Centennial Coal Company Limited

Coxs River

Ecotoxicology Assessment

September 2014

Executive summary

GHD Pty Ltd was commissioned by Centennial Coal Company Limited to conduct an ecotoxicological study to determine toxicity and chemical constituents of mine water discharge from LDP001 at Angus Place Colliery (AP LDP001) and LDP009 at Springvale Mine (SV LDP009) as well as several locations within the upper Coxs River catchment to assess the impact of mine water discharge on the surrounding receiving environment. This ecotoxicology assessment will be used to support the response to submissions for the Environmental Impact Statements for both the mine extension projects.

Direct toxicity assessment was undertaken for the mine water discharge samples from AP LDP001 and SV LDP009. Toxicity testing at all other locations was conducted using screening tests with the freshwater cladoceran, which has been found to be the most sensitive test species in previous toxicity testing conducted by Centennial in the region. Toxicity testing of sampled water was performed using the ANZECC and ARMCANZ (2000) protocol with species endemic to, or representative of, the receiving environment. Water quality analysis was also undertaken for the samples from each location.

The results of this study show that the discharge at SV LDP009 is having an acute impact on cladoceran species at the Sawyers Swamp Creek site downstream of discharges; however this acute toxicity is ameliorated as the discharge enters the Coxs River. Impacts on cladoceran reproduction show a decreasing trend in the Coxs River with distance downstream of the SV LDP009 discharge point until no toxic impacts are detected in the upper portion of Lake Wallace.

The results of the toxicity testing were used to determine the concentration of SV LDP009 discharge of 2.7% to provide protection to 95% of the species in the downstream ecosystem. An estimate of the runoff contributing to the Coxs River was obtained from the water balance model developed by RPS (2014a). The estimated catchment runoff to the Coxs River at each location was compared to the predicted maximum daily discharge volume from AP LDP001 and SV LDP009 to determine the expected dilution of discharge within the river. The target dilution of SV LDP009 discharge was not found to be met under median rainfall conditions.

Aquatic ecology monitoring results provide supporting evidence that the discharges from AP LDP001 and SV LDP009 are not adversely impacting the aquatic health of the Coxs River. The sites downstream of discharges from AP LDP001 were found to have more pollution sensitive taxa present in the macroinvertebrate assemblages than the upstream Coxs River site.

The water quality results for SV LDP009 do not indicate any parameters that are present in concentrations that could cause the significant toxicity observed in the ecotoxicology results. Furthermore, the chemistry of discharge from AP LDP001, which did not show any toxicity to the cladoceran species, was found to be very similar to that of SV LDP009. Further investigations are required to determine the source of the toxicity at SV LDP009.

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Glossary

Acute toxicity	The ability of a substance to cause severe biological harm or death from a single exposure.
Alkalinity	A measure of the ability of an aqueous solution to neutralise acids. Alkalinity of natural waters is due primarily to the presence of hydroxides, bicarbonates and carbonates. It is expressed in units of calcium carbonate (CaCO3).
Analyte	A substance or chemical constituent that is undergoing analysis.
Anion	A negatively charged ion.
Bioassay	An experimental test used to evaluate the relative potency of a chemical by measuring its effect on a living organism relative to a control.
Bioavailability	The fraction of the total of a chemical in the surrounding environment that is available to be taken up by an organism. The environment may include water, sediment, soil, suspended particles and food.
Catchment	The land area draining through the main stream and tributary streams to a particular location.
Cation	A positively charged ion.
Chronic toxicity	The ability of a substance to cause severe biological harm or death from prolonged exposure.
Community	An assemblage of organisms occupying a specified location and time, usually interacting with one another.
Control	The part of an experimental procedure which is like the treated part in every respect except it is not subjected to the test conditions. The control is used as a standard of comparison, to check that the outcome of the experiment is a reflection of the test conditions and not of some unknown factor.
Direct toxicity assessment	The use of toxicity tests to determine the acute and/or chronic toxicity of mixtures of compounds in ambient waters.
Discharge	The quantity of water per unit time, for example cubic metres per second or megalitres per day.
Ecotoxicology	Scientific study of the effects of toxic substances on living organisms.
Effect concentration	The concentration of a substance in water where a certain percent of test organisms exhibit a certain response or effect after a specified exposure period. For example, EC10 is the concentration where 10 percent of the test organisms exhibit a response.

Electrical conductivity	A measure of the concentration of dissolved salts or ions in water.
Guidelines	Numerical concentration or narrative statement that provides appropriate guidance for a designated water use or impact.
Hardness	The concentration of multivalent cations present in water. Generally, hardness is a measure of the concentration of calcium and magnesium ions in water and is expressed in units of calcium carbonate (CaCO3) equivalent. Hardness may influence the toxicity and bioavailability of substances in water.
Ion	An electrically charged atom.
Index	Composite value that can give a quick ranking to an ecosystem feature (e.g. a water body), derived via a formula that combines measurements of important ecosystem characteristics; typically used to rank 'health' or naturalness.
Licensed discharge point	A location where the premises discharge water in accordance with conditions stipulated with the site's Environment Protection Licence.
Longwall mining	Underground coal mining where a block of coal is mined using a longwall shearer, supported by roadway development that is created using a continuous miner unit.
Macroinvertebrate	An animal species that does not develop a vertebral column and is large enough to be seen without the use of a microscope. These animals generally include insects, crustaceans, molluscs, arachnids and annelids.
Median	The middle value, such that there is an equal number of higher and lower values. Also referred to as the 50th percentile.
Meteorology	The science concerned with the processes and phenomena of the atmosphere, especially as a means of forecasting the weather.
No observed effects concentration (NOEC)	The highest tested concentration of a substance in water at which no effect is observable in test organisms in a given population (compared to the control sample).
Percentile	The value of a variable below which a certain per cent of observations fall. For example, the 80th percentile is the value below which 80 per cent of values are found.
pH	The value taken to represent the acidity or alkalinity of an aqueous solution. It is defined as the negative logarithm of the hydrogen ion concentration of the solution.
Physicochemical	Refers to the physical (e.g. temperature, electrical conductivity) and chemical (e.g. concentrations of nitrate, mercury) characteristics of water.
Riparian	Pertaining to, or situated on, the bank of a river or other water body.

Runoff	Amount of rainfall that ends up as streamflow.
Total dissolved solids	A measure of the inorganic and organic substances dissolved in water.
Total Kjeldahl nitrogen	The sum of the concentrations of organic nitrogen, ammonia (NH4) and ammonium (NH4+) in water.
Total nitrogen	A measure of organic and inorganic nitrogen forms in water. The sum of concentrations of total Kjeldahl nitrogen, nitrite and nitrate.
Total phosphorus	A measure of the organic and inorganic phosphorus in particulate and soluble forms.
Total suspended solids	A measure of the filterable matter suspended in water.
Toxicity	The inherent potential or capacity of a substance to cause adverse effects in a living organism.
Trigger value	The concentration or load of physicochemical characteristic of an aquatic ecosystem, below which there exists a low risk that adverse ecological effects will occur. they indicate a risk of impact if exceeded and should ‘trigger’ action to conduct further investigations or to implement management or remedial processes.
Turbidity	A measure of the clarity of water. Turbidity in excess of 5 NTU is just noticeable to the average person.

Abbreviations

AUSRIVAS	Australian Rivers Assessment System
AWBM	Australian Water Balance Model
BOM	Bureau of Meteorology
DO	Dissolved oxygen
DOC	Dissolved organic carbon
DTA	Direct toxicity assessment
EC	Effect concentration
EPA	Environment Protection Authority
EPL	Environment Protection Licence
ESA	Ecotox Services Australasia
GHD	GHD Pty Ltd
km	Kilometre
km2	Square kilometre
L	Litre
LDP	Licensed discharge point
m	Metre
mg/L	Milligram per litre
ML/day	Megalitre per day
mV	Millivolt
NATA	National Association of Testing Authorities
NOEC	No observable effect concentration
NOW	NSW Office of Water
NTU	Nephelometric turbidity unit
SSTV	Site-specific trigger value
TDS	Total dissolved solids
TSS	Total suspended solids
°C	Degrees Celsius
µS/cm	Microsiemens per centimetre

1. Introduction

1.1 Background

Angus Place Colliery is an underground coal mine located approximately 5 km north of Lidsdale and approximately 15 km north-west of Lithgow. Springvale Mine is also an underground coal mine located approximately 6 km south of Angus Place Colliery. A locality figure is provided in Figure 1-1. Both mines are currently seeking approval to extend mining operations using longwall mining methods as part of the Angus Place Mine Extension Project and Springvale Mine Extension Project respectively.

Groundwater inflows into the underground workings at both Angus Place Colliery and Springvale Mine are transferred to a subterranean pipeline network prior to discharge at licensed discharge point (LDP) LDP009 at Springvale Mine. Mine water from Springvale Mine is taken as a priority, with the remaining capacity supplied by mine water from Angus Place Colliery.

GHD Pty Ltd (GHD) was commissioned by Centennial Coal Company Limited (Centennial) to conduct an ecotoxicological study to determine toxicity and chemical constituents of mine water discharge from LDP001 at Angus Place Colliery (AP LDP001) and LDP009 at Springvale Mine (SV LDP009) as well as several locations within the upper Coxs River catchment to assess the impact of mine water discharge on the surrounding receiving environment. This ecotoxicology assessment will be used to support the response to submissions for the Environmental Impact Statements for both the mine extension projects.

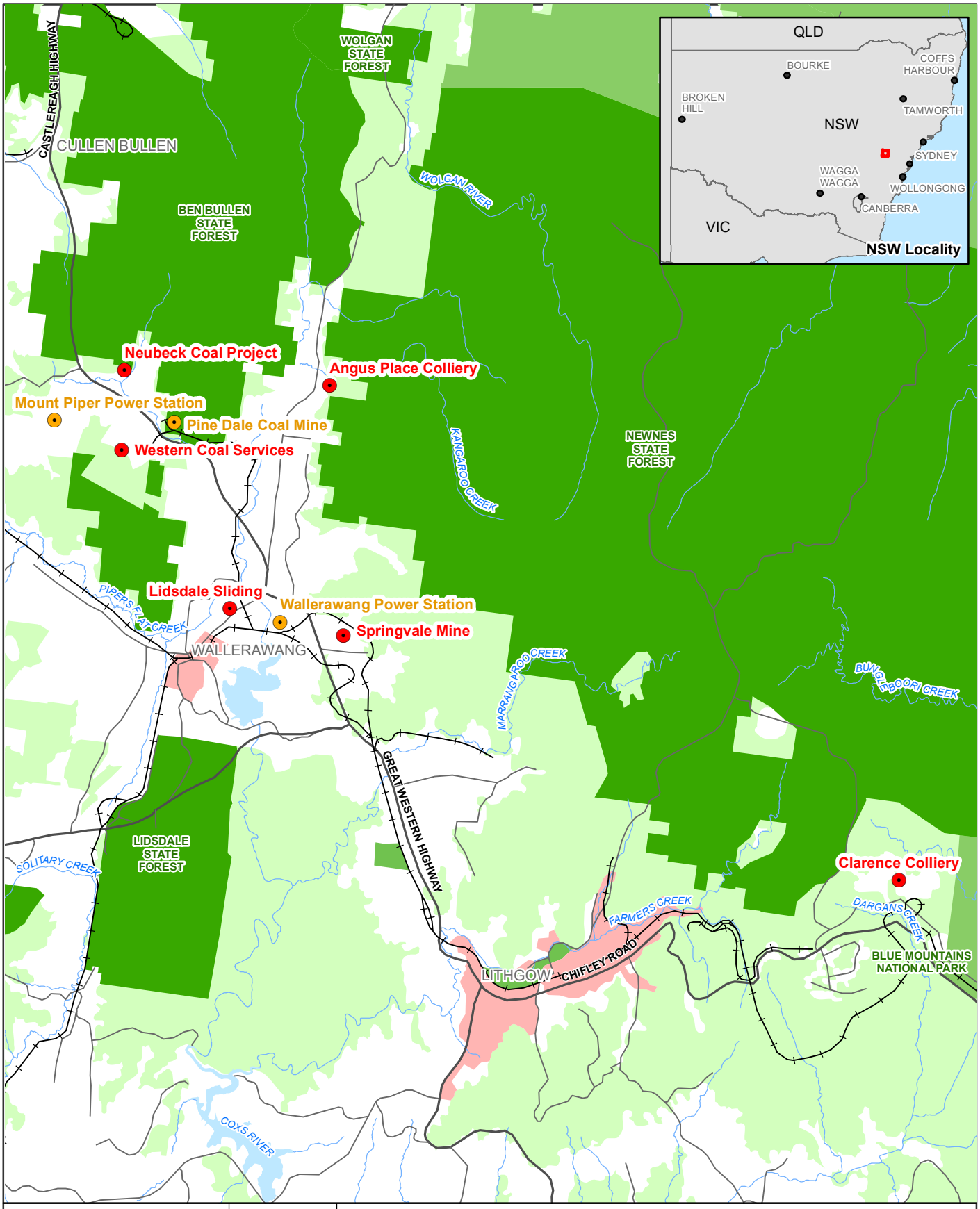
The NSW Environment Protection Authority (EPA) conducted water quality and toxicity testing on discharge from SV LDP009 and the receiving environment on 8 May 2014. GHD was engaged by Centennial to review and interpret the results of the testing provided by the NSW EPA and to determine the impacts on the receiving environment. The outcomes of this assessment are provided in *Springvale EPA Water Quality and Toxicity Assessment: Interpretive Report* (GHD, 2014). The objectives of the work detailed in this report as well as the above mentioned report are to develop a weight of evidence approach to the outcomes of the two mine extension projects.

1.2 Coxs River Catchment

1.2.1 Topography and Land Use

The Western Coalfield lies on the western slopes of the north-south oriented sandstone ridgeline of the Great Dividing Range, to the west of the Wollemi National Park and the Blue Mountains National Park. The area consists primarily of undulating hills and mountain tops, with some low-lying areas.

The region is surrounded by state recognised forests and reserves, including the Turon State Forest and Winburndale Nature Reserve in the west and the Wolgan State Forest, Ben Bullen State Forest and Newnes State Forest to the east. Low-lying areas have been cleared of vegetation for agricultural, commercial and industrial purposes, including coal mining, forestry and power generation. Nearby residential areas include Lithgow and Wallerawang to the south and Portland and Cullen Bullen to the west.



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Kilometres

Map Projection: Universal Transverse Mercator
Horizontal Datum: Geodetic Datum of Australia 1994
Grid: Map Grid of Australia, Zone 56

N

LEGEND

- Non Centennial Site
- Centennial Site
- Existing Rail
- Dual Carriageway
- Principal Road
- Secondary Road
- Minor Road
- Waterway
- Waterbody
- Built Up Area
- Nature Conservation
- State Forest
- Forest Or Shrub

LOCATION	-
SEAM	NA
DRAWN	S.M.
CHECKED	
APPROVED	S.Gray
SCALE	Refer to scalebar

Coxs River Ecotoxicology Assesssment

Locality Plan

Centennial Coal

DATE 29/09/2014

Figure 1-1

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1.2.1 Hydrology

The Coxs River is a perennial river that drains a catchment area of approximately 1,700 km^2 as shown in Figure 1-2 and is part of the greater Hawkesbury/Nepean catchment. The river rises within the Ben Bullen State Forest east of Cullen Bullen and flows generally in a south-east direction into Lake Burragorang (impounded by Warragamba Dam), which is the primary reservoir for drinking water supply to Sydney. The flow in Coxs River is regulated by three reservoirs, Lake Wallace, Thompsons Reservoir and Lake Lyell, which are used to supply power generation activities.

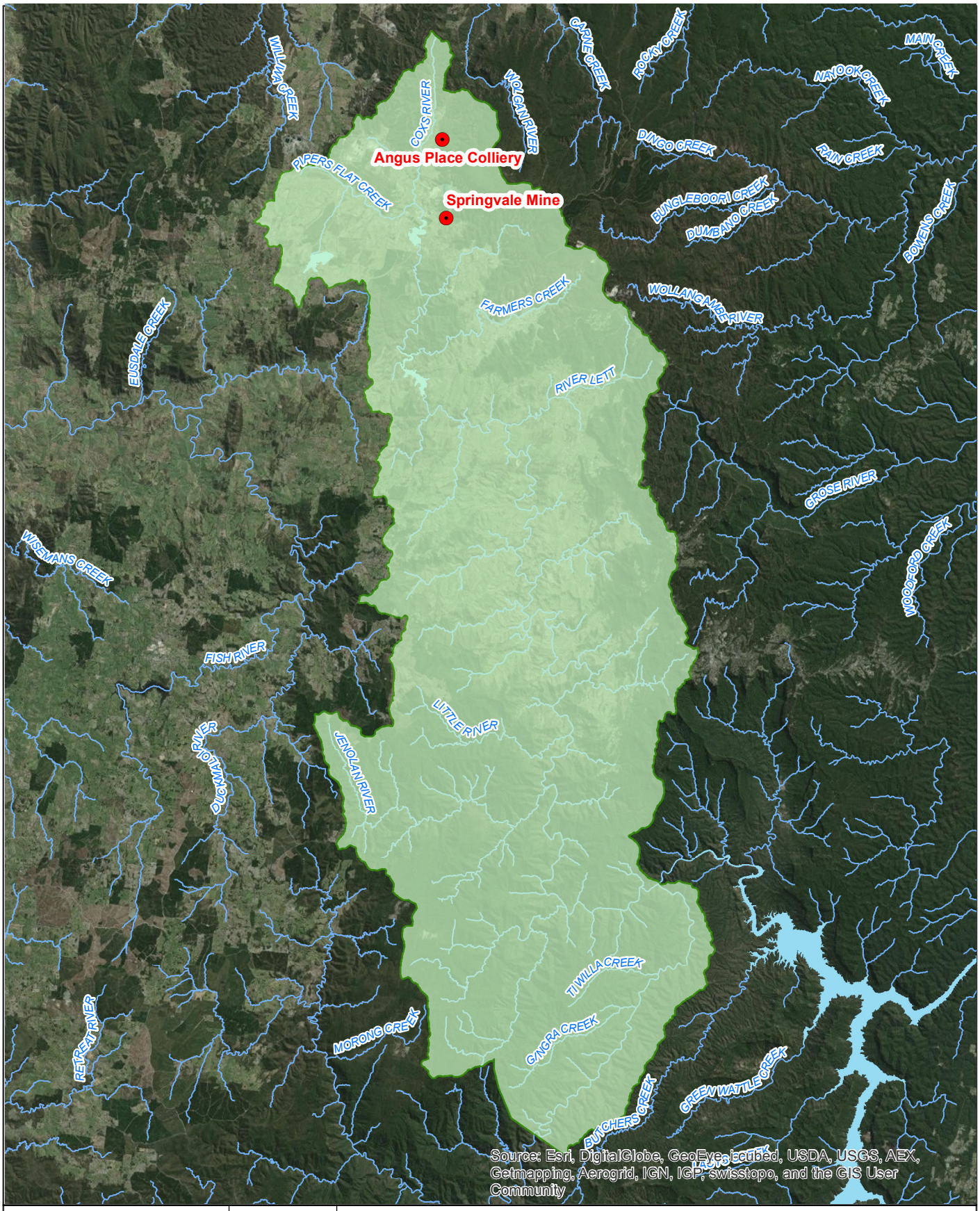
Flows within the Coxs River are monitored at several locations by NSW Office of Water (NOW) gauges. The locations of the four gauges assessed are presented in Figure 1-3 and details are provided in Table 1-1.

A partial series analysis was undertaken on the data available from the NOW gauges on the Coxs River. As the quality of data as provided by the NOW was found to vary, data with a large uncertainty was not included in the analysis. The proportion of the data record used in the analysis is included in Table 1-1 for each flow gauge.

Table 1-1 NSW Office of Water Flow Gauge Details

	Coxs River at Wallerawang Power Station	Coxs River at Bathurst Road	Coxs River at Upstream Lake Lyell	Coxs River at Lithgow	Coxs River at Island Hill
Station number	212054	212008	212058	212011	212045
Record	January 1992 to September 2014	January 1951 to September 2014	December 2000 to September 2014	May 1960 to September 2014	August 1981 to September 2014
Latitude	-33.3971	-33.4277	-33.4757	-33.5343	-33.7573
Longitude	150.0839	150.0825	150.0762	150.0951	150.1970
Elevation	875 m	858 m	857 m	744 m	264
Catchment area	178 km^2	199 km^2	250 km^2	404 km^2	970 km^2
Proportion of record used	97%	97%	95%	97%	99%

Hydrographs and daily percentiles for each flow gauge assessed are presented in Appendix A with selected flow statistics provided in Table 1-2. The median flow within the Coxs River increases from 13.3 ML/day at Wallerawang Power Station downstream to 50 ML/day in the lower Coxs River catchment at Island Hill. The flow statistics presented in Table 1-2 indicate that the average values for the gauges on the Coxs River at Bathurst Road, Lithgow and Island Hill have been skewed by flood events in 1986 and 1990, which were not recorded by the gauges at Wallerawang Power Station or upstream of Lake Lyell.



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0 1.25 2.5 5 7.5 10

Kilometres

Map Projection: Universal Transverse Mercator
Horizontal Datum: Geodetic Datum of Australia 1994
Grid: Map Grid of Australia, Zone 56

N

LEGEND

- Centennial Site
- Waterway
- Waterbody
- Coxs River Catchment

LOCATION	-
SEAM	NA
DRAWN	S.M.
CHECKED	
APPROVED	S.Gray
SCALE	Refer to scalebar

Coxs River Ecotoxicology Assesssment

Watercourses

Centennial Coal

DATE 29/09/2014

Figure 1-2

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Kilometres

Map Projection: Universal Transverse Mercator
Horizontal Datum: Geodetic Datum of Australia 1994
Grid: Map Grid of Australia, Zone 56

N

LEGEND

- Non Centennial Site
- Centennial Site
- NOW Gauge
- Waterway
- Waterbody

LOCATION	-
SEAM	NA
DRAWN	S.M.
CHECKED	
APPROVED	S.Gray
SCALE	Refer to scalebar

Coxs River Ecotoxicology Assesssment

NSW Office of Water Flow Gauge Locations

Centennial Coal

DATE 29/09/2014

Figure 1-3

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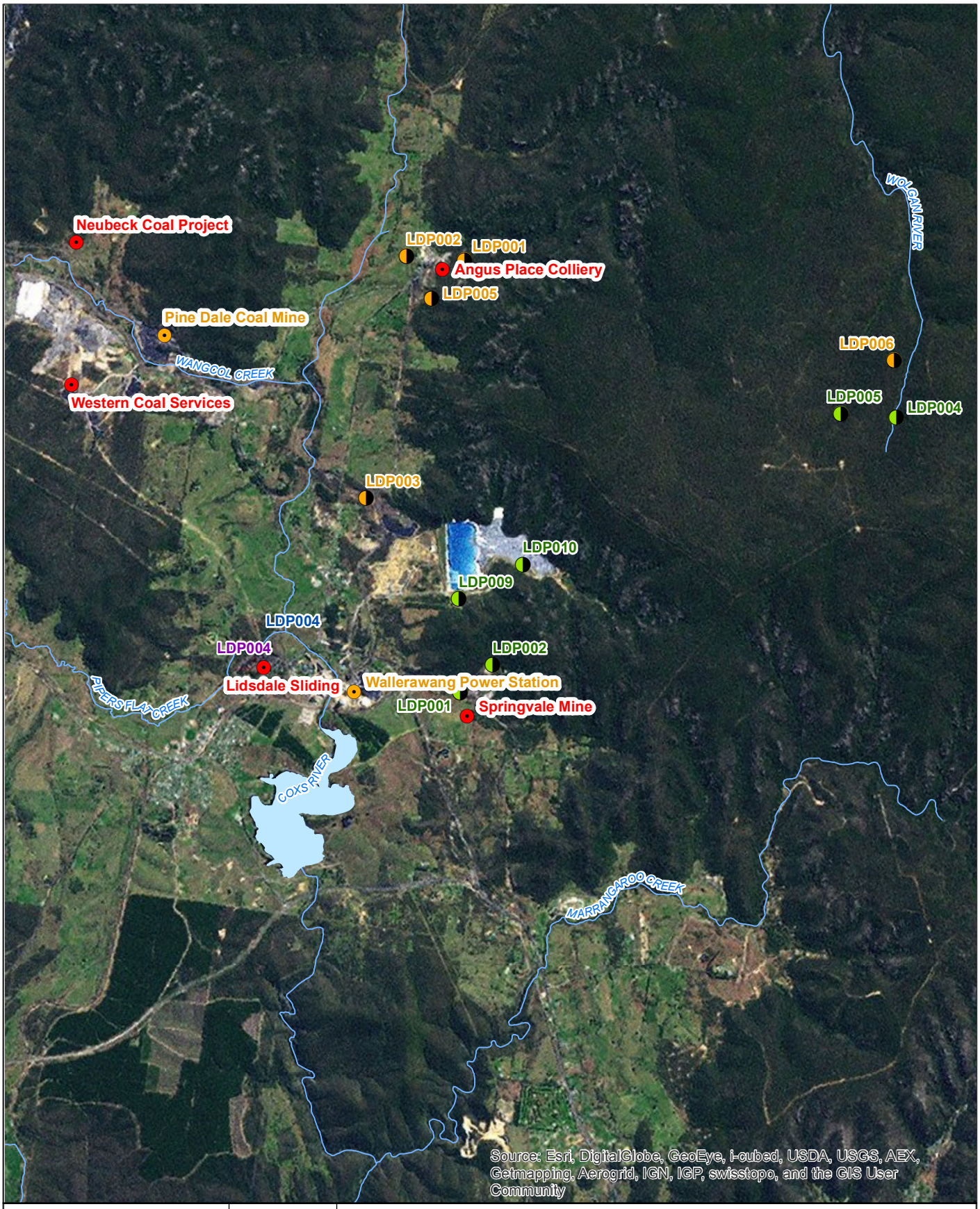
Table 1-2 Coxs River Flow Gauge Statistics

Statistic	Coxs River at Wallerawang Power Station (ML/day)	Coxs River at Bathurst Road (ML/day)	Coxs River at Upstream Lake Lyell (ML/day)	Coxs River at Lithgow (ML/day)	Coxs River at Island Hill (ML/day)
Average	25.5	61.6	29.4	119.7	216.2
Minimum	0.3	0.0	4.9	0.0	0.0
10th percentile	4.5	3.4	12.2	3.3	6.0
50th percentile	13.3	13.9	20.3	30.6	50.0
90th percentile	44.7	94.4	54.1	217.8	425.7
Maximum	4,315	33,729	267	29,319	77,439

1.2.2 Site Overviews

The following coal mining and power generation operations that have been considered in this ecotoxicology assessment, as presented in Figure 1-4:

- Angus Place Colliery – Underground coal mine currently seeking approval to extend mining operations. Mine water is primarily transferred to a pipeline and discharged via SV LDP009.
- Clarence Colliery – Underground coal mine operated by Centennial located in the Wollangambe River catchment, adjacent to the Coxs River catchment. Water transferred from Clarence Colliery to Lithgow City Council to supplement the town water supply may contribute to Farmers Creek, which is a tributary of Coxs River.
- Lidsdale Siding – Coal storage and rail loading facility operated by Centennial that receives coal from Western Coal Services for transport by rail to Port Kembla or Port of Newcastle for export.
- Mount Piper Power Station – Coal-fired power station owned by Energy Australia.
- Neubeck Coal Project – Proposed open cut coal mine currently seeking approval.
- Pine Dale Coal Mine – Open cut coal mine owned by Energy Australia that is currently under care and maintenance while seeking approval to continue mining operations.
- Springvale Mine – Underground coal mine currently seeking approval to extend mining operations. Mine water is transferred to a pipeline and discharged via SV LDP009.
- Wallerawang Power Station – Coal-fired power station owned by Energy Australia that is currently under care and maintenance.
- Western Coal Services – Coal processing facility operated by Centennial that provides coal storage, handling and processing functions. Coal is transported by overland conveyor to Mount Piper Power Station or Lidsdale Siding.



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Kilometres

Map Projection: Universal Transverse Mercator
Horizontal Datum: Geodetic Datum of Australia 1994
Grid: Map Grid of Australia, Zone 56

N

LEGEND

- Non Centennial Site
- Centennial Site
- Springvale LDP
- Angus Place LDP
- Waterway

LOCATION	-
SEAM	NA
DRAWN	S.M.
CHECKED	
APPROVED	S.Gray
SCALE	Refer to scalebar

Coxs River Ecotoxicology Assesssment

Site Locations

Centennial Coal

DATE 29/09/2014

Figure 1-4

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1.3 Discharge Locations

Environment Protection Licences (EPLs) are issued by the NSW EPA under the *Protection of the Environment Operations Act 1997*. Licence conditions relate to pollution prevention and monitoring and can control the air, noise, water and waste impacts of an activity. Each site operates under an EPL which specifies conditions under which water is to be discharged via LDPs. Table 1-3 summarises the licence conditions for Centennial's operations. Pine Dale Coal Mine and Wallerawang Power Station are both currently under care and maintenance and are understood to have ceased discharging to the Coxs River catchment.

Table 1-3 Licensed Discharge Points

Environment Protection Licence	Discharge point	Discharge limit	Description
Angus Place Colliery			
467	LDP001	2 ML/day	Discharge of mine water and runoff to Kangaroo Creek through wetlands.
	LDP002	No limit	Discharge of surface water from facilities area into the Coxs River through settling ponds.
	LDP003	No limit	Discharge of surface water from the old Kerosene Vale Colliery site into the Coxs River through a settling pond.
Clarence Colliery			
726	LDP001	No limit	Discharge from ventilation fan into Wollangambe River.
	LDP002	25 ML/day	Discharge of treated mine water into Wollangambe River.
	LDP003	No limit	Overflow from leachate dam into another dam that is part of the water management system.
	LDP004	No limit	Overflow from leachate dam into adjacent bushland and Wollangambe River.
Lidsdale Siding			
5129	LDP004	No limit	Discharge of surface water from facilities area into Pipers Flat Creek through settling ponds.
Springvale Mine			
3607	LDP001	10 ML/day	Discharge of mine water, surface water from facilities area and runoff into Springvale Creek through settling ponds.
	LDP009	30 ML/day	Discharge of mine water from Angus Place Colliery and Springvale Mine into Sawyers Swamp Creek.

Environment Protection Licence	Discharge point	Discharge limit	Description
Western Coal Services			
3607	LDP006	No limit	Discharge of surface water from facilities area into Wangcol Creek through settling ponds.

1.4 Water Management Strategies

The following three strategies are proposed for the management of mine water as part of the mine extension projects for Angus Place Colliery and Springvale Mine (RPS, 2014a):

- Water strategy WS1 – All mine water from Angus Place Colliery (up to 30.8 ML/day) is discharged via AP LDP001 and all mine water from Springvale Mine (up to 18.8 ML/day) is discharged via SV LDP009.
- Water strategy WS2a – Up to 30 ML/day of mine water from Angus Place Colliery and Springvale Mine is discharged via SV LDP009, consisting of all mine water from Springvale Mine and the remaining volume from Angus Place Colliery. Excess mine water from Angus Place Colliery is discharged via AP LDP001.
- Water strategy WS2b – 2 ML/day of mine water from Angus Place Colliery is discharged via AP LDP001 with the remaining mine water from Angus Place Colliery and Springvale Mine discharged via SV LDP009 (up to 43.4 ML/day).

It should be noted that WS2a is the current water strategy employed by Centennial at the time of water sampling.

1.5 Scope of Work

This report details the ecotoxicology assessment and provides the results for water quality testing at 12 locations within the Coxs River catchment, including mine water discharge from LDPs at Angus Place Colliery and Springvale Mine. The scope of work included the following:

- Provide details of sample collection at 12 sites in the Coxs River catchment and toxicity and water quality testing conducted.
- Interpret toxicity and water quality testing results for the 12 samples of water collected.
- Compare results with current and historical monitoring conducted by Centennial and with site-specific trigger values and EPL limits specified for licensed discharge points.
- Compare results with modelled catchment runoff within the Coxs River catchment, estimated from water balance modelling provided by RPS (2014a), to determine the dilution of mine water discharge downstream of AP LDP001 and SV LDP009.

2. Methodology

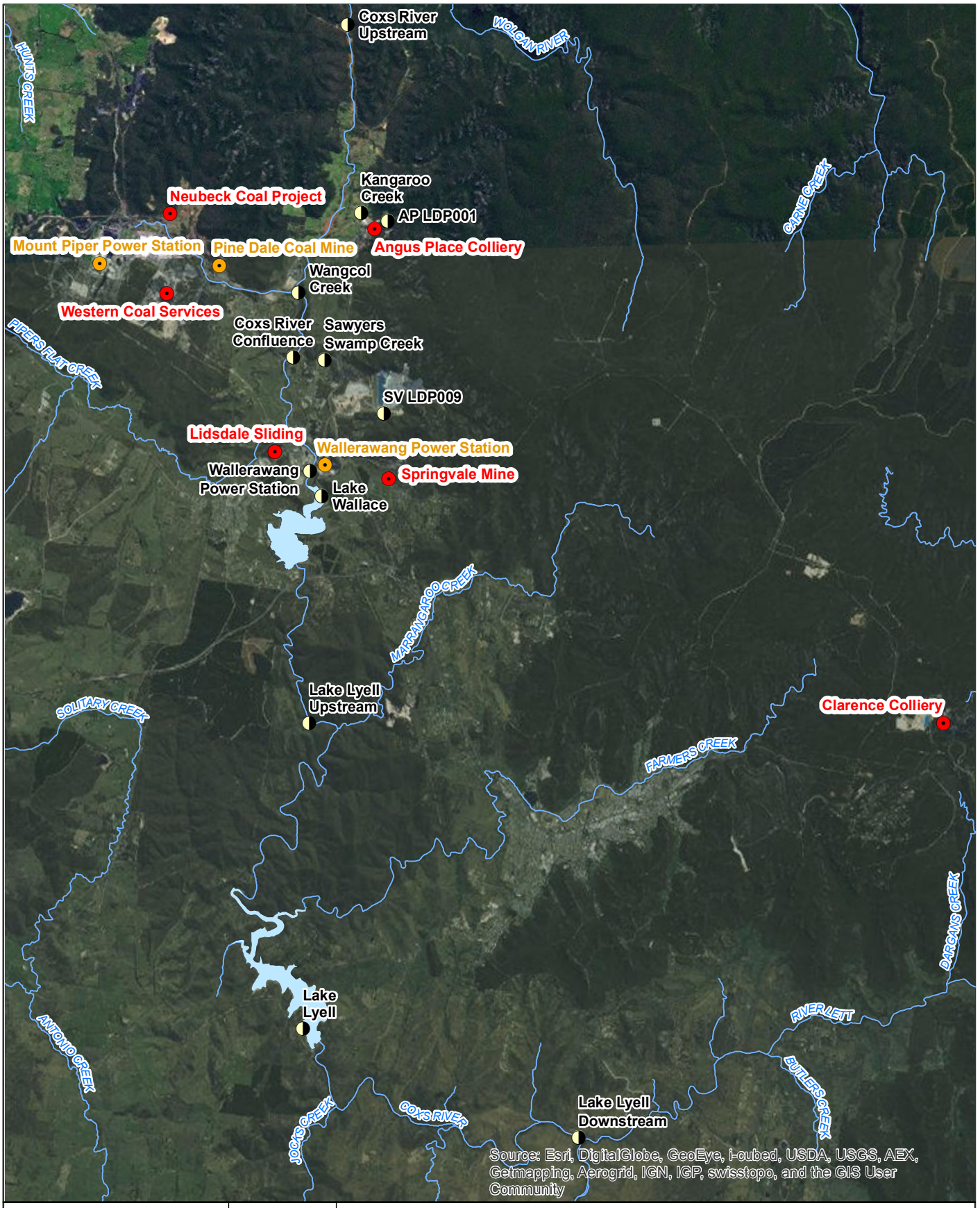
2.1 Sample Collection

Samples were collected on the 21 and 22 August 2014 at the following locations, as shown in Figure 2-1:

- Coxs River upstream – Coxs River upstream of Angus Place Colliery and Springvale Mine (at the same location tested by the NSW EPA).
- AP LDP001 – Mine water discharge from AP LDP001, which receives underground mine water and catchment runoff.
- Kangaroo Creek – Kangaroo Creek downstream of AP LDP001.
- Wangcol Creek – Wangcol Creek upstream of the confluence with Coxs River.
- SV LDP009 – Mine water discharge from SV LDP009, which receives underground mine water from both Angus Place Colliery and Springvale Mine.
- Sawyers Swamp Creek – Sawyers Swamp Creek downstream of discharges from SV LDP009 and upstream of confluence with Coxs River.
- Coxs River confluence – Coxs River downstream of the confluence with Sawyers Swamp Creek and discharges from Angus Place Colliery and Springvale Mine.
- Wallerawang Power Station – Coxs River downstream of discharges from Wallerawang Power Station.
- Lake Wallace – Upper portion of Lake Wallace.
- Lake Lyell upstream – Coxs River downstream of Lake Wallace and upstream of Lake Lyell.
- Lake Lyell – Upper portion of Lake Lyell.
- Lake Lyell downstream – Coxs River downstream of Lake Lyell.

A total of 45 L of water was collected at SV LDP009, 10 L at AP LDP001 and 1 L at all other sites with samples put on ice and immediately transferred to the Ecotox Services Australasia (ESA) laboratory in Sydney for toxicity testing. Samples from each location were also sent to the ALS Environmental Division laboratory in Sydney for water quality analysis.

Approximately 47.5 mm of rainfall was recorded at the Lithgow (Cooerwull) Bureau of Meteorology (BOM) station in the five days prior to sampling, as shown in Figure 2-2. The LDP discharges recorded at each Centennial site on the 21 and 22 August 2014 are presented in Table 2-1. Approximately 1 ML/day was discharged through AP LDP001 and 23 ML/day was discharged through SV LDP009.



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0 0.4 0.8 1.6 2.4 3.2

Kilometres

Map Projection: Universal Transverse Mercator
Horizontal Datum: Geodetic Datum of Australia 1994
Grid: Map Grid of Australia, Zone 56

N

LEGEND

- Non Centennial Site
- Centennial Site
- Sampling Site
- Waterway
- Waterbody

LOCATION	-
SEAM	NA
DRAWN	S.M.
CHECKED	
APPROVED	S.Gray
SCALE	Refer to scalebar

Coxs River Ecotoxicology Assesssment

Sampling Locations

Centennial Coal

DATE 29/09/2014

Figure 2-1

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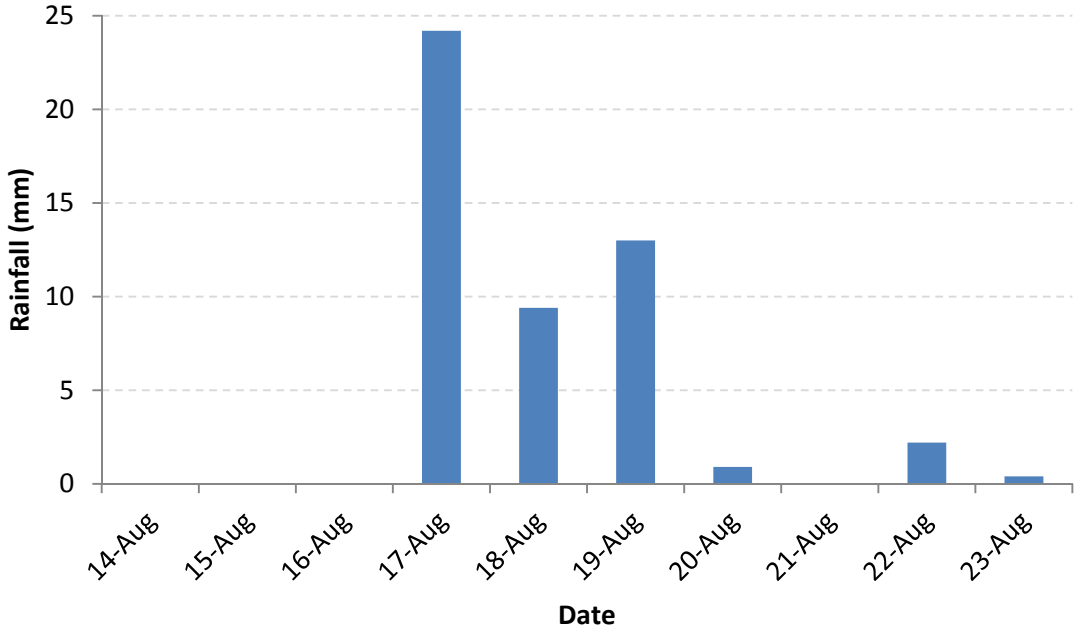


Figure 2-2 Recorded Rainfall Prior To and During Site Visit

Table 2-1 Recorded Discharges during Site Visit

Location	Discharge (ML/day)	
	21 August 2014	22 August 2014
Angus Place Colliery		
LDP001	1.017	1.184
LDP002	0.008	0.009
LDP003	No discharge	No discharge
Lidsdale Siding		
LDP004	No discharge	No discharge
Springvale Mine		
LDP001	1.183	1.232
LDP009	22.507	22.794
Western Coal Services		
LDP006	0.105	0.063

2.2 Ecotoxicology Assessment

2.2.1 Direct Toxicity Assessment

Direct toxicity assessment (DTA) is a common method used to determine the toxicity of mixtures of compounds in ambient waters. The method provides an integrated measure of effects and accounts for interactions (synergistic, additive and ameliorative) within a mixture, therefore closely simulating the effects in the receiving waterway. To ensure a close simulation of the toxic effects of the discharge, site-specific testing was undertaken using species indigenous to, or representative of, the receiving ecosystem.

DTA was undertaken for the mine water discharge samples from AP LDP001 and SV LDP009. Toxicity testing at all other locations was conducted using screening tests with the freshwater cladoceran, which has been found to be the most sensitive test species in previous toxicity testing conducted by Centennial in the region.

Toxicity testing involves exposing laboratory test species to a range of concentrations of sampled water for a specified exposure period. At the end of the exposure period, specific end points are assessed, such as species survival, reproduction or growth. Statistical analysis of the results provide the effect concentration (EC) of the sample where 10% (EC_{10}) and 50% (EC_{50}) of test organisms exhibit the specific end point and the no observable effect concentration (NOEC), which represents the highest concentration that has no effect upon the test species.

2.2.2 Species Tested

Toxicity testing of sampled water was performed using the ANZECC and ARMCANZ (2000) protocol with species endemic to, or representative of, the receiving environment. Where possible, chronic bioassays were performed using National Association of Testing Authorities (NATA) accredited tests.

The following freshwater species and test protocols were used to test the sample collected from SV LDP009 at Springvale Mine:

- Seven day partial life-cycle (chronic) test using the freshwater cladoceran *Ceriodaphnia cf. dubia*, based on the USEPA (2002) and Bailey *et al*. (2000) protocols.
- 72 hour microalgal growth inhibition (chronic) test using the green alga *Selanastrum capricornutum*, based on the USEPA (2002) protocol.
- 96 hour growth inhibition (chronic) test using the freshwater aquatic duckweed *Lemna disperma*, based on the OECD (2006) protocol.
- 96 hour population growth (acute) test using the freshwater hydra *Hydra viridissima*, based on Riethmuller *et al.* (2003).
- 96 hour imbalance (acute) test using the freshwater eastern rainbowfish *Melanotaenia splendida splendida*, based on USEPA (2002).

For the remaining 11 samples, the seven day partial life-cycle (chronic) toxicity test using the freshwater cladoceran *Ceriodaphnia cf. dubia* based on the protocol specified by USEPA (2002) was conducted. The cladoceran bioassay was selected as it has been found to be the most sensitive test species in previous toxicity testing conducted by Centennial in the region.

2.2.3 Concentrations Tested

ESA recommended the use of laboratory dilution water to provide a more accurate indication of the toxicity of the samples. ESA used in-house diluents for all dilutions and controls to ensure the toxicity observed can be attributed directly to the sample tested. All samples were serially diluted with the appropriate diluent to achieve the test concentration. This is important as toxicity tests conducted by the NSW EPA indicated that upstream samples may have a similar toxicity to the SV LDP009 discharge in some bioassays (NSW EPA, 2014).

For the samples of water collected at AP LDP001 at Angus Place Colliery and at SV LDP009 at Springvale Mine, the concentrations used in the toxicity testing were 0%, 6.3%, 12.5%, 25%, 50%, and 100%.

For the remaining 10 samples, screening tests with the cladoceran bioassay were conducted at 100% concentration (i.e. no dilution of samples).

2.3 Water Quality Assessment

Water samples were tested for the parameters listed in Table 2-2 at the NATA accredited facilities at the ALS Environmental Division Laboratory. This suite of analysis includes the parameters recently specified by the NSW EPA in Springvale Mine's EPL 3607. In addition, the dissolved oxygen (DO), electrical conductivity, pH, redox potential and turbidity were measured in the field prior to sample collection.

Table 2-2 Water Quality Parameters

Category	Parameter
Physicochemical parameters	Electrical conductivity, pH, total dissolved solids (TDS), total suspended solids (TSS).
Nutrients	Ammonia, dissolved organic carbon (DOC), nitrate and nitrite, total Kjeldahl nitrogen, total nitrogen, total phosphorus.
Anions	Alkalinity, chloride, sulfate.
Cations	Calcium, magnesium, potassium, sodium.
Metals (total and dissolved)	Aluminium, arsenic, barium, beryllium, boron, cadmium, chromium, cobalt, copper, iron, lead, manganese, mercury, molybdenum, nickel, selenium, strontium, vanadium and zinc.
Other	Bromide, cyanide (total and free), fluoride, oil and grease, silica.

The results were compared to site-specific trigger values (SSTVs) derived for discharge from AP LDP001 and SV LDP009 and limits specified by EPL 467 for AP LDP001 and EPL 3607 for SV LDP009, as shown in Table 2-3. The SSTVs adopted were based on a review of the water quality observed at a monitoring site on Kangaroo Creek upstream of Angus Place Colliery as presented by RPS (2014b; 2014c) and default trigger values recommended by ANZECC and ARMCANZ (2000). The numbers indicated in bold are those selected as the adopted trigger value for each parameter. SSTVs have been taken as the largest of the default trigger values (which have been hardness corrected where appropriate) and the 80th percentile upstream concentrations, in accordance with the methodology recommended by ANZECC and ARMCANZ (2000).

Table 2-3 Trigger Values and EPL Limits for Assessment of Water Quality

Parameter	Unit	80th percentile upstream value	Default trigger value	Adopted trigger value	AP LDP001 EPL limits	SV LDP009 EPL limits
Physicochemical parameters						
pH	pH units	**5.9**[a]–6.8	6.5–**8.0**	5.9–8.0	6.5–9.0	6.5–9.0
Electrical conductivity	µS/cm	89	**350**	350	–	1,200
TSS	mg/L	10	**25**	25	30	50
Turbidity	NTU	19.2	**25**	25	–	50
Nutrients						
Ammonia	mg/L	0.03	**0.9**	0.9	–	–
Nitrogen (total)	mg/L	**0.6**	0.25	0.6	–	–
Phosphorus (total)	mg/L	**0.06**	0.02	0.6	–	–
Anions						
Bicarbonate alkalinity	mg/L	20.8	–	225[b]	–	–
Sulfate	mg/L	6	–	644[c]	–	–
Filtered metals						
Aluminium	mg/L	**0.204**	0.055	0.204	–	0.45
Arsenic	mg/L	0.001[d]	**0.024**	0.024	–	0.024
Barium	mg/L	**0.0368**	–	0.0368	–	–
Boron	mg/L	**0.05**[d]	–	0.05	–	–
Cadmium	mg/L	0.0001[d]	**0.0005**[e]	0.0005	–	–
Chromium	mg/L	**0.001**[d]	–	0.001	–	–
Cobalt	mg/L	**0.005**	–	0.005	–	–
Copper	mg/L	**0.004**	0.003[e]	0.004	–	0.007
Iron	mg/L	**4.002**	0.3	4.002	–	0.4
Lead	mg/L	0.001[d]	**0.011**[e]	0.011	–	–

Parameter	Unit	80th percentile upstream value	Default trigger value	Adopted trigger value	AP LDP001 EPL limits	SV LDP009 EPL limits
Manganese	mg/L	0.4526	**1.9**	1.9	–	1.7
Mercury	mg/L	–	**0.0006**	0.0006	–	–
Nickel	mg/L	0.002	**0.025**[(e)]	0.025	–	0.047
Selenium	mg/L	0.01[(d)]	**0.11**	0.11	–	–
Zinc	mg/L	**0.019**	0.018[(e)]	0.019	–	0.05
Other parameters						
Cyanide (total)	mg/L	0.004[(d)]	**0.007**	0.007	–	–
Fluoride	mg/L	**0.1**[(d)]	–	0.1	–	1.8
Oil and grease	mg/L	**5**[(d)]	–	**5**	10	10

(a) 20th percentile value

(b) NSW OEH (2012)

(c) Elphick *et al.* (2011)

(d) Limit of reporting

(e) Hardness correction applied

The NSW OEH (2012) reports that bicarbonate is one of the more potentially toxic major ions to aquatic organisms. Bicarbonate has been found to be about two to 2.5 times more acutely toxic to cladoceran than chloride. There remains uncertainty regarding the most appropriate trigger value for bicarbonate in freshwater. A 95% species protection trigger value for bicarbonate of 225 mg/L was calculated by NSW OEH (2012) based on NOEC data generated from North American species described by Farag and Harper (2012).

A 95% species protection trigger value for sulfate of 644 mg/L was calculated using results from a suite of freshwater species bioassays for temperate freshwater systems with various hardness concentrations (Elphick *et al.* 2011). Elphick *et al.* (2011) used the EC_{10} results from a suite of nine species, many of them used in routine bioassays for DTA by Australian laboratories for temperate freshwater ecosystems. As shown by Elphick *et al.* (2011), increasing hardness reduces the toxicity of sulfate to freshwater temperate organisms similar to those living in the Coxs River and its tributaries.

2.4 Catchment Dilution Assessment

2.4.1 Statistical Analysis of Ecotoxicology Results

The BurrliOZ statistical analytical program (Campbell *et al.*, 2000) used the EC_{10} results from the sample collected at SV LDP009 to calculate the concentration of mine water discharge to protect 99%, 95%, 90% and 90% of species in the receiving environment from a 10% reduction in growth or reproduction. Dilution factors were then calculated for each species protection level, which can be used to assist in deriving site-specific concentrations of contaminants that will not adversely impact organisms within the receiving ecosystem. Concentrations of individual contaminants cannot be extrapolated from toxicity testing results for use as trigger values. However, concentrations can be used for monitoring purposes to ensure that the dilution factors are met at the appropriate monitoring site.

2.4.2 Catchment Runoff

An estimate of the runoff contributing to the Coxs River was obtained from the water balance model developed by RPS (2014a). The model represented all catchments contributing to Lake Burragorang, as shown in Figure 2-3, using the Australian Water Balance Model (AWBM) within the GoldSim Version 10.50 software modelling package. The AWBM is a catchment water balance model that calculates runoff from rainfall after allowing for relevant losses and storage. The AWBM is widely used throughout Australia and has been verified through comparison with large amounts of recorded streamflow data.

The catchments within the water balance model were categorised into the following land use types, each modelled with different AWBM parameters (RPS, 2014a):

- Natural.
- Pasture.
- Urban.
- Disturbed.
- Channel.

The AWBM parameters for each land use type were calibrated using historical rainfall data from the BOM and flow data from gauges on the Coxs River over the period from 1 January 1979 to 30 June 2014. Further details on the model methodology, calibration, parameters and data used are provided by RPS (2014a).

The daily catchment runoff volume were determined for 16 locations extending downstream of SV LDP009 at Springvale Mine to Lake Burragorang shown in Figure 2-4 using the median rainfall dataset applied within the water balance model by RPS (2014a). Catchment runoff was obtained from the water balance model without the contribution of other operations (Mount Piper Power Station, proposed Neubecks Coal Project and Pine Dale Coal Mine).

2.4.3 Dilution Factor

The estimated catchment runoff to the Coxs River at each location was compared to the predicted maximum daily discharge volume from AP LDP001 and SV LDP009 to determine the expected dilution of discharge within the river. The dilution factor was assessed for the three water management strategies discussed in Section 1.4.

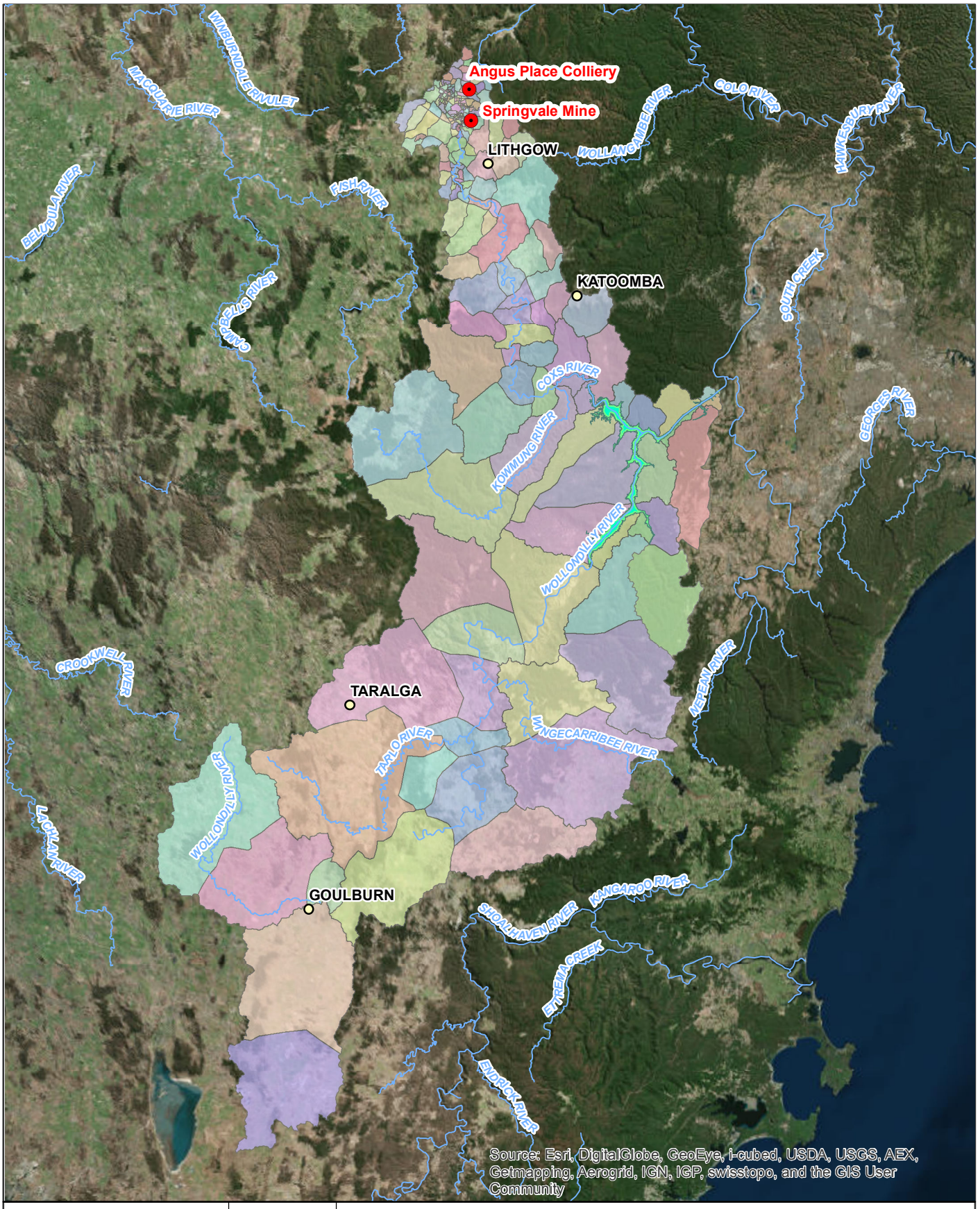
The predicted maximum daily discharge volumes from AP LDP001 and SV LDP009 over the life of each mine for the three water management strategies are presented in Table 2-4. These values were obtained from the water balance model provided by RPS (2014a).

Table 2-4 Predicted Maximum Daily Discharge through AP LDP001 and SV LDP009 (RPS, 2014a)

Water strategy	AP LDP001 discharge (ML/day)	SV LDP009 discharge (ML/day)	Total discharge (ML/day)
WS1	30.8	18.8	45.4*
WS2a	15.4	30	45.4
WS2b	2	43.4	45.4

* Peak daily discharges from AP LDP001 and SV LDP009 occur at different points in time, so the maximum total discharge does not equal the sum of the maximum discharge from the individual LDPs.

The predicted dilution within the Coxs River was compared to the dilution factor determined by the results of toxicity testing using the BurrliOZ statistical analytical program (Campbell *et al.*, 2000).



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0 3 6 12 18 24

Kilometres

Map Projection: Universal Transverse Mercator
Horizontal Datum: Geodetic Datum of Australia 1994
Grid: Map Grid of Australia, Zone 56

N

LEGEND

- Centennial Site
- Lake Burragorang
- Waterway

LOCATION	-
SEAM	NA
DRAWN	S.M.
CHECKED	
APPROVED	S.Gray
SCALE	Refer to scalebar

Coxs River Ecotoxicology Assesssment Catchments within Water Balance Model (RPS, 2014a)

Centennial Coal

DATE 29/09/2014

Figure 2-3

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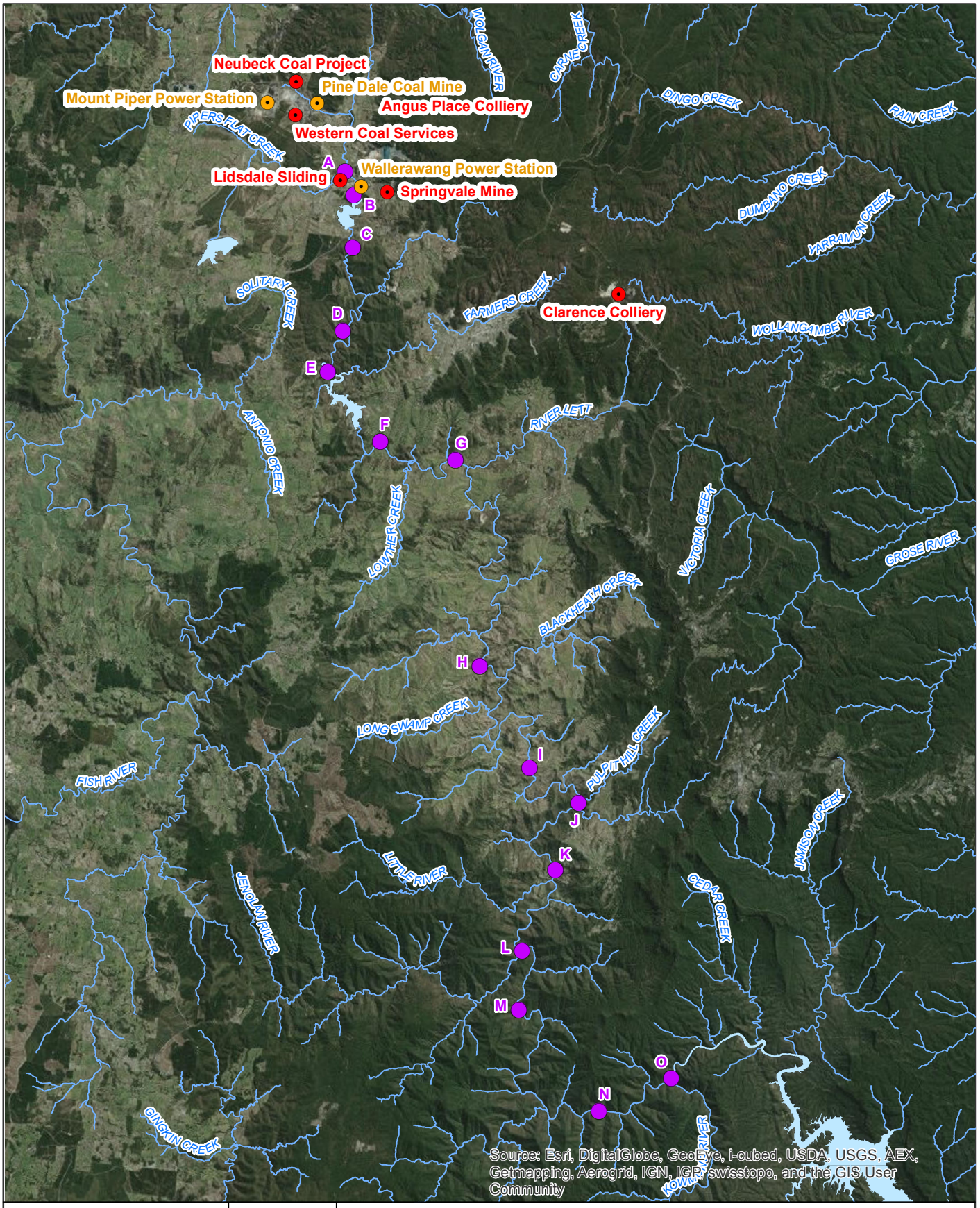

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0 0.751.5 3 4.5 6

Kilometres

Map Projection: Universal Transverse Mercator
Horizontal Datum: Geodetic Datum of Australia 1994
Grid: Map Grid of Australia, Zone 56

N

LEGEND

- Non Centennial Site
- Centennial Site
- Modelled Catchment Runoff Location
- Waterway
- Waterbody

LOCATION	-
SEAM	NA
DRAWN	S.M.
CHECKED	
APPROVED	S.Gray
SCALE	Refer to scalebar

Coxs River Ecotoxicology Assesssment

Catchment Runoff Locations

Centennial Coal

DATE 29/09/2014

Figure 2-4

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3. Results and Discussion

3.1 Ecotoxicology Assessment

The toxicity testing conducted by ESA fulfilled the criteria for NATA accredited tests with all quality assurance/quality control parameters being met. A copy of the toxicity report is provided in Appendix B and a summary of the results is presented in Table 3-1 for the samples collected at AP LDP001 and SV LDP009 and

Table 3-2 for the screening tests with the cladoceran bioassay. Screening bioassay results are considered to show toxicity if the results are <80% of the controls. This is based on the quality control parameter used by the testing laboratory.

As discussed in Section 2.2.1, statistical analysis of the toxicity testing results provide the concentration of the sample where 10% (EC_{10}) and 50% (EC_{50}) of test organisms exhibit the specific end point of the bioassay.

Table 3-1 Summary of AP LDP001 and SV LDP009 Ecotoxicology Results

Bioassay	Concentration (95% confidence limits)	
	EC_{10}	EC_{50}
SV LDP009 discharge		
Eight day cladoceran reproduction	9.3% (5.2%–16.0%)	29.1% (16.3%–50.3%)
72 hour microalgal growth inhibition	3.7% (2.3%–3.8%)	6.0% (5.5%–6.7%)
96 hour duckweed growth inhibition	>100%	>100%
96 hour hydra population growth	5.1% (2.4%–7.3%)	18.0% (13.9%–24.8%)
96 hour eastern rainbowfish imbalance	25% (0.0%–34.2%)	50% (41.7%–59.2%)
AP LDP001 discharge		
Eight day cladoceran reproduction	>100%	>100%

The results of toxicity testing of SV LDP009 discharge presented in Table 3-1 indicate that the discharge is toxic to the test species, with the alga, cladoceran and hydra species showing significant toxicity to the discharge. The alga was observed to have the most sensitivity to the discharge from SV LDP009. The duckweed test showed no toxicity to the discharge and the fish bioassay showed only slight sensitivity.

The results of testing of the sample collected at AP LDP001 indicate that the discharge of mine water from Angus Place Colliery is not toxic to the test species with the reproduction showing no difference to the control organisms at 100% concentration.

Table 3-2 Summary of Screening Ecotoxicology Results

Site	Location description	Reproduction (% of control)	Survival (%)	EC (µS/cm)
Laboratory control		100	90	187
Coxs River upstream	Coxs River upstream of Angus Place Colliery and Springvale Mine	1	40	42
AP LDP001	Mine water discharge from AP LDP001	140	90	1,038
Kangaroo Creek*	Kangaroo Creek downstream of AP LDP001	No data	No data	558
Wangcol Creek	Wangcol Creek upstream of the confluence with Coxs River	70	100	806
SV LDP009	Mine water discharge from SV LDP009	0	0	1,180
Sawyers Swamp Creek	Sawyers Swamp Creek downstream of discharges from SV LDP009 and upstream of confluence with Coxs River	4	80	1,089
Coxs River confluence	Coxs River downstream of the confluence with Sawyers Swamp Creek and discharges from Angus Place Colliery and Springvale Mine	29	100	1,007
Wallerawang Power Station	Coxs River downstream of discharges from Wallerawang Power Station	66	100	949
Lake Wallace	Upper portion of Lake Wallace	116	100	986
Lake Lyell upstream	Coxs River downstream of Lake Wallace and upstream of Lake Lyell	106	100	1,049
Lake Lyell	Upper portion of Lake Lyell	107	90	547
Lake Lyell downstream	Coxs River downstream of Lake Lyell	113	100	506

* Ecotoxicology testing was not possible during this round of testing and will be repeated as part of following rounds.

3.1 Water Quality Assessment

The water quality testing conducted by ALS fulfilled the criteria for NATA accredited tests with all quality assurance/quality control parameters being met, with the exception of pH and nitrite due to testing not being conducted within the appropriate holding times. A copy of the full report is provided in Appendix C and a summary of the results is presented in Table 3-3. The results are compared to SSTVs derived for discharge from AP LDP001 and SV LDP009 and limits specified by EPL 467 for AP LDP001 and EPL 3607 for SV LDP009, as shown in Table 2-3. Exceedances of the adopted trigger values have been shown in bold.

Table 3-3 Summary of Water Quality Assessment Results

Parameter	Unit	Coxs River upstream	AP LDP001	Kangaroo Creek	Wangcol Creek	SV LDP009	Sawyers Swamp Creek	Coxs River confluence	Wallerawang Power Station	Lake Wallace	Lake Lyell upstream	Lake Lyell	Lake Lyell downstream
Physicochemical parameters													
pH (field)	pH units	6.47	7.84	8.33	7.82	8.04	9.00	8.50	9.04	9.55	9.53	9.50	9.40
pH (lab)		5.69	8.01	8.28	6.98	8.21	8.73	8.47	8.4	8.41	8.65	8.42	8.28
DO	%	72	3.7	80	85	94.7	88.9	88.4	62.7	76.5	83.7	93.3	96.6
	mg/L	8.22	0.4	9	9.72	8.1	8.32	8.83	6.64	8.57	9.45	10.62	11.15
Electrical conductivity (field)	µS/cm	44.8	1,000	558	554	1,148	1,055	799	931	1,033	1,029	534	493
Electrical conductivity (lab)		39	1,050	591	823	1,200	1,100	1,030	973	1,010	1,080	557	516
Redox potential	mV	162	63	75	49	9.6	-22.8	51.3	-4.4	-11.9	-17.1	-13.7	-19.2
TDS	mg/L	25	682	384	535	780	715	670	632	656	702	362	335
Temperature	°C	9.4	9.4	6.9	9.5	22.9	18.5	15.2	12	10	9.8	9.4	9.3
Total hardness	mg/L	<1	116	64	244	2	7	76	101	96	82	50	65
TSS	mg/L	22	<5	13	5	19	10	10	<5	<5	<5	<5	<5

Parameter	Unit	Coxs River upstream	AP LDP001	Kangaroo Creek	Wangcol Creek	SV LDP009	Sawyers Swamp Creek	Coxs River confluence	Wallerawang Power Station	Lake Wallace	Lake Lyell upstream	Lake Lyell	Lake Lyell downstream
Turbidity	NTU	0.0	0.0	0.0	–	13.5	10.5	–	0.1	0.0	0.0	0.0	0.0
Nutrients													
Ammonia	mg/L	<0.01	<0.01	<0.01	0.02	0.44	0.09	0.06	0.04	0.03	<0.01	<0.01	<0.01
DOC	mg/L	48	17	14	7	55	66	6	5	6	42	20	24
Nitrite + nitrate	mg/L	0.24	0.34	0.02	<0.01	0.21	0.45	0.42	0.32	0.13	<0.01	0.14	0.04
Total Kjeldahl nitrogen	mg/L	<0.1	<0.1	<0.1	<0.1	0.6	0.1	0.2	0.2	0.3	0.2	0.3	0.2
Nitrogen (total)	mg/L	0.2	0.3	<0.1	<0.1	0.8	0.6	0.6	0.5	0.4	0.2	0.4	0.2
Phosphorus (total)	mg/L	<0.01	<0.01	<0.01	<0.01	0.02	0.01	0.01	0.02	0.01	0.02	0.01	0.02
Anions													
Bicarbonate alkalinity	mg/L	1	538	291	16	625	512	392	359	336	348	111	128
Total alkalinity	mg/L	1	538	291	16	625	572	414	375	352	388	113	128
Chloride	mg/L	8	10	10	34	6	6	15	16	20	18	16	16

Parameter	Unit	Coxs River upstream	AP LDP001	Kangaroo Creek	Wangcol Creek	SV LDP009	Sawyers Swamp Creek	Coxs River confluence	Wallerawang Power Station	Lake Wallace	Lake Lyell upstream	Lake Lyell	Lake Lyell downstream
Sulfate	mg/L	3	25	17	341	34	34	142	126	160	164	117	107
Cations													
Calcium	mg/L	<1	20	11	45	1	1	14	19	17	13	10	13
Magnesium	mg/L	<1	16	9	32	<1	1	10	13	13	12	6	8
Potassium	mg/L	<1	32	19	7	9	10	10	11	12	13	7	8
Sodium	mg/L	4	182	98	59	291	280	208	202	192	209	75	73
Dissolved metals													
Aluminium	mg/L	0.03	<0.01	0.02	0.02	0.01	0.03	0.02	0.02	0.01	<0.01	<0.01	<0.01
Arsenic	mg/L	<0.001	<0.001	<0.001	<0.001	0.024	0.021	0.014	0.01	0.006	0.004	<0.001	<0.001
Barium	mg/L	0.016	0.178	0.092	0.014	0.028	0.021	0.02	0.023	0.026	0.025	0.026	0.023
Beryllium	mg/L	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Boron	mg/L	<0.05	0.06	<0.05	0.14	0.07	0.07	0.1	0.08	0.12	0.18	0.09	0.08
Cadmium	mg/L	<0.0001	<0.0001	<0.0001	0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001
Chromium	mg/L	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Cobalt	mg/L	<0.001	<0.001	<0.001	0.006	<0.001	<0.001	0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Copper	mg/L	<0.001	0.001	0.002	0.003	<0.001	<0.001	<0.001	0.002	0.002	0.002	0.002	0.001

Parameter	Unit	Coxs River upstream	AP LDP001	Kangaroo Creek	Wangcol Creek	SV LDP009	Sawyers Swamp Creek	Coxs River confluence	Wallerawang Power Station	Lake Wallace	Lake Lyell upstream	Lake Lyell	Lake Lyell downstream
Iron	mg/L	0.09	<0.05	0.06	0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05
Lead	mg/L	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Manganese	mg/L	0.057	0.003	0.01	0.812	0.008	0.013	0.113	0.077	0.04	0.011	0.002	0.008
Mercury	mg/L	0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001
Molybdenum	mg/L	<0.001	0.012	0.006	<0.001	0.038	0.034	0.022	0.018	0.015	0.016	0.005	0.004
Nickel	mg/L	0.004	0.003	0.002	0.021	0.004	0.003	0.01	0.007	0.007	0.004	0.002	0.002
Selenium	mg/L	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Strontium	mg/L	0.009	0.117	0.079	0.188	0.03	0.028	0.083	0.088	0.117	0.139	0.12	0.109
Vanadium	mg/L	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Zinc	mg/L	0.011	0.016	0.012	0.037	0.007	0.005	0.012	0.016	0.047	0.005	<0.005	0.005
Total metals													
Aluminium	mg/L	0.05	0.02	0.05	0.11	0.19	0.19	0.14	0.1	0.07	0.06	0.02	0.04
Arsenic	mg/L	<0.001	<0.001	<0.001	<0.001	0.023	0.022	0.014	0.01	0.006	0.004	<0.001	<0.001
Barium	mg/L	0.016	0.194	0.089	0.011	0.027	0.024	0.023	0.022	0.025	0.025	0.023	0.02
Beryllium	mg/L	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Boron	mg/L	<0.05	0.07	<0.05	0.16	0.06	0.08	0.1	0.09	0.12	0.19	0.11	0.09

Parameter	Unit	Coxs River upstream	AP LDP001	Kangaroo Creek	Wangcol Creek	SV LDP009	Sawyers Swamp Creek	Coxs River confluence	Wallerawang Power Station	Lake Wallace	Lake Lyell upstream	Lake Lyell	Lake Lyell downstream
Cadmium	mg/L	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001
Chromium	mg/L	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Cobalt	mg/L	<0.001	<0.001	<0.001	0.005	<0.001	0.002	0.002	<0.001	<0.001	<0.001	<0.001	<0.001
Copper	mg/L	0.002	<0.001	0.002	<0.001	0.003	<0.001	<0.001	<0.001	<0.001	0.001	0.001	<0.001
Iron	mg/L	0.61	<0.05	0.23	0.3	0.3	0.24	0.31	0.2	0.1	0.05	<0.05	0.1
Lead	mg/L	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Manganese	mg/L	0.058	0.006	0.012	0.859	0.014	0.059	0.154	0.09	0.059	0.031	0.006	0.013
Mercury	mg/L	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001
Molybdenum	mg/L	<0.001	0.014	0.005	<0.001	0.036	0.039	0.026	0.021	0.017	0.018	0.005	0.005
Nickel	mg/L	<0.001	0.002	0.001	0.02	0.003	0.004	0.011	0.007	0.006	0.004	0.002	0.002
Selenium	mg/L	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Strontium	mg/L	0.007	0.117	0.066	0.18	0.015	0.025	0.081	0.087	0.116	0.131	0.106	0.097
Vanadium	mg/L	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Zinc	mg/L	0.009	0.01	0.014	0.027	0.017	0.009	0.014	0.008	<0.005	<0.005	<0.005	<0.005
Other parameters													
Bromide	mg/L	<0.010	0.067	0.035	0.092	0.046	0.057	0.082	0.082	0.074	0.065	0.076	0.063

Parameter	Unit	Coxs River upstream	AP LDP001	Kangaroo Creek	Wangcol Creek	SV LDP009	Sawyers Swamp Creek	Coxs River confluence	Wallerawang Power Station	Lake Wallace	Lake Lyell upstream	Lake Lyell	Lake Lyell downstream
Cyanide (free)	mg/L	<0.004	<0.004	<0.004	<0.004	<0.004	<0.004	<0.004	<0.004	<0.004	<0.004	<0.004	<0.004
Cyanide (total)	mg/L	<0.004	<0.004	<0.004	<0.004	<0.004	<0.004	<0.004	<0.004	<0.004	<0.004	<0.004	<0.004
Fluoride	mg/L	<0.1	1	0.7	0.2	1.5	1.8	1.3	1.1	1.1	1.1	0.6	0.6
Oil and grease	mg/L	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5
Silica	mg/L	9.4	8.6	9.7	7.5	8.6	8.5	7.8	7.8	3.9	1	0.2	1.8

As seen in Table 3-3, water quality results show that the majority of sites exceed the adopted trigger values for pH, electrical conductivity, total nitrogen, total phosphorus, bicarbonate alkalinity and bromide. AP LDP001 exceeded the adopted trigger value for barium and the value for dissolved zinc was exceeded at Lake Wallace and Wangcol Creek.

The underground water discharges from Angus Place Colliery and Springvale Mine via AP LDP001 and SV LDP009 were found to be slightly alkaline and fresh to slightly brackish, with a sodium bicarbonate (Na-HCO_3) type.

The change in water type throughout the catchment is shown by the Stiff diagrams in Figure 3-1. A Stiff diagram is a graphical representation of major ion concentrations in water. The greater the area of the polygon presented in the Stiff diagram, the higher the ionic concentration (or electrical conductivity) of the water.

As shown in Figure 3-1, the upper Coxs River catchment is sodium magnesium chloride (Na-Mg-Cl) type water. Mixing of inputs from Wangcol Creek (Mg-Na-Ca-SO_4 water type) and discharges from Angus Place Colliery and Springvale Mine result in a sodium bicarbonate sulfate (Na-HCO_3-SO_4) water type. This is the dominant water type from the confluence of Sawyers Swamp Creek with Coxs River to downstream of Lake Lyell, with the electrical conductivity reducing with distance downstream.

3.2 Catchment Dilution Assessment

3.2.1 Statistical Analysis of Ecotoxicology Results

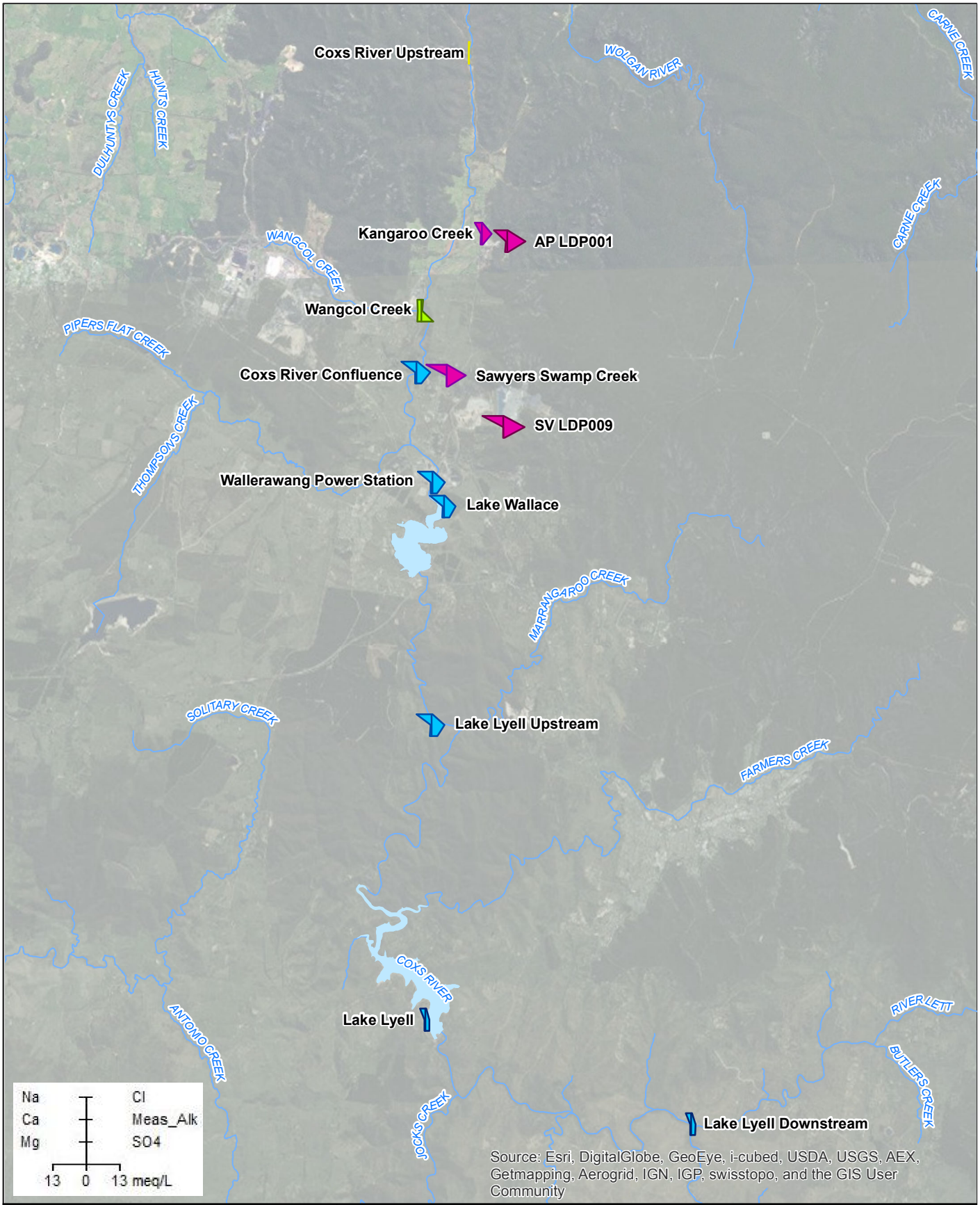
The EC_{10} values presented in Table 3-1 for SV LDP009 discharge were analysed in the BurrliOZ software package (Campbell *et al*., 2000) and the concentration for varying species protection levels were calculated, as shown in Table 3-4. A concentration of SV LDP009 discharge of 2.7% was determined to provide protection to 95% of species in the downstream ecosystem. To reach a concentration of 2.7%, a dilution factor of 1:37 is required.

Table 3-4 Dilution Factor Determined from Ecotoxicology Results

Species protection (%)	Concentration of SV LDP009 (%)	Dilution factor
80	5.1	1:20
90	3.6	1:28
95	2.7	1:37
99	1.7	1:59

3.2.1 Catchment Runoff

The daily catchment runoff determined at locations A to O presented in Figure 2-4 are provided in Table 3-5. Median results are presented along with 10th percentile and 90th percentile values to provide an indication of the possible range of values expected. The median, or 50th percentile, represents the value at which half of the modelled outputs were less than this value. Similarly, the 10th and 90th percentile results represent the values at which 10% and 90% of the modelled outputs were less than these values respectively. The 10th percentile and 90th percentile results have been used (rather than absolute minimum and maximum values) to remove the impact of skewing by infrequent to extreme wet and dry conditions.



1:130,000 for A4

0 0.4 0.8 1.6 2.4 3.2

Kilometres

Map Projection: Universal Transverse Mercator
Horizontal Datum: Geodetic Datum of Australia 1994
Grid: Map Grid of Australia, Zone 56

N

LEGEND

- Waterway
- Waterbody
- Mg-Na-Ca-SO_4
- Na-Mg-Cl
- Na-HCO_3-SO_4
- Na-HCO_3

LOCATION	-
SEAM	NA
DRAWN	S.M.
CHECKED	
APPROVED	S.Gray
SCALE	Refer to scalebar

Coxs River Ecotoxicology Assesssment

Stiff Diagrams

Centennial Coal

DATE 29/09/2014

Figure 3-1

GIS Filename: G:\22\0105001\GIS\Maps\Deliverables\Western\Angus Place\2217471\2217471_003_StiffDiagrams_A.mxd

Table 3-5 Modelled Catchment Runoff

Location	Catchment runoff volume (ML/day)		
	10th percentile	50th percentile	90th percentile
A	0.63	2.33	23.58
B	1.18	3.19	40.29
C	0.70	0.70	39.76
D	1.54	4.14	67.03
E	1.83	5.07	72.84
F	2.29	7.67	39.68
G	2.32	8.31	67.03
H	2.42	10.36	181.12
I	2.44	11.56	243.86
J	2.46	13.16	310.72
K	3.83	24.33	399.82
L	5.45	30.68	471.66
M	10.84	51.90	594.91
N	15.20	68.74	692.29
O	16.07	71.70	717.06

3.2.2 Dilution Factor

The predicted dilution of SV LDP009 discharges by catchment runoff for each location is presented in Table D-1, Table D-2 and Table D-3 of Appendix D for water strategy WS1, WS2a and WS2b respectively. The predicted dilution of total discharges from AP LDP001 and SV LDP009 is presented in Table D-4 of Appendix D. The results presented in Table D-4 apply to all three water strategies, as the predicted total maximum daily discharge of 45.4 ML/day is the same for each strategy.

3.3 Discussion

3.3.1 Ecotoxicology Assessment

The water quality results for SV LDP009 shown in Table 3-3 do not indicate any parameters that are present in concentrations that could cause the significant toxicity observed in the ecotoxicology results presented in Table 3-1. Furthermore, the chemistry of discharge from AP LDP001, which did not show any toxicity in the cladoceran bioassay, was found to be very similar to that of SV LDP009. The cause of the toxicity of SV LDP009 discharge observed may be related to treatment with flocculants prior to discharge. This potential cause of toxicity is recommended to be investigated, as the treatment is the only difference between AP LDP001 discharges (no toxicity) and SV LDP009 discharges (significant toxicity).

The screening bioassay results show that the Coxs River upstream site exhibits significant toxicity to cladoceran reproduction and survival tests. This site had low electrical conductivity and the associated ionic imbalance may be responsible for the observed toxicity, as it places the organisms under osmotic stress.

AP LDP001 discharges showed no significant difference in cladoceran survival and an increased reproduction when compared to the control. The Kangaroo Creek site was not tested for toxicity in this study; however the sampling conducted by the NSW EPA in May 2014 did not show any toxicity at this site with an electrical conductivity of 820 µS/cm.

The Wangcol Creek sample showed that there was a slight toxic impact on the cladoceran with a 37% decrease in reproduction. It is unlikely that the slightly elevated zinc detected at this site would be contributing to all of the observed toxicity.

The sample taken at Sawyers Swamp Creek showed an improvement in cladoceran survival when compared to the SV LDP009 discharge with an 80% survival rate; however reproduction was still significantly decreased. Further downstream in the Coxs River, the cladoceran survival rate improved and was not significantly different from control test at this and all the other downstream sampling locations. The cladoceran reproduction rate was still significantly impacted at the sites on the Coxs River downstream of Sawyers Swamp Creek confluence and downstream of Wallerawang Power Station. The rate of cladoceran reproduction was above the control rate from the upper portion of Lake Wallace and at all other sites downstream of this location.

The electrical conductivity results for each site and the associated cladoceran reproduction toxicity results are shown in Figure 3-2. A linear regression has been conducted on the results, which shows an R^2 value of 0.0018, indicating that there is no correlation between toxicity and electrical conductivity.

Bicarbonate alkalinity has also been suggested by the NSW OEH (2012) as a potential toxicant in coal mine discharge water. The bicarbonate alkalinity results for each site and the associated cladoceran reproduction toxicity results are shown in Figure 3-3. A linear regression has been conducted on the results, which shows an R^2 value of 0.0099, indicating that there is no correlation between toxicity and bicarbonate alkalinity.

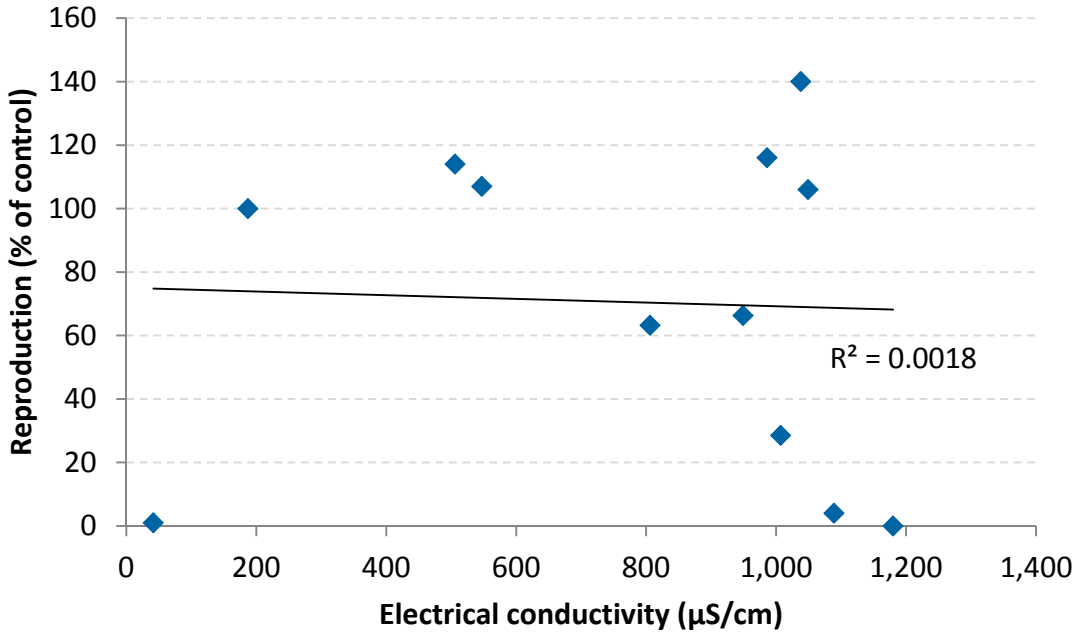


Figure 3-2 Reproduction Toxicity and Electrical Conductivity Results

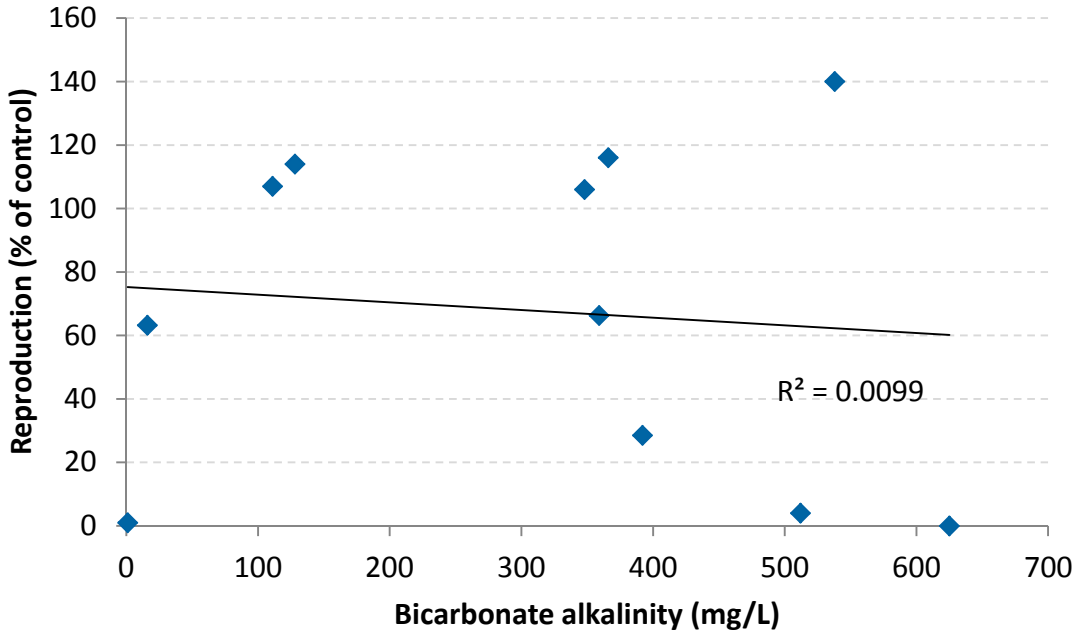


Figure 3-3 Reproduction Toxicity and Bicarbonate Alkalinity Results

3.3.2 Dilution Factor

The target dilution of SV LDP009 discharge to 2.7% (refer Section 3.2.1) is not met under median rainfall conditions. Under 90th percentile rainfall conditions, the target dilution is achieved for water strategy WS1 from Location N, which is situated approximately 5 km upstream of Lake Burragorang. The results indicate that the target dilution of SV LDP009 discharge is not met for water strategies WS2a or WS2b or for the total maximum discharge (AP LDP001 plus SV LDP009 discharges) under any rainfall conditions.

3.3.3 Integrated Catchment Assessment

The aquatic ecological health of the Coxs River has been reported by Cardno (2014a; 2014b), based on monitoring conducted in accordance with the Australian Rivers Assessment System (AUSRIVAS) protocols (Turak *et al.*, 2004). Monitoring of the following four sites on the Coxs River, as shown in Figure 3-4 has been conducted from 2010 to 2012:

- CR1 – Located 700 m upstream of AP LDP001.
- CR2 – Located at the Mount Piper Haul Road crossing, approximately 1 km downstream of AP LDP001.
- CR4 – Located at the Maddox Lane road crossing downstream of AP LDP001, SV LDP009 and discharges from Western Coal Services.
- CR5 – Located at the Main Street road crossing downstream of AP LDP001, SV LDP009 and discharges from Wallerawang Power Station.

Table 3-6 presents the electrical conductivity at each sampling site during aquatic ecology monitoring. Electrical conductivity was found to increase at CR2 downstream of AP LDP001 discharges. However, there were no significant spatial or temporal trends in electrical conductivity during the sampling period between CR2, CR4 and CR5.

1:45,000 for A4

0 0.125 0.25 0.5 0.75 1

Kilometres

Map Projection: Universal Transverse Mercator
Horizontal Datum: Geodetic Datum of Australia 1994
Grid: Map Grid of Australia, Zone 56

N

LEGEND

- Non Centennial Site
- Centennial Site
- Aquatic Ecology Monitoring Location
- Waterway
- Waterbody

LOCATION	-
SEAM	NA
DRAWN	S.M.
CHECKED	
APPROVED	S.Gray
SCALE	Refer to scalebar

Coxs River Ecotoxicology Assesssment

Aquatic Ecology Monitoring Locations (Cardno, 2014a, 2014b)

Centennial Coal

DATE 29/09/2014

Figure 3-4

GIS Filename: G:\22\0105001\GIS\Maps\Deliverables\Western\Angus Place\2217471\2217471_009_AquaticEcologyMonitoring_A.mxd

Table 3-6 Electrical Conductivity Recorded at Aquatic Ecology Monitoring Points (Cardno, 2014a; 2014b)

Monitoring round	Electrical conductivity (µS/cm)			
	CR1	CR2	CR4	CR5
Autumn 2010	–	944	–	829
Spring 2010	186	560	666	558
Autumn 2011	141	749	930	860
Spring 2011	182	939	853	764
Autumn 2012	92	542	640	704
Spring 2012	99	891	837	817

The assessment of aquatic ecology by Cardno (2014a; 2014b) used a number of indices to assess the condition of each monitoring site, including the following:

- SIGNAL 2 biotic index.
- NSW AUSRIVAS model results.

The SIGNAL2 score (Stream Invertebrate Grade Number Average Level) is a biotic index based on pollution sensitivity values (grade numbers) assigned to aquatic macroinvertebrate families. Each taxon is assigned a grade from 1 (tolerant) to 10 (sensitive) based on ecotoxicity assessment data. A score of less than 4 indicates severe degradation. The average SIGNAL 2 scores for each of the aquatic ecology monitoring sites is presented in Table 3-7. The results show there is a general trend for macroinvertebrate community assemblage improvement at CR2 and a slight decrease at CR5. However, all sites fit in the moderately degraded category and there are no significant differences between the aquatic ecology community health at all sites.

Table 3-7 Aquatic Ecology SIGNAL 2 Score (Cardno, 2014a; 2014b)

Monitoring round	CR1	CR2	CR4	CR5
Autumn 2010	–	3.6	–	4.0
Spring 2010	4.0	4.0	4.1	4.3
Autumn 2011	4.1	4.7	4.1	4.0
Spring 2011	4.2	4.4	4.6	3.9
Autumn 2012	4.4	4.3	4.6	3.9
Spring 2012	3.9	4.6	3.9	3.7

The NSW AUSRIVAS model provides a river health assessment based on predictive models of macroinvertebrate distribution. Physical and chemical data at each site was used to determine the predicted composition of the macroinvertebrate fauna. The AUSRIVAS morel compares the macroinvertebrate collected at a site (i.e. observed) to those predicted to occur (i.e. expected) at undisturbed reference sites with similar environmental characteristics. An OE50 score was generated, which is a probability score based on predicted occurrence of macroinvertebrate species which ranges from 0 to 1. A score close to 0 indicates an impoverished assemblage and a score close to 1 indicates similarity to the reference site. The following bands are derived from OE50 scores which indicate the level of impact at a site:

- Band A – equivalent to reference condition.
- Band B – below reference condition (significantly impaired).
- Band C – well below reference condition (severely impaired).
- Band D – impoverished (i.e. extremely impaired).
- Band X – richer macroinvertebrate assemblage than reference condition.

Table 3-8 presents the AUSRIVAS bands for each of the aquatic ecology monitoring sites reported by Cardno (2014a; 2014b). The results indicate that prior to spring 2012, the upstream Coxs River site CR1 was below the reference condition that was expected for an uncontaminated site. The results also show an improvement within macroinvertebrate communities during the sampling periods upstream of CR5.

Table 3-8 Aquatic Ecology AUSRIVAS Bands (Cardno, 2014a; 2014b)

Monitoring round	CR1	CR2	CR4	CR5
Autumn 2011	B	B	B	A
Spring 2011	B	B	B	A
Autumn 2012	B	A	B	B
Spring 2012	A	A	A	B

4. Conclusions

4.1 Ecotoxicology Assessment

The spatial distribution of the sample locations and the toxicity and water quality testing methodologies are considered sufficient to provide information on impacts of mine water discharge from Angus Place Colliery and Springvale Mine on the receiving environment. The results show that the discharge at SV LDP009 is having an acute impact on cladoceran at the Sawyers Swamp Creek site; however this acute toxicity is ameliorated as the discharge enters the Coxs River. Impacts on cladoceran reproduction show a decreasing trend in the Coxs River with distance downstream of the SV LDP009 discharge point until no toxic impacts are detected in the upper portion of Lake Wallace.

The toxicity of the SV LDP009 discharge cannot be attributed to any of the water quality parameters tested. The water quality results indicate that the chemistry of the non-toxic AP LDP001 discharge is not significantly different from the toxic SV LDP009 discharge. The toxicity observed is not able to be attributed to electrical conductivity or to bicarbonate alkalinity. Further investigations are required to determine the source of the toxicity. Once the source of the toxicity has been identified, management actions can be applied to ensure that the toxicity of the discharge is reduced, thus reducing the impact on the Coxs River.

4.2 Integrated Catchment Assessment

The aquatic ecology monitoring results provide supporting evidence that the discharges from AP LDP001 and SV LDP009 are not adversely impacting the aquatic health of the Coxs River. This information supports the findings of the ecotoxicological assessment showing that the electrical conductivity of the Coxs River is not adversely impacting the health of the aquatic ecosystem. Further, the sites downstream of discharges from AP LDP001 were found to have more pollution sensitive taxa present in the macroinvertebrate assemblages (CR2 = 9; CR4 = 6; CR5 = 6) than the upstream CR1 site, which had five pollution sensitive taxa present.

4.3 Coxs River Restoration Program

Centennial has developed the Coxs River Restoration Program as part of a regional biodiversity strategy (RPS, 2014d) that is aimed at further enhancing the biodiversity values of the Coxs River catchment and ameliorating the cumulative impacts associated with Centennial projects and non-Centennial operations in the catchment. Works to improve the terrestrial and aquatic biodiversity value of the Coxs River include the following:

- Watercourse stabilisation activities.
- Removal of grazing pressures.
- Weed removal/control (including blackberry and willow).
- Restoration of riparian areas.
- Revegetation activities with native species.

Further information on the Coxs River Restoration Program is provided by RPS (2014d).

4.4 Assessment Review

It is proposed that Centennial repeat the sampling for this ecotoxicology assessment on a three yearly basis dependent upon water quality results from the assessment locations.

5. References

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Appendices

Appendix A – Flow Gauge Figures

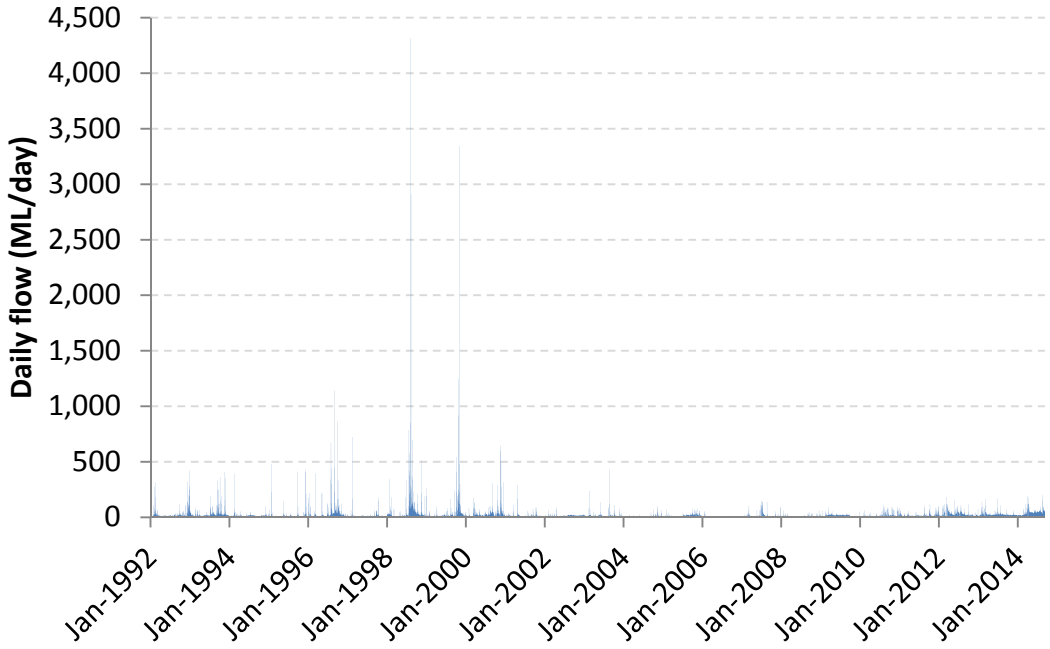


Figure A-1 Observed Flows for Coxs River at Wallerawang Power Station Gauge

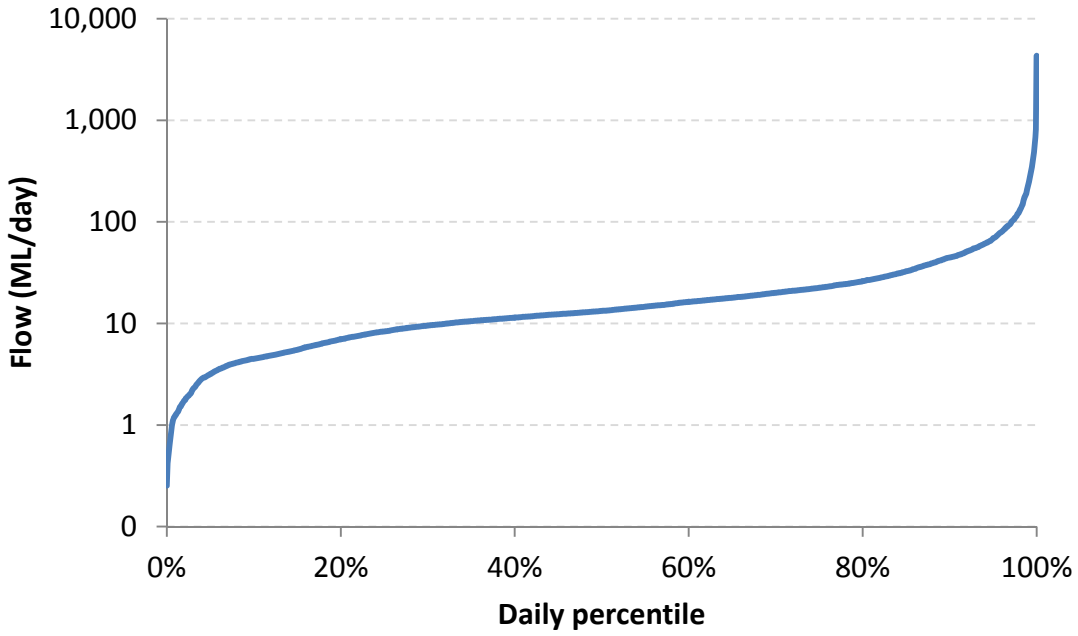


Figure A-2 Daily Flow Percentiles for Coxs River at Wallerawang Power Station Gauge

Coxs River at Bathurst Road Gauge

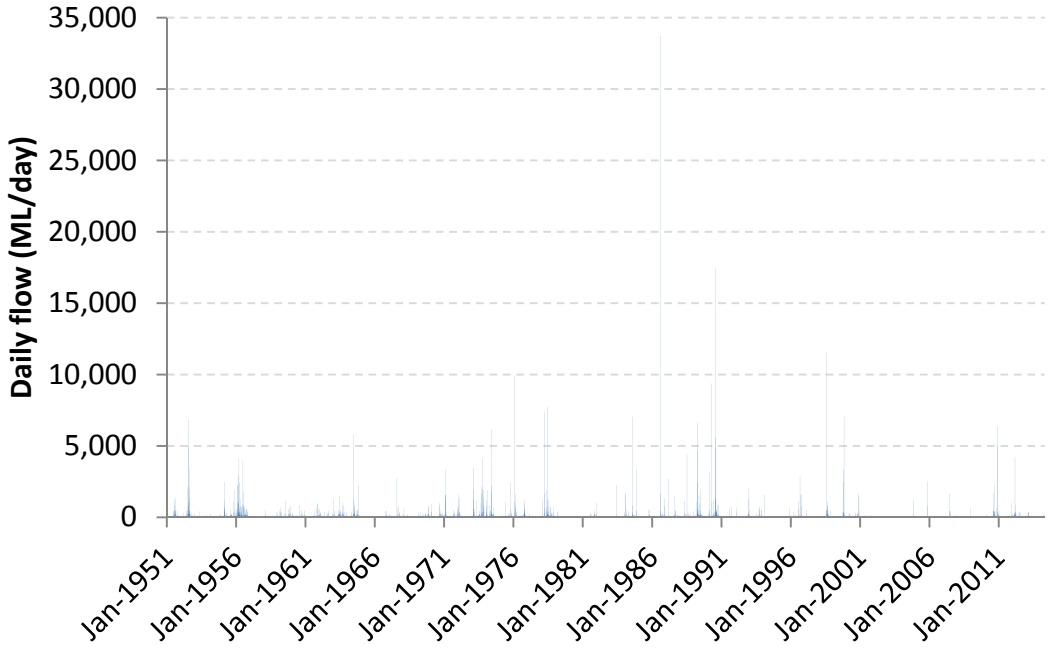


Figure A-3 Observed Flows for Coxs River at Bathurst Road Gauge

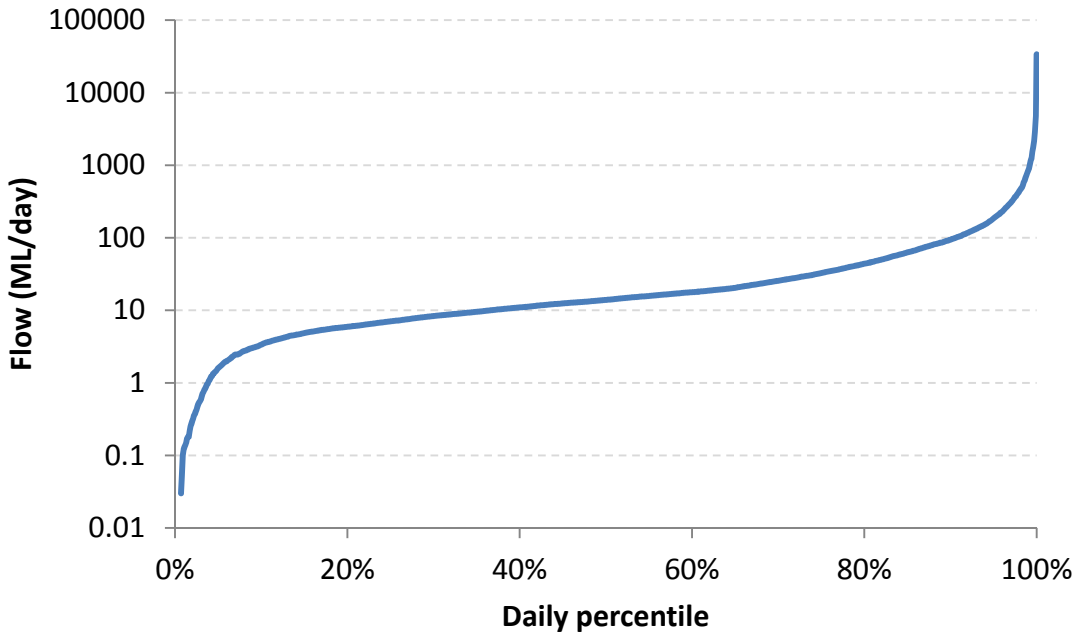


Figure A-4 Daily Flow Percentiles for Coxs River at Bathurst Road Gauge

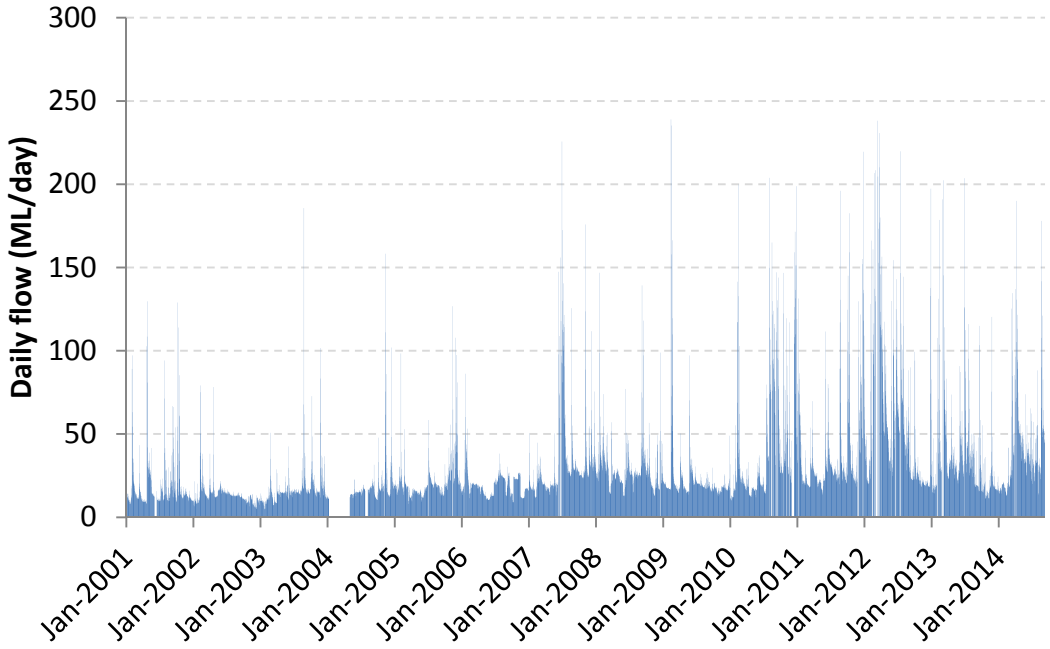


Figure A-5 Observed Flows for Coxs River at Upstream Lake Lyell Gauge

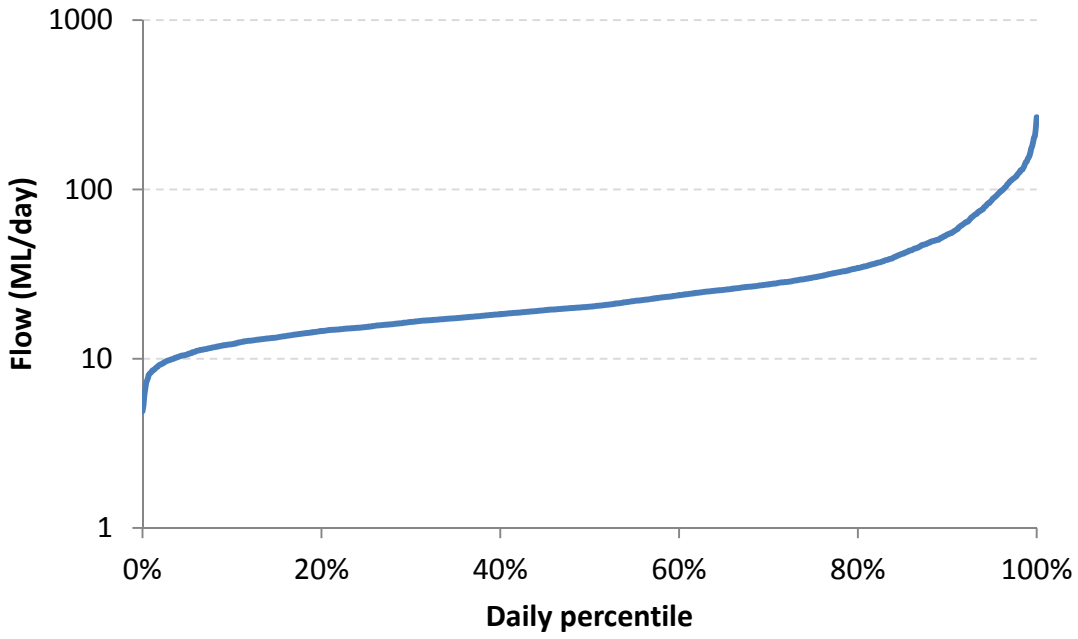


Figure A-6 Daily Flow Percentiles for Coxs River at Upstream Lake Lyell Gauge

Coxs River at Lithgow Gauge

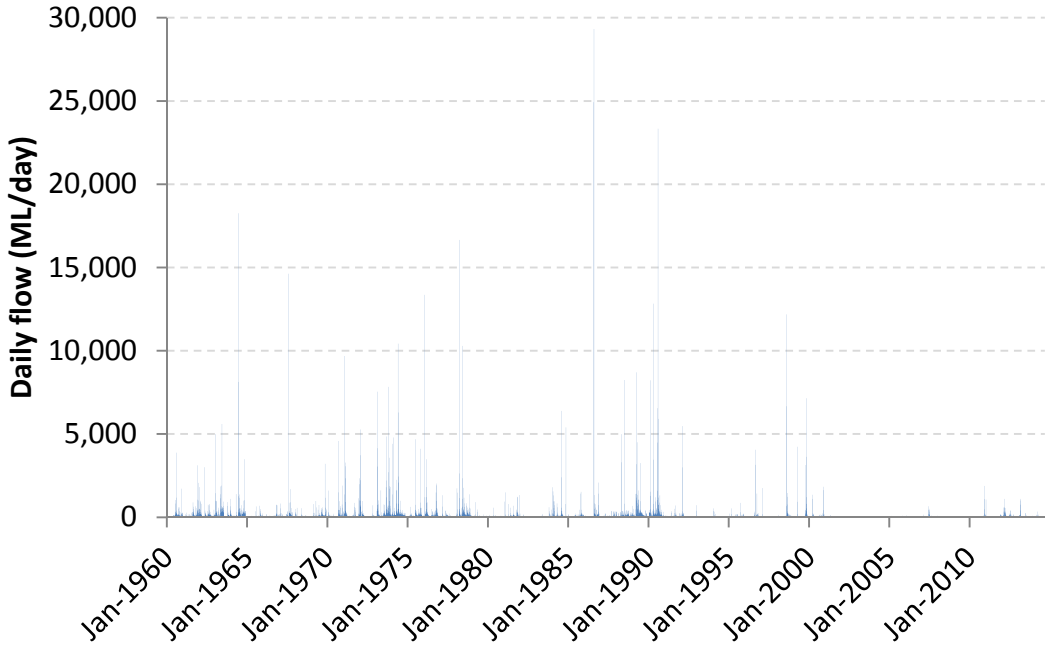


Figure A-7 Observed Flows for Coxs River at Lithgow Gauge

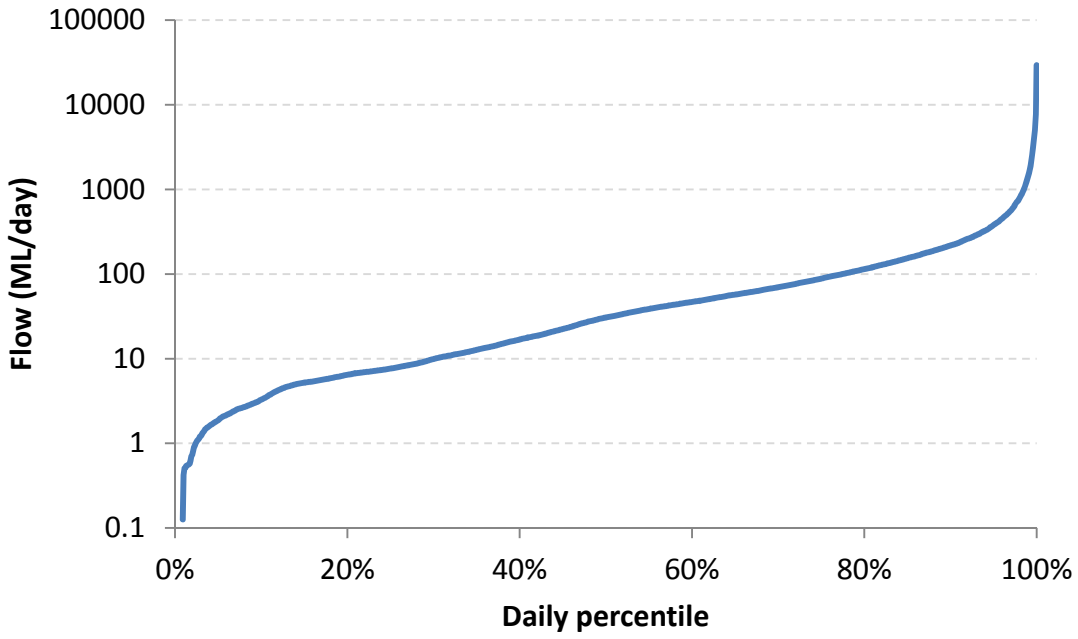


Figure A-8 Daily Flow Percentiles for Coxs River at Lithgow Gauge

Coxs River at Island Hill

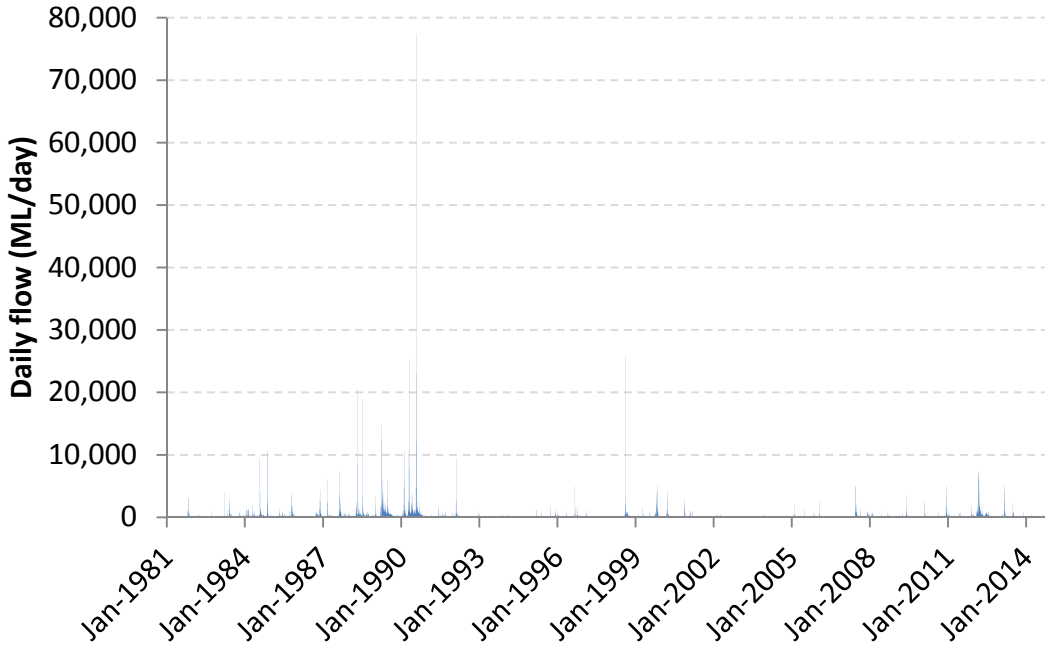


Figure A-9 Observed Flows for Coxs River at Island Hill Gauge

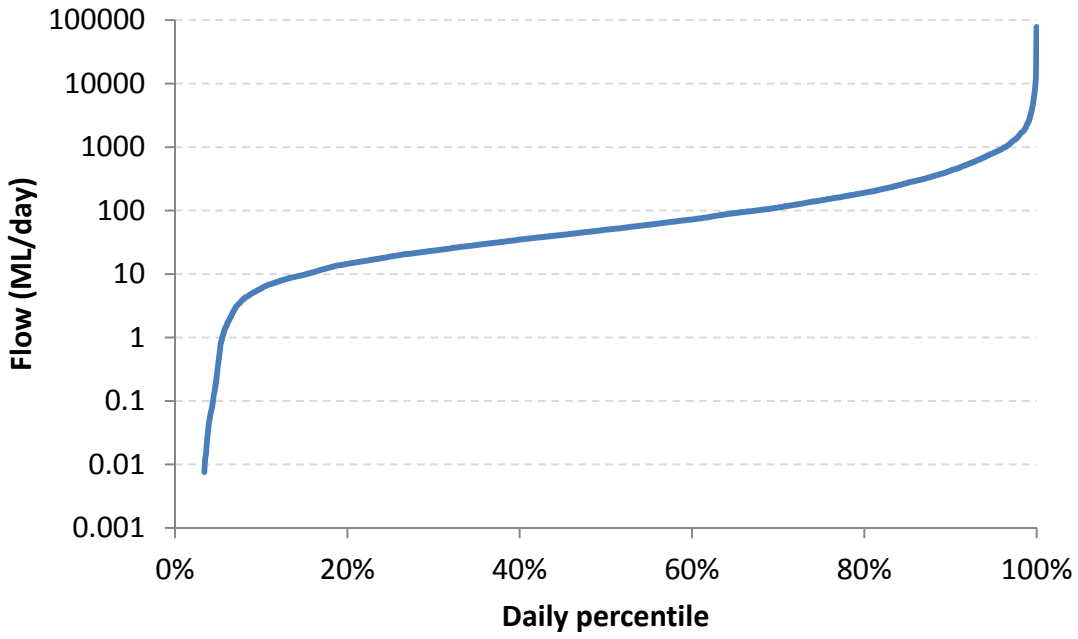


Figure A-10 Daily Flow Percentiles for Coxs River at Island Hill Gauge

Appendix B – Ecotoxicology Report

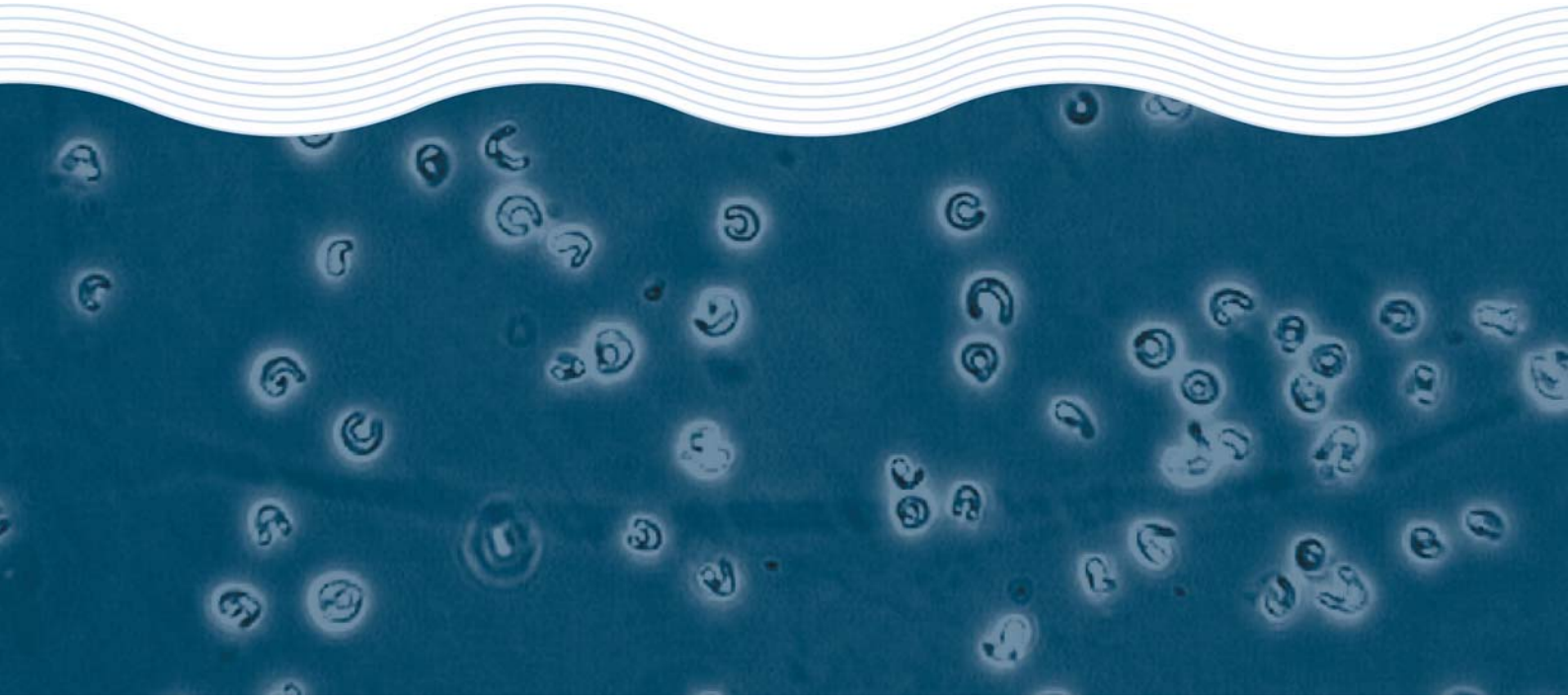
ecotox
SERVICES AUSTRALASIA

Toxicity Assessment of Freshwater Samples

GHD Pty Ltd

Test Report

September 2014



Toxicity Assessment of Freshwater Samples

GHD Pty Ltd

Test Report

September 2014

ECOTOX Services Australasia Pty Ltd ABN>45 094 714 904
unit 27/2 chaplin drive lane cove nsw 2066 T>61 2 9420 9481 F>61 2 9420 9484 W>www.ecotox.com.au

Toxicity Test Report: TR1223/1

Accredited for compliance with ISO/IEC 17025

Client:	GHD Pty Ltd	**ESA Job #:**	PR1223
	GHD Tower, 24 Honeysuckle Drive	**Date Sampled:**	21 August 2014
	Newcastle NSW 2300	**Date Received:**	25 August 2014
Attention:	Stuart Gray	**Sampled By:**	Client
Client Ref:	Not supplied	**ESA Quote #:**	PL1223_q01

Lab ID No.:	**Sample Name:**	**Sample Description:**
6808	SVLDP009	Aqueous sample, pH 8.3*, conductivity 1175µS/cm*, total ammonia <2.0mg/L*. Sample received at 16ºC* in apparent good condition.

*NATA accreditation does not cover the performance of this service

Test Performed:	72-hr microalgal growth inhibition test using the green alga *Selenastrum capricornutum*
Test Protocol:	ESA SOP 103 (ESA 2013), based on USEPA (2002)
Test Temperature:	The test was performed at 25±1°C.
Deviations from Protocol:	Nil
Comments on Solution Preparation:	The sample was filtered to 0.45 µm and then serially diluted with USEPA media. A USEPA control was tested concurrently with the sample.
Source of Test Organisms:	ESA Laboratory culture, originally sourced from CSIRO Microalgal Supply Service, TAS
Test Initiated:	29 August 2014 at 1115h

Sample 6808: *SVLDP009*

Concentration (%)	**Cell Yield x10^4 cells/mL (Mean ± SD)**
USEPA Control	38.2 ± 5.8
3.1	38.8 ± 2.8
6.3	17.5 ± 2.4 *
12.5	9.9 ± 0.7 *
25	7.5 ± 1.3 *
50	7.9 ± 0.4 *
100	3.9 ± 1.6 *

72-hr IC10 = 3.7%**
72-hr IC50 = 6.0 (5.5-6.7)%
NOEC = 3.1%
LOEC = 6.3%

*Significantly lower cell yield compared with the USEPA Control (Wilcoxon Rank Sum Test, 1-tailed, P=0.05)
**95% confidence limits are not reliable

Toxicity Test Report: TR1223/1

QA/QC Parameter	Criterion	This Test	Criterion met?
Control mean cell density	≥16.0x10^4 cells/mL	39.2x10^4 cells/mL	Yes
Control coefficient of variation	<20%	15.2%	Yes
Reference Toxicant within cusum chart limits	1.5-6.2g KCl/L	2.4g KCl/L	Yes

Test Report Authorised by: Dr Rick Krassoi, Director on 25 September 2014

Results are based on the samples in the condition as received by ESA.

NATA Accredited Laboratory Number: 14709

Citations:

ESA (2013) *ESA SOP 103 – Green Alga, Selenastrum capricornutum, Growth Test*. Issue No 10. Ecotox Services Australasia, Sydney, NSW.

USEPA (2002) *Short-term methods for estimating the chronic toxicity of effluents and receiving waters to freshwater organisms*. Fourth Edition. EPA-821-R-02-013. United States Environmental Protection Agency, Office of Research and Development, Washington DC, USA,

Toxicity Test Report: TR1223/2

Accredited for compliance with ISO/IEC 17025

Client:	GHD Pty Ltd	**ESA Job #:**	PR1223
	GHD Tower, 24 Honeysuckle Drive	**Date Sampled:**	21 August 2014
	Newcastle NSW 2300	**Date Received:**	25 August 2014
Attention:	Stuart Gray	**Sampled By:**	Client
Client Ref:	Not supplied	**ESA Quote #:**	PL1223_q01

Lab ID No.:	**Sample Name:**	**Sample Description:**
6808	SVLDP009	Aqueous sample, pH 8.3*, conductivity 1175µS/cm*, total ammonia <2.0mg/L*. Sample received at 16ºC* in apparent good condition.

*NATA accreditation does not cover the performance of this service

Test Performed:	7-day Growth inhibition of the freshwater aquatic duckweed *Lemna disperma*
Test Protocol:	ESA SOP 112 (ESA 2012), based on OECD method 221 (2006)
Test Temperature:	The test was performed at 25±2°C.
Deviations from Protocol:	Nil
Comments on Solution Preparation:	The sample was serially diluted with Swedish standard medium (SIS) to achieve the test concentrations. A SIS control was tested concurrently with the sample.
Source of Test Organisms:	ESA Laboratory culture
Test Initiated:	27 August 2014 at 1100h

Sample 6808: *SVLDP009*		*Vacant*	*Vacant*
Concentration (%)	**Specific Growth Rate (Mean ± SD)**		
SIS Control	0.29 ± 0.04		
3.1	0.21 ± 0.02 *		
6.1	0.24 ± 0.03		
12.1	0.27 ± 0.01		
24.2	0.22 ± 0.04 *		
48.4	0.26 ± 0.01		
96.8	0.29 ± 0.04		
7 day IC10 = <3.1%			
7 day IC50 = >96.8%			
NOEC = 96.8%			
LOEC = >96.8%			

*Significantly lower specific growth rate compared with the SIS Control (Bonferroni t Test, 1-tailed, P=0.05)
**95% confidence limits are not available

Toxicity Test Report: TR1223/2

QA/QC Parameter	Criterion	This Test	Criterion met?
Control specific growth rate	>0.275	0.287	Yes
Reference Toxicant within cusum chart limits	2.3-6.0g KCl/L	3.3g KCl/L	Yes

Test Report Authorised by: Dr Rick Krassoi, Director on 25 September 2014

Results are based on the samples in the condition as received by ESA.

NATA Accredited Laboratory Number: 14709

Citations:

ESA (2012) *SOP 112 – Duckweed Growth Inhibition Test.* Issue No. 5. Ecotox Services Australasia, Sydney NSW

OECD (2006) *Lemna sp*. Growth Inhibition Test. Method 221. OECD Guideline for the Testing of Chemicals. Organisation for Economic Cooperation and Development, Paris

Toxicity Test Report: TR1223/3

Accredited for compliance with ISO/IEC 17025

Client:	GHD Pty Ltd	**ESA Job #:**	PR1223
	GHD Tower, 24 Honeysuckle Drive	**Date Sampled:**	21 August 2014
	Newcastle NSW 2300	**Date Received:**	25 August 2014
Attention:	Stuart Gray	**Sampled By:**	Client
Client Ref:	Not supplied	**ESA Quote #:**	PL1223_q01

Lab ID No.:	**Sample Name:**	**Sample Description:**
6808	SVLDP009	Aqueous sample, pH 8.3*, conductivity 1175µS/cm*, total ammonia <2.0mg/L*. Sample received at 16ºC* in apparent good condition.

*NATA accreditation does not cover the performance of this service

Test Performed:	96-hr fish imbalance toxicity test using the eastern rainbowfish *Melanotaenia splendida splendida*
Test Protocol:	ESA SOP 117 (ESA 2013), based on USEPA (2002)
Test Temperature:	The test was performed at 25±1°C.
Deviations from Protocol:	Nil
Comments on Solution Preparation:	The sample was serially diluted with dilute mineral water (DMW) to achieve the test concentrations. A DMW control was tested concurrently with the sample.
Source of Test Organisms:	In-house cultures
Test Initiated:	9 September 2014 at 1300h

Sample 6808: *SVLDP009* **Concentration (%)**	**% Unaffected (Mean ± SD)**	*Vacant*	*Vacant*
DMW Control	100 ± 0.0		
3.1	95.0 ± 10.0		
6.3	95.0 ± 10.0		
12.5	95.0 ± 10.0		
25	90.0 ± 11.6		
50	50.0 ± 11.6 *		
100	10.0 ± 11.6 *		
96-hr IC10 = 25.0%**			
96-hr EC50 = 50.0 (40.5-61.7)%			
NOEC = 25%			
LOEC = 50%			

*Significantly lower percentage of unaffected larval fish compared with the DMW Control (Steel's Many-One Rank Test, 1-tailed, P=0.05)
**95% confidence limits are not reliable

QA/QC Parameter	**Criterion**	**This Test**	**Criterion met?**
Control mean % unaffected	≥80.0%	100%	Yes
Reference Toxicant within cusum chart limits	5.7-79.3µg Cu/L	47.4µg Cu/L	Yes

Toxicity Test Report: TR1223/3

Test Report Authorised by: Dr Rick Krassoi, Director on 25 September 2014

Results are based on the samples in the condition as received by ESA.

NATA Accredited Laboratory Number: 14709

Citations:

ESA (2013) SOP 117 –*Freshwater and Marine Fish Imbalance Test*. Issue No 10. Ecotox Services Australasia, Sydney, NSW

USEPA (2002) Methods for measuring the acute toxicity of effluents and receiving waters to freshwater and marine organisms. Fifth edition EPA-821-R-02-012. United States Environmental Protection Agency, Office of Research and Development, Washington FC, USA

Toxicity Test Report: TR1223/4

Accredited for compliance with ISO/IEC 17025

Client:	GHD Pty Ltd GHD Tower, 24 Honeysuckle Drive Newcastle NSW 2300	**ESA Job #:** **Date Sampled:** **Date Received:**	PR1223 21 August 2014 25 August 2014
Attention:	Stuart Gray	**Sampled By:**	Client
Client Ref:	Not supplied	**ESA Quote #:**	PL1223_q01

Lab ID No.:	**Sample Name:**	**Sample Description:**
6808	SVLDP009	Aqueous sample, pH 8.3*, conductivity 1175µS/cm*, total ammonia <2.0mg/L*. Sample received at 16ºC* in apparent good condition.

*NATA accreditation does not cover the performance of this service

Test Performed:	96-hr acute toxicity test using the freshwater hydra *hydra viridissima*
Test Protocol:	ESA SOP 125 (2013), based on Riethmuller et al. (2003)
Test Temperature:	The test was performed at 27±1°C.
Deviations from Protocol:	Nil
Comments on Solution Preparation:	The sample was serially diluted with Laboratory Water to achieve the test concentrations. A Laboratory Water control was tested concurrently with the sample.
Source of Test Organisms:	ESA Laboratory culture
Test Initiated:	26 August 2014 at 1330h

Sample 6808: *SVLDP009* **Concentration (%)**	**Population Growth Rate (Mean ± SD)**	*Vacant*	*Vacant*
Lab Control	0.37 ± 0.0		
3.1	0.35 ± 0.02		
6.3	0.33 ± 0.02 *		
12.5	0.25 ± 0.04 *		
25	0.11 ± 0.06 *		
50	0.03 ± 0.03 *		
100	0.00 ± 0.00		
96-hr EC10 = 5.1%**			
96-hr EC50 = 18.0 (14.0-24.8)%			
NOEC = 3.1%			
LOEC = 6.3%			

*Significantly lower population growth rate compared with the Lab Control (Steel's Many-One Rank Test, 1-tailed, P=0.05)
**95% confidence limits are not reliable

Toxicity Test Report: TR1223/4

QA/QC Parameter	Criterion	This Test	Criterion met?
Control mean population growth rate	≥0.25	0.374	Yes
Reference Toxicant within cusum chart limits	0.9-12.6µg Cu/L	5.8µg Cu/L	Yes

Test Report Authorised by: Dr Rick Krassoi, Director on 25 September 2014

Results are based on the samples in the condition as received by ESA.

NATA Accredited Laboratory Number: 14709

Citations:

ESA (2013) SOP 125 –*Hydra Population Growth Test.* Issue No 3. Ecotox Services Australasia, Sydney, NSW

Riethmuller N, Camilleri C, Franklin N, Hogan A, King A, Koch A, Markich SJ, Turley C and van Dam R (2003). Green Hydra Population Growth Test. In: *Ecotoxicological testing protocols for Australian tropical freshwater ecosystems*. Supervising Scientist Report 173, Supervising Scientist, Darwin NT.

Toxicity Test Report: TR1223/5

Accredited for compliance with ISO/IEC 17025

Client:	GHD Pty Ltd	**ESA Job #:**	PR1223
	GHD Tower, 24 Honeysuckle Drive	**Date Sampled:**	21 August 2014
	Newcastle NSW 2300	**Date Received:**	25 August 2014
Attention:	Stuart Gray	**Sampled By:**	Client
Client Ref:	Not supplied	**ESA Quote #:**	PL1223_q01

Lab ID No.:	Sample Name:	Sample Description:
6808	SVLDP009	Aqueous sample, pH 8.3*, conductivity 1175µS/cm*, total ammonia <2.0mg/L*. Sample received at 16ºC* in apparent good condition.

*NATA accreditation does not cover the performance of this service

Test Performed:	Partial life-cycle toxicity test using the freshwater cladoceran *Ceriodaphnia cf dubia*
Test Protocol:	ESA SOP 102 (ESA 2013), based on USEPA (2002) and Bailey *et al*. (2000)
Test Temperature:	The test was performed at 25±1°C.
Deviations from Protocol:	The test was extended to 8 days
Comments on Solution Preparation:	The sample was serially diluted with Dilute Mineral Water (DMW) to achieve the test concentrations. A DMW control was tested concurrently with the sample.
Source of Test Organisms:	ESA Laboratory culture
Test Initiated:	28 August 2014 at 1330h

Sample 6808: *SVLDP009*

Concentration (%)	% Survival at 8 days (Mean ± SD)
DMW Control	90.0 ± 31.6
3.1	80.0 ± 42.2
6.3	100 ± 0.0
12.5	100 ± 0.0
25	90.0 ± 31.6
50	70.0 ± 48.3
100	0.0 ± 0.0

8 day IC10 (survival) = 34.0%*
8 day EC50 (survival) = 58.6 (48.0-71.7)%
NOEC = 50%
LOEC = 100%

Sample 6808: *SVLDP009*

Concentration (%)	Number of Young (Mean ± SD)	
DMW Control	15.3 ± 6.2	
3.1	18.1 ± 5.5	
6.3	18.3 ± 4.5	
12.5	13.7 ± 8.3	
25	9.2 ± 5.2	
50	5.6 ± 5.4	**
100	0.0 ± 0.0	

8 day IC10 (reproduction) = 9.3 (5.2-16.0)%
8 day IC50 (reproduction) = 29.1 (16.3-50.3)%
NOEC = 25%
LOEC = 50%

*95% confidence limits are not reliable
**Significantly lower young compared with the DMW Control (Dunnett's Test, 1-tailed, P=0.05)

QA/QC Parameter	Criterion	This Test	Criterion met?
Control mean % survival	≥80.0%	90.0%	Yes
Control mean number of young	≥15.0	16.6	Yes
Reference Toxicant within cusum chart limits	138.8-478.6KCl/L	219.6mg KCl/L	Yes

Toxicity Test Report: TR1223/5

Test Report Authorised by: Dr Rick Krassoi, Director on 25 September 2014

Results are based on the samples in the condition as received by ESA.

NATA Accredited Laboratory Number: 14709

Citations:

Bailey, H.C., Krassoi, R., Elphick, J.R., Mulhall, A., Hunt, P., Tedmanson, L. and Lovell, A. (2000) Application of *Ceriodaphnia cf. dubia* for whole effluent toxicity tests in the Hawkesbury-Nepean watershed, New South Wales, Australia: method development and validation. *Environmental Toxicology and Chemistry* 19:88-93.

ESA (2013) ESA SOP 102 – *Acute Toxicity Test Using Ceriodaphnia dubia.* Issue No 9. Ecotox Services Australasia, Sydney, NSW.

USEPA (2002) *Short-term Methods for Estimating the Chronic Toxicity of Effluents and Receiving Waters to Freshwater Organisms.4th Ed.* United States Environmental Protection Agency, Office of Water, Washington DC.

Toxicity Test Report: TR1223/6

Accredited for compliance with ISO/IEC 17025

Client:	GHD Pty Ltd	**ESA Job #:**	PR1223
	GHD Tower, 24 Honeysuckle Drive	**Date Sampled:**	21 August 2014
	Newcastle NSW 2300	**Date Received:**	25 August 2014
Attention:	Stuart Gray	**Sampled By:**	Client
Client Ref:	Not supplied	**ESA Quote #:**	PL1223_q01

Lab ID No.:	**Sample Name:**	**Sample Description:**
6807	APLDP001	Aqueous sample, pH8.0*, conductivity 1038µS/cm. Sample received at 16ºC* in apparent good condition.

*NATA accreditation does not cover the performance of this service

Test Performed:	Partial life-cycle toxicity test using the freshwater cladoceran *Ceriodaphnia cf dubia*
Test Protocol:	ESA SOP 102 (ESA 2013), based on USEPA (2002) and Bailey *et al*. (2000)
Test Temperature:	The test was performed at 25±1°C.
Deviations from Protocol:	The test was extended to 8 days
Comments on Solution Preparation:	The sample was serially diluted with Dilute Mineral Water (DMW) to achieve the test concentrations. A DMW control was tested concurrently with the sample.
Source of Test Organisms:	ESA Laboratory culture
Test Initiated:	4 September 2014 at 1500h

Sample 6807: *APLDP001*

Concentration (%)	**% Survival at 8 days (Mean ± SD)**
DMW Control	90.0 ± 31.6
3.1	90.0 ± 31.6
6.3	100 ± 0.0
12.5	100 ± 0.0
25	90.0 ± 31.6
50	100 ± 0.0
100	90.0 ± 31.6

8 day EC10 (survival) = >100%
8 day EC50 (survival) = >100%
NOEC = 100%
LOEC = >100%

Sample 6807: *APLDP001*

Concentration (%)	**Number of Young (Mean ± SD)**
DMW Control	13.6 ± 6.0
3.1	16.1 ± 7.3
6.3	15.2 ± 5.3
12.5	20.1 ± 5.8
25	17.4 ± 7.6
50	25.2 ± 4.2
100	19.1 ± 9.1

8 day IC10 (reproduction) = >100%
8 day IC50 (reproduction) = >100%
NOEC = 100%
LOEC = >100%

*95% confidence limits not reliable

QA/QC Parameter	**Criterion**	**This Test**	**Criterion met?**
Control mean % survival	≥80.0%	90.0%	Yes
Control mean number of young	≥15.0	15.1	Yes
Reference Toxicant within cusum chart limits	137.8-480.2mg KCl/L	238.0mg KCl/L	Yes

Toxicity Test Report: TR1223/6

Test Report Authorised by: Dr Rick Krassoi, Director on 25 September 2014

Results are based on the samples in the condition as received by ESA.

NATA Accredited Laboratory Number: 14709

Citations:

Bailey, H.C., Krassoi, R., Elphick, J.R., Mulhall, A., Hunt, P., Tedmanson, L. and Lovell, A. (2000) Application of *Ceriodaphnia cf. dubia* for whole effluent toxicity tests in the Hawkesbury-Nepean watershed, New South Wales, Australia: method development and validation. *Environmental Toxicology and Chemistry* 19:88-93.

ESA (2013) ESA SOP 102 – *Acute Toxicity Test Using Ceriodaphnia dubia.* Issue No 9. Ecotox Services Australasia, Sydney, NSW.

USEPA (2002) *Short-term Methods for Estimating the Chronic Toxicity of Effluents and Receiving Waters to Freshwater Organisms.4th Ed.* United States Environmental Protection Agency, Office of Water, Washington DC.

Toxicity Test Report: TR1223/7

Accredited for compliance with ISO/IEC 17025

Client:	GHD Pty Ltd	**ESA Job #:**	PR1223
	GHD Tower, 24 Honeysuckle Drive	**Date Sampled:**	21 & 22 August 2014
	Newcastle NSW 2300	**Date Received:**	25 August 2014
Attention:	Stuart Gray	**Sampled By:**	Client
Client Ref:	Not supplied	**ESA Quote #:**	PL1223_q01

Lab ID No.:	Sample Name:	Sample Description:
6809	SVLDP009 DS	Aqueous sample, pH 8.8*, conductivity 1089µS/cm*. Sample received at 16ºC* in apparent good condition.
6810	MADDOX	Aqueous sample, pH 8.6*, conductivity 1007µS/cm*. Sample received at 16ºC* in apparent good condition.
6811	LAKE WALLACE	Aqueous sample, pH 8.5*, conductivity 986µS/cm*. Sample received at 16ºC* in apparent good condition.
6812	WANGOL	Aqueous sample, pH 7.7*, conductivity 806µS/cm*. Sample received at 16ºC* in apparent good condition.
6813	COXS DS LYELL	Aqueous sample, pH 8.3*, conductivity 506µS/cm*. Sample received at 16ºC* in apparent good condition.
6814	COXS US LYELL	Aqueous sample, pH 8.7*, conductivity 1049µS/cm*. Sample received at 16ºC* in apparent good condition.
6815	LAKE LYELL	Aqueous sample, pH 8.4*, conductivity 547µS/cm*. Sample received at 16ºC* in apparent good condition.
6816	WPS	Aqueous sample, pH 8.4*, conductivity 949µS/cm*. Sample received at 16ºC* in apparent good condition.
6817	COXS US	Aqueous sample, pH 6.6*, conductivity 41.5µS/cm*. Sample received at 16ºC* in apparent good condition.

*NATA accreditation does not cover the performance of this service

Test Performed:	Partial life-cycle toxicity test using the freshwater cladoceran *Ceriodaphnia cf dubia*
Test Protocol:	ESA SOP 102 (ESA 2013), based on USEPA (2002) and Bailey *et al*. (2000)
Test Temperature:	The test was performed at 25±1°C.
Deviations from Protocol:	The test was extended to 8 days
Comments on Solution Preparation:	The samples were tested without dilution (i.e. 100% only). A DMW control was tested concurrently with the samples.
Source of Test Organisms:	ESA Laboratory culture
Test Initiated:	11 September 2014 at 1415h

Toxicity Test Report: TR1223/7

Sample 6809-6817: *Various*

Sample ID	% Survival at 8 days (Mean ± SD)	
DMW Control	90.0 ± 31.6	
SVLDP009 DS	80.0 ± 42.2	
MADDOX	100 ± 0.0	
LAKE WALLACE	100 ± 0.0	
WANGOL	100 ± 0.0	
COXS DS LYELL	100 ± 0.0	
COXS UD LYELL	100 ± 0.0	
LAKE LYELL	90.0 ± 31.6	
WPS	100 ± 0.0	
COXS US	40.0 ± 51.6	*

Sample 6809-6817: *Various*

Sample ID	Number of Young (Mean ± SD)	
DMW Control	19.3 ± 7.2	
SVLDP009 DS	0.8 ± 1.7	**
MADDOX	5.5 ± 5.2	**
LAKE WALLACE	22.3 ± 6.2	
WANGOL	13.6 ± 4.8	
COXS DS LYELL	21.9 ± 4.6	
COXS UD LYELL	20.5 ± 8.2	
LAKE LYELL	20.6 ± 7.7	
WPS	12.8 ± 6.7	
COXS US	0.2 ± 0.6	**

*Significantly lower percentage survival compared with the DMW Control (Bonferroni adjusted t Test, 1-tailed, P=0.05)
**Significantly lower young compared with the DMW Control (Bonferroni adjusted t Test, 1-tailed, P=0.05)

QA/QC Parameter	Criterion	This Test	Criterion met?
Control mean % survival	≥80.0%	90.0%	Yes
Control mean number of young	≥15.0	21.3	Yes
Reference Toxicant within cusum chart limits	137.8-479.6mg KCl/L	274.3mg KCl/L	Yes

Test Report Authorised by: Dr Rick Krassoi, Director on 25 September 2014

Results are based on the samples in the condition as received by ESA.

NATA Accredited Laboratory Number: 14709

Citations:

Bailey, H.C., Krassoi, R., Elphick, J.R., Mulhall, A., Hunt, P., Tedmanson, L. and Lovell, A. (2000) Application of *Ceriodaphnia cf. dubia* for whole effluent toxicity tests in the Hawkesbury-Nepean watershed, New South Wales, Australia: method development and validation. *Environmental Toxicology and Chemistry* 19:88-93.

ESA (2013) ESA SOP 102 – *Acute Toxicity Test Using Ceriodaphnia dubia.* Issue No 9. Ecotox Services Australasia, Sydney, NSW.

USEPA (2002) *Short-term Methods for Estimating the Chronic Toxicity of Effluents and Receiving Waters to Freshwater Organisms.4th Ed.* United States Environmental Protection Agency, Office of Water, Washington DC.

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SERVICES AUSTRALASIA

Chain-of-Custody Documentation

Datasheet ID: 601.2
Last Revised: 30 April 2009

Sample Receipt Notification

Attention : Tess Davies

Client : GHD Pty Ltd
GHD Tower, Level 3, 24 Hneysuckle Drive
Newcastle NSW 2300

Email : tess.davies@ghd.com
Telephone : 02 49799993
Facsimile :

Date : 25/08/2014

Re : Receipt of Samples **Pages : 3**

ESA Project : PR1223 ☑ For Review ☐ Additional Documentation Required - Please Respond

Sample Delivery Details

Completed Chain of Custody accompanied samples: **YES**
Samples received in apparent good condition and correctly bottled: **YES**
Security seals on sample bottles and esky intact: **YES**

Date samples received : 25/08/2014
Time samples received : 9:50
No. of samples received : 12
Sample matrix : Aqueous
Sample temperature : 16°C

Comments : Includes 2x5L APLDP001 (ESA ID# 6801, 9x5L SVLDP009 (ESA ID# 6808),
1x1L SV LDP009 DS (ESA ID# 6809), 1x1L MADDOX (ESA ID# 6810)
1x1L LAKE WALLACE (ESA ID# 6811), 1x1L WANGOL (ESA ID# 6812)
1x1L COXS DS LYELL (ESA ID# 6813), 1x1L COXS US LYELL (ESA ID# 6814)
1x1L LAKE LYELL (ESA ID# 6815), 1x1L WPS (ESA ID# 6816)
1x1L COXS US (ESA iD# 6817)

Contact Details

Customer Services Officer : Tina Micevska
Telephone : 61 2 9420 9481
Facsimile : 61 2 9420 9484
Email : tmicevska@ecotox.com.au

Please contact customer services officer for all queries or issues regarding samples

Note that the chain-of-custody provides definitive information on the tests to be performed

Ecotox Services Australia
ABN 45 094 714 904
Unit 27, 2 Chaplin Drive
Lane Cove NSW 2066 Australia

Phone : 61 2 9420 9481
Fax : 61 2 9420 9484
Email : info@ecotox.com.au

Chain-of-Custody / Service Request Form

Datasheet ID: 601.1
Last Revised: 15 July 2014

ecotox SERVICES AUSTRALASIA

Customer: GHD
Contact Name: Stuart Gray
Phone: 0401416936 Email: Stuart.gray@ghd.com (please provide an email address for sample receipt notification)
Sampled by: Stuart Gray

Ship To:
Attention:

Sample Date (day/month /year)	Sample Time	Sample Name (exactly as written on the sample vessel)	Sample Method (eg. Grab, composite etc.)	Number and Volume of Containers (eg 2 x 1L)	Tests Requested (See reverse for guidance): Chronic Cerio	Algal growth Sc	Duckweed Ld	Chronic fish	Hydra		Comments / Instructions
21/8		AP LDP001	Grab	2x 5L	x	x	x	x			All dilutions (3.125% also)
21/8		SV LDP009	|	9x 5L	x	x	x	x	x		All dilutions (3.125% also)
21/8		COXS US	|	1 x 1L	x						100% conc only
21/8		SV LDP009 DS	|	|	|						|
21/8		MADDOX	|	|	|						
22/8		LAKE WALLACE	|	|	|						
21/8		WANGCOL	|	|	|						

Note that testing will be delayed if an incomplete chain of custody is received

- Additional treatment of samples (i.e. spiking)
- Sub-contracted services (i.e. chemical analyses)
- Dilutions required (if different than 100% down to 6.25%)
- Sample holding time restriction (if applicable)
- Sample used for litigation (if applicable)

Note: An MSDS must be attached if Available

ESA Project Number: PR

1) Released By:	Date:	2) Received By: Tina	Date: 25/8/14	3) Released By:	Date:	4) Received By:	Date:
Of:	Time:	Of: ESA	Time: 9:50	Of:	Time:	Of:	Time:

Note that the chain-of-custody documentation will provide definitive information on the tests to be performed.

Ecotox Services Australasia . Unit 27, 2 Chaplin Drive, Lane Cove NSW 2066 AUSTRALIA
Phone: 61 2 9420-9481 Fax 61 2 9420-9484 info@ecotox.com.au

Chain-of-Custody / Service Request Form

Datasheet ID: 601.1
Last Revised: 15 July 2014

ecotox SERVICES AUSTRALASIA

Customer: GHD
Contact Name: Stuart Gray
Phone: 0401416936 Email: Stuart.gray@ghd.com (please provide an email address for sample receipt notification)
Sampled by: Stuart Gray

Ship To:
Attention:

Sample Date (day/month /year)	Sample Time	Sample Name (exactly as written on the sample vessel)	Sample Method (eg. Grab, composite etc.)	Number and Volume of Containers (eg 2 x 1L)	Tests Requested (See reverse for guidance)						Comments / Instructions
					Chronic cerio						**Note that testing will be delayed if an incomplete chain of custody is received** • Additional treatment of samples (i.e. spiking) • Sub-contracted services (i.e. chemical analyses) • Dilutions required (if different than 100% down to 6.25%) • Sample holding time restriction (if applicable) • Sample used for litigation (if applicable) *Note: An MSDS must be attached if Available* **ESA Project Number: PR_____**
6813 22/8		COXS DS LYELL	Grab	1 x 1L	x						100% Conc only
6814 22/8		COXS US LYELL	|	|	|						|
6815 22/8		LAKE LYELL									
6816 22/8		WPS									
16°											

1) Released By:	Date:	2) Received By:	Date:	3) Released By:	Date:	4) Received By:	Date:
Of:	Time:	Of:	Time:	Of:	Time:	Of:	Time:

Note that the chain-of-custody documentation will provide definitive information on the tests to be performed.

Ecotox Services Australasia . Unit 27, 2 Chaplin Drive, Lane Cove NSW 2066 AUSTRALIA
Phone: 61 2 9420-9481 Fax 61 2 9420-9484 info@ecotox.com.au

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Statistical Printouts for the *Selenastrum* Growth Inhibition Tests

Microalgal Growth inhibition Test-Growth-Cell Yield

Start Date:	29/08/2014 11:15	Test ID:	PR1223/02	Sample ID:	SV LDP009
End Date:	1/09/2014 10:30	Lab ID:	6808	Sample Type:	AQ-Aqueous
Sample Date:		Protocol:	ESA 103	Test Species:	SC-Selenastrum capricornutum
Comments:					

Conc-%	1	2	3	4	5	6	7	8
USEPA Control	479157.1	387157.1	349157.1	333157.1	391157.1	377157.1	443157.1	299157.1
3.1	369157.1	403157.1	419157.1	359157.1				
6.3	163157.1	193157.1	195157.1	147157.1				
12.5	105157.1	95157.1	91157.1	105157.1				
25	91157.1	77157.1	69157.1	61157.1				
50	77157.1	73157.1	81157.1	83157.1				
100	25157.1	25157.1	51157.1	53157.1				

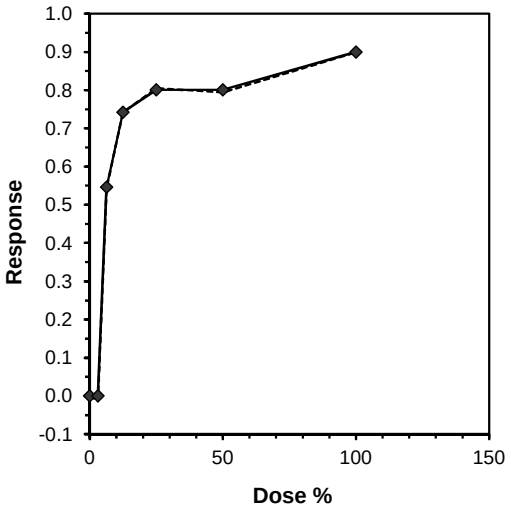
			Transform: Untransformed					Rank	1-Tailed	Isotonic	
Conc-%	Mean	N-Mean	Mean	Min	Max	CV%	N	Sum	Critical	Mean	N-Mean
USEPA Control	382407.1	1.0000	382407.1	299157.1	479157.1	15.197	8			385032.1	1.0000
3.1	387657.1	1.0137	387657.1	359157.1	419157.1	7.276	4	28.00	12.00	385032.1	1.0000
*6.3	174657.1	0.4567	174657.1	147157.1	195157.1	13.432	4	10.00	12.00	174657.1	0.4536
*12.5	99157.1	0.2593	99157.1	91157.1	105157.1	7.179	4	10.00	12.00	99157.1	0.2575
*25	74657.1	0.1952	74657.1	61157.1	91157.1	17.136	4	10.00	12.00	76657.1	0.1991
*50	78657.1	0.2057	78657.1	73157.1	83157.1	5.638	4	10.00	12.00	76657.1	0.1991
*100	38657.1	0.1011	38657.1	25157.1	53157.1	40.380	4	10.00	12.00	38657.1	0.1004

Auxiliary Tests	Statistic	Critical	Skew	Kurt
Shapiro-Wilk's Test indicates non-normal distribution (p <= 0.05)	0.917041	0.93	0.474902	3.761286
Bartlett's Test indicates unequal variances (p = 3.11E-04)	25.21748	16.81189		

Hypothesis Test (1-tail, 0.05)	NOEC	LOEC	ChV	TU
Wilcoxon Rank Sum Test	3.1	6.3	4.419276	32.25806
Treatments vs USEPA Control				

Linear Interpolation (200 Resamples)

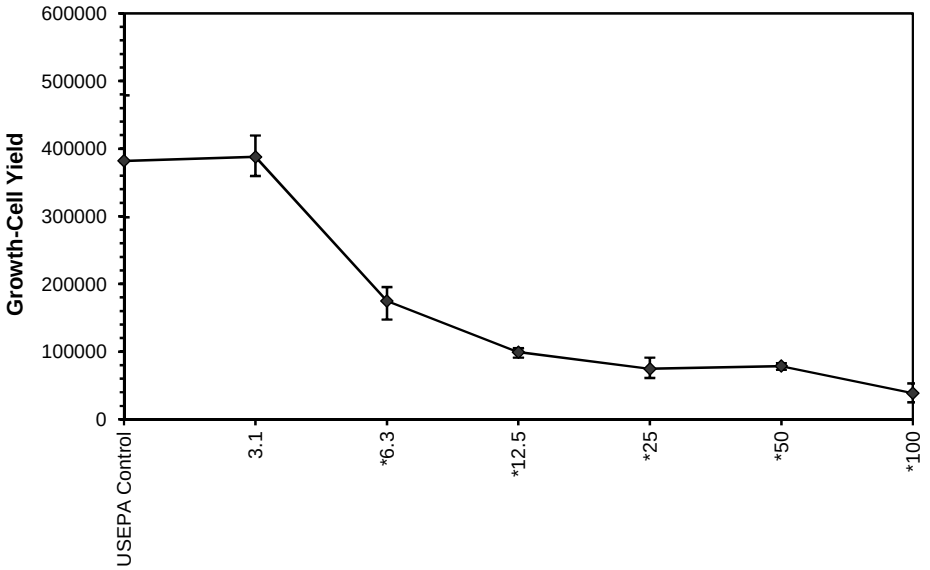
Point	%	SD	95% CL(Exp)		Skew
IC05	3.3928	0.5185	0.2409	3.4425	-2.4593
IC10	3.6857	0.2528	2.3418	3.7851	-3.6327
IC15	3.9785	0.1891	3.0268	4.1276	-2.1668
IC20	4.2713	0.1764	3.4243	4.4702	-1.6081
IC25	4.5642	0.1722	3.7908	4.8127	-1.3398
IC40	5.4427	0.1737	4.8650	5.8404	-0.4644
IC50	6.0283	0.2106	5.4512	6.7251	0.7568



Microalgal Growth inhibition Test-Growth-Cell Yield

Start Date:	29/08/2014 11:15	Test ID:	PR1223/02	Sample ID:	SV LDP009
End Date:	1/09/2014 10:30	Lab ID:	6808	Sample Type:	AQ-Aqueous
Sample Date:		Protocol:	ESA 103	Test Species:	SC-Selenastrum capricornutum
Comments:					

Dose-Response Plot



Microalgal Growth inhibition Test-Growth-Cell Yield

Start Date:	29/08/2014 11:15	Test ID:	PR1223/02	Sample ID:	SV LDP009
End Date:	1/09/2014 10:30	Lab ID:	6808	Sample Type:	AQ-Aqueous
Sample Date:		Protocol:	ESA 103	Test Species:	SC-Selenastrum capricornutum
Comments:					

		Auxiliary Data Summary					
Conc-%	**Parameter**	**Mean**	**Min**	**Max**	**SD**	**CV%**	**N**
USEPA Control	Cell Yield	38.24	29.92	47.92	5.81	6.30	8
3.1		38.77	35.92	41.92	2.82	4.33	4
6.3		17.47	14.72	19.52	2.35	8.77	4
12.5		9.92	9.12	10.52	0.71	8.51	4
25		7.47	6.12	9.12	1.28	15.15	4
50		7.87	7.32	8.32	0.44	8.47	4
100		3.87	2.52	5.32	1.56	32.32	4
USEPA Control	pH	7.60	7.60	7.60	0.00	0.00	1
3.1		7.70	7.70	7.70	0.00	0.00	1
6.3		7.80	7.80	7.80	0.00	0.00	1
12.5		8.00	8.00	8.00	0.00	0.00	1
25		8.20	8.20	8.20	0.00	0.00	1
50		8.20	8.20	8.20	0.00	0.00	1
100		8.20	8.20	8.20	0.00	0.00	1
USEPA Control	Conductivity uS/cm	93.70	93.70	93.70	0.00	0.00	1
3.1		131.50	131.50	131.50	0.00	0.00	1
6.3		167.50	167.50	167.50	0.00	0.00	1
12.5		243.00	243.00	243.00	0.00	0.00	1
25		389.00	389.00	389.00	0.00	0.00	1
50		673.00	673.00	673.00	0.00	0.00	1
100		1231.00	1231.00	1231.00	0.00	0.00	1

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Statistical Printouts for the Duckweed Growth Inhibition Tests

Duckweed Growth Inhibtion Test-Specific Growth Rate

Start Date:	27/08/2014 11:00	Test ID:	PR1223/03	Sample ID:	SV LDP009
End Date:	3/09/2014 10:30	Lab ID:	6808	Sample Type:	AQ-Aqueous
Sample Date:		Protocol:	ESA 112	Test Species:	LD-Lemna disperma
Comments:					

Conc-%	1	2	3	4	5	6	7
SIS Control	0.2728	0.2369	0.2830	0.2780	0.3253	0.3608	0.2499
3	0.1888	0.2299	0.2149	0.2149			
6.1	0.2499	0.2499	0.2560	0.1888			
12.1	0.2780	0.2780	0.2499	0.2560			
24.2	0.2618	0.1684	0.2067	0.2560			
48.4	0.2618	0.2780	0.2435	0.2618			
96.8	0.2925	0.3393	0.2878	0.2299			

			Transform: Untransformed					1-Tailed			Isotonic	
Conc-%	Mean	N-Mean	Mean	Min	Max	CV%	N	t-Stat	Critical	MSD	Mean	N-Mean
SIS Control	0.2867	1.0000	0.2867	0.2369	0.3608	15.007	7				0.2867	1.0000
*3	0.2121	0.7399	0.2121	0.1888	0.2299	8.050	4	3.477	2.574	0.0552	0.2476	0.8637
6.1	0.2361	0.8237	0.2361	0.1888	0.2560	13.414	4	2.356	2.574	0.0552	0.2476	0.8637
12.1	0.2655	0.9260	0.2655	0.2499	0.2780	5.530	4	0.989	2.574	0.0552	0.2476	0.8637
*24.2	0.2232	0.7786	0.2232	0.1684	0.2618	19.768	4	2.959	2.574	0.0552	0.2476	0.8637
48.4	0.2613	0.9114	0.2613	0.2435	0.2780	5.388	4	1.184	2.574	0.0552	0.2476	0.8637
96.8	0.2874	1.0025	0.2874	0.2299	0.3393	15.589	4	-0.034	2.574	0.0552	0.2476	0.8637

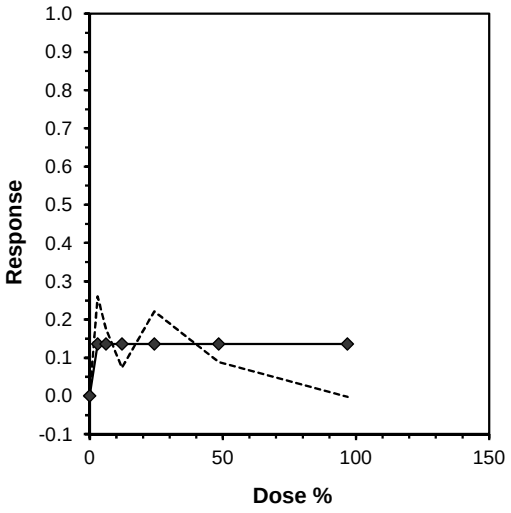
Auxiliary Tests	Statistic	Critical	Skew	Kurt
Shapiro-Wilk's Test indicates normal distribution (p > 0.05)	0.972848	0.929	0.075285	0.252535
Bartlett's Test indicates equal variances (p = 0.23)	8.178167	16.81189		

Hypothesis Test (1-tail, 0.05)	NOEC	LOEC	ChV	TU	MSDu	MSDp	MSB	MSE	F-Prob	df
Bonferroni t Test	96.8	>96.8		1.033058	0.055189	0.192518	0.004095	0.001171	0.012518	6, 24
Treatments vs SIS Control										

Linear Interpolation (200 Resamples)

Point	%	SD	95% CL(Exp)	Skew
IC05*	1.1006			
IC10*	2.2011			
IC15	>96.8			
IC20	>96.8			
IC25	>96.8			
IC40	>96.8			
IC50	>96.8			

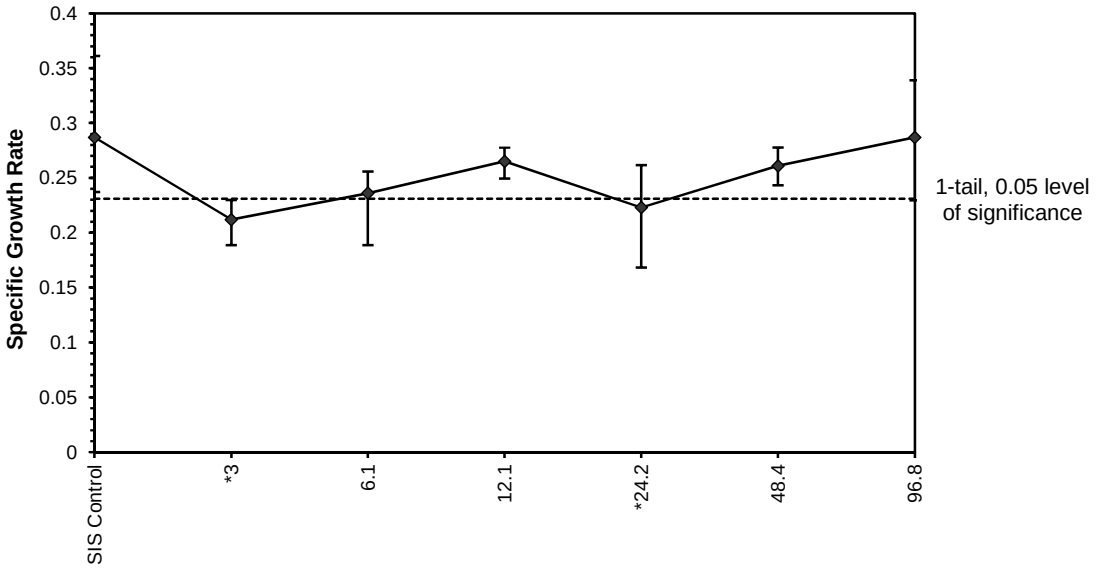
* indicates IC estimate less than the lowest concentration



Duckweed Growth Inhibtion Test-Specific Growth Rate

Start Date:	27/08/2014 11:00	Test ID:	PR1223/03	Sample ID:	SV LDP009
End Date:	3/09/2014 10:30	Lab ID:	6808	Sample Type:	AQ-Aqueous
Sample Date:		Protocol:	ESA 112	Test Species:	LD-Lemna disperma
Comments:					

Dose-Response Plot



Duckweed Growth Inhibtion Test-Specific Growth Rate

Start Date:	27/08/2014 11:00	Test ID:	PR1223/03	Sample ID:	SV LDP009
End Date:	3/09/2014 10:30	Lab ID:	6808	Sample Type:	AQ-Aqueous
Sample Date:		Protocol:	ESA 112	Test Species:	LD-Lemna disperma
Comments:					

		Auxiliary Data Summary					
Conc-%	**Parameter**	**Mean**	**Min**	**Max**	**SD**	**CV%**	**N**
SIS Control	Specific growth rate	0.29	0.24	0.36	0.04	72.35	7
3		0.21	0.19	0.23	0.02	61.60	4
6.1		0.24	0.19	0.26	0.03	75.37	4
12.1		0.27	0.25	0.28	0.01	45.64	4
24.2		0.22	0.17	0.26	0.04	94.11	4
48.4		0.26	0.24	0.28	0.01	45.41	4
96.8		0.29	0.23	0.34	0.04	73.65	4
SIS Control	pH	6.40	6.40	6.40	0.00	0.00	1
3		6.70	6.70	6.70	0.00	0.00	1
6.1		6.90	6.90	6.90	0.00	0.00	1
12.1		7.20	7.20	7.20	0.00	0.00	1
24.2		7.60	7.60	7.60	0.00	0.00	1
48.4		7.90	7.90	7.90	0.00	0.00	1
96.8		8.30	8.30	8.30	0.00	0.00	1
SIS Control	Cond uS/cm	309.00	309.00	309.00	0.00	0.00	1
3		331.00	331.00	331.00	0.00	0.00	1
6.1		362.00	362.00	362.00	0.00	0.00	1
12.1		427.00	427.00	427.00	0.00	0.00	1
24.2		563.00	563.00	563.00	0.00	0.00	1
48.4		829.00	829.00	829.00	0.00	0.00	1
96.8		1380.00	1380.00	1380.00	0.00	0.00	1

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Statistical Printouts for the Larval Fish Imbalance Tests

Fish Acute Toxicity Test-96 hr Imbalance

Start Date:	9/09/2014 13:00	Test ID:	PR1223/01	Sample ID:	SV LDP009
End Date:	13/09/2014 17:45	Lab ID:	6808	Sample Type:	AQ-Aqueous
Sample Date:		Protocol:	ESA 117	Test Species:	MS-Melanotaenia splendida
Comments:					

Conc-%	1	2	3	4
DMW Control	1.0000	1.0000	1.0000	1.0000
3.1	1.0000	0.8000	1.0000	1.0000
6.3	1.0000	1.0000	1.0000	0.8000
12.5	1.0000	1.0000	1.0000	0.8000
25	0.8000	1.0000	0.8000	1.0000
50	0.4000	0.6000	0.6000	0.4000
100	0.0000	0.2000	0.0000	0.2000

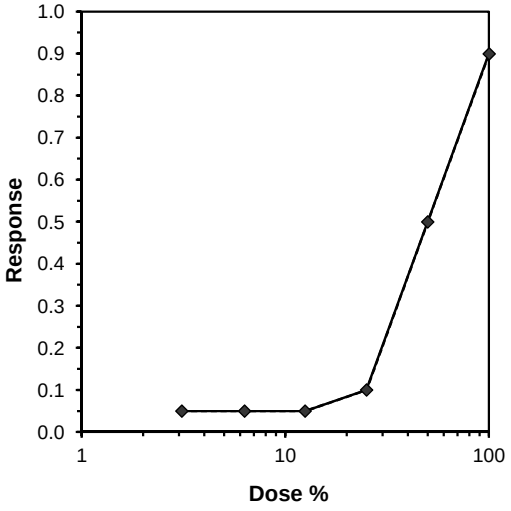
			Transform: Arcsin Square Root					Rank	1-Tailed	Isotonic	
Conc-%	Mean	N-Mean	Mean	Min	Max	CV%	N	Sum	Critical	Mean	N-Mean
DMW Control	1.0000	1.0000	1.3453	1.3453	1.3453	0.000	4			1.0000	1.0000
3.1	0.9500	0.9500	1.2857	1.1071	1.3453	9.261	4	16.00	10.00	0.9500	0.9500
6.3	0.9500	0.9500	1.2857	1.1071	1.3453	9.261	4	16.00	10.00	0.9500	0.9500
12.5	0.9500	0.9500	1.2857	1.1071	1.3453	9.261	4	16.00	10.00	0.9500	0.9500
25	0.9000	0.9000	1.2262	1.1071	1.3453	11.212	4	14.00	10.00	0.9000	0.9000
*50	0.5000	0.5000	0.7854	0.6847	0.8861	14.802	4	10.00	10.00	0.5000	0.5000
*100	0.1000	0.1000	0.3446	0.2255	0.4636	39.900	4	10.00	10.00	0.1000	0.1000

Auxiliary Tests	Statistic	Critical	Skew	Kurt
Shapiro-Wilk's Test indicates non-normal distribution (p <= 0.05)	0.854934	0.924	-0.56904	-1.15873
Equality of variance cannot be confirmed				

Hypothesis Test (1-tail, 0.05)	NOEC	LOEC	ChV	TU
Steel's Many-One Rank Test	25	50	35.35534	4
Treatments vs DMW Control				

Log-Logit Interpolation (200 Resamples)

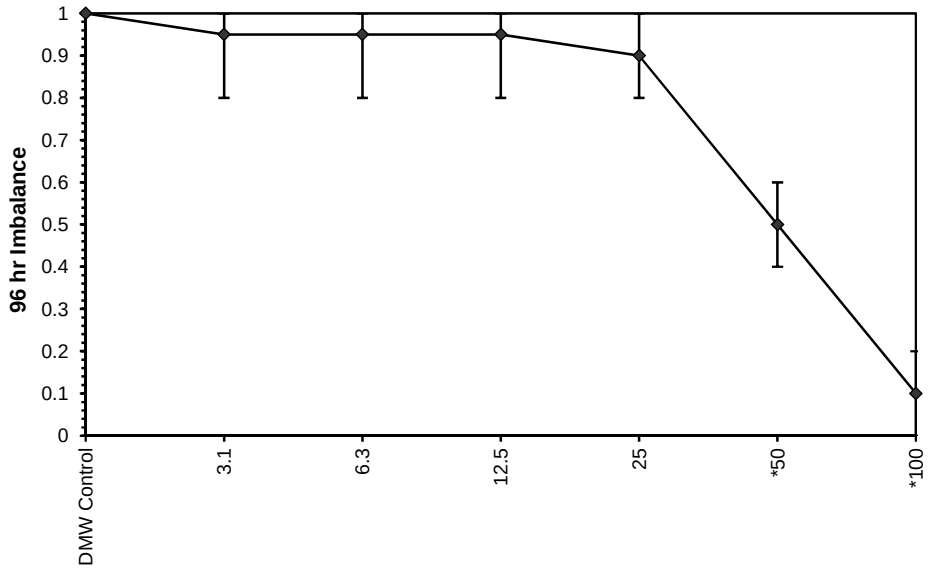
Point	%	SD	95% CL(Exp)		Skew
IC05	12.500	7.862	0.000	34.882	0.6985
IC10	25.000	6.597	0.000	34.148	-0.7220
IC15	28.963	3.832	15.611	37.652	-0.3499
IC20	32.340	3.259	20.596	39.986	0.0255
IC25	35.414	2.902	24.994	42.605	0.0239
IC40	44.038	2.603	37.982	53.577	0.1901
IC50	50.000	2.893	41.870	59.165	0.1542



Fish Acute Toxicity Test-96 hr Imbalance

Start Date:	9/09/2014 13:00	Test ID:	PR1223/01	Sample ID:	SV LDP009
End Date:	13/09/2014 17:45	Lab ID:	6808	Sample Type:	AQ-Aqueous
Sample Date:		Protocol:	ESA 117	Test Species:	MS-Melanotaenia splendida
Comments:					

Dose-Response Plot



Fish Acute Toxicity Test-96 hr Imbalance

Start Date:	9/09/2014 13:00	Test ID:	PR1223/01	Sample ID:	SV LDP009
End Date:	13/09/2014 17:45	Lab ID:	6808	Sample Type:	AQ-Aqueous
Sample Date:		Protocol:	ESA 117	Test Species:	MS-Melanotaenia splendida
Comments:					

Auxiliary Data Summary

Conc-%	Parameter	Mean	Min	Max	SD	CV%	N
DMW Control	% Unaffected	100.00	100.00	100.00	0.00	0.00	4
3.1		95.00	80.00	100.00	10.00	3.33	4
6.3		95.00	80.00	100.00	10.00	3.33	4
12.5		95.00	80.00	100.00	10.00	3.33	4
25		90.00	80.00	100.00	11.55	3.78	4
50		50.00	40.00	60.00	11.55	6.80	4
100		10.00	0.00	20.00	11.55	33.98	4
DMW Control	pH	8.20	8.20	8.20	0.00	0.00	1
3.1		7.80	7.80	7.80	0.00	0.00	1
6.3		7.90	7.90	7.90	0.00	0.00	1
12.5		8.10	8.10	8.10	0.00	0.00	1
25		8.20	8.20	8.20	0.00	0.00	1
50		8.20	8.20	8.20	0.00	0.00	1
100		8.10	8.10	8.10	0.00	0.00	1
DMW Control	DO %	101.20	101.20	101.20	0.00	0.00	1
3.1		100.30	100.30	100.30	0.00	0.00	1
6.3		100.10	100.10	100.10	0.00	0.00	1
12.5		100.50	100.50	100.50	0.00	0.00	1
25		100.90	100.90	100.90	0.00	0.00	1
50		102.50	102.50	102.50	0.00	0.00	1
100		108.10	108.10	108.10	0.00	0.00	1
DMW Control	Conductivity uS/cm	173.60	173.60	173.60	0.00	0.00	1
3.1		213.00	213.00	213.00	0.00	0.00	1
6.3		246.00	246.00	246.00	0.00	0.00	1
12.5		313.00	313.00	313.00	0.00	0.00	1
25		440.00	440.00	440.00	0.00	0.00	1
50		671.00	671.00	671.00	0.00	0.00	1
100		1154.00	1154.00	1154.00	0.00	0.00	1

Fish Acute Toxicity Test-96 hr Imbalance

Start Date:	9/09/2014 13:00	Test ID:	PR1223/01	Sample ID:	SV LDP009
End Date:	13/09/2014 17:45	Lab ID:	6808	Sample Type:	AQ-Aqueous
Sample Date:		Protocol:	ESA 117	Test Species:	MS-Melanotaenia splendida
Comments:					

Conc-%	1	2	3	4
DMW Control	1.0000	1.0000	1.0000	1.0000
3.1	1.0000	0.8000	1.0000	1.0000
6.3	1.0000	1.0000	1.0000	0.8000
12.5	1.0000	1.0000	1.0000	0.8000
25	0.8000	1.0000	0.8000	1.0000
50	0.4000	0.6000	0.6000	0.4000
100	0.0000	0.2000	0.0000	0.2000

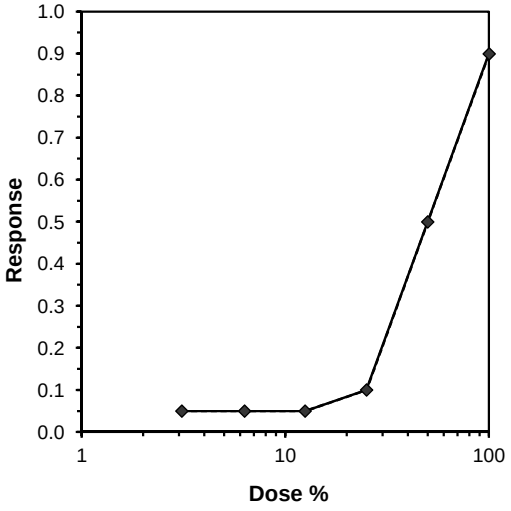
			Transform: Arcsin Square Root					Rank	1-Tailed	Number	Total
Conc-%	Mean	N-Mean	Mean	Min	Max	CV%	N	Sum	Critical	Resp	Number
DMW Control	1.0000	1.0000	1.3453	1.3453	1.3453	0.000	4			0	20
3.1	0.9500	0.9500	1.2857	1.1071	1.3453	9.261	4	16.00	10.00	1	20
6.3	0.9500	0.9500	1.2857	1.1071	1.3453	9.261	4	16.00	10.00	1	20
12.5	0.9500	0.9500	1.2857	1.1071	1.3453	9.261	4	16.00	10.00	1	20
25	0.9000	0.9000	1.2262	1.1071	1.3453	11.212	4	14.00	10.00	2	20
*50	0.5000	0.5000	0.7854	0.6847	0.8861	14.802	4	10.00	10.00	10	20
*100	0.1000	0.1000	0.3446	0.2255	0.4636	39.900	4	10.00	10.00	18	20

Auxiliary Tests	Statistic	Critical	Skew	Kurt
Shapiro-Wilk's Test indicates non-normal distribution (p <= 0.05)	0.854934	0.924	-0.56904	-1.15873
Equality of variance cannot be confirmed				

Hypothesis Test (1-tail, 0.05)	NOEC	LOEC	ChV	TU
Steel's Many-One Rank Test	25	50	35.35534	4
Treatments vs DMW Control				

Trimmed Spearman-Karber

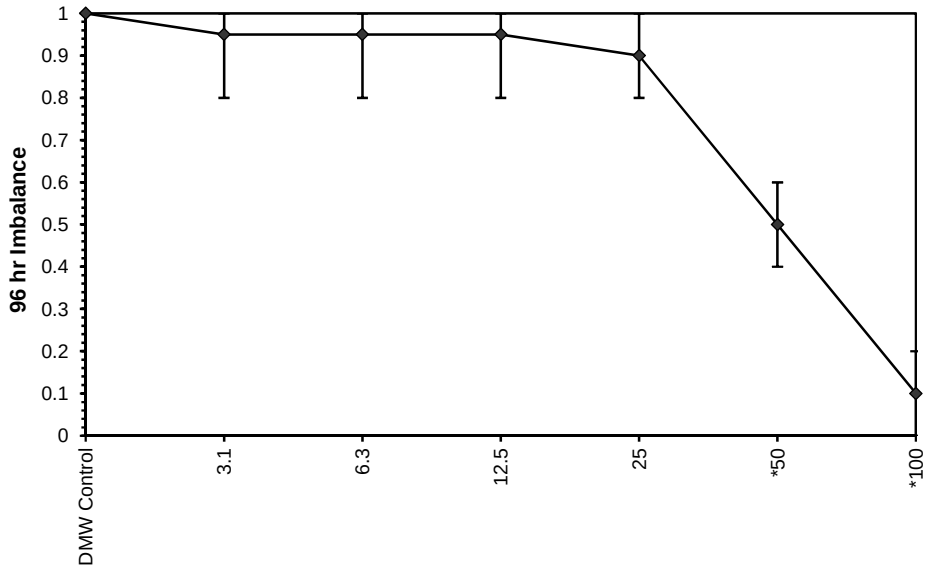
Trim Level	EC50	95% CL	
0.0%			
5.0%			
10.0%	50.000	40.511	61.712
20.0%	50.000	38.338	65.209
Auto-10.0%	50.000	40.511	61.712



Fish Acute Toxicity Test-96 hr Imbalance

Start Date:	9/09/2014 13:00	Test ID:	PR1223/01	Sample ID:	SV LDP009
End Date:	13/09/2014 17:45	Lab ID:	6808	Sample Type:	AQ-Aqueous
Sample Date:		Protocol:	ESA 117	Test Species:	MS-Melanotaenia splendida
Comments:					

Dose-Response Plot



Fish Acute Toxicity Test-96 hr Imbalance

Start Date:	9/09/2014 13:00	Test ID:	PR1223/01	Sample ID:	SV LDP009
End Date:	13/09/2014 17:45	Lab ID:	6808	Sample Type:	AQ-Aqueous
Sample Date:		Protocol:	ESA 117	Test Species:	MS-Melanotaenia splendida
Comments:					

Auxiliary Data Summary

Conc-%	Parameter	Mean	Min	Max	SD	CV%	N
DMW Control	% Unaffected	100.00	100.00	100.00	0.00	0.00	4
3.1		95.00	80.00	100.00	10.00	3.33	4
6.3		95.00	80.00	100.00	10.00	3.33	4
12.5		95.00	80.00	100.00	10.00	3.33	4
25		90.00	80.00	100.00	11.55	3.78	4
50		50.00	40.00	60.00	11.55	6.80	4
100		10.00	0.00	20.00	11.55	33.98	4
DMW Control	pH	8.20	8.20	8.20	0.00	0.00	1
3.1		7.80	7.80	7.80	0.00	0.00	1
6.3		7.90	7.90	7.90	0.00	0.00	1
12.5		8.10	8.10	8.10	0.00	0.00	1
25		8.20	8.20	8.20	0.00	0.00	1
50		8.20	8.20	8.20	0.00	0.00	1
100		8.10	8.10	8.10	0.00	0.00	1
DMW Control	DO %	101.20	101.20	101.20	0.00	0.00	1
3.1		100.30	100.30	100.30	0.00	0.00	1
6.3		100.10	100.10	100.10	0.00	0.00	1
12.5		100.50	100.50	100.50	0.00	0.00	1
25		100.90	100.90	100.90	0.00	0.00	1
50		102.50	102.50	102.50	0.00	0.00	1
100		108.10	108.10	108.10	0.00	0.00	1
DMW Control	Conductivity uS/cm	173.60	173.60	173.60	0.00	0.00	1
3.1		213.00	213.00	213.00	0.00	0.00	1
6.3		246.00	246.00	246.00	0.00	0.00	1
12.5		313.00	313.00	313.00	0.00	0.00	1
25		440.00	440.00	440.00	0.00	0.00	1
50		671.00	671.00	671.00	0.00	0.00	1
100		1154.00	1154.00	1154.00	0.00	0.00	1

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Statistical Printouts for *Hydra* Population Growth Tests

Hydra Population Growth Test-Growth Rate

Start Date:	26/08/2014 13:30	Test ID:	PR1223/02	Sample ID:	SV LDP009
End Date:	30/08/2014 15:44	Lab ID:	6808	Sample Type:	AQ-Aqueous
Sample Date:		Protocol:	ESA 125	Test Species:	HV-Hydra viridissima
Comments:					

Conc-%	1	2	3	4
Lab Control	0.3735	0.3735	0.3785	0.3683
3.1	0.3683	0.3408	0.3349	0.3577
6.3	0.3349	0.3033	0.3408	0.3289
12.5	0.2336	0.1950	0.2670	0.2894
25	0.1844	0.1366	0.0603	0.0603
50	0.0603	0.0000	0.0418	0.0218
100	0.0000	0.0000	0.0000	0.0000

			Transform: Untransformed					Rank	1-Tailed	Isotonic	
Conc-%	Mean	N-Mean	Mean	Min	Max	CV%	N	Sum	Critical	Mean	N-Mean
Lab Control	0.3735	1.0000	0.3735	0.3683	0.3785	1.116	4			0.3735	1.0000
3.1	0.3504	0.9384	0.3504	0.3349	0.3683	4.374	4	10.50	10.00	0.3504	0.9384
*6.3	0.3270	0.8756	0.3270	0.3033	0.3408	5.061	4	10.00	10.00	0.3270	0.8756
*12.5	0.2462	0.6593	0.2462	0.1950	0.2894	16.697	4	10.00	10.00	0.2462	0.6593
*25	0.1104	0.2956	0.1104	0.0603	0.1844	55.309	4	10.00	10.00	0.1104	0.2956
*50	0.0310	0.0829	0.0310	0.0000	0.0603	83.842	4	10.00	10.00	0.0310	0.0829
100	0.0000	0.0000	0.0000	0.0000	0.0000	0.000	4			0.0000	0.0000

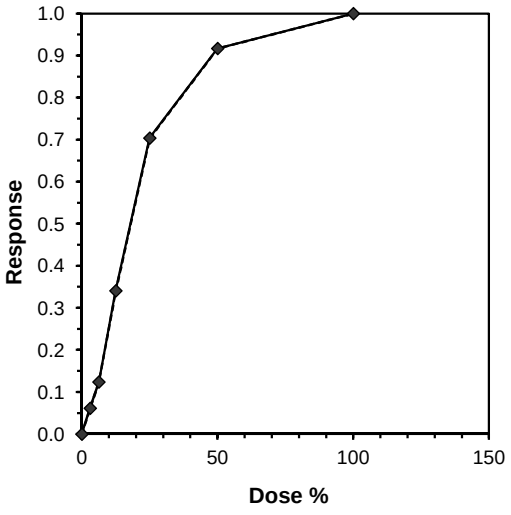
Auxiliary Tests	Statistic	Critical	Skew	Kurt
Shapiro-Wilk's Test indicates normal distribution (p > 0.05)	0.962848	0.916	0.208991	0.793682
Bartlett's Test indicates unequal variances (p = 7.52E-03)	15.77501	15.08627		

Hypothesis Test (1-tail, 0.05)	NOEC	LOEC	ChV	TU
Steel's Many-One Rank Test	3.1	6.3	4.419276	32.25806
Treatments vs Lab Control				

Linear Interpolation (200 Resamples)

Point	%	SD	95% CL(Exp)		Skew
IC05*	2.516	0.648	1.094	4.743	0.5183
IC10	5.056	0.810	2.373	7.276	-0.3033
IC15	7.033	0.585	4.993	9.004	-0.1030
IC20	8.467	0.702	6.785	11.378	0.8354
IC25	9.901	0.989	7.936	13.861	0.7298
IC40	14.539	1.485	10.347	18.967	-0.0769
IC50	17.976	1.666	13.979	24.777	0.7715

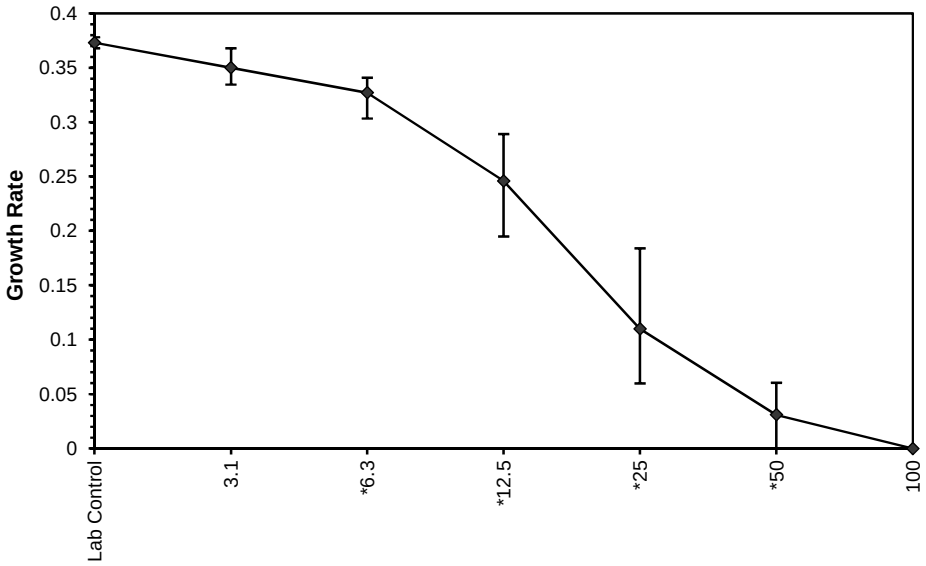
* indicates IC estimate less than the lowest concentration



Hydra Population Growth Test-Growth Rate

Start Date:	26/08/2014 13:30	Test ID:	PR1223/02	Sample ID:	SV LDP009
End Date:	30/08/2014 15:44	Lab ID:	6808	Sample Type:	AQ-Aqueous
Sample Date:		Protocol:	ESA 125	Test Species:	HV-Hydra viridissima
Comments:					

Dose-Response Plot



Hydra Population Growth Test-Growth Rate

Start Date:	26/08/2014 13:30	Test ID:	PR1223/02	Sample ID:	SV LDP009
End Date:	30/08/2014 15:44	Lab ID:	6808	Sample Type:	AQ-Aqueous
Sample Date:		Protocol:	ESA 125	Test Species:	HV-Hydra viridissima
Comments:					

Auxiliary Data Summary

Conc-%	Parameter	Mean	Min	Max	SD	CV%	N
Lab Control	Growth Rate	0.37	0.37	0.38	0.00	17.28	4
3.1		0.35	0.33	0.37	0.02	35.33	4
6.3		0.33	0.30	0.34	0.02	39.34	4
12.5		0.25	0.20	0.29	0.04	82.35	4
25		0.11	0.06	0.18	0.06	223.82	4
50		0.03	0.00	0.06	0.03	520.46	4
100		0.00	0.00	0.00	0.00		4
Lab Control	Conductivity	26.50	26.50	26.50	0.00	0.00	1
3.1		65.00	65.00	65.00	0.00	0.00	1
6.3		104.80	104.80	104.80	0.00	0.00	1
12.5		181.70	181.70	181.70	0.00	0.00	1
25		332.00	332.00	332.00	0.00	0.00	1
50		619.00	619.00	619.00	0.00	0.00	1
100		1175.00	1175.00	1175.00	0.00	0.00	1
Lab Control	pH	7.00	7.00	7.00	0.00	0.00	1
3.1		7.10	7.10	7.10	0.00	0.00	1
6.3		7.30	7.30	7.30	0.00	0.00	1
12.5		7.50	7.50	7.50	0.00	0.00	1
25		7.90	7.90	7.90	0.00	0.00	1
50		8.20	8.20	8.20	0.00	0.00	1
100		8.30	8.30	8.30	0.00	0.00	1
Lab Control	DO, % sat	96.80	96.80	96.80	0.00	0.00	1
3.1		98.50	98.50	98.50	0.00	0.00	1
6.3		99.10	99.10	99.10	0.00	0.00	1
12.5		99.10	99.10	99.10	0.00	0.00	1
25		99.70	99.70	99.70	0.00	0.00	1
50		100.70	100.70	100.70	0.00	0.00	1
100		102.60	102.60	102.60	0.00	0.00	1

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Statistical Printouts for the 7-d Chronic Test with *Ceriodaphnia dubia*

Ceriodaphnia Partial Life-Cycle Test-Reproduction

Start Date:	4/09/2014 15:00	Test ID:	PR1223/02	Sample ID:	AP LDP001
End Date:	12/09/2014 16:00	Lab ID:	6807	Sample Type:	AQ-Aqueous
Sample Date:		Protocol:	ESA 102	Test Species:	CD-Ceriodaphnia dubia
Comments:					

Conc-%	1	2	3	4	5	6	7	8	9	10
DMW Control	22.000	17.000	19.000	12.000	15.000	0.000	11.000	12.000	17.000	11.000
3.1	21.000	26.000	17.000	23.000	14.000	10.000	18.000	17.000	0.000	15.000
6.3	13.000	21.000	23.000	13.000	17.000	7.000	20.000	17.000	9.000	12.000
12.5	18.000	22.000	22.000	22.000	32.000	19.000	20.000	22.000	14.000	10.000
25	0.000	23.000	18.000	23.000	21.000	21.000	21.000	10.000	13.000	24.000
50	22.000	26.000	25.000	34.000	25.000	28.000	20.000	28.000	20.000	24.000
100	33.000	24.000	3.000	22.000	21.000	26.000	12.000	11.000	26.000	13.000

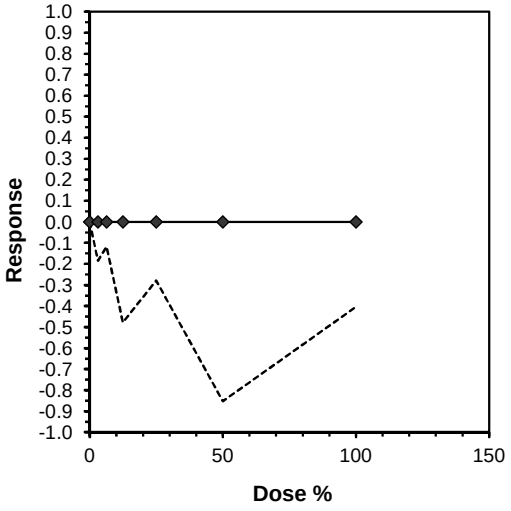
			Transform: Untransformed					1-Tailed			Isotonic	
Conc-%	Mean	N-Mean	Mean	Min	Max	CV%	N	t-Stat	Critical	MSD	Mean	N-Mean
DMW Control	13.600	1.0000	13.600	0.000	22.000	44.416	10				18.100	1.0000
3.1	16.100	1.1838	16.100	0.000	26.000	45.213	10	-0.842	2.347	6.966	18.100	1.0000
6.3	15.200	1.1176	15.200	7.000	23.000	34.646	10	-0.539	2.347	6.966	18.100	1.0000
12.5	20.100	1.4779	20.100	10.000	32.000	28.767	10	-2.190	2.347	6.966	18.100	1.0000
25	17.400	1.2794	17.400	0.000	24.000	43.786	10	-1.280	2.347	6.966	18.100	1.0000
50	25.200	1.8529	25.200	20.000	34.000	16.711	10	-3.908	2.347	6.966	18.100	1.0000
100	19.100	1.4044	19.100	3.000	33.000	47.375	10	-1.853	2.347	6.966	18.100	1.0000

Auxiliary Tests	Statistic	Critical	Skew	Kurt
Kolmogorov D Test indicates normal distribution (p > 0.05)	0.708442	0.895	-0.62529	0.677564
Bartlett's Test indicates equal variances (p = 0.37)	6.518898	16.81189		

Hypothesis Test (1-tail, 0.05)	NOEC	LOEC	ChV	TU	MSDu	MSDp	MSB	MSE	F-Prob	df
Dunnett's Test	100	>100		1	6.966141	0.512216	147.6	44.04286	0.006266	6, 63
Treatments vs DMW Control										

Linear Interpolation (200 Resamples)

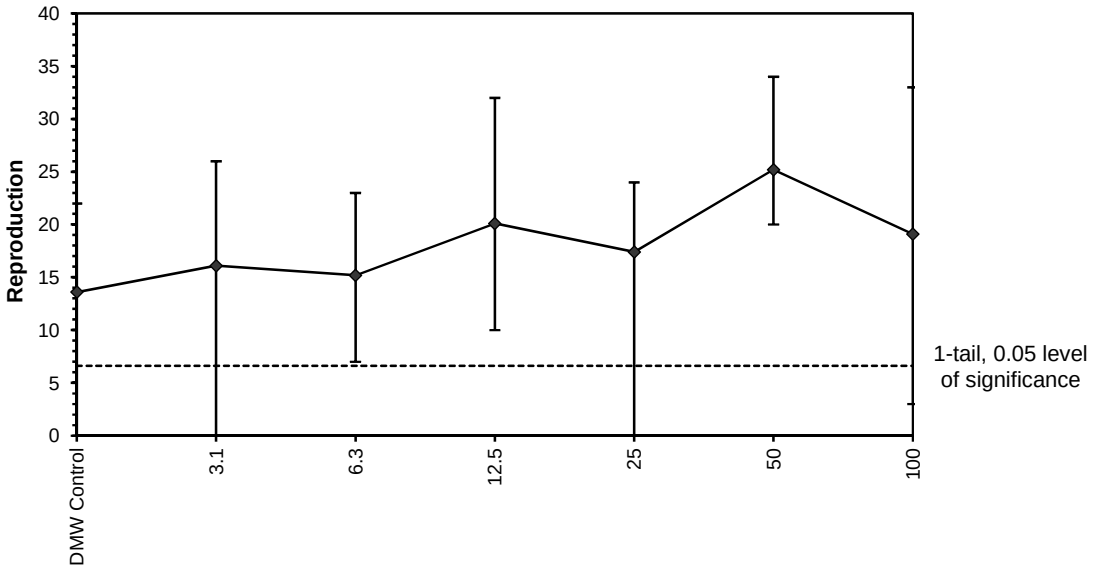
Point	%	SD	95% CL	Skew
IC05	>100			
IC10	>100			
IC15	>100			
IC20	>100			
IC25	>100			
IC40	>100			
IC50	>100			



Ceriodaphnia Partial Life-Cycle Test-Reproduction

Start Date:	4/09/2014 15:00	Test ID:	PR1223/02	Sample ID:	AP LDP001
End Date:	12/09/2014 16:00	Lab ID:	6807	Sample Type:	AQ-Aqueous
Sample Date:		Protocol:	ESA 102	Test Species:	CD-Ceriodaphnia dubia
Comments:					

Dose-Response Plot



Ceriodaphnia Partial Life-Cycle Test-Reproduction

Start Date:	4/09/2014 15:00	Test ID:	PR1223/02	Sample ID:	AP LDP001
End Date:	12/09/2014 16:00	Lab ID:	6807	Sample Type:	AQ-Aqueous
Sample Date:		Protocol:	ESA 102	Test Species:	CD-Ceriodaphnia dubia
Comments:					

Auxiliary Data Summary

Conc-%	Parameter	Mean	Min	Max	SD	CV%	N
DMW Control	No of Young	13.60	0.00	22.00	6.04	18.07	10
3.1		16.10	0.00	26.00	7.28	16.76	10
6.3		15.20	7.00	23.00	5.27	15.10	10
12.5		20.10	10.00	32.00	5.78	11.96	10
25		17.40	0.00	24.00	7.62	15.86	10
50		25.20	20.00	34.00	4.21	8.14	10
100		19.10	3.00	33.00	9.05	15.75	10
DMW Control	% survival	90.00	0.00	100.00	31.62	6.25	10
3.1		90.00	0.00	100.00	31.62	6.25	10
6.3		100.00	100.00	100.00	0.00	0.00	10
12.5		100.00	100.00	100.00	0.00	0.00	10
25		90.00	0.00	100.00	31.62	6.25	10
50		100.00	100.00	100.00	0.00	0.00	10
100		90.00	0.00	100.00	31.62	6.25	10
DMW Control	pH	8.10	8.10	8.10	0.00	0.00	1
3.1		8.10	8.10	8.10	0.00	0.00	1
6.3		8.10	8.10	8.10	0.00	0.00	1
12.5		8.10	8.10	8.10	0.00	0.00	1
25		8.10	8.10	8.10	0.00	0.00	1
50		8.10	8.10	8.10	0.00	0.00	1
100		8.00	8.00	8.00	0.00	0.00	1
DMW Control	DO %	101.00	101.00	101.00	0.00	0.00	1
3.1		100.60	100.60	100.60	0.00	0.00	1
6.3		100.40	100.40	100.40	0.00	0.00	1
12.5		100.60	100.60	100.60	0.00	0.00	1
25		104.30	104.30	104.30	0.00	0.00	1
50		104.30	104.30	104.30	0.00	0.00	1
100		106.00	106.00	106.00	0.00	0.00	1
DMW Control	Cond uS/cm	185.50	185.50	185.50	0.00	0.00	1
3.1		213.00	213.00	213.00	0.00	0.00	1
6.3		242.00	242.00	242.00	0.00	0.00	1
12.5		298.00	298.00	298.00	0.00	0.00	1
25		409.00	409.00	409.00	0.00	0.00	1
50		625.00	625.00	625.00	0.00	0.00	1
100		1038.00	1038.00	1038.00	0.00	0.00	1

Ceriodaphnia Partial Life-Cycle Test-8 day survival

Start Date:	4/09/2014 15:00	Test ID:	PR1223/02	Sample ID:	AP LDP001
End Date:	12/09/2014 16:00	Lab ID:	6807	Sample Type:	AQ-Aqueous
Sample Date:		Protocol:	ESA 102	Test Species:	CD-Ceriodaphnia dubia
Comments:					

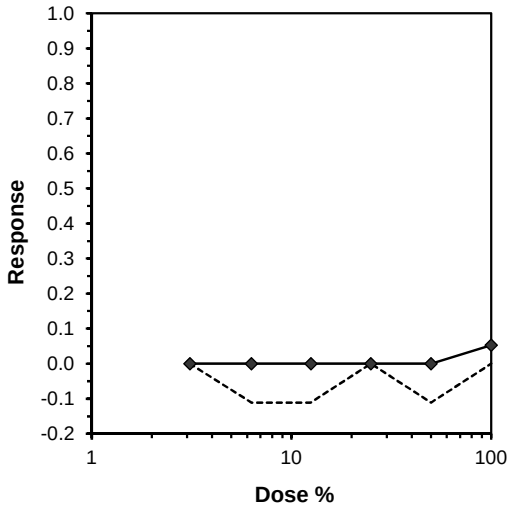
Conc-%	1	2	3	4	5	6	7	8	9	10
DMW Control	1.0000	1.0000	1.0000	1.0000	1.0000	0.0000	1.0000	1.0000	1.0000	1.0000
3.1	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	0.0000	1.0000
6.3	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
12.5	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
25	0.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
50	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
100	1.0000	1.0000	0.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000

Conc-%	Mean	N-Mean	Resp	Not Resp	Total	N	Fisher's Exact P	1-Tailed Critical	Isotonic Mean	Isotonic N-Mean
DMW Control	0.9000	1.0000	1	9	10	10			0.9500	1.0000
3.1	0.9000	1.0000	1	9	10	10	0.7632	0.0500	0.9500	1.0000
6.3	1.0000	1.1111	0	10	10	10	0.5000	0.0500	0.9500	1.0000
12.5	1.0000	1.1111	0	10	10	10	0.5000	0.0500	0.9500	1.0000
25	0.9000	1.0000	1	9	10	10	0.7632	0.0500	0.9500	1.0000
50	1.0000	1.1111	0	10	10	10	0.5000	0.0500	0.9500	1.0000
100	0.9000	1.0000	1	9	10	10	0.7632	0.0500	0.9000	0.9474

Hypothesis Test (1-tail, 0.05)	NOEC	LOEC	ChV	TU
Fisher's Exact Test	100	>100		1
Treatments vs DMW Control				

Log-Logit Interpolation (200 Resamples)

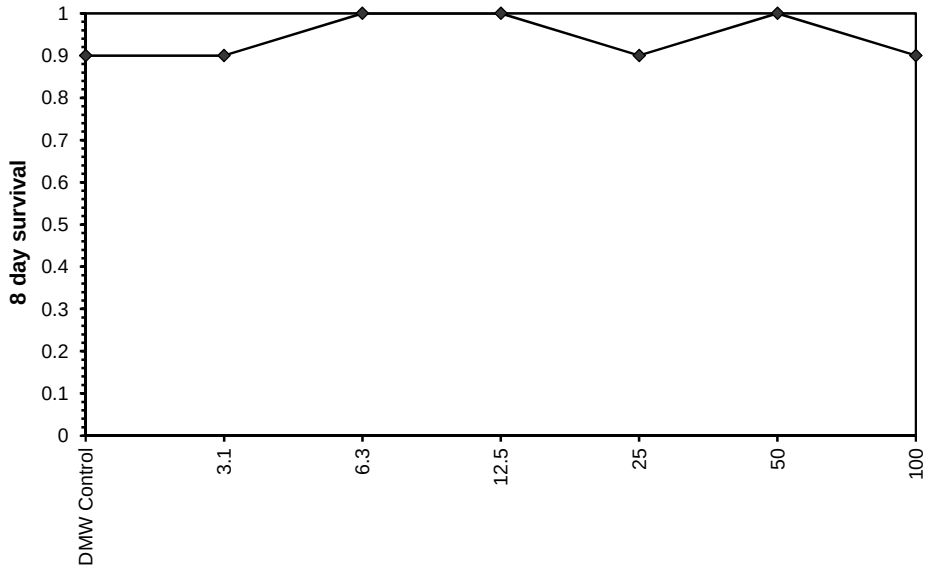
Point	%	SD	95% CL	Skew
IC05	97.438			
IC10	>100			
IC15	>100			
IC20	>100			
IC25	>100			
IC40	>100			
IC50	>100			



Ceriodaphnia Partial Life-Cycle Test-8 day survival

Start Date:	4/09/2014 15:00	Test ID:	PR1223/02	Sample ID:	AP LDP001
End Date:	12/09/2014 16:00	Lab ID:	6807	Sample Type:	AQ-Aqueous
Sample Date:		Protocol:	ESA 102	Test Species:	CD-Ceriodaphnia dubia
Comments:					

Dose-Response Plot



Ceriodaphnia Partial Life-Cycle Test-8 day survival

Start Date:	4/09/2014 15:00	Test ID:	PR1223/02	Sample ID:	AP LDP001
End Date:	12/09/2014 16:00	Lab ID:	6807	Sample Type:	AQ-Aqueous
Sample Date:		Protocol:	ESA 102	Test Species:	CD-Ceriodaphnia dubia
Comments:					

Auxiliary Data Summary

Conc-%	Parameter	Mean	Min	Max	SD	CV%	N
DMW Control	No of Young	13.60	0.00	22.00	6.04	18.07	10
3.1		16.10	0.00	26.00	7.28	16.76	10
6.3		15.20	7.00	23.00	5.27	15.10	10
12.5		20.10	10.00	32.00	5.78	11.96	10
25		17.40	0.00	24.00	7.62	15.86	10
50		25.20	20.00	34.00	4.21	8.14	10
100		19.10	3.00	33.00	9.05	15.75	10
DMW Control	% survival	90.00	0.00	100.00	31.62	6.25	10
3.1		90.00	0.00	100.00	31.62	6.25	10
6.3		100.00	100.00	100.00	0.00	0.00	10
12.5		100.00	100.00	100.00	0.00	0.00	10
25		90.00	0.00	100.00	31.62	6.25	10
50		100.00	100.00	100.00	0.00	0.00	10
100		90.00	0.00	100.00	31.62	6.25	10
DMW Control	pH	8.10	8.10	8.10	0.00	0.00	1
3.1		8.10	8.10	8.10	0.00	0.00	1
6.3		8.10	8.10	8.10	0.00	0.00	1
12.5		8.10	8.10	8.10	0.00	0.00	1
25		8.10	8.10	8.10	0.00	0.00	1
50		8.10	8.10	8.10	0.00	0.00	1
100		8.00	8.00	8.00	0.00	0.00	1
DMW Control	DO %	101.00	101.00	101.00	0.00	0.00	1
3.1		100.60	100.60	100.60	0.00	0.00	1
6.3		100.40	100.40	100.40	0.00	0.00	1
12.5		100.60	100.60	100.60	0.00	0.00	1
25		104.30	104.30	104.30	0.00	0.00	1
50		104.30	104.30	104.30	0.00	0.00	1
100		106.00	106.00	106.00	0.00	0.00	1
DMW Control	Cond uS/cm	185.50	185.50	185.50	0.00	0.00	1
3.1		213.00	213.00	213.00	0.00	0.00	1
6.3		242.00	242.00	242.00	0.00	0.00	1
12.5		298.00	298.00	298.00	0.00	0.00	1
25		409.00	409.00	409.00	0.00	0.00	1
50		625.00	625.00	625.00	0.00	0.00	1
100		1038.00	1038.00	1038.00	0.00	0.00	1

Ceriodaphnia Partial Life-Cycle Test-Reproduction

Start Date:	28/08/2014 13:30	Test ID:	PR1223/02	Sample ID:	SV LDP009
End Date:	5/09/2014 13:24	Lab ID:	6808	Sample Type:	AQ-Aqueous
Sample Date:		Protocol:	ESA 102	Test Species:	CD-Ceriodaphnia dubia
Comments:					

Conc-%	1	2	3	4	5	6	7	8	9	10
DMW Control	18.000	22.000	27.000	13.000	13.000	14.000	4.000	12.000	17.000	13.000
3.1	22.000	21.000	8.000	12.000	20.000	22.000	18.000	12.000	24.000	22.000
6.3	17.000	22.000	21.000	22.000	20.000	10.000	16.000	16.000	14.000	25.000
12.5	19.000	21.000	3.000	16.000	11.000	26.000	23.000	5.000	6.000	7.000
25	0.000	12.000	8.000	6.000	10.000	14.000	18.000	8.000	12.000	4.000
50	6.000	0.000	15.000	4.000	11.000	0.000	5.000	3.000	0.000	12.000
100	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000

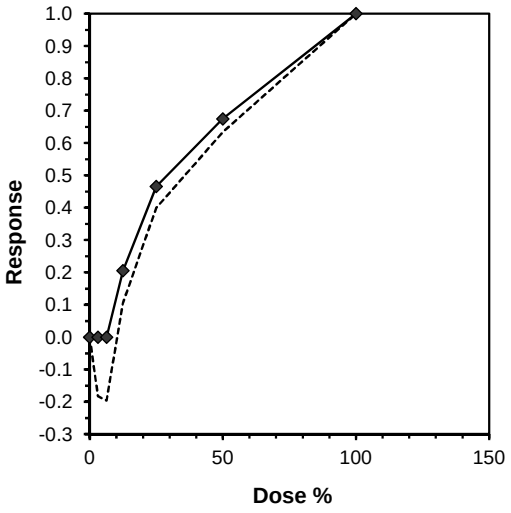
			Transform: Untransformed					1-Tailed			Isotonic	
Conc-%	Mean	N-Mean	Mean	Min	Max	CV%	N	t-Stat	Critical	MSD	Mean	N-Mean
DMW Control	15.300	1.0000	15.300	4.000	27.000	40.648	10				17.233	1.0000
3.1	18.100	1.1830	18.100	8.000	24.000	30.199	10	-1.047	2.287	6.112	17.233	1.0000
6.3	18.300	1.1961	18.300	10.000	25.000	24.580	10	-1.122	2.287	6.112	17.233	1.0000
12.5	13.700	0.8954	13.700	3.000	26.000	60.881	10	0.599	2.287	6.112	13.700	0.7950
25	9.200	0.6013	9.200	0.000	18.000	56.317	10	2.282	2.287	6.112	9.200	0.5338
*50	5.600	0.3660	5.600	0.000	15.000	96.421	10	3.629	2.287	6.112	5.600	0.3250
100	0.000	0.0000	0.000	0.000	0.000	0.000	10				0.000	0.0000

Auxiliary Tests	Statistic	Critical	Skew	Kurt
Kolmogorov D Test indicates normal distribution (p > 0.05)	0.524712	0.895	0.021178	-0.58724
Bartlett's Test indicates equal variances (p = 0.52)	4.232154	15.08627		

Hypothesis Test (1-tail, 0.05)	NOEC	LOEC	ChV	TU	MSDu	MSDp	MSB	MSE	F-Prob	df
Dunnett's Test	25	50	35.35534	4	6.112369	0.399501	256.5467	35.72593	3.2E-05	5, 54
Treatments vs DMW Control										

Linear Interpolation (200 Resamples)

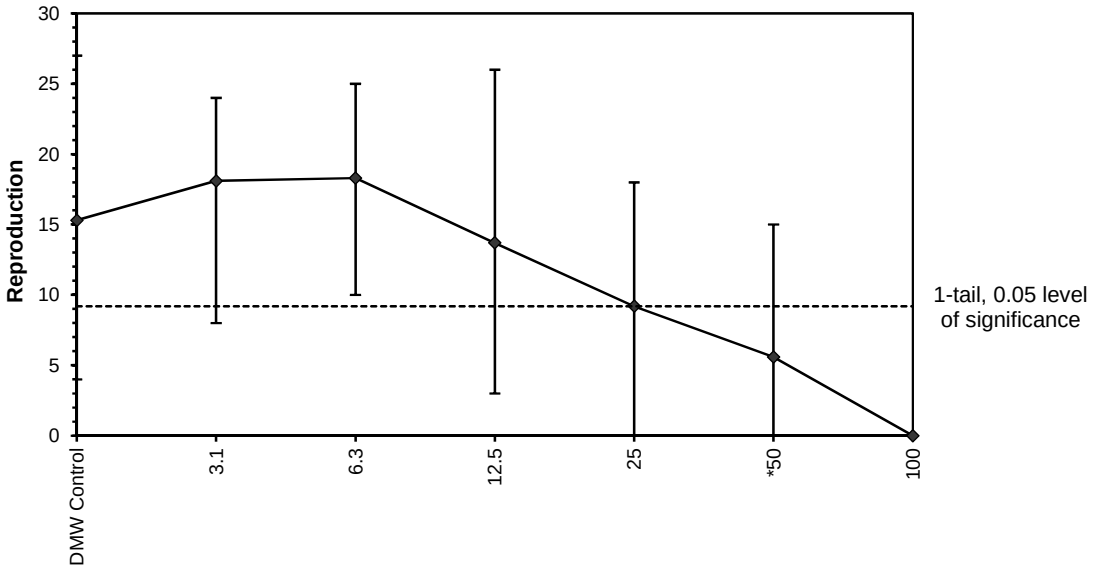
Point	%	SD	95% CL		Skew
IC05	7.812	2.842	2.615	14.253	0.5186
IC10	9.324	2.974	5.246	16.006	0.4828
IC15	10.836	3.134	7.143	17.759	0.5046
IC20	12.348	3.410	7.953	19.842	0.3988
IC25	14.653	3.786	9.147	21.824	0.2875
IC40	21.833	5.661	11.396	32.891	0.2519
IC50	29.051	7.848	16.305	50.346	0.5915



Ceriodaphnia Partial Life-Cycle Test-Reproduction

Start Date:	28/08/2014 13:30	Test ID:	PR1223/02	Sample ID:	SV LDP009
End Date:	5/09/2014 13:24	Lab ID:	6808	Sample Type:	AQ-Aqueous
Sample Date:		Protocol:	ESA 102	Test Species:	CD-Ceriodaphnia dubia
Comments:					

Dose-Response Plot



Ceriodaphnia Partial Life-Cycle Test-Reproduction

Start Date:	28/08/2014 13:30	Test ID:	PR1223/02	Sample ID:	SV LDP009
End Date:	5/09/2014 13:24	Lab ID:	6808	Sample Type:	AQ-Aqueous
Sample Date:		Protocol:	ESA 102	Test Species:	CD-Ceriodaphnia dubia
Comments:					

Auxiliary Data Summary

Conc-%	Parameter	Mean	Min	Max	SD	CV%	N
DMW Control	No of Young	15.30	4.00	27.00	6.22	16.30	10
3.1		18.10	8.00	24.00	5.47	12.92	10
6.3		18.30	10.00	25.00	4.50	11.59	10
12.5		13.70	3.00	26.00	8.34	21.08	10
25		9.20	0.00	18.00	5.18	24.74	10
50		5.60	0.00	15.00	5.40	41.49	10
100		0.00	0.00	0.00	0.00		10
DMW Control	% survival	90.00	0.00	100.00	31.62	6.25	10
3.1		80.00	0.00	100.00	42.16	8.12	10
6.3		100.00	100.00	100.00	0.00	0.00	10
12.5		100.00	100.00	100.00	0.00	0.00	10
25		90.00	0.00	100.00	31.62	6.25	10
50		70.00	0.00	100.00	48.30	9.93	10
100		0.00	0.00	0.00	0.00		10
DMW Control	pH	8.10	8.10	8.10	0.00	0.00	1
3.1		8.20	8.20	8.20	0.00	0.00	1
6.3		8.20	8.20	8.20	0.00	0.00	1
12.5		8.30	8.30	8.30	0.00	0.00	1
25		8.30	8.30	8.30	0.00	0.00	1
50		8.40	8.40	8.40	0.00	0.00	1
100		8.40	8.40	8.40	0.00	0.00	1
DMW Control	DO %	100.70	100.70	100.70	0.00	0.00	1
3.1		100.60	100.60	100.60	0.00	0.00	1
6.3		101.10	101.10	101.10	0.00	0.00	1
12.5		100.70	100.70	100.70	0.00	0.00	1
25		100.80	100.80	100.80	0.00	0.00	1
50		101.70	101.70	101.70	0.00	0.00	1
100		104.70	104.70	104.70	0.00	0.00	1
DMW Control	Cond uS/cm	185.10	185.10	185.10	0.00	0.00	1
3.1		222.00	222.00	222.00	0.00	0.00	1
6.3		252.00	252.00	252.00	0.00	0.00	1
12.5		318.00	318.00	318.00	0.00	0.00	1
25		445.00	445.00	445.00	0.00	0.00	1
50		691.00	691.00	691.00	0.00	0.00	1
100		1180.00	1180.00	1180.00	0.00	0.00	1

Ceriodaphnia Partial Life-Cycle Test-8 day survival

Start Date:	28/08/2014 13:30	Test ID:	PR1223/02	Sample ID:	SV LDP009
End Date:	5/09/2014 13:24	Lab ID:	6808	Sample Type:	AQ-Aqueous
Sample Date:		Protocol:	ESA 102	Test Species:	CD-Ceriodaphnia dubia
Comments:					

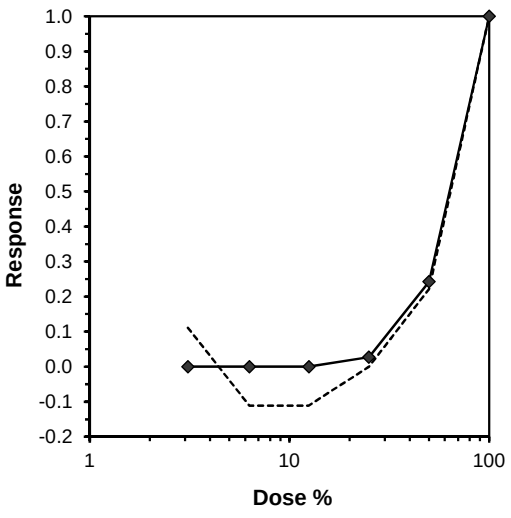
Conc-%	1	2	3	4	5	6	7	8	9	10
DMW Control	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	0.0000	1.0000	1.0000	1.0000
3.1	1.0000	1.0000	0.0000	1.0000	1.0000	1.0000	1.0000	0.0000	1.0000	1.0000
6.3	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
12.5	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
25	1.0000	0.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
50	1.0000	0.0000	1.0000	1.0000	1.0000	0.0000	1.0000	1.0000	0.0000	1.0000
100	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000

Conc-%	Mean	N-Mean	Resp	Not Resp	Total	N	Fisher's Exact P	1-Tailed Critical	Isotonic Mean	Isotonic N-Mean
DMW Control	0.9000	1.0000	1	9	10	10			0.9250	1.0000
3.1	0.8000	0.8889	2	8	10	10	0.5000	0.0500	0.9250	1.0000
6.3	1.0000	1.1111	0	10	10	10	0.5000	0.0500	0.9250	1.0000
12.5	1.0000	1.1111	0	10	10	10	0.5000	0.0500	0.9250	1.0000
25	0.9000	1.0000	1	9	10	10	0.7632	0.0500	0.9000	0.9730
50	0.7000	0.7778	3	7	10	10	0.2910	0.0500	0.7000	0.7568
100	0.0000	0.0000	10	0	10	10			0.0000	0.0000

Hypothesis Test (1-tail, 0.05)	NOEC	LOEC	ChV	TU
Fisher's Exact Test	50	100	70.71068	2
Treatments vs DMW Control				

Log-Logit Interpolation (200 Resamples)

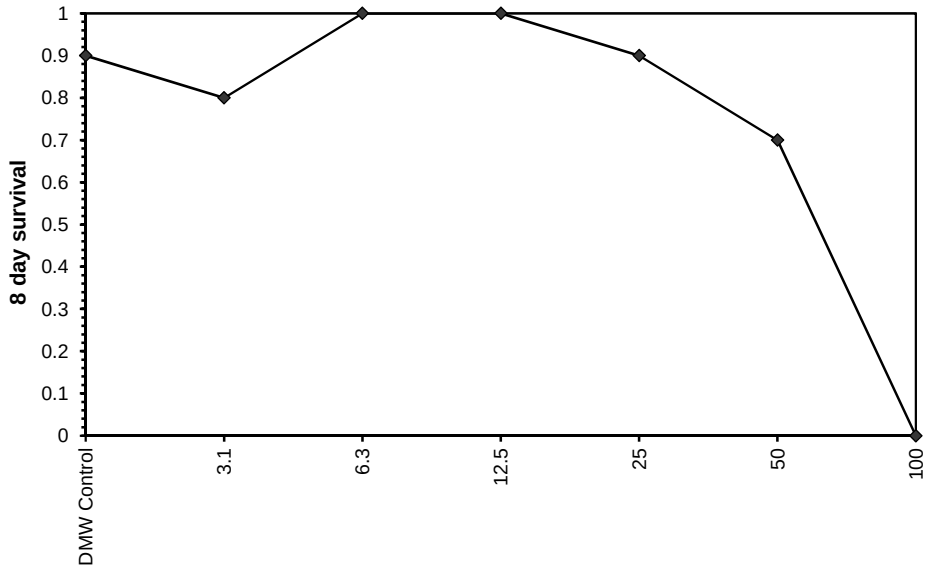
Point	%	SD	95% CL		Skew
IC05	27.968	12.978	2.377	51.172	-0.0598
IC10	33.968	11.803	2.905	52.123	-0.1779
IC15	39.636	10.425	18.668	52.946	-0.3769
IC20	45.186	8.842	23.041	53.715	-0.7060
IC25	50.103	7.084	27.970	54.457	-1.0713
IC40	52.217	3.440	43.267	56.455	-1.5101
IC50	53.576	2.635	47.360	57.739	-0.9084



Ceriodaphnia Partial Life-Cycle Test-8 day survival

Start Date:	28/08/2014 13:30	Test ID:	PR1223/02	Sample ID:	SV LDP009
End Date:	5/09/2014 13:24	Lab ID:	6808	Sample Type:	AQ-Aqueous
Sample Date:		Protocol:	ESA 102	Test Species:	CD-Ceriodaphnia dubia
Comments:					

Dose-Response Plot



Ceriodaphnia Partial Life-Cycle Test-8 day survival

Start Date:	28/08/2014 13:30	Test ID:	PR1223/02	Sample ID:	SV LDP009
End Date:	5/09/2014 13:24	Lab ID:	6808	Sample Type:	AQ-Aqueous
Sample Date:		Protocol:	ESA 102	Test Species:	CD-Ceriodaphnia dubia
Comments:					

Auxiliary Data Summary

Conc-%	Parameter	Mean	Min	Max	SD	CV%	N
DMW Control	No of Young	15.30	4.00	27.00	6.22	16.30	10
3.1		18.10	8.00	24.00	5.47	12.92	10
6.3		18.30	10.00	25.00	4.50	11.59	10
12.5		13.70	3.00	26.00	8.34	21.08	10
25		9.20	0.00	18.00	5.18	24.74	10
50		5.60	0.00	15.00	5.40	41.49	10
100		0.00	0.00	0.00	0.00		10
DMW Control	% survival	90.00	0.00	100.00	31.62	6.25	10
3.1		80.00	0.00	100.00	42.16	8.12	10
6.3		100.00	100.00	100.00	0.00	0.00	10
12.5		100.00	100.00	100.00	0.00	0.00	10
25		90.00	0.00	100.00	31.62	6.25	10
50		70.00	0.00	100.00	48.30	9.93	10
100		0.00	0.00	0.00	0.00		10
DMW Control	pH	8.10	8.10	8.10	0.00	0.00	1
3.1		8.20	8.20	8.20	0.00	0.00	1
6.3		8.20	8.20	8.20	0.00	0.00	1
12.5		8.30	8.30	8.30	0.00	0.00	1
25		8.30	8.30	8.30	0.00	0.00	1
50		8.40	8.40	8.40	0.00	0.00	1
100		8.40	8.40	8.40	0.00	0.00	1
DMW Control	DO %	100.70	100.70	100.70	0.00	0.00	1
3.1		100.60	100.60	100.60	0.00	0.00	1
6.3		101.10	101.10	101.10	0.00	0.00	1
12.5		100.70	100.70	100.70	0.00	0.00	1
25		100.80	100.80	100.80	0.00	0.00	1
50		101.70	101.70	101.70	0.00	0.00	1
100		104.70	104.70	104.70	0.00	0.00	1
DMW Control	Cond uS/cm	185.10	185.10	185.10	0.00	0.00	1
3.1		222.00	222.00	222.00	0.00	0.00	1
6.3		252.00	252.00	252.00	0.00	0.00	1
12.5		318.00	318.00	318.00	0.00	0.00	1
25		445.00	445.00	445.00	0.00	0.00	1
50		691.00	691.00	691.00	0.00	0.00	1
100		1180.00	1180.00	1180.00	0.00	0.00	1

Ceriodaphnia Partial Life-Cycle Test-8 day survival

Start Date:	28/08/2014 13:30	Test ID:	PR1223/02	Sample ID:	SV LDP009
End Date:	5/09/2014 13:24	Lab ID:	6808	Sample Type:	AQ-Aqueous
Sample Date:		Protocol:	ESA 102	Test Species:	CD-Ceriodaphnia dubia
Comments:					

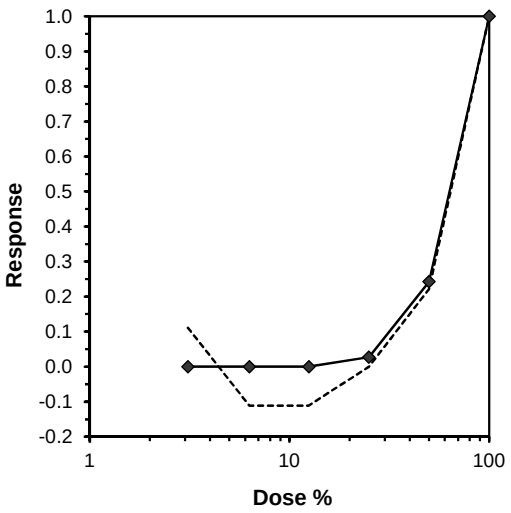
Conc-%	1	2	3	4	5	6	7	8	9	10
DMW Control	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	0.0000	1.0000	1.0000	1.0000
3.1	1.0000	1.0000	0.0000	1.0000	1.0000	1.0000	1.0000	0.0000	1.0000	1.0000
6.3	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
12.5	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
25	1.0000	0.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
50	1.0000	0.0000	1.0000	1.0000	1.0000	0.0000	1.0000	1.0000	0.0000	1.0000
100	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000

Conc-%	Mean	N-Mean	Resp	Not Resp	Total	N	Fisher's Exact P	1-Tailed Critical	Number Resp	Total Number
DMW Control	0.9000	1.0000	1	9	10	10			1	10
3.1	0.8000	0.8889	2	8	10	10	0.5000	0.0500	2	10
6.3	1.0000	1.1111	0	10	10	10	0.5000	0.0500	0	10
12.5	1.0000	1.1111	0	10	10	10	0.5000	0.0500	0	10
25	0.9000	1.0000	1	9	10	10	0.7632	0.0500	1	10
50	0.7000	0.7778	3	7	10	10	0.2910	0.0500	3	10
100	0.0000	0.0000	10	0	10	10			10	10

Hypothesis Test (1-tail, 0.05)	NOEC	LOEC	ChV	TU
Fisher's Exact Test	50	100	70.71068	2
Treatments vs DMW Control				

Trimmed Spearman-Karber

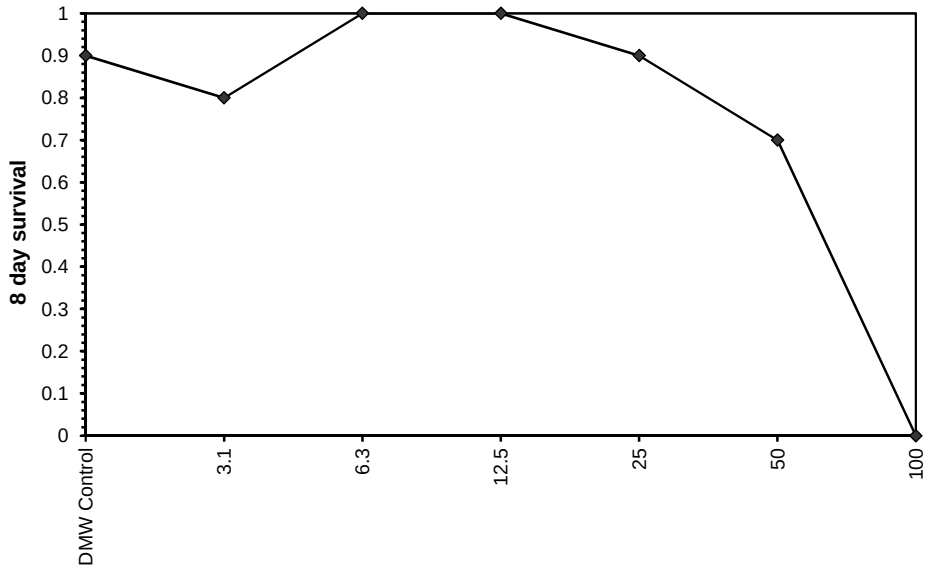
Trim Level	EC50	95% CL	
0.0%	58.631	47.951	71.689
5.0%	60.322	48.795	74.572
10.0%	61.426	47.972	78.653
20.0%	63.031	42.131	94.299
Auto-0.0%	58.631	47.951	71.689



Ceriodaphnia Partial Life-Cycle Test-8 day survival

Start Date:	28/08/2014 13:30	Test ID:	PR1223/02	Sample ID:	SV LDP009
End Date:	5/09/2014 13:24	Lab ID:	6808	Sample Type:	AQ-Aqueous
Sample Date:		Protocol:	ESA 102	Test Species:	CD-Ceriodaphnia dubia
Comments:					

Dose-Response Plot



Ceriodaphnia Partial Life-Cycle Test-8 day survival

Start Date:	28/08/2014 13:30	Test ID:	PR1223/02	Sample ID:	SV LDP009
End Date:	5/09/2014 13:24	Lab ID:	6808	Sample Type:	AQ-Aqueous
Sample Date:		Protocol:	ESA 102	Test Species:	CD-Ceriodaphnia dubia
Comments:					

Auxiliary Data Summary

Conc-%	Parameter	Mean	Min	Max	SD	CV%	N
DMW Control	No of Young	15.30	4.00	27.00	6.22	16.30	10
3.1		18.10	8.00	24.00	5.47	12.92	10
6.3		18.30	10.00	25.00	4.50	11.59	10
12.5		13.70	3.00	26.00	8.34	21.08	10
25		9.20	0.00	18.00	5.18	24.74	10
50		5.60	0.00	15.00	5.40	41.49	10
100		0.00	0.00	0.00	0.00		10
DMW Control	% survival	90.00	0.00	100.00	31.62	6.25	10
3.1		80.00	0.00	100.00	42.16	8.12	10
6.3		100.00	100.00	100.00	0.00	0.00	10
12.5		100.00	100.00	100.00	0.00	0.00	10
25		90.00	0.00	100.00	31.62	6.25	10
50		70.00	0.00	100.00	48.30	9.93	10
100		0.00	0.00	0.00	0.00		10
DMW Control	pH	8.10	8.10	8.10	0.00	0.00	1
3.1		8.20	8.20	8.20	0.00	0.00	1
6.3		8.20	8.20	8.20	0.00	0.00	1
12.5		8.30	8.30	8.30	0.00	0.00	1
25		8.30	8.30	8.30	0.00	0.00	1
50		8.40	8.40	8.40	0.00	0.00	1
100		8.40	8.40	8.40	0.00	0.00	1
DMW Control	DO %	100.70	100.70	100.70	0.00	0.00	1
3.1		100.60	100.60	100.60	0.00	0.00	1
6.3		101.10	101.10	101.10	0.00	0.00	1
12.5		100.70	100.70	100.70	0.00	0.00	1
25		100.80	100.80	100.80	0.00	0.00	1
50		101.70	101.70	101.70	0.00	0.00	1
100		104.70	104.70	104.70	0.00	0.00	1
DMW Control	Cond uS/cm	185.10	185.10	185.10	0.00	0.00	1
3.1		222.00	222.00	222.00	0.00	0.00	1
6.3		252.00	252.00	252.00	0.00	0.00	1
12.5		318.00	318.00	318.00	0.00	0.00	1
25		445.00	445.00	445.00	0.00	0.00	1
50		691.00	691.00	691.00	0.00	0.00	1
100		1180.00	1180.00	1180.00	0.00	0.00	1

Ceriodaphnia Partial Life-Cycle Test-Reproduction

Start Date:	11/09/2014 14:15	Test ID:	PR1223/21	Sample ID:	Various
End Date:	19/09/2014 14:00	Lab ID:	Various	Sample Type:	AQ-Aqueous
Sample Date:		Protocol:	ESA 102	Test Species:	CD-Ceriodaphnia dubia
Comments:					

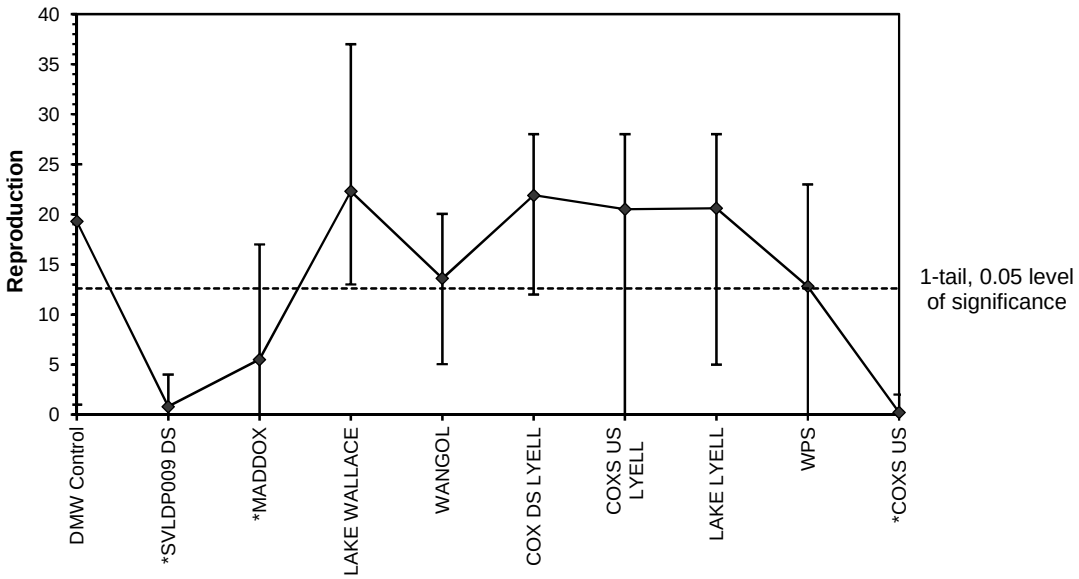
Conc-	1	2	3	4	5	6	7	8	9	10
DMW Control	24.000	23.000	18.000	24.000	20.000	19.000	1.000	24.000	15.000	25.000
SVLDP009 DS	0.000	4.000	0.000	0.000	0.000	0.000	0.000	0.000	4.000	0.000
MADDOX	4.000	7.000	17.000	0.000	4.000	2.000	4.000	2.000	12.000	3.000
AKE WALLACE	22.000	21.000	13.000	24.000	20.000	22.000	23.000	24.000	37.000	17.000
WANGOL	13.000	18.000	13.000	10.000	15.000	10.000	20.000	18.000	5.000	
COX DS LYELL	19.000	28.000	26.000	22.000	22.000	18.000	25.000	24.000	23.000	12.000
COXS US LYELL	25.000	28.000	24.000	20.000	23.000	27.000	22.000	14.000	0.000	22.000
LAKE LYELL	28.000	17.000	5.000	18.000	26.000	26.000	28.000	27.000	17.000	14.000
WPS	17.000	23.000	18.000	11.000	0.000	12.000	16.000	10.000	16.000	5.000
COXS US	0.000	2.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000

			Transform: Untransformed					1-Tailed		
Conc-	Mean	N-Mean	Mean	Min	Max	CV%	N	t-Stat	Critical	MSD
DMW Control	19.300	1.0000	19.300	1.000	25.000	37.367	10			
*SVLDP009 DS	0.800	0.0415	0.800	0.000	4.000	210.819	10	7.128	2.593	6.731
*MADDOX	5.500	0.2850	5.500	0.000	17.000	94.767	10	5.317	2.593	6.731
AKE WALLACE	22.300	1.1554	22.300	13.000	37.000	27.728	10	-1.156	2.593	6.731
WANGOL	13.556	0.7024	13.556	5.000	20.000	35.208	9	2.154	2.593	6.915
COX DS LYELL	21.900	1.1347	21.900	12.000	28.000	21.030	10	-1.002	2.593	6.731
COXS US LYELL	20.500	1.0622	20.500	0.000	28.000	39.978	10	-0.462	2.593	6.731
LAKE LYELL	20.600	1.0674	20.600	5.000	28.000	37.196	10	-0.501	2.593	6.731
WPS	12.800	0.6632	12.800	0.000	23.000	52.447	10	2.504	2.593	6.731
*COXS US	0.200	0.0104	0.200	0.000	2.000	316.228	10	7.359	2.593	6.731

Auxiliary Tests	Statistic	Critical	Skew	Kurt
Kolmogorov D Test indicates non-normal distribution (p <= 0.05)	1.308145	0.895	-0.92016	2.801025
Bartlett's Test indicates unequal variances (p = 9.06E-08)	50.40083	21.66599		

Hypothesis Test (1-tail, 0.05)	MSDu	MSDp	MSB	MSE	F-Prob	df
Bonferroni t Test indicates significant differences Treatments vs DMW Control	6.730781	0.348745	759.0183	33.68002	1.9E-19	9, 89

Dose-Response Plot



Ceriodaphnia Partial Life-Cycle Test-Reproduction

Start Date:	11/09/2014 14:15	Test ID:	PR1223/21	Sample ID:	Various
End Date:	19/09/2014 14:00	Lab ID:	Various	Sample Type:	AQ-Aqueous
Sample Date:		Protocol:	ESA 102	Test Species:	CD-Ceriodaphnia dubia
Comments:					

Auxiliary Data Summary

Conc-	Parameter	Mean	Min	Max	SD	CV%	N
DMW Control	No of Young	19.30	1.00	25.00	7.21	13.91	10
SVLDP009 DS		0.80	0.00	4.00	1.69	162.33	10
MADDOX		5.50	0.00	17.00	5.21	41.51	10
AKE WALLACE		22.30	13.00	37.00	6.18	11.15	10
WANGOL		13.56	5.00	20.00	4.77	16.12	9
COX DS LYELL		21.90	12.00	28.00	4.61	9.80	10
OXS US LYELL		20.50	0.00	28.00	8.20	13.96	10
LAKE LYELL		20.60	5.00	28.00	7.66	13.44	10
WPS		12.80	0.00	23.00	6.71	20.24	10
COXS US		0.20	0.00	2.00	0.63	397.64	10
DMW Control	% survival	90.00	0.00	100.00	31.62	6.25	10
SVLDP009 DS		80.00	0.00	100.00	42.16	8.12	10
MADDOX		100.00	100.00	100.00	0.00	0.00	10
AKE WALLACE		100.00	100.00	100.00	0.00	0.00	10
WANGOL		100.00	100.00	100.00	0.00	0.00	9
COX DS LYELL		100.00	100.00	100.00	0.00	0.00	10
OXS US LYELL		100.00	100.00	100.00	0.00	0.00	10
LAKE LYELL		90.00	0.00	100.00	31.62	6.25	10
WPS		100.00	100.00	100.00	0.00	0.00	10
COXS US		40.00	0.00	100.00	51.64	17.97	10
DMW Control	pH	8.10	8.10	8.10	0.00	0.00	1
SVLDP009 DS		8.80	8.80	8.80	0.00	0.00	1
MADDOX		8.60	8.60	8.60	0.00	0.00	1
AKE WALLACE		8.50	8.50	8.50	0.00	0.00	1
WANGOL		8.70	8.70	8.70	0.00	0.00	1
COX DS LYELL		8.30	8.30	8.30	0.00	0.00	1
OXS US LYELL		8.70	8.70	8.70	0.00	0.00	1
LAKE LYELL		8.40	8.40	8.40	0.00	0.00	1
WPS		8.40	8.40	8.40	0.00	0.00	1
COXS US		6.60	6.60	6.60	0.00	0.00	1
DMW Control	DO %	100.90	100.90	100.90	0.00	0.00	1
SVLDP009 DS		89.00	89.00	89.00	0.00	0.00	1
MADDOX		94.80	94.80	94.80	0.00	0.00	1
AKE WALLACE		99.10	99.10	99.10	0.00	0.00	1
WANGOL		109.00	109.00	109.00	0.00	0.00	1
COX DS LYELL		109.10	109.10	109.10	0.00	0.00	1
OXS US LYELL		104.50	104.50	104.50	0.00	0.00	1
LAKE LYELL		106.40	106.40	106.40	0.00	0.00	1
WPS		90.30	90.30	90.30	0.00	0.00	1
COXS US		102.80	102.80	102.80	0.00	0.00	1
DMW Control	Cond uS/cm	187.20	187.20	187.20	0.00	0.00	1
SVLDP009 DS		1089.00	1089.00	1089.00	0.00	0.00	1
MADDOX		1007.00	1007.00	1007.00	0.00	0.00	1
AKE WALLACE		986.00	986.00	986.00	0.00	0.00	1
WANGOL		806.00	806.00	806.00	0.00	0.00	1
COX DS LYELL		506.00	506.00	506.00	0.00	0.00	1
OXS US LYELL		1049.00	1049.00	1049.00	0.00	0.00	1
LAKE LYELL		547.00	547.00	547.00	0.00	0.00	1
WPS		949.00	949.00	949.00	0.00	0.00	1
COXS US		41.50	41.50	41.50	0.00	0.00	1

Ceriodaphnia Partial Life-Cycle Test-8 day survival

Start Date:	11/09/2014 14:15	Test ID:	PR1223/21	Sample ID:	Various
End Date:	19/09/2014 14:00	Lab ID:	Various	Sample Type:	AQ-Aqueous
Sample Date:		Protocol:	ESA 102	Test Species:	CD-Ceriodaphnia dubia
Comments:					

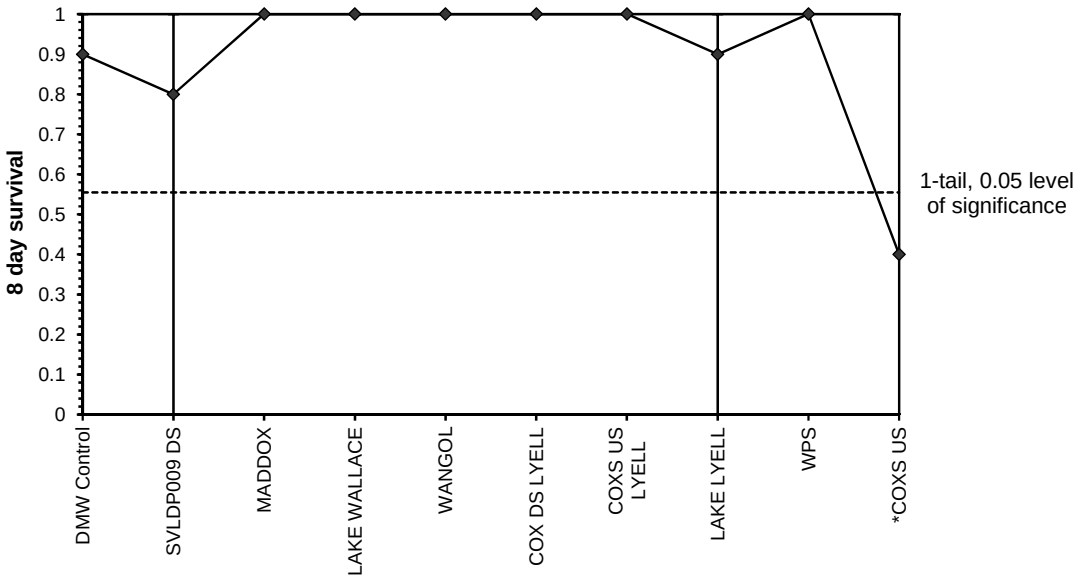
Conc-	1	2	3	4	5	6	7	8	9	10
DMW Control	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	0.0000	1.0000	1.0000	1.0000
SVLDP009 DS	0.0000	1.0000	0.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
MADDOX	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
AKE WALLACE	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
WANGOL	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
COX DS LYELL	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
COXS US LYELL	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
LAKE LYELL	1.0000	1.0000	0.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
WPS	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
COXS US	1.0000	1.0000	1.0000	0.0000	0.0000	0.0000	0.0000	1.0000	0.0000	0.0000

			Transform: Arcsin Square Root					1-Tailed		
Conc-	Mean	N-Mean	Mean	Min	Max	CV%	N	t-Stat	Critical	MSD
DMW Control	0.9000	1.0000	0.9948	0.5236	1.0472	16.644	10			
SVLDP009 DS	0.8000	0.8889	0.9425	0.5236	1.0472	23.424	10	0.881	2.593	0.1541
MADDOX	1.0000	1.1111	1.0472	1.0472	1.0472	0.000	10	-0.881	2.593	0.1541
AKE WALLACE	1.0000	1.1111	1.0472	1.0472	1.0472	0.000	10	-0.881	2.593	0.1541
WANGOL	1.0000	1.1111	1.0472	1.0472	1.0472	0.000	10	-0.881	2.593	0.1541
COX DS LYELL	1.0000	1.1111	1.0472	1.0472	1.0472	0.000	10	-0.881	2.593	0.1541
COXS US LYELL	1.0000	1.1111	1.0472	1.0472	1.0472	0.000	10	-0.881	2.593	0.1541
LAKE LYELL	0.9000	1.0000	0.9948	0.5236	1.0472	16.644	10	0.000	2.593	0.1541
WPS	1.0000	1.1111	1.0472	1.0472	1.0472	0.000	10	-0.881	2.593	0.1541
*COXS US	0.4000	0.4444	0.7330	0.5236	1.0472	36.886	10	4.404	2.593	0.1541

Auxiliary Tests	Statistic	Critical	Skew	Kurt
Kolmogorov D Test indicates non-normal distribution (p <= 0.05)	4.03	0.895	-1.39557	5.718277
Equality of variance cannot be confirmed				

Hypothesis Test (1-tail, 0.05)	MSDu	MSDp	MSB	MSE	F-Prob	df
Bonferroni t Test indicates significant differences	0.148165	0.21065	0.097478	0.017668	5.0E-06	9, 90
Treatments vs DMW Control						

Dose-Response Plot



Ceriodaphnia Partial Life-Cycle Test-8 day survival

Start Date:	11/09/2014 14:15	Test ID:	PR1223/21	Sample ID:	Various
End Date:	19/09/2014 14:00	Lab ID:	Various	Sample Type:	AQ-Aqueous
Sample Date:		Protocol:	ESA 102	Test Species:	CD-Ceriodaphnia dubia
Comments:					

		Auxiliary Data Summary					
Conc-	**Parameter**	**Mean**	**Min**	**Max**	**SD**	**CV%**	**N**
DMW Control	No of Young	19.30	1.00	25.00	7.21	13.91	10
SVLDP009 DS		0.80	0.00	4.00	1.69	162.33	10
MADDOX		5.50	0.00	17.00	5.21	41.51	10
AKE WALLACE		22.30	13.00	37.00	6.18	11.15	10
WANGOL		12.20	0.00	20.00	6.21	20.43	10
COX DS LYELL		21.90	12.00	28.00	4.61	9.80	10
OXS US LYELL		20.50	0.00	28.00	8.20	13.96	10
LAKE LYELL		20.60	5.00	28.00	7.66	13.44	10
WPS		12.80	0.00	23.00	6.71	20.24	10
COXS US		0.20	0.00	2.00	0.63	397.64	10
DMW Control	% survival	90.00	0.00	100.00	31.62	6.25	10
SVLDP009 DS		80.00	0.00	100.00	42.16	8.12	10
MADDOX		100.00	100.00	100.00	0.00	0.00	10
AKE WALLACE		100.00	100.00	100.00	0.00	0.00	10
WANGOL		100.00	100.00	100.00	0.00	0.00	10
COX DS LYELL		100.00	100.00	100.00	0.00	0.00	10
OXS US LYELL		100.00	100.00	100.00	0.00	0.00	10
LAKE LYELL		90.00	0.00	100.00	31.62	6.25	10
WPS		100.00	100.00	100.00	0.00	0.00	10
COXS US		40.00	0.00	100.00	51.64	17.97	10
DMW Control	pH	8.10	8.10	8.10	0.00	0.00	1
SVLDP009 DS		8.80	8.80	8.80	0.00	0.00	1
MADDOX		8.60	8.60	8.60	0.00	0.00	1
AKE WALLACE		8.50	8.50	8.50	0.00	0.00	1
WANGOL		8.70	8.70	8.70	0.00	0.00	1
COX DS LYELL		8.30	8.30	8.30	0.00	0.00	1
OXS US LYELL		8.70	8.70	8.70	0.00	0.00	1
LAKE LYELL		8.40	8.40	8.40	0.00	0.00	1
WPS		8.40	8.40	8.40	0.00	0.00	1
COXS US		6.60	6.60	6.60	0.00	0.00	1
DMW Control	DO %	100.90	100.90	100.90	0.00	0.00	1
SVLDP009 DS		89.00	89.00	89.00	0.00	0.00	1
MADDOX		94.80	94.80	94.80	0.00	0.00	1
AKE WALLACE		99.10	99.10	99.10	0.00	0.00	1
WANGOL		109.00	109.00	109.00	0.00	0.00	1
COX DS LYELL		109.10	109.10	109.10	0.00	0.00	1
OXS US LYELL		104.50	104.50	104.50	0.00	0.00	1
LAKE LYELL		106.40	106.40	106.40	0.00	0.00	1
WPS		90.30	90.30	90.30	0.00	0.00	1
COXS US		102.80	102.80	102.80	0.00	0.00	1
DMW Control	Cond uS/cm	187.20	187.20	187.20	0.00	0.00	1
SVLDP009 DS		1089.00	1089.00	1089.00	0.00	0.00	1
MADDOX		1007.00	1007.00	1007.00	0.00	0.00	1
AKE WALLACE		986.00	986.00	986.00	0.00	0.00	1
WANGOL		806.00	806.00	806.00	0.00	0.00	1
COX DS LYELL		506.00	506.00	506.00	0.00	0.00	1
OXS US LYELL		1049.00	1049.00	1049.00	0.00	0.00	1
LAKE LYELL		547.00	547.00	547.00	0.00	0.00	1
WPS		949.00	949.00	949.00	0.00	0.00	1
COXS US		41.50	41.50	41.50	0.00	0.00	1

Appendix C – Water Quality Report

CERTIFICATE OF ANALYSIS

Work Order	: **ES1418822**	Page	: 1 of 11
Client	: **GHD PTY LTD**	Laboratory	: Environmental Division Sydney
Contact	: MR STUART GRAY	Contact	: Barbara Hanna
Address	: PO BOX 5403 NEWCASTLE WEST NSW, AUSTRALIA 2302	Address	: 277-289 Woodpark Road Smithfield NSW Australia 2164
E-mail	: stuart.c.gray@ghd.com	E-mail	: Barbara.Hanna@alsglobal.com
Telephone	: ----	Telephone	: +61 2 8784 8555
Facsimile	: ----	Facsimile	: +61 2 8784 8555
Project	: 2217471	QC Level	: NEPM 2013 Schedule B(3) and ALS QCS3 requirement
Order number	: ----		
C-O-C number	: 161034	Date Samples Received	: 25-AUG-2014
Sampler	: LH	Issue Date	: 01-SEP-2014
Site	: ----		
		No. of samples received	: 12
Quote number	: EN/005/14	No. of samples analysed	: 12

This report supersedes any previous report(s) with this reference. Results apply to the sample(s) as submitted. All pages of this report have been checked and approved for release.

This Certificate of Analysis contains the following information:

- General Comments
- Analytical Results

NATA Accredited Laboratory 825

Accredited for compliance with ISO/IEC 17025.

Signatories

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

Signatories	*Position*	*Accreditation Category*
Ankit Joshi	Inorganic Chemist	Sydney Inorganics
Ashesh Patel	Inorganic Chemist	Sydney Inorganics
Celine Conceicao	Senior Spectroscopist	Sydney Inorganics
Dian Dao		Sydney Inorganics
Shobhna Chandra	Metals Coordinator	Sydney Inorganics

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

- **EA016: Calculated TDS is determined from Electrical conductivity using a conversion factor of 0.65.**
- **ED093F: Sodium Adsorption ratio could not be calculated as Calcium and Magnesium results are below the detection limit for sample ES1418822 #006.**
- **EG020: It has been confirmed by re-digestion and re-analysis that total Strontium concentration is less than dissolved for sample ES1418822 # 001. For all other samples and analytes where dissolved is greater than total, the difference is within experimental variation of the methods.**
- **Ionic Balance out of acceptable limits due to analytes not quantified in this report.**

Analytical Results

Sub-Matrix: WATER (Matrix: WATER)				Client sample ID	SV LDP009	MADOOX	AP DS LDP001	AP LDP001	SV LDP009 DS
				Client sampling date / time	21-AUG-2014 15:00	21-AUG-2014 15:00	21-AUG-2014 15:00	21-AUG-2014 15:00	21-AUG-2014 15:00
Compound	CAS Number	LOR	Unit		ES1418822-001	ES1418822-002	ES1418822-003	ES1418822-004	ES1418822-005
EA005P: pH by PC Titrator									
pH Value	----	0.01	pH Unit		8.21	8.47	8.28	8.01	8.73
EA006: Sodium Adsorption Ratio (SAR)									
Sodium Adsorption Ratio	----	0.01	-		80.1	10.4	5.31	7.36	47.4
EA010P: Conductivity by PC Titrator									
Electrical Conductivity @ 25°C	----	1	µS/cm		1200	1030	591	1050	1100
EA016: Non Marine - Estimated TDS Salinity									
Total Dissolved Solids (Calc.)	----	1	mg/L		780	670	384	682	715
EA025: Suspended Solids									
Suspended Solids (SS)	----	5	mg/L		19	10	13	<5	10
EA065: Total Hardness as CaCO3									
Total Hardness as CaCO3	----	1	mg/L		2	76	64	116	7
ED009: Anions									
Bromide	24959-67-9	0.010	mg/L		0.046	0.082	0.035	0.067	0.057
ED037P: Alkalinity by PC Titrator									
Hydroxide Alkalinity as CaCO3	DMO-210-001	1	mg/L		<1	<1	<1	<1	<1
Carbonate Alkalinity as CaCO3	3812-32-6	1	mg/L		<1	22	<1	<1	60
Bicarbonate Alkalinity as CaCO3	71-52-3	1	mg/L		625	392	291	538	512
Total Alkalinity as CaCO3	----	1	mg/L		625	414	291	538	572
ED041G: Sulfate (Turbidimetric) as SO4 2- by DA									
Sulfate as SO4 - Turbidimetric	14808-79-8	1	mg/L		34	142	17	25	34
ED045G: Chloride Discrete analyser									
Chloride	16887-00-6	1	mg/L		6	15	10	10	6
ED093F: Dissolved Major Cations									
Calcium	7440-70-2	1	mg/L		1	14	11	20	1
Magnesium	7439-95-4	1	mg/L		<1	10	9	16	1
Sodium	7440-23-5	1	mg/L		291	208	98	182	280
Potassium	7440-09-7	1	mg/L		9	10	19	32	10
EG020F: Dissolved Metals by ICP-MS									
Aluminium	7429-90-5	0.01	mg/L		0.01	0.02	0.02	<0.01	0.03
Arsenic	7440-38-2	0.001	mg/L		0.024	0.014	<0.001	<0.001	0.021
Beryllium	7440-41-7	0.001	mg/L		<0.001	<0.001	<0.001	<0.001	<0.001
Barium	7440-39-3	0.001	mg/L		0.028	0.020	0.092	0.178	0.021
Cadmium	7440-43-9	0.0001	mg/L		<0.0001	<0.0001	<0.0001	<0.0001	<0.0001

Analytical Results

Sub-Matrix: **WATER** (Matrix: **WATER**)

Compound	CAS Number	LOR	Unit	Client sample ID: SV LDP009	MADOOX	AP DS LDP001	AP LDP001	SV LDP009 DS
				Client sampling date / time: 21-AUG-2014 15:00	21-AUG-2014 15:00	21-AUG-2014 15:00	21-AUG-2014 15:00	21-AUG-2014 15:00
				ES1418822-001	ES1418822-002	ES1418822-003	ES1418822-004	ES1418822-005
EG020F: Dissolved Metals by ICP-MS - Continued								
Chromium	7440-47-3	0.001	mg/L	<0.001	<0.001	<0.001	<0.001	<0.001
Cobalt	7440-48-4	0.001	mg/L	<0.001	**0.001**	<0.001	<0.001	<0.001
Copper	7440-50-8	0.001	mg/L	<0.001	<0.001	**0.002**	**0.001**	<0.001
Lead	7439-92-1	0.001	mg/L	<0.001	<0.001	<0.001	<0.001	<0.001
Manganese	7439-96-5	0.001	mg/L	**0.008**	**0.113**	**0.010**	**0.003**	**0.013**
Molybdenum	7439-98-7	0.001	mg/L	**0.038**	**0.022**	**0.006**	**0.012**	**0.034**
Nickel	7440-02-0	0.001	mg/L	**0.004**	**0.010**	**0.002**	**0.003**	**0.003**
Selenium	7782-49-2	0.01	mg/L	<0.01	<0.01	<0.01	<0.01	<0.01
Strontium	7440-24-6	0.001	mg/L	**0.030**	**0.083**	**0.079**	**0.117**	**0.028**
Vanadium	7440-62-2	0.01	mg/L	<0.01	<0.01	<0.01	<0.01	<0.01
Zinc	7440-66-6	0.005	mg/L	**0.007**	**0.012**	**0.012**	**0.016**	**0.005**
Boron	7440-42-8	0.05	mg/L	**0.07**	**0.10**	<0.05	**0.06**	**0.07**
Iron	7439-89-6	0.05	mg/L	<0.05	<0.05	**0.06**	<0.05	<0.05
EG020T: Total Metals by ICP-MS								
Aluminium	7429-90-5	0.01	mg/L	**0.19**	**0.14**	**0.05**	**0.02**	**0.19**
Arsenic	7440-38-2	0.001	mg/L	**0.023**	**0.014**	<0.001	<0.001	**0.022**
Beryllium	7440-41-7	0.001	mg/L	<0.001	<0.001	<0.001	<0.001	<0.001
Barium	7440-39-3	0.001	mg/L	**0.027**	**0.023**	**0.089**	**0.194**	**0.024**
Cadmium	7440-43-9	0.0001	mg/L	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001
Chromium	7440-47-3	0.001	mg/L	<0.001	<0.001	<0.001	<0.001	<0.001
Cobalt	7440-48-4	0.001	mg/L	<0.001	**0.002**	<0.001	<0.001	**0.002**
Copper	7440-50-8	0.001	mg/L	**0.003**	<0.001	**0.002**	<0.001	<0.001
Lead	7439-92-1	0.001	mg/L	<0.001	<0.001	<0.001	<0.001	<0.001
Manganese	7439-96-5	0.001	mg/L	**0.014**	**0.154**	**0.012**	**0.006**	**0.059**
Molybdenum	7439-98-7	0.001	mg/L	**0.036**	**0.026**	**0.005**	**0.014**	**0.039**
Nickel	7440-02-0	0.001	mg/L	**0.003**	**0.011**	**0.001**	**0.002**	**0.004**
Selenium	7782-49-2	0.01	mg/L	<0.01	<0.01	<0.01	<0.01	<0.01
Strontium	7440-24-6	0.001	mg/L	**0.015**	**0.081**	**0.066**	**0.117**	**0.025**
Vanadium	7440-62-2	0.01	mg/L	<0.01	<0.01	<0.01	<0.01	<0.01
Zinc	7440-66-6	0.005	mg/L	**0.017**	**0.014**	**0.014**	**0.010**	**0.009**
Boron	7440-42-8	0.05	mg/L	**0.06**	**0.10**	<0.05	**0.07**	**0.08**
Iron	7439-89-6	0.05	mg/L	**0.30**	**0.31**	**0.23**	<0.05	**0.24**
EG035F: Dissolved Mercury by FIMS								
Mercury	7439-97-6	0.0001	mg/L	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001

Analytical Results

Sub-Matrix: **WATER** (Matrix: **WATER**)

Compound	CAS Number	LOR	Unit	Client sample ID	SV LDP009	MADOOX	AP DS LDP001	AP LDP001	SV LDP009 DS
				Client sampling date / time	21-AUG-2014 15:00	21-AUG-2014 15:00	21-AUG-2014 15:00	21-AUG-2014 15:00	21-AUG-2014 15:00
					ES1418822-001	ES1418822-002	ES1418822-003	ES1418822-004	ES1418822-005
EG035F: Dissolved Mercury by FIMS - Continued									
EG035T: Total Recoverable Mercury by FIMS									
Mercury	7439-97-6	0.0001	mg/L		<0.0001	<0.0001	<0.0001	<0.0001	<0.0001
EG052F: Dissolved Silica by ICPAES									
Silicon as SiO2	14464-46-1	0.1	mg/L		**8.6**	**7.8**	**9.7**	**8.6**	**8.5**
EK025SF: Free CN by Segmented Flow Analyser									
Free Cyanide	----	0.004	mg/L		<0.004	<0.004	<0.004	<0.004	<0.004
EK026SF: Total CN by Segmented Flow Analyser									
Total Cyanide	57-12-5	0.004	mg/L		<0.004	<0.004	<0.004	<0.004	<0.004
EK040P: Fluoride by PC Titrator									
Fluoride	16984-48-8	0.1	mg/L		**1.5**	**1.3**	**0.7**	**1.0**	**1.8**
EK055G: Ammonia as N by Discrete Analyser									
Ammonia as N	7664-41-7	0.01	mg/L		**0.44**	**0.06**	<0.01	<0.01	**0.09**
EK057G: Nitrite as N by Discrete Analyser									
Nitrite as N	----	0.01	mg/L		<0.01	<0.01	<0.01	<0.01	**0.01**
EK058G: Nitrate as N by Discrete Analyser									
Nitrate as N	14797-55-8	0.01	mg/L		**0.21**	**0.42**	**0.02**	**0.34**	**0.44**
EK059G: Nitrite plus Nitrate as N (NOx) by Discrete Analyser									
Nitrite + Nitrate as N	----	0.01	mg/L		**0.21**	**0.42**	**0.02**	**0.34**	**0.45**
EK061G: Total Kjeldahl Nitrogen By Discrete Analyser									
Total Kjeldahl Nitrogen as N	----	0.1	mg/L		**0.6**	**0.2**	<0.1	<0.1	**0.1**
EK062G: Total Nitrogen as N (TKN + NOx) by Discrete Analyser									
^ **Total Nitrogen as N**	----	0.1	mg/L		**0.8**	**0.6**	<0.1	**0.3**	**0.6**
EK067G: Total Phosphorus as P by Discrete Analyser									
Total Phosphorus as P	----	0.01	mg/L		**0.02**	**0.01**	<0.01	<0.01	**0.01**
EN055: Ionic Balance									
Total Anions	----	0.01	meq/L		**13.4**	**11.6**	**6.45**	**11.6**	**12.3**
Total Cations	----	0.01	meq/L		**12.9**	**10.8**	**6.04**	**11.0**	**12.6**
Ionic Balance	----	0.01	%		**1.69**	**3.73**	**3.34**	**2.27**	**0.98**
EP002: Dissolved Organic Carbon (DOC)									
Dissolved Organic Carbon	----	1	mg/L		**55**	**6**	**14**	**17**	**66**
EP020: Oil and Grease (O&G)									
Oil & Grease	----	5	mg/L		<5	<5	<5	<5	<5

Analytical Results

Sub-Matrix: WATER (Matrix: WATER)				Client sample ID	COXS US	WANGCOL	WALLACE	US LYELL	LYELL
				Client sampling date / time	21-AUG-2014 15:00	21-AUG-2014 15:00	22-AUG-2014 15:00	22-AUG-2014 15:00	22-AUG-2014 15:00
Compound	CAS Number	LOR	Unit		ES1418822-006	ES1418822-007	ES1418822-008	ES1418822-009	ES1418822-010
EA005P: pH by PC Titrator									
pH Value	----	0.01	pH Unit		5.69	6.98	8.41	8.65	8.42
EA006: Sodium Adsorption Ratio (SAR)									
Sodium Adsorption Ratio	----	0.01	-		----	1.64	8.52	10.0	4.63
EA010P: Conductivity by PC Titrator									
Electrical Conductivity @ 25°C	----	1	µS/cm		39	823	1010	1080	557
EA016: Non Marine - Estimated TDS Salinity									
Total Dissolved Solids (Calc.)	----	1	mg/L		25	535	656	702	362
EA025: Suspended Solids									
Suspended Solids (SS)	----	5	mg/L		22	5	<5	<5	<5
EA065: Total Hardness as CaCO3									
Total Hardness as CaCO3	----	1	mg/L		<1	244	96	82	50
ED009: Anions									
Bromide	24959-67-9	0.010	mg/L		<0.010	0.092	0.074	0.065	0.076
ED037P: Alkalinity by PC Titrator									
Hydroxide Alkalinity as CaCO3	DMO-210-001	1	mg/L		<1	<1	<1	<1	<1
Carbonate Alkalinity as CaCO3	3812-32-6	1	mg/L		<1	<1	16	40	2
Bicarbonate Alkalinity as CaCO3	71-52-3	1	mg/L		1	16	336	348	111
Total Alkalinity as CaCO3	----	1	mg/L		1	16	352	388	113
ED041G: Sulfate (Turbidimetric) as SO4 2- by DA									
Sulfate as SO4 - Turbidimetric	14808-79-8	1	mg/L		3	341	160	164	117
ED045G: Chloride Discrete analyser									
Chloride	16887-00-6	1	mg/L		8	34	20	18	16
ED093F: Dissolved Major Cations									
Calcium	7440-70-2	1	mg/L		<1	45	17	13	10
Magnesium	7439-95-4	1	mg/L		<1	32	13	12	6
Sodium	7440-23-5	1	mg/L		4	59	192	209	75
Potassium	7440-09-7	1	mg/L		<1	7	12	13	7
EG020F: Dissolved Metals by ICP-MS									
Aluminium	7429-90-5	0.01	mg/L		0.03	0.02	0.01	<0.01	<0.01
Arsenic	7440-38-2	0.001	mg/L		<0.001	<0.001	0.006	0.004	<0.001
Beryllium	7440-41-7	0.001	mg/L		<0.001	<0.001	<0.001	<0.001	<0.001
Barium	7440-39-3	0.001	mg/L		0.016	0.014	0.026	0.025	0.026
Cadmium	7440-43-9	0.0001	mg/L		<0.0001	0.0001	<0.0001	<0.0001	<0.0001

Analytical Results

Sub-Matrix: **WATER** (Matrix: **WATER**)

Compound	CAS Number	LOR	Unit	Client sample ID	COXS US	WANGCOL	WALLACE	US LYELL	LYELL
				Client sampling date / time	21-AUG-2014 15:00	21-AUG-2014 15:00	22-AUG-2014 15:00	22-AUG-2014 15:00	22-AUG-2014 15:00
					ES1418822-006	ES1418822-007	ES1418822-008	ES1418822-009	ES1418822-010
EG020F: Dissolved Metals by ICP-MS - Continued									
Chromium	7440-47-3	0.001	mg/L		<0.001	<0.001	<0.001	<0.001	<0.001
Cobalt	7440-48-4	0.001	mg/L		<0.001	**0.006**	<0.001	<0.001	<0.001
Copper	7440-50-8	0.001	mg/L		<0.001	**0.003**	**0.002**	**0.002**	**0.002**
Lead	7439-92-1	0.001	mg/L		<0.001	<0.001	<0.001	<0.001	<0.001
Manganese	7439-96-5	0.001	mg/L		**0.057**	**0.812**	**0.040**	**0.011**	**0.002**
Molybdenum	7439-98-7	0.001	mg/L		<0.001	<0.001	**0.015**	**0.016**	**0.005**
Nickel	7440-02-0	0.001	mg/L		**0.004**	**0.021**	**0.007**	**0.004**	**0.002**
Selenium	7782-49-2	0.01	mg/L		<0.01	<0.01	<0.01	<0.01	<0.01
Strontium	7440-24-6	0.001	mg/L		**0.009**	**0.188**	**0.117**	**0.139**	**0.120**
Vanadium	7440-62-2	0.01	mg/L		<0.01	<0.01	<0.01	<0.01	<0.01
Zinc	7440-66-6	0.005	mg/L		**0.011**	**0.037**	**0.047**	**0.005**	<0.005
Boron	7440-42-8	0.05	mg/L		<0.05	**0.14**	**0.12**	**0.18**	**0.09**
Iron	7439-89-6	0.05	mg/L		**0.09**	**0.05**	<0.05	<0.05	<0.05
EG020T: Total Metals by ICP-MS									
Aluminium	7429-90-5	0.01	mg/L		**0.05**	**0.11**	**0.07**	**0.06**	**0.02**
Arsenic	7440-38-2	0.001	mg/L		<0.001	<0.001	**0.006**	**0.004**	<0.001
Beryllium	7440-41-7	0.001	mg/L		<0.001	<0.001	<0.001	<0.001	<0.001
Barium	7440-39-3	0.001	mg/L		**0.016**	**0.011**	**0.025**	**0.025**	**0.023**
Cadmium	7440-43-9	0.0001	mg/L		<0.0001	<0.0001	<0.0001	<0.0001	<0.0001
Chromium	7440-47-3	0.001	mg/L		<0.001	<0.001	<0.001	<0.001	<0.001
Cobalt	7440-48-4	0.001	mg/L		<0.001	**0.005**	<0.001	<0.001	<0.001
Copper	7440-50-8	0.001	mg/L		**0.002**	<0.001	<0.001	**0.001**	**0.001**
Lead	7439-92-1	0.001	mg/L		<0.001	<0.001	<0.001	<0.001	<0.001
Manganese	7439-96-5	0.001	mg/L		**0.058**	**0.859**	**0.059**	**0.031**	**0.006**
Molybdenum	7439-98-7	0.001	mg/L		<0.001	<0.001	**0.017**	**0.018**	**0.005**
Nickel	7440-02-0	0.001	mg/L		<0.001	**0.020**	**0.006**	**0.004**	**0.002**
Selenium	7782-49-2	0.01	mg/L		<0.01	<0.01	<0.01	<0.01	<0.01
Strontium	7440-24-6	0.001	mg/L		**0.007**	**0.180**	**0.116**	**0.131**	**0.106**
Vanadium	7440-62-2	0.01	mg/L		<0.01	<0.01	<0.01	<0.01	<0.01
Zinc	7440-66-6	0.005	mg/L		**0.009**	**0.027**	<0.005	<0.005	<0.005
Boron	7440-42-8	0.05	mg/L		<0.05	**0.16**	**0.12**	**0.19**	**0.11**
Iron	7439-89-6	0.05	mg/L		**0.61**	**0.30**	**0.10**	**0.05**	<0.05
EG035F: Dissolved Mercury by FIMS									
Mercury	7439-97-6	0.0001	mg/L		<0.0001	<0.0001	<0.0001	<0.0001	<0.0001

Analytical Results

Sub-Matrix: **WATER** (Matrix: **WATER**)

Compound	CAS Number	LOR	Unit	Client sample ID	COXS US	WANGCOL	WALLACE	US LYELL	LYELL
				Client sampling date / time	21-AUG-2014 15:00	21-AUG-2014 15:00	22-AUG-2014 15:00	22-AUG-2014 15:00	22-AUG-2014 15:00
					ES1418822-006	ES1418822-007	ES1418822-008	ES1418822-009	ES1418822-010
EG035F: Dissolved Mercury by FIMS - Continued									
EG035T: Total Recoverable Mercury by FIMS									
Mercury	7439-97-6	0.0001	mg/L		<0.0001	<0.0001	<0.0001	<0.0001	<0.0001
EG052F: Dissolved Silica by ICPAES									
Silicon as SiO2	14464-46-1	0.1	mg/L		**9.4**	**7.5**	**3.9**	**1.0**	**0.2**
EK025SF: Free CN by Segmented Flow Analyser									
Free Cyanide	----	0.004	mg/L		<0.004	<0.004	<0.004	<0.004	<0.004
EK026SF: Total CN by Segmented Flow Analyser									
Total Cyanide	57-12-5	0.004	mg/L		<0.004	<0.004	<0.004	<0.004	<0.004
EK040P: Fluoride by PC Titrator									
Fluoride	16984-48-8	0.1	mg/L		<0.1	**0.2**	**1.1**	**1.1**	**0.6**
EK055G: Ammonia as N by Discrete Analyser									
Ammonia as N	7664-41-7	0.01	mg/L		<0.01	**0.02**	**0.03**	<0.01	<0.01
EK057G: Nitrite as N by Discrete Analyser									
Nitrite as N	----	0.01	mg/L		<0.01	<0.01	<0.01	<0.01	<0.01
EK058G: Nitrate as N by Discrete Analyser									
Nitrate as N	14797-55-8	0.01	mg/L		**0.24**	<0.01	**0.13**	<0.01	**0.14**
EK059G: Nitrite plus Nitrate as N (NOx) by Discrete Analyser									
Nitrite + Nitrate as N	----	0.01	mg/L		**0.24**	<0.01	**0.13**	<0.01	**0.14**
EK061G: Total Kjeldahl Nitrogen By Discrete Analyser									
Total Kjeldahl Nitrogen as N	----	0.1	mg/L		<0.1	<0.1	**0.3**	**0.2**	**0.3**
EK062G: Total Nitrogen as N (TKN + NOx) by Discrete Analyser									
^ **Total Nitrogen as N**	----	0.1	mg/L		**0.2**	<0.1	**0.4**	**0.2**	**0.4**
EK067G: Total Phosphorus as P by Discrete Analyser									
Total Phosphorus as P	----	0.01	mg/L		<0.01	<0.01	**0.01**	**0.02**	**0.01**
EN055: Ionic Balance									
Total Anions	----	0.01	meq/L		**0.31**	**8.38**	**10.9**	**11.7**	**5.15**
Total Cations	----	0.01	meq/L		**0.17**	**7.62**	**10.6**	**11.1**	**4.43**
Ionic Balance	----	0.01	%		----	**4.71**	**1.68**	**2.75**	**7.46**
EP002: Dissolved Organic Carbon (DOC)									
Dissolved Organic Carbon	----	1	mg/L		**48**	**7**	**6**	**42**	**20**
EP020: Oil and Grease (O&G)									
Oil & Grease	----	5	mg/L		<5	<5	<5	<5	<5

Analytical Results

Sub-Matrix: WATER (Matrix: WATER)				Client sample ID	DS LYELL	WPS	----	----	----
				Client sampling date / time	22-AUG-2014 15:00	22-AUG-2014 15:00	----	----	----
Compound	CAS Number	LOR	Unit		ES1418822-011	ES1418822-012	----	----	----
EA005P: pH by PC Titrator									
pH Value	----	0.01	pH Unit		8.28	8.40	----	----	----
EA006: Sodium Adsorption Ratio (SAR)									
Sodium Adsorption Ratio	----	0.01	-		3.93	8.74	----	----	----
EA010P: Conductivity by PC Titrator									
Electrical Conductivity @ 25°C	----	1	µS/cm		516	973	----	----	----
EA016: Non Marine - Estimated TDS Salinity									
Total Dissolved Solids (Calc.)	----	1	mg/L		335	632	----	----	----
EA025: Suspended Solids									
Suspended Solids (SS)	----	5	mg/L		<5	<5	----	----	----
EA065: Total Hardness as CaCO3									
Total Hardness as CaCO3	----	1	mg/L		65	101	----	----	----
ED009: Anions									
Bromide	24959-67-9	0.010	mg/L		0.063	0.082	----	----	----
ED037P: Alkalinity by PC Titrator									
Hydroxide Alkalinity as CaCO3	DMO-210-001	1	mg/L		<1	<1	----	----	----
Carbonate Alkalinity as CaCO3	3812-32-6	1	mg/L		<1	16	----	----	----
Bicarbonate Alkalinity as CaCO3	71-52-3	1	mg/L		128	359	----	----	----
Total Alkalinity as CaCO3	----	1	mg/L		128	375	----	----	----
ED041G: Sulfate (Turbidimetric) as SO4 2- by DA									
Sulfate as SO4 - Turbidimetric	14808-79-8	1	mg/L		107	126	----	----	----
ED045G: Chloride Discrete analyser									
Chloride	16887-00-6	1	mg/L		16	16	----	----	----
ED093F: Dissolved Major Cations									
Calcium	7440-70-2	1	mg/L		13	19	----	----	----
Magnesium	7439-95-4	1	mg/L		8	13	----	----	----
Sodium	7440-23-5	1	mg/L		73	202	----	----	----
Potassium	7440-09-7	1	mg/L		8	11	----	----	----
EG020F: Dissolved Metals by ICP-MS									
Aluminium	7429-90-5	0.01	mg/L		<0.01	0.02	----	----	----
Arsenic	7440-38-2	0.001	mg/L		<0.001	0.010	----	----	----
Beryllium	7440-41-7	0.001	mg/L		<0.001	<0.001	----	----	----
Barium	7440-39-3	0.001	mg/L		0.023	0.023	----	----	----
Cadmium	7440-43-9	0.0001	mg/L		<0.0001	<0.0001	----	----	----

Analytical Results

Sub-Matrix: WATER (Matrix: WATER)				Client sample ID	DS LYELL	WPS	----	----	----
				Client sampling date / time	22-AUG-2014 15:00	22-AUG-2014 15:00	----	----	----
Compound	CAS Number	LOR	Unit		ES1418822-011	ES1418822-012	----	----	----
EG020F: Dissolved Metals by ICP-MS - Continued									
Chromium	7440-47-3	0.001	mg/L		<0.001	<0.001	----	----	----
Cobalt	7440-48-4	0.001	mg/L		<0.001	<0.001	----	----	----
Copper	7440-50-8	0.001	mg/L		**0.001**	**0.002**	----	----	----
Lead	7439-92-1	0.001	mg/L		<0.001	<0.001	----	----	----
Manganese	7439-96-5	0.001	mg/L		**0.008**	**0.077**	----	----	----
Molybdenum	7439-98-7	0.001	mg/L		**0.004**	**0.018**	----	----	----
Nickel	7440-02-0	0.001	mg/L		**0.002**	**0.007**	----	----	----
Selenium	7782-49-2	0.01	mg/L		<0.01	<0.01	----	----	----
Strontium	7440-24-6	0.001	mg/L		**0.109**	**0.088**	----	----	----
Vanadium	7440-62-2	0.01	mg/L		<0.01	<0.01	----	----	----
Zinc	7440-66-6	0.005	mg/L		**0.005**	**0.016**	----	----	----
Boron	7440-42-8	0.05	mg/L		**0.08**	**0.08**	----	----	----
Iron	7439-89-6	0.05	mg/L		<0.05	<0.05	----	----	----
EG020T: Total Metals by ICP-MS									
Aluminium	7429-90-5	0.01	mg/L		**0.04**	**0.10**	----	----	----
Arsenic	7440-38-2	0.001	mg/L		<0.001	**0.010**	----	----	----
Beryllium	7440-41-7	0.001	mg/L		<0.001	<0.001	----	----	----
Barium	7440-39-3	0.001	mg/L		**0.020**	**0.022**	----	----	----
Cadmium	7440-43-9	0.0001	mg/L		<0.0001	<0.0001	----	----	----
Chromium	7440-47-3	0.001	mg/L		<0.001	<0.001	----	----	----
Cobalt	7440-48-4	0.001	mg/L		<0.001	<0.001	----	----	----
Copper	7440-50-8	0.001	mg/L		<0.001	<0.001	----	----	----
Lead	7439-92-1	0.001	mg/L		<0.001	<0.001	----	----	----
Manganese	7439-96-5	0.001	mg/L		**0.013**	**0.090**	----	----	----
Molybdenum	7439-98-7	0.001	mg/L		**0.005**	**0.021**	----	----	----
Nickel	7440-02-0	0.001	mg/L		**0.002**	**0.007**	----	----	----
Selenium	7782-49-2	0.01	mg/L		<0.01	<0.01	----	----	----
Strontium	7440-24-6	0.001	mg/L		**0.097**	**0.087**	----	----	----
Vanadium	7440-62-2	0.01	mg/L		<0.01	<0.01	----	----	----
Zinc	7440-66-6	0.005	mg/L		<0.005	**0.008**	----	----	----
Boron	7440-42-8	0.05	mg/L		**0.09**	**0.09**	----	----	----
Iron	7439-89-6	0.05	mg/L		**0.10**	**0.20**	----	----	----
EG035F: Dissolved Mercury by FIMS									
Mercury	7439-97-6	0.0001	mg/L		<0.0001	<0.0001	----	----	----

Analytical Results

Sub-Matrix: WATER (Matrix: WATER)				Client sample ID	DS LYELL	WPS	----	----	----
				Client sampling date / time	22-AUG-2014 15:00	22-AUG-2014 15:00	----	----	----
Compound	CAS Number	LOR	Unit		ES1418822-011	ES1418822-012	----	----	----
EG035F: Dissolved Mercury by FIMS - Continued									
EG035T: Total Recoverable Mercury by FIMS									
Mercury	7439-97-6	0.0001	mg/L		<0.0001	<0.0001	----	----	----
EG052F: Dissolved Silica by ICPAES									
Silicon as SiO2	14464-46-1	0.1	mg/L		**1.8**	**7.8**	----	----	----
EK025SF: Free CN by Segmented Flow Analyser									
Free Cyanide	----	0.004	mg/L		<0.004	<0.004	----	----	----
EK026SF: Total CN by Segmented Flow Analyser									
Total Cyanide	57-12-5	0.004	mg/L		<0.004	<0.004	----	----	----
EK040P: Fluoride by PC Titrator									
Fluoride	16984-48-8	0.1	mg/L		**0.6**	**1.1**	----	----	----
EK055G: Ammonia as N by Discrete Analyser									
Ammonia as N	7664-41-7	0.01	mg/L		<0.01	**0.04**	----	----	----
EK057G: Nitrite as N by Discrete Analyser									
Nitrite as N	----	0.01	mg/L		<0.01	<0.01	----	----	----
EK058G: Nitrate as N by Discrete Analyser									
Nitrate as N	14797-55-8	0.01	mg/L		**0.04**	**0.32**	----	----	----
EK059G: Nitrite plus Nitrate as N (NOx) by Discrete Analyser									
Nitrite + Nitrate as N	----	0.01	mg/L		**0.04**	**0.32**	----	----	----
EK061G: Total Kjeldahl Nitrogen By Discrete Analyser									
Total Kjeldahl Nitrogen as N	----	0.1	mg/L		**0.2**	**0.2**	----	----	----
EK062G: Total Nitrogen as N (TKN + NOx) by Discrete Analyser									
^ **Total Nitrogen as N**	----	0.1	mg/L		**0.2**	**0.5**	----	----	----
EK067G: Total Phosphorus as P by Discrete Analyser									
Total Phosphorus as P	----	0.01	mg/L		**0.02**	**0.02**	----	----	----
EN055: Ionic Balance									
Total Anions	----	0.01	meq/L		**5.24**	**10.6**	----	----	----
Total Cations	----	0.01	meq/L		**4.69**	**11.1**	----	----	----
Ionic Balance	----	0.01	%		**5.57**	**2.35**	----	----	----
EP002: Dissolved Organic Carbon (DOC)									
Dissolved Organic Carbon	----	1	mg/L		**24**	**5**	----	----	----
EP020: Oil and Grease (O&G)									
Oil & Grease	----	5	mg/L		<5	<5	----	----	----

Appendix D – Catchment Runoff Results

Table D-1 Dilution of SV LDP009 Discharges for Water Strategy WS1

Location	Dilution (% of daily flow)		
	10th percentile	50th percentile	90th percentile
A	96.78	88.96	44.36
B	94.11	85.49	31.82
C	96.41	96.40	32.11
D	92.43	81.97	21.90
E	91.15	78.75	20.51
F	89.15	71.02	32.15
G	89.01	69.35	21.90
H	88.61	64.48	9.40
I	88.52	61.92	7.16
J	88.43	58.82	5.71
K	83.06	43.59	4.49
L	77.52	37.99	3.83
M	63.43	26.59	3.06
N	55.30	21.48	2.64
O	53.91	20.77	2.55

Table D-2 Dilution of SV LDP009 Discharges for Water Strategy WS2a

Location	Dilution (% of daily flow)		
	10th percentile	50th percentile	90th percentile
A	97.96	92.78	55.99
B	96.23	90.39	42.68
C	97.72	97.72	43.01
D	95.12	87.88	30.92
E	94.26	85.53	29.17
F	92.91	79.63	43.06
G	92.82	78.31	30.92
H	92.54	74.34	14.21
I	92.49	72.18	10.95
J	92.42	69.51	8.80
K	88.67	55.22	6.98
L	84.63	49.44	5.98
M	73.46	36.63	4.80
N	66.37	30.38	4.15
O	65.11	29.50	4.02

Table D-3 Dilution of SV LDP009 Discharges for Water Strategy WS2b

Location	Dilution (% of daily flow)		
	10th percentile	50th percentile	90th percentile
A	98.58	94.90	64.79
B	97.36	93.15	51.86
C	98.41	98.41	52.19
D	96.58	91.30	39.30
E	95.96	89.53	37.34
F	94.99	84.98	52.24
G	94.92	83.93	39.30
H	94.72	80.73	19.33
I	94.68	78.97	15.11
J	94.64	76.73	12.26
K	91.88	64.08	9.79
L	88.84	58.58	8.43
M	80.02	45.54	6.80
N	74.06	38.70	5.90
O	72.97	37.71	5.71

Table D 4 Dilution of Total Discharges (AP LDP001 and SV LDP009) for all Water Strategies

Location	Dilution (% of daily flow)		
	10th percentile	50th percentile	90th percentile
A	98.64	95.11	65.81
B	97.48	93.43	52.98
C	98.48	98.48	53.31
D	96.72	91.65	40.38
E	96.13	89.95	38.40
F	95.20	85.54	53.36
G	95.13	84.53	40.38
H	94.95	81.42	20.04
I	94.90	79.70	15.70
J	94.86	77.53	12.75
K	92.21	65.11	10.20
L	89.28	59.67	8.78
M	80.73	46.66	7.09
N	74.92	39.78	6.15
O	73.85	38.77	5.95

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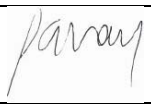
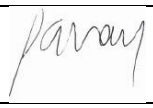
0	J Woodworth / T Davies	S Gray		S Gray		29/09/14

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