

5. Assessment of construction issues

5.1 Terrestrial biodiversity

A terrestrial biodiversity assessment has been prepared for the proposal, based on field surveys undertaken between 18 and 22 July 2005 and 29 May and 2 June 2006 (refer *Technical Paper 1* in *Volume 2*). The field surveys were carried out to assess the extent and condition of vegetation communities and potential flora and fauna habitat, especially for threatened species. Sites surveyed included the proposed construction and stockpile zones.

5.1.1 Existing environment

Vegetation communities

Existing vegetation mapping (Department of Land and Water Conservation 2002; EcoPro 2003) was 'ground-truthed' during random meander surveys, while driving or walking along tracks and from boat on Lake Keepit. Mapped vegetation communities upstream and downstream of Keepit Dam are shown in *Figures 5-1* and *5-2* respectively.

The vegetation surveyed consisted of scattered woodland patches interspersed with cleared grazing country and riparian woodlands along the Namoi and Peel Rivers. Five native vegetation communities were identified in the surveyed area:

- White Box Yellow Box Blakely's Red Gum Woodland
- Poplar Box Open Woodland
- River Red Gum Woodland
- Silver-leaved Ironbark Open Woodland
- Grassland.

Several sections of the surveyed area have been extensively cleared for agriculture or other purposes, including the camping and recreation areas of Lake Keepit State Park. These areas are not considered natural.

White Box Yellow Box Blakely's Red Gum Woodland

White Box Yellow Box Blakely's Red Gum Woodland is listed as an endangered ecological community under Part 3 of Schedule 1 of the *Threatened Species Conservation Act 1995* (NSW Scientific Committee 2002), and as critically endangered under the Commonwealth *Environment Protection and Biodiversity Conservation Act 1999* (Department of the Environment and Heritage 2000).

The main occurrence of this community in the surveyed area was within Lake Keepit State Park on the south-eastern side of Lake Keepit. Other smaller remnant areas of this community were observed in the southern section of the surveyed area. The community generally comprised open grassy woodland, but in some cases, was dominated by other species, including White Cypress Pine. The condition of this vegetation community ranged from moderate to good in the State Park on the south-eastern side of Lake Keepit, to poor in the other areas mapped.

Four distinct associations of White Box Yellow Box Blakely's Red Gum Woodland occurred within the surveyed area:

- *White Box Woodland* — This was the most common association within the surveyed area. It was dominated by *Eucalyptus albens* (White Box) and generally lacked the regenerating eucalypt component. A mid-storey was usually absent or sparse, with only occasional associated trees or shrubs. The understorey comprised native grasses.
- *White Box–White Cypress Pine Open Woodland* — This association occurred extensively within the surveyed area on the southern and western sides of Lake Keepit, particularly within the proposed construction work areas. This association was dominated almost exclusively by *Callitris glaucophylla* (White Cypress Pine) in the highest stratum. In some areas, the eucalypt overstorey was absent and the upper stratum consisted purely of White Cypress Pine regrowth. Most of this vegetation type appeared to have been cleared previously (except possibly the remnant eucalypts), or otherwise heavily disturbed, with dense regrowth of White Cypress Pine since cessation of grazing or active management to suppress its regeneration (DIPNR 2004a). This association was in moderate condition.
- *Blakely's Red Gum Open Woodland* — Only one small area of Blakely's Red Gum Open Woodland was recorded, at the northern end of Lake Keepit State Park on the eastern side of Lake Keepit. It was surrounded by, and was similar structurally and floristically, to White Box Open Woodland, except that the overstorey was dominated by *Eucalyptus blakelyi* (Blakely's Red Gum). Prior to clearing, this community would have occurred more extensively on alluvial soils in moister sites, in a mosaic with White Box-dominated or Yellow Box-dominated woodland. This association had a low level of weed invasion and was in moderate condition.
- *Yellow Box Open Woodland* — Two small patches of Yellow Box Open Woodland were recorded on private property between the Peel River and Keepit Dam Road. These occurred on fertile, level to gentle slopes on the Peel River floodplain. Prior to clearing, this community would have occurred more extensively on alluvial soils in moister sites, in a mosaic with White Box-dominated or Blakely's Red Gum-dominated woodland. Surrounded by cultivated agricultural land, with the understorey replaced by introduced pasture grasses and weeds, and heavily grazed, these remnants were in poor condition.

Poplar Box Open Woodland

The main occurrence of this community in the surveyed area was within the travelling stock reserve on the south-eastern side of Lake Keepit. It also commonly occurred as small remnants on low-lying areas on the foreshore of Lake Keepit. Most of this community was in moderate to good condition.

Silver-leaved Ironbark Open Woodland

This community generally occurred on hillslopes, including the foreshores of Lake Keepit. It was very similar structurally and floristically to White Box Yellow Box Blakely's Red Gum Woodland and Poplar Box Open Woodland, except that the overstorey was dominated by *Eucalyptus melanophloia* (Silver-leaved Ironbark).

This community was less disturbed than other vegetation within the surveyed area and had a high level of species diversity and few weeds. This community was in good condition.

River Red Gum Woodland

This community occurred on deep alluvium along the banks of the Namoi and Peel Rivers and in adjacent areas subject to periodic inundation. This community was observed to be expanding to include the margins of the high water mark of Lake Keepit. In these areas, a narrow band (approximately 10 metres wide) of young saplings of *E. camaldulensis* was observed.

This community was dominated by *Eucalyptus camaldulensis* (River Red Gum) and *Casuarina cunninghamiana* (River She-oak). Many of the overstorey trees in these parts of the surveyed area have been removed and the understorey was often highly degraded by heavy grazing or cropping. Additionally, many of the remnant River Red Gums were growing old and no regrowth of the species was occurring in these areas.

Woody weed species (e.g. *Salix spp.* and *Schinus areira*) also commonly occurred in this community, especially along the Namoi River below the main dam wall. Hence, this vegetation community was mostly in poor condition.

Grassland

Most areas of grasslands were likely to have been created by past clearing of overstorey eucalypt cover. Many areas were also likely to contain a mix of native and introduced species; however, even heavily cultivated areas can sometimes return to native pasture within a few years if the areas are removed from grazing (Hunter 2002).

Ground-truthing of vegetation mapping indicated that the majority of grassland within the surveyed area was dominated by native species, such as *Austrostipa verticillata*, *Bothriochloa spp.*, *Dichanthium sericeum*, *Chloris verticillata* and *Enneapogon gracilis*. This community also included typical introduced pasture and weed species, but was generally dominated by native species of grass. This community was in poor condition.

Based on the altitude, topography and remnant trees or nearby vegetation, the majority of this community is likely to have once supported Poplar Box Woodland. This community would not correspond to a derived grassland of White Box Yellow Box Blakely's Red Gum Woodland, because it does not have an intact native groundcover with a high diversity of native species (more than 12 native species, excluding grasses) (Department of the Environment and Heritage 2006).

Plant species

A total of 114 plant species have been recorded within the surveyed area, of which 82 (72%) are native.

Six of the species recorded within the area are listed as noxious species in the Gunnedah Shire and/or Tamworth Regional control areas under the *Noxious Weeds Act 1993*. These species are shown in *Table 5.1*.

Table 5.1 Noxious species recorded within the surveyed area

Scientific name	Common name	Noxious weed class ¹	Management requirements ¹
<i>Bryophyllum</i> species	Mother-of-millions	4	The growth and spread of the plant must be controlled according to the measures specified in a management plan published by the local control authority.
<i>Cylindropuntia</i> species	Prickly Pear		
<i>Opuntia</i> species	Prickly Pear		
<i>Xanthium</i> species	Nagoora Burr		
<i>Salix</i> species	Willow	5	The requirements in the <i>Noxious Weeds Act 1993</i> for a notifiable weed must be complied with.

Notes: 1 Classification of weeds and management requirements are specified in the *Noxious Weeds Act 1993*.

Threatened species of plant

Two threatened species of plant have been recorded within the surveyed area: *Hakea pulvinifera* and *Bothriochloa biloba*.

Potential habitat for four other threatened species of plant has also been identified within the surveyed area; however, these species were not observed during the field surveys. These are:

- *Digitaria porrecta*
- *Diuris tricolor*
- *Goodenia macbarronii* (Narrow Goodenia)
- *Swainsona murrayana* (Slender Darling Pea).

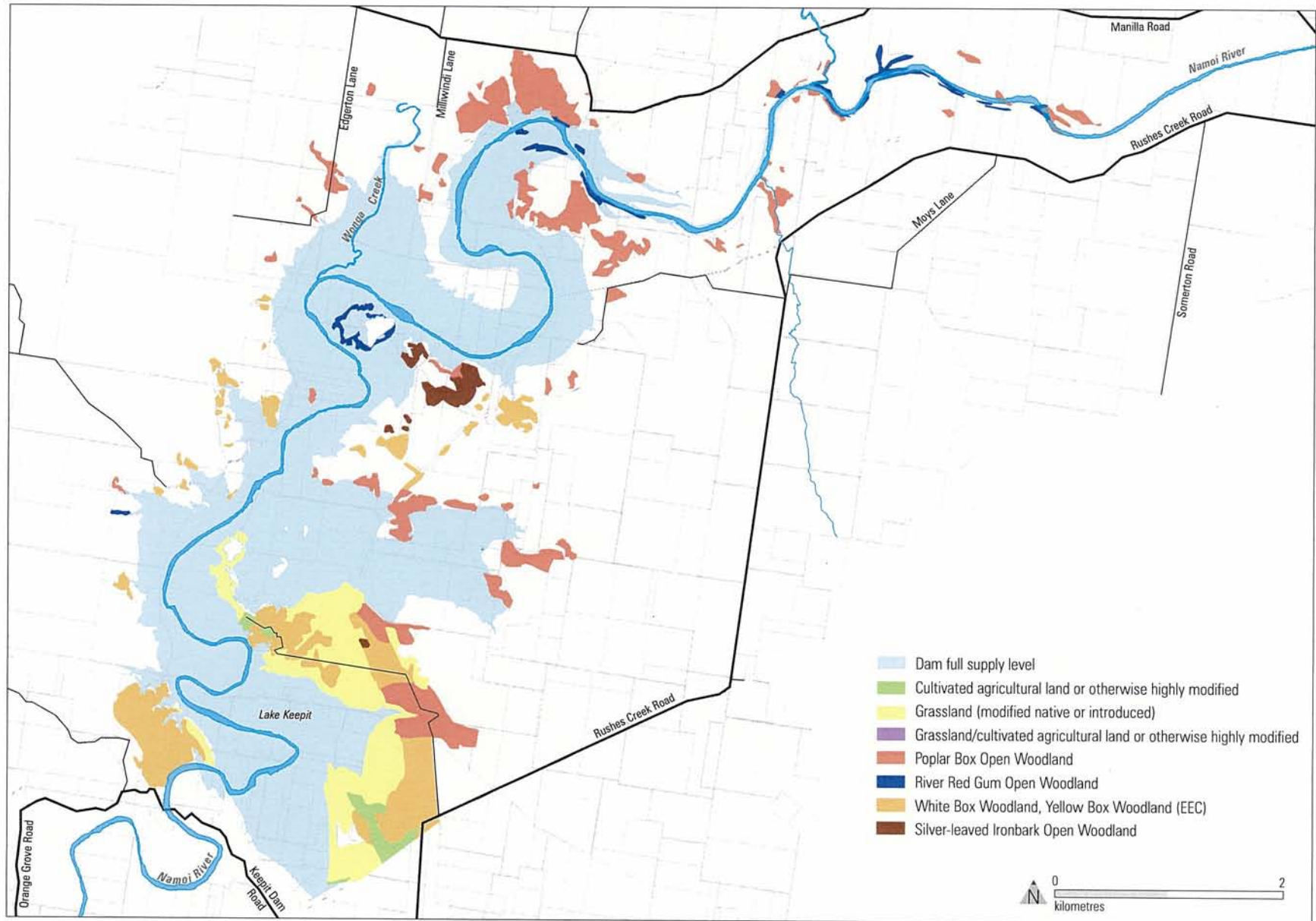


Figure 5-1 Mapped vegetation communities upstream of Keepit Dam

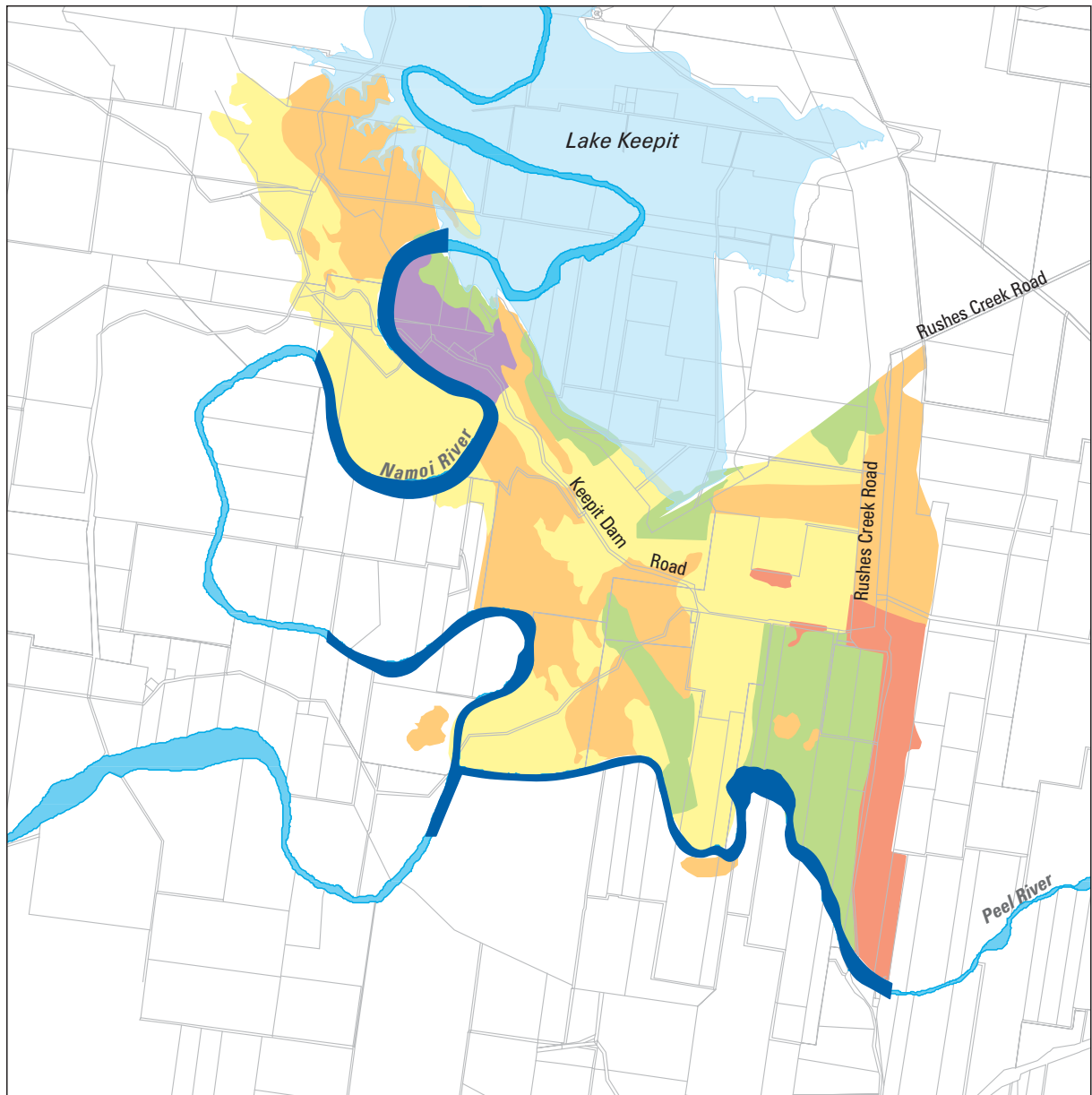


Figure 5-2 **Mapped vegetation communities downstream of Keepit Dam**

- Dam full supply level
- Cultivated agricultural land or otherwise highly modified
- Grassland (modified native or introduced)
- Grassland/cultivated agricultural land or otherwise highly modified
- Poplar Box Open Woodland
- River Red Gum Open Woodland
- White Box Woodland, Yellow Box Woodland (EEC)

The only known population of *Hakea pulvinifera* grows on a steep, rocky slope on the western side of the Namoi River, approximately 2 kilometres downstream of the main dam wall (Hunter 2002). The population contains less than 150 individuals with two evident age classes. The older age class is in decline.

A single individual of *Bothriochloa biloba* was previously recorded beneath the subsidiary dam wall (Hunter 2002), but was not located during the field surveys undertaken for this Environmental Assessment.

Fauna habitat

Grasslands are the most common habitat type in the surveyed area, but offer limited resources for native animals due to the low floristic and structural diversity of their vegetation. Isolated paddock trees are scattered throughout the study area and can be important in grassland habitats, as they provide habitat for a range of fauna and maintain connectivity between larger patches of vegetation (Gibbons and Boak 2000).

Other habitats found in the surveyed area include open woodlands, thick stands of White Cypress Pine (*Callitris glaucophylla*) and riparian zones around the Namoi and Peel Rivers.

Open woodlands (White Box, Poplar Box, Yellow Box, Silver-leaved Ironbark and Blakely's Red Gum) provide moderate habitat for native animals and contain areas with grassy understorey foraging habitats, logs and fallen branches, and tree hollows within Box trees.

Thick stands of White Cypress Pine (*Callitris glaucophylla*) occur in previously cleared woodland areas around the main dam wall and Lake Keepit State Park. The foliage of the White Cypress Pine provides shelter for small birds, and cockatoos and galahs are known to feed on *C. glaucophylla* seeds (Thompson and Eldridge 2005). Groundcover habitats in these areas are limited to small amounts of fallen dead branches and trees, and a small number of hollow bearing logs. These habitats were observed to be in poor condition during field surveys.

The riparian zones of the Peel and Namoi Rivers provide a variety of habitat features, including mature hollow-bearing Red Gum trees (*Eucalyptus camuldulensis*), fallen dead wood and leaf litter. The rivers provide a water resource for birds and mammals, and breeding habitat for frogs. The riparian habitats of the Peel River were observed to be in poorer condition than the Namoi River during field surveys; however, both rivers provide important habitat linkages throughout the region.

Animal species

A total of 124 animal species have been recorded within the surveyed area. These comprise 110 bird, 11 mammal, two reptile and one mammal species. Four introduced species of mammal have also been observed.

Threatened species of animal

Thirty-four threatened faunal species have been recorded, or have the potential to occur in the surveyed area. These comprise 17 bird, 13 mammal, two reptile and two amphibian species. Twenty-eight of these species are listed under the *Threatened Species Conservation Act 1995* and 12 are also listed under the *Environment Protection and Biodiversity Conservation Act 1999*.

Two species listed as vulnerable under the *Threatened Species Conservation Act 1995* were recorded during the field surveys:

- Speckled Warbler (*Pyrrholaemus sagittatus*)
- Yellow-bellied Sheathtail Bat (*Saccolaimus flaviventris*).

The Speckled Warbler was observed on a ridge within 1 kilometre of the caravan park. The Yellow-bellied Sheathtail Bat was recorded foraging in open country, surrounding box woodland on the eastern side of Lake Keepit.

Other threatened fauna species, such as large forest owls, parrots, honeyeaters, ground-dwelling insectivorous and granivorous birds, may also use habitats within the study area as a marginal foraging area. The likelihood of their occurrence and use of habitats are described in *Technical Paper 1* (in *Volume 2*).

Migratory species

Twenty-two migratory bird species listed under the Japan Australia Migratory Bird Agreement, the China Australia Migratory Bird Agreement and/or the Bonn Convention on the Conservation of Migratory Species of Wild Animals have been recorded, or have the potential to occur in the surveyed area. However, migratory species are unlikely to occur in the surveyed area, as it does not contain habitat used by any migratory species and is not located in a region that supports an ecologically significant population of any migratory species.

5.1.2 Assessment of impacts

Option B1

Option B1 would require the clearing of approximately 41.0 hectares of native vegetation, including approximately 13.6 hectares of White Box Yellow Box Blakely's Red Gum Woodland, an endangered ecological community. The removal of dead wood and trees would also be required.

An impact assessment undertaken for the proposed clearing of White Box Yellow Box Blakely's Red Gum Woodland concluded that the construction of Option B1 is likely to have a significant impact on the community (refer *Technical Paper 1* in *Volume 2*). Any clearing of this community would result in fragmentation of woodland habitat in the right-hand abutment area, which

would significantly affect habitat connectivity for native animals in the area. Biodiversity offsets and management measures to minimise these impacts are discussed below and in *Section 5.1.3*.

The removal of dead wood and trees is listed as a key threatening process under the *Threatened Species Conservation Act 1995*. This activity would generally occur in disturbed habitats that are unlikely to provide potential habitat for threatened or endangered species of plants and animals. Therefore, the removal of dead wood and trees is unlikely to result in a substantial impact on ecological communities in the area.

A number of other potential impacts on terrestrial ecosystems could occur as a result of Option B1, including:

- noise and other human disturbance
- soil erosion, compaction and sedimentation
- direct injury to animals or plants
- weed invasion.

None of the above potential impacts are expected to be significant.

Options D2 and D3

Options D2 and D3 would require the clearing of approximately 49.8 and 49.3 hectares of native vegetation respectively, including approximately 18.0 and 17.6 hectares of White Box Yellow Box Blakely's Red Gum Woodland respectively. The removal of dead wood and trees would also be required. As per Option B1, the proposed clearing of White Box Yellow Box Blakely's Red Gum Woodland is likely to have a significant impact on the community and would result in fragmentation of woodland habitat in the right-hand abutment area, which would significantly affect habitat connectivity for native animals in the area. Biodiversity offsets and measures to manage these impacts are discussed below and in *Section 5.1.3*.

The other fauna and flora impacts of construction of Options D2 and D3, including noise and other human disturbance, soil erosion, compaction and sedimentation, direct injury to animals or plants, and weed invasion, would be similar to Option B1.

Biodiversity offsets

State Water has investigated alternative stockpile locations and construction vehicle access routes to avoid clearing White Box Yellow Box Blakely's Red Gum Woodland (refer *Section 4.4.9*). Where possible, the Concept Plan has been refined, however generally this investigation concluded that the alternative locations would result in substantially increased costs (State Water 2006b).

The terrestrial biodiversity assessment of the proposal (refer *Technical Paper 1*) has identified clearing of White Box Yellow Box Blakely's Red Gum Woodland as a significant biodiversity impact of the proposal. State Water has

therefore investigated a range of measures to potentially offset this impact and maintain the biological diversity of the area (Parsons Brinkerhoff, 2006b).

In investigating an appropriate offset for the proposal, the following principles have been considered:

- enduring – they must offset the impact of the development for the period that the impact occurs
- quantifiable – the impacts and benefits must be reliably estimated
- targeted – they must offset the impacts on a 'like for like or better' basis
- located appropriately – they must offset the impact in the same region
- supplementary – beyond existing requirements and not already be funded by another scheme
- enforceable – through development consent conditions, licence conditions, covenants or a contract.

State Water have analysed the areas immediately surrounding Lake Keepit owned or managed by various State Government authorities (including State Water) and have preliminarily identified areas containing the Box Gum Woodland Community which may be able to be rehabilitated as an offset. The use of these areas could also be modified to reduce existing pressures (e.g. animal grazing) on native vegetation which would result in an enhancement of the biodiversity of these areas.

A package of offsets including direct and/or indirect actions proposed by State Water to maintain biodiversity may include one or all of the following:

- *identifying at Lake Keepit an area of land under NSW Government ownership to be used as an offset and changing management of the land including:*
 - ▶ removing or reducing grazing pressure (controlled grazing) to allow for natural regeneration of native plants
 - ▶ controlling exotic plant species that compete with native species
 - ▶ leaving fallen timber on the ground (i.e. not collecting firewood) to provide shelter for wildlife
 - ▶ controlling animals that pose a threat to wildlife populations (e.g. foxes and cats)
 - ▶ planting or regenerating locally indigenous trees, shrubs and grasses.
- *rejuvenation/revegetation* — Land currently managed by State Water could be rejuvenated or revegetated by constructing habitat to link existing areas of high conservation value, resulting in improved connectivity of remnants and the creation of wildlife corridors. Alternatively, revegetation could be used to increase buffer zones around existing areas of high conservation value, which would help to minimise edge effects and ultimately increase the condition of these high conservation value areas.

- *monetary contributions to research* — Monetary contributions could be provided for research into conservation of threatened biodiversity such as the threatened *Hakea pulvinifera* or White Box Yellow Box Blakely's Red Gum Woodland.

State Water would consult with the NSW Government landowners and the Department of Environment and Climate Change to agree an appropriate package of offsets for the proposal. The Department's BioBanking Assessment Methodology would be used as a guideline for sizing an appropriate area of offset in combination with other measures proposed.

5.1.3 Mitigation measures

A Flora and Fauna Management Sub Plan would be prepared prior to commencement of construction and implemented as part of the Construction Environmental Management Plan for the proposal. The Sub Plan would be prepared in consultation with the Department of Environment and Climate Change, Department of Primary Industries (Fisheries) and Gunnedah Shire and Tamworth Regional Local Councils. It is anticipated that the Plan would include:

- plans showing:
 - ▶ terrestrial and aquatic vegetation communities; important habitat areas; locations where threatened species, populations or ecological communities were recorded; areas to be cleared; and vegetation adjoining construction work sites where this contains important habitat areas and/or threatened species, populations or ecological communities
- methods to manage impacts on flora and fauna species (terrestrial and aquatic) and their habitat that may be directly or indirectly affected by the construction works, including:
 - ▶ procedures for vegetation clearing, soil management and managing other habitat damage (terrestrial and aquatic) during construction, including the following mitigation measures:
 - where possible, avoiding removal of trees, particularly those with hollows
 - temporarily moving any dead logs within construction areas to an adjacent area outside the construction area to minimise the loss of habitat
 - reviewing and, where possible, minimising the need for clearing, the work areas required and soil disturbance particularly in the vicinity of threatened species
 - clearly marking work area extents to prevent unnecessary clearing and interference with surrounding areas
 - restricting access for workers, their equipment and vehicles to construction areas and designated access tracks
 - installing sediment control devices appropriate to land-based or water-based construction activities prior to undertaking activities

- with the potential to increase levels of turbidity, nutrient levels and siltation of waterways
- separately stockpiling excavated topsoil for later emplacement on the spoil rehabilitation areas, with care taken not to unnecessarily transfer topsoil between areas
- thoroughly cleaning vehicles and other equipment (including boots) of soil, seeds and plant material before entering or leaving the site
- preparing and implementing a clearing management plan for areas containing native woodlands, including tree clearing protocols such as:
 - shaking the tree using a bulldozer
 - slowly pushing the tree to the ground so that it largely remains intact
 - leaving the tree in place once felled for at least one day/night before removing to allow animals to relocate to nearby vegetation
 - providing all contractors with the contact numbers of wildlife rescue groups should animals be injured during clearing
 - undertaking vegetation clearing during September/October or in March/May to avoid summer breeding seasons and the winter hibernation for hollow-dependent species
- covering all trenches when work is finished for the day to prevent animals being accidentally trapped
- prohibiting the parking, stockpiling or storing of construction equipment and materials under trees to avoid compaction of the tree root zone
- ▶ methods to protect vegetation retained within and adjoining the construction work areas from damage during construction
- ▶ a habitat tree management program, including fauna recovery procedures and habitat maintenance (e.g. relocating hollows or installing nesting boxes)
- ▶ methods to minimise damage to aquatic habitats
- ▶ where possible, and where consistent with Department of Environment and Climate Change requirements, strategies for re-using in rehabilitation works, individuals of any threatened plant species that would otherwise be destroyed by the construction works
- ▶ performance criteria against which to measure the success of the methods
- rehabilitation details, including:
 - ▶ identifying locally native species to be used in rehabilitation and landscaping works, including flora species suitable as a food resource for threatened fauna species
 - ▶ methods to remediate affected aquatic habitats or fish passages

- ▶ identifying the source of all seed or tube stock to be used in rehabilitation and landscaping works, including seed sources within the construction work areas
- ▶ collecting seeds of locally native species within the construction work areas before construction commences to provide seed stock for revegetation
- ▶ methods to re-use topsoil (and where relevant subsoils) and cleared vegetation
- ▶ measures for the management and maintenance of all preserved, planted and rehabilitated vegetation (including aquatic vegetation)
- a Weed Management Strategy, including:
 - ▶ identifying weeds within the construction work areas and adjoining areas
 - ▶ weed eradication methods and protocols for the use of herbicides
 - ▶ methods to treat and re-use weed infested topsoil
 - ▶ strategies to control the spread of weeds during construction
- a program for reporting on the effectiveness of terrestrial and aquatic flora and fauna management measures against the identified performance criteria, with a review of management measures where they are found to be ineffective.

Biodiversity offsets would be designed in conjunction with the Department of Environment and Climate Change during the detailed design of the proposal. The Director-General Department of Environment and Climate Change would be provided with annual reports on the implementation and management of the elements of the biodiversity offset strategy as part of the Operational Environmental Management Plan for a period of 5 years following the completion of construction.

5.2 Aquatic ecology

An aquatic ecology assessment has been prepared for the proposal (refer *Technical Paper 2* in *Volume 2*).

Water quality and macroinvertebrate sampling was undertaken between 13 and 15 June 2006. Fish sampling, habitat assessment and further water quality sampling was undertaken between 26 and 29 June 2006. The sampling and assessment were undertaken for a survey area that included watercourses downstream of Keepit Dam, including the Peel River between the subsidiary dam wall and the confluence with the Namoi River, and Lake Keepit and its tributaries.

Sampling site selection was undertaken in accordance with the *Australian River Assessment System (AUSRIVAS) Sampling and Processing Manual* (Turak *et al.* 2004). Nine sites downstream of Keepit Dam were selected for sampling (seven sites in the Namoi River and two in the Peel River). Ten sites in Lake Keepit and two sites in the Namoi River upstream of Lake Keepit were also sampled. The locations of the sampling sites are shown in *Figure 5-3*.

5.2.1 Existing environment

The overall health of the Namoi River valley, which incorporates all of the study area, was considered by Thoms *et al.* (1999) who found that:

- riparian zones were degraded
- gravel extraction and fluctuating water levels have had adverse impacts on channel morphology, including bank instability and sedimentation
- dams and river regulation have impacted the physical and biological environments
- poor land management practices were evident
- water quality was poor due to high levels of nutrients, turbidity and salinity
- native fisheries were poor, with low species diversity and abundance.

Description of habitats

A qualitative assessment of aquatic habitats was compiled for each sampling site. This included classification of waterways in accordance with *Fish Passage Requirements for Waterway Crossings* (Fairfull and Witheridge 2003), which classifies waterways as:

- Class 1 - major fish habitat
- Class 2 – moderate fish habitat
- Class 3 – minimal fish habitat
- Class 4 – unlikely fish habitat.

The assessment of aquatic habitats also included riparian, channel and environmental (RCE) scores for bank structure, ranging from a highest possible score of 52 for streams with little or no obvious human disturbance and containing very good habitat characteristics, to a lowest score of 13 for streams with strong evidence of human disturbance and poor aquatic habitat.

The results of the assessment are summarised in *Table 5.2*.

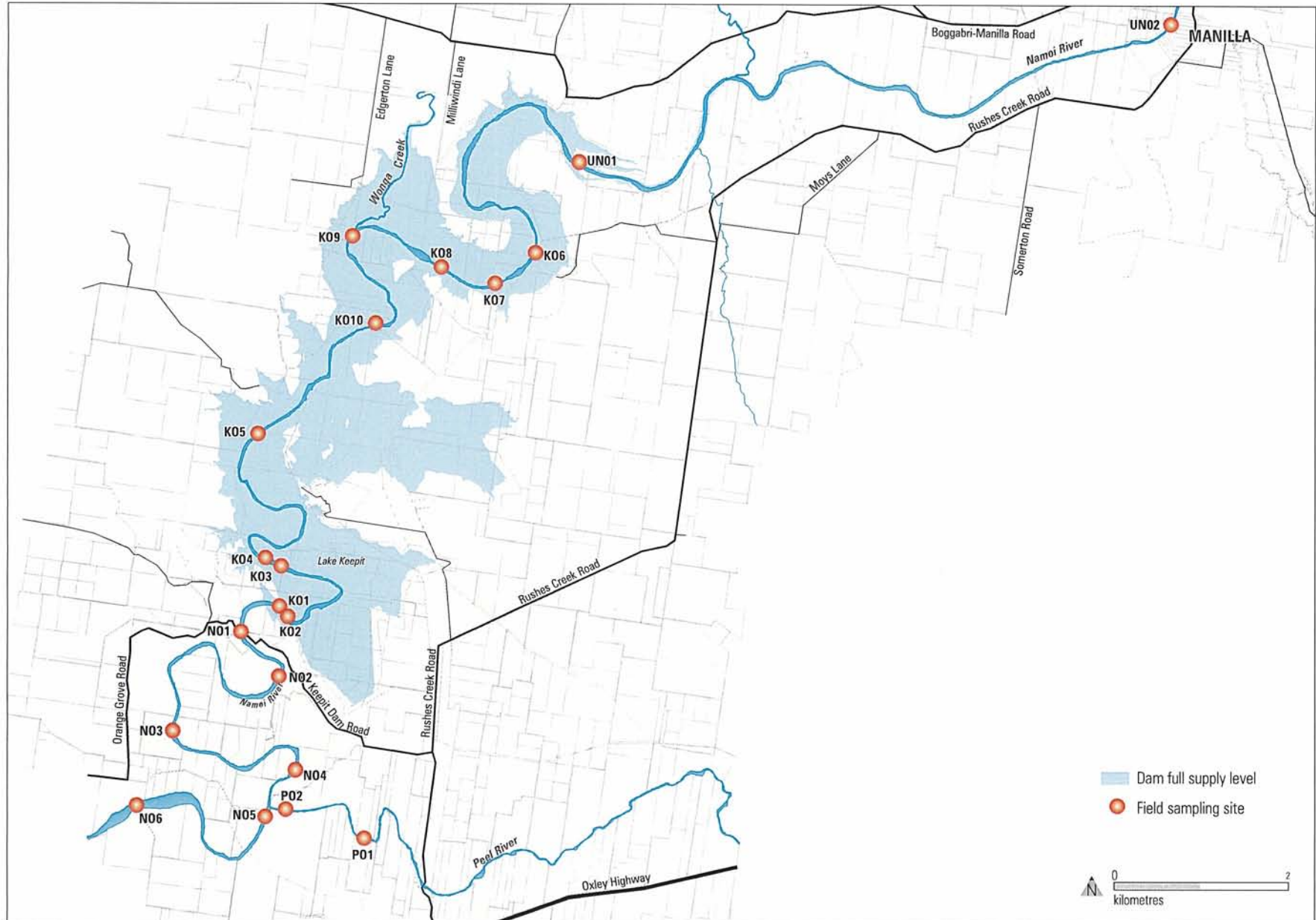


Figure 5-3 Aquatic ecology sampling sites

Table 5.2 Summary of existing aquatic habitats

Namoi River: Downstream of the main dam wall

General conditions

- Highly variable water levels and flow rates were evident due to the variable nature of water releases from Keepit Dam.
- Overall, habitat was poorer than expected with the exception of one site where habitat condition was acceptable.

Riparian habitat

- Riparian vegetation was generally continuous, although often restricted to the bank edge.
- Habitat consists of a mixture of native casurina and eucalypt trees, as well as introduced willows (*Silax* sp.) and pepper trees (*Schinus* sp.).
- River bank vegetation consisted of a variety of native and exotic grasses and shrubs.
- Macrophytes were common and included Floating Fern, Milfoil and Clasped Pondweed.
- A filamentous green algae species was also common.

Aquatic habitat

- Habitat comprised extensive areas of relatively deep, slow flowing pool sections and short sections of riffle habitat with shallow, fast flowing water.
- Fallen trees, overhanging bank vegetation, emergent reed beds, aquatic macrophytes, deep pools and rocky substrates also provide excellent habitat for fish and invertebrate species.
- All sites were graded as Class 1 – major fish habitat.

Overflow from Keepit Dam

- The dam discharges to a large artificial pool at the base of the main dam wall.
- This pool is considered an important native fish habitat.
- Dead native fish species, including Golden and Silver Perch, were observed in this pool near the discharge point.

Waterway type

- All sites were graded as Class 1 – major fish habitat.

RCE scores

- RCE scores ranged from 28 at site N05 to 38 at site N01.

Peel River: Downstream of the subsidiary dam wall

Riparian habitat

- Riparian vegetation cover was less abundant than on the lower Namoi River.
- Erosion was observed.
- Riparian vegetation included grasses, Emergent Common Reed (*Phragmites australis*), eucalypts, casuarinas and willows.

Aquatic habitat

- Fast flowing, shallow riffle and deep pool habitats were present.
 - Riffle areas occurred in upstream sections.
 - No overhanging bank vegetation was observed.
 - Few aquatic invertebrates were found.
-

-
- The water was also observed to be more turbid than in other sections.

Waterway type

- All sites were graded as Class 1 – major fish habitat.

RCE scores

- Sampling sites P01 and P02 had RCE scores of 24 and 26 respectively.
-

Lake Keepit

General conditions

- The supply level of the dam at the time of sampling was 17%.

Aquatic habitat

- Extensive aquatic habitat occurs, particularly along the old channel of the Namoi River and the inflowing tributaries.
- Large standing dead trees from the original riparian zone provide large woody debris (snags).
- Other habitat types include rocky outcrops, deep holes and extensive shallow areas with fine silt substrata in the upper reaches of the river channel.

Waterway type

- All sites were graded as Class 1 – major fish habitat.
-

Namoi River: Upstream of Lake Keepit

Riparian habitat

- Riparian vegetation was highly variable.
- Some reaches had extensive native vegetation along the banks, while others were dominated by introduced species such as willow or had been extensively cleared.
- Stock access to the river was extensive at some points.
- Bank erosion was observed along several sections.
- Instream and emergent aquatic macrophytes include *Juncus* sp., *Phragmites* sp. and *Myriophyllum* sp.

Aquatic habitat

- Flow is regulated by water releases from Split Rock Dam.
- Habitat is characterised by long deep pools and rapid flow over cobble bed riffles.

Waterway type

- All sites were graded as Class 1 – major fish habitat.

RCE scores

- Sampling sites UN01 and UN02 had RCE scores of 23 and 35 respectively.
-

Water quality

The water quality sampling results were compared to Australian and New Zealand Environment and Conservation Council (ANZECC 2000) guidelines for south-eastern Australia for upland rivers and reservoirs. At the Lake Keepit sampling sites, water quality variables were measured at both the surface and at depth. The results are summarised in *Table 5.3*.

Table 5.3 Water quality sampling results

Water quality indicator	Sampling sites			
	Upper Namoi River	Lake Keepit	Lower Namoi River	Peel River
Electrical conductivity (an indicator of salinity)	Exceeded guidelines at all sites	Exceeded guidelines at all sites	Exceeded guidelines at all sites	Exceeded guidelines at all sites
pH	Exceeded guidelines at all sites	Exceeded guidelines at all sites	Exceeded guidelines at all sites	Exceeded guidelines at all sites
Dissolved oxygen	Within the accepted range	Outside the accepted range	Slightly below the accepted range	Outside the accepted range
Turbidity	Within the accepted range	Generally within the accepted range	Within the accepted range	Exceeded guidelines at all sites
Water temperature	Water temperature was similar to that in Lake Keepit	There was no evidence of thermal stratification	Water temperature decreased slightly down the river	Water temperature increased down the river

Macroinvertebrates

Forty-six macroinvertebrate species were recorded at the sampling sites, 44 from the Namoi River and 27 from the Peel River. No specimens of River Snail (*Notopala sublineata*) were recorded.

Statistical analysis of the samples for macroinvertebrates was undertaken using Australian River Assessment System (AUSRIVAS) predictive models. The main output of AUSRIVAS predictive models is an observed to expected taxa ratio. The deviation between the number of taxa expected to occur and the number of taxa actually observed at a sampling site is a measure of stream condition.

The AUSRIVAS model assesses habitat conditions using bands of impairment ranging from much richer than reference habitat conditions to far poorer than reference habitat conditions. The following bands are used:

- band X – richer invertebrate assemblage than reference condition
- band A – equivalent to reference condition
- band B – significantly impaired
- band C – severely impaired
- band D – impoverished.

Overall, the AUSRIVAS model assessed the ecological conditions of most sampling sites as poorer than expected (bands B and C), with the exception of site N06 on the Namoi River where the habitat condition was assessed as roughly equivalent to reference sites used in the model (band A).

The AUSRIVAS model also uses an observed:expected ratio for the Stream Invertebrate Grade Number Average Level (SIGNAL) index, which is an indication of water quality. The following categories are used:

- SIGNAL Index greater than 6 – healthy unimpaired
- SIGNAL Index 5 to 6 – mildly impaired
- SIGNAL Index 4 to 5 – moderately impaired
- SIGNAL Index less than 4 – severely impaired.

SIGNAL Index scores at all sites in both the Namoi and Peel Rivers were lower than 5, indicating that, overall, water quality is moderately to severely impaired and the macroinvertebrate communities comprise tolerant animals.

Fish

Fish sampling was undertaken in the Namoi River downstream of Keepit Dam, the Peel River and Lake Keepit. The results of the sampling, combined with observations of fish not actually sampled, are summarised in *Table 5.4*. Nine species of fish were recorded in total, comprising six native and three exotic species.

Key findings of the fish sampling were as follows:

- Murray Cod (*Maccullochella peelii*), which is listed as a vulnerable species under the Commonwealth *Environment Protection and Biodiversity Conservation Act 1999*, was recorded in Lake Keepit. This species has previously been observed in the Namoi and Peel Rivers both upstream and downstream of Keepit Dam. All watercourses in the surveyed area are considered potential habitat for this species. This species has also been stocked within the dam from a local hatchery (Diplock and van der Walt 2005).
- Silver Perch (*Bidyanus bidyanus*), which is listed as a vulnerable species under the *Fisheries Management Act 1994*, was recorded in Lake Keepit.
- Freshwater Catfish (*Tandanus tandanus*) was recorded throughout the study area and is considered a species of conservation concern. This species has previously been observed in the Namoi and Peel Rivers both upstream and downstream of Keepit Dam. All watercourses in the study area are considered potential habitat for this species.
- Dead Golden Perch (*Macquaria ambigua*) and Silver Perch (*Bidyanus bidyanus*) specimens were observed in the pool at the base of the main dam wall. It is likely that these fish were transported through the outlet from Lake Keepit. Although it is unlikely that such large native fish could survive such transportation, it is possible that the eggs or larvae of some species, particularly the hardier exotic species, could survive.

Table 5.4 Fish sampling results

Species (Conservation status)	Recorded during sampling?		
	Lake Keepit	Namoi River downstream of Keepit Dam	Peel River
Bony Bream <i>Nematalosa erebi</i>	Yes	Yes	No
Goldfish <i>Carassius auratus</i> (alien species)	Yes	No	Yes
Common Carp <i>Cyprinus carpio</i> (alien species)	Yes	Yes	Yes
Carp Gudgeon	No	Yes	Yes
Murray Cod <i>Maccullochella peelii</i> (listed as vulnerable under the <i>Environment Protection and Biodiversity Conservation Act 1999</i>)	Yes	No	No
Golden Perch <i>Macquaria ambigua</i>	Yes	No	No
Freshwater Catfish <i>Tandanus tandanus</i> (species requiring consideration)	No	Yes	No
Mosquito Fish <i>Gambusia holbrooki</i>	No	Yes	Yes
Silver Perch <i>Bidyanus bidyanus</i> (listed as a vulnerable species under the <i>Fisheries Management Act 1994</i>)	Yes	No	No

5.2.2 Assessment of impacts

Impacts on aquatic habitat and biota could occur if mobilised sediment was to enter Lake Keepit or the Namoi River during construction. Potential impacts include:

- reduced water quality, including increased turbidity and increased nutrient levels
- increased turbidity, resulting in reduced light penetration and subsequent reduction of aquatic macrophyte, altering existing aquatic habitat
- algal growth as a result of increased nutrient levels, potentially resulting in toxic algal blooms
- increased sedimentation within watercourses, potentially resulting in reduced deep water refuge areas and smothering of habitat.

These impacts can be effectively minimised or eliminated by implementing standard construction management and mitigation measures (see *Section 5.2.3*).

Significance assessments (refer *Technical Paper 2* in *Volume 2*) were conducted for a number of listed threatened species which may be present in the area. These species were:

- Murray Cod (*Maccullochella peelii*)
- Namoi River Turtle (*Elseya bellii*)

- For the River Snail (*Notopala sublineata*)
- Olive Perchlet (*Ambassis agassizii*)
- Purple Spotted Gudgeon (*Morgurnda adspersa*)
- Silver Perch (*Bidyanus bidyanus*)
- The Lowland Darling River Aquatic Ecological Community

In all cases, these assessments concluded that there would be no significant impacts resulting from the proposal following adoption of the proposed measures to mitigate the impacts during construction and operation (see *Section 5.2.3*).

5.2.3 Mitigation measures

A Soil and Water Quality Management Sub Plan would be prepared as part of the Construction Environmental Management Plan for the proposal. The Sub Plan would be prepared in consultation with the Department of Environment and Climate Change, the Department of Natural Resources and the Gunnedah Shire and Tamworth Regional Local Councils. The Sub Plan would:

- where relevant, be consistent with the Landcom's (2004) guideline *Managing Urban Stormwater - Soils and Construction* and the Roads and Traffic Authority's *Guidelines for the Control of Erosion and Sedimentation in Roadworks*
- identify the construction activities that could cause soil erosion or discharge sediment or water pollutants from the site
- describe management methods to minimise soil erosion or discharge of sediment or water pollutants from the site, including:
 - ▶ a strategy to minimise the area of bare surfaces during construction
 - ▶ placing sediment fences or bunding or other erosion prevention devices between construction work areas and waterbodies to prevent sediment runoff
 - ▶ using a floating silt curtain or other techniques to prevent sediment dispersal for works occurring below the waterline of Lake Keepit
 - ▶ revegetation of disturbed areas following the completion of construction
- describe the location and capacity of erosion and sediment control measures
- identify the timing and conditions under which construction stage controls would be decommissioned

- include an incident management plan for spill response prepared for all construction areas where fuel, oil or chemicals are being used to prevent the contamination of water courses
 - ▶ all staff would be trained in spill management and procedures and the to the location of spill management kits
 - ▶ all plant and equipment would be well maintained and regularly checked for leaks of hydraulic fuels and oils
 - ▶ all fuel and oil storage areas would be bunded to contain at least 120% of the maximum capacity of the largest storage tank/container. The floor of the bunded area would be impervious and storage facilities and bunds would be regularly inspected for spills. Bunds would be regularly drained of rainwater and treated to ensure there is sufficient volume in the event of rupture
 - ▶ refuelling of plant and equipment would be undertaken in an adequately bunded area
 - ▶ if watercourses are flowing during construction works, visual monitoring for oils, greases and turbidity would be undertaken on a weekly basis and after significant rainfall events
- include consideration of the ability to undertake work involving disturbance of soils during periods of high rainfall
- include consideration of the need to lower the storage level, if at full supply level at the time of construction, in order to implement new spillways with sill levels below full storage level
- all roads and other constructed access ways would have sediment protection measures implemented to reduce the amount of sediment reaching waterways to the absolute minimum. This includes the use of an appropriate grade sediment fences and the construction of sediment basins where appropriate
- it would be preferable that soil excavated during the works is used elsewhere within site rather than be removed, or new soil be introduced. It is preferable that all soils be reused as close as possible to their origin
- the site should be reinstated to a condition as nears as practicable to it current condition after construction. In steep areas that would otherwise be left as exposed soil, an appropriate geotextile should be considered for stabilisation. In this situation the use of revegetation may be appropriate, provided the plants used are sourced from local genetic material. The possible use and position of geotextiles and revegetation is to agreed with the site environmental manager
- stabilisation works would be undertaken on any areas with potential for landslip to prevent environmental impacts on the nearby aquatic environment

- Works conducted within the Namoi River and Lake Keepit would where possible utilise prefabricated components as much as possible, to minimise the impacts on water quality associated with construction. For construction works associated, divers would be contracted to manoeuvre the prefabricated panels into position
- Works in and around water courses should be undertaken as quickly as possible to minimise impacts on water quality, aquatic floras, faunas and track-side vegetation
- Uncontaminated runoff from outside the construction area would be diverted around the disturbed catchment and stockpiles or through the area without mixing with the contaminated runoff, to prevent overloading the erosion control structures
- Creek and waterway crossings would be kept clear of excavated material and loose sediments
- Minimise soil disturbance and vegetation clearing activities during periods of wet weather
- identify how the effectiveness of the sediment and erosion control system will be monitored, reviewed and updated.

During construction, an appropriately qualified soil scientist or person with similar expertise in soil and water management would be consulted according to a schedule identified in the Soil and Water Management Sub Plan to:

- undertake inspections of temporary and permanent erosion and sedimentation control devices
- ensure that the most appropriate controls are being implemented
- check that controls are being maintained in an efficient condition
- check that controls meet the requirements of any relevant approval and/or licence condition.

5.3 Cultural heritage

A cultural heritage assessment has been prepared for the proposal (refer *Technical Paper 3* in *Volume 2*) for the purpose of this Environmental Assessment.

Cultural heritage sites potentially affected by the dam safety upgrade were identified through searches of relevant Aboriginal and European heritage registers, a review of previous heritage assessments and field surveys undertaken in July 2005 and July 2006.

Aboriginal participation

As required by the Department of Environment and Conservation's (2005) *Draft Guidelines for Aboriginal Cultural Heritage Impact Assessment*, identification of interested Aboriginal stakeholders was undertaken concurrently with the July 2006 field survey.

Letters were written to the Tamworth and Red Chief Local Aboriginal Land Councils in Tamworth and Gunnedah respectively, the Department of Environment and Conservation, and other statutory bodies, including the Office of the Registrar, Aboriginal Land Rights Act. Advertisements were also placed in the public notices section of two local newspapers and the national *Koori Mail*.

By the close of registrations, only two responses were received. A letter from the Gunida Gunyah Community Development Employment Project expressed an interest in being involved in the cultural heritage assessment. The other letter was from the Office of the Registrar, which indicated that there were no registered Aboriginal owners in the Keepit Dam area.

The Gunida Gunyah Community Development Employment Project group was contacted and discussions held about the cultural heritage assessment. It was agreed to involve the organisation, as well as the Tamworth and Red Chief Local Aboriginal Land Councils, in ongoing consultation about the proposal.

Subsequent to these discussions, the Min Min Aboriginal Corporation of Gunnedah was also contacted and expressed a desire to receive a copy of the draft cultural heritage assessment.

A search of the Native Title Register was also undertaken. The results identified that the Nucoorilma Clan of the Gamilaaroy Aboriginal People has made a claim over a large area of NSW. The claim area is from Wallangra south to Manilla, east to Bendemeer, north to Clarkes Mountain and east to Wallangra. The claim area does not extend to Lake Keepit, so the group was not consulted.

The field survey undertaken in July 2005 targeted areas of potential construction and operational impacts unique to each dam safety upgrade option. The Tamworth Local Aboriginal Land Council attended this survey.

The field survey undertaken in July 2006 targeted areas of potential construction and operational impacts that were common to all the options and that had not been inspected earlier. This field survey was attended by both the Tamworth and Red Chief Local Aboriginal Land Councils.

5.3.1 Existing environment

Aboriginal heritage

Aboriginal heritage sites were initially identified by a search of the Department of Environment and Conservation's Aboriginal Heritage Information Management System and associated archaeological reports. Background research revealed little information relating to Aboriginal heritage

at a local level. This prevented the development of a locally-specific predictive model for location of Aboriginal sites. Consequently, the analysis of predicted archaeological resources in the area was based on a generalised model.

The study area is within the tribal boundaries of the Kamilaroi tribe (Tindale 1974; Howitt 1996).

Twenty-eight Aboriginal heritage sites were recorded within the surveyed area during the 2005 and 2006 field surveys, comprising 13 artefact scatters, nine scarred trees, five isolated finds and one stone procurement source (quarry). A further 11 Aboriginal heritage sites were previously recorded within 10 kilometres of Keepit Dam, comprising six artefact scatters, three scarred trees, one stone procurement source and one collection of grinding grooves (refer *Table 5.5* and *Figure 5-4*). The presence of five of these previously recorded sites was confirmed during the field surveys. Three of the sites (KDA6, KDA20 and 20-5-0002) are considered to be of high archaeological significance at a local level based on their general rarity.

The study area also includes the site of the former Borah Crossing Aboriginal Reserve. The reserve is situated on the southern side of the Namoi River at Borah Crossing, at the northern end of Lake Keepit. The reserve was only marginally affected by the inundation of Keepit Dam, as it is mostly located above the full supply level. No standing structures remain at the reserve; however, there may be archaeological features present. The site is considered to be of high archaeological significance at a regional level.

The 2006 field survey investigated topographies ranging from the crests and slopes of the elevated hills and ridges, to the river and creek banks and flats on the floodplain. The largest four sites recorded (KDA9, KDA20, KDA21 and KDA26), all with over 30 artefacts, show the following characteristics:

- close proximity to the Namoi River or creek-line (three within 20 metres of the Namoi River, one within 10 metres of a creek and 250 metres from the river)
- gentle basal slopes extending down to level ground adjacent to watercourse
- silty deposits with little surface gravel evident.

Common characteristics for all artefact sites in the surveyed area are:

- situated on low gradient slopes to level ground
- often slightly elevated above a watercourse
- within approximately 200 metres of a watercourse
- originally within woodland vegetation.

Large artefact scatters are located within major river riparian corridors (e.g. KDA9, KDA20, KDA21 and KDA26). This is consistent with the model for artefact scatters used to predict Aboriginal archaeological potential. Despite this, not all locations in the study area with similar environmental and topographic characteristics contained such sites. For example, in ploughed paddocks adjacent to the Peel River, only eight artefacts were identified across three site recordings (KDA3-5) and, in a large ploughed paddock adjacent to the Namoi River, only three isolated artefacts were found (KDA11-13). The common characteristic of the smaller sites was that the soils often contained gravel. The gravels were mostly pebbles that were remnant river bed deposits. In contrast, the larger sites did not contain surface gravels. Another factor may be related to ploughing. The larger sites had not been subject to ploughing, while much of the ground inspected along the Peel and Namoi Rivers was ploughed. Although the ploughed ground offered excellent visibility, the turned soils and the gravels may have reduced the visibility of archaeological material.

Scarred trees appear to occur in a range of environments in the study area and it is difficult to predict their location. While scarred trees can potentially occur anywhere, their preservation is likely to be more closely linked to the presence of old growth trees. The travelling stock reserve and other areas of mostly uncleared land in Lake Keepit State Park generally have the highest potential for scarred trees. Such areas are considered, therefore, to have moderate potential to contain scarred trees. Isolated examples of old growth trees in otherwise cleared paddocks may also display evidence of Aboriginal scarring.

Table 5.5 Aboriginal heritage sites

Site name	Description	Significance (context)
Sites recorded during 2005 and 2006 field surveys (28 sites)		
KDA1	Scarred tree	Moderate (local)
KDA2	Artefact scatter	Low (local)
KDA3	Artefact scatter	Low (local)
KDA4	Isolated find	Low (local)
KDA5	Artefact scatter	Low (local)
KDA6	Stone procurement source	High (local)
KDA7	Scarred tree	Moderate (local)
KDA8	Scarred tree	Moderate (local)
KDA9	Artefact scatter	Moderate (local)
KDA10	Artefact scatter	Low (local)
KDA11	Isolated find	Low (local)
KDA12	Isolated find	Low (local)
KDA13	Isolated find	Low (local)
KDA14	Isolated find	Low (local)
KDA15	Artefact scatter	Low (local)

Site name	Description	Significance (context)
KDA16	Scarred tree	Moderate (local)
KDA17	Scarred tree	Moderate (local)
KDA18	Scarred tree	Moderate (local)
KDA19	Scarred tree	Moderate (local)
KDA20	Artefact scatter	High (local)
KDA21	Artefact scatter	Moderate (local)
KDA22	Scarred tree	Moderate (local)
KDA23	Artefact scatter	Low (local)
KDA24	Artefact scatter	Low (local)
KDA25	Artefact scatter	Low (local)
KDA26	Artefact scatter	Moderate (local)
KDA27	Scarred tree	Moderate (local)
KDA28	Artefact scatter	Low (local)
Sites recorded prior to the 2005 field survey (11 sites)		
20-4-0054	Scarred tree	Moderate (local)
20-4-0055	Scarred tree	Moderate (local)
20-4-0056	Isolated find	Low (local)
20-5-0001	Scarred tree	Moderate (local)
20-5-0002	Grinding grooves	High (local)
20-5-0016	Artefact scatter	Low (local)
20-5-0017	Artefact scatter	Low (local)
20-5-0018	Artefact scatters, hearth	Moderate (local)
20-5-0019	Artefact scatters	Low (local)
20-5-0020	Artefact scatter glass, 'contact' site	Moderate (local)
20-5-0021	Stone procurement source	Moderate (local)
Other sites		
Former Borah Crossing Aboriginal Reserve		High (regional)

Source: *Technical Paper 3*

Note: Sites are shown on *Figure 5-4*.

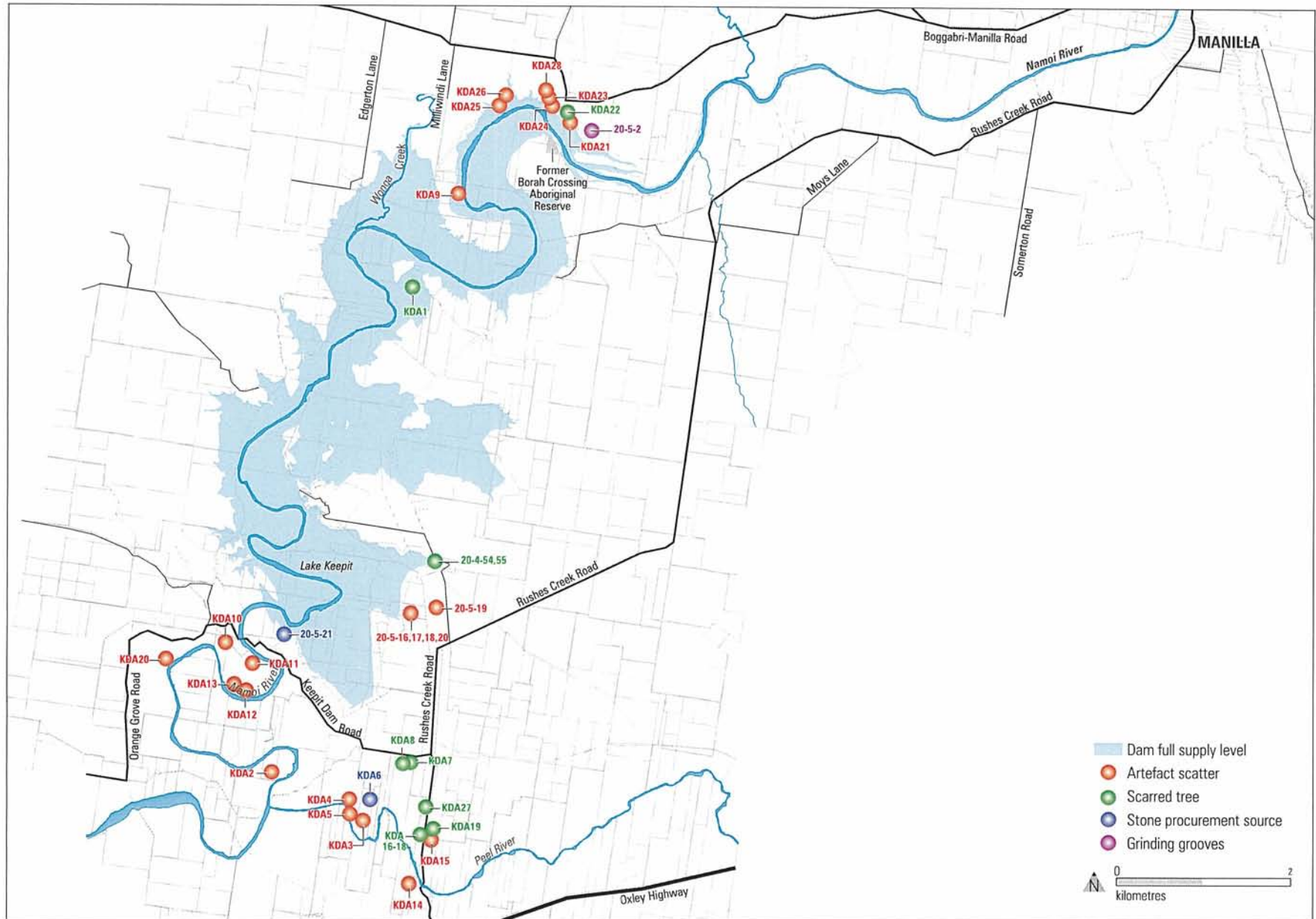


Figure 5-4 Indigenous heritage sites

European heritage

European heritage sites were initially identified by a search of heritage registers, monographs and reports held in the National Library of Australia, and parish maps and portion plans. The following heritage registers were searched:

- National Heritage List (Australian Heritage Council)
- Commonwealth Heritage List (Australian Heritage Council)
- Register of the National Estate (Australian Heritage Council)
- State Heritage Registers (NSW Heritage Office)
- State Heritage Inventory (NSW Heritage Office)
- Schedule 1 of the *Gunnedah Local Environmental Plan 1988*
- Schedule 1 of the *Manilla Local Environmental Plan 1988*
- Schedule 1 of the *Parry Local Environmental Plan 1987*
- the Heritage and Conservation Register compiled by State Water under Section 170 of the *Heritage Act 1977*
- Register of the National Trust of Australia (NSW) (1988).

There are no listed European heritage sites in the study area. Thirteen European heritage sites were, however, identified during the surveys completed for this Environmental Assessment, as shown in *Figure 5-5*. Brief descriptions of these sites are provided in *Table 5.6*.

An assessment of the significance of the European heritage sites in the surveyed area was undertaken in accordance with NSW Heritage Office criteria. The output of the assessment is a grading of either 'exceptional', 'high', 'moderate', 'little' or 'intrusive'. The significance assessments for the identified European heritage sites are shown in *Table 5.6*. The main dam wall was found to fulfil the criteria for both local and state heritage listing. Equipment stored in the Keepit Dam workshop was found to fulfil the criteria for local heritage listing.

Table 5.6 Significance assessment of European heritage sites

Site name	Description	Grading	Assessment
KDH1	House ruin	Little	Does not meet threshold for listing
KDH2	Ruins on island in Lake Keepit	Little	Does not meet threshold for listing
KDH3	School/scout hall	High	Fulfils criteria for local listing
KDH4	'Tulcumbah' homestead	Little	Does not meet threshold for listing
KDH5	Shearing shed and house ruin	Little	Does not meet threshold for listing

Site name	Description	Grading	Assessment
KDH6	House ruin	High	Fulfils criteria for local listing
KDH7	Private residence — previously Carroll Gap Public School (1882-1922)	Moderate	Fulfils criteria for local listing
KDH8	Main dam wall of Keepit Dam	High	Fulfils criteria for local and state listing
KDH9	Keepit Dam workshop equipment	High	Fulfils criteria for local listing
KDH10	'Violet Banks'	Little	Does not meet threshold for listing
KDH11	Former Gunnenbene school	Little	Does not meet threshold for listing
KDH12	Former Church and Presbytery and cemetery	Little	Does not meet threshold for listing
KDH13	Former Keepit school	Little	Does not meet threshold for listing

Source: *Technical Paper 3*

Note: Sites are shown on *Figure 5-5*.

Palaeontologic heritage

An outcropping limestone geological feature, known as Rangari Limestone, extends for many kilometres along a north-south ridge between Keepit Dam and the Peel River (refer *Figure 5-5*). The outcrop extends for many kilometres, but is only exposed at various locations in the district. Rangari Limestone is a potentially significant fossil-bearing deposit. The only known outcrop of this rock occurs to the south of the study area near the Peel River at Carroll Gap. It is reported that this site, and possibly other sites in the area, are used by the University of New England, possibly as a research site (refer *Technical Paper 3* in *Volume 2*).

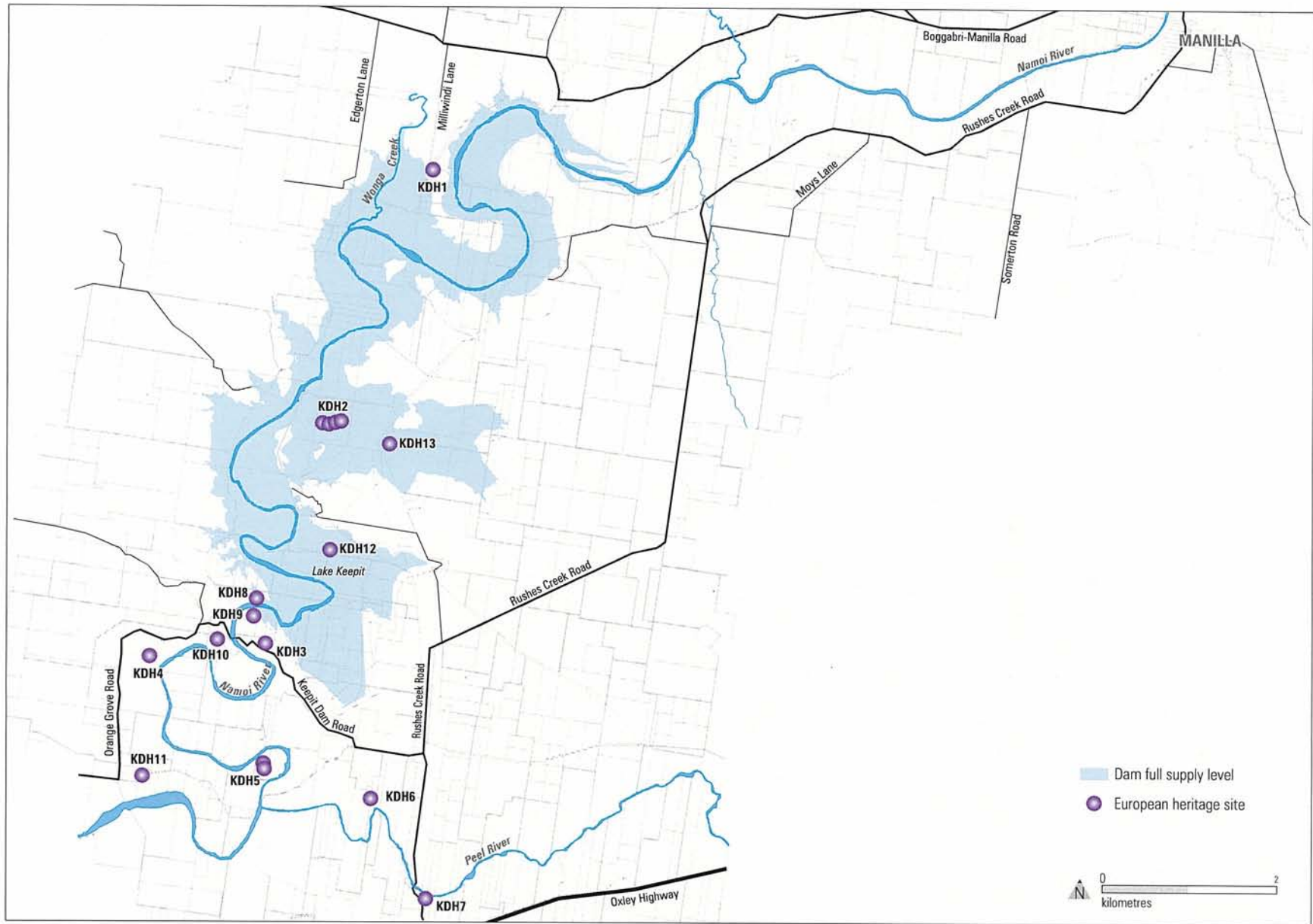


Figure 5-5 European heritage sites

5.3.2 Assessment of impacts

Option B1

The construction works for Option B1 could potentially cause indirect impacts on Aboriginal site 20-5-0021 (stone procurement source), which is located on the crest of a ridge adjacent to the location of the proposed boat ramp saddle dam.

There is low potential for unrecorded archaeological heritage sites at all the proposed construction work areas for Option B1, except at the northern and southern stockpile areas, which have low to moderate and moderate potential for unrecorded sites respectively.

The proposed raising of the main dam wall would result in direct impacts on this historic site (KDH8).

Options D2 and D3

The construction works for Options D2 and D3 could potentially cause direct impacts on Aboriginal site 20-5-0021 (stone procurement source). Impacts on this site are potentially greater than those that could occur as a result of construction of Option B1.

The potential for unrecorded archaeological heritage sites at the proposed construction work sites for Options D2 and D3 is low, except at the road to the boat ramp, which has moderate potential for unrecorded sites, and at the northern and southern stockpile areas.

The construction works for Options D2 and D3 would result in direct impacts on the main dam wall (historic site KDH8). The impacts to the main dam wall would be similar to those caused by construction of Option B1.

The central stockpile area for Options D2 and D3 would encroach into part of the site complex of KDH3 (school/scout hall).

5.3.3 Mitigation measures

Aboriginal heritage

An Indigenous Heritage Management Sub Plan would be prepared as part of the Construction Environmental Management Plan. The Sub Plan would be prepared in consultation with all relevant Aboriginal groups and the Department of Environment and Climate Change. The Plan is anticipated to include:

- details of the archaeological investigations to be undertaken and any associated licences or approvals required
- procedures to be implemented if previously unidentified Aboriginal objects are discovered during construction. If such objects are discovered, all work likely to affect the object(s) would cease immediately and the Department of Environment and Climate Change would be informed in accordance with the *National Parks and Wildlife Act 1974*

- an education program for construction personnel on their obligations for Aboriginal cultural materials
- the following specific measures to avoid impacts to the Aboriginal stone procurement source site 20-5-21:
 - ▶ fencing off of the crest area of the ridge on which the site is situated
 - ▶ avoiding excavation of ridge deposits for fill in the boat ramp saddle dam wall
 - ▶ avoiding excavation of ridge deposits and rock for the boat ramp saddle spillway
 - ▶ if Options D2 or D3 are adopted, an archaeological survey of the proposed boat ramp road alignment to determine if there would be impacts on the stone procurement source site
 - ▶ archaeological salvage of the Aboriginal stone procurement site 20-5-21 if impact cannot be avoided.

European heritage

A Historical Heritage Management Sub Plan would be prepared as part of the Construction Environmental Management Plan. The Sub Plan would be prepared in consultation with the NSW Heritage Office and would include:

- procedures to be implemented if previously unidentified historical relics are discovered during construction
- an education program for construction personnel on their obligations for historic relics
- the following specific measures in relation to the main dam wall:
 - ▶ use of materials that are sympathetic to those that are present in the existing main dam wall
 - ▶ reuse of the existing spillway gate lifting gear
 - ▶ the removal and refurbishment, as necessary, of the gantry crane on top of the existing main dam wall and if possible, its replacement on top of the raised main dam wall
 - ▶ the removal and secure storage of historic items located on the top of the existing main dam wall, including the metal dedication and commemorative plaques and the metal 'Water Conservation and Irrigation Commission, NSW', insignia, and their relocation to similar locations on top of the raised main dam wall
 - ▶ archival recording of the existing main dam wall in accordance with best practice outlined in the NSW Heritage Office (1998) guidelines *How to Prepare Archival Records of Heritage Items* before construction work begins.

5.4 Visual

A visual assessment was prepared for the proposal for the purpose of this Environmental Assessment (refer *Technical Paper 4* in *Volume 2*). The assessment was undertaken based on a methodology developed by the Forests Commission of Victoria and the United States Department of Agriculture.

5.4.1 Existing environment

The landscape character of the Lake Keepit region is typical of the areas immediately to the west of the Great Dividing Range. It consists of undulating hills and expansive plains that gradually fall to the west into the upper reaches of the Darling/Barwon River Basin. In the area immediately surrounding the dam, the landscape generally varies from rugged and heavily vegetated in the areas to the north and west, to flat agricultural plains to the south and east.

Five landscape character units were defined based on topography, vegetation types and landscape cover, as follows:

- *ridgeline and upper wooded slopes*: generally occurring along the western and southern boundaries of the study area
- *undulating foothills (vegetated and cleared)*: occurring throughout the study area
- *low level slope areas*: occurring throughout the study area, though mostly on the eastern shore of Lake Keepit
- *waterbodies*: Lake Keepit and the Namoi and Peel Rivers
- *other cultural elements*: small residences, local roads and minor infrastructure, such as powerlines and low level bridges.

A scenic quality assessment was undertaken for these landscape character units and is summarised in *Table 5.7*.

Table 5.7 Scenic quality assessment

Landscape character unit	Scenic quality criteria				Evaluation of scenic quality
	Diversity of landscape elements	Landform	Vegetation	Water	
Ridgeline and upper wooded slopes	Moderate	Moderate	Moderate	n/a	Moderate
Undulating foothills	High	Moderate	Low	n/a	Moderate
Low level slope areas	Low	Low	Low	Low	Low
Waterbodies	High	High (at junction with land)	n/a	High	High
Other cultural elements	Low	Low	Low	n/a	Low

Source: *Technical Paper 4*.

Visual receivers

Potential visual receivers of the proposal are shown on *Figure 5-6*. Three key groups of visual receivers were identified:

- users of Lake Keepit sport and recreation facilities, the State Park and associated waterbodies
- residents of rural properties in the area and users of secondary travel routes
- users of primary travel routes.

All elements of the proposed Keepit Dam Upgrade would be close to primary recreation areas and visible from Lake Keepit itself. These areas also have high scenic quality, with limited ability to absorb visual changes without significant effects.

5.4.2 Assessment of impacts

Option B1

Generally, this option involves smaller structures than the other options. It would, therefore, result in less change to the overall visual environment of Lake Keepit and is more preferable from a visual perspective. Aerial perspectives that display this option's visual characteristics are shown in *Figures 5-7 to 5-10*. Photomontages are shown in *Figures 5-11 to 5-13*.

The right-hand abutment spillway and associated site works would be visible from many areas in the State Park and surrounding districts. The site of the proposed works for the right-hand abutment spillway is currently heavily vegetated with White Box Yellow Box Blakely's Red Gum Woodland and has a relatively natural visual appearance. The resulting landform would be strongly discordant with the existing area and would double the visible length of the dam crest. The construction of the right-hand abutment spillway would have a moderate to high visual impact at the various viewpoints considered.

The proposed modifications to the main dam wall and left-hand abutment would have a low to 'not visible' visual impact across the various viewpoints identified on *Figure 5-6*. It is unlikely that viewers in locations below the embankment would be able to discern a significant difference between the existing embankment and the new works, as the extension of the wall would be highly compatible with the existing main dam wall.

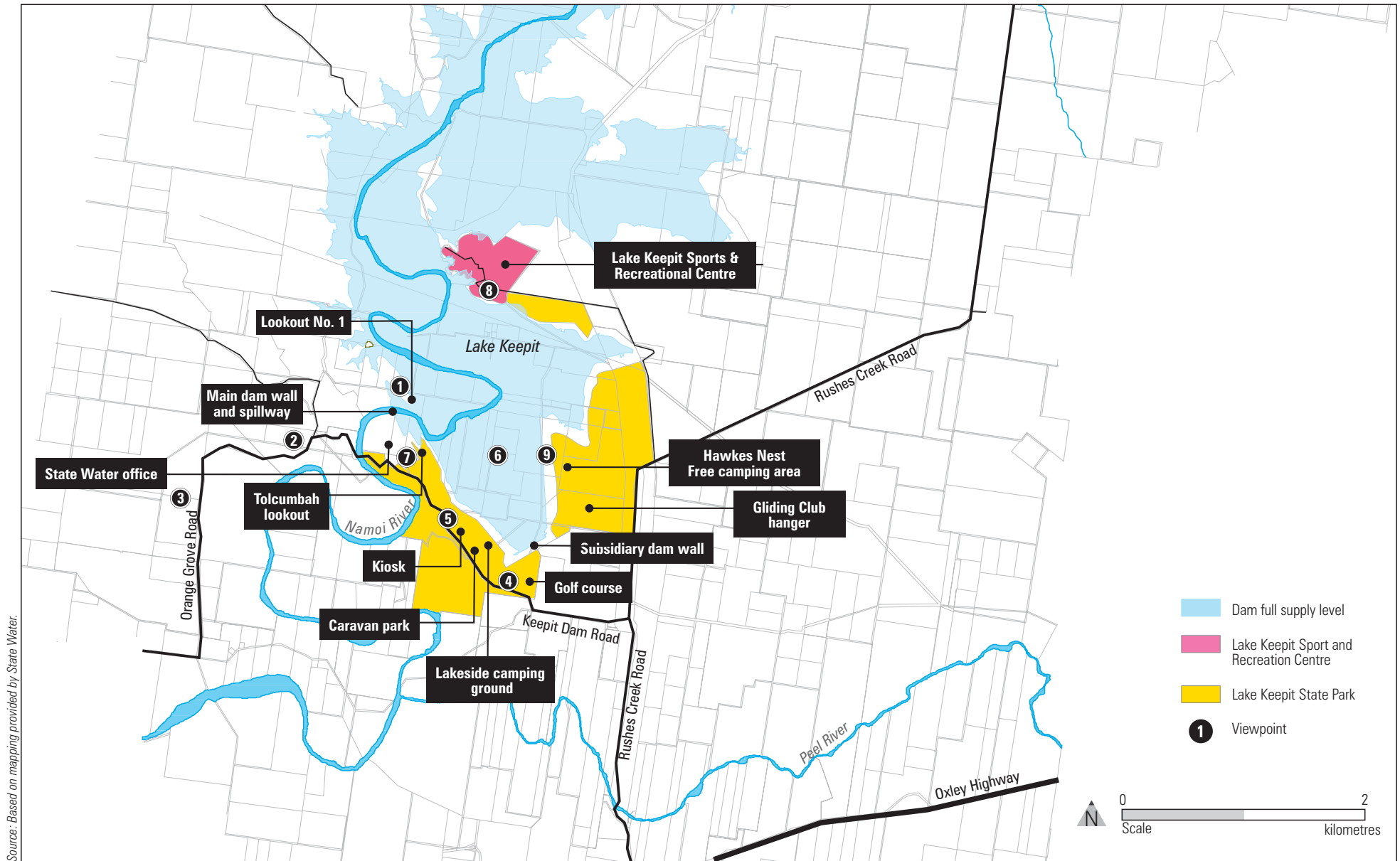


Figure 5-6 Potential visual receivers

The caravan park saddle dam would be visible from the kiosk area, the eastern shore of Lake Keepit, the caravan park, Keepit Dam Road and Orange Grove Road. For viewers in all these locations except along Orange Grove Road, the works would be a foreground element and viewers would be located at inferior to similar viewing levels. The caravan park saddle dam would have similar visual impacts for all the options, although it would be least for Option B1 as that option would require the least clearing and earthworks.

Works relating to the subsidiary dam wall for this option would result in a profound change. The subsidiary dam wall would be converted into a permanent spillway, with a series of four concrete gravity divider walls, different spillway heights and concrete end walls and toe aprons. These elements would appear as a dominant cultural modification in an otherwise relatively natural grassland environment. The subsidiary dam wall area is visible from a large part of Lake Keepit State Park and the surrounding area; however, only a moderate visual impact would result, given that the works would be complementary to the existing structure and the associated earthworks would not require extensive vegetation removal.

Options D2 and D3

The visual impacts of Options D2 and D3 were considered concurrently due to the visual similarity between their various elements. Aerial perspectives Options D2 and D3 are shown in *Figures 5-7 to 5-10*. Photomontages of Options D2 and D3 are shown in *Figures 5-11 to 5-13*.

The proposed modifications to the main dam wall and left-hand abutment for these options would have a similar visual impact to Option B1. Construction of the right-hand abutment spillway is common to all the dam safety options and would have a moderate to high visual impact for Options D2 and D3, as per Option B1.

The visual impact of works for the boat ramp saddle dam and spillway would be substantial as, although they would not be very visible from within the State Park area, they would have a high visual impact on viewers from some of the local residences (e.g. State Water employee housing.)

Works associated with the sailing club saddle dam/spillway would be larger and would involve greater associated earthworks than Option B1. Subsequently, they would be more visible across the study area, with the spillway becoming a significant element in an otherwise relatively natural and intermittently vegetated landscape. Most viewers would see this spillway as a dominant foreground element.



Option B1



Option D2



Option D3

Figure 5-7 **Aerial perspectives of the right-hand abutment spillway and main dam wall raising**



Option B1 - 2.0m high saddle dam



Option D2 - Spillway alternative. Saddle dam alternative 1.4m higher than Option B1



Option D3 - Spillway alternative. Saddle dam alternative 2.3m higher than Option B1

Figure 5-8 **Aerial perspectives of the boat ramp saddle dam/spillway**



Option B1

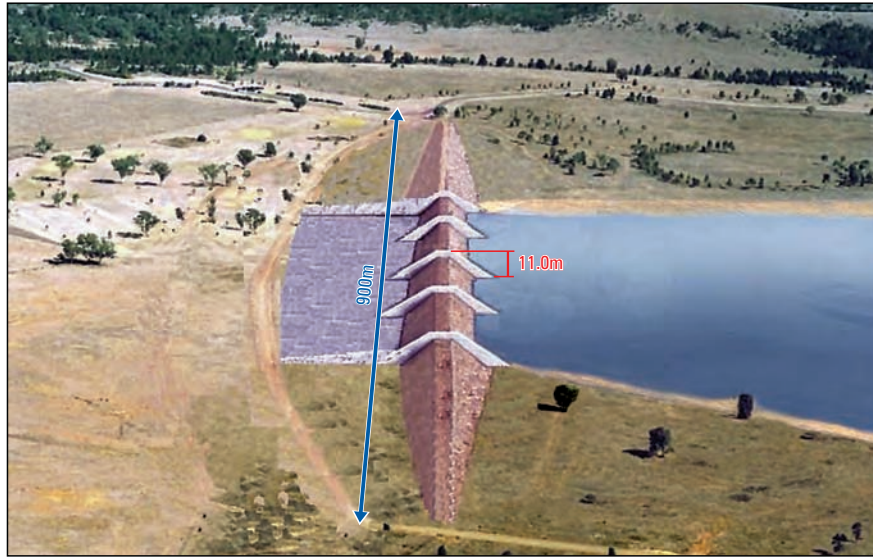


Option D2



Option D3

Figure 5-9 **Aerial perspectives of the boat ramp and sailing club saddle dams and spillways, as well as the caravan park saddle dam**



Option B1 - 11.0m high fuse plug spillway

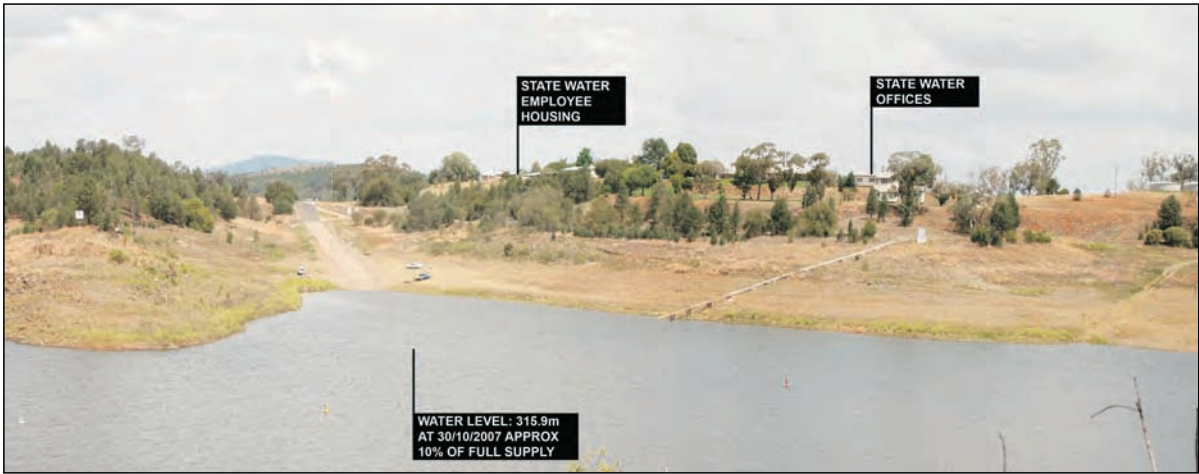


Option D2 - Saddle dam 1.2m higher than Option B1

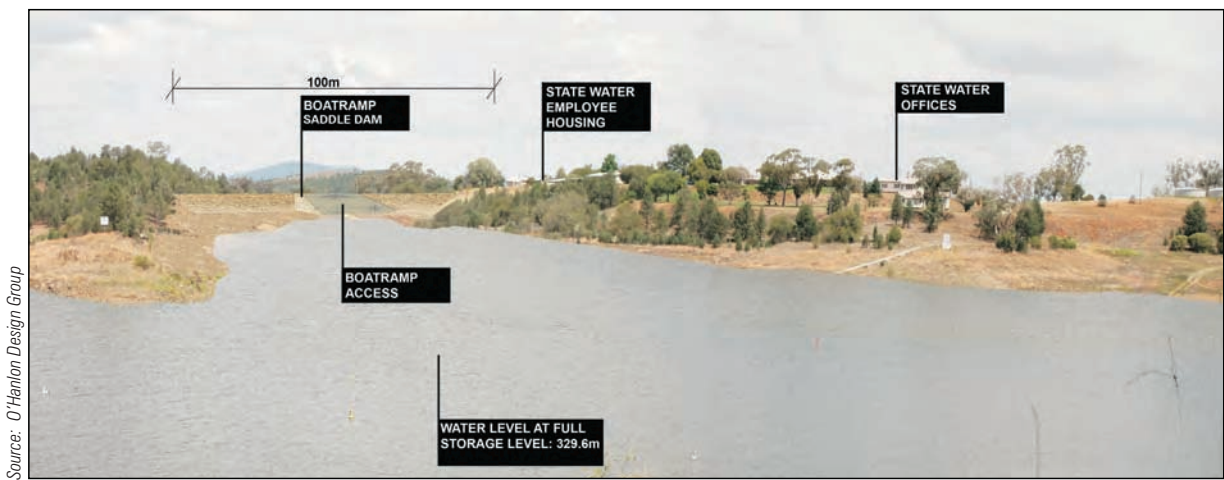


Option D3 - Saddle dam 2.1m higher than Option B1

Figure 5-10 **Aerial perspectives of the subsidiary dam spillway and wall raising**

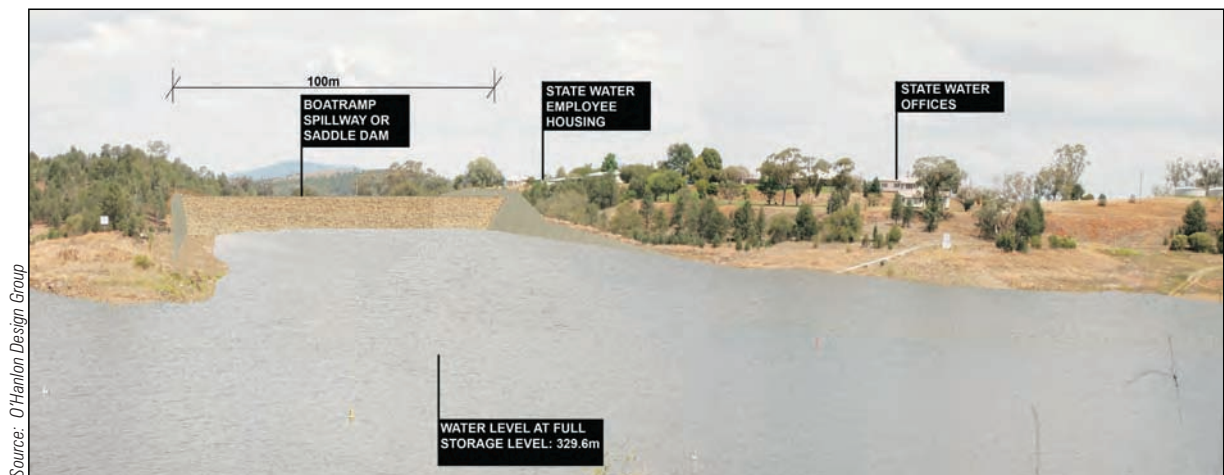


Existing - Looking south east to boat ramp saddle dam/spillway from VP1



Source: O'Hanlon Design Group

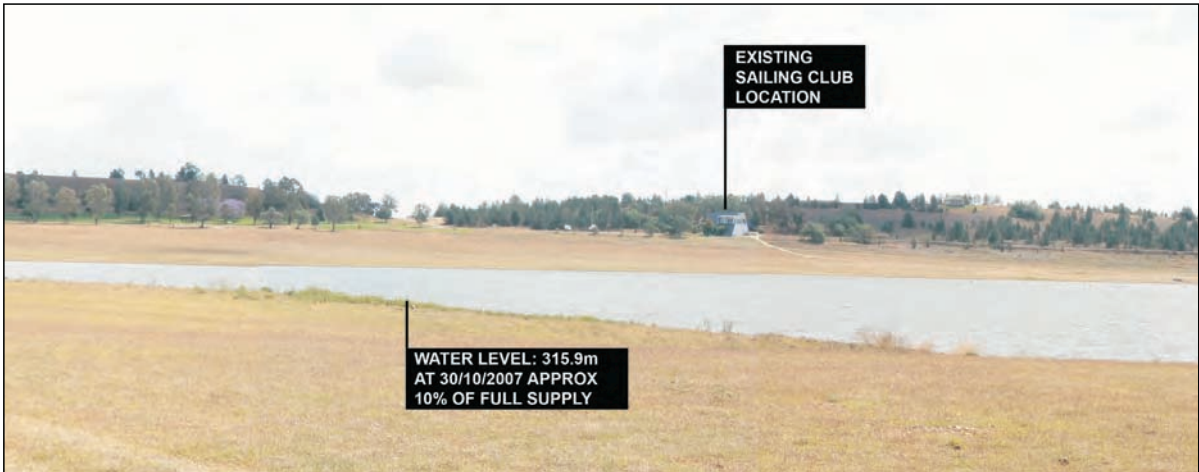
Option B1 - Looking south east to boat ramp saddle dam/spillway from VP1



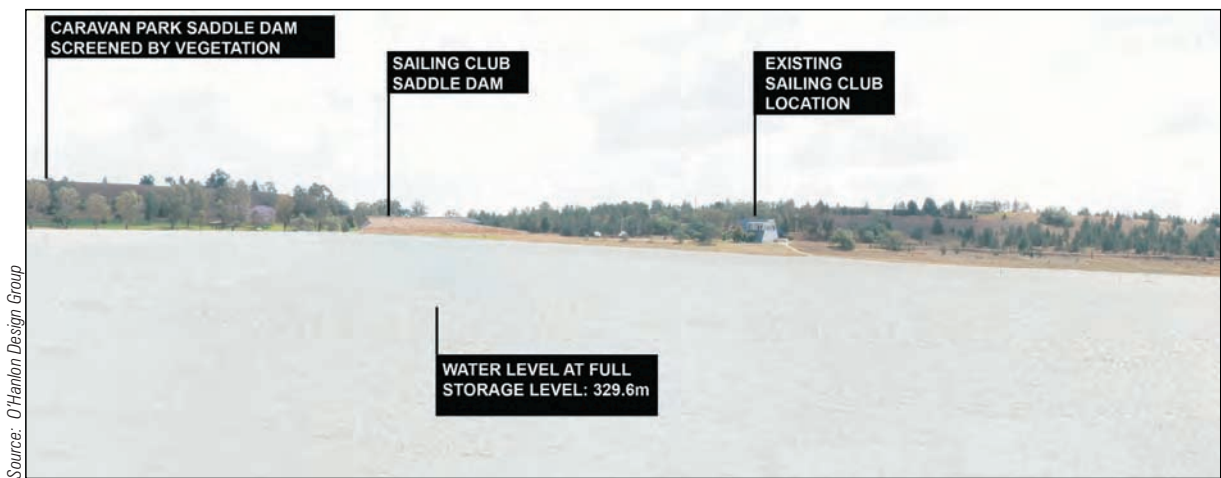
Source: O'Hanlon Design Group

Option D3 - Looking south east to boat ramp saddle dam/spillway from VP1. Option D2 levels 0.9m lower.

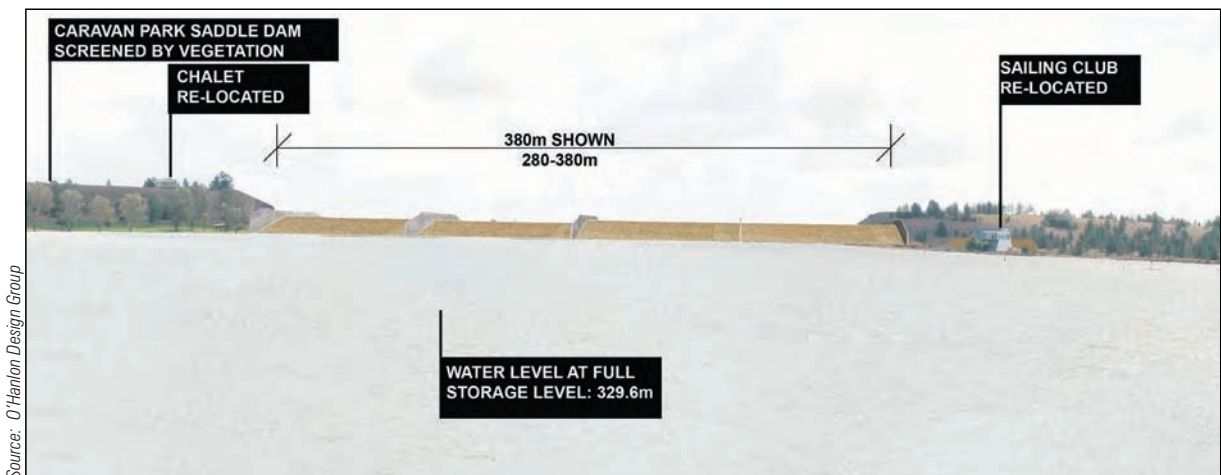
Figure 5-11 Photomontage of boat ramp saddle dam/spillway from VP1



Existing - Looking south west to Sailing Club saddle dam and caravan park saddle dam from VP6



Option B1 - Looking south west to Sailing Club saddle dam and caravan park saddle dam from VP6

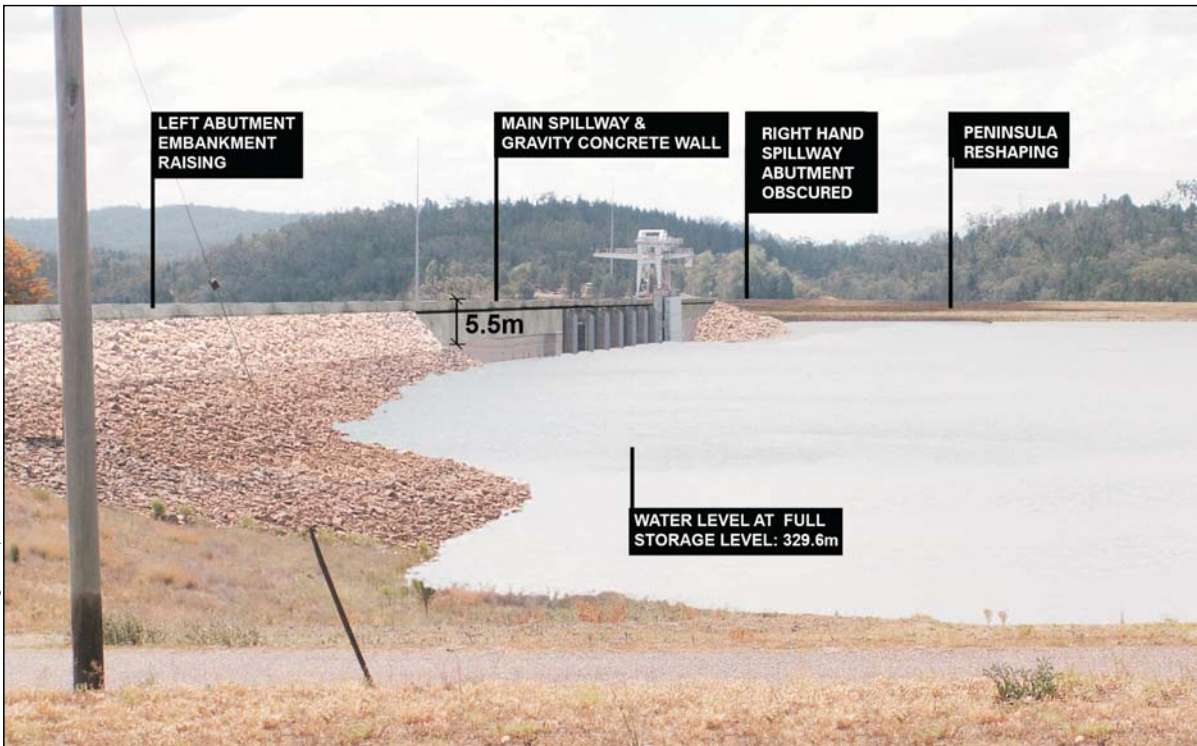


Option D3 - Looking south west to Sailing Club saddle dam and caravan park saddle dam from VP6. Option D2 levels 0.9m lower.

Figure 5-12 Photomontage of Sailing Club saddle dam/spillway and caravan park saddle dam from VP6



Existing - Looking north west to main spillway from VP7



Source: O'Hanlon Design Group

Option D3 - Looking north west to main spillway from VP7. Option B1 levels 2.1m lower.

Figure 5-13 Photomontage of main spillway and dam wall from VP7

The caravan park saddle dam would have similar visual impacts for all the options, although it would be greatest for Option D3 as that option would require the most clearing and greatest earthworks.

The modification of roads associated with Options D2 and D3 would alter access into and around the State Park. However, these modifications are compatible with the general principle of encouraging access in State Parks and, as individual elements, would create few visual impacts. These works would, however, create cumulative visual impacts around the boat ramp and sailing club, as they would connect the visual aspects of the works and reduce the natural appearance of the landscape.

5.4.3 Mitigation measures

Due to the scale of the works, the ability to mitigate the visual impacts of the dam safety upgrade is generally limited by the engineering needs of the infrastructure. Visual impacts would be considered as one factor in the selection of a preferred option.

A Visual Impact, Landscaping and Revegetation Sub Plan would be prepared as part of the Construction Environmental Management Plan. The Sub Plan would be prepared in consultation with the local community and the Lake Keepit State Park Trust. The Sub Plan would present an integrated landscaping and revegetation design for the proposal and would be consistent with the master plan prepared for affected areas of Lake Keepit State Park. The Sub Plan would include design treatments for:

- the location and identification of existing vegetation and proposed landscaped and revegetation areas
- fixtures such as lighting, fencing and signs.

The Sub Plan would also include the following information:

- graphics for key elements, such as sections, sketches and perspective views
- a schedule of species to be used in landscaping, with explanation of the derivation of the schedule, including its relationship with relevant ecological studies
- details of the timing and progressive implementation of landscaping works, considering related environmental controls such as erosion and sedimentation controls and drainage
- procedures and methods to monitor and maintain landscaped or rehabilitated areas.

5.5 Social

5.5.1 Overview of impacts and mitigation

Construction of the proposal would result in disruption to Lake Keepit State Park including temporary reductions in amenity and access. The State Park may suffer a loss of patronage during the construction period as a result of this disruption however there are a range of factors that may account for a loss of patronage. An example is the current low level of water in the dam. However, it is possible that at least part of any patronage impact may be offset by providing accommodation and supplies required by the construction workforce e.g. meals, recreation needs, and accommodation.

Options D2 and D3 would result in greater construction impacts to Lake Keepit State Park than Option B1. Options D2 and D3 would be constructed in close proximity and potentially directly impact the kiosk, The Gums Caravan Park, sailing club, Chalet and boat ramp as well as require the relocation of 7 more caravans than Option B1. These caravans are semi-permanent structures and permanent damage is expected if they were to be moved.

A survey/ review of all existing structures around the foreshore of Lake Keepit would be conducted if the proposal were approved. State Water would subsequently develop a detailed master plan of Lake Keepit State Park for the preferred dam safety upgrade option in conjunction with the Lake Keepit State Park Trust and local clubs. An objective of the master plan would be to, where possible, achieve an amenity that is at least equivalent to the existing park. The master plan would clearly identify the potential impacts of the dam safety upgrade and would assist in developing and negotiating management and mitigation measures. The master plan would identify proposed construction work areas and the proposed timing of construction works. This is expected to assist the Lake Keepit State Park Trust in its overall strategic planning for the park. The master plan would also address issues of disruption and identify potential mitigation measures for the proposed construction period, as well as long-term operational impacts. To minimise the impacts on visitors to the area, interpretive signage would be erected to inform the community of the proposed works and anticipated construction impacts.

The relocation of some structures could potentially be required outside the inundation area, subject to negotiations with the affected owners. Infrastructure would be relocated or upgraded as an early construction activity to reduce potential loss of income. The estimated cost of the proposed relocation and management of identified structures has been included in the option cost estimates.

There is also potential for vibration generated during the construction works to damage properties in the vicinity of the construction works. Property dilapidation inspections would be conducted on all structures (other than structures owned by State Water) in the vicinity of the construction works. These would be used to identify any resulting property damage. State Water would rectify any property or building damage caused by the construction works at no cost to the property owner.

Where there is potential for dust generating activities (e.g. clearing) avoidance or minimisation of these during windy conditions would curtail the impacts. All disturbed areas would be stabilised as soon as practical to prevent or minimise wind blown dust. If any air quality complaints are received during construction, sampling would be undertaken to ensure that the construction works associated with the proposed works do not exceed air quality standards. All unsealed trafficable areas would be kept sufficiently damp to minimise wind blown or traffic generated dust emissions. Transportation of construction material to and from the site would be covered to prevent wind blown emissions or spillages. Cleared vegetation, garbage and other combustible waste material would not be burnt on site and trucks and equipment used on site

To encourage reduced impacts on traffic and access a construction zone and a reduced speed environment sign would be placed at the entrance to Lake Keepit alerting visitors of a construction zone and to ensure traffic and vehicle safety. The construction zones would be fenced and secured to prevent community access and maintain site safety.