Leichhardt River Dam
EMERGENCY ACTION PLAN

Mount Isa Mines
September 2020

Approved by the delegate of the Chief Executive, Department of Natural Resources, Mines and Energy until 1 August 2021.
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### Emergency Activation Quick Reference - Dam Hazards

The Emergency Action Plan (EAP) for Leichhardt River Dam covers five dam hazards evaluated within Glencore Mount Isa Mines management plan. Use the following table to select the relevant section of the EAP that deals with the dam hazard.

<table>
<thead>
<tr>
<th>Dam hazards and sections numbers</th>
<th>Alert</th>
<th>Lean Forward</th>
<th>Stand Up</th>
<th>Stand Down</th>
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</thead>
<tbody>
<tr>
<td><strong>Flood Operations</strong>&lt;br&gt;See Section 4.3 PAGE 17</td>
<td>• Water level is &lt;=2.6m above spillway level.</td>
<td>• Water level is &gt;2.6m above spillway level.</td>
<td>• Water level is &gt;=3.5m above spillway level.</td>
<td>• Water level is falling with no further rain and flood levels are found to be receding over 3 consecutive hourly readings.</td>
</tr>
<tr>
<td><strong>Structural Damage:</strong>&lt;br&gt;Piping, Embankment, Foundation, or Abutments&lt;br&gt;See Section 4.4 PAGE 21</td>
<td>• Increased seepage through an embankment, the foundations, or abutments</td>
<td>• Increasing seepage through an embankment, the foundations, or abutments with cloudy water</td>
<td>• Piping condition has been established&lt;br&gt;• Significant areas of landslip or erosion on the downstream embankment deeper than 2m over an area of greater than 20m².&lt;br&gt;• Seepage measurements of more than 50 litres per second or a visibly increasing rate of seepage concurrent with a decrease in dam level.</td>
<td>• 48 hours elapsed in further increase in structural damage&lt;br&gt;• Structural engineering assessment has determined that failure risk has reduced&lt;br&gt;• Increasing seepage through an embankment, the foundations, or abutments&lt;br&gt;• Seepage measurements of more than 5 litres per second and more than 20% increase in seepage over 24 hours without a corresponding increase in dam level.&lt;br&gt;• Identification of localised erosion on the downstream embankment deeper than 1m over an area of greater than 10m².</td>
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<td><strong>MIM Water Distribution</strong></td>
<td>Name:</td>
<td>Date:</td>
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<td><strong>Owner MIM</strong></td>
<td>Name:</td>
<td>Date:</td>
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<tr>
<td>Isa Processing General Manager</td>
<td>Signature:</td>
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<tr>
<td><strong>Mount Isa City Council Chief</strong></td>
<td>Name:</td>
<td>Date:</td>
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<tr>
<td><strong>District Disaster Management</strong></td>
<td>Name:</td>
<td>Date:</td>
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<td>Group Executive Officer</td>
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Date: 20/07/2020

Date: 20/07/2020

Date: 23/07/20

Date: 31/08/2020

Date 09.09.2020
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<td>Isa Processing General Manager</td>
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<td>Water Distribution Superintendent</td>
<td>Mount Isa</td>
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<td>3</td>
<td>Leichhardt River Dam Operator</td>
<td>Mount Isa</td>
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<tr>
<td>4/5</td>
<td>MIM Representatives on LDMG</td>
<td>Mount Isa</td>
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<tr>
<td>6</td>
<td><strong>Director Dam Safety</strong></td>
<td>Brisbane</td>
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<td>Water Planning and Regulation (DNRME)</td>
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<td>Mount Isa District</td>
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<td>9</td>
<td><strong>Mount Isa Mines Crisis Room (SRRT)</strong></td>
<td>Mount Isa</td>
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<tr>
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<td>1st Floor, Met Plant Building</td>
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## Document Control Details

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| 1               | MOMM - Change of email address  
<p>|                 | DNR&amp;M - Change of contact name                                 | 12-Sept-02   |                         |
|                 | DNR&amp;M - Change of contact name                                 |              |                         |
|                 | MICC - New controlled copy                                    |              |                         |
| 2               | DDC - New controlled copy                                     | 03-Dec-02    |                         |
|                 | DNR&amp;M - Change of contact name                                 |              |                         |
|                 | MICC - New controlled copy                                    |              |                         |
| 3               | DNRM&amp;E - Change of contact name - Change business name / initials | 21-Sept-04   |                         |
|                 | ES - Change of contact name                                    |              |                         |
|                 | Maunsell - Change of contact name                              |              |                         |
|                 | MICC - Change of contact name                                  |              |                         |
|                 | SES - Change of phone numbers                                  |              |                         |
|                 | SSM - Change of contact name                                   |              |                         |
|                 | SSM - Change of title                                          |              |                         |
|                 | WS - Change of contact name                                    |              |                         |
| 4               | Notification List updated.                                     | 30-Jun-07    |                         |
|                 | MIM Water Distribution Superintendent                           |              |                         |
| 5               | Notification List updated.                                     | 31-Jul-08    |                         |
|                 | MIM Water Distribution Superintendent                           |              |                         |
| 6               | Department name change to Utilities UM - Change of contact name | 30-May-09    |                         |
|                 | Incorporate recommendations from 2009 Comprehensive Inspection  |              |                         |
|                 | DNRME - Change of Business Name                                |              |                         |
| 7               | Maunsell - Contact removed from copy list                      | 20-May-10    |                         |
|                 | ES - Contact removed from copy list                            |              |                         |
|                 | DNRM - Contact removed from copy list                          |              |                         |
| 8               | MIM Utilities Manager - Change of contact name and details.     | 09-May-11    |                         |
|                 | MIM Water Distribution Superintendent                           |              |                         |</p>
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<td>[Name Redacted] – 22/05/12</td>
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<td>Name change on company from Xstrata Mount Isa Mines to Mount Isa Mines and XMIM to MIM Department name change to Central Engineering- CEM – Central Engineering Manager Email addresses changed for all MIM personnel</td>
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1 Procedural Flow Chart and Notification List

1.1 Procedural Flow Chart

Legend
4.X.X – Procedure as detailed in Section 4
20kRes – Residents and affected properties within
20km downstream of the dam, as well as Isa Youths Camp and Lake Julius Storage Supervisor
Caretaker – Leichhardt River Dam Caretaker
IPGM – Glencore Mount Isa Mines Isa Processing General Manager
DNRME – Department of Natural Resources, Mining & Energy
EER – Emergency Event Report
LDMG – Chairman of the Local Disaster Management Group
LJSS – Lake Julius Storage Supervisor
GMIMSC – Glencore Mount Isa Mines Security Control
MIWB – Mount Isa Water Board

Abnormal condition or significant discharge identified

IPGM to notify
- LDMG
- GMIMSC
- DNRME
- MIWB
- Notification App. H

Risk of structural failure?

Is dam spilling?

Water level 2.6m above spillway and rising?

Event Receding

Contamination contained

EMERGENCY RESPONSE
MIWB to notify
- Recreational Visitors
IPGM to notify
- Emergency Services
- GMIMSC
- DNRME
- MIWB
- 20kRes
MIWB to notify
- Recreational Visitors

All issues managed?

Leichhardt River Dam
EMERGENCY ACTION PLAN

Version Number 17, September 2020 | 10
## 2 Basic Details of Dam

| **Location**          | Leichhardt River Road, 18km NNE of Mt Isa  
|                       | Latitude 20°34'53"S  
|                       | Longitude 139°34'23"E |
| **Construction Type** | Concrete faced rock fill dam |
| **Construction Date** | 1958 (spillway raised 1971) |
| **Owner**             | Mount Isa Mines |
| **Dam Length**        | 259m |
| **Spillway / gates**  | Primary Spillway: Unlined rock-cut channel on left abutment, with concrete weir inlet control, 77m long, weir crest level RL 3405.53m (MIM datum)  
|                       | Auxiliary spillway 1: Unlined by-wash channel, 37m long, crest level RL 3405.77m (MIM datum)  
|                       | Auxiliary spillway 2: Unlined by-wash channel, 47m long, crest level RL 3405.80m (MIM datum)  
|                       | No gates or scour outlets. |
| **Height above stream bed** | 27.5m above lowest downstream toe level |
| **Storage Capacity**  | 100,000 ML at Full Supply Level |
| **Full Supply Level (FSL)** | 3,405.53m (MIM datum) |
| **Dam Crest Level**   | 3,410.23m (MIM datum) |
| **Catchment Area**    | Approximately 1,200km² |
| **Surface area at FSL** | 21.9km² |
| **Supply**            | Water supply to Mount Isa Water Board, distributed to: Mt Isa Township, Mt Isa Mine, Mica Creek Power Station and Diamantina Power Station.  
|                       | Raw water supply direct to Haslingden Station and West Leichhardt Station. |
| **Spillway capacity** | Combined spillway capacity 4,900m³/s (Dam Crest Level)  
|                       | 1:16,000 AEP flood event |
| **PMF design event**  | 1:35,000 AEP flood event  
|                       | 3410.6m (MIM datum) upstream water level 5,900 m³/s discharge flowrate |
3 Purpose, Scope and Responsibilities

3.1 Purpose
The purpose of an Emergency Action Plan is to pre-plan the coordination of necessary actions by Mount Isa Mines Limited (GMIM) and to provide timely notification to the Department Natural Resource, Mining and Energy, police, Local Disaster Management Groups and affected persons in the event that a condition at Leichhardt River Dam could develop into an emergency.

This action plan is aimed at addressing the requirements of the “Emergency Action Planning for Referable Dams” Water Supply (Safety and Reliability) Act 2008, as the owner(s) of the referable dam to have an approved EAP for the dam.

3.2 Scope
This document applies to Leichhardt River Dam, Mount Isa, and identifies emergency conditions which could endanger the integrity of the dam and which require immediate action; prescribes procedures which are to be followed in the event of an emergency condition developing.

3.3 Responsibilities

3.3.1 General
Mount Isa Mines is the owner and operator of the Leichhardt River Dam. The day to day management of this facility is the responsibility of the Central Engineering Department.

As the dam has no controlled discharge outlets which would be of significance in an emergency event, the primary form of response to emergencies is to provide appropriate and timely notification to people at risk. The Isa Processing General Manager shall be responsible for activation and coordination of the Emergency Action Plan, including assessing the risk in accordance with this plan, providing notifications to affected parties appropriate to the level of impact.

The Isa Processing General Manager shall keep a record of the distribution and location of the Emergency Action Plan. The Manager shall ensure that all copies are current and that duplicate (uncontrolled) copies are not used in the event of an emergency. Records shall be kept of the locations and status of each copy.

The manual shall be reviewed annually by Mount Isa Mines. Revisions shall be approved by the Isa Processing General Manager and shall include the Document Control Details and the Controlled Copy List. A summary listing of all revisions shall be filed in the revision sheet at the front of the manuals.

The controlled copy shall have a watermark on each page clearly indicating that it is the original copy. All copies of the control document shall not have this mark.

3.3.2 Leichhardt River Dam Operator, GMIM shall:
- Advise Isa Processing General Manager, GGMIM, of an intended absence from the dam

3.3.3 Isa Processing General Manager (IPGM), GMIM shall:
- Maintain a current notification list
• Ensure the Water Distribution Superintendent is conversant with the EAP
• Review EAP in consultation with the Water Distribution Superintendent at 12 monthly intervals (maximum)
• If during a potential emergency condition, the Isa Processing General Manager shall
  - enact the EAP
• Notify the Director of Dam Safety (DNRME) within 48 hours of activation of EAP
• Monitor and record emergency situation
• Monitor emergency condition and evaluate situation on best available information
• Organise a helicopter to visually inspect the dam from the air
• Direct action of Mount Isa Mines personnel during an emergency event to protect property and life to the maximum extent considered possible under the prevailing conditions and with the resources available
• Provide internal advice and status reports during an emergency event by phone in the timeframe as mentioned in Section 4 Emergency Events and Actions or Appendix H page 56 to:
  - Affected residents within 20km of the dam
  - Lake Julius Dam Supervisor, Sunwater
  - Mount Isa Water Board (MIWB)
  - GMIM Water Distribution Superintendent (WD)
  - Mount Isa Mines Security Control (GMIMSC)
  - Local Disaster Management Group
  - Director of Dam Safety (DNRME)
• Once activation level returns to Stand Down, prepare an Emergency Event Report and forward within 30 business days after the end of the emergency event. The Emergency Event Report must contain:
  - a description of the event
  - instrumentation readings (where appropriate)
  - description of any observed damage
  - photographs
  - details of communication which took place during the emergency
  - comment on the adequacy of the EAP
  - any recommendations or suggested changes to the EAP

3.3.4 Water Distribution Superintendent, GMIM
• If during a potential emergency condition the Water Distribution Superintendent has not been contacted by the Isa Processing General Manager, the Water Distribution Superintendent shall:
  - attempt to contact the Isa Processing General Manager
  - enact the EAP if the Isa Processing General Manager cannot be contacted
• On delegation from Isa Processing General Manager at the time of an emergency event, act for and on behalf of the Isa Processing General Manager during the event, including all roles as listed above.

3.3.5 Local Disaster Management Group (LDMG)
The Chairman of the Local Disaster Management Group shall be responsible for assessing the impact of and managing the response to downstream hazards beyond 20km from the dam site. Emergency Events and Actions.
4 Emergency Events and Actions

4.1 General

The following events are defined as conditions that could lead to emergency events:

- Significant flow over spillway (≥2.6m depth of flow over spillway), is likely to contribute to downstream flooding
- Extreme flow over spillway (≥3.5m depth of flow over spillway), on the basis that such discharges are likely to contribute to downstream flooding, and further increase may lead to rapid deterioration of the dam integrity
- Earthquake, explosion, landslide or observed structural damage to dam, which could result in dam failure and/or a sudden discharge contributing to downstream flooding
- New area of seepage, significant increase in seepage, or significant unexplained loss of storage contents, which could indicate a potential loss of structural integrity
- Significant movement of the dam wall, indicating potential loss of structural integrity
- Potential contamination of dam water supply, due to object crashing into the dam or toxic waste being dumped into dam water supply

Terrorism / Security Threat

Glencore Mount Isa Mines, Water Distribution personnel undertake daily visual reviews of the dam, daily measurements of the dam level, and weekly reviews of dam seepage when not overtopping. As such, Water Distribution personnel are likely to be the first to identify an issue.

Upon identification of any of the above, an activation level of “Alert” shall be recorded. The person identifying the event shall immediately contact the Isa Processing General Manager for direction and to manage the event. The sections below describe what actions should be directly implemented in the event of an emergency.

The IPGM shall notify the Director Dam Safety (DNRME) within 48 hours of activation of the EAP.

4.2 Emergency Access and Communications

Normal dry weather access is via Leichhardt River Road from Mt Isa, as shown in Appendix A.

During flood events, access to site is only possible by helicopter for the visual inspection of the dam wall, spillways and surrounding area.

Normal communications is by telephone to Caretaker’s house or mobile phone.

The Isa Processing General Manager shall be responsible for managing the EAP, including notification of affected parties as detailed below and standard messages from Appendix H.

Media releases for an emergency event will be issued from the GMIM Site Response Recovery Team (SRRT) through the North Queensland Copper Division (NQCD) Communications Manager.
4.3 Significant flow over spillway

Significant flow over the spillway has the potential to pose a flooding risk to assets and persons downstream of the dam. An assessment of the impacts of flooding from the dam is presented in the Failure Impact Assessment Report (SMEC 2010). Key properties identified as being at risk are as follows:

1.0 Warrina Park Picnic Area is located approximately 0.5km downstream of the dam wall, in close proximity to the watercourse. For the purpose of risk assessments the PAR was estimated at 9. It is noted that further to the FIA Report, overnight camping is not permitted in this area.

2.0 Haslingden Station is located approximately 1.8km downstream of the dam wall. The homestead is offset approximately 300m from the centreline of the watercourse, and elevated approximately 5m above it. A rapid discharge from the spillway would affect the homestead around 0.5 to 1 hour later. The FIA Report assessed that the property would not be inundated by a Dam Crest Flood.

3.0 West Leichhardt Station is located approximately 13km downstream from the dam. The homestead is offset approximately 250m from the centreline of the watercourse, and approximately 4m above it. A rapid discharge from the spillway would affect the homestead around 1 to 2 hours later. The FIA Report assessed that the property would be inundated by a Dam Crest Flood.

4.0 Lake Julius Dam is located approximately 70km downstream from the dam. A rapid discharge from Leichhardt River Dam would affect Lake Julius around 5 to 6 hours later. Discharge from Leichhardt River Dam under flooding and/or dam break events is not expected to affect the Lake Julius Dam integrity, however rising waters may affect the safety of operators on or near the water's edge.

5.0 Four additional properties are located from 100km to 260km downstream from the dam, with the potential to be affected by flooding in the Leichhardt River watercourse.

In addition to the abovementioned properties, it should be noted that the dam is frequently used by recreational watercraft. There is also a youth camp (Isa Youth Camp, formerly known as Lions Youth Camp) located north of the Dam, and whilst the campsite would be unaffected by dam failure, the access road passes downstream of the dam and spillway.

As dam overflow is one of several factors affecting flooding of Lake Julius and properties downstream thereof, assessing the downstream flooding hazards is the responsibility of the Local Disaster Management Group. This EAP is aimed at providing timely information to the Local Disaster Management Group, affected stakeholders and emergency services so as to assist them in assessing the overall hazards and responding accordingly.

The likely causes of a significant flow over the spillway are related to the annual Wet Season and rainfall in the Leichhardt River catchment area. The catchment area is 1,200km² and is the only source of re-supply for the dam. Based on discussions with the Dam Operators, the dam level is normally below full supply capacity, however may overtop for several weeks at a time every 5 years or so. The highest discharge in memory overtopped the spillway by 1.25m.

The level of response to floodwater discharge is dependent on the discharge flow rate. For simplicity, response levels are presented in terms of depth of flow over the spillway. Any measurable flow over the spillway will trigger an activation level of “Alert” in the Emergency Action Plan.

From the FIA Report, a 1:100 AEP flood event corresponds to a theoretical outflow 1,428m³/s, with the dam level at 2.6m above the main spillway. Such discharges are not expected to pose a significant risk of damage to the dam, but are likely to be contributing to downstream flooding. As such, a dam level of 2.6m above the spillway can be used as marking a significant
level of flow appropriate for triggering a “Lean Forward” activation level in the Emergency Action Plan.

From the FIA Report, a 1:1,000 AEP flood event corresponds to a theoretical outflow of 2,610 m$^3$/s, with the dam level at 3.5 m over the main spillway. This represents approximately 50% of the theoretical spillway capacity (4,900 m$^3$/s) and is significantly above any known discharge levels. Whilst the dam can theoretically withstand water levels up to the dam crest (4.70 m above the spillway), a dam level of 3.5 m above the spillway is considered an appropriate level of flow for triggering a “Stand Up” activation level in the Emergency Action Plan.

From the FIA Report, a 1:16,000 AEP flood event corresponds to a theoretical outflow of 4,900 m$^3$/s, with the dam level at the dam crest (ignoring height of parapet). The dam is not expected to be able to withstand flows over this level as overtopping would quickly scour the dam embankment leading to progressive structural failure.

Further details in relation to the extent and findings of the flood modelling from the FIA Report are presented in Appendix B. Discharge and Storage Curves for various storm events are presented in Appendix D.

### 4.3 Low Flow over Spillway (less than 2.6 m depth of flow)

Activation level: **ALERT**

A trigger point of 2.6 m above spillway is set as a reference marker that water levels are significantly higher than recent records. Whilst discharges up to this level may lead to flooding downstream, the dam is considered to be well within its design limits.

Once the spillway begins overtopping:

**The Leichhardt River Dam Operator shall:**
- Inspect the dam as soon as safe access is possible after the event

**The Isa Processing General Manager shall:**
- Visually observe flood levels, record situation and record rainfall
- Notify LDMG of spillway levels, with updates every 24 hours.
- Notify GMIMSC of spillway levels, with updates every 24 hours.
- Monitor the dam levels
- Updates shall continue until water levels begin to recede
- Sample notification messages are presented in Appendix H

### 4.3.2 Significant Flow over Spillway (2.6 m to 3.5 m depth of flow and rising)

Activation level: **LEAN FORWARD**

**Significant Flow over Spillway (2.6 m to 3.5 m depth of flow and rising)**

Activation level: **Lean Forward**

Spillway flow levels of greater than 2.6 m represent an event significantly higher than recent records, and whilst the dam is still within its theoretical capacity, a greater level of vigilance is appropriate. Under such flood events, it is likely that the access road to the dam would be cut
by floodwaters. Telecommunications may or may not be affected, depending on the nature of the storm event.

If flow over the spillway is more than 2.6m and rising then:

**The Leichhardt River Dam Operator shall:**
- Inspect the dam as soon as safe access is possible after the event

**The Isa Processing General Manager shall:**
- Visually observe flood levels, record situation and record rainfall
- Notify LDMG of spillway levels, with updates every 8 hours.
- Notify key contacts on properties within 20km downstream of the dam and Lake Julius Storage Supervisor, with updates every 8 hours.
- Notify GMIMSC, with updates every 8 hours.
- Notify DNRME that activation level has moved to “Lean Forward”
- Monitor the dam levels
- Updates shall continue until water levels begin to recede, or dam levels exceed 3.5m over the spillway
- Sample notification messages are presented in Appendix H

### 4.3.3 Significant Flow over Spillway (greater than 3.5m depth of flow and rising)

**Activation level:** **STAND UP**

**Significant Flow over Spillway (greater than 3.5m depth of flow and rising)**

**Activation level:** **Stand Up**

A trigger point of 3.5m above the spillway is set as a reference marker that water levels are significantly above any historical levels. Discharge flow rates are approximately half of the spillway capacity, and should the spillway capacity be exceeded then the integrity of the dam is likely to be compromised.

Under such flood events, it is likely that the access road to the dam would be cut by floodwaters. Telecommunications may or may not be affected, depending on the nature of the storm event.

If flow over the spillway is more than 3.5m and rising then:

**The Isa Processing General Manager shall:**
- Notify Emergency Services of intent to move into “Stand Up”
- Notify GMIMSC of intent to move into “Stand Up”
- Notify LDMG of spillway levels, and the intent to move into “Stand Up” activation level.
- Notify key contacts on properties within 20km downstream of the dam and Lake Julius Storage Supervisor.
- Notify DNRME of spillway levels, and the intent to move into “Stand Up” activation level.
- If safe, visually monitor dam levels at suitable intervals, including photographic records.
- Monitor the dam levels
• Maintain communications with GMIMSC, LDMG, and affected residents every 8 hours.
• Sample notification messages are presented in Appendix H

The Chairman of the Local Disaster Management Group shall:
• Identify the impact of floodwaters on residents further than 20km downstream of the dam, and coordinate appropriate response measures.
• Liaise with the IPGM

4.3.4 Flow over Spillway Receding

Activation level: **STAND DOWN**

Flow over Spillway Receding

Activation level: **Stand Down**

If rainfall at the dam has ceased and flood levels are found to be receding over 3 consecutive hourly readings, then the impacts of flooding may assume to have peaked and the benefit of further warnings to properties is of limited value. In this instance:

The Leichhardt River Dam Operator shall:
• Inspect the dam as soon as safe access is possible after the event

The Isa Processing General Manager shall:
• Continue to visually observe flood levels, record situation and record rainfall
• Notify all previously contacted parties of the intent to move activation level to Stand Down.
• Monitor the dam levels
• Sample notification messages are presented in Appendix H
• Prepare an Emergency Event Report and forward within 30 business days after the end of the emergency event.

4.4 Potential structural damage to dam

A number of events have the potential to cause significant structural damage to the dam including:
• Earthquakes, placing excessive stress on the dam structure
• Landslide along the abutment or dam wall, damaging or undercutting the dam structure
• Landslide along the reservoir rim, displacing a volume of water that leads to a sudden rise in the dam level and potential flooding downstream
• Uncontrolled seepage leading to piping failure through the dam wall or abutments
• Flood levels overtopping the dam wall.

Signs that the structural integrity of the dam may have been compromised include:
• Observation of significant areas of damage on the upstream dam face or walkway, such as new cracking in the concrete facing
• Significant amounts of scour on the downstream face
• Unexplained loss of storage contents
• Unexplained eddies in proximity to the dam wall, indicating potential piping failure
• Unexpected changes to the levels of seepage observed downstream of the dam
• Significant movement of the dam wall

The effects of dam failure is dependent on the volume of water stored at the time of failure. From the 2010 Failure Impact Assessment Report, the estimated incremental Population At Risk from inundation relating to dam failure at Full Storage Capacity (Sunny day Dambreak) is 30 people, including 9 persons at Warrina Park, 6 people at West Leichhardt Station, and 15 people at various settlements downstream of Lake Julius.

The estimated incremental Population at Risk from inundation relating to dam failure during a 1:16,000 flood event (Dam Crest Flood) is 35 people, including 3 persons at Haslingden Station, and 32 people at various settlements downstream of Lake Julius.

4.4.1 Events considered unlikely to pose risk of structural failure

Reference is made to the Leichhardt River Dam Comprehensive Inspection Report (AECOM 2013). This report identified that the dam is in sound condition, but has a number of issues that require attention including:

• Some of the vertical joints on the face slab have deteriorated and should be repaired. Ongoing monitoring of the face slab joints should continue as part of routine inspections.
• Rock protection is installed on the downstream face, and has irregular grading of material. There are several locations where large rock has not interlocked with smaller material and is leading to rill erosion. These locations should be monitored in future inspections. Should erosion become excessive it is recommended that the area be backfilled and with a suitable material and compacted.
• The condition of the spillway has not deteriorated noticeably since the last comprehensive inspection. Continued monitoring of some potentially unstable rock above the right abutment of the control crest is considered necessary as a rock fall could result in damage to the crest and some uncontrolled loss of storage.

Seepage through the dam wall

Reference is made to GHD’s design drawings for the dam 4509-5 and 4509-7, which indicate the dam being constructed from rock fill founding on bedrock, with batter slopes of 1:11/4. Generally speaking, it is expected that a significant flow velocity would be required to erode sufficient material to lead to progressive piping failure of rock fill. However, as no specific details are available in relation to the type, size or condition of the rock fill, specific limits as to an acceptable seepage rate cannot be accurately calculated. Accordingly it is proposed that a suitable trigger for activating the EAP would be observing a significant increase in seepage flow without a corresponding rise in the dam water level.

Seepage through the dam is currently being monitored by measuring the flow rate in the watercourse, through a V-notch cut into the bedrock approximately 600m downstream of the dam wall. This measurement is undertaken on the assumption that all flow in the watercourse can be attributed to seepage through the dam wall, and is only applicable when the spillway is
not overtopping. Flow rate is measured on a weekly basis by the operator. In general, seepage is only identified when the dam level is close to Full Supply Level.

**Damage to the concrete facing**

The concrete facing on the upstream face of the dam provides the primary water retention barrier. GHD drawing 4509-7 identifies this facing as 4 inch thick Gunite, anchored to the rock fill with A.R.C 5/8 inch rods embedded 4 feet into the rock fill. The Gunite is divided into 24’ x 20’ panels, with rubber water stops central to the facing slab. 1” square cork joint sealants are applied above the rubber water stops, primarily to protect the water stop from degradation.

![Figure 1 - extract from GHD drawing 4509-7](image)

The condition of the cork sealant is important to protect the underlying water stop, but should in itself not be seen as a trigger for activation of the EAP.

Suitable triggers relating to the condition of the concrete facing would include:

- development of new cracks (not at existing joint locations),
- detection of a significant increase in seepage without a corresponding increase in dam level
- detection of an unexplained eddy in proximity of the dam wall

**Damage to the downstream embankment**

The existing drawings for the dam do not indicate any capping to the downstream embankment, however a range of grading including fine particles is visible along the finished surface. As noted in the 2013 Comprehensive Inspection Report, a degree of large rock has not interlocked with smaller material and is leading to rill erosion. Furthermore, an accumulation of large rocks at the toe of the embankment indicate that a degree of erosion may be present leading to dislodgement of these rocks.

Given there is no structural facing to the embankment, a significant loss of material would be required to lead to global instability. Proposed triggers for activating the EAP include:

- Identification of localised erosion deeper than 1m over an area of greater than 10m².
- Identification of new areas of rill erosion or slip failure.
Movement of the dam wall

A key indicator of degradation of the rock fill would be significant movement of the dam wall. Small movements may be attributed to thermal changes or settlement of fill material.

A series of survey monitoring points along the dam wall are being monitored. A trend of horizontal movement is apparent in the order of 40mm since 1969. A trend of vertical movement is also apparent in the order of 30mm since 1966.

Proposed triggers for activating the EAP include:

- Lateral displacement across a crack or movement joint of greater than 20mm.
- Movement of any part of the dam of more than 20mm in one year

4.4.2 Events which may pose risk of structural failure

Activation level: LEAN FORWARD

The following items indicate that the integrity of the dam may have been compromised, and requires precautionary measures to be undertaken:

- Any act of terrorism or sabotage that may have affected the structure
- Earthquakes, with magnitude of over 4 on the Richter scale within 500km of the site. This may be approximated as an event which will be clearly felt by persons on site (or in Mount Isa).
- Seepage measurements of more than 5 litres per second and more than 20% increase in seepage over 24 hours without a corresponding increase in dam level.
- Development of distinct new cracks in the concrete facing (not at existing joint locations),
- Detection of an unexplained eddy in proximity of the dam wall
- Identification of localised erosion on the downstream embankment deeper than 1m over an area of greater than 10m².
- Identification of new areas of rill erosion or slip failure on the downstream embankment.
- Lateral displacement across a crack or movement joint of greater than 20mm.
- Movement of any part of the dam of more than 20mm in one year

Following identification of one or more of the above items, a potential risk of structural failure shall be noted and the following actions undertaken:

The Leichhardt River Dam Operator shall:

- As feasible, inspect all accessible areas of the dam to identify the extent of any damage, including new cracking, new seepage, deformation, or spalling of concrete on the dam face or abutments. Damage should be recorded in terms of notes estimating extent of damage as well as photographs.
- Continue to monitor and record the situation at suitable intervals until otherwise notified by the IPGM
The Isa Processing General Manager shall:

- Notify LDMG of the potential structural risk
- Notify GMIMSC of the potential structural risk
- Notify key contacts on properties within 20km downstream of the dam
- Notify Director Dam Safety (DNRME) within 48 hours of activating the EAP
- Notify MIWB of potential structural risk
- Monitor the dam
- Sample notification messages are presented in Appendix H
- Engage a detailed engineering assessment as soon as practical.

Activation level shall remain at Lean Forward until either a structural engineering review confirms the dam integrity has not been compromised, or 48 hours has passed without further increase in damage.

Prepare an Emergency Event Report at Stand Down level and forward within 30 business days after the end of the emergency event.

4.4.3 Potential indicators of imminent structural failure

Activation level: **STAND UP**

The following items indicate that the integrity of the dam is likely to have been compromised, and requires immediate emergency measures to be undertaken:

- Earthquakes, with magnitude over 6 on the Richter scale within 250km of the site. This may be approximated as an event which causes significant damage to most buildings, and is felt as strong shaking by persons on site (or in Mount Isa).
- Seepage measurements of more than 50 litres per second or a visibly increasing rate of seepage concurrent with a decrease in dam level.
- Observation of major areas of damage to the dam face, such as dislodgement of sections of concrete facing or new cracks over 5mm in width
- Significant areas of landslip or erosion on the downstream embankment deeper than 2m over an area of greater than 20m².
- Lateral displacement across a crack or movement joint of greater than 50mm.

Following identification of one or more of the above items, an imminent risk of structural failure shall be noted and the following actions undertaken:

**The Leichhardt River Dam Operator shall:**

- Monitor visible areas of the dam to identify the extent of any damage, including new cracking, new seepage, deformation, or spalling of concrete on the dam face or abutments. Damage should be recorded in terms of notes estimating extent of damage as well as photographs.
- Continue to monitor and record the situation at suitable intervals until otherwise notified by the IPGM

**The Isa Processing General Manager shall:**

- Instruct any visitors to leave, including persons at the Warrina Park Picnic Area, Isa Youth Camp.
- Notify Emergency Services of the imminent risk of dam failure
• Notify LDMG of the imminent risk of dam failure, with progressive updates on an hourly basis.
• Notify key contacts on properties within 20km downstream of the dam of the imminent risk of dam failure.
• Notify Lake Julius Storage Supervisor of the imminent risk of dam failure
• Notify GMIMSC of the imminent risk of dam failure, with progressive updates on an hourly basis.
• Notify MIWB of the imminent risk of dam failure, with progressive updates on an hourly basis.
• Sample notification messages are presented in Appendix H
• Notify Director Dam Safety (DNRME) within 48 hours of activating the EAP.
• Monitor the dam
• Engage a detailed engineering assessment as soon as practical.

Activation level shall remain at Stand Up until either a structural engineering review confirms the dam integrity has not been compromised, or 48 hours has passed without further increase in damage.

Prepare an Emergency Event Report at Stand Down level and forward within 30 business days after the end of the emergency event.

4.4.4 Structural concerns managed

Activation level: **STAND DOWN**

Once either 48 hours has elapsed without further increase in the observed structural damage, or an engineering assessment has been undertaken and any prescribed actions to make the dam safe have been undertaken then:

**The Isa Processing General Manager shall:**

• Notify all previously contacted parties of the intent to move activation level to Stand Down.
• Sample notification messages are presented in Appendix H.
• Ensure that an appropriate structural engineering assessment has been undertaken to address the observed defects as soon as possible if not already done so, and all recommended follow up actions prescribed by the certifying engineer are closed out.
• Prepare an Emergency Event Report and forward to Director Dam Safety (DNRME) within 30 business days after the end of the emergency event.

4.5 Potential contamination of dam water supply

Contamination of the dam potentially affects the environment and users of the water including

- recreational users,
- Haslingden and West Leichhardt Stations, drawing raw water from the dam.
- MIWB, supplying treated water to Mt Isa Township, Mount Isa Mines, Mica Creek Power Station and Diamantina Power Station.
Early containment of the contamination and notification of the appropriate emergency services is critical.

Any operations undertaken by GMIM or Contractors which have the potential to contaminate a watercourse must include provision of a suitable spill collection kit and environmental management plan.

Likely causes of a contamination include a vehicle or boat accident, with the potential contaminants limited to the contents of fuel on board. Other less likely potential incidents include plane crash, failure of maintenance plant or toxic waste dumped into the dam catchment or water supply storage area.

In the event that an incident occurs which contaminates or has the potential to contaminate the water supply:

4.5.1 Identification of contaminant into the dam or dam catchment
Activation level: ALERT

Identification of possible contaminant.

The Isa Processing General Manager shall:
- Identify the hazardous substance if possible
- Take reasonable steps to isolate the spill or contaminant from the storage and prevent further contamination
- Monitor the hazard

4.5.2 Significant amount of contaminant into the dam or dam catchment
Activation level: LEAN FORWARD

Confirmation or significant amount of contaminant in the water storage area.

The Leichhardt River Dam Operator shall:
- As feasible, inspect all accessible areas of the dam to identify the extent of any contamination. Contamination should be recorded in terms of notes estimating extent of damage as well as photographs.
- Continue to monitor and record the situation at suitable intervals until otherwise notified by the IPGM

The Isa Processing General Manager shall:
- Identify the hazardous substance if possible
- Take reasonable steps to isolate the spill or contaminant from the storage and prevent further contamination
- Contact emergency services as soon as possible
- Notify GMIMSC
- Notify Director Dam Safety (DNRME)
- Notify MIWB
- Monitor the hazard

4.5.3 Excessive amount of contaminant into the dam or dam catchment
Activation level: STAND UP
Very high probability of an excessive amount of contaminant found in the water storage area.

**The Leichhardt River Dam Operator shall:**
- Monitor visible areas of the dam to identify the extent of any contamination. Contamination should be recorded in terms of notes estimating extent of damage as well as photographs.
- Continue to monitor and record the situation at suitable intervals until otherwise notified by the IPGM.

**The Isa Processing General Manager shall:**
- Contact emergency services as soon as possible
- Notify LDMG
- Notify GMIMSC
- Notify key contacts on properties within 20km downstream of the dam and MIWB of the contamination and decision to cut of water supply.
- Notify LJSS
- Notify MIWB
- Sample notification messages are presented in Appendix H
- Notify Director Dam Safety (DNRME) within 48 hours of activating the EAP.
- Monitor the hazard

Prepare an Emergency Event Report and forward within 30 business days after the end of the emergency event.

**Activation level shall remain at Stand Up until the emergency response team has confirmed that the contamination has been controlled.**

### 4.5.4 Contamination concerns managed

**Activation level:** **STAND DOWN**

Once the team responsible for managing the contamination have confirmed that the contamination has been managed:

**The Isa Processing General Manager shall:**
- Notify all previously contacted parties of the intent to move activation level to Stand Down.
- Sample notification messages are presented in Appendix H
- Prepare an Emergency Event Report and forward to Director Dam Safety (DNRME) within 30 business days after the end of the emergency event.

Activation level shall remain at Stand Up until the emergency response team has confirmed that the contamination has been controlled.


4.6 Terrorism / Security Threat
The emergency action described in this section relates to a potential dam hazard due to a terrorist threat or activity.

The vulnerability of Leichhardt River Dam to a terrorist attack is low.

The area likely to be affected by this dam hazard is described as:

- If dam failure does not occur then there will not be any area affected
- If dam failure occurs, reference the flood inundation assessment in Appendix B

4.6.1 Terrorism or security threat which may pose risk of structural failure
Activation level: LEAN FORWARD

The following items may indicate that the integrity of the dam has been compromised, and requires precautionary measures to be undertaken:

- Observation of significant areas of damage to the dam face due to terrorism activity or
- Suspicious behaviour noticed at the dam or surrounding area.

Following identification of one or more of the above items, a potential risk of structural failure shall be noted and the following actions undertaken:

**The Leichhardt River Dam Operator shall:**
- As feasible, inspect all accessible areas of the dam to identify the extent of any damage, including new cracking, new seepage, deformation, or spalling of concrete on the dam face or abutments. Damage should be recorded in terms of notes estimating extent of damage as well as photographs.
- Continue to monitor and record the situation at suitable intervals until otherwise notified by the IPGM.

**The Isa Processing General Manager shall:**
- Liaise with the Leichhardt River Dam Caretaker or otherwise monitor the dam
- Notify Police or National Security hotline
- Notify LDMG of the potential structural risk
- Notify MIMSC of the potential structural risk
- Notify Director Dam Safety (DNRME) within 48 hours of activating the EAP.
- Sample notification messages are presented in Appendix H
- Engage a detailed engineering assessment as soon as practical.

The need to notify key contacts on downstream properties and frequency of updates will depend on the outcomes of the structural investigation. There is little benefit in advising the contacts of defects until there is reasonable cause to believe that there is a realistic threat of a structural failure. Should the structural assessment identify that there is significant cause to notify downstream contacts then that would be managed under subroutine 4.4.3.

Activation level shall remain at Lean Forward until either a structural engineering review confirms the dam integrity has not been compromised, or 48 hours has passed without further increase in damage.
4.6.2 Potential indicators of imminent structural failure from a terrorism or security threat

Activation level: **STAND UP**

The following item may indicate that the integrity of the dam has been compromised, and requires immediate emergency measures to be undertaken:

- Observation of major areas of damage on dam face, such as new cracking actively leaking water greater than 1 litre per minute, any relative movement of part of the dam wall greater than 10mm, or cavitation blowouts over 1m² in area due to an explosion or object crashing into wall.

Following identification of one or more of the above items, an imminent risk of structural failure shall be noted and the following actions undertaken:

**The Leichhardt River Dam Operator shall:**

- Monitor visible areas of the dam to identify the extent of any damage, including new cracking, new seepage, deformation, or spalling of concrete on the dam face or abutments. Damage should be recorded in terms of notes estimating extent of damage as well as photographs.
- Continue to monitor and record the situation at suitable intervals until otherwise notified by the IPGM.

**The Isa Processing General Manager shall:**

- Liaise with the Leichhardt River Dam Caretaker or otherwise monitor the dam.
- Notify Police or National Security hotline
- Notify LDMG of the imminent risk of dam failure, with progressive updates on an hourly basis.
- Notify key contacts on properties within 20km downstream of the dam of the imminent risk of dam failure.
- Notify Mica Creek Power Station and Diamantina Power Station of the dam of the imminent risk of dam failure.
- Notify MIMSC of the imminent risk of dam failure, with progressive updates on an hourly basis.
- Sample notification messages are presented in Appendix H.
- Notify Director Dam Safety (DNRME) within 48 hours of activating the EAP.
- Engage a detailed engineering assessment as soon as practical.

Once elevated to Stand Up, the event will be managed by either the LDMG or DDMG as appropriate, whom will determine the frequency of ongoing updates.

Activation level shall remain at Stand Up until either a structural engineering review confirms the dam integrity has not been compromised, 48 hours has passed without further increase in damage.

4.6.3 Structural concerns managed

Activation level: **STAND DOWN**

Once either 48 hours has elapsed without further increase in the observed structural damage, or an engineering assessment has been undertaken and any prescribed actions to make the dam safe have been undertaken then:
The Isa Processing General Manager shall:

- Notify all previously contacted parties of the intent to move activation level to Stand Down.
- Sample notification messages are presented in Appendix H.
- Ensure that an appropriate structural engineering assessment has been undertaken to address the observed defects as soon as possible if not already done so, and all recommended follow up actions prescribed by the certifying engineer are closed out.
- Prepare an Emergency Event Report and forward to Director Dam Safety (DNRME) within 30 business days after the end of the emergency event.

5 Supporting Documents and Reference Material

The following supporting documents form part of the Emergency Action Plan:

- Queensland Dam Safety Management Guidelines (February 2002)
- ANCOLD Guidelines on Dam Safety Management (August 2003)
- Mines Regulations Act 1964 – 1983
- Metalliferous Mining Regulations 1995
- Mining and Quarrying Safety and Health Act 1999
- Mining and Quarrying Safety and Health Regulations 2001.
- 2010 Failure Impact Assessment.
- Leichhardt River Dam Comprehensive Inspection Report (AECOM 2013)
- GHD’s design drawings for the dam 4509-5 and 4059-7

5.1 List of abbreviations

<table>
<thead>
<tr>
<th>Abbreviation</th>
<th>Description</th>
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<tbody>
<tr>
<td>20kRes</td>
<td>Key contacts on properties within 20km downstream of the dam</td>
</tr>
<tr>
<td>IPGM</td>
<td>Glencore Mount Isa Mines Isa Processing General Manager</td>
</tr>
<tr>
<td>DCF</td>
<td>Dam Crest Flood</td>
</tr>
<tr>
<td>DCL</td>
<td>Dam Crest Level</td>
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<tr>
<td>DNRME</td>
<td>Director of Dam Safety, DNRME</td>
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<tr>
<td>EAP</td>
<td>Emergency Action Plan</td>
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<tr>
<td>EER</td>
<td>Emergency Event Report</td>
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<tr>
<td>FSL</td>
<td>Full Supply Level</td>
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</table>
5.2 Glossary

**the Act**
Water Supply (Safety and Reliability) Act 2008

**Affected Persons**
Any persons which would be significantly and adversely affected as a result of an event, such as expected to lose an essential resource or be subject to an increased safety risk

**Alert**
The first stage of emergency response whereby a heightened level of vigilance is maintained due to the possibility of an emergency event occurring. Action is required to ensure the situation is monitored by someone capable of assessing the potential of the threat.

**Controlled document**
Having an EAP issued as a 'controlled document' means that specified copies of a document are kept up to date in a controlled manner using a system that distributes updated versions/pages of the document as they are issued and retrieves superseded versions/pages of the document as they become redundant. In this way, only the current version of the document is used during any event. A controlled document requires the following metadata to be recorded in the document and securely archived:
- Contents, versions and dates of versions;
- Name and role of the person approving each version and details of any prior consultation undertaken; and
- Names and roles of persons issued with copies.

**Dam Crest Flood (DCF)**
A flood event occurring when the dam is initially at Full Supply Level and results in maximum discharge from the dam correlating to the crest of the dam wall.

**Dam Crest Level (DCL)**
The level correlating to the top of the dam wall

**Downstream release hazard**
The Act defines a downstream release hazard in relation to a dam to be a reasonably foreseeable hazard to the safety of persons or property that could potentially be caused or aggravated by—
(a) a release of water from the dam's spillway; or
(b) a controlled release of the water from the dam. Example—flooding of downstream properties and transport infrastructure caused by a release of water

**Emergency Event Report (EER)**
Report on the performance of the dam and the functioning of the EAP during emergency event which is presented to the chief executive following the end of the event

**Failure Impact Assessment (FIA)**
It is a process used under the Act to determine the number of people whose safety could be at risk should the dam fail. This assessment must be certified by a registered professional engineer in accordance with the Act

**Full Supply Level (FSL)**
A situation where the dam storage is at the level of the spillway.

**Lean Forward**
The stage of emergency response prior to ‘stand up’ whereby a heightened level of situational awareness of a disaster event (either current or impending) is maintained and a state of operational readiness is developed. Personnel at dam are on standby; ready to activate EAP.
| **Local Disaster Management Group (LDMG)** | Local Disaster Management Groups are established to support local government disaster management activities. The Local Group is supported by the relevant District Group if and when disaster management activities exceed the capacity of a Local Group. The functions of the Local Group include (but are not limited to):
- develop, regularly review and assess effective disaster management;
- assist local government for its area to prepare a local disaster management plan;
- ensuring the community is aware of ways of mitigating the adverse effects of an event, and preparing for, responding to and recovery from a disaster;
- identify, and coordinate the use of resources that may be used for disaster operations;
- manage disaster operations in the area under policies and procedures decided by the State Group; and
- ensuring disaster management and disaster operations in the area are consistent with the State Group’s SPF for disaster management for the State. |
| **Population at Risk (PAR)** | The number of people calculated under the FIA guidelines, whose safety will be at risk if the dam, or the proposed dam after its construction, fails. |
| **Referable Dam** | A dam, or a proposed dam after its construction will be a referable dam if—
(a) a failure impact assessment of the dam, or the proposed dam, is required to be carried out under the Act; and
(b) the assessment states the dam has, or the proposed dam after its construction will have, a category 1 or category 2 failure impact rating; and
(c) The chief executive has, under section 349 of the Act, accepted the assessment. |
| **Stand down** | The final stage of emergency response when there is no longer a requirement to respond to the event and the threat is no longer present. At ‘stand down’ there is a transition from responding to an event back to normal core business and/or recovery operations. |
| **Stand up** | The operational state following ‘lean forward’ whereby resources are mobilised, personnel are activated and operational activities commenced. Moving into this operational state triggers the requirement for an emergency event report. |
| **Sunny Day failure / Sunny Day dam break** | The failure of a dam without any other general flooding or spillway discharges. Generally taken from the dam being initially at Full Supply Level. |
Appendices

Appendix A

Locality Map

From Mount Isa (Barkly Hwy Turnoff) to dam wall carpark by road = 15km (20 minutes)

In flood events, the road would be cut in three locations: Moondarra Crossing, Davis Road and Stoney Creek.

During flood the dam wall is only accessible by air.

Refer to Figure A2 for details

Figure A1. – Google Earth Map of Mount Isa to Lake Julius Dam
Figure A2. – Google Earth Map of Lake Moondarra

Figure A3. – Google Earth Map of Leichhardt River Dam V-notch
Appendix B

Flood Inundation ASSESSMENT

Note regarding inundation mapping
A Failure Impact Assessment Report was undertaken by SMEC in 2010. This assessment included a 1-dimensional flow analysis of the Leichhardt River Watercourse. Whilst this assessment appears appropriate for undertaking a high-level review of the impacts of dam failure on Warrina Park, insufficient information is available at this time to produce meaningful inundation maps given the irregular topography along the water course.

Reference is made to Section 9.5 of Emergency Action Planning for Referrable Dams (DNRME, 2013) which notes “Where the number of properties potentially affected and PAR is limited, detailed flood mapping may not be necessary. It may be sufficient to just identify where the particular dwellings are and the circumstances in which they may be affected, in the body of the EAP.”

Extracts from FIA Report (SMEC 2010)

SUMMARY
It was found that the Population at Risk for Sunny Day failure of the dam is 30 persons.
In the event of a Dam Crest Flood, triggering failure of the dam, the incremental population at Risk is 35 persons.
The Population at Risk is spread over a 275 km reach downstream of Leichhardt River Dam and includes Warrina Park, Kajabbi and three other settlements downstream of Lake Julius. In the event of failure, flood waters would peak in the Haslingden station approximately 40 minutes to 1.0 hours later. The failure of Leichhardt River Dam would be likely to result in minor damage to West Leichhardt Station. In the event of failure, flood water would peak in the West Leichhardt station approximately 1.25 to 1.5 hours later.
The failure of the dam would not trigger failure of Lake Julius Dam.
The current Spillway capacity was found to be 4900 m$^3$/s which equates to a 1 in 16,000 AEP flood event. The spillway capacity is currently 86% of the Acceptable Flood Capacity and will need to be upgraded to pass 5900 m$^3$/s or 100% of the AFC prior to the year 2035.

DAM FAILURE ANALYSIS
For the dam failure analysis, a Mike 11 dam break model was adopted with inflow hydrographs based on the hydrology described in previous chapters. MIKE11, developed by Danish Hydraulic Institute, Water and Environment, is used for the simulation of 1-dimensional flow analysis including dam break simulation. The river reaches investigated in this study initially covered the Leichhardt River and its floodplain extending downstream of Leichhardt River Dam to the Lake Julius Dam. Following a review of the report by DNRME, the model was extended approximately 200 km downstream of Julius Dam, to ensure that all Population at Risk would be identified.
In accordance with the Guidelines on Failure Impact Assessment, Table 1, the Dam Crest Flood was simulated assuming the Dam Crest Flood inflow to the dam with 10yr ARI concurrent tributary inflows downstream of the dam. The longitudinal water level profile for different failure scenario has been presented in Figure 15.
**Figure 15: Longitudinal Water Level Profile**

**WARNING TIMES**

The rate of rise of floodwaters at various locations downstream Leichhardt River Dam in a Sunny Day and Dam Crest flood failure scenarios is shown in Figure 16 and Figure 17 which show the time of rise of flood water at the four following locations:

- At the Leichhardt River Dam
- 1.85 km downstream of the Leichhardt River Dam
- 13.0km downstream of the Leichhardt River Dam
- Lake Julius Dam

In a Sunny Day failure, following failure of the Leichhardt River dam, flood waters would rise rapidly at [ ], peaking approximately 1 hour after commencement of failure. The water level would peak at [ ], 13 km downstream, approximately 2 hours after commencement of failure. The flood peak would take approximately 7.0 hours to reach Lake Julius Dam. In a Dam Crest flood with failure of the dam, the dam failure was initiated approximately 9.5 hours after the onset of heavy rainfall. In this circumstance, the peak flood level at Lake Julius Dam was reached approximately 5 hours after failure.
Figure 16: Flood Travel Time – Sunny Day Failure

Figure 17: Flood Travel Time – Dam Crest Flood Failure

CONSEQUENCES
The Incremental Population at Risk (PAR) was determined by inspection of the aerial photography of the floodplain downstream of the dam. Buildings located within the flood extent or properties where the depth of floodwater exceeds 0.3 m are considered to lie within the affect zone. The Warrina Park, and are the possible infrastructure and localities that are situated downstream of the Leichhardt River Dam. In addition, four small settlements were identified downstream of Lake Julius. The furthest downstream of these is approximately 200 km downstream of Lake Julius. These properties may potentially be occupied during a dam failure event and therefore, population at risk exists.

In the Sunny Day failure scenario, it is estimated that the PAR is 30 persons. In the DCF with failure, the incremental PAR would be 35 persons.

The failure of the dam would not trigger failure of Lake Julius Dam.

HYDROGRAPHS

Figure C-2: Sunny Day Failure Water Level
Figure C-4: Dam Crest Flood Failure Water Level
Appendix C

Appendix C Weather Information (Flood Warning)

**Using the Internet** - [www.bom.gov.au](http://www.bom.gov.au)

**Flood Warning**

![Flood Warning Image]

**Weather for Wednesday 24 February**

- **Sydney**
  - Now: 28.9°C, NE 20km/h, Sunny.
  - Max: 32°C

- **Melbourne**
  - Now: 24.9°C, SSW 15km/h, Late shower or drizzle.
  - Max: 29°C

- **Brisbane**
  - Now: 29.3°C, NNE 11km/h, Partly cloudy.
  - Max: 33°C

- **Perth**
  - Now: 23.7°C, SW 18km/h, Mostly sunny.
  - Max: 26°C

- **Adelaide**
  - Now: 25.2°C, SSW 17km/h, A little rain.
  - Max: 30°C

- **Hobart**
  - Now: 18.7°C, SE 30km/h, Mostly sunny.
  - Max: 24°C

- **Canberra**
  - Now: 34.8°C, N 36km/h, Mostly sunny.
  - Max: 36°C

- **Darwin**
  - Now: 31.3°C, NW 20km/h, Mostly sunny.
  - Max: 34°C

**Click on this link**

**Click on QLD for Flood Warning**
Queensland Warnings Summary

- Norfolk Island Tropical Cyclone Advice for TC Winston.
- Flood Warning for Thomson, Baroon and Cooper Creek.
- Flood Warning for Georges River and Eryldene Creek.
- Flood Warning Summary for Queensland.
- Norfolk Island Tropical Cyclone Track Map for TC Winston.

Tropical Cyclone Warnings and Information

Queensland Flood Warning information

Radar Images

Place cursor over AUSTRALIA then click Radar Images

Weather for Wednesday 24 February

Sydney
- Now: 28.9° NC 23km/h
- Max: 32° Sunny

Melbourne
- Now: 24.9° SSW 16km/h
- Max: 29° Late shower or drizzle

Brisbane
- Now: 29.3° NNE 11km/h
- Max: 33° Partly cloudy

Perth
- Now: 23.7° SW 17km/h
- Max: 26° Mostly sunny

Adelaide
- Now: 25.2° SSW 17km/h
- Max: 30° Shower or two.

Hobart
- Now: 18.7° N 26km/h
- Max: 24° A little rain

Canberra
- Now: 34.8° SE 20km/h
- Max: 36° Mostly sunny

Darwin
- Now: 31.3° NW 20km/h
- Max: 34° Possible shower or drizzle
Rainfall and River Conditions
Appendix D

Discharge and Storage Curves

Figure D1 – Stage / storage Relationship
Figure D2 – Stage / discharge relationship

<table>
<thead>
<tr>
<th>Dam water level (m) (GMIM datum)</th>
<th>Depth over main spillway (m)</th>
<th>Storage (ML)</th>
<th>Discharge (m$^3$/s)</th>
<th>Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>3405.5</td>
<td>0.0</td>
<td>99,000</td>
<td>0</td>
<td>Spillway (Full Supply Level)</td>
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<tr>
<td>3406.3</td>
<td>0.7</td>
<td>106,076</td>
<td>140</td>
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<td>3406.6</td>
<td>1.0</td>
<td>109,106</td>
<td>271</td>
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<td>3407.2</td>
<td>1.6</td>
<td>120,017</td>
<td>642</td>
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<td>3407.8</td>
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<td>3408.1</td>
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<td>136,383</td>
<td>1433</td>
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<td>5,900</td>
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<td>3411.1</td>
<td>5.6</td>
<td>217,403</td>
<td>7043</td>
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<td>3411.8</td>
<td>6.2</td>
<td>237,306</td>
<td>8647</td>
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<td>3412.7</td>
<td>7.1</td>
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<td>3414.2</td>
<td>8.7</td>
<td>327,827</td>
<td>15827</td>
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</tr>
<tr>
<td>3415.0</td>
<td>9.5</td>
<td>350,000</td>
<td>18375</td>
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</tbody>
</table>

Figure D3 – tabulated values
* AEP storm events represent the expected system response for a theoretical storm occurring across the most adverse temporal distribution, occurring when the dam is at Full Supply Level prior to the storm.

Appendix E

Modified Mercalli Scale

<table>
<thead>
<tr>
<th>No.</th>
<th>Descriptive Term</th>
<th>Description</th>
<th>Acceleration (cm/s²)</th>
</tr>
</thead>
<tbody>
<tr>
<td>I</td>
<td>Imperceptible</td>
<td>Not felt. Marginal and long-period effects of large earthquakes.</td>
<td>&lt;1</td>
</tr>
<tr>
<td>II</td>
<td>Very Slight</td>
<td>Felt by persons at rest, on upper floor, or favourably placed.</td>
<td>1-2</td>
</tr>
<tr>
<td>III</td>
<td>Slight</td>
<td>Felt indoors. Hanging objects swing. Vibration like passing of light trucks. Duration estimated. May not be recognised as an earthquake.</td>
<td>2-5</td>
</tr>
<tr>
<td>IV</td>
<td>Moderate</td>
<td>Hanging objects swing. Vibration like passing of heavy trucks or sensation of a jolt like a heavy ball striking the walls. Standing motor cars rock. Windows, dishes, doors rattle. Glasses clink, crockery clashes. In upper range of IV, wooden walls and frames creak.</td>
<td>5-10</td>
</tr>
<tr>
<td>V</td>
<td>Rather Strong</td>
<td>Felt outdoors; direction estimated. Sleepers waken. Liquids disturbed, some spilled. Small unstable objects displaced or upset. Doors swing, close, open. Shutters, pictures move. Pendulum clocks stop, start, change rate.</td>
<td>10-20</td>
</tr>
<tr>
<td>VIII</td>
<td>Destructive</td>
<td>Steering of motor cars affected. Damage to masonry C: partial collapse. Some damage to masonry B, none to masonry A. Fall of stucco, some masonry walls. Twisting, fall of chimneys, factory stacks, monuments, towers, elevated tanks. Frame houses move on foundations if not bolted down; loose panel walls thrown out. Decayed piling broken off. Branches broken from trees. Changes in flow or temperature of springs and wells. Cracks in wet ground, on steep slopes.</td>
<td>100-200</td>
</tr>
<tr>
<td>IX</td>
<td>Devastating</td>
<td>General panic. Masonry D destroyed; masonry C heavily damaged, sometimes with complete collapse; masonry B seriously damaged. Frame structures, if not bolted, shifted off foundations. Frames cracked. Serious damage to reservoirs. Underground pipes broken. Conspicuous cracks in ground. In alleviated areas sand, mud ejected, earthquake fountains, sand craters.</td>
<td>200-500</td>
</tr>
<tr>
<td>------</td>
<td>-------------</td>
<td>----------------------------------------------------------------------------------------------------------------</td>
<td>---------</td>
</tr>
<tr>
<td>X</td>
<td>Annihilating</td>
<td>Most masonry and frame structures destroyed with their foundations. Some well-built wooden structures and bridges Destroyed. Serious damage to dams, dykes, and embankments. Large landslides. Water thrown on banks of canals, rivers, lakes, etc. Sand and mud shifted horizontally on beaches and flat land. Rails bent slightly.</td>
<td>500-1000</td>
</tr>
<tr>
<td>XI</td>
<td>Disaster</td>
<td>Disaster Rails bent greatly. Underground pipelines completely out of service.</td>
<td>1000-2000</td>
</tr>
<tr>
<td>XII</td>
<td>Major Disaster</td>
<td>Major Disaster Damage nearly total. Large rock masses displaced. Line of sight and level distorted. Objects thrown into the air.</td>
<td>&gt;2000</td>
</tr>
</tbody>
</table>

**Categories of Masonry**

**Masonry A:**

- Good workmanship, mortar and design; reinforced, especially laterally, and bound together using:
  - Steel
  - Concrete etc.
  - Designed to resist lateral forces

**Masonry B:**

- Good workmanship and mortar; reinforced, but not designed in detail to resist lateral forces.

**Masonry C:**

- Ordinary workmanship and mortar; no extreme weaknesses like failing to tie in at corners, but neither reinforced nor designed against horizontal forces.

**Masonry D:**

- Weak materials such as:
  - Adobe
  - Poor mortar
  - Low standards or workmanship
  - Weak horizontally
Appendix F

EMERGENCY RESOURCES

In an emergency situation, equipment, supplies and construction personnel will likely be needed on short notice. The table below lists general emergency resources, and also indicates how to access them.

<table>
<thead>
<tr>
<th>Item</th>
<th>Contact/Telephone</th>
<th>Location</th>
</tr>
</thead>
<tbody>
<tr>
<td>General</td>
<td>Remploy 4743 4190</td>
<td>101 Duchess Road Mt Isa</td>
</tr>
<tr>
<td>Front end Loader</td>
<td>Remploy 4743 4190</td>
<td>101 Duchess Road Mt Isa</td>
</tr>
<tr>
<td>Excavators</td>
<td>Remploy 4743 4190</td>
<td>101 Duchess Road Mt Isa</td>
</tr>
<tr>
<td>Sand &amp; Gravel</td>
<td>Remploy 4743 4190</td>
<td>101 Duchess Road Mt Isa</td>
</tr>
<tr>
<td>Sandbags</td>
<td>IDC Store 4744 2350</td>
<td>Mount Isa Mines</td>
</tr>
<tr>
<td>Pumps</td>
<td>Coates Hire 47491902</td>
<td>Barkly Highway Mt Isa</td>
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<tr>
<td>Labourers’</td>
<td>Remploy 4743 4190</td>
<td>101 Duchess Road Mt Isa</td>
</tr>
<tr>
<td>Tradesmen</td>
<td>Schmider 0403 045 588</td>
<td>Commercial Road Mt Isa</td>
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<tr>
<td></td>
<td>Custom Steel Fabrication</td>
<td>2 Traders Way Mt Isa</td>
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<tr>
<td></td>
<td>0447 011 412</td>
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</tr>
<tr>
<td>Pipe</td>
<td>One Steel 4743 4089</td>
<td>45 Commercial Road Mt Isa</td>
</tr>
<tr>
<td>Helicopter</td>
<td>NQ Rescue Helicopter 4743 0937</td>
<td>Mount Isa Airport</td>
</tr>
</tbody>
</table>
Appendix G

DAM SAFETY EMERGENCY SITUATION REPORT

Central Engineering – Lake Moondarra Dam Wall Weekly Inspection

Data Record – Weekly Inspection

SAMPLE RECORD SHEET

(To be completed by the Water Distribution Inspector / Caretaker and entered into the Log Book along with any accompanying photographs)

DATA RECORDS: LEICHHARDT RIVER DAM (LAKE MOONDARRA DAM WALL) WEEKLY INSPECTION

<table>
<thead>
<tr>
<th>ITEM</th>
<th>SATISFACTORY</th>
<th>DETAILS / COMMENT</th>
</tr>
</thead>
<tbody>
<tr>
<td>Date and time</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Weather conditions</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Record reservoir water surface level</td>
<td></td>
<td></td>
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<tr>
<td>Spillway discharge</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>VISUAL INSPECTION</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>• Crest of dam</td>
<td></td>
<td></td>
</tr>
<tr>
<td>• Upstream and downstream faces</td>
<td></td>
<td></td>
</tr>
<tr>
<td>• Downstream toe of abutments</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**GENERAL COMMENTS**

Carried out by: ___________________________  Signature: ___________________________

Date: ____/____/____

Unless stamped in RED, this is an ‘Uncontrolled Document’
# Data Record – Monthly Inspection

**SAMPLE RECORD SHEET**
(To be completed by the Water Distribution Inspector / Caretaker and entered into the Log Book along with any accompanying photographs)

**DATA RECORDS:** LEICHHARDT RIVER DAM (LAKE MOONDARRA DAM WALL) MONTHLY INSPECTION

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<th>DETAILS / COMMENT</th>
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<td>Date and time</td>
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<tr>
<td>Weather conditions</td>
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<tr>
<td>Record reservoir water surface level</td>
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<tr>
<td>Spillway discharge</td>
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<tr>
<td><strong>VISUAL INSPECTION</strong></td>
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<tr>
<td>• Crest of spillway</td>
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<tr>
<td>• Auxiliary spillways</td>
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<tr>
<td>• Crest of dam</td>
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<td></td>
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<tr>
<td>• Upstream and downstream faces</td>
<td></td>
<td></td>
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<tr>
<td>• Downstream toe of abutments</td>
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<tr>
<td>• Seepage on:</td>
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<tr>
<td>- Downstream face</td>
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<td>- Abutments</td>
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<tr>
<td>- Veer-notch flow</td>
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<td>- Downstream of wall</td>
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<td><strong>MISCELLANEOUS</strong></td>
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<td>• Changes to normal operating procedure</td>
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<td>• Unusual conditions or occurrences</td>
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<tr>
<td><strong>GENERAL COMMENTS:</strong></td>
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</tr>
</tbody>
</table>

Carried out by: ____________________________  Signature: ____________________________

Date: ___/___/____

Unless stamped in RED, this is an ‘Uncontrolled Document’
DAM SAFETY EMERGENCY SITUATION REPORT

Photocopy and fill-out after termination of Emergency Situation.
Complete ALL sections that are applicable to the situation.

Dam Name: _______________________________________________________________

Dam Location: _____________________________________________________________

Date: ___________________________ Time: _____________________________

Weather Conditions: _______________________________________________________

General Description of Emergency Situation: _________________________________

Area(s) of Dam Affected: ___________________________________________________

Extent of Dam Damage: ____________________________________________________

Possible Cause(s): _________________________________________________________

Effect on dam’s operation: _________________________________________________

Effect on operational capabilities of outlet works: _____________________________

Initial Reservoir Elevation: ___________________________ Time: _________________

Maximum Reservoir Elevation: ___________________________ Time: _______________

Final Reservoir Elevation: ___________________________ Time: _________________

Description of area flooded downstream/damages/injuries/loss of life: ____________

________________________________________________________________________

Other Data and Comments: _________________________________________________

________________________________________________________________________

Observer’s name and telephone number: ________________________________
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<th>Action Item</th>
<th>Action Resolution/Completion</th>
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<td>5.</td>
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**Distribution List:**

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<th>Author’s Signature:</th>
<th>(Print name, then sign.)</th>
<th>(Date)</th>
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</thead>
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Utilities Water Distribution Department
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<th>FEBRUARY</th>
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<th>MAY</th>
<th>JUNE</th>
<th>JULY</th>
<th>AUGUST</th>
<th>SEPTEMBER</th>
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Appendix H

Standard phone, SMS and email messages to the immediately affected downstream residents and others

** ALERT NOTIFICATION FOR** – 4.3.1 (LDMG, GMIMSC, LJSS)

Dam: Leichhardt River Dam

Event: 4.3.1 Dam spillway overtopping, increased downstream flows expected. Flood at XXXX (XXX below Abutment Crest Level).

Act Level: Alert. Moderate flooding possible.

Notification Updates: 24 hourly.

Refer: [www.bom.gov.au](http://www.bom.gov.au) and contact Local Emergency Mgt. Group on [Tel No] for more details

** ALERT NOTIFICATION FOR** – 4.3.2 (LDMG, 20kRes, GMIMSC, DNRME, MIWB, LJSS)

Dam: Leichhardt River

Event: 4.3.2 Flood at XXXX and (rising / steady / falling).

Act Level: Lean Forward. Moderate flooding expected.

Notification Updates: 8 hourly updates.

Refer: [www.bom.gov.au](http://www.bom.gov.au) and contact Local Emergency Mgt. Group on [Tel No] for more details

** ALERT NOTIFICATION FOR** – 4.3.3 (Emergency Services, LDMG, GMIMSC, 20kRes, LJSS, DNRME, MIWB)

Dam: Leichhardt River

Event: 4.3.3 Flood at XXXX and (rising / steady / falling).

Act Level: Stand Up. High level of flooding expected.

Notification Updates: Every 8 hours

Refer: **Immediately contact** the Local Emergency Mgt. Group on [Tel No] for more details

** ALERT NOTIFICATION FOR** – 4.3.4 (LDMG, 20kRes, GMIMSC, DNRME, MIWB, LJSS)

Dam: Leichhardt River

Event: 4.3.4 Flood levels receding.

Act Level: Stand Down. No further updates pending.

Notification Updates: IPGM to notify all previously contacted parties of the intent to move activation level to Stand Down.

Refer: [www.bom.gov.au](http://www.bom.gov.au) and contact Local Emergency Mgt. Group on [Tel No] for more details
**ALERT NOTIFICATION FOR** – 4.4.2 (LDGM, 20kRes, GMIMSC, DNRME, MIWB)

Dam: Leichhardt River

Event: 4.4.2 Potential structural integrity issue identified

Act Level: Lean Forward.

Notification Updates: After structural engineer can confirm integrity or 48 hours without further damage.

Refer: Contact the Local Emergency Mgt. Group on [blank] for more details

**ALERT NOTIFICATION FOR** – 4.4.3 (Emergency Services, LDMG, GMIMSC, 20kRes, LJSS, DNRME, MIWB)

Dam: Leichhardt River

Event: 4.4.3 – Dam structural condition identified with dam failure potential.

Act Level: Stand Up.

Notification Updates: After structural engineer can confirm integrity or 48 hours without further damage

Refer: **Immediately contact** the Local Emergency Mgt. Group on [blank] for more details

**ALERT NOTIFICATION FOR** – 4.5.2 (Emergency Services, GMIMSC, 20kRes, DNRME, MIWB)

Dam: Leichhardt River

Event: Contamination of Dam Water Supply

Act level: Lean Forward.

Notification Updates: Until the emergency response teams can confirm contamination is under control.

Refer: Contact the Local Emergency Mgt. Group on [blank] for more details

**ALERT NOTIFICATION FOR** – 4.5.3 (Emergency Services, LDMG, GMIMSC, 20kRes, LJSS, DNRME, MIWB)

Dam: Leichhardt River

Event: Contamination of Dam Water Supply

Act level: Stand Up.

Notification Updates: Weekly or until an environmental assessment can confirm contamination is not a threat.

Refer: **Immediately contact** Local Emergency Mgt. Group on [blank] for more details
**ALERT NOTIFICATION FOR** – 4.6.2 (Emergency Services, GMIMSC, 20kRes, DNRME, MIWB)

Dam: Leichhardt River  
Event: Terrorist/Security Threat  
Act level: Lean Forward.  
Notification Updates: After structural engineer can confirm integrity or 48 hours without further damage  
Refer: Contact the Local Emergency Mgt. Group on [Insert Contact Information] for more details

**ALERT NOTIFICATION FOR** – 4.6.3 (Emergency Services, LDMG, GMIMSC, 20kRes, LJSS, DNRME, MIWB)

Dam: Leichhardt River  
Event: Terrorist/Security Threat  
Act level: Stand Up.  
Notification Updates: After structural engineer can confirm integrity or 48 hours without further damage  
Refer: **Immediately contact** Local Emergency Mgt. Group on [Insert Contact Information] for more details
Appendix I

Public Access to Notification List Via Internet

**USING THE INTERNET** -
http://www.mountisamines.com.au

Click on Sustainability

Click on this link
Click here for access to supply personal information to receive emergency notifications.

1. Fill out appropriate fields.
2. Click on drop down box and select Lake Moondarra.
3. Press Submit.