

Code of Environmental Compliance for Environmental Authorities for High Hazard Dams Containing Hazardous Waste

Introduction

1. The Minister, pursuant to section 549, of the *Environmental Protection Act 1994* has approved the standard environmental conditions contained in this Code of Environmental Compliance for Environmental Authorities for High Hazard Dams Containing Hazardous Waste.

Application

2. This Code applies to environmental authorities for high hazard dams containing hazardous waste.

Conditions

3. The standard environmental conditions contained in column 1 must be complied with.

Supporting Information

4. The EPA has prepared non-mandatory guidelines that detail the steps that can be taken to comply with the standard environmental conditions in column 1. However, operators can take different approaches to achieving compliance with the standard environmental conditions stated in this Code. These guidelines are contained in column 2.

Other Obligations and Laws

5. In addition to the standard environmental conditions of this Code, the *Environmental Protection Act 1994* imposes an obligation to take all reasonable and practicable measures to prevent or minimise environmental harm ('the general environmental duty').

The requirements of this Code are in addition to other requirements of the *Environmental Protection Act 1994*. Further, this Code does not negate any lawful requirements under Commonwealth, State or local government plans, standards, agreements or legislation. It is the responsibility of the person carrying out the activity to ensure compliance with all relevant laws.

<p style="text-align: center;">Standard Environmental Conditions</p> <p style="text-align: center;"><i>The holder of the environmental authority for the dam must comply with the conditions in this column.</i></p>	<p style="text-align: center;">Environmental Guidelines</p> <p style="text-align: center;"><i>The following Guidelines provide guidance on how to comply with the corresponding standard environmental condition.</i></p>
<p>1. General Obligation</p> <p>The holder of the environmental authority for the dam must design, construct, alter, repair, maintain and operate any dam containing hazardous waste in the location specified in the relevant environmental authority, and take all reasonable and practicable measures to minimise the risk to the environment.</p>	<p>1.1 Notes</p> <p>1.1.1 Examples of dams containing hazardous waste are tailings dams or process water dams.</p>
<p>2. Preparing and Certifying Design Plans</p> <p>Before construction of a dam containing hazardous waste, a person suitably qualified and experienced in dam engineering must:</p> <ul style="list-style-type: none"> (a) prepare design plans which design the dam to an appropriate engineering standard; and (b) certify that the design plans meet an appropriate engineering standard and are consistent with the dam conditions in the environmental authority. 	<p>2.1 Design Plans</p> <p>2.1.1 Some of the factors that a person should consider in designing the dam to an appropriate engineering standard include:</p> <ul style="list-style-type: none"> • dams designed and located to have the smallest practical catchment; • dams should be designed to accept waste inputs for the operational year and inputs from the critical wet season; • the spillway should be designed and maintained to withstand the peak flow from the critical design storm (the critical design storm has a duration that produces the peak discharge for the catchment); • the gradients of earth embankment batters should be stable; • where the foundation material differs from the embankment fill material, the batters should be

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	<p>chosen conservatively to be consistent with the weaker material classification;</p> <ul style="list-style-type: none"> the dam design should provide adequate measures to minimise seepage through the dam wall and to groundwater; the dam design should prevent any erosion of the downstream face of the dam and spillway to avoid surface scour which may lead to failure of the wall; the contents of the ANCOLD Guidelines and Tailings Dam Design Construction and Operation October 1999; and the contents of Department of Mines and Energy, Technical Guidelines for Environmental Management of Exploration and Mining in Queensland, January 1995.
<p>3. Submitting Certified Design Plans</p> <p>Before construction of a dam containing hazardous waste, the holder of the environmental authority for the dam must submit the certified design plans to the administering authority.</p>	
<p>4. Commencing Construction</p> <p>If the holder of the environmental authority for the dam has:</p> <ul style="list-style-type: none"> (a) received a letter acknowledging receipt of the design plans from the administering authority; and (b) not received any further 	<p>4.1 Date for Commencing Construction</p> <p>4.1.1 The letter of acknowledgement from the administering authority will state a date from which the operator may commence construction of the dam if they have not heard from the administering authority within 28 days. In other words,</p>

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<p>correspondence from the administering authority within 28 days of the receipt date stated in the letter of acknowledgment, they may commence construction of the dam containing hazardous waste in accordance with the certified design plans.</p>	<p>the operator will usually be able to commence construction after 28 days of the administering authority receiving the design plans.</p> <p>4.1.2 The administering authority will send out a letter of acknowledgement within a maximum period of 5 business days.</p>
<p>5. Completion of Construction</p> <p>When the construction of the dam containing hazardous waste is complete, the holder of the environmental authority must:</p> <ul style="list-style-type: none"> (a) obtain certification from a person suitably qualified and experienced in dam construction that the construction of the dam is either in accordance with or generally in accordance with the certified design plans; and (b) submit the construction certification to the administering authority. 	<p>5.1 Minor Variation of Design Plans</p> <p>5.1.1 If the person certifying the construction of the dam is required to make a minor modification of the dam design during its construction, they should contact the person who certified the design plans and obtain their agreement to the modifications. They should obtain this agreement before certifying that the construction of the dam is generally in accordance with the certified design plans.</p> <p>5.1.2 If the design of the dam has been modified during construction, the person certifying the construction of the dam must include in their certification:</p> <ul style="list-style-type: none"> (a) written agreement of the modification by the person who certified the design of the dam; and (b) details of the modification.
<p>6. Preparing and Certifying</p>	<p>6.1 Operational Plans</p>

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<p>Operational Plans</p> <p>Before operating a dam containing hazardous waste (other than on a mining tenure), a person suitably qualified and experienced in dam engineering must:</p> <ul style="list-style-type: none"> (a) prepare an operational plan; and (b) certify the operational plan. 	<p>6.1.1 Operational plans outline the detail of how the holder of the environmental authority for the dam proposes to operate the dam. In the case of mining activities, a Plan of Operations contains information, which would otherwise be contained in an operational plan. In this situation, it is not necessary to prepare another document, the Plan of Operations can be submitted to the administering authority.</p> <p>6.1.2 An example of the type of information that may be included in an operational plan is that a suitably qualified and experienced person in dam engineering shall inspect all dams containing hazardous waste at least once a year in October.</p> <p>6.1.3 The information sheet relating to the preparation of Plan of Operations contains more information about these documents.</p>
<p>7. Commencing Operation</p> <p>Before operating a dam containing hazardous waste (other than on a mining tenure), the holder of the environmental authority for the dam must submit to the administering authority the:</p> <ul style="list-style-type: none"> (a) operational plan; (b) certification of the operational plan; and (c) certification that the construction of the dam was in accordance with the certified design plans. 	

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<p>8. Compliance with Plans</p> <p>The holder of the environmental authority must construct and operate the dam in accordance with the certified:</p> <ul style="list-style-type: none"> (a) design plans; (b) operational plans; and (c) conditions contained in the environmental authority, <p>in order to prevent or minimise environmental harm.</p>	
<p>9. Definitions</p> <p>‘construction’ includes building a new dam and modifying or lifting an existing dam.</p> <p>‘hazardous waste’ means any substance, whether liquid, solid or gaseous, derived by or resulting from, the processing of minerals that tends to destroy life or impair or endanger health.</p> <p>‘dam’ means:</p> <ul style="list-style-type: none"> (a) a containment or proposed containment whether permanent or temporary; and (b) which does, would or could contain, divert or control flowable substances; and (c) but does not include a fabricated or manufactured tank or container designed to a recognised standard. <p>‘suitably qualified and experienced person’ means a person who is a</p>	

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<p>Registered Professional Engineer of Queensland under the provisions of the <i>Professional Engineers Act 1988</i> or a Corporate Member of the Institution of Engineers Australia or holds equivalent professional qualifications and has the following:</p> <ul style="list-style-type: none"> (a) knowledge of engineering principles related to the structures, geomechanics, hydrology, hydraulics, chemistry and environmental impact of dams; and (b) at least a total of five years of suitable experience and demonstrated expertise in at least four of the following areas: <ul style="list-style-type: none"> • investigation, design or construction of dams; • operation and maintenance of dams; • geomechanics with particular emphasis stability, geology and geochemistry; • hydrology with particular reference to flooding, estimation of extreme storms, water management or meteorology; • hydraulics with particular reference to sediment transport and deposition, erosion control, beach processes; and • hydrogeology with particular reference to seepage, groundwater, solute transport processes and monitoring thereof; and • dam safety. 	

Dams in environmentally relevant activities

Scope

This document provides information about the Environmental Protection Agency's procedures for dealings involving dams and related land-based containment structures, constructed as part of environmentally relevant activities.

Environmental Authorities (EAs) and Development Approvals (DAs) will carry *conditions* that require applicants/proponents to arrange to have the hazard category of dams that are constructed as part of a project assessed by a suitably qualified and experienced person. That hazard assessment will determine whether a dam is a regulated dam for the purpose of the EA or DA and whether details of the dam need to be included.

Such *conditions* are designed to promote good practice in design, construction, operation and decommissioning of regulated dams.

Background

In the context of dams associated with environmentally relevant activities, protecting the environment requires that the standards used for the design, construction, operation, modification, and decommissioning of dams are appropriate to the hazards associated with the potential failure of those dams.

When assessing the *general* environmental hazards associated with a proposed project or changes to a project, a minimum standard of information is required regarding:

- proposed layout of processing, disposal and storage areas;
- environmental values of the area – including:
 - typical soils and geology,
 - surface contours to a suitable scale, including watercourses,
 - flora and fauna,
 - groundwater and surface water resources,
 - human habitation and property; and
- estimates of the project lifetime, and expected volume and nature of waste products or by-products.

Standard industry practice for dams and related structures is that they must be assessed for hazard that is the potential consequence of a failure due to 'collapse' or 'failure to contain'; and designed, certified and operated to standards consistent with an assessed hazard category. Decommissioning of dams and rehabilitation of the site to other purposes is required when the primary need for the dam ends, in order to minimise the potential consequences of failure that may be present during operation.

The EPA expects that each dam will be designed, constructed, operated and maintained to an engineering standard appropriate to its circumstances and the purpose for which it is intended. The EPA expects that the condition of dams and their operations will be monitored on a regular basis by a suitably qualified and experienced person, and that timely action will be taken to prevent or minimize any actual or potential environmental harm.

Applications for EAs or DAs that involve Dams

Where an application for an environmentally relevant activity involves a dam, two copies of the application documentation should be lodged with the ECSU.

Any application involving dams must contain sufficient information to justify the assessment of the nominated hazard category for all dams. Where an application involves dams, *conditions* applicable to dams will be inserted in the current or proposed EA or DA by the EPA.

A dam assessed as being in the significant or high hazard category (a 'regulated dam'), will require specific authorisation in the EA or DA.

Lodgement of Design Plans for Regulated Dams

If a new dam is a 'regulated dam', a certified design plan must be lodged with the EPA before construction of that dam commences.

The holder of the EA or DA must provide two copies of the design plan to the ECSU.

The EPA will confirm that the design plan is appropriately certified and documented. Where the documentation or certification is not acceptable to the EPA, the relevant condition will not have been satisfied.

Essential Elements of a Design Plan and Certification for a Regulated Dam

A 'design plan' (as defined in Appendix A) is a document setting out how the identified hazard scenarios are addressed in the planned design and operation of a 'regulated dam'.

A design plan for a dam must include:

- all investigation and design reports;
- plans and specifications sufficient to hand to a contractor; and
- planned decommissioning and rehabilitation outcomes.

A design plan for a dam must address all the following issues:

- the hazard scenarios that would be identified by a properly conducted hazard assessment;
- the hydrology/hydraulics required to estimate and deal with flood events, internal and external to the structure, at probabilities appropriate to address properly identified hazard scenarios, including containment of contaminants;
- seepage and stability issues arising for all dams, including containment of contaminants.

A certification is required in the appropriate form by a suitably qualified and experienced person that the proposed design and operating procedures will provide the specific performance required of the dam.

This must be a reasoned certification of performance based on the facts adduced and documented in the design plan. The factual basis and performance should be stated in the certification.

The certifier takes responsibility for the overall performance of the design. A certification must also cite sufficient evidence to justify, and must also state, that the certifier is in fact a 'suitably qualified and experienced person' as required by the EA or DA conditions.

Lodgement of Annual Inspection Reports for Regulated Dams

The holder of the EA or DA should provide two copies of each annual inspection report to the EPA through the ECSU. If the annual inspection report is not compliant with the requirements of an annual report as specified in the EA or DA, then the holder of the EA or DA will be advised in writing with reasons by the EPA.

Form of Certification

For the purposes of certifying a design plan or annual inspection report, the form of certification at Appendix B of this document is considered sufficient to satisfy the requirements of the EPA.

Disclaimer

While this document has been prepared with care it contains general information and does not profess to offer legal, professional or commercial advice. The Queensland Government accepts no liability for any external decisions or actions taken on the basis of this document. Persons external to the Environmental Protection Agency should satisfy themselves independently and by consulting their own professional advisors before embarking on any proposed course of action.

Approved By

Signature

Date

APPENDIX A

Conditions for Dams Environmentally Relevant Activities Environmental Protection Act 1994

Schedule H
Conditions for Dams
Environmentally Relevant Activities
Environmental Protection Act 1994

Schedule H – Dams

All Dams

- (H1-1) The hazard category of each dam must be determined by a suitably qualified and experienced person at least once in each two year period.
- (H1-2) Dams having a hazard category determined to be significant or high, must be specifically authorized by an environmental authority <development approval>.
- (H1-3) The holder of this environmental authority <development approval> must not abandon any dam but must decommission each dam so as to avoid any environmental harm.
- (H1-4) As a minimum, decommissioning must be conducted such that each dam:
either:
 (i) a stable landform, that no longer contains flowable substances, or
 (ii) approved or authorised under relevant legislation for a beneficial use, or
 (iii) is a void authorised by the administering authority to remain after decommissioning;
and,
compliant with the rehabilitation requirements of this environmental authority <development approval>.

Regulated Dams - Location

(H2-1) The following regulated dams must be located within the control points defined in Schedule H - Table 1, below.

Schedule H — Table 1 (Location of Regulated dams)

Name of Regulated Dam	Latitude (GDA 94)	Longitude (GDA 94)
<XXX>	<XXX>	<XXX>
	<XXX>	<XXX>
	<XXX>	<XXX>
	<XXX>	<XXX>
<XXX>	<XXX>	<XXX>
	<XXX>	<XXX>
	<XXX>	<XXX>
	<XXX>	<XXX>

(H2-2) The following regulated dams must conform to the specifications in Schedule H - Table 2, below.

Schedule H — Table 2 (Specifications of Regulated Dams)

Name of Regulated dam	Hazard Category	Maximum surface area of dam (ha)	Maximum volume of dam (m ³)	Maximum depth of dam (m)	Use of dam
<XXX>	<XXX>	<XXX>	<XXX>	<XXX>	<XXX>
<XXX>	<XXX>	<XXX>	<XXX>	<XXX>	<XXX>

- (H2-3) The following regulated dams must meet the hydraulic performance criteria specified in Schedule H - Table 3, below.

Schedule H — Table 3 (Hydraulic Performance of Regulated Dams)

Name of Regulated dam	Spillway Capacity or Diversion Capacity (Levees) AEP	Design Storage Allowance (Dams other than levees) AEP	Mandatory Reporting Level (Dams other than levees) AEP
<XXX>	<XXX>	<XXX>	<XXX>
<XXX>	<XXX>	<XXX>	<XXX>

NOTE: For each entry in the table for Design Storage Allowances, the method of calculation (either 'full hydrological analysis' or 'method of monthly deciles') must be specified in conjunction with the AEP level applicable to the hazard category and method of calculation - as indicated in the Manual for Assessing Hazard Categories and Hydraulic Performance of Dams, maintained and published by the Environmental Protection Agency on its website.

Regulated Dams - Certification and Operation

- (H3-1) The holder of this environmental authority <development approval> must not commence construction of a regulated dam unless:
- (a) the holder has submitted to the administering authority two copies of a design plan, together with the certification of a suitably qualified and experienced person that the design of the regulated dam will deliver the performance stated in the design plan and that it will be compliant in all other respects with this environmental authority <development approval>, and
 - (b) at least 20 business days has passed since the receipt of those documents, or the administering authority notifies the holder that a design plan and certification, has been received.
- (H3-2) When construction of any regulated dam is complete, the holder of this environmental authority <development approval> must submit to the administering authority two copies of a set of 'as constructed' drawings, together with the certification of a suitably qualified and experienced person that the dam 'as constructed' will deliver the performance stated in the design plan and it is compliant in all respects with this environmental authority <development approval>.
- (H3-3) An operational plan must be kept current for each regulated dam.
- (H3-4) Where an operational plan covers decommissioning and rehabilitation, those operations are to be consistent with the design plan for the dam and the rehabilitation requirements of this environmental authority <development approval>.
- (H3-5) The holder of this environmental authority <development approval> must notify the administering authority immediately the level in any regulated dam reaches the mandatory reporting level (MRL), and immediately act to prevent or minimize any actual or potential environmental harm.

Regulated Dams - Annual Inspection and Report

- (H4-1) Each regulated dam must be inspected annually by a suitably qualified and experienced person.
- (H4-2) At each annual inspection, the condition and adequacy of each regulated dam must be assessed for dam safety and against the necessary structural, geotechnical and hydraulic performance criteria.
- (H4-3) At each annual inspection, if a mandatory reporting level is required, it must be determined and marked on each regulated dam.
- (H4-4) A final assessment of adequacy of available storage in each regulated dam must be based on a dam level observed within the month of October and result in an estimate of the level in that dam as at 1 November.
- (H4-5) For each annual inspection, two copies of a report on the condition and adequacy of each regulated dam, certified by the suitably qualified and experienced person and including any recommended actions to be taken to ensure the integrity of each regulated dam; must be provided to the administering authority by 1 December.
- (H4-6) The holder of this environmental authority <development approval> must, upon receipt of the annual inspection report, consider the report and its recommendations, and take action to ensure that each regulated dam safely performs its intended functions.

[NOTE: The following definitions are needed and must replace any definitions of the same terms in the broader Environmental Authority or Development Approval.]

Definitions

“accepted engineering standards” in relation to dams, means those standards of design, construction, operation and maintenance that are broadly accepted within the profession of engineering as being good practice for the purpose and application being considered. In the case of dams, the most relevant documents would be publications of the Australian National Committee on Large Dams (ANCOLD), guidelines published by Queensland government departments, and relevant Australian and New Zealand Standards.

“acceptance criteria” means the measures by which actions implemented are deemed to be complete. The acceptance criteria indicate the success of the decommissioning and rehabilitation outcomes or remediation of areas which have been significantly disturbed by the environmentally relevant activities. Acceptance criteria may include information regarding:

- stability of final land forms in terms of settlement, erosion, weathering, pondage and drainage;
- control of geochemical and contaminant transport processes;
- quality of runoff waters and potential impact on receiving environment;
- vegetation establishment, survival and succession;
- vegetation productivity, sustained growth and structure development;
- fauna colonisation and habitat development;
- ecosystem processes such as soil development and nutrient cycling, and the recolonisation of specific fauna groups such as collembola, mites and termites which are involved in these processes;
- microbiological studies including recolonisation by mycorrhizal fungi, microbial biomass and respiration;
- effects of various establishment treatments such as deep ripping, topsoil handling, seeding and fertiliser application on vegetation growth and development;
- resilience of vegetation to disease, insect attack, drought and fire;
- vegetation water use and effects on ground water levels and catchment yields.

“AEP” means the Annual Exceedance Probability, which is the probability that at least one event in excess of a particular magnitude will occur in any given year.

‘assessment’, ‘assessed’ or ‘assess’ by a suitably qualified and experienced person in relation to a hazard assessment of a dam, means that a statutory declaration has been made by that person and, when taken together with any attached or appended documents referenced in that declaration, all of the following aspects are addressed and are sufficient to allow an independent audit at any time:

- (a) exactly what has been assessed and the precise nature of that assessment;
- (b) the relevant legislative, regulatory and technical criteria on which the assessment has been based;
- (c) the relevant data and facts on which the assessment has been based, the source of that material, and the efforts made to obtain all relevant data and facts; and
- (d) the reasoning on which the assessment has been based using the relevant data and facts, and the relevant criteria.

“associated works” in relation to a dam, means:

- (a) operations of any kind and all things constructed, erected or installed for that dam; and
- (b) any land used for those operations.

“beneficial use” in respect of dams means that the current or proposed owner of the land on which a dam stands, has found a use for that dam that is:

- (a) of benefit to that owner in that it adds real value to their business or to the general community,
- (b) in accordance with relevant provisions of the *Environmental Protection Act 1994*,
- (c) sustainable by virtue of written undertakings given by that owner to maintain that dam, and
the transfer and use have been approved or authorised under any relevant legislation.

‘certification’ or **‘certified’** by a suitably qualified and experienced person in relation to a design plan or an annual report regarding dams, means that a statutory declaration has been made by that person and, when taken together with any attached or appended documents referenced in that declaration, all of the following aspects are addressed and are sufficient to allow an independent audit at any time:

- (a) exactly what is being certified and the precise nature of that certification.
- (b) the relevant legislative, regulatory and technical criteria on which the certification has been based;
- (c) the relevant data and facts on which the certification has been based, the source of that material, and the efforts made to obtain all relevant data and facts; and
- (d) the reasoning on which the certification has been based using the relevant data and facts, and the relevant criteria.

“construction” in relation to a dam includes building a new dam and modifying or lifting an existing dam.

“dam” means a land-based structure or a void that is designed to contain, divert or control flowable substances, and includes any substances that are thereby contained, diverted or controlled by that land-based structure or void and associated works. However; a dam does *not* mean a fabricated or manufactured tank or container designed to a recognised standard, *nor* does a dam mean a land-based structure where that structure is designed to an Australian Standard. In case there is any doubt, a levee (dyke or bund) is a dam, but (for example) a bund designed for spill containment to AS1940 is *not* a dam.

“design plan” is the documentation required to describe the physical dimensions of the dam, the materials and standards to be used for construction of the dam, and the criteria to be used for operating the dam. The documents must include all investigation and design reports, plans and specifications sufficient to hand to a contractor, and planned decommissioning and rehabilitation outcomes; so as to address all hazard scenarios that would be identified by a properly conducted hazard assessment for the structure. Documentation must be such that a ‘suitable qualified and experience person’ could conduct an independent review without seeking further information from the designer.

“design storage allowance” or **“DSA”** means the minimum storage required in a dam at 1 November each year in order to meet the hydraulic performance requirements.

“development approval” means a development approval under the Integrated Planning Act 1997 in relation to a matter that involves an environmentally relevant activity under the Environmental Protection Act 1994.

“environmental authority” means an environmental authority granted in relation to an environmentally relevant activity under the *Environmental Protection Act 1994*.

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“flowable substance” means matter or a mixture of materials which can flow under any conditions potentially affecting that substance. Constituents of a flowable substance can include water, other liquids fluids or solids, or a mixture that includes water and any other liquids fluids or solids either in solution or suspension.

“foreseeable future” is the period used for assessing the total probability of an event occurring. Permanent structures and ecological sustainability should be expected to still exist at the end of a 150 year foreseeable future with an acceptable probability of failure before that time.

“hazard” in relation to a dam as defined, means the potential for environmental harm resulting from the collapse or failure of the dam to perform its primary purpose of containing, diverting or controlling flowable substances.

“hazard category” means a category, either low significant or high, into which a dam is assessed as a result of the application of tables and other criteria in the Manual for Assessing Hazard Categories and Hydraulic Performance of Dams (Version 1.0, 2008) published by the Environmental Protection Agency on its website.

“hydraulic performance” means the capacity of a regulated dam to contain or safely pass flowable substances based on a probability (AEP) of performance failure specified for the relevant hazard category in the current version of the Manual for Assessing Hazard Categories and Hydraulic Performance of Dams published by the Environmental Protection Agency.

“infrastructure” means water storage dams, roads and tracks, buildings and other structures built for the purpose and duration of the conduct the environmentally relevant activities, but does not include other facilities required for the long term management of the impact of those activities or the protection of potential resources. Such other facilities include dams other than water storage dams, waste dumps, voids, or stockpiles and assets, that have been decommissioned, rehabilitated, and lawfully recognised as being subject to subsequent transfer with ownership of the land.

“levee” means a dyke or bund that is designed only to provide for the containment and diversion of stormwater or flood flows from a contributing catchment, or containment and diversion of flowable materials resulting from unplanned releases from other works of infrastructure, during the progress of those stormwater or flood flows or those unplanned releases; and does not store any significant volume of water or flowable substances at any other times.

“mandatory reporting level” or **“MRL”** means a warning and reporting level determined in accordance with the current version of the Manual for Assessing Hazard Categories and Hydraulic Performance of Dams published by the Environmental Protection Agency.

“operational plan” means a document that amongst other things sets out procedures and criteria to be used for operating a dam during a particular time period. The operational plan as defined herein may form part of a plan of operations or plan otherwise required in legislation.

“regulated dam” means any dam in the significant or high hazard category as assessed using the current version of the Manual for Assessing Hazard Categories and Hydraulic Performance of Dams published by the Environmental Protection Agency.

“spillway” means a weir, channel, conduit, tunnel, gate or other structure designed to permit discharges from the dam, normally under flood conditions or in anticipation of flood conditions.

“stable” in relation to land, means land form dimensions are and will remain within tolerable limits now and in the foreseeable future. Issues to be properly considered in regard to whether or not the landform is stable include geotechnical stability, settlement and consolidation allowances,

bearing capacity (trafficability), erosion resistance and geochemical stability with respect to seepage, leachate and related contaminant generation.

"suitably qualified and experienced person" in relation to dams means one who is a Registered Professional Engineer of Queensland (RPEQ) under the provisions of the Professional Engineers Act 1988, OR registered as a National Professional Engineer (NPER) with the Institution of Engineers Australia, OR holds equivalent professional qualifications to the satisfaction of the administering authority for the Act; AND the administering authority for the Act is satisfied that person has knowledge, suitable experience and demonstrated expertise in relevant fields, as set out below:

- (a) knowledge of engineering principles related to the structures, geomechanics, hydrology, hydraulics, chemistry and environmental impact of dams; and
- (b) a total of five years of suitable experience and demonstrated expertise in the geomechanics of dams with particular emphasis on stability, geology and geochemistry, and
- (c) a total of five years of suitable experience and demonstrated expertise each, in three of the following categories:
 - investigation and design of dams.
 - Construction, operation and maintenance of dams.
 - hydrology with particular reference to flooding, estimation of extreme storms, water management or meteorology.
 - hydraulics with particular reference to sediment transport and deposition, erosion control, beach processes.
 - hydrogeology with particular reference to seepage, groundwater.
 - solute transport processes and monitoring thereof.
 - dam safety.

"tolerable limits" means a range of parameters regarded as being sufficient to meet the objective of protecting relevant environmental values. For example, a range of settlement for a tailings capping, rather than a single value, could still meet the objective of draining the cap quickly, preventing pondage and limiting infiltration and percolation.

"void" means any man-made, open excavation in the ground.

"waters" - includes all or any part of a river, stream, lake, lagoon, pond, swamp, wetland, unconfined surface water, unconfined water in natural or artificial watercourses, bed and banks of a watercourse, dams, non-tidal or tidal waters (including the sea), stormwater channel, stormwater drain, roadside gutter, stormwater run-off, and groundwater.

APPENDIX B

**Form of Certification
Design Plan or Annual Report**

**Regulated Dams
EAs or DAs with Dam Conditions**

Form for Certification

Name of Professional Engineer Providing Certification

Address of Professional Engineer Providing Certification

Statement of Relevant Experience

NOTES: This statement must provide sufficient evidence to establish that the person providing certification is a 'suitably qualified and experienced person'.

As a result of the experience set out above, I hereby state that I have the required periods of experience in relevant roles in the categories <categories of experience> to meet the definition of 'suitably qualified and experience person' as a set out below.

'suitably qualified and experienced person' in relation to dams means one who is a Registered Professional Engineer of Queensland (RPEQ) under the provisions of the Professional Engineers Act 1988, OR registered as a National Professional Engineer (NPER) with the Institution of Engineers Australia, OR holds equivalent professional qualifications to the satisfaction of the administering authority for the Act; AND the administering authority for the Act is satisfied that person has knowledge, suitable experience and demonstrated expertise in relevant fields, as set out below:

- (d) knowledge of engineering principles related to the structures, geomechanics, hydrology, hydraulics, chemistry and environmental impact of dams; and
- (e) a total of five years of suitable experience and demonstrated expertise in the geomechanics of dams with particular emphasis on stability, geology and geochemistry, and
- (f) a total of five years of suitable experience and demonstrated expertise each, in three of the following categories:
 - investigation and design of dams.
 - Construction, operation and maintenance of dams.
 - hydrology with particular reference to flooding, estimation of extreme storms, water management or meteorology.
 - hydraulics with particular reference to sediment transport and deposition, erosion control, beach processes.
 - hydrogeology with particular reference to seepage, groundwater.
 - solute transport processes and monitoring thereof.
 - dam safety.

Statement of Certification

NOTES: Possible example wording that might be adopted by the certifier.

All relevant material relied upon is provided in the attached report <report name/ref> dated <date>, such that another suitable qualified and experience person could perform an independent review without seeking further information.

I hereby certify that the *design plan*, including drawings and specifications sufficient to provide to a suitably qualified contractor, for the proposed <name of dam/structure/facility>:

- has been prepared in accordance with best engineering practice consistent with the standards required for such structures,
- all relevant aspects are properly addressed in the attached report <report name/ref> dated <date>, and as a result
- the design of <name of dam/structure/facility> will deliver the performance stated in the attached report <report name/ref> dated <date> so as to be compliant in all respects with the environmental authority or development approval.

OR

I hereby certify that the attached *annual report* <report name/ref> dated <date> for the <name of project> has addressed all relevant matters required by the environmental authority or development approval for dams in that project, and recommendations have been made as necessary regarding any actions to be taken to ensure the integrity of each regulated dam.

NOTES: The following is the general wording of a sworn oath for the EPA.

I [full name and address of person making the declaration], being aware that it is an offence under Section 480 of the Environment Protection Act 1994 to provide false or misleading information, state that:

- I am authorised to sign on behalf of the corporate entity or entities holding the Environmental Authority <Development Approval> for the purposes of providing the certification above.
- I do solemnly and sincerely declare that the information is true and correct to the best of my knowledge and I make this solemn declaration conscientiously believing the same to be true, and by virtue of the provisions of Oaths Act 1867.

Signed

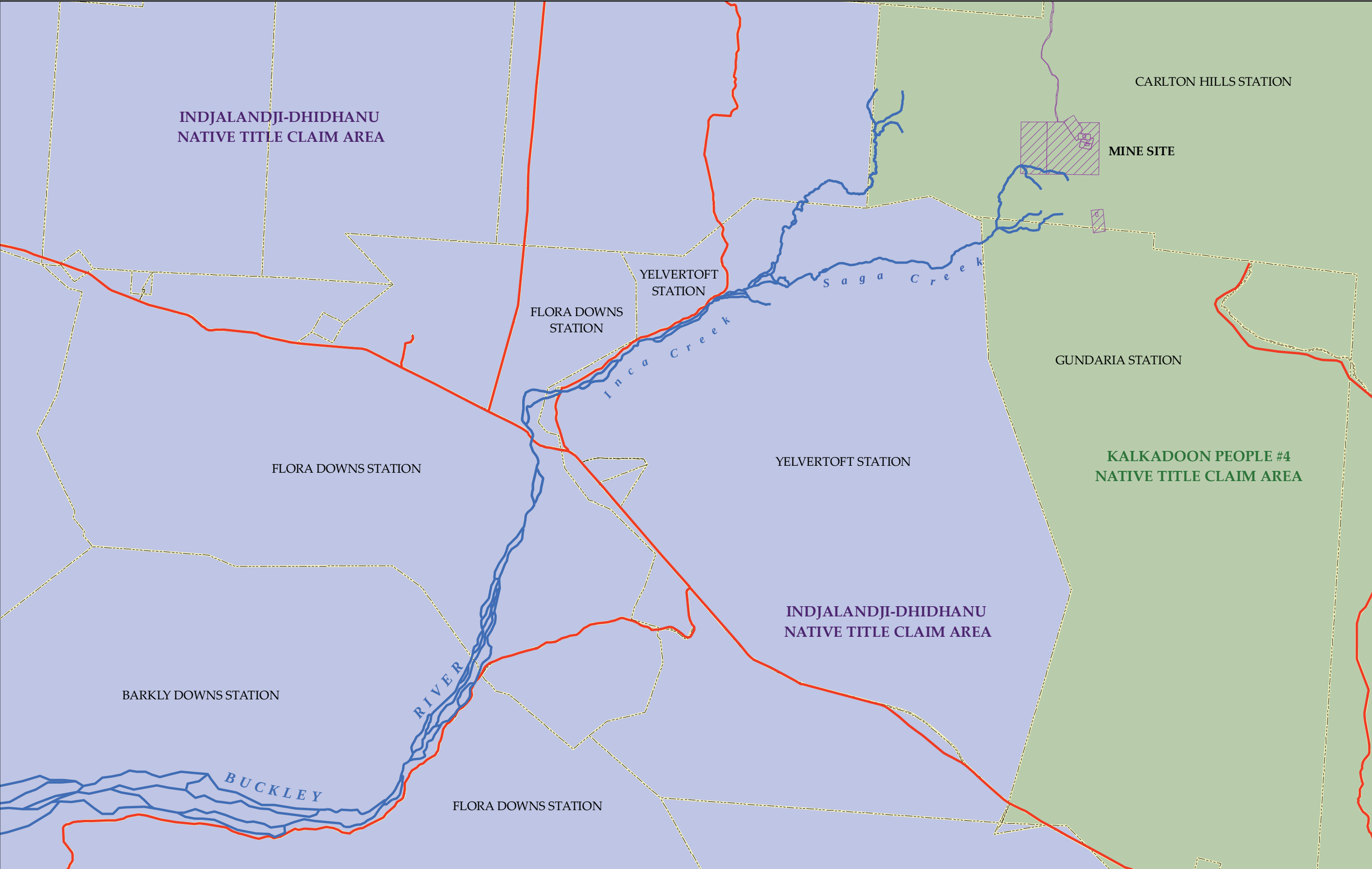
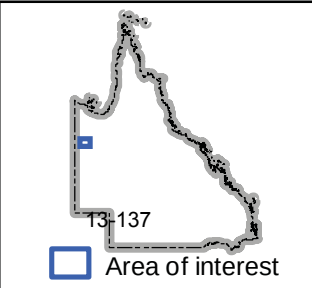
.....
[Signature of Certifier/ Professional Reference Number/s]

Taken and declared before me at
[Location]

This day.....day of.....
[Day] [Month and Year]

.....
Signature of Witness

A Justice of the Peace/Commissioner for Declaration, Barrister or Solicitor



Map Legend

- Drainage
- State Digital Road Network (QLD)
- Mining Leases
- Property Boundaries

Native Title Register Name

- Indjalandji-Dhidhanu
- Kalkadoon People #4

DATA SOURCES:
© National Native Title Tribunal
- Native title boundaries (2012)
© Pitney Bowes MapInfo - Roads (2011)
© The State of Queensland (Department of Environment and Resource Management)
- Drainage (2012)
- Property Boundaries (2012)
© The State of Queensland (Department of Mines and Energy)
- Mining lease boundaries (2012)

ACCURACY STATEMENT
Due to varying sources and scale of data, spatial locations may not coincide when overlaid

**Lady Annie Water Discharge Area
Native Title Boundaries**

0 5 10 15 20
Kilometres

1:250,000

DISCLAIMER
This map is compiled from information supplied to the Department of Environment and Resource Management. While every care is taken to ensure the accuracy of data the State of Queensland makes no representations or warranties about its accuracy, reliability, completeness or suitability for any particular purpose and disclaims all responsibility and all liability (including without limitation, liability in negligence) for all expenses, losses, damages (including indirect or consequential damage) and costs which you might incur as a result of the data being inaccurate or incomplete in any way and for any reason.

MAP PRODUCTION
Spatial Information Services North, Department of Environment and Resource Management, Cairns, Queensland (20 February, 2012)

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Version: 120220_MtAnnieNT_SO

Queensland Government

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Natural Resource Assessments



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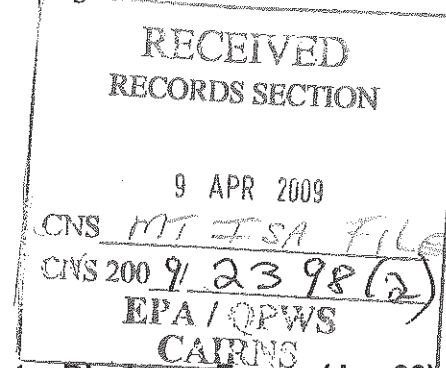
Quality Management System
to AS/NZ ISO 9001:2000
Qld Govt. Self Assessed
Quality Assured Supplier

Our Ref: Report_R01.doc

7 April 2009

Regional Manager, Northern Region
Department of Environment and Resource Management
PO Box 2066
Cairns QLD 4870

Attention: Rob Lawrence



Dear Rob

RE: Lady Annie Operations, Water Discharge Events (Jan-09) – Initial Response

NRA Environmental Consultants (NRA) was commissioned by the Environmental Protection Agency (EPA) on 27 February 2009 to provide independent expertise as a component of immediate actions in response to water discharge events at the Lady Annie Operations, Mt Isa.

The following information is for the exclusive use of the EPA. NRA cannot be held liable for third party reliance on this document. The information herein could be different if the information upon which it is based is determined to be inaccurate or incomplete. It is prepared in the context of inherent limitations associated with any investigation of this type. NRA's opinions in this document are subject to modification if additional information is obtained through further investigation, observations or analysis. The opinion of NRA is based on the technical and practical experience of environmental practitioners; it is not presented as legal advice. Nor does it represent decisions from the regulatory agencies charged with the administration of the relevant acts. Any advice, opinions or recommendations contained in this document should be read and relied upon only in the context of the document as a whole and are considered current to 16 March 2009.

Scope of Works

The scope of works was to provide independent expertise to the EPA directed to addressing a series of questions detailed in a specifications document prepared by the EPA (4 March 2009). These questions are reproduced herein.

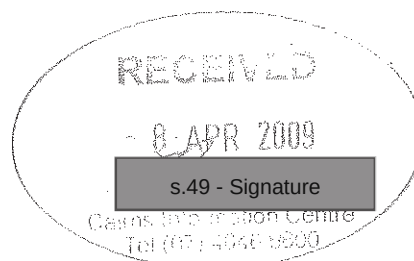
Work required beyond this immediate response will be detailed and undertaken separately.

Approach

Mr Rob Lawrence and Ms Ingrid Fomiatti-Minnesma (EPA) provided Mr Tim Anderson (NRA Principal Scientist and Director) an initial briefing on 27 February 2009. With reference to the information provided and based on experience, NRA provided initial advice to EPA which is summarised under the following headings.

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NRA NATURAL RESC



FINAL REPORTING Report_R01.doc

D SCIENCE • PRACTICAL SOLUTIONS



1. Downstream Users

- a. Downstream users of water need to be advised of incident(s) and told to cease use of water from the waterway for all forms of use until further notification.¹
- b. Alternate water source(s) for cattle, which rely on water from the downstream waterway(s), need to be agreed and provided for downstream users. A period of 4 (four) weeks alternate supply (with the possibility of extension) is suggested.
- c. Downstream users to be consulted daily for at least the first week and thereafter a consultative approach with each landholder is to be agreed and implemented.

2. Pond Integrity

- a. An opinion from an appropriately qualified and experienced professional regarding the integrity of the pond in question (understood to be referred to as Stormwater Pond 2) is required without delay (in the context of dam contents and the receiving environment)². The situation required evaluation and advice regarding immediate corrective actions that may be required (ahead of resolving tasks/actions necessary to achieve reparation post this immediate response). Further, in regard to water management, the feasibility of pumping the water from Stormwater Pond 2 (into another impoundment such that the overall risk is reduced) required evaluation.

NRA made arrangements for an independent professional engineer, having the necessary qualifications and practical experience in mining operations' process water and residue structures and processes, to undertake a site visit. The purpose was to provide an independent opinion regarding the integrity of the pond and advise on any immediate corrective actions required (ahead of resolving tasks/actions necessary to achieve reparation post this immediate response). Ms Lis Boczek, Senior Engineer (Allan Watson Associates Pty Limited (AWA)) visited the project site on 2 March 2009 in the company of representatives of the EPA. AWA prepared a preliminary report (dated 4 March 2009) following the site visit (refer to **Attachment 1**).

In the company of an EPA representative (Ms Elaine Glen, Principal Environmental Officer), Tim Anderson and Martine Adriaansen (NRA Senior Environmental Scientist) visited the project site and areas of the

¹ The rationale for this advice was that polluted waters had been released into receiving waters and although the nature and scale of the impacts had not been defined, prompt action needed to be taken (if not already taken) to alert downstream water users. Given the nature of mining operations it was prudent to adopt a conservative approach and assume waters had been polluted to an extent that prohibits use by humans and stock. With respect to aquatic ecosystems it is probable that waters had been polluted to an extent that kills/harms components of these systems. In the absence of a complete data set from a specific water quality monitoring program designed to assess the nature and scale of any impact, then the conservative approach was considered prudent and recommended.

² The rationale for this advice was that:

- a. Photographs of Stormwater Pond 2 appeared to indicate an uncontrolled failure of a section of the impoundment and water remaining in the pond was of poor quality;
- b. An analysis of rainfall data undertaken by NRA indicated that it was likely that 50-100mm rainfall may occur in March 2009. Given the reported *ca.* 1000 mm rainfall for the period 1 Jan 09 to 17 February 2009, it is probable that any additional rainfall for the remainder of this 'wet season' will report as runoff.

downstream receiving environment on 5 and 6 March 2009 respectively (refer to **Attachment 2**³). The purpose of the visit was to consider the site conditions relevant to the release event(s) and visit areas of the downstream receiving environment. Water samples from various downstream locations were collected by the EPA during this site visit (the complete results of laboratory analyses were not available at the time of reporting). During the visit to the project site, we were accompanied by Jason Alexander (Environmental Advisor, Lady Annie Operations Pty Ltd (LAO)), and immediately prior to this field work a brief meeting was held with consultants (Matthew Jeffs and Brian Fainton of Parsons Brinckerhoff) understood to be have been engaged by the Receivers for LAO.

NRA prepared a working copy report (dated 12 March 2009) and in response to an EPA request for clarification, a working copy of Attachment 4 (dated 16 March 2009) was prepared. There were no further points of clarifications from the EPA and a request to finalise the reporting was received on 6 April 2009.

Reporting

The response to the questions detailed in the specifications prepared by the EPA are presented below, each with the question reproduced for ease of reference.

1. *Is there currently a risk that the damaged wall on stormwater pond 2 will completely fail and is that likely?*

AWA advise the following: The stormwater pond is formed by excavation with no engineered embankments for the purpose of stormwater containment. Bunds have been constructed around the northern, southern and eastern edges of stormwater pond 1 and 2 for stormwater management purposes. The damaged wall is part of the southern stormwater bund and does not form part of the stormwater pond structure. Damage has occurred to a portion of the anchor trench for the HDPE liner of the stormwater pond. Ingress of water has occurred beneath the liner in stormwater pond 1 and 2 and it is suggested that a plume of water now exists within this part of the structures. In addition the liner is no longer anchored at the spillways for either pond.

Figure 3 from the 30th of January 2009, Discharge Event Report (understood to have been prepared by LAO) indicates the presence of a drainage channel (Saga Creek headwaters) crossing beneath the heap leach pads and intersecting stormwater pond 2. Inflow of groundwater via this channel may have occurred during the wet season. It is also noted from the LAO report that a drop in water level in stormwater pond 1 of ca 1.5 m occurred over a 24 hr period indicating the need for further investigation.

The risk for further damage to the liner is low provided that stored water and stormwater is kept away from the affected area (until such time that appropriate reparation actions are taken). A risk exists for other areas of the liner to be undermined subject to the efficacy of stormwater controls during a rainfall event.

³ Attachment 2 also presents information from previous site visits undertaken by the EPA on 23 and 25 February 2009.



2. *Are there any other water holding structures onsite that appear in threat of failure (based on visual observations)?*

AWA advise the following: The process and stormwater ponds observed are formed by excavation and thus failure on account of mass instability is considered unlikely. Ingress of water beneath the liners to all process and stormwater ponds may have occurred potentially damaging the liner subgrade. It is not known if further "sinkholes" have developed beneath the liner of the ponds.

A visual inspection of the downstream batters of the raw water dam was undertaken. Erosion to these batters is evident; however no indications of mass instability were noted during the inspection.

3. *Can you estimate how much contaminated water remains in stormwater pond 2.*

AWA advise the following: The combined capacity provided on the as-constructed drawings (ref: Intech Engineers drawing no.1574-C-0510) for the process and stormwater ponds is 623,856m³ of which 43,200m³ is contained by the process ponds. It is estimated based on a water level in all ponds of approx RL349.6m (being 300mm of water above the design spillway level (RL349.3m) between the process ponds and Stormwater Pond 2) that some 90,000m³ of freeboard exists. It appears based on available information on the drawings that Stormwater Pond 1 and 2 have similar capacities and as such it is estimated that the volume of water currently existing above and below the liner in Stormwater Pond 2 is in the order of 245,000m³.

4. *If it is likely the wall will fail what actions are recommended to mitigate the impact or reduce the risk of complete failure.*

AWA advise the following: As discussed under Question 1, the stormwater pond does not have an embankment and failure of the stormwater pond is considered to be a failure to contain contaminated water above the liner. It is considered that both stormwater ponds and potentially the process water ponds may have already failed in terms of this function. To reduce the risk of further contribution of contaminated water into a formed underground aquifer, the following actions should be taken:

- Construction of appropriate diversion drains around the full perimeter of the process area to reduce catchment.
- Provision of appropriate bunding to existing structures using appropriate material types and armouring (or demonstrated suitable alternate method) for erosion protection.
- Grading of surfaces to minimise ponding in and around the process area.

Measurement of the current rate of fall within the leak detection pipework and available monitoring bores should be undertaken. This would provide an indication of groundwater flow and potential extents of a contaminated plume should one exist.

5. *Would pumping out stormwater pond 2 cause the intermediate wall to pond 1 or any of the other process ponds to fail?*

AWA advise the following: Without access to the design report for the stormwater ponds, the design assumption(s) for the operation of the ponds is not known. Given the ingress of water beneath the liner and the potential for saturation of the internal embankment, a risk of failure exists should stormwater pond 2 be dewatered. A stability assessment of ponds for this scenario would be required addressing rapid drawdown of the water table within the internal embankment.



6. *If the wall is not likely to fail completely what actions are recommend to be taken to prevent or minimise the possibility of any further releases from site. Matters to be considered;*

a. *Can the dam wall and liner be repaired and if the answer is yes what works are required and how long would this take?*

AWA advise the following: To repair the liner the following actions are required:

- dewatering of the pond in a planned manner,
- partial and/or full removal of the existing liner to enable a subgrade inspection to be carried out,
- repair to the subgrade,
- replacement of the liner and leak detection system, and
- reinstatement of appropriate stormwater control measures.

In addition to the above measures and subject to further geotechnical investigations, construction of a cut-off may be required to isolate any underground channels that may exist. Repair to the subgrade of stormwater pond 1 (and other structures) may also be required subject to the outcomes of further investigation works.

Removal of water potentially contained within the “formed” underground aquifer would be required to return the system to its original operating conditions prior to the 2009/10 wet season. It is considered that this water should it occur be used in the process circuit with no make-up from other areas until the resource was exhausted. In addition, investigation of potential contamination of shallow groundwater from the heap leach pad area would also be recommended.

Once suitable conditions exist, it is expected that the liner repair works would take in the order of 3 (three) months covering procurement and construction.

b. *Can water in the failed stormwater pond be treated and or pumped to an open pit and what would be the risks associated with this option. What measures should be put in place – how long would this take.*

It is possible to treat the water stored in stormwater pond 2. There are different treatment technologies, although the addition of neutralising agents, followed by flocculants, appears the most common. A specialist service provider, such as Earth Systems Pty Ltd, could undertake onsite treatment of waters. If time is of the essence, timely notification and engagement of the specialist service provider would be required.

The speed with which treatment occurs is principally a function of costs (given current understanding of the characteristics of the water (refer to **Attachment 3**)); although in a practical sense the volume to be treated (and thus the resources required) is a significant factor. The service provider would seek to gain an understanding of the water chemistry and volumes, familiarise themselves with site conditions for the purpose of resolving logistics and infrastructure constraints/opportunities, and conduct bench scale test work. A minimum of 2 (two) weeks would

be required⁴. Any estimate of timeframe for treatment, based on current information, is speculative, and must be treated as such. Given this qualification, it is estimated that treatment of the stormwater pond 2, following initial period of investigations, would occur over a period no less than 3 (three) months and no more than 6 (six) months.

The characteristics of the water and total volume would require determination, and the water quality specifications to achieve for treated waters would need to be nominated. The advice given by NRA as part of the initial response support service is applicable, which in summary is to characterise the elemental composition of the waste water, determine total acidity (ensuring full oxidation conditions as part of the analysis) and characterise the supernatant and sludge resultant from laboratory scale neutralisation work⁵. The preliminary characterisation work in progress and preliminary data (refer to Attachment 3) provides directly relevant information for any treatment approach.

The sludge⁶ formed as a by product of the treatment process is a waste product that will require appropriate disposal. It is necessary therefore to consider treatment options that also allow the recovery of the sludge directly as part of the treatment process, as distinct from other options, involving *in situ* neutralisation, that are reliant on recovering sludge from the 'base' of the pond. From previous experience the removal of sludge from impoundments has proven problematic and expensive.

Refer to AWA comments at Question 5 in regard to dewatering stormwater pond 2.

Pumping of water stored in stormwater pond 2 to an open pit (noting AWA advice above) appears plausible; however, its feasibility would require specific assessment (eg infrastructure requirements, capacity of open pit).

c. Is it likely that pumping to the pit will contaminate groundwater and if so what measures could be implemented to minimise this risk? (An opinion can be given. It will though be qualified as it would be necessary to review groundwater work done, possibly do specific investigations and engage a specialist. Though in the context of this immediate response, it is considered that an opinion is required in the first instance.)

Assuming a groundwater resource exists, untreated water pumped to the pit has the potential to contaminate the groundwater. Specialists' investigations and opinion would be required to evaluate and report on this issue. Based on our experience, the nature and extent of the potential contamination is influenced by the pre disturbance groundwater conditions. Several factors require consideration:

⁴ In an emergency scenario it is likely that a response, involving some form of direct treatment (albeit based on assumptions and implicit risks) within 3 days could occur.

⁵ For all analyses, nominate appropriate laboratory Limits of Reporting (Detection Limits) before the test work is initiated.

⁶ A metal rich precipitate is formed by the addition of neutralising agents to raise pH of acid waters containing heavy metals. The nature of the precipitate depends on the neutralising agent used and the metals present. A flocculant(s) is likely to be added to achieve required settlement rates.

- i. Groundwater levels relative to water levels in the pit (actual and predicted over time) *ie* to what extent does the pit serve as a localised 'sink' wherein groundwater preferentially drains to the pit?
- ii. Rate of groundwater flow and proximity of users (anthropogenic and/or ecosystem)
- iii. Groundwater quality (pre disturbance)
- iv. Predicted pit water quality. Although it would be necessary to consider any available geochemical investigations (and in its absence undertake necessary investigation) it is not unreasonable to predict that the open pit mining associated with base metals ore bodies exposes mineralised waste rock and ore material the weathering of which gives rise to runoff waters having elevated levels of various elements and compounds in comparison to runoff from non mineralised materials. Given this, the assumption that disposing water stored in stormwater pond 2 into an open pit is flawed, on account of contaminating otherwise uncontaminated water, could be challenged.

d. *Can water be treated so it meets standards for release? If so what would be the risks associated with this option. What measures should be put in place – how long would this take.*

Refer to response to Question 6 (b) above.

To reiterate, in general it is possible to treat water to a standard suitable for release. However, the specifications to be achieved dictate the treatment method and thus cost. Volume to be treated and nature of receiving environment influences the method, costs and timing.

Based on our experience relevant to base metals operations wherein contamination associated with process water and/or acid mine drainage has occurred, and wherein it is necessary to treat contaminated waters to achieve water quality standards specific to the protection of slightly to moderately disturbed aquatic ecosystems, water treatment was reliant on Reverse Osmosis (RO) technology. In comparison to relatively simple neutralisation techniques, RO technology is significantly more expensive.

7. *Identification of nature and reason for failure of dam including:*

- a. *Identification of any actions that could have been taken to prevent or minimise the release that occurred. An opinion can be given. It is not contemplated that interviews and detailed investigations be undertaken. Again given immediate response, it is considered an opinion has value and can be supported, albeit with qualifications. {note – should all theses matters end up in legal proceedings it will be necessary to do further work and/or engage others. As part of the initial response, the tasks to be done and approach being taken is acceptable and capable of defence.}*

AWA advise the following:

Based on the understanding of events, as summarised in AWA email transmission (Attachment 1), actions that should have been taken to minimise the release include the following:

- i. Provision of site water management plan including the installation of appropriate stormwater control measures. This would have included a review of stormwater management around the ponds including materials used in construction;

- ii. Based on a preliminary review of available documents it appears that the initial investigations for the site assumed that no aquifer existed beneath the site and there was no need to divert natural waterways around the site given the flat topography.
- iii. Technically appropriate investigation of the hole(s) that developed within the stormwater bund to assess appropriate repair techniques. The repair of the area containing the hole(s) should have been fully reconstructed rather than filling of the hole(s) without an understanding of the potential extent of undermining that may have occurred.
- iv. Appropriate Quality Control during the pond construction. Exposure of the anchor trench indicates that the trench has been formed within the surface soils with inadequate surface preparation to remove topsoil and vegetation from within the construction area.
- v. It is understood that no geotechnical investigation was carried out prior to the construction of stormwater pond 2. In addition, an assessment of the design drawings provided indicates that the designer appears to have failed to provide for stormwater management outside the process circuit. There are no details provided on the drawings for the construction of bunds around the ponds which would be considered an important design consideration given the below ground construction.

8. *Identification of what actions can be taken to mitigate or address concerns in relation water (and sediment) quality downstream of mine discharge. Including:*

- a. *Can water be treated in situ or on any of the farm dams affected to meet relevant user standards? (if possible include likely timeframes and methods)*

Refer to response to Question 6 (b) above, noting however that it is considered unacceptable to implement a treatment method that results in sludge being deposited in the farm dams. It is considered unacceptable because the farm dams are understood to be permanent water bodies, upon which the landholder is reliant for stock watering. Removing accumulated sludge from the base of the structures would be difficult to impracticable. Rather a treatment method that allows for removal of sludge *ex situ* of the dam is considered necessary. The approach to managing treated water will also need to be resolved.

In terms of approach and timing, the discussion in response to Question 6 (b) above is relevant, with the following modifications. The volume of water in the farm dams observed in the field (*ie* One Mile Creek Dam and Wide Yard Dam) and that anticipated to be held in the remaining known permanent water supply on the creek system, referred to as Big Hole, is significantly less than that stored in ponds on the mine site.

Survey would be required to quantify the volumes of water in these permanent features. It is estimated that One Mile Creek Dam has approx 7.5 ML of polluted water (based on estimated dimensions of 250m*20m and assumed depth of 1.5m) and Wide Yard Dam has approx 50 ML of polluted water (based on estimated dimensions of 200m*100m and assumed average depth of 2.5m).

Noting the important qualifications discussed in the response to Question 6 (b) above, it is estimated that treatment of the two farm dams, following initial period of investigations, could occur over a period no less than 1 (one) month and no more than 3 (three) months. The as yet unresolved issue, that directly dictates this estimated timeframe, concerns the management of treated water. There is

not an immediate solution eg adjacent off stream storage into which treated water can be stored, and thus these time estimates are currently unreliable.

With respect to polluted waters within the creek system (not in the 'on creek' dams) it is considered appropriate that, in the first instance, treatment is the required management response. Treatment should be *ex situ* to avoid sludge being deposited in the creek (which if it were to occur, in addition to chemical related impacts, physical impacts associated with smothering would be expected). Only where it is demonstrated that treatment is impracticable should consideration to leaving the pollution in the creek be given.

The required treatment methods will be dependent upon the water quality specifications to be achieved. It may be that polluted water is removed for treatment at another locality, and that once treated, either locally or remotely, the water is not returned to the creek.

Should the treated water be returned to the creek, then the water quality specification to be achieved should be consistent with the standards for the protection of slightly to moderately disturbed aquatic ecosystems; unless otherwise demonstrated that a lesser standard does not result in impact to the in stream ecosystem.

Wherein the polluted waters evaporate, substances that can generate acidity when rewetted will remain. The magnitude of any subsequent impact can not be evaluated at this time; however, the potential exists for further impact. Again, in the first instance, treatment (*via* removal and disposal in an appropriate location) is the required management response. Only where it is demonstrated that the level of contamination is insufficient to impact on the in stream ecosystem, or that treatment is impracticable, should consideration to leaving the pollution in the creek be given.

Refer to **Attachment 4** for clarification of reasoning for the treatment options.

b. Considering current uses of Saga and Inca creek what are the risks and options to mitigate these risks

With reference to the preliminary results of relevant water samples collected to date (Attachment 3) and to the field visit (refer to Attachment 2) the following comments are provided in response to this question.

It should be noted that a detailed investigation would be required to provide a thorough response and the following presents an opinion based predominantly on experience and with reference to preliminary data received to date.

The release of acid waters to freshwater systems (having approximate neutral pH conditions) will have direct impact on the ecosystem. In this circumstance the waters released had a high total acidity (refer to acidity results eg Wide Yard Dam – Attachment 3).

In terms of stock water, the polluted waters that exist in the 'on creek' farm dams (and note that polluted waters were observed upstream and downstream of these dams) would be unsuitable for stock on account of low pH alone (without the need to consider any soluble elements that one would anticipate would occur in a release of the type that has occurred).

The preliminary advice to destock areas of waterways thought to be impacted by the release is now supported by water quality data. Pending a change in conditions that bring about the necessary improvement in water quality then based on current information:

- i. destocking of areas along Inca creek (upstream of the Barkley Highway) to the upper reach of Saga Creek is recommended.
- ii. destocking of areas along Inca Creek (downstream of the Barkley Highway) to the confluence of Buckley River would appear prudent.

In terms of ecosystems, there have been predictable impacts already reported by the EPA (fish kills) and it is expected that other life forms, such as macro invertebrates and crustaceans, have been killed and will be unable to recolonise areas where the low pH polluted waters remain. Treatment of these waters will be required. Wherein the polluted waters evaporate, substances that can generate acidity when rewetted will remain. The magnitude of any subsequent impact cannot be evaluated at this time; however, the potential exists for further impact. For this specific issue, it is considered necessary to conduct in stream sampling along the length of Inca Creek from the Buckley River confluence to the upper reach of Saga Creek for the purpose of characterising water and sediment quality (note the requirement for further monitoring downstream of the Inca Creek and Buckley River confluence may be identified by the results of monitoring undertaken by the EPA on 11 March 2009 (results not available at time of reporting)). It may prove that treatment of water alone is required, alternatively the sediment may be contaminated and this level of contamination may be sufficient to impact directly on the in stream ecosystem; necessitating therefore, the removal of contaminated sediment from the creek.

- c. *If water can not be treated in situ –how long will impacts persist and how will this effect uses and ecosystem of waters in longer term.*

If water cannot be treated *in situ*, the duration of an impact and effect on uses and the aquatic ecosystem would be difficult to quantify without sufficient monitoring of the downstream environment and understanding of the hydrological characteristics of the system. Where a pollution incident occurred and was followed by effective flushing (and assuming no significant physical impacts to the creek substrate occurred) the impact is expected to be of short term duration. Wherein the pollutant persists the impact would not be short term and recovery is expected to be slow.

Given the nature of the contaminants released from Lady Annie Operations and our experience, it is expected that:

- i. an in stream ecosystem will re-establish in time with the diversity (and hence resilience) being less in areas where the greatest concentration of pollutants persisted. In the absence of treatment, the period of recovery is reliant on flushing (and hence weather dependent, unless an alternate clean water source is available) with flushing moving the pollutants downstream and reduction of impact achieved through natural attenuation, dispersion and dilution. Observations and sampling of the Dip Hole (understood to be on Flora Station) in the period during the immediate response undertaken by EPA support this line of argument (refer to Attachment 3); although it is possible that the polluted water has simply been displaced and is travelling further downstream. It should be noted that the 'natural attenuation approach' appears not to have functioned successfully thus far for areas on Inca Creek upstream of the Barkley Highway.

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- ii. ecosystems downstream of the greatest concentration of untreated pollutants are expected to recolonise and to achieve diversity comparable to unimpacted areas (as noted above, where the polluted waters evaporate, substances that can generate acidity when rewetted will remain and impacts may occur in receiving waters). Our practice has been to conduct 3 (three) years of monitoring to establish conditions of a stream. Therefore, it is suggested that this period be used as a guide to predict when the system can be demonstrated to have recovered.

In addition to known areas of in stream pollution, NRA has advised the EPA to sample waters (and as required sediments) further downstream of the known polluted sites. This monitoring should extend downstream until no indication of pollution is detected (*ie* the extent of the impact is definitively defined).

d. Are there any options available to assist ecosystem recovery

Refer above, though in summary:

- i. Treatment of polluted waters (involving *ex situ* recovery of sludge).
- ii. Depending on the demonstrable need (*ie* determine levels of pollution in sediment) remove polluted sediment from creek.
- iii. Flushing of system (relying on natural rainfall or alternate source of clean water) noting however the limitations/constraints inherent in the 'natural attenuation approach' discussed above.

e. How should the recovery be monitored over longer term.

Recovery of the physical and biological environment downstream of the mine discharge should be monitored by periodic collection of water, sediment and aquatic macroinvertebrate samples from the downstream receiving environment and unimpacted reference streams, as well as an assessment of in stream and riparian condition and health. Aquatic macroinvertebrates are considered appropriate as bioindicators to assess impacts on the downstream environment because they are permanent, relatively sessile inhabitants of streams and are responsive to impacts at the local scale. In our experience, the monitoring of fish has proven less worthwhile than has the use of macroinvertebrates. With respect to toxicological studies, our experience has shown that test work undertaken on fish kills has proven inconclusive. Analysis of macroinvertebrate data and water and sediment quality from a well designed monitoring program can identify the degree of impact to the biological community from the mine discharge, recovery of the aquatic ecosystem, as well as the success of mitigation measures and the need for further remediation works. It is appropriate to consider deriving locally specific water quality standards through toxicology studies using a range of organisms representative of local assemblages.

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Please contact the undersigned to discuss any matters arising from this report.

Yours sincerely
NRA Environmental Consultants

s.49 - Signature

Tim Anderson
Principal Scientist and Director

Attachment 1 – AWA preliminary report on site visit (dated 4 March 2009)

Attachment 2 – Locality Map

Attachment 3 – Preliminary Laboratory Data

Attachment 4 – Clarification of reasoning for treatment options.

*Cc: Ingrid Fomiatti Minnesma, Manager - Far Northern Region Environmental Services, Department of
Environment and Resource Management*

1. Downstream Users

- a. Downstream users of water need to be advised of incident(s) and told to cease use of water from the waterway for all forms of use until further notification.¹
- b. Alternate water source(s) for cattle, which rely on water from the downstream waterway(s), need to be agreed and provided for downstream users. A period of 4 (four) weeks alternate supply (with the possibility of extension) is suggested.
- c. Downstream users to be consulted daily for at least the first week and thereafter a consultative approach with each landholder is to be agreed and implemented.

2. Pond Integrity

- a. An opinion from an appropriately qualified and experienced professional regarding the integrity of the pond in question (understood to be referred to as Stormwater Pond 2) is required without delay (in the context of dam contents and the receiving environment)². The situation required evaluation and advice regarding immediate corrective actions that may be required (ahead of resolving tasks/actions necessary to achieve reparation post this immediate response). Further, in regard to water management, the feasibility of pumping the water from Stormwater Pond 2 (into another impoundment such that the overall risk is reduced) required evaluation.

NRA made arrangements for an independent professional engineer, having the necessary qualifications and practical experience in mining operations' process water and residue structures and processes, to undertake a site visit. The purpose was to provide an independent opinion regarding the integrity of the pond and advise on any immediate corrective actions required (ahead of resolving tasks/actions necessary to achieve reparation post this immediate response). Ms Lis Boczek, Senior Engineer (Allan Watson Associates Pty Limited (AWA)) visited the project site on 2 March 2009 in the company of representatives of the EPA. AWA prepared a preliminary report (dated 4 March 2009) following the site visit (refer to **Attachment 1**).

In the company of an EPA representative (Ms Elaine Glen, Principal Environmental Officer), Tim Anderson and Martine Adriaansen (NRA Senior Environmental Scientist) visited the project site and areas of the

¹ The rationale for this advice was that polluted waters had been released into receiving waters and although the nature and scale of the impacts had not been defined, prompt action needed to be taken (if not already taken) to alert downstream water users. Given the nature of mining operations it was prudent to adopt a conservative approach and assume waters had been polluted to an extent that prohibits use by humans and stock. With respect to aquatic ecosystems it is probable that waters had been polluted to an extent that kills/harms components of these systems. In the absence of a complete data set from a specific water quality monitoring program designed to assess the nature and scale of any impact, then the conservative approach was considered prudent and recommended.

² The rationale for this advice was that:

- a. Photographs of Stormwater Pond 2 appeared to indicate an uncontrolled failure of a section of the impoundment and water remaining in the pond was of poor quality;
- b. An analysis of rainfall data undertaken by NRA indicated that it was likely that 50-100mm rainfall may occur in March 2009. Given the reported *ca.* 1000 mm rainfall for the period 1 Jan 09 to 17 February 2009, it is probable that any additional rainfall for the remainder of this 'wet season' will report as runoff.

downstream receiving environment on 5 and 6 March 2009 respectively (refer to Attachment 2³). The purpose of the visit was to consider the site conditions relevant to the release event(s) and visit areas of the downstream receiving environment. Water samples from various downstream locations were collected by the EPA during this site visit (the complete results of laboratory analyses were not available at the time of reporting). During the visit to the project site, we were accompanied by Jason Alexander (Environmental Advisor, Lady Annie Operations Pty Ltd (LAO)), and immediately prior to this field work a brief meeting was held with consultants (Matthew Jeffs and Brian Fainton of Parsons Brinckerhoff) understood to be have been engaged by the Receivers for LAO.

NRA prepared a working copy report (dated 12 March 2009) and in response to an EPA request for clarification, a working copy of Attachment 4 (dated 16 March 2009) was prepared. There were no further points of clarifications from the EPA and a request to finalise the reporting was received on 6 April 2009.

Reporting

The response to the questions detailed in the specifications prepared by the EPA are presented below, each with the question reproduced for ease of reference.

1. *Is there currently a risk that the damaged wall on stormwater pond 2 will completely fail and is that likely?*

AWA advise the following: The stormwater pond is formed by excavation with no engineered embankments for the purpose of stormwater containment. Bunds have been constructed around the northern, southern and eastern edges of stormwater pond 1 and 2 for stormwater management purposes. The damaged wall is part of the southern stormwater bund and does not form part of the stormwater pond structure. Damage has occurred to a portion of the anchor trench for the HDPE liner of the stormwater pond. Ingress of water has occurred beneath the liner in stormwater pond 1 and 2 and it is suggested that a plume of water now exists within this part of the structures. In addition the liner is no longer anchored at the spillways for either pond.

Figure 3 from the 30th of January 2009, Discharge Event Report (understood to have been prepared by LAO) indicates the presence of a drainage channel (Saga Creek headwaters) crossing beneath the heap leach pads and intersecting stormwater pond 2. Inflow of groundwater via this channel may have occurred during the wet season. It is also noted from the LAO report that a drop in water level in stormwater pond 1 of ca 1.5 m occurred over a 24 hr period indicating the need for further investigation.

The risk for further damage to the liner is low provided that stored water and stormwater is kept away from the affected area (until such time that appropriate reparation actions are taken). A risk exists for other areas of the liner to be undermined subject to the efficacy of stormwater controls during a rainfall event.

³ Attachment 2 also presents information from previous site visits undertaken by the EPA on 23 and 25 February 2009.

2. *Are there any other water holding structures onsite that appear in threat of failure (based on visual observations)?*

AWA advise the following: The process and stormwater ponds observed are formed by excavation and thus failure on account of mass instability is considered unlikely. Ingress of water beneath the liners to all process and stormwater ponds may have occurred potentially damaging the liner subgrade. It is not known if further "sinkholes" have developed beneath the liner of the ponds.

A visual inspection of the downstream batters of the raw water dam was undertaken. Erosion to these batters is evident; however no indications of mass instability were noted during the inspection.

3. *Can you estimate how much contaminated water remains in stormwater pond 2.*

AWA advise the following: The combined capacity provided on the as-constructed drawings (ref: Intech Engineers drawing no.1574-C-0510) for the process and stormwater ponds is $623,856\text{m}^3$ of which $43,200\text{m}^3$ is contained by the process ponds. It is estimated based on a water level in all ponds of approx RL349.6m (being 300mm of water above the design spillway level (RL349.3m) between the process ponds and Stormwater Pond 2) that some $90,000\text{m}^3$ of freeboard exists. It appears based on available information on the drawings that Stormwater Pond 1 and 2 have similar capacities and as such it is estimated that the volume of water currently existing above and below the liner in Stormwater Pond 2 is in the order of $245,000\text{m}^3$.

4. *If it is likely the wall will fail what actions are recommended to mitigate the impact or reduce the risk of complete failure.*

AWA advise the following: As discussed under Question 1, the stormwater pond does not have an embankment and failure of the stormwater pond is considered to be a failure to contain contaminated water above the liner. It is considered that both stormwater ponds and potentially the process water ponds may have already failed in terms of this function. To reduce the risk of further contribution of contaminated water into a formed underground aquifer, the following actions should be taken:

- Construction of appropriate diversion drains around the full perimeter of the process area to reduce catchment.
- Provision of appropriate bunding to existing structures using appropriate material types and armouring (or demonstrated suitable alternate method) for erosion protection.
- Grading of surfaces to minimise ponding in and around the process area.

Measurement of the current rate of fall within the leak detection pipework and available monitoring bores should be undertaken. This would provide an indication of groundwater flow and potential extents of a contaminated plume should one exist.

5. *Would pumping out stormwater pond 2 cause the intermediate wall to pond 1 or any of the other process ponds to fail?.*

AWA advise the following: Without access to the design report for the stormwater ponds, the design assumption(s) for the operation of the ponds is not known. Given the ingress of water beneath the liner and the potential for saturation of the internal embankment, a risk of failure exists should stormwater pond 2 be dewatered. A stability assessment of ponds for this scenario would be required addressing rapid drawdown of the water table within the internal embankment.

6. *If the wall is not likely to fail completely what actions are recommend to be taken to prevent or minimise the possibility of any further releases from site. Matters to be considered;*

a. *Can the dam wall and liner be repaired and if the answer is yes what works are required and how long would this take?*

AWA advise the following: To repair the liner the following actions are required:

- dewatering of the pond in a planned manner,
- partial and/or full removal of the existing liner to enable a subgrade inspection to be carried out,
- repair to the subgrade,
- replacement of the liner and leak detection system, and
- reinstatement of appropriate stormwater control measures.

In addition to the above measures and subject to further geotechnical investigations, construction of a cut-off may be required to isolate any underground channels that may exist. Repair to the subgrade of stormwater pond 1 (and other structures) may also be required subject to the outcomes of further investigation works.

Removal of water potentially contained within the "formed" underground aquifer would be required to return the system to its original operating conditions prior to the 2009/10 wet season. It is considered that this water should it occur be used in the process circuit with no make-up from other areas until the resource was exhausted. In addition, investigation of potential contamination of shallow groundwater from the heap leach pad area would also be recommended.

Once suitable conditions exist, it is expected that the liner repair works would take in the order of 3 (three) months covering procurement and construction.

b. *Can water in the failed stormwater pond be treated and or pumped to an open pit and what would be the risks associated with this option. What measures should be put in place – how long would this take.*

It is possible to treat the water stored in stormwater pond 2. There are different treatment technologies, although the addition of neutralising agents, followed by flocculants, appears the most common. A specialist service provider, such as Earth Systems Pty Ltd, could undertake onsite treatment of waters. If time is of the essence, timely notification and engagement of the specialist service provider would be required.

The speed with which treatment occurs is principally a function of costs (given current understanding of the characteristics of the water (refer to **Attachment 3**)); although in a practical sense the volume to be treated (and thus the resources required) is a significant factor. The service provider would seek to gain an understanding of the water chemistry and volumes, familiarise themselves with site conditions for the purpose of resolving logistics and infrastructure constraints/opportunities, and conduct bench scale test work. A minimum of 2 (two) weeks would

be required⁴. Any estimate of timeframe for treatment, based on current information, is speculative, and must be treated as such. Given this qualification, it is estimated that treatment of the stormwater pond 2, following initial period of investigations, would occur over a period no less than 3 (three) months and no more than 6 (six) months.

The characteristics of the water and total volume would require determination, and the water quality specifications to achieve for treated waters would need to be nominated. The advice given by NRA as part of the initial response support service is applicable, which in summary is to characterise the elemental composition of the waste water, determine total acidity (ensuring full oxidation conditions as part of the analysis) and characterise the supernatant and sludge resultant from laboratory scale neutralisation work⁵. The preliminary characterisation work in progress and preliminary data (refer to Attachment 3) provides directly relevant information for any treatment approach.

The sludge⁶ formed as a by product of the treatment process is a waste product that will require appropriate disposal. It is necessary therefore to consider treatment options that also allow the recovery of the sludge directly as part of the treatment process, as distinct from other options, involving *in situ* neutralisation, that are reliant on recovering sludge from the 'base' of the pond. From previous experience the removal of sludge from impoundments has proven problematic and expensive.

Refer to AWA comments at Question 5 in regard to dewatering stormwater pond 2.

Pumping of water stored in stormwater pond 2 to an open pit (noting AWA advice above) appears plausible; however, its feasibility would require specific assessment (eg infrastructure requirements, capacity of open pit).

c. *Is it likely that pumping to the pit will contaminate groundwater and if so what measures could be implemented to minimise this risk? (An opinion can be given. It will though be qualified as it would be necessary to review groundwater work done, possibly do specific investigations and engage a specialist. Though in the context of this immediate response, it is considered that an opinion is required in the first instance.)*

Assuming a groundwater resource exists, untreated water pumped to the pit has the potential to contaminate the groundwater. Specialists' investigations and opinion would be required to evaluate and report on this issue. Based on our experience, the nature and extent of the potential contamination is influenced by the pre disturbance groundwater conditions. Several factors require consideration:

⁴ In an emergency scenario it is likely that a response, involving some form of direct treatment (albeit based on assumptions and implicit risks) within 3 days could occur.

⁵ For all analyses, nominate appropriate laboratory Limits of Reporting (Detection Limits) before the test work is initiated.

⁶ A metal rich precipitate is formed by the addition of neutralising agents to raise pH of acid waters containing heavy metals. The nature of the precipitate depends on the neutralising agent used and the metals present. A flocculant(s) is likely to be added to achieve required settlement rates.

- i. Groundwater levels relative to water levels in the pit (actual and predicted over time) *ie* to what extent does the pit serve as a localised 'sink' wherein groundwater preferentially drains to the pit?
- ii. Rate of groundwater flow and proximity of users (anthropogenic and/or ecosystem)
- iii. Groundwater quality (pre disturbance)
- iv. Predicted pit water quality. Although it would be necessary to consider any available geochemical investigations (and in its absence undertake necessary investigation) it is not unreasonable to predict that the open pit mining associated with base metals ore bodies exposes mineralised waste rock and ore material the weathering of which gives rise to runoff waters having elevated levels of various elements and compounds in comparison to runoff from non mineralised materials. Given this, the assumption that disposing water stored in stormwater pond 2 into an open pit is flawed, on account of contaminating otherwise uncontaminated water, could be challenged.

d. *Can water be treated so it meets standards for release? If so what would be the risks associated with this option. What measures should be put in place – how long would this take.*

Refer to response to Question 6 (b) above.

To reiterate, in general it is possible to treat water to a standard suitable for release. However, the specifications to be achieved dictate the treatment method and thus cost. Volume to be treated and nature of receiving environment influences the method, costs and timing.

Based on our experience relevant to base metals operations wherein contamination associated with process water and/or acid mine drainage has occurred, and wherein it is necessary to treat contaminated waters to achieve water quality standards specific to the protection of slightly to moderately disturbed aquatic ecosystems, water treatment was reliant on Reverse Osmosis (RO) technology. In comparison to relatively simple neutralisation techniques, RO technology is significantly more expensive.

7. *Identification of nature and reason for failure of dam including:*

- a. *Identification of any actions that could have been taken to prevent or minimise the release that occurred. An opinion can be given. It is not contemplated that interviews and detailed investigations be undertaken. Again given immediate response, it is considered an opinion has value and can be supported, albeit with qualifications. {note – should all theses matters end up in legal proceedings it will be necessary to do further work and/or engage others. As part of the initial response, the tasks to be done and approach being taken is acceptable and capable of defence.}*

AWA advise the following:

Based on the understanding of events, as summarised in AWA email transmission (Attachment 1), actions that should have been taken to minimise the release include the following:

- i. Provision of site water management plan including the installation of appropriate stormwater control measures. This would have included a review of stormwater management around the ponds including materials used in construction;

- ii. Based on a preliminary review of available documents it appears that the initial investigations for the site assumed that no aquifer existed beneath the site and there was no need to divert natural waterways around the site given the flat topography.
- iii. Technically appropriate investigation of the hole(s) that developed within the stormwater bund to assess appropriate repair techniques. The repair of the area containing the hole(s) should have been fully reconstructed rather than filling of the hole(s) without an understanding of the potential extent of undermining that may have occurred.
- iv. Appropriate Quality Control during the pond construction. Exposure of the anchor trench indicates that the trench has been formed within the surface soils with inadequate surface preparation to remove topsoil and vegetation from within the construction area.
- v. It is understood that no geotechnical investigation was carried out prior to the construction of stormwater pond 2. In addition, an assessment of the design drawings provided indicates that the designer appears to have failed to provide for stormwater management outside the process circuit. There are no details provided on the drawings for the construction of bunds around the ponds which would be considered an important design consideration given the below ground construction.

8. *Identification of what actions can be taken to mitigate or address concerns in relation water (and sediment) quality downstream of mine discharge. Including:*

- a. *Can water be treated in situ or on any of the farm dams affected to meet relevant user standards? (if possible include likely timeframes and methods)*

Refer to response to Question 6 (b) above, noting however that it is considered unacceptable to implement a treatment method that results in sludge being deposited in the farm dams. It is considered unacceptable because the farm dams are understood to be permanent water bodies, upon which the landholder is reliant for stock watering. Removing accumulated sludge from the base of the structures would be difficult to impracticable. Rather a treatment method that allows for removal of sludge *ex situ* of the dam is considered necessary. The approach to managing treated water will also need to be resolved.

In terms of approach and timing, the discussion in response to Question 6 (b) above is relevant, with the following modifications. The volume of water in the farm dams observed in the field (*ie* One Mile Creek Dam and Wide Yard Dam) and that anticipated to be held in the remaining known permanent water supply on the creek system, referred to as Big Hole, is significantly less than that stored in ponds on the mine site.

Survey would be required to quantify the volumes of water in these permanent features. It is estimated that One Mile Creek Dam has approx 7.5 ML of polluted water (based on estimated dimensions of 250m*20m and assumed depth of 1.5m) and Wide Yard Dam has approx 50 ML of polluted water (based on estimated dimensions of 200m*100m and assumed average depth of 2.5m).

Noting the important qualifications discussed in the response to Question 6 (b) above, it is estimated that treatment of the two farm dams, following initial period of investigations, could occur over a period no less than 1 (one) month and no more than 3 (three) months. The as yet unresolved issue, that directly dictates this estimated timeframe, concerns the management of treated water. There is

not an immediate solution *eg* adjacent off stream storage into which treated water can be stored, and thus these time estimates are currently unreliable.

With respect to polluted waters within the creek system (not in the 'on creek' dams) it is considered appropriate that, in the first instance, treatment is the required management response. Treatment should be *ex situ* to avoid sludge being deposited in the creek (which if it were to occur, in addition to chemical related impacts, physical impacts associated with smothering would be expected). Only where it is demonstrated that treatment is impracticable should consideration to leaving the pollution in the creek be given.

The required treatment methods will be dependent upon the water quality specifications to be achieved. It may be that polluted water is removed for treatment at another locality, and that once treated, either locally or remotely, the water is not returned to the creek.

Should the treated water be returned to the creek, then the water quality specification to be achieved should be consistent with the standards for the protection of slightly to moderately disturbed aquatic ecosystems; unless otherwise demonstrated that a lesser standard does not result in impact to the in stream ecosystem.

Wherein the polluted waters evaporate, substances that can generate acidity when rewetted will remain. The magnitude of any subsequent impact can not be evaluated at this time; however, the potential exists for further impact. Again, in the first instance, treatment (*via* removal and disposal in an appropriate location) is the required management response. Only where it is demonstrated that the level of contamination is insufficient to impact on the in stream ecosystem, or that treatment is impracticable, should consideration to leaving the pollution in the creek be given.

Refer to **Attachment 4** for clarification of reasoning for the treatment options.

b. Considering current uses of Saga and Inca creek what are the risks and options to mitigate these risks

With reference to the preliminary results of relevant water samples collected to date (Attachment 3) and to the field visit (refer to Attachment 2) the following comments are provided in response to this question.

It should be noted that a detailed investigation would be required to provide a thorough response and the following presents an opinion based predominantly on experience and with reference to preliminary data received to date.

The release of acid waters to freshwater systems (having approximate neutral pH conditions) will have direct impact on the ecosystem. In this circumstance the waters released had a high total acidity (refer to acidity results *eg* Wide Yard Dam – Attachment 3).

In terms of stock water, the polluted waters that exist in the 'on creek' farm dams (and note that polluted waters were observed upstream and downstream of these dams) would be unsuitable for stock on account of low pH alone (without the need to consider any soluble elements that one would anticipate would occur in a release of the type that has occurred).

The preliminary advice to destock areas of waterways thought to be impacted by the release is now supported by water quality data. Pending a change in conditions that bring about the necessary improvement in water quality then based on current information:

- i. destocking of areas along Inca creek (upstream of the Barkley Highway) to the upper reach of Saga Creek is recommended.
- ii. destocking of areas along Inca Creek (downstream of the Barkley Highway) to the confluence of Buckley River would appear prudent.

In terms of ecosystems, there have been predictable impacts already reported by the EPA (fish kills) and it is expected that other life forms, such as macro invertebrates and crustaceans, have been killed and will be unable to recolonise areas where the low pH polluted waters remain. Treatment of these waters will be required. Wherein the polluted waters evaporate, substances that can generate acidity when rewetted will remain. The magnitude of any subsequent impact cannot be evaluated at this time; however, the potential exists for further impact. For this specific issue, it is considered necessary to conduct in stream sampling along the length of Inca Creek from the Buckley River confluence to the upper reach of Saga Creek for the purpose of characterising water and sediment quality (note the requirement for further monitoring downstream of the Inca Creek and Buckley River confluence may be identified by the results of monitoring undertaken by the EPA on 11 March 2009 (results not available at time of reporting)). It may prove that treatment of water alone is required, alternatively the sediment may be contaminated and this level of contamination may be sufficient to impact directly on the in stream ecosystem; necessitating therefore, the removal of contaminated sediment from the creek.

- c. *If water can not be treated in situ –how long will impacts persist and how will this effect uses and ecosystem of waters in longer term.*

If water cannot be treated *in situ*, the duration of an impact and effect on uses and the aquatic ecosystem would be difficult to quantify without sufficient monitoring of the downstream environment and understanding of the hydrological characteristics of the system. Where a pollution incident occurred and was followed by effective flushing (and assuming no significant physical impacts to the creek substrate occurred) the impact is expected to be of short term duration. Wherein the pollutant persists the impact would not be short term and recovery is expected to be slow.

Given the nature of the contaminants released from Lady Annie Operations and our experience, it is expected that:

- i. an in stream ecosystem will re-establish in time with the diversity (and hence resilience) being less in areas where the greatest concentration of pollutants persisted. In the absence of treatment, the period of recovery is reliant on flushing (and hence weather dependent, unless an alternate clean water source is available) with flushing moving the pollutants downstream and reduction of impact achieved through natural attenuation, dispersion and dilution. Observations and sampling of the Dip Hole (understood to be on Flora Station) in the period during the immediate response undertaken by EPA support this line of argument (refer to Attachment 3); although it is possible that the polluted water has simply been displaced and is travelling further downstream. It should be noted that the 'natural attenuation approach' appears not to have functioned successfully thus far for areas on Inca Creek upstream of the Barkley Highway.

- ii. ecosystems downstream of the greatest concentration of untreated pollutants are expected to recolonise and to achieve diversity comparable to unimpacted areas (as noted above, where the polluted waters evaporate, substances that can generate acidity when rewetted will remain and impacts may occur in receiving waters). Our practice has been to conduct 3 (three) years of monitoring to establish conditions of a stream. Therefore, it is suggested that this period be used as a guide to predict when the system can be demonstrated to have recovered.

In addition to known areas of in stream pollution, NRA has advised the EPA to sample waters (and as required sediments) further downstream of the known polluted sites. This monitoring should extend downstream until no indication of pollution is detected (*ie* the extent of the impact is definitively defined).

d. Are there any options available to assist ecosystem recovery

Refer above, though in summary:

- i. Treatment of polluted waters (involving *ex situ* recovery of sludge).
- ii. Depending on the demonstrable need (*ie* determine levels of pollution in sediment) remove polluted sediment from creek.
- iii. Flushing of system (relying on natural rainfall or alternate source of clean water) noting however the limitations/constraints inherent in the 'natural attenuation approach' discussed above.

e. How should the recovery be monitored over longer term.

Recovery of the physical and biological environment downstream of the mine discharge should be monitored by periodic collection of water, sediment and aquatic macroinvertebrate samples from the downstream receiving environment and unimpacted reference streams, as well as an assessment of in-stream and riparian condition and health. Aquatic macroinvertebrates are considered appropriate as bioindicators to assess impacts on the downstream environment because they are permanent, relatively sessile inhabitants of streams and are responsive to impacts at the local scale. In our experience, the monitoring of fish has proven less worthwhile than has the use of macroinvertebrates. With respect to toxicological studies, our experience has shown that test work undertaken on fish kills has proven inconclusive. Analysis of macroinvertebrate data and water and sediment quality from a well designed monitoring program can identify the degree of impact to the biological community from the mine discharge, recovery of the aquatic ecosystem, as well as the success of mitigation measures and the need for further remediation works. It is appropriate to consider deriving locally specific water quality standards through toxicology studies using a range of organisms representative of local assemblages.

Please contact the undersigned to discuss any matters arising from this report.

Yours sincerely
NRA Environmental Consultants

s.49 - Signature

Tim Anderson
Principal Scientist and Director

Attachment 1 – AWA preliminary report on site visit (dated 4 March 2009)

Attachment 2 – Locality Map

Attachment 3 – Preliminary Laboratory Data

Attachment 4 – Clarification of reasoning for treatment options.

*Cc: Ingrid Fomiatti Minnesma, Manager - Far Northern Region Environmental Services, Department of
Environment and Resource Management*

Attachment 1

Released

EMAIL TRANSMISSION



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4 March 2009

To: Tim Anderson
NRA Environmental Consultants

email: tim@natres.com.au

Tim,

RE: LADY ANNIE – AWA SITE VISIT

A site visit was carried out at Lady Annie on the 2 March 2009 by Lis Boczek from Allan Watson Associates Pty Limited (AWA). The following provides a summary of site observations made and discussions held between Jason Alexander (Copper Co) and Ash Leavy and Hamish Butler (Environmental Protection Agency) during the site visit.

The purpose of the site visit was to observe the breach associated with Stormwater Pond 2 and provide an initial assessment on the following:

- Likelihood of dam failure (in terms of loss of containment) and actions that can be taken to mitigate the risks of worsening the breach
- Can the breach area be repaired?
- Cause of the breach
- Issues related to dewatering Stormwater Pond 2.

OBSERVATIONS

- Stormwater Ponds 1 and 2 are located downstream from the heap leach pads and associated process water ponds with the Lady Annie process area. Both stormwater ponds have been constructed by excavating below natural ground level and are lined with geomembrane. Each pond has a spillway which discharges off site to the west. Each pond is also connected by internal spillways. A balancing pipe also connects Stormwater Pond 1 and 2.
- Stormwater bunds for the purpose of diverting overland flow away from the ponds exist on the northern, southern and eastern sides. The bunds appear to be constructed from surface soils and are approximately 1.0m in height. It is understood that these bunds breached at several locations adjacent to both ponds as a result of severe rainfall during Jan/Feb 2009.
- At the same time, a breach developed on the southern side of Stormwater Pond 2 toward the eastern corner. A photograph of the breach is shown on **Plate 1**.

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Plate 1 – Breach



- At the time of the inspection, Copper Co had repaired damaged sections of the stormwater bunds to the north of Stormwater Pond 1 and had filled in the breach area. It is also understood that additional material was being placed to increase the height of the stormwater bund along the southern side of Stormwater Pond 2. The material used for repair was obtained from a spoil stockpile consisting of materials excavated from within the Stormwater Pond footprint during construction.
- In addition, soil material had been placed across each of the spillway to minimise the potential for overflow from the spillway.
- It was observed at the time of the inspection that water was present beneath the liner of the pond causing the liner to float.
- Currently an estimated 300mm depth of water is flowing over the spillway between the process ponds and the stormwater ponds.
- It is understood that Copper Co has temporarily blocked the balancing pipe between Stormwater Ponds 1 and 2.
- Water is currently being transferred onto (and is contained within) unused heap leaching cells to assist with lowering the water level in the ponds.
- It is understood from discussions with Copper Co that the following occurred in the location of the breach.
 - A hole initially appeared in the stormwater bund, which was subsequently filled with spoil material (apparently some 2 weeks prior to the breach). It is understood that no significant rainfall had occurred to this time
 - Following these repair works, the hole reappeared (the rainfall conditions at this time are unknown)

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- Stormwater flowing from the eastern area of the site upstream from the stormwater ponds accumulated behind the bund causing erosion and eventual collapse of the bund in the area where the hole existed. This stormwater continued to flow toward Stormwater Pond 2, disturbing the soils around the anchor trench, allowing water to flow beneath the liner with scouring of the liner subgrade resulting.

In addition to the visual assessment, three soil samples were taken for laboratory testing purposes. Two samples were taken in the location of the breach adjacent to the liner and one in the stormwater bund along the eastern side of the pond.

PRELIMINARY ASSESSMENT

Based on the site visit and associated discussions, the surface soils adjacent to Stormwater Pond 2 appear to be dispersive. The damage that has occurred to Stormwater Pond 2 is as a result of a breach to the stormwater bund. The cause of the breach can be assessed based on the results from the laboratory testing.

It is understood from Copper Co that a single pond cannot be dewatered independently, namely all ponds must be dewatered concurrently to maintain stability of internal embankments. A review of the design report and associated operational documentation would be required to enable an assessment of this scenario.

RECOMMENDED ACTIONS

It is recommended that for an immediate action, the level of water within Stormwater Pond 2 is kept such that there is sufficient freeboard to contain a provision for rainfall occurring during the remainder of the wet season including a 0.5m dry freeboard to the top of the damaged liner section.

Following the wet season, repair to Stormwater Pond 2 will be required including dewatering of the pond, repair to the subgrade and replacement of the liner. Upgrading of the surface water management features would also be required using suitable construction materials.

We trust this meets with your current requirements. Please let me know if you require further information at this stage on any of the items discussed.

Yours faithfully,
Allan Watson Associates Pty Limited

s.49 - Signature

LIS BOCZEK
Senior Engineer

Attachment 2

Released

Attachment 3

Released

Lady Annie Water Discharge 2009 Downstream Environment - Water Quality Summary 2 (Full Metal Suite, Select Sites)

Reference	Units	PQL	Method	62900B	62900B	62900B	62900B	62900B			
date sampled				25/02/09	25/02/09	25/02/09	25/02/09	25/02/09			
Sample				ConInca / Buck Ck DS	ConInca / Buck Ck US	Dip Hole	Saga Ck DS2	Inca Ck DS2			
Site Description				Buckley River, 15 metres downstream of confluence with Inca Creek	Inca Creek, immediately upstream of the confluence with Buckley River	Dip Hole on Inca Creek approximately 450 metres downstream of Barkly Highway crossing	Saga Creek, downstream of Lady Annie Operations	Inca Creek (Yelvertoft Station), upstream of Wide Yard Dam			
map reference (Version 090313 A3 RAP)				21	13	9	4	3			
Date Extracted				02/03/09	02/03/09	02/03/09	02/03/09	02/03/09			
Date Analysed				02/03/09	02/03/09	02/03/09	02/03/09	02/03/09			
Silver, Ag ^	mg/L	<0.001	AN318	<0.001	<0.001	<0.001	<0.001	<0.001			
Total Silver, Ag #^	mg/L	<0.001	ICP	<0.001	<0.001	<0.001	<0.001	<0.001	0.1		1
Aluminium, Al ^	mg/L	<0.001	AN318	0.053	0.32	3.2	88	47			
Total Aluminium, Al #^	mg/L	<0.05	AN318	1.2	0.56	3.9	90	47	0.2		
Arsenic, As ^	mg/L	<0.001	AN318	<0.001	<0.001	<0.001	0.001	<0.001			
Total Arsenic, As #^	mg/L	<0.001	AN318	<0.001	<0.001	<0.001	0.001	<0.001	0.007		0.07
Boron, B ^	mg/L	<0.001	AN318	0.038	0.023	0.022	0.019	0.027			
Total Boron, B #^	mg/L	<0.001	AN318	0.039	0.024	0.022	0.021	0.053	4		40
Barium, Ba ^	mg/L	<0.001	AN318	0.1	0.26	0.19	0.039	0.078			
Total Barium, Ba #^	mg/L	<0.001	AN318	0.13	0.28	0.21	0.042	0.082	0.7		7
Beryllium, Be ^	mg/L	<0.0001	AN318	0.0004	0.006	0.012	0.16	0.082			
Total Beryllium, Be #^	mg/L	<0.001	AN318	0.001	0.006	0.012	0.16	0.082			
Cadmium, Cd ^	mg/L	<0.0001	AN318	<0.0001	0.0004	0.0006	0.0063	0.0035			
Total Cadmium, Cd #^	mg/L	<0.0001	AN318	<0.0001	0.0003	0.0006	0.0065	0.0037	0.002		0.02
Cobalt, Co ^	mg/L	<0.001	AN318	0.036	0.25	0.44	4.6	3.2			
Total Cobalt, Co #^	mg/L	<0.001	AN318	0.052	0.29	0.48	5.1	3			
Chromium, Cr ^	mg/L	<0.001	AN318	<0.001	<0.001	<0.001	0.026	0.011			
Total Chromium, Cr #^	mg/L	<0.001	AN318	0.002	<0.001	<0.001	0.03	0.011	0.05		0.5
Copper, Cu ^	mg/L	<0.001	AN318	0.13	1.9	4	52	31			
Total Copper, Cu #^	mg/L	<0.001	AN318	0.44	2.3	4.5	56	31	2	1	20
Iron, Fe ^	mg/L	<0.005	AN318	0.3	0.03	0.04	6.8	2.7			
Total Iron, Fe #^	mg/L	<0.05	AN318	1.8	0.21	0.25	7.8	2.7	0.3		
Manganese, Mn ^	mg/L	<0.001	AN318	0.31	2.1	2.9	22	16			
Total Manganese, Mn #^	mg/L	<0.05	AN318	0.44	2.2	3.1	23	15	0.5	0.1	5
Molybdenum, Mo ^	mg/L	<0.001	AN318	<0.001	<0.001	<0.001	<0.001	<0.001			
Total Molybdenum, Mo #^	mg/L	<0.001	AN318	<0.001	<0.001	<0.001	<0.001	<0.001	0.05		0.5
Nickel, Ni ^	mg/L	<0.001	AN318	0.013	0.088	0.14	1.5	0.97			
Total Nickel, Ni #^	mg/L	<0.001	AN318	0.018	0.1	0.14	1.6	0.92	0.02		0.2
Lead, Pb ^	mg/L	<0.001	AN318	<0.001	<0.001	<0.001	0.004	0.007			
Total Lead, Pb #^	mg/L	<0.001	AN318	0.001	<0.001	<0.001	0.004	0.007	0.01		0.1
Antimony, Sb ^	mg/L	<0.001	AN318	<0.001	<0.001	<0.001	<0.001	<0.001			
Total Antimony, Sb #^	mg/L	<0.001	AN318	<0.001	0.002	<0.001	<0.001	<0.001	0.003		0.03
Selenium, Se ^	mg/L	<0.002	AN318	<0.002	<0.002	<0.002	0.002	<0.002			
Total Selenium, Se #^	mg/L	<0.002	AN318	<0.002	<0.002	<0.002	0.002	<0.002	0.01		0.1
Strontium, Sr ^	mg/L	<0.001	AN318	0.093	0.1	0.097	0.13	0.2			
Total Strontium, Sr #^	mg/L	<0.001	AN318	0.11	0.11	0.1	0.14	0.2			
Titanium, Ti ^	mg/L	<0.001	AN318	<0.001	0.001	0.001	0.009	0.002			
Total Titanium, Ti #^	mg/L	<0.005	AN318	0.007	<0.005	<0.005	0.008	0.005			
Thallium, Tl ^	mg/L	<0.001	AN318	<0.001	<0.001	<0.001	<0.001	<0.001			
Total Thallium, Tl #^	mg/L	<0.001	AN318	<0.001	<0.001	<0.001	<0.001	<0.001			
Vanadium, V ^	mg/L	<0.001	AN318	0.002	<0.001	<0.001	<0.001	<0.001			
Total Vanadium, V #^	mg/L	<0.001	AN318	0.005	<0.001	<0.001	0.001	<0.001			
Uranium, U ^	mg/L	<0.001	AN318	<0.001	0.001	0.009	0.23	0.1			
Total Uranium, U #^	mg/L	<0.001	AN318	<0.001	0.002	0.012	0.23	0.11	0.02		0.2
Zinc, Zn ^	mg/L	<0.001	AN318	0.014	0.047	0.071	0.55	0.33			
Total Zinc, Zn #^	mg/L	<0.005	AN318	0.02	0.053	0.07	0.58	0.34	3		
Sodium, Na ^	mg/L	<0.1	AN318	5.9	2.3	2.8	17	12	180		
Potassium, K ^	mg/L	<0.2	AN318	3.6	4.8	4.8	8.3	7.4			
Calcium, Ca ^	mg/L	<0.1	AN318	14	19	20	48	53			
Magnesium, Mg ^	mg/L	<0.1	AN318	6.4	15	20	200	120			
Lithium, Li ^	mg/L	<0.005	AN318	<0.005	<0.005	0.005	0.044	0.029			
Silicon, Si ^	mg/L	<0.03	AN318	12	8.1	7.6	13	13			
Tin, Sn ^	mg/L	<0.05	AN318	<0.05	<0.05	<0.05	<0.05	<0.05			
exceeds drinking water health-based guideline value (guideline relevant to total metals)											
exceeds drinking water aesthetic guideline value (guideline relevant to total metals)											
exceeds both drinking water and recreational guideline value (guideline relevant to total metals)											

Lady Annie Water Discharge 2009 Downstream Environment - Sediment Quality Summary

Reference	Units	PQL	Method	62900	62900	62900	62900	62946 - MKUS2 - reference site	62900	Saga Ck DS1	Saga Ck DS2	62900	Discharge 02	62900	Fish Kill 03	62900	Dip hole	Inca Creek Soil	ANZECC 2000	ISQG low	ISQG high
Sample				Inca Ck DS1	Inca Ck DS2	Yellow Pool	Reference Site			Saga Creek, downstream of Lady Annie Operations	Saga Creek, downstream of Lady Annie Operations		Saga Creek, Lady Annie stormwater pond discharge monitoring location (MKDS4)		Inca Creek, upstream of confluence with Buckley River		Dip Hole on Inca Creek downstream of Barkly Highway crossing	Inca Creek at track crossing, downstream of Wide Yard Dam			
Site Description				Inca Creek (Valvertott Station), between One Mile Dam and Bailey's	Inca Creek (Valvertott Station), upstream of Wide Yard Dam	Inca Creek, downstream of confluence with Saga Creek	Reference site unimpacted by Lady Annie Operations	Lady Annie Reference Site		Saga Creek, downstream of Lady Annie Operations	Saga Creek, downstream of Lady Annie Operations		Saga Creek, Lady Annie stormwater pond discharge monitoring location (MKDS4)		Inca Creek, upstream of confluence with Buckley River		Dip Hole on Inca Creek downstream of Barkly Highway crossing	Inca Creek at track crossing, downstream of Wide Yard Dam			
map reference																					
090313_A3_RAP)																					
Sample				6	9	11	13			16	18		20		26		41	9			
Date Sampled				25/02/09	25/02/09	25/02/09	25/02/09	02/03/09	25/02/09	25/02/09	25/02/09		25/02/09		25/02/09		23/02/09	23/02/09			
Date Extracted				03/03/09	03/03/09	03/03/09	03/03/09	04/03/09	03/03/09	03/03/09	03/03/09		03/03/09		03/03/09		03/03/09	03/03/09			
Date Analysed				05/03/09	05/03/09	05/03/09	05/03/09	06/03/09	05/03/09	05/03/09	05/03/09		05/03/09		05/03/09		05/03/09	05/03/09			
Antimony, Sb #	mg/kg	<5	AN304 CEI-201	<5	8	6	<5	<5	6	<5	<5		5		<5		<5	<5		2	25
Arsenic, As	mg/kg	<5	AN304 CEI-201	<5	28	26	15	24	22	7	7		15		<5		<5	5		20	70
Cadmium, Cd	mg/kg	<0.5	AN300 CEI-200	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5		<0.5		<0.5		<0.5	<0.5		1.5	10
Chromium, Cr	mg/kg	<5	AN300 CEI-200	33	160	56	62	33	84	37	37		120		64		46	48		80	370
Copper, Cu	mg/kg	<3	AN300 CEI-200	14	120	92	9	21	30	260	260		210		92		240	120		65	270
Lead, Pb	mg/kg	<3	AN300 CEI-200	14	31	20	17	14	30	15	15		82		8		14	14		50	220
Nickel, Ni	mg/kg	<3	AN300 CEI-200	18	18	20	4	7	19	18	18		21		6		14	12		21	52
Mercury, Hg	mg/kg	<0.05	AN312 CEI-202	<0.05	<0.05	<0.05	<0.05	0.06	<0.05	<0.05	<0.05		<0.05		<0.05		<0.05	<0.05		0.15	1
Silver, Ag	mg/kg	<0.5	AN300 CEI-200	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5		<0.5		<0.5		<0.5	<0.5		1	3.7
Zinc, Zn	mg/kg	<3	AN300 CEI-200	31	41	51	11		32	24	24		26		7		28	18		200	410
				exceeds ANZECC 2000 ISQG-Low																	
				exceeds ANZECC 2000 ISQG-High																	

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13 March 2009

Lady Annie Water Discharge 2009 Downstream Environment - Wide Yard Dam and One Mile Creek Dam
Sample pH adjusted to 7 using neutralising agent. Results are for analysis of Supernatant.

Sample Name Date Sampled	Untreated		Treated (pH 7)		ANZECC 2000
	One mile Dam (untreated) 06/03/09	Wide yard Dam (untreated) 06/03/09	One mile Dam pH7 06/03/09	Wide yard Dam pH7 06/03/09	
Site Description map reference (Version 090313_A3_RAP)	One Mile Creek (Velvortoft Station)	Wide Yard Dam on Inca Creek (Velvortoft Station)	One Mile Creek Dam on Inca Creek (Velvortoft Station)	Wide Yard Dam on Inca Creek (Velvortoft Station)	
Units	13	8	13	8	
Al	1.5		0.14	0.17	5
As	<0.01	<0.01	<0.01	<0.01	0.5
Be	0.005	0.054	<0.002	<0.002	
Co	0.24		0.07		1
Cu			0.07	0.36	1
Fe	0.26	2	<0.05	<0.05	
Mn	2	9.6	0.6	9.6	
Ni	0.08	0.63	0.03	0.5	1
Zn	<0.05	0.24	<0.05	<0.05	20
	exceeds ANZECC (2000) Livestock (cattle) guidelines (guideline relevant to total metals) (note stock values also exceed ecosystem values)				
	exceeds ANZECC 2000 trigger values - not yet hardness adjusted (guideline relevant to soluble metals, total concentrations are a guide only)				
	detection limit not sufficient for comparison against ecosystem guideline values				

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13 March 2009

Attachment 4

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File A Documents

Attachment 4

The following discussion presents further detail on the reasoning behind the selected treatment option, which:

1. is an active treatment option, as distinct from a passive treatment option,
2. involves the addition of neutralising agents to raise pH (and precipitate metals), as distinct from other treatment options that are available,
3. proposes the use of liming materials (possibly agricultural limestone),
4. proposes no pretreatment measures (preliminary laboratory work indicates there appears to be no 'latent' acidity, for example, associated with various oxidation states of Fe), and
5. necessitates *ex situ*, rather than *in situ*, sludge recovery (at least for the instream and 'on creek' permanent water features, though the same may apply for on site water structures albeit economic reasons rather than environmental reasons apply).

The information that has been presented details a defensible approach to address the pollution that exists. It includes the reasoning behind that treatment option.

As stated elsewhere in the report, experience of the type of pollution that has occurred, its probable impacts, and known available treatment methods has been relied upon. Where data exists, and there has been time allowed to interpret the information, it has been used.

It is not intended to present water treatment plant design specifications in this report. This would require more time, a decision on the specified water quality standards to be achieved, input of specialist water treatment expertise and most likely, bench scale trials for the purpose of optimising reagent specifications. As discussed in the response to Question 6 (b), a minimum of 2 (two) weeks would be required to undertake this task, and if time is of the essence, timely notification and engagement of service providers is required.

Characteristics of Polluted Waters

The polluted waters appear to include process waters from the mine site. The LAO operations recover copper through an SXEW process. The solvent extraction component of this process involves the use of significant volumes of a strong acid (sulfuric acid (H_2SO_4)). The extreme acidity of the process water stream coupled with elevated levels of copper would be expected to be the main cause of any downstream impacts. Other metals and/or reagents in the circuit would be important.

The relevance of the above discussion to this incident is that it provided direction to the water analysis program and to the treatment options as follows:

1. Determine acidity (titratable) for waters to be treated (a measure of H^+ concentration and mineral (latent) acidity) (*ie* total acidity that needs to be neutralised to achieve a nominated target pH of the water).

The currently available laboratory data (Attachment 3 to the report) indicates that there appears sufficient acidity and volume (the product of which gives total load) to conclude that the polluted water in Wide Yard Dam will require active treatment (the alternate being reliance on passive treatment). Although the acidity value is relatively low, in comparison to examples of acid mine drainage, it is considered that active management intervention is required.

There is not a complete data set for other polluted areas (either no acidity data or no volume estimate) and thus the same basis for concluding treatment intervention, as used applied for Wide Yard Dam, can not be argued. Rather, for One Mile Creek Dam it has been inferred based on available water quality data, volume estimates and field observations that active treatment is required.

With respect to instream contaminated waters, the principal logic for active treatment intervention is that the level of pollution in otherwise freshwater system was considered significant in places (low pH (eg 3), acidity value of 580 mg/L CaCO₃ and some elevated metals) and not likely to be attenuated naturally. Although the acidity value is relatively low, in comparison to examples of acid mine drainage, it is considered that active management intervention is required. Should these polluted waters be displaced further downstream it is currently not certain that processes of natural attenuation, dispersion and/or dilution will eliminate the risk to downstream receiving environments. Another consideration is the existence of permanent stock watering points on the creek system. Should the instream polluted waters not be treated, and those in the permanent water supplies are treated, the risk is that the untreated upstream waters (or associated sediments should they dry out) will re-pollute the treated permanent water supplies.

2. Determine the need for pretreatment measures to ensure complete oxidation of polluted waters.

The currently available laboratory data (SGS Jon Dicker pers comm. email dated 11 March 2009) indicated that for water samples collected for the purpose of determining acidity from Wide Yard Dam and One Mile Creek, that there was no change in pH following complete oxidation conditions (*ie* the addition of hydrogen peroxide and upon boiling). This result means that the treatment measures need not accommodate a pretreatment phase (pretreatment to achieve complete oxidation of polluted waters associated with acid mine water and/or acid sulfate soils drainage are common).

3. Determine if pH adjustment can achieve sufficient precipitation of metals of concern.

As the pH of these polluted waters is increased through the addition of neutralising agents (such as 'lime') dissolved metal ions precipitate out (the nature of the precipitate being influenced by the pH and dominate ions). Given the natural conditions of the receiving waters was inferred to be near neutral (pH 6.9 recorded at the reference site, refer to Attachment 3), the laboratory was requested to determine acidity on samples collected from Wide Yard Dam and One Mile Creek Dam to pH 7, and to analyse the resultant supernatant for relevant metals. The preliminary results from this work revealed that for all relevant metals, only Co (at 1.6 mg/L) exceeded the relevant stock water guideline (refer to ANZECC 2000, Table 4.3.2, cattle). Further analyses is being undertaken to determine if titrating to pH 8.3 achieves sufficient precipitation of Co.

In terms of the immediate issue of providing suitable water for stock consumption, this test work indicates that it may be possible to achieve the required adjustment to water pH and removal of metal ions from solution with the least expensive treatment technology (neutralisation using limestone) (noting the Co outlier).

4. Determine sulfate content of polluted waters.

It is probable that elevated sulfate levels will be recorded (based on the use of sulfuric acid in the process circuit). Apart from its direct relevance to water quality for stock water and the protection of slightly- moderately disturbed ecosystems, the amount of sulfate in the waters affects the selection of treatment measure in terms of efficacy of sulfate removal as well as implications to precipitate formation. It is our recent experience in the application of water treatment for treating waste waters associated with a base metals mining and processing project, achievement of sulfate removal necessitated RO technology. For although it was possible to remove soluble metals/metalloids to required standards using neutralising agents, sulfate remained a constraint. The use of a simple calcium based neutralant will not be successful in removing sulfate as the main product of neutralising H_2SO_4 is $CaSO_4$ which is partially soluble. RO technology is relatively expensive and demands great attention to understanding of the influent quality for the purpose of avoiding fouling of the RO plant components which are critical to its performance and expensive to replace.

No data regarding sulfate levels in the polluted waters are available at the time of reporting.

Treatment Methods

A summation of basic water treatment technologies is presented in *Leading Practice Sustainable Development Program for the Mining Industry*, published by the Commonwealth (DITR, 2007), as follows:

1. addition of neutralising agents to raise pH (and precipitate metals),
2. ion exchange resin used to remove metals,
3. membrane separation (reverse osmosis, electrodialysis) removes both major ion salts and metals. It is a secondary treatment step that would follow first stage neutralisation of acidity by pH adjustment, and
4. bioreactor systems for the removal of metals and sulfate.

DITR, 2007 reports that the most common and lowest cost form of treatment is chemical neutralisation using fixed plant or portable equipment for *in situ* treatment. A similar view was reported by Jones and Taylor (2008) presented at a recent relevant industry workshop and short course. The basis for these assertions (wherein 'lime' is the neutralising agent) include, proven technology, ease of availability and relative inexpense of raw materials and equipment (all non-propriety), and relative low health and safety issues.

As reported in response to Question 6 (b) in the report, the selection of an appropriate treatment technology is influenced significantly by the:

1. characteristics of the water to be treated,
2. water quality specifications to achieve for treated waters,
3. logistical (and associated infrastructure) constraints and opportunities.

Based on the known characteristics of the polluted waters as described above, the preliminary laboratory work undertaken (wherein it appears likely that simple 'lime' addition may achieve required stock water standards as a minimum) and given recent published information stating neutralisation is the least expensive and easiest of the active measures available, then this treatment by neutralisation appears the most suitable.

Given that:

- i. neutralisation results in the formation of metal rich precipitates,
- ii. the metals are available for remobilisation should suitable conditions occur,
- iii. it is particularly difficult to remove the material from water bodies, and
- iv. the sludge material of this type is routinely treated as hazardous materials,

it has been recommended to undertake *ex situ* treatment (meaning the sludge is recovered external to the water body) (refer to Figure 1).

The alternate option, which was discounted, was to undertake *in situ* treatment, wherein the metal precipitates accumulate on the base of the water body and either are allowed to remain or are removed at a later point. The option of allowing the sludge to remain at the base of the water body has been discounted on account it will be a hazardous waste. Removing sludge from a water body may be achieved following drying of the water body; however, as these water bodies are permanent, drying out appears not to be an option (without pumping out and providing an alternate water supply for stock). In terms of pumping out the sludge, in our experience this approach has proven very expensive, further the reliability of such an approach is uncertain.

With respect to the treatment of polluted waters that are in stream, though not associated with permanent features, the *ex-situ* neutralisation option is the preferred method on account that the method avoids adding more chemicals directly to the creek system. Further the sludge, which would have to be recovered (unless demonstrated that it causes no harm, which is extremely unlikely on account of the chemicals involved and the inevitable smothering that would occur should sludge be permitted to form in stream) is kept out of the stream.

For onsite water structures, the creek bed issues posed by sludge are not relevant. However, the difficulty and expense of handling and recovery of sludge is directly relevant. It should be noted that even wherein treatment ponds are permitted to dry out, any reasonable remaining depth of sludge will retain a high moisture content, making removal problematic. An *ex situ* method of treatment removes the limitations associated with sludge handling and recovery.

Neutralising Agent

NTMC (2004) and the more recent DITR (2007) describe the key steps in selecting candidate neutralising agent in regard to acid mine drainage treatment. As stated previously, the LAO release events is not a case of acid mine drainage, rather it relates to a release of process waters. The steps for selection a neutralising reagent are applicable:

- pH needed to meet water quality targets
- the rate and extent of pH increase;
- the dosage rate;

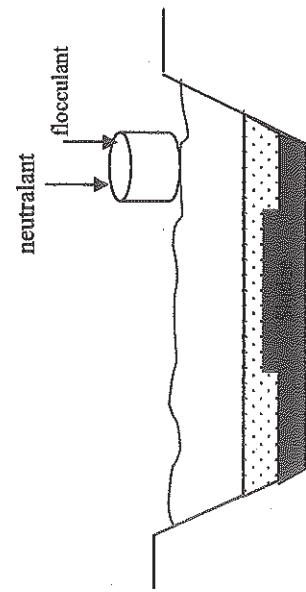
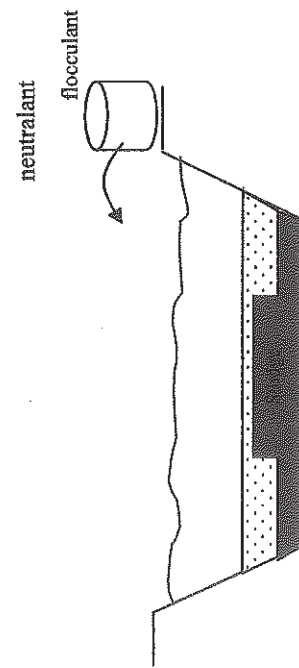
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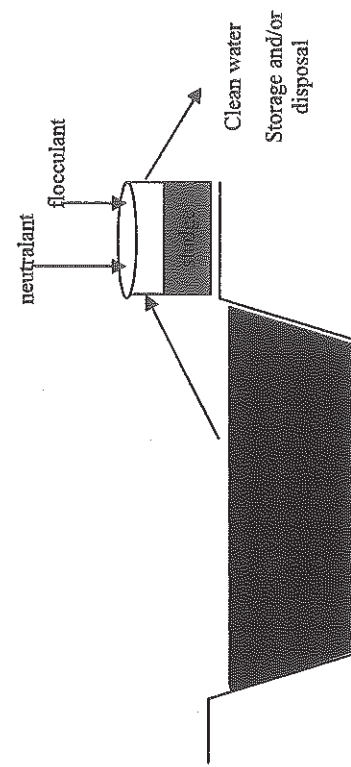
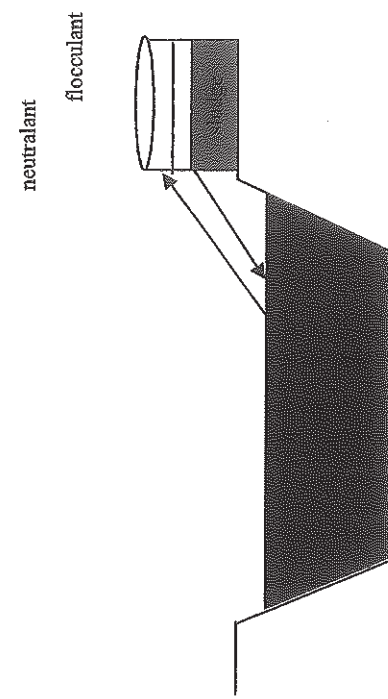
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In situ



Ex Situ



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- the extent of preparation such as grinding and the delivery system needed;
- occupational health and safety issues
- the ease of settling and the volume of sludge produced; and
- cost (the cost of supply, the cost of operational use including consideration of logistics associated with access and provision of essential infrastructure such as, for example power, treated water storage, sludge capture and removal).

Further these publications report that the most commonly used neutralising agents for large scale treatment of acid mine water drainage are 'lime' (quicklime, hydrated lime), magnesite, magnesium oxide, and limestone. The reason for this is the ready commercial availability of these reagents, the well proven technologies for their use, and their cost effectiveness for large scale application.

Limestone (CaCO_3) is the least expensive of the commonly used neutralising agents (Taylor, 2008). A problem associated with some neutralants, such as quicklime (CaO), hydrated lime ($\text{Ca}(\text{OH})_2$) and caustic soda (NaOH), that can not occur with limestone, is the inadvertent creation of alkaline conditions through over dosing. In practice limestone can achieve a pH of around 7 (NTMC, 2004 and Taylor 2008).

Based on the initial review of the preliminary water quality data (*ie* consideration of polluted water pH and metals content prior to and following addition of alkali as part of acidity analyses), and in terms of stock water quality targets, it appears that limestone may be the optimum neutralant. As previously advised, the input of specialist water treatment expertise and most likely, bench scale trials for the purpose of optimising reagent specifications, is required.

In terms of achieving water quality standards consistent with protection of slightly-moderately disturbed ecosystems, our experience is that a RO treatment process is required, and this was on account of the process required to remove sulfate to the required levels. DITR (2007) also suggest that RO may be the appropriate treatment method for removing major ion salts remaining after the 'lime' treatment (in a case study – Mt Morgan).

System Requirements

The water treatment system should include the following:

- a means of delivering the neutralising agent (inclusive of any necessary physical pre treatment)
- a means of mixing the agent with the polluted water. The rate of 'lime' addition should reflect acidity of the polluted waters together with an adjustment for field performance, partly a function of the neutralising capability and finesses of the agent used. The acidity differs from site to site and periodic adjustment of the liming rate will be required. Liming rates will need also to be adjusted based on monitoring of the performance of the treatment system.

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NRA Environmental Consultants

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Page 6 of 7

- Preliminary laboratory results for samples of water from One Mile Creek Dam and Wide Yard Dam indicated no change in pH following addition of hydrogen peroxide and boiling; thus the requirement to include a means of ensuring oxidation to release acidity associated with Fe and Mn oxidation, is not required.
- a means of removing the precipitates
- a means of treating or removing the sludge produced in the process.

In terms of practicability, it would appear that the onsite and 'on creek' farm dams present the least constraints in terms of access. The instream system will, in general, present access constraints.

The option of *in situ* treatment of instream areas has been discounted because of the precipitates (and the need to remove these from the system, which will necessitate more work and disturbance). The instream system may be best managed through removal of the polluted water (pump out polluted waters) for treatment at site and/or in association with the 'on creek' dams.

Power supply would appear not to be a constraint for the onsite situation, though is a constraint for the 'on creek' and instream areas. This constraint may be addressed through portable generators (solar powered unit are available).

A constraint with all sites to overcome will be storage of treated water. It is possible that a recirculation treatment system is established, with *ex situ* sludge recovery, however, such a system would appear more complex (eg in regard to monitoring influent and adjusting reagent mix) than a system wherein treated water is stored or released. For the 'on creek' dams, there are no observed existing storages adjacent to the 'on creek' dams, although off creek dams are known to exist in the vicinity (implying a possible option of pumping water to these, subject to available storage).

References

ANZECC, 2000. *Australian Water Quality Guidelines for Fresh and Marine Waters*. Australian and New Zealand Environment Conservation Council.

DITR, 2007. *Leading Practice Sustainable Development Program for the Mining Industry*, Australian Government, Department of Industry Tourism and Resources.

Jones and Taylor, 2008. *From Concept to Best Practice – Innovations in AMD Prevention and Management*. In Proceedings of the Sixth Australian Workshop on Acid and Metalliferous Drainage.

NTMC (2004). Northern Territory Minerals Council (Inc.) and the Mines and Petroleum Management Division of the Northern Territory Government, 2004, TEAM NT: Technologies for Environmental Advancement of Mining in the Northern Territory: Toolkit.

Taylor, 2008. AMD Treatment Options. *In* An Introduction to Acid and Metalliferous Draining in Mining (ACMER Short Course, April 2008).

Checklist

Compliance

Compliance program — inspection checklist

Instructions for use

Where an Agency issue is determined to be relevant, note appropriate detail in the observations section.

Where there is any non-compliance, discuss with the company representative and any required action.

Where the assessment will include licence conditions, use the licence condition compliance section of the checklist.

This checklist is to be used for all inspections. Refer to the [procedural guide](#) for guidance.

Cover sheet module

Company name: Lady Annie Operations/Savannah Limited		Date of Inspection: 13 January 2009	
Trading as: Lady Annie		EA no.: MIN100401006	
Description of Business Activity: Level 1 Heap Leach EW and SW Plant		Project Ref: 172369	
Site street address: Level 22, Allendale Square, 77 St George Terrace.			
Suburb: Perth	City/Town: Perth	Post Code: 6000	
Registered Office address (if different to site address): As Above			
Suburb:	City/Town:	Post Code:	
Site representative:	Position:	Contact phone:	

Inspection type	☐ Catchment	☐ Industry Sector	☐ Complaint	☒ Routine
Compliance level	☐ 1	☒ 2	☐ 3	Inspection type ☐ A ☒ B ☐ C
Audit focus is the following relevant Agency interests:				
☒ Water issues ¹	☐ Air issues ¹	☐ Noise issues ¹	☐ National and international	
☐ Land issues ¹	☐ Waste issues ¹	☐ Social issues	☐ Impacts on surrounds	
☐ Coastal issues	☐ Heritage issues	☐ Biodiversity		
☐ Resource allocation	☐ Tenure issues	☐ Other issues		
Details of scope or particular focus (if applicable):				
Routine site inspection of Land Annie operations to assess compliance against the Environmental Authority MIN100401006 and General Environmental Duty.				

¹ Main issues to consider for *Environmental Protection Act 1994* focus.



Agency interests module

SECTION: 1

Agency Interest: Water

Non-compliant



Released

SECTION: 1	Agency Interest: <u>Water</u>	Non-compliant ☐
Background:		
<p>1) The mine manager for Lady Annie Operations/Savannah Limited notified the EPA on 5/1/2009 that sink holes were developing in the Southern Wall of Storm Pond 2. The notification was accompanied with photos showing various stages of development of the sink hole(s). The photos also showed that the pond contained very little water, the water covering less than half of the floor of the dam. Russ McConnell (Dams Safety Manager) was of the opinion that the pond would have to be substantially full before there was a significant risk to the environment.</p> <p>2) The EPA arranged for an inspection of the site on the 13/1/2009 by a Dam Safety Manager.</p>		
Observations:		
<p>1) Michael Popov and Russ McConnell (Dam Safety Manager) inspected Lady Annie mine site to ensure compliance against the water schedule component of Environmental Authority MIN100401006 (EA) and to investigate the situation and identify the extent of any potential problems associated with stormwater dam 2.</p> <p>2) During the inspection, EPA officers observed that stormwater pond 1 was approximately 4 to 5 metres below the spillway (Figure 1). Gravels had been used for the access of machinery within the pond.</p> <p>3) Stormwater Pond 2 is a rectangular earth tank excavated below ground level. The pond is totally lined with a welded HDPE liner which is anchored around the perimeter of the tank in a backfilled trench on the crest of the batters. The EPA officers observed that Storm Pond 2 was not full and that water covered approximately half the floor of the pond (Figure 6).</p> <p>4) Stormwater pond 2 berm was observed to have a large sinkhole (Figure 2 & 3) which is approaching the pond bank liner. No surface water was entering the sinkhole at the time and no free water could be observed in the sinkhole. The bottom of the sinkhole was not observable as the walls of the sinkhole had collapsed in soil blocks and covered the bottom. Tension cracks were observable in the soil beside the sinkhole, indicating that more collapses could occur. From earlier photos the depth is estimated to be over 6 meters.</p> <p>5) Shallow erosion gullies to the East (right) and West (left) of the sink hole (Figure 3) indicate that runoff from the pond berm to the left and catchments to the right had been entering the sinkhole. The sinkhole extends as a pipe towards the pond liner suggesting that a source of water could be coming from beneath the pond liner.</p> <p>6) The catchment to the right of the sinkhole produced clean waters from around heap leach pads and the bulk fill stockpile. A bund had already been installed to divert waters from the sinkhole (Figure 4). Diverted waters were sampled by the EPA for metals at a site 150 metres downstream. In-situ measurements were taken and indicated that the pH was 5.73, temperature of 25.6 degrees, conductivity of 78.8 milli-siemens per centimetre and dissolved oxygen reading of 40.8 percent (Figure 5).</p> <p>7) Russ McConnell advised Jodie Kimber (Senior Process Manager) and Paul Martinkus (General Manager) that a safety barrier should be erected around the sinkhole.</p> <p>8) The final sinkhole consisted of a 4 apex star of 12 m external diameter and 6m internal diameter with one apex extending in pipe below the pond liner.</p> <p>9) The area to the South (200 m) of the Southern bank of Storm Pond 2 was examined. It contained numerous small sinkholes, clusters of small sink holes and apparent "melon holes". The original ground surface has been armoured by lateritic gravel. When ground collapse occurs, this gravel falls into the cavity created. If the cavity fills with sediment the armouring does not re-occur and the fill areas remain as depressions. These are the "melon holes". They are often associated with cavernous limestone formations, collapsible soils and very porous soils (Figure 14, 15 & 16).</p> <p>10) Two sterilization bore holes (drilled to plan for the optimum siting of mining and processing infrastructure), complete with degraded polyethylene chip sample bags, were found in the area. They contained large quantities of "white" chips. Some of the exposed white chips had cemented together (Figure 17). The cemented chips effervesced when dropped into sulphuric acid. This is the crude test for limestone and other carbonate based minerals.</p>		

SECTION: 1

Agency Interest: Water

Non-compliant



- 11) On the basis of the observations, the reported occurrence of the Thortonian dolomitic limestone formations in the area and the known occurrence of solution cavities in limestone, there is a high probability that the area investigated consists of soil formations overlying limestone formations. Cavernous limestone formations are usually referred to as karst formations and are problematic situations to be avoided when siting dams or containments. However such formations form strong aquifers of good (carbonate rich) quality groundwater (a resource, an environmental value).
- 12) Stormwater Pond 2 was also examined by Russ McConnell and concluded that the liner may be leaking causing waters to leak to ground water (Figure 6). 100ML of waters were in the pond however the surface water could not be sampled or analysed due to the inaccessibility or suitable equipment to gather results (Figure 7).
- 13) Russ McConnell also concluded that there is water underneath the liner, evident by the liner floating, which could potentially affect the integrity of the liner (Figure 8). EPA observed that waters from underneath pond 2 were being pumped back into stormwater pond 2 by a mobile pump (Figure 9). Russ also stated that the soils underneath pond 2 may be dispersive by the discolouration of waters being pumped into the pond 2 from the leak detection system (Figure 10). Russ stated to Jodie and Paul that the water from pond 2 should be pumped to pond 1 in order to inspect the liner and underlying soils (Company stated this was their intended course of action and would be followed).
- 14) Waters flowing from the pooled waters adjacent to the heap leach pad were also sampled at two locations (adjacent to HLP and adjacent to raw water pond). Waters were observed to be flowing from adjacent to the heap leach pads, under the conveyor belt, towards the storage areas, besides the raw water pond and then finally off-site. In-situ measurements indicate that the waters had a pH of 4.52, temperature of 28.3 degrees, conductivity of 27.5 micro-siemen per centimetre and a dissolved oxygen reading of 59.8 percent.
- 15) Water samples were taken within the raw water pond for metals.

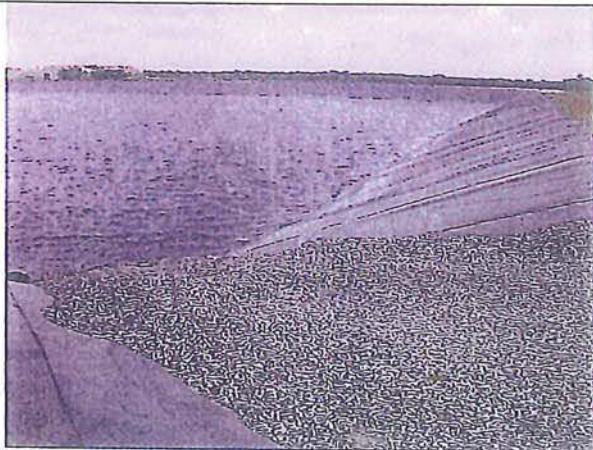


Figure 1- Stormwater pond 1.



Figure 2- Sink hole adjacent to stormwater pond 2.

SECTION: **1**

Agency Interest: **Water**

Non-compliant



Figure 3- Sink hole adjacent to stormwater pond 2.



Figure 4- Sink hole diversion bund.



Figure 5- TPS sampling location (150 metres downstream of storm pond 2).



Figure 6- Possible leaks in stormwater pond 2.



Figure 7- Stormwater pond 2.

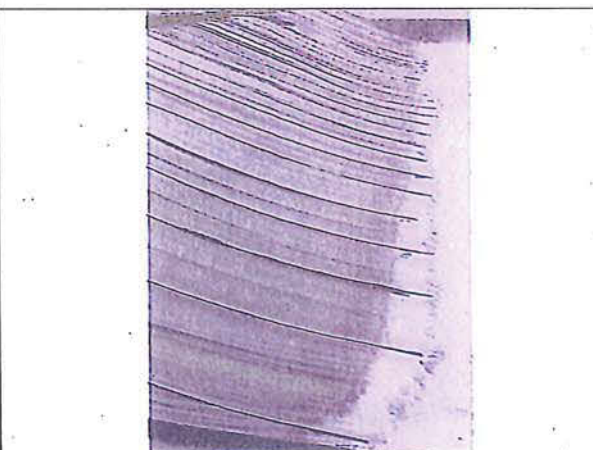


Figure 8- Liner floating on water underneath.

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SECTION: 1

Agency Interest: Water

Non-compliant



Figure 9- Mobile pump and leak detection bore



Figure 10- Pipe discharging waters from underneath pond 2 liner.



Figure 11- Pooled water adjacent to HLP.



Figure 12 - HLP pooled water channel



Figure 12- HLP pooled water channel



Figure 13- HLP pooled water channel

Released

SECTION: 1

Agency Interest: Water

Non-compliant



Figure 14- Lateritic gravel with evidence of sinkholes



Figure 15- Sinkhole developing with lateritic gravels



Figure 16- Sinkholes forming on recently disturbed road for sterilization drilling



Figure 17- Sterilization drill hole with limestone drill chips

Required Actions:

- Barrier erected to minimise entry by employees.
- Geotechnical engineer to inspect sinkholes for proposed actions.
- Send results of samples taken by company to EPA.
-

Released

Condition number	Details of non-compliance																																																																																															
(C4-3)	<p>Subject to Condition (C4-1), groundwater contaminant limits must not exceed the contaminant limits defined in Schedule C –Table 15.</p> <p>Schedule C – Table 15 (Groundwater Contaminant Limits)</p> <table border="1"> <thead> <tr> <th>Parameter</th><th>Units</th><th>Minimum</th><th>Maximum</th><th>Limit Type</th></tr> </thead> <tbody> <tr> <td>pH¹</td><td>pH</td><td>6</td><td>9</td><td>Range</td></tr> <tr> <td>TDS¹</td><td>mg/L</td><td>N/A</td><td>4000</td><td>Maximum</td></tr> <tr> <td>Sulphate¹</td><td>mg/L</td><td>N/A</td><td>1000</td><td>Maximum</td></tr> <tr> <td>Aluminum¹</td><td>mg/L</td><td>N/A</td><td>5</td><td>Maximum</td></tr> <tr> <td>Arsenic¹</td><td>mg/L</td><td>N/A</td><td>0.5</td><td>Maximum</td></tr> <tr> <td>Boron¹</td><td>mg/L</td><td>N/A</td><td>5</td><td>Maximum</td></tr> <tr> <td>Cadmium¹</td><td>mg/L</td><td>N/A</td><td>0.01</td><td>Maximum</td></tr> <tr> <td>Chromium¹</td><td>mg/L</td><td>N/A</td><td>1</td><td>Maximum</td></tr> <tr> <td>Cobalt¹</td><td>mg/L</td><td>N/A</td><td>1</td><td>Maximum</td></tr> <tr> <td>Copper¹</td><td>mg/L</td><td>N/A</td><td>1</td><td>Maximum</td></tr> <tr> <td>Fluoride¹</td><td>mg/L</td><td>N/A</td><td>2</td><td>Maximum</td></tr> <tr> <td>Lead¹</td><td>mg/L</td><td>N/A</td><td>0.1</td><td>Maximum</td></tr> <tr> <td>Manganese²</td><td>mg/L</td><td>N/A</td><td>2.5</td><td>Maximum</td></tr> <tr> <td>Mercury¹</td><td>mg/L</td><td>N/A</td><td>0.002</td><td>Maximum</td></tr> <tr> <td>Molybdenum¹</td><td>mg/L</td><td>N/A</td><td>0.15</td><td>Maximum</td></tr> <tr> <td>Nickel¹</td><td>mg/L</td><td>N/A</td><td>1</td><td>Maximum</td></tr> <tr> <td>Selenium¹</td><td>mg/L</td><td>N/A</td><td>0.02</td><td>Maximum</td></tr> <tr> <td>Zinc¹</td><td>mg/L</td><td>N/A</td><td>20</td><td>Maximum</td></tr> </tbody> </table> <p>¹ Contaminant limits based on ANZECC (2000) Livestock drinking water quality and are analysed as Total Metals (unfiltered)</p> <p>² Contaminant limits based on Table 3.4.1 of Aquatic Ecosystems ANZECC (2000) and are analysed as Filtered Metals.</p> <p>The water from underneath the stormwater pond 2, obtained from PSMB10 may potentially be in non-compliance of these limits once the sample has been assayed.</p>	Parameter	Units	Minimum	Maximum	Limit Type	pH ¹	pH	6	9	Range	TDS ¹	mg/L	N/A	4000	Maximum	Sulphate ¹	mg/L	N/A	1000	Maximum	Aluminum ¹	mg/L	N/A	5	Maximum	Arsenic ¹	mg/L	N/A	0.5	Maximum	Boron ¹	mg/L	N/A	5	Maximum	Cadmium ¹	mg/L	N/A	0.01	Maximum	Chromium ¹	mg/L	N/A	1	Maximum	Cobalt ¹	mg/L	N/A	1	Maximum	Copper ¹	mg/L	N/A	1	Maximum	Fluoride ¹	mg/L	N/A	2	Maximum	Lead ¹	mg/L	N/A	0.1	Maximum	Manganese ²	mg/L	N/A	2.5	Maximum	Mercury ¹	mg/L	N/A	0.002	Maximum	Molybdenum ¹	mg/L	N/A	0.15	Maximum	Nickel ¹	mg/L	N/A	1	Maximum	Selenium ¹	mg/L	N/A	0.02	Maximum	Zinc ¹	mg/L	N/A	20	Maximum
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Recommendation (consider what is being emitted, the activity's impact and the adequacy of the EA)																																																																																																

Signoff sheet

Additional comments
Recommendation
That a letter be sent to Lady Annie operations detailing the non compliance and areas of concern identified at the site during the time of the inspection. Issue EE to identify the source, cause and extent of environmental harm being caused by the sinkholes adjacent to the stormwater dam 2 if the grounds can be identified.
Adoption of report (sign below and initial every page)
This report accurately represents the issues and outcomes of this site inspection.

Inspecting officer

Michael Popov

Signed

Date

Inspecting officer

Russ McConnell

Signed

Date

Comments and recommendation

Supervisor

Elaine Glen

Signed

Date

Signoff sheet

Additional comments

Recommendation

That a letter be sent to Lady Annie operations detailing the non compliance and areas of concern identified at the site during the time of the inspection.

Adoption of report (sign below and initial every page)

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Inspecting officer

Michael Popov

Signed

Date

Inspecting officer

s.49 - Signature

Russ McConnell

Signed

Date

16/1/2009

Comments and recommendation

Supervisor

Elaine Glen

Signed

Date



WJK22

RJM-02

Checklist

Compliance

Compliance program — inspection checklist

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Cover sheet module

Company name: Lady Annie Operations/Savannah Limited		Date of Inspection: 13 January 2009	
Trading as: Lady Annie		EA no.: MIN100401006	
Description of Business Activity: Level 1 Heap Leach EW and SW Plant		Project Ref: 172369	
Site street address: Level 22, Allendale Square, 77 St George Terrace.			
Suburb: Perth	City/Town: Perth	Post Code: 6000	
Registered Office address (if different to site address): As Above			
Suburb:	City/Town:	Post Code:	
Site representative:	Position:	Contact phone:	

Inspection type	☐ Catchment	☐ Industry Sector	☐ Complaint	☒ Routine
Compliance level	☐ 1	☒ 2	☐ 3	Inspection type ☐ A ☒ B ☐ C
Audit focus is the following relevant Agency interests:				
☒ Water issues ¹	☐ Air issues ¹	☐ Noise issues ¹	☐ National and International	
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☐ Coastal Issues	☐ Heritage issues	☐ Biodiversity		
☐ Resource allocation	☐ Tenure issues	☐ Other issues		
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Routine site inspection of Land Annie operations to assess compliance against the Environmental Authority MIN100401006 and General Environmental Duty.				

¹ Main issues to consider for *Environmental Protection Act 1994* focus.

Agency interests module

SECTION: 1

Agency Interest: Water

Non-compliant



SECTION: 1	Agency Interest: Water	Non-compliant ☐
Background: 1) The mine manager for Lady Annie Operations/Savannah Limited notified the EPA on 5/1/2009 that sink holes were developing in the Southern Wall of Storm Pond 2. The notification was accompanied with photos showing various stages of development of the sink hole(s). The photos also showed that the pond contained very little water, the water covering less than half of the floor of the dam. Russ McConnell (Dams Safety Manager) was of the opinion that the pond would have to be substantially full before there was a significant risk to the environment. 2) The EPA arranged for an inspection of the site on the 13/1/2009 by a Dam Safety Manager.		
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SECTION: 1

Agency Interest: Water

Non-compliant



- 11) On the basis of the observations, the reported occurrence of the Thortonian dolomitic limestone formations in the area and the known occurrence of solution cavities in limestone, there is a high probability that the area investigated consists of soil formations overlying limestone formations. Cavernous limestone formations are usually referred to as karst formations and are problematic situations to be avoided when siting dams or containments. However such formations form strong aquifers of good (carbonate rich) quality groundwater (a resource, an environmental value).
- 12) Stormwater Pond 2 was also examined by Russ McConnell and concluded that the liner may be leaking causing waters to leak to ground water (Figure 6). 100ML of waters were in the pond however the surface water could not be sampled or analysed due to the inaccessibility or suitable equipment to gather results (Figure 7).
- 13) Russ McConnell also concluded that there is water underneath the liner, evident by the liner floating, which could potentially affect the integrity of the liner (Figure 8). EPA observed that waters from underneath pond 2 were being pumped back into stormwater pond 2 by a mobile pump (Figure 9). Russ also stated that the soils underneath pond 2 may be dispersive by the discolouration of waters being pumped into the pond 2 from the leak detection system (Figure 10). Russ stated to Jodie and Paul that the water from pond 2 should be pumped to pond 1 in order to inspect the liner and underlying soils (Company stated this was their intended course of action and would be followed).
- 14) Waters flowing from the pooled waters adjacent to the heap leach pad were also sampled at two locations (adjacent to HLP and adjacent to raw water pond). Waters were observed to be flowing from adjacent to the heap leach pads, under the conveyor belt, towards the storage areas, besides the raw water pond and then finally off-site. In-situ measurements indicate that the waters had a pH of 4.52, temperature of 28.3 degrees, conductivity of 27.5 micro-siemens per centimetre and a dissolved oxygen reading of 59.8 percent.
- 15) Water samples were taken within the raw water pond for metals.

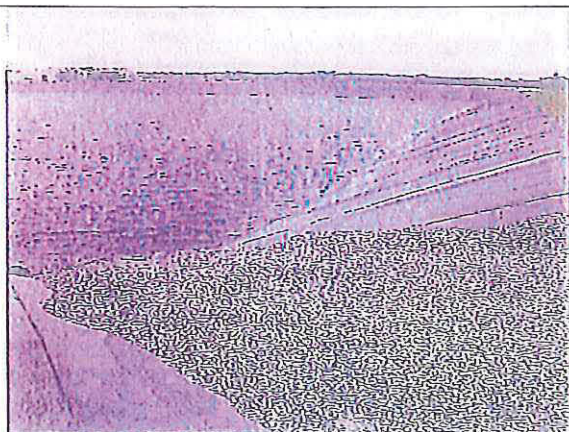


Figure 1- Stormwater pond 1.

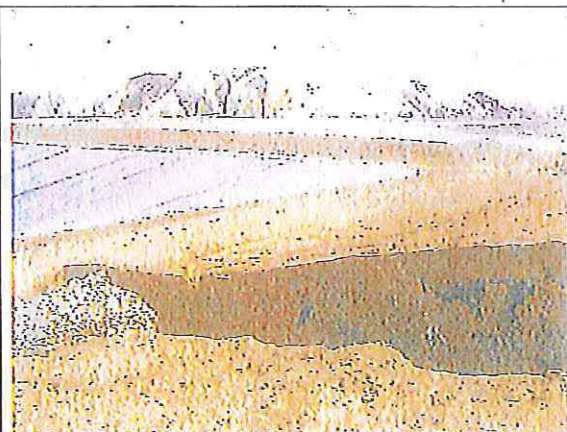
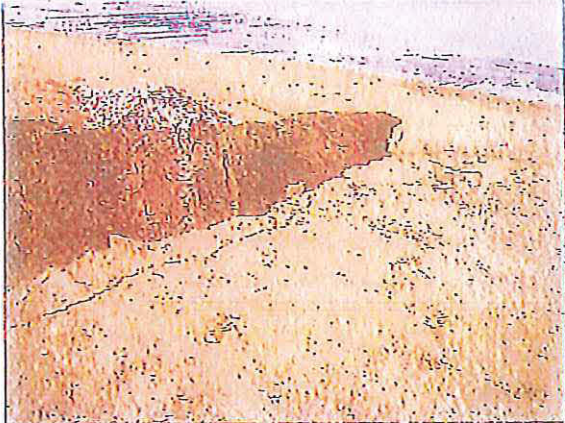
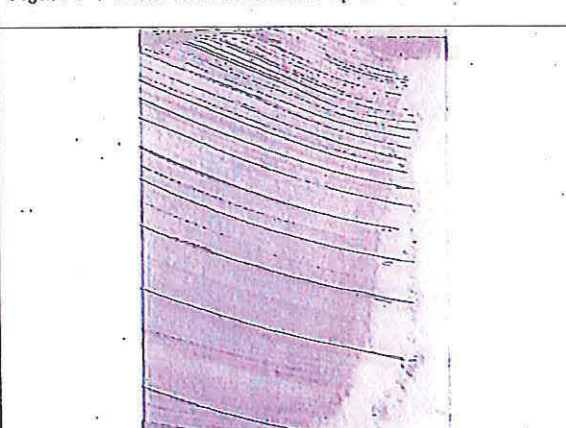


Figure 2- Sink hole adjacent to stormwater pond 2.

SECTION: 1		Agency Interest: <u>Water</u>	Non-compliant ☐
			
Figure 3- Sink hole adjacent to stormwater pond 2.		Figure 4- Sink hole diversion bund.	
			
Figure 5- TPS sampling location (150 metres downstream of storm pond 2).		Figure 6- Possible leaks in stormwater pond 2.	
			
Figure 7- Stormwater pond 2.		Figure 8- Liner floating on water underneath.	

SECTION: 1

Agency Interest: Water

Non-compliant



Figure 9- Mobile pump and leak detection bore

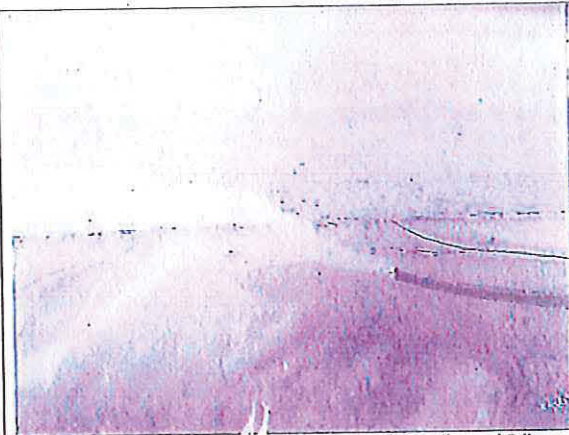


Figure 10- Pipe discharging waters from underneath pond 2 liner.

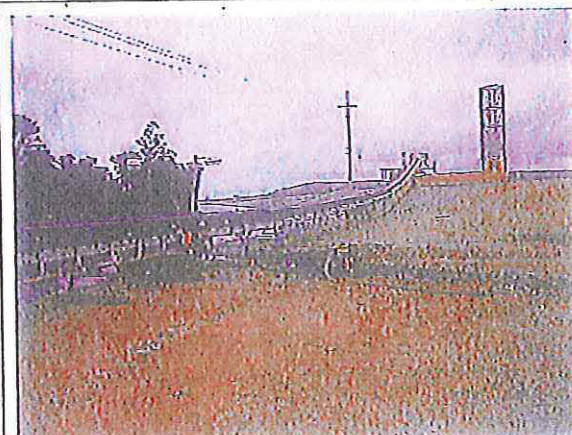


Figure 11- Pooled water adjacent to HLP.



Figure 12 - HLP pooled water channel

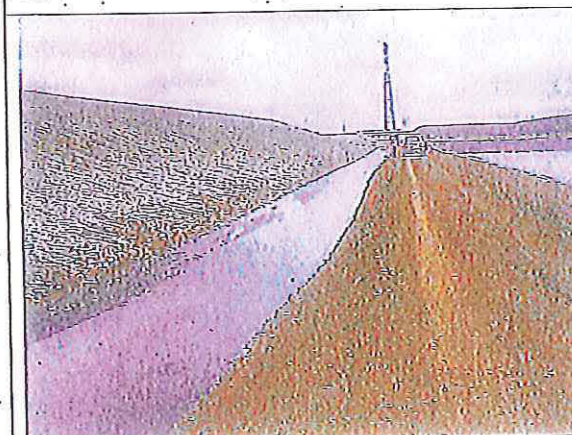


Figure 12- HLP pooled water channel

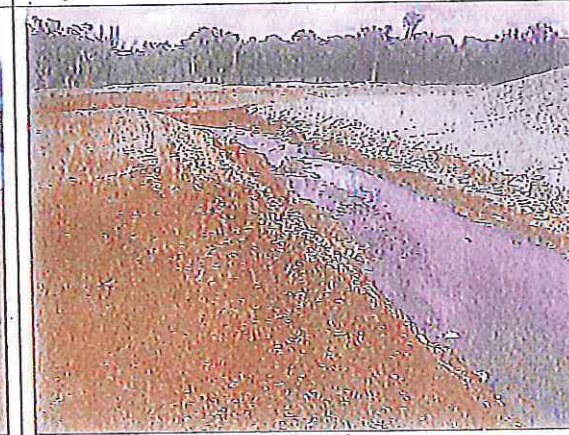
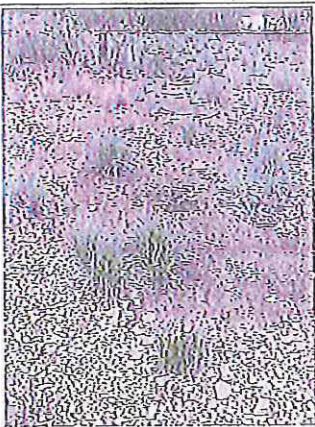


Figure 13- HLP pooled water channel

SECTION: 1		Agency Interest: <u>Water</u>	Non-compliant ☐
			
Figure 14- Lateritic gravel with evidence of sinkholes	Figure 15- Sinkhole developing with lateritic gravels		
			
Figure 16- Sinkholes forming on recently disturbed road for sterilization drilling	Figure 17- Sterilization drill hole with limestone drill chips		
Required Actions:			
<ul style="list-style-type: none"> Barrier erected to minimise entry by employees. Geotechnical engineer to inspect sinkholes for proposed actions. Send results of samples taken by company to EPA. 			

Licence conditions module

Condition number	Details of non-compliance																																																																																														
(C4-3)	Subject to Condition (C4-1), groundwater contaminant limits must not exceed the contaminant limits defined in Schedule C --Table 15. Schedule C – Table 15 (Groundwater Contaminant Limits)																																																																																														
	Parameter	Units	Minimum	Maximum	Limit Type	pH ¹	pH	6	9	Range	TDS ¹	mg/L	N/A	4000	Maximum	Sulphate ¹	mg/L	N/A	1000	Maximum	Aluminium ¹	mg/L	N/A	5	Maximum	Arsenic ¹	mg/L	N/A	0.5	Maximum	Boron ¹	mg/L	N/A	5	Maximum	Cadmium ¹	mg/L	N/A	0.01	Maximum	Chromium ¹	mg/L	N/A	1	Maximum	Cobalt ¹	mg/L	N/A	1	Maximum	Copper ¹	mg/L	N/A	1	Maximum	Fluoride ¹	mg/L	N/A	2	Maximum	Lead ¹	mg/L	N/A	0.1	Maximum	Manganese ²	mg/L	N/A	2.5	Maximum	Mercury ¹	mg/L	N/A	0.002	Maximum	Molybdenum ¹	mg/L	N/A	0.15	Maximum	Nickel ¹	mg/L	N/A	1	Maximum	Selenium ¹	mg/L	N/A	0.02	Maximum	Zinc ¹	mg/L	N/A	20	Maximum
	Parameter	Units	Minimum	Maximum	Limit Type																																																																																										
	pH ¹	pH	6	9	Range																																																																																										
	TDS ¹	mg/L	N/A	4000	Maximum																																																																																										
	Sulphate ¹	mg/L	N/A	1000	Maximum																																																																																										
	Aluminium ¹	mg/L	N/A	5	Maximum																																																																																										
	Arsenic ¹	mg/L	N/A	0.5	Maximum																																																																																										
	Boron ¹	mg/L	N/A	5	Maximum																																																																																										
	Cadmium ¹	mg/L	N/A	0.01	Maximum																																																																																										
	Chromium ¹	mg/L	N/A	1	Maximum																																																																																										
	Cobalt ¹	mg/L	N/A	1	Maximum																																																																																										
	Copper ¹	mg/L	N/A	1	Maximum																																																																																										
	Fluoride ¹	mg/L	N/A	2	Maximum																																																																																										
	Lead ¹	mg/L	N/A	0.1	Maximum																																																																																										
	Manganese ²	mg/L	N/A	2.5	Maximum																																																																																										
	Mercury ¹	mg/L	N/A	0.002	Maximum																																																																																										
	Molybdenum ¹	mg/L	N/A	0.15	Maximum																																																																																										
	Nickel ¹	mg/L	N/A	1	Maximum																																																																																										
	Selenium ¹	mg/L	N/A	0.02	Maximum																																																																																										
Zinc ¹	mg/L	N/A	20	Maximum																																																																																											
	¹ Contaminant limits based on ANZECC (2000) Livestock drinking water quality and are analysed as Total Metals (unfiltered)																																																																																														
	² Contaminant limits based on Table 3.4.1 of Aquatic Ecosystems ANZECC (2000) and are analysed as Filtered Metals.																																																																																														
	The water from underneath the stormwater pond 2, obtained from PSMB10 may potentially be in non-compliance of these limits once the sample has been assayed.																																																																																														

Signoff sheet

Additional comments
Recommendation
That a letter be sent to Lady Annie operations detailing the non compliance and areas of concern identified at the site during the time of the inspection. Issue EE to identify the source, cause and extent of environmental harm being caused by the sinkholes adjacent to the stormwater dam 2 if the grounds can be identified.
Adoption of report (sign below and initial every page)
This report accurately represents the issues and outcomes of this site inspection.

Inspecting officer

Michael Popov

Signed

Date

Inspecting officer

Russ McConnell

Signed

Date

Comments and recommendation

Supervisor

Elaine Glen

Signed

Date

Signoff sheet

Additional comments
Recommendation
That a letter be sent to Lady Annie operations detailing the non compliance and areas of concern identified at the site during the time of the inspection.
Adoption of report (sign below and initial every page)
This report accurately represents the issues and outcomes of this site inspection.

Inspecting officer

Michael Popov

Signed

Date

Inspecting officer

s.49 - Signature

16/1/2009

Russ McConnell

Signed

Date

Comments and recommendation

Supervisor

Elaine Glen

Signed

Date

EMAIL TRANSMISSION



ALLAN WATSON ASSOCIATES
Waste and Water Management Consultants

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ALDERLEY QLD 4051
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Fax: 07 3856 3557

4 March 2009

To: Tim Anderson
NRA Environmental Consultants

email: tim@natres.com.au

Tim,

RE: LADY ANNIE – AWA SITE VISIT

A site visit was carried out at Lady Annie on the 2 March 2009 by Lis Boczek from Allan Watson Associates Pty Limited (AWA). The following provides a summary of site observations made and discussions held between Jason Alexander (Copper Co) and Ash Leavy and Hamish Butler (Environmental Protection Agency) during the site visit.

The purpose of the site visit was to observe the breach associated with Stormwater Pond 2 and provide an initial assessment on the following:

- Likelihood of dam failure (in terms of loss of containment) and actions that can be taken to mitigate the risks of worsening the breach
- Can the breach area be repaired?
- Cause of the breach
- Issues related to dewatering Stormwater Pond 2.

OBSERVATIONS

- Stormwater Ponds 1 and 2 are located downstream from the heap leach pads and associated process water ponds with the Lady Annie process area. Both stormwater ponds have been constructed by excavating below natural ground level and are lined with geomembrane. Each pond has a spillway which discharges off site to the west. Each pond is also connected by internal spillways. A balancing pipe also connects Stormwater Pond 1 and 2.
- Stormwater bunds for the purpose of diverting overland flow away from the ponds exist on the northern, southern and eastern sides. The bunds appear to be constructed from surface soils and are approximately 1.0m in height. It is understood that these bunds breached at several locations adjacent to both ponds as a result of severe rainfall during Jan/Feb 2009.
- At the same time, a breach developed on the southern side of Stormwater Pond 2 toward the eastern corner. A photograph of the breach is shown on **Plate 1**.

Plate 1 – Breach



- At the time of the inspection, Copper Co had repaired damaged sections of the stormwater bunds to the north of Stormwater Pond 1 and had filled in the breach area. It is also understood that additional material was being placed to increase the height of the stormwater bund along the southern side of Stormwater Pond 2. The material used for repair was obtained from a spoil stockpile consisting of materials excavated from within the Stormwater Pond footprint during construction.
- In addition, soil material had been placed across each of the spillway to minimise the potential for overflow from the spillway.
- It was observed at the time of the inspection that water was present beneath the liner of the pond causing the liner to float.
- Currently an estimated 300mm depth of water is flowing over the spillway between the process ponds and the stormwater ponds.
- It is understood that Copper Co has temporarily blocked the balancing pipe between Stormwater Ponds 1 and 2.
- Water is currently being transferred onto (and is contained within) unused heap leaching cells to assist with lowering the water level in the ponds.
- It is understood from discussions with Copper Co that the following occurred in the location of the breach.
 - A hole initially appeared in the stormwater bund, which was subsequently filled with spoil material (apparently some 2 weeks prior to the breach). It is understood that no significant rainfall had occurred to this time
 - Following these repair works, the hole reappeared (the rainfall conditions at this time are unknown)

- Stormwater flowing from the eastern area of the site upstream from the stormwater ponds accumulated behind the bund causing erosion and eventual collapse of the bund in the area where the hole existed. This stormwater continued to flow toward Stormwater Pond 2, disturbing the soils around the anchor trench, allowing water to flow beneath the liner with scouring of the liner subgrade resulting.

In addition to the visual assessment, three soil samples were taken for laboratory testing purposes. Two samples were taken in the location of the breach adjacent to the liner and one in the stormwater bund along the eastern side of the pond.

PRELIMINARY ASSESSMENT

Based on the site visit and associated discussions, the surface soils adjacent to Stormwater Pond 2 appear to be dispersive. The damage that has occurred to Stormwater Pond 2 is as a result of a breach to the stormwater bund. The cause of the breach can be assessed based on the results from the laboratory testing.

It is understood from Copper Co that a single pond cannot be dewatered independently, namely all ponds must be dewatered concurrently to maintain stability of internal embankments. A review of the design report and associated operational documentation would be required to enable an assessment of this scenario.

RECOMMENDED ACTIONS

It is recommended that for an immediate action, the level of water within Stormwater Pond 2 is kept such that there is sufficient freeboard to contain a provision for rainfall occurring during the remainder of the wet season including a 0.5m dry freeboard to the top of the damaged liner section.

Following the wet season, repair to Stormwater Pond 2 will be required including dewatering of the pond, repair to the subgrade and replacement of the liner. Upgrading of the surface water management features would also be required using suitable construction materials.

We trust this meets with your current requirements. Please let me know if you require further information at this stage on any of the items discussed.

Yours faithfully,
Allan Watson Associates Pty Limited

s.49 - Signature

LIS BOCZEK
Senior Engineer