Upper Canal

Aqueduct Expansion Joint Renewals

Statement of Heritage Impact

(To accompany a s60 application under the *Heritage Act, 1977*)

Contents

1. Introduction

The Upper Canal, constructed in the 1880's is an essential component of the water supply for Sydney. It transfers water from the Upper Nepean System to the Prospect Water Filtration Plant or the Prospect Reservoir. Its function includes balancing supplies, providing water security and flexibility in management of water quality. The canal coupled with Prospect Reservoir, is a contingency source of supply during unplanned outages of the Warragamba Pipelines.

The Upper Canal is 64 kilometres long and consists of open canal (43.1km), tunnels (19km), aqueducts (1km), and other ancillary structures. It occupies a continuous corridor that ranges in width from 15 to 50 metres.

The Upper Canal includes approximately:

- 43.1 km of open channel
  - 1.4 km – Unlined
  - 10.3 km – Sandstone Box
  - 4 km – Concrete Box
  - 2 km– Sandstone Trapezoidal
  - 20km – Concrete Trapezoidal
  - 5.4 km – Sandstone Race
- 13 Tunnels.
- 12 Aqueducts
- 9 lay flat Control Gates
- 88 km's of Coping drains
- 63 Cross drains (syphons)
- 177 Cross drains (flumes)
- 452 Props

Of the twelve aqueducts that comprise the Upper Canal system, nine of the aqueducts are situated within the Appin/Campbelltown area. Construction of these aqueducts can be traced back to the late 19th century.

The Aqueducts are made of riveted wrought iron and have a diameter of approximately 2290-2440mm. Of the nine aqueducts within the region, six aqueducts have had their expansion joints perish as they are at end-of-life and need replacement as part of WaterNSW's ongoing maintenance program.

2. Location

The 6 aqueducts are located in South West and Western Sydney along various sections on the Upper Canal. The aqueducts are all owned by WaterNSW and details to their locations are as per the following.

Table 1. Location Details

Aqueduct	Location*	Lot/DP	Suburb
1	Elladale Creek	Lot 2 DP 719962	Appin
2	Ousedale Creek	Lot 1 DP 625921	Appin
3	Mallaty Creek	Lot 2 DP 625921	Appin
4	Leafs Creek	Lot 3 DP 625921	Appin
5	Nepean Creek	Lot 1 DP 730136	Gilead
6	Menangle Creek	Lot 3 DP 730136	Gilead

* (refer to Figure 1 below for location details)

Figure 1. Aqueduct Locations

Figure 2. Aqueduct 1 - Elladale Creek

Figure 3. Aqueduct 2 - Ousedale Creek

Figure 4. Aqueduct 3 – Mallaty Creek

Figure 5. Aqueduct 4 - Leafs Creek

Figure 6. Aqueduct 5 - Nepean Creek

Figure 7. Aqueduct 6 – Menangle Creek

3. Heritage Listings

The following heritage listings apply to the Upper Canal:

Table 2. Heritage Listings

Register	Listing Name and Number	Status
State Heritage Register	Upper Canal 01373	State
Local Environment Plan	Wollondilly Shire Council (Elladale Creek, Ousedale Creek, Mallaty Creek, Leafs Creek) – I16 Campbelltown Shire Council (Nepean Creek, Menangle Creek) - I01373	State
WaterNSW s170 Register	Upper Nepean Scheme (including Upper Canal and Prospect Reservoir) 4580004	State

4. Heritage Significance, Site and Asset Description

The following is taken from the Conservation Management Plan (CMP) (Government Architect's Office, 2016):

The Upper Canal has STATE heritage significance.

The Upper Canal, as part of the Upper Nepean Scheme, has been in use as a gravity fed water supply system and a key part of Sydney's water supply without substantial alteration to its fabric since its completion in 1888. It operates in essentially the same way as was originally envisaged.

The Upper Canal is unique in NSW, being the only extensive gravity fed water supply canal system to supply a large city and its population with fresh water from a distant source in the hinterland. This type of water supply system also appears to be rare in Australia. The rarity of the Canal is enhanced by its integrity and its continuing operation largely using the original infrastructure built in the 1880s which still operates as originally intended. Such intact systems demonstrating an array of nineteenth century engineering techniques are rare.

As a key component in the Upper Nepean Scheme, the Upper Canal is related to the major NSW historic theme of utilities. The provision of potable water is a first priority in any settlement and influences the success of all settlement building endeavours. The Upper Canal supported the development and expansion of Sydney, NSW's largest and most important settlement, particularly during the late nineteenth and early twentieth centuries, a period of rapid population growth and industrial development.

It is an excellent example of the ingenuity of late nineteenth century hydraulic engineering, in particular for its design as a gravity-fed water supply system through difficult terrain. The Upper Canal is an outstanding benchmark site demonstrating a range of late nineteenth century engineering techniques and innovations in water supply technology, particularly techniques in use prior to the revolution inspired by reinforced concrete construction. Although concrete was later used to improve the durability of the Canal, much of the earlier technology is still evident along the Canal.

The Canal itself is an impressive landscape element with its sandstone and concrete lined edges and serpentine route - based on gentle engineered curves - as it negotiates the complex topography along its route. There are numerous areas of significant plantings along the route of the Canal, particularly some avenues of pines dating to the construction of the Canal. The Canal corridor is known to contain a range of historical archaeological sites associated with the construction and operation of the Canal as well as Aboriginal sites that pre-date the Canal's construction. These sites may contribute knowledge about the local area and the lives of the construction workers not available from other sources.

There are twelve aqueducts along the Canal, generally traversing creek beds although one traverses the Southern Railway Crossing. Aqueducts vary in length between 46m (Simpsons Creek and Nepean Creek) and 200m (Elladale Creek) and include nine wrought iron pipe aqueducts and three brick aqueducts.

The pipe aqueducts are made of riveted pipes constructed from ¾ inch (19m) wrought iron plate. These pipes were made in England and installed in 1888, originally without any internal lining. Between 1935 and 1937, the interior of these pipes were cleaned of rust by sandblasting and lined with 25 to 40mm thick cement mortar.

As per the Conservation Management Plan for the Upper Canal, the aqueducts along the canal are rated as having an Exceptional significance. The aqueducts are rated as having an exceptional significance due to their rarity, research significance, aesthetic / technical significance and associational significance as part of the development of NSW and Sydney's drinking water supply stemming from the 19th century.

5. Scope of Works

The objective is to renew the upstream expansion joints on six (6) aqueducts (as per the table below) within the Upper Canal system in the Appin/Campbelltown area. These aqueducts, constructed with riveted wrought iron in the late 19th century, range in diameter from 2290mm to 2440mm and have been compromised due to subsidence from longwall mining.

Considering these issues, WaterNSW has decided to install EPDM (ethylene propylene diene monomer rubber) seals with retaining bands (Expansion joint seals) to better provide sealing between the concrete headwall and the aqueduct pipe concrete lining.

Table 3. Proposed Replacement Seal Type

No.	Aqueduct Name / Location	Current Seal Type (U/S)	Current Seal Type (U/S)
1	Elladale Creek	Turnbuckle rubber seal	EPDM Seal
2	Ousedale Creek	Turnbuckle rubber seal	EPDM Seal
3	Mallaty Creek	Turnbuckle rubber seal	EPDM Seal
4	Leafs Creek	Turnbuckle rubber seal	EPDM Seal
5	Nepean Creek	Epoxy polyurea coating	EPDM Seal
6	Menangle Creek	Epoxy polyurea coating	EPDM Seal

The typical arrangement of the EPDM expansion joint seal involves the following high-level components:

A. EPDM Seal: A resilient, flexible EPDM rubber seal that conforms to the interface between the concrete headwall and the aqueduct pipe lining. This seal provides a watertight barrier and accommodates slight

movements due to subsidence or pipe expansion and contraction.

B. 304 Stainless Steel Retaining Bands: These bands are installed around the EPDM seal to ensure that it stays securely in place. The bands are designed to provide additional compression and maintain the integrity of the seal under pressure.

C. Concrete Headwall Interface: The EPDM seal is positioned against the concrete headwall to create a tight seal. The concrete surface is prepared to ensure proper adhesion and sealing effectiveness.

D. Aqueduct Pipe Concrete Lining: The seal is also applied where the concrete lining of the aqueduct pipe meets the headwall, providing a continuous seal to prevent leakage and protect against environmental factors.

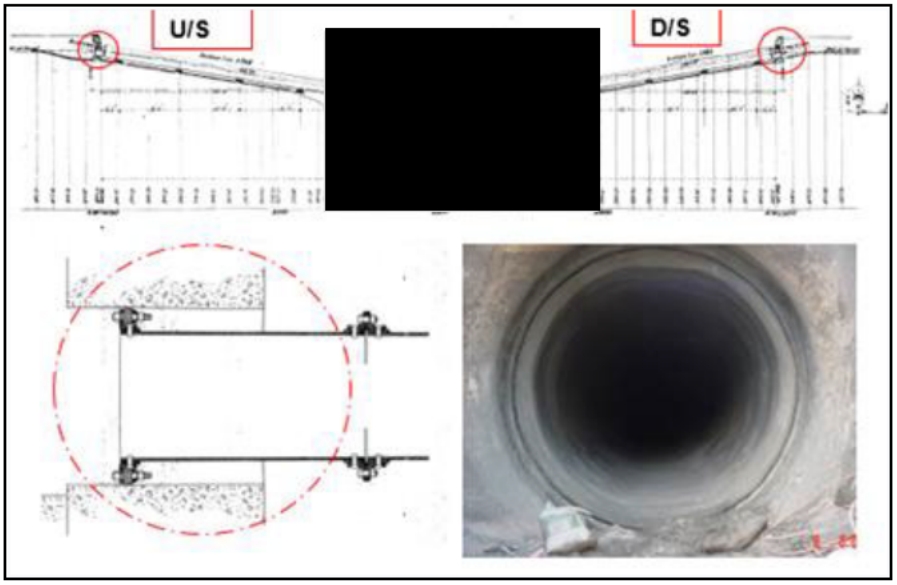

Figure 8. Typical arrangement of the Aqueducts highlighting the upstream and the downstream.

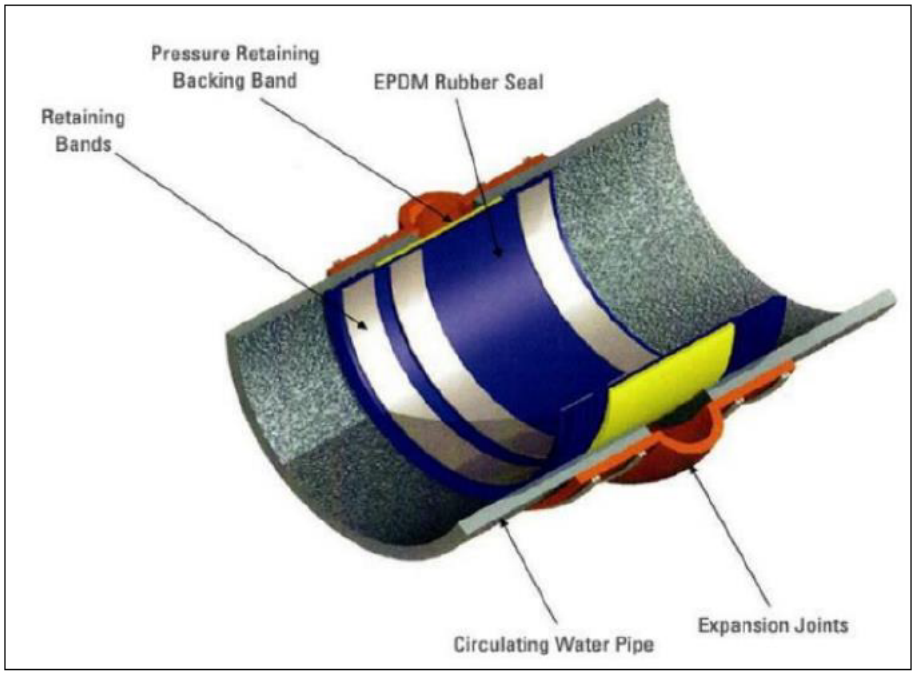

Figure 9. Typical arrangement of the sealing system.

These works shall be supported by the usage of one trailer for the purposes of equipment storage and another for the provision of amenities. This will ensure the works have a minimal footprint within the boundary of the canal. The trailers will stay on establishment service roads within the canal boundary and be moved from location to location as required. Aqueduct seals will be reached by using step ladders to reach the required height for seal replacement.

6. Consideration of Alternatives

WaterNSW considered two alternate options to the installation of the EPDM expansion seal system:

Option A – Do Nothing: No action could result in further deterioration of the Aqueduct joints and the further erosion of the surrounding ground where the Aqueduct supports are located resulting in a major failure.

Option B – Replacing the entire pipeline: Replacing the defective pipes will require a large capital investment cost and that will negatively impact on the Heritage component of the asset and not align with the current Upper Canal strategy.

Neither option proved feasible as these options either did not address the issue of the failing joints or did not provide a cost-efficient solution to remediate the issue. Therefore, they were not chosen.

7. Heritage Impact Statement

This chapter provides an assessment of heritage impact on the significance of the replacement of seals at 6 aqueducts of the Upper Canal as outlined in the *Guidelines for preparing a statement of heritage impact* (Department of Planning and Environment 2023b, 18-20).

The Upper Canal is rated as having Exceptional heritage significance, but the works will not detrimentally impact the significance of the structure. In the 1930s the inside of the aqueduct pipes themselves were lined with a 30mm thick cement mortar, and several pipes were relined c2000. The replacement of seals within the aqueducts themselves is of an insignificant nature but is essential to the on-going operation of the asset for the purposes of supplying Sydney's drinking water.

As per the Conservation Management Plan for the Upper Canal, the aqueducts along the canal are rated as having an Exceptional significance.

WaterNSW is required to meet WH&S requirements in regard to operation of the Upper Canal. Various elements along the Canal are subject to safety upgrades as identified by WaterNSW's preventative maintenance program of works. These elements include: valves, stop boards and other operational equipment; walkways steps and handrails; trashracks; and aqueducts. Safety upgrades are necessary and

inevitable to ensure ongoing operation of the aqueducts along the Upper Canal. The Burra Charter also recognises the need for adaptation of heritage items to suit current uses, including safety upgrades, but advocates changes that have only minimal impact on heritage significance (Article 21). Whilst the seals are modern, they are not of any heritage significance and are a perishable item that is intended to be replaced when it reaches end of life. Therefore, these works are in alignment with Article 21 of the Burra Charter and will not have an impact on the Exceptional rating of the aqueducts themselves.

The following are matters for consideration required to be assessed by the guideline for preparing a Statement of Heritage Impact:

Table 4. Considerations for Heritage Impact

Fabric and Spatial Arrangements	Neither the fabric nor the spatial arrangements will be negatively affected from these works. The seals are a perishable item that are to be intended to be replaced when at end-of-life in order to maintain a water tight seal. There will be no impact upon the spatial/fabric arrangements of the Upper Canal.
Settings, Views and Vistas	Setting, views and vistas will not be altered in any manner as the entirety of the work will be within the aqueduct pipes themselves. The only temporary alteration here will be the erection of scaffolding to facilitate safe access in order to undertake the works.
Landscape	The landscape will not be altered in any way as a result of these works.
Use	These works will ensure the continued use of the Upper Canal in the manner in which its designers intended.
Demolition	There will not be any demolition works undertaken in accordance with this proposal.
Curtilage	There will be no impact to the established curtilage of Upper Canal and all works are within the existing state heritage register curtilage.
Moveable Heritage	The proposed works do not involve movable heritage items and there will be no impact to movable heritage items.
Aboriginal Cultural Heritage	WaterNSW assesses its activities in line with the *National Parks and Wildlife Act* 1974. No Aboriginal items are known from this area and if there is an unexpected find, WaterNSW has a procedure to manage this situation.
Natural Heritage	Whilst the aqueducts are located in a predominantly bushland setting, the replacement of these seals will not impact the Natural Heritage that comprises this bushland or any other elements of the Upper Canal. The usage of trailers for equipment storage and amenities will reduce the

	footprint. Trailers will stay on establishment service roads within the canal boundary.
Conservation Areas	The works are not being undertaken in a conservation area and are not adjacent to such an area. As such, the proposed works will have no impact on a conservation area.
Cumulative Impacts	There will not be any cumulative impacts arising from these works. WaterNSW does intend to construct an over pipe crossing and under fence crossings for unobstructed Koala crossing of the canal, but this is a separate project that will be subject to the assessment of a separate Statement of Heritage Impact. Refer to Figure 10 for details.
Other heritage items in the vicinity	Elladale Creek 2//DP719962 • Appin Massacre Cultural Landscape SHR #02067 Nepean Creek 1//DP730136 – • Beulah 767 Appin Rd Gilead SHR #00368 • Beulah Campbelltown LEP #I00368 • Humewood Forest Campbelltown LEP #I53 Menangle Creek 3//DP730136 – • Mount Gilead Estate 901 Appin Rd Gilead SHR #02020 • Mount Gilead estate Campbelltown LEP #I58 None of the listed items will be impacted by these works as they are outside of the project footprint and are a significant distance from the pipeline itself.

Figure 10. Ousedale Creek - Location of works vs proposed Koala crossing locations

8. The Conservation Management Plan

The following table outlines the proposed works consistency with the relevant policies contained in the Conservation Management Plan (CMP) (Government Architect's Office, 2016).

Table 5. Consistency with the conservation management plan policies.

Policy Number	CMP policy	Assessment
POLICY 2.	Ensure there is adequate funding and resources available to support conservation, repair and maintenance necessary to the long-term conservation of the identified heritage values of the Canal and that new work is undertaken in accordance with the policies of this CMP.	These works have come about because of the provision of adequate funding to facilitate the long term repair and maintenance of the Upper Canal. Therefore these works meet the provision of Policy 2.
POLICY 27.	Proactively prioritise, plan and implement repair and/or remediation works to the Canal to minimise the need for unplanned shutdowns in response to unexpected collapses or other failures and with a view to retaining operational capacity of the Canal and respecting its core heritage values.	These works have been prioritised to ensure that unplanned shutdowns are minimised resulting from failures within the system with the aim of maintaining operational capacity. Therefore these works meet the provision of Policy 27.
POLICY 29.	Implement repair works in accordance with the repair guidelines in Part 4 of this CMP.	These works meet the requirements of 7.2.11 'Repairs to Aqueducts - Modern enhancements to provide improved structural performance are considered appropriate provided that these do not impact on the visual characteristics of the aqueduct as a whole, and do not impact on adjacent elements of Exceptional and High significance'. Whilst the seals are modern, they will add structural performance to the operation of the aqueduct through greater cohesion between pipes that comprise the aqueduct pipeline. This will not impact upon visual characteristic nor any significant or exceptional elements of the Upper Canal. Therefore these works meet the provision of Policy 29.
POLICY 34.	Include inspection as a preventative maintenance activity.	Inspections are part of the planned maintenance inspection schedule, such that any issues requiring maintenance are addressed and rectified. Therefore these works meet the provision of Policy 34.

9. Recommendations

Prior to works

Contractors must be briefed on the heritage sensitive nature of the site and informed of any recommended mitigation measures or controls required.

During works

- All laydown areas will be located within the Boundary of the Upper Canal pipeline. The only site facilities required shall be a trailer mounted port-a-loo and a trailer for tools and equipment. Trailers shall be driven from location to location as required.
- In the event that unexpected historical archaeological remains not identified in this report are discovered within the study area, all works in this area should cease and the area protected. The WaterNSW Heritage Specialist should be notified, and if required Heritage NSW contacted.
- Any accidental damage to heritage items is to be treated as an incident, with appropriate recording and notification.
- Unauthorised removal of heritage fabric or the undertaking of works not outlined and assessed in this SOHI is not permitted.
- All areas affected by works must be cleaned and made good by contractors after works are completed.

10. Conclusion

The works to be undertaken will not have an adverse impact on the heritage item. The works are part of the maintenance of the Upper Canal which is needed to enable WaterNSW to meet its water supply obligations for the Greater Sydney region. Therefore, a s60 approval is appropriate given the minor nature of these works and the overall cost is above the $150,000 threshold for s60 Fast Track works.

11. References

Upper Canal Pheasants Nest to Prospect Reservoir Conservation Management Plan (CMP) (Government Architect's Office, 2016).