5 Summary of written Dam Failure Impact Assessment requirements

The following information is to be included in a written Dam Failure Impact Assessment

Executive Summary/Introduction

A general description of the dam and a summary of the results of the failure impact assessment including:

- Type of dam
- General location of the dam
- Height and storage capacity of the dam
- The maximum population at risk
- A description of the critical failure event producing the maximum population at risk
- The recommended failure impact assessment category for the dam.

General Information

- Name of dam.
- Owner of dam (ie individual or company).
- Dam owner contact details (ie postal address, street address, phone number, facsimile, email).
- Status of dam (ie existing or proposed dam or proposed work).
- Property description of dam (for main part of dam wall including portion, parish, county and locality).
- Location of dam (ie longitude and latitude).
- Date dam construction completed to current arrangement.
- Licence or development permit number (if any).
- Date last failure impact assessment accepted by the chief executive.
- Date last failure impact assessment submitted to the chief executive.
- Attach relevant maps (including map number, scale, map date and height accuracy). Copies of inundation maps in electronic format are also desirable.
- Attach copies of relevant aerial photographs (if any) (including photographic series name, film number, run number, approximate scale, date flown, photograph number(s)).
- Attach other topographic or cadastral source data (eg detailed survey plans, orthographic maps, property boundary details).
- Name of watercourse or offstream storage (including adopted middle thread distance (AMTD) measured in kilometres).

Catchment details

- Catchment area (hectares).
- Catchment general description.
- Percentage of catchment which has:
  - bare ground, rock, pavements, roofs, city areas (fully built)
  - rocky, clayey or non-absorbent soil with scanty herbage
  - open forest or grassed land, cereal crops
  - average grassed timberland of medium soil texture
  - heavily timbered country, closely cultivated land and pasture
  - sand.
- Average catchment slope.

Dam description

- Type (ie homogenous earthfill dam, zoned earth and rockfill dam, concrete dam or other).
- Height (ie the measurement of the difference in level between the natural bed of the watercourse at the downstream toe of the dam or, if the dam is not across a watercourse, between the lowest elevation of the outside limit of the dam and the top of the dam).
- Total length of main dam (ie metres from end of left abutment to end of right abutment).
- Total length and brief description of other dam components (eg saddle dams).
- Saddle dam details
- Purpose of storage (eg water supply for irrigation).
- Dam capacity to full supply level (in megalitres).

- Dam surface area at Full Supply Level
- Details of the storace capacity curve used in the analysis

Spillway description

- Type of spillway.
- Dimensions of spillway.

Data

- Summary of the data collected for the analysis and an assessment of the appropriateness and accuracy of the data.
- Summary of the findings/verification of the site including details of who undertook the inspection and inspection date(s).
- Spillway rating curve used in the analysis
- Details of the critical flood used in the analysis and a summary of the methodology used to derive it.

Results and discussion

- Analytical technique used (ie two-dimensional flow analysis, simplified assessment or comprehensive assessment or a combination of these) and justification for use.
- Details of modelling used including:
  - model or models used in the analysis
  - breach parameters adopted and the basis for their adoption
  - hydrological inputs used
  - statement of calibration data used to validate the models generated
  - degree of extrapolation adopted
  - cross-sections used and roughness parameters adopted
  - predicted accuracy of the modelling, both in terms of flood levels and the population at risk
  - statement on the sensitivity of the model results to the various adopted parameters with supporting evidence drawn from the modelling undertaken.
- Failure events considered.
- Reasonable upper and lower limits of population at risk as a result of the analysis.
- Recommended failure impact rating (i.e. category 1 or 2 failure impact rating or not referable) and the critical dam failure condition determining this rating.
- Failure impact zone accounting for sufficient points of impact for all relevant failure events including map showing the extent of the failure impact zones (hard copy mandatory and electronic format desirable).
- Incremental population at risk for all relevant failure events (including the nature of the site and justification for the populations used for places of occupation not listed in Appendix A).
  Statement on the range of population at risk that can be reasonably expected for the critical case as a result of the analyses.
- Detailed summary of the buildings and other places of occupation containing population at risk, and the location of this population.
- Details of dam break analyses.
- Commentary on sensitivity analyses.

Certifying Registered Professional Engineer

- Name.
- Registration number.
- Contact details (including postal address, street address, telephone number, facsimile, email as appropriate).
- Statement that he or she is not the owner or operator, an employee of the owner or operator
- Statement of certification (refer to section 3.2 for details of what is required in this statement).
- Signature.
- Date.

6 Bibliography

6.1 Papers

Allen, P.H. (1994) "Dam Break Breach Mechanisms", ANCOLD Bulletin No.97, August.

Wang, J.S., Ni., H.G. and He, Y.S. (2000), "Finite Difference TVD Scheme for Computation of Dam Break Problems" , Journal of Hydraulics Division ASCE, Volume 126 (4), April.

Zoppou, C and Roberts, S., (1999), "Catastrophic Collapse of Water Supply Reservoirs in Urban Areas" 1999, Journal of Hydraulics Division ASCE, Volume 125 (7), July.

6.2 Software

Standard commercial packages capable of determining inundated areas for two-dimensional flow include:

- MIKE21 - Danish Hydraulic Institute
- DELFT-FLS - Delft Hydraulics.

Standard commercial packages useful for dam break analysis include:

- BOSS FLOODWAV, NWS DAMBRK (Version 3.0) - International
- MIKE 11 - Danish Hydraulics Institute
- RUBICON.

7 Appendices

7.1 Appendix A - Default Populations

Nature of Buildings or Other Places of Occupation	Equivalent Population
Detached housing [1]	2.9 per house
Semi-detached, row or terrace housing [1]	2.0 per house
Multi-unit buildings [1]	1.7 per unit
Blocks of flats [1]	1.7 per flat
House or flat attached to a shop, office, etc. [1]	2.5 per house or flat
Approved caravan parks [1,16]	1.8 per caravan site
Approved camping grounds [2,16]	0.45 per camping site
Hotel/motel accommodation [3]	1.0 per bedroom
Child-care centres [4]	0.4 per child and staff member
Kindergartens; Pre-schools [5]	0.25 per student and staff member
Primary schools (day) [5]	0.25 per student and staff member
High schools (day) [6]	0.3 per student and staff member
Tertiary education centres [7] lectures - day lectures - evening	 0.35 per student and staff member attending during the day 0.15 per student and staff member attending during the night
Offices [8]	0.4 per employee
Restaurants [9]	0.3 per member of staff and diner's places
Medical centres [10]	1.7 per member of staff
Tavern/hotel bars [11]	0.15 per m^2 of patrons' area
Shops; Shopping centres [12]	2.0 per 100 m^2 of gross area
Hospitals [13]	1.0 per bed plus 0.33 times the total number of staff
Institutional accommodation [14]	1.0 per bed plus 0.33 times the total number of staff
Service stations [15]	0.4 times the total number of staff
Industrial buildings and other non-residential sites	0.4 times the total number of staff
Department of Transport Moorings	2.0 per mooring

Notes:

1. The occupancies for these dwellings are derived from the overall Queensland figures for "persons, by dwelling structure" and occupied "dwelling structures, by tenure type (private dwellings)" in the 1996 census.
2. This occupancy comes from an analysis of 1999 figures for the number of permits issued, the numbers of campers per permit and the duration of each permit for 20 camping grounds under the control of the Department. The average number of campers per permit was 3.0 and the average site occupancy rate was 14.5%. Therefore an average occupancy value of 0.45 campers per site has been adopted.
3. This occupancy assumes that a hotel/motel bedroom will typically accommodate 2 people, who will be present for half of any one day, and that number of staff will compensate for the fact that generally not all rooms will be (fully) occupied.
4. This occupancy is based on a typical 9.5 hour day (8:00-5:30).
5. These occupancies are based on a typical 6 hour day (9:00-3:00).
6. This occupancy is based on a typical 7 hour day (8:30-3:30).
7. These occupancies are based on a typical 8 hour day (9:00-5:00) for day lectures and a typical 3 hour day (6:00-9:00) for evening lectures.
8. This occupancy is based on a typical 9 hour day (8:30-5:30).
9. This occupancy is based on the following assumed patronage:
   a. 10% full-9:00 am - noon, 2:00 pm - 6:30 pm
   b. full-noon - 2:00 pm, 6:30 pm - 10:30 pm
   c. staff numbers are 10% of number of places.
10. This occupancy is based on a 10 hour day (8:00-6:00) and assumes 3 patients at the location for each doctor and other staff member.
11. This occupancy is based on the following assumed breakdown of daily patronage:
    a. 10% of daily peak-10:00 am - noon
    b. daily peak-noon - 2:00 pm
    c. 15% of daily peak-2:00 pm - 5:00 pm
    d. daily peak-5:00 pm - 7:00 pm
    e. 50% of daily peak-7:00 pm - 8:00 pm
    f. 25% of daily peak-8:00 pm - 10:00 pm.

The Liquor Licensing Division of the Department of Tourism and Racing cited maximum numbers of patrons as $2/m^2$ standing and $1/m^2$ dining. The occupancy rate is therefore based on an assumed annual average for the daily peak patronage of 0.6/m2 plus a 10% allowance to cover staff.

12. This occupancy rate is an estimate based on Appendix B of Volume 1 of the Department of Natural Resource Guidelines for Planning and Design of Sewerage Schemes.
13. The occupancy rate of 1.0 per bed assumes that the number of visitors will compensate for the fact that generally not all beds will be occupied. The staff factor applies to the sum of the numbers of staff on different shifts.
14. These occupancies are identical to those for hospitals. It has been assumed that lower visitor numbers will offset the higher "bed" occupancy ratio for institutions.
15. This occupancy rate applies to the sum of the numbers of staff on different shifts. It contains a 20% allowance to cover customers.
16. Only camping areas and caravan parks approved by government agencies (local, state or federal) or included in local authority planning schemes should be included. Because of the difficulties associated with determining the number of sites, and their permanence, of non-approved camping grounds and caravan parks, they are excluded from assessment.

7.2 Appendix B - Definitions

Annual exceedance probability is the probability that a particular flood value will be exceeded in any one year.

Bed and banks for a watercourse or lake is the land over which the water within the watercourse or lake normally flows or the land normally covered by that water, whether permanently or intermittently. This does not include land adjoining or adjacent to the bed or banks that is from time to time covered by floodwater.

Dam means:

1. (a) works that include a barrier, whether permanent or temporary, that does or could or would impound water; and
   (b) the storage area created by the works.
2. The term includes an embankment or other structure that controls the flow of water and is incidental to works mentioned in item 1(a).
3. The term does not include the following-
   (a) a rainwater tank;
   (b) a water tank constructed of steel or concrete or a combination of steel and concrete;
   (c) a water tank constructed of fibreglass, plastic or similar material.

Dam break flood is the flood event produced by a dam failure.

Dam crest flood is the flood event which, when routed through the storage with the storage initially at full supply level, results in a still water level in the storage, excluding wind and wave effects which:

- for an embankment dam, is the lowest point of the embankment crest.
- for a concrete dam, is the level of the non-overflow section of the dam, excluding handrails and parapets if they do not store water against them.
- for a concrete faced rockfill dam, is the lowest point of the crest structure.

Dam failure is the physical collapse of all or part of a dam or the uncontrolled release of any of its contents.

Dam failure impact assessment is an assessment about the safety of a dam or proposed dam certified:

(a) by a registered professional engineer who is not, for the dam, or the proposed dam -
   (i) the owner or
   (ii) an employee of the owner or
   (iii) the operator or
   (iv) an employee of the operator and
(b) in accordance with the guidelines for failure impact assessment of water dams issued by the chief executive.

Development has the meaning given by the *Integrated Planning Act 1997*, section 1.3.2.

Development permit is a development permit as defined under the *Integrated Planning Act 1997.*

Failure impact zone is the area affected by the failure of the dam. The zone is limited to the area where the incremental effect of a dam break flood is 300 mm or higher.

Full supply level is the level of the water surface when the water storage is at maximum operating level when not affected by flood.

Hazardous waste is 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.

Height for a weir, barrage or dam, means the measurement of the difference in level between the natural bed of the watercourse at the downstream toe of the barrier or, if the barrier is not across a watercourse, between the lowest elevation of the outside limit of the barrier and the top of the barrier.

Incremental effect is the difference between flood impact that what would occur under a given set of conditions with no dam break and the flood impact under the same set of conditions with a dam failure.

Information notice for a decision under the *Water Act 2000*, means a notice stating the following:

(a) the decision
(b) the reasons for the decision
(c) that the person given the notice may appeal against the decision, or apply for arbitration within 30 business days after the day the notice is given and how the person may appeal or apply.

Owner of land means any of the following, and includes the occupier of the land:

(a) the registered proprietor of the land
(b) the lessee or licensee under the *Land Act 1994* of the land
(c) the holder of a mineral development licence or mining lease under the *Mineral Resources Act 1989*
(d) the person or body of persons who, for the time being, has lawful control of the land, on trust or otherwise
(e) the person who is entitled to receive the rents and profits of the land.

Owner of a referable dam means the owner of land on which the referable dam is constructed, or is to be constructed.

Population at risk is the number of persons, calculated using these guidelines, whose safety will be at risk if the dam, or the proposed dam after its construction, fails. For the purposes of this guideline, persons are considered to be at risk if they are within the failure impact zone.

Probable maximum flood is the flood resulting from probable maximum precipitation, and where applicable snow melt, coupled with the worst conditions that can be realistically expected in the prevailing meteorological conditions.

Probable maximum precipitation is the theoretical greatest depth of precipitation for a given duration that is physically possible over a particular catchment area, based on generalised methods.

Referable dam is a dam or a proposed dam:

(a) which must have a dam failure impact assessment carried out under the *Water Act 2000*; and
(b) the assessment states that the dam, 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 487, accepted the assessment.

The following are not referable dams:

(a) a dam containing, or a proposed dam that after its construction will contain, hazardous waste.
(b) a weir, unless the weir has a variable flow control structure on the crest of the weir.

The following are not dams are cannot therefore be referable dams:

(a) a rainwater tank;
(b) a water tank constructed of steel or concrete or a combination of steel and concrete;
(c) a water tank constructed of fibreglass, plastic or similar material.

Registered professional engineer is a registered professional engineer, a registered professional engineering company or a registered professional engineering unit as defined under the *Professional Engineers Act 1988* (Qld).

Ring tank is a dam that has a catchment area that is less than 3 times its maximum surface area at full supply.

Storage capacity means the capacity of water ordinarily stored in a thing.

Top of the barrier for a weir, barrage or dam, means the level of the top of the barrier exclusive of any parapet or ancillary structure or, if the barrier includes a spillway, the level of the top of the abutment walls adjoining the spillway exclusive of any parapet or ancillary structure.

Water means -

(a) water in a watercourse, lake or spring; or
(b) underground water; or
(c) overland flow water; or
(d) water that has been collected in a dam

and includes any other liquid or a mixture that includes water or any other liquid or suspended solid[6].
Weir means a barrier constructed across a watercourse below the banks of the watercourse that hinders or obstructs the flow of water in the watercourse.

6 Refer to s.480 which contains a definition for water for the division dealing with referable dams and flood mitigation.

Queensland
Government

Natural Resources
and Mines

DEPARTMENT OF NATURAL RESOURCES AND MINES

GUIDELINES FOR FAILURE IMPACT ASSESSMENT OF WATER DAMS

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