01 FLY ASH	20190207FA-01 FLY ASH
				Client sampling date / time	03-Feb-2019 00:00	04-Feb-2019 00:00	05-Feb-2019 00:00	06-Feb-2019 00:00	07-Feb-2019 00:00
					ES1909166-016	ES1909166-017	ES1909166-018	ES1909166-019	ES1909166-020
					Result	Result	Result	Result	Result
EA055: Moisture Content (Dried @ 105-110°C)									
Moisture Content	----	0.1	%		<0.1	<0.1	<0.1	<0.1	<0.1
EG005(ED093)T-MW: Total Metals by nitric acid microwave digestion / ICP-AES									
Arsenic	7440-38-2	5	mg/kg		**6**	**5**	<5	<5	<5
Boron	7440-42-8	50	mg/kg		<50	<50	<50	<50	<50
Cadmium	7440-43-9	0.4	mg/kg		<0.4	<0.4	<0.4	<0.4	<0.4
Chromium	7440-47-3	2	mg/kg		**4**	**5**	**2**	**4**	**5**
Copper	7440-50-8	5	mg/kg		<5	<5	<5	<5	<5
Lead	7439-92-1	5	mg/kg		<5	<5	<5	<5	<5
Molybdenum	7439-98-7	2	mg/kg		**4**	**4**	**4**	**4**	**4**
Nickel	7440-02-0	2	mg/kg		<2	<2	<2	<2	<2
Selenium	7782-49-2	5	mg/kg		<5	<5	<5	<5	<5
Zinc	7440-66-6	5	mg/kg		<5	**7**	<5	<5	**8**

Analytical Results

Sub-Matrix: **FLY ASH** (Matrix: **SOIL**)

Compound	CAS Number	LOR	Unit	Client sample ID	20190119BA-01 BOTTOM ASH	20190120BA-01 BOTTOM ASH	20190121BA-01 BOTTOM ASH	20190122BA-01 BOTTOM ASH	20190123BA-01 BOTTOM ASH
				Client sampling date / time	19-Jan-2019 00:00	20-Jan-2019 00:00	21-Jan-2019 00:00	22-Jan-2019 00:00	23-Jan-2019 00:00
					ES1909166-021	ES1909166-022	ES1909166-023	ES1909166-024	ES1909166-025
					Result	Result	Result	Result	Result
EA055: Moisture Content (Dried @ 105-110°C)									
Moisture Content	----	0.1	%		**27.6**	**27.2**	**25.3**	**25.2**	**23.5**
EG005(ED093)T-MW: Total Metals by nitric acid microwave digestion / ICP-AES									
Arsenic	7440-38-2	5	mg/kg		<5	<5	<5	<5	<5
Boron	7440-42-8	50	mg/kg		<50	<50	<50	<50	<50
Cadmium	7440-43-9	0.4	mg/kg		<0.4	<0.4	<0.4	<0.4	<0.4
Chromium	7440-47-3	2	mg/kg		<2	<2	<2	<2	<2
Copper	7440-50-8	5	mg/kg		**8**	**7**	<5	<5	<5
Lead	7439-92-1	5	mg/kg		<5	<5	<5	<5	<5
Molybdenum	7439-98-7	2	mg/kg		<2	<2	<2	<2	<2
Nickel	7440-02-0	2	mg/kg		<2	<2	<2	<2	<2
Selenium	7782-49-2	5	mg/kg		<5	<5	<5	<5	<5
Zinc	7440-66-6	5	mg/kg		<5	<5	<5	<5	<5

Analytical Results

Sub-Matrix: **FLY ASH** (Matrix: **SOIL**)

Compound	CAS Number	LOR	Unit	Client sample ID	20190124BA-01 BOTTOM ASH	20190125BA-01 BOTTOM ASH	20190126BA-01 BOTTOM ASH	20190127BA-01 BOTTOM ASH	20190128BA-01 BOTTOM ASH
				Client sampling date / time	24-Jan-2019 00:00	25-Jan-2019 00:00	26-Jan-2019 00:00	27-Jan-2019 00:00	28-Jan-2019 00:00
					ES1909166-026	ES1909166-027	ES1909166-028	ES1909166-029	ES1909166-030
					Result	Result	Result	Result	Result
EA055: Moisture Content (Dried @ 105-110°C)									
Moisture Content	----	0.1	%		**22.6**	**26.2**	**17.9**	**20.8**	**17.7**
EG005(ED093)T-MW: Total Metals by nitric acid microwave digestion / ICP-AES									
Arsenic	7440-38-2	5	mg/kg		<5	<5	<5	<5	<5
Boron	7440-42-8	50	mg/kg		<50	<50	<50	<50	<50
Cadmium	7440-43-9	0.4	mg/kg		<0.4	<0.4	<0.4	<0.4	<0.4
Chromium	7440-47-3	2	mg/kg		<2	<2	<2	<2	<2
Copper	7440-50-8	5	mg/kg		<5	<5	<5	<5	<5
Lead	7439-92-1	5	mg/kg		<5	**9**	<5	<5	<5
Molybdenum	7439-98-7	2	mg/kg		<2	<2	<2	<2	<2
Nickel	7440-02-0	2	mg/kg		<2	<2	<2	<2	<2
Selenium	7782-49-2	5	mg/kg		<5	<5	<5	<5	<5
Zinc	7440-66-6	5	mg/kg		<5	<5	**6**	<5	<5

Analytical Results

Sub-Matrix: **FLY ASH** (Matrix: **SOIL**)

Compound	CAS Number	LOR	Unit	Client sample ID	20190129BA-01 BOTTOM ASH	20190130BA-01 BOTTOM ASH	20190131BA-01 BOTTOM ASH	20190201BA-01 BOTTOM ASH	20190202BA-01 BOTTOM ASH
				Client sampling date / time	29-Jan-2019 00:00	30-Jan-2019 00:00	31-Jan-2019 00:00	01-Feb-2019 00:00	02-Feb-2019 00:00
					ES1909166-031	ES1909166-032	ES1909166-033	ES1909166-034	ES1909166-035
					Result	Result	Result	Result	Result
EA055: Moisture Content (Dried @ 105-110°C)									
Moisture Content	----	0.1	%		**20.2**	**14.3**	**21.7**	**21.0**	**20.2**
EG005(ED093)T-MW: Total Metals by nitric acid microwave digestion / ICP-AES									
Arsenic	7440-38-2	5	mg/kg		<5	<5	<5	<5	<5
Boron	7440-42-8	50	mg/kg		<50	<50	<50	<50	<50
Cadmium	7440-43-9	0.4	mg/kg		**0.6**	<0.4	<0.4	<0.4	<0.4
Chromium	7440-47-3	2	mg/kg		<2	**2**	<2	**4**	<2
Copper	7440-50-8	5	mg/kg		<5	**8**	**6**	<5	<5
Lead	7439-92-1	5	mg/kg		<5	<5	<5	<5	<5
Molybdenum	7439-98-7	2	mg/kg		<2	<2	<2	**2**	<2
Nickel	7440-02-0	2	mg/kg		<2	**10**	<2	**10**	<2
Selenium	7782-49-2	5	mg/kg		<5	<5	<5	<5	<5
Zinc	7440-66-6	5	mg/kg		<5	<5	<5	<5	<5

Analytical Results

Sub-Matrix: **FLY ASH** (Matrix: **SOIL**)

Compound	CAS Number	LOR	Unit	Client sample ID	20190203BA-01 BOTTOM ASH	20190204BA-01 BOTTOM ASH	20190205BA-01 BOTTOM ASH	20190206BA-01 BOTTOM ASH	20190207BA-01 BOTTOM ASH
				Client sampling date / time	03-Feb-2019 00:00	04-Feb-2019 00:00	05-Feb-2019 00:00	06-Feb-2019 00:00	07-Feb-2019 00:00
					ES1909166-036	ES1909166-037	ES1909166-038	ES1909166-039	ES1909166-040
					Result	Result	Result	Result	Result
EA055: Moisture Content (Dried @ 105-110°C)									
Moisture Content	----	0.1	%		**22.1**	**19.5**	**21.3**	**23.9**	**23.7**
EG005(ED093)T-MW: Total Metals by nitric acid microwave digestion / ICP-AES									
Arsenic	7440-38-2	5	mg/kg		<5	<5	<5	<5	<5
Boron	7440-42-8	50	mg/kg		<50	<50	<50	<50	<50
Cadmium	7440-43-9	0.4	mg/kg		<0.4	<0.4	<0.4	<0.4	<0.4
Chromium	7440-47-3	2	mg/kg		<2	<2	**5**	<2	<2
Copper	7440-50-8	5	mg/kg		<5	<5	**10**	**8**	<5
Lead	7439-92-1	5	mg/kg		<5	<5	<5	<5	<5
Molybdenum	7439-98-7	2	mg/kg		<2	<2	**2**	<2	<2
Nickel	7440-02-0	2	mg/kg		<2	<2	**3**	<2	<2
Selenium	7782-49-2	5	mg/kg		<5	<5	<5	<5	<5
Zinc	7440-66-6	5	mg/kg		<5	<5	**5**	<5	**8**

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Bayswater Power Station
AGL Macquarie Pty Ltd
15-Apr-2019
60580964

Commercial-in-Confidence

Bottom Ash Sampling Plan

Coal Ash Order (2014) Characterisation and Routine Sampling

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Bottom Ash Sampling Plan

Coal Ash Order (2014) Characterisation and Routine Sampling

Client: AGL Macquarie Pty Ltd

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Prepared by

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Quality Information

Document Bottom Ash Sampling Plan

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1.0 Introduction

1.1 Background

As a part of operations at Bayswater and Liddell Power Stations, coal ash is produced on a continuous basis as part of the coal combustion process undertaken during the generation of electricity. Combustion within the boiler furnaces at the Power Stations produces two types of ash. Heavier coarse ash particles fall to the bottom of the boiler and are referred to as 'bottom ash'. Lighter fine ash particles remain suspended in the combustion flue gas and are referred to as 'fly ash'. In addition, Cenospheres are also formed during the combustion process. Cenospheres are light weight hollow ceramic microspheres that typically form part of the fly ash produced.

Some of the bottom ash generated from Bayswater Power Station is supplied to a number of commercial operators (the Coal Ash Companies). The Coal Ash Companies then supply the bottom ash to third parties for beneficial reuse.

As a generator of coal ash which is supplied to third parties for such uses, AGL Macquarie Pty Limited (AGL Macquarie) is required to comply with the *Coal Ash Order 2014* (Coal Ash Order) made under the *Protection of the Environment Operations (Waste) Regulation 2014*. The Coal Ash Order commenced on 24 November 2014.

K&L Gates on behalf of AGL Macquarie has requested AECOM to conduct run of plant bottom ash sampling and analysis for the purposes of coal ash characterisation and ongoing routine sampling and analysis in accordance with the requirements of the Coal Ash Order.

It is noted that characterisation sampling, as generally described in this plan, occurred in January/February 2019 and followed an earlier draft coal ash sampling plan.

1.2 Objectives

This sampling plan covers the beneficial reuse of the bottom ash as an engineering material (cementitious and non-cementitious mixes) only. It does not cover any potential use of the bottom ash as a soil amendment for the growing of vegetation.

The objectives of this sampling plan and the proposed works are to:

- Outline the required sampling and sample collection locations;
- Describe the procedures for sampling, sample preparation, sample storage and transport to the analytical laboratory and sample analysis, as well as the reporting requirements; and
- Document compliance with the requirements of the Coal Ash Order.

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2.0 Bottom Ash Characterisation Sampling

2.1 Material to be sampled

The majority of bottom ash generated at Bayswater Station is transported to the Bayswater Ash Dam for onsite disposal. However, a portion of run of plant bottom ash is extracted by excavator from the bottom ash slurry outflow by the Coal Ash Company and stockpiled adjacent to the Bayswater Power Station ash dam before being mechanically classified for size and trucked offsite to be used for engineering purposes. The bottom ash is granular in nature with an approximate nominal sizing of <14mm (i.e. 95% of material is less than 14mm). For the purposes of the characterisation a fresh stockpile will be formed each day, for twenty days, from bottom ash material excavated from the bottom ash outlet pipe channel (see Figure 1 below).

2.2 Purpose of sampling

As the bottom ash is used as an engineering material by the Coal Ash Companies and is generated as part of a continuous process, it is a requirement of the Coal Ash Order to conduct a coal ash characterisation study. 20 bottom ash composite samples will be collected and analysed over twenty days.

2.3 Lot size

For the purposes of this characterisation the sampling “lot” is considered to be a run of plant bottom ash stockpile located adjacent to Bayswater Power Station bottom ash slurry outflow. The characterisation stockpile is formed from fresh bottom ash material on a daily basis for the purposes of sampling for the characterisation program. After sampling, the material is removed to allow room for a fresh, discreet stockpile to be formed.

2.4 Sampling procedure

Sampling will be conducted in accordance with AS 1141.3.1 – 2012 Sections 5, 6 and 8.4.2.

- At least five sampling increments with minimum mass of 3kg (as per AS 1141.3.1 Sect 6.3 Table 1) will be collected from the perimeter of the stockpile.
- For each sampling increment surface material to a depth of > 200mm will be removed. A sampling shield will be inserted above the sampling area to prevent loose material falling into the sampling area. Sample increments will be taken at intervals up the stockpile face to account for the effects of layering in the stockpile.
- The sampling shovel will be square edged (as per AS 1141.3.1 – 2012 Sect 4.3) with sides sufficiently high to prevent loss of material from the sides.
- Increments will be collected in plastic pales with sealable lids.
- Sampling increments will be evenly spaced around the perimeter of the stockpile.
- Each of the sampling increments will be combined to form a single composite sample for analysis.
- Care should be taken to avoid the effects of segregation and related issues. Badly segregated areas of a stockpile should be avoided for sampling or at least taken into consideration when sampling. Segregation may occur dur to the following factors:
- Material rolling or sliding down the face of the stockpile under gravity;
- Effects of rain;
- Vibration of coarse aggregates; and
- Handling and movement by plant and equipment.

2.5 Records

A field sampling record will be kept to record the date and time of collection and the mass of each sampling increment and a description of the stockpile shape and the material itself (unusual colour, size, segregation etc.). An example Aggregate Sampling Field Sheet is shown in **Appendix A**.

2.6 Sampling location

Run of plant bottom ash is extracted by excavator from the bottom ash slurry outflow and stockpiled adjacent to the Bayswater Power Station ash dam before being mechanically classified for size and trucked off site. The approximate GPS coordinates of the stockpile are: E 0307817 N 6413461. The stockpile is identified in **Figure 1**. A typical bottom ash sampling stockpile and the bottom ash pipe outlet pipe are shown in **Figure 2** and **Figure 3** respectively.

Figure 1 Bottom Ash Run of Plant Stockpile – Bayswater Power Station

Figure 2 Typical Bottom Ash Characterisation Sampling Stockpile

Figure 3 Bottom Ash Outlet Pipe

2.7 Sample mixing and division

Sample increments will be weighed on site to confirm that the minimum increment mass has been achieved. Sample increments will be returned to AECOM Singleton for mixing and division and preparation for laboratory delivery. A clean concrete surface will be prepared for the mixing and division of samples by cone and quartering with a minimum composite sample mass of 15 kg (as per AS 1141.3.1 – 2012 Sect 6.4.3). Further sample mixing and division may be performed to meet laboratory sample analysis size requirements (as per AS 1141.3.1 – 2012 Appendix A). Samples divided out for specific testing will be referred to as sub-samples. The remaining sample will be stored in a sealable plastic bucket for three weeks.

The sealed laboratory sample (or sub samples) will be despatched to ALS, a NATA accredited laboratory in Newcastle. AECOM chain of custody procedures will be followed.

2.8 Reporting

Following the receipt of final laboratory reports, a report in accordance with Clause 4.10 of the Coal As Order will be developed and include:

- A copy of this sampling plan.
- A compliance statement including:
  - A comparison of average analyte results to the concentrations in Table 1 - Column 2 of the Coal Ash Order.
  - A comparison of individual analyte results to the concentrations in Table 1 - Column 4 of the Coal Ash Order; and
- A copy of the laboratory reports.

2.9 Characterisation analysis requirements

As per the Coal Ash Order, bottom ash characterisation composite samples will be analysed at ALS NATA accredited laboratory for the following analytes:

- Mercury
- Cadmium
- Lead
- Arsenic
- Boron
- Chromium
- Copper
- Molybdenum
- Nickel
- Selenium
- Zinc
- Electrical Conductivity
- pH.

Testing procedures will be in accordance with or equivalent to those specified in Clauses 4.7 and 4.8 of the Coal Ash Order (sections attached for reference in **Appendix B**).

2.10 Laboratory Quality Assurance and Quality Control

ALS NATA accredited laboratory provides Laboratory Control Samples (LCS), Method Blanks (MB), Matrix Spikes (MS), Laboratory Duplicates (Dups) and Surrogates (where applicable), at frequencies at or above the NEPC (2013) guidelines (ASC NEPM).

2.11 Ongoing Coal Ash Characterisation

The Coal Ash Order requires that where coal ash is produced as part of a continuous process and is used for engineering purposes characterisation must be conducted again during the two year period following commencement of the continuous process. The samples collected for characterisation purposes may also be treated as a sample collected and tested for the purpose of routine sampling as contemplated by clause 4.3.2 of the Coal Ash Order

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3.0 Routine Bottom Ash Sampling Plan

3.1 Material to be sampled

As noted at **section 2.1**, the majority of bottom ash generated at Bayswater Station is transported to the Bayswater Ash Dam for onsite disposal. However, a portion of run of plant bottom ash is extracted by excavator from the bottom ash slurry outflow by the Coal Ash Company and stockpiled adjacent to the Bayswater Power Station ash dam before being mechanically classified for size and trucked offsite to be used for engineering purposes. The bottom ash is granular in nature with an approximate nominal sizing of <14mm (i.e. 95% of material is less than 14mm). The bottom ash is granular in nature with a nominal sizing of <14mm (i.e. 95% of material is less than 14mm).

3.2 Purpose of sampling

As bottom ash produced at Bayswater Power Station is used offsite as an engineering material and is generated as part of a continuous process, it is a requirement of the Coal Ash Order to conduct routine monitoring.

3.3 Estimated production and sampling requirements

As bottom ash production at Bayswater Power Station is considered to be a continuous process and the material is used for engineering the following sections of the Coal Ash Order are relevant to establishing the routine sampling requirements:

- Clause 4.3.2 (engineering application – generation by continuous process).

Estimated production tonnages and relevant sampling frequencies as per the requirements of the Coal Ash Order are presented in **Table 1**.

Table 1 Bayswater Bottom Ash Production and Sampling Requirements

Application	Approximate Tonnage per Annum	Minimum Routine Sampling
Engineering	Up to 170,000 t Note: Subject to further planning approvals being obtained this may increase in the future to up to 1,000,000.	Five composite samples per three months

The five composite samples will be collected over 5 different sampling events in accordance with the sampling procedure specified in **section 3.5** below over the three month period (at intervals of approximately 18 days).

3.4 Lot size

For the purposes of routine monitoring a sampling “lot” is considered to be a run of plant bottom ash stockpile located adjacent to Bayswater Power Station bottom ash slurry outflow excavated from fresh bottom ash material for a period of approximately 18 days leading up to the sampling event. A new stockpile will be formed from fresh material at intervals of approximately 18 days.

3.5 Sampling procedure

Sampling will be conducted in accordance with AS 1141.3.1 – 2012 Sections 5, 6 and 8.4.2.

- At least five sampling increments with minimum mass of 3kg (as per AS 1141.3.1 Sect 6.3 Table 1) will be collected from the perimeter of the stockpile.
- For each sampling increment surface material to a depth of > 200mm will be removed. A sampling shield will be inserted above the sampling area to prevent loose material falling into the

sampling area. Sample increments will be taken at intervals up the stockpile face to account for the effects of layering in the stockpile.

- The sampling shovel will be square edged (as per AS 1141.3.1 – 2012 Sect 4.3) with sides sufficiently high to prevent loss of material from the sides.
- Increments will be collected in plastic pales with sealable lids.
- Each of the sampling increments will be combined to form a single composite sample for analysis.
- Sampling increments will be evenly spaced around the perimeter of the stockpile.
- Care should be taken to avoid the effects of segregation and related issues. Badly segregated areas of a stockpile should be avoided for sampling or at least taken into consideration when sampling. Segregation may occur dur to the following factors:
    - Material rolling or sliding down the face of the stockpile under gravity;
    - Effects of rain;
    - Vibration of coarse aggregates; and
- Handling and movement by plant and equipment.

3.6 Records

A field sampling record will be kept to record the date and time of collection and the mass of each sampling increment and a description of the stockpile shape and the material itself (unusual colour, size, segregation etc.). An example Aggregate Sampling Field Sheet is shown in **Appendix A**.

3.7 Sampling location

Run of plant bottom ash is extracted by excavator from the bottom ash slurry outflow and stockpiled adjacent to the Bayswater Power Station ash dam before being mechanically classified for size and trucked off site. The approximate GPS coordinates of the stockpile are: E 0307817 N 6413461. The stockpile is identified in **Figure 4**. A typical bottom ash sampling stockpile and the bottom ash pipe outlet pipe are shown in **Figure 5** and **Figure 6** respectively.

Figure 4 Bottom Ash Run of Plant Stockpile – Bayswater Power Station

Figure 5 Typical Bottom Ash Routine Sampling Stockpile

Figure 6 Bottom Ash Outlet Pipe

3.8 Sample mixing and division

Sample increments will be weighed on site to confirm that the minimum increment mass has been achieved. Sample increments will be returned to AECOM Singleton for mixing and division and preparation for laboratory delivery. A clean concrete surface will be prepared for the mixing and division of samples by cone and quartering with a minimum composite sample mass of 15 kg (as per AS 1141.3.1 – 2012 Sect 6.4.3). Further sample mixing and division may be performed to meet laboratory sample analysis size requirements (as per AS 1141.3.1 – 2012 Appendix A). Samples divided out for specific testing will be referred to as sub-samples. The remaining sample will be stored in a sealable plastic bucket for three weeks.

The sealed laboratory sample (or sub samples) will be despatched to ALS NATA accredited laboratory, Newcastle. AECOM chain of custody procedures will be followed.

3.9 Routine Monitoring Analysis Requirements

Routine bottom ash composite samples will be tested for the analytes specified in Table 1, Column 3 of the Coal Ash Order. Samples will be analysed at ALS NATA accredited laboratory for the following analytes:

- Cadmium
- Lead
- Chromium
- Nickel
- Selenium
- Zinc
- Electrical Conductivity
- pH.

Routine bottom ash composite sample analysis results may be used for ongoing characterisation. In this case, routine monitoring composite samples that will form part of the characterisation will be analysed for the full suite of analysis as specified in Table 1, Column 1 of the Coal Ash Order (see **section 2.9**). Testing procedures will be in accordance with or equivalent to those specified in Clauses 4.7 and 4.8 of the Coal Ash Order (sections attached for reference in **Appendix B**).

3.10 Laboratory Quality Assurance and Quality Control

One inter-laboratory and one intra-laboratory field duplicate bottom ash sample will be taken once per three month period and analysed for a full suite of analysis (as per **section 3.3**). The inter-laboratory duplicate will be sent to another NATA accredited laboratory for analysis.

ALS NATA accredited laboratory provides Laboratory Control Samples (LCS), Method Blanks (MB), Matrix Spikes (MS), Laboratory Duplicates (Dups) and Surrogates (where applicable), at frequencies at or above the ASC NEPM.

3.11 Reporting

Following the receipt of final laboratory reports, a report in accordance with Clause 4.10 of the Coal Ash Order will be developed and include:

- A copy of this sampling plan;
- A compliance statement including:
    - A comparison of average analyte results to the concentrations in Table 1 - Column 3 of the Coal Ash Order.

- A comparison of individual analyte results to the concentrations in Table 1 - Column 4 of the Coal Ash Order; and

- A copy of the laboratory reports.

AGL Macquarie will be notified as soon as practicable after the receipt of non-complying results so that AGL Macquarie can comply with clauses 4.5 and 4.6 of the Coal Ash Order.

Additional record keeping will include a list of the name and address of each person/company to whom coal ash was supplied and the quantity supplied (responsibility of AGL Macquarie).

4.0 Compliance with Clauses 4.5 and 4.6 of the Coal Ash Order

The following measures will be taken to ensure compliance with Clauses 4.5 and 4.6 of the Coal Ash Order:

- AGL Macquarie will not supply bottom ash to the Coal Ash Companies from a stockpile until confirmation is received that the laboratory results for the samples collected from that stockpile comply with the limits in Table 1 of the Coal Ash Order. Rather, all bottom ash extracted from the Bayswater Ash Dam for the purposes of beneficial reuse after the date on which the samples have been collected, will be diverted into a new stockpile which will then sampled in the next round of analysis.
- Routine sampling will be conducted over the 3 month period to provide representative concentrations over the entire period:
  - Composite samples will be collected over the 3 month production period at approximately 18 day intervals;
  - Each composite sample will be made up of 5 sample increments collected over the stockpile as described in **section 3.5**; and
  - Samples will be submitted to the laboratory as soon as practicable.
- If any given result from a stockpile does not comply with the limits in Table 1 of the Coal Ash Order the following will be conducted:
  - The results will be reviewed to investigate the cause of the apparent exceedance of the limits specified in Table 1 of the Coal Ash Order. If, as part of this investigation, a laboratory error is suspected, the laboratory will be contacted, asked to confirm the results and rerun the sample with the exceedance. In addition, two composite samples of the material in question will be collected and analysed on a rapid turnaround to confirm the reliability of the results.
  - If the analysing laboratory confirms that an error was responsible for the non-complying result and repeat analysis results comply with the limits in Table 1 of the Coal Ash Order, coal ash supplies will resume to the Coal Ash Companies. Note that the highest of all repeat analysis results, confirmed as valid by the laboratory, will be taken as the final result for each analyte retested.
  - If the laboratory confirms its original result or additional composite analysis results do not comply with the limits in Table 1 of the Coal Ash Order then the coal ash in the relevant stockpile will be transferred back into the Bayswater Ash Dam and an investigation into coal ash quality will be carried out. The investigation will include, but not be limited to, changes to coal supply or quality; adherence to the sampling plan during sample collection and preparation; and laboratory error.

AGL Macquarie must also notify the EPA within 7 days of becoming aware that it has not complied with any requirement in clause 4.1 to 4.8 of the Coal Ash Order.

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5.0 Safety

5.1 Bottom ash sampling

The following hazards and controls, while not being limited to, should be considered when developing a safe work method statement (SWMS) for bottom ash sampling:

Table 2 Stockpile Sampling - Hazards and Controls

Hazard	Controls
Mobile plant	Notify all parties in the work area of your intention to sample
	Don't sample if mobile equipment is working near stockpile. Align sampling with breaks and downtime
	Use light vehicle as barricade
Rough ground	Eyes on path
	Clear work area of obstacles and larger rocks
Hand injury	PPE - gloves
Lifting samples	Two man lift if required
	Correct technique – keep load close to chest
Heat / sunburn	Brimmed hard hat - sunscreen
	Water on hand

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6.0 References

National Environmental Protection Council (NEPC), 2013. National Environment Protection (Assessment of Site Contamination) Measure 1999, as amended in 2013.

NSW EPA, 2014. Resource Recovery Order under Part 9, Clause 93 of the Protection of the Environment Operations (Waste) Regulation 2014, the coal ash order 2014.

SAI Global, 2012. AS 1141.3.1—2012, Methods for sampling and testing aggregates, Method 3.1: Sampling—Aggregates.

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Appendix A

Sampling Records

Appendix A Sampling Records

AECOM

Aggregate Sampling Field Sheet

Client: AGL Project No.: 60580964 Sampled by:

Date Collected: Collection Start Time: Collection Stop Time:

Site	Date	Time	Increment Mass (kg)	Sample Description	Comments

Initials……

Appendix B

Test Methods

Appendix B Test Methods

4.5.1. The concentration or other value of that attribute of any sample collected and tested as part of the characterisation or the routine or one-off sampling of the coal ash exceeds the absolute maximum concentration or other value listed in Column 4 of Table 1, or

4.5.2. The average concentration or other value of that attribute from the characterisation or one-off sampling of the coal ash (based on the arithmetic mean) exceeds the maximum average concentration or other value listed in Column 2 of Table 1, or

4.5.3. The average concentration or other value of that attribute from the routine sampling of the coal ash (based on the arithmetic mean) exceeds the maximum average concentration or other value listed in Column 3 of Table 1.

4.6. The absolute maximum concentration or other value of that attribute in any coal ash supplied under this order must not exceed the absolute maximum concentration or other value listed in Column 4 of Table 1.

Table 1

Column 1	Column 2	Column 3	Column 4
Chemicals and other attributes	**Maximum average concentration for characterisation** (mg/kg 'dry weight' unless otherwise specified)	**Maximum average concentration for routine testing** (mg/kg 'dry weight' unless otherwise specified)	**Absolute maximum concentration** (mg/kg 'dry weight' unless otherwise specified)
1. Mercury	0.5	Not required	1
2. Cadmium	0.5	0.5	1
3. Lead	25	25	50
4. Arsenic	10	Not required	20
5. Boron	75	Not required	150 for engineering uses 60 for soil amendment
6. Chromium (total)	25	25	50
7. Copper	20	Not required	40
8. Molybdenum	10	Not required	20
9. Nickel	25	25	50
10. Selenium	10	10	20
11. Zinc	35	35	70
12. Electrical Conductivity[1]	NA	NA	NA for engineering uses 4dS/m for soil amendment
13. pH* in non-cementitious mixes[2]	7 to 12.5	7 to 12.5	6 to 13
14. pH in cementitious mixes	NA	NA	NA

[1]Note: while thresholds are not provided for electrical conductivity this must be tested and a record kept of the results.

[2]Note: The ranges given for pH are for the minimum and maximum acceptable pH values in the coal ash.

Test methods

4.7. The generator must ensure that any testing of samples required by this order is undertaken by analytical laboratories accredited by the National Association of Testing Authorities (NATA), or equivalent.

4.8. The generator must ensure that the chemicals and other attributes (listed in Column 1 of Table 1) in the coal ash it supplies are tested in accordance with the test methods specified below or other equivalent analytical methods. Where an equivalent analytical method is used the detection limit must be equal to or less than that nominated for the given method below.

4.8.1. Test method for measuring the mercury concentration:

4.8.1.1 Analysis using USEPA SW-846 Method 7471B Mercury in solid or semisolid waste (manual cold vapour technique), or an equivalent analytical method with a detection limit < 20% of the stated maximum average concentration in Table 1, Column 2 (i.e. < 0.1 mg/kg dry weight).

4.8.1.2 Report as mg/kg dry weight.

4.8.2. Test methods for measuring chemicals 2 - 11:

4.8.2.1 Sample preparation by digesting using USEPA SW-846 Method 3051A Microwave assisted acid digestion of sediments, sludges, soils, and oils.

4.8.2.2 Analysis using USEPA SW-846 Method 6010C Inductively coupled plasma - atomic emission spectrometry, or an equivalent analytical method with a detection limit < 10% of stated maximum average concentration in Table 1, Column 2 (i.e. 2.5 mg/kg dry weight for lead).

4.8.2.3 Report as mg/kg dry weight.

4.8.3. Test methods for measuring the electrical conductivity and pH:

4.8.3.1 Sample preparation by mixing 1 part coal ash with 5 parts distilled water.

4.8.3.2 Analysis using Method 103 (pH) and 104 (Electrical Conductivity) in Schedule B (3): Guideline on Laboratory Analysis of Potentially Contaminated Soils, National Environment Protection (Assessment of Site Contamination) Measure 1999 (or an equivalent analytical method).

4.8.3.3 Report electrical conductivity in deciSiemens per metre (dS/m).

4.8.4. Test method for measuring boron in coal ash for land application as a soil amendment:

4.8.4.1 Water soluble boron using a calcium chloride extractable method 12C1 or 12C2 in Rayment, G.E. and Lyons D.J. 2011 Soil Chemical Methods - Australasia, CSIRO Publishing (or an equivalent analytical method with a detection limit for water soluble boron <10% of the stated absolute maximum).

4.8.4.2 Report as mg/kg dry weight.