Wagga Wagga City Council

Wagga Wagga and North Wagga Murrumbidgee River Levee Upgrade

Review of Environmental Factors

7 August 2013

Acknowledgement

Wagga Wagga City Council has prepared this document with financial assistance from the NSW Government through its Floodplain Management Program. This document does not necessarily represent the opinions of the NSW Government or the Office of Environment and Heritage.

Executive summary

This report is subject to, and must be read in conjunction with, the limitations set out at the end of this report (page 163) and the assumptions and qualifications contained throughout the report.

The proposal

Wagga Wagga City Council proposes to upgrade the Wagga Wagga and North Wagga Wagga levees along the Murrumbidgee River, including the Main City Levee, North Wagga Wagga Levee and East Street (Bank Two) Levee.

The proposal is required to increase the level of flood protection for residents and businesses of Wagga Wagga.

The proposal would raise the Main City Levee to provide flood protection for up to a 100 year average recurrence interval (ARI) flood event, and would raise the North Wagga Wagga Levee and East Street (Bank Two) Levee to provide flood protection for up to a 20 year ARI flood event.

Key features of the proposal include:

- Constructing the following levee types, with average increases in height of 66 centimetres to 83 centimetres:
  - Embankment levees
  - Sheet pile levees
  - Concrete wall levees
  - Hybrid levees (embankment/sheet pile, embankment/gabion wall and embankment/box culvert)
- Constructing spillways to enable large floods (higher than the proposed level of flood protection) to enter the protected areas in a controlled manner
- Upgrading levee crossings that are lower than the design flood protection level, or that require structural improvement. These would include crossings for the Great Southern Railway, several major roads, and a number of minor roads and access roads.

Need for the proposal

Wagga Wagga and North Wagga Wagga have been subject to a history of flooding. Floods have caused considerable damages, financial loss and disruption. Council seeks to upgrade the levees to comply with its policies for flood protection.

Options considered

Options for managing flood risks have included:

- Flood modification measures that modify the flood's physical behaviour
- Property modification measures that modify the existing land use or buildings and development controls for future development

- Response modification measures that modify the community's response to the potential hazards of flooding.

The proposal was recommended (WMA Water 2009a) as one of a suite of measures selected from all three categories for implementation as part of the Wagga Wagga Floodplain Risk Management Plan. It was classified as high priority.

The flood modification measures considered included:

- Flood mitigation dams
- Retarding basins and on-site detention
- Bypass floodways
- Channel improvement works
- Construction of new eastern industrial levee
- Upgrades of Main City Levee, North Wagga Wagga Levee and East Street (Bank Two) Levee
- Vegetation management.

The Wagga Wagga Floodplain Risk Management Study concluded that for Wagga Wagga, levees are the most appropriate flood modification measure to protect existing development. No other flood modification measures have the potential to provide the levels of flood protection that the proposed levee upgrades would provide.

Statutory and planning framework

State Environmental Planning Policy (Infrastructure) 2007 permits development for the purpose of flood mitigation work to be carried out by or on behalf of a public authority without consent.

The proposal is for the upgrade of levees and constitutes flood mitigation work undertaken on behalf of a public authority. It can therefore be assessed under Part 5 of the *Environmental Planning and Assessment Act 1979*. Development consent is not required.

Community and stakeholder consultation

The local community and key stakeholders such as the Environment Protection Authority, Department of Primary Industries – Fishing and Aquaculture, Office of Environment and Heritage and Aboriginal stakeholders have been consulted on the proposal. Issues raised are addressed in this review of environmental factors.

Community consultation would continue through display of this review of environmental factors for community input. Any submissions received would be considered in finalising the details of the proposal.

Environmental benefits and impacts

Beneficial effects of the proposal would include:

- The proposal would increase the level of flood protection for Central Wagga Wagga from the current 60 year ARI level of flood protection to the 100 year ARI level of flood protection, and for North Wagga Wagga from the current 17 year ARI level of flood protection to the 20 year ARI level of flood protection

- The proposal would increase the level of flood protection for 2,000 buildings in Central Wagga Wagga and for 91 buildings in North Wagga Wagga
- The proposal would reduce the impacts of flooding on land uses in the study area, including residences, businesses, roads, utilities and recreational land uses
- It has been predicted that raising the Main City Levee would reduce the average annual damages of Central Wagga Wagga ($1,406,900) by up to 55 per cent (WMA Water 2009a).

The main adverse effects of the proposal would include:

- Removal of about 1.1 hectares of River Red Gum forest, which provides habitat for flora and fauna, including a number of threatened and migratory species listed under the TSC Act and EPBC Act
- Potential for soil erosion and sedimentation impacts to the Murrumbidgee River
- Small increases in flood depth and velocity at properties outside the levees in floods greater than the 60 year ARI flood level
- Construction noise and vibration impacts on nearby buildings and land uses – noise and vibration would be above the relevant construction criteria for receivers immediately adjacent to the proposal site
- Potential for a reduction in air quality caused by the generation of dust
- Long-term visual impacts through increasing the heights of the levees. Views of the Murrumbidgee River and surrounding countryside may be reduced or blocked at a number of properties
- Potential impacts on non-Aboriginal heritage through the relocation of a monument to the construction of the Main City Levee that was built in 1960 and a flood height gauge that may have been used for historic flood measurements, subject to approval
- A range of other changes in amenity and environmental risks including land use, traffic and access, socio-economic and waste.

The adverse environmental effects would be minimised through the implementation of safeguards and management measures outlined in this review of environmental factors.

Justification and conclusion

A number of options for the proposal have been considered, with input from community and stakeholders. The identification of the preferred option took into account social, environmental and economic factors.

The proposal would result in both positive and negative impacts. Safeguards are identified in this review of environmental factors to manage and mitigate the identified negative impacts.

On balance, it is considered that the adverse environmental impacts of the proposal are outweighed by the beneficial effects and that the proposal is therefore justified.

This review of environmental factors concludes that the proposal is unlikely to have a significant impact on any species, population or ecological community listed under the *Threatened Species Conservation Act 1995*. A species impact statement is not therefore required.

This review of environmental factors finds that the proposal is unlikely to have a significant environmental impact and therefore an Environmental Impact Statement is not required.

Approval from the Minister for Planning and Infrastructure under Part 5.1 of the *Environmental Planning and Assessment Act 1979* would not be required.

This review of environmental factors finds that the proposal is unlikely to have a significant impact on any matter of national environmental significance listed under the *Environment Protection and Biodiversity Conservation Act 1999*. A referral to the Commonwealth Department of Sustainability, Environment, Water, Population and Communities is not therefore required.

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Appendices

1. Introduction

This chapter introduces the proposal and provides the context of the environmental assessment. It provides a summary of the location and need for the proposal and identifies the purpose of this report.

1.1 Proposal identification

Wagga Wagga City Council proposes to upgrade the Wagga Wagga and North Wagga Wagga levees along the Murrumbidgee River. These levees include the Main City Levee, North Wagga Wagga Levee and East Street (Bank Two) Levee (see Figure 1.1 and Figure 1.2).

The proposal is required to increase the level of flood protection for residents and businesses of Wagga Wagga.

The proposal would raise the Main City Levee to provide flood protection for up to a 100 year average recurrence interval (ARI) flood event, and would raise the North Wagga Wagga Levee and East Street (Bank Two) Levee to provide flood protection for up to a 20 year ARI flood event.

The proposal is located adjacent to the Murrumbidgee River in Wagga Wagga, East Wagga Wagga and Kooringal (generally referred to in this REF as Central Wagga Wagga) and North Wagga Wagga (see Figure 1.1 and Figure 1.2).

Key features of the proposal would include:

- Constructing the following levee types, with average increases in height of 66 centimetres to 83 centimetres:
  - Embankment levees
  - Sheet pile levees
  - Concrete wall levees
  - Hybrid levees (embankment/sheet pile, embankment/gabion wall and embankment/box culvert)
- Constructing spillways to enable large floods (higher than the proposed level of flood protection) to enter the protected areas in a controlled manner
- Upgrading levee crossings that are lower than the design flood protection level, or that require structural improvement. These would include crossings for the Great Southern Railway, several major roads, and a number of minor roads and access roads.

Construction of the proposal would commence in 2014. Assuming no funding constraints, the proposal would be constructed sequentially over a period of approximately five years. Funding availability is uncertain however, and this may affect the timetable for delivery of the proposal.

The current estimated cost of the project is about $18.8 million, with about $11.3 million allocated to the Main City Levee and about $7.5 million allocated to the North Wagga Wagga levees. The proposal would be jointly funded by the NSW Government (under the NSW Floodplain Management Program) and Council. Funding would be provided at a ratio of 2:1 (NSW Government: Local Government).

For the purposes of this assessment, the following definitions are used:

- The ‘proposal site’ – the area that would be directly impacted by the proposal. In this case it encompasses the levee design, including embankment levees and other levee types,

as well as the proposed borrow sites. It also includes the construction footprint and any areas that would be disturbed

- The 'study area' – the area of impact and any additional areas, which are likely to be affected by the proposal, either directly or indirectly. Generally the study area includes the area up to 500 metres from the proposal site
- The 'locality' – the area within a 10 kilometre radius of the proposal.

1.2 Purpose of this report

This REF has been prepared by GHD on behalf of Wagga Wagga City Council. For the purposes of these works, Council is the proponent and the determining authority under Part 5 of the *Environmental Planning and Assessment Act 1979* (EP&A Act).

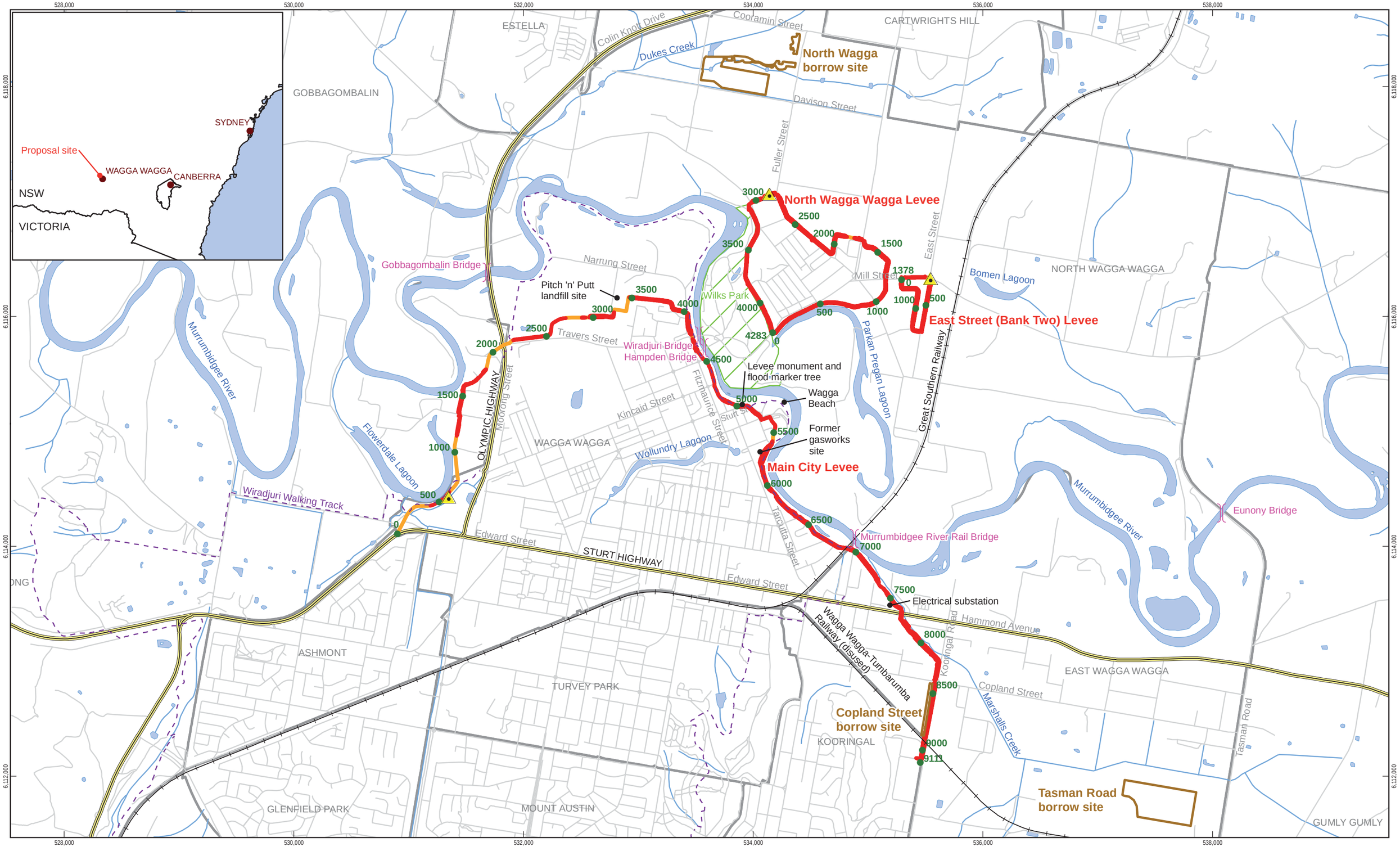
The purpose of the REF is to describe the proposal, to document the likely impacts of the proposal on the environment, and to detail protective measures to be implemented as part of the proposal.

The proposal has been assessed in the context of clause 228 of the *Environmental Planning and Assessment Regulation 2000*, the *Threatened Species Conservation Act 1995* (TSC Act), the *Fisheries Management Act 1994* (FM Act), and the Australian Government's *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act). In doing so, the REF helps to fulfil the requirements of section 111 of the EP&A Act that Council examine and take into account to the fullest extent possible, all matters affecting or likely to affect the environment by reason of the activity.

The findings of the REF would be considered when assessing:

- Whether the proposal is likely to have a significant impact on the environment and therefore the necessity for an Environmental Impact Statement to be prepared and approval to be sought from the Minister for Planning and Infrastructure under Part 5.1 of the EP&A Act
- The significance of any impact on threatened species as defined by the TSC Act and/or FM Act, in section 5A of the EP&A Act and therefore the requirement for a Species Impact Statement
- The potential for the proposal to significantly impact on a matter of national environmental significance or Commonwealth land and the need to make a referral to the Australian Government Department of Sustainability, Environment, Water, Population and Communities (DSEWPaC) for a decision by the Commonwealth Minister for the Environment on whether assessment and approval is required under the EPBC Act.

The scope of this report is limited to the preparation of an REF. The assessment of environmental impacts is limited to the proposed activities described in chapter 3 of this report.



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Metres

Map Projection: Transverse Mercator
Horizontal Datum: GDA 1994
Grid: GDA 1994 MGA Zone 55

N

LEGEND

- Levee chainage (metres)
- Proposed spillway
- Bridge
- Wiradjuri Walking Track
- Proposed levee upgrade
  - Proposed works
  - No works
- Drainage line
- Railway line
- Road
- Highway
- Proposed borrow site
- Waterbody
- Wilks Park
- Suburb

Wagga Wagga City Council
Wagga Wagga levee upgrade REF

Job Number	23-14536
Revision	0
Date	17 Dec 2012

Wagga Wagga and North Wagga Wagga levees proposed upgrade

Figure 1.1

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Suite 3, Level 1, 161-169 Baylis Street Wagga Wagga NSW 2650 Australia **T** 61 2 6923 7400 **F** 61 2 6971 9565 **E** wgamail@ghd.com **W** www.ghd.com

Data source: Wagga Wagga City Council: Extent of proposed works - 2012; LPI: Roads, railway lines, suburbs, waterbodies, drainage lines - 2008; Geoscience Australia: Cities and state boundaries - 2003. Created by:rtrobinson

528,000 530,000 532,000 534,000 536,000 538,000

6,118,000 6,116,000 6,114,000 6,112,000

Cooramin Street
Colin Knott Drive
Dukes Creek
North Wagga borrow site
Davison Street
Fuller Street
East Street
Bomen Lagoon
3000 North Wagga Wagga Levee
2500
2000
1500
3500
Mill Street
1378
0
1000
500
East Street (Bank Two) Levee
Great Southern Railway
Gobbagombalin Bridge
Narrung Street
Pitch 'n' Putt landfill site
3500
3000
4000
Wilks Park
4000
500
1000
Murrumbidgee River
2500
Travers Street
4283
0
Wiradjuri Bridge
Hampden Bridge
4500
Levee monument and flood marker tree
Parkan Pregan Lagoon
2000
OLYMPIC HIGHWAY
Moorong Street
Kinbaid Street
Fitzmaurice Street
Sturt Street
5000
Wagga Beach
1500
Flowerdale Lagoon
5500
Former gasworks site
Wollundry Lagoon
1000
Main City Level
6000
Wiradjuri Walking Track
500
0
Edward Street
STURT HIGHWAY
Fitzhardinge Street
6500
Murrumbidgee River Rail Bridge
7000
Murrumbidgee River
Eunony Bridge
7500
Electrical substation
Wagga Wagga-Tumbarumba Railway (disused)
Hammond Avenue
Koonga Road
8000
8500
Copland Street
Copland Street borrow site
Marshalls Creek
Tasman Road
9000
9111
Tasman Road borrow site

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0 250 500 1,000

Metres

Map Projection: Transverse Mercator
Horizontal Datum: GDA 1994
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- Wilks Park

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Wagga Wagga City Council
Wagga Wagga levee upgrade REF

Job Number	23-14536
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Wagga Wagga and North Wagga Wagga levees aerial photograph

Figure 1.2

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Suite 3, Level 1, 161-169 Baylis Street Wagga Wagga NSW 2650 Australia **T** 61 2 6923 7400 **F** 61 2 6971 9565 **E** wgamail@ghd.com **W** www.ghd.com

Data source: Wagga Wagga City Council: Extent of proposed works - 2012 and aerial photographs - 2012 & 2010; LPI: Roads, railway lines, suburbs, waterbodies, drainage lines - 2008. Created by:rtrobinson

2. Need and options considered

This chapter describes the need for the proposal in terms of its strategic setting and operational need. It provides a discussion of the options considered and the selection of the preferred options for the proposal.

2.1 Strategic need for the proposal

2.1.1 Flood protection

Existing levels of flood protection

Wagga Wagga and North Wagga Wagga have been subject to a history of flooding and have had various levels of food protection throughout the development of the area. Until the Murrumbidgee River Wagga Wagga Flood Study (Webb, McKeown & Associates 2004) was completed, it was believed that the Main City Levee provided protection for a 100 year ARI flood event and that the North Wagga Wagga Levee and East Street (Bank Two) Levee provided protection for a 20 year ARI flood event.

Flood modelling completed by Webb, McKeown & Associates (2004) used a more comprehensive river flow dataset, which included records of several flood events that occurred before the start of the “official” record in 1886. The modelling indicated that the Main City Levee actually provides protection for up to a 60 year ARI flood event. Additional flood modelling (WMA Water 2010) determined that the North Wagga Wagga Levee and East Street (Bank Two) Levee currently provide protection for up to a 17 year ARI flood event.

Council policy for Central Wagga Wagga level of flood protection

The accepted engineering standard for levee protection is for a 100 year ARI flood event (NSW Government 2005a). The Floodplain Risk Management Plan (WMA Water 2009b) recommends that the Main City Levee be raised to provide protection for up to a 100 year ARI flood event, with an allowance for freeboard[1] of between half a metre and one metre (see section 2.1.2 below). Council has adopted this level of flood protection in a planning policy for Central Wagga Wagga.

Ideally, to determine the flood height of a 100 year ARI level of flooding, at least 500 years of river flow records are required. Currently, only 160 years of records are available for flood modelling. For this reason, the modelled 100 year ARI flood level may in future vary as more river flow records are collected.

Council policy for North Wagga Wagga level of flood protection

For North Wagga Wagga, Council has a planning policy to provide protection for up to a 20 year ARI flood event with associated freeboard. The reasons for this limit on the level of flood protection are:

- The Wagga Wagga Development Control Plan does not allow for the raising of the North Wagga Wagga levees above the 20 year ARI flood level (with appropriate freeboard) because this may impede the flow of flood waters. As well, during large floods, the entire area is surrounded by floodwaters. Where flood events greater than the design flood event occur, residents would be unable to escape to higher ground

[1] Freeboard is the height of a levee above the design flood height. It provides a factor of safety to compensate for uncertainties in the estimation of flood levels (see glossary for more detail).

- The Department of Planning has ruled that North Wagga Wagga should not have a 100 year ARI level of flood protection due to the potential impacts of raising the levees on other parts of the floodplain
- The State Emergency Service has determined that raising the North Wagga Wagga levees above the 20 year ARI flood level could encourage people to resist evacuation during floods, which would significantly increase liability and risk for residents and State Emergency Service volunteers
- Cost benefit analysis (WMA Water 2009a) indicates that the costs of raising the North Wagga Wagga levees above the 20 year ARI flood level cannot be justified by the limited benefits that would be achieved.

Nevertheless, the proposed upgrade of the North Wagga Wagga levees to the 20 year ARI flood level, with a freeboard of 75 centimetres, would come at a substantial cost (about $7.5 million), and would improve the existing level of protection.

The need for the proposed upgrades

Since records commenced in 1844, the Murrumbidgee River has been recorded to flood at a height of greater than 10 metres eight times (recorded at the Hampden Bridge gauge – see location in Figure 1.1) (Wagga Wagga City Council flood data). Of these, three floods reached heights equal to or greater than the current levee flood protection level of 10.7 metres, including the 1974 flood of 10.74 metres. No floods have exceeded the 100 year ARI flood level, which is estimated as 11.49 metres at the Hampden Bridge gauge (WMA Water 2010).

The recent flood event in March 2012 highlights the need for an upgrade of the levees. The flood reached a height of 10.6 metres at the Hampden River gauge (classified as a 40 year ARI flood event). Although the flood did not overtop or breach the Main City Levee, about eight thousand people were evacuated from Central Wagga Wagga, with concerns that the levee would not hold the flood.

North Wagga Wagga suffered major flood damage costs and the evacuation of the entire population. Many people were not able to return to their homes for months after the flood. North Wagga Wagga has historically suffered considerable damage, financial loss and disruption from floods.

Council therefore seeks to upgrade the levees to comply with its policies for flood protection.

2.1.2 Relevant plans and strategies

NSW Flood Prone Land Policy

The primary objective of the policy is to reduce the impact of flooding and flood liability on individual owners and occupiers of flood prone property, and to reduce private and public losses resulting from floods, utilising ecologically positive methods wherever possible.

The gazetted Floodplain Development Manual (NSW Government 2005a) addresses the development of flood liable land for the purposes of section 733 of the *Local Government Act 1993* and incorporates the NSW Flood Prone Land Policy.

One of the aims of the NSW Flood Prone Land Policy is to reduce the impact of flooding and flood liability on existing developed areas in floodplain risk management areas through flood mitigation works and measures. These measures include on-going emergency management measures, the raising of houses where appropriate and development controls. The policy provides for financial assistance by the NSW Government for works to reduce potential flood damage and personal danger in existing developed areas.

Under the NSW Flood Prone Land Policy, councils are responsible for the management of flood liable land. The NSW Government assists councils by providing financial support for flood mitigation works through the Floodplain Management Program, and by providing technical advice in relation to the implementation of the Floodplain Development Manual and standard floodplain risk management documents.

The Policy provides for technical and financial support by the Government through the following stages detailed in the Floodplain Development Manual (NSW Government 2005a):

1. Flood study
2. Floodplain risk management study
3. Floodplain risk management plan
4. Implementation of the plan.

Council commissioned a flood study for Wagga Wagga (Webb, McKeown & Associates 2004) in 2004, the Wagga Wagga Floodplain Risk Management Study (WMA Water 2009a) and the Wagga Wagga Floodplain Risk Management Plan (WMA Water 2009b) in 2009.

Council has now commenced stage four of the process. The preparation of this REF is part of stage four, and has been funded through the 2011/12 and 2012/13 Floodplain Management Programs.

The proposal would be consistent with the NSW Flood Prone Land Policy through the upgrade of levees to reduce the impact of flooding and flood liability on the existing developed areas of Central Wagga Wagga and North Wagga Wagga.

The NSW Flood Prone Land Policy states that reducing the impacts of flooding should involve ecologically positive methods wherever possible. As much as possible, the proposal would be constructed in a manner that minimises ecological impacts. The ecological impacts of the proposal are assessed in this REF, and safeguards and management measures are identified to minimise the impacts.

Wagga Wagga Floodplain Risk Management Plan

The Wagga Wagga Floodplain Risk Management Plan (WMA Water 2009b) provides the basis for the management of flood prone lands in the Murrumbidgee River floodplain around Wagga Wagga. Council initiated the development of the plan to address the management of flood risk. It is the final stage detailed in the Floodplain Development Manual before the implementation of flood mitigation works and other preferred flood risk management options.

A high priority action detailed in the Floodplain Risk Management Plan is to undertake further detailed investigation of the feasibility of upgrading the Main City Levee to provide protection for a 100 year ARI flood event. The plan also recommends that consideration be given to maintaining protection for a 20 year ARI flood event for North Wagga Wagga.

The feasibility of upgrading the levees was assessed and accepted by Council through the preparation of the concept design (NSW Public Works 2011). The next stage is the detailed design of which this REF is a prerequisite.

NSW State Rivers and Estuaries Policy

The State Rivers and Estuaries Policy aims to manage the rivers and estuaries of NSW to meet the following objectives:

- Slow, halt or reverse the overall rate of degradation in these systems
- Ensure the long-term sustainability of their essential biophysical functions
- Maintain the beneficial use of these resources.

The policy aims to achieve these objectives through the application of the following principles:

- Those uses of rivers and estuaries that are non-degrading should be encouraged
- Non-sustainable resource uses that are non-essential should be progressively phased out
- Environmentally degrading processes and practices should be replaced with more efficient and less degrading alternatives
- Environmentally degraded areas should be rehabilitated and their biophysical functions restored
- Remnant areas of significant environmental value should be accorded special protection
- An ethos for the sustainable management of rivers and estuarine resources should be encouraged in all agencies and individuals, who own, manage or use these resources, and its practical application enabled.

The proposal involves the upgrade of levees that already exist on the Murrumbidgee River floodplain at Wagga Wagga, and would be unlikely to cause impacts that significantly affect the achievement of the objectives of the policy. The proposal would be consistent with the policy primarily through the implementation of safeguards and management measures to minimise impacts on biodiversity (section 6.1), soils and water quality (section 6.2) and hydrology and water resources (section 6.3).

Riverside Wagga Wagga Strategic Master Plan

The aim of the Riverside Wagga Wagga Strategic Master Plan (Kiah Infranet 2010) is to provide a long term vision that guides the future development and interface of Wagga Wagga with the riverside.

The objectives of the Master Plan are:

- To develop the area as a focal point and destination for residents and visitors inclusive of community gathering points and creation of a sense of place
- To be representative of world class, iconic design that incorporates ecologically sustainable design throughout
- To enhance the existing passive recreation facilities to encourage healthy communities and liveability
- To incorporate appropriate commercial and residential uses
- To improve and create linkages to the city's CBD and existing cultural / civic precinct and integration with existing and future plans
- To preserve and interpret the area's rich cultural heritage.

Underpinning the Riverside Master Plan is the principle that the Murrumbidgee River is an important natural resource and a major asset for the City of Wagga Wagga, which is currently under-utilised. The under-utilisation of the river is partly due to the existing Main City Levee, which forms a barrier between the river and the city.

The proposal has incorporated recommendations in the Riverside Master Plan, including:

- Moving the Main City Levee near Tarcutta Street to permit improved pedestrian access and future city precinct works in the levee and river bank area

- Allowing for the future creation of openings in the Main City Levee at Kincaid Street and Sturt Street, to improve pedestrian access to the river and open up views of the river from the city
- Reducing the steepness of the Main City Levee banks wherever possible
- Maintaining pedestrian access along the levees.

Other recommendations of the Riverside Master Plan relating to the levees have not been incorporated in the design of the proposal. If they are approved before construction of the proposal, the detailed design of the proposal would be modified to accommodate them.

A more detailed description of how the proposal has been designed to accommodate the recommendations of the Riverside Wagga Wagga Strategic Master Plan is provided in section 3.2.7.

Riverside Wagga Wagga Plan of Management

The purpose of the Riverside Wagga Wagga Plan of Management (Insite 2010) is to provide a framework for the future use and management of lands along the Murrumbidgee River at Wagga Wagga. The PoM defines the values, use, management practices and intent relating to the purpose for which the land has been reserved or dedicated. The Plan of Management has been prepared to meet the legislative requirements of the NSW *Local Government Act 1993* and the NSW *Crown Lands Act 1989*.

The recommendations of the Plan of Management generally conform to the recommendations of the Riverside Master Plan.

One of the recommendations of the Plan of Management is to reduce the steepness of the levee banks along the Main City Levee between chainages 4000 and 6000. Where site conditions allow, the embankment levees have been designed with gentler sloping batters, as described in section 3.2.7.

The Plan of Management also identifies the potential creation of openings in the Main City Levee at Kincaid Street and Sturt Street. The proposal would allow for the future construction of these openings, as described in section 3.2.7.

Wagga Wagga Bicycle Plan 2011

The primary focus of the Wagga Wagga Bicycle Plan is to set the Bicycle Network development priorities and standards for the period 2011 to 2016. The Wiradjuri Walking Track, which follows the Main City Levee between chainages 4000 and 7000, and between chainages 200 and 760 (see Figure 1.1), is listed as a key bicycle trip generator in Wagga Wagga.

Continued access along the Wiradjuri Walking Track would be maintained during construction by diverting the track to an alternative alignment adjacent to the proposal.

At present this track is comprised of earth, gravel or in some places a concrete pathway. Wherever earthworks are proposed to upgrade the Main City Levee, the proposal would improve the shared bicycle and pedestrian pathway by constructing a three metre wide crest surfaced with sprayed seal bitumen.

2.2 Existing infrastructure

The information in this section is summarised from the Wagga Wagga Floodplain Risk Management Study (WMA Water 2009a), the Wagga Wagga Floodplain Risk Management Plan (WMA Water 2009b) and the Murrumbidgee River Wagga Wagga Flood Study (Webb, McKeown & Associates 2004).

2.2.1 Main City Levee

The Main City Levee protects Central Wagga Wagga and is 9.1 kilometres long (see Figure 1.1). It is comprised primarily of earthfill embankments (for example see Figure 2.1) and reinforced concrete retaining walls (for example see Figure 2.2).

The levee was constructed in 1960. It was upgraded in the late 1970's and again in 1983. The upgrade in 1983 raised the levee to provide protection for floods up to the 1974 flood level (10.74 metres), with a freeboard of one metre.

Based on modelling with an incomplete river flow dataset, it was previously thought that the levee provided protection for a 100 year ARI flood event. Flood modelling completed by Webb, McKeown & Associates (2004) used a more comprehensive river flow dataset, which included records of several flood events that occurred before the start of the “official” record in 1886. The modelling indicated that the Main City Levee actually provides protection for up to a 60 year ARI flood event, with one metre of freeboard.

The Main City Levee protects about 2,000 buildings from flooding for flood events up to the 60 year ARI flood level (WMA Water 2009b).

Generally the levee comprises one metre of freeboard above the 60 year ARI flood level; however some sections of the levee do not provide one metre of freeboard (WMA Water 2009a). These areas include:

- Upstream and downstream of Hampden Bridge
- Upstream and downstream of the Murrumbidgee River Rail Bridge
- The areas near Hammond Avenue and Copland Street. Hammond Avenue and Copland Street are sandbagged during a flood event. If the sandbagging is completed appropriately, the freeboard in these areas would increase to one metre.

Figure 2.1: Main City Levee - embankment levee looking south near Flowerdale Lagoon, chainage 500

Figure 2.2: Main City Levee – concrete wall levee looking south along Cadell Place, chainage 4500

The Main City Levee is predicted to first be overtopped in about a 70 year ARI flood event (Webb, McKeown & Associates 2004). Assuming the sandbagging at Copland Street and Hammond Avenue is effective, the first overtopping of the levee would be likely to occur at the section between Wagga Beach and Hampden Bridge (chainages 4500 to 5300). This would then be followed by the section downstream of Hampden Bridge (at chainage 4390) and then at the low point near Narrung Street (near chainage 4100). It is noted (Webb, McKeown & Associates 2004) that the location where the levee is first overtopped depends on the flood gradient in the Murrumbidgee River.

2.2.2 North Wagga Wagga Levee and East Street (Bank Two) Levee

Temporary levees have been constructed around North Wagga Wagga since 1936. The North Wagga Wagga Levee and East Street (Bank Two) Levee were constructed in 1990.

Following upgrade works in 1990, the North Wagga Wagga Levee and East Street (Bank Two) Levee were thought to provide protection for a 20 year ARI flood event. It has been determined through flood modelling using an updated river flow dataset that the levees provide protection for floods up to a 17 year ARI flood event. Both levees have a freeboard of 30 centimetres.

The North Wagga Wagga Levee and East Street (Bank Two) Levee protect about 91 buildings from flooding for flood events up to the 17 year ARI flood level (WMA Water 2009b and information provided by Wagga Wagga City Council).

The North Wagga Wagga Levee protects the main part of North Wagga Wagga and is 4.3 kilometres long (Figure 1.1). It is constructed of earthfill embankments (for example see Figure 2.3).

The North Wagga Wagga Levee is first overtopped at the north-western corner of the levee, adjacent to Hopkirk and Gardiner Streets (at chainage 3100) (WMA Water 2009a).

The East Street (Bank Two) Levee surrounds the eastern end of North Wagga Wagga and is 1.4 kilometres long (Figure 1.1). It is also constructed of earthfill embankments (for example see Figure 2.4).

The East Street (Bank Two) Levee is separated from the North Wagga Wagga Levee by a flood passage.

Figure 2.3: North Wagga Wagga Levee – looking north along Wall Street, chainage 4200

Figure 2.4: East Street (Bank Two) Levee – looking west along Mill Street, chainage 200

2.2.3 Soils and stability of the levees

1993 audit

Soil tests of the Main City Levee, the North Wagga Wagga Levee and the East Street (Bank Two) Levee were completed as part of an audit in 1993. The audit found that the levees are constructed of grey/brown to black clays with high shrinkage potential. The levees were found to have adequate compaction in the upper levels and marginally adequate compaction at the lower levels.

Locations on the Main City Levee where stability was found to be inadequate and requiring further investigation and management included:

- South of Hampden Bridge to Sturt Street
- South of Morrow Street
- The railway line
- Flowerdale Lagoon.

The audit recommended that the Main City Levee be repaired at these locations.

Remedial works since 1993

Since 1993 remedial works have occurred at the following locations:

- On the Main City Levee in the area surrounding Wagga Beach
- On the Main City Levee at a section near Flowerdale Lagoon
- Some sections of the North Wagga Wagga levee.

The repair works at these locations included placement of additional fill.

2007 flood levee audit

A visual audit of the Main City Levee, North Wagga Wagga Levee and East Street (Bank Two) Levee was completed in 2007.

The audit found soil erosion in a number of areas along the Main City Levee, with other areas identified as having a risk of further erosion due to a lack of vegetation cover. Vertical cracks were found in concrete sections of the levee. Cracking and holes were also found in sections of the levee adjacent to Flowerdale Lagoon and Marshall's Creek.

Sections of the North Wagga Wagga levee and East Street (Bank Two) Levee had also been eroded. The audit identified that this was possibly due to minimal groundcover vegetation and the existence of trees and shrubs growing on the levee banks.

The 2007 audit concluded that the levees are generally maintained and are in a satisfactory condition. No areas of major concern were identified, but some areas were identified as requiring further investigation and remediation.

2.2.4 Other flood levees in the Wagga Wagga area

Other flood levees in the Wagga Wagga area include:

- The Gobba Levee, which runs from North Wagga Wagga to Gobba Weir. This levee provides protection for properties on the northern floodplain for a six to seven year ARI flood event (although the weir is only capable of providing protection for a five year ARI flood event). The bank has a length of 250 metres

- A levee that protects the suburb of Gumly Gumly, about four kilometres east of Wagga Wagga on the south side of the Murrumbidgee River, was temporarily constructed after the 1974 flood. This levee was upgraded in 1992 and provides protection for approximately a 10 year ARI flood event
- Low banks constructed in 1971 across the end of Kurrajong Lagoon and at the property "Eunonyhareenyha", about eight kilometres east of Wagga Wagga on the north side of the Murrumbidgee River.

2.3 Proposal objectives

The primary objectives of the proposal are to:

- Reduce the potential for flooding impacts on properties located in floodplain risk management areas in Wagga Wagga
- Reduce private and public losses resulting from floods.

A secondary objective of the proposal is to minimise the environmental impacts of constructing the proposal, including ecological impacts (as required by the NSW Flood Prone Land Policy), and impacts on the local community.

2.4 Alternatives and options considered

2.4.1 Floodplain risk management measures

The Wagga Wagga Floodplain Risk Management Study (WMA Water 2009a) aimed to identify and assess risk management measures that mitigate flooding impacts and reduce flood damages. The risk management measures were assessed against the legal, structural, environmental, social and economic conditions or constraints of the Wagga Wagga area.

Three categories of potential floodplain risk management measures were identified:

- **Flood modification measures** that modify the flood's physical behaviour (depth and velocity). Measures assessed included:
  - Flood mitigation dams
  - Retarding basins and on-site detention
  - Bypass floodways
  - Channel improvement works
  - Construction of new eastern industrial levee
  - Upgrades of Main City Levee, North Wagga Wagga Levee and East Street (Bank Two) Levee
  - Vegetation management.
- **Property modification measures** that modify the existing land use or buildings and development controls for future development. Measures assessed included:
  - Zoning
  - Voluntary purchase
  - Building and development controls
  - Flood proofing / house raising
  - Flood access.
- **Response modification measures** that modify the community's response to the potential hazards of flooding. This is achieved by informing flood-affected property

owners as well as the wider community about the nature of flooding so that they can make better informed decisions. Measures assessed included:

- Community awareness/preparedness
- Flood warning
- Evacuation planning
- Evacuation access
- Flood plan / recovery plan
- Flood insurance.

2.4.2 Analysis of options

The proposal was recommended (WMA Water 2009a) as one of a suite of measures selected from all three categories for implementation as part of the Wagga Wagga Floodplain Risk Management Plan. It was classified as high priority.

The proposal is solely related to flood modification (the upgrade of the levees), and this REF therefore focuses on the analysis of flood modification measures and does not give detailed consideration to property modification measures and response modification measures. Analysis of property modification measures and response modification measures is provided in the Wagga Wagga Floodplain Risk Management Study (WMA Water 2009a).

A summary of the analysis of the flood modification measures discounted in the Wagga Wagga Floodplain Risk Management Study (WMA Water 2009a) is provided below.

Flood mitigation dams

Flood storage dams, or dams which have significant flood storage capability can significantly reduce downstream peak flood levels.

Flood mitigation dams were discounted in the Floodplain Risk Management Study due to the high financial cost and the significant environmental impacts often associated with these developments.

Retarding basins and on-site detention

Retarding basins and other on-site stormwater detention systems are typically appropriate for controlling flooding in small catchments (with an area of up to 20 square kilometres), or for mitigating the effects of increased runoff caused by development.

Retarding basins and other on-site stormwater detention systems were discounted because they would have negligible impacts on flood levels in the Murrumbidgee River and lower floodplain areas. This is due to their small size and the large flows that occur during floods in the Murrumbidgee River.

Bypass floodways

Floodways are low channels outside the river channel that can carry significant flow volumes in times of flood. Artificial bypass floodways are most effective in flood control for smaller streams.

They were considered not to be a viable management measure due to the large size of the Murrumbidgee River floodplain, and the large flows that occur during floods in the river.

Channel improvement works

Improvement or remediation works to the main channel can have some impact in improving the flow of water and directing floodwaters.

Channel improvement works were discounted though because it was considered that they would have a negligible effect on the large flows that occur during floods in the Murrumbidgee River. Channel improvement works are also likely to have high environmental impacts.

Constructing a new eastern industrial levee

The Floodplain Risk Management Study considered the potential for providing flood protection to the industrial area in East Wagga Wagga with a levee that would surround the areas near Tasman Road, Hammond Avenue and Kooringal Road, near the eastern end of the Main City Levee (see Figure 1.1). This option was not an alternative to the proposal; but was considered as an additional option for providing flood protection to East Wagga Wagga.

The construction of a levee to protect non-residential areas in East Wagga Wagga was found to be unacceptable due to the potential flood level increases and social impacts that would occur in areas across the floodplain, particularly in Gumly Gumly.

Managing regrowth vegetation

The Floodplain Risk Management Study considered the management of regrowth vegetation in areas adjacent to the Murrumbidgee River and levees. It was considered that vegetation regrowth could hinder flows on the floodplain during floods.

The study recommended that the management of regrowth vegetation in areas adjacent to the Murrumbidgee River and levees be included in all future management planning for the floodplain. Removal of regrowth vegetation was recommended along a 300 metre maintenance strip to reduce flood impacts on North Wagga Wagga and the CBD.

The Floodplain Risk Management Study also recommended that the impact of vegetation regrowth be considered in the design of the Main City Levee. This has occurred through flood modelling completed for the Murrumbidgee River Model Conversion Project (WMA Water 2010).

This modelling showed that vegetation regrowth on the floodplain has minimal impact on flood behaviour. Council therefore elected not to proceed with the 300 metre vegetation maintenance strip. Council will maintain a 50 metre wide mown section adjacent to Wall Street as part of its maintenance program.

Levee upgrades

Main City Levee

The Floodplain Risk Management Study assessed upgrading the Main City Levee to provide protection for the 100 year ARI flood event, with a freeboard of up to one metre.

Raising the Main City Levee to provide protection for a 100 year ARI flood event, with an allowance of half a metre to one metre for freeboard, was predicted to reduce the average annual damages[2] of Central Wagga Wagga by up to 55 per cent.

The raising of the levee was assessed to create only minor increases in flood level in the surrounding floodplain, and so would not substantially impact other areas outside the levee.

North Wagga Wagga Levee and East Street (Bank Two) Levee

Two scenarios for raising the levees at North Wagga Wagga to provide a higher flood protection level were modelled by the Floodplain Risk Management Study. These included:

- Raising the levees to the 100 year ARI flood level
- Raising the levees to the August 1974 level (approximately a 60 year ARI flood event).

[2] Average annual damage is the damage caused by all floods over a long period of time divided by the number of years in that period (see glossary for detailed description).

Results were compared to a scenario that included the existing crest height of the levees and conditions elsewhere across the floodplain (including the current Main City Levee height and failure mechanism).

The results of the modelling indicate that raising the levees at North Wagga Wagga would protect the area to the nominated level (either the 1974 flood level or the 100 year ARI flood level).

The raising of the levees to the 100 year ARI flood level would however result in increases in flood depth of up to 40 centimetres across a wide area of the floodplain. Locations particularly susceptible include Wagga Beach, Hampden Bridge, Parkan Pregan Lagoon and the Great Southern Railway.

The Floodplain Risk Management Study found however that the economic cost and social impacts of raising the levees (to either the 1974 flood level or the 100 year ARI flood level) would be such that raising the levees would not provide significant benefit to North Wagga Wagga.

The study considered that North Wagga Wagga becomes isolated by 10 year ARI flood events due to the low elevation of the areas outside the levees. It was assessed that providing levels of protection for greater than a 20 year ARI flood event could encourage people to resist evacuation during floods, which would significantly increase liability and risk. Raising the levees could also discourage residents from redeveloping their homes in 'flood aware' ways, such as house raising and flood proofing.

The Floodplain Risk Management Study concluded that the level of flood protection for North Wagga Wagga should be maintained at the 20 year ARI flood level.

General analysis of levees

Levees have the following disadvantages, identified in the Floodplain Risk Management Study:

- Initial velocities are high when overtopping occurs in large floods, and substantial damage can occur
- Failure of the levee may occur during a flood event, prior to overtopping
- Levees can engender a false sense of security in the local population and substantially lowered flood awareness. This can lead to people remaining in flood risk areas rather than evacuating
- Levees can cause flood impacts in other areas of the floodplain by changing hydrology and flow characteristics during floods. These impacts may be greater depths of flooding in affected areas, increased flood duration and inundation of areas that may not otherwise have been flooded.

To mitigate these disadvantages, the following measures need to be implemented in the design and management of levees:

- Incorporation of a freeboard allowance in the levee design to account for uncertainties in the design flood height
- Incorporation of spillways in the design to enable controlled spillage when large floods have the potential to overtop the levee
- Regular maintenance of levees
- Continued community education to ensure that the community is fully informed about the risks and impacts associated with overtopping or levee failure

- The potential flooding impacts of proposed levee works on other areas of the floodplain need to be fully assessed and measures developed to avoid adverse impacts. The assessment of these impacts is addressed in section 6.3 of this REF.

With the implementation of these measures, levees are an effective form of flood management, particularly for floodplain environments on large rivers such as the Murrumbidgee River at Wagga Wagga.

Do nothing option

The do nothing option involves not undertaking the proposal, continuing maintenance and repair activities as needed, and retaining the existing level of flood protection for Central Wagga Wagga and North Wagga Wagga.

The do nothing option would not reduce the potential for flooding impacts on properties in Wagga Wagga, and would not reduce the private and public losses resulting from large floods. This option would not therefore meet the proposal objectives. The level of flood protection at Wagga Wagga would remain below the accepted engineering standard for levee protection (ie for a 100 year ARI flood event) (NSW Government 2005a). The do nothing option was therefore discounted.

2.4.3 Preferred option

The Wagga Wagga Floodplain Risk Management Study (WMA Water 2009a) concluded that for Wagga Wagga, levees are the most appropriate flood modification measure to protect existing development. No other flood modification measures have the potential to provide the levels of flood protection that the proposed levee upgrades would provide.

It was concluded by the study that upgrading the Main City Levee to provide protection for the 100 year ARI flood event, with a freeboard of up to one metre, should be a high priority action.

It was concluded that flood protection for up to a 20 year ARI flood event should be maintained at North Wagga Wagga, with an allowance for freeboard. This would require upgrading the North Wagga Wagga Levee and the East Street (Bank Two) Levee from the 17 year ARI flood level to the 20 year ARI flood level.

An assessment of the freeboard requirements for the levee upgrade (NSW Public Works 2010b) found that the Main City Levee would need to have a freeboard allowance of 90 centimetres. It was also determined that the freeboard allowance for the North Wagga Wagga Levee and East Street (Bank Two) Levee would need to be increased from 30 centimetres to 75 centimetres.

2.4.4 Levee design options

Levee types

The following levee types were considered for the proposal (NSW Public Works 2011):

- Embankment levee – embankments constructed of compacted earthfill. This type of levee is most adaptable for raising existing embankment levees and where there is sufficient space to achieve acceptable batter slopes. The levee can be landscaped with shrubs and groundcover vegetation to be sympathetic to the surrounds (although planting with trees should be avoided)
- Sheet pile wall – a single line wall constructed from driven steel sheet piles. Sheet pile walls are used in the following situations:
  - Where space constraints limit other types of levees
  - Where there are deep foundation problems (eg deep layers of highly permeable foundations)

  - Where there are stability problems (eg over-steep river banks)
- Cantilever retaining wall – constructed from an internal stem of steel-reinforced, cast-in-place concrete. These walls are used, in a similar manner to sheet pile walls, where space limitations exist. The cantilever wall is suitable for higher retaining wall type levees and where foundation conditions are adequate to support these very heavy structures
- Hybrid levee consisting of a base levee type plus inclusions where necessary to satisfy particular requirements (eg limited space). The hybrid levee option is generally a combination of the levee options described above. Commonly, the hybrid levee would be based on the embankment levee concept, with included components designed to solve particular issues, for example:
  - Embankment/sheet pile – embankment levee with upper level sheet pile walls to reduce the footprint or extent of the outer batter, or with sheet pile cut-off wall in foundations to intercept deep foundation problems. The retaining wall is typically constructed on the inner embankment to permit extension of urban development
  - Embankment levee with gabion wall – this hybrid levee type is used to reduce the footprint of a low embankment levee, to accommodate aesthetic considerations. The supporting gabion wall is a simple gravity retaining wall constructed of stacked stone-filled gabions tied together with wire
  - Embankment levee with box culverts – this hybrid levee type comprises upturned culverts on top of an embankment levee, used to address space constraints and to provide continued access along the top of the levee
  - Crib-wall embankment levee – an embankment levee with one (or both) faces supported by a steep crib-wall (block work wall). Crib-wall embankment levees enable a reduction in the footprint of the levee where there are space constraints, and can also be used to enable landscaping of the embankment.

Photographs of the different levee types are provided in Appendix A.

NSW Public Works (2011) has analysed the relative costs of the different levee types using information from throughout NSW. The data demonstrate that under similar conditions, where there are no significant constraints, embankment levees are significantly more cost effective than the other options. Comparative cost ratios are shown in Table 2.1.

Table 2.1: Comparative levee costs

Levee type	Cost ratio
Earthfill embankment	1
Sheet pile	3.5
Concrete cantilever wall	5

The majority of the existing levees are earthfill embankments and it is typically more cost effective to upgrade the existing levee than implement a new approach. Based on the cost ratios in Table 2.1, the concept design (NSW Public Works 2011) was prepared with the embankment levee type as the preferred option wherever possible. Hybrid modifications were used to address specific constraints. The more expensive options were only considered where

embankment levees or hybrid levees could not be constructed, or where the proposal would involve the upgrade of an existing non-embankment levee.

Embankment levee alignment

Four options for the alignment of the embankment levees were considered for the proposal (NSW Public Works 2011). As much as possible, the proposal has been designed to follow the existing alignment of the levees. This would be achieved by constructing according to the upstream, downstream and centreline alignments detailed below.

The four alignment options are as follows:

- **Riverside alignment** – raising of the embankment levee by raising the crest and riverside face of the levee
- **Landside alignment** – raising of the embankment levee by raising the crest and landside face of the levee (the face nearest the Wagga Wagga urban area)
- **Centreline alignment** – raising the embankment levee by raising the crest and both faces of the levee
- **Construction of a new levee**.

Although the concept design incorporates all of these options, the proposal is generally located on only one side of the embankment levee (such as for the upstream and downstream options above). This minimises:

- Disturbance to the existing levee
- The extent of excavation and foundation preparation
- Upgrade costs.

Selection of levee type and alignment options

The selection of the alignment and levee type options for different sections of the proposal in the concept design is based on consideration of the following:

- Extent of levee raising required, as determined by the design flood level[3] and freeboard
- Local constraints such as topography, urban development and infrastructure
- Levee alignment
- Suitability of levee option(s)
- Cost.

As much as possible, the option selection process minimised the number of levee types and expected construction techniques in order to minimise construction costs.

Upgrade options were selected for sections of the levees based on the criteria above. A description of the locations of proposed levee types and design specifications is provided in section 3.2. A summary of the levee sections and upgrade options selected is provided in Appendix B.

[3] The design flood level is the flood protection level to which a levee (or other flood protection measure) is designed, such as for a 100 year ARI flood event. This level does not include the freeboard.

3. Description of the proposal

This chapter describes the proposal and provides descriptions of existing conditions, the design parameters, the construction method and associated infrastructure and activities.

Much of the information in this chapter is drawn from the concept design report (NSW Public Works 2011).

3.1 The proposal

It is proposed to upgrade the Wagga Wagga and North Wagga Wagga levees along the Murrumbidgee River. These levees include the Main City Levee, North Wagga Wagga Levee and East Street (Bank Two) Levee (see Figure 1.1).

The Main City Levee would be raised to provide flood protection for up to a 100 year average recurrence interval (ARI) flood event with a freeboard of about 90 centimetres. The North Wagga Wagga Levee and East Street (Bank Two) Levee would be raised to provide flood protection for up to a 20 year ARI flood event, with a freeboard of about 75 centimetres.

Key features of the proposal include:

- Constructing the following levee types, with average increases in height of 66 centimetres to 83 centimetres:
  - Embankment levees
  - Sheet pile levees
  - Concrete wall levees
  - Hybrid levees (embankment/sheet pile, embankment/gabion wall and embankment/box culvert)
- Constructing spillways to enable large floods (higher than the proposed level of flood protection) to enter the protected areas in a controlled manner
- Upgrading levee crossings that are lower than the design flood protection level, or that require structural improvement. These would include crossings for the Great Southern Railway, several major roads, and a number of minor roads and access roads.

3.2 Design

A description of the concept design is included below. The concept design would be further refined during the detailed design phase.

3.2.1 Proposed increases in levee height and width

The proposed increases in levee height (by chainage – in sections of 100 metres) are provided in Appendix C. Table 3.1 below provides the average and maximum increases in height for existing levees. Changes in height of the land surface where new levees are constructed (refer to section titled '*New embankment levees*' in section 3.2.2) are not included in this table.

Table 3.1: Proposed average and maximum increases in levee height for existing levees

Levee	Average increase in height (metres)	Maximum increase in height (metres)
Main City Levee	0.69	1.98
North Wagga Wagga Levee	0.66	1.60
East Street (Bank Two) Levee	0.81	1.04

For embankment levees, increases in height would require levee widening. Generally, an increased height of 76 centimetres, with a riverside batter grade of four horizontal to one vertical and a landside batter grade of two horizontal to one vertical would require total widening of 4.5 metres. The amount of widening required for hybrid levees would be less.

3.2.2 Levee types and design specifications

The locations and key design specifications for the different levee types are described below. Appendix B provides a detailed summary of the levee upgrade options that would be constructed throughout the levees by chainage. Appendix D provides drawings of typical cross sections for different types of levees.

Embankment levees

Embankment levees are the most cost-effective option for the proposal, as outlined in section 2.4.4. These are the main type of levee proposed.

New embankment levees

New embankment levees would be constructed at the following locations:

- Main City Levee (chainage 5600-5800), adjacent to Tarcutta Street. The levee alignment would be relocated by up to 10 metres, towards Tarcutta Street to permit future city precinct works in the levee and river bank area
- Main City Levee (chainage 7260-7330) adjacent to Lonergan Place. The existing concrete wall was located to pass around a building that has since been demolished. It is proposed to straighten the levee alignment and continue the adjacent embankment levee alignment
- Main City Levee (chainage 8900-9080) near the Wagga Wagga Monumental Cemetery at Kooringal. The levee would be extended, as an embankment levee, to the cemetery entrance. A low return embankment is located beside the entrance road to provide closure to the levee
- East Street (Bank Two) Levee (chainage 755-860). The raised levee would be extended to cover high ground not covered by the existing levee.

Specifications for constructing new embankment levees where there are no constraints include:

- Central clay core would be compacted to a minimum of 93 per cent maximum (modified) dry density, at moisture content within two per cent of optimum moisture content
- Existing topsoil would be stripped to a depth of 100 millimetres (minimum) and all organic matter removed from the full extent of the levee upgrade works

- A foundation key trench would be excavated to a minimum additional depth of about 50 centimetres, under the new levee for intercepting potentially contaminated seepage from the former gasworks site. This would be determined fully in consultation with the consultants managing the remediation of the former gasworks site
- The embankment clay core would have a landside minimum batter grade of two horizontal to one vertical and a riverside batter grade of three horizontal to one vertical
- The landside batter would have a topsoil protection thickness of 10 centimetres
- Topsoil protection for the riverside batter would form a grade of four horizontal to one vertical
- The crest would typically be three metres wide and surfaced with a layer of gravel, or sprayed-seal bitumen where the Wiradjuri Walking Track is located
- The crest would have a uniform crossfall of three per cent to direct rainfall runoff to the riverside batter.

Embankment levee upgrades

Upgrades of embankment levees are the main works proposed and would occur at numerous locations throughout the proposal (see description of works by chainage in Appendix B). Specifications for upgrading existing embankment levees would be in line with the principles above but would also include the following design considerations:

- Levee upgrade works would be aligned to minimise the extent of disturbance to the existing levee, by aligning the works to occupy the levee crest and only one batter, where possible
- Levee topsoil batters adjacent to the river would be steepened to a grade of between 3 and 3.5 horizontal to one vertical where necessary, to avoid these batters extending into the river or a considerable distance over the edge of steep slopes
- Where levee sections are located adjacent to steep slopes (either river banks or oversteep existing levee batters), the upgraded levee would be aligned to permit trimming of the oversteep bank to produce a more stable combined batter
- The existing levee, following excavation of surface topsoil and desiccated materials, would be compacted with a heavy roller prior to surface preparation and placement of new earthfill
- Wherever practicable, levee batters on the city side of the levee would be flattened to between three and four horizontal to one vertical. These batters would be topsoiled and grassed.

Sheet pile levees

Sheet pile levees are proposed at locations where other less expensive levee options are not practical due to space constraints.

Sheet pile levees are proposed at the following locations:

- Main City Levee (chainage 4400-4460). This section of levee upgrade requires the inner batter footprint to be reduced to allow for possible extension of the adjacent car park
- Main City Levee (chainage 6060-6120). The existing levee is confined between significant development on the city side and steep levee/river banks. Any expansion of the levee would either impact on the development or extend into the Murrumbidgee River

- Main City Levee (chainage 6900-6905). The existing embankment levee deviates from the general alignment of the adjacent levee and runs under the railway bridge. It is proposed to straighten the levee by extending the upper level sheet pile wall from the adjacent hybrid levee. The sheet pile wall would be capped with a concrete sill.

Specifications for constructing sheet pile levees include:

- Sheet pile walls would extend above existing levels by about 50 centimetres to one metre
- The sheet pile type AZ 12-770 (Z profile, 94.3 kilograms per metre) section would be used
- The sheet piling would be compatible with that proposed for the hybrid embankment/sheet pile levees
- The top of the sheet pile walls would be trimmed with a small inverted (steel) channel.

Concrete wall levees

The existing section of the Main City Levee along Cadell Place (chainage 4460-4860) consists of an embankment, supported at the landside edge of the crest by a reinforced concrete cantilever retaining wall. The wall supports this section of levee to reduce the levee footprint and accommodate the Cadell Place roadway.

The concrete retaining walls beside Cadell Place and to the north-east of Church Street (chainage 5267-5405) are 30 to 40 centimetres thick, depending on height and location. The walls are reinforced with 12 to 16 millimetre steel bars. These walls would be raised by up to 90 centimetres at Cadell Place and 70 centimetres at Church Street to provide additional freeboard only.

Specifications for upgrading the concrete wall levees include:

- There would be no addition of any permanent loading to the existing retaining wall, to avoid reducing the current margin of safety
- The crest of the existing embankment would not be raised
- The retaining wall would be raised to the new design crest level[4] by adding a new reinforced concrete section to the top of the wall. This would provide compatibility with the existing façade
- The new concrete would be secured to the existing wall by dowelled bars drilled and grouted into the top of the existing wall.

Hybrid levees

Hybrid levees have configurations based on earthfill embankment levees, but with additional components to manage site specific requirements. Hybrid levees have been designed to address design constraints that cannot be addressed by a pure embankment levee.

Embankment/sheet pile

The embankment/sheet pile levee is the most commonly used hybrid levee configuration in the concept design. Embankment/sheet pile hybrid levees have been used along the Main City Levee to allow trimming of oversteep levees or river banks, and to prevent new batters from extending considerable distances towards (or into) the Murrumbidgee River.

Hybrid embankment\sheet pile levees are proposed at a number of locations (see description of works by chainage in Appendix B).

[4] The design crest level is the level to which a levee (or other flood protection measure) is designed, to the top of the embankment or structure. This level includes the freeboard.

Specifications for constructing embankment/sheet pile levees include:

- The riverside batter of the embankment levee would have a grade of 3.5 horizontal to one vertical
- The sheet pile wall would be 90 centimetres high at the outer edge of the levee crest
- Design loadings adopted for the sheet pile component are:
  - Light truck (eight tonnes mass) loading on the levee crest, 60 centimetres minimum distance from the sheet pile wall.
  - Embankment fill (saturated) density of two tonnes per cubic metre
  - Embankment strength properties: cohesion of 0 kPa and friction angle of 30 degrees
  - Maximum fill height of 90 centimetres
- The resulting design specification for the sheet pile component includes:
  - Pile section type AZ 12-770 (94.3 kilograms per metre, Z profile)
  - Maximum fill height supported by cantilever height of 90 centimetres
  - Minimum embedment length of 2.8 metres.

Embankment/gabion wall

Hybrid embankment/gabion wall levees are proposed at two locations:

- Main City Levee (chainage 5920-5960). A small car park extension requires that the internal batter footprint be locally reduced within a long length of embankment levee. The facing of this levee batter is required to have aesthetic appeal
- East Street (Bank Two) Levee (chainages 0 and 220). The levee, constrained between Mill Street and the boundary of a private property, requires that either end of the outer batter be prevented from spilling into the private property. To avoid the need for redesigning the entire length of this levee, the two short lengths at either end are supported by a one metre high gabion wall.

Embankment/box culvert

This hybrid levee type has been employed at one location on the Main City Levee (chainage 4930-4990). Space constraints exist on both sides of the existing embankment levee, with a block of flats very close to the landside batter and a steep slope adjacent to the riverside batter.

The embankment/box culvert levee would be constructed by lowering the height of the crest of the existing levee and placing inverted concrete box culverts (three metres by 90 centimetres) on the lowered crest. The culverts would be placed on a bedding mix of sand and clay.

The bases of the upturned culverts would be partially filled with compacted clay to form a trafficable levee crest and to provide a water tight levee. Access along the levee crest would be maintained through the box culverts.

Bank stability would be improved by lowering and widening the existing levee and trimming the batters.

Embankment/crib-walls

This hybrid levee type may be required at one location; between chainages 6000 and 6560. The crib-wall is proposed to address space constraints and to provide continued access along the levee.

3.2.3 Shared bicycle and pedestrian pathway

The Wiradjuri Walking Track follows the Main City Levee between chainages 4000 and 7000, and between chainages 200 and 760. It has been constructed on top of, and adjacent to, the existing levee. At present this track is comprised of earth, gravel or in some places a concrete pathway.

Wherever earthworks are proposed to upgrade the Main City Levee, the proposal would improve the shared bicycle and pedestrian pathway by constructing a three metre wide crest surfaced with sprayed seal bitumen.

3.2.4 Spillways

Spillway design and locations

Construction of spillways is proposed to enable large floods (higher than the proposed level of flood protection) to enter the areas protected by the levees in a controlled manner (NSW Public Works 2011).

Spillways have been designed in accordance with the *Floodplain Risk Management Guideline No 14 – Spillways for Urban Levees*.

Spillway locations were selected according to the following criteria:

- They should be located at or near the downstream end of the city, or the lowest part of the city, to minimise the development of hazardous flows
- They should provide reasonable protection against wave action during the design event
- They should provide for reasonable tailwater build-up prior to the levee overtopping
- They should not operate until the flood is above the design flood level.

The proposed spillway locations are:

- Main City Levee – near the downstream end of the levee at chainages 420 to 620, near Moorong Street. This site has the lowest elevation within the area protected by the levee
- North Wagga Wagga Levee – near the downstream end of the levee at chainages 2850 to 2950, on Hopkirk Street. This site has the lowest elevation within the area protected by the levee
- East Street (Bank Two) Levee – at the intersection of Mill Street and East Street at chainages 248 to 285.

It is noted (NSW Public Works 2011) that due to the magnitude of the area protected by the levees, and the range and variability of floods, controlled inundation of protected areas during large floods may not be possible. It is possible that overtopping of the levees could occur at some locations before controlled inundation occurs from the spillways.

Spillway specifications

The spillways would be designed according to the following specifications:

- The spillways would allow flood water to enter the levee protected areas via lowered levee embankments
- The lowered embankments would be protected by rockfill mattresses 30 centimetres thick, which would accommodate the expected spillway flow velocities
- The mattresses would be laid over geotextile to prevent internal erosion of the levee fill

- Mattress protection would be extended over the crest of the levee, down the inside batter of the levee and for two metres beyond the base of the levee to provide for energy dissipation at the toe of the levee.

The length and crest height of each spillway above the design flood level are provided in Table 3.2.

Table 3.2: Length and crest height of proposed spillways

Levee	Length (metres)	Crest height (centimetres) above design flood level
Main City Levee	200	40
North Wagga Wagga Levee	100	25
East Street (Bank Two) Levee	33	25

3.2.5 Levee crossings

The Main City Levee, North Wagga Wagga Levee and East Street (Bank Two) Levee cross the Great Southern Railway, the Olympic Highway, several major roads and a number of minor roads and access roads for properties outside the levees.

The following guidelines have been adopted for crossings above the design flood level and for crossings below the design flood level. The anticipated treatments at specific crossings are provided in Appendix B.

Crossing above design flood level

Where the crossing is above the design flood level, no works are proposed. Flood protection is required for the freeboard component only. The following protection measures are recommended in the concept design report (NSW Public Works 2011):

- Temporary sandbagging
- Wave action suppression (eg from the roadway)
- Temporary earthfill barrier
- Temporary flood barriers

Traffic barriers would also be installed where necessary.

Crossings above the design flood level where no works would be required include:

- Flowerdale Road, Main City Levee, chainages 1320-1360
- Olympic Highway (Moorong Street), Main City Levee, chainages 2050-2160
- Travers Street, Main City Levee, chainages 4220-4260
- Hampden Avenue, North Wagga Wagga Levee, chainages 1670-1690
- Brotherwood Street, North Wagga Wagga Levee, chainages 2800-2820
- Gardiner Street, North Wagga Wagga Levee, chainages 3050-3070
- Mill Street, East Street (Bank Two) Levee, chainages 1370-5.

Crossing below design flood level

Where the crossing is below the design flood level, full flood protection is required, including for the freeboard component. Protection measures proposed include (NSW Public Works 2011):

- Construction of full height levee
- Raise road to at least design flood level
- Structural flood gates.

The treatments proposed at each crossing are provided in Appendix B. A general description of road raising and flood gate works is provided below. A detailed description of the treatments at each crossing is provided in the concept design report (NSW Public Works 2011).

Road raising

At some minor road/levee crossings, it is more economical to raise the road to at least the design flood level. The crossings range from minor local access ramps to two lane sealed roads.

Road works to raise local roads to the 100 year ARI level would be required at the following locations:

- Marah Street, North Wagga Wagga Levee, chainages 979-994
- Mill Street, East Street (Bank Two) Levee, chainages 250-280.

Local crossings would be raised at the following locations:

- Main City Levee chainage 1720-1740 – provides access over the levee to a business enterprise
- Main City Levee chainage 2400-2420 – horse property and residences
- Main City Levee chainage 6340-6360 – used for access to the levee and riverbank rock protection works maintained by Council
- Main City Levee chainage 9000-9010 – Wagga Wagga Monumental Cemetery entrance
- North Wagga Wagga Levee chainage 2290-2300 – access to a property located outside the levee.

Flood gates

Where the levees cross major roads at levels below the design flood level, the cost of raising these crossings to design flood level is prohibitive. Levee work would involve the installation of structural flood gates.

Six large flood gates are required at locations where major roads cross the levee at levels below the proposed design flood level. The flood gates consist of a removable post and beam system, concrete base beam and a cantilever retaining wall at either end of the opening. The roadways would not be raised or re-aligned.

Flood gates would be installed at the following locations:

- Johnston Street, Main City Levee, chainages 5242-5267
- Sturt Highway (Hammond Avenue), Main City Levee, chainages 7668-7688
- Copland Street, Main City Levee, chainages 8381-8411
- Mill Street, North Wagga Wagga Levee, chainages 1210-1230
- Hampden Avenue, North Wagga Wagga Levee, chainages 4276-8
- East Street, East Street (Bank Two) Levee, chainages 735-750.

Great Southern Railway

At the Grain Southern Railway crossing on the Main City Levee, a sheet pile wall would be constructed under the rail bridge. The wall would have a concrete cap to design flood level.

3.2.6 Engineering constraints

Engineering constraints to the construction of the proposal include:

- Limited space due to close proximity of Murrumbidgee River, streets or adjacent properties, including buildings, sub-stations, car parks etc. Where space is limited, alternative levee options would be constructed, such as sheet pile walls, concrete cantilever retaining walls and hybrid levees, as described in section 2.4.4
- The high costs involved with raising crossings that are below the design flood level, including crossings for major roads and the Great Southern Railway. As an alternative, structural flood gates would be installed.

3.2.7 Compatibility with Riverside Wagga Wagga Strategic Master Plan

Where necessary, the proposal has been designed to accommodate the recommendations of the Riverside Wagga Wagga Strategic Master Plan (Kiah Infranet 2010).

The Riverside Master Plan recommends moving the Main City Levee near Tarcutta Street to permit future city precinct works in the levee and river bank area. This has been incorporated in the proposal, between chainages 5600 and 5800. The levee alignment would be shifted by up to 10 metres, towards Tarcutta Street.

The Riverside Master Plan identifies the potential to create openings in the Main City Levee at Kincaid Street (chainage 4700) and Sturt Street (chainage 5020) to improve pedestrian access to the river and open up views of the river from the city. The Master Plan recommends that flood gates be constructed at these locations to maintain flood protection. While the proposal does not include constructing openings or flood gates in the Main City Levee at these locations, allowance has been made in the design for this to occur in future. The design allows for the construction of a flood defence system such as that detailed in Appendix C of the concept design report (NSW Public Works 2011).

The Riverside Master Plan recommends reducing the steepness of batters to minimise erosion and improve connectivity with the river. Wherever possible, the proposal would achieve this by constructing batters with grades of up to 4 horizontal to 1 vertical, as detailed in the section titled '*Embankment levees*' in section 3.2.2. Where there are space constraints, the proposal would reduce the steepness of batters by constructing hybrid levees with berms (steps in the levee banks).

The Riverside Master Plan identifies the need to maintain pedestrian access along the levees. Wherever earthworks are proposed to upgrade the Main City Levee, the proposal would improve the shared bicycle and pedestrian pathway by constructing a three metre wide crest surfaced with sprayed seal bitumen.

The Riverside Master Plan recommends constructing river crossings for pedestrians and cyclists (bridges). If any of these crossings are approved before construction of the proposal, the detailed design of the proposal would be modified to accommodate them.

The Master Plan recommends other modifications to the Main City Levee, including:

- Replacing levee embankments on the Main City Levee with gates or sheet piling
- Using infill panels for the upgrade of the concrete cantilever retaining wall on the Main City Levee between Sturt Street and Crampton Street (chainages 4460 to 4860)

- Moving the Main City Levee at additional locations.

These options are not included in the proposal. If any of these options are approved by Council before construction of the proposal, the detailed design of the proposal would be modified to accommodate them.

3.3 Construction activities

3.3.1 Work methodology

Staging

The proposal would be staged to match the availability of NSW government funding for the works. It is anticipated that works would commence at the eastern end of the Main City Levee (chainage 9111) and progress to the western end of the levee (chainage 0). Works would commence on the North Wagga Wagga levee and East Street (Bank Two) Levee after completion of the Main City Levee.

General construction activities

Works would mostly involve earthworks to raise and extend the existing embankment levees, including:

- Increasing the height of the levees
- Flattening batters
- Improving compaction where necessary.

Other construction processes would include:

- Sheet pile installation
- Erection of gabion walls
- Raising and extending concrete retaining walls
- Placement of box culverts on Main City Levee (chainage 4930-4990)
- Construction of rockfill mattress lined spillways
- Extending and modifying drainage pipes and pits
- Raising road crossings
- Construction of flood gate support walls, footings, flood gate assemblies (commissioning stage) and storage shed.

On-site concrete works would be required for levee options requiring concrete structures (eg concrete retaining walls).

Wherever possible, native vegetation would be retained. The existing levees are generally free of trees and shrubs. The proposal would involve removal of trees, shrubs, groundcover and topsoil from the existing levees at various locations, and from adjacent land where the levees would be widened.

Embankments and disturbed surfaces would be rehabilitated by placement of topsoil, fertilisation and revegetation with grasses.

A detailed description of the construction methodology for each of the major components of work is provided in the concept design report (NSW Public Works 2011).

3.3.2 Construction program

Timing

The timing of the proposal is dependent on the provision of funding by the NSW Government. Construction is expected to commence in 2014. The proposed construction period could be between five years and 15 years.

Hours and workforce

It is anticipated that work for the proposal would be completed in accordance with the Office of Environment and Heritage's (OEH) recommended standard hours for construction work:

- Monday to Friday: 7am to 6pm
- Saturday: 8am to 1pm
- Sundays and Public Holidays: no work.

At the current stage of planning, the number of workforce personnel is unknown. This would be dependent on the provision of funding by the NSW Government and would be determined by the contractor during the detailed planning phase.

3.3.3 Plant and equipment

Plant and equipment likely to be used for the different components of the proposal (NSW Public Works 2011) are detailed below.

Embankments

- Trucks – for delivering embankment fill and topsoil from borrow areas and local stockpiles
- Excavators – to win and load materials from borrow area and stockpiles, excavate levee and foundations to design lines
- Scrapers – to move materials on-site
- Grader – to grade, level and trim levee fill, maintain access tracks
- Water cart – for suppressing dust, maintaining condition of fill and maintaining topsoil and vegetation
- Compactor – for spreading fill, compacting clay fill on the levee embankment and preparing foundation
- Miscellaneous vehicles – for delivering materials and equipment, soil testing and transporting personnel.

Sheet pile walls

- Excavator with pile driving hammer – for installing sheet pile
- Small crane – for moving materials
- Trenching machine or small excavator – for earthworks
- Ready-mix concrete truck – for delivering concrete
- Miscellaneous delivery vehicles, including trucks to deliver sheet piles
- Personnel vehicles.

Concrete walls

- Concrete agitator trucks – for delivering concrete

- Concrete pump and pipework – for concrete transfer
- Miscellaneous delivery trucks – for reinforcement and formwork
- Generator and power tools – for starter bar holes, formwork cutting and drilling etc
- Miscellaneous personnel vehicles.

Gabion walls

- Trucks – for delivering rockfill
- Backhoe – for placing rockfill
- Miscellaneous delivery and personnel vehicles.

Embankment/box culvert levee

- Delivery truck
- Small mobile crane – for moving and placing box culverts
- Grader – to mix and spread sand/clay bedding mix.

Spillways

- Trucks – for delivering rockfill and transporting excess fill and topsoil
- Excavator – for placing rockfill, excavating the levee, loading excess materials and spreading of topsoil
- Grader – to prepare the work area and access track, and for final rehabilitation
- Miscellaneous delivery and personnel vehicles.

Levee crossings – road raising

Road raising construction works would be in accordance with conventional road building operations. Plant and equipment that may be used for these works is detailed below.

Road embankment and drainage construction

- Trucks
- Scrapers
- Graders
- Vibrating and static rollers
- Backhoes
- Trenching machines
- Excavator.

Road pavement construction

- Milling machine
- Grader
- Trucks
- Scrapers
- Vibrating and static rollers
- Concrete agitator trucks
- Spray sealing equipment
- Line marking plant
- Bitumen spraying cart and asphalt paver
- Bitumen trucks
- Kerb extruding machine.

Levee crossings – flood gates

- Excavator – for trench excavation and foundation trimming
- Small crane – for placing reinforcing cage
- Ready mix truck – for delivering and placing concrete

- Truck – for delivering materials and removing waste and excess materials
- Small equipment such as power tools, generator, plate compactor and concrete vibrator
- Personnel vehicles.

3.3.4 Earthworks

Earthworks would occur primarily for upgrading embankment levees and would include:

- Stripping and stockpiling topsoil from the levees
- Excavating the existing levee banks and foundations. This would involve removing the existing levee banks so that they can be rebuilt with a combination of the existing material and fill material imported from the proposed borrow sites. In some cases where the existing material has been found to be sub-standard the levee banks would be re-constructed entirely with imported material
- Excavation and transport of material from the proposed borrow sites
- Placement and compaction of fill for levee embankments
- Placing and trimming random fill and topsoil for rehabilitation and revegetation of the levee banks.

The estimated quantities of earthworks for the embankment levees are provided in Table 3.3.

Table 3.3: Estimated quantities of earthworks

Levee	Excavation of levee bank (cubic metres)	Placement of fill (cubic metres)	Preparing levee foundations (square metres)	Batter maintenance (square metres)
Main City Levee	29,000	78,820	82,000	54,700
North Wagga Wagga levees	27,700	52,250	57,500	40,520

Source: NSW Public Works 2011.

3.3.5 Source and quantity of materials

Quantities of materials

Materials required for the proposal and their quantities are provided in Table 3.4.

Table 3.4: Estimated quantities of materials

Material	Volume (cubic metres)	Area (square metres)	Length (metres)
Fill for constructing embankment levees (solid)	131,070		
Gravel for surfacing embankment levees	3,380		
Bitumen seal for road works (general)		1,000	
Gravel pavement for road works	500		

Material	Volume (cubic metres)	Area (square metres)	Length (metres)
(general)			
Fill for road raising (general)	2,500		
Flood gates		227.2	
Concrete for flood gate footings	101.2		
Flood gate end walls (including fittings)	126.6		
Road pavement for flood gates	72		
Bitumen seal for flood gates		480	
Geotextile for spillways	4,235		
Rockfill mattresses for spillways (300mm)	3,850		
Sheet pile walls	11,900		
Concrete box culverts (3 metres x 90 centimetres)			60
Rockfill gabions	120		
Guard railing			28.6
Concrete for concrete levee walls	120		

Source: NSW Public Works 2011

These quantities are indicative and may change as a result of the detailed design.

The proposal would also require the following:

- Stormwater culverts
- Precast concrete culvert headwalls
- Storage shed for floodgate components
- Water to achieve required earthworks moisture content, and to suppress dust.

Source of materials

Borrow sites

Fill would be sourced from the borrow sites identified in Figure 1.1, and listed in Table 3.5. The general area of excavation for each borrow site is provided in Table 3.5. Excavation would be to a depth of about three metres.

Table 3.5: Proposed borrow sites and areas of excavation

Borrow site	Area of excavation (hectares)
North Wagga borrow site	13.7
Copland Street borrow site	1.0
Tasman Road borrow site	16.6

These proposed borrow sites are all owned by Council. A photograph of each proposed borrow site is provided in Figure 3.1 to Figure 3.3. A map of each proposed borrow site is provided in Figure 3.4 to Figure 3.6.

Excavation of material has previously occurred at the proposed North Wagga borrow site. The material has been used for levee repairs. Excavation of material for the proposal would occur adjacent to the existing site of excavation. No excavation has occurred at the Tasman Road or Copland Street borrow sites.

The existing pit at the North Wagga borrow site contains water from the flooding that occurred in March 2012. If water is present in the pit when material is excavated from the proposed borrow site, a buffer from the existing pit would be established to minimise movement of water out of the existing pit into the new pit. If necessary, any water in the existing pit may be pumped out for the irrigation of adjacent agricultural land, subject to obtaining a specific purpose access licence from Office of Water and agreement with a landholder.

Fuel storage tanks may need to be kept at the borrow sites for refuelling excavators.

Other materials

Other materials required for the proposal are commercially available. Wherever possible these materials would be sourced from nearby commercial suppliers.

Water would be sourced from Riverina Water County Council water supply mains, or potentially from the Murrumbidgee River, subject to approval.

Figure 3.1: Photograph of proposed North Wagga borrow site looking west from eastern boundary

Figure 3.2: Photograph of proposed Tasman Road borrow site looking west from eastern boundary

Figure 3.3: Photograph of proposed Copland Street borrow site looking south from northern boundary

Paper Size A4

0 50 100 200

Metres

Map Projection: Transverse Mercator
Horizontal Datum: GDA 1994
Grid: GDA 1994 MGA Zone 55

N

LEGEND

- Creek
- Road
- Excavation area

Wagga Wagga City Council
Wagga Wagga levee upgrade REF

Job Number 23-14536
Revision 0
Date 07 Aug 2013

Proposed North Wagga borrow pit site

Figure 3.4

G:\23\14536\GIS\Maps\Maps_REF\WaggaLevee_Fig3.4_NorthWaggaBorrowPit.mxd

Suite 3, Level 1, 161-169 Baylis Street Wagga Wagga NSW 2650 Australia T 61 2 6923 7400 F 61 2 6971 9565 E wgamail@ghd.com W www.ghd.com

Data source: Wagga Wagga City Council: Aerial photograph - 2012; LPI: Roads and creeks - 2008. Created by:rtrobinson

Paper Size A4

0 50 100 200

Metres

Map Projection: Transverse Mercator
Horizontal Datum: GDA 1994
Grid: GDA 1994 MGA Zone 55

N

LEGEND

Road

Excavation area

Wagga Wagga City Council
Wagga Wagga levee upgrade REF

Job Number 23-14536
Revision 0
Date 07 Aug 2013

Proposed Tasman Road borrow pit site

Figure 3.5

G:\23\14536\GIS\Maps\Maps_REF\WaggaLevee_Fig3.5_TasmanRoadBorrowPit.mxd

Suite 3, Level 1, 161-169 Baylis Street Wagga Wagga NSW 2650 Australia **T** 61 2 6923 7400 **F** 61 2 6971 9565 **E** wgamail@ghd.com **W** www.ghd.com

Data source: Wagga Wagga City Council: Aerial photograph - 2012; LPI: Roads - 2008. Created by:rtrobinson

LEGEND

Road

Excavation area

Paper Size A4

0 50 100 200

Metres

Map Projection: Transverse Mercator
Horizontal Datum: GDA 1994
Grid: GDA 1994 MGA Zone 55

N

Wagga Wagga City Council
Wagga Wagga levee upgrade REF

Proposed Copland Street borrow pit site

Job Number 23-14536
Revision 0
Date 07 Aug 2013

Figure 3.6

G:\23\14536\GIS\Maps\Maps_REF\WaggaLevee_Fig3.6_CoplandStreetBorrowPit.mxd

Suite 3, Level 1, 161-169 Baylis Street Wagga Wagga NSW 2650 Australia
T 61 2 6923 7400 F 61 2 6971 9565 E wgamail@ghd.com W www.ghd.com

Data source: Wagga Wagga City Council: Aerial photograph - 2012; LPI: Roads - 2008. Created by:rtrobinson

3.3.6 Traffic management and access

Vehicle movements

The proposal would generate heavy vehicle movements through the transport of fill, machinery, fuel, general provisions and materials. Construction vehicles would access the proposal site via streets connecting to the levee.

Heavy vehicles would transport about 184,000 cubic metres of loose fill to the proposal site. The transport of fill would require about 12,250 heavy vehicle trips (24,500 movements to and from the proposal site) over the construction period, assuming truck and trailer combinations with capacity for 15 cubic metres of fill.

Heavy vehicles would also transport materials such as sheet piles, concrete, rockfill gabions, guard railing, box culverts, rockfill mattresses, flood gates, gravel and bitumen. At the current stage of planning it is unknown what the number of vehicle movements required to transport these would be. It is anticipated that the number of trips may be 1,000 (2,000 movements to and from the proposal site).

Light vehicles would be required to transport staff to and from the proposal site. Light vehicles would also be used in various roles on site. At the current stage of planning it is unknown what the required number of light vehicle movements would be.

Vehicle movements would generally occur along sealed roads. Vehicle movements along unsealed roads would only be required for the transport of excavated material from the North Wagga borrow site (see Figure 1.1). From the North Wagga borrow site, trucks would travel north along Fuller Street (which is unsealed) and then east along Cooramin Street (which is unsealed) to Hampden Avenue (which is sealed). It is likely that road works would be required along Fuller Street and Cooramin Street to accommodate the truck movements.

Traffic management

A traffic management plan would be prepared in accordance with the Australian Standard 1742.3-2002: *Manual of Uniform Traffic Control Devices* and the NSW Roads and Maritime Services *QA Specification G10 "Traffic Control at Worksites", Version 4* before commencement of construction.

The traffic management plan would provide details of traffic management to be implemented during construction, to maintain traffic flows and to manage driving conditions during construction.

During upgrades at road crossings, traffic would be restricted to one lane. Traffic control and speed restrictions of 40 kilometres per hour would be implemented in these situations for the safety of workers and traffic.

3.3.7 Site compound and stockpile sites

At the current stage of planning it is not anticipated that a compound site would be required. Existing Council and contractor depots would be used for storing machinery and materials.

Stockpile sites would be required for storing topsoil stripped from the existing levee before construction. Stockpile sites have not been identified at the current stage of planning. Stockpile sites would be selected using the following guidelines listed below where practicable. Stockpile sites would be located:

- On the opposite side of the levee to the Murrumbidgee River, where possible to maintain a sufficient distance from the river and to use the levee as a barrier to runoff containing sediment
- Where possible, more than 40 metres from a watercourse but where necessary, up to 20 metres from a watercourse
- More than 50 metres from residential areas, the central business district, schools, churches and hospitals
- In previously disturbed areas that do not require removal of native vegetation. If stockpile sites are required in areas of native groundcover vegetation, consultation would be undertaken with a Council environmental officer
- On level ground wherever possible
- Where disruption would be minimised to other existing activities.

At the current stage of planning it is not anticipated that any stockpile sites would be required for construction materials. Fill and other construction materials would be delivered directly to the proposal site as required.

3.4 Public utility adjustment

Requirements for public utility adjustment have not been identified at the current stage of planning.

It is likely that services such as electricity, water, stormwater, sewage, gas, street lighting and telephone services would be temporarily disrupted and may be relocated.

In most cases the works would be completed by the relevant utilities provider using standard safeguards.

Council would consult with the relevant service providers to address issues relating to public utility adjustment. Environmental assessment requirements for public utility adjustment would be identified during the detailed design phase.

3.5 Property acquisition

Requirements for property acquisition have not been identified at the current stage of planning. An assessment of the requirements for property acquisition would be undertaken in relation to cadastral boundaries provided by Department of Primary Industries – Crown Land. This will occur during the detailed design phase. Any property valuations, lease fees and acquisition payments would be carried out in accordance with the *Land Acquisition (Just Terms Compensation) Act 1991* or the *Conveyancing Act 1919*.

4. Statutory and planning framework

This chapter provides the statutory and planning framework for the proposal and considers provisions of relevant state environmental planning policies, local environmental plans and other legislation. The chapter is concluded with confirmation of the proposal's statutory position.

4.1 Environmental Planning and Assessment Act 1979

4.1.1 Overview

The *Environmental Planning and Assessment Act 1979* (EP&A Act) provides the statutory basis for planning and environmental assessment in NSW. The Minister for Planning and Infrastructure, statutory authorities and local councils are responsible for implementing the EP&A Act. The EP&A Act provides the framework for environmental planning and development approvals and includes provisions to ensure that the potential environmental impacts of a development are assessed and considered in the decision making process.

The EP&A Act contains three parts that impose requirements for planning approval. These are generally as follows:

- Part 4 provides for control of 'local development' that requires development consent from the local Council. State Significant Development is also assessed under Part 4 (Division 4.1).
- Part 5 provides for control of 'activities' that do not require approval or development consent under Part 4.
- Part 5.1 provides for control of State Significant Infrastructure.

The need or otherwise for development consent is set out in environmental planning instruments – State Environmental Planning Policies (SEPPs), or Local Environmental Plans (LEPs).

4.1.2 Part 5 environmental assessment and determining authority

The proposal constitutes an activity and is permissible without development consent under *State Environmental Planning Policy (Infrastructure) 2007* (ISEPP) (see section 4.2.1). The proposal is therefore subject to part 5 of the EP&A Act.

Part 5 of the EP&A Act provides for the control of 'activities' that do not require development consent or the approval of the Minister for Planning and Infrastructure.

Section 110 of the EP&A Act defines 'determining authority' as follows:

> '*determining authority means a Minister or public authority and, in relation to any activity, means the Minister or public authority by or on whose behalf the activity is or is to be carried out or any Minister or public authority whose approval is required in order to enable the activity to be carried out*.'

The EP&A Act's definition of 'public authority' (section 4) includes: '*(a) a public or local authority constituted by or under an Act*'.

For the purposes of the proposal, Wagga Wagga City Council is the proponent and determining authority in accordance with the EP&A Act.

The duties of the determining authority are set out in section 111 of the EP&A Act. Section 111(1) requires that a determining authority '*…examine and take into account to the fullest extent possible all matters affecting or likely to affect the environment by reason of that activity*.'

Section 112 provides that a determining authority shall not approve or carry out an activity that is likely to significantly affect the environment (including critical habitat) or threatened species, populations or ecological communities, or their habitats, unless it has considered an environmental impact statement in respect of the activity. In addition, if the proposal was to be carried out on land that is critical habitat, or if the determining authority decides the proposal would be likely to significantly affect a threatened species, population or ecological community or its habitat, then it must obtain and consider a species impact statement.

Section 5A of the EP&A Act includes an assessment of significance, which uses seven factors to assist in determining if the proposed development or activity '*is likely to have a significant effect on threatened species, populations or ecological communities, or their habitats*'. These seven factors must be taken into account by a consent or determining authority when considering a development proposal or development application. This enables a decision to be made as to whether there is likely to be a significant effect on the species, population or ecological community, and hence if a species impact statement is required.

This REF has been prepared to consider whether the proposal would have a significant impact upon the environment under Section 111 of the EP&A Act. Factors that need to be taken into account when considering the likely impact of an activity on the environment are outlined in clause 228 of the EP&A Regulation and are discussed in Appendix E.

4.2 State Environmental Planning Policies

4.2.1 State Environmental Planning Policy (Infrastructure) 2007

State Environmental Planning Policy (Infrastructure) 2007 (ISEPP) aims to facilitate the effective delivery of infrastructure across NSW.

Clause 50 of the ISEPP permits development for the purpose of flood mitigation work to be carried out by or on behalf of a public authority without consent on any land. This includes development for any of the following purposes if the development is in connection with flood mitigation work:

(a) construction works

(b) routine maintenance works

(c) environmental management works.

Under clause 5 of the ISEPP, if a development for a particular purpose that may be carried out without consent includes construction works, the following works or activities are (subject to and without limiting that provision) taken to be construction works if they are carried out for that purpose:

(a) accessways

(b) temporary construction yards

(c) temporary lay-down areas for materials or equipment

(d) temporary structures

(e) conduct of investigations

(f) clearing of vegetation (including any necessary cutting, lopping, ringbarking or removal of trees) and associated rectification and landscaping

(g) demolition

(h) relocation or removal of infrastructure

(i) extraction of extractive materials at the construction site solely for the purpose of the construction.

The proposal for the upgrade of the levees constitutes flood mitigation work undertaken on behalf of a public authority and is therefore permitted without development consent under the provisions of clause 50 if the Infrastructure SEPP. The extraction of materials from the borrow sites is for the purpose of construction activities associated with the upgrade of the levee and is therefore considered permissible without consent under clause 5 of the Infrastructure SEPP.

The proposal will therefore be assessed in accordance with the requirements of Part 5 of the EP&A Act (refer to section 4.1.2).

Clause 16 of the ISEPP states that consultation with the relevant public authorities is required if the development is located on land reserved under the *National Parks and Wildlife Act 1974* or if the development affects land or development regulated by *State Environmental Planning Policy No. 14 - Coastal Wetlands*, *State Environmental Planning Policy No. 26 - Littoral Rainforests*, *State Environmental Planning Policy (State and Regional Development) 2011* or *State Environmental Planning Policy (Major Projects) 2005*. The proposal is not located on land reserved under the *National Parks and Wildlife Act 1974* and would not affect land or development regulated by any of these State Environmental Planning Policies. Council does not therefore need to undertake consultation under the ISEPP with any other public authorities.

4.2.2 State Environmental Planning Policy No 55—Remediation of Land

The object of *State Environmental Planning Policy No 55—Remediation of Land* (SEPP 55) is to provide for a statewide planning approach to the remediation of contaminated land. SEPP 55 aims to promote the remediation of contaminated land for the purpose of reducing the risk of harm to human health or any other aspect of the environment:

- By specifying when consent is required, and when it is not required, for a remediation work
- By specifying certain considerations that are relevant in rezoning land and in determining development applications in general and development applications for consent to carry out a remediation work in particular
- By requiring that a remediation work meet certain standards and notification requirements.

While SEPP 55 does not apply under Part 5 of the EP&A Act, this REF considers the intent of the SEPP.

Three potentially contaminated sites are known to exist in the study area (see Figure 1.1):

- The former gasworks site on Tarcutta Street at chainage 5700. Remediation of this site is expected to commence in January 2013 and would be completed over about 12 months. Remediation is therefore likely to be completed before the commencement of the proposal
- The electrical substation on Hammond Avenue at chainage 7500. The substation was originally constructed in about the 1920s. The land in the vicinity of the substation has the potential to contain Polychlorinated Biphenyls (PCBs) and hydrocarbons
- The Pitch 'n' Putt landfill site on Narrung Street at chainage 3500. The site is likely to contain contaminants from waste disposal, which occurred at the site until around the late 1970s. At the current stage of planning no works are anticipated at this site due to the existing height of the levee above the 100 year ARI flood level.

A contamination management plan would be prepared before construction of the proposal. If it is assessed that there is a risk the proposal could uncover contamination at any of these sites, remediation would be undertaken before construction in line with SEPP 55. The proposal would not conflict with the intent of SEPP 55.

If soil contamination is discovered during construction, safeguards would be implemented as described in section 6.2.3. Remediation would be undertaken in accordance with SEPP 55.

4.2.3 State Environmental Planning Policy No 44 – Koala Habitat Protection

State Environmental Planning Policy No. 44 – Koala Habitat Protection (SEPP 44) aims to encourage the proper conservation and management of areas of natural vegetation that provide habitat for Koalas (*Phascolarctos cinereus*). SEPP 44 also aims to ensure a permanent free-living population of Koalas over their present range, and reverse the current trend of Koala population decline by:

- Requiring the preparation of plans of management before development consent can be granted in relation to areas of core Koala habitat
- Encouraging the identification of areas of core Koala habitat
- Encouraging the inclusion of areas of core Koala habitat in environment protection zones.

While SEPP 44 does not apply under Part 5 of the EP&A Act, this REF considers the intent of the SEPP.

SEPP 44 applies to each local government area (LGA) listed in Schedule 1, which includes the Wagga Wagga LGA. Schedule 2 of SEPP 44 lists preferred feed tree species of the Koala, including River Red Gum (*Eucalyptus camaldulensis*).

River Red Gum constitutes at least 15 per cent of the total number of trees in the upper or lower strata of the tree component within the study area. As a result the habitat in the study area comprises potential Koala habitat as defined under SEPP 44.

The ecological assessment (GHD 2012) found that the Koala is unlikely to inhabit the study area due to a lack of recent local records. The species has not been reliably recorded in the Wagga Wagga LGA since the mid 1960's.

The study area is therefore unlikely to contain core Koala habitat, defined by SEPP 44 as '*an area of land with a resident population of koalas, evidenced by attributes such as breeding females (that is, females with young) and recent sightings of and historical records of a population.*'

4.3 Local planning instruments

4.3.1 Wagga Wagga Local Environmental Plan 2010

Zoning

Under the Wagga Wagga LEP, the proposal is located within the zones provided in Table 4.1.

Table 4.1: Land zonings within proposal site

Location	Zoning	Area (ha)
Main City Levee	B3 – Commercial Core	0.05
	IN1 – General Industrial	1.98
	IN2 – Light Industrial	0.47
	R1 - General Residential	0.05
	R3 – Medium Density Residential	0.35
	RE1 – Public Recreation	2.53
	RE2 – Private Recreation	0.002
	RU1 – Primary Production	0.93
	SP1 – Special Activities	0.25
	SP2 – Infrastructure	2.19
North Wagga Wagga Levee	RE1 – Public Recreation	0.10
	RU1 – Primary Production	2.74
	RU5 – Village	1.70
East Street (Bank Two) Levee	RU1 – Primary Production	2.25
	RU5 – Village	0.01
North Wagga borrow site	RU1 – Primary Production	13.67
Copland Street borrow site	IN1 – General Industrial	1.01
Tasman Road borrow site	RE1 – Public Recreation	6.40
	IN2 – Light Industrial	10.22

The proposal represents environmental protection works for flood mitigation and is generally consistent with all applicable zonings under the LEP. The upgrade of the levee does not constitute prohibited development in any of the applicable land zonings.

Biodiversity Certification of the Wagga Wagga LEP

Biodiversity Certification of the Wagga Wagga LEP was gazetted on 24 December 2010. The Biodiversity Certification Area covers about 10,655 hectares of current and future urban and industrial land around Wagga Wagga.

Within the Biodiversity Certification Area activities under Part 4 and Part 5 of the EP&A Act are deemed not to have a significant impact on threatened species, populations or ecological communities and their habitats provided that they are undertaken in accordance with the Wagga Wagga LEP and the Order of Biodiversity Certification (information provided by OEH).

Much of the proposal is located on land outside the Biodiversity Certification Area (generally on land adjacent to the Murrumbidgee River and at North Wagga Wagga). An ecological assessment has therefore been prepared to assess the ecological impacts of the proposal.

4.3.2 Wagga Wagga Development Control Plan 2005

The *Wagga Wagga Development Control Plan 2005* (Wagga Wagga DCP) contains detailed provisions to support the Wagga Wagga LEP.

The Wagga Wagga DCP specifies the types of development that can occur in different flood precincts. These flood precincts are defined by the existing levees.

In relation to flooding, the objectives of the Wagga Wagga DCP are:

- Minimise the public and private costs of flood damage
- Minimise the risk of loss of life during floods by encouraging construction and development that is “flood proofed” and compatible with the flood risk of the area
- Ensure that development and construction are compatible with the flood hazard
- Require compatibility with the Flood Plain Development Manual 2005 as relevant.

The proposal would be consistent with these objectives through increasing the level of flood protection for Central Wagga and North Wagga Wagga, without causing significant flood impacts in other areas of the floodplain (see section 6.3). The proposal would reduce the likelihood of flood damage to developments in areas protected by the levees.

4.4 Other relevant state legislation

4.4.1 National Parks and Wildlife Act 1974

The *National Parks and Wildlife Act 1974* (NPW Act) provides the basis for legal protection and management of Aboriginal sites within NSW, and for the management of National Parks estate. Implementation of the Aboriginal heritage provisions in the Act is the responsibility of OEH.

All Aboriginal sites and objects, other than those made for sale, are protected under the NPW Act.

Under the NPW Act, it is an offence to:

- Knowingly harm or desecrate an Aboriginal object
- Harm or desecrate an Aboriginal object or Aboriginal place.

Section 90 of the Act specifies that the Director-General may issue an Aboriginal heritage impact permit in relation to a specified Aboriginal object, place, land, activity or person, or specified types or classes of these. An Aboriginal heritage impact permit may be issued subject to conditions, or unconditionally.

Aboriginal heritage impact permits must be obtained prior to the commencement of any project that would, or would be likely to, impact on Aboriginal objects or places.

The Aboriginal heritage assessment concluded that the proposal would be unlikely to have a significant effect on an Aboriginal object or Aboriginal place (see section 6.8). An Aboriginal heritage impact permit would not therefore be required for the proposal.

4.4.2 Threatened Species Conservation Act 1995

The *Threatened Species Conservation Act 1995* (TSC Act) lists a number of threatened species, populations and ecological communities to be considered in deciding whether there is likely to be a significant impact on threatened biota, or their habitats. If any of these could be

impacted by the proposal, an assessment of significance that addresses the requirements of section 5 of the EP&A Act must be completed to determine the significance of the impact.

The potential for impacts on ecology have been considered in section 6.1. The assessment concludes that the proposal would be unlikely to have a significant impact on any threatened species, populations or ecological communities listed under the TSC Act. A species impact statement is therefore not required for impacts on species, populations or ecological communities listed under the TSC Act.

4.4.3 Fisheries Management Act 1994

The *Fisheries Management Act 1994* (FM Act) aims to conserve, develop and share the fishery resources of NSW for the benefit of present and future generations. This includes promoting ecologically sustainable development and conserving fish stocks and habitat.

The FM Act requires an assessment of whether threatened species of fish and marine vegetation, populations or ecological communities are likely to be affected by an activity. If a significant effect on the threatened species is likely, a species impact statement must be completed and concurrence of, or consultation with, NSW Department of Primary Industries (Fishing and Aquaculture) is required.

The ecological assessment found that the proposal would be unlikely to have a significant impact on any threatened species or ecological communities listed under the FM Act (see section 6.1). A species impact statement is therefore not required for impacts on species or ecological communities listed under the FM Act.

4.4.4 Noxious Weeds Act 1993

The objectives of the *Noxious Weeds Act 1993* include:

- Identify noxious weeds in respect of which particular control measures need to be taken
- Specify those control measures
- Specify the duties of public and private landholders as to the control of those noxious weeds
- Provide a framework for the State-wide control of those noxious weeds by the Minister and local control authorities.

Under this Act, noxious weeds have been identified for Local Government Areas and assigned control categories (such as W1, W2, W3 and W4). Part 3 provides that occupiers of land (including owners of land) have responsibility for controlling noxious weeds on the land they occupy.

Seven noxious weeds were identified in the study area, listed in section 6.1. The potential impacts of the proposal relating to noxious weeds, and site specific safeguards, are included in section 6.1.

4.4.5 Water Management Act 2000

The *Water Management Act 2000* controls the carrying out of activities in or near water sources in NSW, the extraction and use of water and the construction of works such as dams and weirs. ‘Water sources' are defined as a river, lake, estuary, place where water occurs naturally on or below the surface of the ground or NSW coastal waters.

If a ‘controlled activity' is proposed on ‘waterfront land', an approval is required under the *Water Management Act 2000* (section 91E). Under the *Water Management Act 2000*, ‘waterfront land’ is defined as land within 40 metres of a river, lake, estuary or shoreline.

Under section 344(1) of the *Water Management Act 2000*, it is an offence to carry out a controlled activity without a controlled activity approval. However, section 39A(1) of the *Water Management (General) Regulation 2004* exempts local councils from section 344 (1)(a) of the *Water Management Act 2000* in relation to all controlled activities that they carry out in, on or under waterfront land.

The proposal would occur on waterfront land adjacent to the Murrumbidgee River. Council is exempt from the need to obtain a controlled activity approval for the proposal.

Under clause 61 of the *Water Management Act 2000*, a person may apply to the Minister for Water for an access licence if the application is for a specific purpose access licence and a management plan provides that an application for the licence may be made. If extraction of water from the Murrumbidgee River is required for the proposal, the contractor would need to apply for a specific purpose access licence.

Before excavation of material from the proposed North Wagga borrow site, the water may be pumped out of the pit for the irrigation of adjacent agricultural land, subject to obtaining a specific purpose access licence from Office of Water and agreement with a landholder.

Water sharing plans created under the *Water Management Act 2000* establish rules for sharing water between the environmental needs of a river or aquifer and water users, and also between different types of water use such as town supply, rural domestic supply, stock watering, industry and irrigation.

The proposal occurs within the area administered by the *Water Sharing Plan for the Murrumbidgee Regulated River Water Source 2003*. Under clause 30 of the Water Sharing Plan, access licences may be granted in the water sources covered by the Plan.

4.4.6 Water Act 1912

Under clause 165A of the *Water Act 1912*, the proposal may be classified as a controlled work. This would depend on whether there is significant realignment of the levees and on whether the realignment or widening of the levees requires that the levees occupy additional cadastre lots. If this is the case Council will need to submit a replacement application to the NSW Office of Water.

Where the levees are realigned Council would need to secure occupancy of the land through one of the following:

- Acquisition of the land
- Creation of an easement
- Written permission for the construction of the levee on a property.

Occupancy would need to be secured before a replacement application is submitted to the Office of Water.

The previous approval for the levees may contain conditions relating to the maximum height or width of the levees. If it is determined that a replacement application is not necessary, Council may be able to apply to the Office of Water to have these conditions changed.

In response to consultation, the Office of Water has advised that the two existing approvals for the Main City Levee and North Wagga Wagga levees could be combined into one replacement approval.

4.4.7 Protection of the Environment Operations Act 1997

The *Protection of the Environment Operations Act 1997* (POEO Act) establishes, amongst other things, the procedures for issuing of licences for environmental protection on aspects such as

waste, air, water and noise pollution control. The owner or occupier of premises engaged in scheduled activities is required to hold an environment protection licence and comply with the conditions of that licence.

The POEO Act defines land-based extractive activity as an activity that involves the extraction, processing or storage of more than 30,000 tonnes per year of extractive materials.

The entire proposal would require about 185,000 tonnes of fill. If the tonnage of material extracted from any single borrow site is likely to exceed 30,000 tonnes in any given year, an environment protection licence from the Environment Protection Authority (EPA) would be required. Final staging and construction planning will determine the extraction requirements from each borrow pit and the requirement for an environment protection licence.

As a result of the proposed erosion and sedimentation controls, the proposal is considered unlikely to cause water pollution. Therefore an environment protection licence under the POEO Act is not required.

The POEO Act creates a number of pollution offences. If a 'pollution incident' occurs during the proposal that causes or threatens 'material harm' to the environment, the contractor and Council would be obliged to notify OEH immediately.

4.4.8 Heritage Act 1977

The *Heritage Act 1977* is concerned with all aspects of the conservation of heritage places and items. Heritage items of state significance are listed on the State Heritage Register.

The Act contains provisions relating to relics. The term 'relic' under the Act means:

> *Any deposit, artefact, object or material evidence that (a) relates to the settlement of the area that comprises New South Wales, not being Aboriginal settlement, and (b) is of State or local heritage significance.*

Section 139 of the Act prohibits a person from disturbing or excavating any land on which the person has discovered or exposed a relic, except in accordance with an excavation permit.

A heritage assessment of the proposal was undertaken, and the potential heritage impacts of the proposal are considered in section 6.9. The proposal may require the removal of a historic flood marker tree and a monument to the construction of the Main City Levee. These have been assessed as having heritage significance. If it is determined during detailed design that impacts to the flood marker tree and levee monument are unavoidable, a Section 139 exemption form would need to be filed with the NSW Heritage Office.

4.4.9 Roads Act 1993

Under section 138 of the *Roads Act 1993* consent would be required for works on public roads. Council would need to obtain consent from Roads and Maritime Services for works on the Sturt Highway.

4.4.10 Crown Lands Act 1989

Under section 155 (1) of the *Crown Lands Act 1989* consent would be required for works within Crown land that are not located within an existing easement (including extension and/or widening of the levee bank). Consent would need to be obtained from the Department of Trade and Investment (Crown Land).

4.4.11 Native Vegetation Act 2003

The *Native Vegetation Act 2003* (NV Act) encourages and promotes the management of native vegetation on a regional basis in the social, economic and environmental interests of the State and prevents broadscale clearing unless it improves or maintains environmental outcomes.

Under Section 25(g) of the NV Act, native vegetation clearing carried out by a determining authority does not require approval under the NV Act if the determining authority has complied with the provisions of Part 5 of the EP&A Act. As Council is the determining authority for the proposal, and has complied with Part 5 of the EP&A Act, approval for the proposal is not required under the NV Act.

4.5 Commonwealth legislation

4.5.1 Environment Protection and Biodiversity Conservation Act 1999

Under the EPBC Act a referral is required to the Australian Government for proposed actions that have the potential to significantly impact on matters of national environmental significance or the environment of Commonwealth land. The impacts of the proposal on matters of national environmental significance are considered in chapter 6 and Appendix E of this REF, and in the ecological assessment in Appendix H.

This REF finds that the proposal is unlikely to have a significant impact on any matters of national environmental significance. Accordingly, it is considered that the approval of the Australian Government Minister for Sustainability, Environment, Water, Population and Communities is not required and that it is not necessary to refer the proposal to DSEWPaC.

4.6 Confirmation of statutory position

An assessment of the relevant statutory planning instruments has concluded that the proposal can be assessed under Part 5 of the EP&A Act, by Wagga Wagga City Council as a determining authority.

5. Stakeholder and community consultation

This chapter discusses the stakeholder and community consultation undertaken for the proposal, describes the consultation process and summarises the issues raised by stakeholders and the community.

5.1 Community involvement

Council has prepared a community engagement plan to guide consultation with the local community and stakeholders.

Consultation has been undertaken with the community and stakeholders (including government agencies) and will be ongoing for the duration of the project.

Information has been made available to the public through mail-outs, public meetings, information sessions and the Council website. Information would continue to be provided to the public throughout the planning and construction phases.

This REF would be displayed for community comment. Any submissions received would be considered in finalising the details of the proposal.

Further details of consultation conducted are provided in the following sections.

5.1.1 Consultation conducted for Floodplain Risk Management Study

A community consultation program was carried out for the Wagga Wagga Floodplain Risk Management Study (WMA Water 2009a), which included:

- A public presentation
- Community newsletters
- Floodplain management committee meetings and workshops
- Public meetings
- Individual consultation
- Open shop days and public exhibition of draft study
- Establishment of a website.

The community input to the Floodplain Risk Management Study, provided in the period from 2002 to 2008, was used to guide the outcomes of the study and has ultimately influenced the development of the Wagga Wagga Floodplain Risk Management Plan (WMA Water 2009b) and the proposal to upgrade the Wagga Wagga levees.

5.1.2 Provision of information to the public

Project website

Council has established a project website for the proposal at web address http://yoursaywagga.com.au/floodfutures.

The website contains:

- A community quick poll about flood impacts
- Discussion forums

- A private web submission page
- Opportunities for community interaction (sharing flood stories and photographs)
- Email and telephone contact details
- News items
- Details of public information sessions
- Concept design report and drawings, with explanatory information
- Levee upgrade fact sheet
- Links to flood studies and other documents.

The website is continually updated with information as it becomes available.

Fact sheets

A fact sheet has been prepared giving a summary of the proposal and details of how to obtain more information (including community meetings and individual meetings). The fact sheet provides a telephone number, email address and the web address of the project website.

A fact sheet has also been prepared with information about this REF. The fact sheet includes a brief description of the REF, where to find more information about the proposal, consultation and how to provide input to the REF.

Copies of both fact sheets have been provided in Appendix K.

Mail-out

A mail-out was sent to all property owners and residents who would be affected by a 100 year ARI flood event (over 6,000 properties), as well as community groups and organisations. The aims of the mail-out were to make known Council's intention to upgrade the Wagga Wagga levees and to provide the community with opportunities to seek further information.

Media releases

In consultation with Council's Media and Communications team a media plan was developed to:

- Provide consistent advice and comments to various media organisations
- Provide information to various media organisations to ensure that the project is well advertised.

Media releases to radio, television and print media have been used to provide information to the public about the proposal and to advertise public meetings.

5.1.3 Public meetings

Community meetings were held to allow community members to gain information about the project, ask questions and provide feedback. Evening meetings were held at:

- Gumly Gumly / East Wagga Wagga (Gumly Gumly Hall, 22 November 2012)
- North Wagga Wagga (North Wagga Hall, 29 November 2012)
- Central Wagga Wagga (Civic Centre, 4 December 2012).

The meetings included a presentation on the proposal and a presentation on the REF. At each meeting a panel was provided comprising members of Council, the NSW State Emergency Service and GHD to answer questions about the proposal and the REF.

Feedback forms were provided at the meetings for members of the community to write and submit any issues in relation to the proposal and the REF.

The three meetings were held in conjunction with two additional meetings; one for the village of Oura (upstream of Wagga Wagga) and the other for the villages of Collingullie and Currawarna (downstream of Wagga Wagga). Although the proposal does not affect these three communities, information on the proposal was provided and other flood management issues were discussed.

5.1.4 One-on-one information sessions

One-on-one information sessions have been conducted to allow community members to meet with a Council officer to discuss specifics relating to their property or the proposal in general. Information sessions have been held at community members' homes and at the Wagga Wagga City Council offices.

Council officers have used the information sessions to:

- Advise community member of predicted depths of flood water at their property before and after the proposed upgrade of the levees, using a flood modelling software application called '*waterRIDE*'
- Answer questions relating directly to the concept designs and associated documentation
- Collect feedback relating to the project.

5.1.5 Community feedback

Feedback forms have been made available to the public for members of the community to write and submit any issues in relation to the proposal and the REF.

Any submissions received by Council through other means have been receipted using Council's ordinary communication receipting processes.

All submissions have been included in an action list and responses have been given to the community members.

5.1.6 Issues raised by the community

A summary of issues raised by the Wagga Wagga community relevant to the REF is provided in Table 5.1.

Table 5.1: Issues raised by the community

Issue	Details	Where addressed in this REF or other studies
Access along levees	Will access tracks along the levees be maintained?	Section 3.2.3 of this REF.
Design of proposal to minimise tree removal	Will the levees be realigned to avoid large trees?	Section 6.1 of this REF.
Flood depths for properties outside levees	Will the proposal result in increased flood depths for properties outside the levees?	Section 6.3 of this REF.
Land surface topographic data used for	Changes in the topography of the floodplain have occurred since 2008 and these changes may have affected the	Addressed in section 6.3.2.

Issue	Details	Where addressed in this REF or other studies
flood modelling	accuracy of the flood modelling.	
Levee hazards for pedestrians	The steepness of the levee banks can pose hazards for pedestrians.	Flattening of levee banks is addressed in the section titled '*Embankment levee upgrades*' in section 3.2.2 and in the section titled '*Riverside Wagga Wagga Strategic Master Plan*' in section 2.1.2.
Levee types	Are earth embankment levees the best type of levee? Are concrete walls quicker and cheaper?	Addressed in the section titled '*Levee types*' in section 2.4.4.
North Wagga Wagga levee heights	Why can't the North Wagga Wagga levees be upgraded to provide a greater level of flood protection than the 20 year ARI flood level?	Section titled '*Council policy for North Wagga Wagga level of flood protection*' in section 2.1.1.
North Wagga Wagga levee upgrade costs	Why are significant costs being incurred for the upgrade of the North Wagga Wagga levees when the level of flood protection is only being increased from a 17 year ARI level of flood protection to a 20 year ARI level of flood protection?	The current freeboard for the North Wagga Wagga levees is 30 cm (see section 2.2.2). The proposed new freeboard for these levees is 75 cm (see section 2.4.3). The proposed increase in freeboard comprises a substantial component of the earthworks to upgrade the levees.
Options other than raising the levees	Have options other than raising the levees been considered?	Section 2.4 of this REF and the Wagga Wagga Floodplain Management Study (WMA Water 2009a).
	The levee upgrade at North Wagga Wagga would provide protection against a 20 year ARI flood level but house-raising provides a greater level of protection against damages. Has this been considered?	Wagga Wagga Floodplain Management Study (WMA Water 2009a).
Vegetation on the floodplain	Can vegetation and woody debris on the floodplain be removed to reduce the impacts of flooding?	Section titled '*Managing regrowth vegetation*' in section 2.4.2 in this REF.

5.2 Aboriginal community involvement

Aboriginal community consultation was conducted by OzArk EHM. Two Aboriginal community representatives from the Wagga Wagga Local Aboriginal Land Council (Wagga Wagga LALC) attended a field survey on 30 August 2012 (see section 6.8).

Records of Aboriginal community stakeholder consultation are provided in the Aboriginal and historic heritage assessment in Appendix J.

Section 6.8 provides an assessment of potential impacts to Aboriginal heritage.

5.3 Government agency involvement

5.3.1 Information provided to government agencies

Consultation on the REF has been undertaken with government agencies that may have an interest in the proposal. Consultation was initiated by a telephone call to the key contact from each organisation, followed by written notification requesting comments or issues to be addressed during the preparation of the REF. A consultation letter and map were issued on 8 November 2012.

Agencies notified included:

- Environment Protection Authority
- Office of Environment and Heritage
- Department of Primary Industries – Fishing and Aquaculture
- Department of Primary Industries – Crown Lands Division
- Office of Water
- Murrumbidgee Catchment Management Authority.

Draft specialist study reports were provided to the Office of Environment and Heritage and the Environment Protection Authority during the preparation of the REF.

5.3.2 Issues raised by government agencies

Formal responses to the consultation letters were received from the EPA and Department of Primary Industries – Fishing and Aquaculture. These responses are provided in Appendix F. Informal responses were received from the Murrumbidgee Catchment Management Authority and the Office of Water. The responses from all agencies are summarised in Table 5.2.

The Office of Environment and Heritage provided comment on the ecological assessment (GHD 2012) and the heritage assessment completed to inform the REF. These responses are also provided in Table 5.2.

Table 5.2: Issues raised by government agencies

Impact / measure	Issue	Where addressed in this REF
Environment Protection Authority (EPA)		
Extraction of material	An environment protection licence will be required for extraction activities that exceed 30,000 tonnes per annum.	Section 4.4.7 and section 7.2.
Air quality	Air quality impacts should be mitigated such that	Section 6.6.3.

Impact / measure	Issue	Where addressed in this REF
	potential impacts on sensitive receivers are minimised in accordance with the EPA particulate matter and deposited dust criteria.	
	Details would need to be provided of the proposed measures to manage dust generated by the proposal.	Section 6.6.3.
	An assessment for dust as detailed in the *Approved Methods and Guidance for the Modelling and Assessment of Air Pollutants in NSW* in conjunction with analysis of local meteorologic and terrain data would be sufficient to inform decisions about design and management options for the proposal.	A qualitative air quality assessment has been completed in section 6.6. Safeguards have been identified to minimise air quality impacts on sensitive receivers. The EPA has indicated to Council that a specialist study is not required.
	The REF should identify any other existing impacts on air quality within the area and if necessary provide an assessment and commentary on the predicted cumulative impacts that may arise.	Section 6.6.2.
Noise	The goals of the project should include design, construction, operation and maintenance of the proposed works in accordance with relevant policies, guidelines, and criteria, and in order to minimise potential impacts from noise.	Section 6.5.3.
	Any potential noise sources should be assessed in accordance with the *Industrial Noise Policy* (EPA 2000) and where required mitigation measures are proposed. All residential or noise sensitive premises likely to be impacted by the development must be identified and included in the assessment.	Section 6.5.
	Short-term impacts should be assessed through the Interim Construction Noise Guideline.	Section 6.5.2.
	The proposed development may see an increase in traffic movements associated with the transport of material. The number of traffic movements associated with the proposal should be quantified and potential noise impacts associated with these traffic movements need to be assessed in accordance with the NSW Road Noise Policy.	The construction noise and vibration management plan identified in section 6.5.3 would include a detailed assessment of the management of

Impact / measure	Issue	Where addressed in this REF
		traffic noise associated with the proposal.
Water quality	The goals of the project should include: • No pollution of waters (including surface water and groundwater) • Polluted water is captured on the site and collected, treated and beneficially reused, where this is safe and practicable to do so. The REF should document the measures that will achieve the above goals.	Section 6.2.3.
	Details of the site drainage and any natural or artificial waters within or adjacent to the development must be identified and where applicable measures proposed to mitigate potential impacts of the development on these waters.	Section 6.2.
	The REF should provide any details of any water management systems for the borrow pits to ensure surface and ground waters are protected from contaminants.	Section 6.2.3.
	A characterisation of potential water pollutants at the site should be undertaken including identification of any proposed water pollution controls and their performance. This should include details of the design and location of tailings disposal sites and any other wastewater treatment ponds.	Section 6.2.2 and section 3.3.5.
Land	The goals of the project should include: • No pollution of land • The potential impact of land erosion from the development is mitigated • Any potentially contaminated sites that are encountered or disturbed are appropriately managed and rehabilitated. The REF should document the measures that will achieve the above goals.	Section 6.2.3.
Waste and chemicals	The goals of the project should include: • It is in accordance with the principles of the waste hierarchy and cleaner production	Section 6.12.3.

Impact / measure	Issue	Where addressed in this REF
	• Where potential impacts associated with the handling, processing and storage of all materials used at the premises are identified, these be mitigated by the development • The beneficial reuse of all wastes generated at the premises are maximised where it is safe and practical to do so • No waste disposal occurs on site.	
	The goal of the project should ensure that environmental risks from hazardous chemicals and chemical waste are minimised. The REF needs to identify the proposed type, quantity and location of chemicals to be stored on site. Spill management measures, including items such as bunding and emergency procedures should be clearly outlined.	Section 6.2 (fuel storage) and section 6.12.
Rehabilitation	The goals of the project should include: • Reforming of the land to a pre-determined profile • Rehabilitation be undertaken in a progressive manner • Planting of any benches and batter slopes to stabilise and visually improve areas • Topsoiling and revegetation of the site, including seeding with local endemic species • Adequate drainage controls. The REF should document the measures that will achieve the above goals.	In relation to the levees these goals are addressed in section 6.2.3. In relation to the proposed borrow pits these goals would be addressed by a rehabilitation plan, identified in section 6.2.3.
Department of Primary Industries – Fishing and Aquaculture		
Impacts on listed aquatic threatened species, populations or ecological communities	The REF should assess whether there is likely to be any significant impacts on listed aquatic threatened species, populations or ecological communities. A 7 part test should be undertaken for aquatic threatened species potentially impacted on by the proposal.	Section 6.1.3 and ecological assessment in Appendix H.
Key threatening processes	The REF should outline any key threatening processes that are going to be undertaken as part of or as a result of the works.	Section 6.1.3.
Mitigation measures	Information should be presented outlining any mitigation measures that are to be undertaken as	Section 6.1.4.

Impact / measure	Issue	Where addressed in this REF
	part of the proposal (ie revegetation).	
Mitigation measures	The REF should include any impact mitigation measures that will be undertaken before, during and after the proposed works are completed including sediment and erosion control and site rehabilitation measures.	Section 6.1.4 and section 6.2.3.
Office of Environment and Heritage		
Vegetation connectivity	Woodland habitat on Willans Hill and connectivity should be incorporated in landscape assessment.	Ecological assessment in Appendix H.
Protection of tree critical root zones	Critical root zones of trees not being removed would be protected in accordance with the Australian Standard – *Protection of trees on development sites* (AS4970-2009)	Section 6.1.4.
Offset of loss of hollows	Habitat pruning techniques should be used to offset the loss of hollows at a 10:1 ratio. Habitat pruning should be used in preference to placement of nest boxes where possible.	Section 6.1.4.
Soil erosion	Erosion control should be carried out according to '*Managing Urban Stormwater – Soils and Construction*' (The Blue Book).	Section 6.2.3.
Murrumbidgee Catchment Management Authority		
Loss of native vegetation	Impacts on native vegetation should be minimised.	Section 6.1.3.
Office of Water		
Approval under the *Water Act 1912*	Council may need to submit a replacement application to the NSW Office of Water.	Section 4.4.6.

5.4 Ongoing or future consultation

5.4.1 Provision of information to the public

Project website

Information would continue to be provided to the public on the project website for the duration of the project, as described in section 5.1.4 above.

Media releases

Media releases to provide information to the public in radio, television and print media would continue for the duration of the project, as described in section 5.1.2 above.

5.4.2 Adjacent property owners and residents

A concerted effort will be made to directly contact the owners of properties and residents adjacent to the levees. The contact will be via telephone and by door knocking for those properties that Council does not have telephone numbers for or cannot be contacted by telephone.

This would be conducted to ensure that adjacent property owners are aware of the project and are given an opportunity to view the concept designs and provide feedback.

5.4.3 One-on-one information sessions

One-on-one information sessions would continue to be provided to the public for the duration of the project, as described in section 5.1.4 above.

5.4.4 Public information sessions

During the public exhibition and display of the REF, two evening drop-in information sessions will be held. The information sessions will outline the key findings of the REF and provide information on the approvals process. Information will also be provided on how members of the community can make a submission. GHD and Council project team members will be available to answer questions and respond to feedback.

6. Environmental assessment

This chapter of the REF provides a detailed description of the potential environmental impacts associated with the construction and operation of the proposal. All aspects of the environment potentially impacted upon by the proposal are considered. This includes consideration of the factors specified in the guideline '*Is an EIS required?*' (DUAP 1999) as required under clause 228(1)(b) of the *Environmental Planning and Assessment Regulation 2000*. The factors specified in clause 228(2) of the *Environmental Planning and Assessment Regulation 2000* are also considered in Appendix E. Site-specific safeguards are provided to ameliorate the identified potential impacts. Most safeguards would be implemented by the contractor with oversight and input, where necessary, by Wagga Wagga City Council. Some safeguards would be implemented by Council.

6.1 Biodiversity

An ecological assessment of the proposal was undertaken (*Wagga Wagga and North Wagga Wagga Murrumbidgee River Levee Upgrades: Ecological assessment*, GHD 2012) and is provided in Appendix H. The outcomes of the assessment are summarised in this section.

6.1.1 Methodology

The assessment involved the following methods:

- Background ecology information was obtained from database searches and reviewed. These searches included:
  - NSW OEH Wildlife Database Atlas – licensed data for Wagga Wagga LGA. Search of all threatened species of flora and fauna (within 10 kilometre radius of proposal site) (searched 21 September 2012)
  - Office of Environment and Heritage (OEH 2012a) Threatened species, populations and ecological communities of NSW, online profiles
  - BioBanking Credit Calculator search for species and communities known or predicted to occur in locality (searched 25 September 2012)
  - DSEWPaC (2012a) EPBC Act Protected Matters Search Tool – for a 10 kilometre radius around the proposal site (searched 20 September 2012)
  - DSEWPaC (2012b) Species profile and threats database, online profiles
  - NSW Department of Primary Industries –Fishing and Aquaculture Records viewer (DPI 2012a) (searched 19 October 2012)
  - NSW Department of Primary Industries – Noxious Weed Declarations – Wagga Wagga Local Government Area (LGA) Control Area (DPI 2012b) (searched 25 September 2012)
- A number of reports and surveys completed in the study area were reviewed (see ecological assessment in Appendix H)
- Flora and fauna field surveys were conducted by two ecologists from 3 September to 4 September 2012, with Anabat detector surveys conducted between 24 September and 26 September 2012. Where appropriate, field surveys were conducted in accordance with *Threatened Biodiversity Survey and Assessment: Guidelines for Developments and Activities Working Draft* (DEC 2004a). The surveys included:
  - Flora quadrat and transect surveys (see Figure 6.1)
  - Hollow-bearing tree surveys within 10 metres of the proposal site

- Count of all trees within the proposal site
- Fauna habitat assessment
- Diurnal bird surveys (see Figure 6.1)
- Anabat echolocation surveys (see Figure 6.1)
- Opportunistic fauna observations
- Spotlighting for nocturnal fauna (see Figure 6.1)
- Reptile and amphibian searches

No trapping was undertaken for the Squirrel Glider (*Petaurus norfolcensis*) as the species is known to occur in the study area and suitable habitat is present

- An assessment of the likelihood of occurrence was completed for threatened species, populations and ecological communities, and migratory species, with the potential to occur in the study area. The possibility of an impact on each species, population or ecological community was also assessed
- Potential impacts on species listed under the TSC Act were assessed in accordance with the Assessment of Significance included in section 5A of the EP&A Act, with reference to DECC (2007) (see ecological assessment in Appendix H)
- Potential impacts on species listed under the EPBC Act were assessed in accordance with the EPBC Act Policy Statement *Matters of National Environmental Significance: Significant impact guidelines 1.1* (DEWHA 2009) (see ecological assessment in Appendix H)
- Safeguards and management measures for the proposal were developed based on the site conditions and the potential impacts of the proposal.

6.1.2 Existing environment

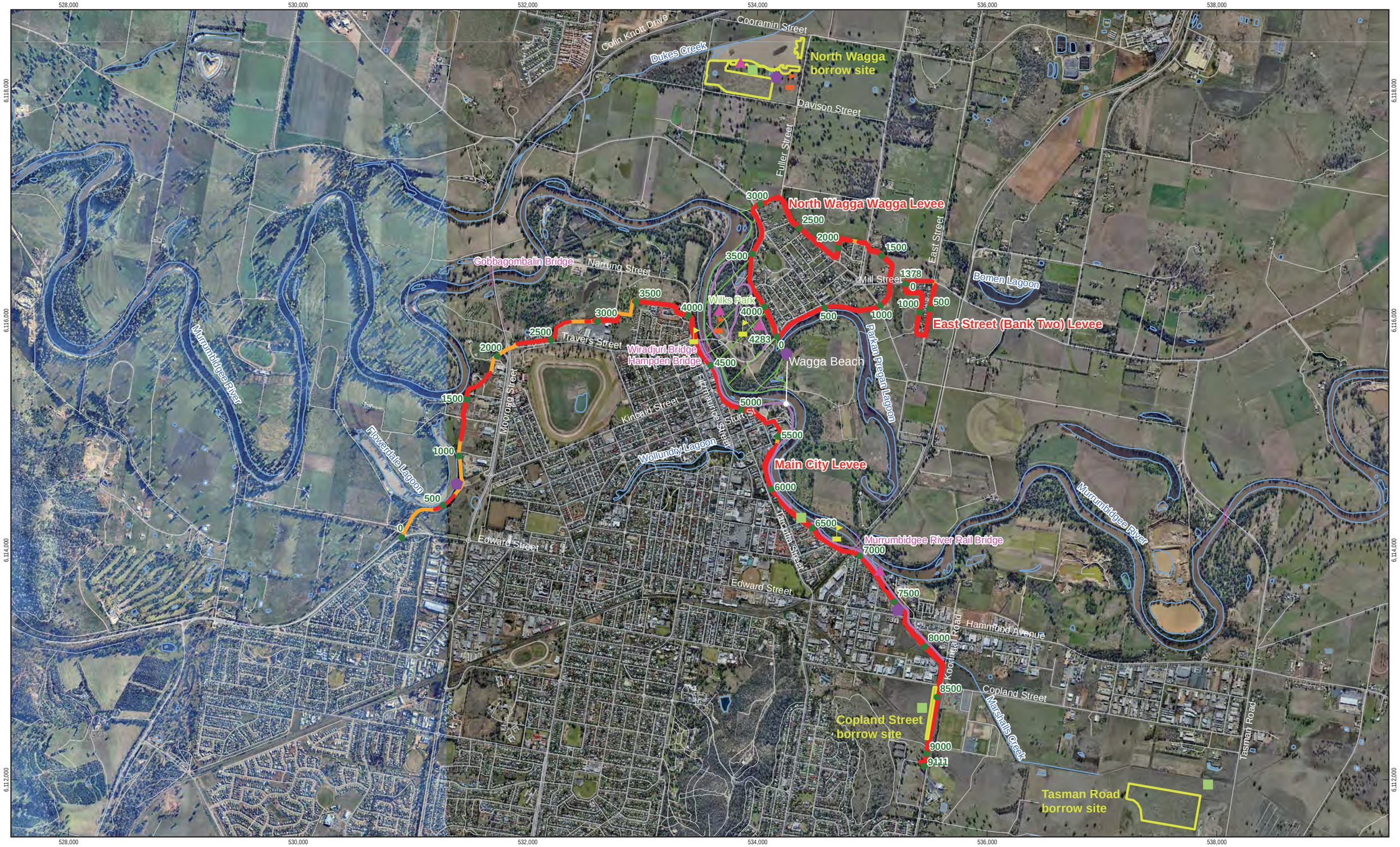
Terrestrial flora

Vegetation communities

Native vegetation in the study area is largely restricted to the riparian corridors along the Murrumbidgee River and Marshall's Creek, and vegetation around Flowerdale and Parkan Pregan Lagoons. This vegetation is dominated by River Red Gum (see Figure 6.2 and Figure 6.3). The plant community type as listed in the NSW Vegetation Types Database is *River Red Gum herbaceous-grassy very tall open forest wetland on inner floodplains in the lower slopes sub-region of the NSW South Western Slopes Bioregion and the eastern Riverina Bioregion*.

This community is not listed under NSW or Commonwealth legislation as a threatened ecological community. No other native vegetation communities were identified in the study area.

The proposed North Wagga borrow site occurs near scattered River Red Gum trees. The Tasman Road borrow site contains one Grey Box (*Eucalyptus microcarpa*) tree, which would be retained. No trees occur are present at the proposed Copland Street borrow site.



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0 250 500 1,000

Metres

Map Projection: Transverse Mercator
Horizontal Datum: GDA 1994
Grid: GDA 1994 MGA Zone 55

N

LEGEND

- Flora quadrat
- Bird survey
- Anabat survey
- Levee chainage (metres)

Threatened species observation

- Brown Treecreeper
- Superb Parrot

- Bridge
- Spotlight survey
- Road
- Creek

Proposed levee upgrade

- Proposed works
- No works

- Proposed borrow site
- Waterbody
- Wilks Park

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Wagga Wagga City Council
Wagga Wagga levee upgrade REF

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Flora and fauna surveys and threatened species records

Figure 6.1

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Suite 3, Level 1, 161-169 Baylis Street Wagga Wagga NSW 2650 Australia **T** 61 2 6923 7400 **F** 61 2 6971 9565 **E** wgamail@ghd.com **W** www.ghd.com

Data source: Wagga Wagga City Council: Extent of proposed works - 2012 and aerial photographs - 2012 & 2010; LPI: Roads, waterbodies, creeks - 2008. Created by:rtrobinson

Figure 6.2: Riparian River Red Gum forest along Marshall's Creek

Recorded flora species

Field surveys identified 103 flora species, of which 28 are native and 75 are introduced. These species are listed in the ecological assessment in Appendix H.

Tree species in the study area were dominated by River Red Gum. Other naturally occurring native tree species recorded included Yellow Box (*Eucalyptus melliodora*), Mugga Ironbark (*E. sideroxylon*), River Sheoak (*Casuarina cunninghamiana*) and Kurrajong (*Brachychiton populneus*).

Naturally occurring shrub species were restricted to a small area at Wilks Park, on the western side of the North Wagga Wagga Levee. Silver Wattle (*Acacia dealbata*) was the only shrub species recorded, although the study area contains other native and introduced shrubs. A number of introduced shrub species have been planted or have become environmental weeds.

The ground layer is dominated by introduced species across the entire study area. Commonly occurring introduced species include Great Brome (*Bromus diandrus*), Phalaris (*Phalaris aquatica*) and Wimmera Ryegrass (*Lolium rigidum*). Native grasses and forbs are generally uncommon. Couch (*Cynodon dactylon*) is the most commonly occurring native species.

No threatened flora species listed under the TSC Act or EPBC Act were recorded in the study area.

Noxious weeds

Seven plants listed as noxious for the Wagga Wagga control area (DPI 2012) were recorded during the flora surveys (Table 6.1).

Paterson's Curse (*Echium plantagineum*) and St John's Wort (*Hypericum perforatum*) are relatively common throughout the study area, with only small, localised occurrences of the other noxious weed species. The Copland Street and Tasman Road borrow sites contain a high abundance of introduced weed species, including noxious species such as St Barnaby's Thistle (*Centaurea solstitialis*).

All of the noxious weeds recorded are Class 4 weeds meaning that the growth of the plant must be managed in a manner that reduces its numbers, spread and incidence, and continuously inhibits its reproduction.

Table 6.1: Noxious weeds in the study area

Name	Class	Occurrence
African Boxthorn *Lycium ferocissimum*	Four	Uncommon. One individual plant located near Flowerdale Lagoon at the western end of the Main City Levee.
Bathurst Burr *Xanthium spinosum*	Four	Uncommon. Scattered individuals located at the North Wagga borrow site.
Paterson's Curse *Echium plantagineum*	Four	Common. Scattered individuals throughout the study area.
St Barnaby's Thistle *Centaurea solstitialis*	Four	Uncommon. Scattered plants located at the Copland Street and Tasman Road borrow sites.
St John's Wort *Hypericum perforatum*	Four	Common. Scattered individuals throughout the study area.
Sweet Briar *Rosa rubignosa*	Four	Uncommon. Scattered plants recorded at the Copland Street borrow pit site.
White Horehound *Marrubium vulgare*	Four	Uncommon. Localised occurrences throughout the study area.

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0 100 200 400

Metres

Map Projection: Transverse Mercator
Horizontal Datum: GDA 1994
Grid: GDA 1994 MGA Zone 55

N

LEGEND

Hollow-bearing tree
- Remove
- Retain

Levee chainage (metres)

Bridge

Creek

Vegetation proposed to be removed
- Introduced garden vegetation
- Introduced groundcover vegetation
- Introduced trees
- River Red Gum forest

Waterbody

Wilks Park

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Wagga Wagga levee upgrade REF

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Vegetation proposed to be removed and hollow-bearing trees

Figure 6.3a

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Suite 3, Level 1, 161-169 Baylis Street Wagga Wagga NSW 2650 Australia **T** 61 2 6923 7400 **F** 61 2 6971 9565 **E** wgamail@ghd.com **W** www.ghd.com

Data source: Wagga Wagga City Council: Aerial photographs - 2012 & 2010; LPI: Roads, waterbodies, creeks - 2008. Created by:rtrobinson

534,000

536,000

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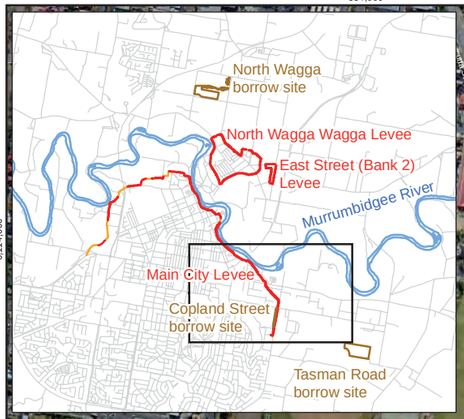

Murrumbidgee River

Murrumbidgee River Rail Bridge

6500

7000

7500

8000

8500

9000

9111

Edward Street

Hammond Avenue

Kooringal Road

Copland Street

Marshalls Creek

1:10,000 @ paper size A3

0 100 200 400

Metres

Map Projection: Transverse Mercator
Horizontal Datum: GDA 1994
Grid: GDA 1994 MGA Zone 55

N

LEGEND

Hollow-bearing tree
- Remove
- Retain

Levee chainage (metres)

Bridge

Creek

Vegetation proposed to be removed
- Introduced garden vegetation
- Introduced groundcover vegetation
- Introduced trees
- River Red Gum forest

Waterbody

Wilks Park

GHD

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Wagga Wagga City Council
Wagga Wagga levee upgrade REF

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Vegetation proposed to be removed and hollow-bearing trees

Figure 6.3b

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Data source: Wagga Wagga City Council: Aerial photographs - 2012 & 2010; LPI: Roads, waterbodies, creeks - 2008. Created by:rtrobinson

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0 100 200 400

Metres

Map Projection: Transverse Mercator
Horizontal Datum: GDA 1994
Grid: GDA 1994 MGA Zone 55

N

LEGEND

Hollow-bearing tree
- Remove
- Retain

Levee chainage (metres)

Bridge

Creek

Vegetation proposed to be removed
- Introduced garden vegetation
- Introduced groundcover vegetation
- Introduced trees
- River Red Gum forest

Waterbody

Wilks Park

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Wagga Wagga City Council
Wagga Wagga levee upgrade REF

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Date	17 Dec 2012

Vegetation proposed to be removed and hollow-bearing trees

Figure 6.3c

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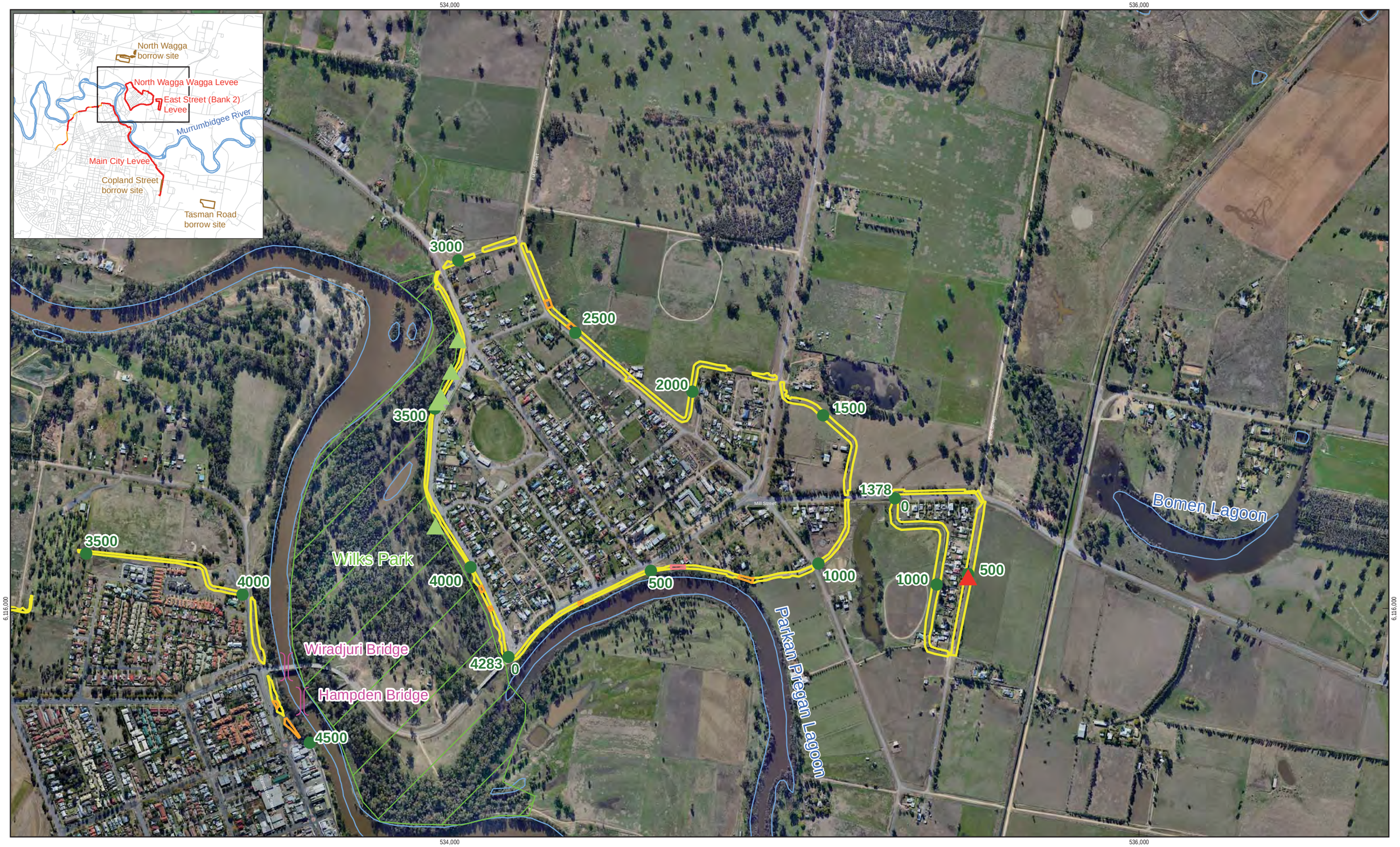
Suite 3, Level 1, 161-169 Baylis Street Wagga Wagga NSW 2650 Australia **T** 61 2 6923 7400 **F** 61 2 6971 9565 **E** wgamail@ghd.com **W** www.ghd.com

Data source: Wagga Wagga City Council: Aerial photographs - 2012 & 2010; LPI: Roads, waterbodies, creeks - 2008. Created by:rtrobinson



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0 100 200 400

Metres

Map Projection: Transverse Mercator
Horizontal Datum: GDA 1994
Grid: GDA 1994 MGA Zone 55

N

LEGEND

Hollow-bearing tree
- Remove
- Retain

Levee chainage (metres)

Bridge

Creek

Vegetation proposed to be removed
- Introduced garden vegetation
- Introduced groundcover vegetation
- Introduced trees
- River Red Gum forest

Waterbody

Wilks Park

GHD
CLIENTS | PEOPLE | PERFORMANCE

Wagga Wagga City Council
Wagga Wagga levee upgrade REF

Job Number	23-14536
Revision	0
Date	17 Dec 2012

Vegetation proposed to be removed and hollow-bearing trees

Figure 6.3d

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Suite 3, Level 1, 161-169 Baylis Street Wagga Wagga NSW 2650 Australia **T** 61 2 6923 7400 **F** 61 2 6971 9565 **E** wgamail@ghd.com **W** www.ghd.com

Data source: Wagga Wagga City Council: Aerial photographs - 2012 & 2010; LPI: Roads, waterbodies, creeks - 2008. Created by:rtrobinson

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0 100 200 400

Metres

Map Projection: Transverse Mercator
Horizontal Datum: GDA 1994
Grid: GDA 1994 MGA Zone 55

N

LEGEND

Hollow-bearing tree
- Remove
- Retain

Levee chainage (metres)

Bridge

Creek

Vegetation proposed to be removed
- Introduced garden vegetation
- Introduced groundcover vegetation
- Introduced trees
- River Red Gum forest

Waterbody

Wilks Park

GHD

CLIENTS | PEOPLE | PERFORMANCE

Wagga Wagga City Council
Wagga Wagga levee upgrade REF

Job Number	23-14536
Revision	0
Date	17 Dec 2012

Vegetation proposed to be removed and hollow-bearing trees

Figure 6.3e

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Suite 3, Level 1, 161-169 Baylis Street Wagga Wagga NSW 2650 Australia **T** 61 2 6923 7400 **F** 61 2 6971 9565 **E** wgamail@ghd.com **W** www.ghd.com

Data source: Wagga Wagga City Council: Aerial photographs - 2012 & 2010; LPI: Roads, waterbodies, creeks - 2008. Created by:rtrobinson

Terrestrial fauna

Fauna species

Surveys undertaken by GHD identified 75 fauna species, of which 67 are native and eight are introduced. These species are listed in the ecological assessment in Appendix H.

The woodland community of the study area provides habitat for a variety of bird species. Fifty-seven bird species were identified during field surveys, five of which were introduced; the Common Blackbird (*Turdus merula*), Common Starling (*Sturnus vulgaris*), House Sparrow (*Passer domesticus*), Rock Dove (*Columba livia*) and European Goldfinch (*Carduelis carduelis*). Commonly occurring native species included the Australian Magpie (*Gymnorhina tibicen*), Yellow Rosella (*Platycercus elegans flaveolus*), Sulphur-crested Cockatoo (*Cacatua galerita*) and Australian Wood Duck (*Chenonetta jubata*).

Ten species of mammal were recorded during field surveys. Three of these were introduced species; the Fox (*Vulpes vulpes*), Cat (*Felis catus*) and Rabbit (*Oryctolagus cuniculus*). Native mammals that were recorded included the Eastern Grey Kangaroo (*Macropus giganteus*), Common Brushtail Possum (*Trichosurus vulpecula*) and White-striped Freetail Bat (*Tadarida australis*). No threatened species of mammals were recorded during field surveys.

During remote Anabat surveys five bat species were positively identified. The two most common of these were Gould's Wattled Bat (*Chalinolobus gouldii*) and the Little Forest Bat (*Vespadelus vulturnus*). Three species were identified as probable. The two most common of these were the Inland Broad-nosed Bat (*Scotorepens balstoni*) and Chocolate Wattled Bat (*Chalinolobus morio*). No threatened bat species were recorded.

Three species of amphibian were recorded during surveys, including the Eastern Sign-bearing Froglet (*Crinia parinsignifera*), Peron's Tree Frog (*Litoria peronii*) and Spotted Marsh Frog (*Limnodynastes tasmaniensis*). No threatened species of amphibian were recorded during field surveys. These species were heard in the areas surrounding the Murrumbidgee River and Marshall's Creek. Drainage lines, lagoons and areas of ephemeral water ponding may provide breeding habitat for additional frog species.

No species of reptile were recorded during field surveys. Woody debris in the study area is likely to provide suitable habitat for commonly occurring species such as skinks and snakes.

Terrestrial fauna habitat

Fauna habitat in the study area occurs in remnant native vegetation and to a lesser extent planted introduced trees. Remnant vegetation exists as riparian corridors along the Murrumbidgee River and Marshall's Creek, and around Flowerdale and Parkan Pregan Lagoons. The North Wagga borrow site contains patchy River Red Gum woodland, with a roadside vegetation corridor leading to the site. Isolated paddock trees occur along roadsides and throughout the study area surrounding the study area.

Remnant vegetation in the study area provides foraging and breeding habitat for a variety of bird species, including the threatened species observed on site. It may also provide habitat for other threatened species not recorded in the study area during current surveys but known from the study area and locality, such as the Barking Owl (*Ninox connivens*) and Squirrel Glider.

Hollow-bearing trees occur commonly throughout the subject site and study area, with 32 identified within or close to the proposal site (see Figure 6.3a-e). Hollow-bearing trees in the study area are likely to provide roosting and nesting habitat for microchiropteran bats (such as the White-striped Freetail Bat), arboreal mammals (such as the Squirrel Glider and Common Brushtail Possum) and a range of woodland birds.

Vegetation along the riparian corridor in the subject site provides connectivity to other remnant vegetation in the locality including Pomingalarna Park, Silvalite Reserve and the Kapooka Military Area to the west and south-west of the proposal site. The connectivity of the riparian vegetation aids in facilitating the movement of fauna across the landscape, including woodland birds, mammals and other fauna.

Grassy areas in the study area provide foraging habitat for mammals such as the Eastern Grey Kangaroo (*Macropus giganteus*), which was observed in introduced grassland during field surveys. Grassy areas may also provide foraging habitat for woodland birds, including threatened species such as the Diamond Firetail (*Stagonopleura guttata*).

Aquatic habitat

The Murrumbidgee River is a major, permanent watercourse in the study area and provides potential habitat for a variety of aquatic fauna species. The river contains fringing riparian vegetation, submerged rocks and woody debris. It provides suitable habitat for fish species, including the Murray Cod (*Maccullochella peelii peelii*) and Golden Perch / Yellowbelly (*Macquaria ambigua*). These species favour habitats with slow-flowing, turbid waters and a cover of vegetation.

The Murrumbidgee River, Marshall's Creek, Parkan Pregan Lagoon and Flowerdale Lagoon are all part of the Lowland Murray River aquatic ecological community.

Aquatic habitat at the North Wagga borrow site has been created artificially through excavation of material and flooding during the March 2012 floods.

The different types of aquatic habitat available within the study area provide foraging and breeding habitat for aquatic birds and other aquatic fauna species. Three frogs were heard calling within the area of the river and Marshall's Creek during the current surveys, including the Eastern Sign-bearing Froglet, Peron's Tree Frog and Spotted Marsh Frog.

The study area contains limited aquatic flora habitat.

Threatened biota

Threatened biota observed during surveys

Two threatened bird species were recorded during surveys (see Figure 6.1);

- Brown Treecreeper (*Climacteris picumnus victoriae*)
- Superb Parrot (*Polytelis swainsonii*).

Both species are listed under the TSC Act as vulnerable and were observed in River Red Gum forest. The Superb Parrot is also listed as vulnerable under the EPBC Act. River Red Gum forest in the study area provides foraging, roosting, movement and nesting habitat for these species. In the study area and locality, Superb Parrots are only known to breed in the hollows of River Red Gum trees along the Murrumbidgee River. This species is known to breed in River Red Gum trees on the North Wagga Wagga flats (eg Wilks Park, see Figure 6.1).

The Murrumbidgee River, Marshall's Creek, Parkan Pregan Lagoon and Flowerdale Lagoon are all part of the Lowland Murray River aquatic ecological community. This ecological community includes all natural creeks, rivers, and associated lagoons, billabongs and lakes of the regulated portions of the Murrumbidgee River below Burrinjuck Dam. The Lowland Murray River aquatic ecological community is listed as endangered under the FM Act.

Likelihood of threatened biota occurring in the study area

The literature review, database search and field surveys identified 21 bird species, three bat species, a mammal population and an ecological community listed under the EPBC Act, TSC

Act and/or FM Act known or likely to occur in the study area. A list of the species that could potentially be impacted by the proposal is provided in Table 6.2 in section 6.1.3 below.

Species known to occur in the study area not observed during surveys include:

- Squirrel Glider (*Petaurus norfolcensis*) – the Wagga Wagga LGA Squirrel Glider population is listed as endangered under the TSC Act
- Barking Owl (*Ninox connivens*) – listed as vulnerable under the TSC Act.

River Red Gum forest in the study area provides foraging, roosting, movement and nesting habitat for these species.

6.1.3 Potential impacts

Potential direct impacts

Vegetation community removal

The proposal would remove 43.9 hectares of vegetation as a result of the construction of the proposed levee upgrades and as a result of the extraction of material from the proposed borrow sites. About 95 per cent of the vegetation to be disturbed or removed comprises introduced groundcover vegetation. The total disturbance footprint for the proposal includes:

- About 42.5 hectares of introduced groundcover vegetation
- About 1.1 hectares of remnant River Red Gum forest
- About 0.3 hectares of tree/garden plantings.

The area of River Red Gum forest in the study area is about 170 hectares. The proposed removal of 1.1 hectares of River Red Gum forest represents about 0.6 per cent of the forest in the study area and a much smaller proportion of forest in the locality (the area within 10 kilometres of the proposal site).

Tree removal

Removal of vegetation would occur sporadically throughout the proposal site. Most trees would be removed from the eastern section of the Main City Levee where vegetation is growing close to the existing levee. Limited removal would occur along the East Street (Bank Two) Levee where the land has largely been cleared of trees. Trees would not be removed from any of the three proposed borrow sites. The Copland Street borrow site is devoid of trees, and remnant mature trees at the North Wagga and Tasman Road borrow sites would be retained.

The proposal would remove 190 trees including five stags, three hollow-bearing trees and 47 trees with a diameter at breast height of greater than 40 centimetres. River Red Gums would comprise 87 per cent of the trees to be removed. Most of these trees have regrown since previous clearing. Of the trees proposed to be removed, 28 would be removed for the upgrade of the North Wagga Wagga and East Street (Bank Two) Levees and 162 would be removed for the upgrade of the Main City Levee.

The removal of trees would reduce the amount of nesting, roosting, movement and foraging habitat for fauna in the study area and would remove known threatened species habitat from the proposal site. Mortality or injury may occur to fauna present during the clearing process unless protection measures are implemented.

Hollow-bearing trees

The proposal would remove three hollow-bearing trees, including a standing dead tree. These trees contain eight hollows. Hollow-bearing trees proposed to be removed or retained are

mapped in Figure 6.3. At least 29 additional hollow-bearing trees occur within 10 metres of the proposal site. Many more occur in the study area (ie within 500 metres of the proposal site).

Hollow-bearing trees are critical habitat components for many fauna species in the study area. Their removal would result in a loss of potential hollow resources for tree-dwelling species such as arboreal mammals, microchiropteran bats and woodland birds. These species may rely on hollows for shelter and breeding habitat.

Two threatened species that utilise hollow-bearing trees were recorded during current surveys. The Superb Parrot, which is listed as vulnerable under both the TSC Act and EPBC Act, is known to breed in the hollows of River Red Gum trees along the Murrumbidgee River in the locality. The Brown Treecreeper, which is listed as vulnerable under the TSC Act, also relies on hollows for nesting. The removal of hollow-bearing trees has the potential to impact on the breeding cycle of both of these species. Squirrel Gliders and Barking Owls are also known to occur in the study area. Both of these species are dependent on hollow-bearing trees for nesting.

The hollow-bearing trees surveyed within 10 metres of the proposal site contain 148 hollows. The loss of eight hollows in the three hollow-bearing trees proposed to be removed represents about five per cent of the hollows within 10 metres of the proposal site and a much smaller proportion of the hollows that occur in the study area.

Due to the much greater number of hollow-bearing trees in the study area, the removal of three hollow-bearing trees is unlikely to significantly impact fauna in the study area.

Removal of water from North Wagga borrow pit

If water is present in the existing North Wagga borrow pit at the time of construction, it may be pumped out of the pit for irrigation on a neighbouring property, if necessary. The borrow pit provides only limited aquatic habitat for species such as frogs. The pumping of water out of the pit would be unlikely to have a substantial impact on flora or fauna.

Indirect impacts

Sedimentation

Sedimentation of the Murrumbidgee River may result from the proposal through vegetation removal and machinery works adjacent to the river banks. These works have the potential to destabilise the banks, leading to further erosion of the channel and deposition of sediment. This is a particular risk where the river banks are likely to be unstable.

Sedimentation has the potential to affect aquatic flora and fauna, including fish. Fish will normally move away from highly turbid water; however, turbid water may block fish passage if it occurs during migration periods. More extreme impacts on fish species as a result of sedimentation and accompanying turbidity increases in the river can include:

- Smothering of gill surfaces with sediment leading to asphyxiation
- Swallowing of large amounts of sediment leading to illness
- Inhibition of light penetration into the water column which can affect predator-prey interactions
- Impacts on habitat diversity in the immediate area and downstream by smothering and filling of interstitial spaces inhabited by fish.

Vegetation would not be removed from the river banks and safeguards would be put in place to minimise sedimentation, as described in section 6.2. Any sedimentation resulting from the proposal would be short-term and appropriate construction site management would ensure there are no significant impacts associated with sediment losses from the work site.

Water quality impacts on flora and fauna

Potential accidental spills of contaminants such as fuel or chemicals (see section 6.2.2) could impact on aquatic fauna and flora in the Murrumbidgee River. Safeguards identified in section 6.2.3 would minimise the risk of water quality impacts.

Weeds

The groundcover vegetation in the study area is dominated by introduced species. The proposal has the potential to further introduce and spread weeds in the study area by movement of machinery and light vehicle traffic and disturbance associated with vegetation removal.

Seven noxious weed species were identified during the surveys. The proposal could cause the further spread of noxious weeds such as St John's Wort and Paterson's Curse, which are the most commonly occurring noxious weed species. The spread of noxious weeds poses the increased risk of their encroachment into areas of native vegetation and the degradation of habitat for native species in the locality. The implementation of safeguards detailed in section 6.1.4 would limit the potential for the spread of weeds associated with the proposal.

Disturbance of fauna

The proposal has the potential to temporarily affect the use of the study area by fauna as a result of increased disturbance during vegetation removal and construction. The use of machinery may temporarily deter some fauna species from using potential habitat in the study area during construction.

Cumulative impacts

The proposal would cause impacts additional to those that have occurred due to previous land use activities in the study area; including residential, commercial and agricultural activities. The proposal would reduce the overall extent of native vegetation cover in a fragmented residential and commercial landscape. Other works that may contribute to cumulative ecological impacts in the study area include vegetation maintenance for linear infrastructure such as roads and powerlines.

The proposal occurs in a locality where there is ongoing development pressure for residential and commercial purposes. The proposal would contribute to the cumulative impacts of the continuing expansion and proposed growth of these areas, placing increased pressure on threatened fauna.

Key threatening processes

Key threatening processes listed under the TSC Act, FM Act and/or EPBC Act relevant to this proposal are:

- Clearing of native vegetation (TSC Act and EPBC Act)
- Clearing of hollow-bearing trees (TSC Act)
- Removal of dead wood and dead trees (TSC Act)
- Degradation of native riparian vegetation (FM Act)
- In stream structures and other mechanisms that alter flow (FM Act).

The impact of the proposal in relation to these processes is discussed in detail in the ecological assessment in Appendix H. The clearing of native vegetation and of hollow-bearing trees is likely to affect biota listed under the TSC Act and EPBC Act (see section titled *Summary of impact assessment* below).

Summary of impact assessment

The literature review, database search and field surveys identified 10 bird species, three bat species, a mammal population and an ecological community listed under the EPBC Act, TSC Act and/or FM Act known or likely to occur in the study area. A list of the species that could potentially be impacted by the proposal is provided in Table 6.2.

For those biota listed under the TSC Act and FM Act, an assessment of significance (7 part test) was applied under section 5A of the EP&A Act to assist in determining if a significant impact is likely (see ecological assessment in Appendix H).

For those biota listed under the EPBC Act, a significance assessment as detailed in the policy statement *Matters of National Environmental Significance: Significance impact guidelines 1.1* (DEWHA 2009) was used to assist in determining if a significant impact is likely (see ecological assessment in Appendix H).

Table 6.2: Threatened and migratory species and ecological communities that have the potential to be impacted by the proposal

Species / ecological community	Status
Birds	
Barking Owl *Ninox connivens*	V – TSC Act
Brown Treecreeper (eastern subspecies) *Climacteris picumnus victoriae*	V – TSC Act
Diamond Firetail *Stagonopleura guttata*	V – TSC Act
Flame Robin *Petroica phoenicea*	V – TSC Act
Little Eagle *Hieraaetus morphnoides*	V – TSC Act
Rainbow Bee-eater *Merops ornatus*	Mi – EPBC Act
Scarlet Robin *Petroica boodang*	V – TSC Act
Superb Parrot *Polytelis swainsonii*	V – EPBC Act V – TSC Act
Varied Sittella *Daphoenositta chrysoptera*	V – TSC Act
White-fronted Chat *Epthianura albifrons*	V – TSC Act
Mammals	
Squirrel Glider population in the Wagga Wagga Local Government Area *Petaurus norfolcensis*	EP – TSC Act
Eastern Bentwing-bat *Miniopterus schreibersii oceanensis*	V – TSC Act
Little Pied Bat *Chalinolobus picatus*	V – TSC Act
Southern Myotis *Myotis macropus*	V – TSC Act

Species / ecological community	Status
Ecological community	
Lowland Murray River endangered ecological community	EEC – FM Act

V – vulnerable, E – endangered, Mi – migratory, EP – endangered population, EEC – endangered ecological community

The ecological assessment found that the proposal would be unlikely to have a significant impact on any species, population or ecological community listed under the TSC Act or EPBC Act mainly due to the small area of habitat proposed to be removed and the low number of hollow-bearing trees proposed to be removed.

6.1.4 Safeguards and management measures

Impact	Safeguard	Timing and responsibility
Loss of native vegetation communities	• Where possible, the detailed design of the proposal would incorporate measures to minimise vegetation removal • Consultation would be undertaken with the NSW Department of Primary Industries – Fishing and Aquaculture in regard to offsetting the removal of native vegetation • All staff would be inducted and informed of the limits of vegetation clearing and the areas of vegetation to be retained. Areas of vegetation not to be removed would be clearly marked prior to construction.	Pre-construction Council Contractor
Spread of weeds	• A weed management plan would be prepared before works commencing, for implementation before, during and after the works.	Pre-construction Contractor
Loss of mature trees and hollow-bearing trees	• Removal of native trees would be minimised wherever possible • Pruning and lopping of limbs would be conducted in preference to tree removal, wherever practicable, particularly in the case of hollow-bearing trees • Where practicable, removal of hollow-bearing trees would not occur in the main fauna breeding season (August to December). If possible, hollow-bearing tree removal would also be avoided in June and July to minimise impacts on bats that may be in a state of torpor • Hollow-bearing trees would be retained as presented in the maps accompanying this REF (Figure 6.3a-e) • Suitably trained personnel would be on site during the removal of hollow-bearing trees to assist in the rescue and/or relocation of any resident fauna	Construction Contractor

Impact	Safeguard	Timing and responsibility
	• Habitat pruning techniques (see Appendix G of ecological assessment in Appendix H) would be used to offset the loss of hollows at a 10:1 ratio. Habitat pruning would use non-hollow-bearing trees. Habitat pruning would be used in preference to placement of nest boxes where possible • Where appropriate hollow limbs of trees would be retained on the ground as potential habitat for ground dwelling fauna • The critical root zones of trees not being removed would be protected in accordance with the Australian Standard – *Protection of trees on development sites* (AS4970-2009) • Excavation of material from the North Wagga Wagga borrow site would not encroach on the drip line of the trees in the vicinity of the site.	
Disturbance of woodland habitat	• All vehicles, plant and equipment used for operations would remain within the proposal site, or on existing tracks, roadside verges, bitumen roads, the existing levee bank or cleared agricultural areas.	Construction Contractor
Loss of woody debris habitat	• Where appropriate woody debris generated from the lopping of trees would be retained as habitat on the ground. The woody debris retained would not be stacked but spread in a fashion that replicates the natural occurrence of woody debris in the environment. The total length of logs placed as woody debris, and the length of logs already existing, would not exceed 56 metres per 0.1 hectares (1,000 square metres).	Construction Contractor
Spread of weeds	• Vehicle and machinery wash/brush downs may be required to ensure that noxious weed species are not spread to previously non-infested areas • Declared noxious weeds would be managed according to the requirements of the NSW *Noxious Weeds Act 1993*. All noxious weeds and environmental weed species would be removed in consultation with Council Noxious Weeds officers.	Construction Contractor
Disturbance of aquatic habitat	• Vehicle movement on the river banks would be restricted wherever practicable to avoid disturbance of aquatic habitat and siltation of the river.	Construction Contractor

6.2 Soils, water quality and groundwater

6.2.1 Existing environment

Topography and geology

The study area is located in the Murrumbidgee - Tarcutta Channels and Floodplains Mitchell Landscape, which comprises channels, floodplain and terraces of Murrumbidgee tributaries rolling hills, low rises and ridges. The general elevation is 180 metres to 400 metres above sea level. Local relief is about 25 metres (Mitchell 2003).

The terrain of the study area is relatively flat, being on the floodplain of the Murrumbidgee River. Minor changes in terrain occur adjacent to the river where natural levees and river banks have formed. These have variations in elevation of up to one metre.

In the vicinity of chainage 5500 the elevation of the land surface increases where there is a hill around which the Murrumbidgee River flows, called 'Church Hill'.

An assessment of the existing levee banks (Aitken Rowe Testing Laboratories 2007) identified that the levee banks along the Murrumbidgee River range in height from 1.5 metres to 4.5 metres, with batter slopes generally ranging from about 30° to 55°.

The geology of the study area comprises an unnamed unit with sedimentary geology. It consists of a Quaternary lithology of gravel, sand, silt and clay (NSW Department of Mineral Resources 2002).

Soils

The study area is located in the Murrumbidgee - Tarcutta Channels and Floodplains Mitchell Landscape, which contains undifferentiated organic sand and loam on the floodplain, with brown gradational loam and yellow texture-contrast soils on higher terraces (Mitchell 2003). Soils are also likely to contain clay, silt and gravel (NSW Department of Mineral Resources 2002).

The soils and stability of the existing levees are described in section 2.2.3.

Geotechnical investigations were carried out at or near the proposed Tasman Road and Copland Street borrow sites (Aitken Rowe Testing Laboratories 2009) and at the North Wagga borrow site (Aitken Rowe Testing Laboratories 2008).

The results of these investigations were as follows:

- Tasman Road borrow site – most of the soil materials assessed were found to be medium to high plasticity silty clays
- Copland Street borrow site – most of the soil materials assessed were found to be medium to high plasticity silty clays and some medium plasticity silty sandy clay
- North Wagga borrow site – most of the soil materials assessed were found to be low to medium plasticity silty clay in the upper profile and medium to high plasticity silty clays at greater depths. Some low to medium plasticity sandy clay, fine to medium grained clayey sand and clayey sand gravel materials were found in certain boreholes at depths ranging from 3.8 metres to 4.5 metres.

Soil contamination

Former gasworks site

A search of the OEH contaminated land register identified one declared contaminated site in the study area. This is the former gasworks at Tarcutta Street at chainage 5700 (see Figure 1.1). The declaration was issued on 10 August 2007. The search result is provided in Appendix G.

The former gasworks site is contaminated with wastes including tar, ash, coke and spent oxides (EES 2009). Spent oxides, ash and coke occur at depths from 0 to three metres. Tar occurs at depths from 1.5 to 10 metres.

The site is being remediated by Wagga Wagga City Council. The remediation is taking place primarily in areas contaminated with tar. Remediation of this site is expected to commence in January 2013 and would be completed over about 12 months. Remediation is likely to be completed before any proposed levee upgrade works at this location.

Other areas in the vicinity of the former gasworks site not being remediated are known to be contaminated with ash and coke, but not with tar. Ash and coke may contain carcinogenic chemicals. The proposal site intersects one of these areas.

Electrical substation – Hammond Avenue

The electrical substation on Hammond Avenue at chainage 7500 was originally constructed in about the 1920s. The land in the vicinity of the substation has the potential to contain polychlorinated biphenyls (PCBs) and hydrocarbons. PCBs are known to have detrimental effects on human health and fauna. They were used extensively in the electrical supply industry from the 1930s to 1970s.

Pitch 'n' Putt landfill site

The Pitch 'n' Putt landfill site is located on Narrung Street at chainage 3500. At the current stage of planning no works are anticipated at this site due to the existing height of the levee above the 100 year ARI flood level. The site is likely to contain contaminants from waste disposal, which occurred at the site until around the late 1970s.

Water quality

The proposal site is located adjacent to the Murrumbidgee River. All water runoff from the study area drains to the river.

Council monitors water quality in the Murrumbidgee River upstream and downstream of Wagga Wagga to assess health and point source pollution. Measurements of various water quality parameters from the Murrumbidgee River from November 2009 to October 2012 are provided in Table 6.3.

The results indicate that there is little difference in water quality parameters upstream and downstream of Wagga Wagga. Water salinity (electrical conductivity) in the Murrumbidgee River is generally below 0.2 deciSiemens per metre.

Table 6.3: Summary of Murrumbidgee River monthly water quality data upstream and downstream of Wagga Wagga from November 2009 to October 2012

Value	Parameter						
	Electrical conductivity (dS/m)	Dissolved oxygen (%sat)	pH	Temperature (°C)	Turbidity (NTU)	Total nitrogen (mg/L)	Total phosphorus (mg/L)
Upstream – Shanty Reserve							
Maximum	0.2	128	8.3	27.2	264.0	4.0	0.3
Minimum	0.04	63	6.2	10.1	7.0	<2	0.01
Average	0.1	88.5	7.6	17.3	42.5	<2	0.1
Downstream – Roach Road							
Maximum	0.3	113	8.3	27.9	111.0	4.0	0.2
Minimum	0.02	62	6.9	8.9	6.0	<2	0.01
Average	0.1	84.4	7.7	16.9	42.4	<2	0.1

dS/m – deciSiemens / metre, %sat – per cent saturation, °C – degrees Celsius, NTU – nephelometric turbidity units, mg/L – milligrams / litre

Source: Wagga Wagga City Council – data supplied November 2012

Water quality monitoring results are compared to the Australian and New Zealand Environment and Conservation Council (ANZECC) guidelines for fresh and marine water quality – 2000. Most results are within the ANZECC guidelines; however results outside the guidelines are sometimes measured for total phosphorus, pH, turbidity and dissolved oxygen. All results for nitrogen and electrical conductivity are within the ANZECC guidelines.

The water quality of the Murrumbidgee River is affected by urban and agricultural runoff.

The four main types of urban stormwater pollution (OEH 2012b) are:

- Litter, such as cigarette butts, cans, paper or plastic bags
- Chemical pollution, such as detergents, oil or fertilisers
- 'Natural' pollution, such as leaves, garden clippings or animal droppings
- Sediment pollution, such as soil erosion and runoff from building sites and unsealed roads.

Agricultural runoff may contain farm chemicals and fertilisers that degrade water quality. Agricultural runoff may also contain manure from stock, which can increase:

- Biochemical oxygen demand
- Levels of nutrients such as nitrogen

- Levels of bacteria such as faecal coliforms.

Groundwater

Groundwater levels are of most importance where fill would be excavated from the proposed borrow sites. For the North Wagga borrow site, bore records within 250 metres of the site (Office of Water 2010) indicate that the water table is at about five metres. At the Copland Street borrow site, Council groundwater monitoring data (Wagga Wagga City Council 2011b) indicate that the water table is at about nine metres. For the Tasman Road borrow site, a bore record 350 metres from the site (Office of Water 2010) indicates that the water table is at about 12 metres.

In the vicinity of the Main City Levee the water table has been recorded at depths of about nine to 11 metres and in the vicinity of the North Wagga Wagga levees at depths of eight to 12 metres.

In general, the depth to the water table would vary with season, rainfall, elevation, proximity to the river and presence of aquifers.

Geotechnical investigations were carried out at the three proposed borrow sites in December 2009 (Tasman Road and Copland Street borrow sites) and January 2008 (North Wagga borrow site). No groundwater was encountered to depths of 3.5 metres, 4.5 metres and five metres at the Tasman Road, Copland Street and North Wagga Wagga borrow sites, respectively (NSW Public Works 2010a).

6.2.2 Potential impacts

Soils

The following construction activities have the potential to directly impact on the soil environment.

Vegetation removal

About 44 hectares of vegetation would be removed as part of the proposal. Vegetation removal would expose soils to weathering processes, increasing the risk of erosion and sedimentation.

Earthworks

Impacts on soils during earthworks could result from the following activities:

- Stripping and stockpiling topsoil from the levees
- Excavating the existing levee banks and foundations
- Excavation and transport of material from the proposed borrow sites
- Placement and compaction of fill for levee embankments
- Placing and trimming random fill and topsoil for rehabilitation and revegetation of the levee banks.

The total volume of solid fill material required for the project is 131,070 cubic metres. The fill requirements of the proposal have the potential to impact on soils and landforms.

During construction, periods of heavy and frequent rainfall could lead to increased runoff and flooding. Topsoil stockpiles, exposed embankments and disturbed areas are susceptible to erosion during these times. It is possible that a flood could occur during the construction of the levee upgrades before the levees have been stabilised.

Loose fill may be eroded during rainfall events by runoff, increasing the potential for mass movements of soils and sedimentation of local drainage lines. This may in turn influence the

vegetation and habitat of adjacent areas by smothering groundcover vegetation and changing soil surface characteristics.

Fill material would be excavated from the proposed borrow sites identified in section 3.3.5. Excavations have the potential to destabilise at borrow pit faces.

Topsoil stripped from the existing levees would require stockpiling before being spread on the upgraded levees. Inadequately stabilised stockpile material could erode in periods of high rainfall or windy conditions.

Rehabilitation of the levee banks would require minor topsoil earthworks that could lead to the erosion of disturbed soils where they are not stabilised.

Vehicle movements, including machinery and support vehicles

Machinery and support vehicles used for the construction of the proposal would be driven off road and would have the potential to transport excess material onto sealed roads near construction sites and stockpile areas.

Erosion of levee after construction

Increased scouring during flooding could occur as a result of the upgrade of the levees and increased flow velocities. In general though, the levee upgrade would be likely to provide greater stability to the levees, reducing the potential for destabilisation and soil erosion during flood events.

Wherever earthworks are proposed to upgrade the Main City Levee, the proposal would improve the shared bicycle and pedestrian pathway that forms the Wiradjuri Walking Track by constructing a three metre wide crest surfaced with sprayed seal bitumen. This surface would give added protection to the Main City Levee against erosion.

Overall impacts

Impacts on soils are likely to be moderate, although localised and short-term. Provided stabilisation strategies are effectively implemented, medium to long-term impacts would be low. Stabilisation and revegetation would act to resist soil erosion.

Soil contamination

Former gasworks site

At the former gasworks site the Main City Levee would be realigned to meet the requirements of the Riverside Wagga Wagga Strategic Master Plan. The proposal would involve excavating a key trench (minimum depth 50 centimetres) under the levee for intercepting potentially contaminated seepage from the former gasworks site.

The excavation of the key trench has the potential to expose and mobilise soils contaminated with ash and coke. These contaminants may contain carcinogenic chemicals. The excavation of the key trench therefore poses a risk to human health, as well as the environment.

Electrical substation – Hammond Avenue

The existing Main City Levee would be upgraded in the vicinity of the electrical substation. It is anticipated that excavation at this location would be to a depth of about 10 centimetres during initial earthworks. There is a low risk that excavation could inadvertently occur to a depth that would expose and mobilise soils contaminated with polychlorinated biphenyls (PCBs) and hydrocarbons. PCBs are known to have detrimental effects on human health and fauna. Inappropriate excavation near the substation site therefore poses a risk to human health, as well as the environment.

Pitch 'n' Putt landfill site

At the current stage of planning no works are anticipated at the Pitch 'n' Putt landfill site due to the existing height of the levee above the 100 year ARI flood level. Provided no excavation occurs at this site, it would be unlikely that the proposal would cause any contamination impacts at this site.

Fuel and chemical spills

There is potential for fuel or chemical spills during construction, which may result in localised contamination of soils. Spills could occur during refuelling or through leaking of hydraulic and lubricating oil from plant and equipment. The potential for contamination from fuel and chemical spills is considered to be low provided the safeguards and management measures outlined in section 6.2.3 are implemented.

Water quality

The introduction of pollutants from construction of the proposal into the surrounding environment, if uncontrolled, could potentially have the following impacts on the water quality of the Murrumbidgee River and drainage lines:

- Increased sediment load and organic matter causing adverse impacts to water quality in the river, such as increased turbidity. Provided safeguards and management measures are implemented, the proposal would be unlikely to contribute significant amounts of sediment and organic matter to the Murrumbidgee River
- Gross pollutants (large waste items) entering the Murrumbidgee River
- Reduced water quality in the Murrumbidgee River due to an influx of man-made substances.

Construction activities could introduce additional materials to the Murrumbidgee River and local drainage lines, particularly during high rainfall events. Contaminants could include rubbish and construction materials, and fuel or chemicals from accidental spills. Spills could occur during refuelling or through leaking of hydraulic and lubricating oil from plant and equipment.

The potential for construction water quality impacts to the Murrumbidgee River and surrounding drainage lines is considered to be moderate.

Groundwater

Excavation at the proposed borrow sites would occur to a depth of three metres below the natural ground surface. The water table depth at these sites varies from about five metres to 12 metres. It is therefore unlikely that the proposed excavation of material from the borrow sites would intercept the water table. The proposal would be unlikely to directly affect any groundwater systems during construction.

It is also unlikely that the proposal would impact on groundwater users due to the minimal depth of excavation.

The proposal has the potential to cause increased recharge of water to the water table. This could occur through the removal of trees that currently intercept water moving through the soil profile and through re-directing runoff from hard surfaces to locations where increased infiltration may occur. This has the potential to contribute to localised salinity. Known areas of salinity in Wagga Wagga are located away from the proposal site, and the likelihood of the proposal causing salinity in the study area is low.

Groundwater contamination

There is potential for fuel or chemical spills where machinery is refuelled at the proposed borrow sites. A spill could occur from on-site fuel storage tanks, which could drain into the borrow pits and potentially enter the groundwater.

6.2.3 Safeguards and management measures

Impact	Safeguard	Timing and responsibility
Soil erosion, sedimentation and water quality	• A soil and water management plan would be prepared as part of the CEMP for the proposal in accordance with the Blue Book - Soils and Construction - Managing Urban Stormwater Volume 1 (Landcom 2004) and Volume 2D (DECC 2008a) • The soil and water management plan would include but not be limited to: – An erosion and sedimentation control plan and a maintenance schedule for ongoing maintenance of temporary erosion and sediment controls – An incident emergency spill plan which would include measures to avoid spillages of fuels, chemicals, and fluids onto any surfaces or into any adjacent/nearby waterways. • A soil conservationist would provide advice during development and implementation of the soil and water management plan. The soil conservationist would regularly review and inspect works throughout the construction phase • The detailed design of the levee upgrades would include adequate drainage controls • A rehabilitation plan would be prepared for the proposed borrow sites.	Pre-construction Contractor
Soil and groundwater contamination	• A contamination management plan would be prepared before construction • Assessment of whether soil contamination exists in the proposal site would be undertaken in non-remediated areas near the former gasworks site at chainage 5700, and near the electrical substation on Hammond Avenue at chainage 7500. Council would liaise closely with Essential Energy to determine where any potential contamination near the substation is likely to occur • If it is determined that excavation is required in the vicinity of the Pitch 'n' Putt landfill site on Narrung Street at chainage 3500, assessment of whether any soil contamination exists in the proposal site would be	Pre-construction Council

Impact	Safeguard	Timing and responsibility
	completed.	
Soil erosion and sedimentation	• Topsoil stockpile sites would be located at least 20 metres away from the Murrumbidgee River and drainage lines, and where possible on the opposite side of the levee to the Murrumbidgee River • Erosion and sedimentation control measures would be implemented around the levee and stockpile sites during construction • Clearing of vegetation and stabilisation/revegetation activities would be carried out progressively to limit the time disturbed areas are exposed to erosion processes • Mulched vegetation would be used in sediment erosion controls, stabilisation and rehabilitation where appropriate • Site stabilisation of disturbed areas would be undertaken progressively as stages are completed • Soil disturbance would be avoided as much as possible • Soil and debris transported onto roads by construction vehicles would be cleaned and removed regularly • High risk soil erosion activities such as earthworks would not be undertaken immediately before or during high rainfall or wind events • Construction erosion and sediment control measures would be maintained until the works are complete and areas are stabilised by revegetation • Revegetation would be completed using locally native groundcover species.	Construction Contractor
Soil and groundwater contamination	• If soil contamination is discovered during construction, works at that specific location would cease, the site would be temporarily fenced and access would be restricted. Soil sampling and analysis would be conducted to assess the extent and nature of the contamination. Remediation would be conducted in line with the guidelines in *Managing Land Contamination: Planning Guidelines SEPP 55–Remediation of Land* (NSW Government 1998) • Any fuel storage tanks kept on site would be bunded • A buffer of 20 metres would be maintained between any fuel storage tanks and the proposed borrow sites.	Construction Contractor

Impact	Safeguard	Timing and responsibility
Water contamination	• No fuels, chemicals or liquids would be stored at the proposed levee upgrade sites • Fuels delivered to site would be transported using appropriate fuel tankers • The refuelling of plant and planned maintenance of machinery and plant would be undertaken 50 metres away from waterways • Refuelling would occur over a bunded surface to prevent any spills from entering the soil or water • Machinery would be checked daily for leaks of oil, fuel or other liquids • Visual monitoring of local water quality (ie turbidity, hydrocarbon spills/slicks) is to be undertaken on a regular basis to identify any potential spills or deficient erosion and sediment controls • Emergency spill kits would be kept on-site at all times • All staff would be inducted about incident and emergency procedures and made aware of the locations of emergency spill kits • Should a spill occur during construction, a Council senior environmental officer would be contacted. The EPA would also be notified as per Part 5.7 of the POEO Act.	Construction Contractor
Soil erosion and sedimentation	• Ongoing monitoring and maintenance of revegetation of the levee banks would be undertaken.	Operation Council

6.3 Hydrology and flooding

6.3.1 Existing environment

Location, catchment and history of river regulation

The study area is located on the Murrumbidgee River floodplain at Wagga Wagga. The river is about 900 kilometres in length. Wagga Wagga is located about 450 kilometres downstream of its source.

The Murrumbidgee River generally flows from east to west through NSW and the ACT and is a major tributary of the Murray River. The total catchment of the Murrumbidgee River is about 80,000 square kilometres. The catchment area of the Murrumbidgee River at Wagga Wagga is about 26,400 square kilometres (WMA Water 2012). The Wagga Wagga LGA is located where the mountains of the Great Dividing Range transition to the flat country of the Riverine Plain.

Two major dams have been constructed on the river; Tantangara Reservoir near the source of the river (constructed in 1960) and Burrinjuck Dam near Yass (constructed in 1928 and

enlarged in 1957). Blowering Dam was constructed on the biggest tributary of the Murrumbidgee River, the Tumut River, north of Talbingo in 1968. Talbingo Dam was constructed on the Tumut River, at Talbingo in 1970.

Flood record

The Murrumbidgee River flood record is extremely variable. Frequent floods occurred around 1974 and from 1950 to 1956. Periods where no significant flooding occurred include from 1939 to 1949, 1960 to 1970 and 1992 to 2006 (WMA Water 2009a).

Records of floods greater than 10 metres in height at the Hampden Bridge gauge are provided in Table 6.4.

Table 6.4: Record of floods in the Murrumbidgee River at Wagga Wagga greater than 10 metres

Month	Year	Hampden Bridge gauge height
June	1852	10.67[1]
July	1853	11.04[1]
April	1870	10.67[2]
June	1891	10.47[2]
May	1925	10.11[2]
March	1950	10.06[2]
August	1974	10.74[2]
March	2012	10.60[3]

Sources: Gormly (undated)[1], DLWC (1999) - Pinneena[2], Wagga Wagga City Council (2012)[3]

A number of smaller but still significant and damaging floods have also occurred at Wagga Wagga. Between 1886 and 2005, 76 floods occurred with peak heights over 8 metres at the Hampden Bridge gauge (WMA Water 2009b).

The most significant floods (greater than 9.3 metres in height at the Hampden Bridge gauge) that have occurred since 1974 are provided in Table 6.5.

Table 6.5: Record of floods in the Murrumbidgee River at Wagga Wagga greater than 9.3 metres since 1974

Month	Year	Hampden Bridge gauge height
August	1974	10.74[1]
October	1975	9.58[1]
October	1976	9.38[1]
July	1991	9.61[1]
December	2010	9.67[2]
March	2012	10.60[2]

Sources: DLWC (1999) - Pinneena[1], Wagga Wagga City Council (2012)[2]

Most floods recorded at Wagga Wagga have occurred in autumn or winter, but a number of floods have also occurred in spring and summer (Wagga Wagga City Council 2012).

Typical flow patterns

Flows in the Murrumbidgee River are highly regulated, and are influenced by demand for water in the Murrumbidgee and Coleambally Irrigation Areas. Typically, low flows occur in winter, with higher flows in spring and summer. In recent years, high rainfall and flooding have influenced the timing of flows in the river. High flow events have also recently been associated with the release of environmental flows, aimed at maintaining and improving the health of aquatic ecosystems along the river.

Monthly flow heights and discharges in the Murrumbidgee River at Wagga Wagga from November 2011 to October 2012 are provided in Table 6.6.

Table 6.6: Monthly flow heights and discharges in the Murrumbidgee River at Wagga Wagga from November 2011 to October 2012

Date	Level (metres)	Discharge (megalitres/day)
01/11/2011	2.5	11,721
01/12/2011	3.2	16,773
01/01/2012	3.0	15,598
01/02/2012	2.4	11,462
01/03/2012	6.1*	71,551*
01/04/2012	2.4	11,397
01/05/2012	1.9	7,907
01/06/2012	2.4	11,193
01/07/2012	3.0	15,379
01/08/2012	3.0	15,250
01/09/2012	2.9	14,582
01/10/2012	3.2	16,536

*Data influenced by March 2012 flood

Source: NSW Government 2012

Characteristics of the study area

The study area is located on the Murrumbidgee River floodplain. Small natural levees and flood runners exist in areas adjacent to the river. A number of lagoons exist adjacent to the river, including Flowerdale, Parkan Pregan, Wollundry and Bomen Lagoons (see Figure 1.2).

The elevation of the floodplain in the study area is generally about 180 metres (Australian Height Datum). The floodplain on the Central Wagga Wagga side of the Murrumbidgee River is higher than the North Wagga Wagga floodplain. As a result, North Wagga Wagga is more prone to flooding than Central Wagga Wagga.

Central Wagga Wagga and North Wagga Wagga are classified as high hazard floodways due to the velocities and depth of flows that occur on the Murrumbidgee River floodplain (WMA Water 2009a). High hazard areas are defined in the Floodplain Development Manual (NSW Government 2005a) as areas where:

- There is a possible danger to personal safety
- The movement of trucks and hence evacuation is difficult
- Able bodied adults would have difficulty wading to safety
- There is potential for significant structural damage to buildings.

Vegetation along the river is dominated by a riparian vegetation community of River Red Gum forest of varied age structure. Other areas have been cleared for agriculture.

Three quarries along the Murrumbidgee River are located in the vicinity of Wagga Wagga. These quarries have some effect in storing water during floods.

Road and rail structures along the Murrumbidgee River at Wagga Wagga that interact with floodplain flows include the Gobbagombalin, Wiradjuri and Eunony road bridges, as well as the decommissioned Hampden Bridge and the Murrumbidgee River Rail Bridge (see Figure 1.1).

A four hectare commercial development is located on the corner of Kooringal Road and Hammond Avenue, 350 metres from the proposal site. This is being constructed on an earthen pad to above the 100 year ARI flood level. Other commercial developments could occur in the Hammond Avenue and Copland Street areas in future.

Levees

Levees that have been constructed around Central Wagga Wagga and North Wagga Wagga include the Main City Levee, North Wagga Wagga Levee and East Street (Bank Two) Levee, as described in section 2.2 (see Figure 1.1). Other flood levees include the Gobba levee, Gumly Gumly levee and low banks constructed at Kurrajong Lagoon, as described in section 2.2.4.

The Main City Levee protects about 2,000 buildings from flooding for flood events up to the 60 year ARI flood level (WMA Water 2009b). The North Wagga Wagga levees protect 91 buildings from flooding for flood events up to the 17 year ARI flood level (WMA Water 2009b and information provided by Wagga Wagga City Council).

6.3.2 Potential impacts

Impacts on flood depth, velocity, extent and duration

Council uses flood modelling data to predict the impact of the proposal on flood depth, velocity, extent and duration in the Wagga Wagga local government area. Council uses a flood modelling software application called the '*TUFLOW 2D hydraulic model*' (WMA Water 2010). The modelling of floodwater depth and flow at different locations varies with topography, river flow and other factors.

Land surface topographic data used by the '*TUFLOW 2D hydraulic model*' flood modelling software were collected in 2008. It is recognised that changes in the topography of the floodplain have occurred since 2008, including changes relating to commercial and industrial developments and changes in land surface caused by the 2010 and 2012 floods. These changes are unlikely to substantially affect the overall assessment of the impacts of the proposal on flooding in areas outside the levees. Nevertheless, Council will endeavour to update the topographic data used in future flood modelling as funding permits.

Modelling by Council indicates that significant changes to flood depth, velocity, extent and duration would be unlikely to occur for any flood event up to the current level of flood protection

provided by the Main City Levee (the 60 year ARI flood event). Modelling by Council indicates that the proposed increase in the level of flood protection for North Wagga Wagga (from a 17 year ARI flood event to a 20 year flood event) would not substantially affect flood depth, velocity, extent or duration at any location.

The proposal would change flood depth, velocity, extent and duration for floods greater than the current Main City Levee 60 year ARI level of flood protection. The most notable effect would be the prevention of flood waters from entering Central Wagga Wagga for floods up to a 100 year ARI flood level. This is an objective of the proposal.

Flood modelling has been completed by Council to determine whether the proposed level of flood protection provided to Central Wagga Wagga would result in increases to flood depth, velocity, extent or duration at other locations, including East Wagga Wagga, Gumly Gumly and North Wagga Wagga (see locations of these suburbs in Figure 1.1). The information provided below is based on specific sites in each suburb and is not necessarily representative of the changes in flood characteristics that could occur at other sites within each suburb.

Flood depth impacts on unprotected areas

The predicted changes in flood depth at key locations for a 100 year ARI flood event caused by the proposal are provided in Table 6.7.

Table 6.7: Predicted change in flood depth at key locations for a 100 year ARI flood event

Location	Flood depth – no upgrade (metres)	Flood depth – after upgrade (metres)	Change in predicted flood depth (metres)
East Wagga Wagga (Hammond Avenue)	1.95	2.08	0.13
Gumly Gumly (Graham Avenue)	1.25	1.28	0.03
North Wagga Wagga (McPherson Oval)	2.19	2.34	0.15

Predicted using the 'TUFLOW 2D hydraulic model' (WMA Water 2010).

Maps showing the locations of the flood depth predictions are provided in Figure 6.4 to Figure 6.6.

The modelling has found that the proposal would be likely to cause minor increases in flood depth outside the areas protected by the Main City Levee. These include:

- East Wagga Wagga – the proposal is predicted to cause an increase in flood depth of about 13 centimetres for a 100 year ARI flood event. Without a levee upgrade, a flood of this magnitude would have a depth of about 1.95 metres at East Wagga Wagga. The likely increase in flood depth caused by the proposal (six per cent of the pre-upgrade flood depth) would therefore be relatively minor
- Gumly Gumly – the proposal is predicted to cause an increase in flood depth of about three centimetres for a 100 year ARI flood event. Without a levee upgrade, a flood of this magnitude would have a depth of about 1.25 metres at East Wagga Wagga. The likely increase in flood depth caused by the proposal (two per cent of the pre-upgrade flood depth) would therefore be relatively minor

- North Wagga Wagga – the proposal is predicted to cause an increase in flood depth of about 15 centimetres for a 100 year ARI flood event. Without a levee upgrade, a flood of this magnitude would have a depth of about 2.19 metres at North Wagga Wagga. The likely increase in flood depth caused by the proposal (seven per cent of the pre-upgrade flood depth) would therefore be relatively minor.

The proposal would be likely to cause minor increases in flood depth at East Wagga Wagga, Gumly Gumly and North Wagga Wagga for floods greater than the 60 year ARI flood level. For most flood-affected buildings in these areas, which are single storey buildings, the predicted impact of increases in flood depth would be unlikely to be significant, given that most of these buildings would be inundated even if the levees were not upgraded.

It is possible that these increases in flood depth could cause some buildings to be flooded that would not otherwise have been flooded. These buildings include the following categories:

- Buildings on the edge of a flood extent that are flooded as a result of increased flood depth caused by the proposal
- Buildings that have been raised that are flooded as a result of increased flood depth caused by the proposal
- Two-storey buildings where the second storey is flooded as a result of increased flood depth caused by the proposal.

In general the number of buildings that fall into these categories would be small compared to the number of buildings that would be protected by the proposal against floods greater than a 60 year ARI magnitude.

Flood velocity impacts on unprotected areas

The predicted changes in flood velocity at key locations for a 100 year ARI flood event caused by the proposal are provided in Table 6.8

Table 6.8: Predicted change in flood velocity at key locations for a 100 year ARI flood event

Location	Flood velocity – no upgrade (m/s)	Flood velocity – after upgrade (m/s)	Change in predicted flood velocity (m/s)
East Wagga Wagga (Hammond Avenue)	0.38	0.46	0.08
Gumly Gumly (Graham Avenue)	0.47	0.46	-0.01
North Wagga Wagga (McPherson Oval)	0.48	0.52	0.04

m – metres, s – second

Predicted using the 'TUFLOW 2D hydraulic model' (WMA Water 2010).

The modelling has found that the proposal would be likely to cause minor changes in flood velocity outside the areas protected by the Main City Levee. These include:

- East Wagga Wagga – the proposal is predicted to cause an increase in flood velocity of about 0.08 metres/second for a 100 year ARI flood event. Without a levee upgrade, a flood of this magnitude would have a relatively low velocity of about 0.38 metres/second

at East Wagga Wagga. The likely increase in flood velocity of 0.08 metres/second would be unlikely to significantly increase the risk of structural damages caused by flooding

- Gumly Gumly – the proposal is predicted to cause a decrease in flood velocity of about 0.01 metres/second for a 100 year ARI flood event. The proposal would be unlikely to have detrimental impacts through increased flood velocity at this location
- North Wagga Wagga – the proposal is predicted to cause an increase in flood velocity of about 0.04 metres/second for a 100 year ARI flood event. Without a levee upgrade, a flood of this magnitude would have a velocity of about 0.48 metres/second at North Wagga Wagga. The likely increase in flood velocity caused by the proposal of 0.04 metres/second would be unlikely to significantly increase the risk of structural damages caused by flooding.

The predicted 100 year ARI flood velocities for all three locations are relatively low. At velocities in excess of two metres/second, the stability of foundations and poles can be affected by scour (NSW Government 2005a). The predicted flood velocities at East Wagga Wagga, Gumly Gumly and North Wagga Wagga are all substantially less than two metres/second.

At floodwater depths in excess of two metres and even at low velocities, there can be damage to light-framed buildings from water pressure, flotation and debris impact (NSW Government 2005a). Flood depths of two metres would occur at East Wagga Wagga and North Wagga Wagga in a 100 year ARI flood event. Despite this, the predicted increases in flood velocity would be unlikely to significantly increase the risk of structural damages.

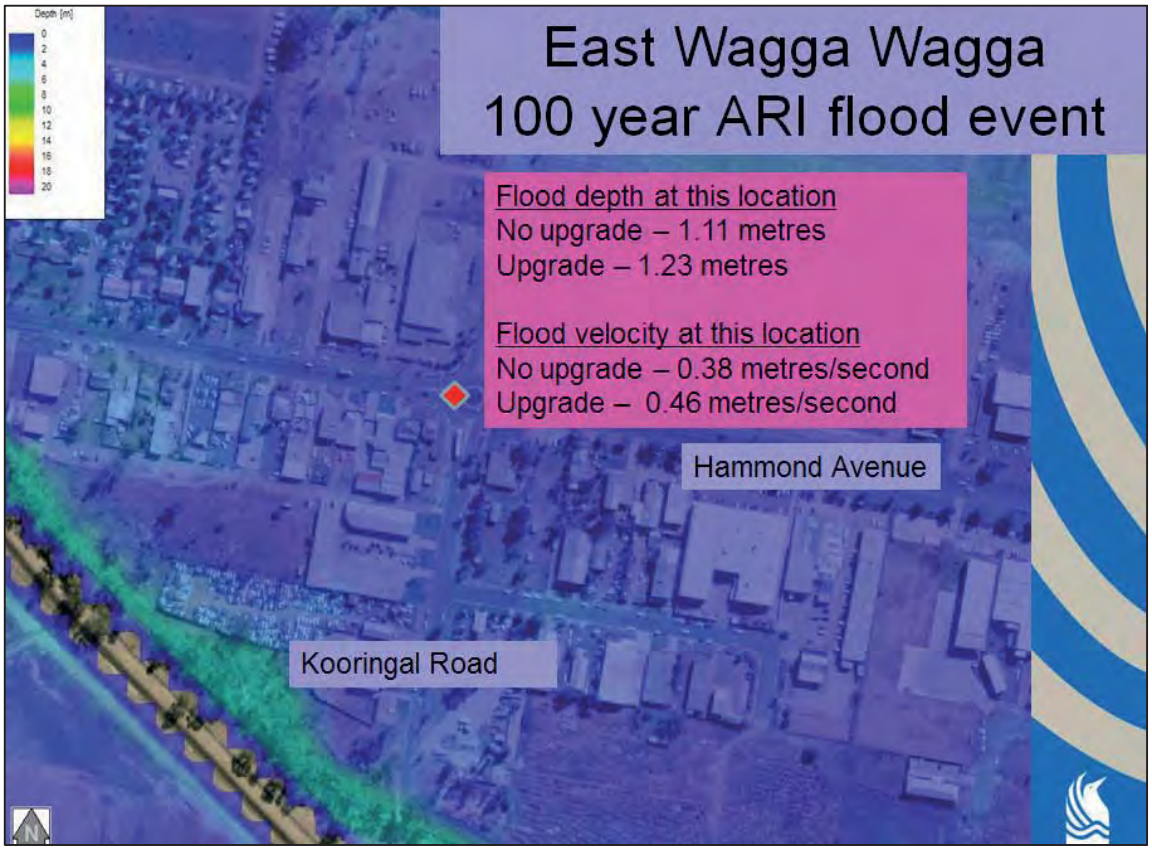

Figure 6.4: Location of East Wagga Wagga flood analysis point

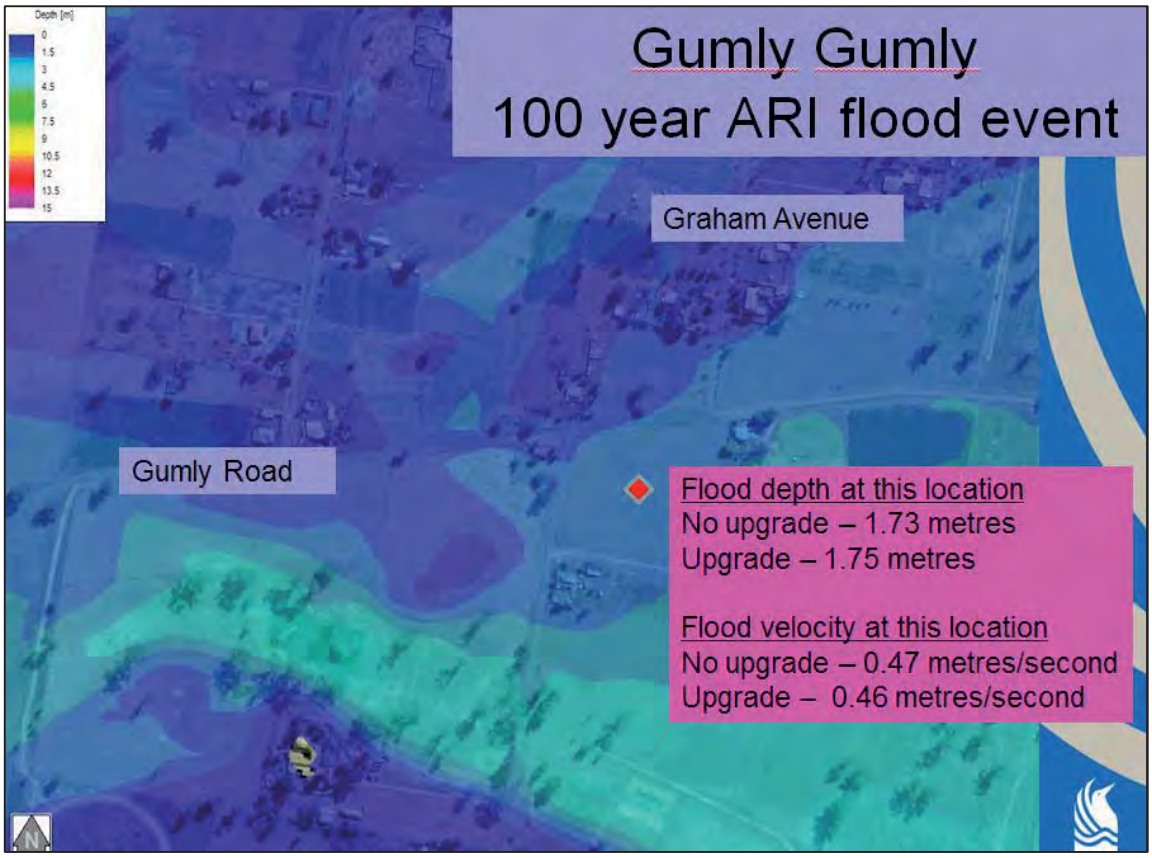

Figure 6.5: Location of Gumly Gumly flood analysis point

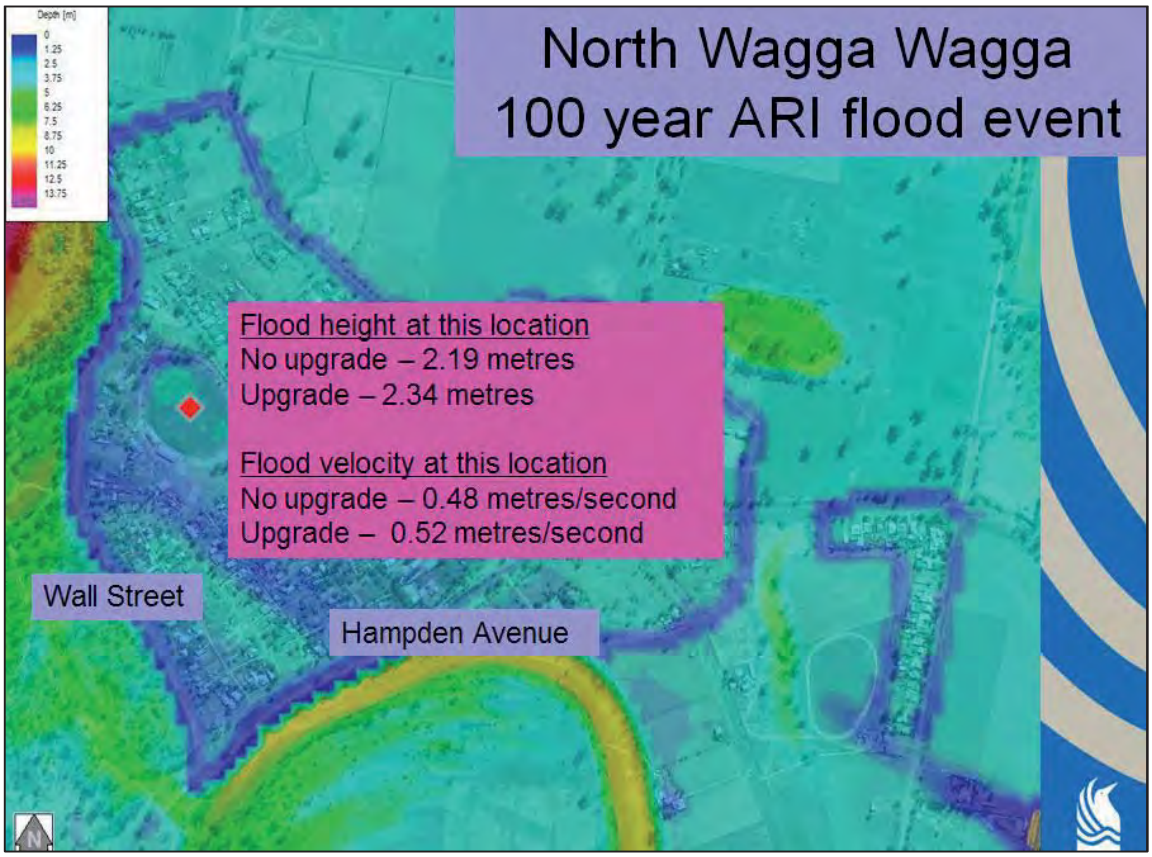

Figure 6.6: Location of North Wagga Wagga flood analysis point

Flood extent impacts on unprotected areas

Modelling indicates that the proposal would be unlikely to substantially affect the extent of flooding at any location outside the areas protected by the Main City Levee. This is despite small predicted increases in flood height for a 100 year ARI flood event. The predicted extent of flooding does not increase mainly because the land elevation increases in the vicinity of this extent.

Flood duration impacts on unprotected areas

Modelling indicates that the proposal would be unlikely to substantially affect the duration of flooding at any location outside the areas protected by the Main City Levee.

Cumulative flood impacts

The proposal could potentially cause cumulative flooding impacts with the commercial development on the corner of Hammond Avenue and Kooringal Road, as well as any other future developments. These developments have been, and will continue to be, subject to flood studies prior to approval. Wherever possible, updated topographical data would be used to assess the nature of the impacts of future developments.

Increased level of flood protection

The proposed upgrade of the Wagga Wagga levees would have a major beneficial impact through providing increased flood protection for 2,000 properties in Central Wagga Wagga and 91 properties in North Wagga Wagga.

6.3.3 Safeguards and management measures

Impact	Safeguard	Timing and responsibility
Flooding	• Council would provide the opportunity for stakeholders, property owners, residents and proprietors to have one-on-one meetings with a Council officer to speak about the levee upgrade concept designs and/or the impact of flooding. Council officers would discuss measures to protect property against flooding.	Pre-construction Council
Flooding	• For buildings that have the potential to be substantially affected by the likely increase in flood depth caused by the proposal (such as buildings on the edge of a predicted flood extent), measures such as sandbagging would be implemented if possible to protect against the likely increase in flood depth.	Operation Council

6.4 Land use and property

6.4.1 Existing environment

In general, land use in the study area is typically characterised by urban development within the levees, with rural properties used for agriculture outside the levees. Land uses in the study area are described below (see aerial photograph and chainages in Figure 1.2).

Main City Levee

- Chainage 0 to 3500 – rural properties used for grazing and horse training, low intensity industrial developments and commercial properties such as a farm machinery dealership, truck depot and rural produce cooperative. The Pitch 'n' Putt landfill site, currently used as a mini golf course and driving range, is located at chainage 3500. An off-leash dog run is located on top of the levee between chainages 3600 and 3800. A gas interception trench is located between chainages 3500 and 3800, south of the proposal site. The purpose of the trench is to intercept any gaseous emissions from the Pitch 'n' Putt landfill site
- Chainage 3500 to 4500 – residential and recreational areas
- Chainage 4500 to 6000 – commercial properties, residences, churches, caravan park, tourist information centre, recreational areas (including Wagga Beach), car parks and motels
- Chainage 6000 to 7000 – residential and recreational areas
- Chainage 7000 to 8500 – commercial and industrial properties, an electricity substation, the Riverina Water County Council headquarters and a picnic area adjacent to the levee
- Chainage 8500 to 9111 – vacant land owned by Council, the Equex sporting complex and the Wagga Wagga Monumental Cemetery
- The Wiradjuri Walking Track follows the Main City Levee between chainages 4000 and 7000, and between chainages 200 and 760. It is commonly used for recreation by Wagga Wagga residents and tourists

- Sturt Highway, Olympic Highway, Wagga Wagga streets and the Great Southern Railway.

North Wagga Wagga Levee

- Chainage 0 to 500 – residential areas, a general store, a school and Parkan Pregan Lagoon
- Chainage 500 to 3000 – residential properties, rural holdings used for grazing and Parkan Pregan Lagoon
- Chainage 3000 to 4283 – residential areas, recreational areas (Wilks Park) and a hotel
- North Wagga Wagga streets.

East Street (Bank Two) Levee

- Chainage 0 to 1378 – residential properties, rural holdings used for grazing and a private trotting track
- North Wagga Wagga streets.

North Wagga borrow site

- Rural holdings used for agriculture and some residential properties.

Tasman Road borrow site

- A go-cart track to the east, a future clay target shooting site to the north, a gun club to the north, commercial properties to the north and south-east and rural holdings used for cropping and grazing
- A powerline runs along the northern boundary of the site.

Copland Street borrow site

- Commercial properties on Copland Street to the north, the Equex sport complex to the east and rural holdings used for cropping and grazing.

6.4.2 Potential impacts

Property acquisition

Small areas of land may need to be acquired where the design of the proposal requires widening of the levees onto adjacent properties. An assessment of the requirements for property acquisition would be undertaken in relation to cadastral boundaries provided by Department of Primary Industries – Crown Land. This will occur during the detailed design phase. Any property valuations, lease fees and acquisition payments would be carried out in accordance with the *Land Acquisition (Just Terms Compensation) Act 1991* or the *Conveyancing Act 1919*.

Generally it is anticipated that the requirements for land acquisition would be relatively small and unlikely to substantially impact on the land use of adjacent properties. Where feasible, Council would minimise acquisition of land by using design options that occupy less space than embankment levees such as hybrid levees and sheet pile levees (see sections 2.4.4 and 3.2.2).

Property access

During construction there would be changes to property access as described in the section titled ‘Property access’ in section 6.10.2. Access would be maintained at all times unless otherwise agreed in consultation with the affected property owners.

Direct impacts on land use

The proposal would require the temporary removal of the off-leash dog run between chainages 3600 and 3800 on the Main City Levee during construction. The proposal would be unlikely to affect the gas interception trench between chainages 3500 and 3800 of the Main City Levee as it is located outside the proposal site.

The proposal may temporarily block access to the picnic area located at chainage 7200 during construction.

The proposal would improve public access to the river in Central Wagga Wagga by reducing the slope of the Main City Levee banks on the city side of the levee.

Indirect impacts on land use

The proposal has the potential to indirectly affect land use through impacts relating to noise and vibration, air quality and visual impacts. These impacts are assessed in sections 6.5.2, 6.6.2 and 6.7.2. Generally, impacts during construction would be short-term. The proposal would primarily upgrade the existing levees, with minor re-alignments. The proposal is therefore unlikely to cause significant long-term impacts to land use through the introduction of new levee structures.

Increased level of flood protection

The proposal would increase the level of flood protection for the City of Wagga Wagga from the current 60 year ARI level of flood protection to the 100 year ARI level of flood protection, and for North Wagga Wagga from the current 17 year ARI level of flood protection to the 20 year ARI level of flood protection.

The proposal would increase the level of flood protection for 2,000 buildings in Central Wagga Wagga and for 91 buildings in North Wagga Wagga.

Large floods have caused severe impacts and disruptions to land use through damage to property and evacuation of people. The proposal would reduce the impacts of flooding on land uses in the study area, including residences, businesses, roads, utilities and recreational land uses.

6.4.3 Safeguards and management measures

Impact	Safeguard	Timing and responsibility
Property acquisition	• Where feasible, Council would minimise acquisition of land by using design options that occupy less space than embankment levees such as hybrid levees and sheet pile levees • Any property valuations, lease fees and acquisition payments would be carried out in accordance with the *Land Acquisition (Just Terms Compensation) Act 1991* or the *Conveyancing Act 1919* • Council would consult with affected landowners and tenants on an ongoing basis regarding the status and timing of acquisition.	Pre-construction Council
Property access	• Access at local crossings during construction would be maintained at all times unless otherwise agreed in consultation with the affected property owners or	Construction Contractor

Impact	Safeguard	Timing and responsibility
	Council staff.	
Land use	• The off-leash dog run between chainages 3600 and 3800 on the Main City Levee would be temporarily relocated during construction and would be reinstated on the levee following construction • Construction works would avoid the gas interception trench between chainages 3500 and 3800 of the Main City Levee. If any impacts to the trench are unavoidable, Council would be consulted before any works are undertaken at the site.	Construction Contractor

6.5 Noise and vibration

A noise and vibration assessment of the proposal was undertaken (*Levee Upgrade Noise and Vibration Assessment*, GHD 2013) and is provided in Appendix I. The outcomes of the assessment are summarised in this section.

6.5.1 Existing environment and methodology

Sensitive receivers

Six sensitive noise catchment areas (NCA 1 to NCA6) have been identified to represent those receivers with the greatest potential for adverse impact (Figure 6.7). The noise sensitive receivers located within these noise catchment areas are primarily residential receivers.

Other sensitive receivers, including educational facilities, churches and heritage-listed buildings, have been identified based on their proximity to the proposal site (within 200 metres) (see Table 6.9).

Table 6.9: Sensitive noise and vibration receivers

Site	Receiver ID	Type
Pre-school - Galing Place	E1	Educational facility
St Joseph's Primary School	E2	Educational facility
Possums Pre-school	E3	Educational facility
North Wagga Primary School	E4	Educational facility
Wagga Wagga Baptist Church	C1	Church
Hampden Bridge	H1	Heritage building
Barters Restaurant - Prince of Wales Motor Inn	H2	Heritage building
Riverine Club	H3	Heritage building
Police station	H4	Heritage building

Site	Receiver ID	Type
Court House	H5	Heritage building
Former CBC Bank	H6	Heritage building
Former Post Office	H7	Heritage building
Wesley Uniting Church	H8	Heritage building
Department of Lands building	H9	Heritage building
Residence	H10	Heritage building
Racecourse buildings	H11	Heritage building
Cottage	H12	Heritage building
Wagga Waterworks	H13	Heritage building
Bishops House and Presbytery	H14	Heritage building
Christian Brothers High School and Staff Centre (former Monastery)	H15	Heritage building
St Andrew's Manse	H16	Heritage building
St Andrew's Presbyterian Church	H17	Heritage building
St John's Anglican Church	H18	Heritage building
St Michael's Catholic Cathedral	H19	Heritage building
Wagga Wagga General Cemetery	H20	Heritage building
Former ANZ bank	H21	Heritage building

Noise

Monitoring

Background noise monitoring for the noise assessment was undertaken in accordance with the NSW Industrial Noise Policy (EPA 2000).

Unattended noise monitoring was undertaken at six representative locations (L1 to L6) along the extent of the levee between 16 October 2012 and 30 October 2012 (see Figure 6.7). These locations are as follows:

- L1 – 10 Galing Place
- L2 – 138 Marah Street
- L3 – 139 Fitzmaurice Street
- L4 – Wagga Beach Caravan Park
- L5 – The Lawson Motel
- L6 – 49 Mason Street

Attended noise measurements were taken at each unattended noise monitoring location immediately after placement. Measurements were conducted for a period of 15 minutes in order to identify ambient noise sources and validate unattended monitoring data. Instantaneous noise levels for operator identified noise sources were observed and noted during measurements.

The results are summarised in Table 6.10.

Figure 6.7: Sensitive receivers and noise catchment areas

Table 6.10: Summary of unattended noise monitoring results

Site	Rating Background Level (RBL) L_{A90} dB(A)			Ambient L_{Aeq} dB(A)		
	Day (7 am to 6 pm)	Evening (6 pm to 10 pm)	Night (10 pm to 7 am)	Day (7 am to 6 pm)	Evening (6 pm to 10 pm)	Night (10 pm to 7 am)
L1	31	30	25	52	40	43
L2	35	33	26	54	54	45
L3	42	41	32	58	49	50
L4	36	36	31	56	51	46
L5	32	35	29	45	47	44
L6	32	35	29	45	49	44

Noise source emissions

Noise source emissions included in the noise model were based on information in the concept design report (NSW Public Works 2011), information provided by Council and the GHD noise source database. Table 6.11 details the main items of noisy plant and machinery used in the model.

Table 6.11: Construction noise equipment sound power levels dB (A)

Construction works	Noise source	Sum dB(A)	Total
Embankments	Delivery trucks (truck and dog)	110	**117**
	Excavator (22T)	99	
	Grader	115	
	Water cart	107	
	Compactor	107	
	Delivery vehicles	93	
Sheet pile walls	Excavator with pile driving hammer (hydraulic hammer rig 240 mm diameter)	124	**124**
	Small crane (hiab crane truck)	78	
	Trenching machine/small excavator (5T)	99	
	Concrete truck	103	
	Delivery vehicles	93	
	Personnel vehicles	84	
Concrete walls	Concrete trucks	103	**107**
	Concrete pump and pipework	99	
	Delivery vehicles	93	
	Generator (H8)	94	
	Power tools	102	
	Personnel vehicles	84	
Gabion walls	Delivery trucks	110	**110**
	Backhoe	95	
	Delivery vehicles	93	
	Personnel vehicles	84	
Embankment/box culvert levee	Delivery vehicles	93	**115**
	Small mobile crane	78	
	Grader	115	

Construction works	Noise source	Sum dB(A)	Total
Spillways	Delivery trucks	110	**116**
	Excavator	99	
	Grader	115	
	Delivery vehicles	93	
	Personnel vehicles	84	
Levee crossings – road raising			
Road embankment and drainage construction	Scrapers	115	**118**
	Graders	115	
	Vibrating and static rollers	107	
	Backhoes	95	
	Trenching machines	99	
	Excavator	99	
Road pavement construction	Milling machine	111	**117**
	Compactor	107	
	Vibrating and static rollers	107	
	Concrete agitator trucks	108	
	Spray sealing equipment	105	
	Line marking plant	105	
	Bitumen spraying cart and asphalt paver	111	
	Bitumen trucks	105	
	Kerb extruding machine (light truck)	104	

Construction noise criteria

The Interim Construction Noise Guideline (DECC 2009) provides guidance for assessment of construction noise. OEH's standard construction hours are as follows:

- 7 am to 6 pm Monday to Friday
- 8 am to 1 pm Saturday
- No work Sundays or public holidays.

Construction noise management levels are identified for noise in the guideline for affected residential receivers and are shown in Table 6.12. The highly noise affected level (75 dB (A)) represents the level above which strong community reaction to noise is likely.

Table 6.12: Construction noise management levels

Time of day	Management level $L_{Aeq(15\ min)}$
Recommended standard hours: Monday to Friday 7am to 6pm, Saturday 8am to 1pm, and no work on Sunday or public holidays	Noise affected RBL + 10dB Highly noise affected 75 dB(A)
Outside recommended standard hours	Noise affected RBL + 5dB

Note – RBL: rating background level

Table 6.13 provides the construction noise management levels with regard to the measured background noise levels for the study area shown in Table 6.10 below.

Table 6.13: Construction noise management levels at residential receivers, dB(A)

Receiver	Noise management level, dBA $L_{Aeq\ (15min)}$		
	During standard hours		Outside standard hours
	Noise affected	Highly noise affected	Noise affected
NCA 1	41	75	36
NCA 2	45	75	40
NCA 3	52	75	37
NCA 4	46	75	41
NCA 5	42	75	37
NCA 6	42	75	37

Note – NCA: noise catchment area (see section 6.5.1)

For construction activities proposed outside of recommended standard hours (out of hours), strong justification for the works is required and all feasible and reasonable measures must be implemented.

Vibration

Human exposure

Human comfort vibration criteria have been set with consideration to *Assessing Vibration: A Technical Guideline* (DEC 2006). British Standard BS 6472 – 1992 *Guide to Evaluation of Human Exposure to Vibration in Buildings (1 Hz to 80 Hz)* is recognised by OEH as the preferred standard for assessing 'human comfort'.

Typically, construction works generate ground vibration of an intermittent nature. Under BS 6472-1992 intermittent vibration is assessed using the vibration dose value. Acceptable vibration dose values for residential receivers are provided in Table 6.14.

Table 6.14: Acceptable vibration dose values for intermittent vibration ($m/s^{1.75}$)

Location	Daytime[1]		Night-time[1]	
	Preferred value	Maximum value	Preferred value	Maximum value
Critical areas[2]	0.10	0.20	0.10	0.20
Residences	0.20	0.40	0.13	0.26
Offices, schools, educational intuitions and places of worship	0.40	0.80	0.40	0.80
Workshops	0.80	1.60	0.8	1.60

1. Daytime is 7:00 to 22:00 and night-time is 22:00 to 7:00
2. Examples include hospital operating theatres and precision laboratories where sensitive operations are occurring. These criteria are only indicative, and there may be need to assess intermittent values again the continuous or impulsive criteria for critical areas.

British Standard BS 5228-2:2009 *Code of practice for noise and vibration on construction and open sites – Part 2: Vibration*, recommends that the guidance values presented in Table 6.15 are more appropriate for construction works as it is easier to assess the intermittent vibration criteria against a peak value rather than a dose value.

Table 6.15: Guidance on effects of vibration levels

Vibration level	Effect
0.14 mm/s	Vibration might be just perceptible in the most sensitive situations for most vibration frequencies associated with construction. At lower frequencies, people are less sensitive to vibration.
0.30 mm/s	Vibration might be just perceptible in residential environments.
1.00 mm/s	It is likely that vibration of this level in residential environments will cause complaint, but can be tolerated if prior warning and explanation has been given to residents.
10.0 mm/s	Vibration is likely to be intolerable for any more than a very brief exposure to this level.

Structural damage

Currently, there is no Australian Standard that sets the criteria for the assessment of building damage caused by vibration. Guidance of limiting vibration values is attained from reference to German Standard *DIN 4150-3: 1999-02 Structural Vibration – Part 3 Effects of vibration on structures.* Short-term vibration guideline values are provided in Table 6.16.

Table 6.16: Guideline values for vibration velocity to be used when evaluating the effects of short-term vibration on structures

Line	Type of Structure	Guideline values for velocity, vi(t)[1]		
		Vibration at the foundation at a frequency of:		
		1 to 10 Hz	10 to 50 Hz	50 to 100 Hz[2]
1	Buildings used for commercial purposed, industrial buildings, and buildings of similar design.	20	20 to 40	40 to 50
2	Dwellings and buildings of similar design and / or occupancy.	5	5 to 15	15 to 20
3	Structures that, because of their particular sensitivity to vibration, cannot be classified under lines 1 and 2 and are of great intrinsic value (e.g. listed buildings under preservation order).	3	3 to 8	8 to 10

1. The term v_i refers to vibration levels in any of the x, y or z axes.
2. At frequencies above 100 Hz the values given in this column may be used as minimum values.

6.5.2 Potential impacts

Noise

Table 6.17 shows the distances from the proposal site within which receivers in the noise catchment areas would be noise affected by construction works. These results are based on the construction criteria outlined in section 6.5.1 for each noise catchment area. The table also details the distances within which the receivers in the noise catchment areas would be highly noise affected.

Construction activities would generally occur during standard construction hours. Noise management levels for construction works would be lower for works outside standard construction hours, as shown by the noise criteria in Table 6.13. If construction works were to occur outside standard construction hours, the noise management levels would be exceeded by greater margins and additional receivers would be noise affected over greater distances. The noise impacts caused by works outside standard construction hours would therefore be substantially greater than the impacts caused by works within standard construction hours.

The results outlined in Table 6.17 indicate that the majority of construction activities are expected to exceed the construction noise management levels of each noise catchment area at a number of receivers up to between 250 and 1,800 metres of the works. It should be noted that this assessment does not consider the reduction in noise that occurs as a result of screening by buildings between the proposal site and receivers further away. The predicted distances over which the noise criteria would be exceeded are therefore conservative and are likely to be substantially smaller.

The majority of noise impacts would occur at buildings adjacent to, or close to, the proposal site. Between 25 and 55 metres of the works the results suggest that certain activities would exceed the highly noise affected level of 75 dB (A).

The noise impacts of the proposal would be temporary in nature and only for the duration of the works along the levees. Noise impacts would generally be localised and would vary for different receivers as the works progress along the levees.

Based on these predictions, the mitigation measures detailed in section 6.5.3 would be implemented where reasonable and feasible to reduce noise impacts. It is emphasised that the modelling undertaken for this assessment has been for the worst case and the predicted results are conservative.

The increase in traffic associated with the proposal would generate some additional traffic noise; however the number of truck movements would be in the order of 100 per day. These movements would only occur during standard working hours. A more detailed assessment of the management of traffic noise would be undertaken for the preparation of the noise and vibration management plan (see section 6.5.3).

Table 6.17: Modelled distances from construction works at which receivers in noise catchment areas are noise affected

Construction works	Distance from levee construction works (metres)						
	Highly affected noise criteria	Noise affected criteria					
	All NCA's 75 dB(A)	NCA 1 41 dB(A)	NCA 2 45 dB(A)	NCA 3 52 dB(A)	NCA 4 46 dB(A)	NCA 5 42 dB(A)	NCA 6 42 dB(A)
Embankments	27	939	630	296	566	851	851
Sheet pile walls	53	1,772	1,225	628	1,139	1,609	1,609
Concrete walls	10	329	211	96	188	296	296
Gabion walls	13	460	293	133	266	411	411
Embankment/box culvert levee	22	772	510	236	458	697	697
Spillways	25	853	568	264	511	773	773
Levee road crossings and road raising - road embankment and drainage construction	30	1,034	699	331	627	941	941
Levee road crossings and road raising - road pavement construction	27	939	630	296	566	851	851

Vibration

Vibration levels

Vibration impacts focus on potential structural damage in close proximity to construction activities. Furthermore, it is possible that local sensitive receivers may perceive construction vibration at times. The level of annoyance will depend on individual perception.

Table 6.18 outlines typical vibration levels for different plant activities sourced from the NSW Roads and Maritime Services publication *Environmental Noise Management Manual* (RTA 2001).

Table 6.18: Typical vibration levels – construction equipment

Item	Peak particle velocity at 10 metres (millimetres/second)
Piling	12-30
Loader breaking kerbs	6-8
15 tonne compactor	7-8
7 tonne compactor	5-7
Roller/rock hammer	5-6
Pavement breaker	4.5-6
Dozer	2.5-4
Backhoe	1
Jackhammer	0.5
Excavators, scrapers, graders etc	2.5

Based on the vibration levels stated in Table 6.18 and the list of construction equipment detailed in section 6.5.1, the maximum potential vibration levels of the sources associated with the project at various distances are shown in Table 6.19.

Table 6.19: Estimated vibration levels

Vibration source	Distance to source (metres) Peak particle velocity (millimetres/second)					
	5 metres	10 metres	20 metres	50 metres	100 metres	150 metres
Roller	10.4	6.0	3.4	1.7	1.0	0.7
15 tonne roller	13.9	8.0	4.6	2.2	1.3	0.9
7 tonne compactor	10.4	6.0	3.4	1.7	1.0	0.7
15 tonne compactor	13.9	8.0	4.6	2.2	1.3	0.9
Backhoe	1.7	1.0	0.6	0.3	0.2	0.1
Excavator/ grader	3.6	2.1	1.2	0.6	0.3	0.2

Due to variations in environmental conditions that affect vibration levels, conditions in the field often differ to the predicted levels. The predicted vibration levels in Table 6.19 are likely to be conservative.

Building damage

Table 6.19 indicates:

- Buildings classified as dwellings or buildings of similar construction (DIN4150-3 'line 2' buildings) within 10 metres of the source are expected to experience vibration above the five millimetre per second peak particle velocity recommended limit
- Structures that, because of their particular sensitivity to vibration and are of great intrinsic value (such as heritage listed buildings under preservation order) (DIN4150-3 'line 3' buildings) within 20 m of the source are expected to experience vibration above the three millimetre per second peak particle velocity recommended limit.

The mitigation measures outlined in section 6.5.3 would be applied where reasonable and feasible. It is important to note that vibration levels exceeding those prescribed in DIN4150-3 do not always cause damage; therefore further investigations would be required.

Human perception

Humans are capable of detecting vibration at levels well below those causing risk of damage to buildings. The degrees of perception for humans are suggested by the vibration level categories given in BS5228:2009 and shown in Table 6.15. Based on the activities outlined in section 6.5.2 and the conservative estimate detailed in Table 6.19, it is possible that construction vibration may be perceptible at times at distances up to 100 metres of the works. The mitigation measures detailed in section 6.5.3 would be implemented where reasonable and feasible.

6.5.3 Safeguards and management measures

Impact	Safeguard	Timing and responsibility
Noise and vibration (management plan)	• A construction noise and vibration management plan would be prepared. Part of the plan would include a detailed assessment of the management of traffic noise associated with the proposal.	Pre-construction Contractor
Noise and vibration (consultation and monitoring)	• The contractor would establish contact with receivers affected by construction noise and communicate the construction program and progress on a regular basis, particularly when noisy or vibration generating activities are planned. Communication with the affected receivers would be maintained throughout the construction period • The contractor would provide a community liaison phone number and permanent site contact so that noise complaints can be received and addressed in a timely manner • Upon receipt of a noise complaint, monitoring would be undertaken and reported as soon as possible • Monitoring measurements would be taken at the	Pre-construction and construction Contractor

Impact	Safeguard	Timing and responsibility
	complainant's location and the monitoring would cover the time of day when the impacts were reported to occur • Noise monitoring would be undertaken by a suitably qualified professional in accordance with the Interim Construction Noise Guideline (DECC 2009) • If exceedances are detected, the situation would be reviewed in order to identify potential means to reduce the impact to acceptable levels.	
Noise (construction)	• Construction activities would be scheduled during standard construction hours, unless otherwise assessed and approved • Where possible, less powerful or quieter generator units would be preferred. Mechanical plant that is acoustically treated would be preferred • All construction equipment and mechanical plant within the proposal site would be located as far from sensitive receivers as practicable • To reduce the annoyance associated with reversing alarms, standard broadband reversing alarms (audible movement alarms) would be used for all site equipment. Satisfactory compliance with occupational health and safety requirements would need to be achieved and a safety risk assessment may need to be undertaken to determine that safety is not comprised. Refer to Appendix C of the *Interim Construction Noise Guideline* (DECC 2009) for more information • All equipment would be selected to minimise noise emissions. Equipment would be fitted with appropriate silencers and be in good working order • Machines found to produce excessive noise compared to normal industry expectations would be removed from the site or stood down until repairs or modifications can be made. Table 6-1 in the noise and vibration assessment (GHD 2013) provides noise control methods and expected noise reductions according to Australian Standard AS 2346 – 2010 *Guide to Noise and Vibration Control on Construction, Demolition and Maintenance Sites* • Where impact piling is carried out, noise would be monitored at the start of the works to verify that impacts are acceptable	Construction Contractor

Impact	Safeguard	Timing and responsibility
	• For very high noise generating activities such as sheet piling that are conducted in close proximity to sensitive receivers, these activities would only occur between 10am and 3pm, where possible • Where shift workers are impacted by the proposed works and the noise criteria cannot be achieved, consideration would be given to finding other temporary accommodation for these workers. Alternatively, scheduling work to minimise impacts upon these sensitive receivers would be considered.	
Noise (work ethics)	• All site workers would be sensitised to the potential for noise impacts on local residents and encouraged to take practical and reasonable measures to minimise the impact during the course of their activities. This would include: – Avoid the use of loud radios – Avoid shouting and slamming doors – Where practical, machines would be operated at low speed or power and switched off when not being used rather than left idling for prolonged periods – Keep truck drivers informed of designated vehicle routes, parking locations and delivery hours – Minimise reversing – Avoid dropping materials from height and avoid metal to metal contact on material – All engine covers would be kept closed while equipment is operating.	Construction Contractor
Vibration (monitoring)	• Where construction activities generating vibration are to be undertaken at a distance of less than 30 metres from any building or structure, vibration monitoring would be conducted during these activities at the most susceptible building • Where impact piling is carried out, vibration would be monitored at the start of the works to verify that impacts are acceptable • Where exceedances of the vibration criteria outlined in section 6.5.1 are recorded, the situation would be reviewed to identify the measures that can be taken to minimise the impacts to buildings and prevent structural damage. The review may result in a requirement to modify work practices or use alternative, low-vibration methods and equipment • Vibration monitoring would be undertaken by a	Construction Contractor

Impact	Safeguard	Timing and responsibility
	suitably qualified professional in accordance with the Interim Construction Noise Guideline (DECC 2009).	
Vibration (building condition)	• Building condition inspections would be undertaken for any utility, structure or building where vibration generating activities such as vibratory rolling are planned within 50 metres. Any utility, structure or building requiring a building inspection would be determined prior to commencement of construction • Building condition inspection reports would classify building structure and susceptibility to damage in accordance with the DIN4150-3 classifications. The resulting building classifications are to be used for determination of the applicable DIN4150-3 vibration criteria curves • Condition inspections are to identify high-risk buildings where additional vibration restrictions and more stringent criteria may apply.	Construction Contractor
Vibration (human comfort)	• Where practical and feasible, vibration-generating operations would be confined to the least vibration-sensitive part of the day – which could be when the background disturbance is highest • An upper level for vibration impact may be determined, with consideration of what is achievable using reasonable and feasible mitigation.	Construction Contractor

6.6 Air quality

6.6.1 Existing environment

In 2010/11 air quality exceedances for the city of Wagga Wagga were recorded for eight days (Wagga Wagga City Council 2011a). Exceedances are defined as days when particle matter in the air exceeds the National Environment Protection Measure of 50 micrograms per cubic metre (Wagga Wagga City Council 2011a).

Air quality exceedances for Wagga Wagga in 2010/11 and previous years are provided in Table 6.20 (Wagga Wagga City Council 2011a).

Table 6.20: Air quality exceedances at Wagga Wagga

Year	Air quality exceedances
2005/06	11 days
2006/07	57 days
2007/08	20 days

Year	Air quality exceedances
2008/09	28 days
2009/10	21 days
2010/11	8 days

Source: Wagga Wagga City Council 2011a

The proposal site is located adjacent to the urban areas of Wagga Wagga, the Murrumbidgee River and properties used for agriculture. Sources of air pollution in the study area are likely to include:

- Emissions from vehicles on local roads, particularly near urban areas, highways and arterial roads
- Dust from vehicles travelling on unsealed roads outside Wagga Wagga
- Dust from agricultural activities
- Smoke from paddock stubble burn-off in agricultural areas, as well as from wood fires
- Emissions from industrial activities.

To reduce levels of pollution from fires, the Wagga Wagga Local Government Area has been listed in the *Protection of the Environment Operations (Clean Air) Regulation 2010*, as an area where all open burning is prohibited without approval including bonfires, incinerators and fire buckets.

Daily site air quality index (24 hour) data were available for North Wagga Wagga from the OEH online air quality database (OEH 2012c). Air quality index values are derived from air quality data readings. Data readings are derived from standards for ozone, nitrogen dioxide, carbon monoxide, sulfur dioxide, particulate matter and visibility.

The air quality index data for the 12 months to November 2012 generally fall within the following categories:

- ‘Very Good’ (0 to 33)
- ‘Good’ (34 to 66)
- ‘Fair’ (67 to 99).
- ‘Poor’ (100 to 149).

One record from 7 April has a value of 134, which is classified as ‘Poor’ (100 to 149). Higher air quality index values in the April period may be related to stubble burn-off for cropping in the locality. No data recorded for North Wagga Wagga are within the ‘Very Poor’ or ‘Hazardous’ categories.

No air quality index data were available for Central Wagga Wagga.

Search results from the national pollutant inventory managed by DSEWPaC (2012c) indicate that six industrial facilities in the local area (postcode 2650) emit the following substances to the atmosphere:

- Total volatile organic compounds
- Lead and compounds
- Sulfur dioxide
- Carbon monoxide

- Oxides of nitrogen.

One of these facilities, a petroleum product wholesaler, is located about 800 metres from the proposal site. The remaining facilities are located at least three kilometres from the proposal site.

6.6.2 Potential impacts

During construction the following activities would potentially result in air quality impacts:

- Clearing of vegetation
- Stripping and stockpiling topsoil
- Earthworks
- Levee construction
- Transport and handling of soils and materials
- Road construction at crossing sites
- Use of construction vehicles, generating exhaust fumes.

Potential air quality impacts during construction would predominantly be from the generation of dust. Dust generation could result in health impacts to nearby receivers.

Sensitive receivers include residents and workers at properties adjacent to the levees, as well as recreational users of the Wiradjuri Walking Track and Murrumbidgee River corridor. The impacts of dust generation have the potential to be moderate due to the close proximity of sensitive receivers. These impacts would be short-term and during the construction phase only. Provided safeguards detailed in section 6.6.3 are implemented, impacts relating to dust would not be substantial.

There is the potential for dust generation at the proposed borrow sites. At the proposed Copland Street borrow site sensitive receivers are located from 60 metres to the north at commercial properties on Copland Street and 70 metres to the east at the Equex sport complex. At the proposed Tasman Road borrow site sensitive receivers are located at a go-cart track 50 metres to the east and a future clay target shooting site just north of the site. Commercial properties are located about 370 metres to the north and south-east. At the proposed North Wagga borrow site a residence is located 180 metres to the south-east. A small number of other residences are located at greater distances.

Vehicle movements along unsealed roads would only be required for the transport of excavated material from the North Wagga borrow site, as described in section 3.3.6. No sensitive receivers are located along this route. The proposal would therefore be unlikely to cause dust impacts to sensitive receivers through vehicle movements on unsealed roads.

Machinery and other construction vehicles would emit exhaust fumes. The impact of these emissions would be temporary in nature and limited to the construction phase. Odours may be generated during the application of sprayed seal bitumen along the Wiradjuri Walking Track, and during the application of asphalt and line marking where the levees are upgraded at road crossings. These impacts would be localised and limited only to particular activities. Impacts at identified receivers would be minor provided safeguards detailed in section 6.6.3 are implemented.

6.6.3 Safeguards and management measures

Impact	Safeguard	Timing and responsibility
General air quality impacts	• Construction activities would be managed to minimise the emission of dust, smoke, and other substances.	Construction Contractor
Dust	• Fill material imported from borrow sites would be dampened if necessary before unloading at the proposal site to avoid creating dust near sensitive receivers • Exposed surfaces would be watered regularly to minimise dust emissions • Clearing of vegetation would be minimised where possible • Dust generating activities would cease during periods of high winds • Stabilisation of disturbed surfaces would take place as soon as practicable • Stockpiles or areas that may generate dust would be managed to suppress dust emissions • Transport of material from the North Wagga borrow site would not generally occur along unsealed roads adjacent to sensitive receivers. The haulage route used would be as described in section 3.3.6 • If transport of any material is required along unsealed roads adjacent to sensitive receivers, measures such as watering would be implemented where necessary to minimise dust impacts on sensitive receivers • Loads would be adequately covered during transportation of materials.	Construction Contractor
Other emissions	• Machinery would be turned off when not in use as much as possible and would be fitted with emission control devices complying with Australian Design Standards • Construction plant and equipment would be maintained in a good working condition in order to limit impacts on air quality • Sprayed-seal bitumen would not be applied to the Main City Levee during periods of high winds • Application of asphalt and line marking to road crossings would not occur during periods of high winds • No burning of any materials would occur.	Construction Contractor
Dust	• The excavated surfaces at the proposed borrow sites	Operation

Impact	Safeguard	Timing and responsibility
	would be monitored and where necessary, measures implemented to stabilise the surfaces and minimise generation of dust.	Council

6.7 Landscape and visual

6.7.1 Existing environment

The landscape character of the study area is generally defined by urban development within the levees and rural properties used for agriculture outside the levees.

The Riverside Wagga Wagga Strategic Master Plan (Kiah Infranet 2010) notes that the Murrumbidgee River forms a strong sinuous element through Wagga Wagga that is predominantly of a natural picturesque feature. River Red Gum forest along the river provides an aesthetic backdrop.

The study area is located on the floodplain of the Murrumbidgee River and is generally flat. In the vicinity of chainage 5500 the elevation of the land surface increases where there is a hill around which the Murrumbidgee River flows, called 'Church Hill'. This hill and spires of the churches on the hill form a prominent visual feature in Wagga Wagga.

The Riverside Wagga Wagga Strategic Master Plan (Kiah Infranet 2010) describes the Main City Levee as follows:

> '*A key visual detractor and spatial barrier is the existing levee itself. It appears as a man-made element, disregards the city's built structure and does not integrate with the natural landscape setting of the river. As a result, the existing levee could be considered an extraneous element that does not relate to either side.*'

Most views to the riverside incorporate a view of the Main City Levee, and in many cases the levee blocks views of the river and riparian vegetation.

Key receivers include:

- Residences
- Businesses
- Recreational users (including users of the Wiradjuri Walking Track, Wagga Beach and Wilks Park at North Wagga Wagga)
- Road users.

6.7.2 Potential impacts

Construction

Visual impacts during construction would generally be associated with:

- Earthworks
- The positioning of plant and equipment along the alignment
- Removal of vegetation
- The establishment of stockpile sites.

These have the potential to temporarily affect views for residents, businesses, road users and recreational users of the river, including Wiradjuri Walking Track users.

The visual impacts of construction works would be temporary.

Operation

The proposal would involve average increases in height of 66 centimetres to 83 centimetres for the levees (see section 3.2.1). The greatest increases in height would occur on the Main City Levee, which has a maximum increase in height of 1.98 metres.

Raising the levees would increase the visual barriers between the urban areas of Wagga Wagga and the Murrumbidgee River and surrounding countryside. Views from buildings adjacent to or near the levees are likely to be affected. These buildings include houses, units, apartments, motels and a hotel at a number of locations in Wagga Wagga.

In Central Wagga Wagga views of the river from many single storey buildings are already compromised by the existing levees, and the proposal would be unlikely to substantially change the visibility of the river from these properties.

The potential visual impacts of raising the levees may not be of major concern to business owners, property owners and residents, given the increased level of flood protection to property provided by raising the levees. Council would consult with businesses, property owners and residents adjacent to the levees individually. This consultation would include discussion of visual impacts. Council would assess whether visual impacts need to be further identified and assessed based on feedback from the community.

The raising of the existing concrete wall between chainages 4460 and 4860 would increase the visibility of the Main City Levee at this location. The visual characteristic of the levee would however benefit at this location from the removal of the aboveground powerlines from the concrete wall levee and relocation of the lines underground. This is proposed by Essential Energy.

Indirectly, the design of the proposal would have a positive visual impact by allowing for the future opening of the Main City Levee (as described in section 3.2.7) at:

- Kincaid Street at chainage 4700, where the existing concrete wall blocks views of the river
- Sturt Street at chainage 5020, where there is an embankment levee.

This would improve pedestrian access to the river and open up views of the river from the city.

6.7.3 Safeguards and management measures

Impact	Safeguard	Timing and responsibility
Visual impacts of proposal	• In the detailed design development, consideration would be given to softening the appearance of the levees (such as rounding the tops of the levee banks) • The footprint for construction works would be kept to a minimum to minimise earthworks and maintain existing stands of vegetation wherever possible.	Pre-construction Council
Obstruction of views by raised levees	• Businesses, property owners and residents adjacent to the levees would be consulted before construction. Wherever practicable the construction of the levees	Pre-construction Contractor

Impact	Safeguard	Timing and responsibility
	would be sympathetic to maintaining visual amenity for sensitive receivers.	
Visual impacts of proposal	• Levee banks would be revegetated progressively, using locally native groundcover species where practicable • Vegetation removal would be minimised as much as possible.	Construction Contractor

6.8 Aboriginal heritage

An Aboriginal heritage assessment for the proposal was completed by OzArk (2012). The report is included in Appendix J.

6.8.1 Methodology

Review of existing information

A desktop search of the following databases was conducted:

- OEH Aboriginal Heritage Information Management System (AHIMS). Searches of the AHIMS database included:
  - Search completed on 29 August 2012 for an area of dimensions four kilometres by three kilometres, centred on the levee upgrade portion of the proposal site
  - Two additional searches completed for areas of dimensions 1400 metres by 900 metres, centred on the proposed North Wagga borrow site (search date: 13 September 2012) and the proposed Tasman Road borrow site (search date: 6 September 2012).
- National Native Title Claims Search - http://www.nntt.gov.au/Applications-And-Determinations/Search-Applications/Pages/Search.aspx

A number of studies completed in the Wagga Wagga region were reviewed (see Aboriginal heritage assessment in Appendix J).

Aboriginal community involvement and field survey

The study area was surveyed by three people including an OzArk archaeologist and two Aboriginal community representative from the Wagga Wagga LALC.

The survey methodology combined vehicle reconnaissance and pedestrian inspection of the proposal site. The vehicle-based inspection identified potentially archaeologically sensitive areas requiring targeted assessment. At these locations the surveyors inspected a 20 metre wide corridor along the proposal site.

All mature trees old enough to bear cultural scarring and all ground surface exposures were inspected closely. Notes on the vegetation, land-use, disturbance, archaeological potential / sensitivity and the need for full survey were made within each area surveyed.

At locations where there was a very high level of disturbance, the Due Diligence Code of Practice for the Protection of Aboriginal Objects in New South Wales was applied. Surveys were

not required due to the likelihood that previous disturbance would have removed any existing sites of Aboriginal heritage.

The survey zones and methods (see Figure 6.8) included:

- Wagga Wagga Levee (WL). Disturbance levels were very high. Six sections of the levee were surveyed using pedestrian transects. Three sections were surveyed by vehicle and three sections were not surveyed due to high levels of disturbance. Grasses and weeds obscured about 80 per cent of the ground surface
- North Wagga Wagga Levee (NL). Disturbance levels were very high. About half the area was assessed by vehicle and the other half was not surveyed due to high levels of disturbance. This survey unit includes the North Wagga Wagga Levee and the East Street (Bank Two) Levee. Grasses and weeds obscured about 80 per cent of the ground surface
- Tasman Road borrow site (TR). This site is located in a flat cleared paddock on the Murrumbidgee floodplain. Grasses and weeds obscured more than 95 per cent of the ground surface
- Copland Street borrow site (CS). This site is located in a flat cleared paddock on the Murrumbidgee floodplain. Grasses and weeds obscured more than 95 per cent of the ground surface
- North Wagga borrow site (NW). This site is heavily disturbed. The site is located in a largely cleared paddock adjacent to an existing borrow pit. Several dispersed mature trees exist adjacent to the site. Grass obscured approximately 90 per cent of the proposed borrow site.

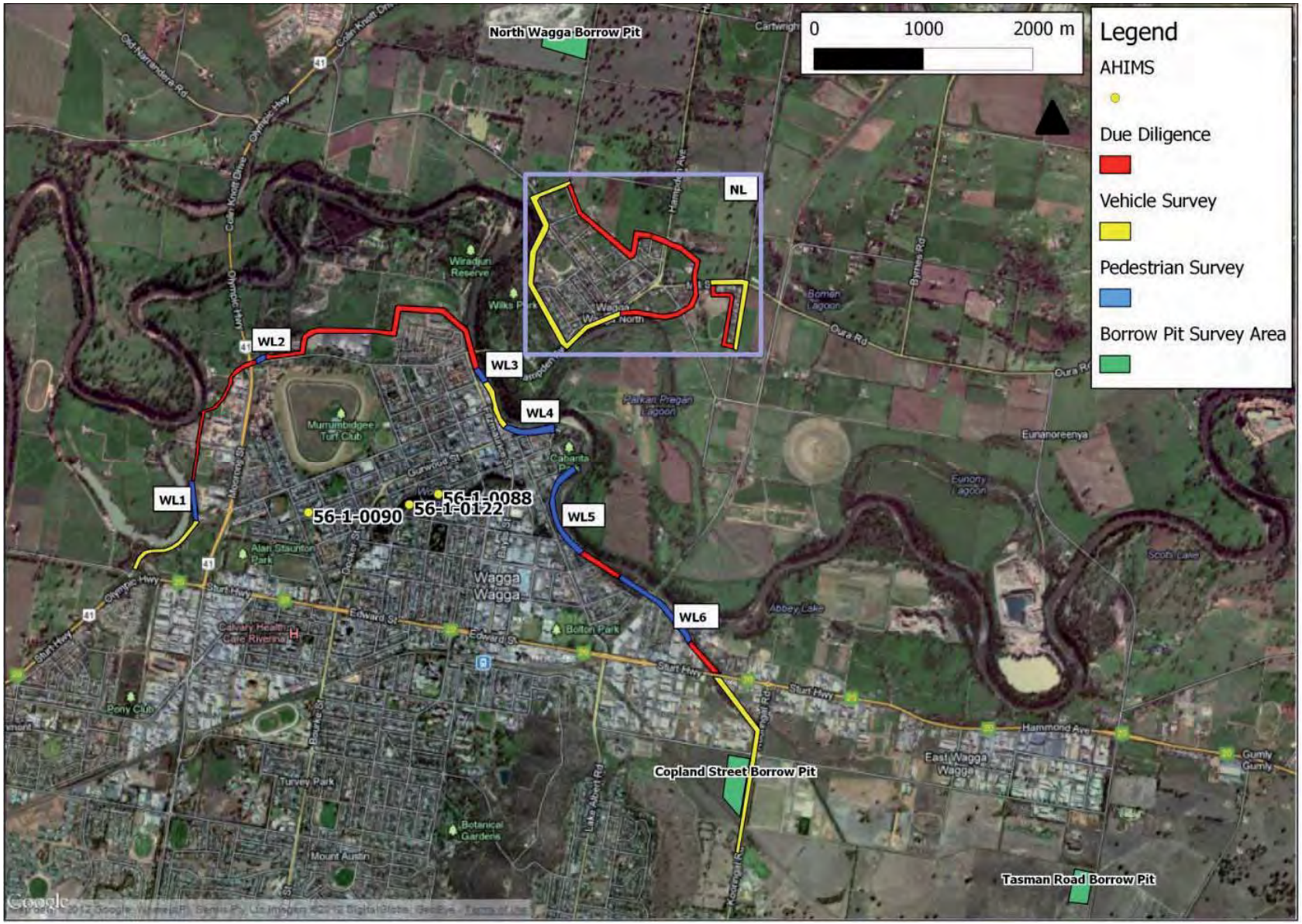

Figure 6.8: Aboriginal heritage field surveys

Source: OzArk 2012

6.8.2 Existing environment

The study area is within the southern boundaries of the Wiradjuri tribal and linguistic group (Tindale 1974, cited in Ozark 2012). In December 1829, Wiradjuri men guided Charles Sturt along the Murrumbidgee River through the Wagga Wagga area. The party camped at a number of sites in the area, including a site at Bomen Lagoon near the East Street (Bank 2) Levee (see Figure 1.1).

Three Aboriginal sites have previously been recorded at locations between 500 metres and 1.5 kilometres from the proposal site. All three sites are scarred trees.

Most of the proposal site is located within the heavily disturbed corridors of the existing levees.

No sites of Aboriginal heritage were recorded during the survey. The study area is unlikely to contain undetected Aboriginal sites due to the high levels of previous disturbance.

Watercourses formed an important focus for traditional Aboriginal activities in the Wagga Wagga area. The majority of the proposal site runs directly along the Murrumbidgee River and traverses a landscape that would have provided the resources necessary for past Aboriginal occupation. The lack of recorded sites is likely to be the result of a combination of the following factors:

- The proposal site has a narrow, linear shape and relatively small area, which may have prevented it from intersecting any Aboriginal sites
- Stands of mature remnant vegetation are limited and scattered
- The proposal is confined to highly disturbed areas that are part of the existing levee corridors and urban infrastructure. If certain Aboriginal site types (eg scarred trees) existed in the study area the development of the levees and urban areas are likely to have destroyed or removed them.

6.8.3 Potential impacts

No Aboriginal sites were identified during the current study, and the study area was assessed as holding little potential for the existence of undetected Aboriginal sites. It is unlikely that the proposal would have any impacts on sites of Aboriginal heritage.

6.8.4 Safeguards and management measures

Impact	Safeguard	Timing and responsibility
Potential impacts to unexpected finds	• In the event of an unexpected find of an Aboriginal heritage item (or suspected item), all works in the vicinity of the find must cease and the site supervisor and Council would be contacted immediately for advice on how to proceed • If the origin of the find cannot be determined quickly, or if it is determined that the find is of Aboriginal origin, immediately notify the following authorities or personnel of the discovery: – OEH (Queanbeyan Office): ph. 131 555 or (02) 9995 5555 – Wagga Wagga LALC: ph. (02) 6921 4095.	Construction Contractor

Impact	Safeguard	Timing and responsibility
	• Facilitate, in co-operation with the appropriate authorities and Wagga Wagga LALC: – The recording and assessment of the finds – Fulfilling any legal constraints arising from the find(s). This will include complying with OEH directions – The development and conduct of appropriate management strategies. Strategies will depend on Aboriginal consultation and the assessment of the significance of the find(s). • Where the find(s) are determined to be Aboriginal objects as defined by the NPW Act, any re-commencement of construction related ground surface disturbance may only resume in the area of the find(s) following compliance with any consequential legal requirements and gaining written approval from OEH (as required).	
Potential impacts to unexpected human remains	• Cease all ground surface disturbance in the area of the find(s) immediately by notifying machinery operators in the immediate vicinity of the find(s). Also avoid touching the discovered remains • Inform the site supervisor and Wagga Wagga City Council as soon as possible to organise for a qualified professional opinion (usually the police in the first instance) • Create a buffer zone of 50m x 50m around the find spot. No authorised entry or earth disturbance would be allowed until the discovery has been assessed.	Construction Contractor

6.9 Non-Aboriginal heritage

A non-Aboriginal heritage assessment for the proposal was completed by OzArk (2012). The report is included in Appendix J.

6.9.1 Methodology

Review of existing information

A desktop search of the following databases was conducted:

- Australian Heritage Database: http://www.environment.gov.au/heritage/ahdb/
- NSW Heritage Office State Heritage Register and State Heritage Inventory: http://www.heritage.nsw.gov.au/
- DSEWPaC Protected Matters (EPBC Act) Database: http://www.environment.gov.au/erin/ert/epbc/index.htmlLocal Environment Plan (LEP)

- S170 RTA Heritage and Conservation Register: http://www.rta.nsw.gov.au/environment/heritage/heritageconservreg/index.html?elid=2

The Wagga Wagga City Council Urban Heritage Study (Freeman 2002, cited in OzArk 2012) was reviewed.

Field survey

The study area was surveyed by an OzArk archaeologist. The survey methodology combined vehicle reconnaissance and pedestrian inspection of the proposal site.

6.9.2 Existing environment

Historic settlement in the region

The study area is located at Wagga Wagga, NSW (see Figure 1.1). Historic settlement in the study area is closely related to the pastoral and agriculture activity that has characterised the region's economy.

The following information has been summarised from the Wagga Wagga City Council Urban Heritage Study (Freeman 2002, cited in OzArk 2012).

Initial European settlement of the Riverina region and Wagga Wagga area began in the 1830s as pastoral landholders from Sydney began to expand south, first into Goulburn area and by 1836 into the Wagga Wagga area.

During this initial pastoral settlement, major routes between Sydney, Melbourne and Adelaide were established. By the 1840s these routes had become well defined tracks or roads. The route used by the early explorer Sir Thomas Mitchell during his 1836 journey eventually became the Port Phillip Road. This was the main overland route from Sydney to Melbourne and passed through Wagga Wagga.

By the late 1860s, the New South Wales government became aware of the increasing settlement and agricultural production in the Riverina region. The Wagga Wagga area was incorporated into a municipality in 1870 as the population had reached more than 1,200.

Local context

Hampden Bridge

A search of relevant heritage listings identified one historic heritage item located close to the proposal site (Item No I85: Hampden Bridge along Fitzmaurice Street) listed on the Wagga Wagga LEP 2010. The Hampden Bridge crosses the Murrumbidgee River near chainage 4500 (see Figure 1.1).

The bridge is a timber truss bridge designed by Percy Allen and built in 1895. It was constructed to replace a smaller toll bridge known as the Wagga Wagga Company Bridge over the Murrumbidgee River that was constructed in 1862. The Hampden Bridge provided access for foot, wagon, horse, and eventually vehicle traffic for nearly 100 years. It was closed in 1995 and was replaced with the Wiradjuri Bridge.

The bridge was formerly listed on the Roads and Maritime Services S170 register but was removed. The bridge was closed due to safety concerns in 1995. Ownership and management of the bridge was transferred to Council (Timber Research Unit 2008, cited in OzArk 2012).

Council recently resolved to demolish the Hampden Bridge due to its failing structural integrity. This decision was reached after a number of years of deliberation, which included community consultation, discussion, condition assessments and investigations, cost assessment, data collection, lobbying and reporting.

The costs of rehabilitating the bridge for pedestrian access and maintaining the bridge are unaffordable for Council.

The Heritage Council arm of OEH recently inspected the bridge and has concurred with Council's decision to demolish the bridge.

It is envisaged that the pylons, part of the eastern end of the bridge and the western abutment would be retained. The western abutment would most likely be retained as a historic marker and visitor viewing platform.

Council is currently in the process of seeking and assessing tenders for the demolition of the bridge.

Other listed heritage sites

A number of other listed heritage sites are located in the study area (see Table 6.21) but due to their distances from the proposal site, would be unlikely to be affected by the proposal. All these sites are listed under the Wagga Wagga LEP, under the Australian Heritage Database, or by state government agencies. None of the sites are listed under the NSW *Heritage Act 1977.*

Table 6.21: Listed heritage sites in the study area

Site	Address
Hampden Bridge	199 Fitzmaurice Street
Barters Restaurant - Prince of Wales Motor Inn	143–147 Fitzmaurice Street
Riverine Club	231 Tarcutta Street
Police station	10–20 Sturt Street
Court House	57 Fitzmaurice Street
Former ANZ bank	44 Fitzmaurice Street
Former CBC Bank	53–55 Fitzmaurice Street
Former Post Office	49–51 Fitzmaurice Street
Wesley Uniting Church	17 Johnston Street
Department of Lands building	26–28 Johnston Street
Residence	201 Tarcutta Street
Racecourse buildings	Corner Moorong and Travers Streets
Cottage	166 Tarcutta Street
Wagga Waterworks	89 Hammond Avenue
Bishops House and Presbytery	9 Church Street
Christian Brothers High School and Staff Centre (former Monastery)	20 Church Street
St Andrew's Manse	5 Church Street
St Andrew's Presbyterian Church	7 Cross Street

St John's Anglican Church	Church Street
St Michael's Catholic Cathedral	10 Johnston Street
Wagga Wagga General Cemetery	380 Kooringal Road
North Wagga Primary School	Hampden Avenue

Unrecorded historic heritage sites

A flood marker tree (Figure 6.9) and a monument to the construction of the Main City Levee (Figure 6.10) are located at the corner of Sturt Street and Henley Lane at chainage 5040. These are immediately adjacent to the embankment of the Main City Levee, on the city side of the levee. The location coordinates of the flood marker tree and levee monument are easting 533898, northing 6115215 (Map Grid of Australia, GDA94, Zone 55).

A gauge marked in feet and inches is attached to the flood marker tree. The age of the gauge is unknown but it is understood that the site may have been used for flood measurement from before the Hampden Bridge was constructed in 1895.

The monument to the construction of the Main City Levee was constructed on 9 September 1960, after the construction of the levee was completed in July 1960. The levee monument includes a commemorative plaque for the unveiling of the monument, a description of the project, a list of the councillors serving at the time and a list of Water Conservation and Irrigation Commission staff and others involved in the project.

6.9.3 Potential impacts

The Hampden Bridge's western approach lies directly adjacent to the proposal site. Council recently resolved to demolish the bridge but will probably retain the pylons, part of the eastern end of the bridge and the western abutment. The proposal would be unlikely to cause any impacts to the western abutment of the bridge, and the bridge's western approach would be unlikely to be impacted, as this is already built to an elevation above the 100 year ARI flood level.

The flood marker tree and Main City Levee monument are located within the footprint of the proposal at chainage 5040. The concept design at this location includes the upgrade of the existing embankment levee to a hybrid embankment/sheet pile levee. The flood marker tree and monument would potentially need to be removed from the proposal site to allow construction to occur. Investigations would be undertaken during detailed design to assess whether the flood marker tree and levee monument can be retained.

An assessment of the flood marker tree and levee monument was completed with reference to the Heritage Council of NSW heritage significance criteria. The flood marker tree and levee monument were assessed as holding importance to the local community because they provide a record of how natural events have shaped the surrounding community.

If impacts to the flood marker tree and levee monument are unavoidable, a Section 139 exemption form would need to be filed with the NSW Heritage Office.

No other previously unrecorded heritage items were identified during the current survey. Due to past disturbances related to urban development and construction of the existing levee it is unlikely that deposits of historic artefacts are present.

Figure 6.9: Flood marker tree

Figure 6.10: Main City Levee monument

6.9.4 Safeguards and management measures

Impact	Safeguard	Timing and responsibility
Removal of flood marker and Main City Levee monument	• Investigate whether the flood marker tree and Main City Levee monument can be protected in their current locations and if possible design the proposal so that they are retained • If the flood marker tree and levee monument need to be removed, the following safeguards would need to be implemented: – A Section 139 exemption form would need to be filed with the NSW Heritage Office – Investigate whether the flood marker should be surveyed to enable using any historic flood data from the site, if it exists – Record the flood marker and levee monument to archival standard at their current location – Dismantle the flood gauge and monument and move to an alternative location to be determined by Council.	Pre-construction Council
Potential impacts to Hampden Bridge	• To ensure no inadvertent impacts to Hampden Bridge, a no-go zone would be established in the vicinity of the site using nightline • Workers would be inducted to ensure that impacts do not go beyond the proposal site.	Construction Contractor
Potential impacts to unexpected finds	• In the event of an unexpected find of a non-Aboriginal heritage item (or suspected item), all works in the vicinity of the find must cease and the site supervisor and Council would be contacted immediately for advice on how to proceed • Works would not recommence until the heritage value and associated protection and any approval requirements have been determined • Council would notify OEH if any item (or suspected item) of non-Aboriginal heritage is found during construction to determine the appropriate course of action.	Construction Contractor

6.10 Traffic and access

6.10.1 Existing environment

Roads

The proposal site is surrounded by the streets and local roads of Wagga Wagga. Figure 1.1 shows the local road network. The levee is accessible from several roads.

The Main City Levee crosses the Sturt and Olympic Highways. The levee is adjacent to the Sturt Highway at chainage 0 and crosses it at chainage 7680. The Main City Levee crosses the Olympic Highway at chainage 2100. The posted speed limits of the Sturt and Olympic Highways in Wagga Wagga range from 60 to 80 kilometres per hour.

Kooringal Road is an arterial road that runs alongside the proposal site between chainages 8200 and 9111. It has posted speed limits of 60 to 70 kilometres per hour. All other roads crossed by, or adjacent to, the proposal site have posted speed limits of 50 kilometres per hour.

Property access

Local crossings providing access to properties across the levees exist at a number of locations along the levees.

Railways

The Main City Levee crosses two railway lines (see Figure 1.1). These include:

- The Great Southern Railway at chainage 6900
- The disused Wagga Wagga-Tumbarumba Railway at chainage 8920.

Wiradjuri Walking Track

The Wiradjuri Walking Track follows the Main City Levee between chainages 4000 and 7000, and between chainages 200 and 760. It has been constructed on top of, and adjacent to, the existing levee. The track provides a shared path for cyclists and walkers for a distance of about 30 kilometres around the city of Wagga Wagga. At present this track is comprised of earth, gravel or in some places a concrete pathway.

Vehicular access along levee

In some sections, vehicular access is possible along the top of the levee bank or adjacent to the levee bank. Access is via the Wiradjuri Walking Track or other unsealed tracks.

6.10.2 Potential impacts

Road traffic

The anticipated treatments at road crossings are described in section 3.2.5 and in Appendix B.

Road works to raise local roads to the 100 year ARI flood level would be required at the following locations:

- Marah Street, North Wagga Wagga Levee, chainages 979-994
- Mill Street, East Street (Bank Two) Levee, chainages 250-280.

Flood gates would be installed at the following locations:

- Johnston Street, Main City Levee, chainages 5242-5267
- Sturt Highway (Hammond Avenue), Main City Levee, chainages 7668-7688
- Copland Street, Main City Levee, chainages 8381-8411
- Mill Street, North Wagga Wagga Levee, chainages 1210-1230
- Hampden Avenue, North Wagga Wagga Levee, chainages 4276-8
- East Street, East Street (Bank Two) Levee, chainages 735-750.

For short periods of time during construction at all these locations, traffic would be restricted to one lane. Traffic control would be implemented for the safety of workers and traffic.

Impacts to the local road network would primarily involve truck movements between the proposed borrow sites and the proposal site. It is anticipated that the transport of fill would require about 12,250 heavy vehicle trips (24,500 movements to and from the proposal site).

Heavy vehicles would also transport materials such as sheet piles, concrete, rockfill gabions, guard railing, box culverts, rockfill mattresses, flood gates, gravel and bitumen. At the current stage of planning it is unknown what the number of vehicle movements required to transport these would be. It is anticipated that the number of trips may be 1,000 (2,000 movements to and from the proposal site).

Light vehicles would be required to transport staff to and from the proposal site. Light vehicles would also be used in various roles on site. At the current stage of planning it is unknown what the required number of light vehicle movements would be.

Construction vehicle movements may comprise on average about 50 heavy vehicles accessing the proposal site per day (100 movements per day). This number could increase during peak times of material transport. The local road network generally has adequate carrying capacity for this temporary increase in vehicle numbers. Construction vehicles could potentially cause some congestion of local roads.

Property access

The levees would be upgraded at the following property access locations, affecting access during construction:

- Main City Levee chainage 1720-1740 – provides access over the levee to a business enterprise
- Main City Levee chainage 2400-2420 – horse property and residences
- Main City Levee chainage 6340-6360 – used for access to the levee and riverbank rock protection works maintained by Council
- Main City Levee chainage 9000-9010 – Wagga Wagga Monumental Cemetery entrance
- North Wagga Wagga Levee chainage 2290-2300 – access to a property located outside the levee.

It is anticipated that during construction access to these properties would be maintained.

Great Southern Railway

At the Great Southern Railway crossing (chainages 6900-6905) a sheet pile wall would be constructed under the Murrumbidgee River Rail Bridge. The works would be conducted in consultation with the rail authorities (Australian Rail Track Corporation and the Country Rail Infrastructure Authority) and outside train movement times. It is anticipated that the proposal would not affect rail users.

Wiradjuri Walking Track

Works along the Main City Levee would affect access for users of the Wiradjuri Walking Track. It is anticipated that alternative access for cyclists and walkers would be maintained adjacent to the proposal site or via detours during construction. Safety for cyclists and walkers would be maintained through implementation of a traffic management plan as detailed in section 6.10.3 below.

In the long term, the proposal would have a beneficial impact through providing an improved track along the Main City Levee, up to three metres wide and surfaced with sprayed-seal bitumen.

6.10.3 Safeguards and management measures

Impact	Safeguard	Timing and responsibility
Construction impacts to traffic	• A traffic management plan would be prepared in accordance with the Australian Standard 1742.3-2002: *Manual of Uniform Traffic Control Devices* and the NSW Roads and Maritime Services *QA Specification G10 "Traffic Control at Worksites", Version 4*, and would be approved by Council before implementation • The traffic management plan would include measures to provide safe access points to work areas from the adjacent road network, safety barriers where necessary, temporary speed restrictions when necessary, specific controls for partial road closures and changed road conditions, adequate sight distances and prominent warning signage. The plan would also include measures to restrict public access to the proposal site.	Pre-construction Contractor
Construction impacts to cyclists and pedestrians	• A procedure would be developed for providing access for pedestrians through the proposal site if necessary.	Pre-construction Contractor
Construction impacts to roads	• A road condition survey would be undertaken on roads used extensively for the haulage of materials before and after construction. Defects arising from construction access would be rectified.	Pre-construction and construction Council and contractor
Construction impacts to traffic	• Construction traffic would enter/exit the construction zone only in areas designated for this purpose in the Traffic Management Plan • The community would be kept informed about upcoming road construction activities, including through advertisements in the local media and by prominently placed advisory notices • The community would be notified of any disruption to access for road users • Traffic flow would be monitored along routes used by construction vehicles. If construction vehicles cause traffic congestion at any locations measures would be implemented to minimise traffic impacts.	Construction Contractor
Construction impacts to property access	• Property access would be maintained at all times unless otherwise agreed with affected property owners. Where changes to access arrangements are necessary, Council would advise owners and tenants and consult with them on alternate access	Construction Contractor

Impact	Safeguard	Timing and responsibility
	arrangements.	

6.11 Socio-economic

6.11.1 Existing environment

Wagga Wagga is the largest regional city in New South Wales. The city provides essential services, such as medical and community facilities, shopping and schools. The city also has manufacturing, research and many other professional services and commercial operations.

2011 Census data

The 2011 Census (ABS 2012) provides the following core demographic data about the Wagga Wagga LGA:

- At the time of the 2011 Census there were 59,463 people in the Wagga Wagga LGA
- The number of dwellings was 24,774, with an average household size of 2.5
- The proportion of people aged 17 years or under was 25.4 per cent
- The proportion of people aged 60 years or older was 18.2 per cent
- The median weekly household income was $1,149
- The proportion of households with two motor vehicles was 78.4 per cent
- People of Australian Aboriginal descent comprised 0.5 per cent of the population.

The top employment industries for the Wagga Wagga LGA (ABS 2012) are provided in Table 6.22.

Table 6.22: Top employment industries for the Wagga Wagga LGA

Industry	Number employed	Percentage of people employed
Health care and social assistance	3,929	13.5
Retail trade	3,405	11.7
Public administration and safety	3,162	10.9
Education and training	3,133	10.8

The area surrounding Wagga Wagga mainly comprises rural land use. In 2011 the agriculture, forestry and fishing industry employed 1,132 people, or 3.9 per cent of all people employed in the Wagga Wagga LGA (ABS 2012).

Land use

Land uses in the study area are described in section 6.4.1. In general, land use in the study area is typically characterised by urban development within the levees, with rural properties used for agriculture outside the levees.

Flood protection and flood impacts

Much of the City of Wagga Wagga is protected from flooding by the levees. The Main City Levee protects about 2,000 buildings from flooding for flood events up to the 60 year ARI flood level (WMA Water 2009b). The North Wagga Wagga levees protect 91 buildings from flooding for flood events up to the 17 year ARI flood level (WMA Water 2009b and information provided by Wagga Wagga City Council).

Wagga Wagga and North Wagga Wagga have been subject to a history of flooding, which has caused major impacts. The recent flood event in March 2012 did not overtop or breach the Main City Levee; however about eight thousand people were evacuated from Central Wagga Wagga, with concerns that the levee would not hold the flood. Previous large floods such as those in 1950 and 1974 have caused major flood damage to Central Wagga Wagga.

In 1950, 1974 and 2012, North Wagga Wagga suffered major flood damage costs and the evacuation of the entire population. Many people were not able to return to their homes for months after the floods. North Wagga Wagga has historically suffered considerable damage, financial loss and disruption from floods.

Community priorities

Consultation with the Wagga Wagga community was undertaken as described in section 5.1. The issues raised by the community are provided in Table 5.1.

The main issues raised by the community are summarised below.

Gumly Gumly / East Wagga Wagga

- Will the proposal result in increased flood depths for properties outside the levees?
- Changes in the topography of the floodplain have occurred since 2008 and these changes may have affected the accuracy of the flood modelling.
- Why are significant costs being incurred for the upgrade of the North Wagga Wagga levees when the level of flood protection is only being increased from a 17 year ARI level of flood protection to a 20 year ARI level of flood protection?
- The levee upgrade at North Wagga Wagga would provide protection against a 20 year ARI flood level but house-raising provides a greater level of protection against damages. Has this been considered?

North Wagga Wagga

- Why can't the North Wagga Wagga levees be upgraded to provide a greater level of flood protection than the 20 year ARI flood level?
- Will the proposal result in increased flood depths for properties outside the levees?
- Can vegetation and woody debris on the floodplain be removed to reduce the impacts of flooding?
- Have options other than raising the levees been considered?

Central Wagga Wagga

- Issues relating to design and construction of the levees – access and hazards, trees, levee types
- Can vegetation on the floodplain be removed to reduce the impacts of flooding?

6.11.2 Potential impacts

Construction

During construction there would be a reduction in amenity for the Wagga Wagga community as a result of construction activities, particularly for residences and businesses adjacent to the levees. Potential impacts on amenity have been assessed in the following sections of the REF:

- Land use and property (section 6.4)
- Noise and vibration (section 6.5)
- Air quality (section 6.6)
- Visual (section 6.7).

The proposal would affect property accesses as described in section 6.10.

A reduction in the water quality of the river due to an influx of sediment or man-made substances could potentially occur during the proposal. This could affect the quality of water for recreational uses such as swimming, or for agricultural uses such as stock drinking water. Impacts of the proposal relating to water quality have been addressed in section 6.2.

The proposal would provide a positive impact through a minor short-term increase in employment opportunities and procurement of local goods and services.

Operation

Property acquisition

The proposal may require permanent acquisition of land from properties adjacent to the proposal site. The extent of acquisition required would be determined during the detailed design phase.

In acquiring property for the proposal, Council would consider the effect that the proposal has on the value of the residual area of each property (the area retained by the land owner), as required by the *Land Acquisition (Just Terms Compensation) Act 1991*. Any decrease in the market value of the residual area caused by the proposal would be included in the fee paid for the acquisition.

Considering the property acquisition process that would be adopted, it is unlikely that the proposal would substantially impact the economic circumstances of any private landowners.

Increased protection against flood damages

The proposed upgrade of the Wagga Wagga levees would have a major beneficial impact through providing increased flood protection for the City of Wagga Wagga.

The proposal would increase the level of flood protection for 2,000 buildings in Central Wagga Wagga and for 91 buildings in North Wagga Wagga.

Direct urban damages caused by flooding are classified into three broad categories:

- Residential
- Commercial
- Public Sector, including damages to recreational/tourist facilities, water and sewerage supply, gas supply, telephone supply, electricity supply including transmission poles/lines, sub-stations and underground cables, roads and bridges including traffic lights/signs, railway line and associated structures and costs to employ the emergency services.

Indirect damages caused by flooding are classified into the following categories:

- Clean-up – clean carpets, furniture, refrigerator, etc. It also includes the cost of alternative accommodation
- Financial – loss of wages, loss of trade for the commercial/industrial sector
- Opportunity – non-provision of commercial and public services.

Flooding can also cause intangible damages, which are damages that are difficult to quantify in monetary terms. Examples of intangible damages may include:

- Stress, ill-health and trauma in residents
- Impacts to businesses through a loss of confidence from regular clients
- The impacts of loss of services to customers, eg transport disruption, loss of education and loss of power.

The proposal would increase the level of protection against all these types of flood damages.

It has been predicted that raising the Main City Levee would reduce the average annual damages[5] of Central Wagga Wagga ($1,406,900) by up to 55 per cent (WMA Water 2009a). This would come at a cost of $11.3 million for the upgrade of the Main City Levee. The cost of upgrading the levee is considered justified by the estimated economic benefit. The cost of upgrading the North Wagga Wagga levees would come at a cost of $7.5 million. The cost benefit ratio for the upgrade of the levees at North Wagga Wagga is lower than that for Central Wagga Wagga but is considered acceptable (information provided by Wagga Wagga City Council).

Reduced insurance costs

Many property owners in Wagga Wagga experienced increased flood damage insurance costs as a result of the 2012 flood. It is expected that the increased level of flood protection provided to Central Wagga Wagga by the proposal would reduce the cost of insurance for property owners in this area.

6.11.3 Safeguards and management measures

In addition to safeguards and management measures identified in sections 6.2.3, 6.4.3, 6.5.3, 6.6.3, 6.7.3 and 6.10.3, the following would be implemented.

Impact	Safeguard	Timing and responsibility
General impacts to the local community	• Potentially affected residences and businesses would be contacted before the commencement of works. Residents and businesses would be notified via door knocks, newsletters or letter box drops providing information on the proposed works, working hours and a contact name and number should any complaints wish to be registered.	Pre-construction Contractor
General impacts to the local community	• The community would be kept updated on the project through the local media.	Pre-construction and construction Council

[5] Average annual damage is the damage caused by all floods over a long period of time divided by the number of years in that period (see glossary for detailed description).

Impact	Safeguard	Timing and responsibility
Local economy	• Local goods and services would be sourced wherever possible during construction.	Construction Contractor

6.12 Waste management

6.12.1 Policy setting

Council is committed to ensuring responsible management of unavoidable waste and to promoting the reuse of such waste through appropriate measures. This is done in accordance with the resource management hierarchy principles contained in the *Waste Avoidance and Resource Recovery Act 2001*. The resource management hierarchy principles in order of priority as outlined in the *Waste Avoidance and Resource Recovery Act 2001* are:

- Avoidance of unnecessary resource consumption
- Resource recovery (including reuse, reprocessing, recycling and energy recovery)
- Disposal.

By adopting the above principles, Council encourages the most efficient use of resources and reduces cost and environmental harm.

6.12.2 Potential impacts

The proposal has the potential to generate waste from the following sources, some of which would be recycled or reused:

- Vegetation (native, introduced and noxious) to be removed as part of the proposal (clearing over an area of 18.2 hectares)
- Stripped topsoil
- Material excavated from existing levees
- Construction materials
- General waste from staff (lunch packaging etc).

The largest quantities of waste expected to be produced would be from clearing and excavation activities. There is potential to reuse these materials on-site.

Some of the trees removed would be re-used as woody debris habitat. The remainder of the trees removed would be mulched. Mulched vegetation would be used in sediment erosion controls, stabilisation and rehabilitation where appropriate. Any surplus mulch would be used at other sites around Wagga Wagga.

Some of the material excavated from the existing levees may not be suitable for re-use in the upgrade of the levee embankments. It could possibly be re-used in landscaping.

Wastes would be removed by tanker or truck and disposed of off-site at a facility that is licensed and able to accept those wastes for storage, reuse or disposal.

There would be no storage areas for waste fuel or chemicals on site. These would be located at an off-site depot.

The impacts of waste generation at the site are considered to be low, and would be minimised. It is expected that the largest component of waste materials on site (surplus spoil) would be reused. Materials would be recycled wherever possible.

No chemicals would be stored on site.

6.12.3 Safeguards and management measures

Impact	Safeguard	Timing and responsibility
General waste impacts	• A waste management plan would be included in the CEMP.	Pre-construction
General waste impacts	• Resource management hierarchy principles would be followed: – Avoid unnecessary resource consumption as a priority – Recover resources as far as is practicable (including reuse of materials, reprocessing, and recycling and energy recovery) – Disposal is undertaken as a last resort (in accordance with the Waste Avoidance and Resource Recovery Act 2001) • Site inductions would be undertaken (and recorded) by a site supervisor for all staff, to provide a thorough knowledge of all key environmental/safety issues, including waste disposal protocols • All waste would be disposed of at appropriately approved and licensed facilities • Cleared weed free vegetation would be mulched and reused on-site to stabilise disturbed soils where possible. Weedy mulch would either be composted to sterilise propagules and seeds, or would not be reused • Waste would not be burned at the site • All wastes would be managed and disposed of in accordance with the Waste Classification Guidelines (DECC 2008b) and managed in accordance with the POEO Act • Waste material, other than vegetation and tree mulch, is not to be left on site once the works have been completed.	Construction

6.13 Climate change

6.13.1 Policy setting

Climate change refers to the warming temperatures and altered climatic conditions associated with the concentration of greenhouse gases in the atmosphere. There is a need to understand climate change and the effect it could have on all existing and potential new projects and infrastructure. In NSW, responses to climate change are provided in various policy and guideline documents such as the *NSW Greenhouse Plan* (NSW Government 2005b).

The Intergovernmental Panel on Climate Change produces global climate change projections. In Australia both the Commonwealth Scientific and Industrial Research Organisation (CSIRO) and the Bureau of Meteorology (BOM) have produced regional downscaled projections for Australia. In 2008 the NSW Government published refined climate change projections for each region in NSW. This work was carried out by researchers at the Climate Change Research Centre, University of New South Wales.

6.13.2 Existing environment

Existing climate

The Wagga Wagga area receives an average annual rainfall of 573.5 millimetres. Rainfall is spread evenly throughout the year with a maximum in October (BOM 2012).

The mean maximum temperature for Wagga Wagga is 22.1 degrees Celsius. The mean minimum temperature is nine degrees Celsius (BOM 2012).

Climate change

The former Department of Environment, Climate Change and Water (now OEH), in partnership with the Climate Change Research Centre at the University of New South Wales, developed regional climate projections for NSW based on preliminary analyses of global modelling data (DECCW 2010). The projections have been developed for 'State Plan regions' throughout NSW. The proposal occurs in the Riverina Murray Region, which lies in the drainage basin of the Murray, Murrumbidgee and Lachlan rivers and their tributaries.

By 2050, annual rainfall in the Riverina Murray Region is projected to decrease, with a shift in pattern from winter-dominant to summer-dominant rainfall.

Winter rainfall is likely to decrease by 20 to 50 per cent. The southern parts of the region, where the proposal is located, are likely to experience the greatest reductions in winter rainfall.

By 2050, rainfall in spring and autumn is also expected to decrease, with declines of up to 50 per cent. Evaporation is projected to increase in spring and autumn, which would further reduce the availability of stored water and moisture in the soil profile.

Summer rainfall is likely to increase by between 10 and 20 per cent over most of the region, with the greatest increases occurring in the eastern Riverina and South-west Slopes, where the proposal is located.

Rainfall events are likely to become more intense, causing altered flooding regimes. However, this would be influenced by factors such as soil moisture, water levels in major water storages and the timing of rainfall events.

By 2050, daily temperatures are projected to increase by 1.5 to three degrees Celsius for all seasons. Night-time temperatures are also projected to increase, but to a lesser extent than daily temperatures.

6.13.3 Potential impacts

Potential impacts of climate change on the proposal

Fluctuations in rainfall and temperature caused by climate change are expected to be variable in nature. There is the potential for climate change to cause short-term and long-term impacts. Impacts could therefore occur during both the construction and operation phases of the proposal.

Construction

Increases in temperatures may reduce work capacity and increase the risk of heat stress for site workers.

There may be impacts to various construction activities from climate change, such as increased temperatures interfering with the laying of asphalt or concreting.

There may be an increase in extreme weather events, such as intense rainfall interfering with construction timeframes or dry, hot weather conducive to generation of dust.

Increased summer rainfall may result in increased flooding and erosion risks at the site and associated sediment loss. Potential overtopping of construction sediment basins could occur during extreme rainfall events.

Operation

Increases in temperature may affect the integrity of the levees, road and track pavements and other aspects of the proposal in the long-term. This may occur either directly or through evaporative changes and changes in soil moisture content and soil instability, which in the long term may affect structures and pavements.

Changes in rainfall intensity may result in the following impacts in the long term:

- Increased potential for localised flooding
- Drainage and stormwater impacts
- Changes to flora and fauna species and distribution, including pest and weed species
- Erosion impacts, resulting in sediment loss from the site
- Watercourse impacts, including changes to channel structure and other characteristics near the proposal site resulting from changed hydrological conditions.

Potential impacts of the proposal on climate change

Construction

Impacts of the proposal on climate change during construction would include the release of the following greenhouse gases:

- Carbon dioxide may be generated from land clearing (decomposition of cleared vegetation)
- Carbon dioxide and nitrous oxide would be generated from liquid fuel use in plant and vehicles (diesel, petrol) during construction and disposal and transport of materials
- Methane would be released from landfilling any carbon based waste
- Various greenhouse gas emissions would be associated with the extraction and production of materials used in the construction of the levee upgrades.

Operation

Maintenance activities would be undertaken along the levees as necessary. Maintenance activities would be potentially less frequent than at present, given the improved quality of the levees after the proposed upgrades. There would therefore be a negligible change in vehicle emissions resulting from maintenance activities for the proposal.

Potential mitigation of the impacts of climate change on the Wagga Wagga community

As discussed in section 6.13.2, rainfall events in the South-west Slopes are predicted to become more intense, causing altered flooding regimes. The proposal would increase the level of protection for Wagga Wagga against floods that may be influenced by climate change.

The freeboard provided by the proposal has been designed with an allowance of 15 centimetres for increases in flood height caused by climate change (NSW Public Works 2010b).

6.13.4 Safeguards and management measures

Impact	Safeguard	Timing and responsibility
Flooding from extreme rainfall events	• Detailed design, including drainage requirements, would take into consideration the effect of climate change on the proposal.	Pre-construction Council
Greenhouse emissions	• Investigations into opportunities for reducing greenhouse emissions during construction and operation of the proposal would be undertaken during the detailed design and construction planning phase.	Pre-construction Council and contractor
Greenhouse emissions	• Delivery of materials with full loads would be undertaken from local suppliers where possible • Appropriately sized construction equipment, plant and vehicles would be used • Regular servicing of equipment would be undertaken to maintain optimal performance, and to minimise down time (which can improve overall efficiency) • The layout of access, machinery and facilities would be designed to minimise movement and vegetation clearing • Investigation of alternative fuels and power sources would be undertaken and implemented, where appropriate • Energy efficiency and related carbon emissions of vehicle and plant equipment would be considered, where possible • Material and waste supply and departure scheduling would be undertaken to optimise full loads and minimise required vehicle trips • Clearing of vegetation would be minimised where feasible.	Construction Contractor

6.14 Demand on resources

6.14.1 Potential impacts

The proposal would require the use of a number of resources, including:

- Resources associated with the operation of construction machinery, and motor vehicles (this includes a variety of resources, the major one being diesel and petrol)
- Fill required to meet design levels, which would be obtained from the proposed borrow sites
- Other materials required for the construction of various components of the proposal
- Material required for road surfaces and infrastructure (road base, paints, solvents, asphalt, spray seal, sand, concrete, aggregate, steel etc)
- Construction water (for concrete and dust suppression). This would be sourced either from the local potable supply or the Murrumbidgee River.

The quantities of materials required for the proposal are detailed in section 3.3.5.

The materials required during the proposed construction works are not currently restricted resources. However, materials such as metals and fuels are considered non-renewable and would be used conservatively.

Materials would be sourced from local quarries and commercial suppliers, where possible. Excess materials would be disposed of in accordance with safeguards and management measures outlined in section 6.12.3.

As outlined in section 3.3.5, the amount of water required during the construction phase is currently unknown. Water sources for the construction phase would be determined during detailed design, including any approvals required under relevant legislation.

6.14.2 Safeguards and management measures

Impact	Safeguard	Timing and responsibility
Resource consumption	• The procurement of materials would be limited to the quantities required for the proposal • Procurement would endeavour to use materials and products with a recycled content where that material or product is cost and performance effective.	Construction Contractor

6.15 Cumulative impacts

6.15.1 Existing environment

The land within the levees has been transformed by urban development over the last 170 years. Outside the levees the land has been developed and managed for agricultural land uses including grazing and cropping.

Two quarries are located 1.3 kilometres east of the proposal site and another quarry is located four kilometres west of the proposal site. All are adjacent to the Murrumbidgee River.

A four hectare commercial development is located on the corner of Kooringal Road and Hammond Avenue, 350 metres from the proposal site. This is being constructed on an earthen pad to above the 100 year ARI flood level. Other commercial developments could occur in the Hammond Avenue and Copland Street areas in future.

It is proposed to remove the Hampden Bridge, which is listed as a heritage item under the Wagga Wagga LEP. It is also possible that a footbridge may be constructed across the Murrumbidgee River near the Tourist Information Centre near Main City Levee chainage 5800. A function centre may also be constructed near the same location.

There are no other known major developments occurring concurrently or planned in the immediate vicinity of the proposal. It is likely that minor housing and commercial developments would continue to occur at various locations in the study area.

Linear infrastructure projects such as roads and powerlines are being developed in the locality. The Byrnes Road Deviation is located about 1.2 kilometres east of the East Street (Bank Two) Levee.

6.15.2 Potential impacts

Biodiversity

The proposal would cause impacts additional to those that have occurred due to previous land use activities in the study area; including residential, commercial and agricultural activities. The proposal would reduce the overall extent of native vegetation cover in a fragmented residential, commercial and rural landscape. Other works that may contribute to cumulative ecological impacts in the study area include vegetation maintenance for linear infrastructure such as roads and powerlines.

The proposal would contribute to the cumulative impacts of the residential and commercial developments, placing increased pressure on threatened fauna in the study area. However, the removal of native vegetation represents about 0.6 per cent of native vegetation in the study area and even less in the locality. The proposal is therefore unlikely to cause significant cumulative ecological impacts.

Flooding

The proposal is anticipated to result in minor increases in flood depth and velocities in surrounding areas as described in section 6.3. Future development proposals in surrounding areas should consider current and future flood levels in the development assessment process.

Other environmental impacts

The known and potential developments outlined in section 6.15.1 would be likely to have cumulative impacts in relation to soils and water quality, noise, traffic, visual amenity, air quality, socio-economic and land use impacts. The proposal would increase the incidence of these impacts in the study area.

6.15.3 Safeguards and management measures

It is considered that the potential for adverse cumulative impacts is most effectively addressed by the application of the individual safeguards recommended throughout the REF.

6.16 Summary of beneficial effects

The proposal would have the following beneficial effects:

- The proposal would increase the level of flood protection for Central Wagga Wagga from the current 60 year ARI level of flood protection to the 100 year ARI level of flood protection, and for North Wagga Wagga from the current 17 year ARI level of flood protection to the 20 year ARI level of flood protection
- The proposal would increase the level of flood protection for 2,000 buildings in Central Wagga Wagga and for 91 buildings in North Wagga Wagga
- The proposal would reduce the impacts of flooding on land uses in the study area, including residences, businesses, roads, utilities and recreational land uses
- It has been predicted that raising the Main City Levee would reduce the average annual damages of Central Wagga Wagga ($1,406,900) by up to 55 per cent (WMA Water 2009a)
- It is expected that the increased level of flood protection provided to Central Wagga Wagga by the proposal would reduce the cost of insurance for property owners in this area.

6.17 Summary of adverse effects

The main adverse effects of the proposal would include:

- Removal of about 1.1 hectares of River Red Gum forest, which provides habitat for flora and fauna, including a number of threatened and migratory species listed under the TSC Act and EPBC Act
- Potential for soil erosion and sedimentation impacts to the Murrumbidgee River
- Small increases in flood depth and velocity at properties outside the levees in floods greater than the 60 year ARI flood level
- Construction noise and vibration impacts on nearby buildings and land uses – noise and vibration would be above the relevant construction criteria for receivers immediately adjacent to the proposal site
- Potential for a reduction in air quality caused by the generation of dust
- Long-term visual impacts through increasing the heights of the levees. Views of the Murrumbidgee River and surrounding countryside may be reduced or blocked at a number of properties
- Potential impacts on non-Aboriginal heritage through the relocation of a monument to the construction of the Main City Levee that was built in 1960 and a flood height gauge that may have been used for historic flood measurements, subject to approval
- A range of other changes in amenity and environmental risks including land use, traffic and access, socio-economic and waste.

7. Environmental management

This chapter describes how the proposal would be managed to reduce potential environmental impacts throughout detailed design, construction and operation. A framework for managing the potential impacts is provided with reference to environmental management plans. The licence and/or approval requirements required before construction are listed.

7.1 Environmental management plan

A number of safeguards and management measures have been identified in order to minimise adverse environmental impacts, including social impacts, which could potentially arise as a result of the proposal. Should the proposal proceed, these management measures would be incorporated into the detailed design and applied during the construction and operation of the proposal.

A construction environmental management plan (CEMP) and relevant environmental sub-plans would be prepared to describe safeguards and management measures identified. These plans would provide a framework for establishing how these measures would be implemented and who would be responsible for their implementation.

The plans would be prepared before the construction of the proposal and must be reviewed and certified by Wagga Wagga City Council before the commencement of any on-site works. The CEMP would be a working document, subject to ongoing change and updated as necessary to respond to specific requirements.

7.2 Licensing and approvals

The proposal would potentially require licences and/or approvals from the relevant statutory agencies as outlined in Table 7.1.

Table 7.1: Summary of licensing and approval required

Requirement	Timing
If extraction of water from the North Wagga borrow site is required, and is to be used for irrigation of adjacent land, a specific purpose access licence from Office of Water would be required.	A specific purpose access licence would be obtained before pumping any water from the borrow site.
Under clause 165A of the *Water Act 1912*, the proposal may be classified as a controlled work. A replacement application to the NSW Office of Water may be required.	A replacement application would be obtained if necessary after the detailed design has been completed and before construction.
If the tonnage of material extracted from any single borrow site is likely to exceed 30,000 tonnes in any given year, an environment protection licence from the EPA would be required.	An environment protection licence would be obtained as soon as Council determines that the required extraction of material from any borrow site would be likely to exceed 30,000 tonnes per year.
If it is determined during detailed design that impacts to the flood marker tree and levee monument are unavoidable, a Section 139 exemption form would need to be filed with the	A Section 139 exemption form would be filed with the NSW Heritage Office before construction occurs within 50 metres of the heritage site. Works in this location would not

Requirement	Timing
NSW Heritage Office.	commence until approval to remove the heritage items has been granted by the NSW Heritage Office.
Under section 138 of the *Roads Act 1993* consent would be required for works on public roads. Council would need to obtain consent from Roads and Maritime Services for works on the Sturt Highway	Consent from Roads and Maritime Services for works on the Sturt Highway would be obtained before any construction works at this location.
Under section 155 (1) of the *Crown Lands Act 1989* consent would be required for works within Crown land that are not located within an existing easement. Consent would need to be obtained from the Department of Primary Industries (Crown Land).	Consent would be obtained from the Department of Primary Industries (Crown Land) before any works commence on Crown Land.

8. Conclusion

This chapter provides the justification for the proposal taking into account its biophysical, social and economic impacts, the suitability of the site and whether or not the proposal is in the public interest. The proposal is also considered in the context of the objectives of the EP&A Act, including the principles of ecologically sustainable development as defined in Schedule 2 of the *Environmental Planning and Assessment Regulation 2000*.

8.1 Justification

The proposal is considered to be consistent with a number of strategies or plans, including:

- NSW Flood Prone Land Policy
- Wagga Wagga Floodplain Risk Management Plan
- NSW State Rivers and Estuaries Policy
- Riverside Wagga Wagga Strategic Master Plan
- Riverside Wagga Wagga Plan of Management
- Wagga Wagga Bicycle Plan 2011.

Flooding in the Murrumbidgee River at Wagga Wagga has caused significant damages, financial loss and disruption to the community. Currently the level of flood protection provided by the levees does not comply with Council's flood protection policies.

The proposed upgrade of the Wagga Wagga levees would have a major beneficial impact through providing increased flood protection for the City of Wagga Wagga.

There would also be a number of adverse environmental impacts as a consequence of the proposal. The primary impacts include:

- Loss of River Red Gum forest and associated flora and fauna habitat, with impacts on 13 threatened species, a population and an ecological community listed under the TSC Act, EPBC Act and/or FM Act. The proposal would be unlikely to have a significant impact on any listed species, population or ecological community
- Potential soil erosion and water quality impacts
- Increased depth of flooding in areas outside the levees during large floods (greater than 60 year ARI flood event)
- Impacts on adjacent properties through noise and vibration, generation of dust and visual impacts
- Potential heritage impacts through the relocation of a monument to the construction of the Main City Levee and a flood gauge.

Where possible, impacts would be avoided or minimised through the design process and site-specific safeguards. On balance, it is considered that the adverse environmental impacts of the proposal are outweighed by the beneficial effects and that the proposal is therefore justified.

8.2 Objects of the EP&A Act

Object	Comment
5(a)(i) To encourage the proper management, development and conservation of natural and artificial	The proposal would result in the loss of 1.1 hectares of River Red Gum forest.

Object	Comment
resources, including agricultural land, natural areas, forests, minerals, water, cities, towns and villages for the purpose of promoting the social and economic welfare of the community and a better environment.	The proposal has the potential to impact on the city of Wagga Wagga through noise and vibration and generation of dust. The proposal aims to promote the social and economic welfare of the community by increasing the level of flood protection for the City of Wagga Wagga.
5(a)(ii) To encourage the promotion and co-ordination of the orderly economic use and development of land.	Council is undertaking consultation and environmental assessments required to properly plan and develop the proposal without undue impacts on the local economy. The increased flood protection achieved by the proposal would benefit the economy by reducing the potential damages and economic impacts caused by floods.
5(a)(iii) To encourage the protection, provision and co-ordination of communication and utility services.	A number of communication and utility services exist in the vicinity of the proposal, as detailed in section 3.4. Council would consult with the relevant service providers to address issues relating to public utility adjustment, and would continue to consult with these providers during the detailed design phase and throughout the proposal.
5(a)(iv) To encourage the provision of land for public purposes.	Works along the Main City Levee would affect access for users of the Wiradjuri Walking Track. It is anticipated that alternative access for cyclists and walkers would be maintained adjacent to the proposal site or via detours during construction. In the long term, the proposal would provide an improved track along the Main City Levee, up to three metres wide and surfaced with sprayed-seal bitumen. Access to a picnic area at chainage 7200 may be temporarily affected during construction. The proposal would improve public access to the river in Central Wagga Wagga by reducing the slope of the Main City Levee banks on the city side of the levee.
5(a)(v) To encourage the provision and co-ordination of community services and facilities.	The picnic area at chainage 7200 and the Wiradjuri Walking Track are available to the public as community facilities. Access to the picnic area may be restricted during construction. In the long term, access on the Wiradjuri Walking Track would be improved by constructing an improved track along the Main City Levee. The proposal is unlikely to substantially affect the use of community facilities by the public.
5(a)(vi) To encourage the protection of the environment, including the protection and conservation of native animals and plants, including threatened species, populations and ecological communities, and their habitats.	The proposal would cause the loss of River Red Gum forest and associated flora and fauna habitat, with impacts on 13 threatened species, a population and an ecological community listed under the TSC Act and EPBC Act. The proposal would be unlikely to have a significant impact on any listed species, population or ecological community.
5(a)(vii) To encourage ecologically sustainable development.	Ecologically sustainable development is considered in Sections 8.2.1 – 8.2.4 below.

Object	Comment
5(a)(viii) To encourage the provision and maintenance of affordable housing.	Not relevant to the project.
5(b) To promote the sharing of the responsibility for environmental planning between different levels of government in the State.	Not relevant to the project.
5(c) To provide increased opportunity for public involvement and participation in environmental planning and assessment.	Council has undertaken consultation for the proposal as described in chapter 5. This has included consultation with stakeholders and the community, including the Aboriginal community. Issues raised during consultation in relation to the proposal have been addressed during the environmental planning and assessment process. This REF would also be put on display for public comment.

8.2.1 The precautionary principle

This principle states that "*if there are threats of serious or irreversible damage, lack of scientific certainty should not be used as a reason for postponing measures to prevent environmental degradation*".

The environmental consequences of the proposal have been assessed as accurately as possible using appropriate specialists in relevant disciplines where required. The assessment process involved computer flood modelling, analysis and interpretation of the potential environmental impacts associated with the proposal. This process has enabled the impacts of the proposal to be predicted within a reasonable degree of certainty. All predictions, however, contain a degree of variability, which reflects the variable nature of the environment. Where there has been any uncertainty in the prediction of impacts throughout the environmental impact assessment process, a conservative approach was adopted to ensure the worst case scenario was predicted in the assessment of impacts.

The proposed works are not anticipated to result in serious or irreversible damage. Under the proposal, as a requirement of the CEMP, environmental monitoring will be undertaken as a precautionary measure to reduce any uncertainty regarding the potential for environmental damage. No mitigation measures or management mechanisms would be postponed as a result of a lack of information.

8.2.2 Intergenerational equity

The principle states that "*the present generation should ensure that the health, diversity and productivity of the environment is maintained or enhanced for the benefit of future generations*".

The proposal would have a major long-term benefit for future generations by providing increased flood protection for the City of Wagga Wagga. This would reduce the likelihood of flood damages to the urban environment and the associated economic costs and disruption to the community. It is expected that the increased level of flood protection provided to Central Wagga Wagga by the proposal would reduce the cost of insurance for property owners in this area.

The proposal would benefit future generations by ensuring that proposed works do not give rise to significant long-term adverse impacts. Potential impacts would be minimised by the implementation of appropriate safeguards.

Should the proposal not proceed, the principle of intergenerational equity may be compromised, as future generations would inherit a sub-standard level of flood protection. The community would be at risk of suffering damages from floods that could otherwise be protected against.

8.2.3 Conservation of biological diversity and ecological integrity

This principle states that the "*diversity of genes, species, populations and communities, as well as the ecosystems and habitats to which they belong, must be maintained and improved to ensure their survival*".

An assessment of the existing local environment has been undertaken in order to identify and manage any potential impacts of the proposal on local biodiversity. The proposal would involve the removal of 1.1 hectares of River Red Gum forest, which provides habitat for native fauna and flora species. The proposal is considered unlikely to significantly impact on any species, population or ecological community listed under the TSC Act or EPBC Act.

An ecological assessment and appropriate site-specific safeguards are provided in section 6.1 and Appendix H of this REF. Safeguards include consideration of design impacts upon biodiversity, vegetation management and weed management.

8.2.4 Improved valuation, pricing and incentive mechanisms

This principle requires that "*costs to the environment should be factored into the economic costs of a project*".

The REF has examined the environmental consequences of the proposal and identified mitigation measures for areas which have the potential to experience adverse impacts. Requirements imposed in terms of implementation of these mitigation measures would result in an economic cost to Council. The implementation of mitigation measures would increase both the capital and operating costs of the proposal. This signifies that environmental resources have been given appropriate valuation.

The design for the proposal has been developed with an objective of minimising potential impacts on the surrounding environment. This indicates that the concept design for the proposal has been developed with an objective to minimise environmental impacts.

8.3 Conclusion

Wagga Wagga City Council proposes to upgrade the Wagga Wagga and North Wagga Wagga levees along the Murrumbidgee River.

The proposal is required to increase the level of flood protection for residents and businesses of Wagga Wagga.

The proposal would raise the Main City Levee to provide flood protection for up to a 100 year average recurrence interval (ARI) flood event, and would raise the North Wagga Wagga Levee and East Street (Bank Two) Levee to provide flood protection for up to a 20 year ARI flood event.

The proposal is subject to assessment under Part 5 of the EP&A Act. The REF has examined and taken into account to the fullest extent possible all matters affecting or likely to affect the environment by reason of the proposed activity.

The proposal as described in this review of environmental factors best meets the project objectives but would still result in impacts relating to biodiversity, soils, water quality, hydrology and flooding, land use, noise and vibration, air quality, landscape and visual, non-Aboriginal heritage, traffic and access and socio-economic impacts.

Adverse environmental effects would be minimised through the implementation of safeguards and mitigation measures outlined in this review of environmental factors.

The proposal would have beneficial impacts by providing increased flood protection for the City of Wagga Wagga. This would reduce the likelihood of flood damages to the urban environment and the associated economic costs and disruption to the community.

On balance, it is considered that the adverse environmental impacts of the proposal are outweighed by the beneficial effects and that the proposal is therefore justified.

This review of environmental factors concludes that the proposal is unlikely to have a significant impact on any species, population or ecological community listed under the *Threatened Species Conservation Act 1995*. A species impact statement is not therefore required.

This review of environmental factors finds that the proposal is unlikely to have a significant environmental impact and therefore an Environmental Impact Statement is not required. Approval from the Minister for Planning and Infrastructure under Part 5.1 of the *Environmental Planning and Assessment Act 1979* would not be required.

This review of environmental factors finds that the proposal is unlikely to have a significant impact on any matter of national environmental significance listed under the *Environment Protection and Biodiversity Conservation Act 1999*. A referral to the Commonwealth Department of Sustainability, Environment, Water, Population and Communities is not therefore required.

9. Certification

This review of environmental factors has assessed the proposal in accordance with section 111 of the *Environmental Planning and Assessment Act 1979* and clause 228 of the *Environmental Planning and Assessment Regulation 2000*.

The review of environmental factors provides a true and fair review of the proposal in relation to its potential effects on the environment. It addresses to the fullest extent possible all matters affecting or likely to affect the environment as a result of the proposal.

Reuben Robinson

Environmental Scientist

GHD Pty Ltd

Date: 7/8/2013

I have examined this review of environmental factors and the certification by Reuben Robinson of GHD and accept the review of environmental factors on behalf of Wagga Wagga City Council.

Brad Jeffrey

Senior Infrastructure Planning Coordinator

Wagga Wagga City Council

Date: 7/8/2013

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11. Terms and acronyms used in this REF

Abutment	An end support of a bridge
AHIMS	Aboriginal Heritage Information Management System
Average annual damages (AAD)	The standard way of expressing flood damages. The average annual damage is equal to the damage caused by all floods over a long period of time divided by the number of years in that period. Average annual damages are calculated by multiplying the damages that can occur in a given flood by the probability of the flood occurring in a given year and then summing across the range of floods.
Average recurrence interval	The likelihood of occurrence of a flood of certain magnitude, expressed in terms of the long-term average number of years between flood events. For example, a flood height in the Murrumbidgee River at Hampden Bridge in Wagga Wagga of 11.49 metres or greater has an average recurrence interval of at least 100 years (WMA Water 2010). See section 2.1.1 for reference.
Biota	The flora and fauna of a region.
Biodiversity Certification Area	The area in the Wagga Wagga local government area within which any development under Part 4 of the EP&A Act, and any activity under Part 5 of that Act, are deemed not to have a significant impact on ecological communities, threatened species, or populations and their habitats, provided that the development or activity is undertaken in accordance with the LEP and Order of Biodiversity Certification.
CEMP	Construction Environmental Management Plan
Council	Wagga Wagga City Council
dB(A)	Frequency weighting filter used to measure 'A-weighted' sound pressure levels, which conforms approximately to the human ear response, as our hearing is less sensitive at very low and very high frequencies
dbh	Diameter at breast height
DECC	Department of Environment and Climate Change, now OEH (see below)
DECCW	NSW Department of Environment, Climate Change and Water, now OEH (see below)
Design crest level	The level to which a levee (or other flood protection measure) is designed, to the top of the embankment or structure. This level includes the freeboard.
Design flood level	The flood protection level to which a levee (or other flood protection measure) is designed, such as for a 100 year ARI flood event. This level does not include the freeboard.
Dispersible soils	Soils that due to having high sodium content are structurally unstable and disperse in water into basic particles (sand, silt and clay). Dispersible soils tend to erode easily and are not suitable for use in earthworks
EIS	Environmental Impact Statement
EP&A Act	Environmental Planning and Assessment Act 1979
EP&A Regulation	Environmental Planning and Assessment Regulation 2000
EPBC Act	Environment Protection and Biodiversity Conservation Act 1999

ESD	Ecologically sustainable development. Development which uses, conserves and enhances the resources of the community so that ecological processes on which life depends, are maintained and the total quality of life, now and in the future, can be increased.
Flood	Relatively high stream flow which overtops the natural or artificial banks in any part of a stream, river, estuary, lake or dam, and/or local overland flooding associated with major drainage before entering a watercourse.
Floodplain	The area of land adjacent to a stream that is subject to inundation by floods up to and including the probable maximum flood event, that is, flood prone land.
Flood prone land	Land that is susceptible to flooding by the probable maximum flood (PMF) event.
FM Act	Fisheries Management Act 1994
Freeboard	In relation to flood levees, freeboard is the height of a levee above the design flood height (for the proposal the design flood height is the 100 year ARI flood event). Freeboard provides a factor of safety to compensate for uncertainties in the estimation of flood levels across the floodplain, such as wave action, localised hydraulic behaviour and impacts that are specific event related, such as levee and embankment settlement.
GHD	GHD Pty Ltd
Hydrograph	A graph that shows how the discharge or stage/flood level at any particular location varies with time during a flood.
Hydrology	Term given to the study of the rainfall and runoff process; in particular, the evaluation of peak flows, flow volumes and the derivation of hydrographs for a range of floods.
ISEPP	State Environmental Planning Policy (Infrastructure) 2007
LALC	Local Aboriginal Land Council
LEP	Local Environmental Plan
LGA	Local government area
Likely	Taken to be a real chance or possibility.
Locality	The area within a 10 kilometre radius of the proposal.
NPW Act	National Parks and Wildlife Act 1974
NSW	New South Wales
OEH	NSW Office of Environment and Heritage
Overtopping (of a levee)	The inundation of a levee by a flood.
POEO Act	Protection of the Environment Operations Act 1997
Probable maximum flood (PMF)	The largest flood that could conceivably occur at a particular location, usually estimated from probable maximum precipitation. Generally, it is not physically or economically possible to provide complete protection against this event. The PMF defines the extent of flood prone land, that is, the floodplain.
Probable maximum precipitation (PMP)	The greatest depth of precipitation for a given duration meteorologically possible over a given size storm area at a particular location at a particular time of the year, with no allowance made for long-term climatic trends

	(World Meteorological Organisation, 1986). It is the primary input to the estimation of the probable maximum flood.
Proposal site	The area that would be directly impacted by the proposal.
RBL (rating background level)	The overall single-figure background noise level representing each assessment period (day/evening/night) over the whole monitoring period. This is the level used for assessment purposes. It is defined as the median value of: • All the day assessment background levels over the monitoring period for the day. • All the evening assessment background levels over the monitoring period for the evening. • All the night assessment background levels over the monitoring period for the night.
REF	Review of environmental factors
Runoff	The amount of rainfall which actually ends up as streamflow, also known as rainfall excess.
SEPP	State Environmental Planning Policy
DSEWPaC	Australian Department of Sustainability, Environmental, Water, Populations and Communities
Study area	The area of impact and any additional areas, which are likely to be affected by the proposal, either directly or indirectly. In this study it includes the area of impact and adjacent areas of Planning Agreement Areas and private land. Generally this includes the area up to 500 metres from the proposal boundary.
Threatened species	A species specified in Schedule 1 Part 1 (endangered species), Part 4 (presumed extinct) and Schedule 2 (vulnerable species) of the TSC Act, in Schedule 4 (endangered species), 4A (critically endangered species) and Schedule 5 (vulnerable species) or under the EPBC Act.
TSC Act	*Threatened Species Conservation Act 1995*
Unlikely	Taken to be an unlikely or remote possibility of occurring.

This report has been prepared by GHD for Wagga Wagga City Council and *may only be used and relied on by Wagga Wagga City Council for the purpose agreed between GHD and Wagga Wagga City Council as set out in section 1.2 of this report.*

GHD otherwise disclaims responsibility to any person other than Wagga Wagga City Council arising in connection with this report. GHD also excludes implied warranties and conditions, to the extent legally permissible.

The services undertaken by GHD in connection with preparing this report were limited to those specifically detailed in the report and are subject to the scope limitations set out in the report.

The opinions, conclusions and any recommendations in this report are based on conditions encountered and information reviewed at the date of preparation of the report. GHD has no responsibility or obligation to update this report to account for events or changes occurring subsequent to the date that the report was prepared.

The opinions, conclusions and any recommendations in this report are based on assumptions made by GHD described in this report (see below). GHD disclaims liability arising from any of the assumptions being incorrect.

GHD has prepared this report on the basis of information provided by Wagga Wagga City Council, which GHD has not independently verified or checked beyond the agreed scope of work. GHD does not accept liability in connection with such unverified information, including errors and omissions in the report which were caused by errors or omissions in that information.

Assumptions

Assumptions made by GHD when undertaking services and preparing the review of environmental factors include (but are not limited to):

- The impact footprint of the proposal would be as presented in data provided by Wagga Wagga City Council to GHD, and as presented in this report
- The safeguards and mitigation measures detailed in Chapter 6 would be implemented.