

## **Appendix A**

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Statutory context and approvals process

## A. Statutory context and approvals process

### A.1 Planning and approvals process

#### A.1.1 Part 3A of the Environmental Planning and Assessment Act 1979

Part 3A ('Major Infrastructure and other Projects') of the *Environmental Planning and Assessment Act 1979* (EP&A Act) was introduced in 2005 and allows for the determination of 'major projects' through a single assessment process. The Minister for Planning (the Minister) is the consent authority and the Director-General of the Department of Planning (the Director-General) is the assessment authority for projects assessed under Part 3A.

Part 3A of the EP&A Act consolidates the assessment and approval process for all major projects as defined under the State Environmental Planning Policy (Major Projects) 2005. Section 75U of the EP&A Act eliminates a range of concurrent approvals that might otherwise be required for such projects under other legislation.

Pursuant to Section 75B(1) of the EP&A Act, by order of the Minister all projects that would otherwise require an environmental impact statement pursuant to Part 5 of the Act would be assessed under Part 3A of the Act. The Minister published a standing order in Government Gazette No. 96 on 29 July 2005 that recognised the following as development to which Part 3A applies:

Development that is an activity for which the proponent (that is not a local council or county council) is also the determining authority and that, in the opinion of the proponent, would (but for this order) require an environmental impact statement to be obtained under Part 5.

*Section A.4.3* establishes that (the proposed Keepit Dam Upgrade) does not require the consent of Tamworth Regional or Gunnedah Shire Councils. In accordance with Section 112 of the EP&A Act, the State Water Corporation is required to consider whether the proposed activity is likely to have any significant impact on the environment, including significant impacts on critical habitat or threatened species, populations or ecological communities and their habitats, and, therefore, whether it is required to prepare an environmental impact statement. State Water is of the opinion that, in the absence of Part 3A of the EP&A Act, the proposal would require the preparation of an environmental impact statement. Therefore, given the standing order issued by the Minister, Part 3A of the EP&A Act applies to the proposed Keepit Dam upgrade.

## A.2 Commonwealth environmental legislation

The Commonwealth *Environment Protection and Biodiversity Conservation Act 1999* (the EPBC Act) is the principal Commonwealth environmental statute in Australia. Under Part 3 of the EPBC Act, an approval from the Commonwealth Minister for the Environment and Heritage is required for:

- An action that is likely to have an effect on specified 'matters of national environmental significance'.
- An action that is carried out by a Commonwealth agency or in a 'Commonwealth area' and is likely to have a significant impact on the environment.

If a proposed action is considered to have the potential to affect the triggers identified above, the person proposing to take the action should refer the proposed action to the Minister for the Environment and Heritage to determine whether an approval is required.

A search of the EPBC Act protected matters database for an area of 10 kilometres radius from the main dam wall was conducted on 25 January 2006. The results of this search are summarised in *Table A.1*.

**Table A.1 EPBC Act protected matters search result**

Matters of national environmental significance	Search result
World Heritage properties	None
National heritage places	None
Wetlands of international significance: (Ramsar sites)	None
Commonwealth marine areas	None
Threatened ecological communities	The threatened ecological community Grassy White Box Woodlands is located within 10 kilometres of the main dam wall. The preliminary ecological assessment completed by PB (2005) established that the proposal is likely to have an effect on the Grassy White Box Woodlands (White Box Open Woodland) and would trigger an EPBC Act referral. Further investigations will need to be undertaken to ascertain the extent and severity of the proposal's effect on these threatened species and ecological communities.
Threatened species	20 threatened species or their habitat may be located within 10 kilometres of the main dam wall. Further investigations would need to be undertaken to determine the proposal's impact on these threatened species.

Matters of national environmental significance	Search result
Migratory species	Five migratory species or their habitat may be located within 10 kilometres of the main dam wall, and a further one migratory species is likely to breed in the area. Further investigations would need to be undertaken to determine the proposal's impact on these migratory species.
Other protected matters	
Commonwealth lands	Commonwealth land associated with the Communications, Information Technology and the Arts (Telstra Corporation Limited) is located within 10 kilometres of the main dam wall.
Commonwealth heritage places	None
Places on the Register of the National Estate	None
Listed marine species	10
Whales and other cetaceans	None
Critical habitats	None
Commonwealth reserves	None
Nuclear actions	No nuclear actions are proposed or would be affected by the proposal.

Based on the outputs of the EPBC Act Protected Matters Search Tool, the proposal is considered likely to have an effect on at least one matter of national environmental significance (the endangered ecological community White Box Open Woodland) and, as such, the proposal would need to be referred to the Commonwealth Minister for the Environment and Heritage pursuant to the EPBC Act.

## A.3 State legislation

As noted in *Section A.1.1*, Part 3A of the EP&A Act consolidates the assessment of major projects into a single process by eliminating a range of approvals that might otherwise be required under other State legislation. Additional approvals which may be required for the proposal are summarised in *Table A.2* while those which are no longer required because of the action of Part 3A are listed beneath the table.

**Table A.2 Summary of applicable state legislation and approvals**

Provision	Requirement	Required Action	Agency
<b>Protection of the Environment Operations Act 1997</b>			
Section 48	Environmental Protection Licence for various construction activities	Apply for an Environmental Protection Licence during construction	Department of Environment and Conservation
<b>Water Act, 1912</b>			
Section 10	Approval for extraction of water from a river or lake (if required).	Apply for approval if water is required to be sourced through direct extraction from surface waters	Department of Natural Resources
<b>Roads Act 1993</b>			
Section 138	Consent for activities involving modifications to or construction over/under a public road	Concurrence must be sought from road owner (as required)	Local Council
<b>Crown Lands Act 1989</b>			
Section 34A	Ministerial approval to grant a 'relevant interest' over a Crown Reserve if required. (Land is generally owned by the Ministerial Water Administration Council. State Park land is administered by the Department of Lands through Section 25A - Crowns Land Consolidation Act 1919 which encumbrances the State Park land)	The State Park area will be impacted by the proposed upgrade. Consultation should be conducted with the Department to ensure that appropriate approval is obtained if necessary.	Department of Lands.

Provision	Requirement	Required Action	Agency
<b>Fisheries Management Act 1994</b>			
Section 218	Provision for Minister to require the construction of a fish way or bypass.	Consult with the Department regarding the feasibility of a fish way or bypass to enable fish to pass through or over the dam, or consider an offset arrangement.	Department of Primary Industries
<b>National Parks and Wildlife Act, 1974</b>			
Clause 8, Schedule 3	States that any reference to a State Park shall be read as a reference to a national park under this Act. (Land is generally owned by the Ministerial Water Administration Council. State Park land is administered by the Department of Lands through Section 25A - Crowns Land Consolidation Act 1919 which encumbrances the State Park land)	The State Park area will be impacted by the proposed upgrade. Consultation should be with the Department to ensure that appropriate approval is obtained (if necessary).	Department of Environment and Conservation

As the proposed upgrade will be assessed under Part 3A of the *EP&A Act* a number of other licences and approvals are no longer required under other Acts. These include:

- concurrence under Part 3 of the *Coastal Protection Act 1979*
- a permit under section 201, 205 or 219 of the *Fisheries Management Act 1994*
- an approval under Part 4 or permit under section 139 of the *Heritage Act 1977*
- a permit under section 87 or consent under section 90 of the *National Parks and Wildlife Act 1974*
- authorisation under section 12 of the *Native Vegetation Act 2003* to clear native vegetation
- a permit under Part 3A of the *Rivers and Foreshores Improvement Act 1948*

- a bush fire safety authority under section 100B of the *Rural Fires Act 1997*, and
- a water use approval under section 89, a water management work approval under section 90 or an activity approval under section 91 of the *Water Management Act 2000*.

## A.4 Local, regional and state planning instruments

Figure 1.2 of the main document shows the relevant local government areas in the vicinity of the proposal.

### A.4.1 Gunnedah Local Environmental Plan 1998

The *Gunnedah Local Environmental Plan 1998* (the Gunnedah LEP) is the principal planning instrument guiding land use and development decisions in the Gunnedah local government area. The plan categorises land into land use zones and provides for the permissibility of development within each zone.

Land in the vicinity of the proposal is zoned *1(a) Rural (Agricultural Protection)* under the Gunnedah LEP. The objectives of the *1(a) Rural (Agricultural Protection)* zone are identified in the Gunnedah LEP and are to:

- a. to protect the use and efficiency of prime agricultural land while permitting appropriate development subject to suitable subdivision controls
- b. to permit other forms of development which are ancillary to rural land uses or that, as a result of their nature, require siting outside the urban area
- c. to avoid further fragmentation and alienation of useable rural land
- d. to retain the low density nature of settlement within the rural areas and ensure that any future development does not create unreasonable demands on the existing infrastructure or available services
- e. to provide for the requirements of the rural community
- f. to maintain safety and convenience along main roads by discouraging uses that are likely to generate traffic volumes which disrupt traffic flow
- g. to ensure that the existing level of scenic amenity is maintained by requiring development to have regard for significant ridgelines and hilltops.

Use of the Keepit Dam site for the storage of water for agricultural irrigation uses is consistent with that objective for the *1(a) Rural (Agricultural Protection)* zone that seeks to provide land for the requirements of the rural community. The proposed Keepit Dam upgrade is consistent with the

objectives of the zone and would represent a continuation of the use of the site for its current purpose.

The Gunnedah LEP defines a 'public utility undertaking' as follows:

public utility undertaking means any of the following undertakings carried on or permitted or suffered to be carried on by or by authority of any government department or under the authority of or in pursuance of any Commonwealth or State Act:

(a) railway, road transport, water transport, air transport, wharf or river undertakings,

(b) undertakings for the supply of water, hydraulic power, electricity or gas or the provision of sewerage or drainage services,

and a reference to a person carrying on a public utility undertaking includes a reference to a council, county council, government department, corporation, firm or authority carrying on the undertaking.

The Gunnedah LEP permits public utility undertakings in the *1(a) Rural (Agricultural Protection)* zone without the consent of council.

#### **A.4.2 Tamworth Regional local government area**

Following an inquiry conducted in 2003-2004, the new Peel Regional Council was proclaimed on 17 March 2004 and commenced operations on 17 March 2004. The Peel Regional Council was formed as a result of an amalgamation of the Barraba, Manilla, Nundle, Parry (part) and Tamworth City local government areas. Following a request from Council, the name Peel Regional Council was changed to Tamworth Regional Council by amending proclamation, which was signed by the Lieutenant Governor on 31 March 2004.

An LEP for the Tamworth Regional local government area has not yet been prepared. In the absence of a new LEP, The LEPs for the pre-amalgamation areas remain applicable. The relevant LEPs for land potentially impacted by the proposal are the *Manilla Local Environmental Plan 1988* (Manilla LEP) for land upstream of the dam wall, and the *Parry Local Environmental Plan 1987* (Parry LEP) for land downstream of the dam wall.

##### **Manilla Local Environmental Plan 1988**

The Manilla LEP is the principal planning instrument guiding land use and development decisions for the former Manilla local government area. The plan categorises land into land use zones and provides for the permissibility of development within each zone.

Land upstream of the Keepit Dam in the former Manilla local government area is zoned *1(a) (General Rural Zone)* under the Manilla LEP. The operation of the proposed dam upgrade may result in the inundation of land zoned *1(a)*

(*General Rural Zone*) in the former Manilla local government area during extreme flood events.

The objectives of the *1(a) (General Rural Zone)* are identified in the Manilla LEP and are:

- a) to enable development for purposes that are:
  - (i) appropriate in a rural location, and
  - (ii) sympathetic with the environmental characteristics of the land and the costs of providing public services and amenities,
- (b) to promote efficient sustainable agricultural utilisation of agricultural land, particularly prime crop and pasture land,
- (c) to facilitate farm adjustments,
- (d) to conserve prime crop and pasture land by ensuring that:
  - (i) it is not unnecessarily converted to non-agricultural purposes, and
  - (ii) any allotment created for an intensive agricultural pursuit is potentially capable of sustaining a range of purposes suitable to the locality, and
- (e) to protect or conserve:
  - (i) soil stability by controlling development in accordance with soil capability,
  - (ii) forests of commercial value for timber production,
  - (iii) valuable deposits of minerals, coal, petroleum and extractive materials by controlling the location of development to enable the efficient extraction of those deposits,
  - (iv) trees and other vegetation in environmentally sensitive areas where the conservation of the vegetation is likely to reduce land degradation,
  - (v) water resources, and
  - (vi) travelling stock routes.

The operation of the upgraded dam in the *1(a) (General Rural Zone)* would be consistent with the objectives of this zone. The storage of water is not a prohibited development in the *1(a) (General Rural Zone)*.

Public utility undertakings are permissible with the consent of council within the *1(a) (General Rural Zone)*.

### **Parry Local Environmental Plan 1987**

The Parry LEP is the principal planning instrument guiding land use and development decisions for the former Parry local government area. The plan categorises land into land use zones and provides for the permissibility of development within each zone.

Land downstream of the Keepit Dam in the former Parry local government area is zoned *1(b) (General Agriculture Zone)* under the Parry LEP. The proposal may result in the inundation of some land zoned *1(b) (General Agriculture Zone)* in the former Parry local government area during extreme flood events.

The objectives of the *1(b) (General Agriculture Zone)* are identified in the Parry LEP and are to:

- (a) to enable the continuation of traditional forms of rural land use and occupation and encourage consolidation of existing undersized allotments and their conversion into productive commercial farmholdings,
- (b) to conserve prime crop and pasture land in units or holdings which may be efficiently used for forms of agriculture common in the locality,
- (c) to discourage fragmentation of landholdings into holdings which are inadequate to support commercial farming practices,
- (d) to enable other forms of development which are associated with rural activities and which require an isolated location, or which support tourism, and recreational activities to be accommodated in an environmentally acceptable manner,
- (e) to ensure that the type and intensity of development is appropriate, having regard to the characteristics of the land, the rural environment, and the cost of providing public services and amenities,
- (f) to permit the development in an environmentally acceptable manner of mines and offensive and hazardous industries where required, and
- (g) to permit the development of intensive commercial horticulture and specialised agriculture where fertile land and a reliable water supply are available.

The operation of the dam in the *1(b) (General Agriculture Zone)* would be consistent with the objectives of the zone. The operation of the dam is not a prohibited development in the *1(b) (General Agriculture Zone)*.

Public utility undertakings are permissible with the consent of council within the *1(b) (General Agricultural Zone)*.

### A.4.3 LEP summary

Table A.3 provides a summary of the permissibility of the proposed activity in the Gunnedah, Manilla and Parry LEPs. As shown in the table, the proposed activity is not a prohibited development in any of the relevant land use zones of these LEPs.

**Table A.3 Summary of permissibility**

Zone	Permissible	Prohibited
<b>Gunnedah Local Environmental Plan 1998</b>		
1(a) Rural (Agricultural Protection) Zone	Without consent	No
<b>Manilla Local Environmental Plan 1988</b>		
1(a) (General Rural Zone) Zone	With consent	No
<b>Parry Local Environmental Plan 1987</b>		
1(b) (General Agriculture) Zone	With consent	No

In the absence of any other planning legislation, construction and operation of the proposal would only be permissible with the consent of Tamworth Regional Council in the former local government areas of Manilla and Parry.

### A.4.4 Regional environmental plans

There are no regional environmental plans that apply to the proposal.

### A.4.5 State environmental planning policies

#### **State Environmental Planning Policy No. 4 - Development Without Consent and Miscellaneous Exempt and Complying Development**

State Environmental Planning Policy 4 (SEPP 4) aims to permit development for certain purposes by public authorities without the need to obtain development consent. It applies only where the carrying out of that development is not prohibited under other provisions of the EP&A Act.

Clause 11 of SEPP 4 provides that:

Where, in the absence of this clause, development, being the construction of water storage dams, by or on behalf of a public authority may be carried out only with development consent being obtained therefore, that development may be carried out without that consent.

SEPP 4 therefore removes the need for State Water to obtain development consent from Tamworth Regional Council for the proposal under the Manilla and Parry LEPs. It therefore means that the environmental effects of the proposal need to be assessed by the proponent in accordance with Part 5 of the EP&A Act. With State Water having reviewed the proposal and in accordance with Section 112 of the EP&A Act, it considers that the proposal is likely to have a significant impact on the environment and that preparation of

an environmental impact statement is required in the absence of any other legislation. As identified in *Section A.1.1*, by order of the Minister for Planning, all projects that would otherwise require an environmental impact statement to be prepared pursuant to Part 5 of the EP&A Act, would be assessed under Part 3A.

## A.5 Other relevant policies and standards

The NSW Weirs Policy is also relevant to the proposal and has been considered as part of the formulation of the Keepit Dam upgrade.

The aim of the NSW Weirs Policy is to halt and where possible reduce and remediate the environmental impact of weirs. The Policy is a further component of the State Rivers and Estuaries Policy which establishes the framework for the management of rivers and estuaries of NSW and related ecosystems, such as wetlands.

The policy applies to privately owned and publicly owned weirs. This does not, however, include off-river storages or farm dams on small, ephemeral streams. The Policy does not act to the exclusion of any applicable environmental impact assessment or heritage protection legislation, notably the EP&A Act.

The Policy states that a proposal to build a new weir or enlarge an existing weir should not be approved unless it can be demonstrated that the primary component of the proposal is necessary to maintaining the essential social and economic needs of the affected community.

In determining the need for a new or expanded weir, State Water is required to apply the following guidelines:

- Provision of fish passage cannot be used as a sole justification to approve a proposal to enlarge an existing weir.
- An increase in town water supply for the purposes of meeting projected population demand cannot be used as a justification to approve a proposal to build a new, or expand an existing weir, if environmentally friendlier alternatives to meeting that demand exist, which are also economically feasible.
- Provision for future industrial expansion (such as, but not limited to, tourism) cannot be used as a justification to build a new, or expand an existing weir.
- Subject to the usual environmental impact assessment process, a proposal for the construction of new, or expansion of an existing weir, that will result in a net environmental benefit may be approved.

The proposed Keepit Dam upgrade seeks to improve existing infrastructure by increasing the safety of the dam to comply with very large to extreme event requirements of the NSW Dams Safety Committee and does not increase the full supply level of the storage. The multi-level off-take proposed as an integral component of the dam upgrade would also improve the

environmental outcomes from the proposal. The upgrade is considered necessary to maintain the essential social and economic needs of the affected community.

## **A.6       References**

Parsons Brinckerhoff 2002, *Draft Keepit Dam Upgrade Statutory Context and Approvals Report*

## **Appendix B**

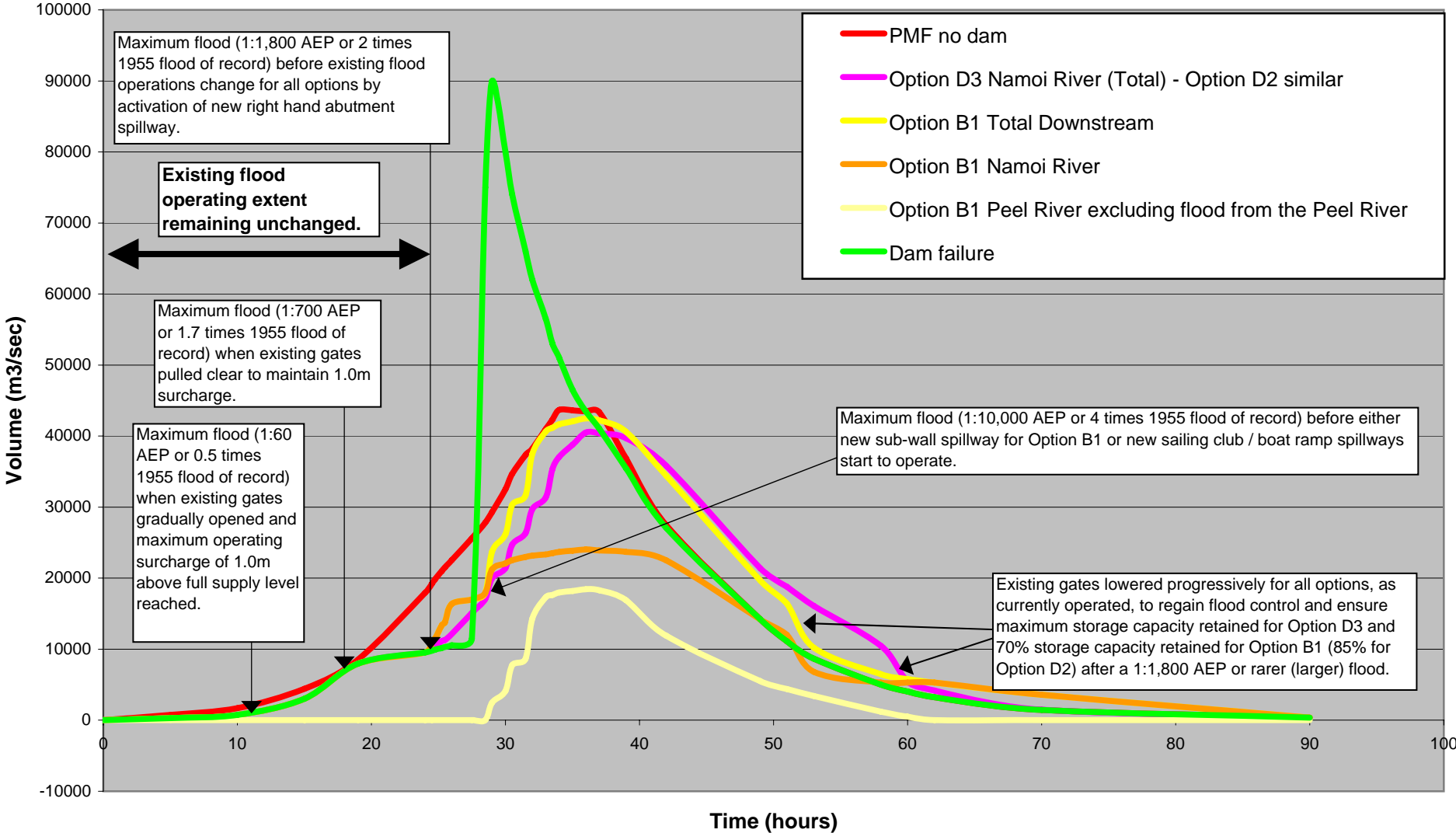
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Extreme flood hydrology information

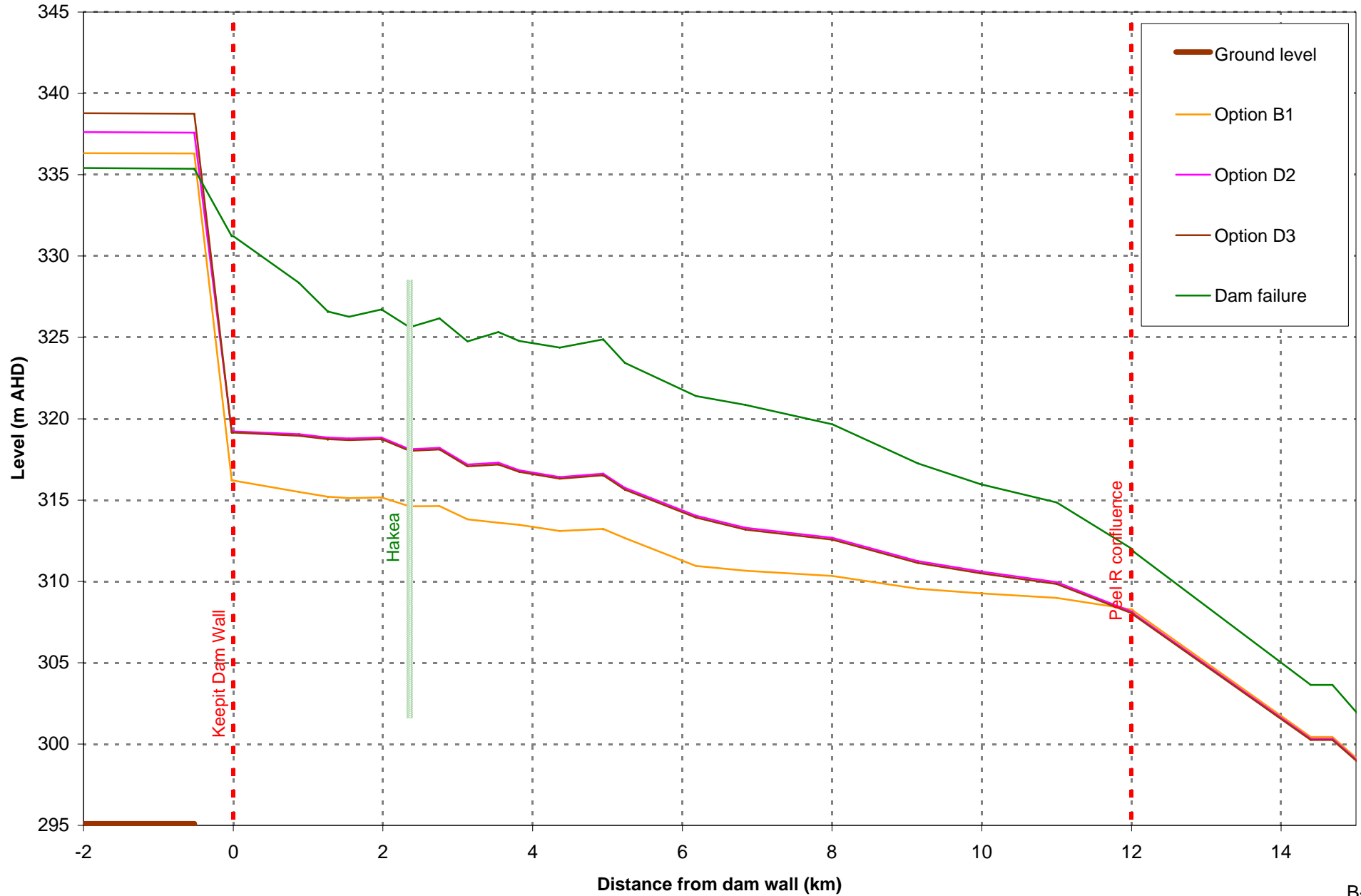
Keepit Dam Upgrade Predicted Upstream Inundation Duration and Frequency													
Storage Level									Existing Dam Capability				Comments
(mAHD)	Above FSL (m)	Area inundated above FSL (ha)	D3		D2		B1		Existing		Maximum Historical Flood		
			5.5m wall raising	4.3m wall raising	3.2m wall raising	Hrs#	Freq'cy##	Hrs#	Freq'cy##	Hrs#	Freq'cy##	Hrs#	
339.0	9.4	2790	2	<1:175,000	na	na	na	na	na	na	na	na	Maximum PMF level - Option D3
337.8	8.2	2540	9	1:175,000	2	<1:175,000	na	na	na	na	na	na	Maximum PMF level - Option D2
336.7	7.1	2320	15	1:27,000	10	1:175,000	5 (8*)	<1:175,000	na	na	na	na	Maximum PMF level - Option B1
335.4	5.8	1340	22	1:9,000 (1:20,000*)	17	1:13,000 (1:50,000*)	12	1:37,000 (1:100,000*)	2	1:2800 (1:30,000**)	na	na	Existing dam crest flood (DCF) ## (Note: Existing design flood level (DFL) 333.5m)
332.0	2.4	580	31	1:1,800	28	1:1,800	25	1:1,800	12	1:1,800	na	na	Start of additional right-hand abutment spillway
330.8	1.2	300	38	1:60	34	1:60	31	1:60	27	1:60	25	1:60	Maximum historical flood and operating level
>329.6	0.0	0	90	1:8	75	1:8	60	1:8	50	1:8	45	1:8	Above full supply level (FSL)

**Notes:**  
All frequencies and durations are estimates calculated from hydrology analysis  
# Hrs related to the worst case occurrence - Probable Maximum Flood (PMF). Durations are approximately proportionally lower for higher frequency floods  
## Frequency is an average estimate of the Annual Exceedance Probability (AEP) of the flood occurrence which would raise the storage to the level indicated  
The frequency of a PMF cannot be calculated.  
The frequency of a Probable Maximum Precipitation Design Flood (PMPDF) storm which equates to some 25% less by volume than a PMF is estimated at 1:175,000 AEP  
\* Initial estimates stated in Draft Options Comparison Report before hydrology refinement available.  
\*\* Post Interim Works  
Historical flood frequency is based on 110 years of data and maximum recorded flood was in 1955 before the dam was completed.

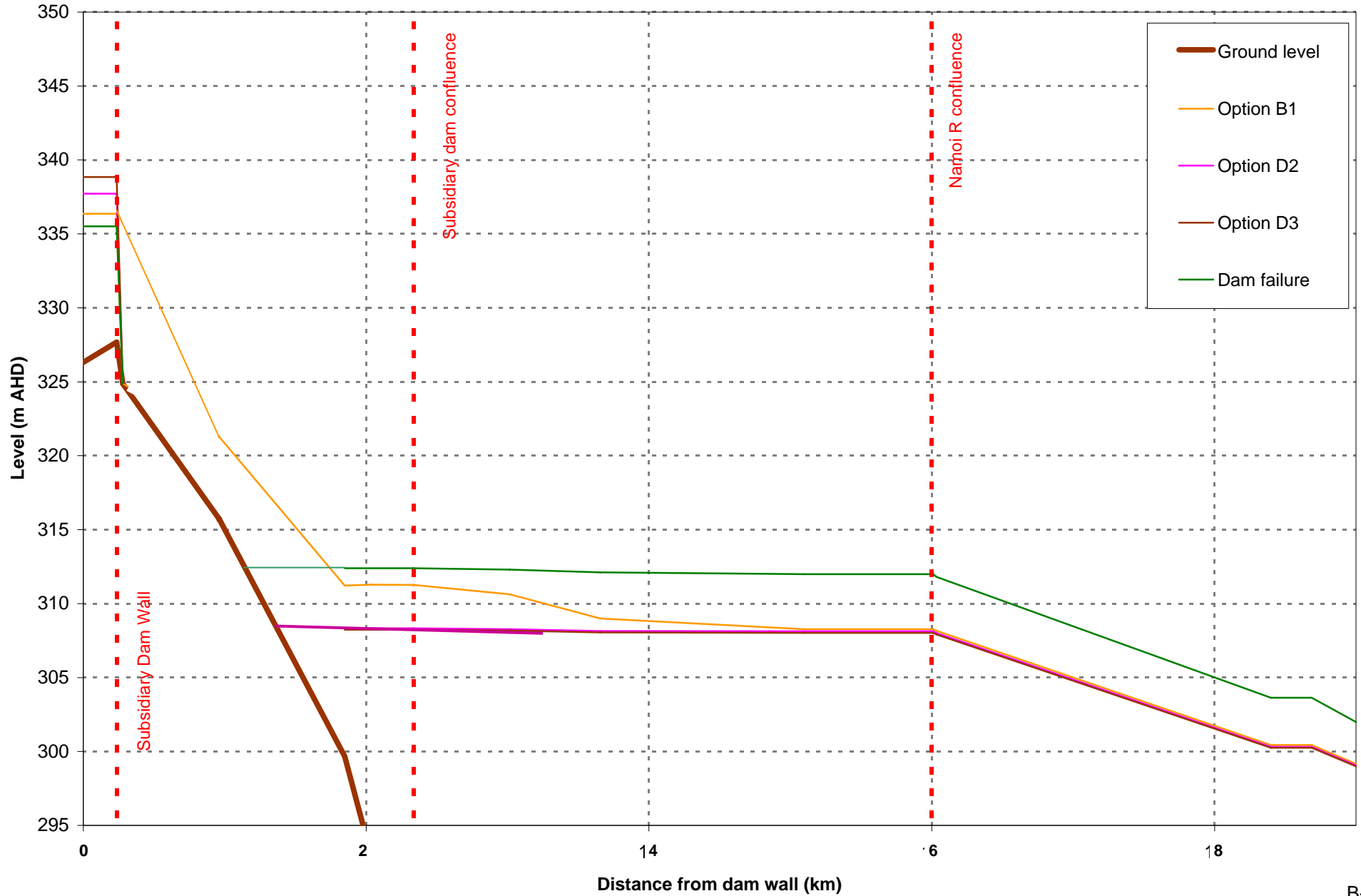
### Keepit Dam hydrographs - probable maximum flood



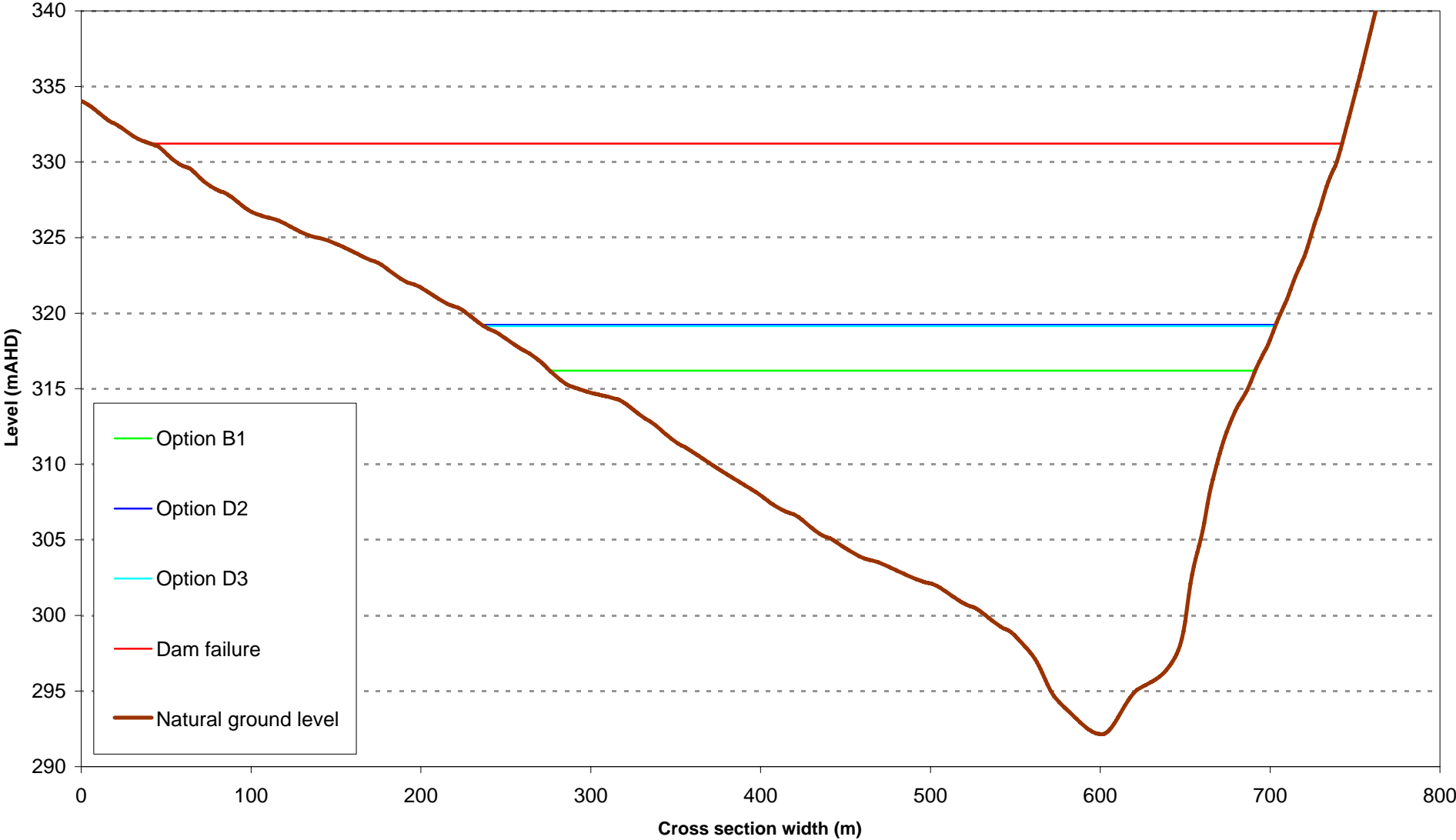
# Namoi River profile - probable maximum flood



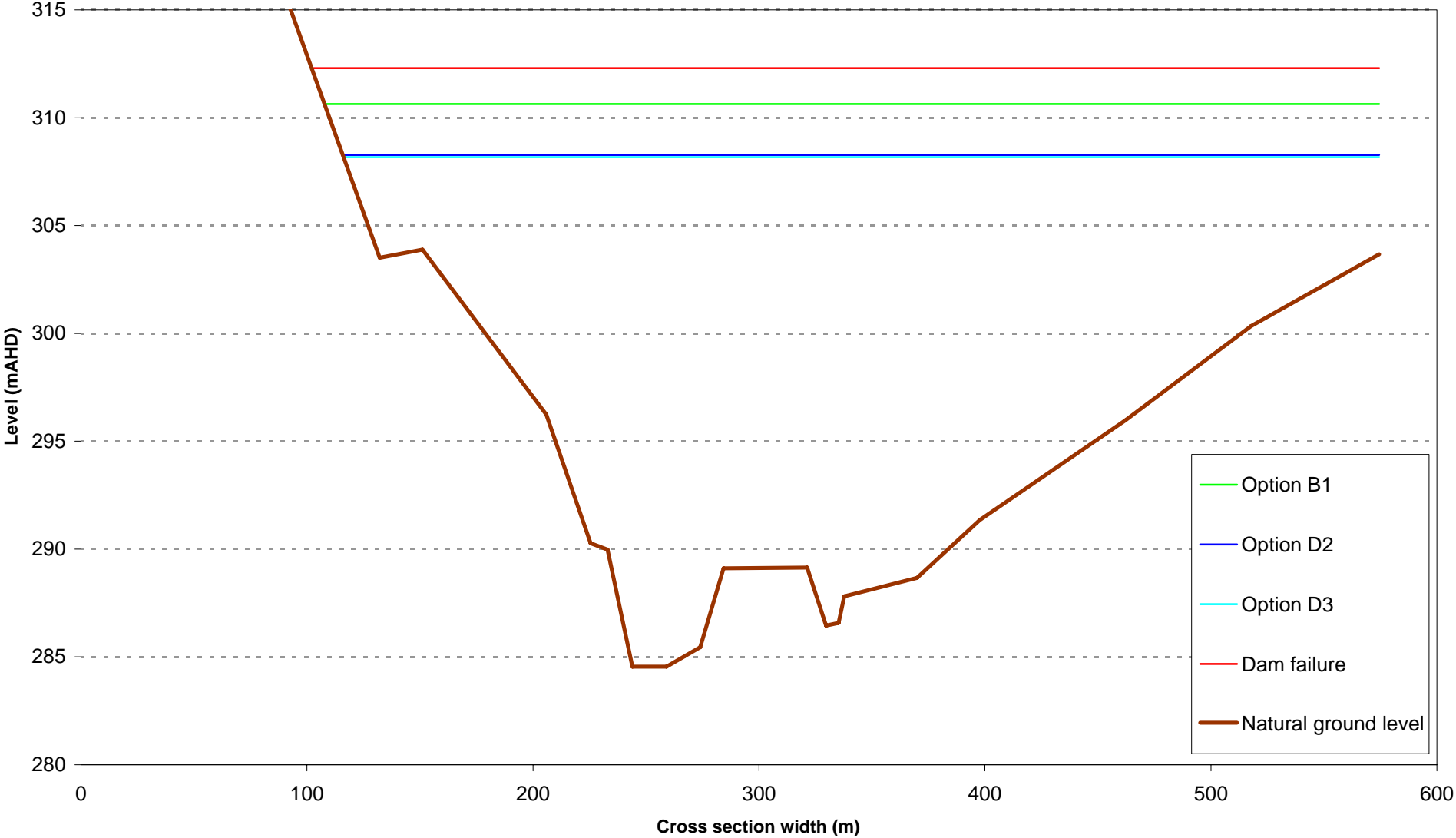
# Subsidiary dam profile - probable maximum flood



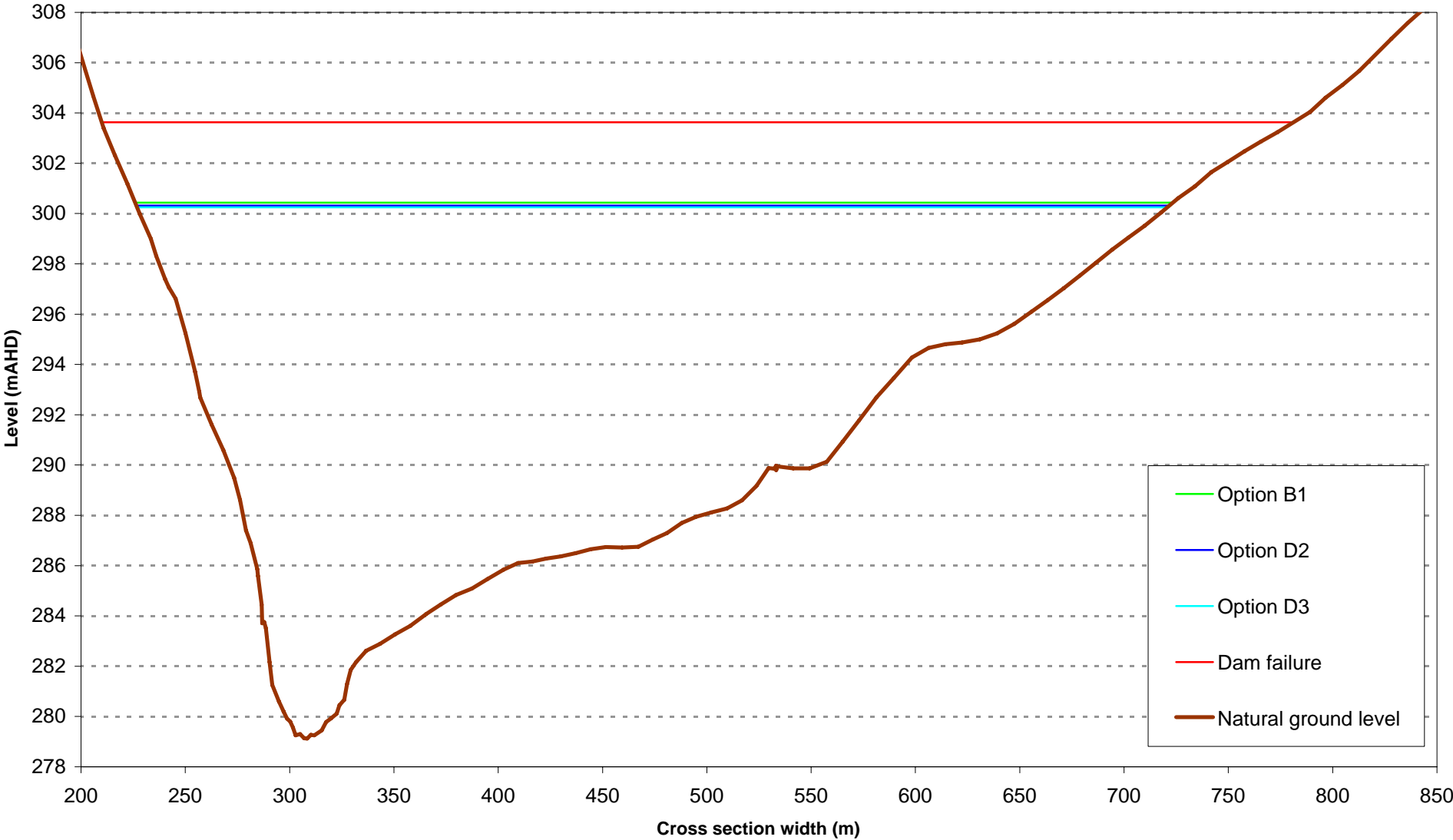
**Namoi River - downstream of the main dam wall - probable maximum flood**



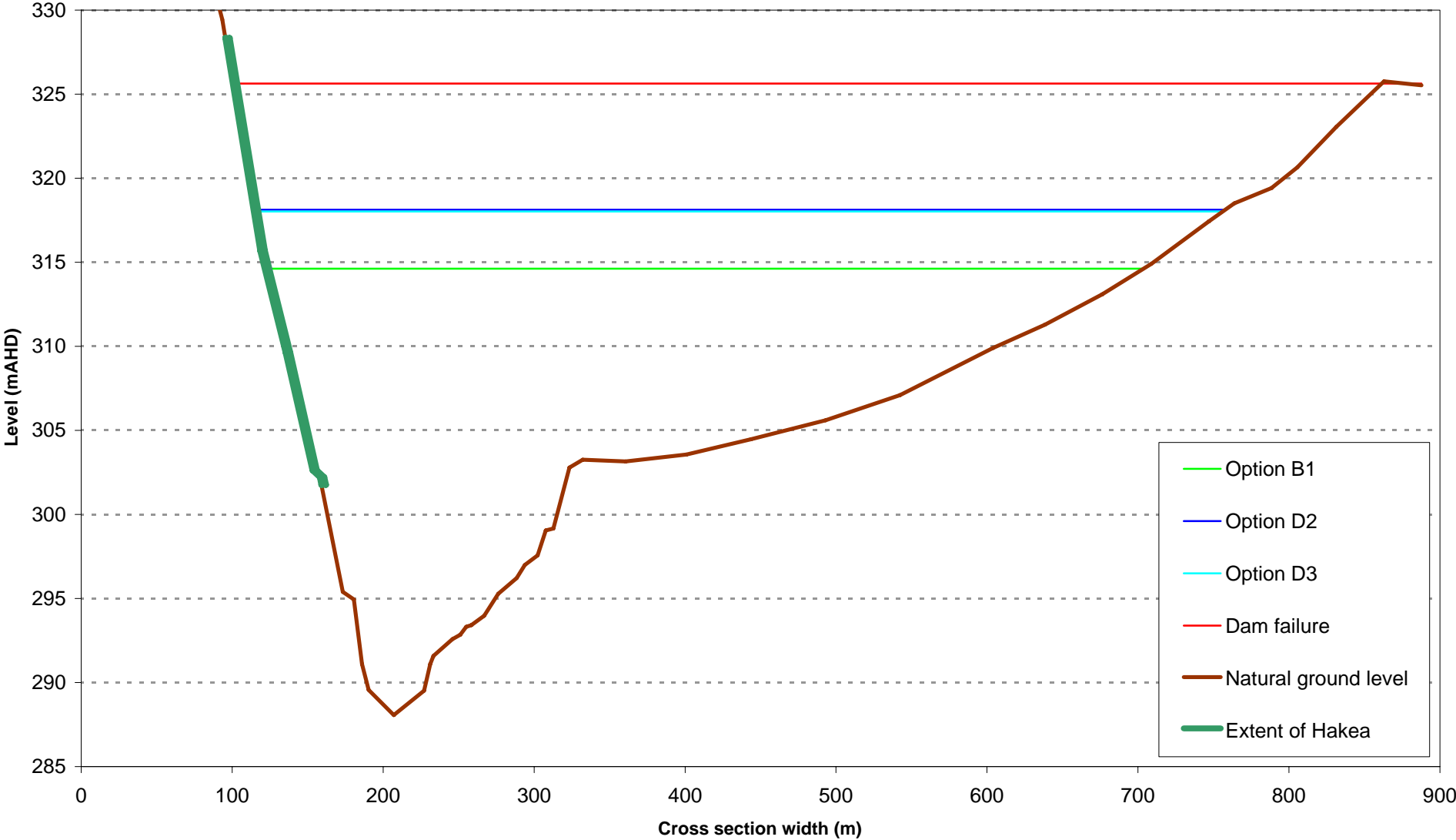
**Peel River at Carroll Gap (upstream of Namoi River confluence) - probable maximum flood**



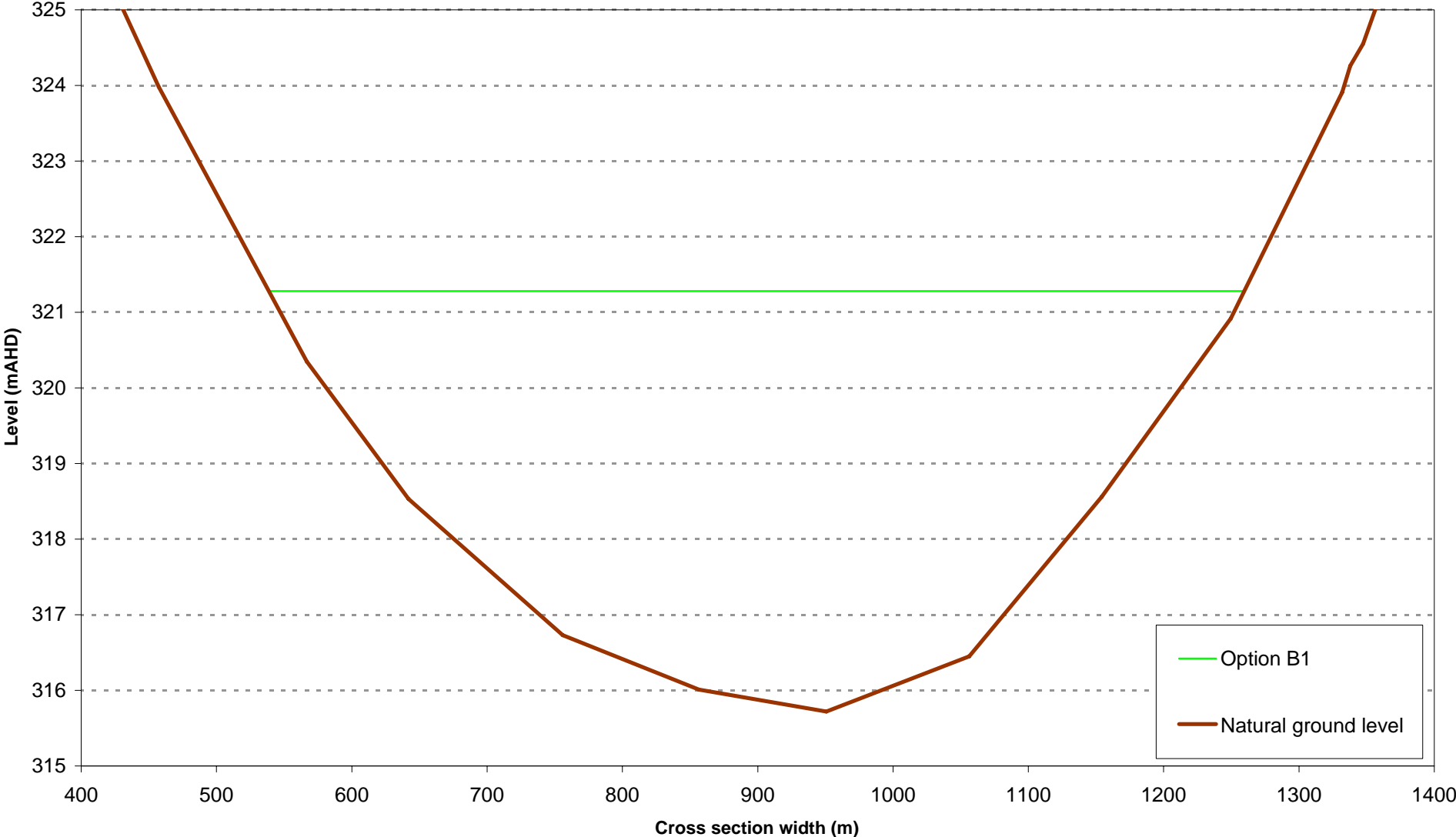
**Namoi River at the gorge (downstream of Peel River confluence) - probable maximum flood**



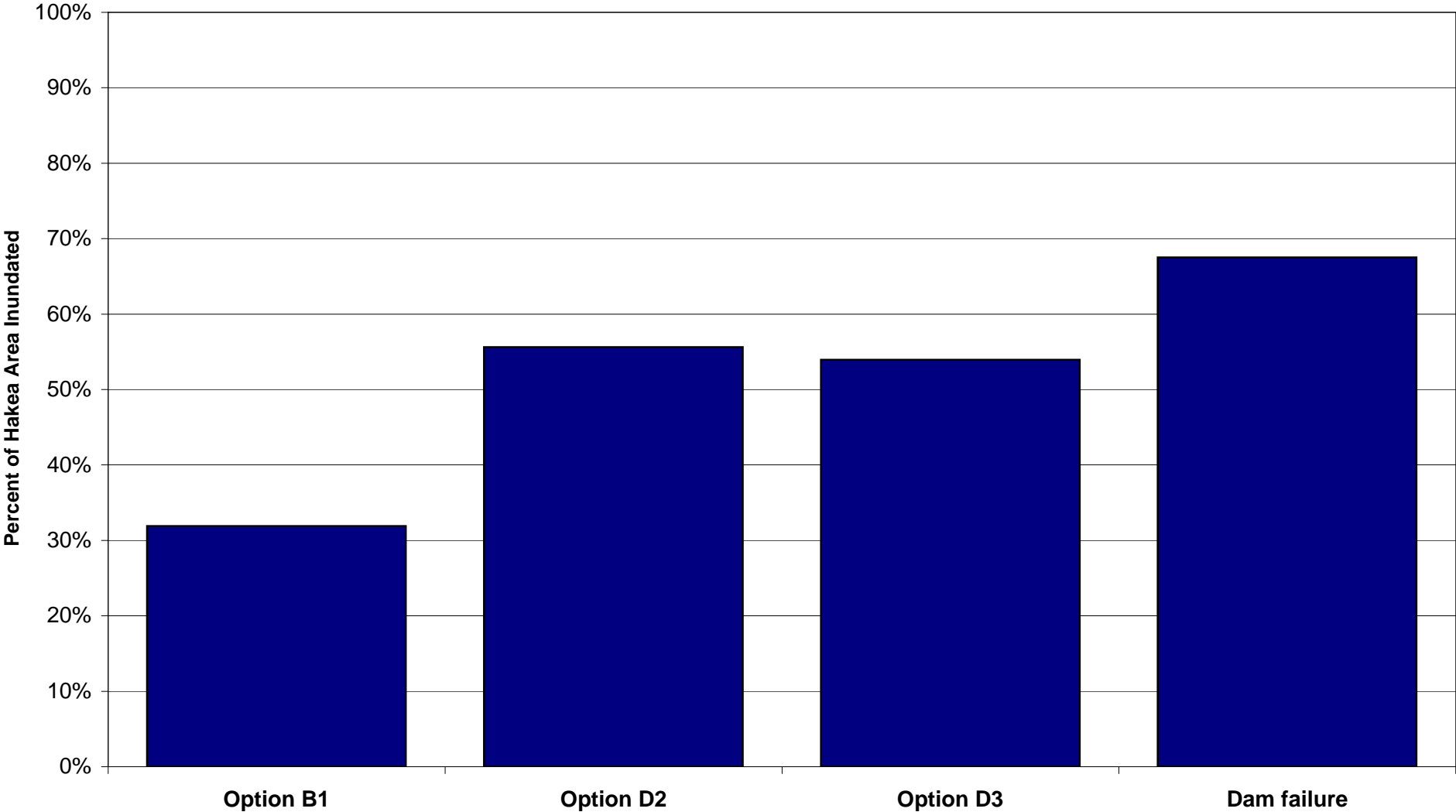
### Namoi River - Hakea - probable maximum flood



**Downstream of the subsidiary dam fuseplugs - probable maximum flood**



**Percent of Hakea area inundated - probable maximum flood**  
(Note: Option D2 Impact on the Hakea is the same as if the dam was not constructed - natural flow)



## **Appendix C**

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Options development and assessment  
process

## C. Dam Safety Options - Development and Evaluation Process

### C.1 Outline of the Process

The option development and assessment process was essentially an integrated one. Options were initially based on feasibility considerations then progressively reduced in number and refined in response to the requirements of the assessment evaluation criteria developed in conjunction with the Community Reference Panel.

The criteria were derived from consideration of the project objectives, the large number of relevant issues and associated outcomes of a wide range of studies and investigations into the issues. The assessment process used these criteria to determine which option was considered the most cost effective in achieving the objectives. This was undertaken in an open and consensual process without the need to use of a “hidden black box effect” through numerical transformation.

The focus of the evaluation was on the impacts of the options in terms of upstream and downstream effects, impacts during construction and cost. Dam Safety as a criteria, while remaining the primary driver was not included as each option considered had to achieve the defined level of performance - Probable Maximum Flood (PMF) and Maximum Design Earthquake (MDE).

Safety improvements alone would be unlikely to result in the achievement of the development and environmental objectives of the project. Various components were needed to be considered in the upgrade proposal in order to respond to all the objectives of the project. Some environmental potential improvements could be evaluated separately against their specifically developed criteria. Resulting modifications or project inclusions could be added to any of the dam safety options chosen and the issues relating to the achievement of these objectives considered on a case-by-case basis.

The process can therefore be considered in two parts:

- development and assessment of a short listed set of dam safety options; and
- consideration and assessment of those individual project components (principally environmental improvements) which could be packaged with in any of the dam safety options.

The development and assessment of the options has been undertaken in a series of steps over an extended period. This allowed a clear decision trail to be achieved while taking account of the wide range of values and opinions represented by the members of the Community Reference Panel. Other considerations included:

- the very large number of options and variations possible at a range of locations around the dam with each requiring initial assessment to verify its achievement of the safety criterion;
- a wide range of issues, benefits/impacts and potential solutions requiring identification and assessment, in some cases including further studies with data collection and computer modelling to provide sufficient material for the decision-making process;
- complexity and inter-relationship of many of the issues often diametrically opposed requiring a wide variety of inputs and trade-offs and necessary reconciliation of sometimes conflicting views of the participants;
- an open and transparent process taking account of State Water and community views requiring consideration of a wide range of assessment criteria; and
- a staged process requiring assessment of many, varied issues, refinement of the options and the re-evaluation of further or modified options to address the implications of the study results.

The process of long-term option development and assessment can be summarized as follows:

- generation of an initial, wide ranging list of options (in excess of 70 initially), culled using potential realistic technical and environmental acceptability and preliminary cost (excess of \$100 million) criteria;
- preparation of a long list (27) based on various combinations of raising and spillway types at possible locations around the dam, development of agreed assessment criteria and initial assessment including impacts and costs;
- generation of a short list (initial 5 subsequently reduced to 4, then subsequently 3) together with further refinement to normalise performance of the options and confirm costs followed by more detailed consideration of the criteria; and
- agreement by Community Reference Panel on the preferred option for the safety upgrade of Keepit Dam and advice to State Water Board.
- formal environmental assessment process to finalise a preferred upgrade solution, (refer later section)

## C.2 Consideration of Dam Safety

The concepts that may address dam safety extreme event concerns for Keepit dam are set out in *Section 4* of the main report.

These have not precluded consideration of the secondary objectives although it is necessary to separate the dam safety solutions to ensure that performance of all the alternatives is considered on an equal basis. Refer *Section 1.4.3* of the main report for details and outcomes of the environmental improvement opportunities.

One aspect which also has been considered, is the cascade potential effect of Split Rock Dam upstream of Keepit Dam, should it fail in a very large to extreme event. There is potential to allow for such failure in the upgrade of Keepit Dam. The approach taken however was a partial allowance equivalent to normal wave action freeboard designed as part of protecting Keepit Dam against an extreme event. It is not considered appropriate to allow for the full failure of Split Rock Dam, as failure of the dam has extreme consequences for the township of Manilla and intervening country side requiring Spilt Rock Dam, in its own right, to be safe from very large to extreme floods. Current studies are underway to identify any extreme flood dam safety issues at Split Rock Dam and depending on the level of issues found, possible solutions.

## C.3 Alternatives Considered

### C.3.1 Strategic Alternatives

At a strategic level, a number of alternatives were considered to address the extreme event safety concerns at Keepit Dam. While these alternatives may satisfy dam safety technically, the social and economic impacts can vary significantly requiring other measures in combination with dam safety works to reduce adverse effects.

The strategic alternatives considered are set out in the following groupings.

#### ***Do Nothing***

The ***Do Nothing*** alternative traditionally sets the baseline against which the environmental and other impacts of proceeding with the proposal are assessed. State Water however is obliged to take action to make the dam safe in response to the requirements of the NSW Dams Safety Committee. Inaction or the normal do nothing approach would not be satisfactory in fulfilling the owner's statutory obligations. The do nothing alternative is therefore not appropriate except as a

baseline for future impact assessment. This position relates both to the pre-interim safety works and post-interim safety works.

The key interim safety works completed in 2003 comprised an early warning system for property owners down to and including the township of Carroll and lowering of the Subsidiary Dam wall with trigger release plugs to allow flood waters to flow over and breach this wall. These works reduce the risk of the main dam wall from failing. However these are considered only temporary works until the long-term solution is developed and implemented, estimated to take 5 or 6 years in view of the complexity of potential solutions. Continuing indefinitely with these interim works is not acceptable, as it does not meet NSW Dams Safety Committee requirements and adequately address State Water Corporation's medium to long-term liability including service obligations and duty of care. It would also be contrary to acceptance of the Review of Environmental Factor assessment for the Interim works which was on the basis that the works would be temporary while a long solution was completed.

### ***Adjusting Full Supply Level (FSL)***

Adjustment could take the form of both lowering or increasing FSL:

- Lowering FSL – a relatively easy reduction in the full supply level of the dam of approximately 11 metres (FSL reduced to 318.6.5m AHD) can be achieved by an operational rule change which requires existing gates to be operated to maintain a lower FSL or permanently left open so the gates sill level becomes a fixed spillway ogee weir. The dam capacity at the gate sill level would be reduced to 22% of current capacity (425,000 megalitres to 94,000 megalitres). However the reduction in FSL would still be totally inadequate to protect the dam from extreme floods. A PMF flood involves a total volume of flood of 8.5 times the current capacity of Keepit Dam. Lowering FSL by 0.8 times the current capacity of the dam still means a shortfall in protecting the dam of 7.7 times its current capacity. Lowering the FSL is not be a feasible technical solution and certainly would not be acceptable from a socio-economic perspective.
- Increasing FSL – an increase in full supply level of the storage by itself, does not address the extreme event safety issues at Keepit Dam. Similar dam safety upgrade works as appropriate for the existing FSL level would still be required to protect the dam from extreme flood and earthquake events.

It should be noted that as part of the upgrade project, increase in FSL was considered with respect to a potential environmental improvement opportunity and separate to meeting dam safety requirements. This potential opportunity is discussed in *Section C.3*.

### ***Maintaining Full Supply Level (FSL)***

Existing Full Supply Level has an associated Design Flood Level (DFL) which is the maximum water level in the dam which can be reached under flood conditions and corresponds to the maximum level of pressure which the dam wall is designed to resist, before the safety of the dam is compromised. This increase in storage level to Design Flood Level is the maximum temporary flood surcharge level to which the worst floods are expected to rise and subsequently return to FSL as the flood recedes.

Increasing the Design Flood Level or increasing the existing spillway capacity or a combination of both are the normal ways the extreme event safety objectives be achieved. Keepit Dam is no exception.

An estimated 12.5 metre raising of the Design Flood Level would be required to achieve sufficient temporary storage of floodwaters without the need to provide additional spillway capacity to safely pass a PMF flood. Alternatively increasing spillway capacity from the existing 6 gated spillway (90 metres total width) to an equivalent 20 gated spillway (300 metres total width) with no increase in Design Flood level would also safely pass a PMF flood. This spillway alternative will still require post-tensioning of the existing gravity and spillway concrete main wall.

Both alternatives are extreme solutions with high cost (in excess \$100 million).

Accordingly the various combinations of Design Flood Level raisings and smaller additional spillway capacities are the alternatives which were considered the most appropriate for achieving the required safety upgrade.

### ***Removing Responsibility***

There are a number of available alternatives in this category which would reduce the liability of State Water with respect to existing safety concerns. Alternatives include:

- transferring ownership;
- decommissioning (taking the Dam out of service); or
- removal of the Dam.

Keepit Dam is an indispensable asset which serves a variety of essential needs in the Namoi Valley. State Water is responsible for managing NSW's major rural water storages and it would not be consistent with its business plan (even if feasible) to sell or manage the asset through a third party. None of these alternatives would therefore be appropriate for consideration by State Water.

### ***Other Alternatives***

While structurally there is only one realistic way to protect the main concrete gravity and spillway wall from the Maximum Design Earthquake event – post-tensioning, there are numerous alternatives which can be considered for protection against very large to extreme floods.

The more normal alternatives for flood protection have been discussed above. However, a number of other alternatives exist which are included to demonstrate that the widest possible range of possibilities have been considered. Such options were not considered more than conceptually because of feasibility issues and excessive costs compared to other upgrade solutions. They generally involve a series of measures remote from the dam wall, either upstream or downstream of Keepit and include:

- morning glory spillway or tunnel spillway;
- upstream storages or controls within Lake Keepit;
- improved upstream gauging techniques; and
- downstream solutions.

Freestanding morning glory spillways or tunnel spillways could be constructed at a couple of locations. However to gain adequate capacity to cater for extreme floods these would be large and numerous and into the hundreds of millions of dollars to provide additional flow when an extreme rainfall event occurred. This option was considered to be greatly excessive in cost compared to others (including additional gates alternative) and was therefore not considered further.

Remote solutions included construction of one or more upstream dams to manage surface water inflows into Keepit and rockfill berms within Lake Keepit to act as a flow-through flood mitigation dam. Construction of additional dams was rejected due to no identifiable technically reasonable sites and the increased attendant environmental impact which would result. Similarly, the rockfill berm concept was technically very difficult and expensive with considerable doubt that sufficient surcharge storage could be created within Lake Keepit. It would restrict the recreational uses of the lake, result in much greater adverse environmental effects on water quality and fish passage and upstream surcharge inundation than raising the existing dam wall to accommodate temporary flood surcharge. Hence these alternatives were not considered further.

Improved upstream gauging would require the introduction of a number of new gauging stations and an automated and highly reliable method of measuring stream flows and predicting flood levels. The

concept would be to attempt to pre-drain the storage through opening the existing gates early when a large to extreme flood is predicted to occur. It is very doubtful such an early prediction system could be devised, as highly reliable and prediction techniques far more infallible than those achieved elsewhere in Australia would be required. However the overriding issue is that even if the storage could be pre-drained to gate sill level, similar to lowering FSL, this additional storage volume is far too small to accommodate the very large to extreme floods. This alternative was not considered further.

Remote downstream solutions included consideration of the construction of one or more flood mitigation dams capable of withstanding a failure of the existing dam. Apart from the problem that Keepit Dam still fails and its associated environmental concerns, the cost of such downstream mitigation measures will be hundreds of millions of dollars. The size of a downstream flood mitigation dam would have to be immense to contain and mitigate the flood wave from a breach of the existing dam wall. Significant farming property would be affected and major environmental impacts would result. Such alternatives were not considered further.

### **Outcome**

*The most cost effective combination of Design Flood Level raising and additional spillway capacity was considered the most realistic and appropriate way of achieving the required safety upgrade of Keepit Dam.*

## **C.3.2 Dam Wall Raising & Additional Spillway Combination Options**

This section deals with the issues associated with determining the most appropriate combinations of dam raising wall and provision of additional spillway capacity. All options include post tensioning of the main dam wall required to achieve compliance with seismic stability of the main concrete gravity and spillway wall to the Maximum Design Earthquake (MDE).

While “sunny day” static failure has not been found an issue, it is important that dam wall raising and spillway configurations do not significantly increase the static risk position and should if possible improve it.

### ***Spillway Types***

There are a number of spillway types which could be used to address inadequate extreme flood capacity of the dam. The different types of spillway structures are:

- flood gates;
- fixed-crested weirs; and
- release plugs / gates.

Six radial flood gates are currently installed at the main dam wall. The gates are opened and closed mechanically to pass floods. The relative merits of gates are that they offer a high level of control over the discharge volume during floods and much greater flow per metre width of spillway than non-gated spillways. The disadvantages of gates are that they are relatively expensive to install and maintain and are prone to reliability problems.

Alternatives to radial gates are automatic hydraulic operated tilt or lift / lowering (overshot) gates which are designed to tilt open / close or raise / lower vertically in response to rising or lowering water levels. Such variants are generally more expensive to build and operate than radial gates.

Fixed crested weirs are structures built with a sill level at or above the dam full supply level and operate by water overtopping the structure. Control over the volume of discharge is determined during the design stage by the spillway shape, width and setting of the weir height above full supply level which may have varying trigger levels. Fixed-crested spillway shapes include broad-crested, knife edged or protruding sill or ogee weirs respectively increasing in efficiency of discharge flows and generally in cost. Weir structures which are normally constructed of concrete can be less expensive than flood gates for similar discharges but it is highly dependant on topography and foundation material. Operation and maintenance costs are generally low and certainly far less than for flood gates.

Release plugs (technically called fuse plugs) are normally the least expensive option available to increase spillway capacity once a pre-set flood water level is reached. Release plugs which are made with a thin sloping clay core and supported by easily eroded granular material, are widely used. Modern designs are generally considered acceptable from a reliability perspective in Australia and overseas subject to being able to achieve certain hydraulic conditions. One of the key issues associated with release plugs relates to their activation. This is relatively rapid, releasing a potentially significant block of water downstream which has a pulsing effect and which can cause greater damage than other spillway options. Minimising this pulsing effect can be achieved by increasing the number of plugs or providing different depths of plug or by delaying breaching sequences by increasing the differential crest levels between plugs. An alternative to release plugs are release gates (technically called fuse gates) which are constructed of concrete or steel or both. These release gates tip and are washed away at predetermined flood levels the same as release gates. Release gates can be made to small widths and much finer differentials in crest levels making them much more flexible in minimising pulse flows. Release gates are often considered more reliable and potentially require less maintenance than release plugs and are well suited to increasing FSL for fixed-crest spillways but are normally more expensive to build.

Both release plugs and gates can be designed with sill levels below FSL. This approach generally has capital cost advantages and helps where spillway width is limited. It does mean storage operation up to FSL can not be achieved after a flood which requires the release of a plug or gate until the plug or gate is replaced. Therefore, the potential frequency and quantity of stored water lost, the time taken to replace the plug or gate, chance of the next flood to refill the storage to FSL and the amount of alternative storage available are key considerations in accepting release plugs or gates with sill levels below FSL.

Either release plugs or gates can potentially provide the adequate safety performance required for Keepit Dam. The choice is likely to come down to how significant the overall advantages of release gates are over plugs, final design capital cost and resulting economic differences.

For the detailed conceptual design, release plugs have been assumed but it should be made clear that no decision has been made whether release plugs or gates will be used. This decision will be part of the final detailed design and procurement process.

Other potential spillway configurations include side channel chutes and labyrinth shaped spillways. Both spillway forms tend to be more expensive than the wide overflow spillway except where topography severely restricts spillway locations and total spillway width. This is not generally the case for Keepit Dam.

### ***Dam Wall Raising & New Saddle Dams***

Dam wall raising and new saddle dams are required for options where the Design Flood Level ( DFL) is required to be increased.

For the concrete gravity spillway existing main wall raising will involve increasing the height of the concrete wall sections, spillway deck / piers and gantry crane. Up to 4.2 metres DFL raising, post-tensioning required for seismic protection will adequately handle the post-tensioning required for an increased DFL. Greater post-tensioning than required for seismic protection, is needed for DFL raising above 4.2 metres.

Initial assessments indicate the main embankment can be raised using vertical crest raising techniques up to 4.5 metres DFL raising. Greater raising requires upstream and possibility downstream embankment raising to maintain adequate embankment stability and road alignment.

The existing subsidiary wall would be raised by removing as required the interim works and extending upwards the centre clay core and stabilising downstream and upstream with selected zoned filter, gravel and as appropriate rock/riprap material – standard clay core earthen embankment construction.

Standard clay core earthen embankment construction is proposed for several saddle dam locations required along the ridge from near the main embankment to the subsidiary wall. The number of locations and height of the saddle dams increase as the DFL raising required, increases.

DFL raising and associated dam wall raising and new saddle dams will temporarily inundate for up to 5 days, additional upstream rural areas and further impact on lakeside facilities and the storage rim environment. Other attendant environmental issues with DFL raising relate to the quality of impounded waters and the downstream effects once these waters are released.

The over-riding issue is the very low frequency any such additional inundation may occur – 1:9000 AEP or less.

### ***Spillway & Raising Option Combinations***

Additional spillway capacity creates a set of impacts which can be contrary to impacts created by dam wall (DFL) raising. For Keepit Dam generally additional spillway capacity creates greater local impacts but is less expensive than dam wall raising. Selection of the most cost-effective option has required the consideration and weighing up / trade off of these competing benefits / impacts and relative costs.

#### **C.3.3 Upgrade Locations**

The existing landform and topography of the area surrounding Lake Keepit effectively determines locations where potential structural options could or need to be located. Impacts resulting from each location such as placing an additional spillway near the existing spillway to minimise immediate downstream impacts and associated costs, become critical determinants for selecting the best locations for certain types of works in particular additional spillways.

Various locations around Lake Keepit were assessed and the following were identified where potential dam wall raising, new saddle dams and / or additional spillways may need to be or could be located.

- right side saddle (north of the main dam wall);
- right hand abutment of the main dam wall;
- main dam wall – concrete gravity and embankment;
- left hand abutment of the main dam wall;
- boat ramp saddle;
- sailing club saddle;
- caravan park saddle;
- subsidiary wall; and
- north of the glider club.

The complexity of works required at the various locations increases exponentially, when the most cost effective upgrade option needs to consider a range of spillway types and could have additional spillways in any of the above nine locations or at several locations, each of which will have different social and environmental impacts, capital and economic costs.

## C.4 Initial Screening of Options

An initial list of options included a wide range of concepts with a number of variations and some less conventional possibilities. Options were included on the list if they warranted consideration on engineering grounds.

One of the key guiding principles of the initial screening process was to remove those options where it was reasonably considered that the implementation of the solution could be achieved at another location for a lower cost, where the engineering feasibility was more certain and/ or where the environmental impact was likely to be lower. A first pass at the capital costs of the alternatives indicated a range from greater than \$360M (a 2.6 kilometre spillway at the Glider Club) to \$41M (an 860 metre release plug spillway at the location of the existing subsidiary wall in addition to a 2 metre dam raising). An initial upper bound cost of \$100M was selected as it represented a figure approximately double the cost of the cheapest option.

On this basis, the number of conceptual locations where a spillway could be constructed was initially reduced from nine to three locations; those being the right hand abutment, the subsidiary wall or the caravan park. The reasons for removal of the other locations were:

- right side saddle - the spillway width would have to be realistically restricted to 60-80 metres due to entry constraints, providing limited safety improvement compared likely needed 600 metres additional spillway width. It was also more costly per unit width and higher environmental impact than the right abutment location;
- main concrete gravity wall - inclusion of additional gates or overflow section. Costs were found to be prohibitive compared with other spillway locations. Main embankment - major concern was expressed with being able to retain the structural integrity of the main embankment during spillway operation and so was not considered further;
- left hand abutment – concern over providing adequate protection of the main embankment during operation of this additional spillway and excessive cost and downstream erosion compared with the right abutment;
- boat ramp saddle – major limitation in width (maximum realistically is 120 metres). Initial costs indicated using more than two locations for additional spillways would not be cost effective. Use of the Boat Ramp Saddle meant three additional spillway locations would be likely. In addition, initial assessment indicated the Caravan Park location was environmental little different in

impacts and despite relocation of the Gums Caravan Park appeared more cost effective.

- sailing club saddle - limitation in spillway width (maximum realistically is 300 metres) compared over 600 metres at the Caravan Park or Subsidiary Wall. This location also meant potential relocation of the sailing club building and accommodation chalet. In addition, initial assessment indicated the Caravan Park location was environmental little different and despite relocation of the Gums Caravan Park appeared more cost effective.
- north of the glider club - similar issue as for the subsidiary wall location – that is flood water is discharged into the lower Peel River before rejoining the Namoi River compared with other options retaining all flood flows in the Namoi River. The main difference is that a spillway at the subsidiary wall location is achieved at far lesser cost and lower environmental impact compared with the location north of the gliding club.

Some other alternatives were screened out such as excessively wide spillways (say greater than 1000 metres) due to technical and operational issues, overall local social and environmental impacts and high costs.

The large number of DFL raising / spillway combinations were not investigated in detail at this initial screening stage to reduce the amount of investigation work required. This approach however means that when a short-listing of more detailed investigated options is undertaken, it will be important that the reasons for screening out options earlier in the process are reviewed in case the more detailed investigations and costing have different outcomes to those initially identified.

Optimal combination options were determined from a balanced assessment of the:

- technical requirements needed to make a particular spillway configuration operate reliably and safely such as the total of outflow rates should not exceed inflow rates or release plugs are designed to reduce pulsing of flows downstream;
- limitations to DFL raising such main embankment stability issues and ability to lift the existing radial gates clear of raised flood flows;
- local impacts such as relocation of recreational facilities or extent and frequency of environmental damage with the over-riding premise that increase in environmental impact should be kept to a minimum; and

- most cost effective outcome where dam wall raising is generally more expensive than additional spillway capacities. Since wall raising is generally the more expensive item in comparison to spillway provision, the relative cost-effectiveness of these options would be driven by the amount of raising proposed. These options were formulated and considered explicitly in the subsequent assessment phase.

Many options were rejected in the initial screening due to excessive environmental impacts, high cost (in excess of \$100 million) or dubious technical feasibility. Options discarded (including combinations) involved:

- spillways located to the north of the right abutment (right side saddle) and in the left abutment – 10 possibilities;
- additional spillways in the main gravity concrete dam wall or over the main embankment – 9 possibilities;
- spillways involving side channel chutes – 6 possibilities;
- tilt or lift / lowering gates at various locations – 4 possibilities;
- wide fixed crested spillways (over 2 kilometres wide) located to the north of the gliding club – 3 possibilities;
- tunnel and morning glory spillways or increased FSL – 6 possibilities;
- remote (upstream) solutions:
  - ▶ one or more additional dams;
  - ▶ rockfill wall within Lake Keepit to provide flow through flood mitigation;
  - ▶ upstream automated flood gauging linked to early opening of the dam gates;
- remote (downstream) solutions:
  - ▶ one or more additional dams;
  - ▶ purchase of downstream areas subject to flooding; and
- full or partial decommissioning of the dam:
  - ▶ complete removal to restore natural river flow;
  - ▶ partial removal reducing storage capacity.

The remaining options involved combinations of three types of works:

- raising the dam wall plus adding saddle dams;
- adding more existing radial gates at the dam and in several of other locations; and

- adding other forms of additional spillway capacity such as various types of fixed crest weirs and release (fuse) plug weirs at the:
  - ▶ right hand abutment;
  - ▶ caravan park; and
  - ▶ existing subsidiary wall.

A total in excess of 70 composite options was assessed to achieve a preliminary long list of 27.

## C.5 Conceptual Long List of Options and Screening

Combining the conceptual dam safety alternatives with the potential locations where they could be implemented provided a matrix of 27 conceptual upgrade alternatives for initial consideration. In order to progress the options evaluation process and to ensure that the public is able to comprehend and provide educated opinion on the alternatives being considered, it was necessary to reduce the number of conceptual alternatives to a manageable size. A screening process was employed by the CRP to do this using the criteria listed in *Table C.1* to identify those options which were considered to most effectively achieve the objectives of the project. In summary the criteria were:

- operational reliability including storage loss and the frequency of operation of the spillway;
- upstream impacts around the rim of the storage and on local facilities as a result of dam raising;
- downstream impacts during flood events including frequency, extent, depth and velocity at various locations;
- impacts during construction; and
- capital and operating costs.

**Table C.1 Definition of dam safety option assessment criteria**

Category	Criteria	Definition
Reliability of supply	Temporary storage loss	Some options, in providing the necessary level of flood safety, may result in the loss of stored water from the dam following an extreme rainfall event. In comparing the relative performance of these options, the amount of storage loss, its anticipated frequency and the amount of time taken for the dam to refill are relevant.
Upstream inundation impacts	Storage rim	Relevant in the event of a proposal which contains dam wall raising. May include consideration of frequency, depth and duration. Impacts to facilities/activities which usually take place around the perimeter of the dam.
Downstream inundation impacts	Below main dam wall	Includes consideration of the frequency, inundation area, depth and velocity of flow in the area immediately downstream of the dam wall to the confluence of the Namoi and Peel Rivers.
	Below subsidiary dam wall	Includes consideration of the frequency, inundation area, depth and velocity of flow in the area immediately downstream of the subsidiary dam wall to the confluence of the Namoi and Peel Rivers.
	Downstream of the confluence of the Namoi and Peel Rivers	Includes consideration of the frequency, area, depth and velocity of flow in the area downstream of the confluence of the Namoi and Peel Rivers.
	Flood mitigation	Ability of the proposed works to mitigate small to medium floods.
Works impacts	Impacts on <i>Hakea pulvinifera</i>	Impacts of extreme floods on downstream populations of the threatened shrub <i>Hakea pulvinifera</i> .
	Construction effects	Qualitative assessment of amenity type impacts such as dust, water quality, etc which may arise from the works.
Works impacts	Visual effects	Extent of permanent visual change posed by the works and visibility from key existing landmarks.
	Financial and economic costs and benefits	Capital, operating and maintenance costs of the works, expressed as a net present value and benefit to cost ratio for each of the options.
Financial and economic costs and benefits	Estimated capital, operating and maintenance costs and benefit to cost ratio	

The long list of options assessed against the criteria is summarised in the following section:

***Right Hand Abutment***

- Eight options, all with spillways (90 to 200 metres wide with sill levels at 318 to 330.9 metres AHD) controlled by gates, fuse plugs or weirs together with dam wall raising ranging from 4.05 to 8.77 metres.

***Right Hand Abutment and Sub Wall***

- One option with a spillway (200 metres wide with sill level at 327.5 metres AHD) controlled by gates at the right hand abutment and a spillway (730 metres wide with sill level at 325 metres AHD) controlled by fuse plugs at the sub wall; and
- Two options with a spillway (195 to 390 metres wide with sill levels at 325 to 327.5 metres AHD) controlled by gates or fuse plugs at the right hand abutment and a spillway (110 to 280 metres wide with sill levels at 325 to 327.5 metres AHD) controlled by fuse plugs at the sub wall together with dam wall raising ranging from 3.85 to 4.95 metres.

***Right Hand Abutment and Caravan Park***

- Three options similar to the Right Hand Abutment and Sub Wall but substituting the Sub Wall for the Caravan Park.

***Caravan Park***

- Four options, all with spillways (210 to 2,500 metres wide with sill levels at 318 to 329.5 metres AHD) controlled by gates or plugs; and
- Four options, all with spillways (300 to 600 metres wide with sill levels at 325 to 327.5 metres AHD) controlled by gates, fuse plugs or weirs together with dam wall raising ranging from 2.00 to 5.04 metres.

***Sub Wall***

- One option with a spillway (860 metres wide with sill level at 325 metres AHD) controlled by fuse plugs; and
- Four options, all with spillways (300 to 600 metres wide with sill levels at 325 to 332.2 metres AHD) controlled by gates, fuse plugs or weirs together with dam wall raising ranging from 2.00 to 5.04 metres.

The assessment of these options against the criteria resulted in the identification of a short list of five alternatives. This was achieved using a step by step process:

- the alternatives were described with their impacts relative to the criteria which are to be used in the assessment;

- the criteria for assessment are defined and modified as required;
- each alternative is assessed against each criterion to derive a ranking – best to worst;
- if there is no difference between the performance of each alternative against a particular criterion, that comparison is discarded; and
- the criteria are reduced to the fundamental ones illustrating real differences between the alternatives. A choice is then made between the criteria – which is more important – those alternatives which perform better against the chosen criteria (there may be more than one) are included on the short list.

The process requires a steady simplification of the comparison between the alternatives on the basis of clearly stated preferences. The decision trail is clear to all and can be retraced either to confirm the decision or amend it where additional information is required.

The initial short listed options were:

- raising the main dam wall and sub-wall by 8.9 metres and adding a spillway with overflow weir (220 metres long) at the right hand abutment plus large saddle dam walls at the right hand saddle, boat ramp saddle, sailing club saddle and caravan park saddle and no temporary loss of storage (Option A1);
- raising the main dam wall and sub-wall by 7.7 metres and adding a spillway with three release plugs (220 metres long) at the right hand abutment plus medium to large saddle dam walls at the right hand saddle, boat ramp saddle, sailing club saddle, and caravan park saddle and a 20 % temporary loss of storage (Option A2);
- raising the main dam wall and the sub-wall by 2.7 metres and adding a spillway with three release plugs (220 metres long) at the right hand abutment and four release plugs (380 metres long) at the sub-wall plus small to medium saddle dam walls at the boat ramp saddle, sailing club saddle and caravan park saddle and a 38 % temporary loss of storage (original Option B1);
- raising the main dam wall and the sub-wall by 4.2 metres and adding a spillway with three release plugs (220 metres long) at the right hand abutment and four release plugs (380 metres long) at the sub-wall plus medium to large saddle dam walls at the boat ramp saddle, sailing club saddle and caravan park saddle and a 20 % temporary loss of storage (Option B2); and
- raising the main dam wall and sub-wall by 4.6 metres and adding dual spillways with 10 release plugs (900 metres long) at the caravan park and sailing club saddles plus a medium saddle dam wall at the boat ramp saddle (Option C1).

This initial short list of options included at least one located at each of the potential spillway sites plus that with the lowest cost and likely lowest local impacts but highest cost.

## C.6 Refinement of the Short Listed Options

The performance of each of these options in terms of operational frequency of the additional spillway(s) was normalised. This was achieved by refining the release plug arrangement which resulted in a need to adjust sill levels and spillway widths with a subsequent affect on costs. This included ensuring that outflow from the release plugs did not exceed flood in-flows – an operating requirement which resulted in the reduction of temporary storage loss for Option B1 (refined).

The first additional spillway to operate in each option was also adjusted so that it activates at 1:1,800 AEP, achieving consistency across the options and removing this consideration from the evaluation.

Refinement of environmental impacts of the short-listed options indicated that Option C1 with a spillway through the Caravan Park would result in impact on the threatened hakea more severely than any other option considered. This issue led to a review of options considered previously that retain all flood flows from Keepit Dam in the Namoi River.

A more refined assessment of incorporating 3 additional spillways was considered (ie right hand abutment, sailing club and boat ramp Option D3). This option was found to be cost competitive with Option C1 (Caravan Park) and reduced the impact on the hakea.

The options with a temporary loss of storage were refined to 30% (Option B1) and 15% (Option A2) but concern was highlighted by the relatively high cost of Option A2. With the identification of the cost effectiveness of Option D3, an Option D2 was assessed which was effectively the same as Option D3 but with 15% temporary loss of storage by lowering the release plug sills. This Option D2 was substantially less in cost than Option A2 (refined) and had very little increase in impact on the hakea compared with Option D3. The cost of Option D2 was similar to Option B2 (refined) and was chosen in view of the much greater environmental impacts in the Peel River associated with Option B2 (refined).

Refinement of spillway efficiencies lead to a reduced cost option for Option A1 which included only an additional spillway at the right-hand abutment and wall raising. This option was called Option A3.

A review of these refinements and associated environmental impacts led to the Panel revising their short list of options to four namely Options A3, B1, D2 and D3. (These options are more detailed in Appendix E).

After consideration of the advice from the CRP and all other consultation and potential funding limitations, the State Water Board removed one of the options (Option A3) because its significant additional cost was not considered commensurate with the overall increase in environmental benefits.

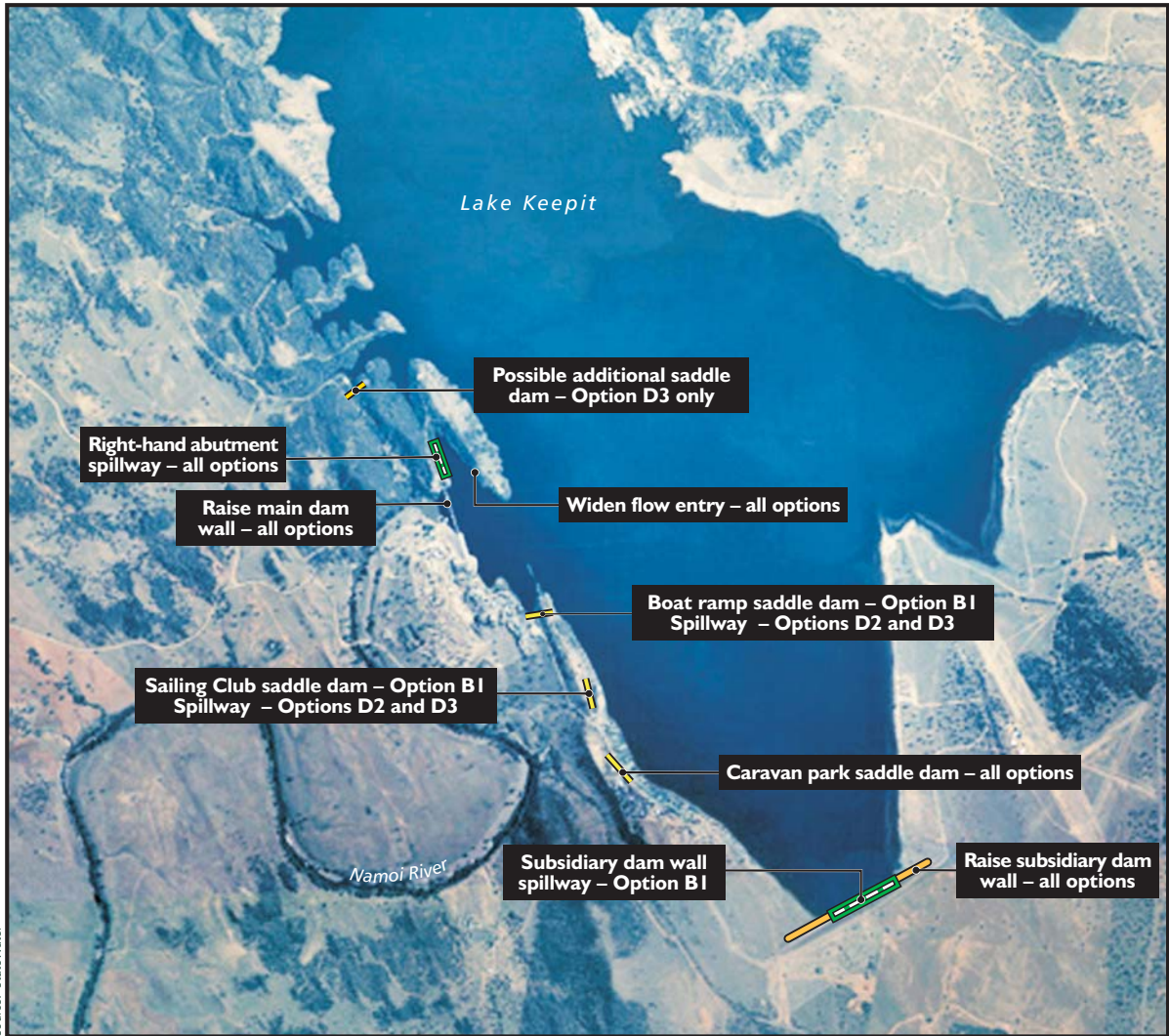
The key features of the short-listed options are shown in *Figure C.1*.

## **C.7 Other Objectives Outcomes**

### **C.7.1 Responding to the Regional Development and Environmental Objectives**


While primary and secondary objectives have been considered separately, work has also been conducted on identifying areas which can realistically be affected by the proposed upgrade work and attempting to ensure that the benefit will be measurable and result from the proposed works. State Water engaged a series of technical groups and value management workshops from key environmental agencies to assist with investigation of areas of proposed improvement including mitigation of the effects of the existing dam via works to be incorporated in the upgrade. These have included:

- provision of fish passage at the dam wall;
- the ability to in future, provide variable environmental flows in the Namoi River through improvement of outlet capacity and potentially increased impoundment of water for these purposes; and



Source: StateWater

Figure C.1 Key features of options

-  Saddle dam
-  Spillway

- in combination with the above, the ability to better align the temperature and water quality of discharged water from the dam with those of natural river waters.

Conclusive data on most of these issues was not available, either due to the nature of some of the devices required or because there is a lack of background data either on which to base assumptions or to draw conclusions about the effectiveness of existing management methods. The benefits achievable from fish passage hails mostly from overseas experience, with limited information on success or otherwise in Australia. Similarly, the benefits of providing variable environmental flows from the dam into a highly degraded ecosystem are the subject of much debate. Generally however, it is agreed that provision of variable flows in a way that seeks to mimic more natural conditions would result in environmental improvements.

The ability to affect the temperature differential in a storage the size of Lake Keepit both between the water layers and more uniformly across the Lake has been found to be very difficult and an expensive exercise.

The outcomes of the various investigations, expert groups and value assessments were used to help determine which improvements should be pursued and potentially included as part of the upgrade. Influencing the temperature of discharge releases has been identified as having potential, and would benefit up to 100 kilometres of river downstream of Keepit Dam.

Possible improvements relate to:

- reduction of cold water releases;
- reduction of algae, sedimentation and nutrients within the storage;
- removal of restrictions on fish passage (dam wall and downstream weirs);
- increased hydro-power generation; and
- improvement in health of the river bed and banks and wetlands downstream by variable flows and an increase in full supply level.

### **C.7.2 Cold Water Pollution**

Thermal stratification in the storage and the resulting discharge of water colder than would be the case under natural conditions, has a number of affects downstream of Keepit Dam. These include reduction in biological productivity, reduction in the diversity and number of native fish, increase in feral fish breeding, shift in species distribution and a reduction in primary contact recreation.

The objective is to increase water temperature discharged from the storage. A total of 11 options were identified including provision for selective withdrawal, aeration of the storage and systems of impellers for mixing. These were reduced to two options involving a multi-level offtake attached to the existing outlet. These would comprise sliding plates (proven technology) or roller doors (less costly but untried technology). The most cost effective approach overall would be to add the multi-level off-take as part of the safety upgrade.

The provision of the off-take is strongly supported by the CRP.

### **C.7.3 Improvement in Water Quality in the Storage**

Existing water quality is influenced by stratification, sedimentation and the presence of conditions conducive to the formation of algal blooms usually as a result of nutrients.

The inclusion of de-stratification measures in the dam is considered to be unacceptable due to high costs. Sedimentation is occurring below gate sill level but is considered to be minor and algal management would be included in the design of the multi-level off-take.

### **C.7.4 Fish Passage**

The issue of fish passage includes removing restrictions on fish passage through modification or replacement of existing ineffective fishways downstream of Keepit Dam at Mollee and Gunidgera weirs and consideration of a fish lift past the main dam wall.

Fish passage improvements past Mollee and Gunidgera downstream weirs have been included in the overall Namoi River Fishway Strategy downstream of Keepit Dam which is being developed in conjunction with Namoi Catchment Authority and Department of Primary Industries (Fisheries).

Until recently, consideration of fish passage past Keepit Dam was not going to form part of the upgrade. This position was due to the time and high cost of research required to resolve the outstanding issues identified during investigations associated with the environmental value of a fish lift (the only realistic option identified) at Keepit Dam and potential difficulty and cost of achieving, in particular, downstream passage. Consideration of the outstanding issues including an appropriate level of research was proposed to continue and if able to be resolved, then a fish lift could be reconsidered.

However at the Planning Focus Meeting in February 2006 and at a workshop on 3 March 2006, the Department of Primary Industries (Fisheries) identified that more recent research and data on fish

passage generally should help resolve these outstanding issues at Keepit Dam without the need for major further research.

In addition, DPI has formally advised on 14 April 2006, that under Section 218 of the Fisheries Management Act, State Water should evaluate the current impact the dam has on the fish passage and investigate and assess the value of potential ameliorative measures as part of the Environmental Assessment. The ameliorative measures may involve either construction of a fish lift at the dam or other measures to improve fish passage elsewhere in the catchment. Therefore State Water will further develop the assessment of providing fish passage or trade-offs as part of the Environmental Assessment.

### **C.7.5 Hydro-power**

There is little potential to increase existing power generation under existing flow regimes at the dam. This situation could change if a decision is made in the future to increase the full supply level.

### **C.7.6 Increasing Full Supply Level**

The safety upgrade of the dam could provide an opportunity for improving downstream environmental conditions. An option considered, involved the storage of additional water in an enlarged dam by capturing a percentage of medium to large floods for later release as environmental flows targeting high value areas downstream. Investigations have been undertaken to establish if this option is cost-effective and flexible with the ability to provide effective regional environmental improvements.

The investigations have indicated that environmental improvements would be achieved with flows of 4,000 megalitres per day plus in the Bugilbone region. These events would provide flows into important floodrunner and anabranch habitats resulting in improvements to approximately 1,000 kilometres of floodrunner habitat, habitat for threatened and non-threatened native species, improved nutrient cycling and flush events triggering fish migration and breeding events.

The capture of the flood flows would occur above the existing full storage level having no effect on current irrigation supply and reliability. Releases of 8,000 megalitres per day are required to achieve a 4,000 megalitres per day plus flow event at Bugilbone. This would require the additional storage of some 100 gigalitres of water in Keepit Dam (additional 24% capacity) resulting in an additional increase in full supply level of 2.1 metres. Further wall raising and /or additional spillway capacity, together with modifications to the existing release gates would cost between \$13 million and \$16 million depending on which option is selected, if undertaken in conjunction

with the dam safety upgrade and (at least \$21 million if undertaken separately).

The upstream impacts resulting from an increase of 2.1 metres (510 hectares) are considered to be limited and would occur for only seven percent of the time (on average) for periods of up to five months.

The potential improvements resulting from the environmental flows would only be fully achieved by integration with land management improvements in the target areas. This has major cost and long term management implications for State Water and other State government agencies.

Similar outcomes could be achieved if 36 gigalitres was bought back from the irrigators. This would cost at least \$36 million with major additional socio-economic impacts.

The increase in full supply level concept appears to have net environmental value but a number of issues would need to be resolved including:

- long term security of the water reserved for environmental purposes;
- implications for the Water Sharing Plan;
- management responsibilities;
- priorities within the context of State Water's total portfolio;
- release management;
- monitoring and performance evaluation;
- overall value for money;
- source of funds; and
- potential liability.

Further raising of the height of the dam wall of those options which already including considerable raising of the height of the dam wall would not be cost effective. Additional spillway capacity would be need for these options

The outcome of a value management assessment of this increased FSL concept is that the concept would not be pursued as part of the upgrade as support by key environmental agencies that would manage such a concept, could not be obtained. The lack of support was due to their concern environmental value, impacts and management processes had not been sufficiently demonstrated and overall the concept was not consistent with current environmental policies. Support for the concept was however indicated by local community groups and regional organisations and so it is proposed that any

upgrade would not prevent consideration of the concept sometime in the future.

## **C.8 Stakeholder Involvement**

A chronological record of the meetings, workshops, task groups and other forms of stakeholder involvement in the development and selection of upgrades and environmental improvements is provided in Attachment 1.

A record of the technical assessments and reports that support the development and refinement of the upgrade options is provided in Attachment 2.

## **Attachment 1**

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Consultation summary for Keepit  
Dam Upgrade (2001 – 2006)

## Consultation Summary for Keepit Dam Upgrade (2001–2006)

Who	Issue	Category/ Format	Date	Attendees	Location	Key Relevant Deliverables	Key Outcomes (if any)
CRP 1 <sup>st</sup> Meeting	Keepit Dam Upgrade	Meeting	23&24/05/01	CRP Members & SW	Smithurst Theatre, Gunnedah	Media Release	<ul style="list-style-type: none"> <li>• First meeting of the CRP</li> <li>• Initial briefing on the Project</li> </ul>
CRP 2 <sup>nd</sup> Meeting	Keepit Dam Upgrade	Meeting	25&26/07/01	CRP Members & SW	Gunnedah Service Club	Minutes Produced	<ul style="list-style-type: none"> <li>• Roll of the CRP</li> <li>• Upgrading options developed to-date</li> <li>• Discussion of how options will be assessed</li> <li>• Discussion of desired outcomes for the project</li> <li>• Who needs to be involved in consultation process</li> <li>• Cost sharing principles being developed for IPART</li> </ul>
CRP 3 <sup>rd</sup> Meeting	Keepit Dam Upgrade	Meeting	26&27/09/01	CRP Members & SW	NSW Dept Sport & Recreation, Keepit Homestead Hall, Keepit Dam	Presentation Minutes Produced Media Release	<ul style="list-style-type: none"> <li>• Feedback from Keepit Steering Group Mtg</li> <li>• Early Warning System</li> <li>• Interim Works               <ul style="list-style-type: none"> <li>- The need for Interim Options</li> <li>- Alter Dam Operations</li> <li>- Raise main dam / Lower subsidiary dam embankment</li> </ul> </li> <li>• Consultation Strategy</li> <li>• CRP Objectives</li> <li>• Environmental Assessment/EIS               <ul style="list-style-type: none"> <li>- Legislative requirements</li> <li>- Draft brief</li> <li>- Other Issues</li> </ul> </li> </ul>
CRP 4 <sup>th</sup> Meeting	Keepit Dam Upgrade	Meeting	29&30/11/01	CRP Members & SW	Keepit Dam Homestead	Presentation Minutes Produced Media Release	<ul style="list-style-type: none"> <li>• Work Program Timeline</li> <li>• Interim Options Investigation &amp; Impacts</li> <li>• What we've done so far</li> <li>• Discussion and CRP Assessment of</li> </ul>

Who	Issue	Category/ Format	Date	Attendees	Location	Key Relevant Deliverables	Key Outcomes (if any)
							Options
Lower Peel Landowners	Keepit Dam Upgrade and the need for Interim Works	Meeting	25/03/02	Lower Peel Landowners	Keepit Dam State Park Trust Conference Room	Presentation Minutes produced	<ul style="list-style-type: none"> <li>• General Briefing on the Project</li> <li>• Discussed potential Interim Works options</li> </ul>
CRP 5 <sup>th</sup> Meeting	Keepit Dam Upgrade	Meeting	26&27/03/02	CRP Members & SW	The Gallery, Creative Arts Centre, 83 Chandos St. Gunnedah	Presentation Minutes produced	<ul style="list-style-type: none"> <li>• Feedback from Keepit Steering Group Mtg</li> <li>• Revised project management and program Interim</li> <li>• Interim option development</li> <li>• Interim Sub-options initial multi-criteria assessment</li> <li>• Outcomes of landowner meeting</li> <li>• Hydrology modelling and verification status</li> <li>• Interim Option REF draft terms of reference assessment</li> <li>• Options Assessment/EIS consultancy (EIS) status / Revised EIS Consultancy scope &amp; program:</li> <li>• Long-term options evaluation issues and priorities</li> <li>• Consultation and Communication Framework / Package</li> <li>• Draft Situation Report by DLWC Barwon Region Status</li> </ul>
Lower Peel Landowners	Interim Works Options	Meeting	16/05/02	Lower Peel Landowners	Keepit Dam State Park Trust Conference Room	Minutes produced	<ul style="list-style-type: none"> <li>• Update participants on the Interim Works Options</li> </ul>
CRP 6 <sup>th</sup> Meeting	Keepit Dam Upgrade	Meeting	28&29/05/02	CRP Members & SW	Keepit Dam Sport & Rec Conference Room	Presentation Minutes produced	<ul style="list-style-type: none"> <li>• Outline of long-term options, options evaluation and EIS program and timeline, communication strategy and statutory requirements</li> <li>• Hydrology Modelling</li> <li>• State Water's</li> </ul>

Who	Issue	Category/ Format	Date	Attendees	Location	Key Relevant Deliverables	Key Outcomes (if any)
							Communication/Consultation Strategy <ul style="list-style-type: none"> <li>• Economic Analysis of Interim Options</li> <li>• Interim Option Assessment including multi-criteria development – key issues outlined and relative importance of these key issues</li> </ul>
CRP 7 <sup>th</sup> Meeting	Keepit Dam Upgrade	Meeting	07/08/02	CRP Members & SW	Creative Arts Centre, Gunnedah	Presentation Minutes produced	<ul style="list-style-type: none"> <li>• Interim Works               <ul style="list-style-type: none"> <li>- Construction Issues</li> <li>- Process Issues and Construction Program</li> </ul> </li> <li>• New Hydrology</li> <li>• Long-term options refinement</li> </ul>
Lower Peel Landowners	Interim Works Options	Meeting	27/06/02	Lower Peel Landowners	Keepit Dam State Park Trust Conference Room	Presentation Minutes produced	Update participants on the preferred interim works option – what it means for them.
Environmental Improvements Workshop	Environmental improvement opportunities	Workshop	01/11/02	DLWC, NSW Fisheries, DPWS, PB, SWC.	Macquarie Towers Parramatta	Presentation Minutes produced Summary Report	To develop environmental improvement options which could be incorporated into the upgrade project.
CRP 8 <sup>th</sup> Meeting	Keepit Dam Upgrade	Meeting	19/11/02	CRP Members & SW	Gunnedah Shire Council, Training Centre	Presentation Minutes produced Media Release	<ul style="list-style-type: none"> <li>• Consultation Update</li> <li>• Issues to be incorporated into Long-term upgrade</li> <li>• Outcomes of Environmental Improvements Workshop</li> </ul>
Manilla Shire Council	Keepit Dam Upgrade Project – IW required, Long Term Options	Meeting	11/04/02	David Watson, Mayor, General Manager & Director of Environmental & Health Services	Manilla Shire Council Office	Presentation Minutes produced	Keepit Dam Upgrade – Interim Works required and the Long Term Options
Parry Shire Council	Keepit Dam Upgrade Project – EWS, IW, LT Options EP & A Act	Meeting	17/05/02	John Davis, Jocelyn Potts, David Watson	Parry Shire Council Offices	Presentation Minutes produced	Keepit Dam Upgrade Project – Early Warning System, Interim Works, and Long term Options.

Who	Issue	Category/ Format	Date	Attendees	Location	Key Relevant Deliverables	Key Outcomes (if any)
Keepit Communications Group	Keepit Dam Upgrade – Communication Strategy	Meeting	12/07/02	Parsons Brinckerhoff & State Water	State Water Office - Parramatta	Minutes produced	Communication Strategy
CRP 9 <sup>th</sup> Meeting	Keepit Dam Upgrade	Meeting	20/02/03	CRP Members & SW	State Park Conference Room, Keepit Dam	Presentation Minutes produced	<ul style="list-style-type: none"> <li>• Interim Works Status</li> <li>• Consultation / Communication Update</li> <li>• Long-term Option Status</li> </ul>
Environmental Task Group		Meeting	May 2003	Environmental Task Group Members	Parramatta	Minutes produced	<ul style="list-style-type: none"> <li>• Role of the Environmental Task Group</li> <li>• Environmental Investigation Update</li> </ul>
CRP 10 <sup>th</sup> Meeting	Keepit Dam Upgrade	Meeting	08/05/03	CRP Members & SW	Lake Keepit State Park Trust Board Room	Presentation Minutes produced	<ul style="list-style-type: none"> <li>• Development of comprehensive information package on the environmental investigations by Environmental Task Force</li> </ul>
Water Quality Experts	“In-storage environment” Expert Workshop	Workshop	14/05/03	Water Quality Experts	Parramatta	Presentation Minutes produced	<ul style="list-style-type: none"> <li>• Project Outline</li> <li>• Improvement Options</li> <li>• Impact of increased FSL</li> </ul>
CRP 11 <sup>th</sup> Meeting	Keepit Dam Upgrade	Meeting	19&20/06/03	CRP Members & SW	Smithurst Theatre, Gunnedah	Minutes produced Media Release	<ul style="list-style-type: none"> <li>• Set of smaller floods with AEP's to be undertaken</li> <li>• Arrange for sub-wall spillway configurations to be determined</li> <li>• Subwall options with a deep sill level removed</li> <li>• State Water seek refinement of the current model for increased FSL assessment</li> </ul>
Namoi Catchment Management Authority	Keepit Dam Upgrade	Meeting	29/07/03	CMA Members		Presentation	<ul style="list-style-type: none"> <li>• Interim Works</li> <li>• Long Term Upgrade (Dam Safety &amp; Environmental Improvements)</li> </ul>

Who	Issue	Category/ Format	Date	Attendees	Location	Key Relevant Deliverables	Key Outcomes (if any)
Namoi / Peel Customer Service Committee Meeting	Project Update	Meeting	01/08/03	Namoi / Peel CSC Members	Narrabri	Meeting	Keepit Dam Upgrade Project –Interim Works, Long-term Options & Environmental Opportunities
CRP 12 <sup>th</sup> Meeting	Keepit Dam Upgrade	Meeting	4 & 5/08/03	CRP Members & SW	Smithurst Theatre, Gunnedah	Presentation	<ul style="list-style-type: none"> <li>Update on project to date</li> <li>Short-listing options begun</li> </ul>
Environmental Task Group		Meeting	05/08/03	Environmental Task Group Members	Smithhurst Theatre Gunnedah	Presentation Minutes produced	Discussed environmental improvement options but concentrated on Increased FSL option Issues
Agquip Stall 2003	Project Update	Public Display	August 03	General Public	Tamworth Showgrounds	General Public Presentation Display	Community Awareness of the Project
Fishing Club Newsletter	Project Update	Article – Newsletter	October 03	Fishing Club Members		Article	Increased awareness of the Project by members
Caravan Owners	Project Update	Newsletter & Project Update	October 03	Caravan Owners		Newsletter	<ul style="list-style-type: none"> <li>Project Update for caravan owners</li> </ul>
Upstream Residents	Project Update	Meeting	06/11/03	Upstream Residents	Manilla	Minutes produced	<ul style="list-style-type: none"> <li>Project Update</li> <li>Assessment Process</li> <li>Potential impacts</li> <li>Timetable</li> </ul>
Environmental Task Group	Environmental	Meeting	07/11/03	Environmental Task Group Members		Presentation	Update on Environmental Opportunity investigations
Factsheets	Keepit Dam Upstream Upgrade	Factsheets	December 03			Factsheet	<ul style="list-style-type: none"> <li>Project Update</li> <li>Process</li> <li>contacts</li> </ul>
Environmental Task Group	Environmental	Meeting	15/12/03	Environmental Task Group Members	Tamworth Community Centre	Presentation Minutes	Environmental Opportunities

Who	Issue	Category/ Format	Date	Attendees	Location	Key Relevant Deliverables	Key Outcomes (if any)
						produced	
Environmental Task Group	Environmental	Meeting	19/02/04	Environmental Task Group Members	Tamworth Community Centre	Presentation Minutes produced	Environmental Opportunities
Environmental Task Group	Environmental	Meeting	08/03/04	Environmental Task Group Members	Tamworth Community Centre	Presentation Minutes produced	<ul style="list-style-type: none"> <li>Environmental Update</li> <li>Fish Passage and multi-level offtake</li> </ul>
CRP 13 <sup>th</sup> Meeting	Keepit Dam Upgrade	Meeting	5&6/04/04	CRP Members & SW	Gunnedah Bowling Club	Presentation Minutes produced	<ul style="list-style-type: none"> <li>Demand efficiency and management investigations required</li> <li>Refine the 5 options</li> <li>Narrabri Shire and Show to be included in the communication briefs</li> </ul>
Peer Review – Environmental Professionals	Keepit Dam Upgrade	Workshop	13/05/04	Key environmental professionals from a cross-section of disciplines	Stamford Hotel - Airport	Presentation Minutes produced	<ul style="list-style-type: none"> <li>Review Environmental Options Report</li> <li>Position Statement</li> </ul>
DIPNR	Environmental Opportunities	Meeting	June 04			Presentation	Environmental Opportunities
Treasury	Potential Environmental Opportunities	Meeting	June 04			Presentation	Potential Environmental Opportunities
Snr Agencies	Environmental Improvement Opportunities	Workshop	22/06/04		Royal Automobile Club	Presentation	Environmental improvement Opportunities – potential way forward
Agquip Stall 2004	Keepit Dam Upgrade	Public Display	Aug 04	General Public	Tamworth Showgrounds	General Public Presentation Display	Keepit Dam Upgrade
Namoi Water Users	Need for Upgrade, Interim Works, Long Term Safety Options	Meeting	Sept 04	Namoi Water Users		Presentation	<ul style="list-style-type: none"> <li>Update members of the upgrade</li> </ul>
CRP 14 <sup>th</sup>	Keepit Dam	Meeting	19/10/04	CRP Members &	Smithurst Theatre,	Meeting	<ul style="list-style-type: none"> <li>Consolidate the short listed dam safety and flood investigation</li> </ul>

Who	Issue	Category/ Format	Date	Attendees	Location	Key Relevant Deliverables	Key Outcomes (if any)
Meeting	Upgrade			SW	Gunnedah		action options
Value Management Workshop	Dam Safety / Environmental Improvement Options	Workshop	04/11/04	CRP, CMA, Treasury, DIPNR, DEC, DPI, DEUS, SW, PB	American Club Sydney	Presentation Minutes produced	<ul style="list-style-type: none"> <li>Dam Safety</li> <li>Environmental improvement Options</li> </ul>
CRP 15 <sup>th</sup> Meeting	Keepit Dam Upgrade	Meeting	30/11/04	CRP Members & SW	Tamworth Community Centre	Presentation Minutes produced	<ul style="list-style-type: none"> <li>Options Study Consultants to meet with CRP to ensure all issues are covered</li> <li>Increased FSL option requirements to be resolved</li> </ul>
FSL Value Management Workshop	Value and way forward for Increased FSL	Workshop	01/12/04	CRP Chair and representative, DPI, DIPNR, DEC, CMA, SW		Presentation Minutes produced	<ul style="list-style-type: none"> <li>Discussion on Value &amp; way forward for Increased FSL</li> </ul>
Catchment Management Authority	Keepit Upgrade Update	Meeting	09/12/04	SW and Bruce Brown	Tamworth		More detail regarding Upgrade
CRP 16 <sup>th</sup> Meeting	Keepit Dam Upgrade	Meeting	31/03/05	CRP Members & SW	Parramatta	Presentation Minutes produced	<ul style="list-style-type: none"> <li>Update members on environmental option deliberations</li> <li>Finalise short-listed options</li> </ul>
Department of Environment & Conservation	Increased FSL Opportunity	Meeting	March 05	Department of Environment & Conservation Members		Environmental contingency allowance- Increased FSL Opportunity	<ul style="list-style-type: none"> <li></li> </ul>
Namoi / Peel CSC	Update on Keepit Upgrade	Meeting	10 May 2005	Namoi Peel CSC & David Watson		Presentation	<ul style="list-style-type: none"> <li>Outline 4 short-listed dam safety options &amp; other potential improvement opportunities</li> <li>Update members on formal assessment process</li> <li>Outline opportunities for CSC input</li> </ul>
Tamworth Regional Council	Consultation of 4 short-listed options	meeting	14/6/05	TRC & State Water	TRC Tamworth	Presentation	Outline 4 short-listed dam safety options & other potential

Who	Issue	Category/ Format	Date	Attendees	Location	Key Relevant Deliverables	Key Outcomes (if any)
State Water Staff Keepit Dam Office	Consultation of 4 short-listed options	Meeting	15/06/05	State Water Staff at Keepit Dam	Keepit Dam	Presentation	Outline 4 short-listed dam safety options & other potential
Mike Ticehurst Sport & Recreation Club	Consultation of 4 short-listed options	One-on-one Meeting	15/06/05	Mike Ticehurst	Sport & Recreation Club	General Discussion	One-on-one on consultation methods
Gunnedah Shire Council	Consultation of 4 short-listed options	Meeting	15/06/05	Gae Swain & Council Members	Gunnedah Shire Council Chambers	Presentation	Outline 4 short-listed dam safety options & other potential
Red Chief Local Aboriginal Land Council	Consultation of 4 short-listed options	Meeting	15/06/05	Peter Beale & Red Chief Council Members	Red Chief Local Aboriginal Land Council Offices	Presentation	Outline 4 short-listed dam safety options & other potential
Walgett Shire Council	Consultation of 4 short-listed options	Meeting	16/06/05	Stephen McLean & Council Members	Walgett Shire Council Chambers	Presentation	Outline 4 short-listed dam safety options & other potential
Lower Peel & Namoi Land Owners	Consultation of 4 short-listed options	Meeting	16/06/05	Lower Peel & Namoi Land Owners	Keepit State Park Trust Offices	Presentation	Outline 4 short-listed dam safety options & other potential
Manilla Ski Gardens Managers	Consultation of 4 short-listed options	One-on-one Meeting	17/06/05	John/Jan McArtney Manilla Ski Gardens Mgr	Manilla Ski Gardens	Presentation	One-on-One on consultation methods
Carroll Residents	Consultation of 4 short-listed options	Meeting	17/06/05	Carroll Residents	Carroll Local Public School	Presentation	Outline 4 short-listed dam safety options & other potential as well as the Early Warning System procedures
North & Northwest Fishing Association	Consultation of 4 short-listed options	Meeting	19/06/05	North & Northwest Fishing Association Members	Royal Hotel - Manilla	Presentation	Outline 4 short-listed dam safety options & other potential
Narrabri Shire Council	Consultation of 4 short-listed options	Meeting	21/06/05	Narrabri Shire Council Members	Narrabri Shire Council Chambers	Presentation	Outline 4 short-listed dam safety options & other potential
Keepit Dam Sailing Club	Consultation of 4 short-listed	Meeting	21/06/05	Keepit Dam Sailing Club Members	Keepit Dam Sailing Club	Presentation	Outline 4 short-listed dam safety options & other potential

Who	Issue	Category/ Format	Date	Attendees	Location	Key Relevant Deliverables	Key Outcomes (if any)
	options						
Namoi Catchment Management Authority	Consultation of 4 short-listed options	Meeting	27/06/05	Namoi CMA Board meeting Members	Namoi CMA Office in Gunnedah	Presentation	Outline 4 short-listed dam safety options & other potential
West Rim Land Owners / Agistees	Consultation of 4 short-listed options	Meeting	28/06/05	West Rim Land Owners / Agistees Members	Acacia Waters Holiday Resort	Presentation	Outline 4 short-listed dam safety options & other potential
East Rim Land Owners / Agistees	Consultation of 4 short-listed options	Meeting	29/06/05	East Rim Land Owners / Agistees Members	Sport & Rec in Fitness Camp Rd	Presentation	Outline 4 short-listed dam safety options & other potential
Lake Keepit State Park Caravan Owners	Consultation of 4 short-listed options	Meeting	02/07/05	Lake Keepit State Park Caravan Owners	Lake Keepit State Park – Kiosk Area	Presentation	Outline 4 short-listed dam safety options & other potential
Manilla Ski Gardens Caravan Owners	Consultation of 4 short-listed options	Meeting	03/07/05	Manilla Ski Gardens Caravan Owners	Manilla Ski Gardens	Presentation	Outline 4 short-listed dam safety options & other potential
Pre-planning Focus Meeting	Keepit EIS Requirement	Meeting	07/07/05	Department of Environment & Conservation Members	DEC Office Level 17 Goulburn Street Sydney	Presentation Minutes produced	Potential assessment requirements and relevance of new Part 3A process to the Keepit Upgrade
Agquip Stall 2005	Consultation of 4 short-listed options	Public display	August 05	General Public	Tamworth Showgrounds	General Public Presentation Display	Outline 4 short-listed dam safety options & other potential
CRP 17 <sup>th</sup> Meeting	Keepit Dam Upgrade	Meeting	26/09/05	CRP Members & SW	Tamworth	Presentation Minutes produced	Provide feedback on consultation outcomes
Murray-Darling Basin Committee	Increased FSL	Meeting	03/12/05	River Murray Water, MDBC, State Water	Canberra	Meeting – Minutes produced	Increased FSL Option
Newsletter to Gums Caravan	Project Update, 4 short-listed options, CRP	Newsletter	December 05	Caravan Park residents	State Water Office Parramatta	Newsletter sent out to residents/ Owners Gums	Project Update, 4 short-listed options, CRP role

Who	Issue	Category/ Format	Date	Attendees	Location	Key Relevant Deliverables	Key Outcomes (if any)
Park Residents	role					Caravan Park, State Park	
State Park Working Group	Project Status & implications for State Park	Working Group	18/01/06	Nominated attendees from State Park & David Watson	Keepit Dam State Park Trust Conference Room	Working Group – Outcomes Listed	<ul style="list-style-type: none"> <li>• Status of Project</li> <li>• Implications for State Park</li> </ul>
State Park Working Group	Project Status & determining a way forward	Working Group	23-02-06	Nominated attendees from State Park & David Watson	Keepit Dam State Park Trust Conference Room	Working Group – Outcomes Listed	<ul style="list-style-type: none"> <li>• Status of Project</li> <li>• Determining a way forward</li> </ul>
Planning Focus Meeting	Agency Assessment requirements under Pt 3A	Meeting	03/02/06	DoP, DEC,DPI, TSC, GSC,CMA, DoL, DSC,PB, SW	State Water Office Parramatta	Meeting – Minutes produced	To discuss Agency assessment requirements under Part 3A
CRP 18 <sup>th</sup> Meeting	Keepit Dam Upgrade	Meeting	24/03/06	CRP Members & SW	Smithurst Theatre, Gunnedah	Meeting	

## **Attachment 2**

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Keepit Dam Upgrade – technical  
reports and supporting documents

## Keepit Dam Upgrade Documents

Title	Date	Organisation
Keepit Dam – Preliminary (Phase 1) Concept Design Geological Investigations.	July 1998	Department of Public Works
Keepit Dam Investigation of Remedial Options (Options 1-4) for Department of Land and Water Conservation	August 1998	Department of Public Works
Keepit Dam – Concept Design (Phase 2) Geological Investigations, Volume 1. Incl engineering & regional geology, interpreted	May 1999	Department of Public Works
Concept Design (Phase 2) Geological Investigations, Volume 2 (Appendices) Incl summary investigations, engineering geology	May 1999	Department of Public Works
Concept Design (Phase 2) Geological Investigations. Volume 3	May 1999	Department of Public Works
Keepit Dam Concept Design (Phase 2) Supplementary Geological Investigations at the Subsidiary Embankment	July 1999	Department of Public Works
Keepit Dam Investigation of Remedial Options – Supplementary Report for Department of Lands & Water Conservation	December 1999	Department of Public Works
Keepit Dam – Peel River Incremental DR Inundation from Proposed Fuse Plug (Option 5) Version 1	March 2001	Department of Public Works
Keepit Dam Upgrade Project Development of Remedial Options	November 2001	Department of Public Works
Keepit Dam Interim Safety Works Review of Environment Factors	June 2002	Environmental Resources Management
Keepit Dam Upgrade - Series of Technical (Engineering, Hydraulics, Hydrology and Associated issues) and Costing on the Evaluation and Finalisation of Options	November 2002 to Present	Department of Commerce & State Water Corporation
Keepit Dam Cold Water Pollution Data Collection, Report No. MHL1236	May 2003	Manly Hydraulics Laboratory
Keepit Dam Cold Water Pollution Data Analysis Phase One Report No. MHL1245	May 2003	Department Of Commerce & Manly Hydraulics Laboratory
Literature Review - Environmental Position Of Lake Keepit, The Namoi River And The Potential Influence Of Proposed Dam Upgrade Works	June 2003	Cooperative Research Centre for Freshwater Ecology

Report on Environmental Improvement Engineering Investigations – Stage 1 Report No. DC03110	July 2003	Department of Commerce
Keepit Dam Upgrade - Economic Evaluation of shortlisted Options	October 2003 & June 2005	Hassall and Associates
Keepit Dam – Review of Seismicity	December 2003	Department of Commerce
Keepit Dam Long Term Options: Refined Hydraulic Modelling of Various AEP Events	March 2004	Sinclair Knight Merz
Draft Conditional Audit Stage 1 for Keepit Dam	June 2004	Department of Commerce
Draft Seismic Analysis for Keepit Dam	June 2004	Department of Commerce
Percentage Hakea Inundation Comparison of Options	March 2005	State Water Corporation
Keepit Dam: Assessment of Spillway Adequacy using GTS/MR/PMP Estimates	March 2005	Department of Planning and Natural Resources
Series of State Water Corporation Information & Fact Sheets used in Community consultation including Final Long-Term Upgrade Option – General Information	June 2005	State Water Corporation
Keepit Dam: Preliminary Geological Assessment of Alternative Spillway Options	August 2005	Department of Commerce
Keepit Dam Upgrade – Options Evaluation & Environmental Assessment – Options Comparison Report	December 2005	Parsons Brinckerhoff
Design Concept for Three Alternative Options For Provision Of Multi-Level Offtake Facilities Report No. DC05082	December 2005	Department Of Commerce
Keepit Dam Upgrade: Mike 21 Hydraulic Modelling and Geomorphic Study for Assessing Environmental Impacts	January 2006	Sinclair Knight Merz

## **Appendix D**

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Minutes from the planning focus meeting

## **Keepit Dam Upgrade**

### **Planning Focus Meeting**

#### **Draft Minutes**

**Friday 3rd February 2006**

**State Water Conference Room**

**(Level 8, 2-10 Wentworth Street, Parramatta)**

**Present:** Neville Osborne, Paul Weiner - *Department of Planning (DoP)*  
Greg Roberts, Barbara Richardson, Steve O'Donoghue, Gillian Dunkerley  
- *Department of Environment & Conservation (DEC)*  
Adam Vey, Eddie Parr - *Department of Primary Industries (DPI)*  
Michael Bloem - *Tamworth Regional Council (TRC)*  
Mike Silver - *Gunnedah Shire Council (GSC)*  
Neal Foster - *Department of Natural Resources (DNR)*  
Tony Page - *Namoi Catchment Management Authority (NCMA)*  
Robert Towler - *Department of Lands (DoL)*  
Norm Himsley - *NSW Dams Safety Committee (DSC)*  
Peter Allen, Greg Marshall - *Parsons Brinckerhoff P/L (PB)*  
David Watson, Alex White, Jocelyn Karsten, Jennifer Liebenberg  
- *State Water Corporation (SWC)*

**Apologies:** Randall Hart (*DNR*),  
Phil Purcell (*DEC*),  
Lisa Roberts (*DoP*),  
Jubrahil Khan (*SWC*)

**Meeting opened at 9.30am**

#### **5. Welcome, Introductions & Aim of Meeting**

David Watson welcomed everyone to the meeting and outlined the aims of the meeting, which in summary is:

- Assist with understanding of the project.
- Discuss the new Part 3A assessment process
- Provide opportunity for agencies to focus on and ask about key issues.

(MEETING SLIDE PRESENTATION SEPARATELY PROVIDED SHOULD BE READ INCONJUNCTION WITH THESE MINUTES)

## ***Keepit Dam Upgrade Focus Planning Meeting: 3-2-06***

### **6. Brief Presentations:**

- ***Project Status***

David gave a brief overview and recap on the project status, during which the following issues/questions were raised.

- *Potential vegetation offsets associated with the auxiliary spillway clearing, particularly in the area of the right hand abutment.* Currently this area contains regrowth predominately Cyprus pine, with a small amount of White Box. A potential offset area could be on the downstream side of the left hand abutment (LHA) below the SWC Village, which was cleared as part of the original dam construction and has never regenerated. This area could be revegetated with a White Box/White Cypress Pine community.
- **Question:** Where will the construction plant and equipment depot and office be located?  
**Response:** Proposing to use existing works and office areas on the left hand abutment for the main works depot and construction office location. Temporary works site areas during construction will be required next to the various construction sites between the right hand abutment (RHA) of the main dam and the existing sub-wall.
- **Question:** Is the hydrology scenario modelling such that a Probable Maximum Flood (PMF) is occurring concurrently in the Namoi and Peel catchments?  
**Response:** Hydrology assessment based on potential rainfall patterns for extreme storms considers the most likely concurrent flooding events which would occur in the Peel and Namoi River and all tributaries downstream when a PMF flood occurs in the Namoi River upstream of Keepit Dam. This assessment indicates when a PMF occurs in the Namoi River catchment above Keepit Dam a lower than PMF occurs in the Peel and lower tributaries. However these lower floods are still very large.

- ***Options Comparison Report***

Greg Marshall from PB gave a presentation on the findings of the Draft Options Comparison Report. (Refer presentation slides for more details). This draft report brings together all the main environmental issues and is considered the main document to provide background information for this meeting.

The following issues and questions were raised during discussion.

- **Question:** What are the key construction impacts associated with each option and how do you define or describe the PMF through Keepit Dam?  
**Response:** With regards to the first section of the question, David suggested the impacts would be covered during the later part of the presentations – but if not adequately please raise the question again.

PMF is described as having a peak flow of approximately 43,000 cubic metres per second (or approximately 3,700,000ML/d), a total volume 3,600,000ML (or 8.5 time the fully supply level capacity of Keepit Dam) and lasting about 90 hours with estimated chance of occurrence of the order of 1:500,000 to 1:1,000,000 annual exceedence probability (AEP).

**Keepit Dam Upgrade Focus Planning Meeting: 3-2-06**

- **Question:** Will downstream of the auxiliary spillways be armoured to reduce erosion?  
**Response:** No, the downstream areas aren't going to be protected. The Environmental Assessment (EA) report will explain and justify this decision not to provide a concrete chute or other forms of protection downstream. There will be differing degrees of soil erosion depending on the spillway location which is being better quantified as part of the proposed Expert Erosion and Sedimentation Workshop. Principally the main reasons for no protection are the significant high cost and lower probability of occurrence. Velocities through these new spillways are very high-up to 8 metre per second which can only be protected against by using a full concrete chute. The RHA spillway is the only feasible chute location but the cost is over \$15 million and has a very low cost/benefit outcome. If there are concerns in the future a downstream concrete chute could be build below the RHA spillway.
- **Question:** Did the economic analysis include costs associated with restoring erosion damaged areas immediately downstream of the new spillways?  
**Response:** In part, yes. Full restoration is considered impractical and has been analysed as uneconomic. This position will be detailed in the EA Report. An amount was allowed in each option to provide for re-establishment of vegetation and some rehabilitation to prevent further erosion from normal rainfall events. As an example, the cost to fully reinstate erosion areas immediately downstream of the sub-wall would be at least \$40 million - up to 4,000,000 m<sup>3</sup> of soil required which is unlikely to be achieved without damage borrowing areas, stabilising will be difficult and spending such money is considered very unlikely to occur on a localised area.
- **Question:** Did the financial assessment include replacement of the fuse plugs?  
**Response:** Yes, replacement costs of release plugs have been included. The RHA release plugs will start to trigger at 1:1,800 AEP which is equivalent to twice the 1955 flood of record. The next spillway will then begin to trigger at 1 in 10,000 AEP which is 4 times the 1955 flood of record. There is very little difference between the options in how the additional spillways operate. The major difference is that the release plug sill levels are different between the options with options D2 and B1 sill levels below full supply level creating temporary loss of storage until release plugs are replaced and higher more costly release plugs. This higher cost is more than offset by lower embankment dam wall raising costs. The replacement costs of larger fuse plugs for Options D2 & B1 is one of the reasons why despite higher capital cost, D3 benefit cost ratio is not much lower than the other two options.

• **Issues raised at Pre-Planning Workshop (July 05)**

Jocelyn briefly outlined the outcomes at the Pre-planning focus meeting held with key environmental agencies last year. The following questions were raised.

- **Question:** As part of the assessment into the impacts of erosion and sedimentation on downstream environment, will cultural heritage issues be taken into consideration and Aboriginal groups consulted during the EA process?  
**Response:** Yes, cultural heritage specialists will form part of the Erosion & Sedimentation Workshop to be held later this month. To date, involvement with the key Aboriginal Councils have been patchy despite considerable effort to consult. Recent cultural investigations have involved local tribal members during the site visits. Aboriginal involvement and consultation during the EA process

## ***Keepit Dam Upgrade Focus Planning Meeting: 3-2-06***

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will be essential. SWC will discuss this issue further to Phil Purcell (DEC) to ensure maximum exposure opportunity and involvement can be gained.

- ***Proposed Environmental Assessment Approach/Issues***

David Watson gave a presentation on further details of the options construction impacts and potential mitigation and on the EA approach (refer presentation slides for more details) and the following questions were raised.

- ***Question:*** David was asked to elaborate further on the criteria used in evaluation, on the ease of any further upgrades and does it mean increased storage capacity sometime in the future?  
***Response:*** Ease of any further upgrades evaluation criteria used by the Community Reference Panel (CRP) related to not preventing any future upgrade as far as practical, be it for further safety upgrade or increased storage capacity. Key aspect which reduces the ease of further upgrades is restriction in further post tensioning of the main concrete spillway and replacement of large release plugs.
- ***Question:*** What about the loss of storage, was this factored into the economic analysis?  
***Response:*** Yes, for Option D2 – 15% and for Option B1 – 30%. Due to the low chance of occurred 1:1800 AEP it did not have a large impact on the benefit/cost ratio.
- ***Question:*** Like to seek clarification of today's aims. Is it to determine the Agencies preferred options, although it seems as though the SWC Board has a preferred option subject to certain outcomes occurring?  
***Response:*** Today's planning focus meeting is not about Agencies selecting a preferred option but to clearly identify the process for that to happen and focus on key issues. The concept approval process will require Agencies to advise acceptability of each option as part of approvals process and then determine which option is preferred. Option A3 has been ruled out of the process (refer presentation slide for further details) and will not form part of the formal assessment process. Options D3, D2 & B1 will be assessed.
- ***Question:*** How many Land Holders are there in the flow path below Option B1 Sub-wall Spillway?  
***Response:*** There are seven identified landowners downstream of the sub-wall to the confluence of the Peel and Namoi Rivers, but two landowners will be subject to major erosion immediately downstream of the sub-wall.
- ***Question:*** Will State Water buy these properties as part of the project?  
***Response:*** The general approach being taken is that compensation will be considered when the flood event occurs. The very low chance of such flood events makes it very uneconomic to consider any compensation upfront. Affected landowners are well aware of this approach through extensive consultation in 2005 and to date have not raised any significant concerns. Due to the very direct and major impact immediately downstream of the sub-wall the two properties affected may require special consideration.
- ***Question:*** What is the construction period of the project?  
***Response:*** Likely around 2½ years. The RHA Spillway will need to be substantially completed before the main wall is raised to ensure its safety during the raising.

**Keepit Dam Upgrade Focus Planning Meeting: 3-2-06**

- **Question:** Particularly Options D3 & D2 have an impact in the State Park during and after construction. How are these impacts going to be addressed?  
**Response:** A working group has been formed with State Park Trust including, Caravan Park residences and other users of the Park representatives, to identify and resolve construction, relocation, compensation and ongoing operational issues. Examples of issues being addressed are:
  - Land tenure
  - Maximum excavation during the winter period when occupancy is low.
  - Relocation of boat ramp and sailing club.
  - Emergency management during major flood times
  - Relocation of services, caravan sites and overall amenity impacts.

The process is seen as one of negotiation with the State Park Trust and other key stakeholders who currently are embracing this approach.
  
- **Question:** Where will the material for the release plugs, spillways, and concrete come from?  
**Response:** At this stage it has been determined that a significant amount of the material for the release plugs will come from the excavation areas and a clay borrow pit between the SWC village and the Sailing Club Saddle. However material will need to be brought in via the Manilla/Oxley Highway road for both the release plugs and beaching. There is a good quarry at Carroll which could be used resulting in extra traffic load. The potential external materials required and sources will be identified in the EA Report and any damage to access roads will need to be repaired.
  
- **Question:** Where will the batching plant/depot area be located?  
**Response:** The batching plant will probably be near the existing workshop downstream of the left abutment. A crushing plant could also be located here, but there are a number of relatively low impact sites available.
  
- **Question:** How will the spillways be protected from cutback erosion?  
**Response:** A combination of long concrete downstream aprons, cut offs, grouting and other standard methods.
  
- **Question:** Steve O' Donoghue (DEC) asked if the information obtained during the environmental investigations and economic analysis by Hassall & Associates could be useful for the Agencies, in helping with comparing options.  
**Response:** David considered it maybe useful, but could be more beneficial if we discussed what you were looking for in risk assessment, to better compare options.
  
- **Question:** As the upgrade project will be using Government funding, will the final option/decision be put forward to the Budget Committee?  
**Response:** Yes, this process is involved as is the "Gateway" Assessment process as the upgrade is greater than \$50 million. The EA process will assess the merits of the different options and selection of a final preferred solution. Treasury has indicated that the lower cost option B1 is their starting position with the EA process needing to convince them otherwise, before a high cost option would be considered for funding.

### 3. General Discussions on Key Issues

Agency representatives were asked if they had any other issues/areas that should be assessed as part of the EA which hadn't already been mentioned; any particular Agency requirements.

- **Questions:** How will the different options change the current flow regime? DPI (Fisheries) representative Adam Vey noted that Fisheries were concerned about identifying the impacts of the upgrade on downstream endangered ecological communities. DPI is also considering the relevance of s218 of the Fish Management Act. Does this constitute an alteration or modification of the structure and therefore fish passage would need to be considered? Can the fish passage program be incorporated into the conditions of approval?

**Response:** David briefly explained how flow patterns occur pre and post installation of temporary interim works including dam failure and how the various options upgrade prevented dam failure and their associated flow regimes. Some key points made were:

- All options prevented dam failure by a combination of additional spillways and some additional surcharging during the flood through higher dam walls.
- This spillway/wall raising combination to dam safety improvements had been identified as the most likely form of upgrade and advised to key stakeholders, for more than 2 years.
- David advised he would provide hydrographs to help show the flow patterns, and any potential impacts downstream.
- Jocelyn Karsten (SWC) outlined the fish lift investigation (only realistic method of fish passage past Keepit Dam) and outcomes to date. It was SWC's understanding that the fish passage was not a requirement of the upgrade. SWC and DPI to discuss this issue further outside of this meeting.

General statements made by various Agencies are as follows:

- Neal Foster (DNR) said there were no new requirements.
- Mike Bloem (TRC) said his Council would like to better understand the potential use of access roads during construction and impacts relating to road access during extreme flooding.
- Mike Silver (GSC) said his Council was interested to see social improvements/implications due to the upgrade.
- Tony Page (NCMA) said that the authority sees commitment and proposals to fish passage as a separate issue.
- Robert Towler (DoL) indicated his department would like to be involved in the ongoing investigations and changes which potentially may occur in the State Park.

#### 4. Project Requirements Raised and Discussed by Agencies

- **Question:** What is Councils role in the approvals?  
**Response:** At this stage all is to be assessed under Part 3A therefore there is no need for approval under Part 4. However there maybe some approval role relating to roads and access. This aspect to be confirmed at a later stage when construction details are better known.
- **Question:** Appendix A in the Ecologist Report of the Comparison Report mentions Part 5 instead of Part 3A. Why the difference?
- **Response:** David explained that Appendix A of the Options Comparison Report was completed before Part 3A of the Act was proclaimed. It was correct at the time of writing Appendix A but should now be updated to reflect current process. Neville Osborne (DoP) also explained there were a range of approval scenarios under Part 3A which could occur as follows:
  - could get approval to a specific or amended option, likely with conditions.
  - could be broken up and require to get approvals under a number of parts of the EP&A Act.
  - could require a further Project Approval process to proceed for a specific or amended option.

Some approvals under a number of other legislations were now incorporated into Part 3A of EP&A Act but others remained to be separately obtained.

**Noted:** Some parts of the Fish Management Act are rolled into the Part 3A approvals but others were not such as s218. To ensure there is no confusion, jurisdiction of Part 3A approvals will be clarified.

- **Question:** What is the pathway/process for obtaining DG requirements?  
**Response:** SWC is to forward a Project Application to DoP. Agencies to provide assessment requirements to DoP by end of February 2006. DoP to issue Director General requirements by mid March. SWC will issue updated information as it becomes available to Agency representatives, as we progress.
- **Question:** Will the Project Application be circulated to Agencies before it gets submitted?  
**Response:** The Project Application will be circulated to Agencies at the same time as it is submitted to DoP. Comments from Agencies will be sought on any issues considered still to be addressed.
- **Question:** Will the DoP formally write to agencies asking for requirements or is this Planning Focus Meeting the formal start of the process? How would Agencies like to see the process progress? Do Agencies need to forward a copy of their requirements and conditions to other Agencies? (The approach should be agreed on).  
**Response:** Forwarding or discussing requirements and conditions between Agencies prior to forwarding to submitting to the DoP is a matter for each Agency, but there could be merit in this approach. SWC would certainly like to discuss any key issues arising before requirements are forwarded to ensure Agencies have the latest information on the issue. SWC will send a copy of the Project Application to all Agencies and provide up-dated information as it becomes available or address issues as they arise. Agencies are urged to continue to advise DoP and SWC any issues, as they arise even after

***Keepit Dam Upgrade Focus Planning Meeting: 3-2-06***

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Agencies assessment requirements have been submitted. This approach will provide the maximum opportunity to properly address such issues. Agencies will again get an opportunity to see if requirements and issues have been properly covered when the draft Environmental Assessment Report is forwarded to them before the final report goes on public exhibition for formal submissions.

- **Question:** Will the licensing such as for extraction be address during this part of the process?  
**Response :** Any such formal licensing required will be processed as part of getting construction underway. However, the any key concerns or potential issues identified, will be addressed in the EA report.

**5. Summarised Outcomes and Process to Follow**

- While a preferred Option has been identified, the final option selected will be heavily dependant on the outcome of the formal EA process and ability to secure funding. It is unlikely approval will be obtained before August 2006 and any significant construction commence before 2007.
- Three Options D3, D2 & B1 are being considered under Concept Approval Part 3A EP & A Act Process
- Specific discussions regarding threatened species assessment, vegetation offsets and Aboriginal consultation issues with Greg Roberts and other DEC staff to follow.
- SWC and DPI to meet to discuss Fish Management Act requirements.
- Agencies to send assessment requirements to the DoP by end of February.

**NOTE: It was agreed by all present that no further advise other than confirmation through these minutes would be provided to Agencies about forwarding assessment requirements to Department of Planning (Neville Osborne) by end of (28<sup>th</sup>) February 2006.**

- It was discussed and decided that there was a need for all the agencies to get involved, in order to come to an agreement on how to work though the issues during the assessment process.
- Cultural heritage specialist to be involved in Expert Erosion and Sedimentation workshop.
- SWC to provide updated information to Agencies as available and will address discuss and advise on issues raised in the meeting particular through the Project Application and Environmental Assessment Report.

**6. Further Meeting: to be arranged, if need arises.**

***Close Meeting: 1:00pm***

## **Appendix E**

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Preliminary environmental assessment of  
key issues / aspects

## E. Preliminary assessment of key environmental issues

### E.1 Overview

This Appendix provides a preliminary assessment of key environmental issues and other environmental aspects associated with the proposed Keepit Dam Upgrade. The investigation of the incremental effects acknowledges the impacts caused by the operation of the existing dam infrastructure and distinguishes those which would result from the proposal. These include both environmental benefits and impacts.

Further refinement of this assessment will be provided in the Environmental Assessment report.

The key environmental issues and proposed further investigations for the Environmental Assessment are:

- The inundation of upstream areas above the adopted baseline level and consequent environmental effects eg heritage and flora and fauna issues.
- The proposed discharge of floodwaters through new downstream spillways and consequent environmental effects eg heritage and flora and fauna issues.
- Differential downstream erosion and sedimentation (and consequent environmental) effects.
- Further assessment on the feasibility and cost effectiveness of a fish lift or other ameliorative measures elsewhere in the catchment including trade-offs as sought under *Section 218 of the Fisheries Management Act 1994* by Department of Primary Industries.
- A review of the 2002 heritage assessment of Keepit Dam, considered as an item of local heritage significance, in the context of any changes proposed by the upgrade.

Environmental assessment of the remaining environmental aspects is proposed to cover:

- terrestrial ecology (construction)
- heritage (construction)
- aquatic ecology
- topography, soil and spoil management
- surface water quality and groundwater management
- visual
- noise and vibration

- air quality
- planning and land use
- business impacts and effects on community facilities
- waste minimisation and management
- land contamination
- risk and hazards
- social impacts
- traffic (construction)
- resources, energy use and greenhouse gases
- finance and economics
- cumulative impacts.

Table E.1 and E.2 summarise a preliminary assessment conducted for each of the above key environmental issues and environmental aspects and the indicative management response.

To assist in understanding the proposed options, photomontages of each option are provided in *Figure E7* (Option B1), *Figure E8* (Option D2) and *Figure E9* (Option D3).

*Further information on the proposed options and preliminary environmental assessment can be found in:*

- *the Keepit Dam Upgrade Brochure – June 2005 – Final Long-term Upgrade Options – General Information* and
- *the Keepit Dam Upgrade – Options Evaluation and Environmental Assessment – Options Comparison Report* (PB 2005).

**Table E.1 Potential impacts and management responses - key issues**

Issue	Existing environment /level of investigation	Risk assessment	Management response
<p><i>Terrestrial ecology (upstream and between spillways and receiving waters down to the confluence of the Peel &amp; Namoi Rivers)</i></p>	<p>Normal operational surcharge flooding for small to medium floods currently occurs to 1.2 metres above the full supply level of the existing dam (RL 330.8 metres).</p> <p>Proposed upgrade options would result in impacts to upstream areas not previously subject to flooding or areas flooded for a longer duration. (refer <i>Figure E.1</i>)</p> <p><i>Figure E.2</i> indicates the areas where flooding would occur downstream from the various new spillways to the receiving waters down to the confluence of the Namoi and Peel Rivers.</p> <p>Flood mapping shown in <i>Figure E.2</i> demonstrates that all options would result in a reduction in downstream inundation compared with the dam failure base case except for Option B1 below the subsidiary wall.</p> <p>Most of the downstream areas consist of cleared or modified agricultural land, although threatened flora communities have also been identified.</p> <p>Existing investigations include a desktop assessment conducted by interpretation of aerial photography and a four day site inspection. Habitat mapping outlined in <i>Figures E.3</i> and <i>E.4</i> indicates the typical vegetation types found.</p>	<p>An extreme flood would result in an upstream surcharge approximately equal to the level of wall raising. The duration of inundation will be 38 hours or less and a frequency of 1:60 AEP or less. The duration and frequency of inundation above this level will be significantly reduced on a logarithmic scale. <i>Appendix B</i> contains details of the duration and frequency of upstream inundation for various intervals.</p> <p>The upstream rising and falling of dam water levels over a period of 38 hours is not expected to result in a significant impact on mature trees but would, in conjunction with expected sediment deposition, result in the destruction of grasses. Slow moving fauna habitat would also be submerged.</p> <p>In the downstream areas between the new spillways and the receiving waters terrestrial ecology within these areas would be destroyed in the event of a very large to extreme flood event. This impact is due to the fact that vegetation would be removed, topsoil stripped and significant scouring and erosion of soils and soft rocks would occur. Due to the far greater length and more friable soils the flood area below the subsidiary wall associated with Option B1 would have the greatest impact.</p>	<p>Project-specific impacts within the upstream inundation areas and between spillways and receiving waters and down to the confluence of the Namoi and peel Rivers would be further investigated and documented during the preparation of the environmental assessment.</p> <p>Differences in scour and erosion (and consequent effects on terrestrial ecology) would be addressed through a specific study (see erosion and sedimentation issue below).</p> <p><i>Table 6.1</i> of the main report outlines the proposed further investigations for the Environmental Assessment.</p>
		<p>Extent of downstream inundation changes between options for very large to extreme</p>	

Issue	Existing environment /level of investigation	Risk assessment	Management response
		<p>floods with less than 1:10000 AEP:</p> <ul style="list-style-type: none"> <li>▪ In particular, effects on the threatened hakea and bothriochloa biloba (and other threatened communities) would be different for each option.</li> <li>▪ Significantly higher velocities (up to 70% higher) of flood flows in the lower Peel River down to the confluence of the Namoi and Peel Rivers associated with Option B1 would also have the greatest impact, being greater than would normally occur or would occur from Options D2 &amp; D3. However velocities in the Namoi River would for Option B1 would be lower further reducing the impact on the hakea.</li> </ul>	
<p><i>Heritage (upstream and between spillways and receiving waters down to the confluence of the Peel &amp; Namoi Rivers)</i></p>	<p>Normal operational surcharge flooding for small to medium floods currently occurs to 1.2 metres above the full supply level of the existing dam (RL 330.8 metres).</p> <p>Proposed upgrade options would result in impacts to upstream areas not previously subject to flooding or areas flooded for a longer duration. (refer <i>Figure E.1</i>)</p> <p><i>Figure E.2</i> indicates the areas where flooding would occur downstream from the various new spillways to the receiving waters down to the confluence of the Namoi and Peel Rivers.</p> <p>Flood mapping shown in <i>Figure E.2</i> demonstrates that all options would result in a reduction in downstream inundation compared with the dam failure base case except for Option B1 below the subsidiary wall.</p>	<p>An extreme flood would result in an upstream surcharge approximately equal to the level of wall raising. The duration of inundation will be 38 hours or less and a frequency of 1:60 AEP or less. The duration and frequency of inundation above this level will be significantly reduced on a logarithmic scale. <i>Appendix B</i> contains details of the duration and frequency of upstream inundation for various intervals.</p> <p>Reference to <i>Figure E.5</i> indicates that approximately 4 heritage sites would be inundated upstream. The rising and falling of dam water levels over a period of 38 hours is not expected to result in a significant impact on heritage sites but this would depend on the nature of each artefact. It is anticipated that the flood event would result in the deposition of</p>	<p>Project-specific impacts within the upstream inundation areas and between spillways and receiving waters and down to the confluence of the Namoi and peel Rivers would be further investigated and documented during the preparation of the environmental assessment.</p> <p>Differences in scour and erosion (and consequent effects on terrestrial ecology) would be addressed through a specific study (see erosion and sedimentation issue below).</p> <p><i>Table 6.1</i> of the main report outlines the proposed further investigations for the Environmental Assessment.</p>

Issue	Existing environment /level of investigation	Risk assessment	Management response
	<p><i>Figure E.2</i> indicates that all options would reduce the level of downstream inundation compared with dam failure.</p> <p>Existing investigations include a cultural heritage desktop review and a three day site inspection. Recorded sites are mapped in <i>Figures E.5 and E.6</i>.</p>	<p>sediment over the inundated area.</p> <p>In the downstream areas between the new spillways and the receiving waters heritage sites within these areas could be destroyed in the event of a very large to extreme flood. This impact is due to the fact that vegetation would be removed, topsoil stripped and significant scouring and erosion of soils and soft rocks would occur.</p> <p>Due to the far greater length and more friable soils and rocks the flood area below the subsidiary wall associated with Option B1 would have the greatest impact.</p> <p>Of the identified heritage sites downstream of the dam, <i>Figure E.6</i> indicates that selection of a preferred option would have an effect on only about three recorded sites subject to accurate location of these sites in the field.</p> <p>Extent of downstream inundation changes between options for very large to extreme floods with less than 1:10000 AEP:</p> <ul style="list-style-type: none"> <li>▪ Several heritage sites along the lower Peel River could be a concern</li> <li>▪ Significantly higher velocities (up to 70% higher) of flood flows in the lower Peel River down to the confluence of the Namoi and Peel Rivers associated with Option B1 would also have the greatest potential impact, being greater than would normally occur or would occur from Options D2 &amp; D3.</li> </ul>	

Issue	Existing environment /level of investigation	Risk assessment	Management response
<i>Erosion and sedimentation</i>	There is a paucity of information that enables ready quantification of erosion or sediment loads of extreme flood events. The Namoi River downstream of the main dam wall comprises a rocky, steep-sided gorge. The Peel River downstream of the subsidiary dam wall passes in a cutting through mostly agricultural land and comprises both soil and rocky areas with different (more erodible) characteristics to those along the Namoi River.	Estimates by Parsons Brinckerhoff (PB, 2005) indicate that the natural erosion and sedimentation effects from an extreme flood event would be massive on both a local and regional scale. The preliminary estimates also indicated that the impact of Option B1 may be substantially worse than the other options at a local level.	The local effects of Option B1 would be further investigated during the Environmental Assessment by an expert panel and consultants. The local and regional effects of all options would also be investigated further. The secondary effects of erosion and sedimentation on agriculture, regional development, terrestrial and aquatic ecology would also be documented.  <i>Table 6.1</i> of the main report outlines the proposed scope of further investigations in the Environmental Assessment.
<i>Fish lift or other ameliorative measures elsewhere in the catchment including trade-offs</i>	Existing significant investigation into fish passage past Keepit Dam and downstream along the Namoi River requires enhancement in light of recent research advised by Department of Primary Industries (Fisheries).	Sought under Section 218 of the Fisheries Management Act by Department of Primary Industries.	Further assessment and consultation on the feasibility and cost effectiveness and identify potential cost effective options.
<i>Keepit Dam heritage assessment</i>	Assessment undertaken as part of the development of State Water's s170 Heritage Register and rated as having local heritage significance. Preliminary review in relation to assessment indicated unlikely to be any change to the existing assessment outcome.	Formal review recommended by State Heritage Office.	Review the Keepit Dam heritage assessment by incorporating the changes and any applicable mitigation measures proposed as part of the upgrade options.

**Table E.2 Potential impacts and management responses - other environmental aspects**

Issue	Existing environment/level of investigation	Risk assessment	Management response
<p><i>Terrestrial ecology (construction impacts and downstream past the confluence of the Namoi &amp; peel Rivers)</i></p>	<p>Vegetation in the vicinity of the works associated with the various options is composed of a mosaic of woodland patches interspersed with cleared grazing country, as well as the riparian woodlands along the Namoi and Peel rivers. Some areas potentially affected by the works are highly modified by agricultural activities and/or extensively cleared and maintained in this state. Many of the native fauna species recorded or considered likely to occur in the vicinity of the proposal are tolerant of such variegated landscapes.</p> <p>Existing investigations include a desktop assessment conducted by interpretation of aerial photography and a four day site inspection to the extent indicated in the Habitat mapping outlined in <i>Figures E3 &amp; E.4.</i></p> <p>Hydraulic modelling indicates that all options would result in a reduction in downstream inundation past the confluence of the Namoi and Peel Rivers compared with the dam failure base case and there little distinguishable difference between options.</p>	<p>Clearing of native vegetation and the removal of dead wood and trees will be required principally in the areas proposed for bulk earthworks and at the spoil disposal location. These areas are however disturbed vegetation communities that are unlikely to contain potential habitat for threatened plants and animals. Areas of the endangered ecological community White Box Open Woodland would be affected by the construction works.</p> <p>Keepit Dam contributes only about 21% (by volume) of downstream floodwaters.</p> <p>Modelling indicates floodwater levels beyond the confluence of the Namoi and Peel Rivers between the options have only differences between 300 to 500mm. This difference is within the error range of the hydraulic modelling.</p>	<p>A manageable level of impact is expected subject to the application of standard mitigation and best practice construction measures.</p> <p>The construction environmental management plan (CEMP) would include management and mitigation measures to prevent or minimise construction impacts.</p> <p>Except for the additional investigation proposed in Table E1, no further assessment is proposed on impacts below the confluence of the Namoi and peel Rivers impacts will be less than the dam failure base line and in fact are slightly less than if the dam had not been constructed and there is very little difference between options.</p>

<p><i>Heritage (construction impacts and downstream past the confluence of the Namoi &amp; peel Rivers)</i></p>	<p>Existing investigations include a cultural heritage desktop review and a three day site inspection. Recorded sites are mapped in <i>Figures E.5 and E.6</i>.</p> <p>Hydraulic modelling indicates that all options would result in a reduction in downstream inundation past the confluence of the Namoi and Peel Rivers compared with the dam failure base case and there little distinguishable difference between options.</p>	<p>Mapping of recorded sites indicates that construction is unlikely to impact areas of heritage significance and that impacts on one site are likely to be avoidable (subject to accurate location).</p> <p>Only one site near the boat ramp has the potential to impact on the works. However investigations to-date indicated the site should be able to be avoided.</p> <p>Keepit Dam contributes only about 21% (by volume) of downstream floodwaters.</p> <p>Modelling indicates floodwater levels beyond the confluence of the Namoi and Peel Rivers between the options have only differences between 300 to 500mm. This difference is within the error range of the hydraulic modelling.</p>	<p>A manageable level of impact is expected subject to the application of standard mitigation and best practice construction measures.</p> <p>The construction environmental management plan (CEMP) would include management and mitigation measures to prevent or minimise construction impacts.</p> <p>Except for the additional investigation proposed in Table E1, no further assessment is proposed on impacts below the confluence of the Namoi and peel Rivers impacts will be less than the dam failure base line and in fact are slightly less than if the dam had not been constructed and there is very little difference between options.</p>
<p><i>Aquatic ecology (in-storage and downstream)</i></p>	<p>Keepit Dam is home to a number of native and exotic species of fish which are actively fished by locals and tourists. Threatened species likely to be present include silver perch while native species include golden perch and catfish.</p>	<p>Construction works which interface with the storage eg peninsula reshaping, construction of the multi-level offtake have the potential to result in local impacts to aquatic ecology.</p> <p>Operation of the multi-level offtake is expected to have a substantial beneficial impact on the temperature of downstream waters which will provide a better environment for native fish species and better cueing for breeding cycles.</p> <p>(The control of site runoff is discussed under surface water.)</p>	<p>A manageable level of impact is expected subject to the application of standard environmental management measures. These would include use of silt curtains for excavation works within the storage. The construction environmental management plan (CEMP) would include these and other management and mitigation measures to minimise construction impacts.</p> <p>Further development of operating procedures for the multi-level off-take would be undertaken and incorporated into an operational environmental management plan (OEMP).</p>

<i>Topography, soil and spoil management</i>	<p>The topography around the south-eastern side of Lake Keepit is gently undulating. From the subsidiary dam wall to the west and north around the lake perimeter, the topography becomes more varied and steep, culminating in an area of hills to the north-west of the main dam wall.</p>	<p>The proposal is expected to require substantial earthworks in conjunction with the raising of the main and subsidiary dam walls and the construction of saddle dams and spillways. These earthworks are likely to involve both cutting and filling of the existing ground and would result in localised changes in topography.</p> <p>Borrowing and disposal of materials on-site is also anticipated eg rock armour for dam walls, clay cores for release plugs.</p>	<p>A manageable level of impact is expected subject to the application of standard environmental management measures. These would be included in the CEMP to be prepared by the construction contractor following approval.</p> <p>A fill/spoil management sub-plan would be prepared as part of the CEMP for the proposal to detail the processes for identifying the quality, source and disposal of these materials on-site and that related impacts are appropriately managed.</p>
<i>Surface water quality and groundwater management</i>	<p>Areas upstream of the dam wall drain to Lake Keepit. Areas downstream drain to either the Namoi or Peel Rivers. The presence of groundwater aquifers has not been investigated.</p>	<p>Earthworks required for the upgrade may result in localised changes to surface water flows, including direction and volume of flows, the location of natural flow channels and run-off. Interactions and impacts on groundwater aquifers are not expected.</p>	<p>A manageable level of impact is expected subject to the application of standard mitigation and best practice construction measures.</p> <p>A surface water management sub-plan would be prepared as part of the CEMP for the proposal.</p>

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*Visual*

The landscape at the locations of the proposed upgrade options is picturesque, generally open and undulating. From the subsidiary dam wall to the west and north around the dam perimeter, the topography becomes more varied and steep, culminating in an area of hills to the north-west of the existing main dam wall. This area is visually distinctive relative to the other areas surrounding the dam.

The existing main dam and subsidiary dam walls are dominant visual features of the dam. They are clearly visible from various view points and roads entering the State Park.

Receiver sites are shown in *Figure 10*.

The proposal upgrade locations (including construction worksites, workforce ablutions and storage facilities, safety fencing, construction machinery and car parking) would be visible from internal and park approach roads and may reduce visual amenity for recreational users of Lake Keepit State Park and residences in the vicinity of the dam and to a lesser extent recreational users of the Lake Keepit Sport and Recreation Centre. These impacts would be temporary and removed once construction is complete.

While the right-hand abutment spillway and peninsula works are significant there are limited viewing points and generally will flow on as works associated with the main dam.

The proposed raising of the main and subsidiary dam walls would have the effect of levelling the skyline when viewed from the south-eastern side of Lake Keepit. The works proposed to the subsidiary dam would be very visible and would create a more dominant built environment particularly for Option B1 due to the concrete and increase rock protection associated with the proposed spillway structure.

The proposed sailing club spillway for Options D2 and D3 will be very visible from the kiosk, camping and picnic areas and some caravan site of the State Park.

Overall a manageable level of impact is expected subject to the application of standard environmental management measures.

The majority works should blend with the surroundings or existing structures. Where visual changes may be considered significant, mechanisms including landscaping to soften the change, if necessary, will be incorporated as part of the CEMP for the proposal.

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<i>Noise and vibration</i>	<p>Keepit Dam is located within a rural setting. Ambient noise levels throughout the daytime period are expected to be low with the intermittent activities of the local gliding club, recreational users of the lake (eg motor boats and water skiing) and local fauna expected to be the primary influences.</p> <p>A desktop assessment of potential noise and vibration impacts has been conducted.</p> <p>Receiver sites are shown in <i>Figure 10</i>.</p>	<p>Noise and vibration from the proposed construction works/sites has the potential to exceed noise limits specified in the Environmental Protection Authority's <i>Environmental Noise Control Manual</i> (1994). The primary influence on the level of impact would be the location of the receiver relative to the construction works/sites. Key receivers are State Caravan Park residents and State Water staff and families.</p> <p>Plant movement, drilling, blasting, excavation and compaction will be the the main noise makers</p> <p>There is potential for road traffic noise associated with rock and concrete material haulage to periodically exceed noise goals.</p> <p>The most potentially impact from works is at the back of the Gums Caravan Park and Sailing Club and Boat Ramp spillways would be undertaken at the low season of the Caravan Park to minimise impacts.</p>	<p>A manageable level of impact is expected subject to the application of standard environmental mitigation and best practice construction measures including the recommended approaches contained in the Environmental Protection Authority's <i>Environmental Noise Control Manual</i> (1994) and <i>Environmental Criteria for Road Traffic Noise</i> (1999).</p> <p>A noise and vibration sub-plan would be prepared as part of the CEMP for the proposal</p>
<i>Air quality</i>	<p>Limited background information. There are no industrial sources or urban areas in the vicinity of the proposal.</p>	<p>Local air quality impacts (particulates) may result from vehicle/machinery emissions and dust particularly during bulk earthworks. An increase in carbon dioxide emissions from excavation and embankment construction fuels and movement of spoil will occur, but there are few receivers.</p>	<p>A manageable level of impact is expected subject to the application of standard environmental mitigation and best practice construction measures. These would be prepared as part of the CEMP for the proposal.</p>
<i>Planning and land use</i>	<p>Existing zoning is mostly rural and rural residential. Land uses are recreational (State Park) and private agricultural lands. Public utilities undertaken is allowed.</p>	<p>The proposal would result in the inundation of land upstream of the dam on the foreshore of Lake Keepit during extreme floods.</p>	<p>A manageable level of impact is expected. Implementation of the proposal would not change the existing land uses or zonings. Refer <i>Section 5.3</i> of the main report for further details.</p>
<i>Business impacts</i>	<p>Identification of rural residences,</p>	<p>The proposal would disrupt the operation</p>	<p>A manageable level of impact on</p>

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*and effects on businesses and recreational land uses around the dam as indicated in Figure 10*  
*community facilities*

of some businesses and community facilities located near to the proposed construction worksites, including the caravan park, kiosk, sailing club and boat ramp. Works would also be undertaken in the vicinity of the State Water staff and family village.

The requirement to construct a saddle dam at the rear of the caravan park would result in the need to relocate one row of caravans (8 vans) and some amenities from the Gums caravan park for Option B1. Taller embankments associated with options D2 and D3 would require the relocation of up to two rows (or 15 caravans) and some amenities facilities. The displaced vans could be relocated to the south east of the Lakeside caravan park. Replacement of amenity and facilities would be subject to negotiation with the State Park Trust.

For options D2 and D3, additional spillways are required to be constructed at the locations of the existing public boat ramp and the sailing club. The boat ramp would be relocated (at least temporarily) as part of the works. The sailing club would also be relocated subject to detailed survey of its location relative to the proposed spillway and the need for construction clearances. New or modified facilities would be provided as required and subject to negotiation with the relevant parties. The State Park internal access road to the existing boat ramp and sailing club would also have to be relocated depending on the location of the new facilities.

The sailing club spillway will affect picnic

residences, businesses and recreational land uses is expected subject to the finalisation of details and negotiations regarding the reprovision of displaced facilities and other compensation arrangements being considered by State Water. These commitments would be included in the CEMP for the proposal.

		areas of the caravan park. Subject to detailed survey of impacts, new, temporary or modified amenities would be installed subject to negotiation and agreement with the Trust. All main construction works in close proximity to existing facilities are proposed to be undertaken during the tourist low season to minimise the impact and inconvenience on occupants.	
<i>Waste minimisation and management</i>	A range of construction wastes from litter to grease and oils from construction machinery would be generated at the site and would require appropriate disposal.	Preliminary assessment has indicated no unusual issues.	A manageable level of impact is expected subject to the application of standard environmental management measures. These would be prepared as part of the CEMP for the proposal.
<i>Land contamination</i>	There is a range of potential contamination sources, particularly from machinery and work depots.	<p>Preliminary assessment has indicated no unusual issues except an existing small tip.</p> <p>The tip which is used by State Water is located in the potential area of the proposed location of the right-hand abutment spoil disposal site.</p>	<p>A manageable level of impact is expected subject to the application of standard environmental management measures. These would be prepared as part of the CEMP for the proposal.</p> <p>The existing tip site and placement of spoil will be managed to ensure at least no additional contamination of the area occurs.</p>
<i>Risks and hazards (construction – refer Section 6 of the main report for operational issues)</i>	Risks and hazards would include those associated with operating the storage during construction work implications such as storage and use of explosives, potential flooding during construction and general construction OH&S issues.	<p>Preliminary assessment has indicated no unusual issues although some risks such as working on the main dam will require specially trained rigging personnel and very specific safety procedures developed</p> <p>Operations of the gates of the existing spillway will be restricted during the raising of the main dam wall. Option B1 and to a lesser degree Option D2 will involve excavation of the additional spillways below full supply level.</p>	<p>A manageable level of impact is expected subject to the application of standard environmental emergency management measures. These would be prepared as part of the CEMP for the proposal.</p> <p>The construction sequence will need to be managed to ensure dam safety risk is not increased during construction. Similarly protection from premature operation of the additional spillways during construction will need to be included.</p>

<p><i>Social Impacts</i></p>	<p>Impacts and benefits arise for both construction and operations aspects of the options</p>	<p>The proposal would potentially result in social impacts during its construction mostly as a result of amenity type issues, physical impacts upon existing facilities and reduced access to community facilities.</p> <p>Additional impacts under very large to extreme events will occur particularly to facilities and rural properties around the storage rim.</p>	<p>A manageable level of impact is expected by undertaking the construction works during the tourist low season and by relocating and upgrading existing impacted amenities / facilities and landscaping (as appropriate).</p> <p>Due to the very low frequency of these very large to extreme events, emergency management planing and, as appropriate, fair compensation is proposed for when (if) the event occurs.</p>
<p><i>Traffic (construction)</i></p>	<p>Issues relate to access to and from the area of construction and in the vicinity of construction areas.</p>	<p>The proposal would generate an increase in vehicle trips to/ from the site including workers vehicles and haulage trucks. These vehicles would variously use the Oxley Highway, Orange Grove Road and Keepit Dam Road as well as other internal roads on land managed by State Water and the Lake Keepit State Park.</p> <p>It will also require the temporary closure of access across the main dam wall and to the peninsula.</p>	<p>A manageable level of impact is expected subject to the application of standard environmental management measures and agreement with the Local municipalities and the State Park. These would be prepared as part of the CEMP for the proposal and also incorporated into agreements.</p> <p>Alternative existing access is available or can be made available (if appropriate) during the temporary closures.</p>
<p><i>Resources, energy use and greenhouse gases</i></p>	<p>Undertaking the works and resultant use of resources.</p>	<p>The construction of the proposal is expected to result in the consumption of non-renewable energy and the generation of greenhouse gas emissions. The proposal is expected to result in a small increase in the ongoing consumption of non-renewable energy at Keepit Dam and an associated increase in greenhouse gas emissions attributable to the dam.</p>	<p>A manageable level of impact is expected subject to the application of standard environmental management measures. These would include measures to minimise water and electricity use and be prepared as part of the CEMP for the proposal.</p>

<i>Finance economics</i>	<i>and</i>	Construction and operational costs have been used to complete a financial and economic assessment of the options consistent with Treasury guidelines and economic assessments conducted for other dams by State Water.	A financial and economic comparison of costs and indicates economic efficiency in line with capital cost of the options. Overall benefits costs are less than unity but typical of such dam safety projects  Costs are at March 2005.	Refer to <i>Section 5.4.2</i> of the main report for summary  Updated financial and economic information will be provided in the Environmental Assessment.
<i>Cumulative impacts</i>		Activities by others during the period of construction.	There are no known construction works in the vicinity of Keepit Dam that would coincide with the construction of the proposal and result in cumulative impacts.	No management measures are expected to be required to mitigate cumulative impacts.



Figure E.1 Upstream flooding inundation

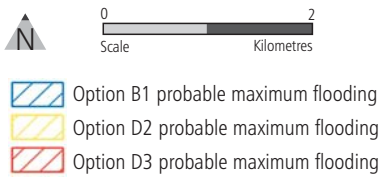




Figure E.2 Downstream flooding inundation







-  Option B1 probable maximum flooding
-  Option D2 probable maximum flooding
-  Option D3 probable maximum flooding
-  Existing dam failure probable maximum flooding



Figure E.3 Vegetation upstream of the dam

- Option B1 probable maximum flooding
- Option D2 probable maximum flooding
- Option D3 probable maximum flooding

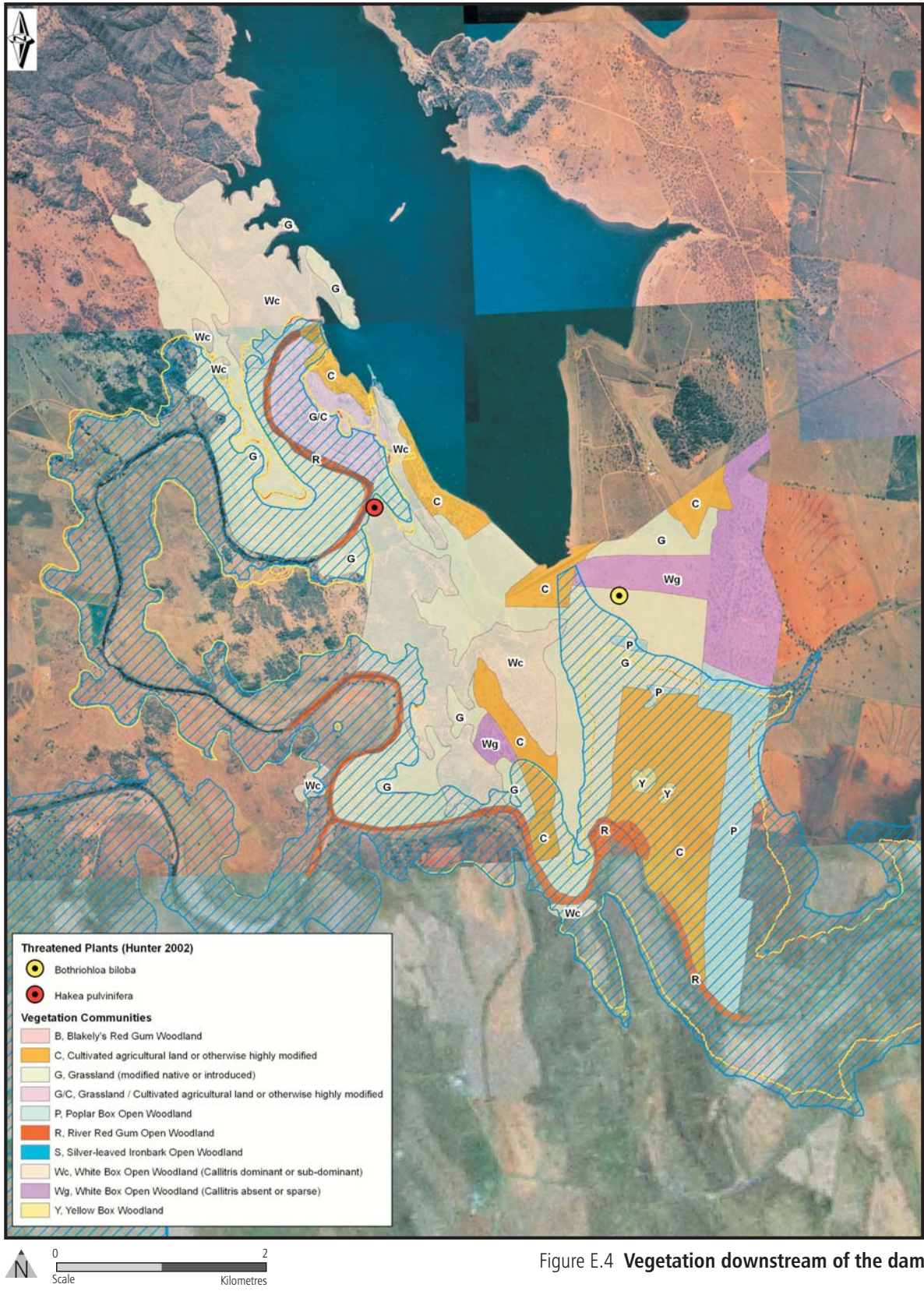


Figure E.4 Vegetation downstream of the dam



Figure E.5 Heritage sites upstream of the dam












-  Heritage sites
-  Option B1 probable maximum flooding
-  Option D2 probable maximum flooding
-  Option D3 probable maximum flooding



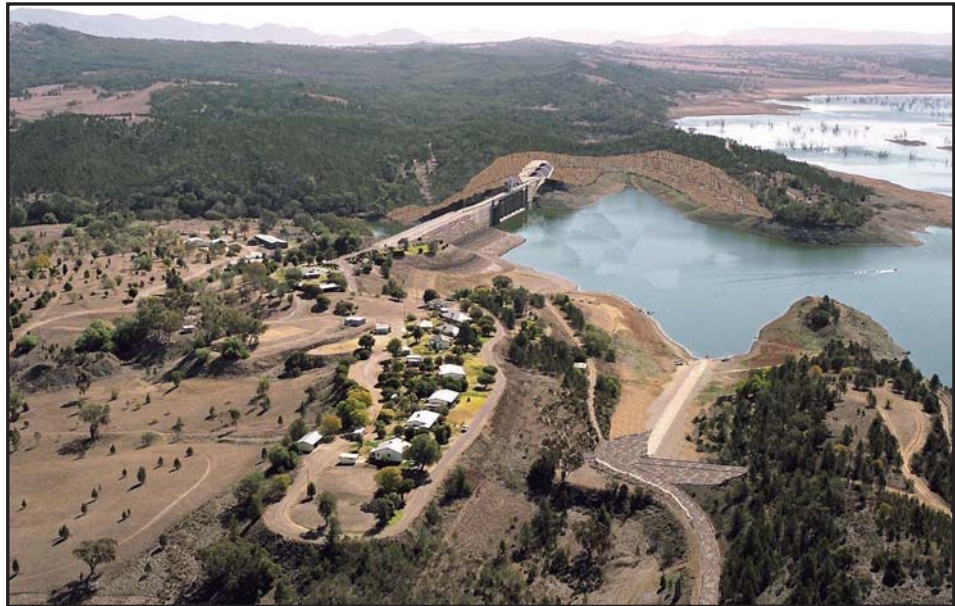
Figure E.6 Heritage sites downstream of the dam



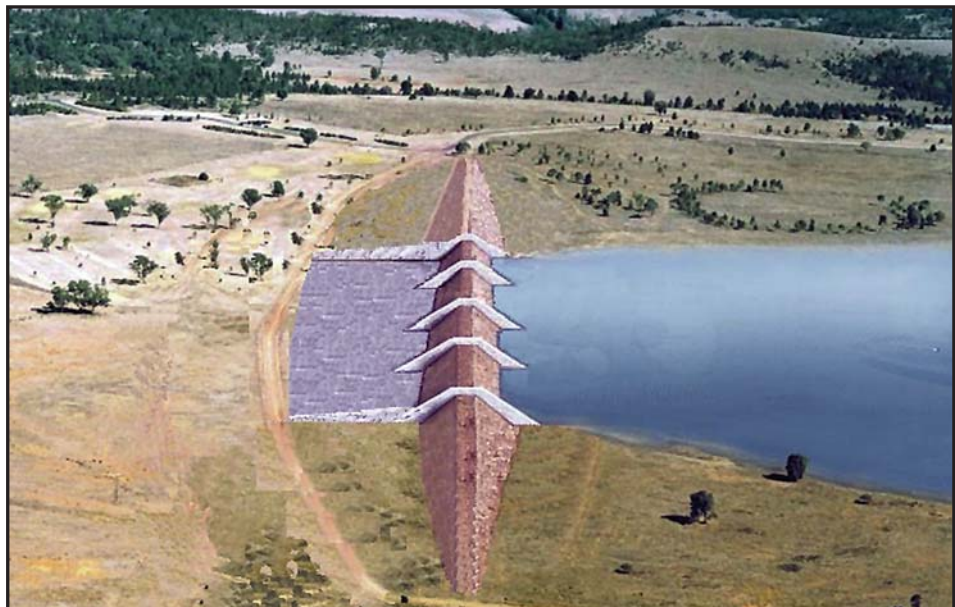
-  Heritage sites
-  Option B1 probable maximum flooding
-  Option D2 probable maximum flooding
-  Option D3 probable maximum flooding
-  Existing dam failure



Saddle dams and flow entry widening



Boat ramp saddle dam and right-hand abutment spillway

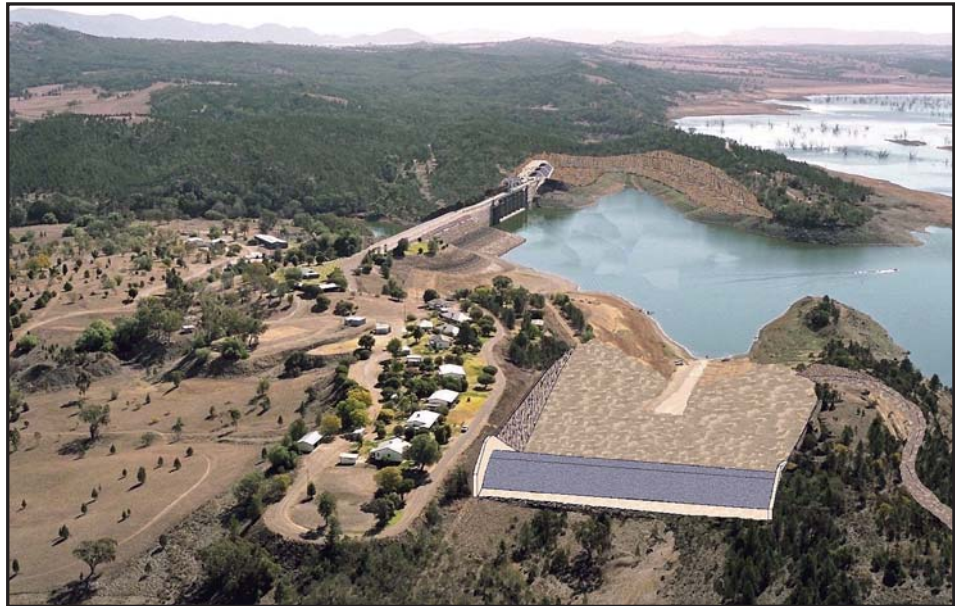


Subsidiary dam wall raising

Figure E.7 Photomontages of the key components of Option B1



Saddle dams and flow entry widening



Boat ramp saddle dam and right-hand abutment spillway

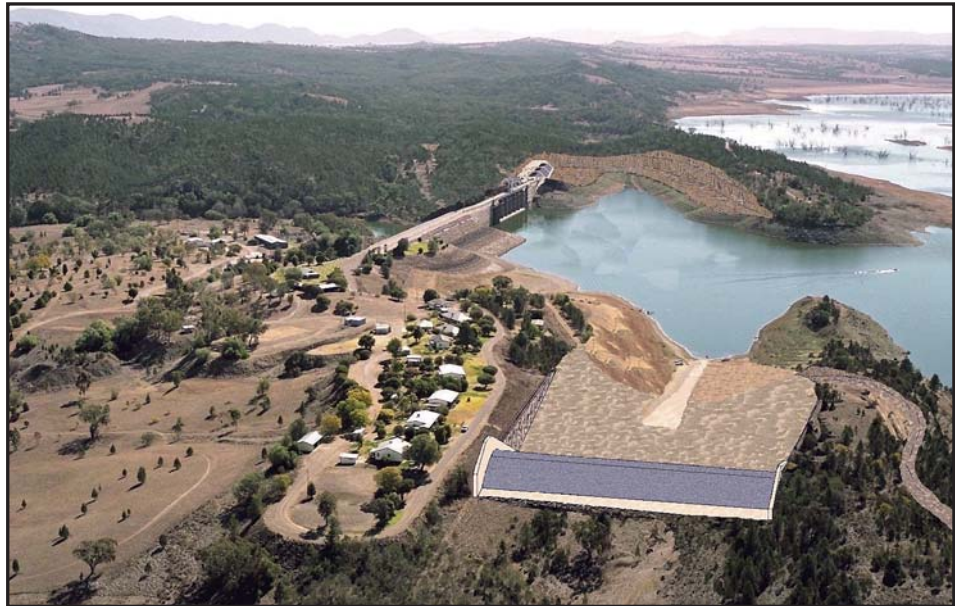


Subsidiary dam wall raising

Figure E.8 Photomontages of the key components of Option D2



Saddle dams and flow entry widening



Boat ramp saddle dam and right-hand abutment spillway



Subsidiary dam wall raising

Figure E.9 Photomontages of the key components of Option D3

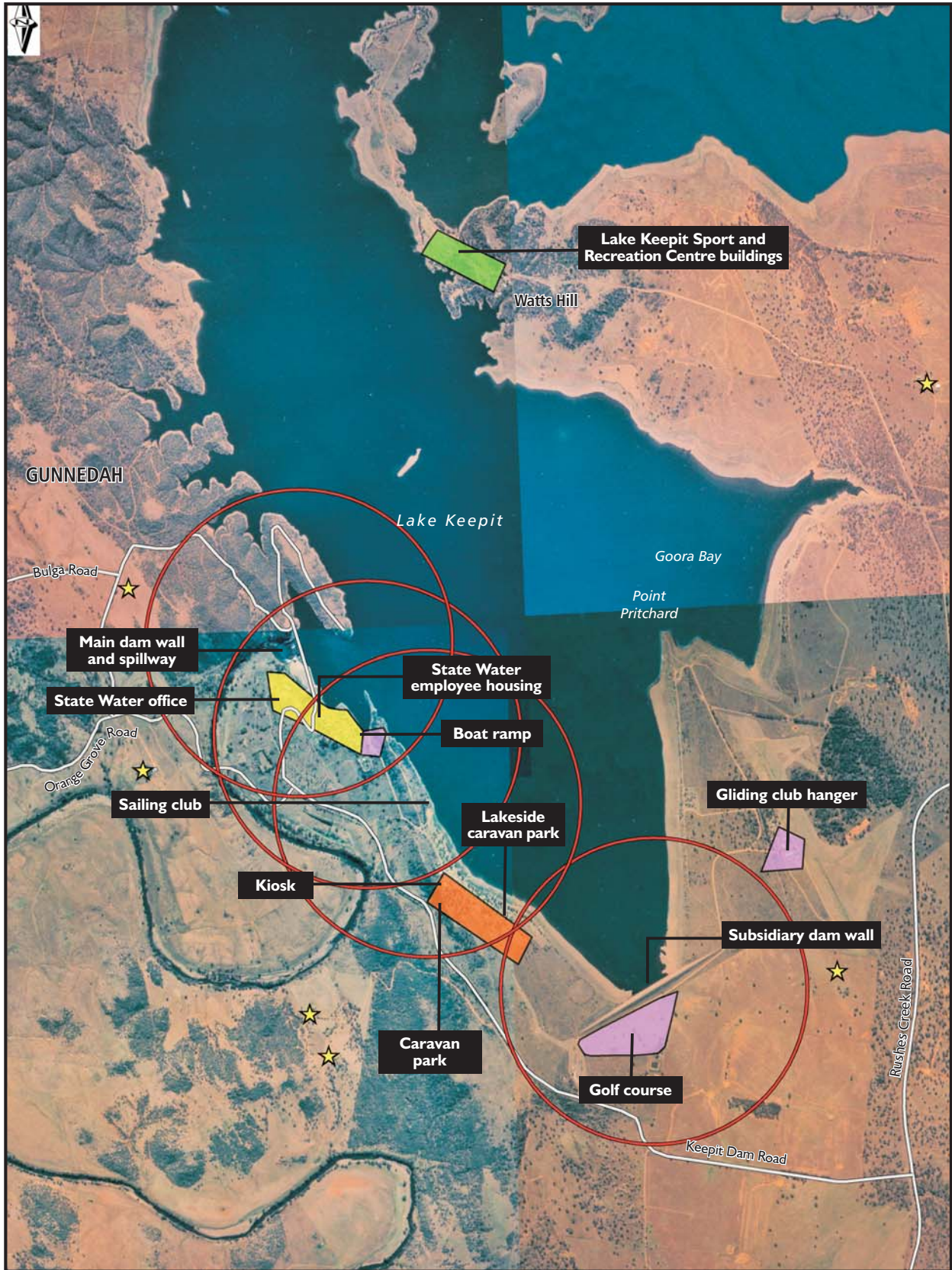


Figure E.10 Potential visual and noise receivers



- ★ Private residence
- Local road
- Area potentially impacted by noise (2km diameter, topography not considered)
- Caravan park
- Sport and recreation centre
- State Park recreational facility users
- State Water office and employee housing

## E.2 References

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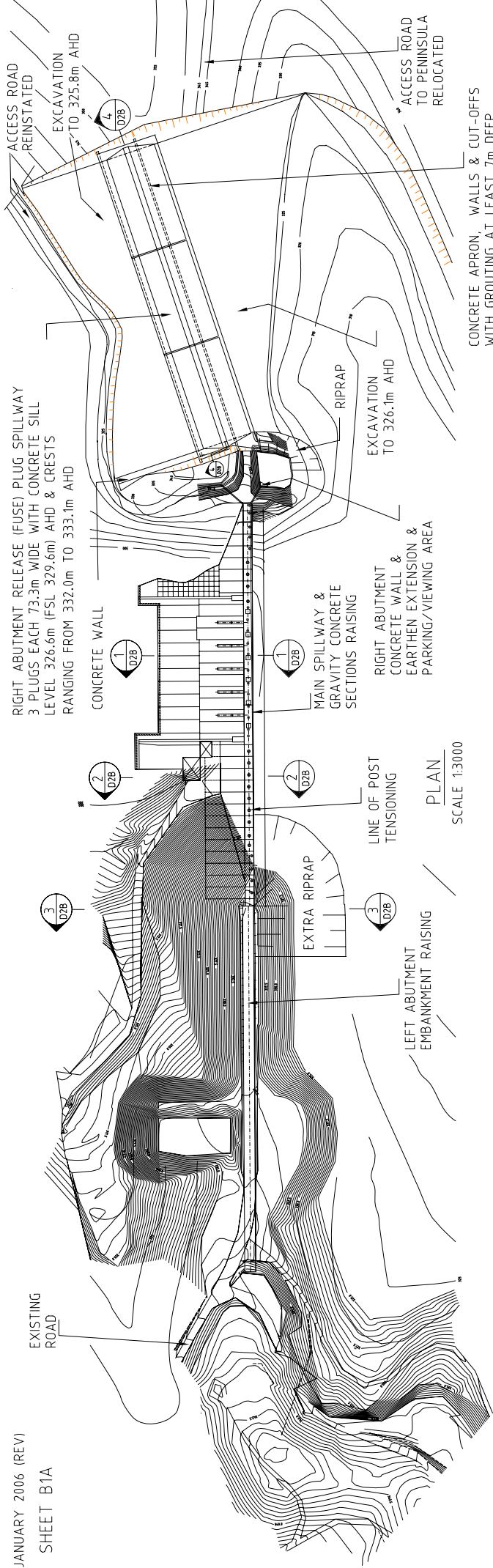
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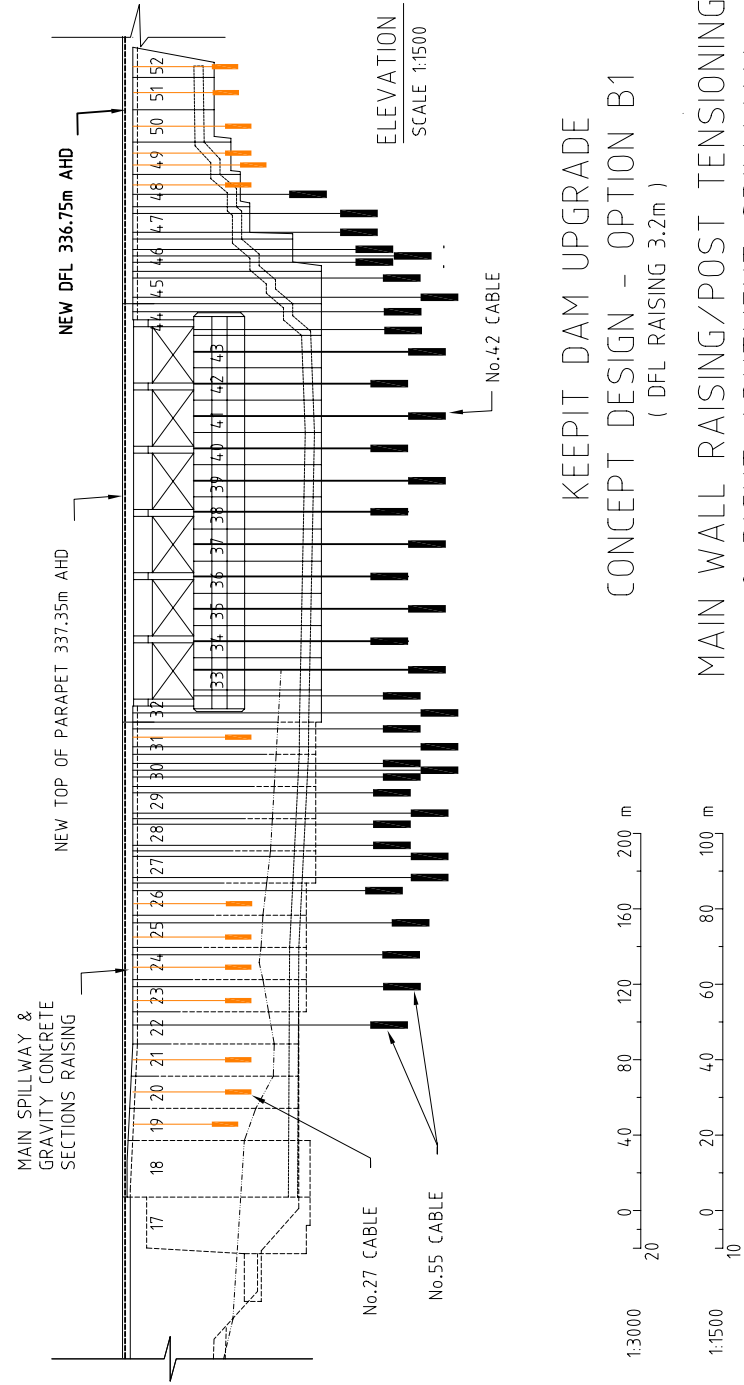
## **Appendix F**

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Concept design drawings of dam safety  
upgrade options



PLAN  
SCALE 1:3000



POST TENSIONING REQUIREMENT

MONOLITH No.	POST TENSION CABLE	
	No.27	No.55
19	1	-
20	1	-
21	1	-
22	1	1
23	1	1
24	1	1
25	1	1
26	1	1
27	-	2
28	-	2
29	-	2
30	-	3
31	1	2
32	-	2
33	-	1
34	-	1
35	-	1
36	-	1
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38	-	1
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40	-	1
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51	1	-
52	1	-

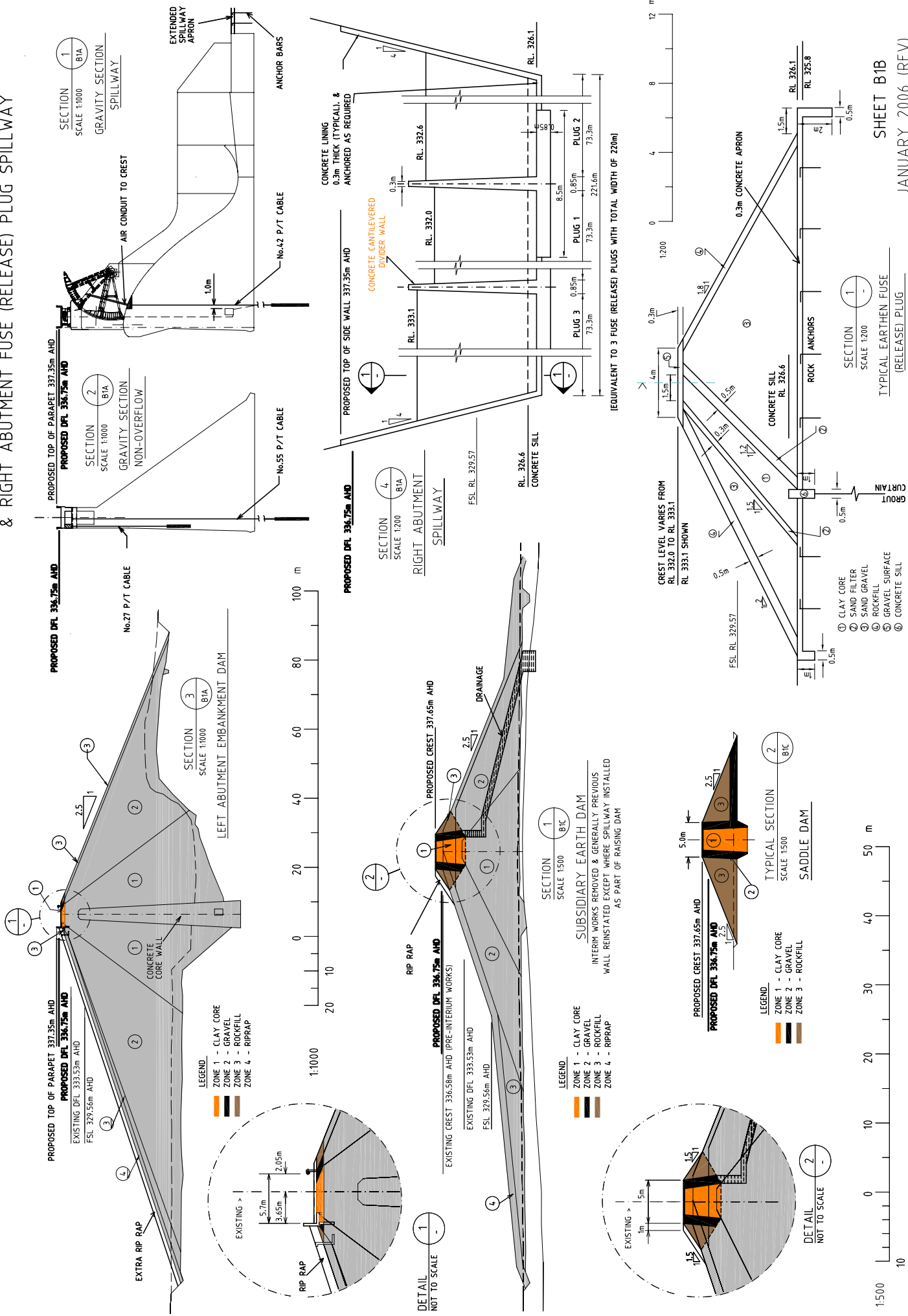
No.27 - 6750kN U.T.S.  
No.42 - 10500kN U.T.S.  
No.55 - 13750kN U.T.S.

KEEPIT DAM UPGRADE  
CONCEPT DESIGN - OPTION B1  
( DFL RAISING 3.2m )  
MAIN WALL RAISING/POST TENSIONING  
& RIGHT ABUTMENT SPILLWAY

# KEEPIT DAM UPGRADE - CONCEPT DESIGN - OPTION B1

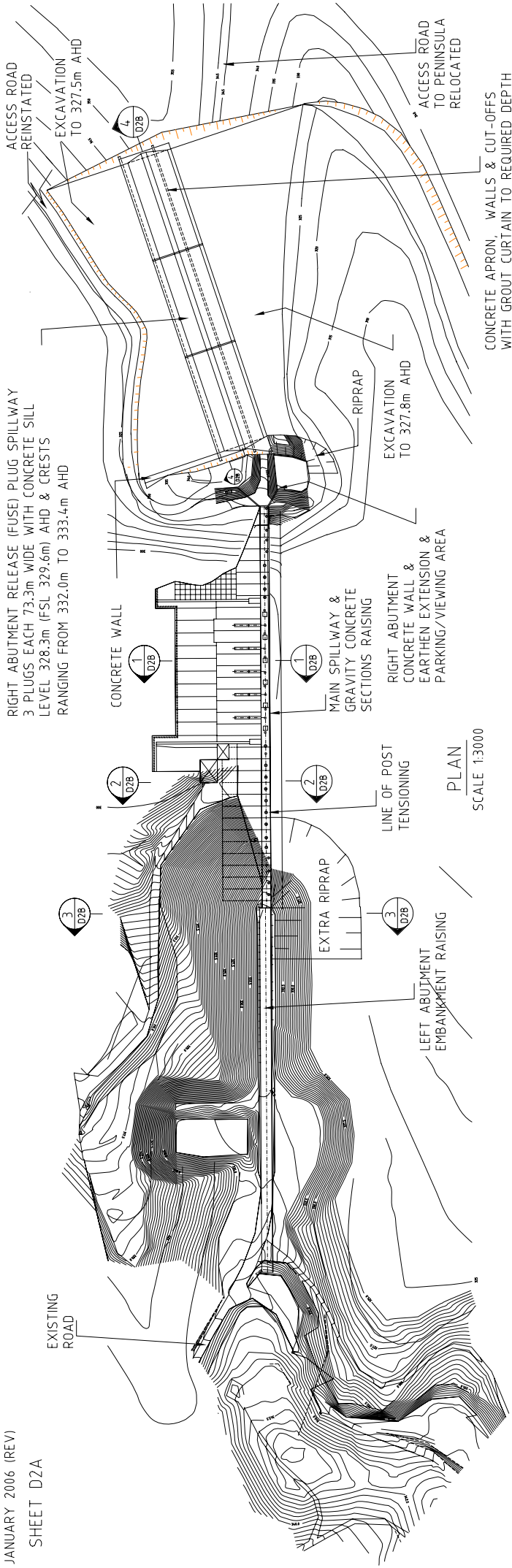
( DFL RAISING 3.2m )

# MAIN WALL RAISING/POST TENSIONING, SUBSIDIARY DAM RAISING, TYPICAL SADDLE DAM & RIGHT ABUTMENT FUSE (RELEASE) PLUG SPILLWAY





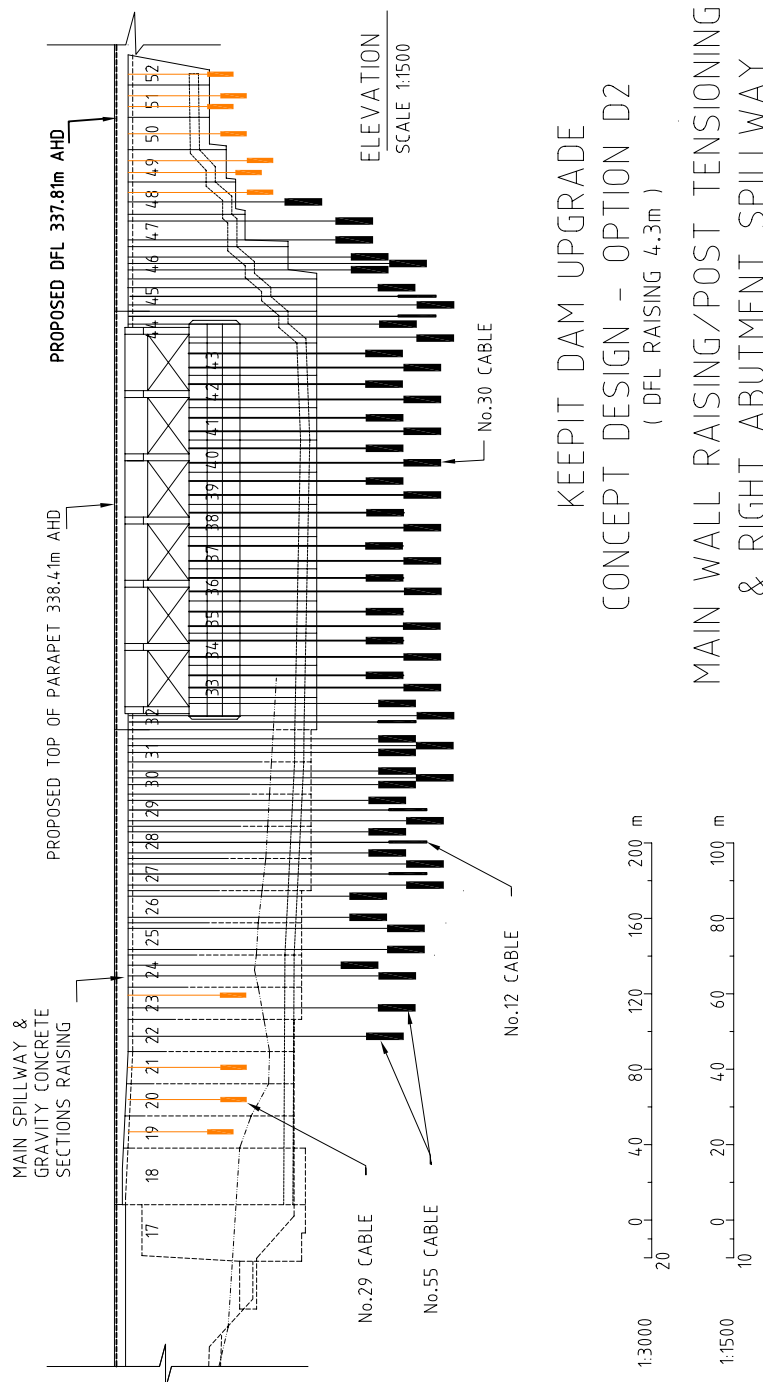
RIGHT ABUTMENT RELEASE (FUSE) PLUG SPILLWAY  
 3 PLUGS EACH 73.3m WIDE WITH CONCRETE SILL  
 LEVEL 328.3m (FSL 329.6m) AHD & CRESTS  
 RANGING FROM 332.0m TO 333.4m AHD



PLAN  
 SCALE 1:3000

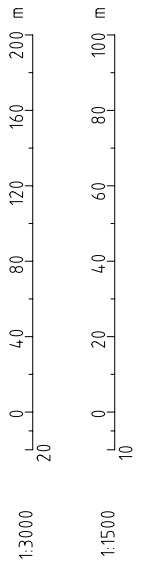
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21	1	-	-
22	1	-	1
23	-	-	1
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48	-	1	1
49	-	2	-
50	-	1	-
51	-	2	-
52	-	1	-

No.12 - 3000kN U.T.S.  
 No.29 - 7250kN U.T.S.  
 No.30 - 7500kN U.T.S.  
 No.55 - 13750kN U.T.S.



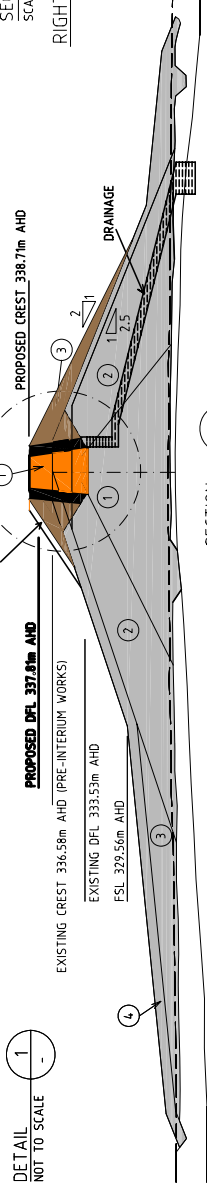
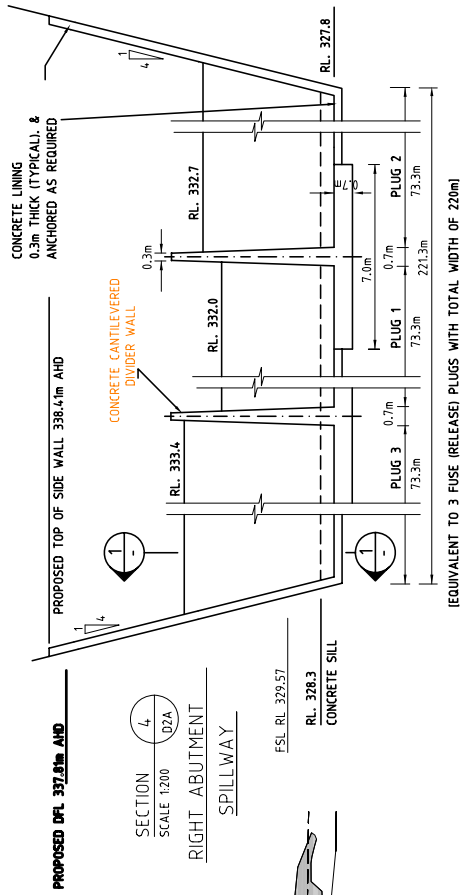
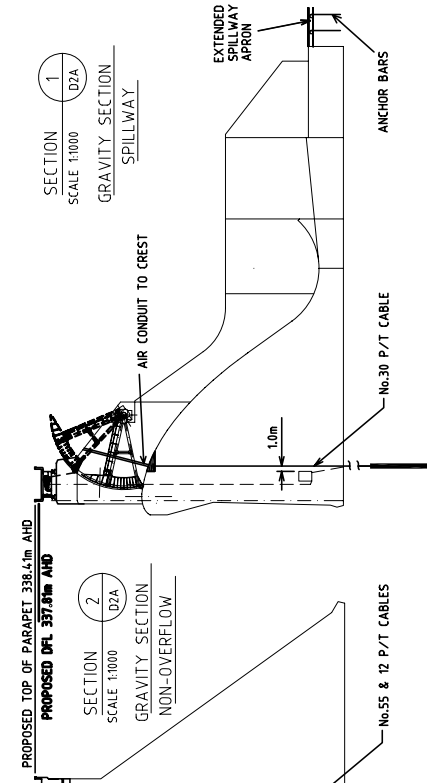
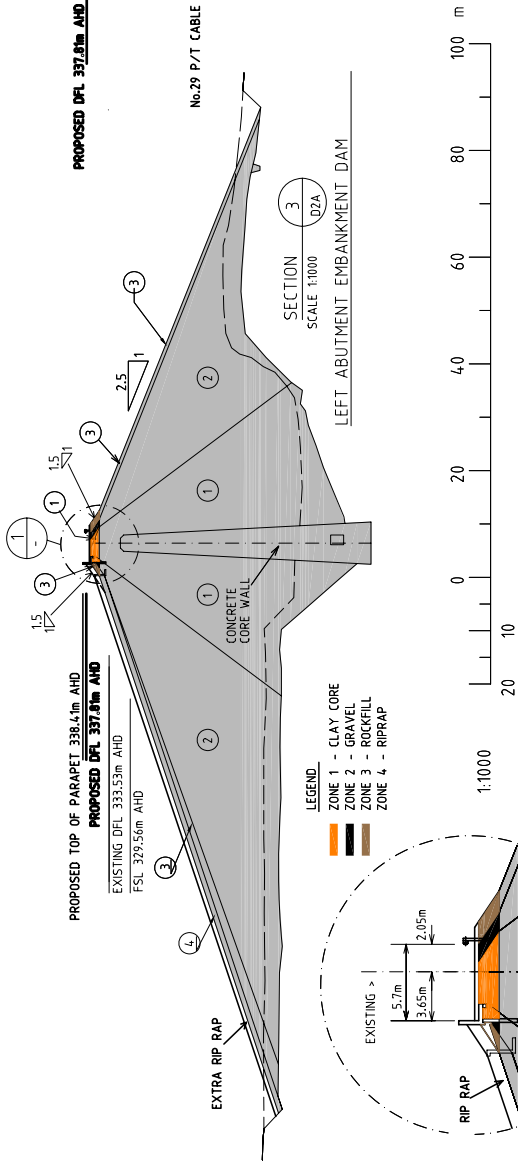
ELEVATION  
 SCALE 1:1500

KEEPIT DAM UPGRADE  
 CONCEPT DESIGN - OPTION D2  
 ( DFL RAISING 4.3m )  
 MAIN WALL RAISING/POST TENSIONING  
 & RIGHT ABUTMENT SPILLWAY



**KEEPIT DAM UPGRADE - CONCEPT DESIGN - OPTION D2**  
( DFL RAISING 4.3m )

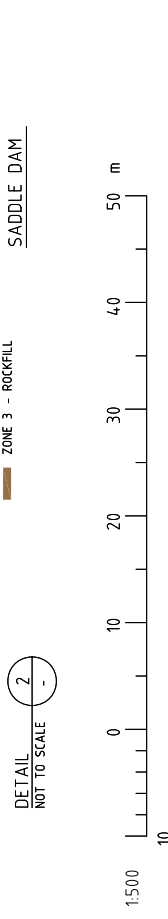
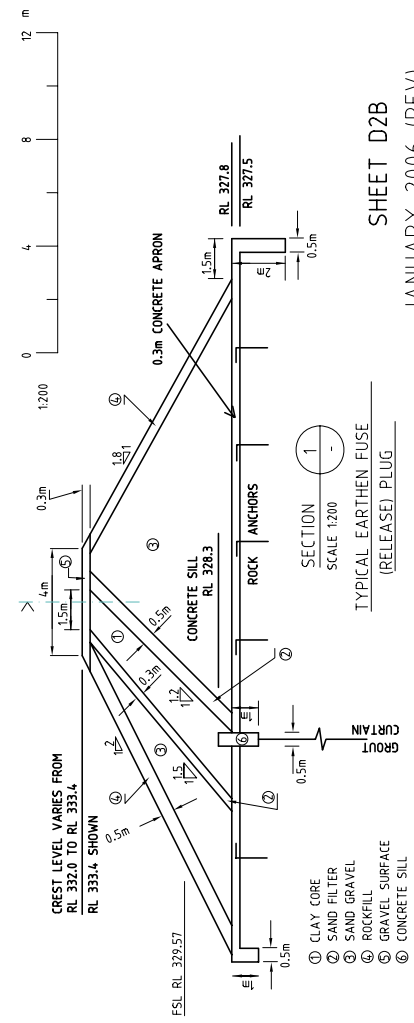
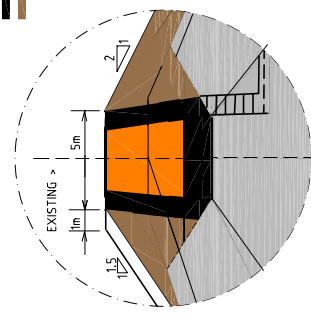
**MAIN WALL RAISING/POST TENSIONING,  
SUBSIDIARY DAM RAISING, TYPICAL SADDLE DAM  
& RIGHT ABUTMENT FUSE (RELEASE) PLUG SPILLWAY**



**LEGEND**  
 ZONE 1 - CLAY CORE  
 ZONE 2 - GRAVEL  
 ZONE 3 - ROCKFILL  
 ZONE 4 - RIPRAP

**SECTION 1**  
SCALE 1:500  
D2C

**SUBSIDIARY EARTH DAM**  
 INTERIUM WORKS REMOVED & GENERALLY PREVIOUS  
 WALL REINSTATED AS APRT OF RAISING DAM

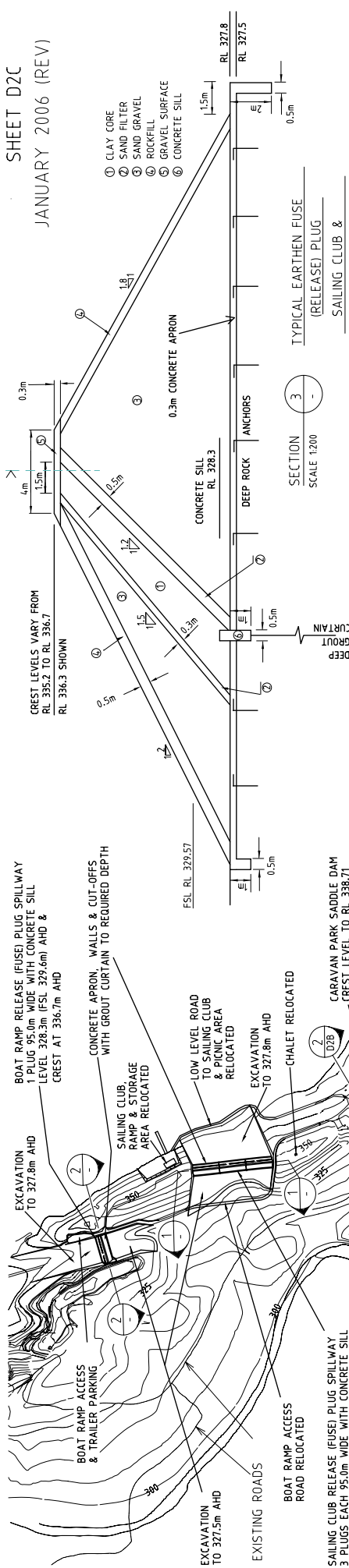


**SECTION 1**  
SCALE 1:200  
D2A

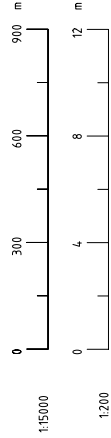
**TYPICAL EARTHEN FUSE (RELEASE) PLUG**

1:200

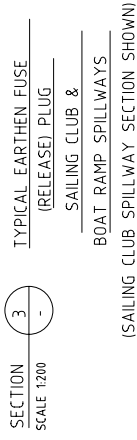
① CLAY CORE  
 ② SAND FILTER  
 ③ SAND GRAVEL  
 ④ ROCKFILL  
 ⑤ GRAVEL SURFACE  
 ⑥ CONCRETE SILL



PLAN  
SCALE 1:15000

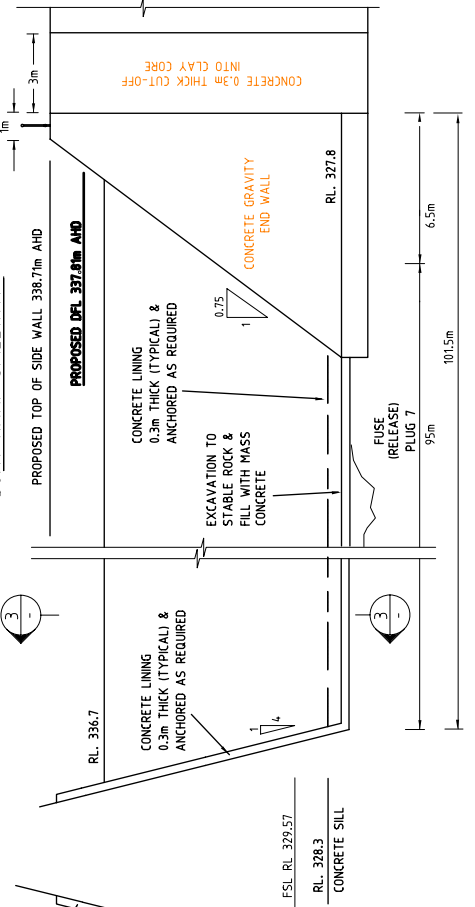


KEEPIT DAM UPGRADE  
CONCEPT DESIGN  
OPTION D2  
( DFL RAISING 4.3m )  
SUBSIDIARY DAM RAISING  
SAILING CLUB & BOAT RAMP  
SPILLWAYS & CARAVAN PARK SADDLE DAM



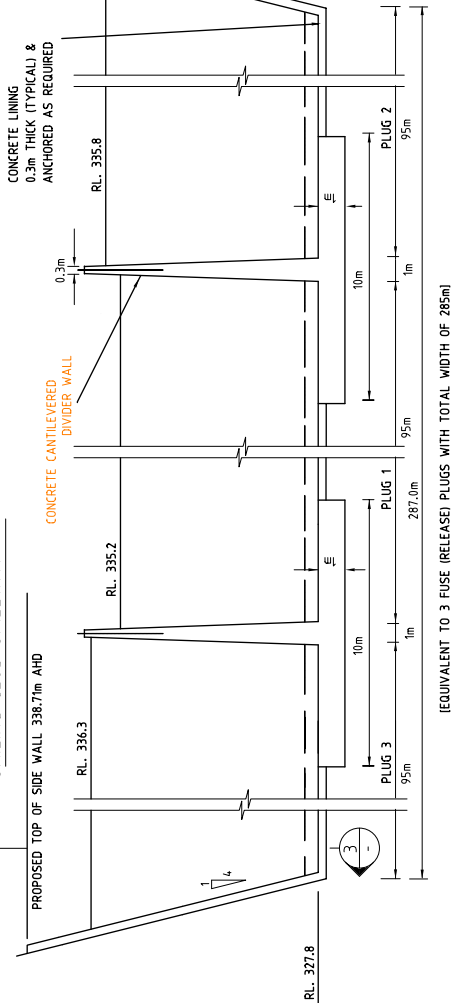
SECTION 2  
SCALE 1:200

BOAT RAMP SPILLWAY

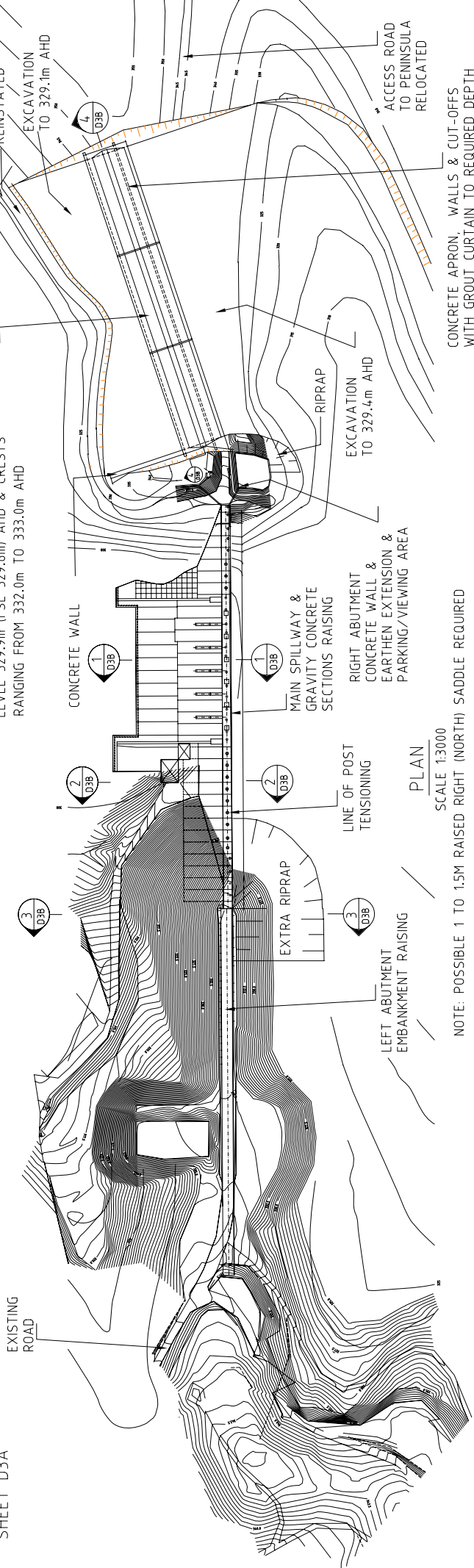


SECTION 1  
SCALE 1:200

SAILING CLUB SPILLWAY



RIGHT ABUTMENT RELEASE (FUSE) PLUG SPILLWAY  
 3 PLUGS EACH 73.3m WIDE WITH CONCRETE SILL  
 LEVEL 329.9m (FSL 329.6m) AHD & CRESTS  
 RANGING FROM 332.0m TO 333.0m AHD



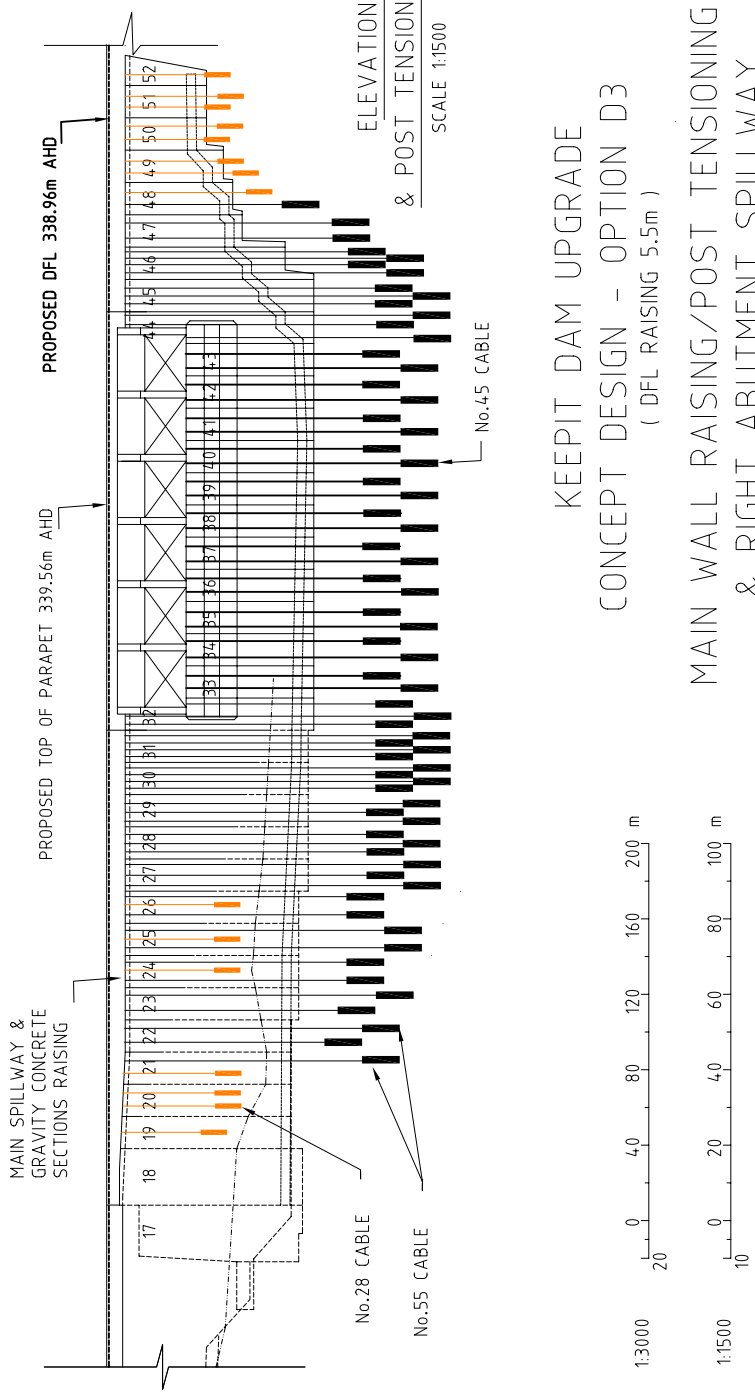
PLAN  
 SCALE 1:3000

NOTE: POSSIBLE 1 TO 1.5M RAISED RIGHT (NORTH) SADDLE REQUIRED

CONCRETE APRON, WALLS & CUT-OFFS  
 WITH GROUT CURTAIN TO REQUIRED DEPTH

MONOLITH No.	POST TENSIONING REQUIREMENT	
	No.28	No.55
19	-	-
20	-	-
21	-	1
22	-	2
23	-	2
24	1	2
25	1	2
26	1	2
27	1	3
28	2	3
29	-	3
30	-	4
31	-	4
32	-	3
33	2	-
34	2	-
35	2	-
36	2	-
37	2	-
38	2	-
39	2	-
40	2	-
41	2	-
42	2	-
43	2	-
44	-	3
45	-	3
46	-	4
47	-	2
48	1	-
49	2	-
50	2	-
51	2	-
52	1	-

No.27 - 6750KN U.T.S.  
 No.45 - 11250KN U.T.S.  
 No.55 - 13750KN U.T.S.



ELEVATION  
 & POST TENSIONING  
 SCALE 1:1500

KEEPIT DAM UPGRADE  
 CONCEPT DESIGN - OPTION D3  
 (DFL RAISING 5.5m)

MAIN WALL RAISING/POST TENSIONING  
 & RIGHT ABUTMENT SPILLWAY

