HERITAGE MANAGEMENT PLAN GOLDFIELDS WATER SUPPLY SCHEME MAIN CONDUIT, WESTERN AUSTRALIA

In accordance with the *Environment Protection and Biodiversity Conservation Act 1999*

2025-2030

Version 5.4
16/04/2025

stephen carrick architects

Prepared for:
The Water Corporation of Western Australia

Image 1: Main Conduit at Fred Jacoby Park

Source: SCA, 2024.

Declaration of accuracy

In making this declaration, I am aware that section 491 of the *Environment Protection and Biodiversity Conservation Act 1999* (Cth) (EPBC Act) makes it an offence in certain circumstances to knowingly provide false or misleading information or documents to specified persons who are known to be performing a duty or carrying out a function under the EPBC Act or the *Environment Protection and Biodiversity Conservation Regulations 2000* (Cth). The offence is punishable on conviction by imprisonment or a fine, or both. I am authorised to bind the approval holder to this declaration and that I have no knowledge of that authorisation being revoked at the time of making this declaration.

Signed

Full name (please print) Dr Digby Short

Position (please print) Head of Environment

Organisation (please print including ABN/ACN if applicable) 28 003 434 917

Date 16/ 04/ 2025

491 Providing false or misleading information to authorised officer etc.

(1) A person is guilty of an offence if the person:

(a) provides information or a document to another person (the recipient); and

(b) knows the recipient is:

(i) an authorised officer; or

(ii) the Minister; or

(iii) an employee or officer in the Department; or

(iv) a commissioner;

performing a duty or carrying out a function under this Act or the regulations; and

(c) knows the information or document is false or misleading in a material particular.

(2) The offence is punishable on conviction by imprisonment for a term not more than 1 year, a fine not more than 60 penalty units, or both.

Note: Subsection 4B(3) of the *Crimes Act 1914* lets a court fine a body corporate up to 5 times the maximum amount the court could fine a person under this subsection

ACKNOWLEDGMENT OF COUNTRY

The main conduit of the Goldfields Water Supply Scheme travels eastward across the Noongar Nation through the clan group lands of the Whadjuk, Ballardong, and Njakinjaki peoples. For the final third of its length, it crosses the border to the Kapurn Nation before reaching Karlkurla, the traditional name of Kalgoorlie.

We acknowledge the Traditional Owners throughout Western Australia and their continuing connection to the land, water, and community. We pay our respects to all language groups, their unique cultures, their Elders, past and present, and the generations to come.

Aboriginal and Torres Strait Islander People are warned that this document may contain photographs and images of people who have died.

Image 2: Image of a painting by Goldfields Artist Sally Butler

Source: Finalist in National Art Prize, Sally Butler, 2022.

Finalist in National Art Prize, Sally Butler, 2022 Source: 'Northern Goldfields Indigenous artist selected as finalist in national art prize', Kalgoorlie Miner, Madeleine Clark, 2022 accessed 01.07.2024 < https://www.kalminer.com.au/news/kalgoorlie-miner/northern-goldfields-indigenous-artist-selected-as-finalist-in-national-art-prize-c-8058753 >

ABORIGINAL HERITAGE

The following information has been sourced from the Australian Heritage Database:[1]

> *'Sites of significance in Aboriginal culture are often associated with water. Approximately eighty Aboriginal sites are identified along the Goldfields Water Supply Scheme pipeline (DIA 2009). The highest densities of sites occur in three places: at the beginning of the pipeline, at Mundaring Dam and Helena River; about 80 kilometres from Mundaring at Northam, and at Coolgardie and Kalgoorlie, at the end of the pipeline (DIA Sites Register, 2009).'*

For additional Information, please see Australian Heritage Database (Appendix A)[2].

Image 3: Aboriginal man on horse with gold prospector

Source: '008586D: A. P. Brophy prospector and Misery the camel, 1895.', State Library of Western Australia, 1895.

1 Appendix A -Australian Heritage Database Entry

2 Appendix A -Australian Heritage Database Entry

EXECUTIVE SUMMARY

The Goldfields Water Supply Scheme (GWSS) is an enormous engineering achievement bringing benefits to the people of the goldfields, towns and later agricultural districts along its path. The GWSS was included on the National Heritage List (NHL) in 2011 (place ID 106007)[1], and comprises pump stations, reservoirs, tanks and the 566 km main conduit pipeline between Mundaring and Kalgoorlie. The GWSS was included on the State Register of Heritage Places in December 2022[2]. Today, the GWSS remains an operational water supply scheme, providing fresh drinking water to over 100,000 customers.

In 2022 Water Corporation obtained a 70-year approval under the Environment Protection and Biodiversity Act 1999 (EPBC Act):

> *"To remove extant elements of the above ground pipeline forming part of the National Heritage Listed Goldfields Water Supply Scheme, extending from Mundaring Weir to Kalgoorlie [See EPBC Act referral EPBC 2019/8547]."*

Condition 1 of the approval requires the preparation of a *Heritage Management Plan* (HMP) to minimise the impact of the action on the heritage values of the GWSS. This HMP has been prepared to address this requirement and will guide future upgrades.

Water Corporation has also commissioned an Interpretation Strategy for the GWSS, which focuses on interpreting the heritage values of the main conduit as it is gradually replaced with a new below-ground pipeline over the 70-year course of the EPBC Act approval. The *Interpretation Strategy* is to be read in conjunction with this HMP. Together, the HMP and *Interpretation Strategy* will protect and interpret the heritage values of the GWSS, while recognising the operational nature of the scheme that has been characterised by a history of upgrades and renewal to serve the people of Western Australia.

1 Appendix A -Australian Heritage Database Entry

2 Appendix B - Goldfields Water Supply Scheme Registered Entry

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VERSIONS

Heritage Management Plan (HMP) - Goldfields Water Supply Scheme Main Conduit, Western Australia. The current version is Draft 5.4.

The version control table below is a summary of the versions completed to date.

Version Control Table

Version:	Main Feedback Issued:	Date:
Draft 1.0: Initial Structure	Stephen Carrick Architects	28 November 2024
Draft 2.0: Graded Zones Analysis	Water Corporation	05 February 2024
Draft 3.0: Interpretation Inclusion	Response to Water Corporations Surveys	27 June 2024
Draft 4.0: Operations	Water Corporation	06 November 2024
Draft 5.0: Commonwealth Comments	DCCEEW	18 March 2025
Draft 5.1: Initial Response to DCCEEW	Stephen Carrick Architects & H+H Architects	21 March 2025
Draft 5.2: Second Response to DECCEEW	Water Corporation	25 March 2025
Draft 5.3: Response to DCCEEW 'Heritage Division'	DCCEEW	27 March 2025
Draft 5.4: Response to DCCEEW 'Post Approvals Section'	DCCEEW	16 April 2025

PART A : CONTEXT

This section of the plan sets out the context for the management of the heritage values of the Goldfields Water Supply Scheme, including the heritage significance and history.

Chapter 1: Introduction

Chapter 2: Historical Background

Chapter 3: Place Description

Chapter 4: Heritage Significance and Condition of the National Heritage values

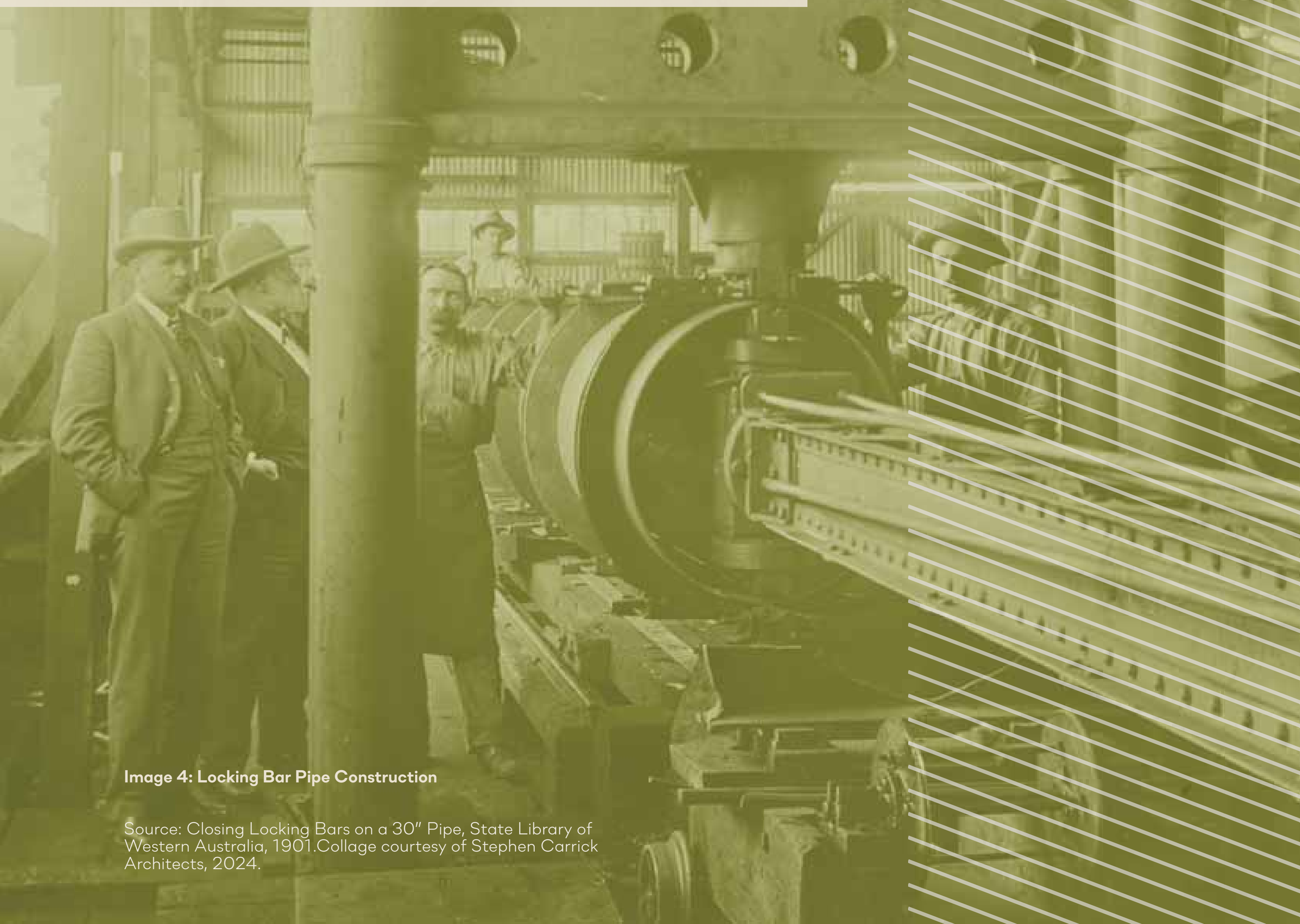

Image 4: Locking Bar Pipe Construction

Source: Closing Locking Bars on a 30" Pipe, State Library of Western Australia, 1901.Collage courtesy of Stephen Carrick Architects, 2024.

CHAPTER 1: INTRODUCTION

1

1.1 OBJECTIVE

1.1.1 KEY OBJECTIVES

This Heritage Management Plan (HMP) is focused on the main conduit of the Goldfields Water Supply Scheme (GWSS) and has the following objectives:

- To ensure operational activities of the Water Corporation protect and conserve the National Heritage values of the GWSS.
- To ensure compliance with the *EPBC Act* and other legislation that requires protection of the National Heritage values of the GWSS.
- To guide implementation of the *EPBC Act* approval 2019/8547 relating to the renewal of the main conduit.
- To ensure the implementation of an *Interpretation Strategy* that presents and transmits the National Heritage values of the GWSS.

1.1.2 PURPOSE AND SCOPE

This Heritage Management Plan (HMP) deals specifically with the main conduit of the GWSS, Western Australia (place ID 106007).

This HMP was a condition of the *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act) Approval 2019/8547 and will outline how the main conduit of the GWSS will be managed in the years ahead.

The individual place Conservation Plans include policies for the GWSS pump stations, reservoirs, and tanks. This HMP does not attempt to repeat these policies. The purpose of this HMP is to define policies for the main conduit only. Although we do make reference to the additional fabric of the GWSS, the policies defined are to manage the main conduit only.

This HMP has been developed to guide works associated with the Water Corporation's seventy-year EPBC approval to remove extant elements of the above ground pipeline so that impacts to national heritage values are minimised, and to promote the protection of the-national heritage values of the Goldfield Water Supply Scheme.

1.1.3 KEY OUTCOMES

The policies within this plan aim to conserve the heritage values of the GWSS main conduit by pursuing the following outcomes:

- The conservation of heritage values.
- Informing staff of heritage values.
- Assessing the impact of actions on the heritage values.
- Various outcomes of the GWSS pipe including: maintenance, installation,conservation, stabilisation, decommission, donation and disposal.
- Archaeological finds discovery procedures.
- Creation of archival records.
- How to employ the Interpretation Strategy.
- Interpretation site documentation and safe access.
- Heritage advice.
- HMP review.

1.1.4 CONSERVATION

Conserve heritage values through:

- Safeguarding, monitoring, and sustaining the condition of these heritage values.
- Adhering to the principles of the Burra Charter.
- Ensuring ongoing and suitable maintenance.
- Managing and mitigating risks through the specified policies.

1.1.5 ZONES

Providing achievable interpretation practices by retaining representative sections of the pipeline.

1.1.6 DECISION-MAKING

Establish effective mechanisms for decision-making by:

- Instituting a sound and transparent day-to-day internal process grounded in the site's heritage values.
- Conducting thorough research before taking action to ensure well-informed decisions.

1.1.7 DOCUMENTATION AND REPORTING

Maintain comprehensive records of actions, archival recording, annual reporting and regular (five-yearly) review of the HMP.

1.1.8 INTERPRETATION AND COMMUNICATION

Achieve appropriate interpretation and communication of the heritage values of the place through implementing the recommendations made in the 2024-2025 Interpretation Strategy (See Appendix C).

1.1.9 USE AND ACCESS

Facilitate public access where land tenure, safety and operational considerations permit. Public access is to focus on interpretation sites due to security issues relating to the GWSS being an operational public drinking water supply scheme.

1.1.10 HUMAN IMPACT

Manage the impacts of use and change through:

- Recording and monitoring change.
- Providing increased interpretation opportunities.
- Establishing systems for users to raise awareness of heritage values and reduce their impact on these values.

1.2 THE PLACE

1.2.1 OVERVIEW

The Goldfields Water Supply Scheme (GWSS) is a monumental engineering triumph, delivering water to the goldfields region and nearby towns and extending its benefits to agricultural districts. This achievement pioneered its era and ranks among the world's most extraordinary engineering accomplishments. Commissioned in 1896 and completed in 1903, the GWSS was the largest of its kind in the world, stretching across 566 kilometres from Mundaring to Kalgoorlie. The main conduit comprises pipes ranging from 762mm to 1016mm in diameter and is predominantly situated above ground, supported by concrete anchor blocks.

Throughout the lifespan of the GWSS, original pump stations were decommissioned, and substantial segments of the main conduit have undergone replacement. Two historic steam pump stations, No. 1 and No. 8, are now managed by the National Trust of Australia (WA), while No. 3 and No. 4 are jointly held by the National Trust of Australia (WA) and local governments. Presently, the Water Corporation of Western Australia (formerly the Public Works Department) possesses and manages the main conduit, operating it under the ownership of the State Government of Western Australia.

Image 5: MSCL pipe with a spiral weld near Mundaring Weir

Source: 'MSCL pipe with a spiral weld near Mundaring Weir', photograph taken near Mundaring, Courtesy of: Stephen Carrick Architects, 2024.

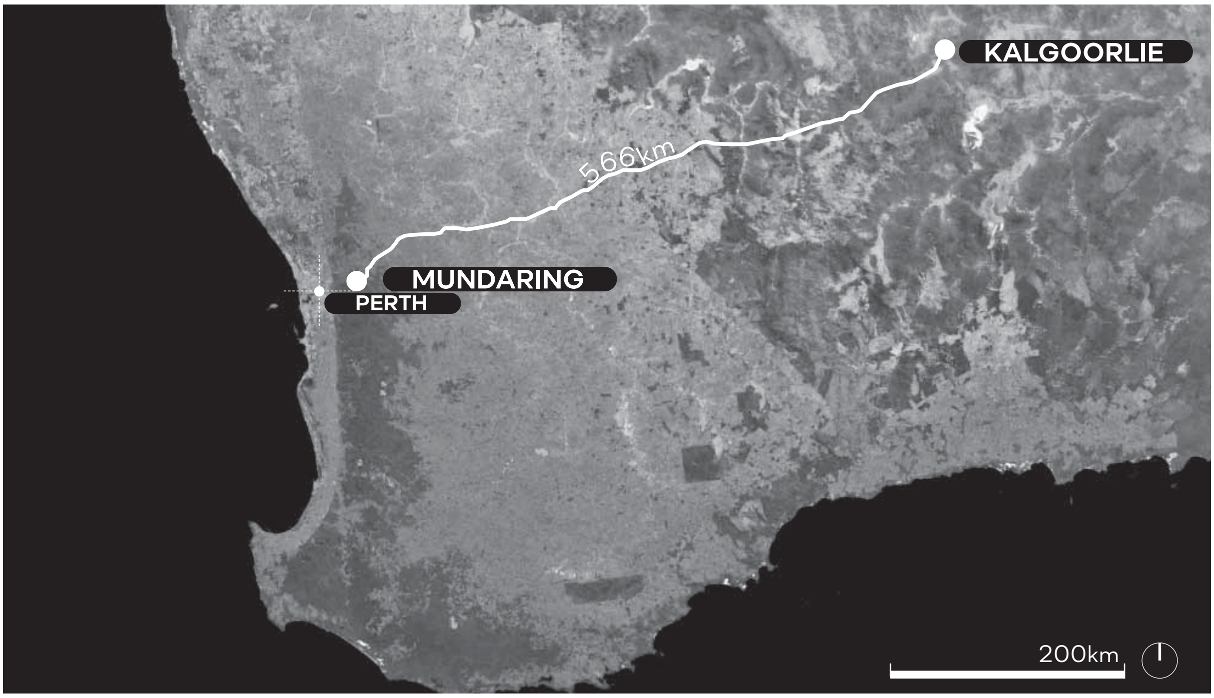

Figure 1: Map of Western Australia showing the GWSS Pipeline

Source: WA map showing the GWSS Pipeline, diagram by Stephen Carrick Architects, satellite images courtesy of Google Maps.

1.3 LOCATION

1.3.1 OVERVIEW

The pipeline begins at Mundaring Weir, 30km east of Perth, and stretches approximately 566km east to Kalgoorlie. The pipeline terminates at Mount Charlotte Reservoir northeast of Kalgoorlie. Figure 1 (above) shows the path of the main conduit.

1.3.2 OWNERSHIP OF THE GWSS

Water Corporation manages all operational components of the GWSS (including the entire pipeline) and some non-operational components (e.g. some of the old steam pumping stations). The National Trust and Local Governments manage various other non-operational components of the GWSS.

In January 1998, various decommissioned assets that formed part of the original scheme were transferred to the National Trust for conservation and interpretation. The transfer arrangement included seed funding so the National Trust could commence the 'Golden Pipeline' project and seek further grants from the State and Federal governments. The outcome of this process included the redevelopment of the No. 1 Pumping Station to form a museum and interpretive centre, a heritage trail with an accompanying guidebook between Mundaring Weir and Kalgoorlie, and a comprehensive education program. Further information on the project is available here.

Notwithstanding this transfer arrangement, some historic decommissioned elements of the GWSS are managed by Water Corporation and other parties.

The pipeline resides predominantly within road reserves, unmanaged reserves and the Public Transport Authority (PTA) rail corridor. There are also large sections located within managed Crown Reserves and private farmland. Some pipe sections within these areas benefit from an easement corridor; however, many do not. Where the pipe does not have any formal tenure (such as an easement), Water Corporation can access the pipe for operational / maintenance purposes per the *Water Services Act 2012*, after serving a Notice of Entry to the relevant landowner.

When upgrading/replacing pipes within private farmland without easement, the Water Corporation will negotiate the purchase of an easement from the relevant landowners[1].

1.3.3 OBLIGATIONS

The GWSS is the principal means of water supply to the Goldfields and Wheatbelt. The primary operational consideration of the pipeline is providing drinking water safely and efficiently. To achieve this objective, the pipeline must be maintained, repaired, and upgraded periodically.

The GWSS's National Heritage values must be maintained, and obligations related to the main conduit arising from them must be considered and, to the extent possible, protected.

1.3.4 CONTEXT AND ENVIRONMENT

The following information (written in italics) has been sourced from the Australian Heritage Database[2] with some updated text from the Water Corporation:

> *"The GWSS traverses the southwest biodiversity hotspot, with notable endemic flora, including the botanical families Myrtaceae (eucalyptus and allies), Proteaceae (Banksias and allies), Fabaceae (native peas), and Epacridaceae (southern heaths) (Hopper 1992). The conduit also traverses several biogeographic regions, including the Jarrah Forrest, Avon Wheatbelt, and Coolgardie IBRA, each with variable vegetation, climates and rainfall. The Avon-Wheatbelt Bioregion is the most notable, containing one of the most species-rich areas.[3]"*

For additional environmental information visit the Australian Heritage Database[4].

1 Email courtesy of Daniel Stevens, Water Corporation, 2023.
2 Appendix A -Australian Heritage Database Entry
3 Appendix A -Australian Heritage Database Entry
4 Appendix A -Australian Heritage Database Entry

Image 6: Environmental context at Mundaring Weir

Source: 'Environmental context at Mundaring Weir', photograph taken near Mundaring, Courtesy of: Stephen Carrick Architects, 2024.

1.3.5 THE GOLDFIELDS WATER SUPPLY SCHEME

The following information has been sourced from the Australian Heritage Database:[5]

> *"The Goldfields Water Supply Scheme is a late 19th century/early 20th century inter-basin transfer water system which extends from Mundaring Weir (Dam) in the west (approximately 41.5 km east of Perth), to Mount Charlotte Reservoir at Kalgoorlie in the east. The Scheme stretches from the Darling Ranges across the arid interior of Western Australia, a total distance of some 566 kilometres. Included are:*
>
> - *the main reservoirs: Mundaring Weir (Dam) and Mount Charlotte Reservoir;*
> - *the main conduit of the pipeline (including all locking bar pipe, wood stave pipe and continuously welded pipe) which stretches 566km from Mundaring in the west to Kalgoorlie in the east;*
> - *the remaining six of the eight original pump stations (No. 1, 3, 5, 6, 7 and 8) including remaining equipment;*
> - *the remaining four associated holding tanks (located at Steam Pump Stations No., 2, 4, 7 and 8); and*
> - *the four regulating tanks located at Bakers Hill, West Northam; Bullabulling and Toorak Hill.[6]"*

1.3.6 HOW THE SCHEME OPERATED

The following information has been sourced from the Australian Heritage Database:[7]

> *"Pump Station No1 pumped water directly from the Mundaring Weir. The water was pumped the short but steep distance (over a lift of 128.3 meters) to the receiving tank at No 2 Pump Station known as O'Connor. Pump Station No 2 pumped the water to the highest tank on the pipeline: Bakers Hill. The water was gravity fed to the regulating tank at West Northam. Continuing under force of gravity, the water arrived at the former railway tank (also referred to as a reservoir) at Cunderdin. The adjacent Pump Station No 3 pumped the water to the receiving tank at Cunderdin. From Cunderdin the remaining pump stations and associated receiving tanks are generally located an even distance apart. The water continues to be pumped the round tank at Merredin (Pump Station No 4), onto the tank and Pump Station at Yerbillon (Pump Station No 5) followed by Ghooli (tank and Pump Station No 6); to Gilgai (tank and Steam Pump Station No 7) to the final tank and Steam Pump Station No.8 located at Dedari. From Dedari the water was pumped to the Bullabulling Reservoir and on to the Toorak Hill Reservoir which was gravity fed and delivered the water to its final destination the Mount Charlotte Reservoir in Kalgoorlie (Ghassemi and White (2007).[8]"*

1.3.7 THE PIPELINE

The following information has been sourced from the Australian Heritage Database[9] with some clarified text from the Water Corporation:

> *"C.Y. O'Connor's 1903 pipeline is commonly referred to as the 'main conduit' of the Goldfields Water Supply Scheme and is approximately 566km in length (National Trust of Australia (WA) 2002). It commences at Mundaring Weir and terminates at Mount Charlotte Reservoir. Much of the pipeline is aligned with the current Great Eastern Highway. The pipes were made of 30-inch diameter steel. Originally (1903) the pipeline was buried underground, however, refurbishment in the 1930s raised the pipeline and it now rests on reinforced concrete anchor blocks (RICHCU 1999a). It is estimated that 60% of the pipeline is original[10]." ... "The pipeline is a visible icon stretching across Western Australia's arid interior.*

5 Appendix A- Australian Heritage Database Entry
6 Appendix A- Australian Heritage Database Entry
7 Appendix A- Australian Heritage Database Entry
8 Appendix A- Australian Heritage Database Entry
9 Appendix A- Australian Heritage Database Entry
10 Appendix A- Australian Heritage Database Entry

The pipeline consists of:

- *the length of the main conduit of the pipeline from Mundaring Weir (Dam) to Mount Charlotte Reservoir at Kalgoorlie;*
- *the caulked joints;*
- *the reinforced concrete anchor blocks;*
- *stop and reflux-valves; and*
- *Locking bar pipes[11]."*

The Water Corporation has advised that the caulked joints from the original entry are no longer extant. The following sections, Chapter 1.3.8-1.3.11, provide further information on these pipeline components.

11 Appendix A- Australian Heritage Database Entry

Image 7: Anchor blocks insitu at Fred Jacoby Park

Source: 'Anchor blocks insitu at Fred Jacoby Park', photograph taken near Mundaring, Courtesy of: Stephen Carrick Architects, 2024.

1.3.8 LOCKING BAR PIPES

The following information has been sourced from the Australian Heritage Database[12] with some clarified text from the Water Corporation:

> *The "locking bar pipe was invented in Australia by Mephan Ferguson in 1896, it consists of two steel plates, bent into semi circles and joined by two 'locking bars', which were closed by pressure. The secured ends of the steel plates are chamfered in a way that resembles a dovetail joint. The 30-inch locking bar pipes for the GWSS were manufactured from ¼ inch thick steel plates. The pipes were completely coated in asphalt to protect from corrosion.'*
>
> *The pipes were originally joined with a ring joint sealed with caulked lead. When the pipeline was raised in the 1930s these joints were cut out and the pipes were welded together. The present day locking bar pipes are cement lined, however originally only a coating of asphalt protected the insides of the pipes from corrosion, it was during the pipe raising in the 1930s that cement linings were applied in insitu[13]."*

Image 8: Close up of cross-section of locking bar pipe

Source: 'Close up of cross-section of locking bar pipe', photograph taken near Museum at No. 3 Pump Station, Courtesy of: H+H Architects, 2023.

1.3.9 KELLERBERRIN PIPES

The following information has been sourced from the Australian Heritage Database[14] with some clarified text from the Water Corporation:

> *"'Kellerberrin Pipes' are reconstructed locking bar pipes; they consist of two usable halves from condemned locking bar pipes that would be cut and welded together without the locking bar. This refurbishment process was devised by Frank Mather on his farm in Kellerberrin in 1937; he would go on to create the Electweld Steel Company, the only company to reconstruct pipes for the GWSS and did so from 1938 to 1958. With the locking bar removed Kellerberrin pipes were smaller with a diameter of 28¾ inch. These pipes were cement lined with a centrifugal process."*

Image 9: Monument near Kalgoorlie

Source: 'National Engineering Landmark', photograph taken at Collier Place created from a Kellerberrin pipe, Courtesy of: Monuments Australia, 2022.

12 Appendix A- Australian Heritage Database Entry

13 Appendix A- Australian Heritage Database Entry

14 Appendix A- Australian Heritage Database Entry

1.3.10 MSCL PIPES

The following information has been sourced from the Australian Heritage Database[15] with some clarified text from the Water Corporation:

> *"Mild Steel Cement Lined pipes (MSCL) describe a variety of modern pipes suitable for transporting water. They are often stitched with longitudinal, lateral or spiral welds and are made of mild steel, a relatively malleable and ductile steel with low carbon composition. An interior cement lining is applied centrifugally to inhibit internal corrosion by preventing contact between the transported water and pipe steel[16]."*

1.3.11 COMPOSITION OF PIPES

The Water Corporation advised that as of 2015, the main conduit was made up of 43.4% Locking Bar (1901-1920s) (280.0km), 4.6% Kellerberrin pipe (1938-1958) (29.5km), and 52% MSCL (335.0km) (1926-2016). 90.6% of the pipeline was above ground.

The process up to date for increasing the capacity of the pipeline has generally occurred from west to east. When pipe was removed and replaced due to lack of capacity, the more recent upgraded pipe was then used to replace lower capacity pipe to the east.

15 Appendix A- Australian Heritage Database Entry

16 Appendix A- Australian Heritage Database Entry

Image 10: Mixed composition of pipe located near Mundaring

Source: 'Mixed composition of pipe located near Mundaring', photograph taken near Mundaring, Courtesy of: Stephen Carrick Architects, 2024.

1.4 SITE PLAN

The pipeline begins at Mundaring Weir, 30km east of Perth, and stretches approximately 566km east to Kalgoorlie. There are several site features and alterations of the environment over the 566km of main conduit.

The pipeline services several town-sites in the region from Mundaring to Kalgoorlie including: Mundaring, Chidlow, Wundowie, Bakers Hill, Northam, Grass Valley, Meckering, Cunderdin, Tammin, Kellerberrin, Baandee, Merredin, Burracoppin, Walgoolan, Yerbillon, Bodallin, Nulla Nulla, Moorine Rock, Southern Cross, Ghooli, Yellowdine, Karalee, Koorarawalyee, Boorabbin, Boondi, Bullabulling, Coolgardie, Toorak, Mungari, Binduli and Kalgoorlie.

To depict this broad area, four maps were created in four regions: Mundaring to Kellerberrin, Kellerberrin to Yellowdine, Yellowdine to Coolgardie and Coolgardie to Kalgoorlie.

Figure 2: Mapping from Mundaring to Kalgoorlie

Source: Stephen Carrick Architects, 2023.

1.5 GWSS MAPS

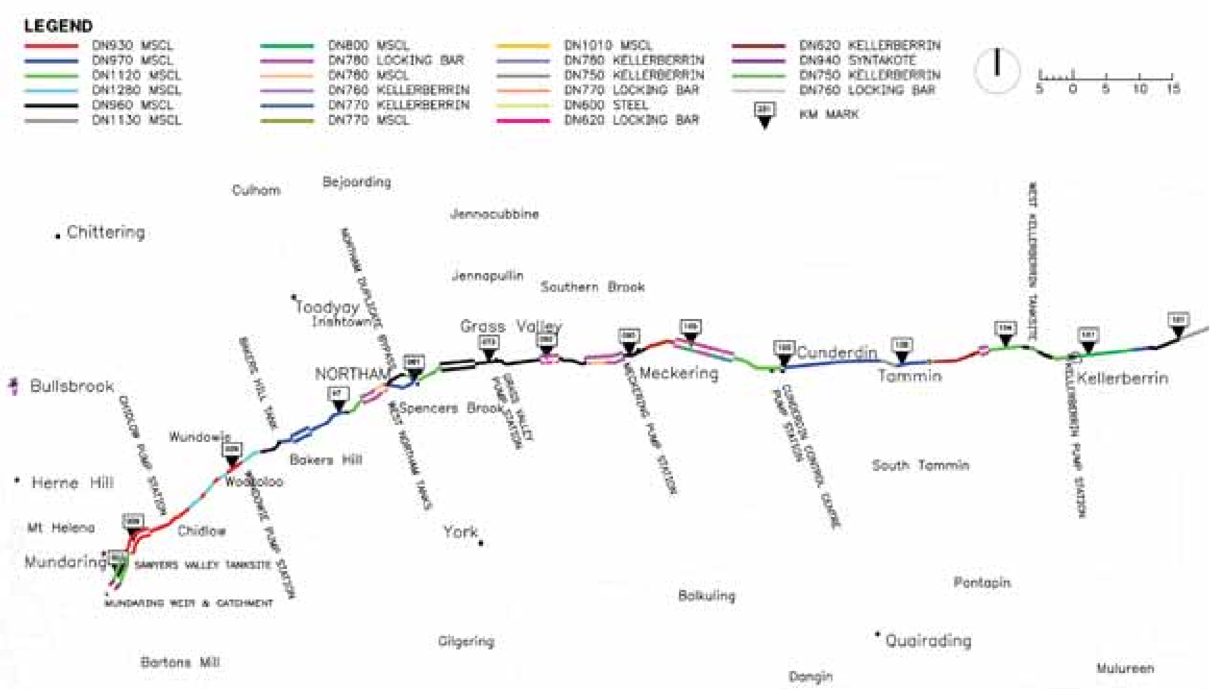

Figure 3: GWSS Main Conduit from Mundaring to Kellerberrin

Source: Stephen Carrick Architects, 2024 Developed from 'Goldfields and Agricultural Water Supply - Main Conduit Mundaring to Kalgoorlie Pipeline - GPS feature survey overall route Plan, 2001', Adjusted to depict Mundaring to Kellerberrin.

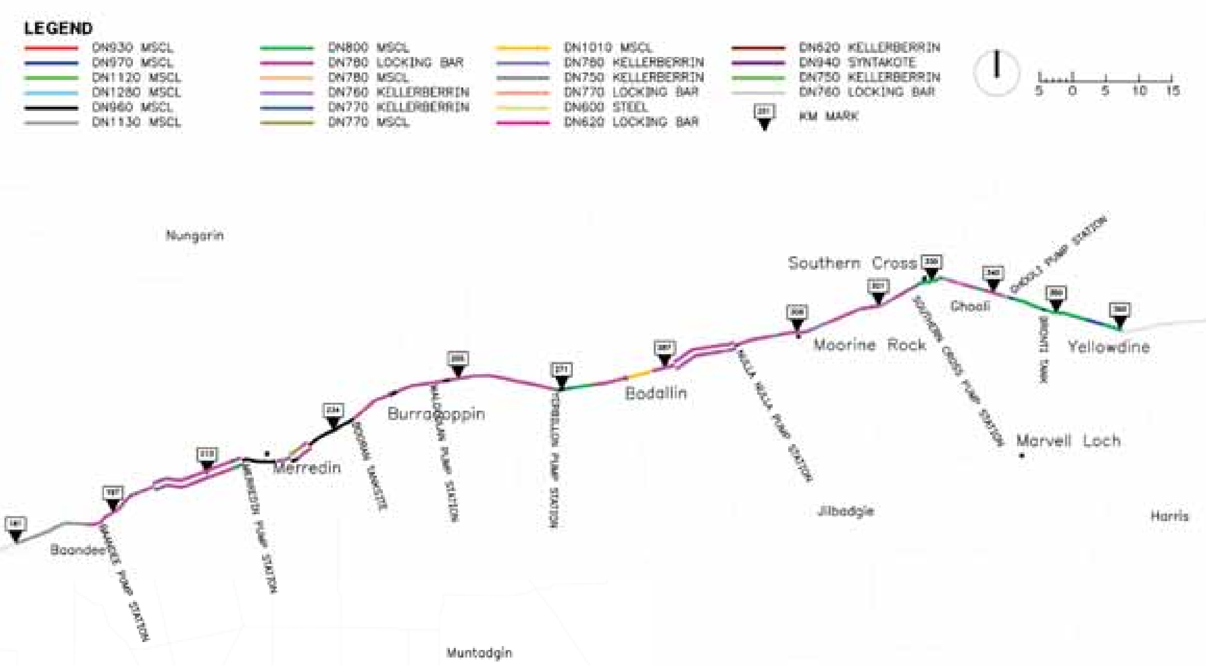

Figure 4: GWSS Main Conduit Mapping from Kellerberrin to Yellowdine

Source: Stephen Carrick Architects, 2024. Developed from 'Goldfields and Agricultural Water Supply - Main Conduit Kellerberrin to Yellowdine Pipeline - GPS feature survey overall route Plan, 2001', Adjusted to depict Kellerberrin to Yellowdine. Accessed 10.06.2024

1.5 GWSS MAPS (CONTINUED)

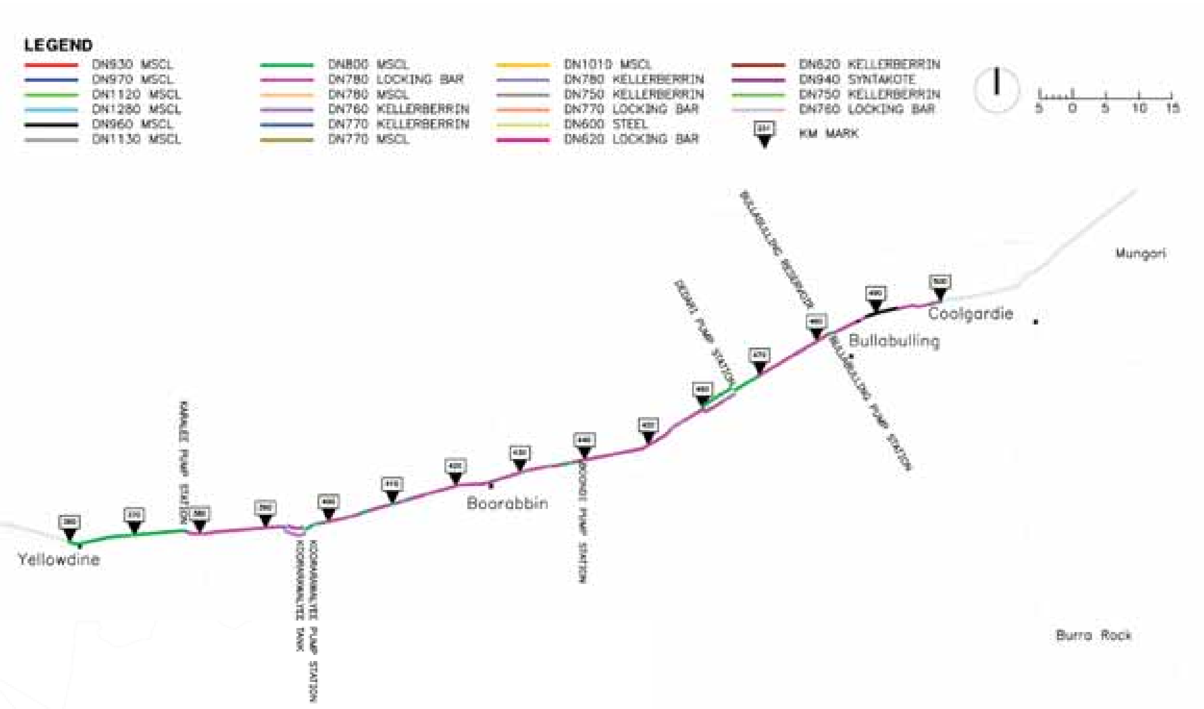

Figure 5: GWSS Main Conduit Mapping from Yellowdine to Coolgardie

Source: Stephen Carrick Architects, 2024. Developed from 'Goldfields and Agricultural Water Supply - Main Conduit Kellerberrin to Yellowdine Pipeline - GPS feature survey overall route Plan, 2001', Adjusted to depict Yellowdine to Coolgardie. Accessed 10.06.2024

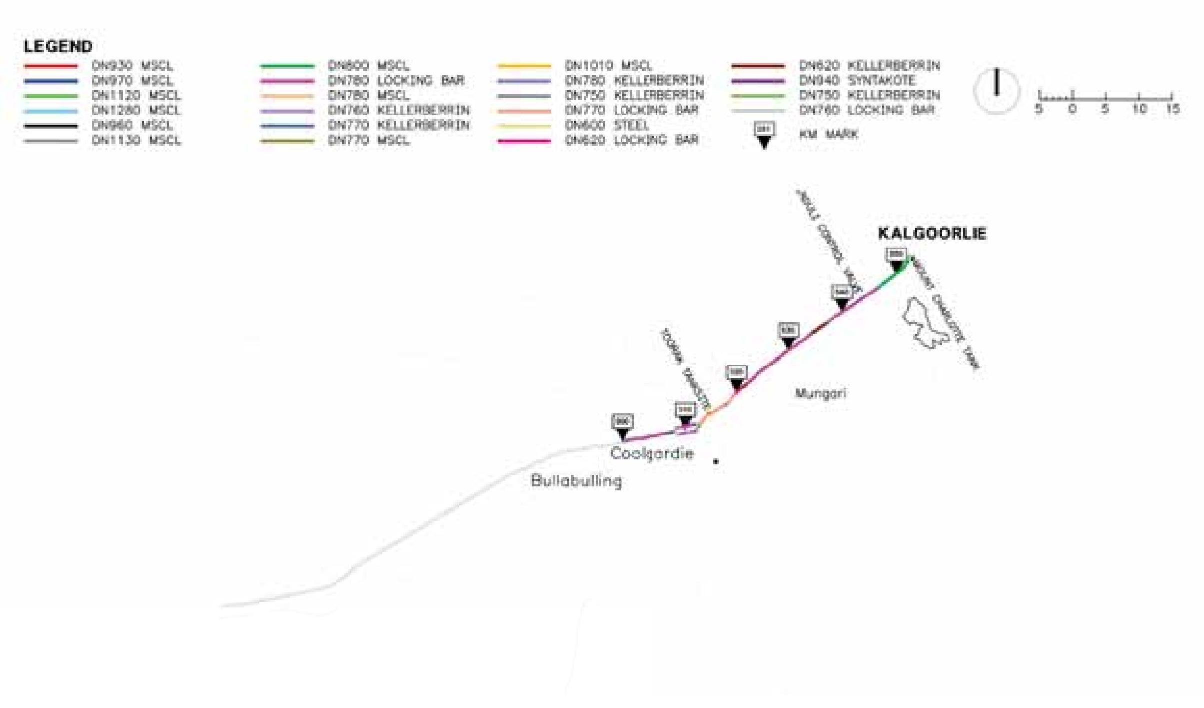

Figure 6: GWSS Main Conduit Mapping from Coolgardie to Kalgoorlie

Source: Stephen Carrick Architects, 2024. Developed from 'Goldfields and Agricultural Water Supply - Main Conduit Coolgardie to Kalgoorlie Pipeline - GPS feature survey overall route Plan, 2001', Adjusted to depict Coolgardie to Kalgoorlie. Accessed 10.06.2024

1.6 HERITAGE LISTINGS

1.6.1 HERITAGE LISTINGS OVERVIEW

The main conduit was included on the National Heritage List in 2011 as the Goldfields Water Supply Scheme, Western Australia (place ID 106007, 22 June 2011). The GWSS is also recognised by Heritage Listings at state and local level, is classified by the National Trust, a National Engineering Landmark by Engineers Australia and as international historic civil engineering landmark by the American Society of Civil Engineers.

The following heritage listings directly apply or are relevant to the GWSS in addition to the National Listing and have been sourced from the State Register entry:

State Register of Heritage Places[17] (text from entry in italics):

> *" The Goldfields Water Supply Scheme was included on the State Register of Heritage Places on 8 December 2022.*
>
> *The Goldfields Water Supply Scheme, extends in a discontiguous precinct across the 566km linear water pipeline, commencing at Mundaring Weir (1902, 1951) in the Helena Valley and terminating at Mount Charlotte Reservoir (1902) in Kalgoorlie- Boulder. Comprising six extant original Steam Pump Stations (1902) at Mundaring, Cunderdin, Merredin, Yerbillon, Ghooli and Dedari; the sites of two demolished Steam Pump Stations (1902) at O'Connor and Gilgai; Reservoirs and Tanks (1902, 1911, 1924, 1932) at O'Connor, Sawyers Valley, Bakers Hill, West Northam, Cunderdin, Merredin, Yerbillon, Ghooli, Bronti, Gilgai, Koorarawalyee, Dedari, Toorak, and Bullabulling; second generation Electric Pump Station at Merredin (1954), pump community buildings associated with the Mundaring Weir Village (1898-1909), Mundaring Weir Hotel (1898; 1906), Karalee Reservoir, Rock Catchment & Aqueduct (1897), ancillary structures; equipment and machinery, archaeological sites; and small discontiguous portions of the main pipeline conduit associated with the construction and operation of the Scheme from 1902 to the present. "*

1.6.2 NATIONAL TRUST CLASSIFICATION

- No. 1 Pumping Station Classified 11/06/1973
- No. 3 Pumping Station Classified 02/09/1974
- No. 4 Steam Pumping Station Classified 02/03/1992
- Old Pumping Station Classified 06/09/1982
- Toorak Hill, Goldfields Water Supply Reservoir Classified 11/02/2002
- Mundaring Weir Hall Classified 09/07/2001
- Mundaring Weir School & Quarters (fmr) Classified 14/05/2007
- Karalee Reservoir, Rock Catchment & Aqueduct Classified 12/03/2001

1.6.3 HERITAGE LIST (LOCAL GOVERNMENT: STATUTORY)

- No. 1 Pumping Station 08/03/2016
- Mundaring Weir School & Quarters (fmr) 08/03/2016
- Mundaring Weir, Gardens and Village Precinct 08/03/2016
- Mundaring Weir Hall 08/03/2016
- Mundaring Weir Hotel 08/03/2016
- Mount Charlotte Reservoir 18/04/1997
- Toorak Hill, Goldfields Water Supply Reservoir 15/04/2003

17 Appendix B - Goldfields Water Supply Scheme Registered Entry

1.6.4 MUNICIPAL INVENTORY (LOCAL GOVERNMENT: NON-STATUTORY)

- No. 1 Pumping Station 22/04/1997
- No. 2 Pumping Station - Site of 22/04/1997
- No. 3 Pumping Station 31/12/1996
- No. 4 Steam Pumping Station 16/047/1999
- Old Pumping Station 27/07/1995
- Mundaring Weir School & Quarters (fmr) 22/04/1997
- Mundaring Weir, Gardens and Village Precinct 22/04/1997
- Mundaring Weir Hall 22/04/1997
- Mount Charlotte Reservoir 09/07/2001
- Karalee Reservoir, Rock Catchment & Aqueduct 16/05/1997
- Caroling Rocks Dam No. 16 16/05/1997

1.6.5 REGISTER OF THE NATIONAL ESTATE (NON-STATUTORY)

The Register of the National Estate is non-statutory but is important to mention as a recognition of heritage value.

- No. 1 Pumping Station Permanent 21/03/1978
- No. 3 Pumping Station Permanent 21/03/1978
- Old Pumping Station Permanent 11/08/1987
- Mundaring Weir, Gardens and Village Precinct Indicative
- Mundaring Weir Hall Indicative
- Mount Charlotte Reservoir Indicative

1.6.6 ABORIGINAL SITES REGISTER

Registered Sites:

- 1421- Registered, Paddy Hannans Tree, Goldfields
- 1422- Registered, Mulyinyu Rockhole (QUARRY ROCKHOLE.) Goldfields
- 1541- Registered, Nanny Goat Hill (Pilyurru), Goldfields
- 1745- Registered, 568 MILE PEG Goldfields
- 3522- Registered, Northam Hill, Metro/Wheatbelt
- 3550- Registered, Coates Gully, Metro/Wheatbelt
- 4045- Registered, Blogart: Boolegin, Metro/Wheatbelt
- 5902- Registered, Mooraine Rock, Metro/Wheatbelt 03/12/1998
- 4046- Registered, Burlong Pool, Metro/Wheatbelt
- 20844- Registered, SX15, Goldfields
- 37000- Registered, Wooroloo Brook, Metro/Wheatbelt
- 15979- Registered, Avon River, Metro/ Wheatbelt
- 1540- Registered, Kalgoorlie Rockhole, Goldfields
- 3010- Registered, Mt Charlotte, Goldfields
- 1542- Registered, Microwave Tower Hill, Goldfields

Lodged Sites:

- 5883- Lodged, Lake Brown, Metro/Wheatbelt 01/11/1999
- 3474- Lodged, Clackline 2, Metro/Wheatbelt
- 4031- Lodged, Grass Valley 2, Metro/Wheatbelt
- 19598- Lodged, Garrett Camping Ground
- 19599- Lodged, Garrett Marked Tree
- 20136- Lodged, Bullabing 1
- 20829- Lodged, SX01, Goldfields
- 20830- Lodged, SX02, Goldfields

- 20840- Lodged, SX11, Goldfields
- 20841- Lodged, SX12 Goldfields
- 20842- Lodged, SX13, Goldfields
- 20843- Lodged, SX14, Goldfields
- 22675- Lodged, Mundaring Weir Corroboree Grounds (Booralyn) Metro/Wheatbelt
- 24290- Lodged, Coolgardie Reserve, Goldfields
- 22284- Lodged, Clackline Brook, Metro/Wheatbelt
- 26174- Lodged, Yamatji Ngurra Burial Goldfields
- 3758- Lodged, Helena River, Metro/Wheatbelt
- 32761- Lodged (Female only access), Roundhead/Ngumarn, Goldfields

1.7 METHODOLOGY

1.7.1 OVERVIEW

In 2015, Water Corporation commenced planning to install an approximately 5.6 km section of below-ground pipe at Meckering and to remove the corresponding aboveground main conduit pipeline. Whilst the Meckering project represented only around one per cent of the 566 km main conduit pipeline, it became clear that the cumulative impacts of similar projects in the future would eventually impact the National Heritage values of the GWSS. To address these impacts, in 2016 Griffiths Architects prepared an HMP focusing on the main conduit of the GWSS for the Water Corporation. The 2016 HMP guides managing impacts to the National Heritage values of the GWSS, along with policies for interpretation of the main conduit as it is gradually upgraded and replaced with new below-ground pipe. It is important to note that this document relates to the main conduit only and is focused on guiding the heritage impacts associated with placing the pipe underground.

While the 2016 HMP provided a solid basis to manage the heritage values of the GWSS, it was acknowledged it contained some gaps. A referral was made in accordance with the *EPBC Act*, supported by the 2016 HMP, but was later withdrawn to allow more detailed consideration of how to address the heritage impacts of the project.

Water Corporation engaged GML Heritage to review the 2016 HMP against Schedule 5A & 5B of the EPBC Regulations 2000. The review found that while the 2016 HMP provides useful guidance on the management and conservation of the National Heritage values of the GWSS main conduit, the plan has gaps in policies and monitoring and reporting processes which reduce its overall effectiveness as a tool for managing the National Heritage values of the GWSS.

Water Corporation completed a new referral in 2019, and in 2022, obtained approval to remove extant elements of the above ground pipeline forming part of the National Heritage listed Goldfields Water Supply Scheme, extending from Mundaring Weir to Kalgoorlie (See EPCB Act referral EPBC 2019/8547). The approval has effect until 30 January 2092 and is subject to several conditions, including the following:

> *"Condition 1: To minimise the impact of the action on the National Heritage Listed Goldfields Water Supply Scheme, the approval holder must submit a HMP for the [Cth Environment] Minister's approval. The Australian Heritage Council must endorse the HMP before it is submitted to the Department for the Minister's approval*[18]*."*

This HMP was commissioned to integrate the review recommendations provided by GML Heritage and address Condition 1 of EPBC 2019/8547. It was prepared in accordance with the *Burra Charter 2013* (*The Australian ICOMOS Charter for Places of Cultural Significance*) and in collaboration with the Water Corporation.

18 Appendix D -EPBC Act Approval, 2022

The Methodology for this HMP (for the main conduit) update has included the following:

- Review of all available documentation.
- Comparative analysis with other National Heritage Managements Plans.
- Site visits and zone analysis process along the GWSS.

1.7.2 KEY DOCUMENTS

Previous reports prepared for the GWSS main conduit and associated places include:

GWSS main conduit only:

- *2016 HMP* prepared by Griffiths Architects[19]
- April 2019 *Goldfields Pipeline Heritage Impact Statement* prepared by GML Heritage
- September 2019 *Goldfields Pipeline Heritage Impact Assessment* prepared by GML Heritage
- *2022 Review of the 2016 HMP* prepared by GML Heritage

GWSS Associated Sites:[20]

- *2000 Conservation and Interpretation Plan for No.1* Pumping Station Mundaring, prepared by the Research Institute for Cultural Heritage at Curtin University
- *August 1998 Conservation Plan for No.3 Pumping Station Cunderdin*, prepared by the Research Institute for Cultural Heritage at Curtin University
- *1999 Conservation Plan for Goldfields Water Supply Scheme Volume II No.5 Pumping Station - Yerbillon*, prepared by the Research Institute for Cultural Heritage at Curtin University
- *1999 Conservation Plan for Goldfields Water Supply Scheme Volume II No.6 Pumping Station - Ghooli*, prepared by the Research Institute for Cultural Heritage at Curtin University
- *1999 Conservation Plan for Goldfields Water Supply Scheme Volume II No.7 Pumping Station - Gilgai*, prepared by the Research Institute for Cultural Heritage at Curtin University
- *1999 Conservation Plan for Goldfields Water Supply Scheme Volume II No.8 Pumping Station - Dedari*, prepared by the Research Institute for Cultural Heritage at Curtin University
- *1999 Conservation Plan for Goldfields Water Supply Scheme Volume IV- Part A, Object Administrative Reports Electronic Database*, prepared by the Research Institute for Cultural Heritage at Curtin University for the National Trust of Western Australia
- *1999 Conservation Plan for Goldfields Water Supply Scheme Volume IV- Part B, Object Administrative Reports Electronic Database*, prepared by the Research Institute for Cultural Heritage at Curtin University for the National Trust of Western Australia

19 Appendix E- HMP, Griffiths Architects, 2016

20 Appendix F- Chronology of Conservation Plans of the GWSS

Image 11: Main Conduit

Source: 'Main Conduit', photograph taken near Mundaring, Courtesy of: Stephen Carrick Architects, 2024.

Following are relevant documents, with a summary, that have been referenced in preparing this Heritage Management Plan.

1.7.3 HERITAGE MANAGEMENT PLAN (AUGUST, 2016)

Griffiths Architects prepared a Heritage Management Plan to support a referral for works by the Water Corporation in accordance with the *EPBC Act*. The HMP was commissioned to ensure that heritage values of the pipeline are accessible and maintained as a whole as sections are replaced overtime.

The HMP contains 41 policies that address the following broad areas:

- New pipeline
- Interpretive and retained sites
- Location of interpretive and retained sites
- Non-operational pipe
- Non-operational MSCL pipe
- Unused anchor blocks
- Interpretive sites
- Pipeline display at presented interpretive sites
- Management of interpretive and retained sites

1.7.4 HERITAGE REVIEW REPORT (APRIL, 2022)

GML Heritage prepared a Report for the Water Corporation to review the existing Heritage Management Plan (HMP) for the Goldfields Water Supply Scheme (GWSS) Main Conduit, prepared by Griffiths Architects in 2016.

This review was undertaken in accordance with the requirements of the *EPBC Act* and the guidance published by the Department of Agriculture, Water and the Environment. It informs the development of a project brief for the update of the 2016 HMP, enabling the development of an updated document which meets the requirements of the *EPBC Act* for heritage management plans, and the *EPBC Act* project approval conditions.

GML considered the following:

- the 2016 HMP is consistent with the National Heritage Management Principles;
- the plan is effective in protecting and managing the National Heritage values of the place; and
- recommendations for revisions to the plan to ensure the improved protection of the National Heritage values of the place and compliance with relevant legislation.

The Review provided tables showing where the 2016 HMP was compliant or non-compliant and provides review commentary for when the HMP is next reviewed and updated.

1.8 AUTHORS

- Stephen Carrick Architects and Lucy Hair, Historian
- Daniel Stevens, Senior Planner, Water Corporation.

1.9 ACKNOWLEDGEMENTS

- Current and former staff of the Department of Planning, Lands and Heritage (DPLH), including Adelyn Siew, Sheree Morrison, Penny O'Connor and Karina Williams.
- Current and former staff of the National Trust (WA) including Kelly Rippingale, Diana Frylinck and Julian Donaldson.
- Julie de Jong of H+H Architects, Briony Arnold of Jouerdine Consultancy.

1.10 TERMS AND ACRONYMS

The following terms and acronyms are used throughout this document:

DCCEEW- Department of Climate Change, Energy the Environment and Water
DPLH- Department of Planning Lands and Heritage
EPBC Act- Environment Protection and Biodiversity Conservation Act 1999
GWSS- Goldfields Water Supply Scheme
HCWA- Heritage Council of Western Australia
HIA- Heritage Impact Assessment
HIS- Heritage Impact Statement
HMP- Heritage Management Plan
MNES- Matters of National Environmental Significance
MSCL- Mild Steel Cement Lined
GHPT- Goldfields Heritage Pipeline Trail
NHL- National Heritage List
NTWA- National Trust of Australia (WA)

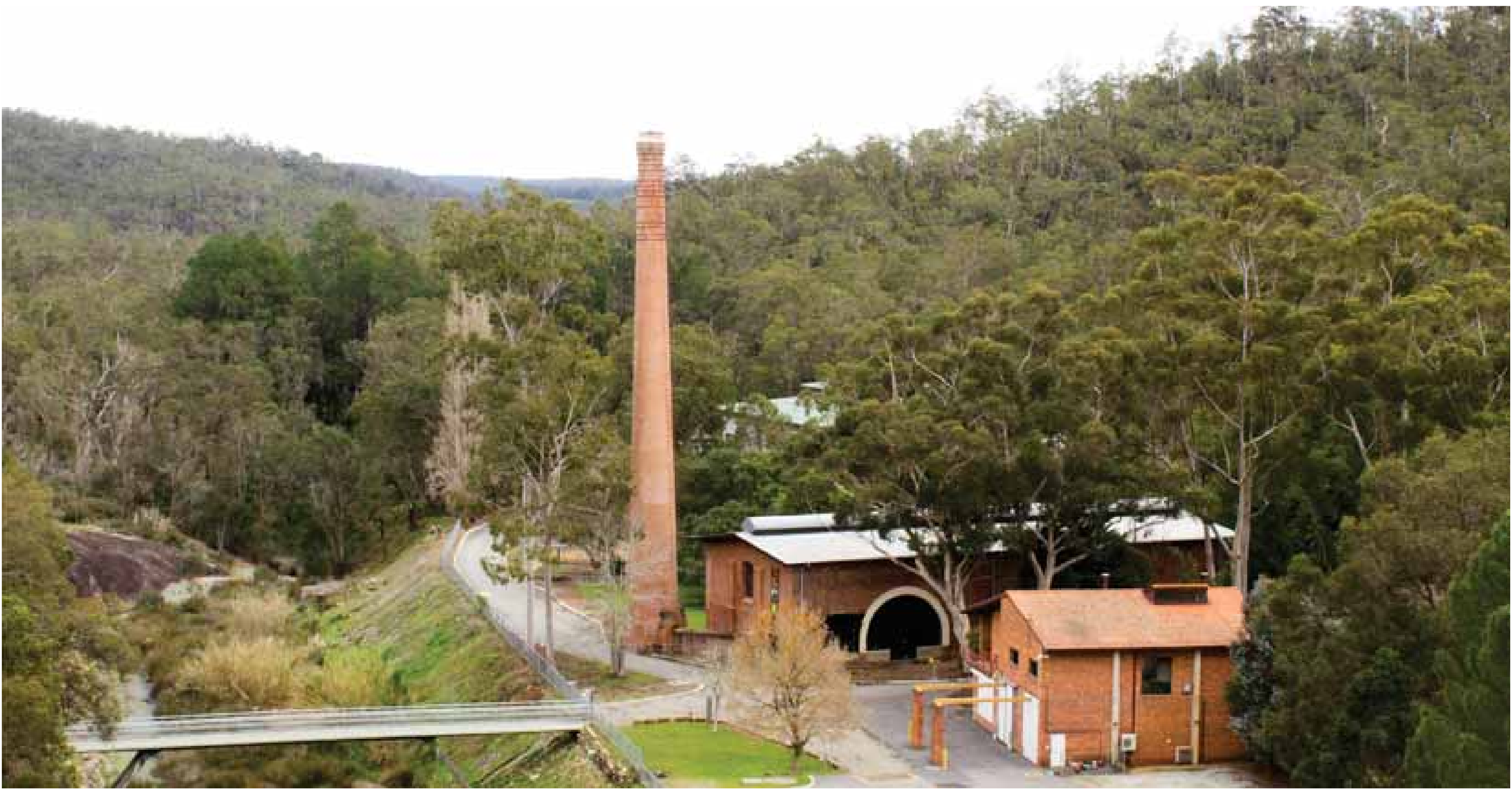

Image 12: Place No. 1 Pumping Station

Source: 'Place No. 1 Pumping Station', photograph taken near Mundaring, Courtesy of: Stephen Carrick Architects, 2024.

2

CHAPTER 2: HISTORICAL BACKGROUND

2.1 HISTORY OF PLACE

The following section details the component parts of the GWSS and was sourced from the Australian Heritage Place Database Records, with minor updates from the Water Corporation and Stephen Carrick Architects. The main conduit is discussed in detail in Chapter 1.3.7 and is not further discussed here.

2.1.1 ASSOCIATED PLACES

This section is divided into the GWSS associated places, they are:

- Reservoirs;
- Regulating tanks; and
- Pumping stations.

RESERVOIRS

2.1.2 MUNDARING WEIR (DAM)

> *"Mundaring Weir (Dam) is located at Weir Road, Mundaring, Western Australia. The site is in the valley of the Helena River on the western slopes of the Darling Range, 30 kilometres east of Perth City Centre and approximately 566 kilometres west of Kalgoorlie. The weir (dam) is located at the narrowest part of the steep-sided valley with the impounded lake stretching in a south-easterly direction for 16 kilometres (RNE Entry Mundaring Dam and Helena River Reservoir). The two main arms of the lake to the east and south-east are fed by the Helena River and the Darkin River respectively. Mundaring Weir is recognised as a large dam (Cole 1999 p.4-27). The spillway occupied such a large proportion of the crest that it lead to people referring to it as a weir (Doherty 1999 p. 4-16).*


Image 13+14: Mundaring Weir wall and valve houses

Source: 'Mundaring Weir wall and valve houses', photograph taken near Mundaring, Courtesy of: Stephen Carrick Architects, 2024.

Mundaring Weir (Dam) represents the start of the Goldfields Water Supply Scheme. The Mundaring Weir (Dam) was completed by 1902 and damed the Helena River. Mundaring Weir (Dam) was the highest gravity dam constructed in Australia between 1871 and 1910 (Doherty 2000: p.21). It is a curved concrete face dam and when completed measured 61 meters in height above the lowest foundation level (Doherty 2000: p. 26). This type of dam was selected as its design could assist in managing the predicted flooding from the 1,450m^2 catchment area (Cole 1999: p.1-6). The height of the wall was raised to 71 meters in 1951 which increased the dam's capacity to 60,000m^3 (Doherty 2000: p. 39). While the weir (dam) wall has been raised it retains its original 1902 appearance and profile. The Mundaring Weir (Dam) spillway has been identified as a nationally significant example of an early twentieth century ogee spillway (Kinstler 2000 p.191). It is located on the left hand side of the dam and allows the discharge to flow over the dam face onto the granite rock foundations. The capacity of the spillway is 1,000m^3 (Kinstler 2000: p.191).

It includes:
- *the weir (dam) wall;*
- *spillway;*
- *the foot-walk across the crest of the weir (dam) which is a reconstruction of the original; and*
- *the inner and outer valve houses[1]."*

Please note the change from 560km to 566km for accuracy, as supplied by the Water Corporation.

2.1.3 MOUNT CHARLOTTE RESERVOIR

"Mount Charlotte Reservoir is located on Hannan Street, some 566km from Mundaring Weir (Dam). It is a round reinforced concrete tank which is dug into the crest of the hill (National Trust of Australia (WA) 2002 p.112) . It is the final receptacle and the terminus for the Goldfields Water Supply Scheme, Western Australia. The capacity of the reservoir when it was completed in 1902 was two million gallons (7,570,823.568 litres). Sir John Forrest officially turned the valve at Mount Charlotte Reservoir on 24 January 1903 as part of the opening celebrations. Mount Charlotte Reservoir is currently used to service the Kalgoorlie community as a reserve tank by the Water Corporation (WA) (National Trust of Australia (WA) 2002 p.112) . A metal roof was added in the 1970s to prevent evaporation and for security reasons (RICHCU 1999k). Mount Charlotte Reservoir includes (RICHCU 1999k) :

- *the reservoir including the walls;*
- *the valve pit; and*
- *the valve pit to the pipe trench[2]."*

Please note the change from 560km to 566km for accuracy, as supplied by the Water Corporation.

2.1.4 BULLABULLING RESERVOIR

"The Bullabulling Reservoir is located at Bullabulling between Pump Station No 8 at Dedari and Coolgardie. It is located approximately 30km west from Coolgardie along the Great Eastern Highway and then north along a gravel track for approximately 3km. It is situated approximately 0.7 km from the current electric pump station.

Completed in 1902, Bullabulling Reservoir is a rectangular holding tank. Plans from 1901 indicate that the tank was used to receive water from pump station No 8 at Dedari which was then gravity fed to Toorak Hill. Features of the tank include an overflow pipe which is located in the centre of the north wall. Excess water is discharged via the channel and ditch. The constituent material is reinforced concrete. Barbed wire was used to reinforce the concrete to assist in overcoming concrete cracking induced by temperature extremes. The walls of the tank are more than two feet (0.61 metres) thick (RICHCU 1999). The capacity of the tank is 45.4 million litres. The site is currently enclosed by a mesh security fence. In 2024, the reservoir is extant but no longer in use[3]."

1 Appendix A- Australian Heritage Database Entry
2 Appendix A- Australian Heritage Database Entry
3 Appendix A- Australian Heritage Database Entry

TANKS

2.1.5 TOORAK HILL REGULATING TANK

"Toorak Hill Goldfields Water Supply Reservoir is located on Moran Street (Lefroy Street), 1.5km north of Coolgardie.

It consists of:

- *the concrete walls of the reservoir, were once enclosed to reduce evaporation. The roof was removed and the structure is extant but no longer in use (2024)[4]."*

PUMP STATIONS

2.1.6 PUMP STATIONS

"Eight steam powered pumping stations were required to transport the water the 566km from Mundaring to Kalgoorlie. The pump station buildings are aesthetically pleasing, architecturally designed, purpose built industrial structures. It is believed that the Pump Stations were designed by George Temple Poole (RICHCU 1999x, during his time as a consulting architect with the Public Works Department of the Coolgardie Water Supply Branch. They were constructed by the Western Australian Department of Public Works (RICHU 1999m p.52). Architecturally the Pump Stations are not indicative of a single style or type. However, a number of stylistic elements contribute to the symmetry and form of these industrial buildings. Of notable importance are the large Romanesque arch, Baroque style canopy, bulls-eye windows, long Georgian windows with deep sills (reported by RICHCU 1999m p. 83) as reflecting generally Baroque characteristics. The pump stations themselves were substantial buildings of wire cut red brick constructed in an English bond, with cut and struck lime mortar joints. Roof fabric was generally corrugated iron roofs supported on steel trusses with timber fascias. Each pump station had a similar layout consisting of a boiler and pump room separated by a passage way (Foxley 2008 and RICHCU 1999m). The pump (also known as engine rooms) contained the engines, pumps and working benches for maintenance works. The lower levels of the pump rooms were constructed of concrete with a cement mortar. Steel framing (joists and bearers) is used for the upper work levels, which were finished with Jarrah floors. Boiler rooms contained the boilers, an economiser, boiler feed pumps and a large arched doorway where coal (later wood) was delivered for the boilers. Each pump station also featured a circular chimney constructed from steel. Some were later replaced with brick chimneys due to corrosion damage. Those with brick chimneys' retained the circular profile and featured an English brick bond a with lime mortar. The chimneys height was generally approximately 135 feet (41 metres) high and gently tapered. Chimneys were connected to the boilers and economisers by a brick tunnel flue. The Steam pump stations were initially powered by coal, but later changed to run on wood (RICHCU 1999m).

At six of the pumping stations, concrete lined holding (also referred to as suction and regulating tanks) were constructed adjacent to the pump stations. Water was pumped into the holding tank through the previous stage of the pipeline and was drawn from these tanks by the pump for transmission through the next stage of pipeline to the holding tank at the next pumping station. The exceptions were at Station No 1, which drew water directly from Mundaring Weir (Dam) and Station No 3, where a nearby 10 million gallon (37.8 million litres) capacity reservoir had been previously constructed for the railway (National Trust 2000, Vol 208)[5]."

4 Appendix A- Australian Heritage Database Entry

5 Appendix A- Australian Heritage Database Entry

2.1.7 NO 1 PUMP STATION (MUNDARING)

"No 1 pump station is located at the base of Mundaring Weir and is currently operated by the National Trust of Australia (Western Australia). It is operated as a visitors centre and has been known as the C.Y. O'Connor Museum since it opened in 1963 (RICHCU 1999b) . Pump station No 1 was operational by December 1902. Sir John and Lady Forrest opened the pump station on 22nd January 1903 (National Trust of Australia (WA) 1999) . Unlike the other pump stations, water was delivered directly from the Mundaring Weir (Dam) via a pipe which ran under the pump station (Foxley 2008). Pump station No 1 ceased operating in 1955. It consisted of (RICHCU 1999b and 1999m):

The pump station building;

- *all three of the original Babcock and Wilcox water tube boilers with super-heaters, as installed at this station;*
- *air compressors;*
- *the chains from the scrapers which removed the soot from the tubes and the governor that controlled their movement;*
- *the brick chimney stack which was installed in 1910 measuring approximately 41 metres high (this replaced the original steel chimney which had been damaged by corrosion);*
- *the one remaining Worthington duplex engine (there were originally three installed at this station);*
- *the remaining fabric of the standpipe (which was supplied by Mephan Ferguson and designed by James Simpson and Co); and*
- *the lime-setting tank[6]."*

In 2010, Stephen Carrick Architects prepared a Heritage Impact Statement to remove remnant structures of Pump Station No. 1, Heritage Council of Western Australia supported the approach with additional research conditions and the creation of an archival record. Please note that text in the quotation has been altered to reflect the current condition[7].

6 Appendix A- Australian Heritage Database Entry

7 Archival Record, prepared for the Water Corporation of WA, December 2011 by Stephen Carrick Architects.

Image 15 +16: Interior of Pump Station 1 Museum with Babcock and Wilcox water tube boilers

Source: 'Interior of Pump Station 1 Museum with Babcock and Wilcox water tube boilers', photograph taken near Mundaring, Courtesy of: Stephen Carrick Architects, 2024.

2.1.8 NO 2 PUMP STATION (O'CONNOR)

"The site of the No 2 pump station is located 2.5 km from No 1 (Mundaring Weir/Dam). The positioning of the pumping station was thoroughly investigated (consideration was given to the geology and topography) and the final position selected was a flattened area on the eastern slope of the hill. From pump station No 2 (O'Connor) water was pumped to the tank at Bakers Hill. Pump station No 2 ceased operating in 1956 and was demolished in March 1968. Interpretive signage has been installed, indicating the presence and function of the former pump station. The site is important for its relationship with the original Coolgardie Water Supply Scheme as designed by C.Y. O'Connor (RICHCU 1999c). The site is managed by the Water Corporation (WA) and was not in use at the time of the site visit (2008).

Extant fabric includes (RICHCU 1999c):

- *remains of the concrete suction tank (also referred to as a receiving tank) supported by dry rubble backing and earth filling, including drainage, pipe work and access stairs[8]."*

2.1.9 NO 3 PUMP STATION (CUNDERDIN)

"No 3 pump station is located at 100 Forrest Street, Cunderdin. Pump station No 3 ceased operating in 1956 (National Trust of Australia (WA) 2002). It is open to the public and serves as a local district museum. Pump Station No 3 was completed in 1902. A receiving tank was never constructed for this steam pump station. Rather, No 3 utilised an existing reservoir previously constructed for the railway.

It consists of (RICHCU 1999(d).:

the pump station building;
- *the 1919 brick chimney (the only other steam pump station to have a brick chimney was Pump Station No 1);*
- *the one remaining Worthington duplex engine (originally three were installed at this station); and*
- *the only Venturi water meter which survives at any of the stations[9]."*

2.1.10 NO 4 PUMP STATION (MERREDIN)

"No 4 pump station is located at Merredin approximately 3 kilometres west of the Merredin township along the Great Eastern Highway. It is approximately 219 kilometres from the Mundaring Weir and was completed around April 1902. It is one of three generations of pump stations at this location (RICHCU 1999g and 1999m). Operations ceased at pump station No 3 in 1956, when replaced by an electric pump station (replaced in late 1950s). The pump station has been fenced in with chain mesh to protect it from vandalism and can be viewed from the outside. It consists of:

- *the pump station building;*
- *coal bin;*
- *remnant rail trestle;*
- *weighbridge;*
- *the remains of the chimney flue;*
- *three control valve pits;*
- *blow off pits;*
- *water gauge;*
- *overhead travelling crane;*
- *concrete pits forming former lines of pipeline; and*
- *a round receiving tank (also referred to as a suction tank). The original capacity of the tank was one million gallons (4.5 million litres)[10]."*

Statements: '*when replaced by an electric pump station (replaced in late 1950s)*' were added to update the current condition of the station.

8 Appendix A- Australian Heritage Database Entry

9 Appendix A- Australian Heritage Database Entry

10 Appendix A-Australian Heritage Database Entry

2.1.11 NO 5 PUMP STATION (YERBILLON)

"No 5 pump station is located at Yerbillon, approximately 45 kilometres westward of Southern Cross along the Great Eastern Highway. Pump station No 5 is located 270 kilometres from Mundaring Weir (Dam). This Pump Station ceased operating in 1968, with the introduction of the electric pump station. The site has been fenced in with chain mesh fencing to protect it from vandalism and can only be viewed from the outside. All associated machinery and fittings have been removed. It consists of (RICHCU 1999g and 1999m):

- *the pump station building;*
- *the economiser;*
- *remnant coal bin;*
- *boilers;*
- *overhead travelling crane;*
- *weighbridge remains;*
- *remains of the venturi metre house*
- *remains of the pipe trench; and*
- *the original suction tank[11]."*

2.1.12 NO 6 PUMP STATION (GHOOLI)

"No 6 pump station is located on the Great Eastern Highway, Ghooli and is approximately 10km east of Southern Cross. Pump station No 6 was completed in 1902 and is located 342 kilometres from Mundaring Weir (Dam). Operations ceased at this site in 1969. The site has been fenced in with chain mesh fencing to protect it from vandalism and can be viewed from the outside. It consists of (RICHCU 1999g and 1999m):

the pump station building;
economiser;
boilers;
steam pumps;
weighbridge and scale balance;
overhead travelling crane;
coal bin;
railhead;
weighbridge; and
reservoir (suction tank) which has since been covered over to prevent evaporation and contamination[12];"

The following statements: 'and contamination' were added as an update to illustrate the current conditions of the station in 2024.

2.1.13 NO 7 PUMP STATION (GILGAI)

"Steam Pump No 7 was located at Gilgai, approximately 40 kilometres east from Yellowdine along the Great Eastern Highway. One of the engines from this site was relocated to Pump Station No. 3 at Cunderdin. All buildings have been demolished and no extant fabric remains. The site consists of (RICHCU 1999h and 1999m):

- *the rectangular receiving tank[13]."*

11 Appendix A-Australian Heritage Database Entry

12 Appendix A-Australian Heritage Database Entry

13 Appendix A-Australian Heritage Database Entry

2.1.14 NO 8 PUMP STATION (DEDARI)

"Pump station No 8 is located on the Great Eastern Highway at Dedari (Benari) and is approximately 45km west of Coolgardie. The site was vested to the National Trust of Australia (Western Australia) as an interpretation site. Pump station No 8 was the last of C.Y. O'Connor's original pump stations to cease operation in 1970. The site is now closed due to contamination.

The building is intact and contains all its original Worthington pumping engines and all three of the Babcock and Wilcox boilers, air compressors and the economiser. It is the only steam pump station to retain its original overhead gantry. The receiving tank survives along side the pump station. It retains both the inlet and outlet pipes which remain connected to the pumps. Outlet pipes from the pumps are also still connected to a stretch of the original 1903 pipeline. Remnants of the original railway siding remain, including the best preserved of the wooden trestles which are located at this site. This siding is still covered by the corrugated iron framed lean-to, attached to the side of the main pump station. No 8 pump station at Dedari is the most complete and representative of the stations of all the pumping stations. This station was the last of the original Pumping Stations to cease operating in the 1970s. The site has been enclosed and has a caretaker. The site consists of (RICHCU 1999i and 1999m):

- *the pump station building;*
- *the pumps;*
- *all three Babcock and Wilcox boilers;*
- *air compressors;*
- *economiser;*
- *the overhead gantry;*
- *tools;*
- *equipment;*
- *the original steel chimney;*
- *coal bin;*
- *store;*
- *blacksmith's shop;*
- *suction tank including the inlet and outlet pipes which remain connected to the pumps;*
- *the section of outlet pipe from the pumps which is still connected to a stretch of the original 1903 pipeline;*
- *the remaining extant fabric of the original railway siding including the best preserved of the wooden trestles;*
- *the extant fabric of the siding which includes the corrugated iron framed lean-to structure, attached to the side of the main pump house;*
- *some of the associated ancillary corrugated iron buildings, including:*
- *the weigh station incorporating the operational weighbridge and scales;*
- *the station office; and*
- *the blacksmith's forge incorporating its original charcoal furnace; and*
- *the Venturi meter house (the only example remaining at any of the sites)[14]."*

Statements: 'as an interpretation site. Pump station No 8 was the last of C.Y. O'Connor's original pump stations to cease operation in 1970. The site is now closed due to contamination.' were added as an update to illustrate the current use of the station in 2024.

2.1.15 REGULATING TANKS

"A number of regulating tanks were constructed to assist in managing the flow between the pump stations. The regulating tanks were imperative in maintaining water pressure and flow. They were used at the places listed below[15]."

14 Appendix A-Australian Heritage Database Entry

15 Appendix A-Australian Heritage Database Entry

2.1.16 BAKERS HILL REGULATING TANK

"Located at Bakers Hill the regulating tank was built to control the water flow at the highest point between pumping stations 2 and 3. It consists of:

- *the concrete lined tank; and*
- *timber framed railway platform[16]."*

2.1.17 WEST NORTHAM

"Located at West Northam the regulating tank was built to maintain water pressure at the standard required for working order. Just after Station No 2 the pipeline crossed a high ridge, and the Station pumped the water for 37 km with a net lift of 104 metres to Bakers Hill." The regulating tank is currently empty but remains operational with roof covering as of 2024. (From State Listing)[17]."

16 Appendix A-Australian Heritage Database Entry

17 Appendix A-Australian Heritage Database Entry.

Image 17: GWSS main conduit at Pump Station no. 1

Source: 'Pump Station no. 1', photograph taken near Mundaring, Courtesy of: Stephen Carrick Architects, 2024.

2.2 HISTORIC BACKGROUND

2.2.1 INTRODUCTION

Additional information and historical research was completed on the main conduit in order to strengthen the knowledge available on existing cultural heritage values. To assist with additional research and associated stories, Lucy Hair, Historian, was appointed.

The history of the water scheme, along with the notable individuals John Forrest and C.Y. O'Connor, has been extensively documented. The pipeline played a significant role in propelling the development of the goldfields and wheatbelt regions, profoundly influencing the growth of Western Australia. This section encompasses a comprehensive overview of the scheme's evolution, spanning from its initial proposal to the present day. Additionally, it provides a dedicated account of the post-construction history of the GWSS main conduit.

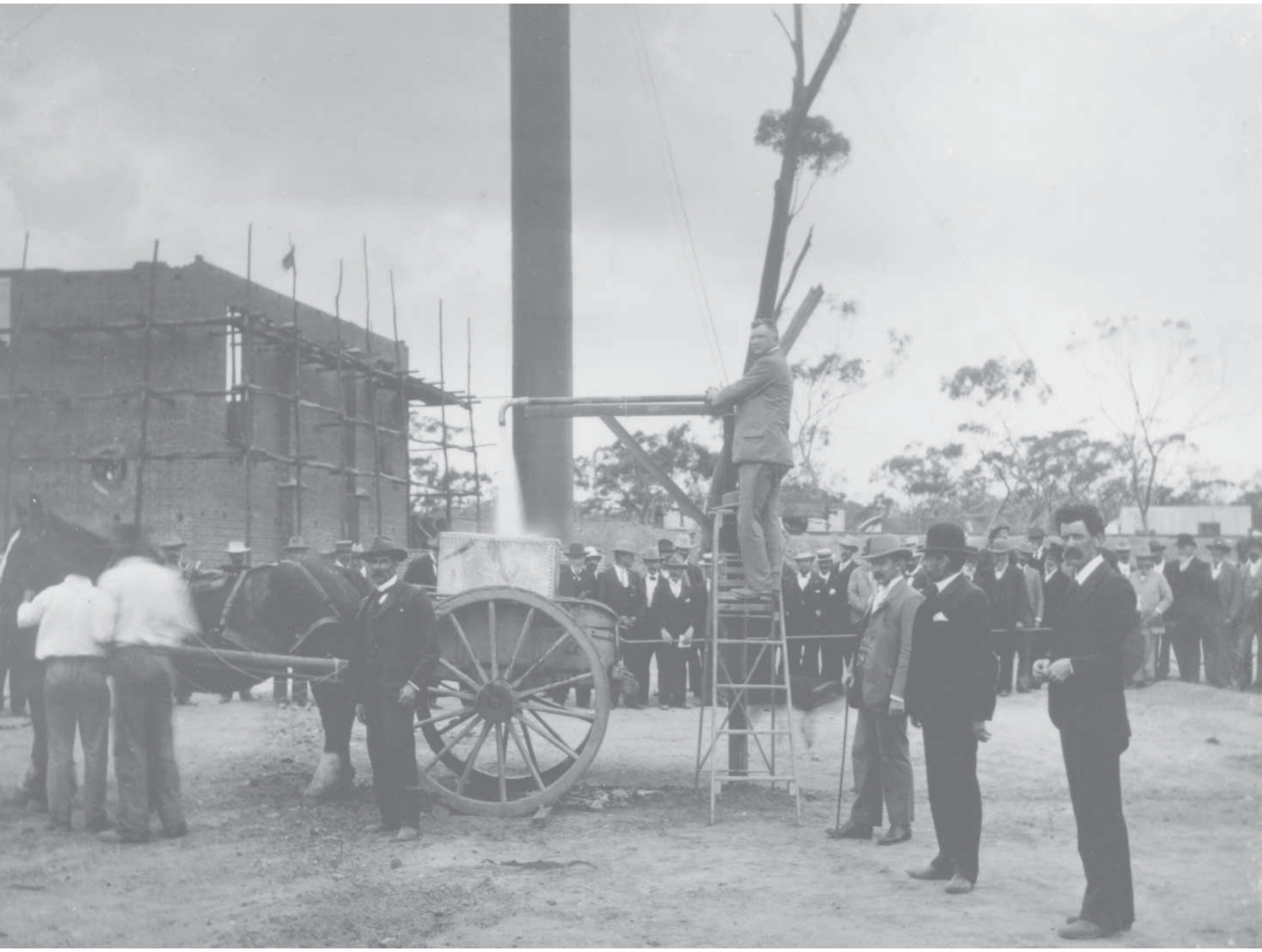

Image 18: Water arrives at Cunderin

Source: State Library of Western Australia, 1902. 000845D: Water arrives at Cunderdin, 1902.

2.2.2 CONDITIONS ON THE EASTERN GOLDFIELDS

Western Australia made little progress in the first fifty years following its foundation in 1829. By 1891 the colony was teetering on the verge of collapse. The Government's coffers were empty, the railway system about to collapse, urgent public works were needed across the colony, and the port at Fremantle was so unsafe that most ships bypassed it in favour of Albany 400 kilometres by road to the south. The 1890s were a watershed in Western Australia's economic and political history. Discovery of large deposits of initially alluvial and later reef gold in the eastern Yilgarn district attracted thousands of miners from other colonies and overseas. On 17 September 1892, Bayley and Ford found gold at Fly Flat (later to become Coolgardie). Then on 17 June 1893 Paddy Hannan struck gold at what developed into one of the richest goldfields of all time centred on the 'Golden Mile' between Kalgoorlie and Boulder. In a couple of days of fossicking, Hannan and his partner collected over 100 ounces of gold. These rich goldfields drew prospectors from all over the world, particularly from the eastern Australian colonies[1]. By October 1895 Coolgardie was the undisputed capital of the goldfields and centre of the colony's gold mining industry. The town itself had a population of about 8,000, while within a radius of some 65 kilometres, there was a floating population of another twenty to thirty thousand. At the time Kalgoorlie was a village of tents and dust, and Boulder did not exist[2].

Large international investment in mining and related ventures made a dramatic impact on the slow growing colony[3]. In 1890 the population of Western Australia was 48,502, and by 1900 it had increased to 179,967. In just on a decade the small, isolated, rural-based economy saw an almost fourfold increase in population and a massive increase in capital which lifted infrastructure to a level previously thought impossible to achieve[4]. By 1911 the population had reached over 293,923, with the bulk of this population increase being on the eastern goldfields themselves[5]. Over the same period the value of gold exports rose from £86.664 in 1890 (12.9% of the gross value of WA colonial exports), to £5,549,879 in 1900 (81.0% of export value) [6].

As the Western Australian gold rush gathered momentum in the 1890s, one of the biggest problems facing gold seekers on the eastern goldfields was the lack of adequate water. The Coolgardie region had an unreliable rainfall, with annual falls during the early 1890s varying from 90mm to 260mm[7]. The region lacked any surface supplies of fresh water, and geologists reported that there was little prospect of finding useful artesian supplies. A variety of short-term water supply works were installed by the WA Public Works Department (PWD), including earth dams, catchments on rock outcrops, condensing plants, wells and bores. However, it became increasingly difficult and costly to provide the rapidly expanding population with uncontaminated water supplies using these means.

By the mid 1890s over 40 percent of Western Australia's population lived on the eastern goldfields under appalling conditions and paying exorbitant prices for domestic water[8]. A contemporary report complained

> *"The seriousness of the problem can be gauged by the usual prices paid for water - 25 shillings per 1,000 gallons when the occasional rains filled the tanks - and £4 per 1,000 gallons when only water condensed from wells and shafts was available[9]."*

The harsh unhealthy conditions on the goldfields raised death rates to 16 per thousand in the period 1896 to 1898, due in most part to the prevalence of typhoid fever in the arid Yilgarn where clean water was difficult for prospectors to obtain[10]. For so long as these miners were deprived of an adequate safe water supply for domestic use, they refused to bring their wives and families from the eastern colonies. As a result, the masculinity ratio rose dramatically in the colony. By 1896 Western Australia contained twice as many males as females[11].

1 (IEA 1986: p.1)

2 Hartley, R G (2000): 'A Century of Water Supply to the Western Australian Goldfields and Wheatbelt from Mundaring Weir and the Kalgoorlie Pipeline', in Early Days, Journal of the Royal Western Australian Historical Society, Vol 11, Part 6, Nedlandspp 727.

3 Appleyard, R T (1981): "Western Australia: Economic and demographic growth 1850-1914" in Stannage, C T, (ed) (1981): A New History of Western Australia, University of Western Australia Press, Crawley. pp 218.

4 Appleyard, R T (1981): "Western Australia: Economic and demographic growth 1850-1914" in Stannage, C T, (ed) (1981): A New History of Western Australia, University of Western Australia Press, Crawley. pp 219.

5 (IEA 1986: p.1)

6 Appleyard, R T (1981): "Western Australia: Economic and demographic growth 1850-1914" in Stannage, C T, (ed) (1981): A New History of Western Australia, University of Western Australia Press, Crawley. pp 236.

7 Hartley, R G (2000): 'A Century of Water Supply to the Western Australian Goldfields and Wheatbelt from Mundaring Weir and the Kalgoorlie Pipeline', in Early Days, Journal of the Royal Western Australian Historical Society, Vol 11, Part 6, Nedlands pp. 727.

8 (NTWA 2000: vol 208).

9 (quoted in IEA 1986: p.1)

10 Appleyard, R T (1981): "Western Australia: Economic and demographic growth 1850-1914" in Stannage, C T, (ed) (1981): A New History of Western Australia, University of Western Australia Press, Crawley, pp.221.

11 Appleyard, R T (1981): "Western Australia: Economic and demographic growth 1850-1914" in Stannage, C T, (ed) (1981): A New History of Western Australia, University of Western Australia Press, Crawley, pp.221.

The problem was compounded by the method of extraction used in the mining process. In 1895, the few small processing plants on the Golden Mile were using 2,000 gallons of water per ton of ore crushed[12]. This was a high usage by international standards, particularly in an area where water was so scarce. However, the high usage was necessary because the talc-like nature of the oxidised ore tended to clog stampers and screens unless washed through with a good flow of water. The extraction rates were also poor because the stamped ore readily formed slimes from which gold could not be easily recovered by the usual method of amalgamation with mercury[13]. Tailings, therefore, had to be ponded in dams until such time as they could be treated.

The adoption of the filter press in 1897, to contain these slimes while gold was removed by cyanide treatment, allowed the recycling of water with important consequences. Water usage fell dramatically from 2,000 gallons per ton in 1895 to around 500 gallons per ton by 1900. However, this increasing economy of water usage was offset as the scale of operations on the Golden Mile changed dramatically. In 1896, only 33,000 tons of ore were processed on the East Coolgardie Goldfield using 66 million gallons of water. By 1903 when this goldfield had become one of the most productive in the world 967,000 tons of ore were processed - almost thirty times more than in 1896 and using 483.5 million gallons of water[14]. Infrequent rains together with a high evaporation rate and lack of suitable dam sites ruled out the development on the goldfields of impounding dams large enough to store water sufficient to accommodate this level of heavy usage[15]. A source outside the goldfields was needed.

12 Hartley, R G (2000): 'A Century of Water Supply to the Western Australian Goldfields and Wheatbelt from Mundaring Weir and the Kalgoorlie Pipeline', in Early Days, Journal of the Royal Western Australian Historical Society, Vol 11, Part 6, Nedlands, pp.728.

13 Hartley, R G (2000): 'A Century of Water Supply to the Western Australian Goldfields and Wheatbelt from Mundaring Weir and the Kalgoorlie Pipeline', in Early Days, Journal of the Royal Western Australian Historical Society, Vol 11, Part 6, Nedlands, pp.728.

14 Hartley, R G (2000): 'A Century of Water Supply to the Western Australian Goldfields and Wheatbelt from Mundaring Weir and the Kalgoorlie Pipeline', in Early Days, Journal of the Royal Western Australian Historical Society, Vol 11, Part 6, Nedlands, pp.728.

15 Hartley, R G (2000): 'A Century of Water Supply to the Western Australian Goldfields and Wheatbelt from Mundaring Weir and the Kalgoorlie Pipeline', in Early Days, Journal of the Royal Western Australian Historical Society, Vol 11, Part 6, Nedlands, pp.727.

Image 19: Dispatching Gold in Kalgoorlie

Source: State Library of Western Australia, 1905. 019060PD: Dispatching gold from the Union Bank of Australia, Kalgoorlie, ca.1905

2.2.3 THE GOLDFIELDS WATER SUPPLY SCHEME

A number of schemes were suggested, including bringing sea water from Esperance Bay to the Goldfields for use in the government condensers[16]. However, the Premier Sir John (later Baron) Forrest did not support the scheme and the decision was made to investigate the possibility of piping water from the Darling Ranges east of Perth to the Goldfields, a distance of some 352 miles (566 km).

In mid-1895 Premier Forrest asked Charles Yelverton O'Connor, Engineer-in-Chief of the Public Works Department, to prepare data for a scheme to pump water from a reservoir in the Darling Ranges to the Goldfields. O'Connor had been recruited from New Zealand and arrived in Western Australia in June of 1891. Prior to his work on the pipeline, he had completely rebuilt and restructured the state's railway system. He was also responsible for the construction of the inner harbour on the Swan River at Fremantle.

He had argued for an inner harbour in opposition to the panel of overseas experts who had recommended an outer harbour based on a causeway ending in a curved breakwater running a half a mile out to sea on the northern side of the river mouth[17].

The first trial designs for a pumped water supply were completed in November 1895 and were based on three different supply rates: one million gallons per day, five million gallons per day and ten million gallons per day. In 1896, the processing requirements of the whole of Western Australia's gold mining industry could have been met with water supplies totalling one million gallons per day - assuming a usage of 2,000 gallons per ton of ore[18]. O'Connor argued that a one million gallons per day capacity pipeline would only be adequate for short term requirements. Because of its smaller diameter, such a pipeline would have had a friction head nearly twice that of a five million gallons pipeline, and its operating costs would have been greater in the same proportion. He estimated that a one million gallons capacity pipeline would require some twelve to fifteen pumping stations compared with the eight or nine needed for a five million gallons line[19]. O'Connor also argued that, as the cost of pumping was proportional to the quantity pumped, it would be no more expensive to pump 11 million gallons daily through a pipeline of five million gallons capacity than it would be to pump the same quantity through a one million gallons capacity pipeline. In fact it would be cheaper because of the reduced friction in the larger pipe. He estimated that a supply of one million gallons would entail a capital cost of about £1 million, while a five million gallons supply would cost £2.5 million: five times the capacity for 2½ times the cost[20].

16 Alexander, F, Crowley, F K & Legge, J D (1954): The Origins of the Eastern Goldfields Water Scheme in Western Australia, University of Western Australia Press, Crawley, pp.32.

17 (Trust News 2000: Vol 208).

18 Hartley, R G (2000): 'A Century of Water Supply to the Western Australian Goldfields and Wheatbelt from Mundaring Weir and the Kalgoorlie Pipeline', in Early Days, Journal of the Royal Western Australian Historical Society, Vol 11, Part 6, Nedlands, pp.730.

19 Hartley, R G (2000): 'A Century of Water Supply to the Western Australian Goldfields and Wheatbelt from Mundaring Weir and the Kalgoorlie Pipeline', in Early Days, Journal of the Royal Western Australian Historical Society, Vol 11, Part 6, Nedlands, pp.730-731.

20 Hartley, R G (2000): 'A Century of Water Supply to the Western Australian Goldfields and Wheatbelt from Mundaring Weir and the Kalgoorlie Pipeline', in Early Days, Journal of the Royal Western Australian

Image 20: Opening of Mount Charlotte Reservoir

Source: State Library of Western Australia, Water entering Mt Charlotte Reservoir at the opening of the Goldfields Water Supply Scheme, 229080PD: 24 January 1903. Accessed 2024.

On 16 July 1896, Premier John Forrest introduced into the WA Parliament a Bill to authorise the raising of a loan of £2.5 million to construct the pipeline scheme. The Bill passed through the Parliament in September 1896[21].

O'Connor supported the view that a group of experienced overseas engineers should be appointed to advise on major issues, such as: the type, thickness and diameter of the pipe; the spacing of the pumping stations; and the power requirements and capacity of the pumps themselves. A Commission of three experienced English engineers was appointed in December 1896, and in January 1897 O Connor travelled to London to discuss the proposed scheme with them. The Commission was led by Sir John Carruthers, previously head of the PWD in New Zealand[22], and included Professor William Unwin, widely regarded as the pre-eminent authority of the day on the transmission of power, and Dr George F Deacon, engineer-in-charge of the Liverpool Water Supply[23]. In their interim report of 3 August 1897 the Commission indicated that the proposed scheme was theoretically practical although of a greater scope and size than any similar scheme attempted elsewhere in the world to that time[24]. Although they had originally recommended nine pumping stations, in their final report of 31 December 1897 they revised this to eight stations. The ninth station was omitted when the decision was made to deliver the water to a large distribution reservoir at Bullabulling instead of Mt Burgess, north of Coolgardie. From this reservoir at Bullabulling the water would flow under the influence of gravity 21 miles (33.8 km) to the Coolgardie service reservoir at Toorak and eventually down the extra 23½ miles (37.8 km) to the Kalgoorlie service reservoir at Mt Charlotte[25].

2.2.4 THE MUNDARING RESERVOIR

When the scheme was first proposed and until shortly before the construction of the weir was begun, there were no river-gauge water flow measurements available for rivers in the Darling Ranges. Calculations based on results obtained in other countries were necessary in order to estimate the probable inflow into any proposed reservoir. In order to identify potential dam sites for the scheme O'Connor's principal assistant, Thomas Hodgson, made an exhaustive examination of the Darling Range watershed and rivers in late 1895 and 1896 covering about 3,000 square miles of the ranges. Hodgson, an extremely qualified and experienced water supply engineer from Victoria, had been appointed in late 1895 as O'Connor's principal assistant on the water supply project. He identified thirteen potential sites, but recommended one on the Helena River which he was confident would have the capacity to provide the required supply of five million gallons of water per day. It was finally decided that the most economical place for the reservoir was at Mundaring on the Helena River, where it was estimated that the cost of construction per million gallons of storage would be least.

Mundaring Weir (Dam), which was built at the recommended site, was a one hundred feet high concrete dam capable of impounding over 4,600 million gallons. At the site chosen for the weir, the valley through which the Helena runs converges abruptly into a deep gorge flanked on both sides by high hills. The river's width at its bed is 15 feet (4.6 m) and it is only 750 feet (228.6 m) in width at a height of 100 feet (30.5 m) above the bed. There was ample evidence to show that the Helena and other streams in the area were liable to heavy floods and the usual method of disposing of flood-waters, by means of a by-wash, was precluded by its cost. It was therefore decided to pass all floods over the weir crest. Calculation showed that to provide a safe margin for the passage of flood waters as much as 5 feet (1.5 m) in depth over the whole length of the weir would have to be allowed for[26].

Historical Society, Vol 11, Part 6, Nedlands, pp.731.

21 (Trust News 2000: Vol 207).

22 Evans, A G (2002): C.Y. O'Connor: His Life and Legacy, UWA Press, pp.164.

23 Evans, A G (2002): C.Y. O'Connor: His Life and Legacy, UWA Press, pp.167.

24 (Trust News 2000: Vol 209).

25 (Trust News 2000: Vol 209).

26 Strickland, R M (1986): National Historic Engineering Landmark Nomination: Coolgardie Goldfields Water Supply 1898-1903, The Institution of Engineers, Australia, June, pp.19.

The country at the reservoir site consisted largely of undecomposed granite traversed by intrusive basaltic dykes whose direction was mostly at right-angles to the course of the river. At the site of the weir, however, the granite showed out particularly clearly and trial-shafts reached solid granite at no great depth, the deepest of the shafts being only 20 feet (6.1 m) deep from the ground surface[27]. During the later excavation of the foundations, however, it was discovered that the rock was not as solid as surface indications and the trial-pits had originally promised. On the right bank a large portion of what at first appeared to be bed-rock was found to consist of an immense boulder with a large cavity below it. Additionally, under the bed of the river the granite was very badly fissured over the full width of the foundations, and the disruption was found to extend both up and down stream for a considerable distance. There was no alternative but to follow the fissure down, which eventually required excavation to a depth of 90 feet (27.4 m) below the river bed. At this level the filling material in the fissure was found to be compact, and it was concluded that the fissure at this depth was safe as the base of the weir.

Where the fissure occurred under the foundations and the wall would be highest, the excavations were carried down about 15 feet (4.6 m) from the building-line in a vertical direction on the up-stream face[28]. However, as one of the basalt dykes crossed the valley a short distance away on the down-stream side, it was considered necessary to remove the whole of the material between this dyke and what would otherwise have been the toe of the weir. A concrete-lined spill-water basin, about 150 feet (45.7 m) long by 100 feet (30.5 m) wide, was constructed in the bed of the river at the toe of the wall, with a depth of water in the basin of about 10 feet (3.1 m). The concrete filling of the foundations was carried up to bed level on the up-stream face, but on the lower side the mass filling was stopped 18 feet (5.5 m) below bed-level and the parabolic section of the weir wall proper was begun. The granite beds under the foundations were deeply chased in longitudinal rows about 6 feet (1.8 m) wide and 3 feet (0.9 m) deep, and the toe of the wall-batter where it met the granite floor was channelled the whole length in order to key in the concrete foundations[29].

The reservoir is provided with two valve-towers constructed of concrete. The inner tower is situated on the reservoir side of the weir and was built into and concurrently with the main wall. The inner valve-tower has provision for drawing water from the reservoir by means of cast-iron bell-mouthed pipes passing through the valve-tower wall into a cast-iron stand-post, at three different levels: 25 ½ feet (7.7m), 53 feet (16.2 m), and 80 feet (24.4 m) below full supply level[30]. The outer valve-tower is situated 175 feet (53.3 m) down stream from the centre of the weir-wall, being connected to the reservoir by a viaduct which carries the outlet and scour-pipes.

The excavations for the foundations were begun in May. 1898 and completed by January 1900, with the building of the reservoir wall being completed in June 1902.

27 Strickland, R M (1986): National Historic Engineering Landmark Nomination: Coolgardie Goldfields Water Supply 1898-1903, The Institution of Engineers, Australia, June, pp.20.

28 Strickland, R M (1986): National Historic Engineering Landmark Nomination: Coolgardie Goldfields Water Supply 1898-1903, The Institution of Engineers, Australia, June, pp.20.

29 Strickland, R M (1986): National Historic Engineering Landmark Nomination: Coolgardie Goldfields Water Supply 1898-1903, The Institution of Engineers, Australia, June, pp.21.

30 Strickland, R M (1986): National Historic Engineering Landmark Nomination: Coolgardie Goldfields Water Supply 1898-1903, The Institution of Engineers, Australia, June, 21-22.

Image 21: Construction of Mundaring Weir

Source: State Library of Western Australia,1900. 029185PD: Conveyors, 1900-1902, accessed 2024.

2.2.5 THE PIPELINE

The pipeline as originally constructed runs approximately 566 km from the reservoir at Mundaring to the Yilgarn district, terminating in holding reservoirs at Coolgardie and Kalgoorlie. It was designed to follow as closely as practicable the railway line which reached Kalgoorlie in early 1897. From Northam eastward the pipes were laid parallel with the railway at a distance of 45 feet (13.7 m). This meant that pipes could be unloaded from rail trucks near to where they were required on the pipeline, an activity that had to be carried out quickly so as not to disrupt normal rail traffic. Another great advantage was the subsequent easy supply of water to the railway. The pipeline deviated from the railway between the weir at Mundaring and Northam in order to shorten the distance, and also for the purpose of traversing higher country and reducing the pressure on the pipe. Where the pipeline deviated from the rail line the pipes were unloaded at a siding and distributed using horse drawn wagons. The telephone was new technology and Perth only opened its first exchange in 1887, but a special telephone line was laid between the PWD Head Office in Perth and Kalgoorlie via each of the pumping stations. This was found to be extremely useful during construction and was retained as an on-going operational facility[31].

The English Commission of Engineers recommended that pipe for the line between Mundaring and the goldfields should be of steel throughout, supported above ground on concrete bolsters, and riveted up in lengths of about 110 feet (33.52 metres) with expansion-joints at these intervals and anchor joints midway. The pipes were to be fixed to the bolsters in order to prevent the pipes from creeping. The Commissioners were of the view that there were possibly alkaline salts in the soil of a large part of the district through which the pipeline would pass, and for this reason they recommended that the pipes should be laid above ground, uncovered, and with expansion-joints. Additional considerations were to avoid pressure on the empty pipes, to save the expense of trenching, and to facilitate detection and suppression of leakage from the pipes[32]. The minimum thickness was fixed at 5/16 inch to give an allowance for corrosion, and the pipes were to be longitudinally riveted where the pressure could have been accommodated by pipe of a lesser thickness of 1/4 inch, and welded for all higher pressures[33]. Tenders for the stipulated pipes for delivery in the Colony at a point 22 miles (35.4 kilometres) inland were invited from manufacturers in Australia, Europe, and America. Tenderers were invited at the same time to submit alternative prices for other types of steel pipe[34].

The first tenders received were for riveted, welded, and/or locking bar pipes, as follows:

Table 1.0: cost of pipe types[35]

Class of Pipe	Lowest tenders received (EU)	Lowest tenders received (AU)
Riveted pipe	£782,708	£682,827
Welded Pipe	£472,600	-
Locking bar pipe	-	£239,868
Total	£1,255,308	£922,695

The locking-bar pipe, invented by the Australian, Mephan Ferguson, had been considered by the English Commission of Engineers and favourably commented on. They were not recommended for so large a scheme, however, because proof of their successful manufacture and use on any considerable scale was not at that time available[36]. Subsequently, and before receipt of the tenders, 10 miles of main 25 ½ inches in diameter had been laid in South Australia. It had been found that these pipes made from 1/4 inch plate and fresh from the closing machine would withstand a pressure of 400 lbs. per square inch without weeping - nearly twice what had be stipulated by the English Commission of Engineers for the Goldfields pipeline scheme[37]. Moreover, all pipes which did not stand this test could be passed back through the closing-machine to be re-closed, instead of being subjected to the usual caulking-processes which were necessary with riveted pipes and which had always been found to be injurious to their plates and jointings. Practical use on a fair length of main also showed that the joining of the sections of locking-bar pipes could be successfully accomplished. As a result, the question of comparative cost and usefulness became the determining factor in deciding whether the new locking-bar pipe should be used in

31 *(Trust News 2000: Vol 208)*

32 Strickland, R M (1986): National Historic Engineering Landmark Nomination: Coolgardie Goldfields Water Supply 1898-1903, The Institution of Engineers, Australia, June, pp.26.

33 Strickland, R M (1986): National Historic Engineering Landmark Nomination: Coolgardie Goldfields Water Supply 1898-1903, The Institution of Engineers, Australia, June, pp.26

34 Strickland, R M (1986): National Historic Engineering Landmark Nomination: Coolgardie Goldfields Water Supply 1898-1903, The Institution of Engineers, Australia, June, pp.26

35 Strickland, R M (1986): National Historic Engineering Landmark Nomination: Coolgardie Goldfields Water Supply 1898-1903, The Institution of Engineers, Australia, June, pp.27

36 Strickland, R M (1986): National Historic Engineering Landmark Nomination: Coolgardie Goldfields Water Supply 1898-1903, The Institution of Engineers, Australia, June, pp.27

37 Strickland, R M (1986): National Historic Engineering Landmark Nomination: Coolgardie Goldfields Water Supply 1898-1903, The Institution of Engineers, Australia, June, pp.27

place of welded and riveted pipes[38].

When the Australian price for locking-bar pipes was contrasted with that for welded pipes the savings were found to be almost 50 per cent. Additionally, the price of locking-bar pipes was but little more than that for the same quantity of riveted pipes. The lowest tenderers were asked to consider the matter again, and they quoted prices for the locking-bar pipes which contrasted as follows with those received for the riveted pipes:

Table 2.0: cost of pipe types[39].

Thickness of Steel Pipe Wall	Riveted Pipe (per Foot)	Locking Bar Pipe (per Foot)
3/16 inch	£12.12.09	£13.10.00
¼ inch	£16.05.00	£16.15.00
5/16 inch	£20.03.06	£21.00.00

Moreover, it was found that the locking bar pipes could sustain a considerably greater safe head of pressure for each of the three thicknesses of pipe wall than comparable riveted pipe, enabling further economies to be made by utilising pipes with a thinner wall section.

As a result of the favourably low tenders for locking bar pipe, it was decided that 30 inch pipe with a minimum thickness of 1/4 inch could be provided throughout the whole of the pipeline, rather than the 5/16 inch thickness originally specified by the Commission of English engineers. By having one thickness and one diameter throughout, the tenderers were able to make further reductions in the cost per pipe. Locking bar pipes also reduced considerably the drag caused by the friction of water in riveted pipe flowing over the heads of the rivets protruding through the wall and into the interior of the pipe. The use of uniform pipe and the lessening of the friction drag of the water also had the effect of enabling savings in the capital cost of the pumps as well as in the cost of pumping[40].

As the adoption of locking-bar pipes obviated the anticipated continuous loss of water from pipes having a multitude of rivet-holes, the potential advantage of whether the pipes could be trenched underground was considered. Careful analysis of the soils along the pipe-track showed that these ancient soils had been leached of many of their harmful salts and acidic properties. Although the recommendation of the Commission of English engineers had been for the pipeline to be laid above ground on bolsters, it was decided that only where the pipes traversed salt pans should they be laid on timber trestles. In the remainder of the line it was decided that the pipes should be buried, which had the advantage of stabilising temperature fluctuation and resultant expansion and contraction of the pipes, obviating the necessity for expansion-joints, and permitting the use of ordinary lead jointing at the joins[41]. Another advantage of trenching the pipes was that it allowed a coating comprised of one part of Trinidad asphaltum and one part of coal tar to be applied both inside and outside each pipe, thus providing the steel with further protection from any corrosive action in the soil. It had originally been found that with pipes laid above ground, the fierce heat of the goldfields summer caused the mixture to melt and run off the pipes, while the frosts of winter caused it to crack and flake off[42].

38 Strickland, R M (1986): National Historic Engineering Landmark Nomination: Coolgardie Goldfields Water Supply 1898-1903, The Institution of Engineers, Australia, June, pp.27

39 (quoted in IEA 1986: p.1)

40 Strickland, R M (1986): National Historic Engineering Landmark Nomination: Coolgardie Goldfields Water Supply 1898-1903, The Institution of Engineers, Australia, June, pp.28.

41 Strickland, R M (1986): National Historic Engineering Landmark Nomination: Coolgardie Goldfields Water Supply 1898-1903, The Institution of Engineers, Australia, June, pp.28.

42 Strickland, R M (1986): National Historic Engineering Landmark Nomination: Coolgardie Goldfields Water Supply 1898-1903, The Institution of Engineers, Australia, June, pp.29.

2.2.6 MANUFACTURE OF THE PIPES

The locking-bar pipe was invented in Australia by Mephan Ferguson. Born on 25 July 1843 at Falkirk, Scotland, he arrived in Melbourne with his parents in 1854. Ferguson owed his early success to his entrepreneurial and technical skills and to the Victorian government's protectionist policy of awarding contracts to colonial firms. By 1885 he was well established and in that year, Alfred Deakin returned from California and decided that wrought-iron pipes should replace cast-iron in the Melbourne water supply. Ferguson acted promptly. He won government contracts for the supply of wrought-iron piping, and bought the Glasgow Iron Works in West Melbourne where he established a new factory and testing works. He also imported the latest hydraulic machinery and designed a plant said to match any in the world. He continually experimented with wrought-iron pipes, and perfected straight-riveted, longitudinal and transverse seams and pipes with spiral seams. Seventy miles (113 km) of this lighter piping was used in the Melbourne water supply by 1909, while Ferguson also supplied the pipes for many of the Victorian Water Trusts, the Chaffey brothers' irrigation scheme and similar ventures in New Zealand, Ceylon and Malaya [43].

Late one night in 1896, Ferguson was sitting at his desk with his son beside him. He opened a drawer and observed the dovetail joints. He hit on the idea of using a similar joint in steel. Producing a piece of lead he made a model of a lock bar joint in a few minutes. In the morning a joint was made in steel at the works and, when tested, proved to be 100% efficient. Ferguson quickly patented the process, and planned a production line suitable for the mass production of pipes[44].

Under the new process, a pipe consisted of two plates, each of the full length of the pipe and each bent to a semicircle. Steel was delivered to one end of the works and passed from one machine to another, until a pipe came off the production line at the other end of the works, was tested under water pressure, and then dipped in the molten asphalt protective mixture[45].

43 ADB Forrest (2008). Australian Dictionary of Biography - Forrest, Sir John [Baron Forrest] (1847 - 1918). http://www.adb.online.anu.edu.au/biogs/A080565b.html

44 Ferguson, J M (1992): Mephan Ferguson: A Biography, Tubemakers of Australia, Geelong, pp.19.

45 Ferguson, J M (1992): Mephan Ferguson: A Biography, Tubemakers of Australia, Geelong, pp.20.

In the first machine the steel plate was passed through straightening rollers for the purpose of taking out all kinks and rendering the plates perfectly straight. They were then cut square and to the exact length of 28 feet (8.5 m). The second machine was the planer, consisting of nearly 100 tonnes of castings and components. The base was like a huge lathe bed and the sections of this bed had to be replaced for pipes of different diameter. The plate was clamped on to the top of the bed and a saddle moved along the bed. The saddle carried cutting knives which machined the edges of the plate, producing straight edges of the exact width required. After the knives had passed, rollers chamfered the edges of the plate to produce an edge similar to the 'dove tail' in a wooden joint [46]. After the rollers passed, the edges of the plate were ready to fit into the lock bar. Each plate then went to the plate bending rolls, which were nearly 10 metres long, and which bent the plate into a semi-circular half pipe. Roller supports were provided above the top roll to prevent its deflection, and ensure the correct radius in the finished product. The chamfered edges of two half pipes were fitted into two locking bars. The closing machine which then pressed the locking bars closed over the chamfered edges of the plates was a hydraulic press. A cantilever, as long as the pipes, supported the dies inside the pipe. An hydraulic cylinder, which produced a force equivalent to a weight of 1,200 tonnes, squeezed the metal of the locking bars closed over the chamfers in the edge of the plates and a length of the joint was made. The whole process was done "cold"[47].

46 Ferguson, J M (1992): Mephan Ferguson: A Biography, Tubemakers of Australia, Geelong, pp.20.

47 Ferguson, J M (1992): Mephan Ferguson: A Biography, Tubemakers of Australia, Geelong, pp.21

Image 22: Pipe Lowering near Kalgoorlie

Source: State Library of Western Australia,1900. 011080D: Lowering a pipe into the trench, accessed 2024.

The clamps could then be removed and the completed pipe moved to the testing machine. The testing machine consisted of cast iron seals which fitted on to the ends of the pipe. Tension bars ran the length of the pipe to hold these seals tightly. The pipe was then filled with water and the water pressure increased to the specified amount. If there was any weeping of water from the locking bar at either side joint the pipe was returned to the closing machine for a second pass. Finally, the pipe would be dipped in molten asphalt mixture[48].

The joining of pipes in the field required some innovation, and Ferguson took out and abandoned patents on a number of alternatives. The joint eventually developed by Ferguson could be mass produced and withstand a head of 140m of water. The pipes were butted together and a steel ring or 'thimble' was fitted around the joint.

This ring was made from rolled steel segments forced out radially by a steam press until the ring was of the required diameter. Two of the segments were specially shaped so that cavities were created at two places on opposite sides of the ring into which the locking bars of the pipe would fit. There was a 6mm clearance between the ring and the pipe, including around the lock bars. A mould was placed around the whole joint and molten lead poured into the space between the pipe and the ring. After solidification the lead was caulked (hammered into the space between the ring and the pipes) and a sealed water pressure proof joint was achieved[49].

As the whole length of main was of uniform diameter the possibility of using machinery in place of hand-caulking of the lead joint was considered at an early stage. Initially, however, the caulking was done by hand but this proved to be a major bottleneck in the progress of construction. In 1899 a Victorian engineer named James Couston developed a machine for caulking the joints. The machine was clamped around the steel collar at the join in the pipes and after the molten lead had been poured in an electric motor was engaged to drive a series of hammers around the joint to make a tight seal. Not only did it prove to be quicker, but it also did a better job than hand caulking[50]. Careful trial of joints caulked by hand and by machine demonstrated that the machine made joints remained water tight when subjected to hydraulic pressure of 400 lbs per square inch. In the hand caulked joints, on the other hand, slight sweats and pin-squirts manifested themselves when the joints were submitted to the same hydraulic pressure[51]. In comparison with hand caulking, machine caulking proved so effective that the WA PWD purchased the patent rights from Couston and built twelve of the machines for use on the Goldfields Water Supply Scheme[52].

At intervals of about 5 miles stop-valves were inserted, and where long rising gradients occurred reflux-valves were placed. The stop-valves were actuated by slow motion gearing and where the water hammer was likely to be considerable, small by-passes were introduced in order to bring the water to rest very slowly. Glenfield pattern air-valves were placed where the pipe passed over all summits, a nest of three being placed at the highest points, a nest of two at intermediate points, and a single valve at the lowest points. These valves enabled the escape of air when charging the main, and also enabled air accumulating in the pipe during normal pumping operations to be automatically discharged[53].

48 Ferguson, J M (1992): Mephan Ferguson: A Biography, Tubemakers of Australia, Geelong, pp.22.

49 Ferguson, J M (1992): Mephan Ferguson: A Biography, Tubemakers of Australia, Geelong, pp.23.

50 (Trust News 2000: Vol 207)

51 Strickland, R M (1986): National Historic Engineering Landmark Nomination: Coolgardie Goldfields Water Supply 1898-1903, The Institution of Engineers, Australia, June, pp.33.

52 (Trust News 2000: Vol 207)

53 Strickland, R M (1986): National Historic Engineering Landmark Nomination: Coolgardie Goldfields Water Supply 1898-1903, The

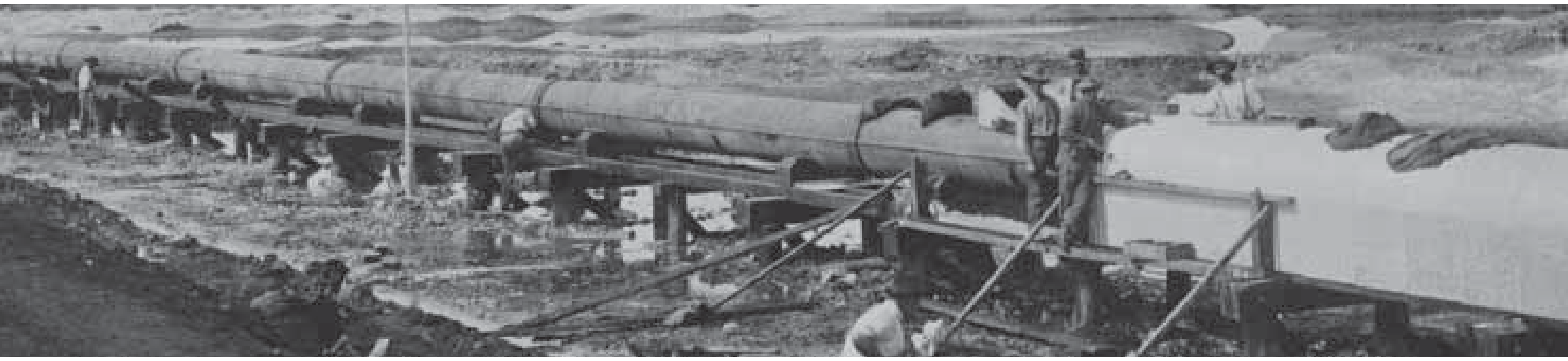

Image 23: Construction process of the GWSS

Source: State Library of Western Australia, 024237PD: Goldfields Water Supply Scheme crossing salt lakes - pipes partly covered, ca. 1901 accessed 2024.

2.2.7 THE PUMPING STATIONS AND HOLDING RESERVOIRS

Given the remoteness of the region through which the pipeline would pass, it was recognised that all pumping machinery should be of a uniform size and pattern, and that there be a standby pumping set available at each station.

The pumps needed to lift the water to a height which equalled the highest point between each station, and also had to overcome the frictional resistance caused by the water moving through the pipes. Across all eight pumping stations there was a total vertical lift of water of 832 metres. The eight stations were positioned so that the first four stations pumped against a head of between 110 and 126 metres, while the last four stations pumped against a head of between 55 and 64 metres[54].

To achieve this the first four stations were equipped with three identical pumping sets. Any two of these sets when operating together could lift the water to the required head height, leaving one set as a standby. At stations five to eight, two pumping sets were provided as one set only was needed to lift water the required head height, again with a standby set. A total of twenty pumping sets were required, of which only twelve would be working at any one time[55].

Tenders for the twenty pumping sets were advertised in Europe and the USA in July 1899. There were difficulties in obtaining satisfactory tenders, mainly due to the abundance of work worldwide. It was not until March 1900 that a contract was awarded to the British firm of James Simpson and Company for the supply and installation of twenty Worthington type pumping sets complete with Babcock and Wilcox boilers at an aggregate cost of £242,750. Delivery was to commence in July 1901 and installation to be completed by June 1902[56] .

At six of the pumping stations, concrete lined holding tanks were constructed adjacent to the pump house. Water was pumped in to the holding tank through the previous stage of the pipeline and was drawn from these tanks by the pumphouse for transmission through the next stage of pipeline to the holding tank at the next pumping station. The exceptions were at Station No. 1 which drew water directly from Mundaring Weir (Dam), and Station No. 3 where use was made of a nearby 10 million gallon capacity reservoir that had originally been constructed for the railway[57]. Just after Station No.2 the pipeline crossed a high ridge, and the Station pumped the water for 37 kilometres with a net lift of 104 metres to a high level regulating tank at Bakers Hill. The water then flowed under the force of gravity to another regulating tank at West Northam and then to the holding tank at the pumping station at Cunderdin. Similarly, the No.8 pumping station pumped the water for 19 kilometres through a head of 56 metres to the main distribution tank at Bullabulling where the water was fed by gravity to the Toorak Hill reservoir at Coolgardie and eventually through to the Mt Charlotte Reservoir at Kalgoorlie[58].

The pump stations themselves were substantial buildings of red brick with corrugated iron roofs supported on steel trusses[59]. The eight buildings were substantially the same design, with two rooms connected by a passageway. One room contained the steam boilers which provided the motive power to the pumps, which were contained in the other room. The chimney stacks were of steel 1.5 metres in diameter and ranging from 27 to 40 metres in height. The two at Mundaring and Cunderdin were later replaced by brick stacks. Six of these buildings remain today. Nearby to each pumphouse it was necessary to house the operational staff and their families, and small settlements of houses, schools and sporting facilities gradually grew up[60].

Initially the boilers were to be fired using coal from the government coal mine at Collie, at an estimated cost of 32 shillings per ton[61]. Although a 1,000 ton sample had been raised from the mine in 1893 for testing, it was not until 1899 that the first successful commercial production of Collie coal commenced. However, Collie coal was of poor quality, and in relation to its heating value per ton proved to be a high cost option.

Institution of Engineers, Australia, June, pp.30.

54 (Trust 2000. Vol 208)

55 (Trust 2000: Vol 208)

56 (Trust 2000. Vol 208)

57 (Trust 2000. Vol 208)

58 (Trust 2000. Vol 208)

59 (Foxley 2008)

60 (Trust 2000. Vol 208)

61 Hartley, R G (2000): 'A Century of Water Supply to the Western Australian Goldfields and Wheatbelt from Mundaring Weir and the Kalgoorlie Pipeline', in Early Days, Journal of the Royal Western Australian Historical Society, Vol 11, Part 6, Nedlands.

As soon as it became obvious that the far cheaper locally cut firewood was more efficient, coal was abandoned in favour of wood and the scheme's pumps operated on coal for less than a year[62]. Enormous quantities of wood were utilised from the countryside surrounding each pumping station. Wood-cutters were paid on the basis of weight and weighbridges were established at each station to weigh consignments. Special railway sidings lead to raised trestles covered by a corrugated iron and steel lean-to beside each station to facilitate the delivery of wood. Over the period of steam driven pumping at each of the stations, increasingly large areas were denuded of timber to feed the boilers and even today the effects of this are noticeable around some of the stations.

62 Hartley, R G (2000): 'A Century of Water Supply to the Western Australian Goldfields and Wheatbelt from Mundaring Weir and the Kalgoorlie Pipeline', in Early Days, Journal of the Royal Western Australian Historical Society, Vol 11, Part 6, Nedlands.

Image 24: Steam Engine and Water Pump, Boulder City

Source: State Library of Western Australia, 090459PD Boulder City, 1902. Accessed 2024.

2.2.8 INSTALLATION OF THE PIPELINE AND COMPLETION

Once the decision was made to bury the pipeline, trenching was commenced along the route. The surface formation of the country traversed was very irregular. On the plains, ironstone conglomerate predominated but never extended continuously for more than a short distance, being broken by bands of sand, diorite, and granite. In the timbered belts sandy clay was the usual surface soil, but with outcrops of granite, diorite, and schist[63]. It was found that the most economical depth of trench was about a metre in depth, and the bulk of the material was taken out of the trench by manual labour. It was necessary, however, to use explosives to remove material on more than one-fourth of the total trench line. The excavation of the trench was kept well ahead of pipe-distribution, laying and jointing, in order to provide continuous work for the gangs involved in these later operations[64].

The pipelaying work was divided into sections of about 14 miles each. Each stretch was worked on by one caulking team, and when the work was completed the whole gang went forward to the next available section. When the works were brought into full swing, seven such gangs were at work on several sections. As the work performed by each gang was identical, there was considerable rivalry between the parties. Bad work due to haste was prevented, however, by the appointment of an inspector on each section, who reported directly to the head office and was responsible only for the quality and not for the cost of the work. The rate of progress of the seven gangs when they were at their most experienced during the last 3 months before the completion of the pipeline and the disbanding of the gangs, was 1 and 2/5 miles of laying, jointing, and complete in-filling of trenches per eight hour working-day[65].

By the 13th April 1902, the works were sufficiently far advanced to enable pumping to be commenced with one of the engines at No. 1 station. No trouble was experienced in getting the engines underway and by the 22nd April the water had reached the Cunderdin Reservoir, at mile 77. Four months now elapsed before the laying and jointing of the next section was completed, and it was not till the 22nd

63 Strickland, R M (1986): National Historic Engineering Landmark Nomination: Coolgardie Goldfields Water Supply 1898-1903, The Institution of Engineers, Australia, June.pp.34.

64 Strickland, R M (1986): National Historic Engineering Landmark Nomination: Coolgardie Goldfields Water Supply 1898-1903, The Institution of Engineers, Australia, June,pp.35.

65 Strickland, R M (1986): National Historic Engineering Landmark Nomination: Coolgardie Goldfields Water Supply 1898-1903, The Institution of Engineers, Australia, June, pp.35.

August 1902 that the water reached the Merredin receiving tank at mile 140. Some trouble was experienced in charging this section, through the joints leaking due mostly to the subsidence of the pipes laid across soft ground in the bed of the Mortlock River. The water reached the Coolgardie service reservoir at mile 328 on the 22nd December 1902, and finally the Kalgoorlie service reservoir on the 16th January 1903, about 8 months after the charging of the main was started[66] .

The pumping was restricted to an amount sufficient to fill about 12 to 15 miles of main per day, and at this rate no trouble was experienced from air-pocketing. It was found that at this charging rate the Glenfield pattern air-valves had sufficient discharge capacity to pass the volume of displaced air[67] .

The original scheme did not allow for any reticulation of water to townships for domestic purposes, or to mining centres. It was originally intended to bring the water to Mount Burgess a few miles north of Coolgardie, from where the local-government authority would then lay a subsidiary main to its own service reservoir for each township or mining centre. Eventually, however, the complete reticulation of the townships of Kalgoorlie, Coolgardie, Boulder, and the Kalgoorlie Mining Belt, had to be undertaken as part of the main scheme[68].

The pipeline was completed in early 1903, and the scheme was officially opened by Sir John Forrest at the Mount Charlotte Reservoir in Kalgoorlie on 24 January 1903. The total actual cost of the water supply pipeline, including all extras, contingencies, and establishment charges was £2,660,000, an excess of only £225,000 on the original estimate[69].

66 Strickland, R M (1986): National Historic Engineering Landmark Nomination: Coolgardie Goldfields Water Supply 1898-1903, The Institution of Engineers, Australia, June.pp.37.

67 Strickland, R M (1986): National Historic Engineering Landmark Nomination: Coolgardie Goldfields Water Supply 1898-1903, The Institution of Engineers, Australia, June.pp.37.

68 Strickland, R M (1986): National Historic Engineering Landmark Nomination: Coolgardie Goldfields Water Supply 1898-1903, The Institution of Engineers, Australia, June.pp.42.

69 Strickland, R M (1986): National Historic Engineering Landmark Nomination: Coolgardie Goldfields Water Supply 1898-1903, The Institution of Engineers, Australia, June.pp.43.

2.2.9 PATRIOTIC SENTIMENT AND NATION BUILDING

Sir John Forrest was committed to the development of Western Australia as a self supporting and viable colony. Western Australia had recorded a very low population growth rate in its early days of free settlement. For Forrest the transition of Western Australia from a frontier to settled society was to be undertaken by the building of substantial infrastructure projects such as ports, harbours and railways. Water supply was one of the fundamental and recurrent issues in the establishment of human settlement across Australia[70], but one which was particularly pertinent in the drier west of the continent. The discovery of gold and the establishment of the 'golden mile' as outlined above, was an important catalyst in the development of the colony, its role as a state and its contribution to nation building. The value of gold for Coolgardie, and more broadly Western Australia, was multi faceted. The wealth it created was the most immediate, but long term it attracted a mass increase in population[71], which had been experienced earlier in the gold rushes to the eastern states. For the Western Australian Government it provided a much needed boost to prosperity and revenue in terms of mining taxes and leases. During the late nineteenth and early twentieth century patriotic sentiment was 'specifically tied to a politically constituted state and the geographic territory over which that state exercises sovereignty'[72]. Major infrastructure projects are closely aligned with the patriotic sentiment which contributed to nation building, particularly during the federation period of 1890-1915. Completion of public works such as the Goldfields Water Supply Scheme represent a stage of national maturity. The development of the Goldfields Water Supply Scheme is an important part of the history of how Western Australia entered into federation.

O'Keefe and Pearson[73] identified Coolgardie as an important place, linked to an event, in the federation story. In 1899 the Eastern Goldfields Reform League formed to promote Goldfields separation and federation. Many of the gold diggers were from the eastern colonies and the majority, supportive of the federation movement[74] (Bastin 1955: p.76). Highly

70 (Cathcart 2008)

71 Appleyard, R T (1981): "Western Australia: Economic and demographic growth 1850-1914" in Stannage, C T, (ed) (1981): A New History of Western Australia, University of Western Australia Press, Crawley, pp220.

72 O'Keefe, B. and Pearson, M. (1998): Federation a National Survey of Heritage Places. Australian Heritage Commission, Canberra, pp.22.

73 O'Keefe, B. and Pearson, M. (1998): Federation a National Survey of Heritage Places. Australian Heritage Commission, Canberra, pp. 81. Bastin, John (1955) The Western Australian Separation for federation movement. The Australian Quarterly Vo1. 27 (1) pp.76-88.

74 Clark, M (1986): A short history of Australia: Revised illustrated edition. Penguin Books, Victoria, pp.167.

critically of the Forrest Government, including the time taken to deliver a reliable water source, the diggers proposed to separate the eastern goldfields from Western Australia. Forrest was concerned about the implications for Western Australia should it become part of the new proposed Commonwealth of Australia. Clark[75] notes that Forrest

> …'*was plagued with anxiety about goldfields radicalism and about government revenues after the loss of the right to impose customs, which in 1898 comprised nearly ninety percent of the revenue of the colony.*'

So he bargained. The Commonwealth was to facilitate the building of the railway from Kalgoorlie to Port Augusta and the eastern state would continue to pay the levy. At the referendum in 1900 forty six percent voted yes, the highest in all the colonies[76]. These large scale infrastructure projects were important in furthering the relationships between the eastern and western states. Forrest used the opening of the original Coolgardie Goldfields Water Supply, to further other nation building endeavours with the newly formed Commonwealth Government[77].

75 Clark, M (1986): A short history of Australia: Revised illustrated edition. Penguin Books, Victoria, pp.167.

76 Clark, M (1986): A short history of Australia: Revised illustrated edition. Penguin Books, Victoria, pp.168.

77 Lowe, Godfrey (2001) "The golden pipeline" in The Institution of Engineers, Australia. Federation: engineering a nation. Conference proceedings of the 11th National Conference on Engineering Heritage 8-10 October 2001 Old Parliament House, Canberra. Institution of Engineers, Canberra. pp.93-104.

Image 25: GWSS pipe and caulking machine

Source: State Library of Western Australia, 303922PD: Surveyor Philip Robinson stands on the pipe behind the caulking machine during construction of the Goldfields Water Supply Scheme, 1902, accessed 2024.

2.2.10 IMPACT ON THE ENVIRONMENT

Large increases in the population of the Coolgardie region with the discovery of gold had a dramatic impact on the arid environs. Water shortages and outbreaks of typhoid provided the impetus for a water supply scheme to be built. To construct the scheme it was necessary to clear large areas to accommodate the pipeline and provide ongoing access for maintenance. Clearing also occurred at most of the pump station and tank sites. One of the largest-scale clearings was that at Mundaring Weir (Dam) where Hartley [78] estimates that 20,000 acres (8,093 ha) of the catchment were ring-barked to improve the run off rate of water into the reservoir. This practise impacted on the quality of the water and by 1910 there was a notable increase in the salinity levels. Railway water supply engineers were not surprised, as the water had become excessively saline for use in the locomotive boilers[79]. The Pump Stations were originally designed to be powered by coal. However, in less than a year the pump stations were burning timber. The preferred source was locally available Jarrah or red gum (Marri) at Pump Stations 1, 2 and 3. From Stations No. 3 and onwards species such as Salmon gum and gimlets were sourced locally[80]. This ongoing need for fuel resulted in a local lucrative fire wood trade being established in the areas surrounding the pump stations. Land clearing around Mundaring Weir ceased in 1918 and the area allowed to re-vegetate naturally[81].

With the opening up of the areas for agriculture, land clearing continued. It is estimated that 'Today less than 5% of the natural vegetation remains' [82]. In addition WA has lost 10% of the Wheatbelt to scourge[83]. Soil salinity and the raising of saline water tables are impacting on approximately 30 towns in the Wheatbelt[84].

78 Hartley, R. G. (2007) River of Steel a history of the Western Australian Goldfields Agricultural Water Supply 1895-2003. Access Press, Bassendean, pp.340.

79 Hartley, R. G. (2007) River of Steel a history of the Western Australian Goldfields Agricultural Water Supply 1895-2003. Access Press, Bassendean, pp.203.

80 Hartley, R. G. (2007) River of Steel a history of the Western Australian Goldfields Agricultural Water Supply 1895-2003. Access Press, Bassendean, pp.203.

81 Hartley, R. G. (2007) River of Steel a history of the Western Australian Goldfields Agricultural Water Supply 1895-2003. Access Press, Bassendean, pp.207.

82 National Trust of Australia, (2001). The Golden Pipeline Interpretation Plan, Spellbound Interpretation, Baron Planning and Project, pp.28.

83 Lowe, Godfrey (2001) "The golden pipeline" in The Institution of Engineers, Australia. Federation: engineering a nation. Conference proceedings of the 11th National Conference on Engineering Heritage 8-10 October 2001 Old Parliament House, Canberra. Institution of Engineers, Canberra. pp.99.

84 Lowe, Godfrey (2001) "The golden pipeline" in The Institution of Engineers, Australia. Federation: engineering a nation. Conference proceedings of the 11th National Conference on Engineering Heritage 8-10 October 2001 Old Parliament House, Canberra. Institution of Engineers,

2.2.11 SUBSEQUENT OPERATION AND EXPANSION

Early operational experience with the pipeline was dominated by problems of corrosion. External corrosion began to appear as early as March 1905 and internal corrosion about three years later. Initially it seemed internal corrosion posed the greater threat, because it was substantially increasing the friction head which in turn placed extra load on the pumping stations. The first attempt to counter the problem of internal corrosion was to add lime to the water, and a plant for this purpose was constructed at Pumping Station No. 1 in 1910[85].

The lime treatment was not successful and in 1917 it was replaced by de-aeration treatment which removed dissolved oxygen from the water. A plant for this purpose was installed, again at Pumping Station No 1. This system of de-oxygenation brought the internal corrosion under control.

In the meantime the problem of external corrosion increased rapidly with more than 4,000 rust holes being repaired in 1921. This number had doubled by 1928 and the wastage of water was by then an issue of major concern [86]. In the late 1920s two engineers, Norman Fernie and Reg Keating, from the Northam District Office of the PWD commenced a thorough investigation of the external corrosion problem in the locking bar pipes. Fernie and Keating could see no practical alternative other than to lift the pipeline and re-lay it above ground. This operation was a major technical development which was widely copied elsewhere. It placed the Goldfields Water Supply Scheme among the world leaders in pipeline technology for the second time in less than 40 years[87].

By 1930 it was becoming widely recognised throughout the water industry that a relatively thin lining of cement mortar applied in the factory by a centrifugal spinning process would effectively eliminate internal corrosion. The locking bar pipes presented difficulties for the centrifugal spinning process, however experiments in the field enabled the development of a satisfactory process whereby a lining of sand cement mortar could be applied to the interior of the pipes during the raising and re-laying process. The reconditioning of the buried pipeline commenced in 1933 with priority being given to the sections where external corrosion was most severe. By the time the work was halted in 1941 (due to labour shortages caused by World War II) the major problem of leakages had been brought under control[88] .

The refurbishing of the pipeline in 1933 included a new method of lifting the pipeline out of the ground and relaying it above ground. The method involved lifting the pipes out of the ground, trimming-off the corroded end sections of the pipes, and replacing the flexible lead joints with rigid welded joints forming what was known as a 'continuously welded pipeline'. The outside of the pipe was recoated and painted with a sun-reflecting paint. During the pipeline reconstruction, the expansion forces were directed into reinforced concrete anchor blocks built over the pipe at 50 metre intervals, which prevented movement and transferred these forces into the ground. Although today such anchor blocks are familiar features of all above ground pipelines in Australia this was the first time anywhere in the world that pipe anchorages of this type had been used to permit such a large diameter pipeline to be laid above ground in such adverse conditions[89].

The 1930s refurbishment of the pipeline also involved another innovation, the large scale use of wood stave pipes. During the depression of the 1930s, steel was in short supply and sections of the pipeline were in need of repair. It was decided that timber stave pipes would provide a viable alternative given the lack of steel. Oregon timber had been used previously in a 33 chain (0.66 kilometres) long by-pass of the Coolgardie Reservoir in 1912 [90]. Between 1933 and 1937 a distance of 39 miles 30 chains of wooden stave pipes, in fluorised Karri (some were later replaced by Jarrah), were a laid between Kellerberrin and Kalgoorlie. Hartley [91] reports that it was

> *"...laid in a series of above ground diversions to the main conduit so that the 30 inch locking bar pipes which they replaced could be refurbished and relaid above ground in other sections of the main conduit as part of the continuously welded pipeline".*

It was the most extensive use of wooden pipes in Australia at the time [92] in a country water supply scheme.

In his report of I7 July 1896, O'Connor had stressed the importance of the pipeline for the development of agriculture, and soon after the scheme became

Canberra. pp.99.

85 (Trust News 2001: Vol 210 p.8)

86 (Trust News 2001: Vol 210 p.8)

87 (Trust News 2001: Vol 210 p.9)

88 (Trust News 2001: Vol 210 p.9)

89 Hartley, R G (2000): 'A Century of Water Supply to the Western Australian Goldfields and Wheatbelt from Mundaring Weir and the Kalgoorlie Pipeline', in Early Days, Journal of the Royal Western Australian Historical Society, Vol 11, Part 6, Nedlands, pp.736-737.

90 Hartley, R. G. (2007) River of Steel a history of the Western Australian Goldfields Agricultural Water Supply 1895-2003. Access Press, Bassendean, pp. 246.

91 Hartley, R. G. (2007) River of Steel a history of the Western Australian Goldfields Agricultural Water Supply 1895-2003. Access Press, Bassendean, pp. 247.

92 Hartley, R. G. (2007) River of Steel a history of the Western Australian Goldfields Agricultural Water Supply 1895-2003. Access Press, Bassendean, pp. 246-247.

operational water services were provided to properties adjoining the pipeline. In 1907 a branch main was constructed to serve farmlands north of Tammin and this demonstrated the value to farmers of an assured water supply for stock and domestic purposes. By 1910 it was obvious that the capacity of the Scheme was greater than was required on the goldfields and the Goldfields Water Supply Act was amended to allow farming properties to be rated for the purpose of supplying water for stock and domestic purposes [93]. By 1928 the total area of farmland being serviced had increased to approximately 1 million acres (404,685 hectares). The pipeline was now operating to full capacity and the area of rated farmland had to be held at this size until after World War II [94].

In 1948 the Commonwealth Government agreed to provide financial support to Western Australia for construction of a Comprehensive Agricultural Areas Water Supply Scheme. The northern section of this scheme was based on the existing Goldfields Water Supply system and provided for a reticulated water supply to towns and farmlands over an area of 4 million acres (1,618,742.5 hectares) as far north as Koorda and Bencubbin [95].

In 1951 increased storage was provided by raising the wall of Mundaring Weir by 32 feet (10 m) which trebled the Weir's holding capacity. The enlargement of the dam wall involved the placing of 80,000 cubic yards (61,164 cu metres) of concrete and cost £720,000 [96]. The line of the vertical upstream face of the wall was not altered, however, the wall was thickened by some 40 feet (12 m) at the base and a new sloping downstream face was created. The heritage value of Weir was recognised, and accordingly great care was taken to reproduce the style from the Victorian period that had characterised the appearance of the original structure. The original footwalk across the crest of the weir was salvaged and reused, and the control tower in the centre of the wall was faithfully reconstructed to the same design as the original [97].

A substantial upgrade of the original 30 inch (76 cm) pipe line was also undertaken and the original steam pumping stations were replaced with high powered electric pumps. Branch mains were laid north and south from the main pipeline, to reservoirs which were constructed on highest points in the area. From these tanks water was distributed to the surrounding areas by gravity[98]. A ceremony to mark the completion of the Comprehensive Water Supply Scheme was held on 24th November 1961. However, these mains were subsequently extended to the townships of Dalwallinu, Pithara, Ballidu and Corrigin. Later again, four small areas of northern farmlands were included at Kalannie, North Koorda, north Bencubbin and Wilgayne. All work on the Comprehensive Water Supply Scheme was finally completed in 1974[99].

Today the Pipeline is operated by the WA Water Corporation. It is the Corporations largest asset and the basis of billions of dollars of annual economic activity. Approximately 10,000 services are provided within the agricultural area and the eastern goldfields through 8,000 km of pipelines and over 40 pumping stations[100].

93 (Trust News 2001: Vol 210 p.9)

94 (Trust News 2001: Vol 210 p.9)

95 (Trust News 2001: Vol 210 p.11)

96 (Trust News 2001: Vol 210 p.12)

97 (Trust News 2001: Vol 210 p.12)

98 (Trust News 2001: Vol 210 p.11)

99 (Trust News 2001: Vol 210 p.11)

100 MHI (2008) Water Pipeline and Mt Charlotte Reservoir – Place No, 203. City of Kalgoorlie-Boulder Municipal Heritage Registry.

Image 26: Digging a trench to lay pipes for the GWSS

Source: State Library of Western Australia, 025588PD: Digging a trench to lay pipes for the Goldfields Water Supply Scheme, ca. 1902.

2.2.12 INDIGENOUS ASSOCIATION

The Goldfields Water Supply Scheme extends from Mundaring to Kalgoorlie in Western Australia, and traverses the traditional lands of Aboriginal people who identify themselves as Noongar (also referred to as Bibbulmun by Bates in 1904), Ballaruk, Ballardong, Gubrun, Kalamaia Kubun, and Widji[101]. Noongar was the Bibbulmun word for man[102].

Aboriginal occupation in the south-west of Western Australia dates to 47,000 years BP (before present) at the Devils Lair rock shelter [103]. Other sites in the south-west with early occupation dates include the Upper Swan, (38,000 years BP) and a Helena River site above Mundaring Weir, (29,400 years BP). The Helena River provides evidence of continual use to the present day with seasonal camps and a permanent camp site[104]. There is also evidence of artefact manufacture occurring in the Mundaring Dam area 4,000 -1,000 years BP[105].

The Western Australian Department of Indigenous Affairs[106] identifies numerous Aboriginal sites in close proximity to the Goldfields Water Supply Scheme pipeline. The highest densities of sites occur at the beginning of the pipeline at Mundaring Dam and Helena River, at Northam, about eighty kilometres from Mundaring, and at Coolgardie and Kalgoorlie at the end of the pipeline. As a result of environmental disturbances associated with the building of the pipeline and earlier infrastructure, many Aboriginal sites have been disturbed. The greatest environmental impact occurred at the beginning of the pipeline, at the Mundaring Dam.

Many sites along the pipeline are of ongoing significance to Aboriginal people who visit them regularly today. Aboriginal sites identified on the pipeline include corroboree grounds and soaks associated with trade routes, wells, granite outcrops, birthing rocks on the Avon River at Northam, cave and rock paintings near Kellerberrin and a number of secret/sacred sites [107]. Webb[108] notes concerns that few of the water sources on Hunts Track have been recorded as Aboriginal sites, and more generally, with the accuracy of site locations and the lack of a systematic archaeological survey of Noongar Aboriginal sites and complexes; including rock art sites.

The West Australian Government employed Daisy Bates to research the Aboriginal tribes of the state. Bates' research was used as evidence in the Single Noongar Native Title application of 2006 to verify they were originally one group.

> *"Bates' material comprises the largest available corpus of information dealing with the Aborigines of the Perth region obtained at least partly from people who were alive in the early years of European settlement ... the first really serious ethnography for any part of the south-west... The cumulative effect of these writings is to provide an insight into Aboriginal life, including Aboriginal laws and customs, in and about the date of settlement, which is possibly not replicated elsewhere in Australia[109]."*

At the time of building the pipeline, two Aboriginal groups inhabited the three hundred and thirty miles it traversed. The Bibbulmun lived on the west coast, from Jurien Bay to Perth and Esperance and west as far as Kellerberrin. The Karatjibbin occupied land from Mt Jackson in the north through the Southern Cross district including Kalgoorlie[110]. The border between the two groups divided the circumcised from the non-circumcised southwest, crossing the pipeline at around Mooranoppin/ Kellerberrin.

Trade existed between the two groups in tools, raw materials and women with adjustments to in-law relationships to accommodate the two groups[111].

> *"They used to induce the Bibbulmun to give their boys for initiation though the circumcised group never gave any in return. ...These young boys grew up and married in their adopted groups, and as young men, and later as fathers and grandfathers they returned to the Bibbulmun" [112].*

101 National Native Title Tribunal, (2009). South West Native Title and Determination Areas as per the Federal Court 31/12/08 viewed on 16 Jan 2009, http://www.nntt.gov.au/Publications-And-Research/Maps-and-Spatial-Reports/Documents/Quarterly%20Maps/WA_Sth-West_NTDA_schedule.pdf

102 Bates, D (1985). The Native Tribes of Western Australia, edited by Isobel White, National Library of Australia, Canberra.

103 Dortch, J (2001). Thesis abstract: Palaeo-Environmental Change and the Persistence of Human Occupation in the South-Western Australian Forests. Australian Archaeology vol 53, Dec 2001:52-53.

104 Schwede, M (1983). Supertrench – phase two: a report on excavation, Western Australia Museum, Perth.

105 Villiers, L (2007). Report of an Archaeological Survey for Aboriginal Sites in the area of Proposed Water Treatment Plant and Associated Infrastructure at Mundaring Western Australia, Australian Interaction Consultants.

106 Doherty, L (2000) 'Gravity dams', in Cole, B (ed) (2000) Dam technology in Australia 1850-1999. Australian National Committee on Large Dams Inc, Penrith.

107 National Trust of Australia, (2001). The Golden Pipeline Interpretation Plan, Spellbound Interpretation, Baron Planning and Project.

108 Webb, E (2004). Re-recording culturally significant Aboriginal sites in south-western Australia as a guide to Noongar usage of the region in the past, Preliminary report, Rock Art Research, Vol 21, no.1, 93-97.

109 Indigenous Law Bulletin, (2006). Bennell v Western Australia [2006] FCA 1243 (19 September 2006), Statement of Justice Wilcox, viewed on 2 Feb 2009 http://www.austlii.edu.au/cgi-bin/sinodisp/au/cases/cth/FCA/2006/1243.html?query=Nyungars

110 Bates, D (1985). The Native Tribes of Western Australia, edited by Isobel White, National Library of Australia, Canberra.

111 Ibid.

112 Bates, D (1929). Unnamed article, Sunday Times in MS 865/45/88/759, National Library of Australia.

Bates recorded thirty to forty Bibbulmun living on the first Aboriginal reserve

> *"...for old and infirm natives of the Southern district"[113]*

set up by Premier John Forrest in the 1890's. Maamba Reserve was a 100-acre fertile plateau on Bibbulmun land at the foot of the Darling Ranges, approximately twelve kilometres east of the Mundaring Dam and included a 'splendid' spring and camping ground called Goooininup [114].

Bates lived at the reserve for two years with the Bibbulmun who relied on government rations but lived a semi-traditional lifestyle. She recorded information from Joobaitch, an 80 year old Bibbulmun man who died on the reserve near his sacred Kaanya tree [115].

> *"He had parted with the whole site of the present Mundaring Weir, and both sides of the Swan River from beyond Perth Guildford to Perth Water, for some special meat food which pleased him in his old age" [116].*

Corroborees or kenings were held at Maamba, including one for Governor and Lady Bedford. The last Bibbulmun corroboree Bates recorded at Maamba was in 1910 and included men for Kellerberrin, Gingin, Victoria Plains, Southern Cross, Guildford and Bunbury[117].

At the head of the pipeline, the Mundaring area is a highly significant and sensitive mythological area. The Mundaring (Mundjalline) myth links the Helena River (Mandoon) east via Mundaring to the Swan River and west to York[118]. The most important totem was the snake Woggal, also known as Waugyl/Waugal [119]. The DIA listing of the Helena River

> *"as a ceremonial and mythological site ... is consistent with the significance attributed to all waterways as having been created and inhabited by the primary Ancestor beings associated with the Creative Era, in this case the Waugyl[120]. "*

Bates details physical landscape features such as strewn rushes, lime and saltpans that denote the life cycle of the Woggal and associated sacred sites. Villiers[121] also notes the presence of the Woggal at Mundaring:

> *"The swamp and pools know as Mundjalline according to tradition, were located in a deep valley that has been inundated as a result of the construction of the Mundaring Weir...A powerful Waugal associated with rainmaking lived here. Disturbance of the swamp reeds at Mundajalline resulted in cyclonic winds and rain..."*

Bates describes sites with reed disturbance as sacred Woggal camping places. She refers to a Helena River site called Beeragunning as a sacred (Janga) split rock, surrounded by reeds that Aboriginal people could walk through but became ill and died if they touched it or it closed up on them. A myth associated with another sacred stone marked with stick-like indentations at Dargain, in the Helena River area was also recorded by Bates [122].

Aboriginal people and their water supply were impacted by several events prior to the building of the pipeline. These included diseases, explorers and the building of infrastructure prior to and during the gold rushes. Typhoid fever associated with poor sanitation, cramped conditions and lack of water was rife in Western Australia in the late 1800s[123].

Access to water was essential for survival in the semi-arid zone of south-west West Australia. In relation to the expansion of European settlement Hallam notes [124]

113 Bates, D (1909). Two Years in a Native Camp, Woman magazine, in MS865/44/88/759, National Library of Australia.

114 Ibid

115 Bates, D (2004). My Natives and I, edited by PJ Bridge, Carlisle, West Australia.

116 Bates, D (1985). The Native Tribes of Western Australia, edited by Isobel White, National Library of Australia, Canberra, pp.64.

117 Bates, D (1985). The Native Tribes of Western Australia, edited by Isobel White, National Library of Australia, Canberra, pp.64.

118 Villiers, L (2007). Report of an Archaeological Survey for Aboriginal Sites in the area of Proposed Water Treatment Plant and Associated Infrastructure at Mundaring Western Australia, Australian Interaction Consultants.

119 Bates, D (1985). The Native Tribes of Western Australia, edited by Isobel White, National Library of Australia, Canberra, pp.64.

120 Villiers, L (2007). Report of an Archaeological Survey for Aboriginal Sites in the area of Proposed Water Treatment Plant and Associated Infrastructure at Mundaring Western Australia, Australian Interaction Consultants, pp.13.

121 Villiers, L (2007). Report of an Archaeological Survey for Aboriginal Sites in the area of Proposed Water Treatment Plant and Associated Infrastructure at Mundaring Western Australia, Australian Interaction Consultants, pp.17.

122 Bates, D (1985). The Native Tribes of Western Australia, edited by Isobel White, National Library of Australia, Canberra, pp.64.

123 Wittington, V (1988). Gold and Typhoid: Two fevers: a social history of Western Australia, 1891-1900, University of Western Australia Press, Nedlands, Western Australia.

124 Hallam, S (1979). Fire and Hearth, a study of Aboriginal usage and European usurpation in south-western Australia, Australian Aboriginal Studies No 58, AIATSIS, Canberra.

> *"...water supplies dictated that European movement and settlement must follow Aboriginal movement and settlement in Western Australia also. Bidi and Gongan, zones of easiest and habitual movement between water sources, were as basic to European as to Aboriginal ecology... 'Native wells' and 'native paths' marked their regular progress through and around their own country."*

Aboriginal people have rights to water in their territory.

> *"Every Aboriginal knows the rocks, soaks, springs and anything that gives water on their hunting grounds[125]."*

Non-Aboriginal people were often unaware of traditional water sources until shown by Aboriginal people[126]. Aboriginal people disclosed their sources either willingly, through coercion or as a result of force, as detailed by one early gold explorer.

> *"Sorry as I was to be rude to a lady, I had to make her prisoner, but not without a deal of trouble... I felt myself justified, therefore, in unceremoniously making captives from what wandering tribes we might fall in with. And in light of after events I say unhesitatingly that, without having done so, and without having to a small extent used rough treatment to some natives so caught, we could not by any possibility have succeeded in crossing the desert, and should not only have lost our own lives, but possibly those of others who would have made search for us after[127].."*

In the 1860s Charles Hunt, a government surveyor, modified traditional water sources to receive and store rainwater to supply seasonably reliable water to expand European settlement. In 1863, the Gnarlbine Soaks at Coolgardie were disclosed by Kowitch, an Aboriginal assistant to M H Lefroy's expedition, and were later incorporated into Hunts Track[128]. The Goldfields Pipeline followed the route of previously installed infrastructure including road, rail and telegraph which roughly followed Hunt's Track.
Bates [129]also noted that

> *"...most of the 'roads' of these tribes (including eastern goldfields) run 'erratically' east and west for a considerable distance, but not very far north and south".*

The absence of artesian water sources and unacceptable salt levels in ground water meant traditional sources of Aboriginal water were co-opted to supply not only huge numbers of European settlers but horses, camels and industry. As populations grew, Aboriginal water sources and bore water condensers were insufficient to meet demand.

The preparation work for the six-mile long, 4.6 billion gallon Mundaring Dam began in June 1898. Three hundred men and their families living on site supplemented their food by fishing, kangaroo hunting and collecting wild honey, staples for the local Aboriginal people. Eight hundred acres of land was completely cleared with two hundred acres of the lower catchments ringbarked and the riverbed cleared and burnt. A thousand cubic metres of local sand was used in the weir wall[130].

Fifty miles along the pipeline, the town of Northam became the manufacturing centre and food producer for the goldfields. Burlong Pool, a DIA registered mythological site and important Aboriginal water source, was turned into a camping ground for railway contractors, including their horses and camels [131]. The last recorded corroboree took place in 1899 at the Northam Government Well, which later became the Northam Aboriginal Reserve. At that time, the desperate state of the local Aboriginals was documented.

> *"The hundred who gathered on that occasion were near starving, and the children sick and miserable from want of food and clothing"[132].*

Northam was connected to the unfinished pipeline in 1902 due to a very hot summer and typhoid infected local water sources.

At Coolgardie towards the end of the pipeline, Aboriginal people were desperate for water and not receiving help from the local Council who saw it as a State government issue[133]. Deaths due to typhoid peaked in Coolgardie during 1896-7. Tickenbutt, an Aboriginal man also known as Fred McGill, wrote to

125 Bates, D (1985). The Native Tribes of Western Australia, edited by Isobel White, National Library of Australia, Canberra, pp.262.

126 Bates, D (1913). Aboriginal names of Places, Science of Man, in MS865/44/88/759, National Library of Australia; Carnegie, D (1897). Spinifex and Sand, viewed on 15 January 2009 http://freeread.com.au/ebooks/e00042.html#p1c1
Carnegie, D (1897). Spinifex and Sand, viewed on 15 January 2009 http://freeread.com.au/ebooks/e00042.html#p1c1

127 (Carnegie 1871)

128 Heritage Council of West Australia, Register of Heritage Places, viewed on 9 Feb 2009
http://register.heritage.wa.gov.au/PDF_Files/G%20Reg/Gnarlbine%20Soaks%28P%29.PDF

129 Bates, D (1909). Two Years in a Native Camp, Woman magazine, in MS865/44/88/759, National Library of Australia.

130 Quicke, E (1978). Mundaring Weir among the hills, Belmont, WA.

131 Garden, D (1979). Northam: an Avon Valley history, Oxford University Press, Melbourne (pp137-163).

132 Garden, D (1979). Northam: an Avon Valley history, Oxford University Press, Melbourne (pp56).

133 Wittington, V (1988). Gold and Typhoid: Two fevers: a social history of Western Australia, 1891-1900, University of Western Australia Press, Nedlands, Western Australia.

the Kalgoorlie Miner newspaper complaining of the unavailability of water for independent Aboriginal people who could no longer get it from their traditional sources, as rations or from bore water condensers. Some people were more generous, one miner set up a small condenser for Aboriginal people who had helped his family[134].

> *"The local Aboriginal contribution to the developments of the Goldfields cannot be ignored. It is well known that Aboriginal people led explorers and miners to both water and gold"[135].*

Carnegie exploring the area from Lake Darlot to Halls Creek and return in 1896-97 was also assisted by Aboriginal people.

> *"Throughout our journey we never once found water by chance—though chance took us to more than one dry hole—but found it only by systematic and patient work, involving many scores of miles of tracking, the capture of the wild Aboriginals, and endless hours of manual labour"[136].*

It is unknown how many Aboriginal people worked on the pipeline or with associated contractors. A large part of the work for the pipeline was undertaken by the West Australian Public Works Department. Photographic evidence identifies an Aboriginal man working on the pipeline with a non-Aboriginal team[137]. Numerous photos portray Aboriginal people from Coolgardie and Kalgoorlie in a variety of roles including accompanying explorers and working, for example as a butcher, a miner and police assistant.

These photos also depict Aboriginal people attending church-sponsored Christmas dinner and interactions with non-Aboriginal people including taking part in mainstream sporting events and processions in the townships[138].

Developments along the pipeline depleted Aboriginal people's traditional food and water sources through over use, carelessness or greed[139]. Aboriginal people chose or were forced to move into settlements including reserves. If they maintained their independence, they were expected to purchase water from the pipeline[140] [141], be recompensed with water for services rendered or rely on the kindness of others[142]. As one Kalgoorlie resident commented:

> *"The blacks are in a bad way just now…It's a pity something can't be done to help them, water being so scarce just now, all the soaks and gnamma holes are just about dry…so you see the poor blacks are robbed of their water. It's cruel" [143].*

134 Wittington, V (1988). Gold and Typhoid: Two fevers: a social history of Western Australia, 1891-1900, University of Western Australia Press, Nedlands, Western Australia, pp. 63.

135 Wyatt, B (2006). From cycles of dispossession and conflict to accommodation and partnership: some reflections on history and the contemporary cycle, Minerals Council of Australia Sustainable Development Conference.

136 Carnegie, D (1897). Spinifex and Sand, viewed on 15 January 2009 http://freeread.com.au/ebooks/e00042.html#p1c1

137 National Trust of Australia, (2001). The Golden Pipeline Interpretation Plan, Spellbound Interpretation, Baron Planning and Project.

138 Templeman, I & McDonald, B (1988). The fields: the Kalgoorlie and Coolgardie goldfields, 1892-1912, Fremantle Arts Centre Press, Fremantle; Wittington, V (1988). Gold and Typhoid: Two fevers: a social history of Western Australia, 1891-1900, University of Western Australia Press, Nedlands, Western Australia.

139 Wittington, V (1988). Gold and Typhoid: Two fevers: a social history of Western Australia, 1891-1900, University of Western Australia Press, Nedlands, Western Australia; Carnegie, D (1897). Spinifex and Sand, viewed on 15 January 2009 http://freeread.com.au/ebooks/e00042.html#p1c1

140 Templeman, I & McDonald, B (1988). The fields: the Kalgoorlie and Coolgardie goldfields, 1892-1912, Fremantle Arts Centre Press, Fremantle; Wittington, V (1988). Gold and Typhoid: Two fevers: a social history of Western Australia, 1891-1900, University of Western Australia Press, Nedlands, Western Australia.

141 Wittington, V (1988). Gold and Typhoid: Two fevers: a social history of Western Australia, 1891-1900, University of Western Australia Press, Nedlands, Western Australia; Carnegie, D (1897). Spinifex and Sand, viewed on 15 January 2009 http://freeread.com.au/ebooks/e00042.html#p1c1

142 Wittington, V (1988). Gold and Typhoid: Two fevers: a social history of Western Australia, 1891-1900, University of Western Australia Press, Nedlands, Western Australia; Carnegie, D (1897). Spinifex and Sand, viewed on 15 January 2009 http://freeread.com.au/ebooks/e00042.html#p1c1

143 Templeman, I & McDonald, B (1988). The fields: the Kalgoorlie and Coolgardie goldfields, 1892-1912, Fremantle Arts Centre Press, Fremantle, pp. 53.

2.3 THEMATIC FRAMEWORK

2.3.1 HISTORIC THEMES

As an outstanding technical achievement and a major community asset, the GWSS and the people associated with it have been the subject of several books and other research.

This section has been prepared using the themes developed for *'A Thematic History of Western Australia'* prepared by Clare Menck and published by the Heritage Council of Western Australia in 2022 [hereafter Menck, 2022]. Within the context of the history of Western Australia, this section aims to provide a general overview of the GWSS rather than a comprehensive time-line of developments.

No new primary sources have been researched during the preparation of this section. Information has been based on existing heritage assessments, conservation plans (prepared by the Research Institute for Cultural Heritage in 1999/2000), the *2016 HMP* (HMP) and the 2022 review of the 2016 HMP and the *'Stories in the Pipeline'* project completed by H+H Architects in 2023 [hereafter H+H, 2023]. Some sections have been reproduced from the Australian Heritage Council's (AHC) National Heritage List, place 106007 [hereafter NHL].

As information has been summarised from these reports, usual referencing conventions (i.e. footnotes) have not been employed. The aim has been to provide sufficient information from which to develop the arising conservation policies rather than provide an exhaustive history of the Goldfields Pipeline.

The predominant historical themes identified arise from the existing evidence and no new historical material or values has been discovered. The thematic framework engages with broad stories of the pipeline and forges 8 main categories below:

These eight categories can be further split into a variety of themes to further characterise the GWSS storyline.

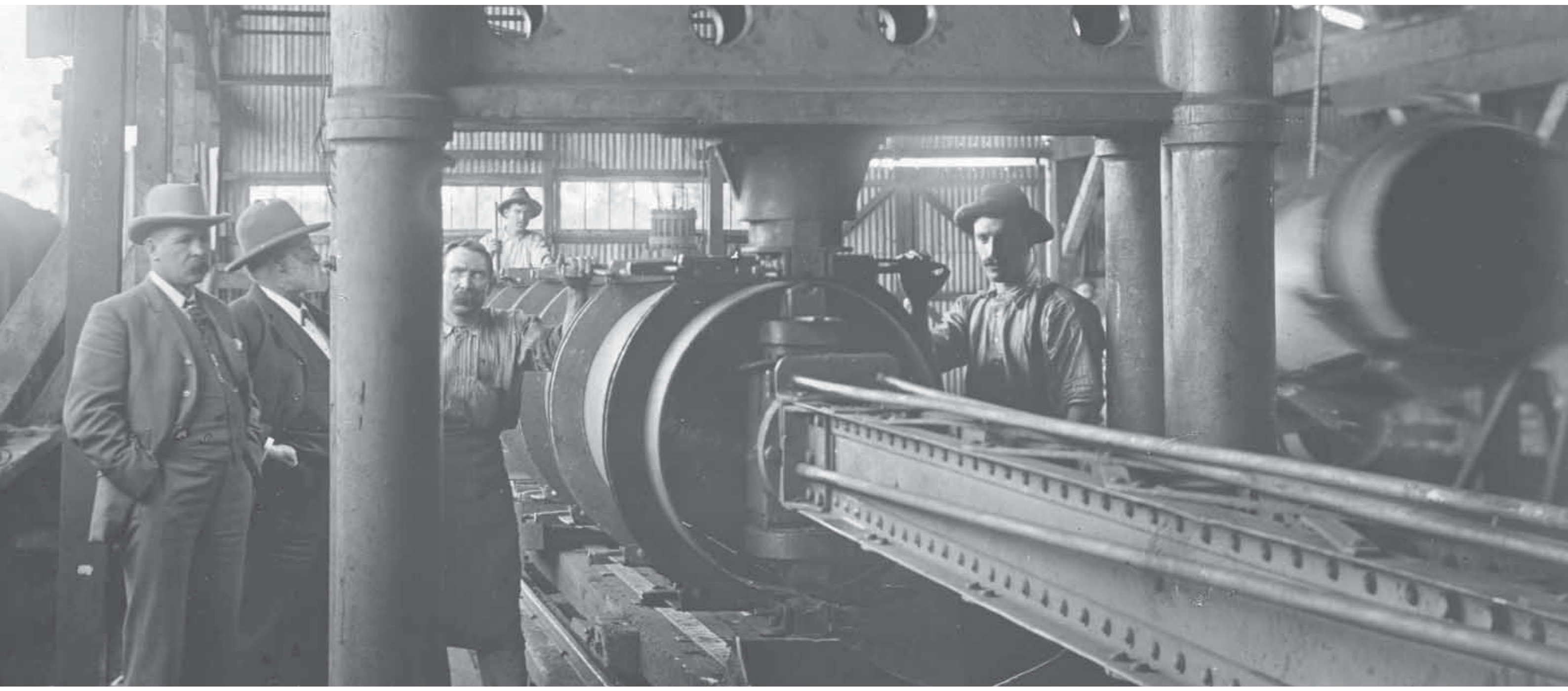

Image 27: Closing the Locking Bars on the 30" Pipe

Source: State Library of Western Australia, 013549D: Closing the Locking Bars on the 30" Pipe, 1901, accessed 2024.

2.3.2 OVERVIEW OF THEMES

1. ENVIRONMENT

2. PEOPLING WA
- Colonisation
- Demographic Development

3. ECONOMY
- Rural Occupations
- Natural Resources
- Mining and Mineral Resources
- Manufacturing and Secondary Industry
- Commerce
- Workers and Working

4. INFRASTRUCTURE
- Development of Settlement and Services
- Transport and Communications

5. SOCIAL SERVICES
- General Social Services
- Education
- Health

6. GOVERNING
- Government and Politics
- Law, Order and Defence

7. CULTURAL LIFE
- Religion
- Recreation – Arts, Culture and Entertainment
- Recreation – Sport
- Domestic Life

8. INTERNATIONAL LINK

2.3.3 SUMMARY OF THEMES

Table 3.0: Summary of Historical Themes of the GWSS

ENVIRONMENT	PEOPLING WA	ECONOMY	INFRASTRUCTURE
SOCIAL SERVICES	GOVERNING	CULTURAL LIFE	INTERNATIONAL LINKS

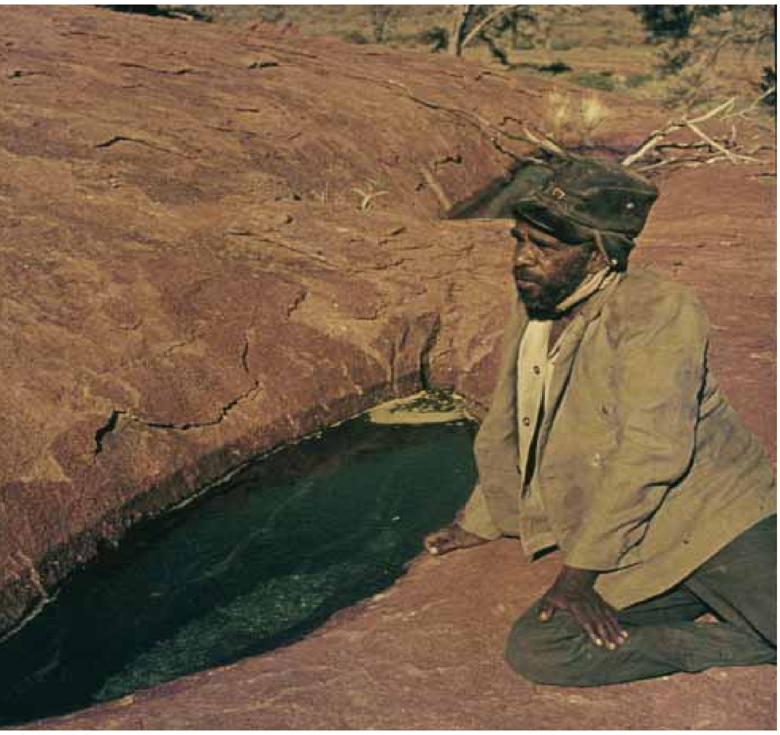

Image 28: Aboriginal man by a water hole in rock

Source: Courtesy of the State Library of Western Australia, 148653PD, Aboriginal man by a water hole in rock, possibly in the Goldfields, Western Australia, ca. 1965.

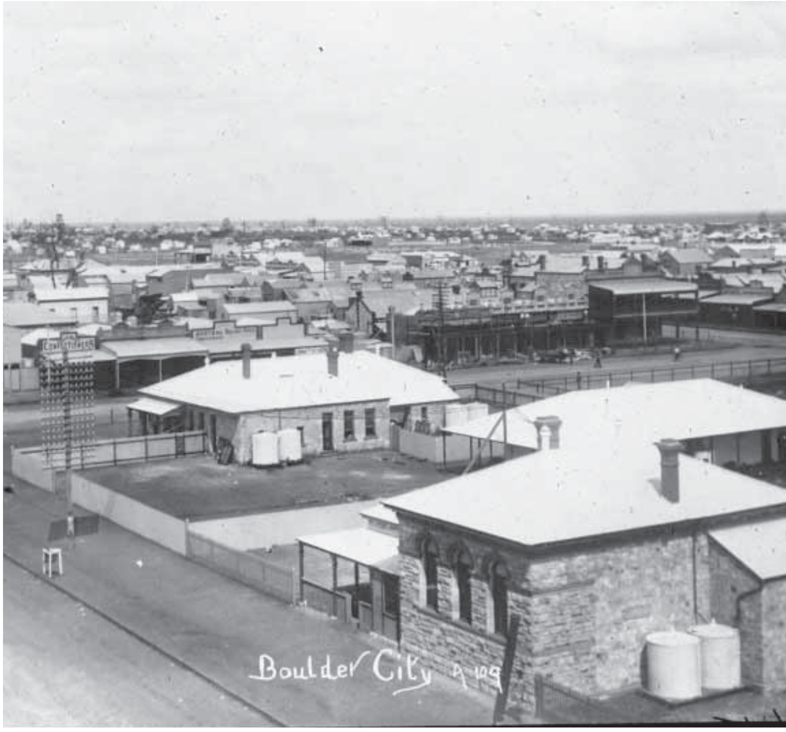

Image 29: Boulder Courthouse

Source: courtesy of the State Library of Western Australia, 090459PD Boulder City, 1902.

2.3.4 ENVIRONMENT

The GWSS relates to the theme of discovering water within aboriginal and post settlement stories. These stories contain information about finding water sources in the Kalgoorlie region. Many of the locations are mentioned in Dreaming stories at gnamma holes, soaks and springs. Many of the traditional waterholes were destroyed during operation, and some traditional water sources were expanded to house additional water required to expand settlements, particularly in rural areas. There was also considerable destruction of the natural environment to provide energy to the various pumps along the main conduit. This resulted in a clearing of natural forest surrounding the water pumps.

2.3.5 PEOPLING WA

Aboriginal persons long occupied the space that is now known as the goldfields. After settlement, the expansion Perth began, particularly, the Avon Valley. For most of the nineteenth century, population of the area between the Avon Valley and what is now the eastern goldfields was sporadic. From the early 1890s, discoveries of gold in the eastern goldfields led to a substantial increase in population in the various towns. The GWSS then allowed the agricultural use of these towns and their subsequent agricultural industries to flourish, resulting in increases of populations in rural areas which was not possible before, due to drought and low rainfall. Additionally, Many people who worked on the Comprehensive Water Supply Scheme after World War II were displaced persons from Europe who emigrated to Australia for a new beginning after the war[144].

144 Stories in the Pipeline, H +H Architects, 2023, p. 48

Image 30: Londonderry Gold Mine

Source: Courtesy of the State Library of Western Australia, 090459PD
Londonderry Gold Mine, featuring gold storage hut, near Coolgardie, 1894.

2.3.6 ECONOMY

The GWSS provided water services to the goldfields and was instrumental in the economic boom associated with mining. This continuous water supply service was instrumental in farming, particularly in producing crops serving Western Australia's farming industry in the region from 1910 to today. In 1948, the Commonwealth afforded additional financial support to expand the scheme for agricultural use.

The GWSS's water service is instrumental in mining and will require upgrades to meet the demands of the mining and resource industry. Initially, the GWSS serviced locations for the mining and extraction of gold. In recent years, this included mining for iron ore and other non-precious metals.

Image 31: The Goldfields Water Supply Scheme pipeline

Source: Courtesy of the State Library of Western Australia, 090248PD, The Goldfields Water Supply Scheme pipeline, 1936

2.3.7 INFRASTRUCTURE

For a decade, the facilities at Kalgoorlie and Coolgardie rivalled coastal centres and the infrastructure was built rapidly over 30 years. The eight pump stations also served as substantial infrastructure in their own right.

> *"By 1910 it was obvious that the capacity of the Scheme was greater than was required on the goldfields and the Goldfields Water Supply Act was amended to allow farming properties to be rated for the purpose of supplying water for stock and domestic purposes. By 1928 the total area of farmland being serviced had increased to approximately 1 million acres (404,685 hectares) and held this size until after World War II. In 1933, the main conduit was raised and wood stave pipes installed. The northern section of this scheme was based on the existing Goldfields Water Supply system and provided for a reticulated water supply to towns and farmlands over an area of 4 million acres (1,618,742.5 hectares) as far north as Koorda and Bencubbin [145]."*

In 1951 increased storage was provided by raising the wall of Mundaring Weir by 32 feet (10 m) which trebled the Weir's holding capacity.

> *"Water schemes expanded settlement in the post-war years. The Comprehensive Agricultural Areas Water Supply Scheme, completed over nearly 30 years and covering most of the Wheatbelt by 1974, particularly facilitating expansion to the north and east."[146]*

145 Appendix A- Australian Heritage Database Entry

146 A Thematic History of Western Australia, Heritage Council of Western Australia, Clare Menck, 2022. p 40.

Image 32: Kalgoorlie railway opening

Source: Courtesy of the State Library of Western Australia, BA597/18, Kalgoorlie railway opening, "Ministerial Special" at Hines Hill, 1896.

2.3.8 TRANSPORT AND COMMUNICATIONS

The Perth- Coolgardie railway line was completed in March 1896 and the extension to Kalgoorlie opened in September 1896. To enable railway construction, modifications to several natural water sources, such as at Karralee Rocks, were made[147].

The GWSS pipeline largely followed the line of the railway as the existing infrastructure was used to transport the pipes and other items required for its construction[148].

> *"In the 1900s, government funding prioritised rail. Government railways more than double, mostly in the Wheatbelt. The transcontinental railway was completed in 1917[149]."*

Like the railway (subsequently Transcontinental Railway) and the pipeline, the main road to Kalgoorlie followed much of the original line of Hunt's mapping of water sources during the nineteenth century[150] .

From the 1930s onwards, people's connection to the pipeline along the route between Mundaring and Kalgoorlie was experienced more by road than by rail.

147 Stories in the Pipeline:preserving Goldfields Pipeline Heritage, H + H Architects, 2023, p.14.

148 Appendix A- Australian Heritage Database Entry

149 A Thematic History of Western Australia, Heritage Council of Western Australia, Clare Menck, 2022. p.47.

150 Stories in the Pipeline:preserving Goldfields Pipeline Heritage, H + H Architects, 2023, p.13.

Image 33: Eastern Goldfields Methodist Sunday School

Source: Eastern Goldfields Methodist Sunday School, May Lang, 1908, Courtesy of the State Library of Western Australia, 233169PD: Sunday school group,1908.

Image 34: Record Poll for Federal Poll

Source: Courtesy of the State Library of Western Australia, 009979PD: Record board for the federal poll, 31 July 1900.

2.3.9 SOCIAL SERVICES

The completion of the Goldfields Water Supply Scheme as a public work represents a stage of national maturity. With the increased population arising from the gold boom and particularly the influx of migrants from eastern colonies, expectations about the provision of education rose. Schools were established in the eastern goldfields as mining towns developed. The largest typhoid epidemic in Australian history resulted. Typhoid was the colony's biggest killer for over a decade until the construction of water supply systems curtailed it by 1910. Charitable nursing was also established, especially religious-based services[151] [152].'

2.3.10 GOVERNING

The GWSS was constructed during a time of great change in Western Australian political systems.

> *"Responsible Government was granted in 1890. A bicameral parliament met from 1891, with factions rather than political parties. Electoral boundaries favoured northern and country districts, with goldfields electorates added from 1893[153] ."*

Influenced by migrants from the eastern colonies, the colony voted 'yes' to Federation. Western Australia became a founding state of Australia in 1901[154]. The introduction of the Aborigines Act in 1905 had a significantly adverse impact on the quality of lives of Aboriginal people along the pipeline.

151 A Thematic History of Western Australia, Heritage Council of Western Australia, Clare Menck, 2022. p.58.

152 Stories in the Pipeline: Preserving Goldfields Pipeline Heritage, H + H Architects, 2023, p.18..

153 A Thematic History of Western Australia, Heritage Council of Western Australia, Clare Menck, 2022. p.64.

154 A Thematic History of Western Australia, Heritage Council of Western Australia, Clare Menck, 2022. p.64.

Image 35: Lord Forrest Olympic Pool

Source: Joy Jones and friends at the Lord Forrest Olympic Pool,1948, Kalgoorlie, Western Australia. Courtesy of the State Library of Western Australia, BA3024/29, accessed, 2024.

Image 36: Initial Pipes for the Pipeline Leaving Midland

Source: Courtesy of the State Library of Western Australia, 009979PD: Initial pipes for the pipeline leaving Midland, 1901, accessed, 2024.

2.3.11 CULTURAL LIFE

People from many different countries worked on the construction and maintenance of the GWSS. As such, a different range of faiths and cultures were represented. The pipeline has been the inspiration for many stories, poems, songs and other creative works[155]. The GWSS provided new recreational facilities for eastern goldfields residents. The first swimming pool in Kalgoorlie had opened in 1897, serviced by salt water from a nearby mine. In 1938, the Lord Forrest Swimming Pool was opened using water from the GWSS. The 'Goldfields Pipeline Marathon' has been held every July since 2013[156].

155 Stories in the Pipeline: Preserving Goldfields Pipeline Heritage, H + H Architects, 2023, p.52-53..

156 Stories in the Pipeline: Preserving Goldfields Pipeline Heritage, H + H Architects, 2023, p.59..

2.3.12 INTERNATIONAL LINKS

During World War II, the GWSS was regarded as a key asset and measures taken to protect it. Additional men were assigned to guard the GWSS[157].

In 2009, the scheme was recognised internationally by the American Society of Civil Engineers as an international Historic Civil Engineering Landmark.

157 Stories in the Pipeline: Preserving Goldfields Pipeline Heritage, H + H Architects, 2023, p.43..

2.4 CHRONOLOGY

Table 4.0: Summary of Historical Themes of the GWSS

1887	Gold discovered in Yilgarn (Southern Cross), beginning the Western Australian gold rush.
1891	C. Y. O' Connor takes the position of Engineer-in-Chief of the colony.
1892	Gold Discovered in Coolgardie.
1892	Public Works Department begins planning a water scheme to service the goldfields.
1895	O'Connor submits his proposal for the Goldfields pipeline scheme.
1896	A bill is passed to raise a loan of £2.5 million to construct O'Connor's pipeline scheme.
1898	Works begin on the reservoir at Mundaring.
1901	Works begin on the pump stations.
1902	Mundaring Weir wall completed.
1903	Official opening at Mt Charlotte Reservoir.
1910	Goldfields Water Supply Act amended to allow supply for agricultural outside of the goldfields.
1922	A four mile portion of replacement main conduit is installed in East Northam to deviate from Northam Central Business District.
1928	Approximately 1 million acres of farmland served.
1933	565 kilometres of pipe are excavated, cleaned, lined with cement mortar, and re-laid above ground on reinforced concrete anchors[1] .
1935	Fernie, and colleague Reg Keating, are awarded the a Medal for advances in structural engineering for their paper on the continuously welded pipeline[2].
1935	A 2,000,000 gallon capacity circular summit tank replaces the No. 1 Summit Tank at Sawyers Valley[3].
1937	Kellerberrin Pipes were devised by Frank Mather[4].
1948	4 million acres of farmland is served by GWSS.
1951	Works to raise Mundaring Weir wall by 10m completed, with buttresses.
1951	Upgrades to the main conduit are undertaken between Mundaring and Kellerberrin. Sections of Kellerberrin Pipe are added to the system, running parallel to the existing main conduit[5].
1954-1969	The original pump stations were replaced with electric pump stations.
1968	An Earthquake hits Meckering, Closure of No. 6 Ghooli. New electric pumping station constructed at Yerbillon, replacing the original No. 5 Station[6].
2011	GWSS added to the National Heritage Register.
2022	GWSS added to the State Register of Heritage Places.

1 Curtin Institute, 2001, Conservation Plan for Toorak Tank (Goldfields Water Supply Scheme – Place V), for the National Trust of Western Australia, p. 9; Engineering Heritage WA, 2011, p. 7.

2 Engineering Heritage WA, 2011, p. 7; Hartley, 2007, 236

3 A third tank is constructed in 1975. Curtin, 2001, Place R, pp. 7, 13.

4 Griffiths, 2016, pp. 34, 37; The Golden Pipeline, Mather Pipes, Source: https://www.goldenpipeline.com.au/the-scheme/pipes/mather-pipes/, Accessed September 2021.

5 Griffiths Architects, 2016, Goldfields Water Supply Scheme Heritage Management Plan, p. 28.

6 Curtin Institute 1999 Conservation Plan for Goldfields Water Supply Scheme, Vol II Place H – No. 5 Pumping Station Yerbillon, p. 45.

CHAPTER 3: PLACE DESCRIPTION

3.1 CONDITION

3.1.1 CONDITION OF THE MAIN CONDUIT

The following Chapter provides a description of the place with reference to its condition. In this case, 'Condition' refers to the current physical condition of the place relative to the values for which the place has been nominated for inclusion on the NHL.

3.1.2 CONDITION AND INTEGRITY - AS ASSESSED BY THE AUSTRALIAN HERITAGE DATABASE

The following text in italics has been sourced from the Australian Heritage Database, National Heritage Listing, Place ID 106007:

> *"Components of the original scheme are still in use and in excellent condition. Historic elements no longer in use have in general been stabilized or conserved while some elements are in poor condition. Changes have been made and continue to be made for operational purposes.*
>
> *Reservoirs:*
> *Post World War 2 Mundaring Weir was raised by 32 feet [10m] to treble the capacity of the weir in order to supply agricultural areas north and south of the pipeline. As part of raising the weir wall, the upper valve house was dismantled from the original wall and re-erected on the raised one to preserve the appearance of the original wall.*
> *Mount Charlotte has been covered for safety / water quality reasons.*
>
> *Pipes:*
> *As mentioned above, the pipeline was re-laid above ground. This was in the 1930s and was a state project initiated to create jobs during the Depression. Part of the pipeline was duplicated when the scheme was expanded post World War Two. However, although they are now concrete-lined to prevent corrosion, 58% of the original pipes are still in service.*
>
> *Pumping Stations:*
> *The pumps, capable of delivering five million gallons of water per day, performed until they were decommissioned in the 1950s and 1960s and replaced by electric powered pumps. Two of the steam pumping stations are no longer standing and the six remaining are in various conditions, some with the original equipment, some with none. No 4 is simply a shell while Nos 6 and 8 still the majority of their machinery[1]."*

1 Appendix A- Australian Heritage Database Entry

3.2 FRAMEWORK TO MEASURE CONDITION

Table 5.0: Framework of Condition and Integrity of main conduit[2]

Condition Criteria	Integrity Criteria
Good A site, or place, has its important features well-maintained. For example, a garden is well kept, or a building is structurally sound, weather-tight, and with no significant repair needed. Internally walls, floors and joinery are well maintained.	**High** The features, or attributes, that contribute to the value of the place are in very largely intact and not compromised by significant removals, modifications or additions.
Fair A site, or place, retains its important features, including landscape elements, vegetation, associated moveable objects etc., but these are in need of conservation action and maintenance, For example, a building is structurally sound, but has inadequate maintenance and it is in need of minor repair.	**Medium** There has been some loss of important elements or attributes, but the site or building still retains sufficient significant fabric for its values to be understood and interpreted. Intrusions are not substantial.
Poor A site, or place, demonstrates damage to, or loss of, significant fabric including landscape elements, moveable objects, archaeological deposits etc. Internally, walls floors or joinery are missing, or in dilapidated condition.	**Low** A site or place has had important features, or attributes removed or substantially altered. For example, original cladding of walls or roof may have been removed or destroyed, or rearranged entirely, interiors may have been removed or destroyed, or rearranged with the insertion of a new interior. Where the values of a site, or place, do not relate directly to fabric (such as in a place valued for association with a historic event, community association or use), judgement must be made on the impact of changes in diminishing the ability of the viewer to understand the associations of the place.

2 Heritage, GML. 2021. High Court of Australia and National Galelry of Australia Precinct . HMP, Canberra : GML Heritage .p109

3.2.1 CURRENT CONDITION OF THE MAIN CONDUIT

Since its inception, Water Corporation and its predecessors have undertaken regular maintenance works to the main conduit. These include the repair and replacement of elements over time (as required). For older sections of the pipe, repair works such as patch welding have contributed to its narrative and heritage value. While much of the original locking bar pipe has undergone replacement or relocation over the years, a significant portion remains in operation today (43 percent in 2015). The main conduit's prominence in the landscape; its linear continuity; and its public visibility are qualities that have been maintained since its construction.

While parts of the main conduit are in good condition, other parts are showing evidence of their age. This is particularly evident of the original locking bar pipe, which is becoming increasingly prone to leaks and bursts. Upgrades are required to address asset condition and capacity requirements.

The main conduit of the GWSS forms part of an operational water supply scheme that continues to provide fresh drinking water to over 100,000 customers today. Recent announcements by the Western Australian Government to prioritise upgrades to the scheme will ensure it continues to support the growth of the goldfields and agricultural regions well into the future. Based on the criteria in the table above, the condition of the main conduit is considered to be fair, acknowledging the need for planned upgrades to the scheme. The integrity of the main conduit is high, in recognition that it remains the centrepiece of an operational water supply scheme, a role that will only become more important in future years.

The Water Corporation continually monitors the condition and function of the main conduit to ensure continuous service delivery of fresh drinking water to its customers. Extensive information, spatial GIS data, and conditions are maintained as part of the standard internal functions of the Water Corporation. Some data on the condition of the pipe is published on the Water Corporation's website:

https://www.watercorporation.com.au/Outages-and-works/Ongoing-Works/Goldfields-Pipeline-Planning-for-replacement#:~:test=In%20January%202022%20we%20received,Interpretation%20Strategy%20for%20the%20pipeline

Image 37: Image showing pipes at Fred Jacoby Park

Source: 'Image showing pipes at Fred Jacoby Park', photograph taken near Mundaring, Courtesy of: Stephen Carrick Architects, 2024.

3.3 KEY PHOTOGRAPHS

Key photographs have been selected to depict the key sites that reflect the Heritage Values and significance of the main conduit fabric. Key considerations in selection were:

- Proximity to the highway;
- Relationship with landscape features: and
- Ownership of the land.

These key considerations are further detailed in Chapter 7.

PHOTOGRAPH NO. 1

TOWN:
MUNDARING

GPS:
31°57′14.14″S
116° 9′52.70″E

PHOTOGRAPH NO. 2

TOWN:
MUNDARING

GPS:
31°56′37.29″S
116°10′43.24″E

3.3 KEY PHOTOGRAPHS (CONTINUED)

PHOTOGRAPH NO. 3

TOWN:
SAWYER VALLEY

GPS:
31°54′7.28″S
116°12′3.06″E

PHOTOGRAPH NO. 4

TOWN:
BAKERS HILL

GPS:
31°45′4.91″S
116°26′35.60″E

PHOTOGRAPH NO. 5

TOWN:
CLACKLINE

GPS:
31°42′56.07″S
116°31′43.64″E

3.3 KEY PHOTOGRAPHS (CONTINUED)

PHOTOGRAPH NO. 6

TOWN:
NORTHAM

GPS:
31°40′40.22″S
116°38′27.84″E

PHOTOGRAPH NO. 7

TOWN:
CUNDERIN

GPS:
31°37′5.63″S
117° 5′11.38″E

PHOTOGRAPH NO. 8

TOWN:
CUNDERIN

GPS:
31°39′11.05″S
117°14′31.04″E

3.3 KEY PHOTOGRAPHS (CONTINUED)

PHOTOGRAPH NO. 09

TOWN:
EAST TAMMIN

GPS:
31°37′32.85″S
117°34′29.32″E

PHOTOGRAPH NO. 10

TOWN:
KELLERBERRIN

GPS:
31°37′58.28″S
117°43′32.44″E

PHOTOGRAPH NO. 11

TOWN:
DOODLAKINE

GPS:
31°36′36.49″S
117°52′38.60″E

3.3 KEY PHOTOGRAPHS (CONTINUED)

PHOTOGRAPH NO. 12

TOWN:
MERREDIN

GPS:
31°29′26.37″S
118°14′33.17″E

PHOTOGRAPH NO. 13

TOWN:
BURRACOPPIN

GPS:
31°23′51.18″S
118°28′53.23″E

PHOTOGRAPH NO. 14

TOWN:
WALGOOLAN

GPS:
31°22′48.06″S
118°33′55.56″E

3.3 KEY PHOTOGRAPHS (CONTINUED)

PHOTOGRAPH NO. 15

TOWN:
CARRABIN

GPS:
31°22′50.46″S
118°40′42.67″E

PHOTOGRAPH NO. 16

TOWN:
YERBILLON

GPS:
31°23′29.00″S
118°44′24.27″E

PHOTOGRAPH NO. 17

TOWN:
BODALLIN

GPS:
31°22′19.40″
118°51′10.42″E

3.3 KEY PHOTOGRAPHS (CONTINUED)

PHOTOGRAPH NO. 18

TOWN:
MOORINE ROCK

GPS:
31°18’25.23”S
119° 7’21.42”E

PHOTOGRAPH NO. 19

TOWN:
GHOOLI

GPS:
31°15’11.64”S
119°27’14.86”E

PHOTOGRAPH NO. 20

TOWN:
YELLOWDINE

GPS:
31°17’40.74”S
119°39’16.90”E

3.3 KEY PHOTOGRAPHS (CONTINUED)

PHOTOGRAPH NO. 21

TOWN:
KARALEE ROCKS

GPS:
31°16′39.44″S,
119°51′3.19″E

PHOTOGRAPH NO. 22

TOWN:
GILGAI

GPS:
31°12′13.97″S
120°19′5.03″E

PHOTOGRAPH NO. 23

TOWN:
BOORABBIN

GPS:
31°12′26.04″S
120°18′34.43″E

3.3 KEY PHOTOGRAPHS (CONTINUED)

PHOTOGRAPH NO. 24

TOWN:
DEDARI

GPS:
31°5′34.85″S,
120°41′25.13″E

PHOTOGRAPH NO. 25

TOWN:
TOORAK HILL

GPS:
30°56′20.11″S
121° 9′54.47″E

PHOTOGRAPH NO. 26

TOWN:
COOLGARDIE
+KALGOORLIE

GPS:
VARIOUS

3.3 KEY PHOTOGRAPHS (CONTINUED)

PHOTOGRAPH NO. 27

TOWN:
MOUNT CHARLOTTE

GPS:
30°44'22.68"S,
121°28'41.48"E

Image 38: Images for Maps:1,5,6,13 and 24.
Source: Stephen Carrick Architects, October, 2023.

Image 39: Images for Maps:2-4,7-12 ,14-22 and 25-27.
Source: Google Earth Images, NASA, 2024 accessed, 01.07.2024.

Image 40: Map 22, Pump Station 7.
Source: Gary Peters. All that remains at No 7, the receiving tank.< https://www.goldenpipeline.com.au/place/no-7-pump-station/ > accessed 08.07.2024.

3.4 CONTEXT OF PLACE AND ENVIRONMENT

This section describes the natural context and natural corridors that the pipeline travels through.

The following information has been sourced from the Australian Heritage Database, National Heritage Listing, Place ID 106007:

> *"The pipeline component of the Goldfields Water Supply Scheme stretches 566km from Mundaring to Kalgoorlie. The terrain which the pipeline occupies is not included in the place, rather the extant fabric of the pipeline (including the remaining original steel pipes, the 1930s refurbished continuously welded pipe, 1950s replacements and concrete anchor blocks) constitute the boundary of this element of the Goldfields Water Supply Scheme. The following section describes the natural context which the pipeline traverses and the natural corridors which it occupies.*
>
> *The Goldfields Water Supply Scheme is found within the south-west Australian biodiversity hotspot, which is the only Australian biodiversity hotspot amongst 34 described globally. This biodiversity hotspot rating is a reflection of the number of species restricted to the region also known as endemic species and the degree of historical land clearing for agriculture (Myers et al 2000; Conservation International: 2007).*
>
> *The flora of south-west Australia is notable for its diversity with around 8000 species, and high endemic with 75-80% of species restricted to the southwest region. This floristic diversity occurs at the species rather than at the genera level, which is in contrast to other regions of Australia such as the rainforests of Queensland, where there is a great diversity of plant families and genera but relatively few species within each genus. The south-west Australian flora is dominated by speciose genera from the following botanical families: Myrtaceae (eucalypts and allies), Proteaceae (banksias and allies), Fabaceae (native peas) and Epacridaceae (southern heaths) (Hopper 1992).*
>
> *Within the south-west, the Goldfields Water Supply Scheme pipeline corridor runs through three broad biogeographic regions that have been identified under the Interim Biogeographic Regionalisation of Australia (IBRA) classification scheme (Thackway et al 1995). These IBRA are the Jarrah Forest, Avon Wheatbelt and Coolgardie IBRA regions. ...Reserves along the corridor include the Boorabbin and Goldfields Woodlands National Parks in the Coolgardie Bioregion, however the values of the listing only encompass the pipeline itself[3]. "*

3 Appendix A-Australian Heritage Database Entry

Image 41: Karalee Rocks from Google, Michael Warren, 2022,

Source: 'Karalee Rocks from Google' Courtesy of Michael Warren, accessed < https://old.australia247.info/explore/western_australia/shire_of_yilgarn/yellowdine/karalee-rocks-08-9321-6088.html

4

CHAPTER 4: HERITAGE SIGNIFICANCE

4.1 NATIONAL HERITAGE VALUES

The following lists the full National Heritage Values from the Commonwealth of Australia Special Gazette (No. S106, 23 June 2011)[1] for the inclusion of the GWSS on the National Heritage List.

1 Appendix G- Inclusion of Place in the National Heritage List, GWSS

Table 6.0: National Heritage Values.

Criterion A:	**The place has outstanding heritage value to the nation because of the place's importance in the course, or pattern, of Australia's natural or cultural history.**

"The Goldfields Water Supply Scheme runs for over 566km and was opened in 1903. It is significant as the impetus for agricultural expansion that was of lasting benefit to Western Australia and to the nation as a whole. Water from the pipeline became available just as the production of gold on the eastern goldfields was starting to decline, but the true value of the pipeline both to Western Australia and to Australia as a whole was the effect that regular water supplies had in opening up the south-western agricultural area to production. While activity on the goldfields declined between 1905 and the 1960s, the quantity and value of wheat produced increased steadily over the same period. Today the Western Australian wheatfields are the most productive in Australia, accounting for 42% of the nation's wheat crop. This comes mainly from the areas serviced by the goldfields pipeline, which has continued to operate as a water supply scheme since its inception. The pipeline, its extensions and associated infrastructure represent the initiative that opened up the south-western agricultural area to development."

Please note the change from 560km to 566km for accuracy, as supplied by the Water Corporation.

Criterion D:	**The place has outstanding heritage value to the nation because of the place's importance in demonstrating the principal characteristics of:** • **a class of Australia's natural or cultural places; or** • **a class of Australia's natural or cultural environments.**

"The Goldfields Water Supply Scheme incorporates the remaining elements of the former Coolgardie Goldfields Water Supply Scheme, as designed by engineer CY O'Connor and completed in 1903. The Goldfields Water Supply Scheme is an outstanding representative example of an inter-basin water transfer system while demonstrating a major development in water scheme design. It contains the principal characteristics of a water supply/transfer scheme including dams (pondages), extensive pipeline, tanks, reservoirs and pump stations. The pipeline continues to serve the needs of the communities between Mundaring and Kalgoorlie.

The characteristic features of the Goldfields Water Supply Scheme that express this value include the remaining extant features of the 1903 Scheme: the main conduit of the pipeline (the length of pipeline including all locking bar pipes, wood stave pipe and continuously welded pipes from Mundaring Weir to Mount Charlotte); with its surviving pumping stations (Pump Stations Nos 1, 3, 5,6 and 8) and their associated equipment (including the pumps, boilers, compressors, venturi meters and reservoirs located at Pump Stations 2, 4, 7 and 8), regulating tanks (located at Bullabulling, Toorak Hill, Bakers Hill and West Northam) and the Mundaring Weir (dam, including the valve houses, spillway, the weir wall profile and fabric) and the round Mount Charlotte Reservoir at Kalgoorlie. "

Criterion F:	**The place has outstanding heritage value to the nation because of the place's importance in demonstrating a high degree of creative or technical achievement at a particular period.**

"Both in the size of the project and in the use of new technology, the Goldfields Water Supply Scheme was an outstanding technological achievement for its time. The pipeline pumping scheme, consisting of the pipeline itself, the reservoirs, and the pumping stations, was regarded internationally as being the largest such engineering undertaking for its time. The amount of steel used in construction was greater than for previous large steel structures. The contracts for the supply of steel were the largest pipe contracts, and the most expensive Australian construction contracts, let to that time.

The pipeline also made use of innovative Australian design in the locking bar pipe invented by Mephan Ferguson.

The refurbishment of the pipeline in 1933 was also a major technical development. Lifting the pipeline out of the ground and re-laying it above ground placed the Goldfields Water Supply Scheme among the world leaders in pipeline technology for the second time in less than 40 years. During this refurbishment, the expansion forces were directed into reinforced concrete anchor blocks built over the pipe at 50 metre intervals, which prevented movement and transferred these forces into the ground. This was the first time anywhere in the world that pipe anchorages of this type had been used to permit such a large diameter pipeline to be laid above ground.

The technical achievement of the Goldfields Water Supply Scheme was internationally recognised by the American Society of Civil Engineers as an International Historic Civil Engineering Landmark in 2009, marking the Scheme as one of the most significant engineering projects of the 20th century."

Criterion H:	**The place has outstanding heritage value to the nation because of the place's special association with the life or works of a person, or group of persons, of importance in Australia's natural or cultural history.**

"The Goldfields Water Supply Scheme is significant for its association with the work of Charles Yelverton O'Connor, Engineer-in Chief of the Western Australian Public Works Department from 1891 to his death in March 1902. O'Connor was the driving force behind the construction of the pumping scheme including the pipeline, pumping stations and equipment, reservoirs and tanks, and the Mundaring Weir, which provided great economic benefit to the state of Western Australia and to the nation as a whole. While the Coolgardie Goldfields Water Supply Scheme was originally intended to serve the immediate needs of the goldfields, Sir John Forrest considered that its longer-term future was to service agriculture. At the completion of the work, the Premier Sir John Forrest praised him as "the great builder of this work ... to bring happiness and comfort to the people of the goldfields for all time".

4.2 NATIONAL HERITAGE LISTING - STATEMENT OF SIGNIFICANCE

The following lists the full Nominator's Summary Statement of Significance from the Australian Heritage Database, National Heritage Listing of GWSS, Place ID 106007.

> *"The Goldfields Water Supply Scheme incorporates the remaining elements of the Coolgardie Goldfields Water Supply Scheme, as designed by engineer Charles Yelverton O'Connor (C.Y. O'Connor) and completed in 1903. These elements include the former steam powered pump stations (and associated receiving tanks), reservoirs, regulating tanks and over 566km of pipeline, commonly referred to as the 'main conduit'. It is significant for the economic benefits it brought to Western Australia and to the nation as a whole, for its demonstration of outstanding technological achievement for its time, and for its association with the engineer, C.Y. O'Connor.*
>
> *The Goldfields Water Supply Scheme was the impetus for agricultural expansion that was of lasting benefit to Western Australia and to Australia as a whole. Water from the pipeline became available just as the production of gold on the eastern goldfields was starting to decline, but its true value resulted from the effect that regular water supplies had in opening up the south-western agricultural area to production. As the value of gold recovered on the goldfields declined between 1905 and the 1960s, the quantity and value of wheat produced increased steadily over the same period. Today the Western Australian wheatfields are the most productive in Australia, accounting for 42% of the nation's wheat crop. Most of the WA wheat crop is produced in the areas serviced by the goldfields pipeline and its extensions, which continues to operate as a water supply scheme.*
>
> *Both in the size of the project and in the use of new technology the Goldfields Water Supply Scheme was an outstanding technological achievement in the early 20th century. C.Y. O'Connor's original scheme, known as the Coolgardie Goldfields Water Supply Scheme and consisting of the pipeline itself, the reservoirs, and the pumping stations, was regarded internationally as being the largest such engineering undertaking for its time. The amount of steel used in construction was greater than for previous large steel structures elsewhere in the world. The contracts for the supply of steel were the largest pipe contracts, and the most expensive Australian construction contracts, let to that time.*
>
> *The Goldfields Water Supply Scheme (including the individual components) is of outstanding value to the nation as a representative example of early 20th century engineering in Australia. Principal characteristics of the Goldfields Water Supply Scheme include: Mundaring Weir (Dam) including the dam wall, spillway and two valve houses; Mount Charlotte Reservoir, the former pump station buildings (and receiving tanks); regulating tanks and the pipeline itself. The scheme is recognised by the American Society of Civil Engineers as an International Historic Civil Engineering Landmark.*
>
> *The pipeline also made use of innovative Australian design in the locking bar pipe invented by Mephan Ferguson.*
>
> *The refurbishment of the pipeline in 1933 was also a major technical development. Lifting the pipeline out of the ground and re-laying it above ground placed the Goldfields Water Supply Scheme among the world leaders in pipeline technology for the second time in less than 40 years. During this process, the forces in the continuously welded pipeline resulting from expansion and contraction were directed into reinforced concrete anchor blocks built over the pipe to prevent movement and to transfer these forces into the ground. This was the first time anywhere in the world that pipe anchorages of this type had been used to permit such a large diameter pipeline to be laid above ground.*
>
> *The Goldfields Water Supply Scheme is significant for its association with the work of C.Y. O'Connor, Engineer-in Chief of the Western Australian Public Works Department from 1891 to his death in March 1902. O'Connor was the driving force behind the construction of the Scheme, which provided great economic benefit to Australia. At the completion of the work, the Premier Sir John Forrest praised him as "the great builder of this work ... to bring happiness and comfort to the people of the goldfields for all time".* [1]

Please note the change from 560km to 566km for accuracy, as supplied by the Water Corporation.

1 Appendix A-Australian Heritage Database Entry

4.3 STATE HERITAGE VALUES

Below lists the State Heritage values for the GWSS.

Table 7.0: State Heritage values.

a. Importance in demonstrating the evolution or pattern of Western Australia's history

"The construction of the Goldfields Water Supply Scheme was one of the greatest engineering and infrastructure schemes of the late nineteenth century. The successful completion of the scheme was pivotal in the growing confidence and economic importance of the state of Western Australia.

In providing a continuous and reliable water supply to Eastern Goldfields, the Goldfields Water Supply Scheme was fundamental to the continued development of the Western Australian mining industry, reflecting its importance to the regional and state economy at the end of the nineteenth century.
The construction of the Goldfields Water Supply Scheme allowed for the successful development of the Wheatbelt region throughout the twentieth century. The installation of branch mains off the Pipeline began in 1907 and continued for the next forty years, servicing what has become the most productive wheatfields in Australia.

The construction and continued maintenance and expansion of the Goldfields Water Supply Scheme provided direct employment for a large number of men, particularly in the nineteenth century construction of Mundaring Weir, the laying of the conduit and branch extensions at the turn of the century. The raising of the pipeline as part of the sustenance program during the 1930s Depression and the raising of the Mundaring Weir from 1946-1951 utilised considerable numbers of immigrant labourers, particularly southern Europeans, who were accommodated in camps near the Weir.

The Goldfields Water Supply Scheme is recognised as a symbol of State pride that, at the time of construction when federalism was being established, was utilised as an example of the infrastructure capabilities of one of the least populated colonies."

b. Importance in demonstrating rare, uncommon or endangered aspects of Western Australia's heritage

"The Goldfields Water Supply Scheme was a unique combination of attested technology and infrastructure combined with innovative engineering and technological advances at the time of construction.

The Goldfields Water Supply Scheme retains exceptionally important individual components associated with the largest Australian engineering scheme of its type at the time, and the continued innovations undertaken to maintain its successful operation over 120 years.

Individual components of the Goldfields Water Supply Scheme, in particular the archaeological sites and remaining buildings at Mundaring Weir, Mount Charlotte, the original eight and later generation pump stations and staff housing, and workers camps, reflect the distinctive way of life of those who lived and worked on the construction and operation of the Pipeline from 1898 to the 1970s."

c. Potential to yield information that will contribute to an understanding of Western Australia's history;

"The Goldfields Water Supply Scheme, in association with the interpretation along the Golden Pipeline Heritage Trail, demonstrates the exceptional historical importance of the provision of water to the towns along the route from Mundaring to the Eastern Goldfields.

Along with the existing interpretation associated with the Golden Pipeline Heritage Trail and the museum facilities at No 1 Steam Pump Station Mundaring and No. 3 Steam Pump Station Cunderdin, the Goldfields Water Supply Scheme has exceptional potential as a benchmark site to communicate the history of the Goldfields Water Supply Scheme and its importance to the Wheatbelt, the Eastern Goldfields and Western Australia.

Comprising a comprehensive collection of archaeological sites, buildings, infrastructure and technology, the Goldfields Water Supply Scheme has outstanding importance for its ability to demonstrate engineering and technological advances across the nineteenth, twentieth and twenty-first centuries.

The discontiguous individual components, including archaeological sites, decommissioned and operational infrastructure, steam pump stations, electric pump stations, tanks, portions of conduit, valves and reservoirs, have the potential to educate the public on the operational aspects associated with the delivery of water from Mundaring Weir to the Wheatbelt and Eastern Goldfields via the Goldfields Water Supply Scheme.

Archaeological sites associated with the residences, workers camps, school buildings and other community facilities within the pump station complexes have the potential to yield information on the lives of the individuals who worked on and lived near the Goldfields Water Supply Scheme."

d. Its importance in demonstrating the characteristics of a broader class of places;

"The original Goldfields Water Supply Scheme is representative of the ambitious engineering and infrastructure schemes of the late nineteenth century, and was Australia's boldest project to that date. Goldfields Water Supply Scheme comprises a series of places that individually and collectively demonstrate the characteristics of water supply across a distance of 566km from Mundaring to Kalgoorlie, including the remaining and semi-ruined Steam Pump Stations, Electric Pump Station, tanks, portions of conduit, valves and reservoirs.

The remaining Steam Pump Stations at Mundaring, Cunderdin, Merredin, Ghooli, Yerbillon and Dedari, are a recognisable discontiguous group of industrial buildings of considerable architectural refinement, designed by renowned architect George Temple Poole, and intended to demonstrate the social and political importance of the Goldfields Water Supply Scheme."

e. Any strong or special meaning it may have for any group or community because of social, cultural or spiritual associations;

"Established in the late nineteenth century and operating at a far greater capacity in the twenty-first century, the Goldfields Water Supply Scheme represents an exceptional technical achievement held in high esteem by the Western Australian community.

The successful construction and operation of the Goldfields Water Supply Scheme had considerable importance in contributing to the sense of place for the people of Western Australia. Creating employment opportunities and shaping local patterns of land use, farming, transport, and education, the Scheme was pivotal in the continued success of goldmining in the Eastern Goldfields, the development of small long-lasting rural communities along its breadth and allowing for permanent settlement inland.

The Goldfields Water Supply Scheme, and the complementary Golden Pipeline Heritage Trail, is highly valued as a tourist destination with educational, cultural and aesthetic aspects appreciated by history and engineering enthusiasts, teachers, Western Australians and visitors to the state.

...

The Goldfields Water Supply Scheme has special meaning for many former Public Works Department, Goldfields Water Supply and Water Corporation employees and their descendants, including the communities of workers and their families who lived alongside the original Steam Pump Stations. For some descendants of the men employed in the construction and raising of the reservoirs and weir, the laying the original Mundaring to Kalgoorlie conduit, the 1933 raising of the conduit, and the runners who monitored the pipeline for leaks, the continued operation of the Pipeline is a demonstration of their skill and perseverance, and part of the family folklore and pride."

f. Its importance in exhibiting particular aesthetic characteristics valued by any group or community;

"Many of the individual components associated with the Goldfields Water Supply Scheme, including the remaining and semi-ruined steam pump stations, electric pump stations, tanks, portions of conduit, valves and reservoirs individually have landmark qualities in their rural and country town settings. Collectively they form a significant precinct that is recognisable across the changing landscape from the Perth Hills, the Wheatbelt and Eastern Goldfields of Western Australia.

The use of architectural design in the construction of the eight original Steam Pump Stations reflects the cultural importance and ambition of the Goldfields Water Supply Scheme to the Western Australian government at the time. The remaining Steam Pump Stations at Mundaring, Cunderdin, Merredin, Ghooli, Yerbillon and Dedari, are a recognisable discontiguous group of industrial buildings of considerable architectural refinement, reflecting the style of architect George Temple Poole.

The individual precincts at Mundaring, O'Connor, Cunderdin, Merredin, Yerbillon, Gilgai, Ghooli and Dedari, established to maintain the Goldfields Water Supply Scheme, vary widely in terms of condition, conservation and retention of remaining operational infrastructure and buildings, residences, and the presence of additional facilities such as halls, schools, gardens and playgrounds. Collectively, they demonstrate and are evocative of the self-contained nature of the small communities established near the main conduit.

The archaeological sites of former Steam Pump Stations at O'Connor, picturesque and encroached by the surrounding Perth forest, and Gilgai, exposed and open to the elements in the Wheatbelt region, are striking in their individual landscape, but also demonstrative examples of the different types of sites and environments within the Goldfields Water Supply Scheme that are valued by visitors to the Golden Pipeline Heritage Trail for aesthetic, evocative and educational reasons.

The scale of construction of both the Mundaring Weir and Mount Charlotte reservoirs in addition to the associated facilities, buildings, interpretation and surrounding natural landscapes in both locations combine to form a significant recreational landscapes in two vastly different environments at either end of the Goldfields Water Supply Scheme.

The location of the reservoir at the top of Mount Charlotte, and the visibility of dual conduits undulating down the hill, both transporting water to the reservoir from Coolgardie and distributing it out to Kalgoorlie creates a landmark feature in the Kalgoorlie landscape and a symbol of the purpose of the Goldfields Water Supply Scheme.''

g. Any special association it may have with the life or work of a person, group or organisation of importance in Western Australia's history;

"Goldfields Water Supply Scheme is associated with a number of notable figures in Western Australian history, including the Scheme's designer C.Y. O'Connor, State and Federal politician Lord John Forrest, the Director of the Public Works Department HW Venn and former Superintendent of Public Works, architect George Temple Poole, who each contributed to the successful completion of the Scheme.

The longevity of the Goldfields Water Supply Scheme is associated with innovators Mephan Ferguson, inventor of the locking-bar pipe; James Couston, inventor of the caulking machine, whose designs allowed the successful construction and laying of the original main conduit; engineers Norman Fernie and Reg Keating, proponents of the 1930s scheme to lift and relay the conduit above ground to combat ongoing issues with corrosion; and Frank Mather, who devised the repurposing of the locking bar pipe as Kellerberrin Pipe.

The place has importance for its close association with the talented and committed engineers employed by the Goldfields Water Supply Branch, Public Works Department and other iterations of the Water Corporation, whose pioneering research and innovations were instrumental in the successful construction and continued operation of the Goldfields Water Supply Scheme throughout the twentieth century."

h. Its importance in demonstrating a high degree of creative or technical achievement;

"The Goldfields Water Supply Scheme has exceptional importance in demonstrating a series of highly original technical achievements in the successful completion of one of the longest overland pipeline schemes attempted in the nineteenth century.

The construction of two reservoirs connected by 566km below-ground pipeline, supported by eight steam pump stations and associated infrastructure utilised new technology, and exceptional engineering and architectural design. The completion of the scheme was recognised as one of the largest and outstanding engineering achievements at the time.
The use of Mephan Ferguson's innovative locking bar technology and James Couston's caulking machine was pivotal in ground-breaking decision to construct the main conduit of the Goldfields Water Supply Scheme in steel. The scale of the scheme was such that an unprecedented 70,000 tons of steel was required, necessitating the contract to manufacture the pipes was split between two contractors. The most expensive Australian construction scheme undertaken produced the longest steel pipe in Australia and the world at the time.

As a precinct, Goldfields Water Supply Scheme is an exceptional example of applied science, technical excellence and innovative design in the nineteenth and twentieth century. A series of innovative solutions to corrosion and increased capacity requirements were undertaken in the 1930s, including the successful raising of the pipeline using reinforced concrete anchor blocks to provide stability; most extensive use of wooden pipes in Australia with the installation of 63km of Karri timber in timber stave pipes; and the raising of the Mundaring Weir via the additional of grouted aggregate concrete buttresses to the downstream wall of the Weir. Ongoing maintenance of the Goldfields Water Supply Scheme has continued to utilise cutting edge technology and expertise to ensure the optimal delivery of water across the Wheatbelt and Eastern Goldfields region."

4.4 STATE HERITAGE LISTING - STATEMENT OF SIGNIFICANCE

The following text has been sourced from the Heritage Council of Western Australia, Register of Heritage Places, Register Entry Database No. 16610.

> *"The Goldfields Water Supply Scheme, extends in a discontiguous precinct across the 566km linear water pipeline, commencing at Mundaring Weir (1902, 1951) in the Helena Valley and terminating at Mount Charlotte Reservoir (1902) in Kalgoorlie-Boulder. Comprising six extant original Steam Pump Stations (1902) at Mundaring, Cunderdin, Merredin, Yerbillon, Ghooli and Dedari; the sites of two demolished Steam Pump Stations (1902) at O'Connor and Gilgai; Reservoirs and Tanks (1902, 1911, 1924, 1932) at O'Connor, Sawyers Valley, Bakers Hill, West Northam, Cunderdin, Merredin, Yerbillon, Ghooli, Bronti, Gilgai, Koorarawalyee, Dedari, Toorak, and Bullabulling; second generation Electric Pump Station at Merredin (1954), pump community buildings associated with the Mundaring Weir Village (1898-1909), Mundaring Weir Hotel (1898; 1906), Karalee Reservoir, Rock Catchment & Aqueduct (1897), ancillary structures; equipment and machinery, archaeological sites; and small discontiguous portions of the main pipeline conduit associated with the construction and operation of the Scheme from 1902 to the present, Goldfields Water Supply Scheme has cultural heritage significance for the following reasons:*
>
> - *The place demonstrates exceptional technical achievement as one of the longest overland pipeline schemes attempted in the nineteenth century, both in Australia and the world, and was recognised as an outstanding engineering achievement;*
> - *The construction of two reservoirs connected by a 566km below-ground pipeline, supported by eight steam pump stations and associated infrastructure, utilised new technology, and exceptional engineering and architectural design;*
> - *The success of the scheme was pivotal in the growing confidence and economic importance of the State, in creating employment opportunities and shaping local patterns of land use, farming, transport, and education, and was fundamental to the continued success of goldmining in the Eastern Goldfields;*
> - *The place has exceptional value in demonstrating the historical importance of the provision of water to settlements along the route from Mundaring to the Eastern Goldfields, and enabled the continued development of the Western Australian mining industry;*
> - *In providing a continuous and reliable water supply to the Eastern Goldfields, the place was the foundation of the successful development of agriculture in the Wheatbelt region throughout the twentieth century as part of the Comprehensive Water Supply Scheme, which allowed for the development of long-lasting townships and communities along the route and for people to permanently settle inland;*
> - *The construction and operation of the Pipeline had considerable importance in contributing to the sense of place for the people of Western Australia, and visitors to the State, as a highly valued tourist destination, the educational, cultural and aesthetic aspects of which are appreciated by history and engineering enthusiasts and teachers to this day;*
> - *Individual elements of the place, including the existing interpretation associated with the Golden Pipeline Heritage Trail, museums, archaeological sites and remaining buildings and infrastructure, collectively have exceptional potential to communicate the history of the Goldfields Water Supply Scheme and its importance to Western Australia;*
> - *The design of the eight original Steam Pump Stations by renowned architect George Temple Poole, was intended to demonstrate the social and political importance of the place, and this is still evident in the Pump Stations remaining at Mundaring, Cunderdin, Merredin, Ghooli, Yerbillon and Dedari which form a discontiguous group of industrial buildings of considerable architectural refinement;*
> - *The place is highly valued as a tourist destination with educational, cultural and aesthetic aspects appreciated by history and engineering enthusiasts, teachers, Western Australians and visitors to the State. Individual elements of the place, including the existing interpretation associated with the Golden Pipeline Heritage Trail, museums, archaeological sites and remaining and remnant buildings and infrastructure, collectively have exceptional potential to communicate the history of the Goldfields Water Supply Scheme and its importance to the Wheatbelt, the Eastern Goldfields and Western Australia;*

- *Many of the individual components within the place have individual landmark qualities in their rural and country town settings. Collectively they form a significant precinct that is recognisable across the changing landscape from the Perth Hills, the Wheatbelt and Eastern Goldfields of Western Australia;*
- *The place is associated with a number of notable figures in Western Australian history, including the Scheme's designer C.Y. O'Connor, State and Federal politician Lord John Forrest, the Director of the Public Works Department H. W. Venn and former Superintendent of Public Works, architect George Temple Poole, who each contributed to the successful completion of the Goldfields Water Supply Scheme; and*
- *The place is an exceptional example of applied science, technical excellence and innovative design, reflecting the ongoing ingenuity and innovation demonstrated by the talented and committed engineers employed by the Goldfields Water Supply Branch, Public Works Department and other iterations of the Water Corporation in the provision of water in the State. The longevity of the scheme is associated with innovators Mephan Ferguson, James Couston, engineers Norman Fernie and Reg Keating, and Frank Mather.*

The majority of the above ground pipeline conduit running adjacent to Great Eastern Highway en route from Mundaring to Kalgoorlie is not included in the curtilage of this place. The later tanks located adjacent to the 1911 tanks at Koorarawalyee and Bronti are of little significance.

Please note the change from 560km to 566km for accuracy, as supplied by the Water Corporation.

Image 42: GWSS Main Conduit at Mundaring

Source: 'GWSS Main Conduit at Mundaring', photograph taken near Mundaring, Courtesy of: Stephen Carrick Architects, 2024.

4.5 OVERVIEW OF NATIONAL HERITAGE VALUES

The National Heritage List criteria are based on identified National Heritage values. These heritage values form the basis of the GWSS heritage listing's Statement of Significance. The following section outlines the condition of the National Heritage values, assessed as a change since the national listing (22nd June 2011 to August 2024). The condition of the values is not simply referring to the physical condition of the main conduit.

4.6 METHODOLOGY TO ASSESS THE CURRENT CONDITION OF VALUES

4.6.1 METHODOLOGY INTRODUCTION

This review evaluated the National Heritage values as of August 2024 to establish a reference point prior to the commencement of future works. The assessment evaluates all National Heritage values written for the entire GWSS, despite the HMP having a focus on the main conduit.

There is no specific methodology for assessing the condition of National Heritage values, so the authors have developed a methodology that assesses the condition by considering how evident the values are through the tangible and intangible characteristics of the place. In order for the National Heritage values to be assessed, the sub-values, including the tangible and intangible characteristics are defined. The sub-values are then assessed to provide to overall condition of the National Heritage values.

These are described in the following sub-chapters:

Sub-values:
- Definition of sub-values: as taken from the National Heritage List criteria (Chapter 4.6.3).

Tangible characteristics (Chapter 4.7):
- Definition of tangible characteristics.
- Metric for the assessment of tangible characteristics.
- Assessment of tangible characteristics across the sub-values.

Intangible characteristics (Chapter 4.8):
- Definition of intangible characteristics.
- Metric for the assessment of intangible characteristics.
- Assessment of intangible characteristics across the sub-values.

National Heritage values (Chapter 4.9):
- Assessment of the condition of National Heritage values.

The assessment consisted of an initial review to identify any potential additional National Heritage values and a secondary review that analysed the tangible and intangible characteristics of the National Heritage values in greater detail[1]. A summary of the final methodology is included in this report to aid in future reviews and assessments.

1 Appendix E -HMP, Griffiths Architects, 2016

Image 43: Image of the GWSS at Fred Jacoby Park

Source: 'Image of the GWSS at Fred Jacoby Park', photograph taken near Mundaring, Courtesy of: Stephen Carrick Architects, 2024.

4.6.2 METHODOLOGY FOR VALUES ASSESSMENT

1 **Desktop review of existing documentation**:

- An initial review identified the crucial components of the National Heritage values and compiled the existing documentation (GML reviews, Stories in the Pipeline, and information available on the Internet).

2 **A site visit was conducted:**

- A site visit to review the main conduit from Mundaring to Kalgoorlie.
- This visit examined of the tangible and intangible aspects of the current National Heritage values: potential landmark qualities, physical condition, present interpretation and additional observations.

3 **Assessment and documentation of data from site visits:**

- The data collected from site visits was mapped, with observations recorded in photographs.

4 **Definition of sub-values, tangible and intangible characteristics:**

- The National Heritage values were divided into key points as described in paragraphs, for example; with National Heritage value criterion 'A' divided into two sub-values: 1 and 2. This was completed for the four GWSS National Heritage values criterion (A,D,F and H).
- Sub - values were identified and titles were given to each key component of the National cultural heritage values (total of 16 values).
- A list of intangible characteristics were developed, with 10 key intangible characteristics identified.

5 **Definition of matrix and criteria for assessment:**

- Criteria were developed to measure the tangible characteristics of values as 'intact' or 'not intact'.
- Criteria were developed to measure the condition of cultural heritage values: 'strong' and 'weak', depending on the intactness of characteristics.
- The tangible characteristics were described as 'intact' or 'not intact'.
- Intangible characteristics were mapped across the 16 sub-values of the National Heritage values criterion. These characteristics were described as 'intact' or 'not intact'.

6 **Sub-values were assessed:**

- Tangible characteristics were assessed, to determine if tangible characteristics are intact as of 2024.
- Intangible characteristics were assessed. A sub-value with 3 or more identified intangible characteristics was defined as 'intact', with others as 'not intact'.
- The intangible and tangible characteristics are assessed using the matrix prepared to determine the overall condition of the values.

7 **Internal assessment reviews:**

- The methodology and criteria underwent internal project team reviews to confirm logic and accuracy of assessment.

8 **Documentation of results:**

- A summary of any potential changes in values focused on potential loss in either tangible or intangible values over 2011 - 2024. A suggested time-frame for re-evaluation has been provided.

4.6.3 DEFINITION OF SUB - VALUES

The National Heritage values give clear guidance on the key aspects to be considered in the assessment of their condition. These key points are summarised below.

Table 8.0: Sub-values within the National Heritage values.

Sub - value	Quotation from National Heritage values
Criterion A: **The place has outstanding heritage value to the nation because of the place's importance in the course, or pattern, of Australia's natural or cultural history.**	
1. Agricultural Production	*'It is significant as the impetus for agricultural expansion that was of lasting benefit to Western Australia and to the nation as a whole. ..but the true value of the pipeline both to Western Australia and to Australia as a whole was the effect that regular water supplies had in opening up the south-western agricultural area to production. While activity on the goldfields declined between 1905 and the 1960s, the quantity and value of wheat produced increased steadily over the same period. Today the Western Australian wheatfields are the most productive in Australia, accounting for 42% of the nation's wheat crop.*
2. Area of Service	*'This comes mainly from the areas serviced by the goldfields pipeline, which has continued to operate as a water supply scheme since its inception. The pipeline, its extensions and associated infrastructure represent the initiative that opened up the south-western agricultural area to development.'*
Criterion *D:* ***The place has outstanding heritage value to the nation because of the place's importance in demonstrating the principal characteristics of:*** ***A class of Australia's natural or cultural places; or a class of Australia's natural or cultural environments.***	
3. 1903 Scheme	*'The characteristic features of the Goldfields Water Supply Scheme that express this value include the remaining extant features of the 1903 Scheme: the main conduit of the pipeline (the length of pipeline including all locking bar pipes, wood stave pipe and continuously welded pipes from Mundaring Weir to Mount Charlotte) '*
4. Representative (inter-basin water transfer system)	*'...representative example of an inter-basin water transfer system while demonstrating a major development in water scheme design. It contains the principal characteristics of a water supply/transfer scheme including dams (pondages), extensive pipeline, tanks, reservoirs and pump station.'*
5. Service Continuity	*'The pipeline continues to serve the needs of the communities between Mundaring and Kalgoorlie.'*
6. Pump Stations	*'with its surviving pumping stations (Pump Stations Nos 1, 3, 5, 6 and 8) and their associated equipment (including the pumps, boilers, compressors, venturi meters and reservoirs located at Pump Stations 2, 4, 7 and 8), '*
7. Regulating Tanks	*'...regulating tanks (located at Bullabulling, Toorak Hill, Bakers Hill and West Northam)'*
8. Reservoirs	*'Mundaring Weir (dam, including valve houses, spillway, the weir wall profile and fabric) and the round Mount Charlotte Reservoir at Kalgoorlie.'*

Sub - value	Quotation from National Heritage values
Criterion *F:* ***The place has outstanding heritage value to the nation because of the place's importance in demonstrating a high degree of creative or technical achievement at a particular period.***	
9. Size of scheme and use of new technology	*'Both in the size of the project and in the use of new technology, the Goldfields Water Supply Scheme was an outstanding technological achievement for its time. '*
10. Volume of Steel	*'The amount of steel used in construction was greater than for previous large steel structures. The contracts for the supply of steel were the largest pipe contracts, and the most expensive Australian construction contracts, let to that time.'*
11. Locking Bar	*'...use of innovative Australian design in the locking bar pipe invented by Mephan Ferguson.'*
12. Lifting of the Pipeline	*'The refurbishment of the pipeline in 1933 was also a major technical development. Lifting the pipeline out of the ground and relaying it above ground placed the Goldfields Water Supply Scheme among the world leaders in pipeline technology for the second time in less than 40 years.'*
13. Anchorage	*'This was the first time anywhere in the world that pipe anchorages of this type had been used to permit such a large diameter pipeline to be laid above ground.'*
14. International Recognition	*'...internationally recognised by the American Society of Civil Engineers as an International Historic Civil Engineering Landmark in 2009.'*
Criterion *H:* ***The place has outstanding heritage value to the nation because of the place's special association with the life or works of a person, or group of persons, of importance in Australia's natural or cultural history.***	
15. Charles Yelverton O'Connor	*''The Goldfields Water Supply Scheme is significant for its association with the work of Charles Yelverton O'Connor, Engineer in-Chief of the Western Australian Public Works Department from 1891 to his death in March 1902. O'Connor was the driving force behind the construction of the pumping scheme including the pipeline, pumping stations and equipment, reservoirs and tanks, and the Mundaring Weir, '*
16. Sir John Forrest	*'While the Coolgardie Goldfields Water Supply Scheme was originally intended to serve the immediate needs of the goldfields, Sir John Forrest considered that its longer-term future was to service agriculture. At the completion of the work, the Premier Sir John Forrest praised him as "the great builder of this work ... to bring happiness and comfort to the people of the goldfields for all time".'*

Image 44: Anchor Blocks in Fred Jacoby Park

Source: 'Anchor Blocks in Fred Jacoby Park', photograph taken near Mundaring, Courtesy of: Stephen Carrick Architects, 2024.

4.7 TANGIBLE CHARACTERISTICS

4.7.1 DEFINITION OF TANGIBLE CHARACTERISTICS

The National Heritage values of the GWSS are expressed through the tangible features of the place, such as the fabric of the Main Conduit, the Pump Stations and the Mundaring Weir. We define the tangible characteristics, for the purposes of this assessment, as any extant physical built fabric. These are mapped in relationship to the sub-values defined in 4.6.3. In order to assess the condition of the tangible components of the values, a metric was defined.

4.7.2 TANGIBLE METRIC

The metric for tangible characteristics defines the built fabric as 'intact', or 'not intact'. Not intact is described loosely to encompass any changes to the fabric since 2011, including the replacement of fabric. The metric is as follows:

Table 9.0: Definition of Metric for the Assessment of Tangible Characteristics.

Symbol	Condition	Definition
◆	Intact	Physical elements are extant
◆	Not intact	Elements are no longer extant.

4.7.3 TANGIBLE ASSESSMENT

The Tangible characteristics of each value are assessed using the defined metric. The sub-values are cumulative to provide the overall condition of each National Heritage value. In this case, if any sub-value is defined as no longer extant, the overall condition of the National Heritage value is considered 'not intact'. For example, if sub-value No. 1 and No. 2 are both intact, the National Heritage value for Criterion A is intact. If one sub-value is 'not intact', the entire National Heritage value is 'not intact'. The assessment was performed from sub-value 1 to 16 and the cumulative effects visually documented in the Table 10.0.

Image 45: GWSS Main Conduit at Fred Jacoby Park

Source: ' GWSS Main Conduit at Fred Jacoby Park' SCA, 2024.

Table 10.0: Analysis of the condition of National heritage values.

Value	No.	Sub-value	Description	Condition
A	1	Agricultural Production	The wheatbelt continues to be a thriving economic sector in WA and Australia more widely, and the GWSS continues to support the growth of agricultural production.	◆
	2	Area of Service	The area the GWSS services is still intact.	◆
D	3	1903 Scheme	Some elements of the Coolgardie Water Supply scheme and work of C. Y. O'Connor are extant.	◆
	4	Representative	The representative portions are still intact with tanks, reservoirs, the main conduit and pump stations.	◆
	5	Continuity of Service	The GWSS has 120 years of continued service of the GWSS through replacement and repair.	◆
	6	Pump Stations	Mundaring and Cunderin Pump Stations serve as museums and are conserved. Pump stations No. 1, No. 3, No. 5, No. 6 and No. 8 are intact.	◆
	7	Regulating Tanks	Regulating tanks are intact but not operational.	◆
	8	Reservoirs	Mundaring Weir is known as a destination in Perth and is visited by locals and tourists. Many of its components are intact. Mount Charlotte Reservoir has a lookout and is a destination.	◆
F	9	Size of scheme and use of new technology	The locking-bar pipe, Kellerberrin pipe types, the scale and trajectory of the main conduit are intact.	◆
	10	Volume of Steel	Volume of steel is still evident, even in the maintenance through replacement and is not considered altered.	◆
	11	Locking Bar	The locking bar pipe is present insitu.	◆
	12	Lifting of the Pipeline	The main conduit still exists as a functioning above ground conduit.	◆
	13	Anchorage	Anchorage is extant as the pipeline is still elevated across the majority of its length.	◆
	14	International Recognition	Pipeline maintains international recognition.	◆
H	15 + 16	C. Y. O'Connor + Sir John Forrest	Whilst both significant individuals have passed away there is tangible evidence of their importance.	◆

4.8 INTANGIBLE CHARACTERISTICS

4.8.1 INTANGIBLE INTRODUCTION

The National Heritage values of the GWSS are expressed through the tangible features of the place, such as the fabric of the Main Conduit, the Pump Stations and the Mundaring Weir, as well as its intangible characteristics, such as the role it has played in community memory and myth, as well as the knowledge and ideas it expresses as a feature of Australia's history. In some cases, intangible characteristics may also include tangible items. An example of this is when knowledge is captured in a book. Whilst a book is tangible it also represents an intangible characteristic, being a source of knowledge. For the purposes of this assessment, 'intangible' is described more loosely to encompass anything that is not the built fabric.

As part of the assessment, we have identified ten significant intangible characteristics that can be applied to the GWSS including: identity, ideas, knowledge, spiritual, events, stories, images, experiences, symbols, aesthetics.

The intangible characteristics and their evidence within the GWSS are defined in the Table 11.0.

4.8.2 DEFINITION OF INTANGIBLE CHARACTERISTICS

Table 11.0: Definition of Intangible Characteristics identified.

No.	Intangible	Definition
i	identity	the characteristics determining who or what a person or thing is. This can include a brand image.
ii	ideas	a thought or suggestion as to a possible course of action or the creation of an object. In this case we are also referring to concepts including inventions and patents. This can be documented in drawings or books.
iii	knowledge	facts, information, data and skills acquired through experience or education; the theoretical or practical understanding of a subject. In this case, this can include text that forms part of existing interpretation or education programs themselves.
iv	spiritual	relating to or affecting the human spirit or soul as opposed to material or physical things, this can include the cultural beliefs of First Nations people, including Dreamtime stories.
v	events	a planned public or social occasion or an occasion of specific significance.
vi	stories	account of past events and development, including personal memories and experiences.
vii	images	a picture made using a camera, or a mental image. These images can also refer to video recordings, abstract maps, artworks and any visual representations.
viii	experiences	practical contact with and observation of facts or events including emotions, memories, feelings and social interactions.
ix	symbols	a mark or character used as a conventional representation of an object, function, or process.
x	aesthetics	a set of principles underlying the work of a particular creator or creative movement. This includes form, architectural expression proportion, approach, colour, texture or other stylistic elements.

4.8.3 INTANGIBLE METRIC

Intangible characteristics are described in a similar manner to tangible characteristics, as being 'intact' or 'not intact'. In this case, the extended list of intangible characteristics created the metric that if 3 or more intangible characteristics are identified, the characteristic is recorded as 'intact'.If less than 3 characteristics are identified, it would result in the sub-value being described as 'not intact'.

Table 12.0: Metric for assessment of intangible characteristics.

Intangible Characteristics		
Symbol	**Condition**	**Definition**
◆	Intact	3 or more intangible characteristics found
◆	Not intact	less than 3 intangible characteristics found

4.8.4 INTANGIBLE ASSESSMENT

The assessment details the reasoning behind each assigned intangible characteristics to the sub-values. As intangibles are more abstract, greater justification is required in the assessment. These are described as per the metric describes in Chapter 4.8.3.

Table 13.0: Condition of intangible characteristics across Sub-values.

Sub-value	Intangibles	Condition
1. Agricultural Production	**iii (knowledge):** knowledge as written histories of the wheatbelt. **vi (stories):** personal stories of living and working in the wheatbelt. **v (events):** agricultural shows, such as the 'Kellerberrin Agricultural Show' and the Merredin Field day. **viii (experiences):** increase in agricultural production with the supply of water caused a change in the experience of people in the region.	◆
2. Area of Service	**viii (experiences):** experience of water in the regions and working with water in industry (livestock, commercial, irrigation). There are many daily experiences associated with the supply of water in the regions serviced by the GWSS. **vi (stories):** stories of bursting pipes and maintenance conducted. **vii (images):** numerous photographic evidence depicting the repairs along the pipeline.	◆
3. 1903 Scheme	**iii (knowledge):** C. Y. O' Connor and his work is taught in schools and presented in: museums, interpretation and websites. Presented extensively in books and writings in 'A Thematic History of Western Australia', Clare Menck, 2017. **vi (stories):** local stories are captured in the 'Stories in the Pipeline'. **ix (symbols):** there are many pipes of the early scheme used in interpretation to act as symbols of the achievement.	◆

Sub-value	Intangibles	Condition
4. Represent.	**i (identity):** enduring symbol of innovation of the Water Corporation. **iii (knowledge):** websites such as the 'Golden Pipeline Heritage Trail'. Patents, plans and drawings of inventions programs within Pump Station Museums. **vi (stories):** Stories in the Pipeline document. **vii (images):** photographs of the pipeline archived in the State Library of Western Australia. **viii (experiences):** experiences of the conduit when driving to (or from) Kalgoorlie.	◆
5. Continuity of Service	**viii (experiences):** experience of water in the regions and working with water in industry (livestock, commercial, irrigation). There are many daily experiences of the service of this water in the regions. **vi (stories):** stories of bursting pipes and maintenance conducted. **vii (images):** numerous photographic evidence depicting the repairs along the pipeline.	◆
6. Pump Stations	**ii (ideas):** there are documented drawings of the Pump Stations, including plans sections and elevations, such as *'George Temple Poole -Architect of the Golden Years 1885-1897, Ray and John Oldham'*. **iii (knowledge):** there are numerous writings on the industrial architectural expression of the Pump Stations with well presented in educational material. The educational material elevates the importance of this as a representation of the whole system and purpose. Documentation captured in Conservation Management Plans also add to this knowledge. **viii (experiences):** some pump stations are museums, enabling public visitation and experiences (architecture and sounds of machinery ect.). **x (aesthetics):** Pump stations and drawings are intact and conserved, maintaining the aesthetic value of the place.	◆
7. Regulating Tanks	**iii (knowledge):** The regulating tanks are still in existence and the documentary evidence explains their role in the scheme. This is also documented in the Museum displays and existing interpretive information in No. 1 and No. 3 Museums. **vi (stories):** stories associated with regulating tanks.	◆

Sub-value	Intangibles	Condition
8. Reservoirs	**iii (knowledge):** well presented in museum material, online and interpretive material on site and in digital forms. Regular trips are made in educational programs to the weir, including the National Trust Program: *'The Australian Colonies No 1 Pump Station, Mundaring Weir'*. It is also well know by locals as a destination, where informal education may occur. There is a museum at the location of the Mundaring Weir. There are considerable public records of the place within archives as drawings, plans, reports and documents. **viii (experiences):** the Mount Charlotte Reservoir has a lookout as a tourist destination, many forming experiences of the Reservoir and its associated conduit. **vii (images):** considerable photographic archives are within the State Library of Western Australia of the weir across its lifespan.	◆
9. Size of scheme and use of new technology	**iii (knowledge):** The scheme in its entirety is discussed and presented widely in historical texts. The scheme is well documented in maps, drawings and historical records. Presentation of the technology and parts is in the Pump Station Museums. The original technical and design documents continue to be a resource for those interested in vast overland inter-basin water transfer systems. There is extensive knowledge of both Locking Bar and Kellerberrin pipe types. **vi (stories):** local stories are captured in the 'Stories of the Pipeline'. **viii (experiences):** The pipeline travels from Mundaring to Kalgoorlie, with many chance opportunities to experience the extent of the pipeline. **ix (symbols):** by virtue of its vast scale and innovative technology the place is a symbol of engineering innovation of the era, and the investment made by the State of WA and the Commonwealth in the pursuit of nation-building.	◆
10. Volume of steel	**iii (knowledge):** presented extensively in books and writings in 'A Thematic History of Western Australia', Clare Menck, 2017. Payments to the steel contractors and other data is within public record. Stories of the contracts and digital information are evident in 'The Golden Pipeline: Building the GWSS'. **ii (ideas):** steel was a major design consideration in the early development of the scheme based on the availability of this resource and its suitability for the task.	◆
11. Locking bar type	**iii (knowledge):** Mephan Ferguson and the locking bar is known widely and written in predominant historical accounts such as: *'The Golden Pipeline: pipes of the Goldfields Water Supply Scheme'*. There is extensive archival material in drawings, designs, documents of the locking bar. **ix (symbols):** the locking bar is abstracted to form the symbol of the Golden Pipeline Heritage Trail. **ii (ideas):** the creative and technical information on the locking bar is also presented in museums. **vii (images):** photographic material is in existence of the locking bar and how it was invented and made.	◆

Sub-value	Intangibles	Condition
12. Lifting of the pipeline	**iii (knowledge):** presented in interpretation and in public sections of the pipeline, including Fred Jacoby Park and The Mount Charlotte Lookout. There is considerable data relating to why the pipes were buried then lifted. **ii (ideas):** the creative and technical information on the lifting of the pipeline is also presented in museums. **viii (experiences):** : exist in relation to the extensive sections of elevated pipe that can still be experienced between Mundaring and Kalgoorlie.	◆
13. Anchorage	**iii (knowledge):** there is knowledge on the anchor blocks in digital formats, such as on the Golden Pipeline website. **ii (ideas):** there is documentation of the design of the anchorage as being 50m apart, along with technical drawings of the anchor blocks. **viii (experiences):** personal recounts and experiences in Fred Jacoby Park and other sites where elevated portions of the pipe. **x (aesthetics)**: the anchor blocks are extant and have an aesthetic presence and add to the industrial language developed by the pump stations, especially Pump Station No. 1.	◆
14. International Recognition	**iii (knowledge) and ii (ideas):** the 2009 'International Historic Civil Engineering Landmark' award by the American Society of Civil Engineers is presented in museums and websites.	◆
15 + 16. Charles Yelverton O'Connor Sir John Forrest	**iii (knowledge):** presented extensively in books and writings in 'C. Y. O'Connor: His Life and Legacy', A. G. Evans, 2002 and many other texts. C. Y. O' Connor and John Forrest his their legacy is presented in schools, museums, interpretation and websites. **ii (ideas):** the ideas and thoughts of both O'Connor and Forrest are known through their involvement in not only the pipeline but other significant projects and milestones in Western Australia's history. **vii (images):** multiple photographs and archived material exists within the State Library of Western Australia and other sources. **vi (stories):** oral histories exist of O' Connor and Forrest and their contribution to Western Australia.	◆

The intangible characteristics are intact across most sub-values, especially in terms of experience, knowledge and education. The spiritual and emotional aspects are mostly non-existent. It is to be noted that it is difficult to define and therefore assess these intangible characteristics. The presence of spiritual characteristics presents an opportunity for future interpretation, including the presentation of First Nations stories.

4.9 CONDITION OF NATIONAL HERITAGE VALUES

The National Heritage values have been defined, as part of the assessment for the National Heritage Listing, along with the sub-values. This Chapter completes the assessment of the condition of National Heritage values as a combination of the prior assessments of both tangible and intangible characteristics. The result is that the condition of the National Heritage values as a whole can be defined as 'strong' or 'weak' as of 2024. The following chapter defines the metric and provides the assessment of the condition of National Heritage values.

4.9.1 METRIC FOR THE CONDITION OF NATIONAL HERITAGE VALUES

The assessment of national values includes both tangible and intangible characteristics to determine the condition. The criteria for assessment of the condition of National Heritage values are:

Table 14.0: Criteria for assessment of condition of National Heritage values.

Indicator	Condition	Description
	Strong	Condition of the value is enduring.
	Weak	Aspects of the value are no longer present.

4.9.2 NATIONAL HERITAGE VALUES ASSESSMENT

The condition of National Heritage values is determined through the combination of both tangible and intangible assessments. If the tangible characteristics are unchanged and 'intact', then the overall National Heritage value can be seen as strong. If the tangible characteristics are weak, the intangible characteristics can maintain the strength of that value, and the condition overall can remain strong. This allows for intactness of both characteristics to be incorporated into the assessment and a more detailed assessment methodology to track both intangible and tangible characteristics of sub-values over time.

Table 15.0: Analysis of the condition of National Heritage values.

Value	Sub -Value	Tangible		Intangible		Overall
A	1. Agricultural Production	◆	◆	◆	◆	
	2. Area of Service	◆		◆		
D	3. 1903 Scheme	◆	◆	◆	◇	
	4. Representative	◆		◆		
	5. Continuity of Service	◆		◆		
	6. Pump Stations	◆		◆		
	7. Regulating Tanks	◆		◇		
	8. Reservoirs	◆		◆		
F	9. Size of scheme and use of new technology	◆	◆	◆	◇	
	10. Volume of Steel	◆		◇		
	11. Locking Bar	◆		◆		
	12. Lifting of the Pipeline	◆		◆		
	13. Anchorage	◆		◆		
	14. International Recognition	◆		◇		
H	15/16. C. Y. O'Connor + Sir John Forrest	◆	◆	◆	◆	

4.9.3 SUMMARY OF FINDINGS

Overall the condition of the National Heritage values for the GWSS is 'strong' in 2024. Some sub-values have been determined as not intact in either tangible or intangible characteristics, including 'Volume of Steel', 'Regulating Tanks' and 'International Recognition'. However, considering there are intact tangible characteristics, the condition of the National Heritage values as a whole is 'strong'.

4.9.4 LIMITATIONS

The authors acknowledge that there are limitations in the methodology that has been developed and used for assessment of the National Heritage values. However, by identifying specific sub-values and assessing their sub-values it provides a basis for future reviews to assess the condition of the values. We expect that this methodology and some of the definition, especially intangible characteristics, may be modified and refined in future assessments.

4.9.5 INTERCONNECTION OF INTANGIBLE AND TANGIBLE CHARACTERISTICS OF THE NATIONAL HERITAGE VALUES

While the tangible and intangible elements of values are presented separately in this section, they are intrinsically linked. The physical experience of the pipe insitu (tangible) will always be connected to the stories, memories, and experiences of people who inhabit the communities along the conduit's path (intangible). The separation of intangible and tangible allows for a detailed examination of the characteristics in play in relation to each National Heritage value in the specific context of the GWSS.

As a whole, the tangible aspects of the National Heritage Values are strong in 2024. With increasing work and undergrounding over the next 70 years, there is a need to guide the HMP on the key intangible characteristics to maintain and monitor their strength over time. The detailed table provides a means for identifying and monitoring intangible and tangible values. However, we recognise the complex relationships between the immaterial and tangible, along with the need to review the tables and strategies as more significant research and guidance emerge. The methodology and characteristics must be examined in future five yearly reviews of the HMP.

4.9.6 OPPORTUNITIES FOR INTERPRETATION

This assessment of the condition of National Heritage values assists with future opportunities for interpretation. Additional values, such as Aboriginal water farming can be explored in further interpretation and this research may strengthen the intangible characteristic 'spiritual', along with other intangible characteristics. The main conduit has most of its value as a continuous pipe, not necessarily as a series of parts and portions. The condition of this value is assessed as strong now, but in the future, the condition is likely to be affected by the removal of the main conduit. This means multiple pipe sections should be conserved as a part of the Interpretation Strategy. The Interpretation Strategy provides insight into how the values can be retained and conserved without the existence of fabric.

Image 46: Elevated Main Conduit in Fred Jacoby Park

Source: 'Elevated Main Conduit in Fred Jacoby Park', Courtesy of: Stephen Carrick Architects, 2024.

4.10 MONITORING THE FUTURE CONDITION OF THE HERITAGE VALUES

As the Action to remove the extant main conduit in accordance with EPBC Act approval 2019/85462 has not commenced, at the time of drafting this HMP, there has not been a significant change to the condition of National Heritage values of the main conduit. The condition of the heritage values (intangible and tangible) will need to be monitored when the Action is implemented, which will occur as part of the regular review of this HMP, or when any major changes are proposed, as per SECT 324W of the EPBC Act. Otherwise, the condition of National Heritage values should be internally re-assessed every 5 years by a similar methodology.

The National Heritage values remain predominantly strong as of 2024. The Action will impact on the future condition of the heritage values as it will directly affect the intactness and therefore the relative strength of both tangible and intangible characteristics.

PART B : MANAGEMENT POLICIES

This section of the plan sets out the context for the management of the heritage values of the GWSS.

- Chapter 5: Opportunities and Constraints
- Chapter 6: GWSS Current Use and Operational Requirements
- Chapter 7: Proposed Use and Works
- Chapter 8: Management Policies
- Chapter 9: Documentation, Monitoring and Review

Image 47: Unloading pipes from a train for the GWSS

Source: State Library of Western Australia, 1902, 000834D: Unloading pipes, 1902

CHAPTER 5: OPPORTUNITIES AND CONSTRAINTS

This section details the statutory context and other obligations, along with opportunities and constraints, that govern the management framework and decision making process relating to the main conduit.

Chapter 5 is to be read in conjunction with Part C, which details the implementation of this decision making process.

5.1 STATUTORY CONTEXT

The following section outlines the statutory context governing management of the GWSS.

5.1.1 ENVIRONMENT PROTECTION AND BIODIVERSITY CONSERVATION ACT 1999 (COMMONWEALTH)

The GWSS, which includes the pipeline, was included in the National Heritage List (NHL) (Place ID: 106007) on 23 June 2011. The inclusion in the NHL means that the Scheme is a Matter of National Environment Significance (MNES) and as such, is protected under the *Environment Protection and Biodiversity Conservation Act 1999* (Cth) and the *Environment Protection and Biodiversity Conservation Regulations 2000* (EPBC Regulations).

In conjunction with the *EPBC Act*, the *Environment Protection and Biodiversity Conservation Regulations 2000* (Regulations) offer guidance for adhering to the Act's provisions. Pertinent sections include Schedules 5A and 5B for National Heritage-listed sites.

This Heritage Management Plan (HMP) establishes a formal administrative process for evaluating actions pertaining to the day to day operations of the GWSS. Any action with potential to have a significant impact on the National Heritage values of a place included on the National Heritage List must be referred to the Federal Environment Minister for assessment. Further details of the Water Corporation's 'self-assessment' process used to determine what activities might trigger such a referral are included in Chapter 10. Actions consistent with this HMP do not require referral.

5.1.2 PLANNING AND DEVELOPMENT ACT 2005

Unless specifically exempt, development (including demolition) requires approval under planning schemes created under the *Planning and Development Act 2005*. Within the project area, each local government authority (except the Shire of Westonia) operates a local planning scheme, and in addition the Shire of Mundaring is subject to the Metropolitan Region Scheme (MRS).

Works to renew the main conduit are 'public works' and in accordance with section 6 of the *Planning and Development Act 2005* do not require approval under local planning schemes. While development approval is not required, section 6 requires Water Corporation to have regard to any advice from the relevant local authority. Accordingly, advice should be sought from local authorities when new works are proposed to ensure the works are consistent with orderly and proper planning, and the purpose and intent of any applicable planning scheme.

Within the Shire of Mundaring, development approval requirements will be determined on a case-by-case basis and will depend on the land tenure and relevant zoning in the MRS.

5.1.3 HERITAGE ACT 2018

When development approval is required under the *Planning and Development Act 2005*, and the proposal relates to a State Registered place, the decision-making authority under the relevant planning scheme must refer the proposal under section 73 of the *Heritage Act 2018* to HCWA for advice. Where development approval is not required under a planning scheme, Water Corporation becomes the 'decision maker' for the purpose of section 73 and must make that referral directly to HCWA.

The Goldfields Water Supply Scheme was included on the State Register of Heritage Places on 8 December 2022. The majority of the above ground pipeline main conduit running adjacent to Great Eastern Highway en route from Mundaring to Kalgoorlie is not included in the curtilage of this place. The Registered Curtilage of the GWSS is included at Appendix H.

Any development (including works to the main conduit) within the Registered Curtilage of the GWSS and specific 'adjacent works' must be referred to the HCWA for advice in accordance with section 73.

5.1.4 ABORIGINAL HERITAGE ACT 1972

In Western Australia the *Aboriginal Heritage Act 1972* protects places and objects of importance and significance to people of Aboriginal descent in Western Australia. Where there is potential to impact an Aboriginal Site, prior authorisation is required from the Western Australian Registrar of Aboriginal sites and/or consent of the Minister for Aboriginal Affairs in accordance with sections 16 and 18 of the *Aboriginal Heritage Act 1972*.

All construction, maintenance and investigative works must be assessed by Water Corporation's Aboriginal Heritage and Native Title Section. This will involve an Aboriginal Heritage and Native Title Impact Assessment to determine all required approvals as required under the *Aboriginal Heritage Act 1972 (WA), the Native Title Act 1992* and any Indigenous Land Use Agreements (ILUAs) for the proposed activities.

5.1.5 OTHER LEGISLATION AND POLICY

Water Corporation's activities in relation to the GWSS main conduit (and generally) are regulated by a range of legislation in addition to the heritage related legislation noted above. To ensure compliance with regulatory requirements Water Corporation has a dedicated 'External Approvals' team and *External Approvals Manual*, available to Water Corporation staff and contractors.

A summary of this HMP, covering responsibilities and actions, are to be included in the External Approvals Manual.

5.1.6 GUIDELINES FOR STATE HERITAGE (VERSION 2021.3, UPDATED OCTOBER 2022)

The State Government (including Government Trading Enterprises like the Water Corporation) is the largest single owner of heritage places in Western Australia, responsible for managing around one third of places entered in the State Register of Heritage Places.

In 2022 Heritage Council of Western Australia (HCWA) assessed the GWSS, including the main conduit, for inclusion in the State Register. Given this assessment has occurred, there is no further requirement to refer proposals for demolition of the main conduit to HCWA, unless the proposals sit within the curtilage of a State Registered place (e.g. the old pumping stations). It is possible future reviews of the Register Entry for the GWSS will consider inclusion of sections of the main conduit identified for conservation in this HMP.

5.2 RESPONSIBLE PERSON(S)

Table 16.0: Summary of Responsibility in Enacting Frameworks and Policies.

Framework(s)	Approval Advice:	Responsible Person:
EPBC Act	Water Corporation: Property Portfolio	Water Corporation: Project Manager Conducting Works
Planning and Development Act	Water Corporation: Property Portfolio	Water Corporation: Project Manager Conducting Works
Heritage Act	Water Corporation: Property Portfolio	Water Corporation: Project Manager Conducting Works
Aboriginal Heritage Act	Aboriginal Affairs and Native Title Manager	Water Corporation: Project Manager Conducting Works
Other	Water Corporation: External Approvals	Water Corporation: Project Manager Conducting Works
Guidelines for State Government Heritage	Water Corporation: Property Portfolio	Water Corporation: Property Portfolio

5.3 OPPORTUNITIES

5.3.1 OPPORTUNITIES OVERVIEW

The following opportunities have been identified for the management of the GWSS of the National and State Heritage values. The GWSS and its continued service offer the following opportunities:

1. High Integrity

The GWSS remains an operational water supply scheme and retains a high degree of integrity, with each of the sixteen elements included on the National Heritage List remaining largely intact. The ongoing operation and expansion of the scheme will ensure its continued integrity into the future.

2. High Authenticity

The GWSS continues to express a high degree of authenticity as an operational water supply scheme. The Western Australian government, in 2024, has announced major upgrades to the scheme, which will ensure its ongoing function into the future.

3. Interpretation Potential

While demolition of the extant main conduit will result in a loss of pipe fabric, numerous opportunities exist to interpret its heritage values and to retain representative examples of pipe fabric at strategic locations along the 566 km length of the pipeline. Twenty-seven locations have been identified for pipe conservation, refer Chapter 7 and *H + H Architecture's Interpretation Strategy*, in Appendix C.

4. Conservation Knowledge

Water Corporation has a sound understanding of how to conserve heritage pipe fabric. Conservation is detailed in a Technical Note that forms part of this HMP (refer Appendix I[1]). This knowledge has

1 Appendix I -Stabilisation Technical Note

been developed from pipe conservation projects that have previously been completed at Clackline and Dedari, demonstrating the successful implementation of conservation of decommissioned pipe.

5. Extant Fabric

A significant quantity of historic main conduit fabric remains in operation (43 % of original locking bar and 5% Kellerberrin) and additional sections of decommissioned pipe are located in storage. Details of the location and age of pipe fabric are recorded and captured in Water Corporation's Geographic Information System (GIS).

6. 70 year Vision

The very long-term vision to upgrade the GWSS, reflected in the 70 year EPBC Act approval (EPBC 2019/8547), will ensure cumulative impacts to the National Heritage values of the GWSS are appropriately managed through time. The regular review of this *HMP* and *Interpretation Strategy* will ensure management of the scheme responds to community expectations and preserves its heritage values for future generations.

7. Extensive available information

There is a wealth of information available on the GWSS, which with the National Trust's Golden Pipeline Heritage Trail, provides the building blocks for future conservation and interpretation initiatives.

8. Collaborative relationships

The Water Corporation has a close relationship with the National Trust (WA) and maintains regular management meetings between staff.

9. GWSS State registration

In 2022, the GWSS was included in the Western Australian State Register of Heritage Places. While there are differences in the spatial extent and heritage values defined in the State and National Heritage Lists, the recent inclusion of the GWSS as a single place on the State Register improves consistency between the State and Commonwealth regulatory frameworks and, notably, ensures that any impacts to a part of the GWSS consider those impacts in the context of the entire scheme.

Image 48: Image of the GWSS near Mundaring

Source: 'Image of the GWSS near Mundaring', photograph taken near Mundaring, Courtesy of: Stephen Carrick Architects, 2024.

5.4 CONSTRAINTS

The following constrains must be considered in management of the National Heritage values of the GWSS:

- The sheer scale of the 566 km pipeline and the remote locations through which it travels present significant cost challenges.
- Decommissioned heritage pipeline is not stable, as described in the Water Corporation's Technical Note (Refer Appendix I). Stabilisation of decommissioned pipe requires extensive works, including re-pouring of concrete anchors to stabilises the pipe, which is known to present a significant cost. This cost is exacerbated by the remote location of much of the main conduit.
- A significant portion of the main conduit is located immediately adjacent to Great Eastern Highway, the main arterial route between Perth, the goldfields and the eastern states. There have been numerous instances of vehicular impacts to the above ground main conduit. The high-speed environment of Great Eastern Highway also presents safety issues to the public, and therefore limits the location of interpretive sites to where safe access can be provided.
- The proximity of the above ground main conduit to Great Eastern Highway is often incompatible with road safety initiatives, for example drainage improvements, road widening, or the introduction of dual carriageway or overtaking lane sections.
- Much of the alignment of the main conduit runs through land not owned or controlled by Water Corporation, including Prospector rail corridor, Great Eastern Highway, and private farmland.
- Significant lengths of the main conduit pipe were historically dipped in coal tar, which is now known to contain Polycyclic Aromatic Hydrocarbons (PAHs). PAHs are harmful to human health, and where they are present, main conduit pipeline cannot be offered to the community for heritage or artistic re-use.
- Soil conditions can be an impediment to the long-term conservation of steel pipe, particularly in salt lake locations, which are common in the eastern wheatbelt.

5.5 DECISION MAKING PROCESS

As this HMP responds to Water Corporation's 70 year approval to demolish the extant main conduit, the decision making process is very much focussed on ensuring that interpretation is undertaken as the pipeline is gradually demolished, and that representative portions of the pipeline are conserved that best represent its National Heritage values. There is also a desire to create effective Interpretation Strategies to best incorporate growing stories and values identified regarding the GWSS.

Chapter 7 details how and why representative sections of the main conduit have been selected for conservation.

Chapter 8 details the Water Corporation's policy position on conservation and interpretation.

Part C - Chapter 10 includes an Action Proposal Process that will ensure day to day activities conserve the heritage values of the GWSS, and how and when conservation and interpretation initiatives will be implemented.

CHAPTER 6: PUBLIC USE AND ACCESS

6.1 OPERATOR REQUIREMENTS

The GWSS is the main water supply for the goldfields and wheatbelt. Providing drinking water safely and efficiently is the primary operational consideration of the main conduit, and to do so the pipeline must be maintained, repaired, and upgraded.

6.2 CURRENT USE

The following briefly describes the sites that are publicly accessible along the length of the GWSS and their current use.

6.2.1 MUNDARING WEIR

Mundaring Weir is a concrete gravity dam that forms the storage reservoir for the GWSS. It is part of the Golden Pipeline Heritage Trail (GPHT) and serves as the primary source of drinking water for the goldfields. The area is popular for picnics and tourism, with a signposted walk outlining its history. The main conduit begins at this site and carries water from the reservoir to the goldfields.

6.2.2 PUMP STATION NO. 1

Pump Station No. 1 is the first in a series of pumping stations transporting water from Mundaring Weir to the goldfields. It originally housed three engines (the Worthington-Simpson triple expansion engines), but today, just one remains, making it the only engine of a three-pump pumping station. Other original components of the No. 1 Pump Station, including the three Babcock and Wilcox boilers and accompanying Green's Economizer, are still insitu. According to The National Trust of Western Australia (NTWA),

> *"the boilers are in an excellent state with features such as explosion doors and pressure gauges still intact".*

Pump Station No. 1 is a museum open to the public. The National Trust also have a separate education centre within the broader site.

6.2.3 SITE OF PUMP STATION NO. 2

Pump Station No. 2, located 2.5 km from Pump Station No. 1, stopped operating in 1956 and was demolished in 1968. In 2024, the site is publicly accessible and features signs showcasing its original operations. It is part of the O'Connor Trail and the Kep Track.

6.2.4 PUMP STATION NO. 3

The former GWSS Pump Station No. 3 in Cunderdin is now a museum and heritage site. It operated until 1956 when a new electric pump station was opened, after which it housed a cement factory. In 1973, it was converted into a public museum, featuring a pump from station No. 7 for display. The original caretaker's cottage is now used as a storage room for the local golf club.

Other heritage sites around this section of the GPHT from Mundaring to Cunderdin include the Poole Street Bridge, the Old Northam Railway Station and the Meckering Earthquake Display.

6.2.5 PUMP STATION NO. 4

The No. 4 Pump Station in Merredin was the last of the larger 'three-pump' stations, and it ceased operating in 1956. The building is jointly vested with the National Trust and Shire of Merredin. Nearby GPHT sites include Merredin Peak.

6.2.6 PUMP STATION NO. 5

The No. 5 Pump Station in Yerbillon was the first of the smaller pump stations, initially with just two pumping sets. Only four structures were built at first, including three engineers' residences and a barracks for single men. Additional houses were constructed as needed.

The houses were strategically placed away from the pump building, separated by bushland and the reservoir, likely to reduce noise and dirt. While the houses have been demolished, the site contains archaeological evidence of the former pumping station community.

Parts of the site, including the pumping station, are currently fenced off due to asbestos contamination. The Water Corporation is planning the site's remediation. An archaeological survey supported the referral and included provision for an archaeological park.

6.2.7 PUMP STATION NO. 6

The No. 6 Pump Station at Ghooli on the outskirts of Southern Cross still stands, with remnants of the coal bin and a weighbridge. Remediation works have recently been completed to remove asbestos contamination in the soil surrounding the site.

6.2.8 SITE OF PUMP STATION NO. 7

The stretch of road from No. 6 Pump Station to No. 7 in Gilgai was known as 'Siberia', due to the vastness and isolation of the area. Pump Station No. 7 is now a site only, as neither the building nor its contents are still standing. The only remnant of the pump station is the receiving tank that once received water from Pump Station No. 6.

The heritage trail in this area includes the Karalee Rocks, a massive aqueduct and earth tank capable of holding 50 million gallons of water, which was designed to service prospectors and other travellers' who stopped there on their way between Coolgardie and Southern Cross.

6.2.9 PUMP STATION NO. 8

Located in Dedari, the No. 8 Pump Station was the last of the steam-powered pump stations to continue operating, closing in 1970. It remains the most intact of all the original GWSS pump stations. The building and its contents – two boilers, two engines and pumps – are still standing, as are many surrounding structures, from the steel chimney 'coal bin' and weighbridge to the blacksmith shop with its blacksmith's forge, the engineer's office and meter house. Although only one 1950s house remains, the line of housing allotments is extant. A tennis court and BBQ area were previously located at the western end of these allotments.

Water Corporation has recently completed remediation works to remove asbestos contamination from the soil surrounding the pumping station and has completed a display of stabilised 'heritage pipe' to 'road test' pipe conservation measures that Water Corporation will apply to other sections of main conduit pipe along the pipeline.

The National Trust manages the Pump Station and worker's cottage.

6.2.10 MOUNT CHARLOTTE RESERVOIR

Mount Charlotte Reservoir is still in use, but only as a reserve tank. There is a Reservoir Lookout at the summit, and as a heritage site included on the Golden Heritage Pipeline Trait (GPHT), it features interpretive signage to help communicate the history of the GWSS to the public.

6.2.11 OTHER SITES

Another State heritage-listed site on the GPHT between Dedari and Coolgardie is the old town site of Bullabulling, which had a railway dam and hotel. As stated above, Bullabulling held water pumped from the No. 8 Pump Station, which was then supplied to Mount Charlotte. In the 1890s, it was a popular stopping place for prospectors and workers on the GWSS.

Image 49: Aerial view of Mt Charlotte reservoir and surroundings, 1935

Source: '041238PD: Mt Charlotte reservoir, 1935', Stuart Gore Collection, State Library of Western Australia, 1935.

6.3 COMMUNITY INVOLVEMENT AND REVIEW

Water Corporation engaged H+H Architects to undertake a public research project, '*Stories in the Pipeline'*. H+H Architects identified the community history and memories associated with the Goldfields Water Supply Scheme. This was completed as part of meeting the conditions of the *EPBC Act approval 2019/8547*.

The aim was to collect all the 'water stories' that are associated with the pipeline and the Goldfields Water Supply Scheme, acknowledging the varied meanings that this feat of engineering holds for the community of WA and how these meanings might be retained and interpreted as the pipeline in stages over the next 70 years.

The project received many submissions from the public, some of which shared memorabilia, family photos and newspaper clippings, which were delivered to H+H Architecture locations in Albany, Bunbury and Kalgoorlie. Follow up interviews were also conducted either remotely or in-person to ensure that many personal stories as possible were captured.

A variety of engagement methods were used to attract submissions, including a week-long road show conducted by community engagement personnel travelling eastward from Mundaring to Kalgoorlie-Boulder. This included visits to local community hubs situated along the pipeline to facilitate more informal meetings and interviews, amongst many other engagement activities.

The findings from this project has been presented in a research report, Stories in the Pipeline. This research report has directly informed the preparation of this HMP and Interpretation Strategy. The draft HMP and Interpretation Strategy was published for public and agency comment, with four weeks for comment. The comments received during this review period have been taken into consideration. The HMP was then presented to the Australian Heritage Council for endorsement. Water Corporation will continue to work closely with local government, the National Trust, HCWA and the broader community in future reviews of the HMP.

Additional community engagement is required for the ongoing implementation of the HMP. The five-year review process will enable community comment and these review points will also allow for additional consultation with key stakeholders.

In addition to these considerations of sites and regions, a series of policies have been developed to strengthen the management of the main conduit and the policies presented in the previous HMP. These are discussed in Chapters 8 and 9.

Image 50: Meeting with Judumul Aboriginal Corporation.

Source:Meeting with Judumul Aboriginal Corporation, Coolgardie. H+H Architects, 2023.

CHAPTER 7: CONSERVATION

7.1 BACKGROUND

EPBC Act approval 2019/8547[1] provides for removal of the extant main conduit. Notwithstanding, the Water Corporation recognises that in addition to intangible interpretation, there is an important role for physical pipe conservation to convey the National Heritage values of the GWSS.

The physical pipe conservation proposals of this HMP build on the concepts introduced in the 2016 HMP and seek to preserve both sections of aboveground pipeline 'insitu' (whether operational or not), and provide Interpretive Sites, where decommissioned sections of pipe fabric are 'presented' in an educational manner in locations that are accessible to the public and that meet the policy objectives of this HMP.

While the 2016 HMP sets out criteria for when pipe conservation should occur, this wasn't defined spatially. The current HMP spatially locates the conserved pipe (both 'insitu' and 'presented'), which will be implemented based on an updated set of criteria. This pipe conservation now forms part of the *Interpretation Strategy* (see Appendix C).

Chapter 7 details the criteria for physical pipe conservation and the methodology used to identify sections of the main conduit to be conserved in perpetuity. This section is to be read in conjunction with Chapter 8 (Heritage Management Policy) and the Interpretation Strategy (see Appendix C), which together specify how, why, and when the conservation of non-operational heritage pipe will occur.

These conservation initiatives are essential to conveying the GWSS's National Heritage values and the pipe's relationship to place. These relationships are understood through consultation with stakeholders at conservation sites, which is important to the development of Interpretation Plans at the 27 selected sites.

7.2 PIPE CONSERVATION

7.2.1 PIPE CONSERVATION CRITERIA

Pipe conservation criterion respond to the impact of the Action on the National Heritage values of the GWSS, in particular:

- Criterion A: the pipeline was essential for the development of the towns and regions it traverses and for the overall progress of the nation.
- Criterion D: The pipeline is a key characteristic of the GWSS and is crucial in showcasing the principal features of this cultural site.
- Criterion F: The pipeline is important for demonstrating high technical achievement in creating the GWSS.
- Criterion H: The pipeline is associated with notable figures, including C. Y. O'Connor and Sir John Forrest.

1 Appendix D-EPCB Act referral EPBC 2019/8547

7.2.2 PIPELINE SELECTION STRATEGY

In response to the above criterion the following was considered in selecting locations to conserve main conduit pipe fabric:

- Pipeline to be conserved should be visible from the public domain, especially Great Eastern Highway (Criterion A, Criterion H).
- Both 'insitu' and 'presented' pipe conservation should occur at regular intervals along the 566 km length of the main conduit to reinforce the scale of the pipeline in the landscape and the technical achievement that was required to undertake a project of this magnitude (Criterion D, Criterion F).
- Both 'insitu' and 'presented' pipe conservation should be located on or near the historic alignment of the pipeline (Criterion A).
- Representative sections of pipeline should be conserved in each local government area along the length of the pipeline and where pipeline fabric is important to a townscape (Criterion A).
- The pipeline should be conserved where it has unique landscape qualities (e.g., over the Darling escarpment's rolling hills) (Criterion A, Criterion D).
- Examples of innovative pipe technology, including Locking Bar and Kellerberrin pipe, should be included at 'presented sites' where there is an opportunity for the public to appreciate the technological innovations used in the GWSS (Criterion F) and associations with notable persons (e.g. Mephan Ferguson) (Criterion F and H). The particular pipe fabric is less critical for longer sections of pipeline to be conserved 'insitu' for their landscape qualities, which will often be viewed at a distance and speed (110 km/h) from the Great Eastern Highway.
- Pipeline should be conserved in locations where it can be read in conjunction with other elements that make up the GWSS (Criterion D) .
- Opportunities to conserve sections of pipeline should be considered where they can be co-located with other heritage places that help to tell similar or synergistic stories about the development of the goldfields and wheatbelt region of Western Australia (Criterion A). Practical benefits include the utilisation of existing infrastructure such as road access, walking trails and parking.

7.2.3 CONSTRAINTS FOR CONSERVATION

The following constraints were also considered when determining the location of pipe conservation initiatives:

- Safe public access from Great Eastern Highway is essential, especially for sections of 'presented pipe' where there is an opportunity for members of the public to interact with the pipeline close up at an interpretive site.
- Land access and land tenure considerations.
- Geotechnical conditions that are favourable to the long-term retention of steel pipe (i.e. not on the salt lakes).
- Potential Polycyclic Aromatic Hydrocarbons (PAH) contamination.
- Pipeline immediately adjacent to Great Eastern Highway has generally been avoided for conservation initiatives as this is incompatible with future road upgrading requirements and safety measures.

7.3 PIPE CONSERVATION METHODOLOGY

The team from Stephen Carrick Architects travelled along the Pipeline from Mundaring to Kalgoorlie and conducted a Graded Zones Analysis to identify Priority Conservation Investigation Areas. These areas were then discussed with H+H Architects to ensure that the locations for pipe conservation would align with potential interpretation projects outlined in the *Interpretation Strategy*. This process also considered the feedback received from public consultations by H+H Architects as part of the public research project *Stories in the Pipeline*. The project is considered to be a part of the site selection process. Eighty three potential pipe conservation locations were superimposed on aerial maps and presented to the Water Corporation.

The Water Corporation used a Geographic Information System (GIS) to import spatial data to analyse potential pipe conservation locations. They developed a GIS web application to assess these locations against social, historical, and environmental data, land tenure and operational considerations. The application helped Water Corporation evaluate conservation proposals, and they held workshops to refine the proposed list and add new conservation sites. The end result of the mappings are found below. The details of the conservation proposals are summarised in the following section and mapped out in Appendix 1 of the *Interpretation Strategy*.

Image 51: Karalee Rocks, National Trust of Western Australia

Source: Places to Visit: Golden Outback, National Trust of Western Australia website, accessed 2023.

7.4 SELECTED SITES

7.4.1 MAPPING OF SELECTED SITES

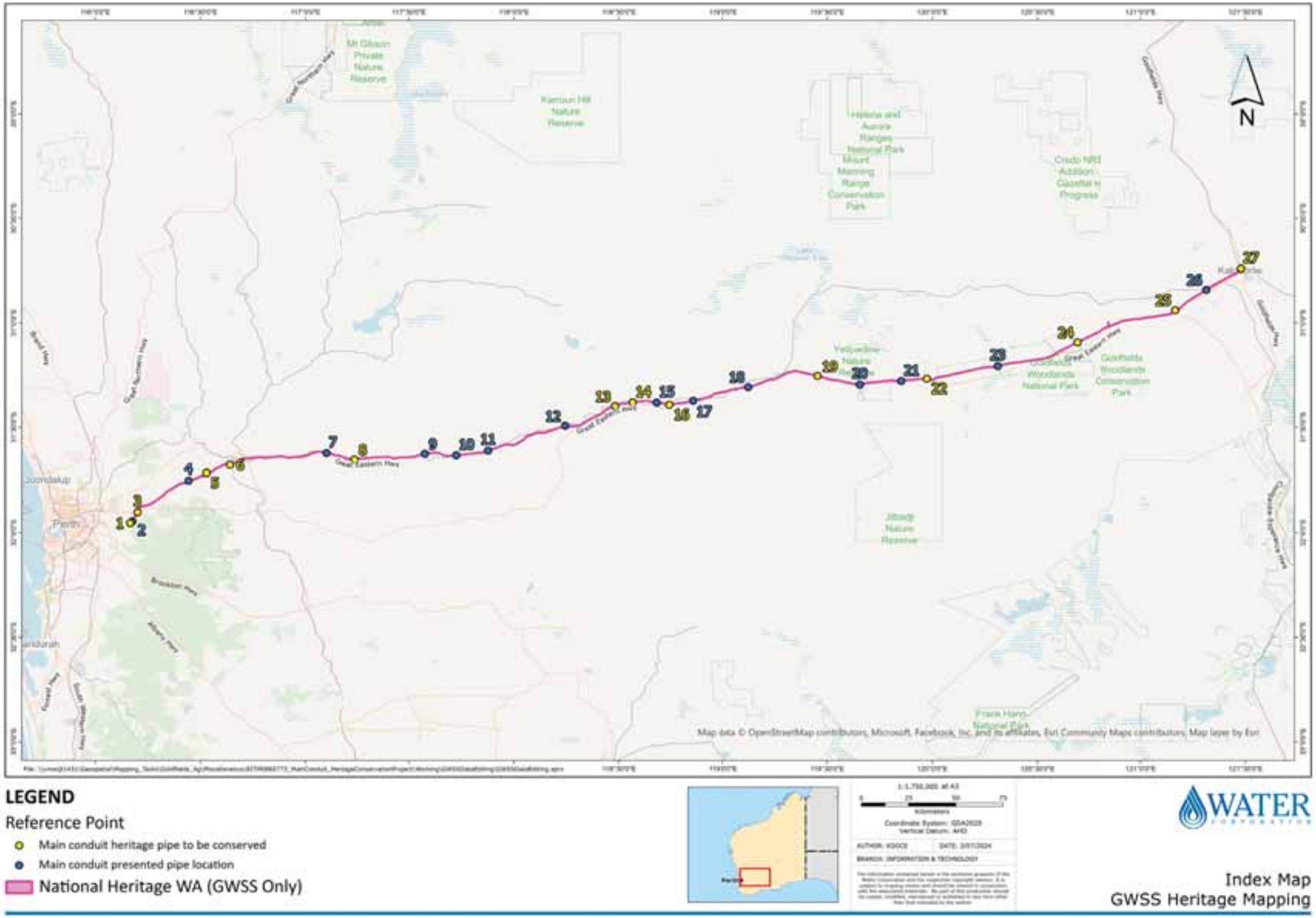

Figure 7: Water Corporation, Overview of Mapping of the main conduit at the 27 locations.

Source: Water Corporation, 2024.

Figure 8: Water Corporation Map 1

Source: Water Corporation, 2024.

Figure 9: Water Corporation Map 2

Source: Water Corporation, 2024.

Figure 10: Water Corporation Map 3

Source: Water Corporation, 2024.

Figure 11: Water Corporation Map 4

Source: Water Corporation, 2024.

Figure 12: Water Corporation Map 5

Source: Water Corporation, 2024.

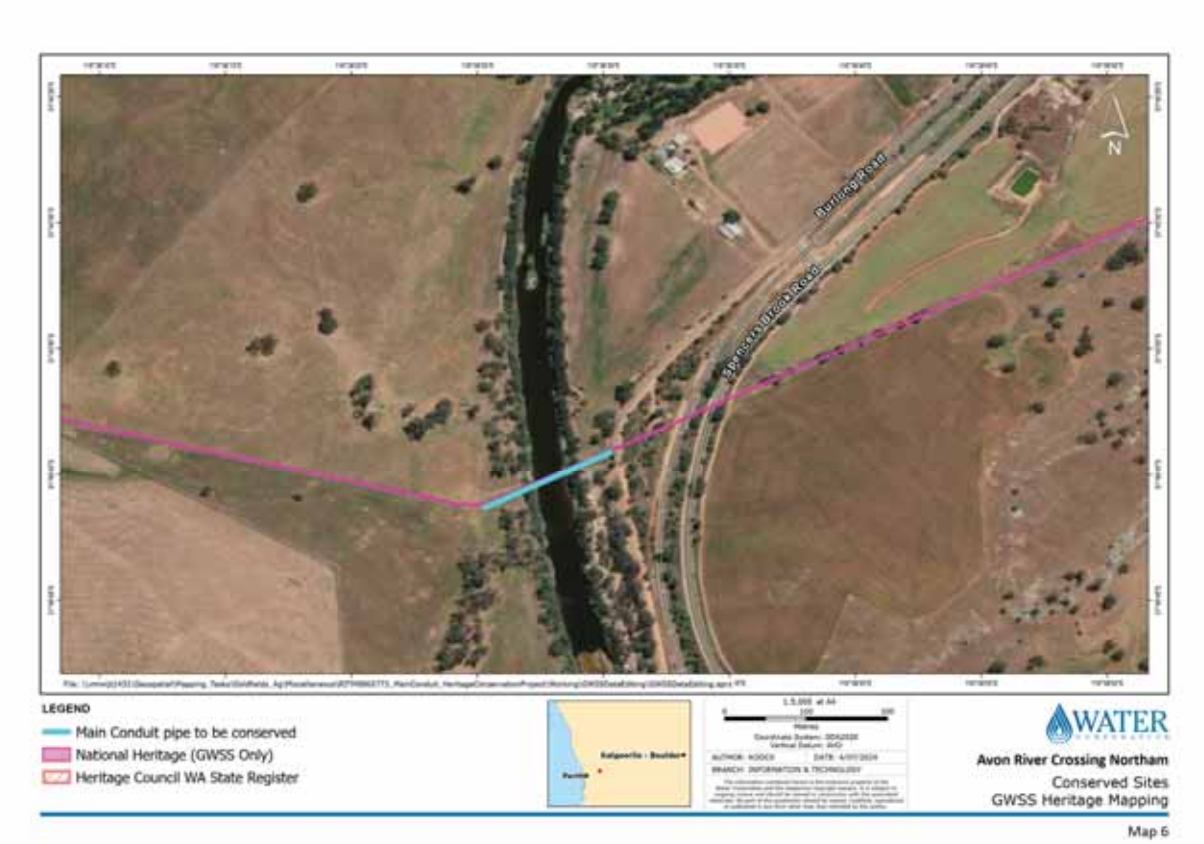

Figure 13: Water Corporation Map 6

Source: Water Corporation, 2024.

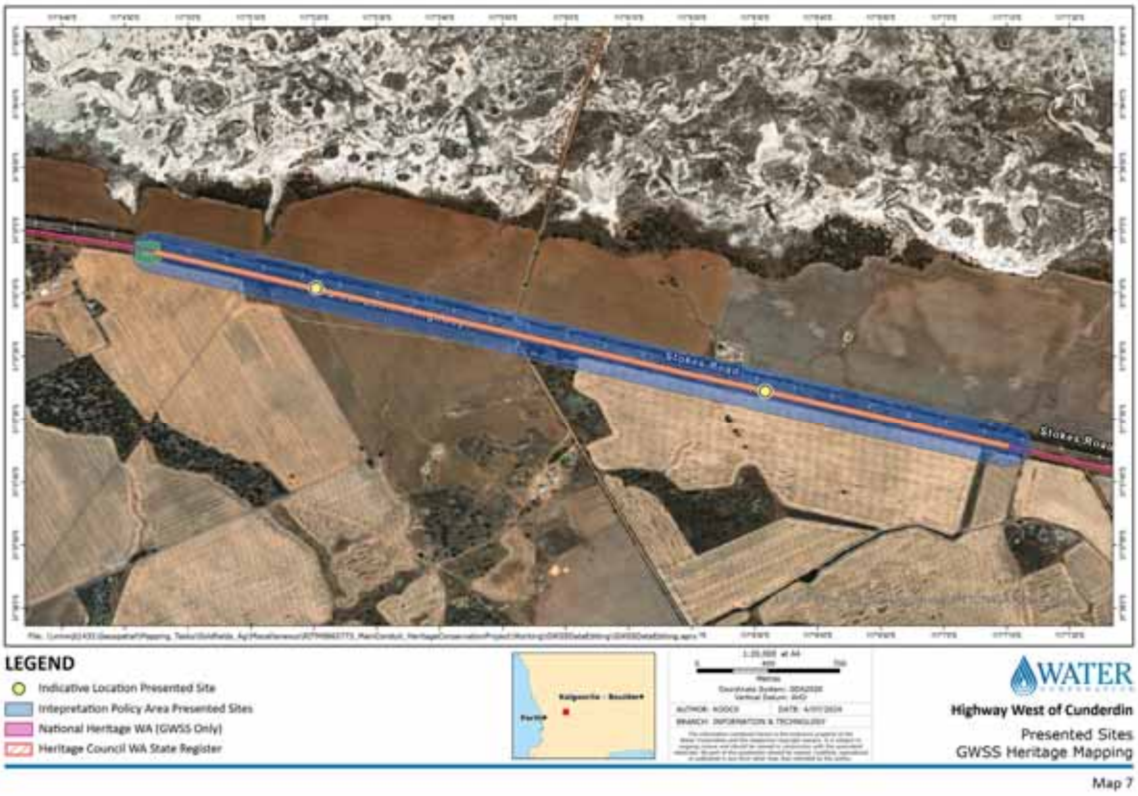

Figure 14: Water Corporation Map 7

Source: Water Corporation, 2024.

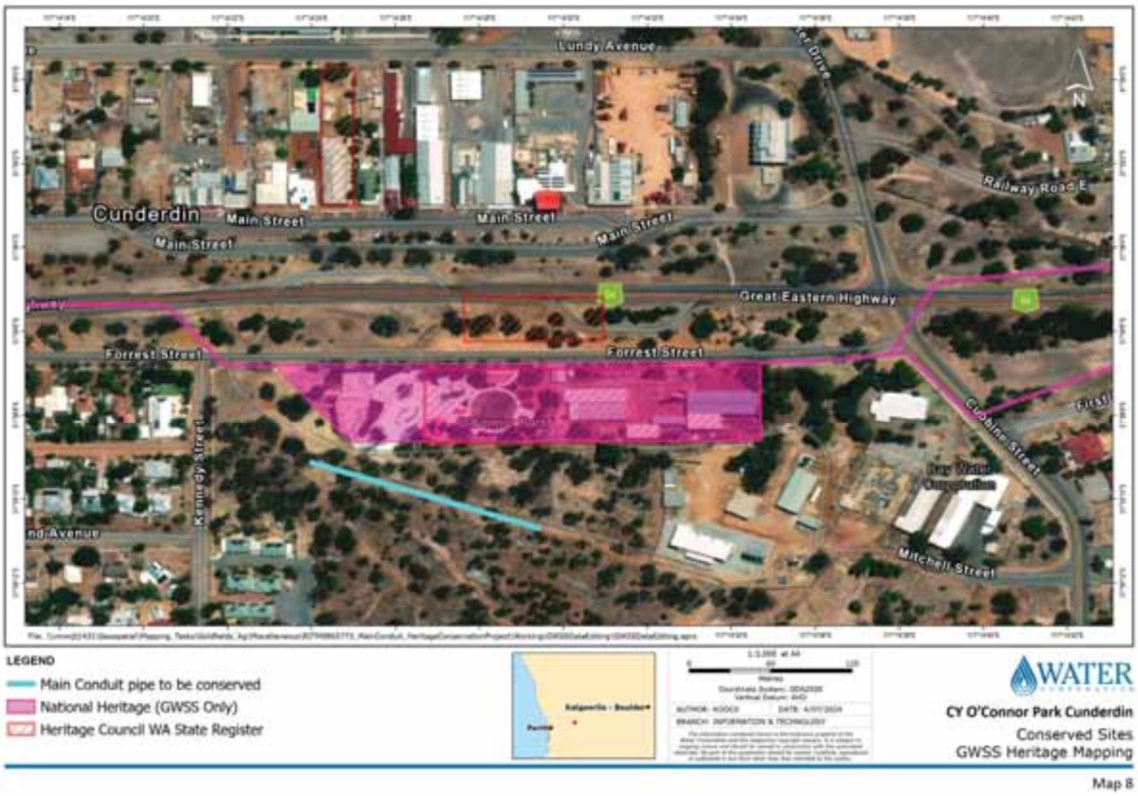

Figure 15: Water Corporation Map 8

Source: Water Corporation, 2024.

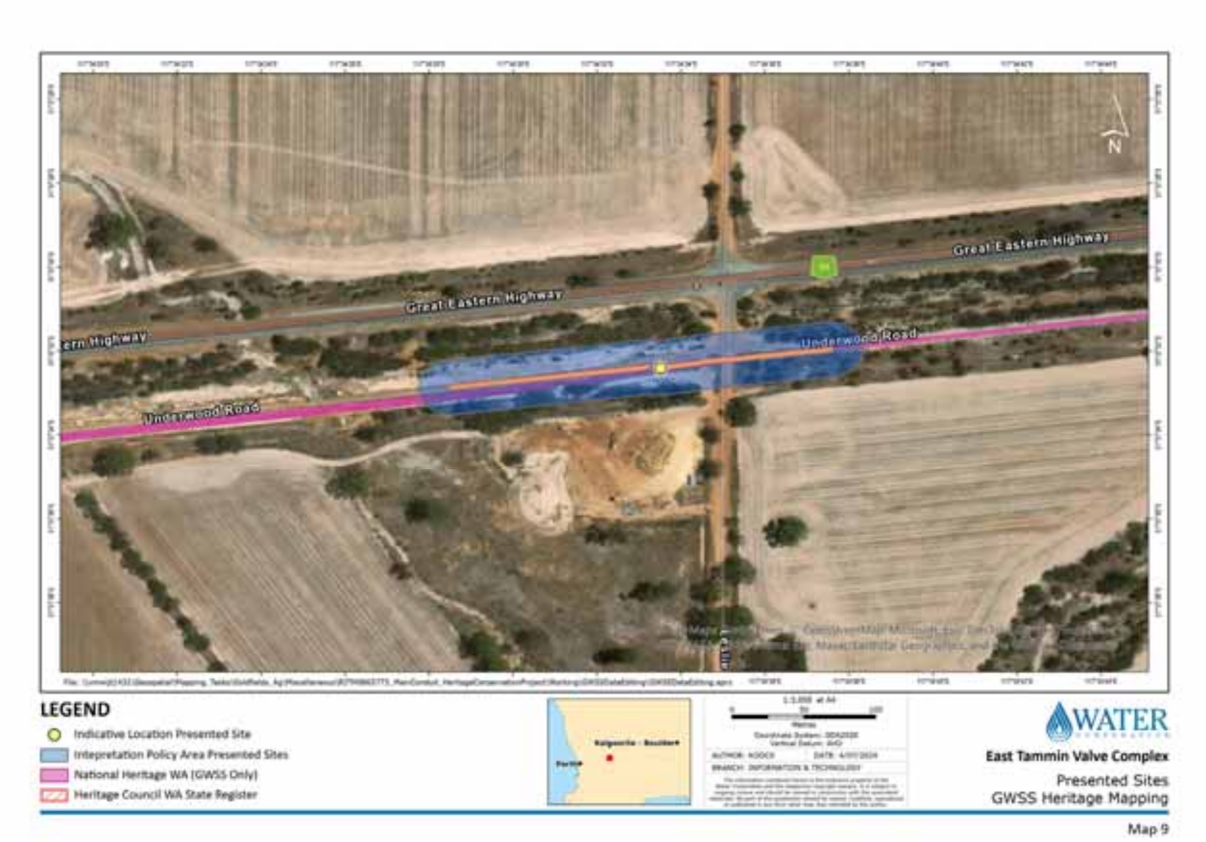

Figure 16: Water Corporation Map 9

Source: Water Corporation, 2024.

Figure 17: Water Corporation Map 10

Source: Water Corporation, 2024.

Figure 18: Water Corporation Map 11

Source: Water Corporation, 2024.

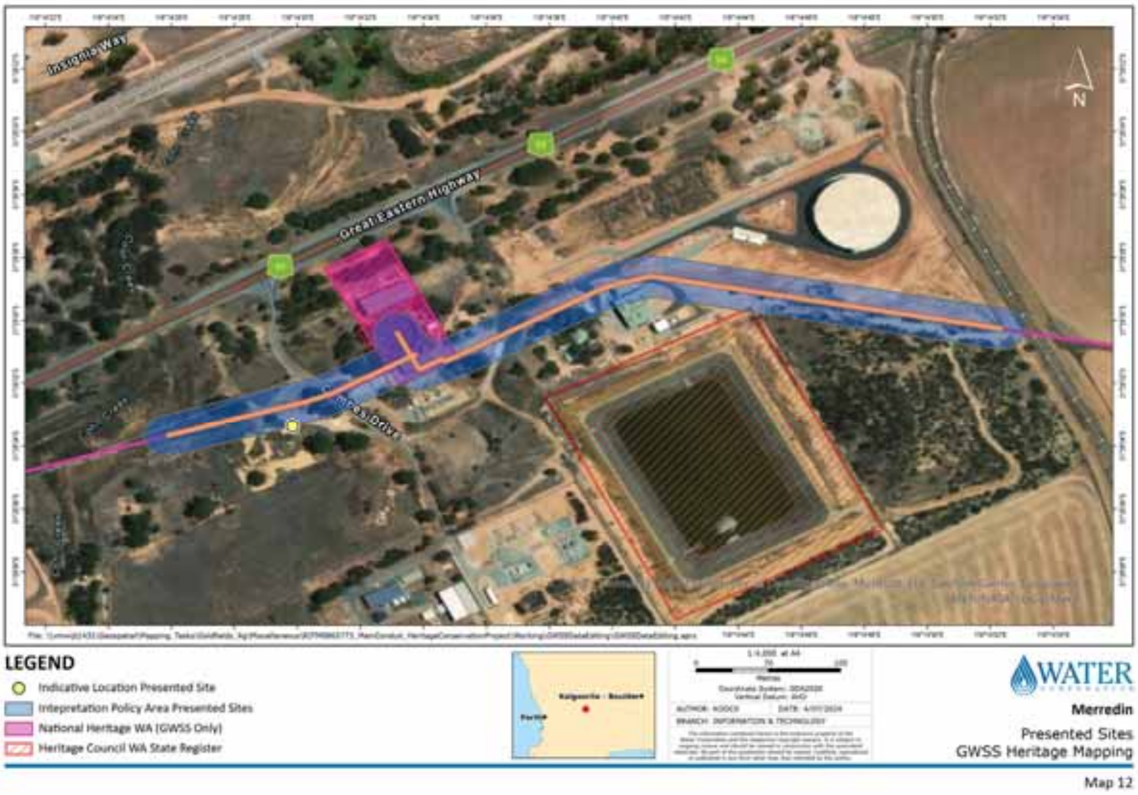

Figure 19: Water Corporation Map 12

Source: Water Corporation, 2024.

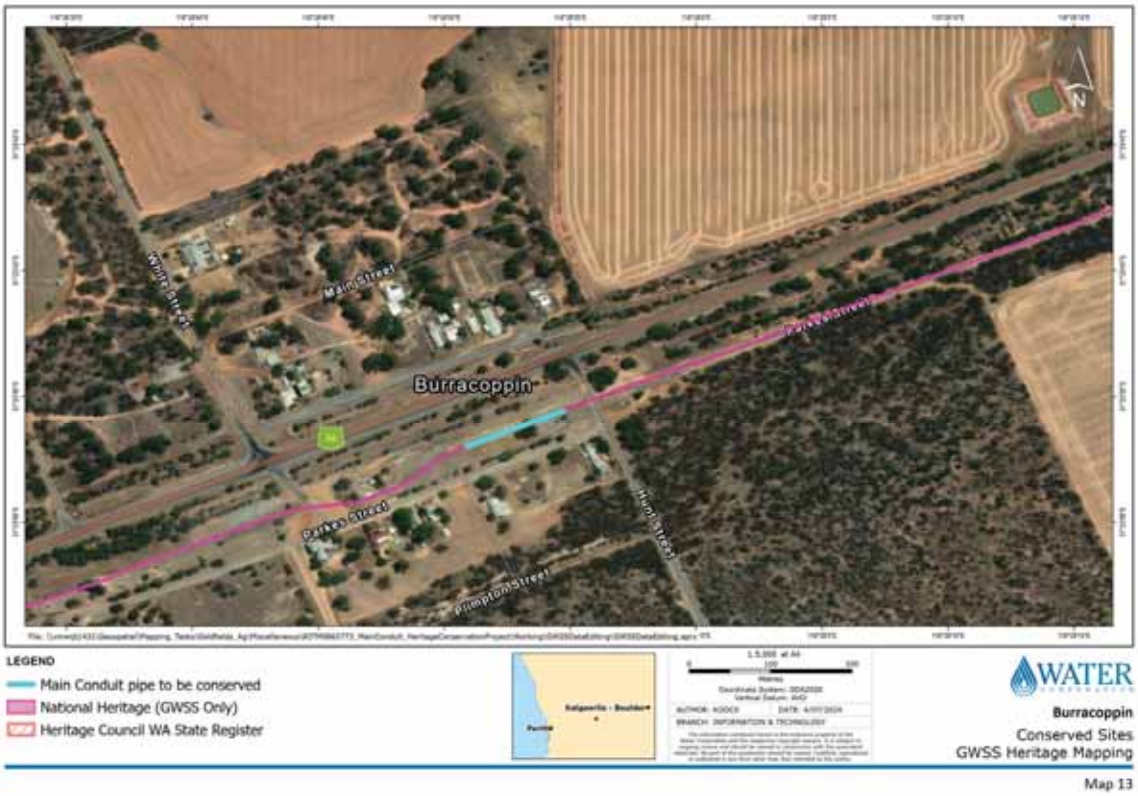

Figure 20: Water Corporation Map 13

Source: Water Corporation, 2024.

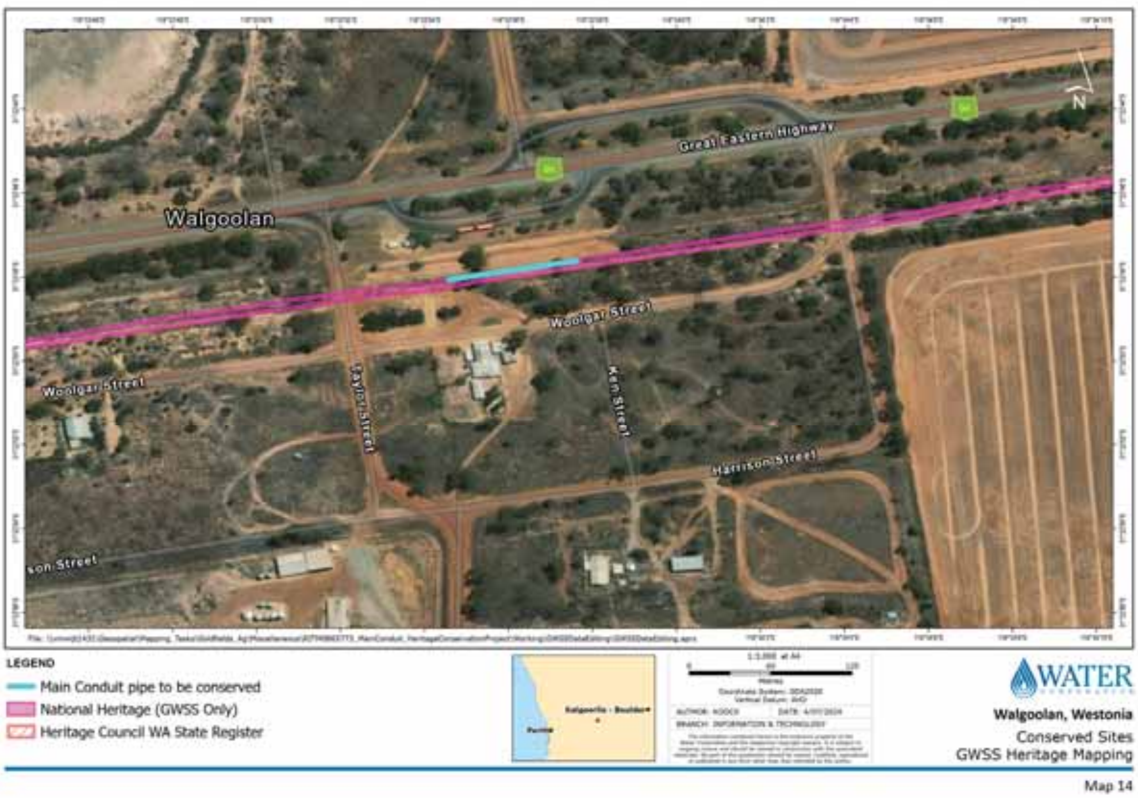

Figure 21: Water Corporation Map 14

Source: Water Corporation, 2024.

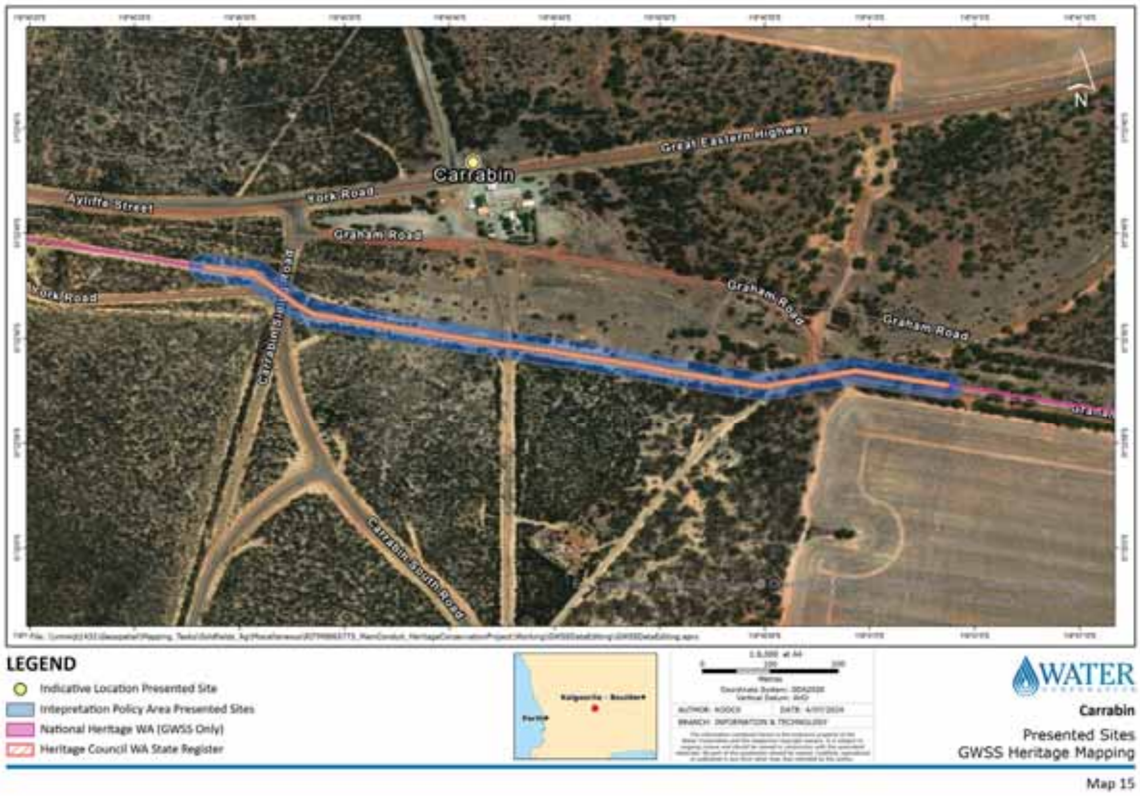

Figure 22: Water Corporation Map 15

Source: Water Corporation, 2024.

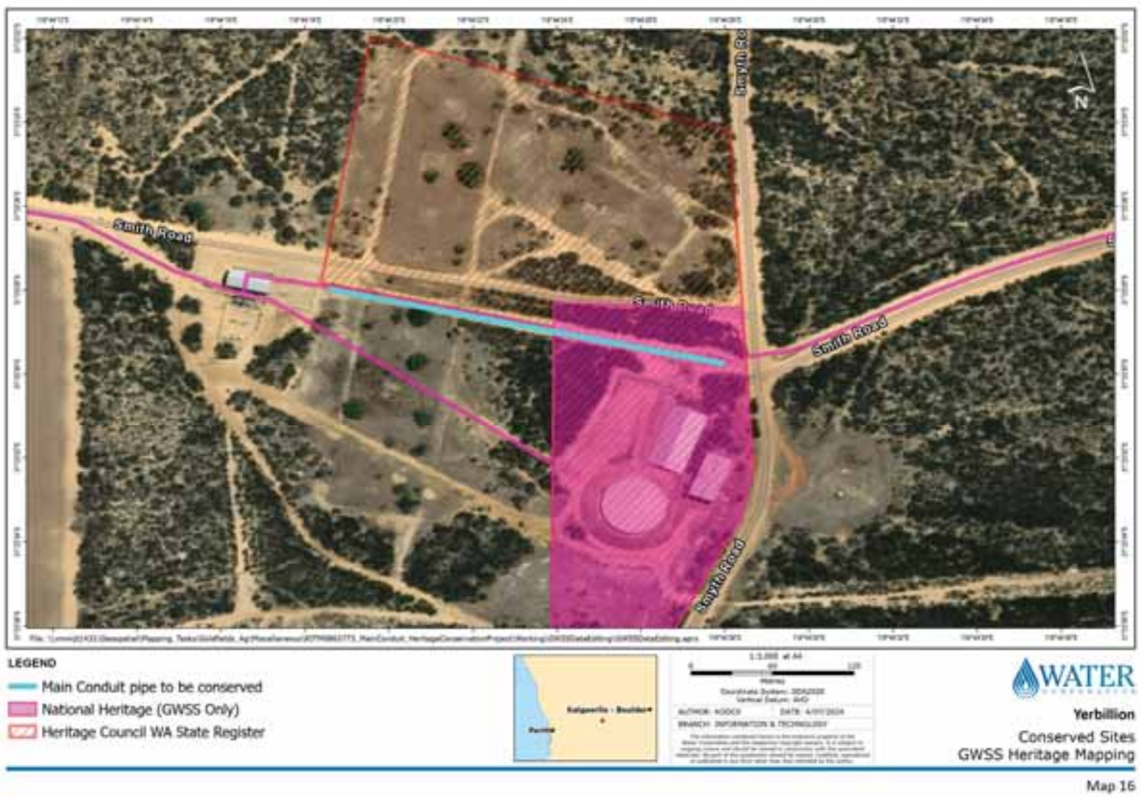

Figure 23: Water Corporation Map 16

Source: Water Corporation, 2024.

Figure 24: Water Corporation Map 17

Source: Water Corporation, 2024.

Figure 25: Water Corporation Map 18

Source: Water Corporation, 2024.

Figure 26: Water Corporation Map 19

Source: Water Corporation, 2024.

Figure 27: Water Corporation Map 20

Source: Water Corporation, 2024.

Figure 28: Water Corporation Map 21

Source: Water Corporation, 2024.

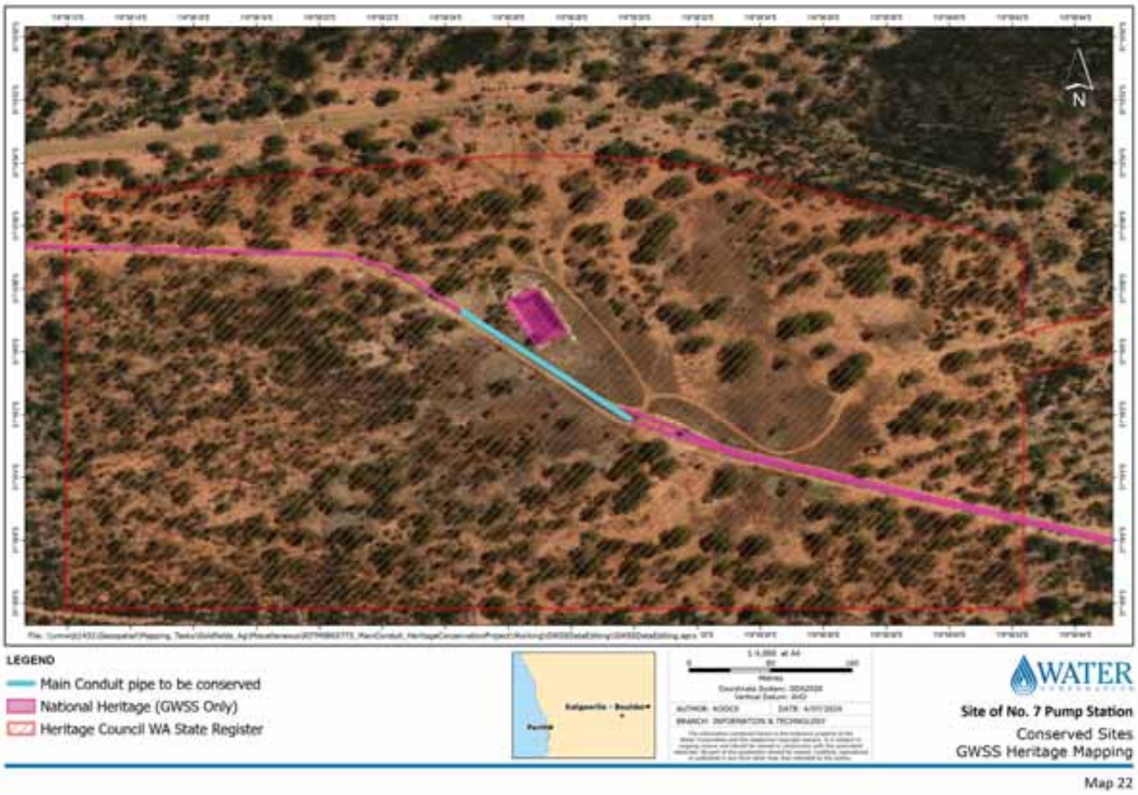

Figure 29: Water Corporation Map 22

Source: Water Corporation, 2024.

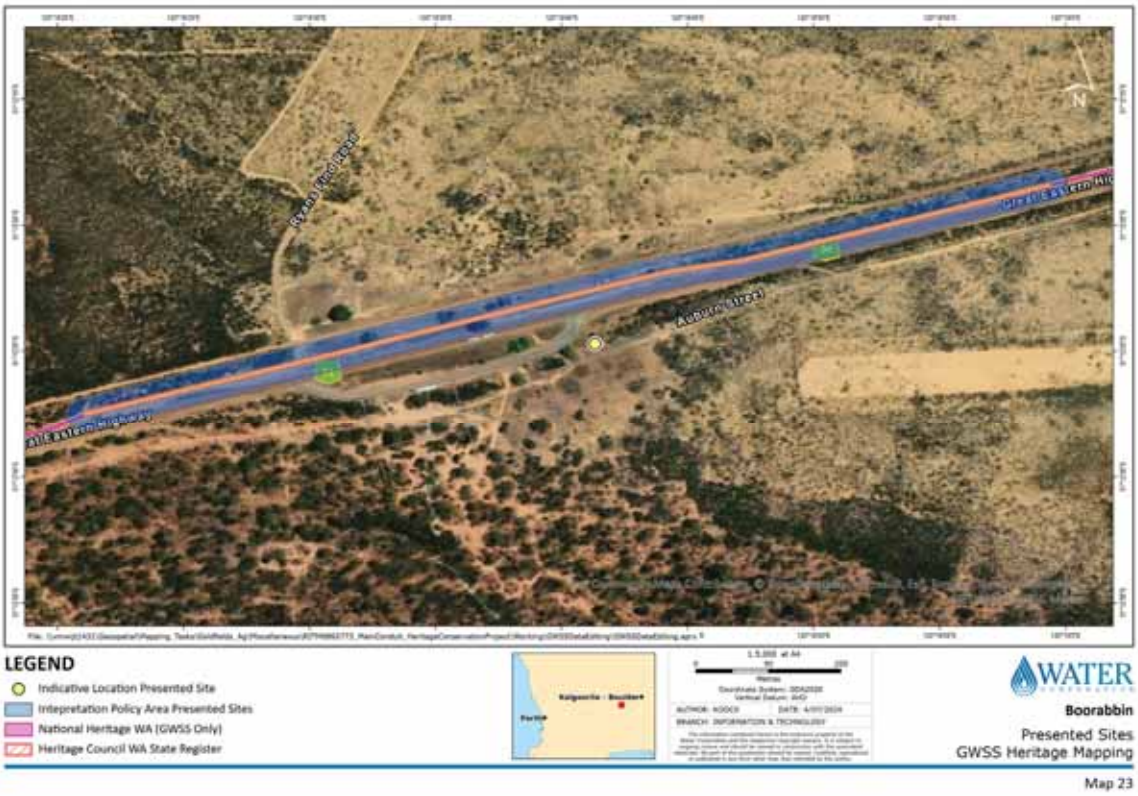

Figure 30: Water Corporation Map 23

Source: Water Corporation, 2024.

Figure 31: Water Corporation Map 24

Source: Water Corporation, 2024.

Figure 32: Water Corporation Map 25

Source: Water Corporation, 2024.

Figure 33: Water Corporation Map 26

Source: Water Corporation, 2024.

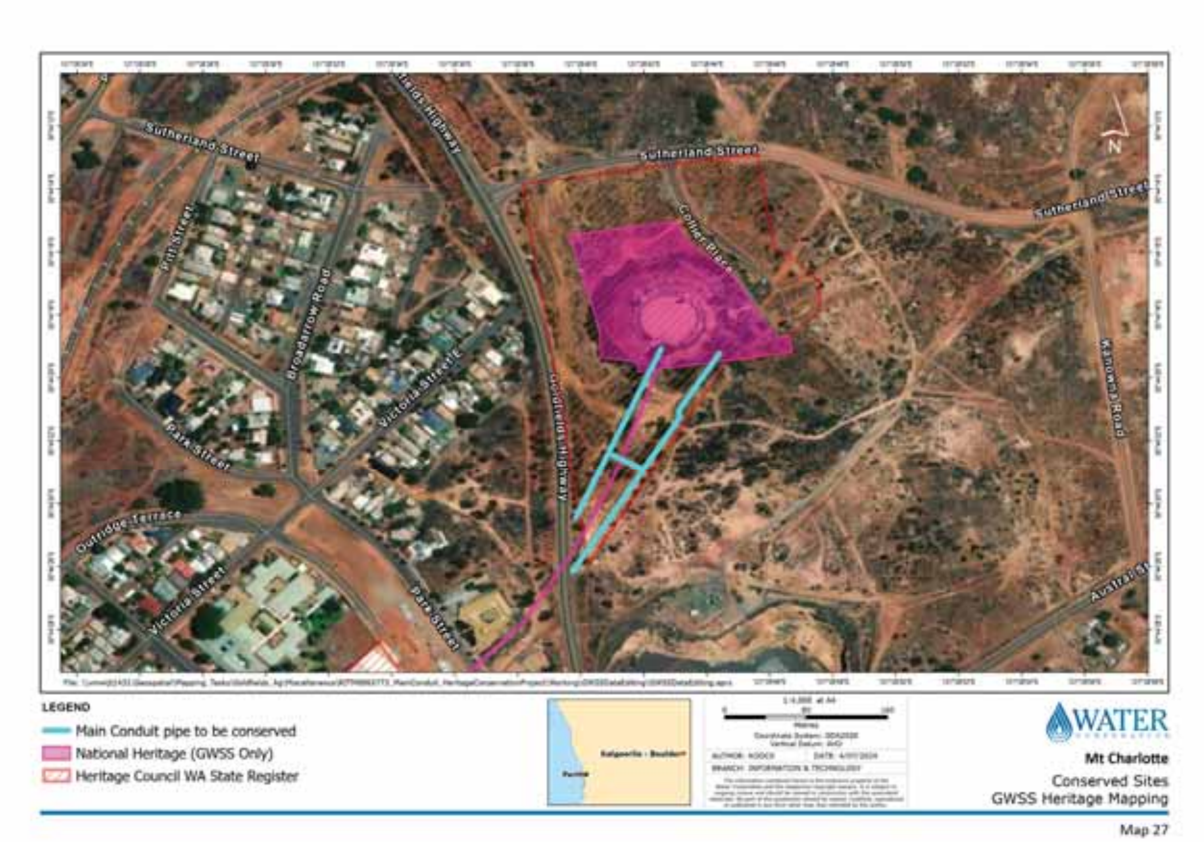

Figure 34: Water Corporation Map 27

Source: Water Corporation, 2024.

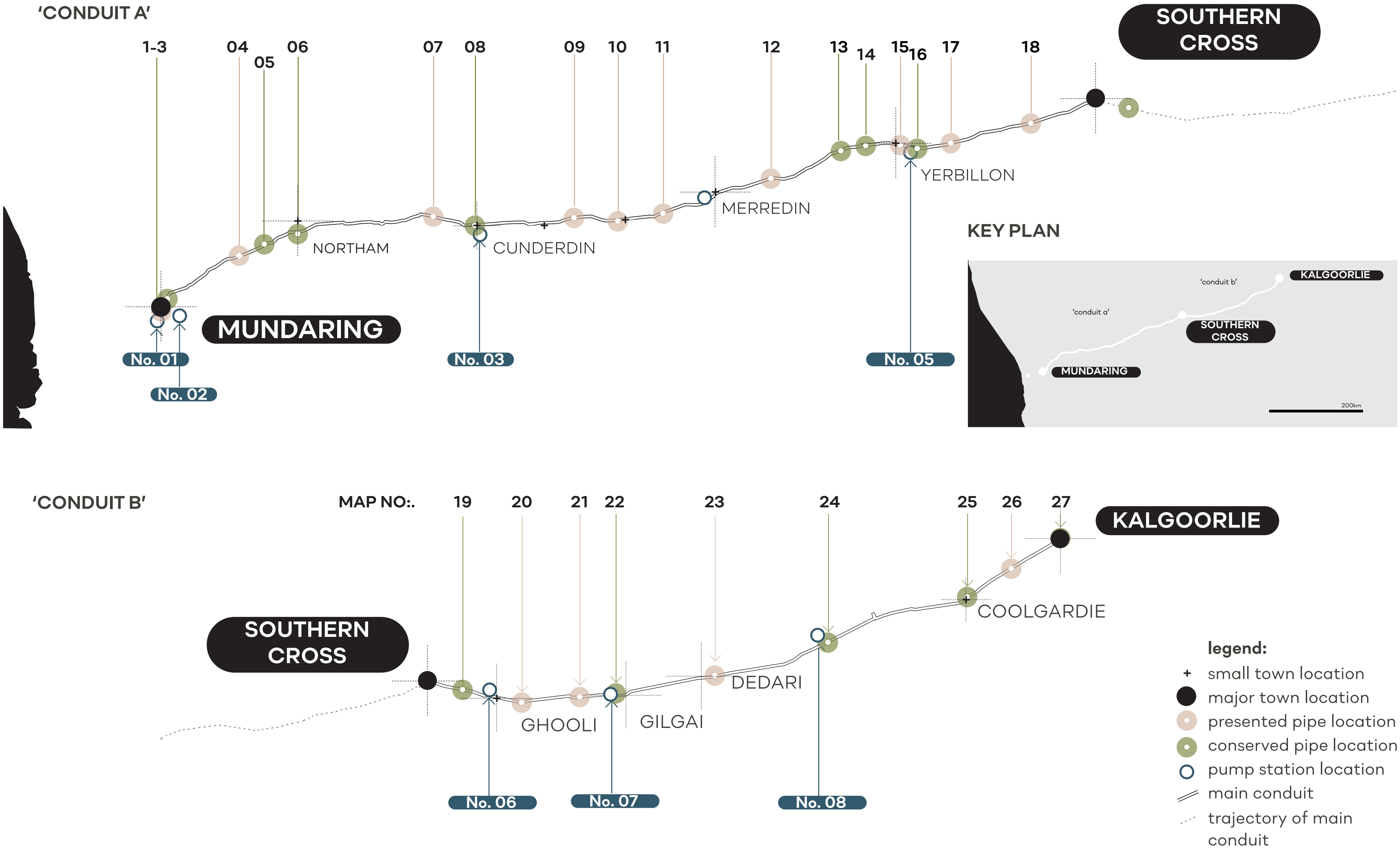

Figure 35: Diagram of main conduit with relevant features, including pipe conservation areas

Source: Stephen Carrick Architects, 2024.

7.4.2 SELECTED SITES AND ACTIONS

After conducting site visits and considering pipe conservation criteria, the Water Corporation chose multiple locations to interpret and showcase the GWSS main conduit. These chosen sites are deemed important for interpretation, preservation, and management. The specific actions and management details are outlined in Table 17.0.

Table 17.0: Selected Sites for Interpretation and Presentation of Main Conduit.[2]

Map Number. Location	Description	Action
1. Mundaring Weir	Retain pipe marked in blue 'insitu' in perpetuity. Minor maintenance activities to operational pipe can occur as per 'self-assessment' process. Stabilise in accordance with Technical Note when decommissioned from service. Removal of other pipe or works constituting 'development' within State Registered curtilage require referral to WA Heritage Council as per *Heritage Act 2018*. Minor maintenance activities to operational pipe can occur as per 'self-assessment' process.	Conserve insitu
2. Fred Jacoby Park	Removal or more than a single length of main conduit pipe within Fred Jacoby Park triggers the requirement to install 12m section of 'presented pipe' with signage to interpret heritage values.	Presented site with signage
3. Sawyers Valley	Retain pipe marked in blue 'insitu' in perpetuity. Minor maintenance activities to operational pipe can occur as per 'self-assessment' process. Stabilise in accordance with Technical Note when decommissioned from service.	Conserve insitu
4. Bakers Hill Regulatory Tank	Removal of more than a single length of main conduit pipe within Map 4 triggers the requirement to install 12m section of 'presented pipe' with signage to interpret National Heritage values at / near regulating tank or pumping station. As an alternative, an equivalent length of extant pipe can be retained insitu. Part of Map 4 is also subject to *Heritage Act 2018*. Removal of other pipe or works constituting 'development' within State Registered curtilage requires referral to WA Heritage Council.	Presented site with signage
5. Clackline	Retain pipe marked in blue 'insitu' in perpetuity. Minor maintenance activities to operational pipe can occur as per 'self-assessment' process. Stabilise in accordance with Technical Note when decommissioned from service. An existing section of locking bar pipe has been displayed as a 'presented' site at Lion Park, Clackline. Interpretive signage is to be installed at this site as part of agreed Interpretation Projects. There is also potential to install interpretive signage at the Eadine Springs Picnic Area, also shown on Map 5.	Conserve insitu

2 Details provided by Daniel Stevens, The Water Corporation, 2024.

Map Number. Location	Description	Action
6. Avon River Crossing, Northam	Retain pipe marked in blue 'insitu' in perpetuity. Minor maintenance activities to operational pipe can occur as per 'self-assessment' process. Stabilise in accordance with Technical Note when decommissioned from service. There is potential to install interpretive signage at Burlong Park, from where the bridge is visible, as part of future Interpretation Projects.	Conserve insitu
7. Presented sites on Great Eastern Highway	Present or retain two 12m lengths of pipe by Great Eastern Highway, west of Cunderdin. Due to road safety issues and poor access, signage is not required. The section of pipeline within Map 7 contains an excellent selection of locking bar pipe that demonstrates its ongoing repair and management through the years, along with numerous welders' signatures from former Water Corporation and PWD employees. Pipe from this location may therefore be used as material for other presented sites proposed in the *Interpretation Strategy*. In the event Great Eastern Highway needs to be widened at this location, the pipes are to be relocated to an alternative site(s) within the Shire of Cunderdin, with interpretive signage to be provided.	Presented Site(s)
8. Cunderin	Retain pipe marked in blue 'insitu' in perpetuity. Minor maintenance activities to operational pipe can occur as per 'self-assessment' process. Stabilise in accordance with Technical Note when decommissioned from service.	Conserve insitu
9. East Tammin	Retain or present circa 12m section (ideally with valve complex) on or near current alignment. Note:- pipe has been decommissioned from service at this location.	Presented Site(s)
10. Kellerberrin	Removal of more than a single length of main conduit pipe within Map 10 triggers the requirement to install 12m section of 'presented pipe' with signage.	Presented site with signage
11. Doodlakine	Removal of more than a single length of main conduit pipe within Map 11 triggers the requirement to install 12m section of 'presented pipe' with signage.	Presented site with signage
12. Merredin	Removal of more than a single length of main conduit pipe within Map 12 triggers the requirement to install 12m section of 'presented pipe' with signage. Part of Map 12 is also subject to *Heritage Act 2018*. Removal of other pipe or works constituting 'development' within State Registered curtilage requires referral to WA Heritage Council.	Presented site with signage

Map Number. Location	Description	Action
13. Burracoppin	Retain pipe marked in blue 'insitu' in perpetuity. Minor maintenance activities to operational pipe can occur as per 'self-assessment' process. Stabilise in accordance with Technical Note when decommissioned from service. Interpretive signage is to be installed at this site as part of agreed interpretation projects.	Conserve insitu with signage
14. Walgoolan, Westonia	Retain pipe marked in blue 'insitu' in perpetuity. Minor maintenance activities to operational pipe can occur as per 'self-assessment' process. Stabilise in accordance with Technical Note when decommissioned from service. Interpretive signage is to be installed when pipe is decommissioned from service, or as part of agreed interpretation projects.	Conserve insitu with signage
15. Carrabin	Removal or more than a single length of main conduit pipe within Map 15 triggers the requirement to install 12m section of 'presented pipe' with signage. Interpretive signage is to be installed at this site as part of agreed interpretation projects.	Presented site with signage
16. Yerbillon	Retain pipe marked in blue 'insitu' in perpetuity. Minor maintenance activities to operational pipe can occur as per 'self-assessment' process. Stabilise in accordance with Technical Note when decommissioned from service. Interpretive signage to be installed as part of planned upgrades to pumping station. Pipe may be relocated to site of former settlement if required due to capital works. In this case a minimum or 3 lengths of pipe (circa 36 m) is to be conserved and stabilised. Part of Map 16 is also subject to *Heritage Act 2018*. Removal of other pipe or works constituting 'development' within State Registered curtilage requires referral to WA Heritage Council.	Conserve insitu with signage
17. Bodallin	Removal of more than a single length of main conduit pipe within Map 17 triggers the requirement to install 12m section of 'presented pipe' with signage. Interpretive signage is to be installed at this site as part of agreed interpretation projects.	Presented site with signage
18. Moorine Rock	Removal of more than a single length of main conduit pipe within Map 18 triggers the requirement to install 12m section of 'presented pipe' with signage. Interpretive signage is to be installed at this site as part of agreed interpretation projects.	Presented site with signage

Map Number. Location	Description	Action
19. Ghooli	Retain pipe marked in blue 'insitu' in perpetuity. Minor maintenance activities to operational pipe can occur as per 'self-assessment' process. Stabilise in accordance with Technical Note when decommissioned from service. Removal of other pipe or works constituting 'development' within State Registered curtilage requires referral to WA Heritage Council as per Heritage Act 2018. Minor maintenance activities to operational pipe can occur as per 'self-assessment' process.	Conserve insitu
20. Yellowdine	Removal of more than a single length of main conduit pipe within Map 20 triggers the requirement to install 12m section of 'presented pipe' with signage. Interpretive signage is to be installed at this site as part of agreed interpretation projects.	Presented site with signage
21. Karalee Rocks	Removal of more than a single length of main conduit pipe within Map 21 triggers the requirement to install 12m section of 'presented pipe' with signage. Interpretive signage is to be installed at this site as part of agreed interpretation projects.	Presented site with signage
22. Site of No. 7 Pump Station	Retain pipe marked in blue 'insitu' in perpetuity. Minor maintenance activities to operational pipe can occur as per 'self-assessment' process. Stabilise in accordance with technical note when decommissioned from service. Removal of other pipe or works constituting 'development' within State Registered curtilage requires referral to WA Heritage Council as per *Heritage Act 2018*. Minor maintenance activities to operational pipe can occur as per 'self-assessment' process. Interpretive signage is to be installed at this site as part of agreed interpretation projects.	Conserve insitu with signage
23. Boorabin	Removal of more than a single length of main conduit pipe within Map 23 triggers the requirement to install 12m section of 'presented pipe' with signage. Interpretive signage is to be installed at this site as part of agreed interpretation projects. Consider alternative site at Boondi Rock dam turn-off if preferred by Shire of Coolgardie or Main Roads Western Australia.	Presented site with signage

Map Number. Location	Description	Action
24. No. 8 Pump Station, Dedari.	Existing section of decommissioned pipe has been retained and stabilised in accordance with the Technical Note. This is to be retained in perpetuity. Removal of other pipe or works constituting 'development' within State Registered curtilage requires referral to WA Heritage Council as per *Heritage Act 2018*. Minor maintenance activities to operational pipe can occur as per 'self-assessment' process. Interpretive signage is to be installed at this site as part of agreed interpretation projects.	Conserve insitu with signage
25. Toorak Hill	Existing decommissioned pipes indicated on Map 25 in blue to be retained in perpetuity. No further action required. Removal of other pipe or works constituting 'development' within State Registered curtilage requires referral to WA Heritage Council as per *Heritage Act 2018*.	Monitor only, manage as ruin with aim to stabilise any further degradation.
26. Coolgardie to Kalgoorlie	Removal of more than a single length of main conduit pipe within Map 26 triggers the requirement to install two x 12m section of 'presented pipe' with signage, to be funded as part of the relevant capital project. Site selection to be determined in consultation with the Shire of Coolgardie, City of Kalgoorlie- Boulder and Goldfields Pipeline Marathon organisers.	Presented site with signage
27. Mount Charlotte	Retain pipe marked in blue 'insitu' in perpetuity. Minor maintenance activities to operational pipe can occur as per 'self-assessment' process. Stabilise in accordance with Technical Note when decommissioned from service. Removal of other pipe or works constituting 'development' within State Registered curtilage requires referral to WA Heritage Council as per *Heritage Act 2018*. Minor maintenance activities to operational pipe can occur as per 'self-assessment' process.	Conserve insitu

CHAPTER 8: HERITAGE MANAGEMENT POLICIES

8.1 MANAGEMENT OVERVIEW

This section sets out the Heritage Management Policies for this document and focuses on ensuring the protection and conservation of the National Heritage values of the GWSS with respect to the main conduit. The policies will guide implementation of the EPBC Act approval 2019/8547.

This HMP has five key policy areas, outlined below:

1. **Management**
   Policies to embed the heritage management plan in Water Corporation planning and operations.

2. **Conservation**
   Policies for retention of main conduit pipe.

3. **Demolition**
   Policies for removal of main conduit pipe.

4. **Operations**
   Policies for the management of operational main conduit pipeline and installation of new assets.

5. **Interpretation**
   Policies for interpretation of the main conduit as its replaced with new below ground pipe.

8.2 MANAGEMENT

Policies to embed the Heritage Management Plan in Water Corporation planning and operations.

Policy 01:	**Water Corporation adopts this HMP as the basis for conserving the National Heritage values of the GWSS and implementing EPBC 2019/8547**

Policy 02:	**Water Corporation will ensure all staff and contractors working on the GWSS have access to the information in this HMP and have suitable induction sessions to understand its importance and intent to ensure best heritage practice.**

The above policy will be implemented by including this HMP within the Water Corporation's 'External Approvals' manual[1], by production of a 'Learning Management System'[2] module, and by providing inductions and recurring training to all staff working on the GWSS.

As part of the implementation of the HMP Water Corporation will produce a series of shorter 'cheat sheets' for project managers and internal personnel to guide them in using policies and procedures outlined in the HMP.

1 The External Approvals Manual assists our staff, consulting engineers and authorised contractors to comply with relevant legislation and statutory requirements. It is available online: https://www.watercorporation.com.au/About-us/Suppliers-and-contractors/Resources/External-approvals

2 The Learning Management System an e-learning tool available to Water Corporation staff that enables specified training to be allocated to designated work areas by managers.

Policy 03:	**Water Corporation will assess all new actions for potential impacts to the heritage values of the GWSS and any other Matters of National Environmental Significance that may be applicable.**

Any proposals or action with potential to impact the National Heritage values of the GWSS will be assessed in accordance with the Water Corporation's Action Proposal Process that forms part of this HMP (refer Part C). Where there is a departure from this HMP, or if the Action Proposal Process determines an action may have a 'significant impact' on the National Heritage values of the GWSS (beyond the scope of EPBC Act approval 2019/8547), Water Corporation will engage a suitably qualified expert in accordance with Condition 6e the EPBC Act approval. The suitably qualified expert will be externally sourced and independent and will be briefed to undertake a heritage impact assessment for the action and to provide advice on whether the action should be referred in accordance the *EPBC Act*.

Image 52: Anchor blocks and stabilisation at Fred Jacoby Park

Source: 'Anchor blocks and stabilisation at Fred Jacoby Park', photograph taken near Mundaring, Courtesy of: Stephen Carrick Architects, 2024.

8.3 CONSERVATION

Policies for retention of heritage pipe.

Policy 04:	**Lengths of aboveground main conduit 'heritage pipeline' shall be conserved as specified and mapped in the Interpretation Strategy.**

Sections of pipeline have been identified that best present and transmit the National Heritage values of the main conduit as they relate to the broader GWSS and shall not be removed. For simplicity, sections of the main conduit to be conserved in accordance with the *H+H Report : Interpretation Strategy* are referred to as 'heritage pipeline'. The rationale for selection of 'heritage pipeline' is set out in the Interpretation Strategy and Chapter 7 of this HMP.

'Heritage pipeline' may be operational or decommissioned. It is to be retained for the benefit of future generations.

In exceptional circumstances, small sections of heritage pipeline may be removed for operational or emergency requirements, as detailed in Part C.

Water Corporation Responsible areas:
- Project Management Business Unit (PMBU) on advice from Property Portfolio team

Policy 05:	**'Heritage pipeline' that has been decommissioned from service shall be stabilised in accordance with the Technical Note on Preservation of Decommissioned Heritage Pipe and be maintained thereafter. See Appendix I.**

Decommissioned steel pipeline has a far greater vulnerability to thermal expansions forces than operational pipeline. It's therefore important that any decommissioned pipeline to be retained for heritage purposes is stabilised in accordance with the technical note. The technical note also provides specifications for protective coatings to manage corrosion, and for sealing pipe ends to prevent wildlife entering the pipe and to deter vandalism. Stabilised pipe is expected to be highly durable, annual inspections are recommended as part of the maintenance plan for the pipe.

Water Corporation Responsible areas:
- PMBU to undertake stabilisation and establish maintenance plan
- Goldfields and Agricultural Region (GAR) to implement maintenance plan

Image 53: Pipeline Challenge Charity Ride

Source: 'Pipeline Challenge Charity Ride', Pipeline Challenge website, accessed 2024.

Policy 06:	**Arrangements to stabilise heritage pipe must be established within 12 months of the pipe being decommissioned and are to be funded as part of the program to construct the corresponding portion of upgraded main conduit pipeline.**

Timely arrangements to stabilise 'heritage pipeline' are required to ensure irreversible degradation of the heritage fabric does not occur. Pipe is only decommissioned after it has been replaced by a new operational pipe, thereby ensuring implementation of this policy.

Water Corporation Responsible areas:
- PMBU

Image 54: Inscriptions on the pipe at Fred Jacoby Park

Source: 'Inscriptions on the pipe at Fred Jacoby Park', photograph taken near Mundaring, Courtesy of: Stephen Carrick Architects, 2024.

8.4 DEMOLITION

Policies for removal of decommissioned main conduit pipeline.

Policy 07:	**Lengths of main conduit pipeline <u>not identified</u> for preservation in the Interpretation Strategy may be removed once decommissioned from service as seen fit.**

Disposal of surplus pipe is to be initiated by the Project Manager in accordance with Procurement and Property Branch Materials Management Disposal Process.

<u>Water Corporation Responsible area:</u>
- PMBU

Policy 08:	**Where practical and financially feasible, Water Corporation's preference is to demolish and dispose decommissioned main conduit piped not identified for heritage purposes in the Interpretation Strategy, to avoid the build-up of non-operational legacy assets.**

Decommissioning and demolition to be considered in project planning for main conduit replacements.

<u>Water Corporation Responsible area:</u>
- Asset Investment Planning

Policy 09:	**Prior to removal of decommissioned pipe, a photographic archival record of the pipe is to be prepared in accordance with the 'Guide to preparing an Archival Record' issued by Department of Planning, Lands and Heritage, 2019.**

<u>Water Corporation Responsible area:</u>
- Property Portfolio team

The photographic archival record and other relevant details are to be made available to the public by publication on the website for the life of the life of the approval (70 years) as per Condition 6a of EPBC Act approval 2019/8547.

<u>Water Corporation Responsible area:</u>
- Community Engagement Team

Copies of the archival record are to be provided to Department of Climate Change, Energy, the Environment and Water (DCCEEW), Australian Heritage Council, WA Heritage Council and the relevant local Government authority as per Condition 6d of EPBC Act approval 2019/8547, and to the National Trust of Western Australia.

<u>Water Corporation Responsible area:</u>
- Property Portfolio team

Policy 10:	Water Corporation is to consider offering decommissioned pipeline to the community / not for profit organisations for artistic, tourism or heritage purposes.

Prior to offering pipe for community use, a clearance must be obtained by the Project Manager to ensure the pipe is not coated in any substances that may be harmful to human health. Pipe that is not suitable for reuse should be recycled or disposed. Where sections of pipeline are offered to the community, they will be offered on an 'expressions of interest' basis. Expressions of interest that assist in communicating the National Heritage values of the GWSS will be given priority. Water Corporation anticipates that up to two lengths of pipeline could be made available per upgrade project where suitable community interest is demonstrated, and the pipe is free of contaminants.

Water Corporation Responsible area:
- PMBU
- Community Engagement
- Property Portfolio team

Policy 11:	A disposal plan shall be prepared at the outset of each decommissioned pipeline removal project and shall comprise the following elements: • Scheduling for archival recording • Contamination clearance – to confirm if any contaminants are present on the pipe • Consideration of offering pipe (up to two lengths) to the local government or community where it is free from contaminants • Consideration of additional opportunities for interpretation not identified in the Interpretation Strategy • Consideration of retention of pipe section(s) for use by Water Corporation in future heritage projects • Safe disposal or recycling of any pipe not to be retained.

Water Corporation Responsible area:
- PMBU
- Community Engagement
- Property Portfolio team

Image 55: Photograph of the conduit near Mundaring

Source: 'Conduit Near Mundaring', photograph taken near Mundaring, Courtesy of: Stephen Carrick Architects, 2024.

8.5 OPERATIONS

Policies for the management of operational main conduit pipeline and installation of new assets.

Policy 12:	**Operational heritage pipeline shall be maintained in accordance with Water Corporation operational standards.**

Water Corporation and its predecessors have a proud history of delivering sustainable water services to the people of Western Australia. Today, the Water Corporation is authorised to operate in accordance with its Operating Licence[3], granted by the Economic Regulation Authority in accordance with *the Water Services Licensing Act 1995 (WA)*. Operational pipeline is stable and safe and this Heritage Management Plan does not seek to modify maintenance standards that apply to operational assets.

Water Corporation Responsible area:

- GAR

Policy 13:	**In areas identified by HCWA as having archaeological potential, an Archaeological Management Plan is to be prepared prior to commencement of works. Refer Appendix J.**

Water Corporation Responsible area:

- PMBU
- Property Portfolio

Policy 14:	**In areas where archaeological potential is not identified in this HMP, project managers are to be informed of Water Corporation's 'chance find procedures'. Refer Appendix J.**

Water Corporation Responsible area:

- PMBU
- Property Portfolio

3 Available online: chrome-extension://efaidnbmnnnibpcajpcglclefindmkaj/https://www.erawa.com.au/cproot/4438/2/20110125%20D58407%20Water%20Corporation%20Water%20Operating%20Licence%2032.pdf

Image 56: Pipe diverging near Mundaring Weir

Source: 'Pipe diverging near Mundaring Weir', photograph taken near Mundaring, Courtesy of: Stephen Carrick Architects, 2024.

8.6 INTERPRETATION

Policies for interpretation of the main conduit as it's replaced with new below ground pipeline

Policy 15:	**The Interpretation Strategy included at Appendix G is to read in conjunction with and forms part of this HMP**

Policy 16:	**Interpretation Strategy implementation is to be appropriately funded and maintained under the relevant Water Corporation works program.**

As the GWSS is an operational water supply scheme, the decommissioning of pipeline is always preceded by the installation of a new upgraded operational pipe to ensure continuity of water supply. This upgrading process provides a funding mechanism to stabilise heritage pipe and implement other aspects of the *Interpretation Strategy* and is synergistic with mobilisation of contractors and Water Corporation staff.

In addition to funding implementation of the Interpretation Strategy, early consideration of decommissioning requirements as part of Water Corporation's works program will avoid the build-up of legacy assets when these assets are not required to be retained for heritage purposes.

The *Interpretation Strategy* contains an implementation plan with further details of how and when the strategy will be implemented.

Water Corporation Responsible areas:
- Asset Investment Planning

Policy 17:	**Interpretation policy areas will be captured within the Water Corporation's Corporate GIS to ensure that conservation and interpretation policy requirements are visible for the life of the approval.**

Water Corporation Responsible areas:
- Property Portfolio

The Water Corporation must retain systems for monitoring, evaluating, documenting and reporting on the condition of the GWSS and its heritage values.

Policy 18:	**The Interpretation Plan should take into consideration the State and National Heritage values.**

Water Corporation Responsible areas:
- Property Portfolio

Policy 19:	**The Interpretation Plans shall consider the place's National and State heritage values, especially lesser-known stories identified in the Interpretation Strategy in Appendix G.**

Water Corporation Responsible areas:
- Property Portfolio

The Interpretation Strategy has identified a hierarchy of themes and stories that examines the existing interpretations along the pipeline. This examination developed three key expressive themes: ' Living and working on the pipeline', 'connecting to the Goldfields' and 'Innovative water farming technology'. The Interpretation Strategy also acknowledges the breadth and depth of the stories associated with the main conduit. These also can form an essential reference for guidance in developing Interpretation Plans for the 27 selected interpretation sites. For more information, see the Interpretation Strategy in Appendix G.

CHAPTER 9: DOCUMENTATION, MONITORING AND REVIEW

This chapter details the systems and documents for monitoring, documenting and reviewing on the physical condition of the GWSS and the condition of its National Heritage values.

9.1 DOCUMENTATION AND MONITORING

The monitoring of the HMP's implementation will be carried out using the following methods:

9.1.1 EVALUATION OF THE CONDITION OF HERITAGE VALUES

Assessment of the condition of values will be conducted during the next review (five yearly). Various aspects of both tangible and intangible characteristics will be systematically monitored, particularly in relation to the pipeline's demolition. This enables small changes to the condition of the values to be assessed over time.

9.1.2 PROCESS FOR ACTION PROPOSALS

The Water Corporation Property Portfolio Team will document all proposals and decisions relating to the relocation of the pipeline project and the installation of additional interpretation. Action Proposals and their evaluations will explicitly outline the anticipated impacts on National Heritage values. (Refer to Chapter 10).

9.1.3 ASSESSMENT OF PERMITTED ACTIONS

Project Managers will discuss Action Proposals with the Property and Portfolio Team and submit a 'Self Assessment' form for approval. If Proposed Actions fall outside the Self Assessment Guidelines then the proposal will undergo evaluation from an external (independent) heritage consultant to prepare a Heritage Impact Assessment and Mitigation Plan. Decisions not to refer actions are to be documented and retained on corporate files.

9.1.4 EVALUATION OF IMPLEMENTATION

Implementation of the HMP will be monitored as part of the annual reporting by the Water Corporation Property and Portfolio Team (in accordance with Condition 13 of EPBC Act Approval 2019/8547).

9.1.5 PROCESS FOR COMMUNITY ENGAGEMENT DURING REVIEW

Water Corporation will seek public, agency and stakeholder feedback as part of the 5-yearly review of the HMP and undertake more targeted consultation as part of the development of Interpretation Plans, including consultation with local government, the National Trust and other stakeholders as relevant to the project. This will ensure contextual and appropriate interpretation responses. Through ongoing community engagement, there is an opportunity to discover new values associated with the GWSS for consideration in developing interpretation plans.

9.2 MAINTENANCE OF ACCURATE COMPLIANCE RECORDS

In accordance with Condition 9 of EPBC Act approval 2019/8547 Water Corporation are to maintain accurate records of Action Proposals and permitted actions within its corporate record management system (Nexus)for the life of the approval, and make these available to DCCEEW upon request.

The Corporate (Nexus) file structure is shown at Appendix L.

9.3 REPORTING NON-COMPLIANCE

In accordance with Condition 14 of EPBC Act approval 2019/85 the Water Corporation must notify the DCCEEW in writing of any: incident; non-compliance with the conditions; or non-compliance with the commitments made in plans. The notification must be given as soon as practicable, and no later than two business days after becoming aware of the incident or non-compliance.

9.4 REVIEW

This HMP is scheduled for a review every five years, as outlined in section 324W (National Heritage Places) of the *EPBC Act*.

Subsequent reviews may be conducted, focusing on potential amendments related to:

- New pertinent research findings or information.
- Unforeseen management issues of significant importance that may impact the National Heritage values of the site.
- Outcomes of monitoring programs, revealing instances where the policies within the plan fail to achieve the stated management objectives.
- Additional community and stakeholder feedback and consultation highlight changing community values and needs.

The plan will remain effective until a new plan is formally adopted.

9.5 PREVIOUS REVIEWS

9.5.1 2016 HMP

The first HMP for the GWSS was prepared in 2016 by Griffiths Architects. Prior to this HMP, there was no recorded heritage management policies for the main conduit of the GWSS. Policies for the GWSS pump stations, reservoirs and tanks were included in the Conservations Plans for the Goldfields Water Supply Scheme (1999) and the Mundaring Weir Conservation Plan (2000).

9.5.2 2022 REVIEW

A review of the 2016 HMP was undertaken by GML to inform the development of the project brief for this (2024) HMP update. This document outlined the update requirements to meet the standard for *EPBC Act* for HMPs, and the EPBC Act project approval. These requirements have been incorporated within this HMP.

9.6 ANNUAL REPORTING

To ensure compliance with the *EPBC Act* for National Heritage Listed places, annual reporting by the Water Corporation is required.

Water Corporation Property Portfolio team, will complete a compliance report for each 12 month period following the date of commencement of the action in accordance with Condition 13 of EPBC Act approval 2019/8547. Water Corporation will publish each compliance report on the website within 60 business days following the relevant 12 month period.

Water Corporation will notify DCCEEW by email that a compliance report has been published on the website and provide the web- link for the compliance report and documentary evidence providing proof of the date of publication of the report within 5 business days of the date of publication. All compliance reports will be publicly available on the website for the life of the approval.

Image 57: Image of GWSS pipe valve interpretation

Source: 'Image of GWSS pipe valve interpretation', photograph taken near Mundaring, Courtesy of: Stephen Carrick Architects, 2024.

PART C : MANAGEMENT + IMPLEMENTATION TOOLS

Part C details management and implementation tools for the HMP in accordance with Water Corporation's Action Proposal Process.

- Chapter 10: Action Proposal Process and Implementation

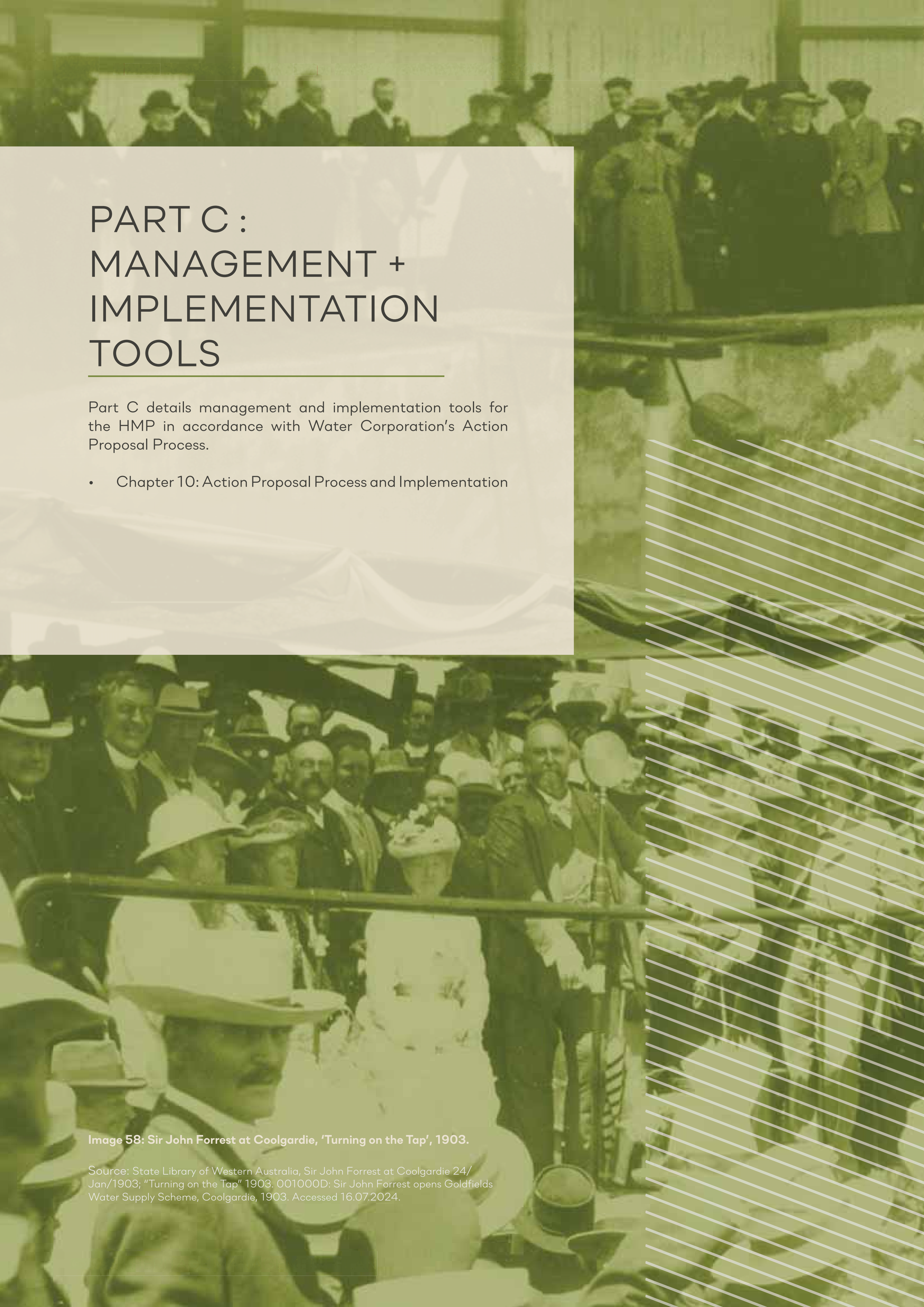

Image 58: Sir John Forrest at Coolgardie, 'Turning on the Tap', 1903.

Source: State Library of Western Australia, Sir John Forrest at Coolgardie 24/Jan/1903; "Turning on the Tap" 1903. 001000D: Sir John Forrest opens Goldfields Water Supply Scheme, Coolgardie, 1903. Accessed 16.07.2024.

CHAPTER 10: ACTION PROPOSALS AND IMPLEMENTATION

10.1 STANDARD WORK

The Water Corporation's 'Action Proposal Process' for the main conduit of the GWSS comprises the following elements:

1. Permitted actions and standard work instructions.
2. Actions requiring 'self-assessment' and documentation.
3. Actions requiring a Heritage Impact Assessment (HIA) and potential referral under *EPBC Act*.
4. Interpretation and conservation.

10.1.1 PERMITTED ACTIONS AND STANDARD WORK INSTRUCTIONS

Work that the Water Corporation Operations Team delivers can be divided into: Planned (operational and non-operational), Maintenance and Emergency works. With emergency work, time is always the priority.

Planned and maintenance activities include the following:

- Banding/welding repairs: welding patches and/or 'bands' over the pipe. No pipe section would be removed, only welded over existing pipe and painted in a like for like colour.
- Minor valve replacements: air valves, service valves and similar.
- Inspections and mark-ups.
- Fire-break maintenance.
- Access track maintenance.
- Vegetation removal.
- Paint and coating replacement (like for like).
- Tank and reservoir cleaning and inspections.
- Building maintenance i.e. gutter cleaning, painting etc.
- Pump maintenance (Mechanical).
- Motor maintenance (Electrical).
- Cathodic protection testing and inspection.
- Asset condition assessment inspections: require pipe piece removal for testing.
- New service installs.
- Service removals/disconnections.
- Water sampling.
- Valve maintenance (Mechanical).
- Valve maintenance (Electrical).
- Chemical dosing.
- Driveway crossings to serve a single dwelling, but not including new public road crossings.

Planned works and maintenance are routine in nature and are not considered to have a significant impact on the National Heritage values of the GWSS. Provided the works fit within the above examples, they do not require a formal self-assessment, documentation or reporting under this HMP.

Image 59: GWSS, new air valve at Bakers Hill

Source: Water Corporation, Stuart Burnett, 2023.

10.2 EMERGENCY WORKS

Emergency works relate to service continuity and safety, including water quality and public safety. In such instances, works to remedy the failure take precedence over all other requirements.

Emergency work includes:

- Service continuity.
- General safety and water quality.
- Public safety.
- Damage by others: this includes vandalism, terrorism or unintended damage through vehicular impacts or other accidents.
- Failure of asset: for example pipe burst.
- Natural causes: for example bushfire or flood.

Emergency works will typically be classed as an incident and may proceed without prior formal assessment under the HMP due to their time-sensitive nature.

Any emergency works involving removal of greater than a single length (10 – 12m) of main conduit pipe are to be documented (photographically) and the Water Corporation Property team is to be informed. Otherwise, there are no formal requirements for documentation or reporting of emergency works under this HMP.

Where emergency works are required to be reported to the Water Corporation's Property team, the Property team must assess whether the works need to be reported or referred under *The EPBC Act*, and must document this decision on the Nexus File Located.

https://nexus.watercorporation.com.au/otcs/cs.exe/app/nodes/81778748

The Water Corporations' standard work instruction for works to the main conduit is included at Appendix M. This will be updated to include additional training requirements (Refer HMP Policy 04) and list of permitted activities upon approval of this HMP.

10.3 ACTIONS REQUIRING 'SELF-ASSESSMENT' AND DOCUMENTATION

More substantial works, generally regarded to be 'development', must be assessed under this HMP.

Examples include:

- Upgrades and replacements to the main conduit.
- Demolition of the main conduit.
- Adjacent works such as new tanks or pumping stations.

Prior to commencing works within this category, a 'self-assessment' form (Refer <u>Appendix N</u>) must be completed by the Project Manager and be submitted to the Water Corporation's Property Team (which are subject matter experts). The role of the Water Corporation's Property Team includes assessing all historic heritage proposals and are responsible to ensure no unapproved removal of the main conduit occurs.

The purpose of this process is to determine:

1. Are the works consistent with the policies of this HMP?
2. Are any special requirements applicable for the works, such as the completion of an archaeological survey?
3. Do the works need to be referred to the Heritage Council of WA?
4. Is there a requirement for archival recording of the works?
5. Are there any special reporting or documentation requirements?
6. Do the works trigger the requirement to implement part of the Interpretation Strategy?

The completed 'self-assessment' form is to be retained as a record of the Water Corporation's decision on whether to refer an Action in accordance with *The EPBC Act*. This record is to be retained for the life of the EPBC Act approval 2019/8547 on the following file within the Nexus File System.

https://nexus.watercorporation.com.au/otcs/cs.exe/app/nodes/81778748

This will ensure Water Corporation's ability to comply with Conditions 9 and 10 (Compliance Records), 13 (Annual Reporting), and 16 – 18 (Audits) of EPBC Act approval 2019/8547.

The following are examples of actions that would require completion of a self-assessment form, and provides a preliminary position on whether these actions require independent heritage advice or referral under the *EPBC Act*.

Scenario 1:	**Removal of portions of the main conduit greater than a single length (10-12m) designated for future conservation in Interpretation Strategy (still operational).**

A key pillar of the Interpretation Strategy is to conserve representative sections of the main conduit to communicate the National Heritage values of the GWSS. These sections were identified through the methodology described in Chapter 7. There is a strong presumption against removing greater than a single length of main conduit pipeline within the areas and this will require independent heritage advice and potential referral under the *EPBC Act*. The advice and potential *EPBC Act* referral should consider including an alternative section of main conduit pipe for conservation or additional interpretation.

Scenario 2:	**Removal of portions of non-operational main conduit (any length) that have been stabilised and conserved for heritage purposes in accordance with Interpretation Strategy (decommissioned heritage pipe).**

In the unlikely event a section of pipeline that has been conserved for heritage purposes needs to be modified or removed, the project manager shall liaise with the Water Corporation Property Team. The need to remove the pipe, options for reinstatement or replacement, and the potential need for independent heritage advice or referral under *The EPBC Act* are to be considered.

Scenario 3:	**Removal of portions of the main conduit not exceeding a single length (10 - 12 metres) designated for conservation in the Interpretation Strategy (still operational).**

Cut ins to the pipeline may be required to install new valves, off takes and for other operational purposes including emergency works. In most cases, these minor works will be acceptable.

Scenario 4:	**Removal of portions of the main conduit not designated for conservation in Interpretation Strategy.**

As EPBC Act approval 2019/8547 provides for removal of extant elements of the main conduit, removal of pipeline under Scenario 4 is generally acceptable, subject to compliance with conditions of the EPBC Act approval, this *HMP* and the *Interpretation Strategy*. The Water Corporation Property Team will provide advice to the Project Manager on interpretation, archival recording and any other requirements of the HMP, as part of completion of the 'Self-assessment' form.

Scenario 5:	**Installation of new below ground pipe.**

The installation of new below ground pipe is not likely to impact the National Heritage values of the GWSS and is generally acceptable. Even though approval under the *EPBC Act* is unlikely to be required under scenario 5, referral of a 'Self-assessment' form is required to address potential requirements under the *Heritage Act 2018* or if special requirements of this HMP apply.

Scenario 6:	**Development of new structures within 50 metres of the main conduit.**

Any development within proximity of the GWSS, such as new tanks or pumping stations, has potential to impact its setting and the National Heritage values. In this scenario a 'Self- assessment' form should be prepared for discussion with the Water Corporation Property Team. While development of new operational infrastructure is generally compatible with the National Heritage values of the GWSS, approval may be required in some instances under State or Commonwealth legislation, and it may be appropriate to seek external advice for more significant proposals.

10.4 ACTIONS REQUIRING HERITAGE IMPACT ASSESSMENT (HIA) AND POTENTIAL REFERRAL UNDER EPBC ACT.

The purpose of the 'Self-assessment' process is for Water Corporation to determine whether an action is likely to have a significant impact on the National Heritage values of the GWSS and should be referred for assessment in accordance with the *EPBC Act*. Works that are inconsistent with the policies of this HMP, as determined through the self-assessment process, require a Heritage Impact Assessment (HIA) to be prepared by a suitably qualified heritage consultant that is external to and independent from the Water Corporation.

In addition to preparing an HIA, the consultant may provide advice on ways to mitigate the impacts of the works on the National Heritage values of the GWSS. The HIA is to provide advice on whether the works have potential to impact National Heritage values of the GWSS and require referral in accordance with the *EPBC Act*.

The Water Corporation Property team is to assist in management of this process. The outcome of the HIA process, including the decision whether to refer an Action under *The EPBC Act*, are to be documented on the following file Nexus File Location.

https://nexus.watercorporation.com.au/otcs/cs.exe/app/nodes/81778748

See Figure 36 and 37 EPBC Act Referral and Assessment flow chart below for further details.

10.5 INTERPRETATION AND CONSERVATION

As this HMP will implement an action to remove the extant main conduit, it has a heavy focus on interpretation, but also identifies several strategic locations where it is proposed to conserve main conduit pipe.

The mapping included in Chapter 7, Part 7.4, identifies a total of 27 sites along the main conduit between Mundaring and Kalgoorlie. Of these sites:

- 13 sites have been identified where it is proposed to conserve main conduit pipe in perpetuity. While it may not be necessary to replace main conduit pipe in these locations for many years, where asset condition or capacity factors determine a need to upgrade the pipe, the extant pipe will be conserved insitu and stabilised as per the Technical Note at Appendix I. The new upgraded pipe will be located adjacent to the stabilised pipe, typically below ground. Subject to consultation with the Department responsible for administering *The EPBC Act*, new aboveground pipe may be constructed on the same alignment, in lieu of conserving the extant pipe. Additional interpretation may be required when the pipe fabric is considered to be of particular importance. Refer Policies 04 – 06 of this HMP.

- 14 'presented sites' have been selected where it is proposed to 'present' sections of 'heritage pipe' in an educational manner, typically with signage detailing stories of the GWSS and / or linking with interpretation projects from the *Interpretation Strategy*. The 'presented sites' will be located close to the current alignment of the main conduit. 'Interpretation Policy Areas' have been captured on each of the maps. Where pipe upgrade projects that entail demolition of the extant main conduit to fall within these policy areas, the relevant project will fund and implement the 'presented site'.

As per Policy 17 of this HMP, Interpretation Policy Areas will be captured within the Water Corporation's Corporate GIS to ensure that conservation and interpretation policy requirements are visible for the life of EPBC Act approval 2019/8547. The time-frame for implementation of other elements of the interpretation is detailed in the Interpretation Strategy and will be typically be undertaken in association with major upgrades to the main conduit.

The interpretation Strategy prepared by H+H Architects details the implementation approach for conservation and interpretation initiatives under both the HMP and Interpretation Strategy, an important component of which is to align the conservation of ' retained' and ' presented' sections of pipe (Project 1 - 'Conserve the Pipe' and with other Interpretation initiatives in the strategy. Wherever a Water Corporation project interacts with any of the 27 'retained' or 'presented' sites in this HMP, and pipe is decommissioned in these locations, Water Corporation shall undertake the conservation initiatives detailed in Project 1. Water Corporation is committed to undertaking these conservation initiatives, and other Interpretation Projects, as detailed in the Interpretation Strategy.

Water Corporation is planning to commence Action EPBS 2019/8547 as part of planned upgrades to 45 kilometres of main conduit pipeline in the 2025 / 2026 financial year. Planned projects interact with Maps 14, 15, 17 and 18, meaning conservation initiatives will be undertaken at these locations as part of the first tranche of works. The timeframe for other conservation initiatives within Project 1 will be implemented as Water Corporation's capital program to upgrade the pipe is further developed, having regard to the very long (70-year) term of the approved Action. Other Interpretation initiatives will be implemented as per the scheduled detailed in the Interpretation Strategy.

10.6 EPBC ACT ASSESSMENT PROCESSES- REFERRAL

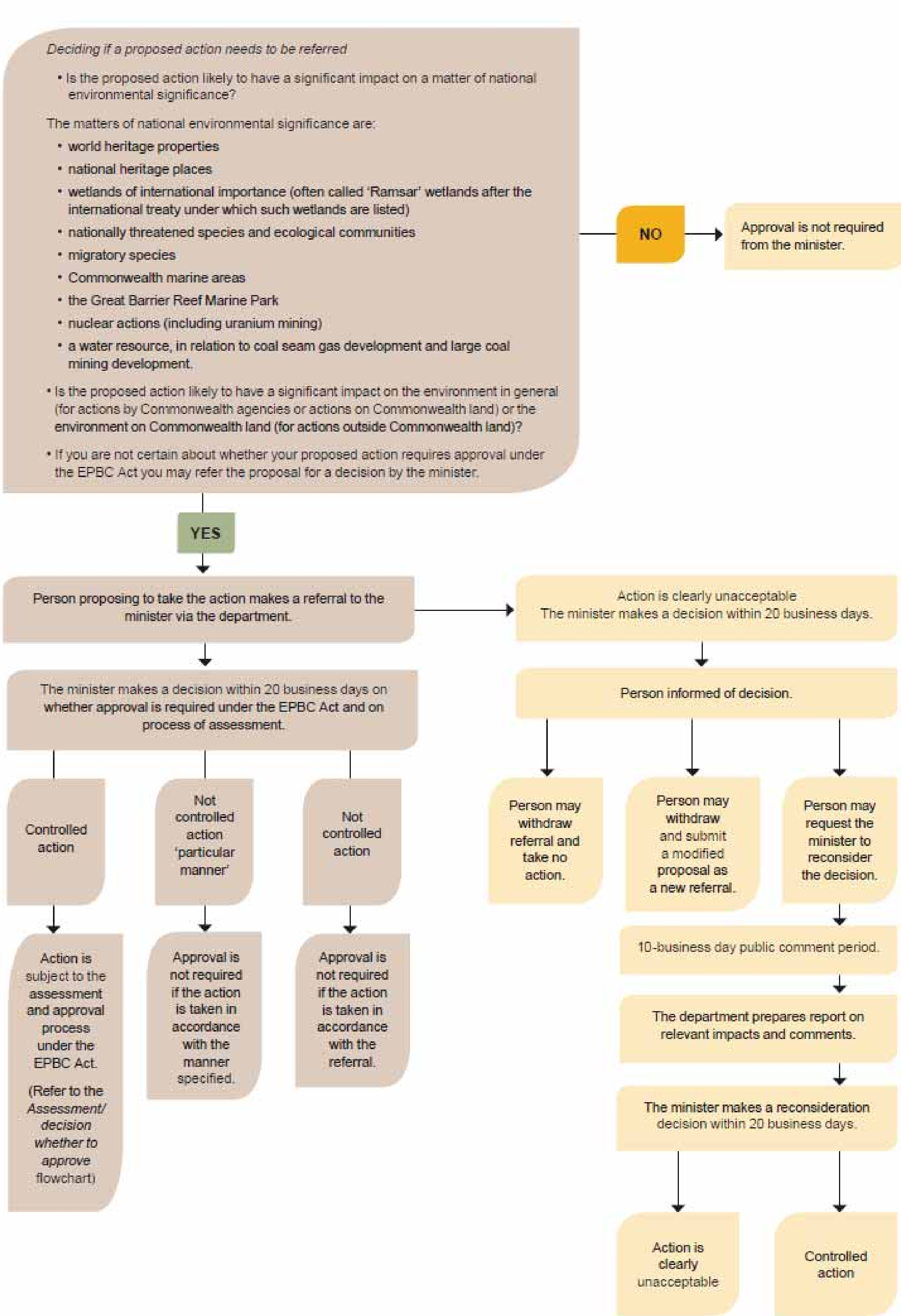

Figure 36: EPBC Action Environment Assessment Process

EPBC Action Environment Assessment Process- Assessment Decision Whether to Approve (Source: DCCEEW website)

10.7 EPBC ACT ASSESSMENT PROCESSES- DECISION WHETHER TO APPROVE

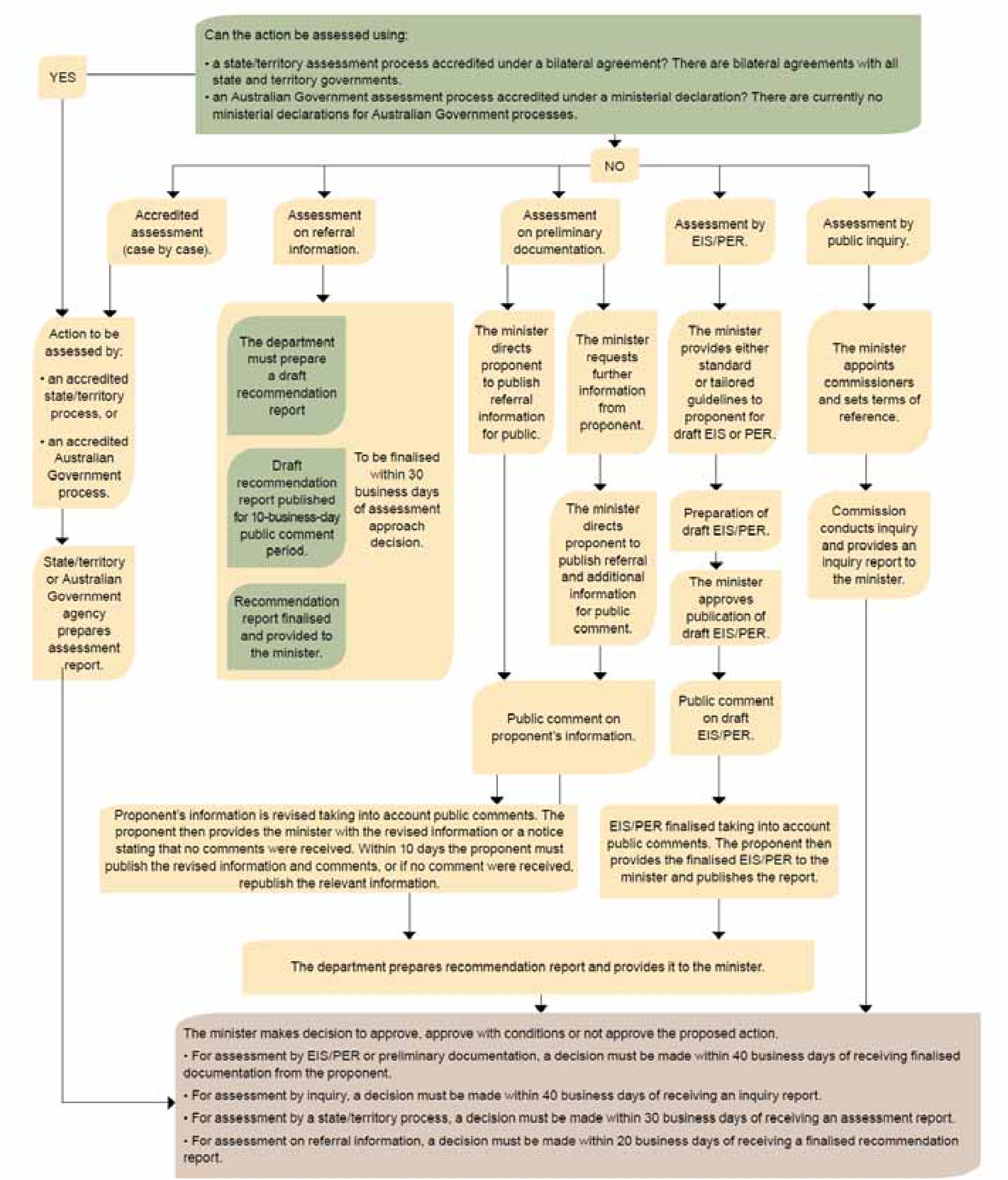

Figure 37: EPBC Action Environment Assessment Process

EPBC Action Environment Assessment Process- Assessment Decision Whether to Approve (Source: DCCEEW website)

PART D : APPENDICES

This section compiles the essential procedures, documents and additional information required to enact the Heritage Management of the GWSS:

Appendix A- Australian Heritage Database Entry, Goldfields Water Supply Scheme, Place No. 25251, Heritage Council, 2022.

Appendix B- Goldfields Water Supply Scheme Registered Entry, Heritage Council of Western Australia, database number 16610, 2022.

Appendix C- Goldfields Water Supply Scheme, Heritage Interpretation Strategy, H+H Architects, 2024.

Appendix D- EPCB Act Approval, Goldfields Water Supply Scheme Project, WA (EPBC 2019/8547), 2022.

Appendix E- EPBC Heritage Management Plan: Goldfields Water Supply Scheme, Main Conduit, Western Australia, Griffiths Architects, 2016.

Appendix F- Chronology of Conservation Plans for the GWSS and associated sites, Stephen Carrick Architects, 2024.

Appendix G- Gazette Notices: Inclusion of Place in the National Heritage List, Goldfields Water Supply Scheme, Western Australia, Commonwealth of Australia, 2011.

Appendix H- Registered Curtilage of the Goldfields Water Supply Scheme, Western Australia, Commonwealth of Australia, 2011.

Appendix I- Technical Note: G&AWS Main Conduit - Heritage Preservation, Stabilisation of Decommissioned Sections for Display. The Water Corporation, 2021.

Appendix J- P16610 GWSS No. 1 Station Complex, Mundaring and Mundaring Weir - Zones of Archaeological Potential, Timothy Kippo, HCWA, 2022.

Appendix K- Contractor Procedure Handout-Archaeological Finds Discovery, The Water Corporation, 2019.

Appendix L- Nexus File Structure, The Water Corporation, 2024.

Appendix M- Standard Work Instruction: C00001-Pipeline(Water)-Inspection, The Water Corporation.

Appendix N- Proposed Action: National Heritage 'Self-Assessment' Form, EPBCA 1999, The Water Corporation, 2024.

Image 60: Historical collage from SLWA Images

Source: Stephen Carrick Architects, 2024.

Photographs






















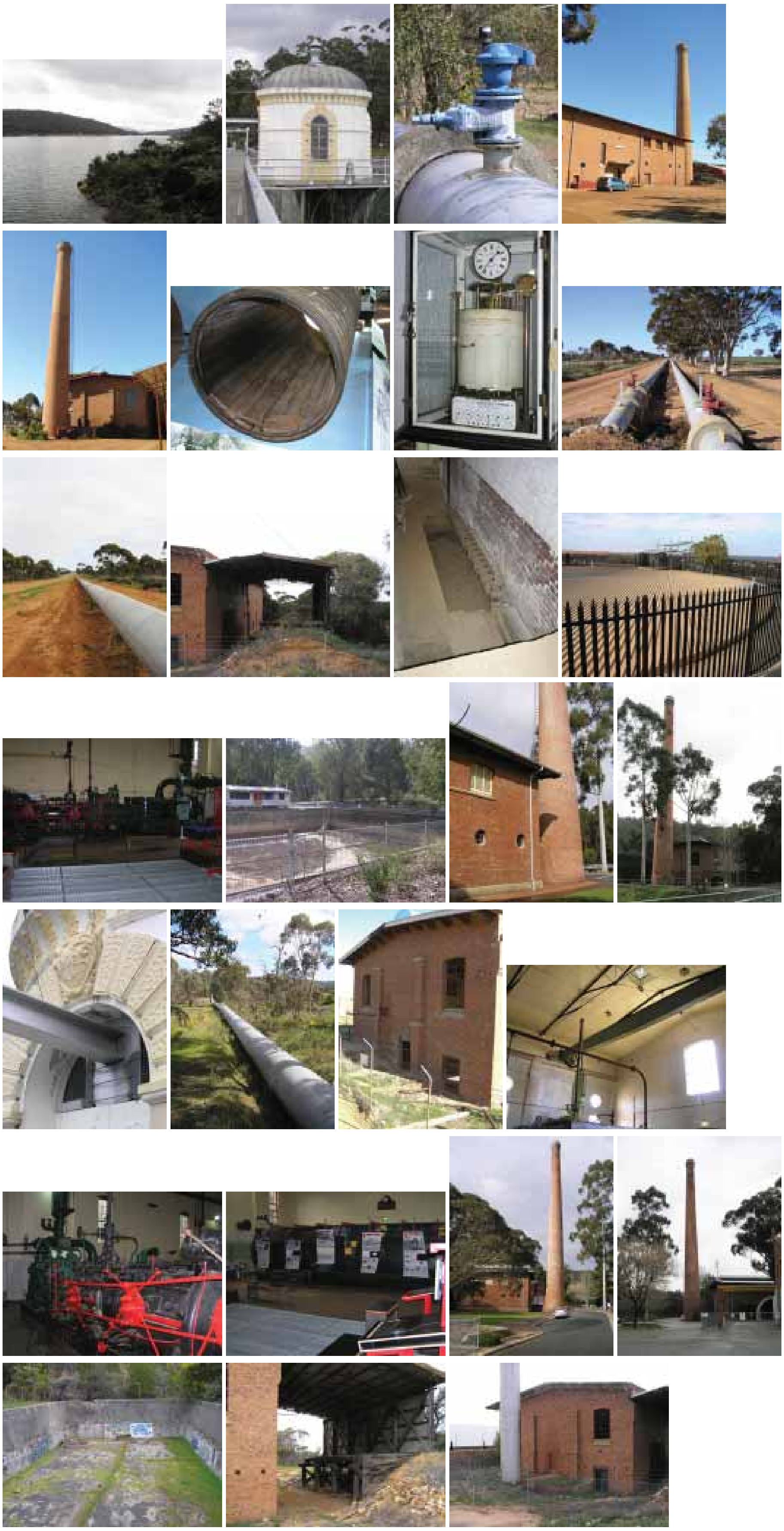

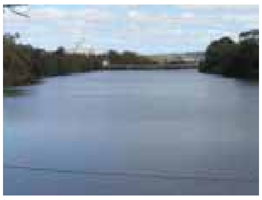






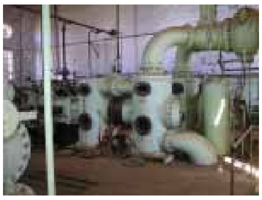

List	National Heritage List
Class	Historic
Legal Status	Listed place (23/06/2011)
Place ID	106007
Place File No	5/04/161/0049

Summary Statement of Significance

The Goldfields Water Supply Scheme incorporates the remaining elements of the Coolgardie Goldfields Water Supply Scheme, as designed by engineer Charles Yelverton O'Connor (CY O'Connor) and completed in 1903. These elements include the former steam powered pump stations (and associated receiving tanks), reservoirs, regulating tanks and over 560km of pipeline, commonly referred to as the 'main conduit'. It is significant for the economic benefits it brought to Western Australia and to the nation as a whole, for its demonstration of outstanding technological achievement for its time, and for its association with the engineer, CY O'Connor.

The Goldfields Water Supply Scheme was the impetus for agricultural expansion that was of lasting benefit to Western Australia and to Australia as a whole. Water from the pipeline became available just as the production of gold on the eastern goldfields was starting to decline, but its true value resulted from the effect that regular water supplies had in opening up the south-western agricultural area to production. As the value of gold recovered on the goldfields declined between 1905 and the 1960s, the quantity and value of wheat produced increased steadily over the same period. Today the Western Australian wheatfields are the most productive in Australia, accounting for 42% of the nation's wheat crop. Most of the WA wheat crop is produced in the areas serviced by the goldfields pipeline and its extensions, which continues to operate as a water supply scheme.

Both in the size of the project and in the use of new technology the Goldfields Water Supply Scheme was an outstanding technological achievement in the early 20th century. CY O'Connor's original scheme, known as the Coolgardie Goldfields Water Supply Scheme and consisting of the pipeline itself, the reservoirs, and the pumping stations, was regarded internationally as being the largest such engineering undertaking for its time. The amount of steel used in construction was greater than for previous large steel structures elsewhere in the world. The contracts for the supply of steel were the largest pipe contracts, and the most expensive Australian construction contracts, let to that time.

The Goldfields Water Supply Scheme (including the individual components) is of outstanding value to the nation as a representative example of early 20th century engineering in Australia. Principal characteristics of the Goldfields Water Supply Scheme include: Mundaring Weir (Dam) including the dam wall, spillway and two valve houses; Mount Charlotte Reservoir, the former pump station buildings (and receiving tanks); regulating tanks and the pipeline itself. The scheme is recognised by the American Society of Civil Engineers as an International Historic Civil Engineering Landmark.

The pipeline also made use of innovative Australian design in the locking bar pipe invented by Mephan Ferguson.

The refurbishment of the pipeline in 1933 was also a major technical development. Lifting the pipeline out of the ground and re-laying it above ground placed the Goldfields Water Supply Scheme among the world leaders in pipeline technology for the second time in less than 40 years. During this process, the forces in the continuously welded pipeline resulting from expansion and contraction were directed into reinforced concrete anchor blocks built over the pipe to prevent movement and to transfer these forces into the ground. This was the first time anywhere in the world that pipe anchorages of this type had been used to permit such a large diameter pipeline to be laid above ground.

The Goldfields Water Supply Scheme is significant for its association with the work of CY O'Connor, Engineer-in Chief of the Western Australian Public Works Department from 1891 to his death in March 1902. O'Connor was the driving force behind the construction of the Scheme, which provided great economic benefit to Australia. At the completion of the work, the Premier Sir John Forrest praised him as "the great builder of this work ... to bring happiness and comfort to the people of the goldfields for all time".

Official Values

Criterion A Events, Processes

The Goldfields Water Supply Scheme runs for over 560km and was opened in 1903. It is significant as the impetus for agricultural expansion that was of lasting benefit to Western Australia and to the nation as a whole. Water from the pipeline became available just as the production of gold on the eastern goldfields was starting to decline, but the true value of the pipeline both to Western Australia and to Australia as a whole was the effect that regular water supplies had in opening up the south-western agricultural area to production. While activity on the goldfields declined between 1905 and the 1960s, the quantity and value of wheat produced increased steadily over the same period. Today the Western Australian wheatfields are the most productive in Australia, accounting for 42% of the nation's wheat crop. This comes mainly from the areas serviced by the goldfields pipeline, which has continued to operate as a water supply scheme since its inception. The pipeline, its extensions and associated infrastructure represent the initiative that opened up the south-western agricultural area to development.

Criterion D Principal characteristics of a class of places

The Goldfields Water Supply Scheme incorporates the remaining elements of the former Coolgardie Goldfields Water Supply Scheme, as designed by engineer CY O'Connor and completed in 1903. The Goldfields Water Supply Scheme is an outstanding representative example of an inter-basin water transfer system while demonstrating a major development in water scheme design. It contains the principal characteristics of a water supply/transfer scheme including dams (pondages), extensive pipeline, tanks, reservoirs and pump stations. The pipeline continues to serve the needs of the communities between Mundaring and Kalgoorlie.

The characteristic features of the Goldfields Water Supply Scheme that express this value include the remaining extant features of the 1903 Scheme: the main conduit of the pipeline (the length of pipeline including all locking bar pipes, wood stave pipe and continuously welded pipes from Mundaring Weir to Mount Charlotte); with its surviving pumping stations (Pump Stations Nos 1, 3, 5,6 and 8) and their associated equipment (including the pumps, boilers, compressors, venturi meters and reservoirs located at Pump Stations 2, 4, 7 and 8), regulating tanks (located at Bullabulling, Toorak Hill, Bakers Hill and West Northam) and the Mundaring Weir (dam, including the valve houses, spillway, the weir wall profile and fabric) and the round Mount Charlotte Reservoir at Kalgoorlie.

Criterion F Creative or technical achievement

Both in the size of the project and in the use of new technology, the Goldfields Water Supply Scheme was an outstanding technological achievement for its time. The pipeline pumping scheme, consisting of the pipeline itself, the reservoirs, and the pumping stations, was regarded internationally as being the largest such engineering undertaking for its time. The amount of steel used in construction was greater than for previous large steel structures. The contracts for the supply of steel were the largest pipe contracts, and the most expensive Australian construction contracts, let to that time.

The pipeline also made use of innovative Australian design in the locking bar pipe invented by Mephan Ferguson.

The refurbishment of the pipeline in 1933 was also a major technical development. Lifting the pipeline out of the ground and re-laying it above ground placed the Goldfields Water Supply Scheme among the world leaders in pipeline technology for the second time in less than 40 years. During this refurbishment, the expansion forces were directed into reinforced concrete anchor blocks built over the pipe at 50 metre intervals, which prevented movement and transferred these forces into the ground. This was the first time anywhere in the world that pipe anchorages of this type had been used to permit such a large diameter pipeline to be laid above ground.

The technical achievement of the Goldfields Water Supply Scheme was internationally recognised by the American Society of Civil Engineers as an International Historic Civil Engineering Landmark in 2009, marking the Scheme as one of the most significant engineering projects of the 20th century.

Criterion H Significant people

The Goldfields Water Supply Scheme is significant for its association with the work of Charles Yelverton O'Connor, Engineer-in Chief of the Western Australian Public Works Department from 1891 to his death in March 1902. O'Connor was the driving force behind the construction of the pumping scheme including the pipeline, pumping stations and equipment, reservoirs and tanks, and the Mundaring Weir, which provided great economic benefit to the state of Western Australia and to the nation as a whole. While the Coolgardie Goldfields Water Supply Scheme was originally intended to serve the immediate needs of the goldfields, Sir John Forrest considered that its longer-term future was to service agriculture. At the completion of the work, the Premier Sir John Forrest praised him as "the great builder of this work ... to bring happiness and comfort to the people of the goldfields for all time".

Description

The Natural Context

The pipeline component of the Goldfields Water Supply Scheme stretches 560km from Mundaring to Kalgoorlie. The terrain which the pipeline occupies is not included in the place, rather the extant fabric of the pipeline (including the remaining original steel pipes, the 1930s refurbished continuously welded pipe, 1950s replacements and concrete anchor blocks) constitute the boundary of this element of the Goldfields Water Supply Scheme. The following section describes the natural context which the pipeline traverses and the natural corridors which it occupies.

The Goldfields Water Supply Scheme is found within the south-west Australian biodiversity hotspot, which is the only Australian biodiversity hotspot amongst 34 described globally. This biodiversity hotspot rating is a reflection of the number of species restricted to the region also known as endemic species and the degree of historical land clearing for agriculture (Myers *et al* 2000; Conservation International: 2007).

The flora of south-west Australia is notable for its diversity with around 8000 species, and high endemism with 75-80% of species restricted to the southwest region. This floristic diversity occurs at the species rather than at the genera level, which is in contrast to other regions of Australia such as the rainforests of Queensland, where there is a great diversity of plant families and genera but relatively few species within each genus. The south-west Australian flora is dominated by speciose genera from the following botanical families: Myrtaceae (eucalypts and allies), Proteaceae (banksias and allies), Fabaceae (native peas) and Epacridaceae (southern heaths) (Hopper 1992).

Within the south-west, the Goldfields Water Supply Scheme pipeline corridor runs through three broad biogeographic regions that have been identified under the Interim Biogeographic Regionalisation of Australia (IBRA) classification scheme (Thackway *et al* 1995). These IBRA are the Jarrah Forest, Avon Wheatbelt and Coolgardie IBRA regions.

Along the Goldfields Water Supply Scheme corridor the vegetation grades from wetter eucalypt forests in the Jarrah Forest region through to sparse open eucalypt woodland, which is a reflection of the change in rainfall of 1300mm in the west at Mundaring to around 200-300mm around Coolgardie.

The Jarrah Forest Bioregion vegetation is dominated by jarrah - marri (*Eucalyptus marginata - Corymbia calophylla*) forest on the Darling scarp (300m high) grading to wandoo (*Eucalyptus wandoo*) and marri woodlands in the east, with extensive Banksia low woodlands on localised sandsheets (Mackenzie *et al* 2002).

The Avon Wheatbelt Bioregion has proteaceous heaths, rich in endemics on the higher weathered (lateric) and residual uplands, with mixed eucalypt and Jam-York (*Acacia acuminata - Eucalyptus loxophleba*) woodlands on lower areas of the region. The Avon Wheatbelt Bioregion is characterised by low relief, and is especially notable biologically as it straddles a transitional rainfall zone of 700mm in the west to 400mm in the east, which contains the south-west's most species-rich areas. This rainfall transition zone is thought to have been periodically drier in the past, for example during the last glacial maximum 18,000 years ago, and plant population expansion and retraction is theorised to have driven the south-west flora's higher speciation rates (Hopper 1992 & Mackenzie *et al* 2002).

The Coolgardie Bioregion vegetation has mallee (multi-stemmed) eucalypts, *Acacia* thickets and shrub-heaths on sandplains. The area is rich in endemic *Acacias* and highly diverse Eucalypt woodlands, rich in endemics, occur around salt lakes, on ranges and in valleys. The salt lakes have dwarf shrublands of samphire (Mackenzie *et al* 2002).

Goldfields Water Supply Scheme is a very narrow corridor, as it is a 30-inch (76.2cm) diameter pipeline, which intersects the bioregions described above. Much of the corridor has been cleared for agriculture, especially in the Avon Wheatbelt Bioregion. Reserves along the corridor include the Boorabin and Goldfields Woodlands National Parks in the Coolgardie Bioregion, however the values of the listing only encompass the pipeline itself.

Historically eight steam pump stations along the pipeline used timber for fuel, which were located at Mundaring Weir, O'Connor (2.5 km from Mundaring Weir), Cunderdin, Merredin, Ghooli, Gilgai, Yerbillon and Dedari. Further information on the impact of the Goldfields Water Supply Scheme on the environment is provided in subsequent sections.

The Goldfields Water Supply Scheme

The Goldfields Water Supply Scheme is a late 19th century/early 20th century inter-basin transfer water system which extends from Mundaring Weir (Dam) in the west (approximately 41.5 km east of Perth), to Mount Charlotte Reservoir at Kalgoorlie in the east. The Scheme stretches from the Darling Ranges across the arid interior of Western Australia, a total distance of some 560 kilometres. Included are:

- the main reservoirs: Mundaring Weir (Dam) and Mount Charlotte Reservoir;
- the main conduit of the pipeline (including all locking bar pipe, wood stave pipe and continuously welded pipe) which stretches 560km from Mundaring in the west to Kalgoorlie in the east;
- the remaining six of the eight original pump stations (Nos 1, 3, 5, 6, 7 and 8) including remaining equipment;

- the remaining four associated holding tanks (located at Steam Pump Stations Nos, 2, 4, 7 and 8); and
- the four regulating tanks located at Bakers Hill, West Northam; Bullabulling and Toorak Hill.

How the scheme operated
Pump Station No1 pumped water directly from the Mundaring Weir. The water was pumped the short but steep distance (over a lift of 128.3 meters) to the receiving tank at No 2 Pump Station known as O'Connor. Pump Station No 2 pumped the water to the highest tank on the pipeline: Bakers Hill. The water was gravity fed to the regulating tank at West Northam. Continuing under force of gravity, the water arrived at the former railway tank (also referred to as a reservoir) at Cunderdin. The adjacent Pump Station No 3 pumped the water to the receiving tank at Cunderdin. From Cunderdin the remaining pump stations and associated receiving tanks are generally located an even distance apart. The water continues to be pumped the round tank at Merredin (Pump Station No 4), onto the tank and Pump Station at Yerbillon (Pump Station No 5) followed by Ghooli (tank and Pump Station No 6); to Gilgai (tank and Steam Pump Station No 7) to the final tank and Steam Pump Station No.8 located at Dedari. From Dedari the water was pumped to the Bullabulling Reservoir and on to the Toorak Hill Reservoir which was gravity fed and delivered the water to its final destination the Mount Charlotte Reservoir in Kalgoorlie (Ghassemi and White (2007).

The pipeline
CY O'Connor's 1903 pipeline is commonly referred to as the 'main conduit' of the Goldfields Water Supply Scheme and is approximately 560km in length (National Trust of Australia (WA) 2002). It commences at Mundaring Weir and terminates at Mount Charlotte Reservoir. Much of the pipeline is aligned with the current Great Eastern Highway. The pipes were made of 30-inch diameter steel. Originally (1903) the pipeline was buried underground, however, refurbishment in the 1930s raised the pipeline and it now rests on reinforced concrete anchor blocks (RICHCU 1999a). It is estimated that 60% of the pipeline is original. Still in use today (2009), the pipeline is in operating condition and continues to service the community.

The pipeline is a visible icon stretching across Western Australia's arid interior. The pipeline consists of:

- the length of the main conduit of the pipeline from Mundaring Weir (Dam) to Mount Charlotte Reservoir at Kalgoorlie;
- the reinforced concrete anchor blocks;
- caulked joints;
- stop and reflux-valves; and
- locking bar pipes.

Reservoirs
Mundaring Weir (Dam)
Mundaring Weir (Dam) is located at Weir Road, Mundaring, Western Australia. The site is in the valley of the Helena River on the western slopes of the Darling Range, 30 kilometres east of Perth City Centre and approximately 560 kilometres west of Kalgoorlie. The weir (dam) is located at the narrowest part of the steep-sided valley with the impounded lake stretching in a south-easterly direction for 16 kilometres (RNE Entry Mundaring Dam and Helena River Reservoir). The two main arms of the lake to the east and south-east are fed by the Helena River and the Darkin River respectively. Mundaring Weir is recognised as a large dam (Cole 1999 p.4-27). The spillway occupied such a large proportion of the crest that it lead to people referring to it as a weir (Doherty 1999 p. 4-16).

Mundaring Weir (Dam) represents the start of the Goldfields Water Supply Scheme. The Mundaring Weir (Dam) was completed by 1902 and damed the Helena River. Mundaring Weir (Dam) was the highest gravity dam constructed in Australia between 1871 and 1910 (Doherty 2000: p.21). It is a curved concrete face dam and when completed measured 61 meters in height above the lowest foundation level (Doherty 2000: p. 26). This type of dam was selected as its design could assist in managing the predicted flooding from the 1,450m² catchment area (Cole 1999: p.1-6). The height of the wall was raised to 71 meters in 1951 which increased the dam's capacity to 60,000m³ (Doherty 2000: p. 39). While the weir (dam) wall has been raised it retains its original 1902 appearance and profile. The Mundaring Weir (Dam) spillway has been identified as a nationally significant example of an early twentieth century ogee spillway (Kinstler 2000 p.191). It is located on the left hand side of the dam and allows the discharge to flow over the dam face onto the granite rock foundations. The capacity of the spillway is 1,000m³ (Kinstler 2000: p.191).

It includes:

- the weir (dam) wall;
- spillway;
- the footwalk across the crest of the weir (dam) which is a reconstruction of the original; and
- the inner and outer valve houses.

Mount Charlotte Reservoir
Mount Charlotte Reservoir is located on Hannan Street, some 560km from Mundaring Weir (Dam). It is a round reinforced concrete tank which is dug into the crest of the hill(National Trust of Australia (WA 2002 p.112) . It is the

final receptacle and the terminus for the Goldfields Water Supply Scheme, Western Australia. The capacity of the reservoir when it was completed in 1902 was two million gallons (4,540,000 litres). Sir John Forrest officially turned the valve at Mount Charlotte Reservoir on 24 January 1903 as part of the opening celebrations. Mount Charlotte Reservoir is currently used to service the Kalgoorlie community as a reserve tank by the Water Corporation (WA) (National Trust of Australia (WA) 2002 p.112) . A metal roof was added in the 1970s to prevent evaporation and for security reasons (RICHCU 1999k). Mount Charlotte Reservoir includes (RICHCU 1999k) :

· the reservoir including the walls;
· the valve pit; and
· the valve pit to the pipe trench.

Bullabulling Reservoir

The Bullabulling Reservoir is located at Bullabulling between Pump Station No 8 at Dedari and Coolgardie. It is located approximately 30km west from Coolgardie along the Great Eastern Highway and then north along a gravel track for approximately 3km. It is situated approximately 0.7 km from the current electric pump station.

Completed in 1902, Bullabulling Reservoir is a rectangular holding tank. Plans from 1901 indicate that the tank was used to receive water from pump station No 8 at Dedari which was then gravity fed to Toorak Hill. Features of the tank include an overflow pipe which is located in the centre of the north wall. Excess water is discharged via the channel and ditch. The constituent material is reinforced concrete. Barbed wire was used to reinforce the concrete to assist in overcoming concrete cracking induced by temperature extremes. The walls of the tank are more than two feet (0.61 metres) thick (RICHCU 1999j). The capacity of the tank is 45.4 million litres. The site is currently enclosed by a mesh security fence. The reservoir is still in use.

Toorak Hill Regulating Tank

Toorak Hill Goldfields Water Supply Reservoir is located on Moran Street (Lefroy Street), 1.5km north of Coolgardie. It consists of:

- the concrete walls of the reservoir, which have been enclosed and covered to reduce evaporation and for security reasons.

Pump Stations

Eight steam powered pumping stations were required to transport the water the 560km from Mundaring to Kalgoorlie. The pump station buildings are aesthetically pleasing, architecturally designed, purpose built industrial structures. It is believed that the Pump Stations were designed by George Temple Poole (RICHCU 1999x, during his time as a consulting architect with the Public Works Department of the Coolgardie Water Supply Branch. They were constructed by the Western Australian Department of Public Works (RICHU 1999m p.52). Architecturally the Pump Stations are not indicative of a single style or type. However, a number of stylistic elements contribute to the symmetry and form of these industrial buildings. Of notable importance are the large Romanesque arch, Baroque style canopy, bulls-eye windows, long Georgian windows with deep sills reported by RICHCU 1999m p. 83) as reflecting generally Baroque characteristics. The pump stations themselves were substantial buildings of wire cut red brick constructed in an English bond, with cut and struck lime mortar joints. Roof fabric was generally corrugated iron roofs supported on steel trusses with timber fascias. Each pump station had a similar layout consisting of a boiler and pump room separated by a passage way (Foxley 2008 and RICHCU 1999m). The pump (also known as engine rooms) contained the engines, pumps and working benches for maintenance works. The lower levels of the pump rooms were constructed of concrete with a cement mortar. Steel joist provided the formwork for the upper work levels, which were finished with Jarrah floors. Boiler rooms contained the boilers, an economiser, boiler feed pumps and a large arched doorway where coal was delivered for the boilers. Each pump station also featured a circular chimney constructed from steel. Some were later replaced with brick chimneys due to corrosion damage. Those with brick chimneys' retained the circular profile and featured an English brick bond a with lime mortar. The chimneys height was generally approximately 135 feet (41 metres) high and gently tapered. Chimneys were connected to the boilers and economisers by a brick tunnel flue. The Steam pump stations were initially powered by coal, but later changed to run on wood (RICHCU 1999m).

At six of the pumping stations, concrete lined holding (also referred to as suction and regulating tanks) were constructed adjacent to the pump stations. Water was pumped into the holding tank through the previous stage of the pipeline and was drawn from these tanks by the pump for transmission through the next stage of pipeline to the holding tank at the next pumping station. The exceptions were at Station No 1, which drew water directly from Mundaring Weir (Dam) and Station No 3, where a nearby 10 million gallon (37.8 million litres) capacity reservoir had been previously constructed for the railway (National Trust 2000, Vol 208).

No 1 Pump station (Mundaring)

No 1 pump station is located at the base of Mundaring Weir and is currently operated by the National Trust of Australia (Western Australia). It is operated as a visitors centre and has been known as the CY O'Connor Museum since it opened in 1963 (RICHCU 199b) . Pump station No 1 was operational by December 1902. Sir John and Lady Forrest opened the pump station on 22nd January 1903(National Trust of Australia (Western Australia 1999) . Unlike the other pump stations, water was delivered directly from the Mundaring Weir (Dam) via a pipe which ran under the pump station (Foxley 2008). Pump station No 1 ceased operating in 1955. It consists of (RICHCU 1999b and 1999m):

- the pump station building;
- all three of the original Babcock and Wilcox water tube boilers with superheaters, as installed at this station;
- air compressors;
- the chains from the scrapers which removed the soot from the tubes and the governor that controlled their movement;
- the brick chimney stack which was installed in 1910 measuring approximately 41 metres high (this replaced the original steel chimney which had been damaged by corrosion);
- the one remaining Worthington duplex engine (there were originally three installed at this station);
- the remaining fabric of the standpipe (which was supplied by Mephan Ferguson and designed by James Simpson and Co); and
- the lime-setting tank.

No 2 Pump station (O'Connor) Receiving tank remains only

The site of the No 2 pump station is located 2.5 km from No1 (Mundaring Weir/Dam). The positioning of the pumping station was thoroughly investigated (consideration was given to the geology and topography) and the final position selected was a flattened area on the eastern slope of the hill. From pump station No 2 (O'Connor) water was pumped to the tank at Bakers Hill. Pump station No 2 ceased operating in 1956 and was demolished in March 1968. Interpretive signage has been installed, indicating the presence and function of the former pump station. The site is important for its relationship with the original Coolgardie Water Supply Scheme as designed by CY O'Connor (RICHCU 1999c). The site is managed by the Water Corporation (WA) and was not in use at the time of the site visit (2008). Extant fabric includes (RICHCU 1999c):

- remains of the concrete suction tank (also referred to as a receiving tank) supported by dry rubble backing and earth filling, including drainage, pipe work and access stairs.

No 3 Pump station (Cunderdin)

No 3 pump station is located at 100 Forrest Street, Cunderdin. Pump station No 3 ceased operating in 1956 (National Trust of Australia (WA) 2002). It is open to the public and serves as a local district museum. Pump Station No 3 was completed in 1902. A receiving tank was never constructed for this steam pump station. Rather, No 3 utilised an existing reservoir previously constructed for the railway. It consists of (RICHCU 1999(d).:

- the pump station building;
- the 1919 brick chimney (the only other steam pump station to have a brick chimney was Pump Station No 1);
- the one remaining Worthington duplex engine (originally three were installed at this station); and
- the only Venturi water meter which survives at any of the stations.

No 4 Pump station (Merredin)

No 4 pump station is located at Merredin approximately 3 kilometres west of the Merredin township along the Great Eastern Highway. It is approximately 219 kilometres from the Mundaring Weir and was completed around April 1902. It is one of three generations of pump stations at this location (RICHCU 1999g and 1999m. Operations ceased at pump station No 3 in 1956, when replaced by an electronic control system. The pump station has been fenced in with chain mesh to protect it from vandalism and can be viewed from the outside. It consists of:

- the pump station building;
- coal bin;
- remnant rail trestle;
- weighbridge;
- the remains of the chimney flue;
- three control valve pits;
- blow off pits;
- water gauge;
- overhead travelling crane;
- concrete pits forming former lines of pipeline; and
- a round receiving tank (also referred to as a suction tank). The original capacity of the tank was one million gallons (4.5 million litres).

No 5 Pump station (Yerbillon)

No 5 pump station is located at Yerbillon, approximately 45 kilometres westward of Southern Cross along the Great Eastern Highway. Pump station No 5 is located 270 kilometres from Mundaring Weir (Dam). This Pump Station ceased operating in 1968, with the introduction of the electronic pump station. The site has been fenced in with chain mesh fencing to protect it from vandalism and can only be viewed from the outside. All associated machinery and fittings have been removed. It consists of (RICHCU 1999g and 1999m):

- the pump station building;
- the economiser;
- remnant coal bin;
- boilers;
- overhead travelling crane;

- weighbridge remains;
- remains of the venturi metre house
- remains of the pipe trench; and
- the original suction tank.

No 6 Pump station (Ghooli)

No 6 pump station is located on the Great Eastern Highway, Ghooli and is approximately 10km east of Southern Cross. Pump station No 6 was completed in 1902 and is located 342 kilometres from Mundaring Weir (Dam). Operations ceased at this site in 1969. The site has been fenced in with chain mesh fencing to protect it from vandalism and can be viewed from the outside. It consists of (RICHCU 1999g and 1999m):

- the pump station building;
- economiser;
- boilers;
- steam pumps;
- weighbridge and scale balance;
- overhead travelling crane;
- coal bin;
- railhead;
- weighbridge; and
- reservoir (suction tank) which has since been covered over to prevent evaporation;

No 7 Pump station (Gilgai)

Steam Pump No 7 was located at Gilgai, approximately 40 kilometres east from Yellowdine along the Great Eastern Highway. One of the engines from this site was relocated to Pump Station No. 3 at Cunderdin. All buildings have been demolished and no extant fabric remains. The site consists of (RICHCU 1999h and 1999m):

- the rectangular receiving tank.

No 8 Pump station (Dedari)

Pump station No 8 is located on the Great Eastern Highway at Dedari (Benari) and is approximately 45km west of Coolgardie. The site has been vested to the National Trust of Australia (Western Australia) and is currently used as a visitors and interpretation centre. Pump station No 8 was the last of CY O'Connor's original pump stations to cease operation in 1970.

The building is intact and contains all its original Worthington pumping engines and all three of the Babcock and Wilcox boilers, air compressors and the economiser. It is the only steam pump station to retain its original overhead gantry. The receiving tank survives along side the pump station. It retains both the inlet and outlet pipes which remain connected to the pumps. Outlet pipes from the pumps are also still connected to a stretch of the original 1903 pipeline. Remnants of the original railway siding remain, including the best preserved of the wooden trestles which are located at this site. This siding is still covered by the corrugated iron framed lean-to, attached to the side of the main pump station. No 8 pump station at Dedari is the most complete and representative of the stations of all the pumping stations. This station was the last of the original Pumping Stations to cease operating in the 1970s. The site has been enclosed and has a caretaker. The site consists of (RICHCU 1999i and 1999m):

- the pump station building;
- the pumps;
- all three Babcock and Wilcox boilers;
- air compressors;
- economiser;
- the overhead gantry;
- tools;
- equipment;
- the original steel chimney;
- coal bin;
- store;
- blacksmith's shop;
- suction tank including the inlet and outlet pipes which remain connected to the pumps;
- the section of outlet pipe from the pumps which is still connected to a stretch of the original 1903 pipeline;
- the remaining extant fabric of the original railway siding including the best preserved of the wooden trestles;
- the extant fabric of the siding which includes the corrugated iron framed lean-to structure, attached to the side of the main pump house;
- some of the associated ancillary corrugated iron buildings, including:
  - the weigh station incorporating the operational weighbridge and scales;
  - the station office; and
  - the blacksmith's forge incorporating its original charcoal furnace; and
  - the Venturi meter house (the only example remaining at any of the sites).

Regulating Tanks

A number of regulating tanks were constructed to assist in managing the flow between the pump stations. The regulating tanks were imperative in maintaining water pressure and flow. They were used at the places listed below.

Bakers Hill Regulating Tank

Located at Bakers Hill the regulating tank was built to control the water flow at the highest point between pumping stations 2 and 3. It consists of:

- the concrete lined tank; and
- timber framed railway platform.

West Northam

Located at West Northam the regulating tank was built to maintain water pressure at the standard required for working order. Just after Station No 2 the pipeline crossed a high ridge, and the Station pumped the water for 37 km with a net lift of 104 metres to Bakers Hill. It appears that there is no extant fabric relating to this individual element.

Aboriginal Heritage

Sites of significance in Aboriginal culture are often associated with water. Approximately eighty Aboriginal sites are identified along the Goldfields Water Supply Scheme pipeline (DIA 2009). The highest densities of sites occur in three places: at the beginning of the pipeline, at Mundaring Dam and Helena River; about 80 kilometres from Mundaring at Northam, and at Coolgardie and Kalgoorlie, at the end of the pipeline (DIA Sites Register, 2009). As a result of environmental disturbances associated with the building of the pipeline and earlier infrastructure, many Aboriginal sites have been disturbed. The greatest environmental impact occurred at the beginning of the pipeline, at the Mundaring Dam.

Webb (2004) notes that few of the water sources on Hunts Track have been recorded as Aboriginal sites, and that there are issues with the accuracy of site locations and the lack of a systematic archaeological survey of Noongar Aboriginal sites and complexes, including rock art sites.

The most important totem in the south of Western Australia is the snake Woggal, also known as Waugyl/Waugal (Bates 1985). The Mundaring area, a highly significant and sensitive mythological area, has ongoing associations with the Waugyl spirit. The Mundaring (*Mundjalline*) myth links the Helena River east via Mundaring to the Swan River and west to York (Villiers 2007). Aboriginal people moved via the Helena River and Canning River valleys through the Darling Escarpment (Villiers 2007). "It is noted that a number of Aboriginal see the construction of the Mundaring Weir as a desecration of a highly significant site which should not have occurred" (Villiers 2007, 15).

The Mundaring Dam and weir has eleven registered DIA sites and the Helena River has four, including a total of three ceremonial/mythological sites and one quarry. The remainder are artefacts/scatters. A local history of the area identifies a ceremonial one-metre high rock site that depicts two intersecting snakes below the weir (Quicke 1979). The Mundaring Corroboree Grounds (*Booralyn*) below the weir wall is listed as interim on the DIA register due to lack of information (Villiers 2007). Maamba Reserve is registered as Welshpool Reserve.

Many Aboriginal sites along the pipeline are of ongoing significance to Aboriginal people who visit them regularly today. Sites identified on the pipeline include corroboree grounds and soaks associated with trade routes, wells, granite outcrops, birthing rocks on the Avon River at Northam, cave and rock paintings near Kellerberrin and a number of secret/sacred sites (The National Trust 2001). Bates (1985) recorded the presence of cave paintings as the identifier of Karatjibbin initiation grounds and cites Kellerberrin as an example.

The Goldfields Pipeline traverses the traditional lands of Aboriginal people who identify themselves as Noongar, Ballaruks peoples and Ballardong, all represented by the South West Aboriginal Land and Sea Council, the Gubrun and Kalamaia Kubun, represented by the Central West Goldfields People and the Widji represented by the Goldfields Land and Sea Council Aboriginal Corporation Central Desert Native Title Services (National Native Title Tribunal).

Justice Wilcox noted the ongoing relationship contemporary Noongar Aboriginal people have to their country.

"I have concluded that the contemporary Noongar community acknowledges and observes laws and customs relating to land which are a recognisable adaptation to their situation of the laws and customs existing at the date of settlement. In particular, contemporary Noongars continue to observe a system under which individuals obtain special rights over particular country – their *boodjas* – through their father or mother, or occasionally a grandparent. Those rights are generally recognised by other Noongars, who must obtain permission to access another person's *boodja* for any traditional purpose. Present day Noongars also maintain the traditional rules as to who may 'speak for' particular country" (Indigenous Law Bulletin 2007).

History

Conditions on the eastern goldfields

Western Australia made little progress in the first fifty years following its foundation in 1829. By 1891 the colony was teetering on the verge of collapse. The Government's coffers were empty, the railway system about to collapse, urgent public works were needed across the colony, and the port at Fremantle was so unsafe that most ships bypassed it in favour of Albany 400 kilometres by road to the south. The 1890s were a watershed in Western Australia's economic and political history. Discovery of large deposits of initially alluvial and later reef gold in the eastern Yilgarn district attracted thousands of miners from other colonies and overseas. On 17 September 1892, Bayley and Ford found gold at Fly Flat (later to become Coolgardie). Then on 17 June 1893 Paddy Hannan struck gold at what developed into one of the richest goldfields of all time centred on the 'Goldern Mile' between Kalgoorlie and Boulder. In a couple of days of fossicking, Hannan and his partner collected over 100 ounces of gold. These rich goldfields drew prospectors from all over the world, particularly from the eastern Australian colonies (IEA 1986: p.1). By October 1895 Coolgardie was the undisputed capital of the goldfields and centre of the colony's gold mining industry. The town itself had a population of about 8,000, while within a radius of some 65 kilometres, there was a floating population of another twenty to thirty thousand. At the time Kalgoorlie was a village of tents and dust, and Boulder did not exist. (Hartley 2000: p.727).

Large international investment in mining and related ventures made a dramatic impact on the slow growing colony (Appleyard 1981: p. 218). In 1890 the population of Western Australia was 48,502, and by 1900 it had increased to 179,967. In just on a decade the small, isolated, rural-based economy saw an almost fourfold increase in population and a massive increase in capital which lifted infrastructure to a level previously thought impossible to achieve (Appleyard 1981: p. 219). By 1911 the population had reached over 293,923, with the bulk of this population increase being on the eastern goldfields themselves (IEA 1986: p.1). Over the same period the value of gold exports rose from £86.664 in 1890 (12.9% of the gross value of WA colonial exports), to £5,549,879 in 1900 (81.0% of export value) (Appleyard 1981: p. 236).

As the Western Australian gold rush gathered momentum in the 1890s, one of the biggest problems facing gold seekers on the eastern goldfields was the lack of adequate water. The Coolgardie region had an unreliable rainfall, with annual falls during the early 1890s varying from 90 mm to 260 mm (Hartley 2000: p.727). The region lacked any surface supplies of fresh water, and geologists reported that there was little prospect of finding useful artesian supplies. A variety of short-term water supply works were installed by the WA Public Works Department (PWD), including earth dams, catchments on rock outcrops, condensing plants, wells and bores. However, it became increasingly difficult and costly to provide the rapidly expanding population with uncontaminated water supplies using these means.

By the mid 1890s over 40 percent of Western Australia's population lived on the eastern goldfields under appalling conditions and paying exorbitant prices for domestic water (NTWA 2000: vol 208). A contemporary report complained "The seriousness of the problem can be gauged by the usual prices paid for water - 25 shillings per 1,000 gallons when the occasional rains filled the tanks - and £4 per 1,000 gallons when only water condensed from wells and shafts was available" (quoted in IEA 1986: p.1). The harsh unhealthy conditions on the goldfields raised death rates to 16 per thousand in the period 1896 to 1898, due in most part to the prevalence of typhoid fever in the arid Yilgarn where clean water was difficult for prospectors to obtain (Appleyard 1981: p. 221). For so long as these miners were deprived of an adequate safe water supply for domestic use, they refused to bring their wives and families from the eastern colonies. As a result, the masculinity ratio rose dramatically in the colony. By 1896 Western Australia contained twice as many males as females (Appleyard 1981: p. 220).

The problem was compounded by the method of extraction used in the mining process. In 1895, the few small processing plants on the Golden Mile were using 2,000 gallons of water per ton of ore crushed (Hartley 2000: p.728). This was a high usage by international standards, particularly in an area where water was so scarce. However, the high usage was necessary because the talc-like nature of the oxidised ore tended to clog stampers and screens unless washed through with a good flow of water. The extraction rates were also poor because the stamped ore readily formed slimes from which gold could not be easily recovered by the usual method of amalgamation with mercury (Hartley 2000: p.728). Tailings, therefore, had to be ponded in dams until such time as they could be treated.

The adoption of the filter press in 1897, to contain these slimes while gold was removed by cyanide treatment, allowed the recycling of water with important consequences. Water usage fell dramatically from 2,000 gallons per ton in 1895 to around 500 gallons per ton by 1900. However, this increasing economy of water usage was offset as the scale of operations on the Golden Mile changed dramatically. In 1896, only 33,000 tons of ore were processed on the East Coolgardie Goldfield using 66 million gallons of water. By 1903 when this goldfield had become one of the most productive in the world 967,000 tons of ore were processed - almost thirty times more than in 1896 and using 483.5 million gallons of water (Hartley 2000: p.728). Infrequent rains together with a high evaporation rate and lack of suitable dam sites ruled out the development on the goldfields of impounding dams large enough to store water sufficient to accommodate this level of heavy usage (Hartley 2000: p.727).
A source outside the goldfields was needed.

The Goldfields Water Supply Scheme

A number of schemes were suggested, including bringing sea water from Esperance Bay to the goldfields for use in the government condensers (Alexander 1954: p.32). However, the Premier Sir John (later Baron) Forrest did not support the scheme and the decision was made to investigate the possibility of piping water from the Darling Ranges east of Perth to the goldfields, a distance of some 352 miles (566 km).

In mid-1895 Premier Forrest asked Charles Yelverton O'Connor, Engineer-in-Chief of the Public Works Department, to prepare data for a scheme to pump water from a reservoir in the Darling Ranges to the goldfields. O'Connor had been recruited from New Zealand and arrived in Western Australia in June of 1891. Prior to his work on the pipeline, he had completely rebuilt and restructured the state's railway system. He was also responsible for the construction of the inner harbour on the Swan River at Fremantle. He had argued for an inner harbour in opposition to the panel of overseas experts who had recommended an outer harbour based on a causeway ending in a curved breakwater running a half a mile out to sea on the northern side of the river mouth (Trust News 2000: Vol 208).

The first trial designs for a pumped water supply were completed in November 1895 and were based on three different supply rates: one million gallons per day, five million gallons per day and ten million gallons per day. In 1896, the processing requirements of the whole of Western Australia's gold mining industry could have been met with water supplies totalling one million gallons per day - assuming a usage of 2,000 gallons per ton of ore (Hartley 2000: p.730). O'Connor argued that a one million gallons per day capacity pipeline would only be adequate for short term requirements. Because of its smaller diameter, such a pipeline would have had a friction head nearly twice that of a five million gallons pipeline, and its operating costs would have been greater in the same proportion. He estimated that a one million gallons capacity pipeline would require some twelve to fifteen pumping stations compared with the eight or nine needed for a five million gallons line (Hartley 2000: pp.730-1). O'Connor also argued that, as the cost of pumping was proportional to the quantity pumped, it would be no more expensive to pump 11 million gallons daily through a pipeline of five million gallons capacity than it would be to pump the same quantity through a one million gallons capacity pipeline. In fact it would be cheaper because of the reduced friction in the larger pipe. He estimated that a supply of one million gallons would entail a capital cost of about £1 million, while a five million gallons supply would cost £2.5 million: five times the capacity for 2½ times the cost (Hartley 2000: p.731).

On 16 July 1896, Premier John Forrest introduced into the WA Parliament a Bill to authorise the raising of a loan of £2.5 million to construct the pipeline scheme. The Bill passed through the Parliament in September 1896 (Trust News 2000: Vol 207).

O'Connor supported the view that a group of experienced overseas engineers should be appointed to advise on major issues, such as: the type, thickness and diameter of the pipe; the spacing of the pumping stations; and the power requirements and capacity of the pumps themselves. A Commission of three experienced English engineers was appointed in December 1896, and in January 1897 O Connor travelled to London to discuss the proposed scheme with them. The Commission was led by Sir John Carruthers, previously head of the PWD in New Zealand (Evans 2001: p.164), and included Professor William Unwin, widely regarded as the pre-eminent authority of the day on the transmission of power, and Dr George F Deacon, engineer-in-charge of the Liverpool Water Supply (Evans 2001: p.167). In their interim report of 3 August 1897 the Commission indicated that the proposed scheme was theoretically practical although of a greater scope and size than any similar scheme attempted elsewhere in the world to that time (Trust News 2000: Vol 209). Although they had originally recommended nine pumping stations, in their final report of 31 December 1897 they revised this to eight stations. The ninth station was omitted when the decision was made to deliver the water to a large distribution reservoir at Bullabulling instead of Mt Burgess, north of Coolgardie. From this reservoir at Bullabulling the water would flow under the influence of gravity 21 miles (33.8 km) to the Coolgardie service reservoir at Toorak and eventually down the extra 23½ miles (37.8 km) to the Kalgoorlie service reservoir at Mt Charlotte (Trust News 2000: Vol 209).

The Mundaring Reservoir

When the scheme was first proposed and until shortly before the construction of the weir was begun, there were no river-gauge water flow measurements available for rivers in the Darling Ranges. Calculations based on results obtained in other countries were necessary in order to estimate the probable inflow into any proposed reservoir. In order to identify potential dam sites for the scheme O'Connor's principal assistant, Thomas Hodgson, made an exhaustive examination of the Darling Range watershed and rivers in late 1895 and 1896 covering about 3,000 square miles of the ranges. Hodgson, an extremely qualified and experienced water supply engineer from Victoria, had been appointed in late 1895 as O'Connor's principal assistant on the water supply project. He identified thirteen potential sites, but recommended one on the Helena River which he was confident would have the capacity to provide the required supply of five million gallons of water per day. It was finally decided that the most economical place for the reservoir was at Mundaring on the Helena River, where it was estimated that the cost of construction per million gallons of storage would be least.

Mundaring Weir (Dam), which was built at the recommended site, was a one hundred feet high concrete dam capable of impounding over 4,600 million gallons. At the site chosen for the weir, the valley through which the Helena runs converges abruptly into a deep gorge flanked on both sides by high hills. The river's width at its bed is 15 feet (4.6 m) and it is only 750 feet (228.6 m) in width at a height of 100 feet (30.5 m) above the bed. There was ample evidence to show that the Helena and other streams in the area were liable to heavy floods and the usual method of disposing of flood-waters, by means of a by-wash, was precluded by its cost. It was therefore decided to pass all floods over the weir crest. Calculation showed that to provide a safe margin for the passage of flood waters as much as 5 feet (1.5 m) in depth over the whole length of the weir would have to be allowed for (Strickland 1986: p.19).

The country at the reservoir site consisted largely of undecomposed granite traversed by intrusive basaltic dykes whose direction was mostly at right-angles to the course of the river. At the site of the weir, however, the granite showed out particularly clearly and trial-shafts reached solid granite at no great depth, the deepest of the shafts being only 20 feet (6.1 m) deep from the ground surface (Strickland 1986: p.20). During the later excavation of the foundations, however, it was discovered that the rock was not as solid as surface indications and the trial-pits had originally promised. On the right bank a large portion of what at first appeared to be bed-rock was found to consist of an immense boulder with a large cavity below it. Additionally, under the bed of the river the granite was very badly fissured over the full width of the foundations, and the disruption was found to extend both up and down stream for a considerable distance. There was no alternative but to follow the fissure down, which eventually required excavation to a depth of 90 feet (27.4 m) below the river bed. At this level the filling material in the fissure was found to be compact, and it was concluded that the fissure at this depth was safe as the base of the weir. Where the fissure occurred under the foundations and the wall would be highest, the excavations were carried down about 15 feet (4.6 m) from the building-line in a vertical direction on the up-stream face (Strickland 1986: p.20). However, as one of the basalt dykes crossed the valley a short distance away on the down-stream side, it was considered necessary to remove the whole of the material between this dyke and what would otherwise have been the toe of the weir. A concrete-lined spill-water basin, about 150 feet (45.7 m) long by 100 feet (30.5 m) wide, was constructed in the bed of the river at the toe of the wall, with a depth of water in the basin of about 10 feet (3.1 m). The concrete filling of the foundations was carried up to bed level on the up-stream face, but on the lower side the mass filling was stopped 18 feet (5.5 m) below bed-level and the parabolic section of the weir wall proper was begun. The granite beds under the foundations were deeply chased in longitudinal rows about 6 feet (1.8 m) wide and 3 feet (0.9 m) deep, and the toe of the wall-batter where it met the granite floor was channelled the whole length in order to key in the concrete foundations (Strickland 1986: p.21).

The reservoir is provided with two valve-towers constructed of concrete. The inner tower is situated on the reservoir side of the weir and was built into and concurrently with the main wall. The inner valve-tower has provision for drawing water from the reservoir by means of cast-iron bell-mouthed pipes passing through the valve-tower wall into a cast-iron stand-post, at three different levels: 25 ½ feet (7.7m), 53 feet (16.2 m), and 80 feet (24.4 m) below full supply level (Strickland 1986: pp.21-2). The outer valve-tower is situated 175 feet (53.3 m) down stream from the centre of the weir-wall, being connected to the reservoir by a viaduct which carries the outlet and scour-pipes.

The excavations for the foundations were begun in May. 1898 and completed by January 1900, with the building of the reservoir wall being completed in June 1902.

The Pipeline

The pipeline as originally constructed runs approximately 566 km from the reservoir at Mundaring to the Yilgarn district, terminating in holding reservoirs at Coolgardie and Kalgoorlie. It was designed to follow as closely as practicable the railway line which reached Kalgoorlie in early 1897. From Northam eastward the pipes were laid parallel with the railway at a distance of 45 feet (13.7 m). This meant that pipes could be unloaded from rail trucks near to where they were required on the pipeline, an activity that had to be carried out quickly so as not to disrupt normal rail traffic. Another great advantage was the subsequent easy supply of water to the railway. The pipeline deviated from the railway between the weir at Mundaring and Northam in order to shorten the distance, and also for the purpose of traversing higher country and reducing the pressure on the pipe. Where the pipeline deviated from the rail line the pipes were unloaded at a siding and distributed using horse drawn wagons. The telephone was new technology and Perth only opened its first exchange in 1887, but a special telephone line was laid between the PWD Head Office in Perth and Kalgoorlie via each of the pumping stations. This was found to be extremely useful during construction and was retained as an on-going operational facility (Trust News 2000: Vol 208).

The English Commission of Engineers recommended that pipe for the line between Mundaring and the goldfields should be of steel throughout, supported above ground on concrete bolsters, and riveted up in lengths of about 110 feet (33.52 metres) with expansion-joints at these intervals and anchor joints midway. The pipes were to be fixed to the bolsters in order to prevent the pipes from creeping. The Commissioners were of the view that there were possibly alkaline salts in the soil of a large part of the district through which the pipeline would pass, and for this reason they recommended that the pipes should be laid above ground, uncovered, and with expansion-joints. Additional considerations were to avoid pressure on the empty pipes, to save the expense of trenching, and to facilitate detection and suppression of leakage from the pipes (Strickland 1986: p.26). The minimum thickness was fixed at 5/16 inch to give an allowance for corrosion, and the pipes were to be longitudinally riveted where the pressure could have been accommodated by pipe of a lesser thickness of 1/4 inch, and welded for all higher pressures (Strickland 1986: p.26). Tenders for the stipulated pipes for delivery in the Colony at a point 22 miles (35.4 kilometres) inland were invited from manufacturers in Australia, Europe, and America. Tenderers were invited at the same time to submit alternative prices for other types of steel pipe (Strickland 1986: p.26).

The first tenders received were for riveted, welded, and/or locking bar pipes, as follows:

Class of Pipe	Lowest tenders received In Europe	Lowest tenders received in Australia
Rivetted pipe	£782,708	£682,827
Welded Pipe	£472,600	
Locking bar pipe		£239,868
TOTAL	£1,255,308	£922,695

(Strickland 1986: p.27)

The locking-bar pipe, invented by the Australian, Mephan Ferguson, had been considered by the English Commission of Engineers and favourably commented on. They were not recommended for so large a scheme, however, because proof of their successful manufacture and use on any considerable scale was not at that time available (Strickland 1986: p.27). Subsequently, and before receipt of the tenders, 10 miles of main 25 ½ inches in diameter had been laid in South Australia. It had been found that these pipes made from *1/4* inch plate and fresh from the closing machine would withstand a pressure of 400 lbs. per square inch without weeping - nearly twice what had be stipulated by the English Commission of Engineers for the Goldfields pipeline scheme (Strickland 1986: p.27). Moreover, all pipes which did not stand this test could be passed back through the closing-machine to be reclosed, instead of being subjected to the usual caulking-processes which were necessary with riveted pipes and which had always been found to be injurious to their plates and jointings. Practical use on a fair length of main also showed that the joining of the sections of locking-bar pipes could be successfully accomplished. As a result, the question of comparative cost and usefulness became the determining factor in deciding whether the new locking-bar pipe should be used in place of welded and riveted pipes (Strickland 1986: p.27).

When the Australian price for locking-bar pipes was contrasted with that for welded pipes the savings were found to be almost 50 per cent. Additionally, the price of locking-bar pipes was but little more than that for the same quantity of riveted pipes. The lowest tenderers were asked to consider the matter again, and they quoted prices for the locking-bar pipes which contrasted as follows with those received for the riveted pipes:

Thickness of steel pipe wall	Rivetted pipe per foot	Locking bar pipe per foot
3/16 inch	£12.12.09	£13.10.00
¼ inch	£16.05.00	£16.15.00
5/16 inch	£20.03.06	£21.00.00

(Strickland 1986: p.28)

Moreover, it was found that the locking bar pipes could sustain a considerably greater safe head of pressure for each of the three thicknesses of pipe wall than comparable riveted pipe, enabling further economies to be made by utilising pipes with a thinner wall section.

As a result of the favourably low tenders for locking bar pipe, it was decided that 30 inch pipe with a minimum thickness of 1/4 inch could be provided throughout the whole of the pipeline, rather than the 5/16 inch thickness originally specified by the Commission of English engineers. By having one thickness and one diameter throughout, the tenderers were able to make further reductions in the cost per pipe. Locking bar pipes also reduced considerably the drag caused by the friction of water in riveted pipe flowing over the heads of the rivets protruding through the wall and into the interior of the pipe. The use of uniform pipe and the lessening of the friction drag of the water also had the effect of enabling savings in the capital cost of the pumps as well as in the cost of pumping (Strickland 1986: pp.28-9).

As the adoption of locking-bar pipes obviated the anticipated continuous loss of water from pipes having a multitude of rivet-holes, the potential advantage of whether the pipes could be trenched underground was considered. Careful analysis of the soils along the pipe-track showed that these ancient soils had been leached of many of their harmful salts and acidic properties. Although the recommendation of the Commission of English engineers had been for the pipeline to be laid above ground on bolsters, it was decided that only where the pipes traversed salt pans should they be laid on timber trestles. In the remainder of the line it was decided that the pipes should be buried, which had the advantage of stabilising temperature fluctuation and resultant expansion and contraction of the pipes, obviating the necessity for expansion-joints, and permitting the use of ordinary lead jointing at the joins (Strickland 1986: p.28). Another advantage of trenching the pipes was that it allowed a coating comprised of one part of Trinidad asphaltum and one part of coal tar to be applied both inside and outside each pipe, thus providing the steel with further protection from any corrosive action in the soil. It had originally been found that with pipes laid above ground, the fierce heat of the goldfields summer caused the mixture to melt and run off the pipes, while the frosts of winter caused it to crack and flake off (Strickland 1986: p.29)

Manufacture of the pipes

The locking-bar pipe was invented in Australia by Mephan Ferguson. Born on 25 July 1843 at Falkirk, Scotland, he arrived in Melbourne with his parents in 1854. Ferguson owed his early success to his entrepreneurial and technical skills and to the Victorian government's protectionist policy of awarding contracts to colonial firms. By 1885 he was well established and in that year, Alfred Deakin returned from California and decided that wrought-iron pipes should replace cast-iron in the Melbourne water supply. Ferguson acted promptly. He won government contracts for the supply of wrought-iron piping, and bought the Glasgow Iron Works in West Melbourne where he established a new factory and testing works. He also imported the latest hydraulic machinery and designed a plant said to match any in the world. He continually experimented with wrought-iron pipes, and perfected straight-riveted, longitudinal and transverse seams and pipes with spiral seams. Seventy miles (113 km) of this lighter piping was used in the Melbourne water supply by 1909, while Ferguson also supplied the pipes for many of the Victorian Water Trusts, the Chaffey brothers' irrigation scheme and similar ventures in New Zealand, Ceylon and Malaya (ADB 'Mephen Ferguson': http://www.adb.online.anu.edu.au/biogs/A0140174b.htm)

Late one night in 1896, Ferguson was sitting at his desk with his son beside him. He opened a drawer and observed the dovetail joints. He hit on the idea of using a similar joint in steel. Producing a piece of lead he made a model of a lock bar joint in a few minutes. In the morning a joint was made in steel at the works and, when tested, proved to be 100% efficient. Ferguson quickly patented the process, and planned a production line suitable for the mass production of pipes (Ferguson 1992: p.19).

Under the new process, a pipe consisted of two plates, each of the full length of the pipe and each bent to a semicircle. Steel was delivered to one end of the works and passed from one machine to another, until a pipe came off the production line at the other end of the works, was tested under water pressure, and then dipped in the molten asphalt protective mixture (Ferguson 1992: p.20).

In the first machine the steel plate was passed through straightening rollers for the purpose of taking out all kinks and rendering the plates perfectly straight. They were then cut square and to the exact length of 28 feet (8.5 m). The second machine was the planer, consisting of nearly 100 tonnes of castings and components. The base was like a huge lathe bed and the sections of this bed had to be replaced for pipes of different diameter. The plate was clamped on to the top of the bed and a saddle moved along the bed. The saddle carried cutting knives which machined the edges of the plate, producing straight edges of the exact width required. After the knives had passed, rollers chamfered the edges of the plate to produce an edge similar to the 'dove tail' in a wooden joint (Ferguson 1992: p.20). After the rollers passed, the edges of the plate were ready to fit into the lock bar. Each plate then went to the plate bending rolls, which were nearly 10 metres long, and which bent the plate into a semi-circular half pipe. Roller supports were provided above the top roll to prevent its deflection, and ensure the correct radius in the finished product. The chamfered edges of two half pipes were fitted into two locking bars. The closing machine which then pressed the locking bars closed over the chamfered edges of the plates was a hydraulic press. A cantilever, as long as the pipes, supported the dies inside the pipe. An hydraulic cylinder, which produced a force equivalent to a weight of 1,200 tonnes, squeezed the metal of the locking bars closed over the chamfers in the edge of the plates and a length of the joint was made. The whole process was done "cold" (Ferguson 1992: p.21).

The clamps could then be removed and the completed pipe moved to the testing machine. The testing machine consisted of cast iron seals which fitted on to the ends of the pipe. Tension bars ran the length of the pipe to hold these seals tightly. The pipe was then filled with water and the water pressure increased to the specified amount. If there was any weeping of water from the locking bar at either side joint the pipe was returned to the closing machine for a second pass. Finally, the pipe would be dipped in molten asphalt mixture (Ferguson 1992: p.22).

The joining of pipes in the field required some innovation, and Ferguson took out and abandoned patents on a number of alternatives. The joint eventually developed by Ferguson could be mass produced and withstand a head of 140m of water. The pipes were butted together and a steel ring or "thimble" was fitted around the joint. This ring was made from rolled steel segments forced out radially by a steam press until the ring was of the required diameter. Two of the segments were specially shaped so that cavities were created at two places on opposite sides of the ring into which the locking bars of the pipe would fit. There was a 6mm clearance between the ring and the pipe, including around the lock bars. A mould was placed around the whole joint and molten lead poured into the space between the pipe and the ring. After solidification the lead was caulked (hammered into the space between the ring and the pipes) and a sealed water pressure proof joint was achieved (Ferguson 1992: p.23).

As the whole length of main was of uniform diameter the possibility of using machinery in place of hand-caulking of the lead joint was considered at an early stage. Initially, however, the calking was done by hand but this proved to be a major bottleneck in the progress of construction. In 1899 a Victorian engineer named James Couston developed a machine for calking the joints. The machine was clamped around the steel collar at the join in the pipes and after the molten lead had been poured in an electric motor was engaged to drive a series of hammers around the joint to make a tight seal. Not only did it prove to be quicker, but it also did a better job than hand calking (Trust News 2000: Vol 207). Careful trial of joints caulked by hand and by machine demonstrated that the machine made joints remained water tight when subjected to hydraulic pressure of 400 lbs per square inch. In the hand caulked joints, on the other hand, slight sweats and pin-squirts manifested themselves when the joints were submitted to the same hydraulic pressure (Strickland 1986: p.33). In comparison with hand calking, machine calking proved so effective that the WA PWD purchased the patent rights from Couston and built twelve of the machines for use on the Goldfields Water Supply Scheme (Trust News 2000: Vol 207).

At intervals of about 5 miles stop-valves were inserted, and where long rising gradients occurred reflux-valves were placed. The stop-valves were actuated by slow motion gearing and where the water hammer was likely to be considerable, small by-passes were introduced in order to bring the water to rest very slowly. Glenfield pattern air-valves were placed where the pipe passed over all summits, a nest of three being placed at the highest points, a nest of two at intermediate points, and a single valve at the lowest points. These valves enabled the escape of air when charging the main, and also enabled air accumulating in the pipe during normal pumping operations to be automatically discharged (Strickland 1986: p.30).

The pumping stations and holding reservoirs

Given the remoteness of the region through which the pipeline would pass, it was recognised that all pumping machinery should be of a uniform size and pattern, and that there be a standby pumping set available at each station.

The pumps needed to lift the water to a height which equalled the highest point between each station, and also had to overcome the frictional resistance caused by the water moving through the pipes. Across all eight pumping stations there was a total vertical lift of water of 832 metres. The eight stations were positioned so that the first four stations pumped against a head of between 110 and 126 metres, while the last four stations pumped against a head of between 55 and 64 metres (Trust 2000. Vol 208). To achieve this the first four stations were equipped with three identical pumping sets. Any two of these sets when operating together could lift the water to the required head height, leaving one set as a standby. At stations five to eight, two pumping sets were provided as one set only was needed to lift water the required head height, again with a standby set. A total of twenty pumping sets were required, of which only twelve would be working at any one time (Trust 2000: Vol 208).

Tenders for the twenty pumping sets were advertised in Europe and the USA in July 1899 There were difficulties in obtaining satisfactory tenders, mainly due to the abundance of work worldwide. It was not until March 1900 that a contract was awarded to the British firm of James Simpson and Company for the supply and installation of twenty Worthington type pumping sets complete with Babcock and Wilcox boilers at an aggregate cost of £242,750. Delivery was to commence in July 1901 and installation to be completed by June 1902 (Trust 2000. Vol 208).

At six of the pumping stations, concrete lined holding tanks were constructed adjacent to the pump house. Water was pumped in to the holding tank through the previous stage of the pipeline and was drawn from these tanks by the pumphouse for transmission through the next stage of pipeline to the holding tank at the next pumping station. The exceptions were at Station No.1 which drew water directly from Mundaring Weir (Dam), and Station No. 3 where use was made of a nearby 10 million gallon capacity reservoir that had originally been constructed for the railway (Trust 2000. Vol 208). Just after Station No.2 the pipeline crossed a high ridge, and the Station pumped the water for 37 kilometres with a net lift of 104 metres to a high level regulating tank at Bakers Hill. The water then flowed under the force of gravity to another regulating tank at West Northam and then to the holding tank at the pumping station at Cunderdin. Similarly, the No.8 pumping station pumped the water for 19 kilometres through a head of 56 metres to the main distribution tank at Bullabulling where the water was fed by gravity to the Toorak Hill reservoir at Coolgardie and eventually through to the Mt Charlotte Reservoir at Kalgoorlie (Trust 2000. Vol 208).

The pump stations themselves were substantial buildings of red brick with corrugated iron roofs supported on steel trusses (Foxley 2008) . The eight buildings were substantially the same design, with two rooms connected by a passageway. One room contained the steam boilers which provided the motive power to the pumps, which were contained in the other room. The chimney stacks were of steel 1.5 metres in diameter and ranging from 27 to 40 metres in height. The two at Mundaring and Cunderdin were later replaced by brick stacks. Six of these buildings remain today. Nearby to each pumphouse it was necessary to house the operational staff and their families, and small settlements of houses, schools and sporting facilities gradually grew up (Trust 2000. Vol 208).

Initially the boilers were to be fired using coal from the government coalmine at Collie, at an estimated cost of 32 shillings per ton (Hartley 2000: p.731). Although a 1,000 ton sample had been raised from the mine in 1893 for testing, it was not until 1899 that the first successful commercial production of Collie coal commenced. However, Collie coal was of poor quality, and in relation to its heating value per ton proved to be a high cost option. As soon as it became obvious that the far cheaper locally cut firewood was more efficient, coal was abandoned in favour of wood and the scheme's pumps operated on coal for less than a year (Hartley 2000: p.732). Enormous quantities of wood were utilised from the countryside surrounding each pumping station. Wood-cutters were paid on the basis of weight and weighbridges were established at each station to weigh consignments. Special railway sidings lead to raised trestles covered by a corrugated iron and steel lean-to beside each station to facilitate the delivery of wood. Over the period of steam driven pumping at each of the stations, increasingly large areas were denuded of timber to feed the boilers and even today the effects of this are noticeable around some of the stations.

Installation of the pipeline and completion

Once the decision was made to bury the pipeline, trenching was commenced along the route. The surface formation of the country traversed was very irregular. On the plains, ironstone conglomerate predominated but never extended continuously for more than a short distance, being broken by bands of sand, diorite, and granite. In the timbered belts sandy clay was the usual surface soil, but with outcrops of granite, diorite, and schist (Strickland 1986: p.34). It was found that the most economical depth of trench was about a metre in depth, and the bulk of the material was taken out of the trench by manual labour. It was necessary, however, to use explosives to remove material on more than one-fourth of the total trench line. The excavation of the trench was kept well ahead of pipe-distribution, laying and jointing, in order to provide continuous work for the gangs involved in these later operations (Strickland 1986: p.35).

The pipelaying work was divided into sections of about 14 miles each. Each stretch was worked on by one caulking team, and when the work was completed the whole gang went forward to the next available section. When the works were brought into full swing, seven such gangs were at work on several sections. As the work performed by each gang was identical, there was considerable rivalry between the parties. Bad work due to haste was prevented, however, by the appointment of an inspector on each section, who reported directly to the head office and was responsible only for the quality and not for the cost of the work. The rate of progress of the seven gangs when they were at their most experienced during the last 3 months before the completion of the pipeline and the disbanding of the gangs, was 1 and 2/5 miles of laying, jointing, and complete in-filling of trenches per eight hour working-day (Strickland 1986: p.35).

By the 13th April 1902, the works were sufficiently far advanced to enable pumping to be commenced with one of the engines at No. 1 station. No trouble was experienced in getting the engines underway and by the 22nd April the water had reached the Cunderdin Reservoir, at mile 77. Four months now elapsed before the laying and jointing of the next section was completed, and it was not till the 22nd August 1902 that the water reached the Merredin receiving tank at mile 140. Some trouble was experienced in charging this section, through the joints leaking due mostly to the subsidence of the pipes laid across soft ground in the bed of the Mortlock River. The water reached the Coolgardie service reservoir at mile 328 on the 22nd December 1902, and finally the Kalgoorlie service reservoir on the 16th January 1903, about 8 months after the charging of the main was started (Strickland 1986: p.37). The pumping was restricted to an amount sufficient to fill about 12 to 15 miles of main per day, and at this rate no trouble was experienced from air-pocketing. It was found that at this charging rate the Glenfield pattern air-valves had sufficient discharge capacity to pass the volume of displaced air (Strickland 1986: p.37).

The original scheme did not allow for any reticulation of water to townships for domestic purposes, or to mining centres. It was originally intended to bring the water to Mount Burgess a few miles north of Coolgardie, from where the local-government authority would then lay a subsidiary main to its own service reservoir for each township or mining centre. Eventually, however, the complete reticulation of the townships of Kalgoorlie, Coolgardie, Boulder, and the Kalgoorlie Mining Belt, had to be undertaken as part of the main scheme (Strickland 1986: p.42).

The pipeline was completed in early 1903, and the scheme was officially opened by Sir John Forrest at the Mount Charlotte Reservoir in Kalgoorlie on 24 January 1903. The total actual cost of the water supply pipeline, including all extras, contingencies, and establishment charges was £2,660,000, an excess of only £225,000 on the original estimate (Strickland 1986: p.43).

Patriotic sentiment and nation building

Sir John Forrest was committed to the development of Western Australia as a self supporting and viable colony. Western Australia had recorded a very low population growth rate in its early days of free settlement. For Forrest the transition of Western Australia from a frontier to settled society was to be undertaken by the building of substantial infrastructure projects such as ports, harbours and railways. Water supply was one of the fundamental and recurrent issues in the establishment of human settlement across Australia (Cathcart 2008), but one which was particularly pertinent in the drier west of the continent. The discovery of gold and the establishment of the 'golden mile' as outlined above, was an important catalyst in the development of the colony, its role as a state and its contribution to nation building. The value of gold for Coolgardie, and more broadly Western Australia, was multi faceted. The wealth it created was the most immediate, but long term it attracted a mass increase in population (for statistics see Appleyard 1981: p. 220), which had been experienced earlier in the gold rushes to the eastern states. For the Western Australian Government it provided a much needed boost to prosperity and revenue in terms of mining taxes and leases. During the late nineteenth and early twentieth century patriotic sentiment was ‘specifically tied to a politically constituted state and the geographic territory over which that state exercises sovereignty’ (O’Keefe and Pearson 1998: p.2). Major infrastructure projects are closely aligned with the patriotic sentiment which contributed to nation building, particularly during the federation period of 1890-1915. Completion of public works such as the Goldfields Water Supply Scheme represent a stage of national maturity. The development of the Goldfields Water Supply Scheme is an important part of the history of how Western Australia entered into federation.

O’Keefe and Pearson (1998: p. 81) identified Coolgardie as an important place, linked to an event, in the federation story. In 1899 the Eastern Goldfields Reform League formed to promote Goldfields separation and federation. Many of the gold diggers were from the eastern colonies and the majority, supportive of the federation movement (Bastin 1955: p.76). Highly critically of the Forrest Government, including the time taken to deliver a reliable water source, the diggers proposed to separate the eastern goldfields from Western Australia. Forrest was concerned about the implications for Western Australia should it become part of the new proposed Commonwealth of Australia. Clark (1986 p. 167) notes that Forrest ...‘was plagued with anxiety about goldfields radicalism and about government revenues after the loss of the right to impose customs, which in 1898 comprised nearly ninety percent of the revenue of the colony.’ So he bargained. The Commonwealth was to facilitate the building of the railway from Kalgoorlie to Port Augusta and the eastern state would continue to pay the levy. At the referendum in 1900 forty six percent voted yes, the highest in all the colonies (Clark 1986 p, 168). These large scale infrastructure projects were important in furthering the relationships between the eastern and western states. Forrest used the opening of the original Coolgardie Goldfields Water Supply, to further other nation building endeavours with the newly formed Commonwealth Government (Lowe 2001: p. 96).

Impact on the environment

Large increases in the population of the Coolgardie region with the discovery of gold had a dramatic impact on the arid environs. Water shortages and outbreaks of typhoid provided the impetus for a water supply scheme to be built. To construct the scheme it was necessary to clear large areas to accommodate the pipeline and provide ongoing access for maintenance. Clearing also occurred at most of the pump station and tank sites. One of the largest-scale clearings was that at Mundaring Weir (Dam) where Hartley (2007 p.340) estimates that 20,000 acres (8,093 ha) of the catchment were ring-barked to improve the run off rate of water into the reservoir. This practise impacted on the quality of the water and by 1910 there was a notable increase in the salinity levels. Railway water supply engineers were not surprised, as the water had become excessively saline for use in the locomotive boilers (Hartley 2007 p.203). The Pump Stations were originally designed to be powered by coal. However, in less than a year the pump stations were burning timber. The preferred source was locally available Jarrah or red gum (Marri) at Pump Stations 1, 2 and 3. From Stations No 3 and onwards species such as Salmon gum and gimlets were sourced locally (Hartley 2007). This ongoing need for fuel resulted in a local lucrative fire wood trade being established in the areas surrounding the pump stations. Land clearing around Mundaring Weir ceased in 1918 and the area allowed to revegetate naturally (Hartley 2007, p.207).

With the opening up of the areas for agriculture, land clearing continued. It is estimated that ‘Today less than 5% of the natural vegetation remains’ (National Trust WA 2000: p.28). In addition WA has lost 10% of the Wheatbelt to scourge (Lowe 2001: p. 99). Soil salinity and the raising of saline water tables are impacting on approximately 30 towns in the Wheatbelt (Lowe 2001: p. 99).

Subsequent operation and expansion

Early operational experience with the pipeline was dominated by problems of corrosion. External corrosion began to appear as early as March 1905 and internal corrosion about three years later. Initially it seemed internal corrosion posed the greater threat, because it was substantially increasing the friction head which in turn placed extra load on the pumping stations. The first attempt to counter the problem of internal corrosion was to add lime to the water, and a plant for this purpose was constructed at Pumping Station No l in 1910 (Trust News 2001: Vol 210 p.8). The lime treatment was not successful and in 1917 it was replaced by de-aeration treatment which removed dissolved oxygen from the water. A plant for this purpose was installed, again at Pumping Station No 1. This system of de-oxygenation bought the internal corrosion under control.

In the meantime the problem of external corrosion increased rapidly with more than 4,000 rust holes being repaired in 1921. This number had doubled by 1928 and the wastage of water was by then an issue of major concern (Trust News 2001: Vol 210 p.8). In the late 1920s two engineers, Norman Fernie and Reg Keating, from the Northam District Office of the PWD commenced a thorough investigation of the external corrosion problem in the locking bar pipes. Fernie and Keating could see no practical alternative other than to lift the pipeline and re-lay it above ground. This operation was a major technical development which was widely copied elsewhere. It placed the Goldfields Water Supply Scheme among the world leaders in pipeline technology for the second time in less than 40 years (Trust News 2001: Vol 210 p.9).

By 1930 it was becoming widely recognised throughout the water industry that a relatively thin lining of cement mortar applied in the factory by a centrifugal spinning process would effectively eliminate internal corrosion. The locking bar pipes presented difficulties for the centrifugal spinning process, however experiments in the field enabled the development of a satisfactory process whereby a lining of sand cement mortar could be applied to the interior of the pipes during the raising and re-laying process. The reconditioning of the buried pipeline commenced in 1933 with priority being given to the sections where external corrosion was most severe. By the time the work was halted in 1941 (due to labour shortages caused by World War II) the major problem of leakages had been brought under control (Trust News 2001: Vol 210 p.9).

The refurbishing of the pipeline in 1933 included a new method of lifting the pipeline out of the ground and relaying it above ground. The method involved lifting the pipes out of the ground, trimming-off the corroded end sections of the pipes, and replacing the flexible lead joints with rigid welded joints forming what was known as a 'continuously welded pipeline'. The outside of the pipe was recoated and painted with a sun-reflecting paint. During the pipeline reconstruction, the expansion forces were directed into reinforced concrete anchor blocks built over the pipe at 50 metre intervals, which prevented movement and transferred these forces into the ground. Although today such anchor blocks are familiar features of all above ground pipelines in Australia this was the first time anywhere in the world that pipe anchorages of this type had been used to permit such a large diameter pipeline to be laid above ground in such adverse conditions (Hartley 2000: pp.736-7).

The 1930s refurbishment of the pipeline also involved another innovation, the large scale use of wood stave pipes. During the depression of the 1930s, steel was in short supply and sections of the pipeline were in need of repair. It was decided that timber stave pipes would provide a viable alternative given the lack of steel. Orgeon timber had been used previously in a 33 chain (0.66 kilometres) long by-pass of the Coolgardie Reservoir in 1912 (Hartley 2007: p. 246). Between 1933 and 1937 a distance of 39 miles 30 chains of wooden stave pipes, in fluorised Karri (some were later replaced by Jarrah), were a laid between Kellerbin and Kalgoorlie. Hartley (2007: p. 247) reports that it was '...laid in a series of above ground diversions to the main conduit so that the 30 in locking bar pipes which they replaced could be refurbished and relaid above ground in other sections of the main conduit as part of the continuously welded pipeline'. It was the most extensive use of wooden pipes in Australia at the time (Hartley 2007: pp. 246-247) in a country water supply scheme.

In his report of l7 July 1896, O'Connor had stressed the importance of the pipeline for the development of agriculture, and soon after the scheme became operational water services were provided to properties adjoining the pipeline. In 1907 a branch main was constructed to serve farmlands north of Tammin and this demonstrated the value to farmers of an assured water supply for stock and domestic purposes. By 1910 it was obvious that the capacity of the Scheme was greater than was required on the goldfields and the *Goldfields Water Supply Act* was amended to allow farming properties to be rated for the purpose of supplying water for stock and domestic purposes (Trust News 2001: Vol 210 p.9). By 1928 the total area of farmland being serviced had increased to approximately 1 million acres (404,685 hectares). The pipeline was now operating to full capacity and the area of rated farmland had to be held at this size until after World War II (Trust News 2001: Vol 210 p.9).

In 1948 the Commonwealth Government agreed to provide financial support to Western Australia for construction of a Comprehensive Agricultural Areas Water Supply Scheme. The northern section of this scheme was based on the existing Goldfields Water Supply system and provided for a reticulated water supply to towns and farmlands over an area of 4 million acres (1,618,742.5 hectares) as far north as Koorda and Bencubbin (Trust News 2001: Vol 210 p.11).

In 1951 increased storage was provided by raising the wall of Mundaring Weir by 32 feet (10 m) which trebled the Weir's holding capacity. The enlargement of the dam wall involved the placing of 80,000 cubic yards (61,164 cu metres) of concrete and cost £720,000 (Trust News 2001: Vol 210 p.12). The line of the vertical upstream face of the wall was not altered, however, the wall was thickened by some 40 feet (12 m) at the base and a new sloping downstream face was created. The heritage value of Weir was recognised, and accordingly great care was taken to reproduce the style from the Victorian period that had characterised the appearance of the original structure. The original footwalk across the crest of the weir was salvaged and reused, and the control tower in the centre of the wall was faithfully reconstructed to the same design as the original (Trust News 2001: Vol 210 p.12).

A substantial upgrade of the original 30 inch (76 cm) pipe line was also undertaken and the original steam pumping stations were replaced with high powered electric pumps. Branch mains were laid north and south from the main pipeline, to reservoirs which were constructed on highest points in the area. From these tanks water was distributed to the surrounding areas by gravity (Trust News 2001: Vol 210 p.11). A ceremony to mark the completion of the Comprehensive Water Supply Scheme was held on 24th November 1961. However, these mains were subsequently extended to the townships of Dalwallinu, Pithara, Ballidu and Corrigin. Later again, four small areas of northern farmlands were included at Kalannie. North Koorda, north Bencubbin and Wilgayne. All work on the Comprehensive Water Supply Scheme was finally completed in 1974 (Trust News 2001: Vol 210 p.11).

Today the Pipeline is operated by the WA Water Corporation. It is the Corporations largest asset and the basis of billions of dollars of annual economic activity. Approximately 10,000 services are provided within the agricultural area and the eastern goldfields through 8,000 km of pipelines and over 40 pumping stations (MHI 2008)

Indigenous Association

The Goldfields Water Supply Scheme extends from Mundaring to Kalgoorlie in Western Australia, and traverses the traditional lands of Aboriginal people who identify themselves as Noongar (also referred to as Bibbulmun by Bates in 1904), Ballaruk, Ballardong, Gubrun, Kalamaia Kubun, and Widji (National Native Title Tribunal 2009). Noongar was the Bibbulmun word for man (Bates 1985).

Aboriginal occupation in the south-west of Western Australia dates to 47,000 years BP (before present) at the Devils Lair rock shelter (Dortch 2001). Other sites in the south-west with early occupation dates include the Upper Swan, (38,000 years BP) and a Helena River site above Mundaring Weir, (29,400 years BP). The Helena River provides evidence of continual use to the present day with seasonal camps and a permanent camp site (Schwede1983). There is also evidence of artefact manufacture occurring in the Mundaring Dam area 4,000 -1,000 years BP (Villiers 2007).

The Western Australian Department of Indigenous Affairs (DIA 2009) identifies numerous Aboriginal sites in close proximity to the Goldfields Water Supply Scheme pipeline. The highest densities of sites occur at the beginning of the pipeline at Mundaring Dam and Helena River, at Northam, about eighty kilometres from Mundaring, and at Coolgardie and Kalgoorlie at the end of the pipeline. As a result of environmental disturbances associated with the building of the pipeline and earlier infrastructure, many Aboriginal sites have been disturbed. The greatest environmental impact occurred at the beginning of the pipeline, at the Mundaring Dam.

Many sites along the pipeline are of ongoing significance to Aboriginal people who visit them regularly today. Aboriginal sites identified on the pipeline include corroboree grounds and soaks associated with trade routes, wells, granite outcrops, birthing rocks on the Avon River at Northam, cave and rock paintings near Kellerberrin and a number of secret/sacred sites (The National Trust 2001). Webb (2004) notes concerns that few of the water sources on Hunts Track have been recorded as Aboriginal sites, and more generally, with the accuracy of site locations and the lack of a systematic archaeological survey of Noongar Aboriginal sites and complexes; including rock art sites.

The West Australian Government employed Daisy Bates to research the Aboriginal tribes of the state. Bates' research was used as evidence in the Single Noongar Native Title application of 2006 to verify they were originally one group.

"Bates' material comprises the largest available corpus of information dealing with the Aborigines of the Perth region obtained at least partly from people who were alive in the early years of European settlement ... the first really serious ethnography for any part of the south-west... The cumulative effect of these writings is to provide an insight into Aboriginal life, including Aboriginal laws and customs, in and about the date of settlement, which is possibly not replicated elsewhere in Australia." (Indigenous Law Bulletin 2009).

At the time of building the pipeline, two Aboriginal groups inhabited the three hundred and thirty miles it traversed. The Bibbulmun lived on the west coast, from Jurien Bay to Perth and Esperance and west as far as Kellerberrin. The Karatjibbin occupied land from Mt Jackson in the north through the Southern Cross district including Kalgoorlie (Bates 1985). The border between the two groups divided the circumcised from the non-circumcised southwest, crossing the pipeline at around Mooranoppin/ Kellerberrin.

Trade existed between the two groups in tools, raw materials and women with adjustments to in-law relationships to accommodate the two groups (Bates 1985).

"They used to induce the Bibbulmun to give their boys for initiation though the circumcised group never gave any in return. ...These young boys grew up and married in their adopted groups, and as young men, and later as fathers and grandfathers they returned to the Bibbulmun" (Bates 1929).
Bates (1909) recorded thirty to forty Bibbulmun living on the first Aboriginal reserve "...for old and infirm natives of the Southern district" (Bates 1909) set up by Premier John Forrest in the 1890's. Maamba Reserve was a 100-acre fertile plateau on Bibbulmun land at the foot of the Darling Ranges, approximately twelve kilometres east of the Mundaring Dam and included a "splendid" spring and camping ground called Gooininup (Bates 1909).

Bates lived at the reserve for two years with the Bibbulmun who relied on government rations but lived a semi-traditional lifestyle. She recorded information from Joobaitch, an 80 year old Bibbulmun man who died on the reserve near his sacred *Kaanya* tree (Bates 2004).

"He had parted with the whole site of the present Mundaring Weir, and both sides of the Swan River from beyond Perth

Guildford to Perth Water, for some special meat food which pleased him in his old age" (Bates 1985, 64).

Corroborees or *kenings* were held at Maamba, including one for Governor and Lady Bedford. The last Bibbulmun corroboree Bates recorded at Maamba was in 1910 and included men for Kellerberrin, Gingin, Victoria Plains, Southern Cross, Guildford and Bunbury (Bates 2004).

At the head of the pipeline, the Mundaring area is a highly significant and sensitive mythological area. The Mundaring (*Mundjalline*) myth links the Helena River *(Mandoon)* east via Mundaring to the Swan River and west to York (Villiers 2007). The most important totem was the snake Woggal, also known as Waugyl/Waugal (Bates 1985). The DIA listing of the Helena River "as a ceremonial and mythological site … is consistent with the significance attributed to all waterways as having been created and inhabited by the primary Ancestor beings associated with the Creative Era, in this case the Waugyl" (Villiers 2007,13). Bates (1985) details physical landscape features such as strewn rushes, lime and saltpans that denote the life cycle of the Woggal and associated sacred sites. Villiers (2007, 17) also notes the presence of the Woggal at Mundaring

"The swamp and pools know as Mundjalline according to tradition, were located in a deep valley that has been inundated as a result of the construction of the Mundaring Weir…A powerful Waugal associated with rainmaking lived here. Disturbance of the swamp reeds at Mundajalline resulted in cyclonic winds and rain…"

Bates describes sites with reed disturbance as sacred Woggal camping places. She refers to a Helena River site called *Beeragunning* as a sacred *(Janga)* split rock, surrounded by reeds that Aboriginal people could walk through but became ill and died if they touched it or it closed up on them. A myth associated with another sacred stone marked with stick-like indentations at *Dargain*, in the Helena River area was also recorded by Bates (1985).

Aboriginal people and their water supply were impacted by several events prior to the building of the pipeline. These included diseases, explorers and the building of infrastructure prior to and during the gold rushes. Typhoid fever associated with poor sanitation, cramped conditions and lack of water was rife in Western Australia in the late 1800s (Wittington 1988).

Access to water was essential for survival in the semi-arid zone of south-west West Australia. In relation to the expansion of European settlement Hallam notes (1979, 68)

"…water supplies dictated that European movement and settlement must follow Aboriginal movement and settlement in Western Australia also. *Bidi* and *Gongan*, zones of easiest and habitual movement between water sources, were as basic to European as to Aboriginal ecology… 'Native wells' and 'native paths' marked their regular progress through and around their own country."

Aboriginal people have rights to water in their territory. "Every Aboriginal knows the rocks, soaks, springs and anything that gives water on their hunting grounds" (Bates 1985, 262). Non-Aboriginal people were often unaware of traditional water sources until shown by Aboriginal people (Bates 1913; Carnegie 1871). Aboriginal people disclosed their sources either willingly, through coercion or as a result of force, as detailed by one early gold explorer.

"Sorry as I was to be rude to a lady, I had to make her prisoner, but not without a deal of trouble… I felt myself justified, therefore, in unceremoniously making captives from what wandering tribes we might fall in with. And in light of after events I say unhesitatingly that, without having done so, and without having to a small extent used rough treatment to some natives so caught, we could not by any possibility have succeeded in crossing the desert, and should not only have lost our own lives, but possibly those of others who would have made search for us after." (Carnegie 1871).

In the 1860s Charles Hunt, a government surveyor, modified traditional water sources to receive and store rainwater to supply seasonably reliable water to expand European settlement. In 1863, the Gnarlbine Soaks at Coolgardie were disclosed by Kowitch, an Aboriginal assistant to M H Lefroy's expedition, and were later incorporated into Hunts Track (Heritage Council of West Australia 2009). The Goldfields Pipeline followed the route of previously installed infrastructure including road, rail and telegraph which roughly followed Hunt's Track. Bates (1909) also noted that "… most of the 'roads' of these tribes (including eastern goldfields) run 'erratically' east and west for a considerable distance, but not very far north and south".

The absence of artesian water sources and unacceptable salt levels in ground water meant traditional sources of Aboriginal water were co-opted to supply not only huge numbers of European settlers but horses, camels and industry. As populations grew, Aboriginal water sources and bore water condensers were insufficient to meet demand.

The preparation work for the six-mile long, 4.6 billion gallon Mundaring Dam began in June 1898. Three hundred men and their families living on site supplemented their food by fishing, kangaroo hunting and collecting wild honey, staples for the local Aboriginal people. Eight hundred acres of land was completely cleared with two hundred acres of the lower catchments ringbarked and the riverbed cleared and burnt. A thousand cubic metres of local sand was used in the weir wall (Quicke 1978).

Fifty miles along the pipeline, the town of Northam became the manufacturing centre and food producer for the goldfields. Burlong Pool, a DIA registered mythological site and important Aboriginal water source, was turned into a camping ground for railway contractors, including their horses and camels (Garden, 1979). The last recorded corroboree took place in 1899 at the Northam Government Well, which later became the Northam Aboriginal Reserve. At that time, the desperate state of the local Aboriginals was documented. “The hundred who gathered on that occasion were near starving, and the children sick and miserable from want of food and clothing” (Garden 1979, 56). Northam was connected to the unfinished pipeline in 1902 due to a very hot summer and typhoid infected local water sources.

At Coolgardie towards the end of the pipeline, Aboriginal people were desperate for water and not receiving help from the local Council who saw it as a State government issue (Wittington 1988). Deaths due to typhoid peaked in Coolgardie during 1896-7. Tickenbutt, an Aboriginal man also known as Fred McGill, wrote to the Kalgoorlie Miner newspaper complaining of the unavailability of water for independent Aboriginal people who could no longer get it from their traditional sources, as rations or from bore water condensers. Some people were more generous, one miner set up a small condenser for Aboriginal people who had helped his family (Wittington 1988, 63).

“The local Aboriginal contribution to the developments of the Goldfields cannot be ignored. It is well known that Aboriginal people led explorers and miners to both water and gold” (Wyatt 2006). Carnegie exploring the area from Lake Darlôt to Halls Creek and return in 1896-97 was also assisted by Aboriginal people.

“Throughout our journey we never once found water by chance—though chance took us to more than one dry hole—but found it only by systematic and patient work, involving many scores of miles of tracking, the capture of the wild aboriginals, and endless hours of manual labour” (Carnegie 2009).

It is unknown how many Aboriginal people worked on the pipeline or with associated contractors. A large part of the work for the pipeline was undertaken by the West Australian Public Works Department. Photographic evidence identifies an Aboriginal man working on the pipeline with a non-Aboriginal team (National Trust, 2001). Numerous photos portray Aboriginal people from Coolgardie and Kalgoorlie in a variety of roles including accompanying explorers and working, for example as a butcher, a miner and police assistant. These photos also depict Aboriginal people attending church-sponsored Christmas dinner and interactions with non-Aboriginal people including taking part in mainstream sporting events and processions in the townships (Templeman and McDonald 1988; Wittington, 1988).

Developments along the pipeline depleted Aboriginal people’s traditional food and water sources through over use, carelessness or greed (Wittington 1988, and Carnegie 1871). Aboriginal people chose or were forced to move into settlements including reserves. If they maintained their independence, they were expected to purchase water from the pipeline (Templeman and McDonald 1988, Wittington 1988), be recompensed with water for services rendered or rely on the kindness of others (Wittington 1988). As one Kalgoorlie resident commented:

“The blacks are in a bad way just now...It’s a pity something can’t be done to help them, water being so scarce just now, all the soaks and gnamma holes are just about dry...so you see the poor blacks are robbed of their water. It’s cruel” (Templeman and McDonald 1988, 53).

Condition and Integrity

Components of the original scheme are still in use and in excellent condition. Historic elements no longer in use have in general been stabilized or conserved while some elements are in poor condition. Changes have been made and continue to be made for operational purposes.

Reservoirs:
Post World War 2 Mundaring Weir was raised by 32 feet [10m] to treble the capacity of the weir in order to supply agricultural areas north and south of the pipeline. As part of raising the weir wall, the upper valve house was dismantled from the original wall and re-erected on the raised one to preserve the appearance of the original wall. Mount Charlotte has been covered for safety / water quality reasons.

Pipes:
As mentioned above, the pipeline was re-laid above ground. This was in the 1930s and was a state project initiated to create jobs during the Depression. Part of the pipeline was duplicated when the scheme was expanded post World War Two. However, although they are now concrete-lined to prevent corrosion, 58% of the original pipes are still in service.

Pumping Stations:
The pumps, capable of delivering five million gallons of water per day, performed until they were decommissioned in the 1950s and 1960s and replaced by electric powered pumps. Two of the steam pumping stations are no longer standing and the six remaining are in various conditions, some with the original equipment, some with none. No 4 is simply a shell while Nos 6 and 8 still the majority of their machinery.

Location

Located between Mundaring Weir and Mount Charlotte Reservoir, Kalgoorlie, and comprising the following:
1. the pipeline (main conduit) that extends from Mundaring Weir in the west to Mount Charlotte Reservoir in the east;
2. the Mundaring Weir wall, two valve houses, spillway and the basin;
3. the No 1 Pump Station located at the base of Mundaring Weir;
4. the site of No 2 Pump Station and the remains of the associated concrete receiving tank, Mundaring Weir Road;
5. the Bakers Hill Regulating Tank**,** Bowstock Street, Bakers Hill;
6. the West Northam Regulating Tank, West Northam, comprising the original rectangular shaped reservoir;
7. the No 3 Pump Station, Forrest Road, Cunderdin, comprising the whole of Lot 418 P220560;
8. the No 4 Pump Station and Holding Tank, Great Eastern Highway, Merredin, comprising an area bounded by a line commencing at the north east corner of Lot 1361 P216984, then south easterly to MGA point Zone 50 618062mE 6515200mN, then south westerly to MGA point 618011mE 6515173mN, then north westerly to the north west corner of Lot 1361 P216984, then north easterly via the north western boundary of Lot 1361 P216984 to the point of commencement;
9. the No 5 Pump Station and Yerbillon Reservoir, Smyth Road, Yerbillon, comprising an area bounded by a line commencing at the intersection of the western road reserve boundary of Smyth Road and MGA northing Zone 50 6525727mN (approximate MGA point 665555mE 6525727mN). then westerly to MGA point 665438mE 6525732mN, then southerly to MGA point 665433mE 6525492mN, then easterly to the intersection of the western road reserve boundary of Smyth Road with MGA northing 6525482mN (approximate MGA point 665504mE 6525482mN), then northerly via the western road reserve boundary of Smyth Road to the point of commencement;
10. the No 6 Pump Station and Ghooli Tank, Great Eastern Highway, Ghooli;
11. the site of No 7 Pump Station and the associated Reservoir (regulating tank), Great Eastern Highway, Koorarawalee, comprising the whole of Lot 1060 P031436;
12. the No 8 Pump Station and Holding Tank, Great Eastern Highway, Benari, comprising an area bounded by a line joining the following MGA points consecutively: Zone 51 279947mE 6557892mN, 28002mE 6557870mN, 279952mE 6557678mN, 279786mE 6557579mN, 279712mE 6557704mN, 279882mE 6557810mN, then directly to the point of commencement;
13. the Bullabulling Regulating Tank (Reservoir), Great Eastern Highway, Bullabulling;
14. the Toorak Hill Regulating Tank (Reservoir), Moran Street, Coolgardie;
15. the Kalgoorlie No 1 Tank, Hannan Street, Kalgoorlie, being an area comprising a circle of 70 metres radius centred on MGA point Zone 51 352593mE 6595880mN;
16. the Mt Charlotte Reservoir, Collier Place, Kalgoorlie, comprising the whole of Lot 2714 P043132 and that part of Lot 2713 P043132 to the west of Collier Place.

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HERITAGE COUNCIL OF WESTERN AUSTRALIA

REGISTER OF HERITAGE PLACES

Register Entry

1. **DATA BASE No.** 16610

2. **NAME** *Goldfields Water Supply Scheme* (1898-1903; 1953-1963)

   FORMER NAME (or OTHER NAMES) The Golden Pipeline; The Mundaring to Kalgoorlie Pipeline

3. **LOCATION** Various locations along the route from Mundaring to Kalgoorlie adjacent to the Golden Pipeline Heritage Trail.

4. **DESCRIPTION OF PLACE INCLUDED IN THIS ENTRY**

   1. Pt Reserve 47880 being Portion of Lot 3042 on Deposited Plan 36439 being part of the land contained in Crown Land Record Volume 3134 Folio 990; Pt Reserve 47880 being Portion of Lot 3040 on Deposited Plan 36439 being part of the land contained in Crown Land Record Volume 3134 Folio 988; Portion of State Forest Number 7, Mundaring/Sawyers Valley.
   2. Reserve 10448 Lot 13750 on Deposited Plan 195023 being the land contained in Crown Land Record Volume 3118 Folio 662.
   3. Lot 71 on Deposited Plan 41867 being the land contained in Crown Land Record Volume 3134 Folio 965; Portion Lot 2 on Deposited Plan 51377 being the land contained in Crown Land Record Volume 3140 Folio 588; Lot 500 on Deposited Plan 59025 being the land contained in Crown Land Record Volume 3144 Folio 1000; Portion of Reserve 17101 being Portion of Lot 501 on Deposited Plan 63523 being part of the land contained in Crown Land Record Volume 3158 Folio 678; Lot 300 on Deposited Plan 213659 being the land contained in Crown Land Record Volume 3151 Folio 401; Lots 3610 and 3611 on Deposited Plan 213659 being the land contained in Crown Land Record Volume 3147 Folios 902 and 903; Portion Lot 4992 on Deposited Plan 218200 being part of Crown Land Record Volume 3134 Folio 900; Lots 3996, 3997, 4994 and 4995 on Deposited Plan 218200 being the land contained in Crown Land Record Volume 3134 Folios 963 and 964 and Volume 3126 Folios 901, and 902; Pt Lot 5000 on Deposited Plan 218201 being part of the land contained in Crown Land Record Volume 3126 Folio 907; Portion of Lot 377 on Deposited Plan 236093 being part of the land contained in Crown Land Record Volume 3012 Folio 153; Portion of Bakers Hill Town Lot 254.

4. Reserve 29930 Lot 7783 on Deposited Plan 171224 being the land contained in Crown Land Record Volume 3045 Folio 698.
5. Reserve 40494 Lot 1361 on Deposited Plan 216984 being the land contained in Crown Land Record Volume 3034 Folio 479.
6. Reserve 48460 Lot 300 on Deposited Plan 49437 being the land contained in Crown Land Record Volume 3136 Folio 963; Reserve 46725 Lot 14348 on Deposited Plan 28784 being the land contained in Crown Land Record Volume 3125 Folio 546; Reserve 38354 Lot 75 on Deposited Plan 215769 being the land contained in Crown Land Record Volume 3109 Folio 410; Reserve 3531 Lot 1589 on Deposited Plan 194046 being the land contained in Crown Land Record Volume 3108 Folio 309.
7. Portion Reserve 31433 Lot 418 on Deposited Plan 220560 being part of the land contained in Crown Land Record Volume 3115 Folio 23.
8. Reserve 24441 Lot 736 on Deposited Plan 162941 being the land contained in Crown Land Record Volume 3020 Folio 340.
9. Reserve 13198 Lot 1060 on Deposited Plan 31436 being the land contained in Certificate of Title Volume 3128 Folio 6; Reserve 50966 Lot 340 on Deposited Plan 43049 being the land contained in Crown Land Record Volume 3136 Folio 937; Reserve 9892 Lots 2713 and 2714 on Deposited Plan 43132 being the land contained in Crown Land Record Volume 3042 Folios 376 and 377; Portion R8230 Lot 501 on DP423950 Crown Land Record Volume 3175/46; Reserve 13393 Lot 500 on Deposited Plan 56726 Crown Land Record Volume 3151 Folio 170; R50315 Lot 515 on Deposited Plan 57259 being the land contained in Crown Land Record Volume 3158 Folio 679; Pt Reserve 8228 being Portion of Lot 505 on Deposited Plan 61268 being part of the land contained in Crown Land Record Volume 3159 Folio 549; Pt Reserve 25155 Lot 506 on Deposited Plan 69553 being part of the land contained in Crown Land Record Volume 3171 Folio 494; Reserve 9892 Lot 501 on Deposited Plan 73921 being the land contained in Crown Land Record Volume 3020 Folio 753; Pt Reserve 8232 being Portion of Lot 74 on Deposited Plan 215769 being part of the land contained in Crown Land Record Volume 3089 Folio 960; Reserve 9730 Lot 2291 on Deposited Plan 222291 being the land contained in Crown Land Record Volume 3037 Folio 114; Portion Reserve 5342 Lot 341 on Deposited Plan 43049 being part of the land contained in Crown Land Record Volume 3136 Folio 938; Reserve 8231; Pt Reserve 8229; Reserve 39644 Lot 3848 on Deposited Plan 191445 being the land contained in Crown Land Record Volume 3102 Folio 45.
10. Lot 501 on Deposited Plan 302079 being the land contained in Certificate of Title Volume 1177 Folio 961
11. Lot 502 on Deposited Plan 302079 being the land contained in Certificate of Title Volume 1478 Folio 153.

together with all those portions of Unallocated Crown Land and road reserve as shown in HC Curtilage Map 16610-D.

5. LOCAL GOVERNMENT AREA

Shire of Cunderdin
Shire of Merredin
Shire of Kellerberrin
Shire of Tammin
Shire of Yilgarn
Shire of Mundaring
Shire of Northam
Shire of Westonia
Shire of Coolgardie
City of Kalgoorlie –Boulder

6. OWNERS AT REGISTRATION

1. State of Western Australia; Vested in Conservation Commission of Western Australia; Responsible Agency Department of Biodiversity, Conservation & Attractions (DBCA); Lessee Telstra Corporation Ltd.
2. State of Western Australia; Responsible Agency Department of Education, Management Order to the Minister for Education.
3. State of Western Australia; Responsible Agency Department of Planning, Lands and Heritage.
4. State of Western Australia; Responsible Agency Department of Planning, Lands and Heritage; Management Order to the Shire of Mundaring; Lessee Eastern Hills Arts & Crafts Inc.
5. State of Western Australia; Responsible Agency Department of Planning, Lands and Heritage; Management Orders to the Shire of Merredin & National Trust of Australia (WA)
6. State of Western Australia; Responsible Agency National Trust of Australia (WA)
7. State of Western Australia; Responsible Agency National Trust of Australia (WA); Management Orders to the Shire of Cunderdin & National Trust of Australia (WA)
8. State of Western Australia; Responsible Agency Public Transport Authority
9. State of Western Australia; Responsible Agency Water Corporation
10. Giles, Marina and Schnierer, Mark Brendan
11. Jorgensen, Jens Vilhelm

7. HERITAGE LISTINGS

• National Heritage List		22/06/2011
Register of Heritage Places:	Registered	08/12/2022
• No 1 Pumping Station		04/05/2001
• No 3 Pumping Station		02/07/1999
• Railway Water Tower, Cunderdin		28/08/1992
• No. 6 Steam Pumping Station (fmr)		28/08/1992
• Old Pumping Station		25/06/1993
• Mundaring Weir Hall		22/01/2002
• Mundaring Weir Hotel		20/06/2003
• Mount Charlotte Reservoir		14/12/2001
• Karalee Reservoir, Rock Catchment & Aqueduct		14/12/2001
National Trust Classification:		

• No 1 Pumping Station	Classified	11/06/1973
• No 3 Pumping Station	Classified	02/09/1974
• No. 4 Steam Pumping Station	Classified	02/03/1992
• Old Pumping Station	Classified	06/09/1982
• Toorak Hill, Goldfields Water Supply Reservoir	Classified	11/02/2002
• Mundaring Weir Hall	Classified	09/07/2001
• Mundaring Weir School & Quarters (fmr)	Classified	14/05/2007
• Karalee Reservoir, Rock Catchment & Aqueduct	Classified	12/03/2001
<u>Heritage List</u>		
• No 1 Pumping Station		08/03/2016
• Mundaring Weir School & Quarters (fmr)		08/03/2016
• Mundaring Weir, Gardens and Village Precinct		08/03/2016
• Mundaring Weir Hall		08/03/2016
• Mundaring Weir Hotel		08/03/2016
• Mount Charlotte Reservoir		18/04/1997
• Toorak Hill, Goldfields Water Supply Reservoir		15/04/2003
<u>Municipal Inventory:</u>		
• No 1 Pumping Station		22/04/1997
• No 2 Pumping Station - Site of		22/04/1997
• No 3 Pumping Station		31/12/1996
• No. 4 Steam Pumping Station		16/047/1999
• Old Pumping Station		27/07/1995
• Mundaring Weir School & Quarters (fmr)		22/04/1997
• Mundaring Weir, Gardens and Village Precinct		22/04/1997
• Mundaring Weir Hall		22/04/1997
• Mount Charlotte Reservoir		09/07/2001
• Karalee Reservoir, Rock Catchment & Aqueduct		16/05/1997
<u>Register of the National Estate</u>:		----------------
• No 1 Pumping Station	Permanent	21/03/1978
• No 3 Pumping Station	Permanent	21/03/1978
• Old Pumping Station	Permanent	11/08/1987
• Mundaring Weir, Gardens and Village Precinct	Indicative	
Mundaring Weir Hall	Indicative	
• Mount Charlotte Reservoir	Indicative	
<u>Aboriginal Sites Register</u>		
• 3010 Mt Charlotte	Registered	
• 3758 Helena River	Registered	
• S00093 Cunderdin	Lodged	
• 20837 SX09	Lodged	
• 22675 Mundaring Weir Corroboree Grounds (Booralyn)	Lodged	
• 32761 Roundhead/Ngumarn	Lodged	

8. ORDERS UNDER SECTION OF THE ACT

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9. HERITAGE AGREEMENT

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10. STATEMENT OF SIGNIFICANCE

The *Goldfields Water Supply Scheme*, extends in a discontiguous precinct across the 560km linear water pipeline, commencing at Mundaring Weir (1902, 1951) in the Helena Valley and terminating at Mount Charlotte Reservoir (1902) in Kalgoorlie-Boulder. Comprising six extant original Steam Pump Stations (1902) at Mundaring, Cunderdin, Merredin, Yerbillon, Ghooli and Dedari; the sites of two demolished Steam Pump Stations (1902) at O'Connor and Gilgai; Reservoirs and Tanks (1902, 1911, 1924, 1932) at O'Connor, Sawyers Valley, Bakers Hill, West Northam, Cunderdin, Merredin, Yerbillon, Ghooli, Bronti, Gilgai, Koorarawalyee, Dedari, Toorak, and Bullabulling; second generation Electric Pump Station at Merredin (1954), pump community buildings associated with the Mundaring Weir Village (1898-1909), Mundaring Weir Hotel (1898; 1906), Karalee Reservoir, Rock Catchment & Aqueduct (1897), ancillary structures; equipment and machinery, archaeological sites; and small discontiguous portions of the main pipeline conduit associated with the construction and operation of the Scheme from 1902 to the present, *Goldfields Water Supply Scheme* has cultural heritage significance for the following reasons:

the place demonstrates exceptional technical achievement as one of the longest overland pipeline schemes attempted in the nineteenth century, both in Australia and the world, and was recognised as an outstanding engineering achievement;

the construction of two reservoirs connected by a 560km below-ground pipeline, supported by eight steam pump stations and associated infrastructure, utilised new technology, and exceptional engineering and architectural design;

the success of the scheme was pivotal in the growing confidence and economic importance of the State, in creating employment opportunities and shaping local patterns of land use, farming, transport, and education, and was fundamental to the continued success of goldmining in the Eastern Goldfields;

the place has exceptional value in demonstrating the historical importance of the provision of water to settlements along the route from Mundaring to the Eastern Goldfields, and enabled the continued development of the Western Australian mining industry;

In providing a continuous and reliable water supply to the Eastern Goldfields, the place was the foundation of the successful development of agriculture in the Wheatbelt region throughout the twentieth century as part of the Comprehensive Water Supply Scheme, which allowed for the development of long-lasting townships and communities along the route and for people to permanently settle inland;

the construction and operation of the Pipeline had considerable importance in contributing to the sense of place for the people of Western Australia, and visitors to the State, as a highly valued tourist destination, the educational, cultural and aesthetic aspects of which are appreciated by history and engineering enthusiasts and teachers to this day;

individual elements of the place, including the existing interpretation associated with the Golden Pipeline Heritage Trail, museums, archaeological sites and remaining buildings and infrastructure, collectively have exceptional potential to communicate the history of the Goldfields Water Supply Scheme and its importance to Western Australia;

the design of the eight original Steam Pump Stations by renowned architect George Temple Poole, was intended to demonstrate the social and political importance of the place, and this is still evident in the Pump Stations remaining at Mundaring, Cunderdin, Merredin, Ghooli, Yerbillon and Dedari which form a discontiguous group of industrial buildings of considerable architectural refinement;

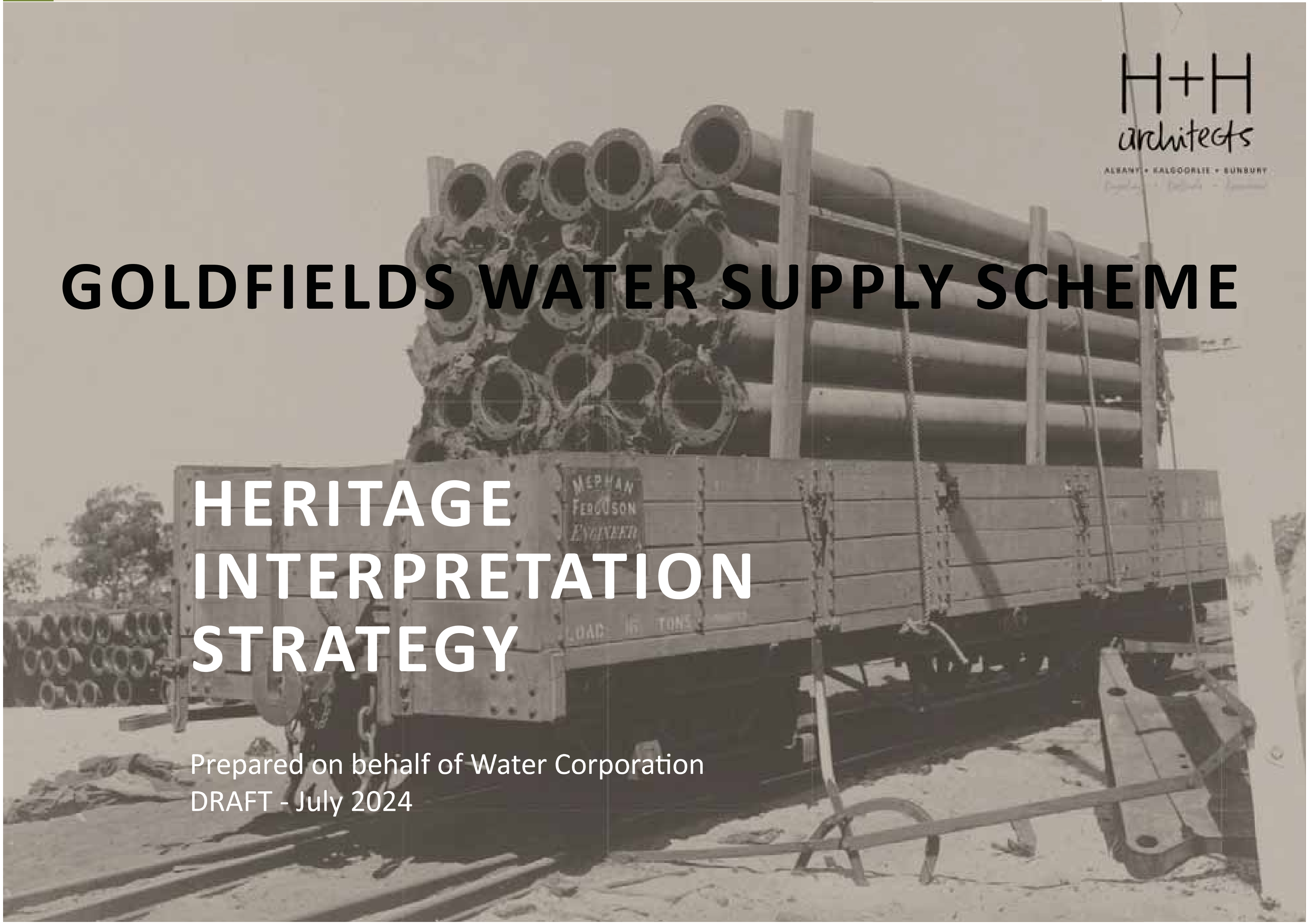
the place is highly valued as a tourist destination with educational, cultural and aesthetic aspects appreciated by history and engineering enthusiasts, teachers, Western Australians and visitors to the State. Individual elements of the place, including the existing interpretation associated with the Golden Pipeline Heritage Trail, museums, archaeological sites and remaining and remnant buildings and infrastructure, collectively have exceptional potential to communicate the history of the Goldfields Water Supply Scheme and its importance to the Wheatbelt, the Eastern Goldfields and Western Australia;

many of the individual components within the place have individual landmark qualities in their rural and country town settings. Collectively they form a significant precinct that is recognisable across the changing landscape from the Perth Hills, the Wheatbelt and Eastern Goldfields of Western Australia;

the place is associated with a number of notable figures in Western Australian history, including the Scheme's designer CY O'Connor, State and Federal politician Lord John Forrest, the Director of the Public Works Department HW Venn and former Superintendent of Public Works, architect George Temple Poole, who each contributed to the successful completion of the Goldfields Water Supply Scheme; and

the place is an exceptional example of applied science, technical excellence and innovative design, reflecting the ongoing ingenuity and innovation demonstrated by the talented and committed engineers employed by the Goldfields Water Supply Branch, Public Works Department and other iterations of the Water Corporation in the provision of water in the State. The longevity of the scheme is associated with innovators Mephan Ferguson, James Couston, engineers Norman Fernie and Reg Keating, and Frank Mather.

The majority of the above ground pipeline conduit running adjacent to Great Eastern Highway *en route* from Mundaring to Kalgoorlie is not included in the curtilage of this place. The later tanks located adjacent to the 1911 tanks at Koorarawalyee and Bronti are of little significance.



H+H architects

ALBANY • KALGOORLIE • BUNBURY

GOLDFIELDS WATER SUPPLY SCHEME

HERITAGE INTERPRETATION STRATEGY

Prepared on behalf of Water Corporation
DRAFT - July 2024

Australian Government
Department of Agriculture, Water and the Environment

APPROVAL

Goldfields Water Supply Scheme Project, WA (EPBC 2019/8547)

This decision is made under sections 130(1) and 133(1) of the *Environment Protection and Biodiversity Conservation Act 1999* (Cth) (the EPBC Act). Note that section 134(1A) of the EPBC Act applies to this approval, which provides in general terms that if the approval holder authorises another person to undertake any part of the action, the approval holder must take all reasonable steps to ensure that the other person is informed of any conditions attached to this approval, and that the other person complies with any such condition.

Details

Person to whom the approval is granted (approval holder)	Water Corporation
ACN or ABN of approval holder	ABN: 28 003 434 917
Action	To remove extant elements of the above ground pipeline forming part of the National Heritage Listed Goldfields Water Supply Scheme, extending from Mundaring Weir to Kalgoorlie [See EPCB Act referral EPBC 2019/8547].

Approval decision

My decision on whether or not to approve the taking of the action for the purposes of the controlling provision for the action is as follows.

Controlling Provisions

National Heritage values of a National heritage place	
Section 15B	Approve
Section 15C	Approve

Period for which the approval has effect

This approval has effect until 30 January 2092

Decision-maker

Name and position	Tanya Stacpoole Acting Assistant Secretary Environment Assessment West (WA, SA, NT) Branch
Signature	
Date of decision	20 January 2022

Conditions of approval

This approval is subject to the conditions under the EPBC Act as set out in ANNEXURE A.

ANNEXURE A – CONDITIONS OF APPROVAL

Part A – Conditions specific to the action

Heritage Management Plan

1. To minimise the **impact** of the action on the **National Heritage Listed Goldfields Water Supply Scheme,** the approval holder must submit a Heritage Management Plan for the **Minister's** approval. The Heritage Management Plan must be endorsed by the **Australian Heritage Council** before it is submitted to the **Department** for the **Minister**'s approval.
2. The approval holder must not **commence the action**, with the exception of **preliminary works**, unless the **Minister** has approved the Heritage Management Plan in writing. The approval holder must implement the approved Heritage Management Plan for the **life of the approval**.
3. The approval holder must, within 12 months of commencing **preliminary works**:
   a. Provide a photographic archival record of all elements comprising the **preliminary works** to the **Department**, **Australian Heritage Council**, **WA Heritage Council,** and the relevant local Government authority; and
   b. Provide decommissioned pipeline elements comprising the **preliminary works** to the community for interpretation, conservation or artistic reuse.

Interpretation Strategy

4. To minimise the **impact** of the action on **protected matters**, the approval holder must submit an Interpretation Strategy for the **Minister's** approval. The Interpretation Strategy must be consistent with the approved Heritage Management Plan and must:
   a. Demonstrate and communicate the **National Heritage Listed Goldfields Water Supply Scheme** values of the National Heritage Place, and specifically elaborate how the pipeline relates to these values;
   b. Ensure the Interpretation Strategy aligns with the condition and integrity of the **National Heritage Listed Goldfields Water Supply Scheme** values;
   c. Provide evidence of how interpretation will be implemented and timelines for its implementation;
   d. Include details of how interpretation will be communicated to the public; and
   e. Specify details of the monitoring and evaluation methods to be employed to ensure interpretation is successful.
5. The approval holder must not **commence the action,** with the exception of **preliminary works**, unless the **Minister** has approved the Interpretation Strategy in writing. The approval holder must implement the approved Interpretation Strategy for the **life of the approval**.

Main conduit removal

6. To minimise the **impact** of the action on **protected matters** of the **main conduit**, the approval holder must:
   a. Prepare a photographic archival record of the **main conduit**, of each section of pipeline before it is removed and throughout the development process. This photographic archival record must be made available to the public by being published on the **website** for the **life of the approval**;

b. Conduct a research project to document the public's historic and modern interactions with the heritage elements of the site to allow the interpretation of the architectural development of the site;
c. Conduct a research project to document, record and archive the public memories of the **main conduit** from designers and visitors and make the archive publicly available on the **website** for the **life of the approval**;
d. Provide copies of the archival records to the **Department**, the **Australian Heritage Council**, the relevant local Government authority, and the **WA Heritage Council**;
e. Engage a suitably qualified expert to:
   i. Oversee and inspect the demolition and the removal of the **main conduit** and ensure no unapproved removal of the **main conduit** occurs;
   ii. Advise on procedures to handle and monitor **impacts** to the **main conduit**;
   iii. Advise on the preparation of a Heritage Management Plan and the Interpretation Strategy;
   iv. Advise on the preparation of archival records for the action**.**

Part B – Standard administrative conditions

Notification of date of commencement of the action

7. The approval holder must notify the **Department** in writing of the date of **commencement of the action** within 10 **business days** after the date of **commencement of the action.**

8. If the **commencement of the action** does not occur within 5 years from the date of this approval, then the approval holder must not **commence the action** without the prior written agreement of the **Minister**.

Compliance records

9. The approval holder must maintain accurate and complete **compliance records**.

10. If the **Department** makes a request in writing, the approval holder must provide electronic copies of **compliance records** to the **Department** within the timeframe specified in the request.

Note: **Compliance records** may be subject to audit by the **Department** or an independent auditor in accordance with section 458 of the **EPBC Act**, and or used to verify compliance with the conditions. Summaries of the result of an audit may be published on the **Department**'s website or through the general media.

Submission and publication of plans

11. The approval holder must:

    a. submit **plans** electronically to the **Department**;

    b. unless otherwise agreed to in writing by the **Minister,** publish each **plan** on the website within 20 **business days** of the date:

       i. of this approval, if the version of the **plan** to be implemented is specified in these conditions; or

       ii. that the **plan** is submitted to the **Minister** or the **Department** if the **plan** does not require the approval of the Minister but was not finalised before the date of this approval; or

       iii. that the **plan** is approved by the Minister.

    c. exclude or redact **sensitive ecological data** from **plans** published on the **website** or provided to a member of the public; and

    d. keep **plans** published on the **website** until the end date of this approval.

12. The approval holder must ensure that any **monitoring data** (including **sensitive ecological data**), surveys, maps, and other spatial and metadata produced under a **plan**, is prepared in accordance

with the **Department's** *Guidelines for biological survey and mapped data* (2018) and submitted electronically to the **Department** in accordance with the requirements of the **plan**.

Annual compliance reporting

13. The approval holder must prepare a **compliance report** for each 12 month period following the date of **commencement of the action**, or otherwise in accordance with an annual date that has been agreed to in writing by the **Minister**. The approval holder must:
    a. publish each **compliance report** on the **website** within 60 **business days** following the relevant 12 month period;
    b. notify the **Department** by email that a **compliance report** has been published on the **website** and provide the weblink for the **compliance report** and documentary evidence providing proof of the date of publication of the report within 5 **business days** of the date of publication;
    c. keep all **compliance reports** publicly available on the **website** until this approval expires;
    d. exclude or redact **sensitive ecological data** from **compliance reports** to be published on the **website**; and
    e. where any **sensitive ecological data** has been excluded from the version published, submit the full **compliance report** to the **Department** within 5 **business days** of publication.

Note: **Compliance reports** may be published on the **Department**'s website.

Reporting non-compliance

14. The approval holder must notify the **Department** in writing of any: **incident;** non-compliance with the conditions; or non-compliance with the commitments made in **plans**. The notification must be given as soon as practicable, and no later than two **business days** after becoming aware of the **incident** or non-compliance. The notification must specify:
    a. any condition which is or may be in breach;
    b. a short description of the **incident** and/or non-compliance; and
    c. the location (including co-ordinates), date, and time of the **incident** and/or non-compliance. In the event the exact information cannot be provided, provide the best information available.
15. The approval holder must provide to the **Department** the details of any **incident** or non-compliance with the conditions or commitments made in **plans** as soon as practicable and no later than 10 **business days** after becoming aware of the **incident** or non-compliance, specifying:
    a. any corrective action or investigation which the approval holder has already taken or intends to take in the immediate future;
    b. the potential **impact**s of the **incident** or non-compliance; and
    c. the method and timing of any remedial action that will be undertaken by the approval holder.

Independent audit

16. The approval holder must ensure that **independent audits** of compliance with the conditions are conducted as requested in writing by the **Minister**.
17. For each **independent audit**, the approval holder must:
    a. provide the name and qualifications of the **suitably qualified auditor** and the draft audit criteria to the **Department**;
    b. only **commence** the **independent audit** once the audit criteria have been approved in writing by the **Department**; and

c. submit an audit report to the **Department** within the timeframe specified in the approved audit criteria.

18. The approval holder must publish the audit report on the **website** within 10 **business days** of receiving the **Department's** approval of the audit report and keep the audit report published on the **website** until the expiry date of this approval.

Revision of action management plans

19. The approval holder may, at any time, apply to the **Minister** for a variation to an action management plan approved by the **Minister**, by submitting an application in accordance with the requirements of section 143A of the **EPBC Act**. If the **Minister** approves a revised action management plan (RAMP) then, from the date specified, the approval holder must implement the RAMP in place of the previous action management plan.

Completion of the action

20. Within 20 **business days** after the **completion of the action**, the approval holder must notify the **Department** in writing and provide **completion data**.

Part C - Definitions

In these conditions, except where contrary intention is expressed, the following definitions are used:

Australian Heritage Council means the principal adviser to the Australian Government on heritage matters established by the **Minister** under the *Environment Protection and Biodiversity Conservation Act 1999*.

Business day/s means a day that is not a Saturday, a Sunday or a public holiday in Western Australia.

Commence the action/Commencement of the action means the first instance of any specified activity associated with the action including clearing and **construction**. **Commencement of the action** does not include physical disturbance necessary to:

i. undertake **preliminary works,** pre-clearance surveys or monitoring programs;
ii. install signage and /or temporary fencing to prevent unapproved use of the project area;
iii. protect environmental and property assets from fire, weeds and pests, including installation of temporary fencing, and use of existing surface access tracks;
iv. install temporary site facilities for persons undertaking pre-commencement activities so long as these are located where they have no **impact** on the **protected matters.**

Completion data means an environmental report and spatial data clearly detailing how the conditions of this approval have been met. The **Department**'s preferred spatial data format is **shapefile**.

Completion of the action means the day on which all specified activities associated with the action have permanently ceased.

Compliance records means all documentation or other material in whatever form required to demonstrate compliance with the conditions of approval in the approval holder's possession or that are within the approval holder's power to obtain lawfully.

Compliance report/s means written reports:

i. providing accurate and complete details of compliance, **incidents**, and non-compliance with the conditions and the **plans**;
ii. consistent with the **Department's** *Annual Compliance Report Guidelines* (2014): found at https://www.environment.gov.au/epbc/publications/annual-compliance-report-guidelines;

iii. include a **shapefile** of any clearance of any **protected matters**, or their habitat, undertaken within the relevant 12 month period; and
iv. annexing a schedule of all **plans** prepared and in existence in relation to the conditions during the relevant 12 month period.

Construction means the erection of a building or structure that is or is to be fixed to the ground and wholly or partially fabricated on-site; the alteration, maintenance, repair or demolition of any building or structure; preliminary site preparation work which involves breaking of the ground (including pile driving); the laying of pipes and other prefabricated materials in the ground, and any associated excavation work; but excluding the installation of temporary fences and signage.

Department means the Australian Government agency responsible for administering the **EPBC Act**.

EPBC Act means the *Environment Protection and Biodiversity Conservation Act 1999* (Cth).

Impact/s (verb) means to cause any measurable direct or indirect disturbance or harmful change as a result of any activity associated with the action. **Impact/s** (noun) means any measurable direct or indirect disturbance or harmful change as a result of any activity associated with the action.

Incident means any event which has the potential to, or does, **impact/s** on one or more **protected matter**, other than as authorised by this approval.

Independent audit means an audit conducted by an independent and **suitably qualified auditor** as detailed in the *Environment Protection and Biodiversity Conservation Act 1999 Independent Audit and Audit Report Guidelines* (2019), available from: http://www.environment.gov.au/epbc/publications/independent-audit-report-guidelines.

Life of the approval means the period for which this approval has effect.

Main conduit means the primary water pipeline between Mundaring and Kalgoorlie, which forms one of the 16 elements that make up the **National Heritage Listed Goldfields Water Supply Scheme**. The approximate location of the **main conduit** is shown by the red line designated 'Listed place' on the map at Attachment A. The location is specified in the Gazettal of the Goldfields Water Supply Scheme, which can be found at: https://www.awe.gov.au/parks-heritage/heritage/places/national/goldfields

Minister means the Australian Government Minister administering the **EPBC Act** including any delegate thereof.

Monitoring data means the data required to be recorded under the conditions of this approval.

National Heritage Listed Goldfields Water Supply Scheme means the Goldfields Water Supply Scheme National Heritage Place that was inscribed in the National Heritage List on 4 October 2010. The specific elements of this place and their locations are specified in the Gazettal of the Goldfields Water Supply Scheme, which can be found at: https://www.awe.gov.au/parks-heritage/heritage/places/national/goldfields

Plan/s means any of the documents required to be prepared, approved by the **Minister**, implemented by the approval holder and/or published on the **website** in accordance with these conditions (includes action management plans and/or strategies).

Preliminary works means the removal of 1.4 km of pipeline at Tammin, 2.7 km of pipeline at Baandee and 3.4 km of pipeline at Merredin, where shown marked in red designated 'Main Conduit Replacement Project' in Attachment B, resulting in the removal of no more than 7.5 kilometres (total) of the **main conduit**.

Protected matter/s refers to the matters protected under a controlling provision in Part 3 of the **EPBC Act**. For this approval the relevant protected matter is **National Heritage Listed Goldfields Water Supply Scheme**.

Sensitive ecological data means data as defined in the Australian Government Department of the Environment (2016) *Sensitive Ecological Data – Access and Management Policy V1.0* available from http://www.environment.gov.au/about-us/environmental-information-data/information-policy/sensitive-ecological-data-access-and-management-policy.

Shapefile means location and attribute information of the action provided in an Esri shapefile format. Shapefiles must contain '.shp', '.shx', '.dbf' files and a '.prj' file that specifies the projection/geographic coordinate system used. Shapefiles must also include an '.xml' metadata file that describes the shapefile for discovery and identification purposes.

Suitably qualified auditor means a person who has relevant professional qualifications, training, skills and/or experience related to the nominated subject matter and can give authoritative independent assessment, advice and analysis on performance relative to the subject matter using the relevant protocols, standards, methods and/or literature.

WA Heritage Council means The Heritage Council of Western Australia which is the State Government's expert body on Western Australia's cultural heritage significance as vested under the *Heritage Act 2018.*

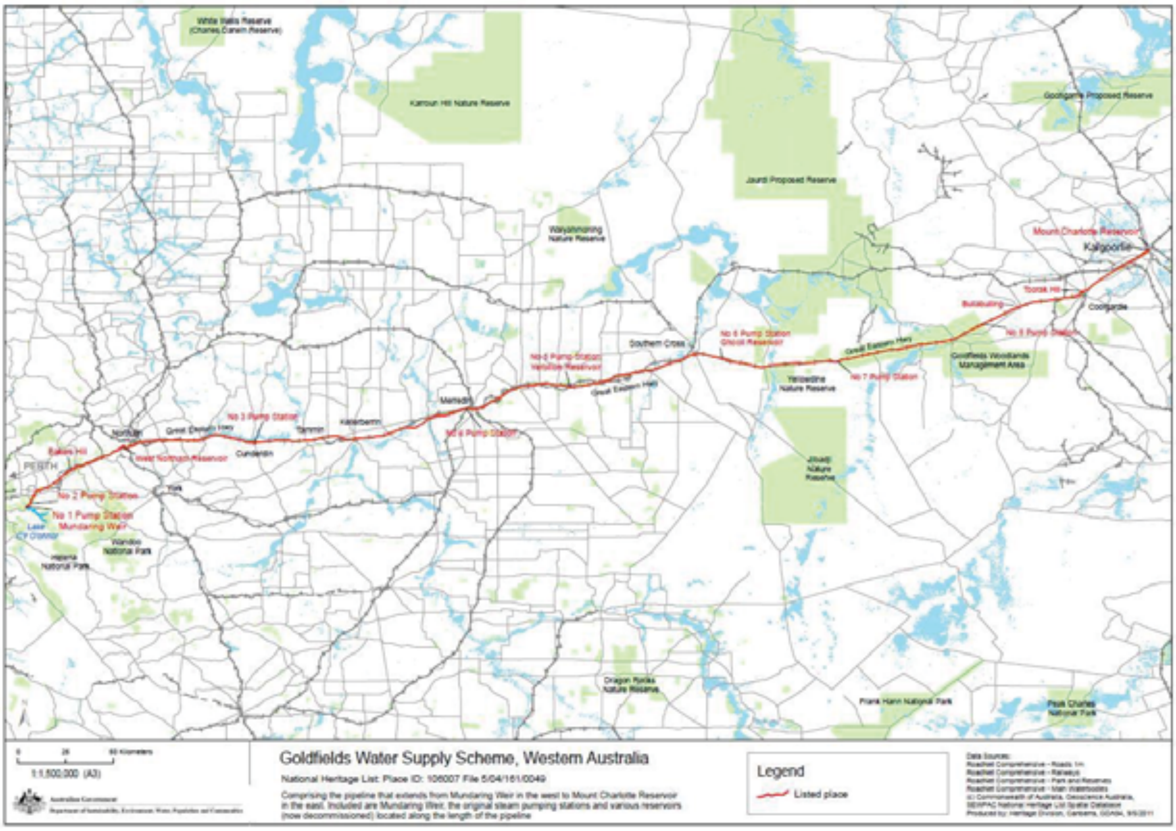
Website means a set of related web pages located under a single domain name attributed to the approval holder and available to the public.

ATTACHMENTS

A: The Goldfields and Agricultural Region Water Supply Scheme (GAWS) Main Conduit

B: The locations of preliminary works at Tammin (spanning 1.4 km), Baandee (2.7 km) and Merredin (3.4 km)

Attachment A – The Goldfields and Agricultural Region Water Supply Scheme (GAWS) Main Conduit



Attachment B – The locations of preliminary works at Tammin (spanning 1.4 km), Baandee (2.7 km) and Merredin (3.4 km)

Job No. 16112

EPBC Heritage Management Plan

Goldfields Water Supply Scheme, Main Conduit, Western Australia

Environmental Protection and Biodiversity Conservation Act 1999

Prepared on behalf of Water Corporation of Western Australia

August 2016

Griffiths Architects

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Cover: GWSS Conduit near Meckering, *Griffiths Architects* (April 2016)

Revision History

Date of this revision: 04 May 2017

Document	Version	Author	Status	Date	Distribution
Management Plan	06	Griffiths Architects	Referral Draft	04 May 2017	DoE + WC
Management Plan	05	Griffiths Architects	Referral Draft	06 April 2017	Water Corporation
Management Plan	04	Griffiths Architects	First Submission	18 Aug 2016	DoE + WC
Management Plan	03	Griffiths Architects	Final Draft	11 Aug 2016	Water Corporation + NT
Management Plan	02	Griffiths Architects	Draft	05 July 2016	Water Corporation + NT
Management Plan	01	Griffiths Architects	Draft	29 June 2016	Water Corporation

Executive Summary

Introduction

The Goldfields Water Supply Scheme (GWSS) is an enormous engineering achievement that brought important benefits to the Goldfields, towns and later agricultural districts along its path. The pipeline was completed in 1903 and spans some 560km between Mundaring and Kalgoorlie. The system continues to operate today, and during its lifetime much has been upgraded, replaced and renewed.

The main conduit is included on the National Heritage List (NHL) (place ID 106007) which includes pump stations, reservoirs and tanks. Ownership of the various parts of the system are segmented between different parties, with a number of historic non-operational steam pump stations vested with the National Trust of Australia (WA). This heritage management plan (HMP) concerns heritage management responsibilities for the main conduit by the Water Corporation of Western Australia.

The pipeline was originally buried below ground, but the frequency of leaks led to it being excavated and raised above ground during the 1930s. The pipeline has been continually maintained, upgraded and increased in capacity since the time of its construction, almost half of the operational pipeline remains made up of original locking bar pipes.

Objective

This HMP was prepared to assist the Water Corporation to comply with legislative requirements under the Environment Protection and Biodiversity Act 1999 (EPBC Act). It also assists in the understanding and conservation of the heritage values of the pipeline and offers practical policies that recognise the operational needs of the pipeline.

Management

The Water Corporation of Western Australia, under the State Government of Western Australia, owns and operates the main conduit, and is responsible for the service and infrastructure of the scheme.

Obligations

The GWSS is the principal means of water supply to the Goldfields and Wheatbelt. Providing drinking water safely and efficiently is the primary operational consideration of the pipeline, and to do so the pipeline must be maintained, repaired, and upgraded periodically.

National heritage values of the GWSS must be maintained, and obligations related to the main conduit arising from the national heritage values must be considered and to the extent possible, protected.

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1. Introduction

1.1. The Place

Goldfields Water Supply Scheme (GWSS) is an enormous engineering achievement that brought important benefits to the Goldfields, towns and later agricultural districts along its path. It was innovative for its time and one of the world's great engineering feats. The pipeline spans some 560km between Mundaring and Kalgoorlie. It was completed in 1903 and has been continually maintained and upgraded since the time of its construction. The main conduit consists of 30 inch to 40-inch diameter pipe of varying ages, and is mainly above ground, supported between concrete anchor blocks.

Over the lifetime of the GWSS the original pump stations have been decommissioned and large sections of locking bar conduit have been replaced. Two non-operational steam pump stations are vested with the National Trust of Australia (WA) (No. 1, No. 8), and two are jointly vested with National Trust of Australia (WA) and local governments (No. 3, No. 4). The main conduit is owned and operated by the Water Corporation of Western Australia, the modern successor to the Public Works Department, under ownership of the state government of Western Australia.

1.2. Terms and Acronyms

GWSS	Goldfields Water Supply Scheme
EPBC Act	Environment Protection and Biodiversity Conservation Act 1999
MSCL	Mild Steel Cement Lined
DoE	Department of Environment
HMP	Heritage Management Plan
NHL	National Heritage List
NTWA	National Trust of Australia (WA)

1.3. Objective

The Water Corporation commissioned Griffiths Architects to prepare a Heritage Management Plan (HMP) for the main conduit of the *Goldfields Water Supply Scheme, Western Australia* (GWSS) (place ID 106007). The main conduit is included on the National Heritage List (NHL), which includes pump stations, reservoirs and tanks. Ownership of the various parts of the system are segmented between different parties.

This HMP deals specifically with the main conduit of the GWSS. Prior to this HMP there are no recorded heritage management policies for the main conduit of the GWSS. Policies for the GWSS pump stations, reservoirs, and tanks, are included in *Conservation plan for Goldfields Water Supply Scheme* (1999) and *Mundaring Weir Conservation Plan* (2000).

Introduction

This HMP was prepared to consider potential long-term upgrades to the capacity of the pipeline and ensure the protection of the heritage values of the main conduit as a whole. This is achieved by assisting in the understanding of the heritage values of the pipeline and offers practical policies that recognise the operational nature of the pipeline. This will assist the Water Corporation in complying with legislative requirements under the Environment Protection and Biodiversity Act 1999 (EPBC Act).

1.4. Heritage Listings

The main conduit is included on the National Heritage List entry for *Goldfields Water Supply Scheme, Western Australia* (place ID 106007, 22 June 2011). Also included on the listing are the six remaining original pump stations, the Mundaring and Mt Charlotte reservoirs, four regulating tanks, and four holding tanks. The main conduit is not included on any other heritage listing statutory or otherwise.

Most of the pump stations, reservoirs, and other aspects of the scheme have individual listings, these are listed below with accompanying State Heritage Office of Western Australia place numbers:

Mundaring Weir (08538)
Register of the National Estate (Indicative Place)
Mundaring Municipal Inventory (22 Apr 1997)

Mount Charlotte Reservoir (15727)
State Register (14 Dec 2001)
Register of the National Estate (Indicative Place)
Kalgoorlie Municipal Inventory (09 Jul 2001)

No 1 Pumping station (01677)
State Register (04 May 2001)
Mundaring Municipal Inventory (22 Apr 1997)
Register of the National Estate (21 Mar 1978)
Classified by the National Trust (11 Jun 1973)
Aboriginal Heritage Sites Register

No 2 Pumping station site (08539)
Mundaring Municipal Inventory (22 Apr 1997)

No 3 Pumping station (00649)
State Register (02 Jul 1999)
Register of the National Estate (21 Mar 1978)
Classified by the National Trust (02 Sep 1974)
Cunderdin Municipal Inventory (31 Dec 1996)

No 4 Pumping station (01564)
Classified by the National Trust (02 Mar 1982)
Merredin Municipal Inventory (16 Apr 1999)

No 5 Pumping station
No other listings

No 6 Pumping station (02789)
State Register (28 Aug 1992)
Classified by the National Trust (15 Jan 1976)
Register of the National Estate (21 Mar 1978)
Yilgarn Municipal Inventory (16 May 1997)

No 7 Pumping station (site)
No other listings

No 8 Pumping station (00583)
State Register (25 Jun 1993)
Coolgardie Municipal Inventory (27 Jul 1995)
Register of the National Estate (11 Aug 1987)
Classified by the National Trust (06 Sep 1982)

Bakers Hill
No other listings

Bullabulling (03933)
State Register (13 Aug 2004)

West Northam
No other listings

Toorak Hill (03660)
Coolgardie Municipal Inventory (27 Jul 1995)
Classified by the National Trust (11 Feb 2002)

1.5. Methodology

This HMP was prepared in accordance with the Burra Charter 2013 (The Australian ICOMOS Charter for Places of Cultural Significance) and the Environmental Protection and Biodiversity Conservation Act 1999 (EPBC Act). The HMP was prepared in collaboration with the Water Corporation and the National Trust of Australia (WA).

1.6. Authors

Philip Griffiths, Griffiths Architects
Jordan Russell, Griffiths Architects

1.7. Acknowledgments

Anne Brake, National Trust of Australia (WA)
Kelly Rippingale, National Trust of Australia (WA)
Daniel Stevens, Water Corporation

2. Location

The pipeline begins at Mundaring Weir, 30km east of Perth, and stretches approximately 560km east to Kalgoorlie. The pipeline and Great Eastern Highway share much of the journey from Perth to Kalgoorlie and is predominately above ground, dipping below to make way for side roads and towns. The pipeline terminates at Mount Charlotte Reservoir north east of Kalgoorlie.

Towns passed by the pipeline include: Chidlow, Bakers Hill, Northam, Meckering, Cunderdin, Kellerberrin, Merredin, Burracoppin, Southern Cross, Coolgardie.

The following figures show the path of the main conduit and indicate the type of pipe present across the length.

Location

2.1. Maps

Figure 01 Map of Western Australia showing the pipeline path
Griffiths Architects / Google Maps (2016)

Figure 02 Map - Path of the pipeline
Department of Environment (2011)

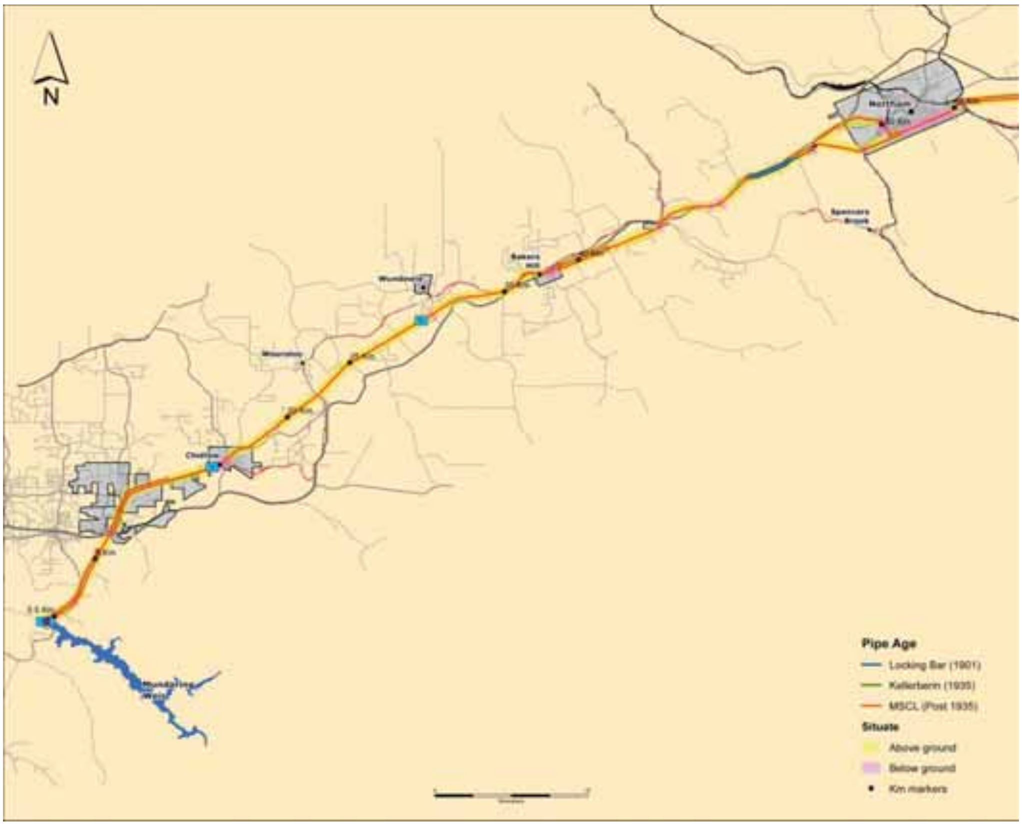

Figure 03 Map of Pipeline 0km - 85km *Water Corporation (2015)*

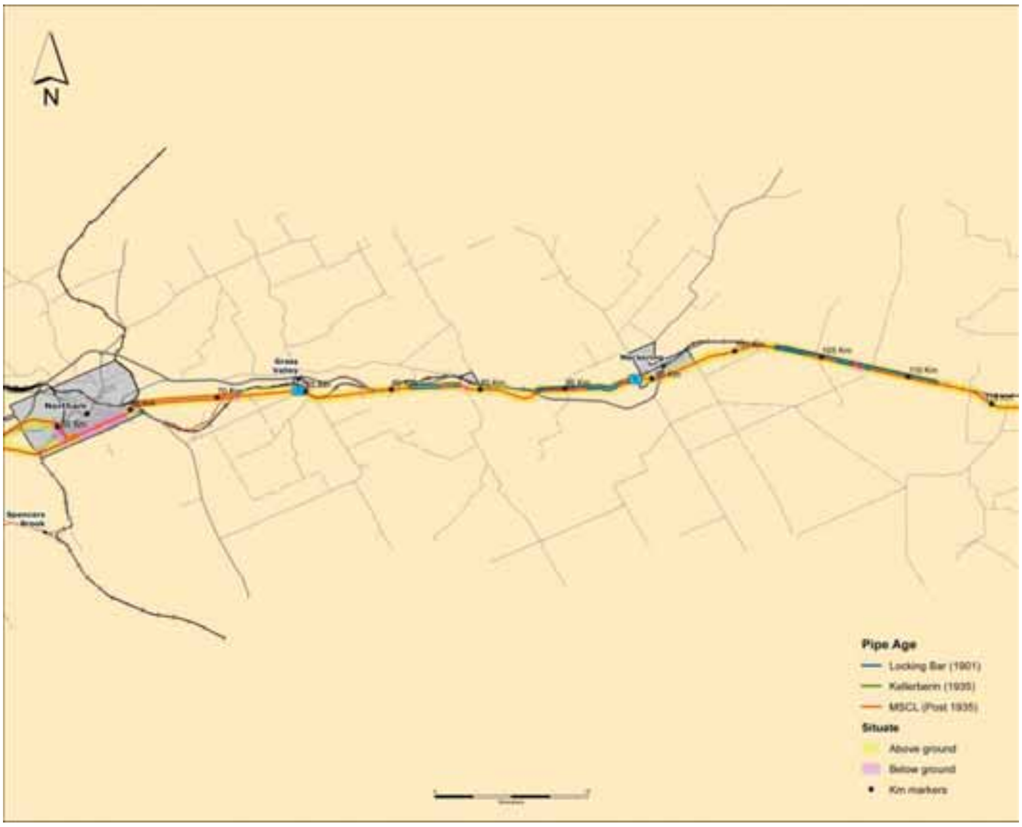

Figure 04 Map of Pipeline 60km - 115km *Water Corporation (2015)*

Location

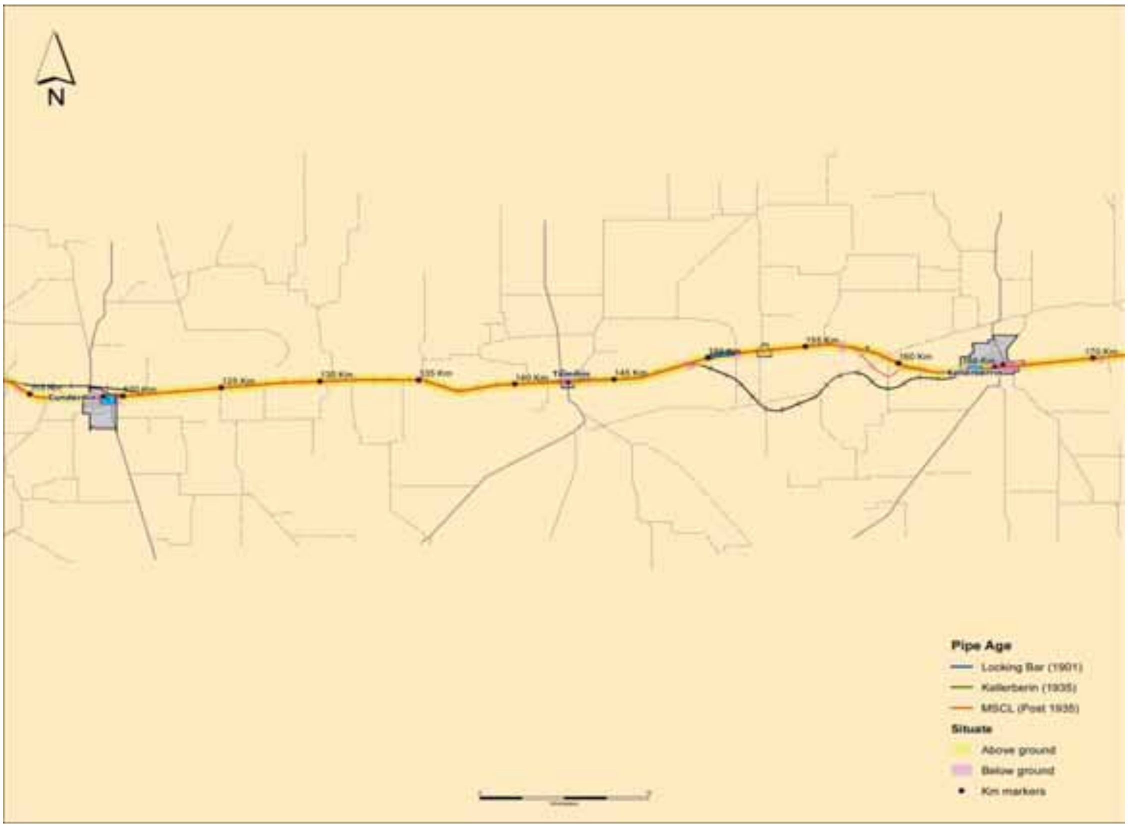

Figure 05 Map of Pipeline 115km - 170km *Water Corporation (2015)*

Figure 06 Map of Pipeline 170km - 230km *Water Corporation (2015)*

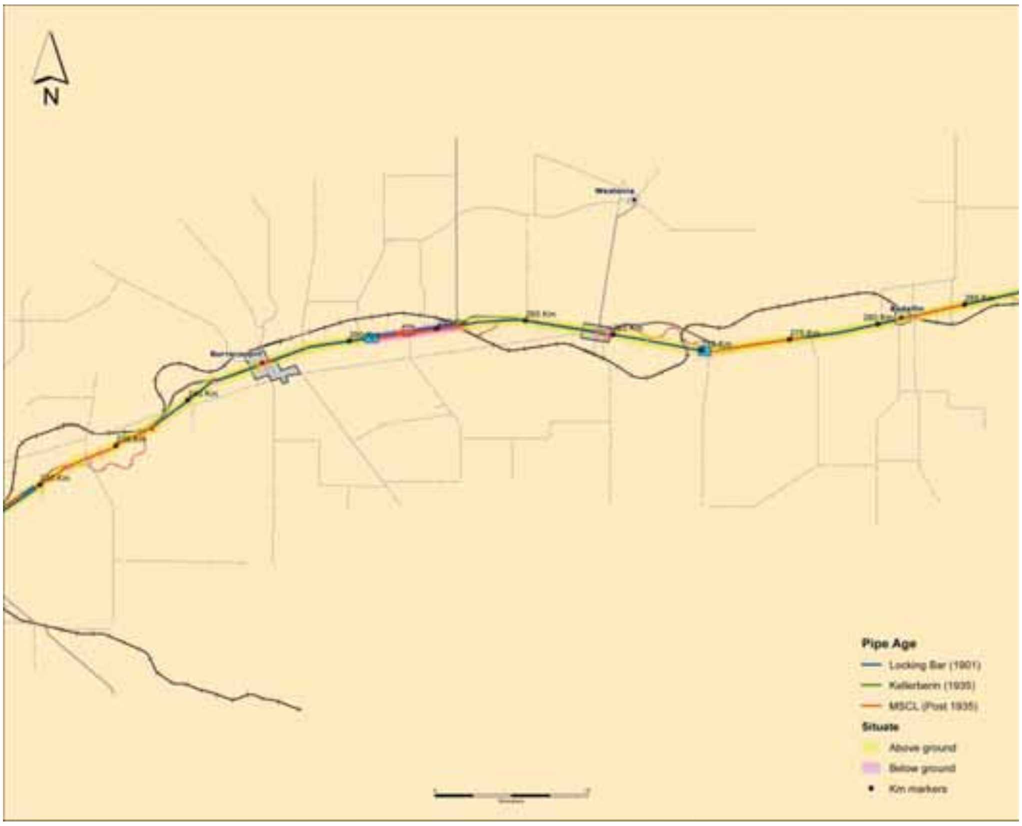

Figure 07 Map of Pipeline 230km - 285km *Water Corporation (2015)*

Figure 08 Map of Pipeline 280km - 345km *Water Corporation (2015)*

Location

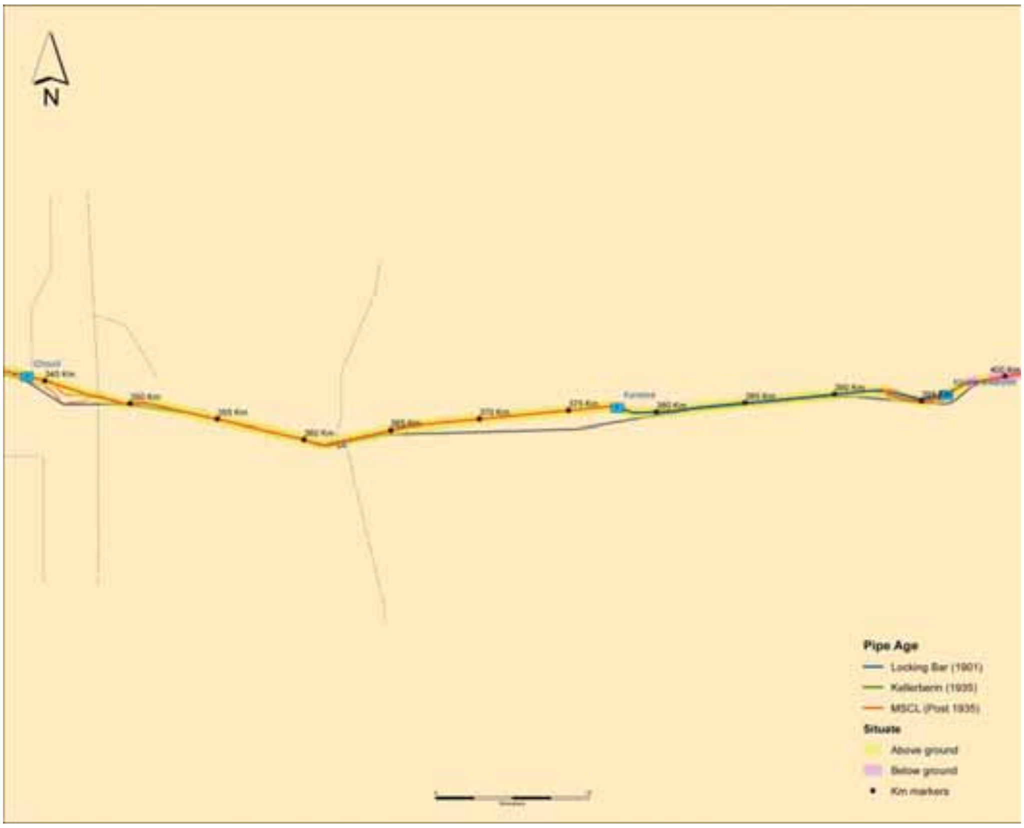

Figure 09 Map of Pipeline 345km - 400km *Water Corporation (2015)*

Figure 10 Map of Pipeline 395km to 450km *Water Corporation (2015)*

Figure 11 Map of Pipeline 455km - 515km *Water Corporation (2015)*

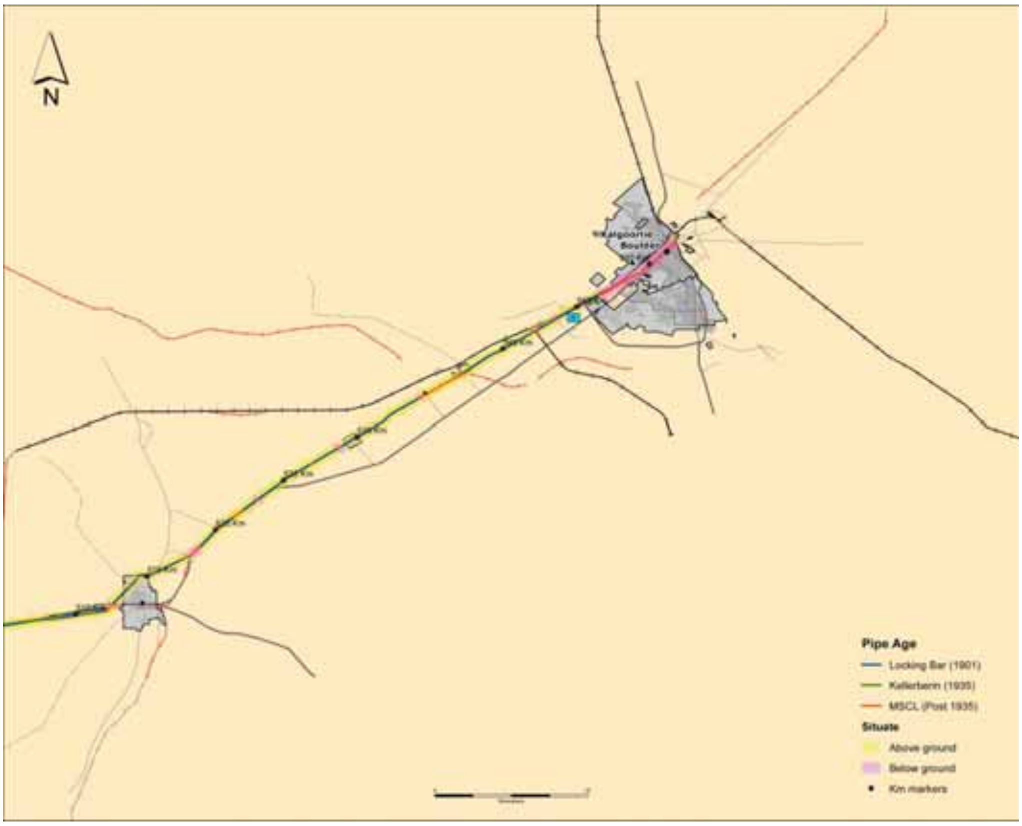

Figure 12 Map of Pipeline 510km - 550km *Water Corporation (2015)*

3. Historic Background

The history of the water scheme as well as key figures John Forest and C. Y. O'Connor have been well documented. The pipeline was a large driving factor in the development of the Goldfields and Wheatbelt, and greatly affected the development of Western Australia. This section includes an overall history of the scheme from initial proposal to the present day, as well as an account specifically regarding the post construction history of the main conduit.

3.1. Chronology

1887 Gold discovered in Yilgarn (Southern Cross), beginning the Western Australian gold rush.

1891 C. Y. O'Connor takes the position of Engineer-in-Chief of the colony.

1892 Gold discovered in Coolgardie.

1892 Public Works Department begins planning a water scheme to service the goldfields.

1895 O'Connor submits his proposal for the Goldfields pipeline scheme.

1896 A bill is passed to raise a loan of £2.5 million to construct O'Connor's pipeline scheme.

1898 Work begins on the reservoir at Mundaring.

1901 Work begins on the pump stations.

1902 Mundaring Weir wall completed.

1903 Official opening by Sir John Forest at Mt Charlotte Reservoir.

1910 Goldfields Water Supply Act amended to allow supply for agriculture outside of the goldfields.

1928 Approximately 1 million acres of farmland served.

1933 Lifting the pipe and relaying above ground begins.

1948 Comprehensive Agricultural Areas Water Supply Scheme funded.

1948 Approximately 4 million acres of farmland served.

1951 Raising of Mundaring Weir wall by 10m begins.

2011 GWSS added to the National Heritage Register.

3.2. History

The following background history was extracted from the Australian Heritage Database entry on the GWSS.

> **Conditions on the eastern goldfields**
>
> Western Australia made little progress in the first fifty years following its foundation in 1829. By 1891 the colony was teetering on the verge of collapse. The Government's coffers were empty, the railway system about to collapse, urgent public works were needed across the colony, and the port at Fremantle was so unsafe that most ships bypassed it in favour of Albany 400 kilometres by road to the south. The 1890s were a watershed in Western Australia's economic

and political history. Discovery of large deposits of initially alluvial and later reef gold in the eastern Yilgarn district attracted thousands of miners from other colonies and overseas. On 17 September 1892, Bayley and Ford found gold at Fly Flat (later to become Coolgardie). Then on 17 June 1893 Paddy Hannan struck gold at what developed into one of the richest goldfields of all time centred on the 'Goldern Mile' between Kalgoorlie and Boulder. In a couple of days of fossicking, Hannan and his partner collected over 100 ounces of gold. These rich goldfields drew prospectors from all over the world, particularly from the eastern Australian colonies. By October 1895 Coolgardie was the undisputed capital of the goldfields and centre of the colony's gold mining industry. The town itself had a population of about 8,000, while within a radius of some 65 kilometres, there was a floating population of another twenty to thirty thousand. At the time Kalgoorlie was a village of tents and dust, and Boulder did not exist.[1]

Large international investment in mining and related ventures made a dramatic impact on the slow growing colony.[2] In 1890 the population of Western Australia was 48,502, and by 1900 it had increased to 179,967. In just on a decade the small, isolated, rural-based economy saw an almost fourfold increase in population and a massive increase in capital which lifted infrastructure to a level previously thought impossible to achieve.[3] By 1911 the population had reached over 293,923, with the bulk of this population increase being on the eastern goldfields themselves.[4] Over the same period the value of gold exports rose from £86.664 in 1890 (12.9% of the gross value of WA colonial exports), to £5,549,879 in 1900 (81.0% of export value).[5]

As the Western Australian gold rush gathered momentum in the 1890s, one of the biggest problems facing gold seekers on the eastern goldfields was the lack of adequate water. The Coolgardie region had an unreliable rainfall, with annual falls during the early 1890s varying from 90 mm to 260 mm.[6] The region lacked any surface supplies of fresh water, and geologists reported that there was little prospect of finding useful artesian supplies. A variety of short-term water supply works were installed by the WA Public Works Department (PWD), including earth dams, catchments on rock outcrops, condensing plants, wells and bores. However, it became increasingly difficult and costly to provide the rapidly expanding population with uncontaminated water supplies using these means.

By the mid-1890s over 40 percent of Western Australia's population lived on the eastern goldfields under appalling conditions and paying exorbitant prices for domestic water.[7] A contemporary report complained "The seriousness of the problem can be gauged by the usual prices paid for water - 25 shillings per 1,000 gallons when the occasional rains filled the tanks -

[1] Hartley 2000: p.727

[2] Appleyard 1981: p. 218

[3] Appleyard 1981: p. 219

[4] IEA 1986: p.1

[5] Appleyard 1981: p. 236

[6] Hartley 2000: p.727

[7] NTWA 2000: vol 208

and £4 per 1,000 gallons when only water condensed from wells and shafts was available".[8] The harsh unhealthy conditions on the goldfields raised death rates to 16 per thousand in the period 1896 to 1898, due in most part to the prevalence of typhoid fever in the arid Yilgarn where clean water was difficult for prospectors to obtain.[9] For so long as these miners were deprived of an adequate safe water supply for domestic use, they refused to bring their wives and families from the eastern colonies. As a result, the masculinity ratio rose dramatically in the colony. By 1896 Western Australia contained twice as many males as females.[10]

The problem was compounded by the method of extraction used in the mining process. In 1895, the few small processing plants on the Golden Mile were using 2,000 gallons of water per ton of ore crushed.[11] This was a high usage by international standards, particularly in an area where water was so scarce. However, the high usage was necessary because the talc-like nature of the oxidised ore tended to clog stampers and screens unless washed through with a good flow of water. The extraction rates were also poor because the stamped ore readily formed slimes from which gold could not be easily recovered by the usual method of amalgamation with mercury.[12] Tailings, therefore, had to be ponded in dams until such time as they could be treated.

The adoption of the filter press in 1897, to contain these slimes while gold was removed by cyanide treatment, allowed the recycling of water with important consequences. Water usage fell dramatically from 2,000 gallons per ton in 1895 to around 500 gallons per ton by 1900. However, this increasing economy of water usage was offset as the scale of operations on the Golden Mile changed dramatically. In 1896, only 33,000 tons of ore were processed on the East Coolgardie Goldfield using 66 million gallons of water. By 1903 when this goldfield had become one of the most productive in the world 967,000 tons of ore were processed - almost thirty times more than in 1896 and using 483.5 million gallons of water.[13] Infrequent rains together with a high evaporation rate and lack of suitable dam sites ruled out the development on the goldfields of impounding dams large enough to store water sufficient to accommodate this level of heavy usage.[14]

A source outside the goldfields was needed.

The Goldfields Water Supply Scheme

A number of schemes were suggested, including bringing sea water from Esperance Bay to the goldfields for use in the government condensers.[15] However, the Premier Sir John (later Baron)

8 Quoted in IEA 1986: p.1
9 Appleyard 1981: p. 221
10 Appleyard 1981: p. 220
11 Hartley 2000: p.728
12 Hartley 2000: p.728
13 Hartley 2000: p.728
14 Hartley 2000: p.727
15 Alexander 1954: p.32

Forrest did not support the scheme and the decision was made to investigate the possibility of piping water from the Darling Ranges east of Perth to the goldfields, a distance of some 352 miles (566 km).

In mid-1895 Premier Forrest asked Charles Yelverton O'Connor, Engineer-in-Chief of the Public Works Department, to prepare data for a scheme to pump water from a reservoir in the Darling Ranges to the goldfields. O'Connor had been recruited from New Zealand and arrived in Western Australia in June of 1891. Prior to his work on the pipeline, he had completely rebuilt and restructured the state's railway system. He was also responsible for the construction of the inner harbour on the Swan River at Fremantle. He had argued for an inner harbour in opposition to the panel of overseas experts who had recommended an outer harbour based on a causeway ending in a curved breakwater running a half a mile out to sea on the northern side of the river mouth.[16]

The first trial designs for a pumped water supply were completed in November 1895 and were based on three different supply rates: one million gallons per day, five million gallons per day and ten million gallons per day. In 1896, the processing requirements of the whole of Western Australia's gold mining industry could have been met with water supplies totalling one million gallons per day - assuming a usage of 2,000 gallons per ton of ore.[17] O'Connor argued that a one million gallons per day capacity pipeline would only be adequate for short term requirements. Because of its smaller diameter, such a pipeline would have had a friction head nearly twice that of a five million gallons pipeline, and its operating costs would have been greater in the same proportion. He estimated that a one million gallons capacity pipeline would require some twelve to fifteen pumping stations compared with the eight or nine needed for a five million gallons line.[18] O'Connor also argued that, as the cost of pumping was proportional to the quantity pumped, it would be no more expensive to pump 11 million gallons daily through a pipeline of five million gallons capacity than it would be to pump the same quantity through a one million gallons capacity pipeline. In fact it would be cheaper because of the reduced friction in the larger pipe. He estimated that a supply of one million gallons would entail a capital cost of about £1 million, while a five million gallons supply would cost £2.5 million: five times the capacity for 2½ times the cost.[19]

On 16 July 1896, Premier John Forrest introduced into the WA Parliament a Bill to authorise the raising of a loan of £2.5 million to construct the pipeline scheme. The Bill passed through the Parliament in September 1896.[20]

16 Trust News 2000: Vol 208

17 Hartley 2000: p.730

18 Hartley 2000: pp.730-1

19 Hartley 2000: p.731

20 Trust News 2000: Vol 207

O'Connor supported the view that a group of experienced overseas engineers should be appointed to advise on major issues, such as: the type, thickness and diameter of the pipe; the spacing of the pumping stations; and the power requirements and capacity of the pumps themselves. A Commission of three experienced English engineers was appointed in December 1896, and in January 1897 O Connor travelled to London to discuss the proposed scheme with them. The Commission was led by Sir John Carruthers, previously head of the PWD in New Zealand,[21] and included Professor William Unwin, widely regarded as the pre-eminent authority of the day on the transmission of power, and Dr George F Deacon, engineer-in-charge of the Liverpool Water Supply.[22] In their interim report of 3 August 1897 the Commission indicated that the proposed scheme was theoretically practical although of a greater scope and size than any similar scheme attempted elsewhere in the world to that time[23]. Although they had originally recommended nine pumping stations, in their final report of 31 December 1897 they revised this to eight stations. The ninth station was omitted when the decision was made to deliver the water to a large distribution reservoir at Bullabulling instead of Mt Burgess, north of Coolgardie. From this reservoir at Bullabulling the water would flow under the influence of gravity 21 miles (33.8 km) to the Coolgardie service reservoir at Toorak and eventually down the extra 23½ miles (37.8 km) to the Kalgoorlie service reservoir at Mt Charlotte[24].

The Mundaring Reservoir

When the scheme was first proposed and until shortly before the construction of the weir was begun, there were no river-gauge water flow measurements available for rivers in the Darling Ranges. Calculations based on results obtained in other countries were necessary in order to estimate the probable inflow into any proposed reservoir. In order to identify potential dam sites for the scheme O'Connor's principal assistant, Thomas Hodgson, made an exhaustive examination of the Darling Range watershed and rivers in late 1895 and 1896 covering about 3,000 square miles of the ranges. Hodgson, an extremely qualified and experienced water supply engineer from Victoria, had been appointed in late 1895 as O'Connor's principal assistant on the water supply project. He identified thirteen potential sites, but recommended one on the Helena River which he was confident would have the capacity to provide the required supply of five million gallons of water per day. It was finally decided that the most economical place for the reservoir was at Mundaring on the Helena River, where it was estimated that the cost of construction per million gallons of storage would be least.

Mundaring Weir (Dam), which was built at the recommended site, was a one hundred feet high concrete dam capable of impounding over 4,600 million gallons. At the site chosen for the weir, the valley through which the Helena runs converges abruptly into a deep gorge flanked

21 Evans 2001: p.164

22 Evans 2001: p.167

23 Trust News 2000: Vol 209

24 Trust News 2000: Vol 209

on both sides by high hills. The river's width at its bed is 15 feet (4.6 m) and it is only 750 feet (228.6 m) in width at a height of 100 feet (30.5 m) above the bed. There was ample evidence to show that the Helena and other streams in the area were liable to heavy floods and the usual method of disposing of flood-waters, by means of a by-wash, was precluded by its cost. It was therefore decided to pass all floods over the weir crest. Calculation showed that to provide a safe margin for the passage of flood waters as much as 5 feet (1.5 m) in depth over the whole length of the weir would have to be allowed for.[25]

The country at the reservoir site consisted largely of undecomposed granite traversed by intrusive basaltic dykes whose direction was mostly at right-angles to the course of the river. At the site of the weir, however, the granite showed out particularly clearly and trial-shafts reached solid granite at no great depth, the deepest of the shafts being only 20 feet (6.1 m) deep from the ground surface.[26] During the later excavation of the foundations, however, it was discovered that the rock was not as solid as surface indications and the trial-pits had originally promised. On the right bank a large portion of what at first appeared to be bed-rock was found to consist of an immense boulder with a large cavity below it. Additionally, under the bed of the river the granite was very badly fissured over the full width of the foundations, and the disruption was found to extend both up and down stream for a considerable distance. There was no alternative but to follow the fissure down, which eventually required excavation to a depth of 90 feet (27.4 m) below the river bed. At this level the filling material in the fissure was found to be compact, and it was concluded that the fissure at this depth was safe as the base of the weir. Where the fissure occurred under the foundations and the wall would be highest, the excavations were carried down about 15 feet (4.6 m) from the building-line in a vertical direction on the up-stream face.[27] However, as one of the basalt dykes crossed the valley a short distance away on the down-stream side, it was considered necessary to remove the whole of the material between this dyke and what would otherwise have been the toe of the weir. A concrete-lined spill-water basin, about 150 feet (45.7 m) long by 100 feet (30.5 m) wide, was constructed in the bed of the river at the toe of the wall, with a depth of water in the basin of about 10 feet (3.1 m). The concrete filling of the foundations was carried up to bed level on the up-stream face, but on the lower side the mass filling was stopped 18 feet (5.5 m) below bed-level and the parabolic section of the weir wall proper was begun. The granite beds under the foundations were deeply chased in longitudinal rows about 6 feet (1.8 m) wide and 3 feet (0.9 m) deep, and the toe of the wall-batter where it met the granite floor was channelled the whole length in order to key in the concrete foundations.[28]

The reservoir is provided with two valve-towers constructed of concrete. The inner tower is situated on the reservoir side of the weir and was built into and concurrently with the main wall.

25 Strickland 1986: p.19

26 Strickland 1986: p.20

27 Strickland 1986: p.20

28 Strickland 1986: p.21

The inner valve-tower has provision for drawing water from the reservoir by means of cast-iron bell-mouthed pipes passing through the valve-tower wall into a cast-iron stand-post, at three different levels: 25 ½ feet (7.7m), 53 feet (16.2 m), and 80 feet (24.4 m) below full supply level.[29] The outer valve-tower is situated 175 feet (53.3 m) down stream from the centre of the weir-wall, being connected to the reservoir by a viaduct which carries the outlet and scour-pipes.

The excavations for the foundations were begun in May. 1898 and completed by January 1900, with the building of the reservoir wall being completed in June 1902.

The Pipeline

The pipeline as originally constructed runs approximately 566 km from the reservoir at Mundaring to the Yilgarn district, terminating in holding reservoirs at Coolgardie and Kalgoorlie. It was designed to follow as closely as practicable the railway line which reached Kalgoorlie in early 1897. From Northam eastward the pipes were laid parallel with the railway at a distance of 45 feet (13.7 m). This meant that pipes could be unloaded from rail trucks near to where they were required on the pipeline, an activity that had to be carried out quickly so as not to disrupt normal rail traffic. Another great advantage was the subsequent easy supply of water to the railway. The pipeline deviated from the railway between the weir at Mundaring and Northam in order to shorten the distance, and also for the purpose of traversing higher country and reducing the pressure on the pipe. Where the pipeline deviated from the rail line the pipes were unloaded at a siding and distributed using horse drawn wagons. The telephone was new technology and Perth only opened its first exchange in 1887, but a special telephone line was laid between the PWD Head Office in Perth and Kalgoorlie via each of the pumping stations. This was found to be extremely useful during construction and was retained as an on-going operational facility.[30]

The English Commission of Engineers recommended that pipe for the line between Mundaring and the goldfields should be of steel throughout, supported above ground on concrete bolsters, and riveted up in lengths of about 110 feet (33.52 metres) with expansion-joints at these intervals and anchor joints midway. The pipes were to be fixed to the bolsters in order to prevent the pipes from creeping. The Commissioners were of the view that there were possibly alkaline salts in the soil of a large part of the district through which the pipeline would pass, and for this reason they recommended that the pipes should be laid above ground, uncovered, and with expansion-joints. Additional considerations were to avoid pressure on the empty pipes, to save the expense of trenching, and to facilitate detection and suppression of leakage from the pipes.[31] The minimum thickness was fixed at 5/16 inch to give an allowance for corrosion, and the pipes were to be longitudinally riveted where the pressure could have been

29 Strickland 1986: pp.21-2

30 Trust News 2000: Vol 208

31 Strickland 1986: p.26

accommodated by pipe of a lesser thickness of 1/4 inch, and welded for all higher pressures.[32] Tenders for the stipulated pipes for delivery in the Colony at a point 22 miles (35.4 kilometres) inland were invited from manufacturers in Australia, Europe, and America. Tenderers were invited at the same time to submit alternative prices for other types of steel pipe.[33]

The first tenders received were for riveted, welded, and/or locking bar pipes, as follows:[34]

Class of Pipe	Lowest tenders received in Europe	Lowest tenders received in Australia
Riveted pipe	£782,708	£682,827
Welded Pipe	£472,600	
Locking bar pipe		£239,868

The locking-bar pipe, invented by the Australian, Mephan Ferguson, had been considered by the English Commission of Engineers and favourably commented on. They were not recommended for so large a scheme, however, because proof of their successful manufacture and use on any considerable scale was not at that time available.[35] Subsequently, and before receipt of the tenders, 10 miles of main 25 ½ inches in diameter had been laid in South Australia. It had been found that these pipes made from 1/4 inch plate and fresh from the closing machine would withstand a pressure of 400 lbs. per square inch without weeping - nearly twice what had be stipulated by the English Commission of Engineers for the Goldfields pipeline scheme.[36] Moreover, all pipes which did not stand this test could be passed back through the closing-machine to be reclosed, instead of being subjected to the usual caulking-processes which were necessary with riveted pipes and which had always been found to be injurious to their plates and jointings. Practical use on a fair length of main also showed that the joining of the sections of locking-bar pipes could be successfully accomplished. As a result, the question of comparative cost and usefulness became the determining factor in deciding whether the new locking-bar pipe should be used in place of welded and riveted pipes.[37]

When the Australian price for locking-bar pipes was contrasted with that for welded pipes the savings were found to be almost 50 per cent. Additionally, the price of locking-bar pipes was but little more than that for the same quantity of riveted pipes. The lowest tenderers were asked to consider the matter again, and they quoted prices for the locking-bar pipes which contrasted as follows with those received for the riveted pipes: [38]

32 Strickland 1986: p.26
33 Strickland 1986: p.26
34 Strickland 1986: p.27
35 Strickland 1986: p.27
36 Strickland 1986: p.27
37 Strickland 1986: p.27
38 Strickland 1986: p.28

Thickness of steel pipe wall	Riveted pipe per foot	Locking bar pipe per foot
3/16 inch	£12.12.09	£13.10.00
1/4 inch	£16.05.00	£16.15.00
5/16 inch	£20.03.06	£21.00.00

Moreover, it was found that the locking bar pipes could sustain a considerably greater safe head of pressure for each of the three thicknesses of pipe wall than comparable riveted pipe, enabling further economies to be made by utilising pipes with a thinner wall section.

As a result of the favourably low tenders for locking bar pipe, it was decided that 30 inch pipe with a minimum thickness of 1/4 inch could be provided throughout the whole of the pipeline, rather than the 5/16 inch thickness originally specified by the Commission of English engineers. By having one thickness and one diameter throughout, the tenderers were able to make further reductions in the cost per pipe. Locking bar pipes also reduced considerably the drag caused by the friction of water in riveted pipe flowing over the heads of the rivets protruding through the wall and into the interior of the pipe. The use of uniform pipe and the lessening of the friction drag of the water also had the effect of enabling savings in the capital cost of the pumps as well as in the cost of pumping.[39]

As the adoption of locking-bar pipes obviated the anticipated continuous loss of water from pipes having a multitude of rivet-holes, the potential advantage of whether the pipes could be trenched underground was considered. Careful analysis of the soils along the pipe-track showed that these ancient soils had been leached of many of their harmful salts and acidic properties. Although the recommendation of the Commission of English engineers had been for the pipeline to be laid above ground on bolsters, it was decided that only where the pipes traversed salt pans should they be laid on timber trestles. In the remainder of the line it was decided that the pipes should be buried, which had the advantage of stabilising temperature fluctuation and resultant expansion and contraction of the pipes, obviating the necessity for expansion-joints, and permitting the use of ordinary lead jointing at the joins.[40] Another advantage of trenching the pipes was that it allowed a coating comprised of one part of Trinidad asphaltum and one part of coal tar to be applied both inside and outside each pipe, thus providing the steel with further protection from any corrosive action in the soil. It had originally been found that with pipes laid above ground, the fierce heat of the goldfields summer caused the mixture to melt and run off the pipes, while the frosts of winter caused it to crack and flake off.[41]

Manufacture of the pipes

The locking-bar pipe was invented in Australia by Mephan Ferguson. Born on 25 July 1843 at Falkirk, Scotland, he arrived in Melbourne with his parents in 1854. Ferguson owed his early

39 Strickland 1986: pp.28-9

40 Strickland 1986: p.28

41 Strickland 1986: p.29

success to his entrepreneurial and technical skills and to the Victorian government's protectionist policy of awarding contracts to colonial firms. By 1885 he was well established and in that year, Alfred Deakin returned from California and decided that wrought-iron pipes should replace cast-iron in the Melbourne water supply. Ferguson acted promptly. He won government contracts for the supply of wrought-iron piping, and bought the Glasgow Iron Works in West Melbourne where he established a new factory and testing works. He also imported the latest hydraulic machinery and designed a plant said to match any in the world. He continually experimented with wrought-iron pipes, and perfected straight-riveted, longitudinal and transverse seams and pipes with spiral seams. Seventy miles (113 km) of this lighter piping was used in the Melbourne water supply by 1909, while Ferguson also supplied the pipes for many of the Victorian Water Trusts, the Chaffey brothers' irrigation scheme and similar ventures in New Zealand, Ceylon and Malaya.[42]

Late one night in 1896, Ferguson was sitting at his desk with his son beside him. He opened a drawer and observed the dovetail joints. He hit on the idea of using a similar joint in steel. Producing a piece of lead he made a model of a lock bar joint in a few minutes. In the morning a joint was made in steel at the works and, when tested, proved to be 100% efficient. Ferguson quickly patented the process, and planned a production line suitable for the mass production of pipes.[43]

Under the new process, a pipe consisted of two plates, each of the full length of the pipe and each bent to a semicircle. Steel was delivered to one end of the works and passed from one machine to another, until a pipe came off the production line at the other end of the works, was tested under water pressure, and then dipped in the molten asphalt protective mixture[44].

In the first machine the steel plate was passed through straightening rollers for the purpose of taking out all kinks and rendering the plates perfectly straight. They were then cut square and to the exact length of 28 feet (8.5 m). The second machine was the planer, consisting of nearly 100 tonnes of castings and components. The base was like a huge lathe bed and the sections of this bed had to be replaced for pipes of different diameter. The plate was clamped on to the top of the bed and a saddle moved along the bed. The saddle carried cutting knives which machined the edges of the plate, producing straight edges of the exact width required. After the knives had passed, rollers chamfered the edges of the plate to produce an edge similar to the 'dove tail' in a wooden joint.[45] After the rollers passed, the edges of the plate were ready to fit into the lock bar. Each plate then went to the plate bending rolls, which were nearly 10 metres long, and which bent the plate into a semi-circular half pipe. Roller supports were provided above the top roll to prevent its deflection, and ensure the correct radius in the finished product. The chamfered edges of two half pipes were fitted into two locking bars. The

42 ADB 'Mephan Ferguson'

43 Ferguson 1992: p.19

44 Ferguson 1992: p.20

45 Ferguson 1992: p.20

closing machine which then pressed the locking bars closed over the chamfered edges of the plates was a hydraulic press. A cantilever, as long as the pipes, supported the dies inside the pipe. An hydraulic cylinder, which produced a force equivalent to a weight of 1,200 tonnes, squeezed the metal of the locking bars closed over the chamfers in the edge of the plates and a length of the joint was made. The whole process was done "cold".[46]

The clamps could then be removed and the completed pipe moved to the testing machine. The testing machine consisted of cast iron seals which fitted on to the ends of the pipe. Tension bars ran the length of the pipe to hold these seals tightly. The pipe was then filled with water and the water pressure increased to the specified amount. If there was any weeping of water from the locking bar at either side joint the pipe was returned to the closing machine for a second pass. Finally, the pipe would be dipped in molten asphalt mixture[47].

The joining of pipes in the field required some innovation, and Ferguson took out and abandoned patents on a number of alternatives. The joint eventually developed by Ferguson could be mass produced and withstand a head of 140m of water. The pipes were butted together and a steel ring or "thimble" was fitted around the joint. This ring was made from rolled steel segments forced out radially by a steam press until the ring was of the required diameter. Two of the segments were specially shaped so that cavities were created at two places on opposite sides of the ring into which the locking bars of the pipe would fit. There was a 6mm clearance between the ring and the pipe, including around the lock bars. A mould was placed around the whole joint and molten lead poured into the space between the pipe and the ring. After solidification the lead was caulked (hammered into the space between the ring and the pipes) and a sealed water pressure proof joint was achieved.[48]

As the whole length of main was of uniform diameter the possibility of using machinery in place of hand-caulking of the lead joint was considered at an early stage. Initially, however, the caulking was done by hand but this proved to be a major bottleneck in the progress of construction. In 1899 a Victorian engineer named James Couston developed a machine for caulking the joints. The machine was clamped around the steel collar at the join in the pipes and after the molten lead had been poured in an electric motor was engaged to drive a series of hammers around the joint to make a tight seal. Not only did it prove to be quicker, but it also did a better job than hand caulking[49]. Careful trial of joints caulked by hand and by machine demonstrated that the machine made joints remained water tight when subjected to hydraulic pressure of 400 lbs per square inch. In the hand caulked joints, on the other hand, slight sweats and pin-squirts manifested themselves when the joints were submitted to the same hydraulic pressure.[50] In comparison with hand caulking, machine caulking proved so

46 Ferguson 1992: p.21

47 Ferguson 1992: p.22

48 Ferguson 1992: p.23

49 Trust News 2000: Vol 207

50 Strickland 1986: p.33

effective that the WA PWD purchased the patent rights from Couston and built twelve of the machines for use on the Goldfields Water Supply Scheme.[51]

At intervals of about 5 miles stop-valves were inserted, and where long rising gradients occurred reflux-valves were placed. The stop-valves were actuated by slow motion gearing and where the water hammer was likely to be considerable, small by-passes were introduced in order to bring the water to rest very slowly. Glenfield pattern air-valves were placed where the pipe passed over all summits, a nest of three being placed at the highest points, a nest of two at intermediate points, and a single valve at the lowest points. These valves enabled the escape of air when charging the main, and also enabled air accumulating in the pipe during normal pumping operations to be automatically discharged.[52]

The pumping stations and holding reservoirs

Given the remoteness of the region through which the pipeline would pass, it was recognised that all pumping machinery should be of a uniform size and pattern, and that there be a standby pumping set available at each station.

The pumps needed to lift the water to a height which equalled the highest point between each station, and also had to overcome the frictional resistance caused by the water moving through the pipes. Across all eight pumping stations there was a total vertical lift of water of 832 metres. The eight stations were positioned so that the first four stations pumped against a head of between 110 and 126 metres, while the last four stations pumped against a head of between 55 and 64 metres.[53] To achieve this the first four stations were equipped with three identical pumping sets. Any two of these sets when operating together could lift the water to the required head height, leaving one set as a standby. At stations five to eight, two pumping sets were provided as one set only was needed to lift water the required head height, again with a standby set. A total of twenty pumping sets were required, of which only twelve would be working at any one time.[54]

Tenders for the twenty pumping sets were advertised in Europe and the USA in July 1899 There were difficulties in obtaining satisfactory tenders, mainly due to the abundance of work worldwide. It was not until March 1900 that a contract was awarded to the British firm of James Simpson and Company for the supply and installation of twenty Worthington type pumping sets complete with Babcock and Wilcox boilers at an aggregate cost of £242,750. Delivery was to commence in July 1901 and installation to be completed by June 1902.[55]

At six of the pumping stations, concrete lined holding tanks were constructed adjacent to the pump house. Water was pumped in to the holding tank through the previous stage of the

51 Trust News 2000: Vol 207

52 Strickland 1986: p.30

53 Trust 2000. Vol 208

54 Trust 2000: Vol 208

55 Trust 2000. Vol 208

pipeline and was drawn from these tanks by the pumphouse for transmission through the next stage of pipeline to the holding tank at the next pumping station. The exceptions were at Station No.1 which drew water directly from Mundaring Weir (Dam), and Station No. 3 where use was made of a nearby 10 million gallon capacity reservoir that had originally been constructed for the railway.[56] Just after Station No.2 the pipeline crossed a high ridge, and the Station pumped the water for 37 kilometres with a net lift of 104 metres to a high level regulating tank at Bakers Hill. The water then flowed under the force of gravity to another regulating tank at West Northam and then to the holding tank at the pumping station at Cunderdin. Similarly, the No.8 pumping station pumped the water for 19 kilometres through a head of 56 metres to the main distribution tank at Bullabulling where the water was fed by gravity to the Toorak Hill reservoir at Coolgardie and eventually through to the Mt Charlotte Reservoir at Kalgoorlie.[57]

The pump stations themselves were substantial buildings of red brick with corrugated iron roofs supported on steel trusses.[58] The eight buildings were substantially the same design, with two rooms connected by a passageway. One room contained the steam boilers which provided the motive power to the pumps, which were contained in the other room. The chimney stacks were of steel 1.5 metres in diameter and ranging from 27 to 40 metres in height. The two at Mundaring and Cunderdin were later replaced by brick stacks. Six of these buildings remain today. Nearby to each pumphouse it was necessary to house the operational staff and their families, and small settlements of houses, schools and sporting facilities gradually grew up.[59]

Initially the boilers were to be fired using coal from the government coalmine at Collie, at an estimated cost of 32 shillings per ton.[60] Although a 1,000 ton sample had been raised from the mine in 1893 for testing, it was not until 1899 that the first successful commercial production of Collie coal commenced. However, Collie coal was of poor quality, and in relation to its heating value per ton proved to be a high cost option. As soon as it became obvious that the far cheaper locally cut firewood was more efficient, coal was abandoned in favour of wood and the scheme's pumps operated on coal for less than a year[61]. Enormous quantities of wood were utilised from the countryside surrounding each pumping station. Wood-cutters were paid on the basis of weight and weighbridges were established at each station to weigh consignments. Special railway sidings lead to raised trestles covered by a corrugated iron and steel lean-to beside each station to facilitate the delivery of wood. Over the period of steam driven pumping at each of the stations, increasingly large areas were denuded of timber to feed the boilers and even today the effects of this are noticeable around some of the stations.

56 Trust 2000. Vol 208
57 Trust 2000. Vol 208
58 Foxley 2008
59 Trust 2000. Vol 208
60 Hartley 2000: p.731
61 Hartley 2000: p.732

Installation of the pipeline and completion

Once the decision was made to bury the pipeline, trenching was commenced along the route. The surface formation of the country traversed was very irregular. On the plains, ironstone conglomerate predominated but never extended continuously for more than a short distance, being broken by bands of sand, diorite, and granite. In the timbered belts sandy clay was the usual surface soil, but with outcrops of granite, diorite, and schist.[62] It was found that the most economical depth of trench was about a metre in depth, and the bulk of the material was taken out of the trench by manual labour. It was necessary, however, to use explosives to remove material on more than one-fourth of the total trench line. The excavation of the trench was kept well ahead of pipe-distribution, laying and jointing, in order to provide continuous work for the gangs involved in these later operations.[63]

The pipelaying work was divided into sections of about 14 miles each. Each stretch was worked on by one caulking team, and when the work was completed the whole gang went forward to the next available section. When the works were brought into full swing, seven such gangs were at work on several sections. As the work performed by each gang was identical, there was considerable rivalry between the parties. Bad work due to haste was prevented, however, by the appointment of an inspector on each section, who reported directly to the head office and was responsible only for the quality and not for the cost of the work. The rate of progress of the seven gangs when they were at their most experienced during the last 3 months before the completion of the pipeline and the disbanding of the gangs, was 1 and 2/5 miles of laying, jointing, and complete in-filling of trenches per eight hour working-day.[64]

By the 13th April 1902, the works were sufficiently far advanced to enable pumping to be commenced with one of the engines at No. 1 station. No trouble was experienced in getting the engines underway and by the 22nd April the water had reached the Cunderdin Reservoir, at mile 77. Four months now elapsed before the laying and jointing of the next section was completed, and it was not till the 22nd August 1902 that the water reached the Merredin receiving tank at mile 140. Some trouble was experienced in charging this section, through the joints leaking due mostly to the subsidence of the pipes laid across soft ground in the bed of the Mortlock River. The water reached the Coolgardie service reservoir at mile 328 on the 22nd December 1902, and finally the Kalgoorlie service reservoir on the 16th January 1903, about 8 months after the charging of the main was started.[65] The pumping was restricted to an amount sufficient to fill about 12 to 15 miles of main per day, and at this rate no trouble was experienced from air-pocketing. It was found that at this charging rate the Glenfield pattern air-valves had sufficient discharge capacity to pass the volume of displaced air.[66]

62 Strickland 1986: p.34

63 Strickland 1986: p.35

64 Strickland 1986: p.35

65 Strickland 1986: p.37

66 Strickland 1986: p.37

The original scheme did not allow for any reticulation of water to townships for domestic purposes, or to mining centres. It was originally intended to bring the water to Mount Burgess a few miles north of Coolgardie, from where the local-government authority would then lay a subsidiary main to its own service reservoir for each township or mining centre. Eventually, however, the complete reticulation of the townships of Kalgoorlie, Coolgardie, Boulder, and the Kalgoorlie Mining Belt, had to be undertaken as part of the main scheme.[67]

The pipeline was completed in early 1903, and the scheme was officially opened by Sir John Forrest at the Mount Charlotte Reservoir in Kalgoorlie on 24 January 1903. The total actual cost of the water supply pipeline, including all extras, contingencies, and establishment charges was £2,660,000, an excess of only £225,000 on the original estimate.[68]

Patriotic sentiment and nation building

Sir John Forrest was committed to the development of Western Australia as a self supporting and viable colony. Western Australia had recorded a very low population growth rate in its early days of free settlement. For Forrest the transition of Western Australia from a frontier to settled society was to be undertaken by the building of substantial infrastructure projects such as ports, harbours and railways. Water supply was one of the fundamental and recurrent issues in the establishment of human settlement across Australia[69], but one which was particularly pertinent in the drier west of the continent. The discovery of gold and the establishment of the 'golden mile' as outlined above, was an important catalyst in the development of the colony, its role as a state and its contribution to nation building. The value of gold for Coolgardie, and more broadly Western Australia, was multi faceted. The wealth it created was the most immediate, but long term it attracted a mass increase in population[70], which had been experienced earlier in the gold rushes to the eastern states. For the Western Australian Government it provided a much needed boost to prosperity and revenue in terms of mining taxes and leases. During the late nineteenth and early twentieth century patriotic sentiment was 'specifically tied to a politically constituted state and the geographic territory over which that state exercises sovereignty'.[71] Major infrastructure projects are closely aligned with the patriotic sentiment which contributed to nation building, particularly during the federation period of 1890-1915. Completion of public works such as the Goldfields Water Supply Scheme represent a stage of national maturity. The development of the Goldfields Water Supply Scheme is an important part of the history of how Western Australia entered into federation.

O'Keefe and Pearson[72] identified Coolgardie as an important place, linked to an event, in the federation story. In 1899 the Eastern Goldfields Reform League formed to promote Goldfields

67 Strickland 1986: p.42

68 Strickland 1986: p.43

69 Cathcart 2008

70 For statistics see Appleyard 1981: p. 220

71 O'Keefe and Pearson 1998: p.2

72 O'Keefe and Pearson 1998: p. 81

separation and federation. Many of the gold diggers were from the eastern colonies and the majority, supportive of the federation movement.[73] Highly critically of the Forrest Government, including the time taken to deliver a reliable water source, the diggers proposed to separate the eastern goldfields from Western Australia. Forrest was concerned about the implications for Western Australia should it become part of the new proposed Commonwealth of Australia. Clark[74] notes that Forrest …'was plagued with anxiety about goldfields radicalism and about government revenues after the loss of the right to impose customs, which in 1898 comprised nearly ninety percent of the revenue of the colony.' So he bargained. The Commonwealth was to facilitate the building of the railway from Kalgoorlie to Port Augusta and the eastern states would continue to pay the levy. At the referendum in 1900 forty six percent voted yes, the highest in all the colonies.[75] These large scale infrastructure projects were important in furthering the relationships between the eastern and western states. Forrest used the opening of the original Coolgardie Goldfields Water Supply, to further other nation building endeavours with the newly formed Commonwealth Government.[76]

Impact on the environment

Large increases in the population of the Coolgardie region with the discovery of gold had a dramatic impact on the arid environs. Water shortages and outbreaks of typhoid provided the impetus for a water supply scheme to be built. To construct the scheme it was necessary to clear large areas to accommodate the pipeline and provide ongoing access for maintenance. Clearing also occurred at most of the pump station and tank sites. One of the largest-scale clearings was that at Mundaring Weir (Dam) where Hartley[77] estimates that 20,000 acres (8,093 ha) of the catchment were ring-barked to improve the run off rate of water into the reservoir. This practise impacted on the quality of the water and by 1910 there was a notable increase in the salinity levels. Railway water supply engineers were not surprised, as the water had become excessively saline for use in the locomotive boilers.[78] The Pump Stations were originally designed to be powered by coal. However, in less than a year the pump stations were burning timber. The preferred source was locally available Jarrah or red gum (Marri) at Pump Stations 1, 2 and 3. From Stations No 3 and onwards species such as Salmon gum and gimlets were sourced locally.[79] This ongoing need for fuel resulted in a local lucrative fire wood trade being established in the areas surrounding the pump stations. Land clearing around Mundaring Weir ceased in 1918 and the area allowed to revegetate naturally.[80]

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73 Bastin 1955: p.76
74 Clark 1986: p. 167
75 Clark 1986: p. 168
76 Lowe 2001: p. 96
77 Hartley 2007: p.340
78 Hartley 2007: p.203
79 Hartley 2007
80 Hartley 2007: p.207

With the opening up of the areas for agriculture, land clearing continued. It is estimated that 'Today less than 5% of the natural vegetation remains'.[81] In addition WA has lost 10% of the Wheatbelt to scourge.[82] Soil salinity and the raising of saline water tables are impacting on approximately 30 towns in the Wheatbelt.[83]

Subsequent operation and expansion

Early operational experience with the pipeline was dominated by problems of corrosion. External corrosion began to appear as early as March 1905 and internal corrosion about three years later. Initially it seemed internal corrosion posed the greater threat, because it was substantially increasing the friction head which in turn placed extra load on the pumping stations. The first attempt to counter the problem of internal corrosion was to add lime to the water, and a plant for this purpose was constructed at Pumping Station No l in 1910.[84] The lime treatment was not successful and in 1917 it was replaced by de-aeration treatment which removed dissolved oxygen from the water. A plant for this purpose was installed, again at Pumping Station No 1. This system of de-oxygenation bought the internal corrosion under control.

In the meantime the problem of external corrosion increased rapidly with more than 4,000 rust holes being repaired in 1921. This number had doubled by 1928 and the wastage of water was by then an issue of major concern.[85] In the late 1920s two engineers, Norman Fernie and Reg Keating, from the Northam District Office of the PWD commenced a thorough investigation of the external corrosion problem in the locking bar pipes. Fernie and Keating could see no practical alternative other than to lift the pipeline and re-lay it above ground. This operation was a major technical development which was widely copied elsewhere. It placed the Goldfields Water Supply Scheme among the world leaders in pipeline technology for the second time in less than 40 years.[86]

By 1930 it was becoming widely recognised throughout the water industry that a relatively thin lining of cement mortar applied in the factory by a centrifugal spinning process would effectively eliminate internal corrosion. The locking bar pipes presented difficulties for the centrifugal spinning process, however experiments in the field enabled the development of a satisfactory process whereby a lining of sand cement mortar could be applied to the interior of the pipes during the raising and re-laying process. The reconditioning of the buried pipeline commenced in 1933 with priority being given to the sections where external corrosion was

81 National Trust WA 2000: p.28
82 Lowe 2001: p. 99
83 Lowe 2001: p. 99
84 Trust News 2001: Vol 210 p.8
85 Trust News 2001: Vol 210 p.8
86 Trust News 2001: Vol 210 p.9

most severe. By the time the work was halted in 1941 (due to labour shortages caused by World War II the major problem of leakages had been brought under control.[87]

The refurbishing of the pipeline in 1933 included a new method of lifting the pipeline out of the ground and relaying it above ground. The method involved lifting the pipes out of the ground, trimming-off the corroded end sections of the pipes, and replacing the flexible lead joints with rigid welded joints forming what was known as a 'continuously welded pipeline'. The outside of the pipe was recoated and painted with a sun-reflecting paint. During the pipeline reconstruction, the expansion forces were directed into reinforced concrete anchor blocks built over the pipe at 50 metre intervals, which prevented movement and transferred these forces into the ground. Although today such anchor blocks are familiar features of all above ground pipelines in Australia this was the first time anywhere in the world that pipe anchorages of this type had been used to permit such a large diameter pipeline to be laid above ground in such adverse conditions.[88]

The 1930s refurbishment of the pipeline also involved another innovation, the large scale use of wood stave pipes. During the depression of the 1930s, steel was in short supply and sections of the pipeline were in need of repair. It was decided that timber stave pipes would provide a viable alternative given the lack of steel. Orgeon timber had been used previously in a 33 chain (0.66 kilometres) long by-pass of the Coolgardie Reservoir in 1912.[89] Between 1933 and 1937 a distance of 39 miles 30 chains of wooden stave pipes, in fluorised Karri (some were later replaced by Jarrah), were a laid between Kellerbin and Kalgoorlie. Hartley[90] reports that it was '...laid in a series of above ground diversions to the main conduit so that the 30 in locking bar pipes which they replaced could be refurbished and relaid above ground in other sections of the main conduit as part of the continuously welded pipeline'. It was the most extensive use of wooden pipes in Australia at the time in a country water supply scheme.[91]

In his report of l7 July 1896, O'Connor had stressed the importance of the pipeline for the development of agriculture, and soon after the scheme became operational water services were provided to properties adjoining the pipeline. In 1907 a branch main was constructed to serve farmlands north of Tammin and this demonstrated the value to farmers of an assured water supply for stock and domestic purposes. By 1910 it was obvious that the capacity of the Scheme was greater than was required on the goldfields and the Goldfields Water Supply Act was amended to allow farming properties to be rated for the purpose of supplying water for stock and domestic purposes.[92] By 1928 the total area of farmland being serviced had increased to approximately 1 million acres (404,685 hectares). The pipeline was now operating

87 Trust News 2001: Vol 210 p.9

88 Hartley 2000: p.736-7

89 Hartley 2007: p. 246

90 Hartley 2007: p. 247

91 Hartley 2007: p. 246-247

92 Trust News 2001: Vol 210 p.9

to full capacity and the area of rated farmland had to be held at this size until after World War II.[93]

In 1948 the Commonwealth Government agreed to provide financial support to Western Australia for construction of a Comprehensive Agricultural Areas Water Supply Scheme. The northern section of this scheme was based on the existing Goldfields Water Supply system and provided for a reticulated water supply to towns and farmlands over an area of 4 million acres (1,618,742.5 hectares) as far north as Koorda and Bencubbin.[94]

In 1951 increased storage was provided by raising the wall of Mundaring Weir by 32 feet (10 m) which trebled the Weir's holding capacity. The enlargement of the dam wall involved the placing of 80,000 cubic yards (61,164 cu metres) of concrete and cost £720,000.[95] The line of the vertical upstream face of the wall was not altered, however, the wall was thickened by some 40 feet (12 m) at the base and a new sloping downstream face was created. The heritage value of Weir was recognised, and accordingly great care was taken to reproduce the style from the Victorian period that had characterised the appearance of the original structure. The original footwalk across the crest of the weir was salvaged and reused, and the control tower in the centre of the wall was faithfully reconstructed to the same design as the original.[96]

A substantial upgrade of the original 30 inch (76 cm) pipe line was also undertaken and the original steam pumping stations were replaced with high powered electric pumps. Branch mains were laid north and south from the main pipeline, to reservoirs which were constructed on highest points in the area. From these tanks water was distributed to the surrounding areas by gravity.[97] A ceremony to mark the completion of the Comprehensive Water Supply Scheme was held on 24th November 1961. However, these mains were subsequently extended to the townships of Dalwallinu, Pithara, Ballidu and Corrigin. Later again, four small areas of northern farmlands were included at Kalannie. North Koorda, north Bencubbin and Wilgayne. All work on the Comprehensive Water Supply Scheme was finally completed in 1974.[98]

Today the Pipeline is operated by the WA Water Corporation. It is the Corporation's largest asset and the basis of billions of dollars of annual economic activity. Approximately 10,000 services are provided within the agricultural area and the eastern goldfields through 8,000 km of pipelines and over 40 pumping stations[99]

Indigenous Association

The Goldfields Water Supply Scheme extends from Mundaring to Kalgoorlie in Western Australia, and traverses the traditional lands of Aboriginal people who identify themselves as

93 Trust News 2001: Vol 210 p.9
94 Trust News 2001: Vol 210 p.11
95 Trust News 2001: Vol 210 p.12
96 Trust News 2001: Vol 210 p.12
97 Trust News 2001: Vol 210 p.11
98 Trust News 2001: Vol 210 p.11
99 MHI 2008

Noongar (also referred to as Bibbulmun by Bates in 1904), Ballaruk, Ballardong, Gubrun, Kalamaia Kubun, and Widji.[100] Noongar was the Bibbulmun word for man.[101]

Aboriginal occupation in the south-west of Western Australia dates to 47,000 years BP (before present) at the Devils Lair rock shelter[102]. Other sites in the south-west with early occupation dates include the Upper Swan, (38,000 years BP) and a Helena River site above Mundaring Weir, (29,400 years BP). The Helena River provides evidence of continual use to the present day with seasonal camps and a permanent camp site.[103] There is also evidence of artefact manufacture occurring in the Mundaring Dam area 4,000 -1,000 years BP.[104]

The Western Australian Department of Indigenous Affairs identifies numerous Aboriginal sites in close proximity to the Goldfields Water Supply Scheme pipeline[105]. The highest densities of sites occur at the beginning of the pipeline at Mundaring Dam and Helena River, at Northam, about eighty kilometres from Mundaring, and at Coolgardie and Kalgoorlie at the end of the pipeline. As a result of environmental disturbances associated with the building of the pipeline and earlier infrastructure, many Aboriginal sites have been disturbed. The greatest environmental impact occurred at the beginning of the pipeline, at the Mundaring Dam.

Many sites along the pipeline are of ongoing significance to Aboriginal people who visit them regularly today. Aboriginal sites identified on the pipeline include corroboree grounds and soaks associated with trade routes, wells, granite outcrops, birthing rocks on the Avon River at Northam, cave and rock paintings near Kellerberrin and a number of secret/sacred sites.[106] Webb notes concerns that few of the water sources on Hunts Track have been recorded as Aboriginal sites, and more generally, with the accuracy of site locations and the lack of a systematic archaeological survey of Noongar Aboriginal sites and complexes; including rock art sites.[107]

The West Australian Government employed Daisy Bates to research the Aboriginal tribes of the state. Bates' research was used as evidence in the Single Noongar Native Title application of 2006 to verify they were originally one group.

"Bates' material comprises the largest available corpus of information dealing with the Aborigines of the Perth region obtained at least partly from people who were alive in the early years of European settlement … the first really serious ethnography for any part of the south-west… The cumulative effect of these writings is to provide an insight into Aboriginal life,

100 National Native Title Tribunal 2009

101 Bates 1985

102 Dortch 2001

103 Schwede1983

104 Villiers 2007

105 DIA 2009

106 The National Trust 2001

107 Webb 2004

including Aboriginal laws and customs, in and about the date of settlement, which is possibly not replicated elsewhere in Australia."[108]

At the time of building the pipeline, two Aboriginal groups inhabited the three hundred and thirty miles it traversed. The Bibbulmun lived on the west coast, from Jurien Bay to Perth and Esperance and west as far as Kellerberrin. The Karatjibbin occupied land from Mt Jackson in the north through the Southern Cross district including Kalgoorlie.[109] The border between the two groups divided the circumcised from the non-circumcised southwest, crossing the pipeline at around Mooranoppin/ Kellerberrin.

Trade existed between the two groups in tools, raw materials and women with adjustments to in-law relationships to accommodate the two groups.[110]

"They used to induce the Bibbulmun to give their boys for initiation though the circumcised group never gave any in return. …These young boys grew up and married in their adopted groups, and as young men, and later as fathers and grandfathers they returned to the Bibbulmun"[111]

Bates[112] recorded thirty to forty Bibbulmun living on the first Aboriginal reserve "…for old and infirm natives of the Southern district"[113] set up by Premier John Forrest in the 1890's. Maamba Reserve was a 100-acre fertile plateau on Bibbulmun land at the foot of the Darling Ranges, approximately twelve kilometres east of the Mundaring Dam and included a "splendid" spring and camping ground called Goojninup.[114]

Bates lived at the reserve for two years with the Bibbulmun who relied on government rations but lived a semi-traditional lifestyle. She recorded information from Joobaitch, an 80 year old Bibbulmun man who died on the reserve near his sacred Kaanya tree.[115]

"He had parted with the whole site of the present Mundaring Weir, and both sides of the Swan River from beyond Perth Guildford to Perth Water, for some special meat food which pleased him in his old age"[116]

Corroborees or kenings were held at Maamba, including one for Governor and Lady Bedford. The last Bibbulmun corroboree Bates recorded at Maamba was in 1910 and included men for Kellerberrin, Gingin, Victoria Plains, Southern Cross, Guildford and Bunbury.[117]

108 Indigenous Law Bulletin 2009
109 Bates 1985
110 Bates 1985
111 Bates 1929
112 Bates 1909
113 Bates 1909
114 Bates 1909
115 Bates 2004
116 Bates 1985: p.64
117 Bates 2004

At the head of the pipeline, the Mundaring area is a highly significant and sensitive mythological area. The Mundaring (Mundjalline) myth links the Helena River (Mandoon) east via Mundaring to the Swan River and west to York.[118] The most important totem was the snake Woggal, also known as Waugyl/Waugal.[119] The DIA listing of the Helena River "as a ceremonial and mythological site … is consistent with the significance attributed to all waterways as having been created and inhabited by the primary Ancestor beings associated with the Creative Era, in this case the Waugyl".[120] Bates details physical landscape features such as strewn rushes, lime and saltpans that denote the life cycle of the Woggal and associated sacred sites. [121] Villiers also notes the presence of the Woggal at Mundaring.[122]

> The swamp and pools know as Mundjalline according to tradition, were located in a deep valley that has been inundated as a result of the construction of the Mundaring Weir…A powerful Waugal associated with rainmaking lived here. Disturbance of the swamp reeds at Mundajalline resulted in cyclonic winds and rain…

Bates describes sites with reed disturbance as sacred Woggal camping places. She refers to a Helena River site called Beeragunning as a sacred (Janga) split rock, surrounded by reeds that Aboriginal people could walk through but became ill and died if they touched it or it closed up on them. A myth associated with another sacred stone marked with stick-like indentations at Dargain, in the Helena River area was also recorded by Bates.[123]

Aboriginal people and their water supply were impacted by several events prior to the building of the pipeline. These included diseases, explorers and the building of infrastructure prior to and during the gold rushes. Typhoid fever associated with poor sanitation, cramped conditions and lack of water was rife in Western Australia in the late 1800s.[124]

Access to water was essential for survival in the semi-arid zone of south-west West Australia. In relation to the expansion of European settlement Hallam notes[125]

> …water supplies dictated that European movement and settlement must follow Aboriginal movement and settlement in Western Australia also. Bidi and Gongan, zones of easiest and habitual movement between water sources, were as basic to European as to Aboriginal ecology... 'Native wells' and 'native paths' marked their regular progress through and around their own country.

Aboriginal people have rights to water in their territory. "Every Aboriginal knows the rocks, soaks, springs and anything that gives water on their hunting grounds".[126] Non-Aboriginal

118 Villiers 2007
119 Bates 1985
120 Villiers 2007: p.13
121 Bates 1985
122 Villiers 2007: p.17
123 Bates 1985
124 Wittington 1988
125 Hallam notes 1979: p.68

people were often unaware of traditional water sources until shown by Aboriginal people.[127] Aboriginal people disclosed their sources either willingly, through coercion or as a result of force, as detailed by one early gold explorer.

> Sorry as I was to be rude to a lady, I had to make her prisoner, but not without a deal of trouble… I felt myself justified, therefore, in unceremoniously making captives from what wandering tribes we might fall in with. And in light of after events I say unhesitatingly that, without having done so, and without having to a small extent used rough treatment to some natives so caught, we could not by any possibility have succeeded in crossing the desert, and should not only have lost our own lives, but possibly those of others who would have made search for us after.[128]

In the 1860s Charles Hunt, a government surveyor, modified traditional water sources to receive and store rainwater to supply seasonably reliable water to expand European settlement. In 1863, the Gnarlbine Soaks at Coolgardie were disclosed by Kowitch, an Aboriginal assistant to M H Lefroy's expedition, and were later incorporated into Hunts Track[129]. The Goldfields Pipeline followed the route of previously installed infrastructure including road, rail and telegraph which roughly followed Hunt's Track. Bates[130] also noted that "…most of the 'roads' of these tribes (including eastern goldfields) run 'erratically' east and west for a considerable distance, but not very far north and south".

The absence of artesian water sources and unacceptable salt levels in ground water meant traditional sources of Aboriginal water were co-opted to supply not only huge numbers of European settlers but horses, camels and industry. As populations grew, Aboriginal water sources and bore water condensers were insufficient to meet demand.

The preparation work for the six-mile long, 4.6 billion gallon Mundaring Dam began in June 1898. Three hundred men and their families living on site supplemented their food by fishing, kangaroo hunting and collecting wild honey, staples for the local Aboriginal people. Eight hundred acres of land was completely cleared with two hundred acres of the lower catchments ringbarked and the riverbed cleared and burnt. A thousand cubic metres of local sand was used in the weir wall.[131]

Fifty miles along the pipeline, the town of Northam became the manufacturing centre and food producer for the goldfields. Burlong Pool, a DIA registered mythological site and important Aboriginal water source, was turned into a camping ground for railway contractors, including their horses and camels.[132] The last recorded corroboree took place in 1899 at the Northam Government Well, which later became the Northam Aboriginal Reserve. At that time, the

126 Bates 1985: p.262

127 Bates 1913; Carnegie 1871

128 Carnegie 1871

129 Heritage Council of West Australia 2009

130 Bates 1909

131 Quicke 1978

132 Garden, 1979

desperate state of the local Aboriginals was documented. "The hundred who gathered on that occasion were near starving, and the children sick and miserable from want of food and clothing".[133] Northam was connected to the unfinished pipeline in 1902 due to a very hot summer and typhoid infected local water sources.

At Coolgardie towards the end of the pipeline, Aboriginal people were desperate for water and not receiving help from the local Council who saw it as a State government issue.[134] Deaths due to typhoid peaked in Coolgardie during 1896-7. Tickenbutt, an Aboriginal man also known as Fred McGill, wrote to the Kalgoorlie Miner newspaper complaining of the unavailability of water for independent Aboriginal people who could no longer get it from their traditional sources, as rations or from bore water condensers. Some people were more generous, one miner set up a small condenser for Aboriginal people who had helped his family.[135]

"The local Aboriginal contribution to the developments of the Goldfields cannot be ignored. It is well known that Aboriginal people led explorers and miners to both water and gold".[136] Carnegie exploring the area from Lake Darlôt to Halls Creek and return in 1896-97 was also assisted by Aboriginal people.

> Throughout our journey we never once found water by chance—though chance took us to more than one dry hole—but found it only by systematic and patient work, involving many scores of miles of tracking, the capture of the wild aboriginals, and endless hours of manual labour.[137]

It is unknown how many Aboriginal people worked on the pipeline or with associated contractors. A large part of the work for the pipeline was undertaken by the West Australian Public Works Department. Photographic evidence identifies an Aboriginal man working on the pipeline with a non-Aboriginal team.[138] Numerous photos portray Aboriginal people from Coolgardie and Kalgoorlie in a variety of roles including accompanying explorers and working, for example as a butcher, a miner and police assistant. These photos also depict Aboriginal people attending church-sponsored Christmas dinner and interactions with non-Aboriginal people including taking part in mainstream sporting events and processions in the townships.[139] [140]

Developments along the pipeline depleted Aboriginal people's traditional food and water sources through over use, carelessness or greed.[141] Aboriginal people chose or were forced to move into settlements including reserves. If they maintained their independence, they were

133 Garden 1979: p.56
134 Wittington 1988
135 Wittington 1988: p.63
136 Wyatt 2006
137 Carnegie 2009
138 National Trust 2001
139 Templeman and McDonald 1988
140 Wittington 1988
141 Wittington 1988, and Carnegie 1871

expected to purchase water from the pipeline,[142] be recompensed with water for services rendered or rely on the kindness of others.[143] As one Kalgoorlie resident commented:

> The blacks are in a bad way just now…It's a pity something can't be done to help them, water being so scarce just now, all the soaks and gnamma holes are just about dry…so you see the poor blacks are robbed of their water. It's cruel.[144]

3.3. Post Construction History of the Main Conduit

For the first 30 years of operation the main conduit of the GWSS was laid below ground. Tests had indicated that the newly invented locking bar pipes would be less susceptible to leakage than riveted pipes and could be buried with fewer issues than riveted pipes. Burying the pipeline would also reduce problems associated with thermal expansion, which was a common problem in above ground pipes. If locking bar pipes had not been used the pipe was to be laid above ground.[145]

The first 30 years of operation saw the number of pipeline bursts steadily increase, by in the 1930s the maintenance of the pipeline was becoming unsustainable, in 1933 the decision was made to excavate and reconstruct it above ground. The leak prone lead caulked ring joints were replaced with fully welded rigid joints, and insitu concrete anchor blocks managed thermal expansion forces in the pipeline.[146]

'Kellerberrin Pipes' are reconstructed locking bar pipes produced by the Electweld Steel Company under Frank Mather and his family. The processes used were devised by Mather in 1937, it involved new techniques to cut condemned locking bar pipes in half and weld usable halves together without the locking bar. The reconstructed pipes were 1¼ inch smaller in diameter than the original 30 inch locking bar pipes. Kellerberrin pipes were produced between 1938 and 1958.

MSCL pipes were first used in the GWSS in the 1920s and were originally produced by the Hume Pipe Company; these pipes were superior to locking bar pipes in quality, performance and price. Competition from Hume saw Ferguson's Maylands factory shut down in 1928, and no further locking bar pipes were produced for the GWSS.

In the early 1950s upgrades to the capacity of the main conduit were required to meet demand from lateral services to the Wheatbelt. The upgrades took place between Mundaring and Kellerberrin, and consisted of either a 30in (762mm) refurbished locking bar pipeline being added in parallel or the existing pipeline section being replaced with 36in (914mm) MSCL pipes.[147]

142 Templeman and McDonald 1988, Wittington 1988
143 Wittington 1988
144 Templeman and McDonald 1988: p.53
145 Hartley, *River of Steel*, 39
146 Hartley, *River of Steel*, p.234
147 Hartley, p.359

Today water services are typically delivered as below ground pipelines, which are more cost effective, safer, and secure to operate than above ground pipelines.[148] In 2013-2014 a 5.8km section of the main conduit near Meckering was duplicated below ground with 1000mm (40 inch) diameter MSCL, the remaining non-operational above ground locking bar and MSCL pipe was left in place. The policies set out in this HMP allow for this section of unused pipeline to be removed.

4. Place Description

4.1. Definition of place

This HMP covers the main conduit of the GWSS between Mundaring and Kalgoorlie, the place is considered as one linear site. This HMP does not cover physical structures other than the pipeline and its concrete anchor blocks, specific items excluded are: Mundaring Weir and its reservoir, the Mount Charlotte Reservoir, various tanks, modern or historic pump stations, and lateral additions to the pipeline. The excluded items are either not significant or have separate management plans. Parcels of land and curtilages have not been defined in this report by nature of the large amount of data required to represent them. Information on individual land parcels related to the conduit is available on from Western Australian statutory authority on land information, Landgate.

The following description of the whole *Goldfields Water Supply Scheme, Western Australia* is extracted from its entry in the Australian Heritage Database:

> The Goldfields Water Supply Scheme is a late 19th century/early 20th century inter-basin transfer water system which extends from Mundaring Weir (Dam) in the west (approximately 41.5 km east of Perth), to Mount Charlotte Reservoir at Kalgoorlie in the east. The Scheme stretches from the Darling Ranges across the arid interior of Western Australia, a total distance of some 560 kilometres. Included are:
>
> - the main reservoirs: Mundaring Weir (Dam) and Mount Charlotte Reservoir;
> - the main conduit of the pipeline (including all locking bar pipe, wood stave pipe and continuously welded pipe) which stretches 560km from Mundaring in the west to Kalgoorlie in the east;
> - the remaining six of the eight original pump stations (Nos 1, 3, 5, 6, 7 and 8) including remaining equipment;
> - the remaining four associated holding tanks (located at Steam Pump Stations Nos, 2, 4, 7 and 8); and,
> - the four regulating tanks located at Bakers Hill, West Northam; Bullabulling and Toorak Hill.

148 Daniel Stevens (Water Corporation), e-mail message to author, 30 March 2016.

4.2. Description of Main Conduit

The following description of the conduit is extracted from the place's entry in the Australian Heritage Database

> C. Y. O'Connor's 1903 pipeline is commonly referred to as the 'main conduit' of the Goldfields Water Supply Scheme and is approximately 560km in length[149]. It commences at Mundaring Weir and terminates at Mount Charlotte Reservoir. Much of the pipeline is aligned with the current Great Eastern Highway. The pipes were made of 30-inch diameter steel. Originally (1903) the pipeline was buried underground, however, refurbishment in the 1930s raised the pipeline and it now rests on reinforced concrete anchor blocks[150]. It is estimated that 60% of the pipeline is original.[151] Still in use today, the pipeline is in operating condition and continues to service the community.
>
> The pipeline is a visible icon stretching across Western Australia's arid interior. The pipeline consists of:
>
> - the length of the main conduit of the pipeline from Mundaring Weir (Dam) to Mount Charlotte Reservoir at Kalgoorlie;
> - the reinforced concrete anchor blocks;
> - caulked joints;
> - stop and reflux-valves; and
> - locking bar pipes.

Locking Bar Pipes

The locking bar pipe was invented in Australia by Mephan Ferguson in 1896, it consists of two steel plates, bent into semi circles and joined by two 'locking bars', which were closed by pressure. The secured ends of the steel plates are chamfered in a way that resembles a dovetail joint. The 30-inch locking bar pipes for the GWSS were manufactured from ¼ inch thick steel plates. The pipes were completely coated in asphalt to protect from corrosion.

The pipes were originally joined with a ring joint sealed with caulked lead. When the pipeline was raised in the 1930s these joints were cut out and the pipes were welded together. The present day locking bar pipes are cement lined, however originally only a coating of asphalt protected the insides of the pipes from corrosion, it was during the pipe raising in the 1930s that cement linings were applied insitu.[152]

[149] At the time of the National Heritage Listing (2011), now closer to 48% (2016).

[150] Research Institute for Cultural Heritage Curtin University, *Conservation Plan for Goldfields Water Supply Scheme. Vol I.*

[151] At the time of the National Heritage Listing (2011). The listing does not deal with later replacement works, which are part of the historic continuum.

[152] Hartley p.251

Kellerberrin Pipes

'Kellerberrin Pipes' are reconstructed locking bar pipes; they consist of two useable halves from condemned locking bar pipes that would be cut and welded together without the locking bar. This refurbishment process was devised by Frank Mather on his farm in Kellerberrin in 1937; he would go on to create the Electweld Steel Company, the only company to reconstruct pipes for the GWSS and did so from 1938 to 1958. With the locking bar removed Kellerberrin pipes were smaller with a diameter of 28¾ inch. These pipes were cement lined with a centrifugal process.

MSCL Pipes

Mild Steel Cement Lined pipes (MSCL) describe a variety of modern pipes suitable for transporting water. They are often stitched with longitudinal, lateral or spiral welds and are made of mild steel, a relatively malleable and ductile steel with low carbon composition. An interior cement lining is applied centrifugally to inhibit internal corrosion by preventing contact between the transported water and pipe steel.

Composition

In 2015, the main conduit was made up of 43.4% Locking Bar (1901-1920s) (280.0km), 4.6% Kellerberrin pipe (1938-1958) (29.5km), and 52% MSCL (335.0km) (1926-2016). 90.6% of the pipeline was above ground.[153]

4.3. Current Condition

The pipeline is operational and in good condition. It has been continuously upgraded and maintained since its inception pipes have been replaced or repaired as necessary. Older pipes have had patches welded in place to seal previous leaks. Much of the original locking bar pipe has been replaced over its lifetime in response to failures or to increase pipeline capacity.

4.4. Current situation

The Water Corporation own and manage the pipeline. Pump stations No 1 and No 8 are vested with NTWA, No 3 and No 4 jointed vesting with Shires of Cunderdin and Merredin respectively. The Golden Pipeline Project, managed by NTWA in conjunction with the Water Corporation, local communities, and key stakeholders, aims to conserve and interpret the history and heritage of the GWSS and bring tangible benefits to the community. The Golden Pipeline Heritage Trail is central to this program, the drive trail provides access to the heritage values of this National Heritage Listed place and to improve engagement with awareness of the values of the place was listed for.

The pipeline continues to supply agricultural areas through lateral extensions to the main conduit, the system, named the Goldfields and Agricultural Water Supply (G&AWS), consists of 7,800km of water supply pipeline.[154]

153 Water Corporation. "Goldfields and Agricultural Water Supply Main Conduit Pipe Age."

154 https://www.mediastatements.wa.gov.au/Pages/Barnett/2015/07/Improving-farmlands-water-supply-in-the-Wheatbelt.aspx

Place Description

Current and future demand will require further increases to the capacity of the pipeline. This HMP was commissioned to ensure that the heritage values of the pipeline are accessible and maintained as a whole as sections are replaced over time.

4.5. Photographs

Photograph 01 Locking bar pipeline emerges from ground near Meckering
Griffiths Architects, April 2016

Photograph 02 Deteriorated concrete anchor near Meckering
Griffiths Architects, April 2016

Photograph 03 Repairs to locking bar pipe near Meckering
Griffiths Architects, April 2016

Photograph 04 GWSS goes below ground by the Meckering booster pump station
Griffiths Architects, April 2016

Place Description

Photograph 05 Locking bar pipe near Coolgardie
Water Corporation, March 2015

Photograph 06 Locking bar pipe near Burracoppin
Water Corporation, July 2014

Photograph 07 MSCL pipe
Water Corporation

Photograph 08 MSCL pipe
Water Corporation, July 2014

Place Description

Photograph 09 Kellerberrin pipe
Water Corporation

Photograph 10 Kellerberrin pipe
Water Corporation

Photograph 11 Kellerberrin pipe
Water Corporation

Photograph 12 Dual locking bar joining to a single MSCL pipe near Tammin
Water Corporation, November 2011

Photograph 13 Spiral weld MSCL with plastic coating before being laid below ground
Water Corporation

Photograph 14 Locking bar meeting spiral weld MSCL pipe
Water Corporation, August 2014

5. Significance

5.1. Official Values

The following lists the full National Heritage Values from the Commonwealth of Australia Special Gazette (No. S106, 23 June 2011) for the inclusion of the GWSS on the National Heritage List.

Criterion A: The place has outstanding heritage value to the nation because of the place's importance in the course or pattern of Australia's natural or cultural history.

The Goldfields Water Supply Scheme runs for over 560km and was opened in 1903. It is significant as the impetus for agricultural expansion that was of lasting benefit to Western Australia and to the nation as a whole. Water from the pipeline became available just as the production of gold on the eastern goldfields was starting to decline, but the true value of the pipeline both to Western Australia and to Australia as a whole was the effect that regular water supplies had in opening up the south-western agricultural area to production. While activity on the goldfields declined between 1905 and the 1960s, the quantity and value of wheat produced increased steadily over the same period. Today the Western Australian wheatfields are the most productive in Australia, accounting for 42% of the nation's wheat crop. This comes mainly from the areas serviced by the goldfields pipeline, which has continued to operate as a water supply scheme since its inception. The pipeline, its extensions and associated infrastructure represent the initiative that opened up the south-western agricultural area to development.

Criterion D: The place has outstanding heritage value to the nation because of the place's importance in demonstrating the principal characteristics of: (i) a class of Australia's natural or cultural places; or (ii) a class of Australia's natural or cultural environments.

The Goldfields Water Supply Scheme incorporates the remaining elements of the former Coolgardie Goldfields Water Supply Scheme, as designed by engineer C. Y. O'Connor and completed in 1903. The Goldfields Water Supply Scheme is an outstanding representative example of an inter-basin water transfer system while demonstrating a major development in water scheme design. It contains the principal characteristics of a water supply/transfer scheme including dams (pondages), extensive pipeline, tanks, reservoirs and pump stations. The pipeline continues to serve the needs of the communities between Mundaring and Kalgoorlie.

Significance

The characteristic features of the Goldfields Water Supply Scheme that express this value include the remaining extant features of the 1903 Scheme: the main conduit of the pipeline (the length of pipeline including all locking bar pipes, wood stave pipe and continuously welded pipes from Mundaring Weir to Mount Charlotte); with its surviving pumping stations (Pump Stations Nos 1, 3, 5,6 and 8) and their associated equipment (including the pumps, boilers, compressors, venturi meters and reservoirs located at Pump Stations 2, 4, 7 and 8), regulating tanks (located at Bullabulling, Toorak Hill, Bakers Hill and West Northam) and the Mundaring Weir (dam, including the valve houses, spillway, the weir wall profile and fabric) and the round Mount Charlotte Reservoir at Kalgoorlie.

Criterion F: The place has outstanding heritage value to the nation because of the place's importance in demonstrating a high degree of creative or technical achievement at a particular period.

Both in the size of the project and in the use of new technology, the Goldfields Water Supply Scheme was an outstanding technological achievement for its time. The pipeline pumping scheme, consisting of the pipeline itself, the reservoirs, and the pumping stations, was regarded internationally as being the largest such engineering undertaking for its time. The amount of steel used in construction was greater than for previous large steel structures. The contracts for the supply of steel were the largest pipe contracts, and the most expensive Australian construction contracts, let to that time.

The pipeline also made use of innovative Australian design in the locking bar pipe invented by Mephan Ferguson.

The refurbishment of the pipeline in 1933 was also a major technical development. Lifting the pipeline out of the ground and re-laying it above ground placed the Goldfields Water Supply Scheme among the world leaders in pipeline technology for the second time in less than 40 years. During this refurbishment, the expansion forces were directed into reinforced concrete anchor blocks built over the pipe at 50 metre intervals, which prevented movement and transferred these forces into the ground. This was the first time anywhere in the world that pipe anchorages of this type had been used to permit such a large diameter pipeline to be laid above ground.

The technical achievement of the Goldfields Water Supply Scheme was internationally recognised by the American Society of Civil Engineers as an International Historic Civil Engineering Landmark in 2009, marking the Scheme as one of the most significant engineering projects of the 20th century.

Criterion H: The place has outstanding heritage value to the nation because of the place's special association with the life or works of a person or group of persons, of importance in Australia's natural or cultural history.

The Goldfields Water Supply Scheme is significant for its association with the work of Charles Yelverton O'Connor, Engineer-in Chief of the Western Australian Public Works Department from 1891 to his death in March 1902. O'Connor was the driving force behind the construction of the pumping scheme including the pipeline, pumping stations and equipment, reservoirs and tanks, and the Mundaring Weir, which provided great economic benefit to the state of Western Australia and to the nation as a whole. While the Coolgardie Goldfields Water Supply Scheme was originally intended to serve the immediate needs of the goldfields, Sir John Forrest considered that its longer-term future was to service agriculture. At the completion of the work, the Premier Sir John Forrest praised him as "the great builder of this work … to bring happiness and comfort to the people of the goldfields for all time".

5.2. Statement of Significance

The following lists the full Nominator's Summary Statement of Significance from the National Heritage Listing of GWSS on the Australian Heritage Database.

In 1987 the Institution of Engineers Australia awarded its ultimate accolade, the National Engineering Landmark, for historic engineering works of outstanding heritage significance, to the Coolgardie Goldfields Water Supply Scheme.

The Goldfields Pipeline has exceptional and unique cultural significance for the nation as one of the greatest engineering and infrastructure schemes of the late nineteenth century. It attracted worldwide attention since never before had water been pumped so far nor lifted so high. It was also the first major pipeline in the world to be constructed of steel.

The Goldfields Pipeline is highly significant as a key element in the pattern of population, development, economics and resource exploitation in Western Australia and the nation. It has been the lifeline to the Eastern Goldfields gold and nickel mining province which has made an enormous contribution to the prosperity of Western Australia and the nation in turn over the past one hundred plus years. The extension of the scheme has also had a significant impact on the development of the Western Australian wheatbelt.

Criteria

a, f, g, h

a - the place has outstanding heritage value to the nation because of the place's importance in the course, or pattern, of Australia's natural or cultural history The Goldfields Pipeline is important to Australia's cultural history as it tells a national story about the driest inhabited continent in the world. In fact, a section of the original steel pipe is on loan in display in the National Museum in Canberra at present to illustrate an exhibition about this very theme.

Significance

The pipeline was built to overcome the shortage of water in the inhospitable interior, to provide a reliable source of water for the goldfields. The extensions of the scheme in the 1940s and 50s encouraged and allowed for the development of the Western Australian wheatbelt. As such it has contributed to the growth of not only Western Australia but also the nation as a whole. Some historians argue that the discovery of gold and the pipeline are linked to Australia becoming a nation of federated states. Many "t'othersiders" rushed to Western Australia in the 1890s in hopes of finding fortunes. Their allegiance to the eastern states of Australia came to the fore when, despite the Forrest government only agreeing to a referendum at the last possible opportunity, Western Australia voted overwhelmingly in favour of federation.

f - the place has outstanding heritage value to the nation because of the place's importance in demonstrating a high degree of creative or technical achievement at a particular period The Goldfields Pipeline is highly significant for its instigation and application of Australian technological innovation. It was typical to this point that water pipes were made from cast iron. Due to the prohibitive costs and difficulty in transporting, O'Connor ruled out this as an option. In terms of technological achievement the Goldfields Pipeline, opened in 1903, was the equivalent of the Firth of Forth Bridge in Scotland, built in the 1880s, the world's first major railway bridge built of steel. However, the 54,000 tons of steel required for the Forth Bridge were dwarfed by the 70,000 tons of steel required for the goldfields pipeline. Manufacture of the pipes had to be split into two equal contracts, each of which was the largest pipe fabrication contract ever let and, to that time, also the most costly Australian construction contract ever carried out.

In addition, the pipes were made to an innovative design. At a time when welding was in its infancy and riveted pipes were the norm, a Melbourne engineer, Mephan Ferguson, came up with a design for a rivetless pipe. This so-called locking bar pipe obviated the need for rivet holes, sites of potential leaks, and rivets, the heads of which slowed down the flow of water in the pipe.

g - the place has outstanding heritage value to the nation because of the place's strong or special association with a particular community or cultural group for social, cultural or spiritual reasons The Goldfields Pipeline holds special significance for the numerous members and their descendants of the "pipeline communities", the small settlements that grew up at each of the eight pumping stations. The communities existed to operate and maintain the pipeline. With the workers came their families, requiring small one-teacher schools and resulting in a rich and close community life. Individuals were born and died on 'No 2' or 'No 7' as former residents affectionately and with pride refer to their homes.

The pipeline also has strong associations with the small wheatbelt towns through which it passes. The pipeline not only supplies these towns with water, it also contributes to their wellbeing, both directly and indirectly. People living in Southern Cross might be employed as welders working on the pipeline, for example. The pipeline gives security to farmers in these wheatbelt communities and allows them to diversify. Six million sheep rely on the pipeline!

Many displaced persons from war torn Europe served out their contractual agreements with the Australian Government by working on the water supply scheme, either on the raising of the weir wall as part of the agricultural expansion or at one of the pump stations. Many of these men continued to work with the water supply scheme after the completion of their contractual obligations becoming an integral part of these small and remote communities.

h - the place has outstanding heritage value to the nation because of the place's special association with the life or works of a person, or group of persons, or importance in Australia's natural or cultural history.

The Goldfields Pipeline is highly significant for social and political imagination and ambition. The driving political force behind the decision to build it was Western Australian's first Premier, Sir John Forrest. After Federation in 1901 John Forrest represented his state as a Minister in the Federal Parliament until 1918 at which time he became the first Australian born citizen to be elevated to the peerage of the British Empire.

It is also associated with the brilliant engineer Charles Yelverton O'Connor who tragically took his own life before the pipeline was completed. As the Engineer-in-Chief for Western Australia, O'Connor, "The Chief", was involved in laying the foundations of WA's infrastructure. As Premier John Forrest telegraphed him, he was responsible for "Railways, Harbours, everything". The Chief is celebrated in artwork, literature, film and oral tradition, not only in Western Australia. Robert Juniper, who enjoys a national reputation, has painted several works relating to the pipeline and O'Connor. Robert Drewe's award winning novel "The Drowner" is centred on the pipeline. A popular piece of public artwork is a statue in the sea off South Fremantle depicting C. Y. O'Connor. Renowned sculptor Pietro Porcelli's bust of him overlooks the weir and his more than life-size statue of O'Connor overlooks

5.3. Other listings

The main conduit is not included on other listings.

6. Opportunities and Constraints

6.1. Obligations

The national heritage values of the GWSS must be maintained. These values were considered in the creation of heritage management policies. A summary of the main conduit heritage values concludes:

- The pipeline is landmark in its significance to the history of the Western Australia.
- The design of the locking bar pipe and other features of the original 1903 scheme and 1930s refurbishment have outstanding heritage value
- The significance of the pipeline is enhanced by its continued operation.
- The pipeline has a strong association with C. Y. O'Connor and John Forrest.
- The scale of the pipeline recognised as an outstanding technical achievement.

6.2. Operational requirements

The GWSS is the principal means of water supply to the Goldfields and Wheatbelt. Providing drinking water safely and efficiently is the primary operational consideration of the pipeline, and to do so the pipeline must be maintained, repaired, and upgraded to meet ongoing and increasing demand.

6.3. Decision making process

Activities proposed to be undertaken by Water Corporation and/or external proponents that do not meet the heritage management policy need to be assessed for their potential impacts before a decision can be made on whether the proposal should be approved.

Some proposed actions might be 'controlled actions' under the EPBC Act. Controlled actions require assessment and approval by the Minister because they are likely to have a significant impact on the national heritage values of the place.

Proposed actions that do not trigger the EPBC Act assessment and approval provisions may still have impacts that require assessment before a decision can be made on whether the action should proceed.

If outside the scope of the heritage management policy, proposals should be assessed by a heritage specialist.

If proposed actions are not properly assessed, there is a risk of significant impacts to the heritage values of the pipeline main conduit.

7. Heritage Management Policy

7.1. Policy Summary

The GWSS is the main water supply to WA's Wheatbelt and surrounding areas, to sustain this role it has been the subject of many upgrades throughout its life. It is likely the main conduit will continue to be an important part of WA's water supply many years to come, and as such, upgrades will be needed to preserve its utility and meet demand.

Today large capacity pipelines are laid belowground to meet modern operational, safety, security and cost requirements. The policies in this document aim to account for the gradual removal of aboveground pipeline as replacement pipe is laid belowground, while continuing to maintain the heritage values of the GWSS as a whole and to guide the process from a heritage perspective.

The policies in this document specify the interpretation or retention of original pipeline at appropriate locations and at a frequency which allows the length of the original pipeline to be read by the public. The policies acknowledge the long term nature of upgrade works and mandate a satisfactory heritage outcome at any stage of future development.

7.2. Introduction

The Heritage Management Policy is concerned with providing a practical guide for the conservation of the National Heritage values of the GWSS Main Conduit in the context of the continued operation and use of the pipeline.

The detailed heritage management objectives provided herein are the primary responsibility of the Water Corporation. The objectives for heritage management of the pipeline are to ensure:

- the continued, sustainable use of the pipeline is compatible with the heritage values summarised in this HMP;
- the management and maintenance of the pipeline is informed and guided by its heritage values and operational requirements; and,
- the heritage values are understood, maintained and interpreted appropriately.

7.3. Policy for new pipeline

The following policies relate to new sections of pipeline on the main conduit of the GWSS, including above and below ground pipe sections, and those that replace or duplicate an existing sections.

1. *Pipe replacement*
   To sustain ongoing operation of the pipeline existing pipe, including locking bar and Kellerberrin pipe, may be bypassed and decommissioned. Removal of pipe must adhere to the polices set out in this document.

Since its inception the pipeline has been continually maintained and upgraded, often with the latest pipeline technology available. The increased coverage of the scheme has led to much of the pipeline being replaced or duplicated to increase capacity. The continuation of practices such as these are necessary for GWSS's ongoing operation.

2. *Concrete anchor block replacement*
   Supporting concrete block anchors may be replaced with any support system deemed suitable for the pipeline. This applies to new and existing pipe sections.

If an alternate method of anchoring the pipeline is determined, it would be acceptable to use this method in place of concrete block anchors.

3. *Belowground pipeline*
   New pipe may be laid below ground without affecting heritage values of the above ground section of pipeline.

When new below ground pipeline is constructed without removing the existing above ground pipeline, there is no effect on the heritage values as the historic pipeline remains in place. As the main conduit was first laid below ground, a below-ground solution re-establishes the original intent. The above ground re-laying in the 1930s was an intervening management strategy.

Policies relating to the remaining non-operational above ground pipeline is discussed in section 7.6.

4. *Archaeological potential*
   Trenches for new below ground pipeline may reveal items of archaeological significance. Workers should be instructed in chance find procedures in the event of an archaeological item being discovered. Items of interest should be retained and assessed by an archaeologist for their value and disposed in accordance with the archaeologist's recommendations.

Found items are likely to be equipment or refuse from the 1930s raising of the pipeline, though there is potential for recovery of earlier material.

5. *Replaced Pipeline location*
   If practical and feasible, the new pipe should endeavour to generally match the path of the original pipeline. Where new pipe diverges from original path, the original path should be interpreted.

Pipe laid both below and above ground should remain in the proximity of the original pipeline path. Concessions may be made for operational requirements requiring divergences from the original path, however in these cases the original path should be appropriately interpreted, with some sections of retained material and through mapping and other material available for GWSS interpretation.

7.4. Policy for Interpretive and Retained Sites

The following polices describe 'Interpretive Sites' and 'Retained Sites' which should be located in areas where a significant amount of pipeline is removed, as noted in section 7.5.

6. *Retained site: Existing locking bar or Kellerberrin pipeline*
   Sections of existing pipeline of lengths 500m or greater, whether operational or not, with the majority being above ground, made up of locking bar or Kellerberrin pipeline, and visible from Great Eastern Hwy.

A length of locking bar or Kellerberrin pipeline visible from Great Eastern Hwy contributes to the perception of a long and continuous pipeline, this may be considered as an alternative to an interpretive site. This site does not require public access.

7. *Retained site: Existing pipeline*
   Sections of existing pipeline of lengths of 1km or greater, whether operational or not, made up of any pipe type, with the majority above ground and visible from Great Eastern Hwy.

A length of MSCL or other pipe visible from Great Eastern Hwy contributes to the perception of a long and continuous pipeline, this may be considered as an alternative to an interpretive site. This site does not require public access.

8. *Interpretive site: Presented section of pipeline*
   A 20m or greater section of locking bar pipeline which is accessible to the public and meets policies 26 - 38.

A specific area designed to present a small section of pipeline in an educational manner, meeting polices in sections 7.10 and 7.11.

7.5. Policy for Location of Interpretive and Retained Sites

'Interpretive Sites' and 'Retained Sites' are described section 7.4 and should be located across the length of the pipeline at a frequency that adequately illustrates the continuous nature and length of the pipeline.

Between Mundaring Weir and Meckering much of the pipeline is not visible from Great Eastern Highway and does not require retention or interpretation. Between Meckering and Merredin the pipeline is predominately MSCL pipe, with few opportunities to retain or interpret locking bar pipe.

9. *Interpretive and retained sites should be located on the historic path of the pipeline*

10. *There should be no distance greater than 75km along the historic path of the pipeline between Merredin and Mount Charlotte without an interpretive or retained site. Interpretive and retained sites should be within 75km of another interpretive or retained site, Merredin or Mount Charlotte.*

11. *Five or more interpretive or retained sites should be between Merredin and Mount Charlotte.*

7.4. Policy for Interpretive and Retained Sites

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6. *Retained site: Existing locking bar or Kellerberrin pipeline*
   Sections of existing pipeline of lengths 500m or greater, whether operational or not, with the majority being above ground, made up of locking bar or Kellerberrin pipeline, and visible from Great Eastern Hwy.

A length of locking bar or Kellerberrin pipeline visible from Great Eastern Hwy contributes to the perception of a long and continuous pipeline, this may be considered as an alternative to an interpretive site. This site does not require public access.

7. *Retained site: Existing pipeline*
   Sections of existing pipeline of lengths of 1km or greater, whether operational or not, made up of any pipe type, with the majority above ground and visible from Great Eastern Hwy.

A length of MSCL or other pipe visible from Great Eastern Hwy contributes to the perception of a long and continuous pipeline, this may be considered as an alternative to an interpretive site. This site does not require public access.

8. *Interpretive site: Presented section of pipeline*
   A 20m or greater section of locking bar pipeline which is accessible to the public and meets policies 26 - 38.

A specific area designed to present a small section of pipeline in an educational manner, meeting polices in sections 7.10 and 7.11.

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9. *Interpretive and retained sites should be located on the historic path of the pipeline*

10. *There should be no distance greater than 75km along the historic path of the pipeline between Merredin and Mount Charlotte without an interpretive or retained site. Interpretive and retained sites should be within 75km of another interpretive or retained site, Merredin or Mount Charlotte.*

11. *Five or more interpretive or retained sites should be between Merredin and Mount Charlotte.*

12. *Long sections of above ground pipe greater than 5km may be considered as multiple retained sites*

Provision of interpretive or retained sites is only required where continuous sections of above ground pipeline greater than 75 km in length will be removed. Where the above ground pipeline is to remain in situ (operational or not) there is no need to provide interpretive sites on the basis the historic fabric remains. The intent of this provision is to ensure that sections of the pipeline, whether they be existing above ground operational pipeline, retained sites, or interpretive sites, are available at regular intervals for the enjoyment of the public.

As such, the required number interpretive or retained sites would be met until a continuous section of pipeline exceeding 75km in length has been removed and replaced with underground pipeline.

Merredin and Mount Charlotte are approximately 335km apart, considering the requirement for five or more interpretive or retained sites, a scenario meeting minimum required sites would have average distance of 55km between each. Allowing a maximum distance of 75km between sites ensures there would not be an extended distance along the historic path without a site, while still allowing leeway to position sites in the most appropriate areas for interpretation or retention.

13. *One or more interpretive or retained sites should be within 50km east of Meckering, this does not need to adhere to other distance requirements.*

14. *Interpretative or retained sites should be visible from Great Eastern Hwy or other popular public locations.*

Most, but not all the pipeline is visible from Great Eastern Highway. Readily visible and accessible sections of pipeline should be selected for interpretation or retention.

7.6. Policy for non-operational locking bar or Kellerberrin pipeline

The locking bar and Kellerberrin sections of pipeline are early or original fabric, Kellerberrin pipes are modified locking bar from 1938-1958.

15. *Retention of non-operational pipe*
    There is no obligation to remove non-operational pipe, it may be left in place.

16. *Removal of non-operational pipe*
Non-operational sections of locking bar and Kellerberrin pipeline may be removed if:

- *The pipeline is not visible from Great Eastern Highway or any other popular public area; or*
- *The pipe section in question is within 75km of an appropriate interpretive or retained site (see section 7.4), Merredin, or Mount Charlotte; or*
- *The pipeline is between Mundaring and Merredin.*

Removal of locking bar and Kellerberrin pipe must adhere to the policies in section 7.8

Pipeline may be removed if it is not easily visible to the public or would not be required for future interpretation or retention. Sections of pipeline near proposed interpretive or retained sites should be assessed based on condition, surrounds, historical and education value to allow the most appropriate pipes to be considered for inclusion.

7.7. Policy for non-operational MSCL pipeline

52% of the conduit is MSCL (as of 2016), dating from 1926 to 2013.

17. *Interpretation of MSCL pipe*
Some MSCL pipeline should be retained for possible use in interpretive sites (see section 7.4).

To allow the whole life of the pipeline to be interpreted one or more sections of this pipeline should be retained for an interpretive site.

18. *Removal of non-operational MSCL pipe*
MSCL not included in interpretive or retained sites may be removed and disposed as seen fit.

7.8. Policy for removal of locking bar and Kellerberrin pipeline

In the case of a section of pipeline meeting policy 1 or 16 the following policies apply.

19. *Community use*
Pipeline proposed for removal should be offered to the local communities and stakeholders, for use in educational, artistic, or any other appropriate endeavours as seen fit.

20. *Contact listing*

    To ensure interested parties are kept informed on the availability of pipe sections, a contact database should be maintained. Parties should be contacted in advance of pipeline being removed and adequate time should be given for responses before removal begins.

The locking bar pipeline is valued in the Western Australian community, in the past removed sections have been offered for use as museum exhibits or as materials in sculptures, this practice should continue for the removal of future sections. A stakeholder may maintain this database on behalf of the Water Corporation.

21. *Storage of removed allocated and interpretive pipe*

    As pipe allocated for interpretation or for use in the community is removed it should be promptly installed at an interpretive site or disposed to an interested party. This pipe may be stored in situ while arrangements are made.

Ideally non-operational pipes allocated for community or interpretive uses would only be removed when a new use is prepared.

22. *Dismantling the pipeline for interested parties*

    Allocated pipes should be cut into lengths to the specification of the party if possible and feasible for ready transport.

. The length of a pipe section between joints is 8.5m. Lengths of pipe will be cut into sections of 6m of less for ease of transport. Interested parties must provide own transport for longer lengths.

23. *Unallocated pipe*

    Excess pipe not needed for interpretation, retention, or not allocated to a third party after reasonable notice may be removed and disposed as seen fit.

7.9. Policy for unused anchor blocks

Concrete anchor blocks were poured insitu and are dated from the raising of the pipeline in the 1930s.

24. *Removing unused anchor blocks*

    Anchor blocks may be removed with associated pipeline, or alternately be left in place as interpretation.

25. *Maintenance of unused anchor blocks*

    Concrete anchor and support blocks do not require ongoing maintenance and may be allowed to decline over time. If blocks become unsafe, works to render them safe is permissible and where such work is assessed as being ineffective, removal may be considered.

Blocks left as interpretation should meet any safety requirements, but do not require ongoing care.

7.10. Policy for interpretive sites

These polices describe the site requirements for an interpretive site.

26. *An interpretation strategy may be developed that would take precedent over policies in this section.*

27. *Where interpretation is suggested by the strategy, site interpretation should be professionally prepared and be designed to suit the interpretation of the system that has already been established.*

28. *Interpretation should integrate into the setting.*

29. *Site should be clearly visible and readily accessible.*

30. *Site should be well maintained.*

7.11. Policy for pipeline display at presented interpretive sites

These policies state the requirements for pipeline on display at an interpretive site.

31. *A 20m or greater length of pipe should be retained.*

Interpretive sites are focused on a small section of pipeline.

32. *Pipes should be presented as they were in operation, on concrete supports between concrete anchor blocks.*

33. *Pipes should be rust treated, and painted to match existing or stripped to reveal underlying bitumen.*

Originally the locking bar pipes were coated in bitumen to prevent corrosion, evidence of this beneath the current layers of paint.

34. *A section of locking bar pipeline should be on display at interpretive sites.*

Each site must have at least one section of locking bar pipe displayed, MSCL or Kellerberrin pipe may be displayed but the focus should be on the use of locking bar.

35. *If there are more than two interpretive sites in total, a section of Kellerberrin pipe should be displayed at one of more interpretive sites.*

Kellerberrin pipe is not as common on the pipeline as locking bar or MSCL and should be represented at interpretive sites where possible. As interpretive sites are likely only to be developed as the pipeline is duplicated and buried across as significant length of time, policies 35 and 36 are to ensure a diverse selection of pipeline components are shown in interpretive sites as they are developed over time.

36. *If there are more than four presented interpretive sites in total, a section MSCL pipe should be displayed at one or more interpretive sites.*

Although not as significant as the locking bar or Kellerberrin pipe, MSCL pipe has been used on the pipeline since 1926 and should be represented at one or more interpretive sites.

37. *Pipe sections with repair patches have heritage value in illustrating the various methods of repair over the lifetime of the pipeline. Interpretation sites may have nearby pipe relocated in order to display a diverse range of conditions and repair methods.*

Much of the locking bar pipe has been repaired and patched numerous times during its lifespan; this should be included as part of the interpretive story the pipeline tells. Pipes in a range of conditions are preferred and may be moved from nearby sections to a presentation site.

38. *Pipe ends may be sealed as seen fit.*

7.12. Policy for Management of interpretive and retained sites

39. *The Water Corporation of Western Australia is responsible for maintaining and arranging the interpretation and retained sites of the main conduit of the Goldfields Water Supply Scheme*

40. *Interpretive and retained sites vested to other groups must take responsibility for maintaining the sites in accordance with this management plan.*

7.13. Policy for Reporting

41. *The Water Corporation of Western Australia will liaise with the Department of Environment on an appropriate reporting method of the status of the heritage fabric of the main conduit.*

7.14. Notes

If a situation arises where there is no available locking bar pipeline to interpret in an area requiring a presented interpretive site, locking bar pipeline from another section of the pipeline may be relocated to serve as the interpretation.

7.15. Example Diagrams

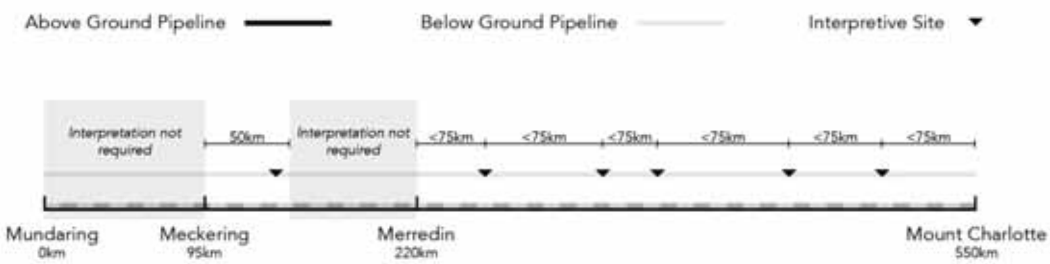

Figure 13 Policy example - all pipeline below ground

Example of scenario requiring six interpretive sites. All operational pipeline is below ground, the location of the interpretive sites shown meet the minimum number of required sites.

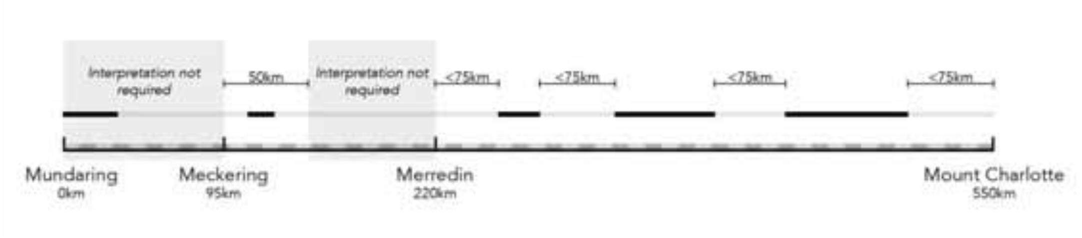

Figure 14 Policy example - no interpretive site

Example of scenario requiring no interpretative sites. Large sections of above ground pipeline have been replaced with below ground pipeline, enough above ground pipeline is retained to not require an interpretative site.

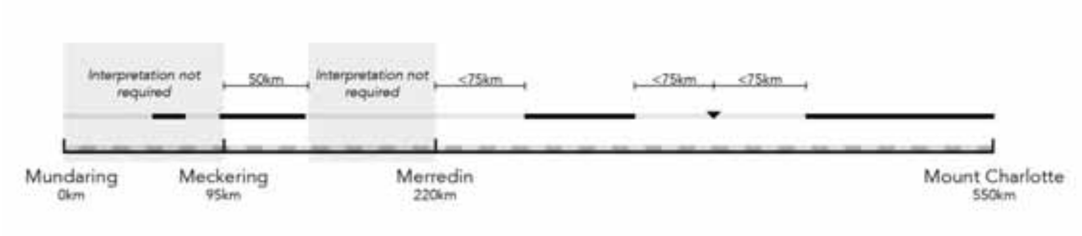

Figure 15 Policy example - single interpretive sites

Example of scenario of requiring only one interpretative site. Large sections of above ground pipeline have been replaced with below ground pipeline, one continuous span of below ground pipeline meets the conditions to require an interpretive site.

8. Policy Implementation

8.1. Parties

The responsibility to ensure the heritage management policies are implemented is that of the Water Corporation of Western Australia or any third party vested with land containing main conduit pipeline.

8.2. Timeframe

No specific time frame is required for the implementation of policy. The heritage aspects of the main conduit are in good condition and require no conservation further than the maintenance required for continued operation.

The heritage management policy affects sections of main conduit pipeline proposed for removal from operation or demolition. The polices consider the state of the main conduit as a whole and specify outcomes to maintain the heritage values alongside operational needs.

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10. Appendices

Burra Charter

http://australia.icomos.org/wp-content/uploads/The-Burra-Charter-2013-Adopted-31.10.2013.pdf

EPBC Act

https://www.legislation.gov.au/Details/C2016C00521

Table 1.0: Summary of Heritage Management Actions

Year	Document/Action
1896	Commissioned
1903	Completed
June 2011	Included on the National Heritage List in recognition of its outstanding cultural heritage values
August 2016	EPBC Heritage Management Plan prepared by Griffiths Architects
March 2019	Heritage Impact Statement prepared by GML Heritage
September 2019	Heritage Impact Statement prepared by GML Heritage
January 2022	Environment Protection and Biodiversity Conservation Act Approval Notice 2019/8547 - including Conditions of Approval
April 2022	Review Report on 2016 Heritage Management Plan prepared by GML Heritage
December 2022	Included on the State Register of Heritage Places

At current (2024), a HMP is being prepared for the demolition of portions of the Main Conduit, to guide the preservation of Heritage values during the upgrade to the water services.

Commonwealth of Australia **Gazette**

No. S106, Thursday, 23 June 2011
Published by the Commonwealth of Australia

SPECIAL

Environment Protection and Biodiversity Conservation Act 1999

INCLUSION OF A PLACE IN THE NATIONAL HERITAGE LIST

Goldfields Water Supply Scheme, Western Australia

I, Tony Burke, Minister for Sustainability, Environment, Water, Population and Communities, being satisfied that the place described in the Schedule has the National Heritage values specified in the Schedule, pursuant to section 324JJ of the *Environment Protection and Biodiversity Conservation Act 1999*, include it in the National Heritage List.

Dated

4. 10. 10

Tony Burke

Tony Burke
Minister for Sustainability, Environment,
Water, Population and Communities

Cat. No. S10611
ISSN 1032-2345
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2 Special Gazette

Commonwealth of Australia Gazette
No. S106, 23 June 2011

SCHEDULE

STATE / TERRITORY
Local Governments
Name
Location / Boundary
Criteria / Values

WESTERN AUSTRALIA

Coolgardie Shire, Cunderdin Shire, Kalgoorlie - Boulder City, Kellerberrin Shire, Merredin Shire, Mundaring Shire, Northam Shire, Northam Town, Tammin Shire, Westonia Shire, Yilgarn Shire

Goldfields Water Supply Scheme, Western Australia:

Located between Mundaring Weir and Mount Charlotte Reservoir, Kalgoorlie, and comprising the following:

1. the pipeline (main conduit) that extends from Mundaring Weir in the west to Mount Charlotte Reservoir in the east;
2. the Mundaring Weir wall, two valve houses, spillway and the basin;
3. the No 1 Pump Station located at the base of Mundaring Weir;
4. the site of No 2 Pump Station and the remains of the associated concrete receiving tank, Mundaring Weir Road;
5. the Bakers Hill Regulating Tank, Bowstock Street, Bakers Hill;
6. the West Northam Regulating Tank, West Northam, comprising the original rectangular shaped reservoir;
7. the No 3 Pump Station, Forrest Road, Cunderdin, comprising the whole of Lot 418 P220560;
8. the No 4 Pump Station and Holding Tank, Great Eastern Highway, Merredin, comprising an area bounded by a line commencing at the north east corner of Lot 1361 P216984, then south easterly to MGA point Zone 50 618062mE 6515200mN, then south westerly to MGA point 618011mE 6515173mN, then north westerly to the north west corner of Lot 1361 P216984, then north easterly via the north western boundary of Lot 1361 P216984 to the point of commencement;
9. the No 5 Pump Station and Yerbillon Reservoir, Smyth Road, Yerbillon, comprising an area bounded by a line commencing at the intersection of the western road reserve boundary of Smyth Road and MGA northing Zone 50 6525727mN (approximate MGA point 665555mE 6525727mN). then westerly to MGA point 665438mE 6525732mN, then southerly to MGA point 665433mE 6525492mN, then easterly to the intersection of the western road reserve boundary of Smyth Road with MGA northing 6525482mN (approximate MGA point 665504mE 6525482mN), then northerly via the western road reserve boundary of Smyth Road to the point of commencement;
10. the No 6 Pump Station and Ghooli Tank, Great Eastern Highway, Ghooli;
11. the site of No 7 Pump Station and the associated Reservoir (regulating tank), Great Eastern Highway, Koorarawalee, comprising the whole of Lot 1060 P031436;
12. the No 8 Pump Station and Holding Tank, Great Eastern Highway, Benari, comprising an area bounded by a line joining the following MGA points consecutively: Zone 51 279947mE 6557892mN, 28002mE 6557870mN, 279952mE 6557678mN, 279786mE 6557579mN, 279712mE 6557704mN, 279882mE 6557810mN, then directly to the point of commencement;
13. the Bullabulling Regulating Tank (Reservoir), Great Eastern Highway, Bullabulling;
14. the Toorak Hill Regulating Tank (Reservoir), Moran Street, Coolgardie;
15. the Kalgoorlie No 1 Tank, Hannan Street, Kalgoorlie, being an area comprising a circle of 70 metres radius centred on MGA point Zone 51 352593mE 6595880mN;
16. the Mt Charlotte Reservoir, Collier Place, Kalgoorlie, comprising the whole of Lot 2714 P043132 and that part of Lot 2713 P043132 to the west of Collier Place.

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No. S106, 23 June 2011 *Special Gazette* 3

	Criterion	Values
(a)	the place has outstanding heritage value to the nation because of the place's importance in the course, or pattern, of Australia's natural or cultural history.	The Goldfields Water Supply Scheme runs for over 560km and was opened in 1903. It is significant as the impetus for agricultural expansion that was of lasting benefit to Western Australia and to the nation as a whole. Water from the pipeline became available just as the production of gold on the eastern goldfields was starting to decline, but the true value of the pipeline both to Western Australia and to Australia as a whole was the effect that regular water supplies had in opening up the south-western agricultural area to production. While activity on the goldfields declined between 1905 and the 1960s, the quantity and value of wheat produced increased steadily over the same period. Today the Western Australian wheatfields are the most productive in Australia, accounting for 42% of the nation's wheat crop. This comes mainly from the areas serviced by the goldfields pipeline, which has continued to operate as a water supply scheme since its inception. The pipeline, its extensions and associated infrastructure represent the initiative that opened up the south-western agricultural area to development.
(d)	the place has outstanding heritage value to the nation because of the place's importance in demonstrating the principal characteristics of: (i) a class of Australia's natural or cultural places; or (ii) a class of Australia's natural or cultural environments.	The Goldfields Water Supply Scheme incorporates the remaining elements of the former Coolgardie Goldfields Water Supply Scheme, as designed by engineer CY O'Connor and completed in 1903. The Goldfields Water Supply Scheme is an outstanding representative example of an inter-basin water transfer system while demonstrating a major development in water scheme design. It contains the principal characteristics of a water supply/transfer scheme including dams (pondages), extensive pipeline, tanks, reservoirs and pump stations. The pipeline continues to serve the needs of the communities between Mundaring and Kalgoorlie. The characteristic features of the Goldfields Water Supply Scheme that express this value include the remaining extant features of the 1903 Scheme: the main conduit of the pipeline (the length of pipeline including all locking bar pipes, wood stave pipe and continuously welded pipes from Mundaring Weir to Mount Charlotte); with its surviving pumping stations (Pump Stations Nos 1, 3, 5,6 and 8) and their associated equipment (including the pumps, boilers, compressors, venturi meters and reservoirs located at Pump Stations 2, 4, 7 and 8), regulating tanks (located at Bullabulling, Toorak Hill, Bakers Hill and West Northam) and the Mundaring Weir (dam, including the valve houses, spillway, the weir wall profile and fabric) and the round Mount Charlotte Reservoir at Kalgoorlie.
(f)	the place has outstanding heritage value to the nation because of the place's importance in demonstrating a high degree of creative or technical achievement at a particular period.	Both in the size of the project and in the use of new technology, the Goldfields Water Supply Scheme was an outstanding technological achievement for its time. The pipeline pumping scheme, consisting of the pipeline itself, the reservoirs, and the pumping stations, was regarded internationally as being the largest such engineering undertaking for its time. The amount of steel used in construction was greater than for previous large steel structures. The contracts for the supply of steel were the largest pipe contracts, and the most expensive Australian construction contracts, let to that time. The pipeline also made use of innovative Australian design in the locking bar pipe invented by Mephan Ferguson. The refurbishment of the pipeline in 1933 was also a major technical development. Lifting the pipeline out of the ground and re-laying it above ground placed the Goldfields Water Supply Scheme among the world leaders in pipeline technology for the second time in less than 40 years. During this refurbishment, the expansion forces were directed into reinforced concrete anchor blocks built over the pipe at 50 metre intervals, which prevented movement and transferred these forces into the ground. This was the first time anywhere in the world that pipe anchorages of this type had been used to permit such a large diameter pipeline to be laid above ground.

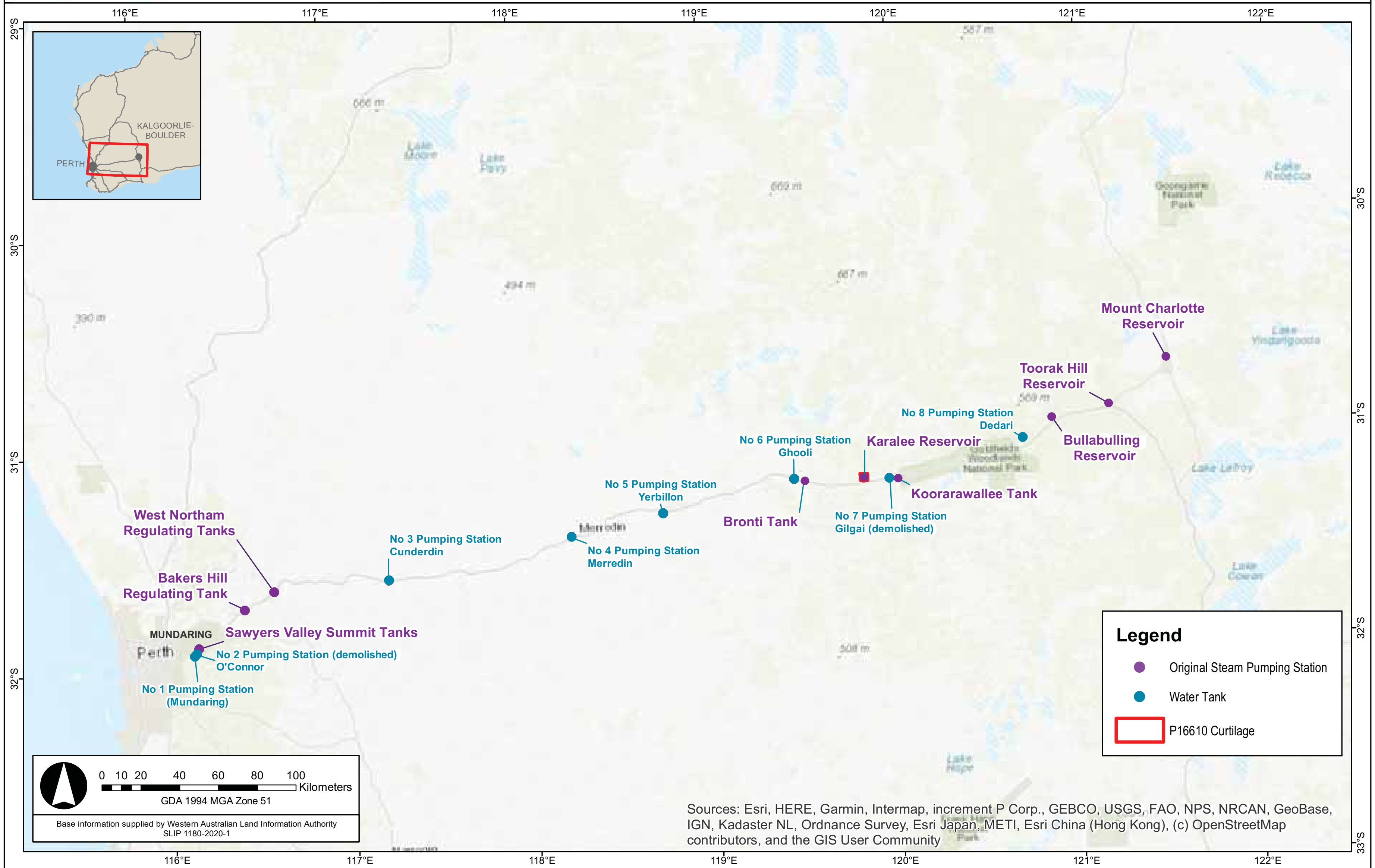
	Criterion	Values
		The technical achievement of the Goldfields Water Supply Scheme was internationally recognised by the American Society of Civil Engineers as an International Historic Civil Engineering Landmark in 2009, marking the Scheme as one of the most significant engineering projects of the 20th century.
(h)	the place has outstanding heritage value to the nation because of the place's special association with the life or works of a person, or group of persons, of importance in Australia's natural or cultural history.	The Goldfields Water Supply Scheme is significant for its association with the work of Charles Yelverton O'Connor, Engineer-in Chief of the Western Australian Public Works Department from 1891 to his death in March 1902. O'Connor was the driving force behind the construction of the pumping scheme including the pipeline, pumping stations and equipment, reservoirs and tanks, and the Mundaring Weir, which provided great economic benefit to the state of Western Australia and to the nation as a whole. While the Coolgardie Goldfields Water Supply Scheme was originally intended to serve the immediate needs of the goldfields, Sir John Forrest considered that its longer-term future was to service agriculture. At the completion of the work, the Premier Sir John Forrest praised him as "the great builder of this work ... to bring happiness and comfort to the people of the goldfields for all time".

For a description of any references quoted above, and more information on each of the places please search the Australian Heritage Database at http://www.environment.gov.au/cgi-bin/ahdb/search.pl using the name of the place.

HERITAGE COUNCIL
STATE HERITAGE OFFICE

HC CURTILAGE MAP P16610-D
GOLDFIELDS WATER SUPPLY SCHEME CURTILAGE OVERVIEW

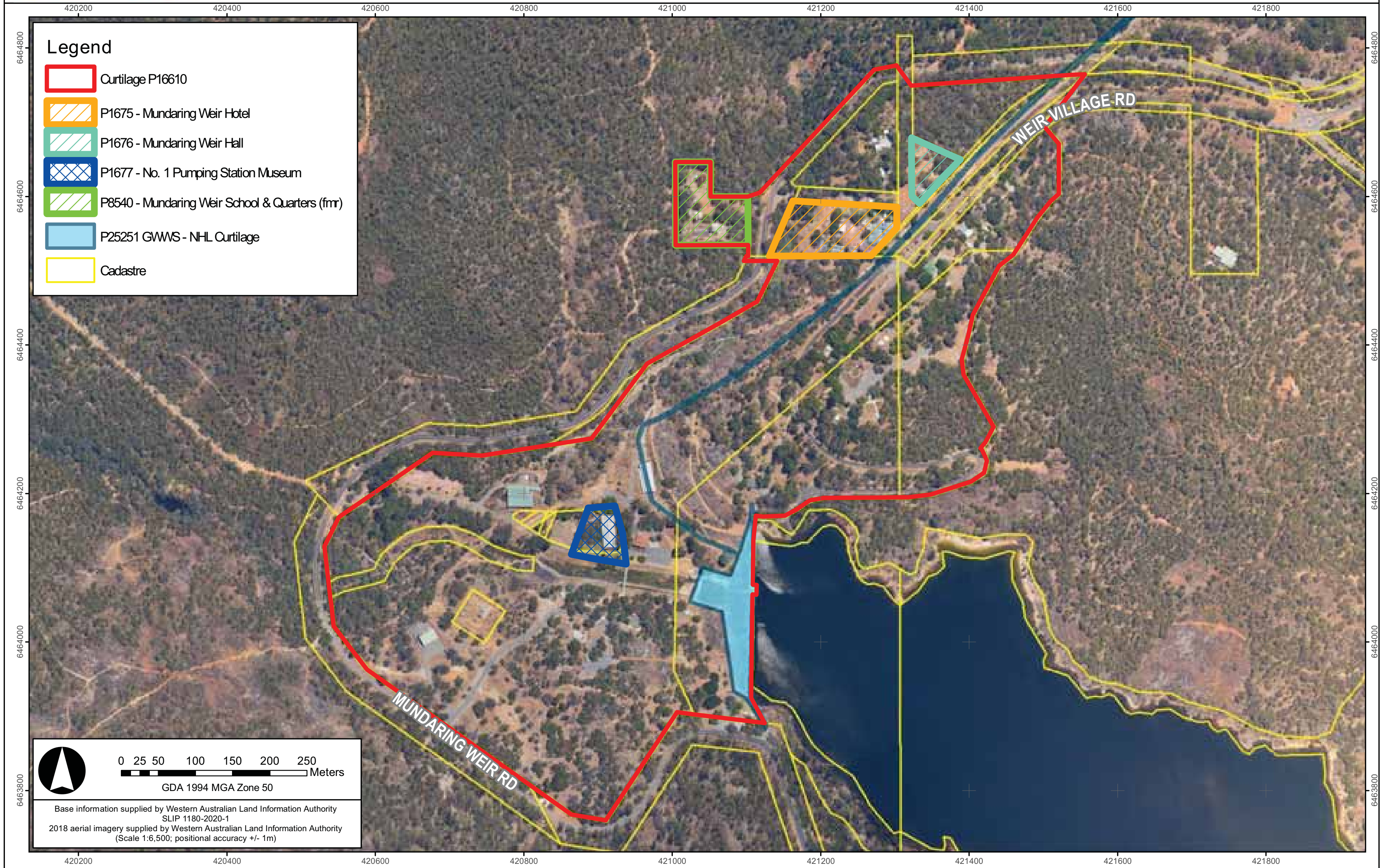
PREPARED BY CASEY GINBEY (MAPPING/GIS OFFICER) 12/10/2022



HERITAGE COUNCIL
STATE HERITAGE OFFICE

HC CURTILAGE MAP P16610-**D** GOLDFIELDS WATER SUPPLY SCHEME NO. 1 STATION COMPLEX, MUNDARING AND MUNDARING WEIR

PREPARED BY CASEY GINBEY (MAPPING/GIS OFFICER) 12/10//2022

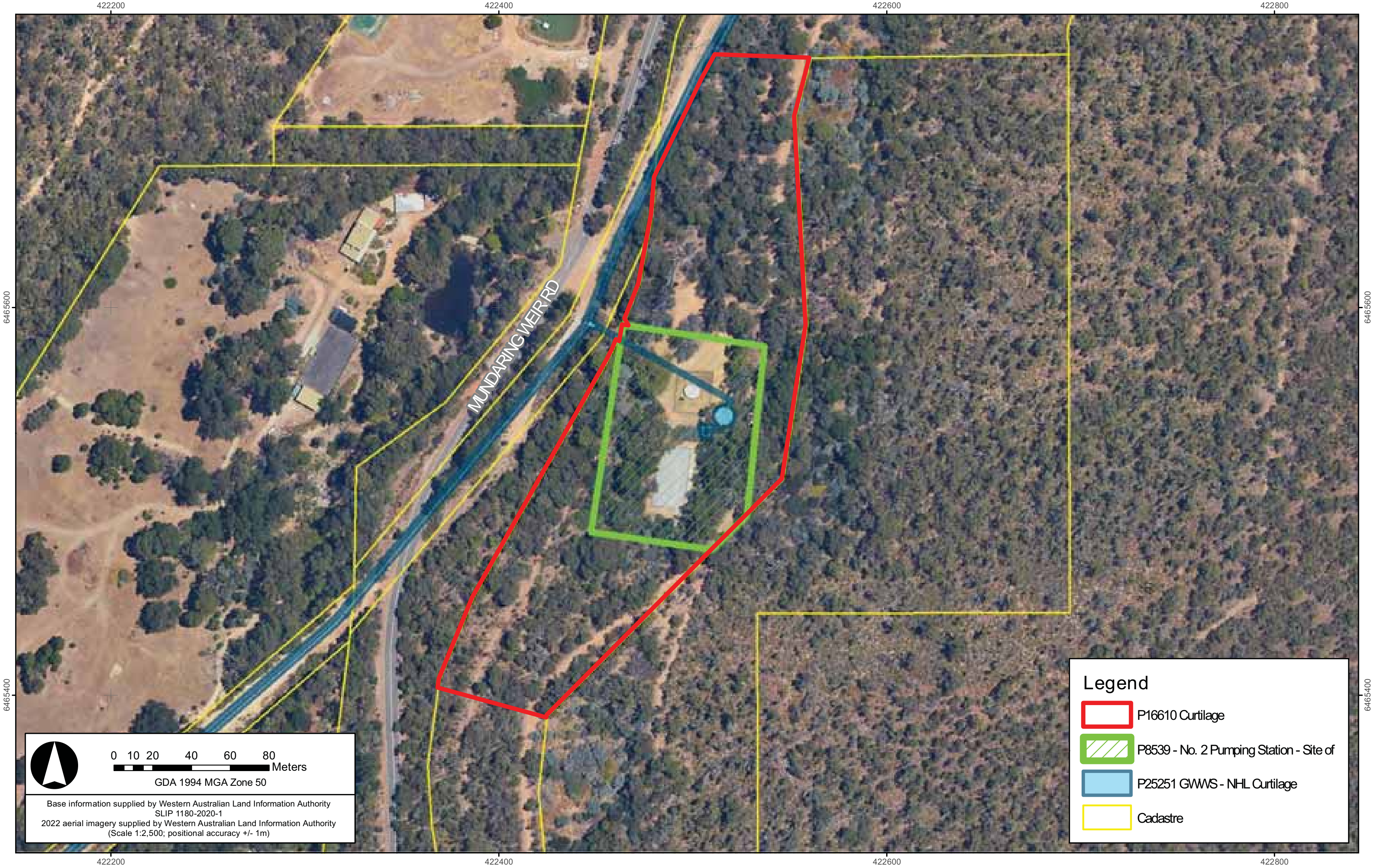


Base information supplied by Western Australian Land Information Authority SLIP 1180-2020-1
2018 aerial imagery supplied by Western Australian Land Information Authority (Scale 1:6,500; positional accuracy +/- 1m)

HERITAGE COUNCIL
STATE HERITAGE OFFICE

HC CURTILAGE MAP P16610-**D** GOLDFIELDS WATER SUPPLY SCHEME
SITE OF NO. 2 PUMP STATION, O'CONNOR

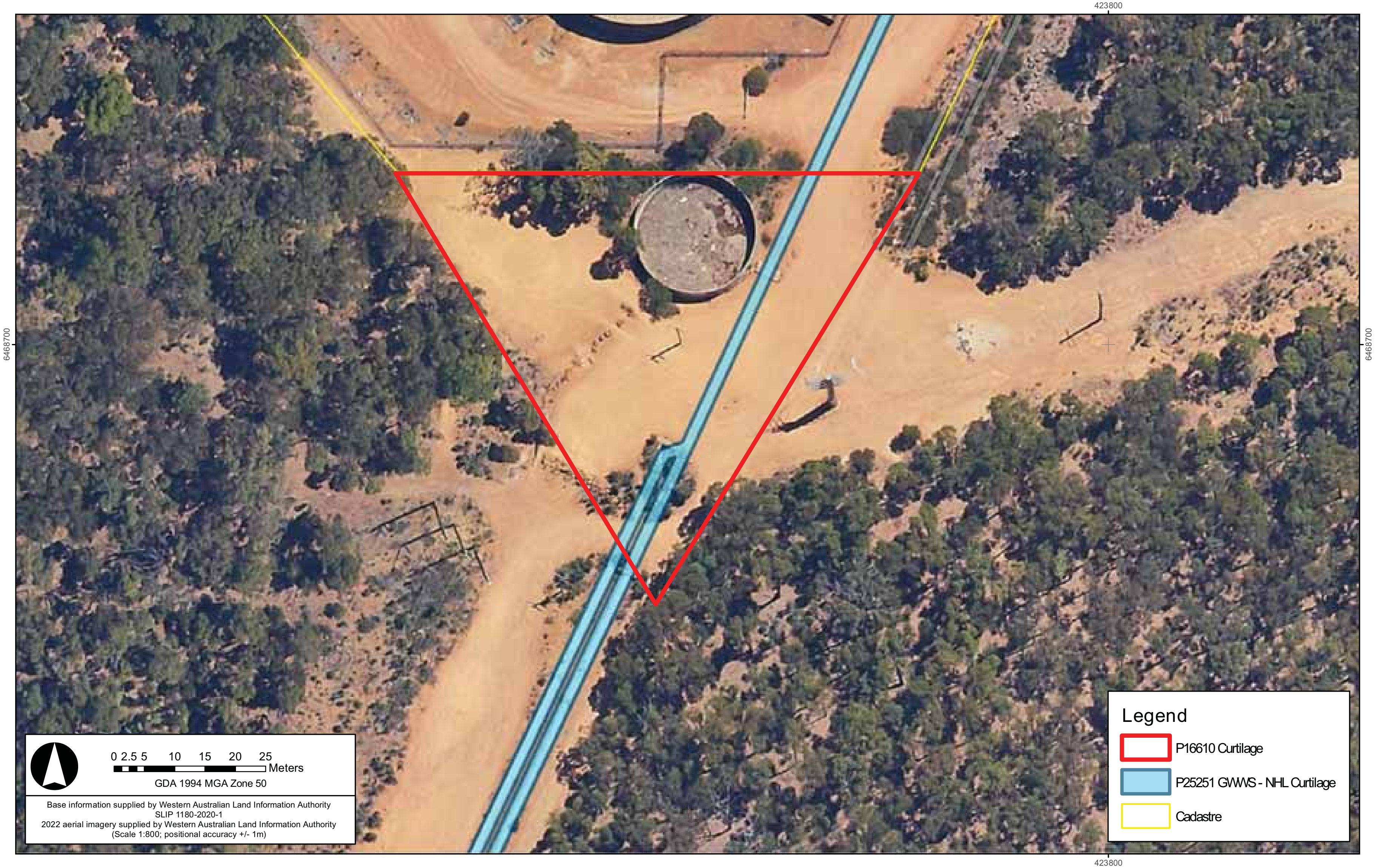
PREPARED BY CASEY GINBEY (MAPPING/GIS OFFICER) 12/10/2022



HERITAGE COUNCIL
STATE HERITAGE OFFICE

HC CURTILAGE MAP P16610-**D** GOLDFIELDS WATER SUPPLY SCHEME
SUMMIT TANK NO. 1 SAWYERS VALLEY

PREPARED BY TIMOTHY KIPPO (MAPPING/GIS OFFICER) 18/05/2022

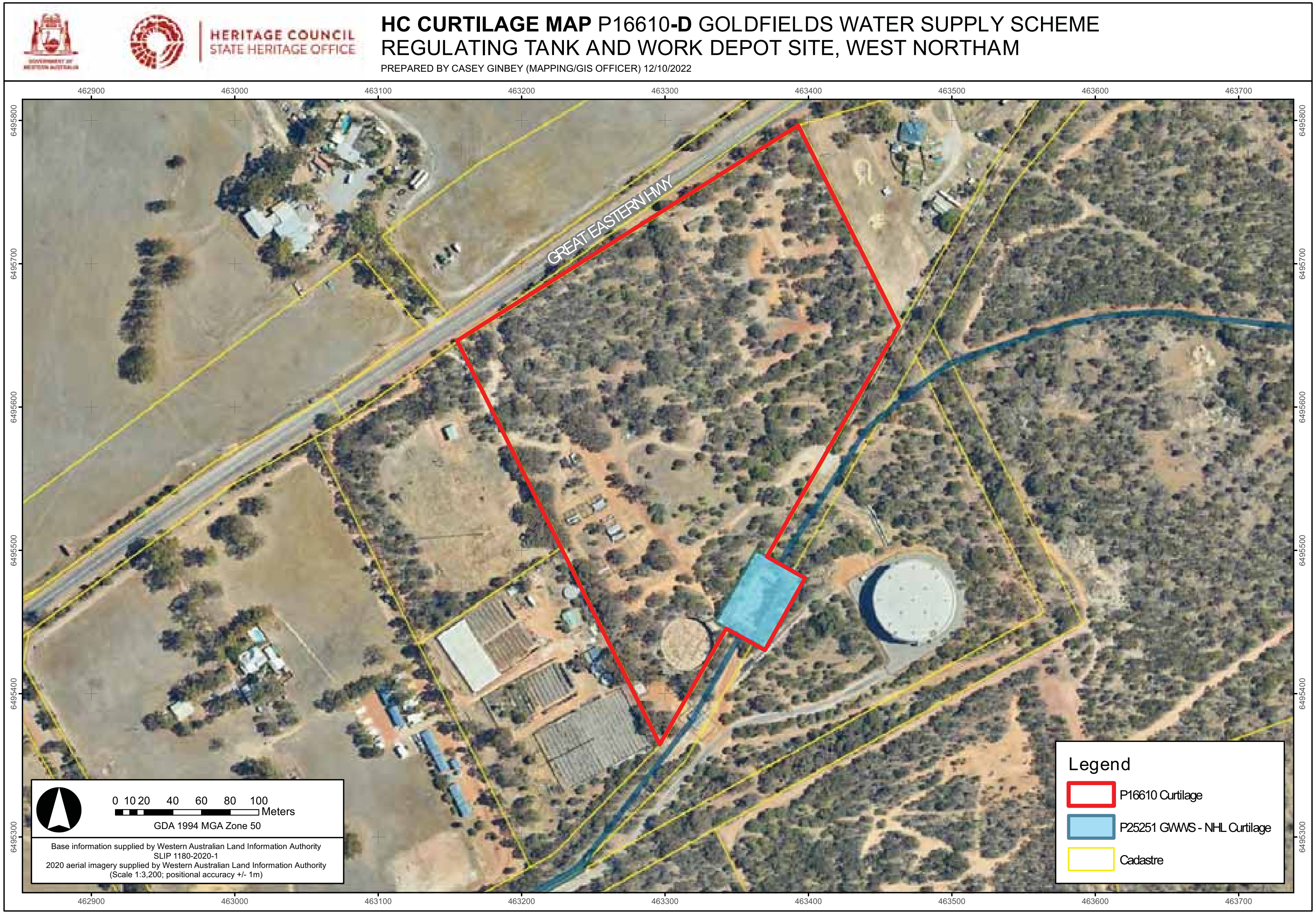


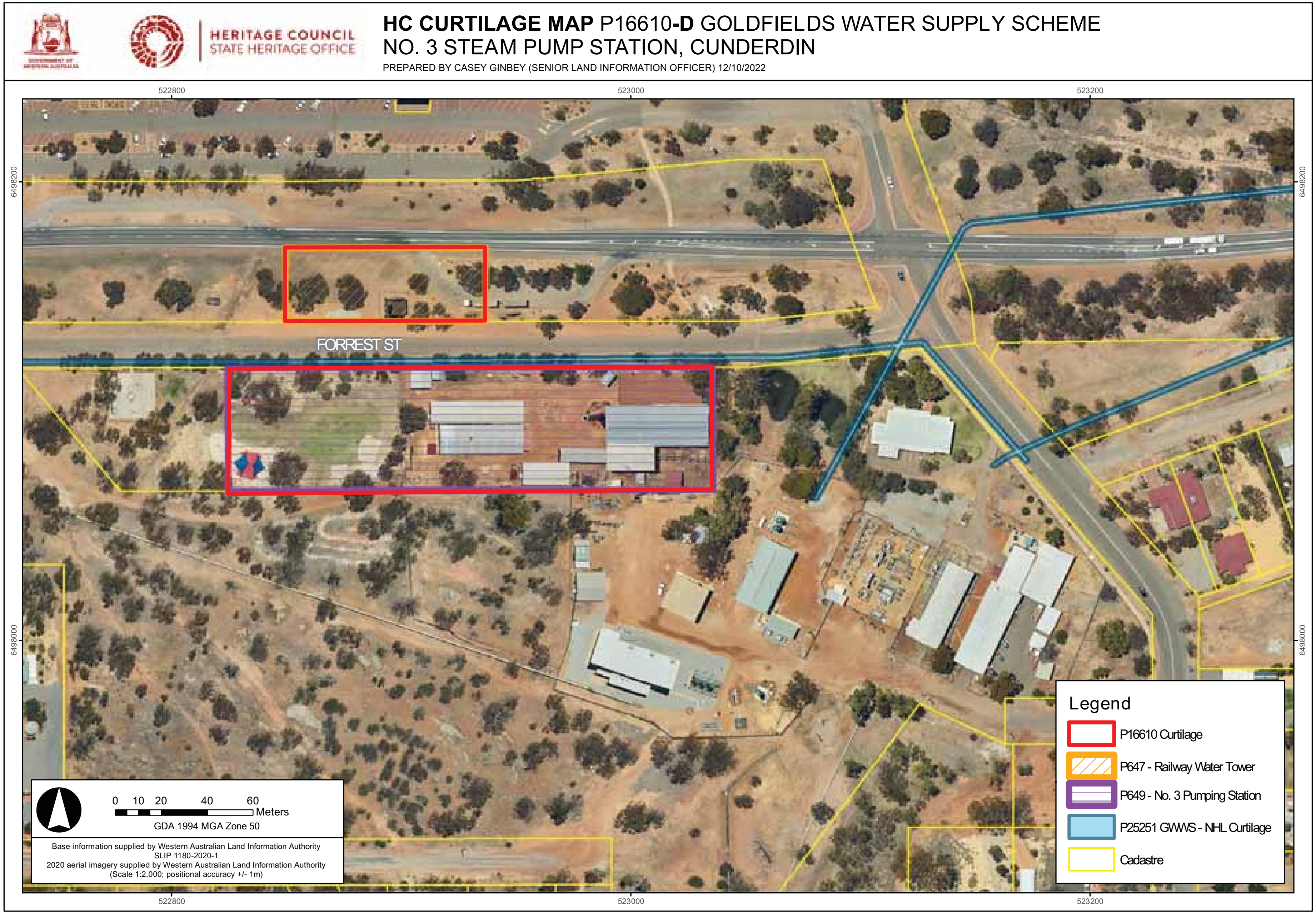
Base information supplied by Western Australian Land Information Authority
SLIP 1180-2020-1
2022 aerial imagery supplied by Western Australian Land Information Authority
(Scale 1:800; positional accuracy +/- 1m)

HERITAGE COUNCIL
STATE HERITAGE OFFICE

HC CURTILAGE MAP P16610-**D** GOLDFIELDS WATER SUPPLY SCHEME
REGULATING TANK, BAKERS HILL

PREPARED BY CASEY GINBEY (MAPPING/GIS OFFICER) 12/10/2022


HERITAGE COUNCIL
STATE HERITAGE OFFICE
HC CURTILAGE MAP P16610-D GOLDFIELDS WATER SUPPLY SCHEME
REGULATING TANK AND WORK DEPOT SITE, WEST NORTHAM
PREPARED BY CASEY GINBEY (MAPPING/GIS OFFICER) 12/10/2022
GREAT EASTERN HWY
Legend
P16610 Curtilage
P25251 GWWS - NHL Curtilage
Cadastre
0 10 20 40 60 80 100 Meters
GDA 1994 MGA Zone 50
Base information supplied by Western Australian Land Information Authority
SLIP 1180-2020-1
2020 aerial imagery supplied by Western Australian Land Information Authority
(Scale 1:3,200; positional accuracy +/- 1m)


HERITAGE COUNCIL
STATE HERITAGE OFFICE
HC CURTILAGE MAP P16610-D GOLDFIELDS WATER SUPPLY SCHEME
NO. 3 STEAM PUMP STATION, CUNDERDIN
PREPARED BY CASEY GINBEY (SENIOR LAND INFORMATION OFFICER) 12/10/2022
522800
523000
523200
6498200
6498000
FORREST ST
0 10 20 40 60 Meters
GDA 1994 MGA Zone 50
Base information supplied by Western Australian Land Information Authority
SLIP 1180-2020-1
2020 aerial imagery supplied by Western Australian Land Information Authority
(Scale 1:2,000; positional accuracy +/- 1m)
Legend
P16610 Curtilage
P647 - Railway Water Tower
P649 - No. 3 Pumping Station
P25251 GWWS - NHL Curtilage
Cadastre

HC CURTILAGE MAP P16610-**D** GOLDFIELDS WATER SUPPLY SCHEME
NO 4. STATION COMPLEX, MERREDIN

PREPARED BY CASEY GINBEY (MAPPING/GIS OFFICER) 12/10/2022

HERITAGE COUNCIL
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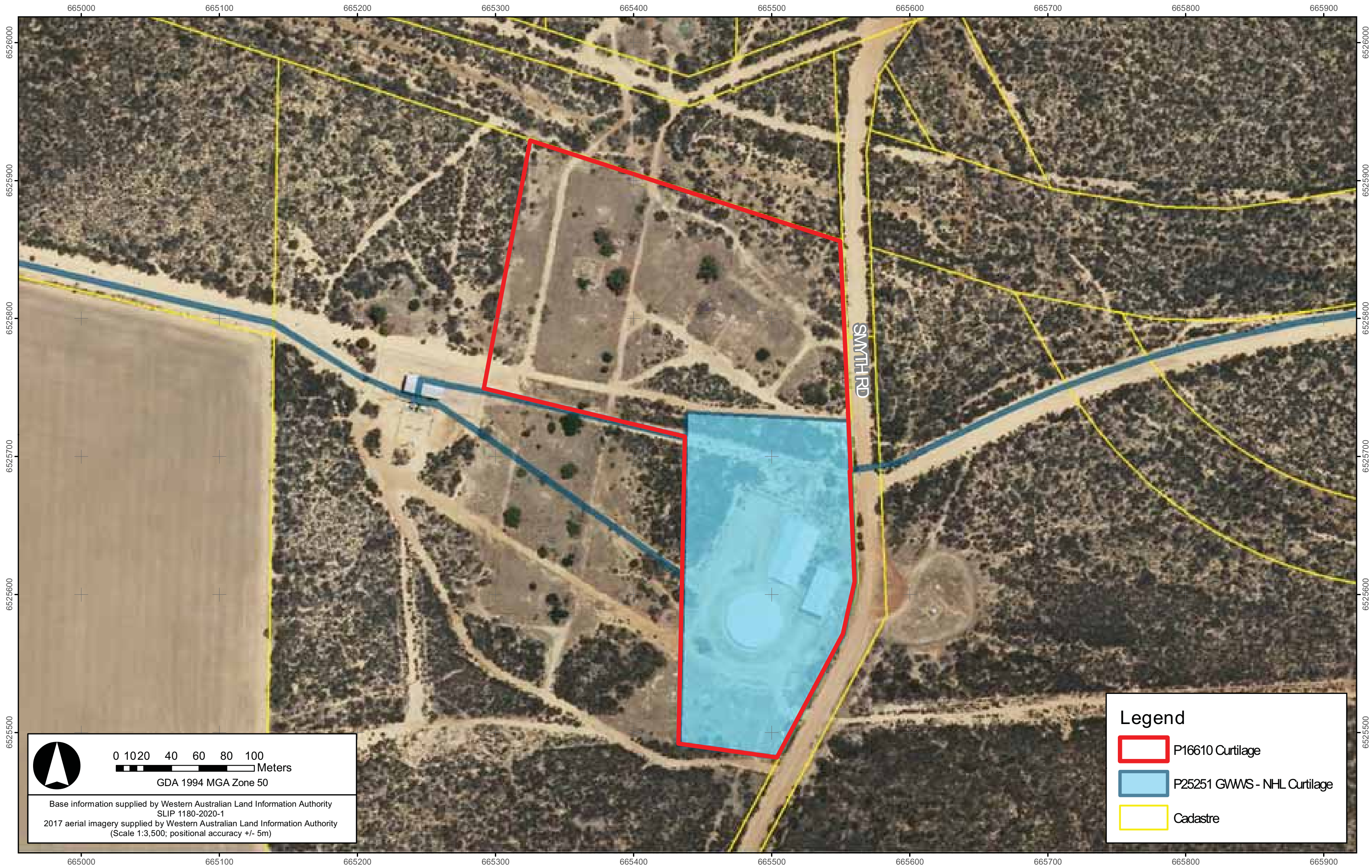
HC CURTILAGE MAP P16610-D GOLDFIELDS WATER SUPPLY SCHEME NO 5. STATION COMPLEX, YERBILLON

PREPARED BY CASEY GINBEY(MAPPING/GIS OFFICER) 12/10/2022



HERITAGE COUNCIL
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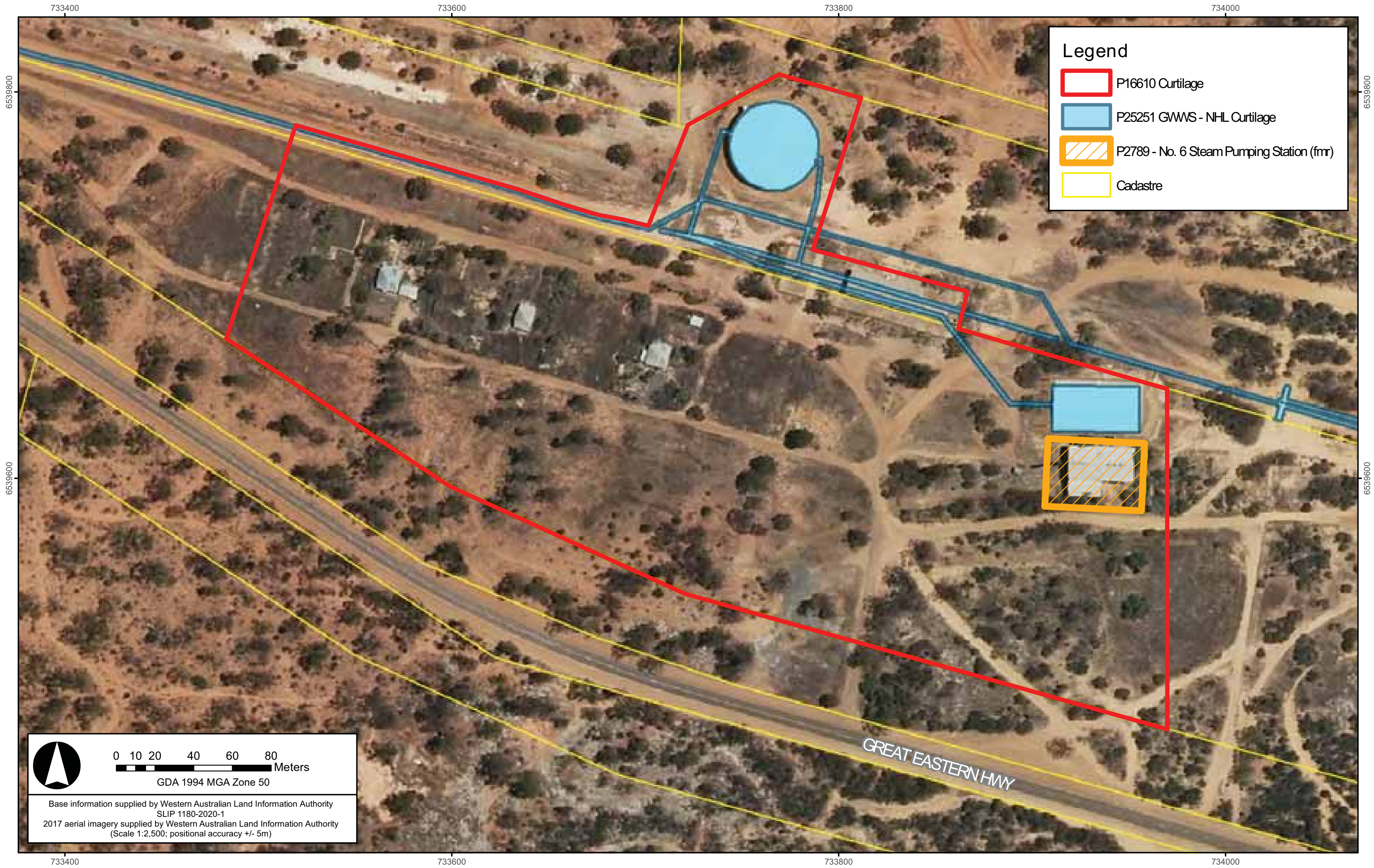
HC CURTILAGE MAP P16610-**D** GOLDFIELDS WATER SUPPLY SCHEME
NO 6. STEAM PUMP STATION COMPLEX, GHOOLI

PREPARED BY CASEY GINBEY (MAPPING/GIS OFFICER) 12/10/2022



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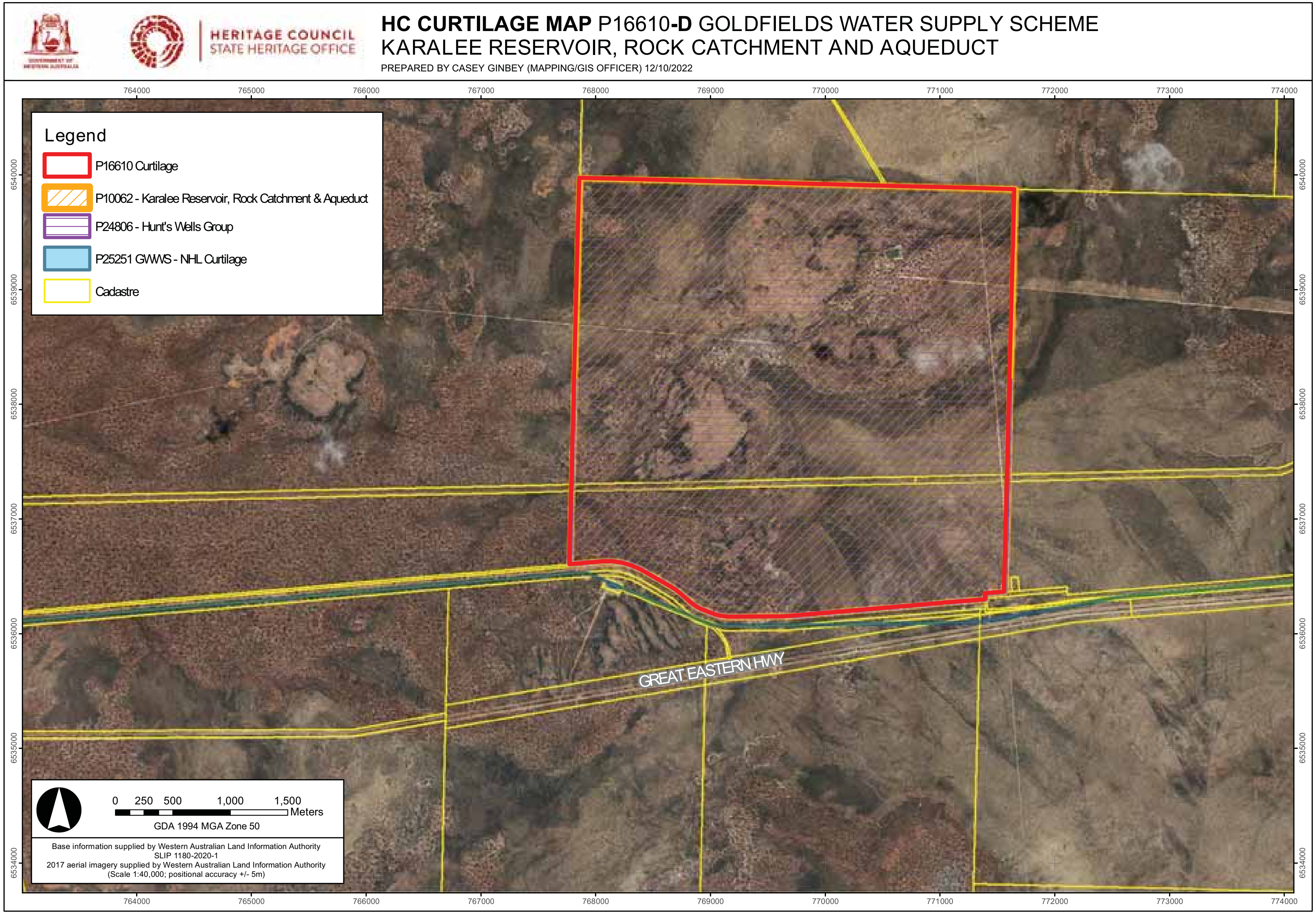
HC CURTILAGE MAP P16610-**D** GOLDFIELDS WATER SUPPLY SCHEME
BRONTI TANK

PREPARED BY CASEY GINBEY (MAPPING/GIS OFFICER) 12/10//2022


HERITAGE COUNCIL
STATE HERITAGE OFFICE
HC CURTILAGE MAP P16610-D GOLDFIELDS WATER SUPPLY SCHEME
KARALEE RESERVOIR, ROCK CATCHMENT AND AQUEDUCT
PREPARED BY CASEY GINBEY (MAPPING/GIS OFFICER) 12/10/2022
Legend
P16610 Curtilage
P10062 - Karalee Reservoir, Rock Catchment & Aqueduct
P24806 - Hunt's Wells Group
P25251 GWWS - NHL Curtilage
Cadastre
GREAT EASTERN HWY
0 250 500 1,000 1,500 Meters
GDA 1994 MGA Zone 50
Base information supplied by Western Australian Land Information Authority
SLIP 1180-2020-1
2017 aerial imagery supplied by Western Australian Land Information Authority
(Scale 1:40,000; positional accuracy +/- 5m)

HC CURTILAGE MAP P16610-**D** GOLDFIELDS WATER SUPPLY SCHEME
KOORARAWALLEE TANK

PREPARED BY CASEY GINBEY (MAPPING/GIS OFFICER) 12/10/2022


HERITAGE COUNCIL
STATE HERITAGE OFFICE
HC CURTILAGE MAP P16610-D GOLDFIELDS WATER SUPPLY SCHEME
SITE OF NO. 7 STEAM STATION COMPLEX, GILGAI
PREPARED BY CASEY GINBEY (MAPPING/GIS OFFICER) 12/10/2022
Legend
P16610 Curtilage
P25251 GWWS - NHL Curtilage
Cadastre
GREAT EASTERN HWY
0 25 50 100 150 200 250 Meters
GDA 1994 MGA Zone 51
Base information supplied by Western Australian Land Information Authority
SLIP 1180-2020-1
2017 aerial imagery supplied by Western Australian Land Information Authority
(Scale 1:6,500; positional accuracy +/- 5m)
211000
211200
211400
211600
211800
212000
212200
212400
212600
6537200
6537000
6536800
6536600
6536400

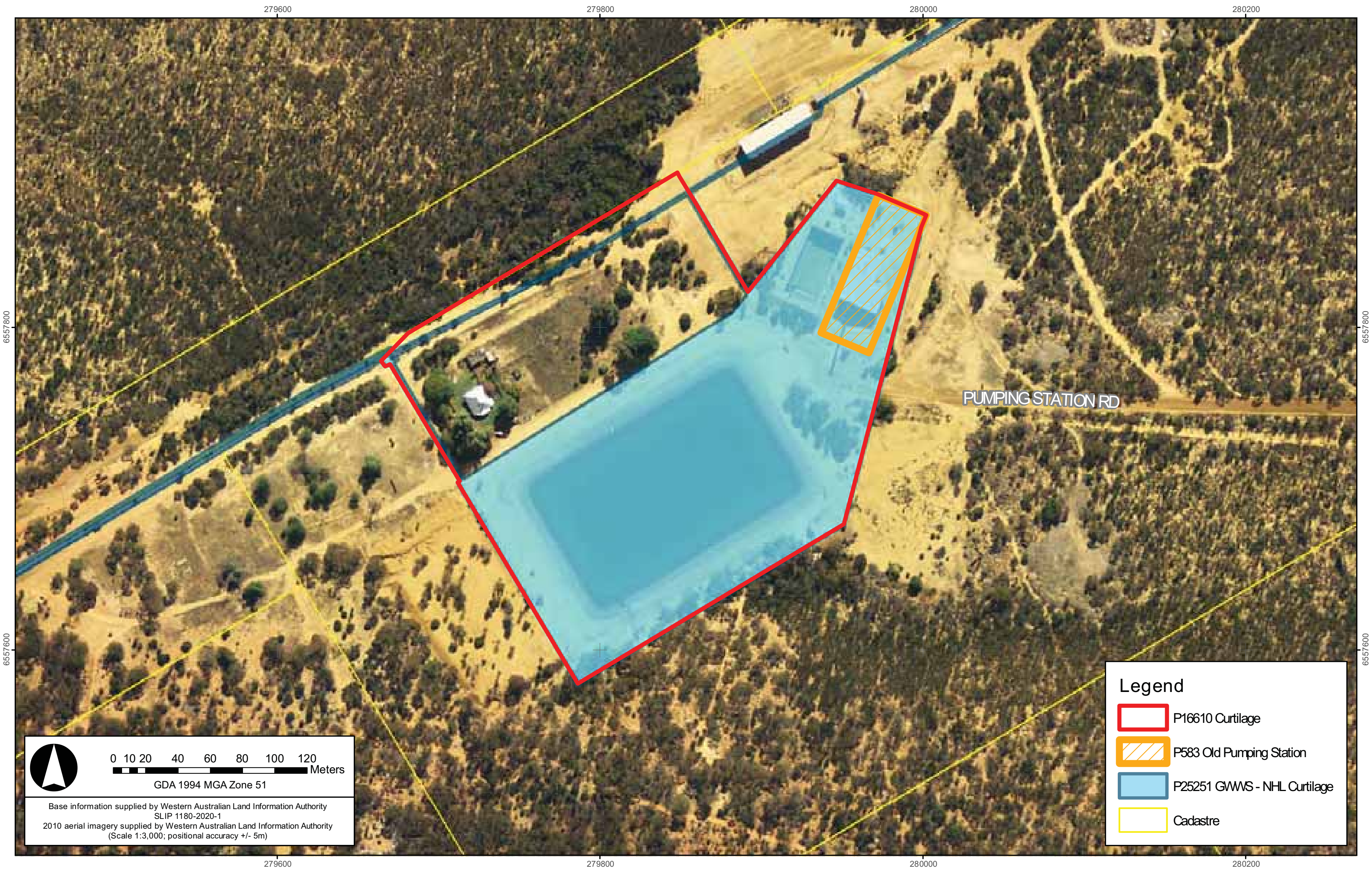
HC CURTILAGE MAP P16610-**D** GOLDFIELDS WATER SUPPLY SCHEME
WEST BULLABULLING RESERVOIR

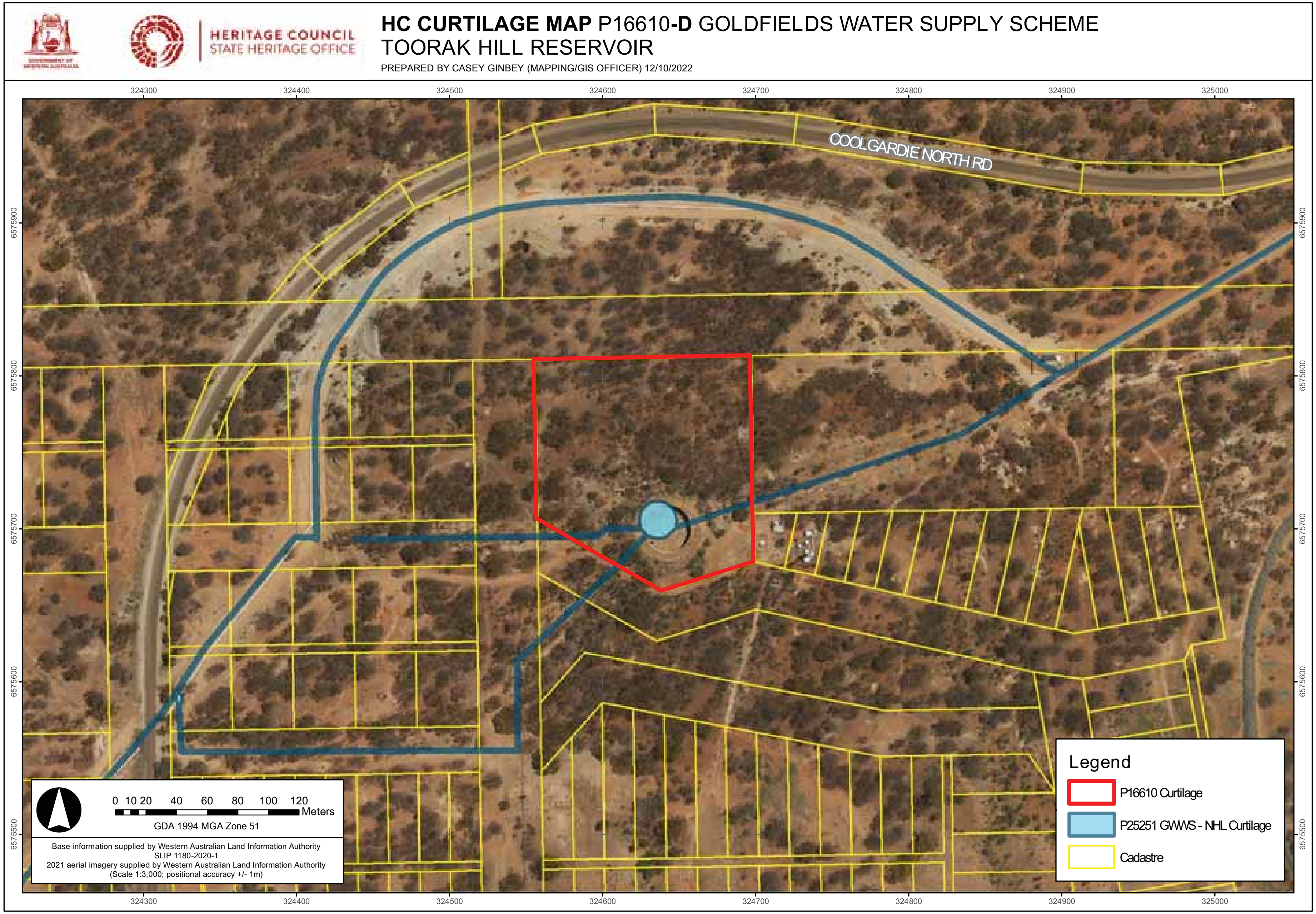
PREPARED BY CASEY GINBEY (MAPPING/GIS OFFICER) 12/10//2022

HERITAGE COUNCIL
STATE HERITAGE OFFICE

HC CURTILAGE MAP P16610-**D** GOLDFIELDS WATER SUPPLY SCHEME
NO. 8 STEAM PUMP STATION COMPLEX, DEDARI

PREPARED BY CASEY GINBEY (MAPPING/GIS OFFICER) 12/10/2022





HERITAGE COUNCIL
STATE HERITAGE OFFICE
HC CURTILAGE MAP P16610-D GOLDFIELDS WATER SUPPLY SCHEME
TOORAK HILL RESERVOIR
PREPARED BY CASEY GINBEY (MAPPING/GIS OFFICER) 12/10/2022
COOLGARDIE NORTH RD
324300
324400
324500
324600
324700
324800
324900
325000
6575900
6575800
6575700
6575600
6575500
0 10 20 40 60 80 100 120
Meters
GDA 1994 MGA Zone 51
Base information supplied by Western Australian Land Information Authority
SLIP 1180-2020-1
2021 aerial imagery supplied by Western Australian Land Information Authority
(Scale 1:3,000; positional accuracy +/- 1m)
Legend
P16610 Curtilage
P25251 GWWS - NHL Curtilage
Cadastre

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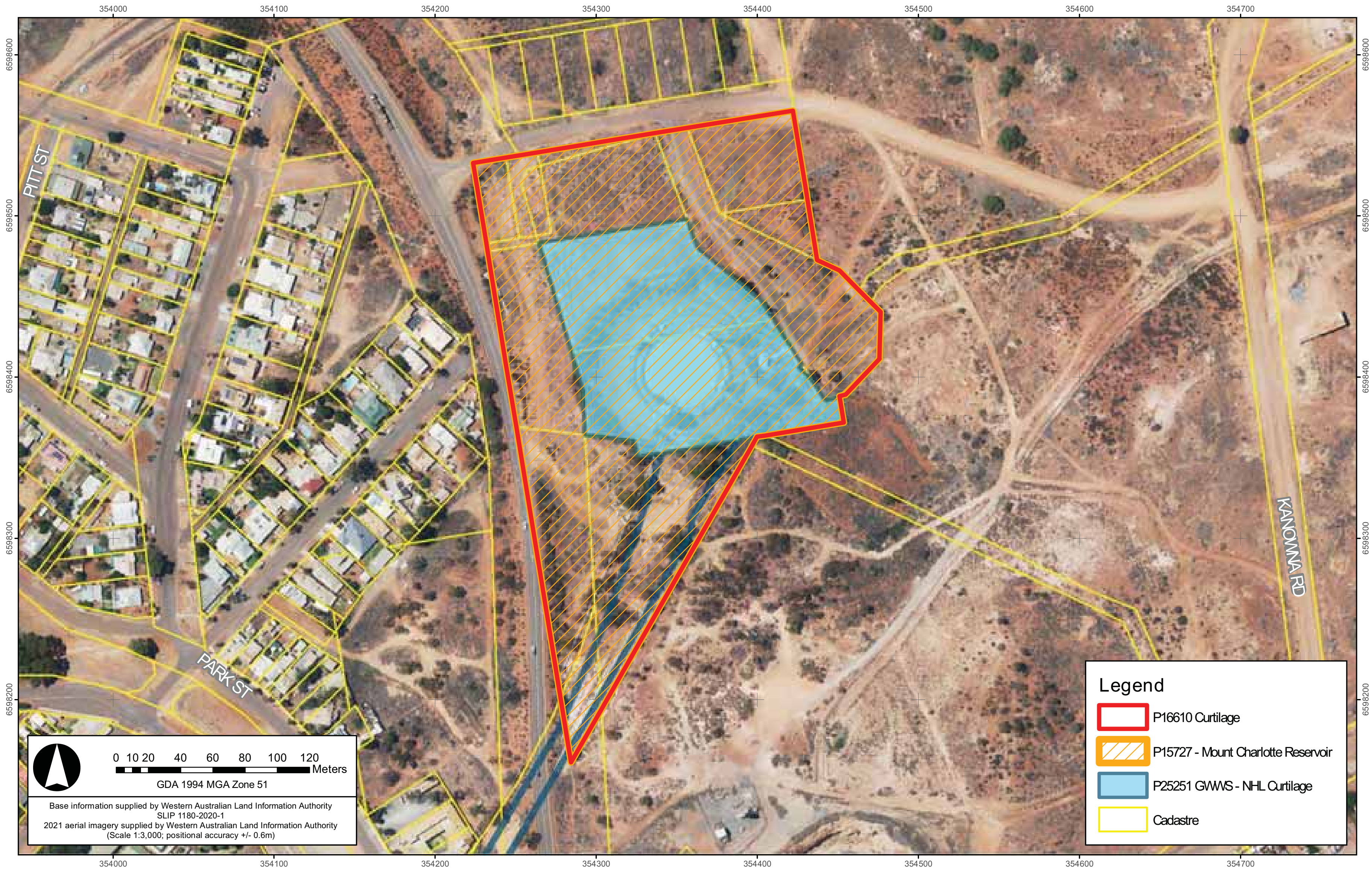
STATE HERITAGE OFFICE

HC CURTILAGE MAP P16610-**D** GOLDFIELDS WATER SUPPLY SCHEME
MOUNT CHARLOTTE RESERVOIR

PREPARED BY CASEY GINBEY(MAPPING/GIS OFFICER) 12/10//2022



Base information supplied by Western Australian Land Information Authority
SLIP 1180-2020-1
2021 aerial imagery supplied by Western Australian Land Information Authority
(Scale 1:3,000; positional accuracy +/- 0.6m)

TECHNICAL NOTE

DATE: 31 MARCH 2021

SUBJECT: **G&AWS MAIN CONDUIT – HERITAGE PRESERVATION STABILISATION OF DECOMMISSIONED SECTIONS FOR DISPLAY**

SUMMARY

Analysis has been made of requirements to stabilise and preserve decommissioned sections of the Goldfields Water Supply Scheme main conduit for display, due its heritage status. Recommendations are made on treatment of the pipeline for long-term display purposes.

BACKGROUND

The Goldfields Water Supply Scheme (GWSS) main conduit is included on the National Heritage List and requires Commonwealth Government referral for approval to remove and replace sections, or otherwise modify the pipeline.[1]

A Heritage Management Plan (HMP) for the main conduit has been prepared to ensure the protection of the heritage values of the whole main conduit, while undertaking pipe repairs, renewals and upgrades to the capacity of the pipeline.[2]

Section of locking bar pipe near Burracoppin (2014)

Through the HMP, Water Corporation is required to arrange and maintain interpretative and retained sites of the main conduit, which includes safe and durable installations, effectively treated and sealed against further corrosion, either painted to match existing or stripped to reveal underlying bitumen.[3]

CURRENT SITUATION

Water Corporation's Property Portfolio Section has sought engineering advice on how best to preserve the decommissioned sections of the main conduit at interpretative and retained sites order to maintain its heritage value.

Three scenarios are being considered and described so that estimates of costs can be prepared and presented to stakeholders:[4]

1. 1 km long section of decommissioned pipeline left insitu, mostly above ground and made up of locking bar or Kellerberrin pipeline visible from Great Eastern Highway;
2. 100 m long section of decommissioned pipeline left insitu, all above ground and made up of locking bar or Kellerberrin pipeline visible from Great Eastern Highway; and
3. 20 m (2-length) section of locking bar pipeline, transferred and displayed in a community friendly interpretive site, accessible to the public, such as a town park.

[1] Commonwealth of Australia Special Gazette (No. S106, 23 June 2011)
[2] EPBC Heritage Management Plan, Goldfields Water Supply Scheme Main Conduit, Griffiths Architects, 2016, p.2
[3] Management Plan, p.57
[4] Email from Daniel Stevens, Water Corporation, 9 Feb 2021

STABILISATION OF DECOMMISSIONED PIPE

Managing thermal expansion of decommissioned main conduit above-ground pipeline sections (pipe left empty)

The extent of expansion and contraction due the temperature changes that would occur on sections of decommissioned main conduit pipeline retained for display purposes has been calculated, taking into account resistance to movement posed by anchor and support blocks, and any underground sections.

Water Corporation design temperature range criteria for above ground steel pipework is maximum 58°C to minimum -7°C, as stated in standard general notes on main conduit design drawings.[5] This is supported by measurements and a thermal model of the temperatures of an out of service (empty) steel pipe for Hydro Tasmania (2006), which found that on a sunny day, the pipe surfaces can reach temperatures of 25 - 30 °C above ambient temperature, and during out of service times, pipe temperatures could rise to more than 60°C.[6]

For the purposes of calculating total pipe movement, the following assumptions have been made:

- Pipeline is empty
- Pipe temperature is reasonably uniform
- Pipeline sections are fully exposed to the Sun
- Highest temperature = 63°C, lowest temperature = -7°C
- Initial restraint from overhead anchor blocks and pipe support saddles is included

Anchor blocks on above ground sections of the pipeline were designed to restrain movement when full of water, which from experience generally limits the temperature range to 18°C - 35°C.

However, the greater temperature range of the empty pipe will create forces that are likely to exceed the anchor block capacity, resulting in damage to the anchor block and loss of restraint. Seasonal unrestrained longitudinal thermal movement for sections of steel pipe on display under these scenarios may vary from as much as 0.3 m in long (1 km) insitu sections to approximately 1 mm in short (20 m) relocated display sections.

Thermal expansion will also occur in the hoop of the pipes, which can also contribute to cracking of anchor blocks, however this can be controlled through use of compressive pads around the pipe at overhead anchor blocks.

Proposed arrangements for securing the display sections to accommodate the expected temperature range of the empty decommissioned pipeline are described below.

Short (2-length) section relocated for display

Even though predicted expansion is quite small, experience has shown that it may be enough to cause cracking of concrete anchor blocks if expansions stresses are restrained. Movements due to thermal expansion can be minimised if the display section is anchored at the centre and allowed to expand over the pipe support blocks, as shown in Sketch 1 below.

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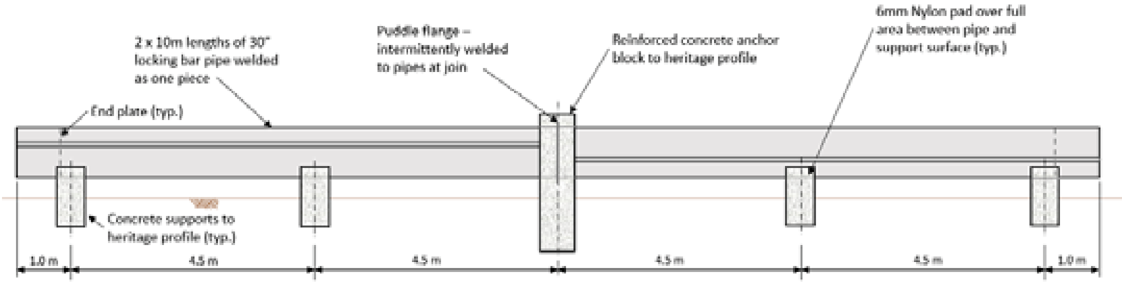
[5] For example: Drawing ML07-1-1B, GAWS Coolgardie, Main Conduit Replacement - CH493. to 503.5, General Notes

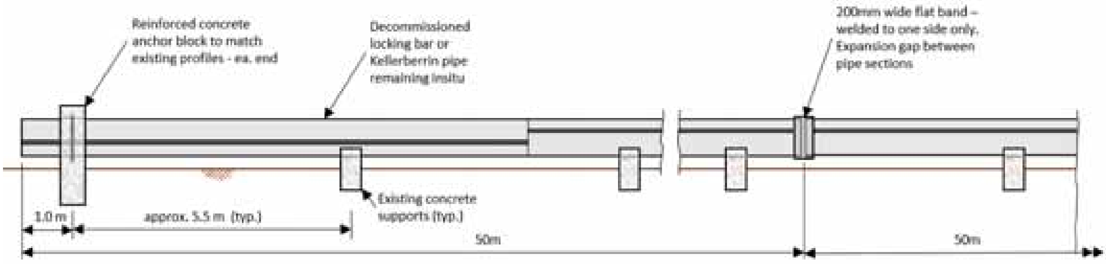
[6] *Pipeline Protection and Extension of Internal Coating Life*, Dr J. Sargison, "Corrosion and Materials", Vol 31, No 2, April 2006 (https://eprints.utas.edu.au/2300/1/pipelineprotection.pdf)



Sketch 1: Proposed typical relocated short display section of locking bar pipe

Medium Length sections insitu – 100 m

For 100 m sections of decommissioned pipeline left insitu it is proposed that each section be cut into 2 x 50m lengths, with an initial 90mm gap provided between the sections to accommodate movement due to temperature changes. The gap will be covered with a 200mm flat welding band, welded on one side only. The proposed arrangement is shown in Sketch 2, and a typical detail of the expansion joint is shown in Sketch 4, below. Other pipe supports and anchor blocks would be reconstructed with nylon pads between concrete and pipe, to allow expansion to occur without risk of damage.

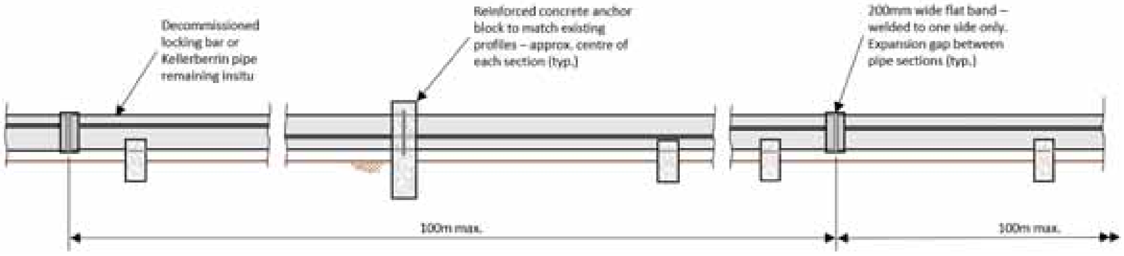


Sketch 2: Proposed 100m insitu length interpretive display section of locking bar pipeline

Long sections insitu – 1 km

For longer lengths of decommissioned pipeline left insitu, construction of anchor blocks to fully resist thermal expansion stresses would require large reinforced concrete anchors, not in keeping with the appearance of the pipeline during its operating life.

For such long (1 km) lengths, it is proposed that the pipe be cut into 100m sections, with a puddle flange anchor block installed at about the centre of each section and an air gap and welded band covering, as described above, installed between each section. The proposed arrangement is shown in Sketch 3. Low-friction pads will also be inserted between pipe and support blocks. Depending on the land profile at each display section and if necessary, additional anchor blocks with puddle flange may be installed in order to stabilise overall movement, replacing an existing overhead anchor block where practicable.



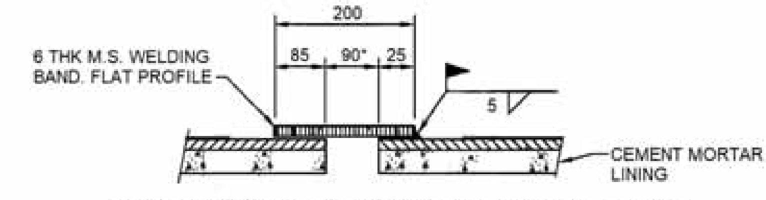
Sketch 3: Proposed 1 km insitu length interpretive display section of locking bar pipeline

3

Document ID: 113976744

Air Gap Arrangement

Gaps cut into the insitu pipeline to allow temperature movement will be installed when the pipe temperature is in the range 18°C - 25°C and sized such that the initial gap is 90mm (±5mm). The air gap will be covered by a flat band welding band, welded on one side only. The pipe protective coating will then be reinstated, as described below. Covering of the gap is considered necessary to maintain a continuous pipeline appearance and to prevent entry of small animals. Modelling has shown the air gap may vary between 30mm - 120mm over the temperature range nominated above.



Sketch 4: Proposed typical expansion joint arrangement

PROTECTIVE COATINGS OF DECOMMISSIONED PIPE

Part of the heritage value of the main conduit is its external appearance, which varies along the length of the pipeline. It is proposed that this be retained for both insitu display sections and interpretive displays. Final colours for sections requiring repair or reinstatement following preparation for display will thus be matched as closely as practicable to the insitu colour(s).

Coatings for operational pipeline assets, including the main conduit, are required to comply with Water Corporation Design Standard DS95.[7] It is proposed that the sections retained for display and interpretive use continue to be protected by this standard.

Coating systems applied and maintained to DS95 have a minimum design life to first minor maintenance of 10 years, which is categorised as no more than 1% of the total surface area having corrosion of the parent metal. Adoption of this system will ensure that display sections maintain a satisfactory appearance in keeping with the heritage nature of the displays without the need for continuous maintenance.

As the display sections of pipeline will be mostly or entirely above ground, and entirely within the agricultural and goldfields regions east of the Perth metropolitan area, it is assessed that the atmospheric corrosivity category in DS95 for coating protection purposes is C2 (Low). This applies to dry rural areas as well as other regions remote from the coast or sources of pollution.

For sections left insitu it is proposed that all sharp edges, cut faces, damaged surfaces and rusted areas be ground smooth, slightly rounded, cleaned, prepared and coated in accordance with DS95 specifications, as follows:

- A1 - Surface Preparation for the Application of Protective Coatings on Steel or Cast Iron
- B1 - Inorganic Zinc Silicate Coating on Steel or Cast Iron
- C2 - Zinc Rich Epoxy Primer, Epoxy Mastic Coat, Polyurethane Topcoat on Steel or Cast Iron

[7] DS95 - Standard for the Selection, Preparation, Application, Inspection and Testing of Protective Coatings on Water Corporation Assets

Repairs to pipe coatings damaged insitu, from transport, field welding or vandalism will be reinstated by the application of two or more coats of an epoxy zinc rich coating from a Water Corporation approved manufacturer in accordance with coating specification:

- H3 - Repair of Zinc Coated Structures

Sealing of Ends

For all sections of decommissioned pipeline, the ends will be cut square and sealed shut with a circular plate set back from the open end and fully welded to the pipe. The cement lining will be cut back as necessary to enable the plate to be installed and then reinstated.

Where appropriate on short display sections, the steel plate may be positioned about 750mm back from pipe end and the cement lining reinstated at least in part to show how the internal cement lined protected the pipe. For locking bar pipes, the cement lining will be removed for about 150mm from the pipe ends and exposed steel surfaces painted with a clear-coat protective paint, so the steel pipe internal and the locking bar joint are visible for inspection.

For the longer sections, where close inspection of the pipe is not as likely to occur, the circular plate will be seal welded approximately 100mm from the pipe openings, with the cement lining removed on the outside of the plate.

Prepared by:

Tim Rigden
PRINCIPAL ENGINEER
WATER CONVEYANCE DESIGN
WATER CORPORATION

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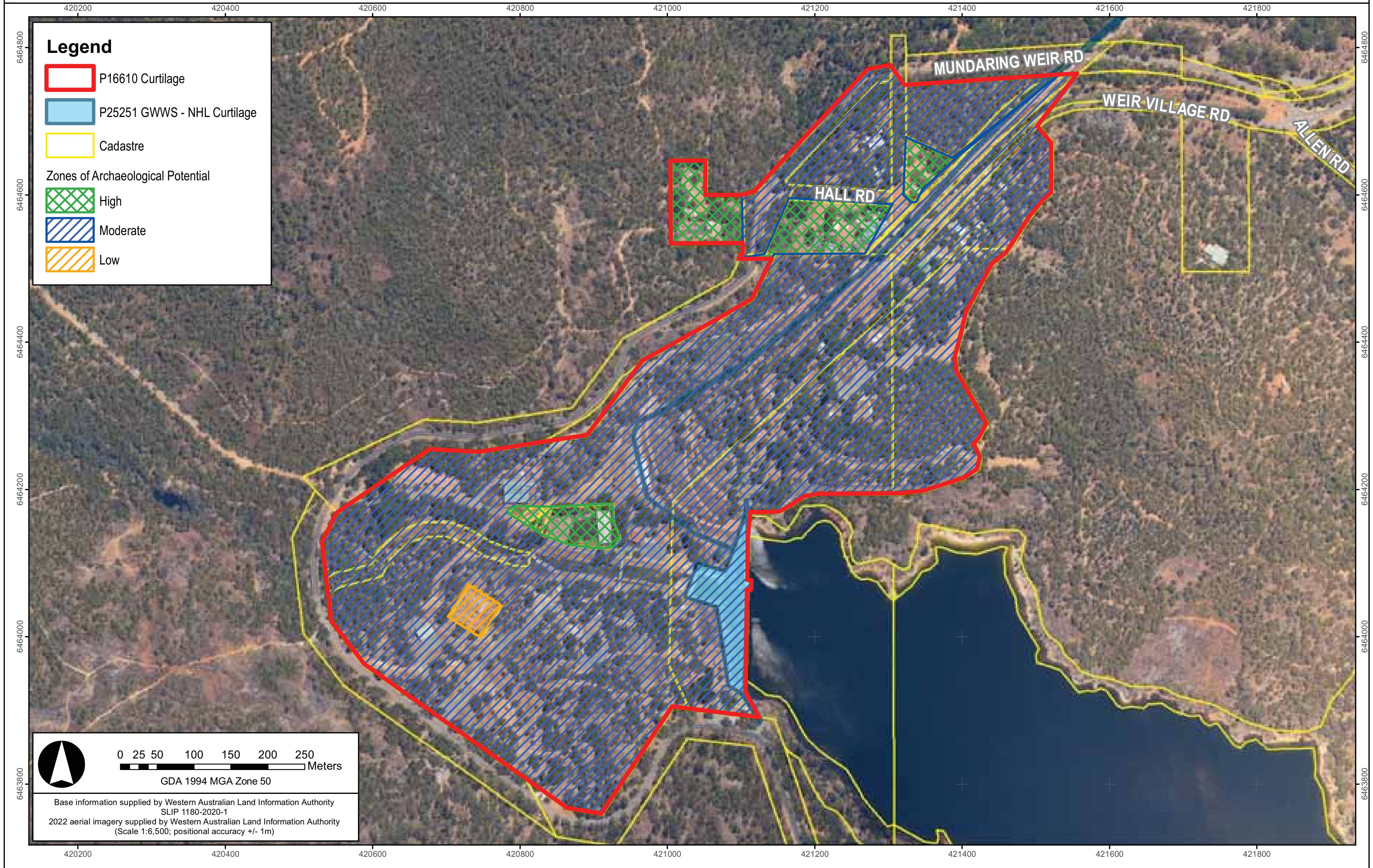
P16610 GOLDFIELDS WATER SUPPLY SCHEME
NO. 1 STATION COMPLEX, MUNDARING AND MUNDARING WEIR - ZONES OF ARCHAEOLOGICAL POTENTIAL

PREPARED BY TIMOTHY KIPPO (MAPPING/GIS OFFICER) 3/06/2022



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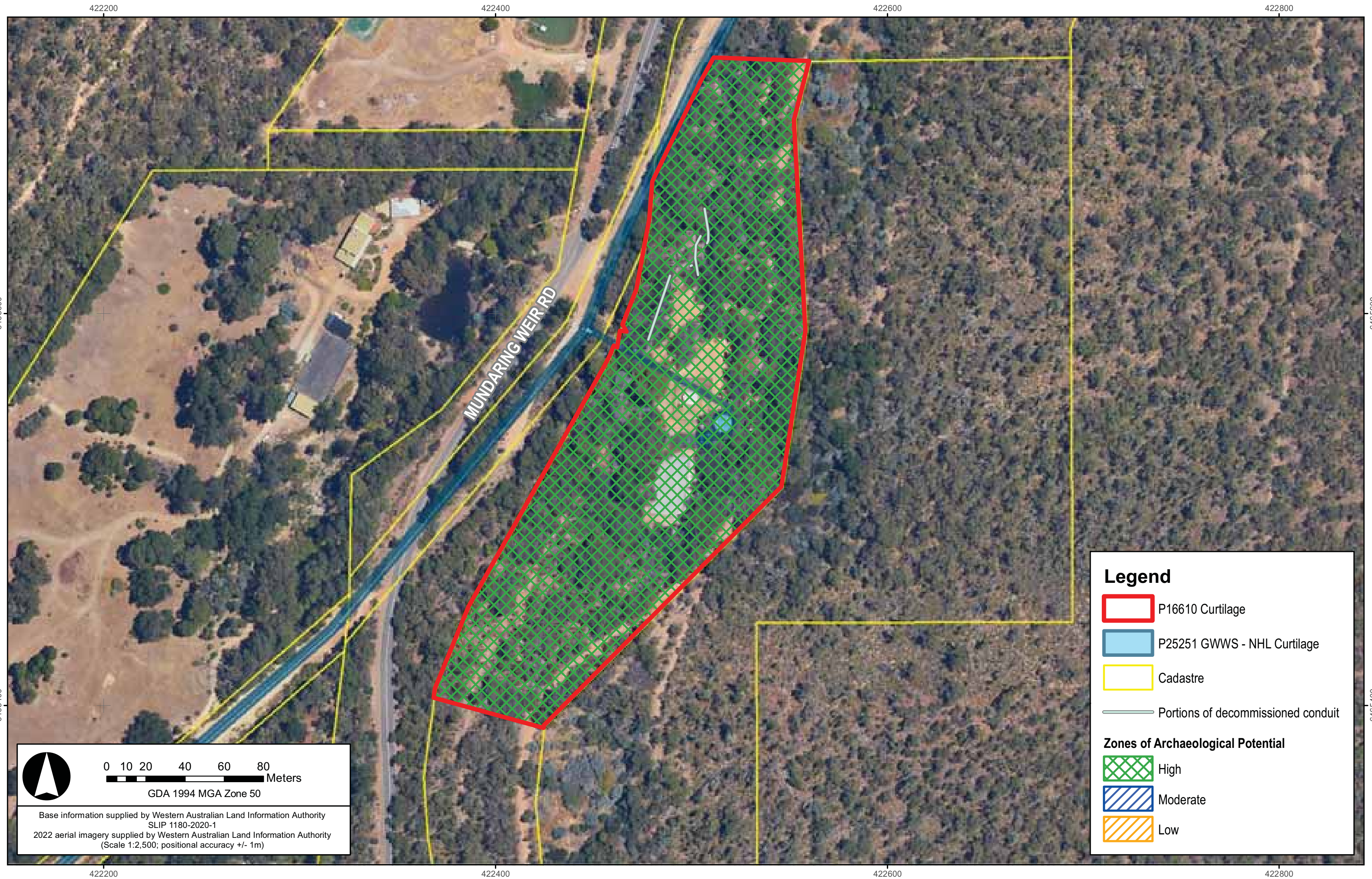
P16610 GOLDFIELDS WATER SUPPLY SCHEME
SITE OF NO. 2 PUMP STATION, O'CONNOR - ZONES OF ARCHAEOLOGICAL POTENTIAL

PREPARED BY TIMOTHY KIPPO (MAPPING/GIS OFFICER) 23/05/2022



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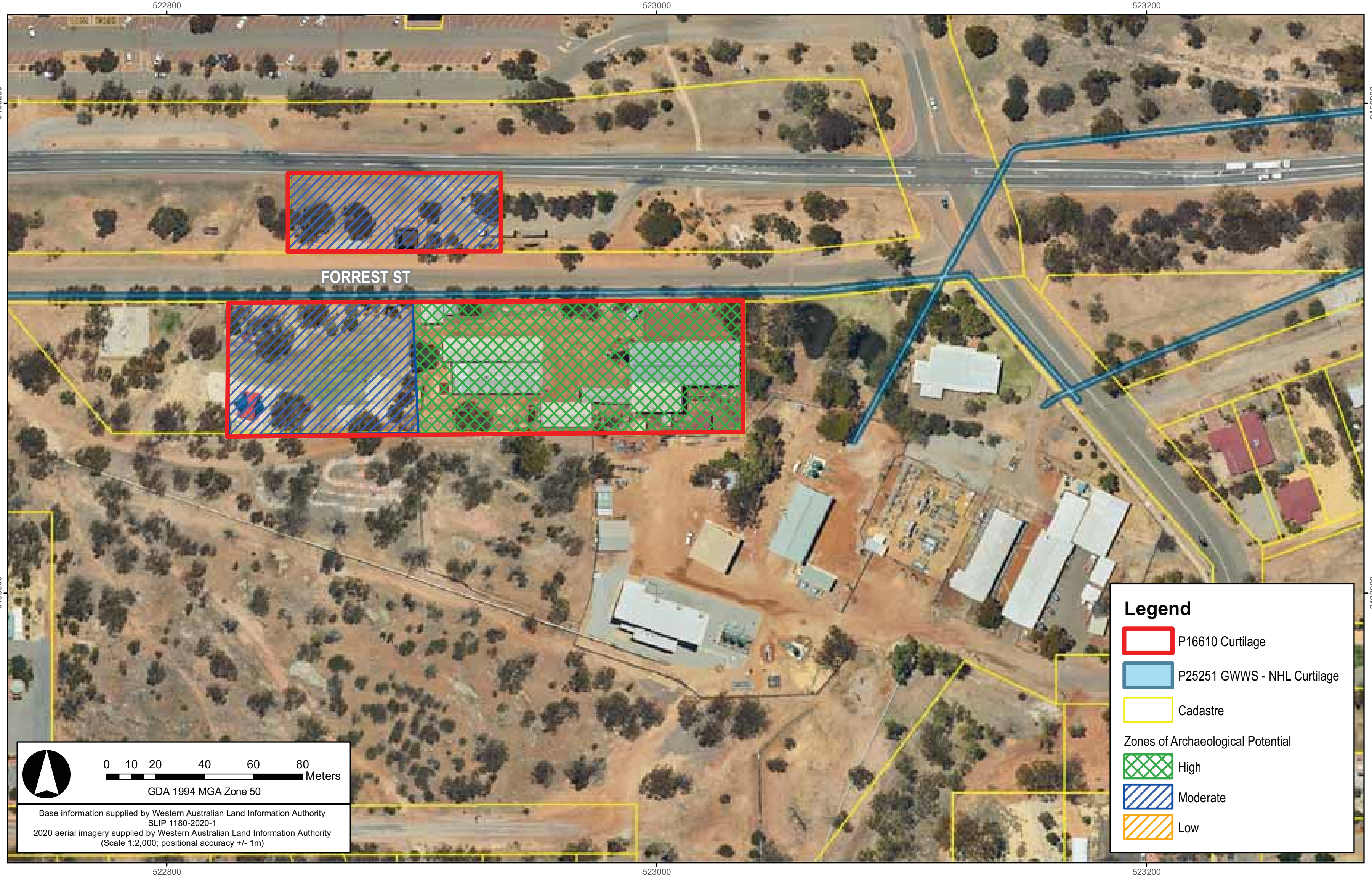
P16610 GOLDFIELDS WATER SUPPLY SCHEME
NO. 3 STEAM PUMP STATION, CUNDERDIN - ZONES OF ARCHAEOLOGICAL POTENTIAL

PREPARED BY TIMOTHY KIPPO (MAPPING/GIS OFFICER) 23/05/2022



HERITAGE COUNCIL
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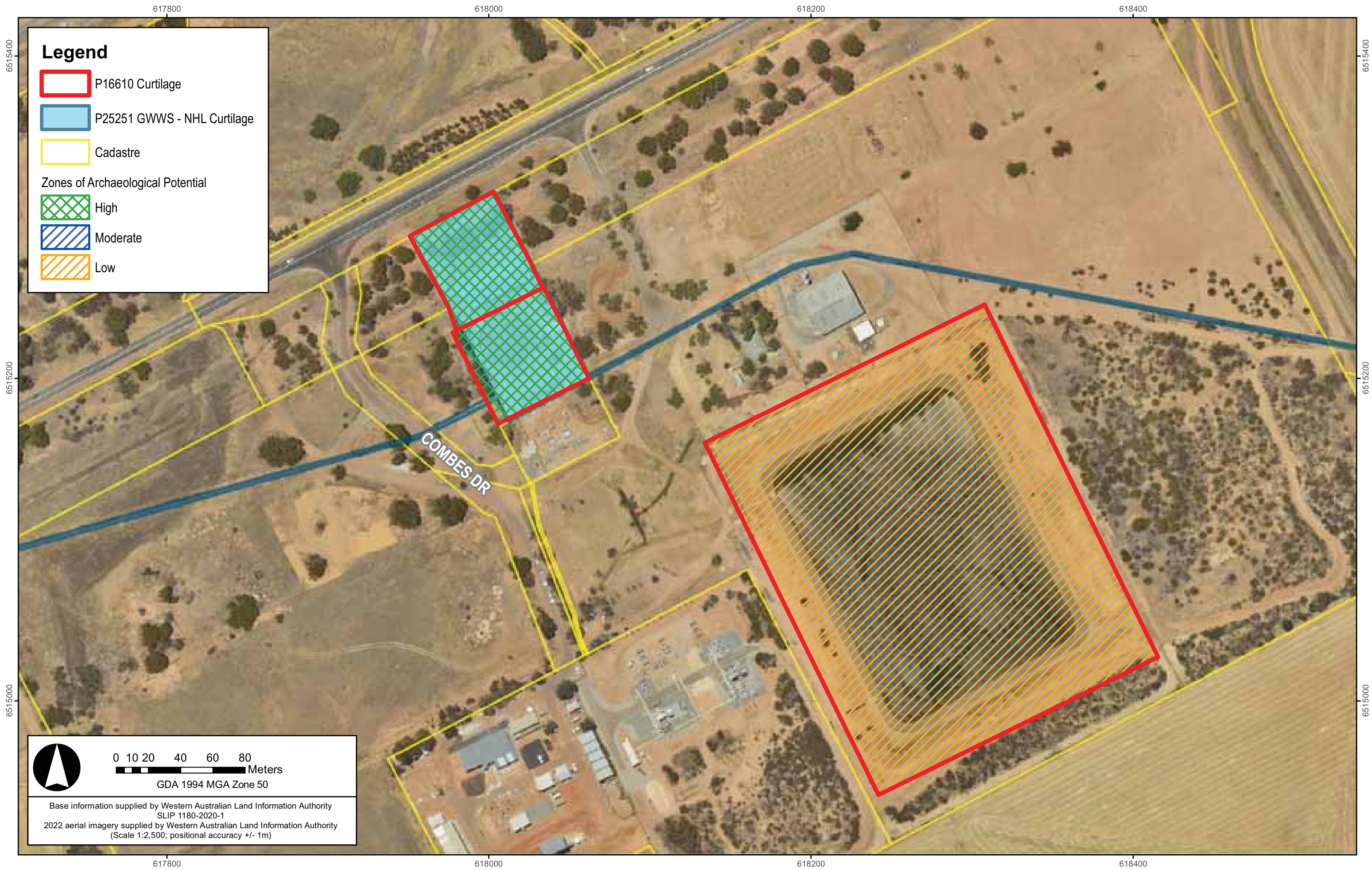
P16610 GOLDFIELDS WATER SUPPLY SCHEME
NO 4. STATION COMPLEX, MERREDIN - ZONES OF ARCHAEOLOGICAL POTENTIAL

PREPARED BY TIMOTHY KIPPO (MAPPING/GIS OFFICER) 23/05/2022



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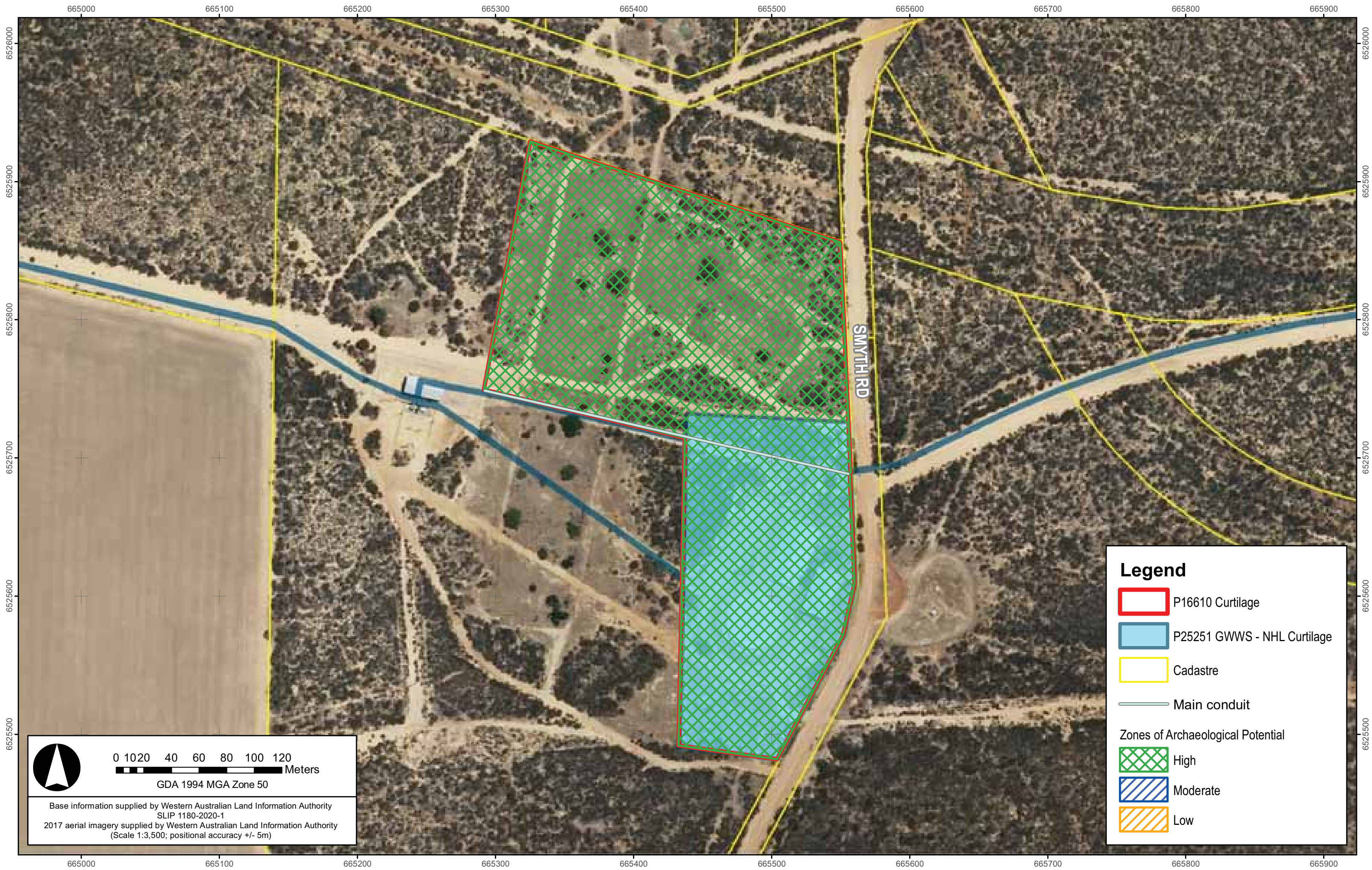
P16610 GOLDFIELDS WATER SUPPLY SCHEME
NO 5. STATION COMPLEX, YERBILLON - ZONES OF ARCHAEOLOGICAL POTENTIAL

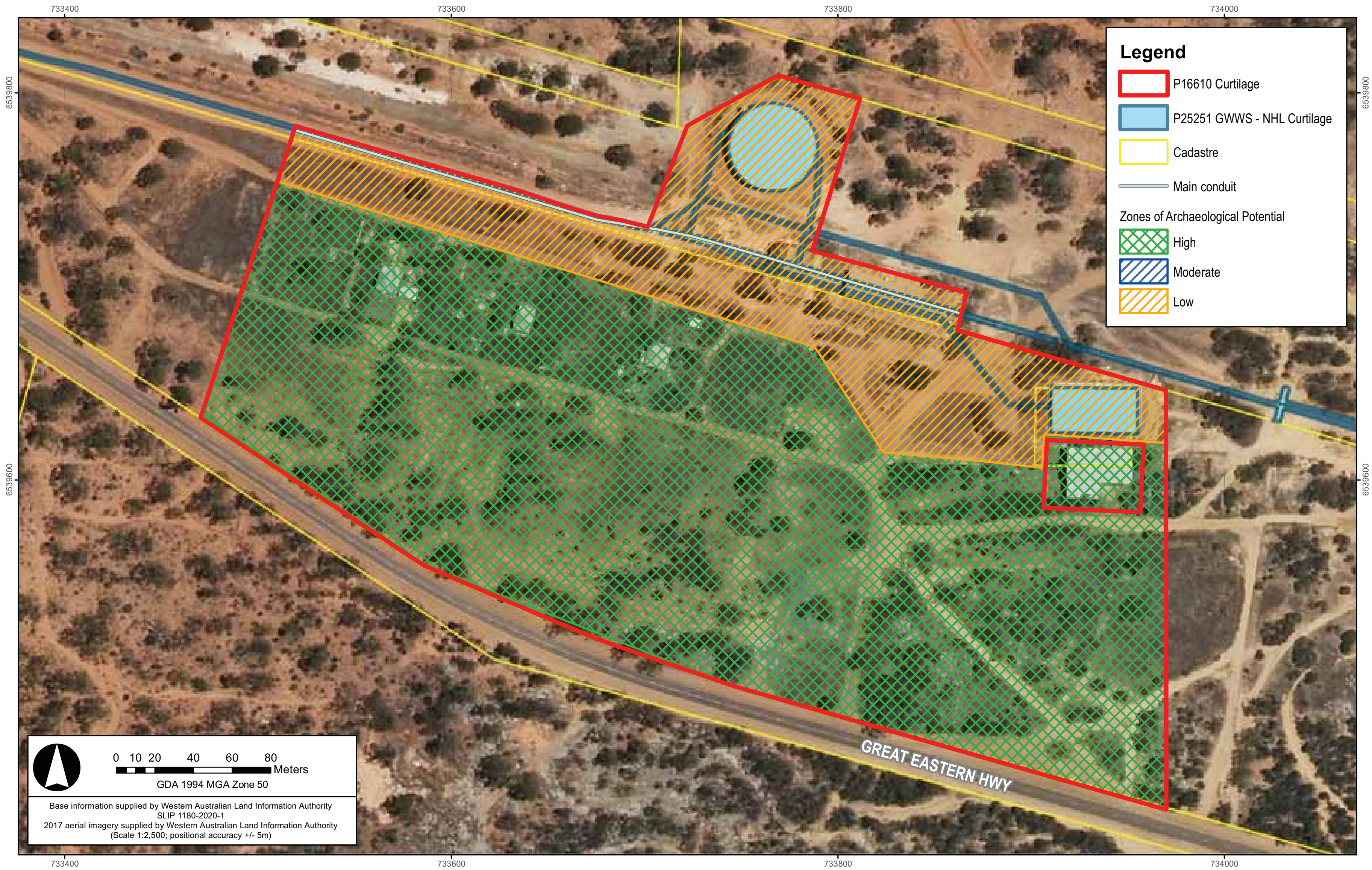
PREPARED BY TIMOTHY KIPPO (MAPPING/GIS OFFICER) 23/05/2022



HERITAGE COUNCIL
STATE HERITAGE OFFICE

P16610 GOLDFIELDS WATER SUPPLY SCHEME
NO 6. STEAM PUMP STATION COMPLEX, GHOOLI - ZONES OF ARCHAEOLOGICAL POTENTIAL

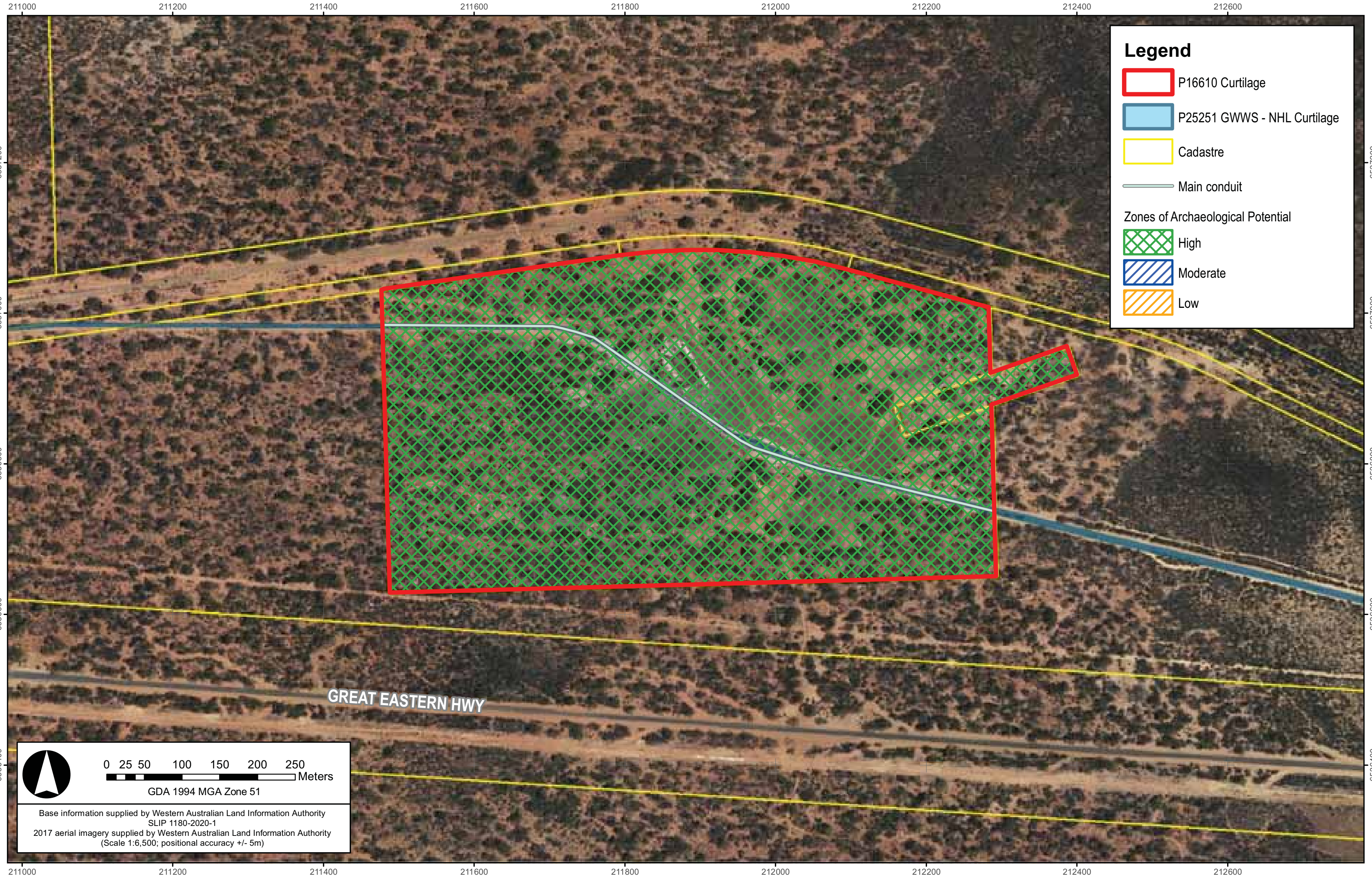
PREPARED BY TIMOTHY KIPPO (MAPPING/GIS OFFICER) 3/06/2022



HERITAGE COUNCIL
STATE HERITAGE OFFICE

P16610 GOLDFIELDS WATER SUPPLY SCHEME
SITE OF NO. 7 STEAM STATION COMPLEX, GILGAI - ZONES OF ARCHAEOLOGICAL POTENTIAL

PREPARED BY TIMOTHY KIPPO (MAPPING/GIS OFFICER) 3/06/2022



Base information supplied by Western Australian Land Information Authority
SLIP 1180-2020-1
2017 aerial imagery supplied by Western Australian Land Information Authority
(Scale 1:6,500; positional accuracy +/- 5m)

HERITAGE COUNCIL
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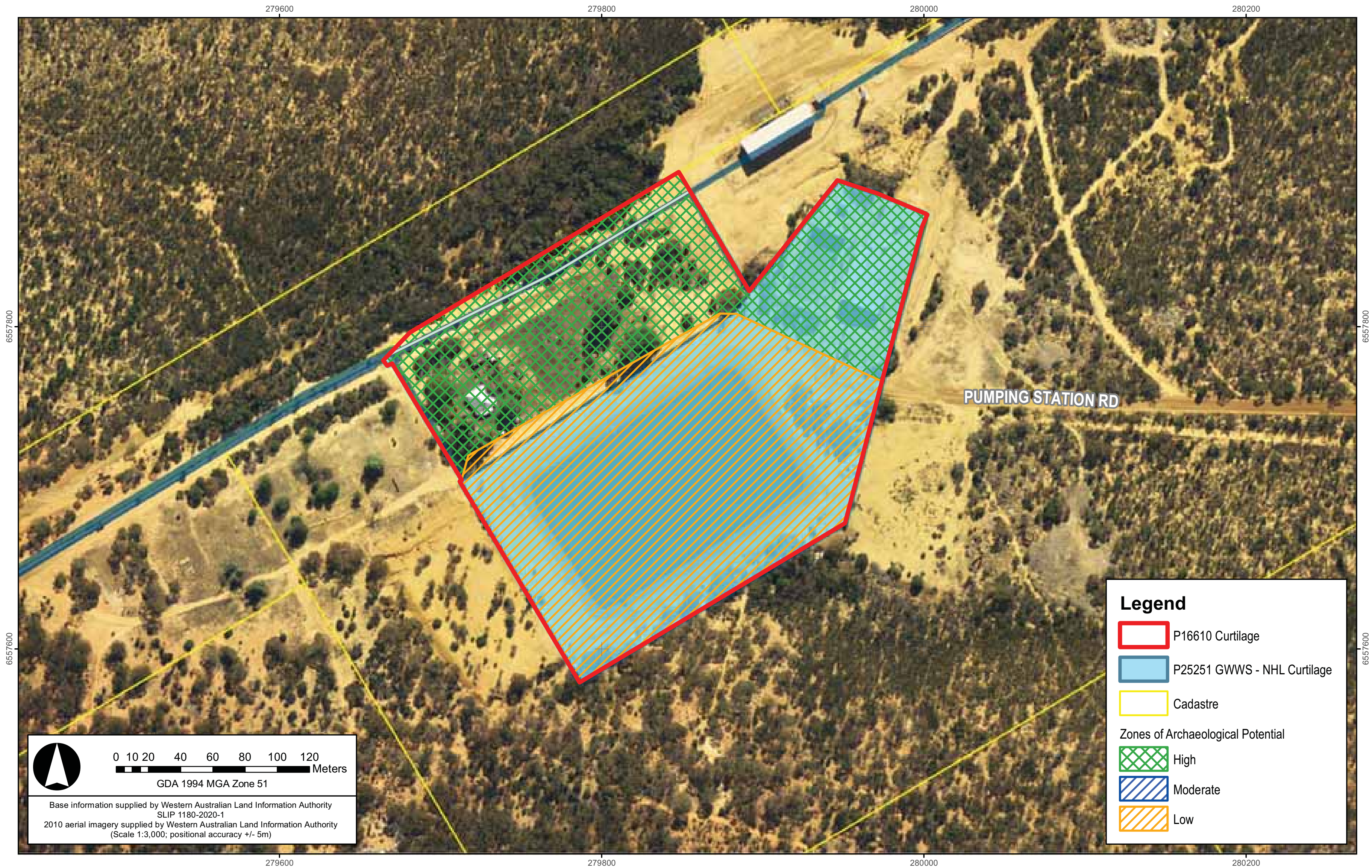
P16610 GOLDFIELDS WATER SUPPLY SCHEME
NO. 8 STEAM PUMP STATION COMPLEX, DEDARI - ZONES OF ARCHAEOLOGICAL POTENTIAL

PREPARED BY TIMOTHY KIPPO (MAPPING/GIS OFFICER) 3/06/2022



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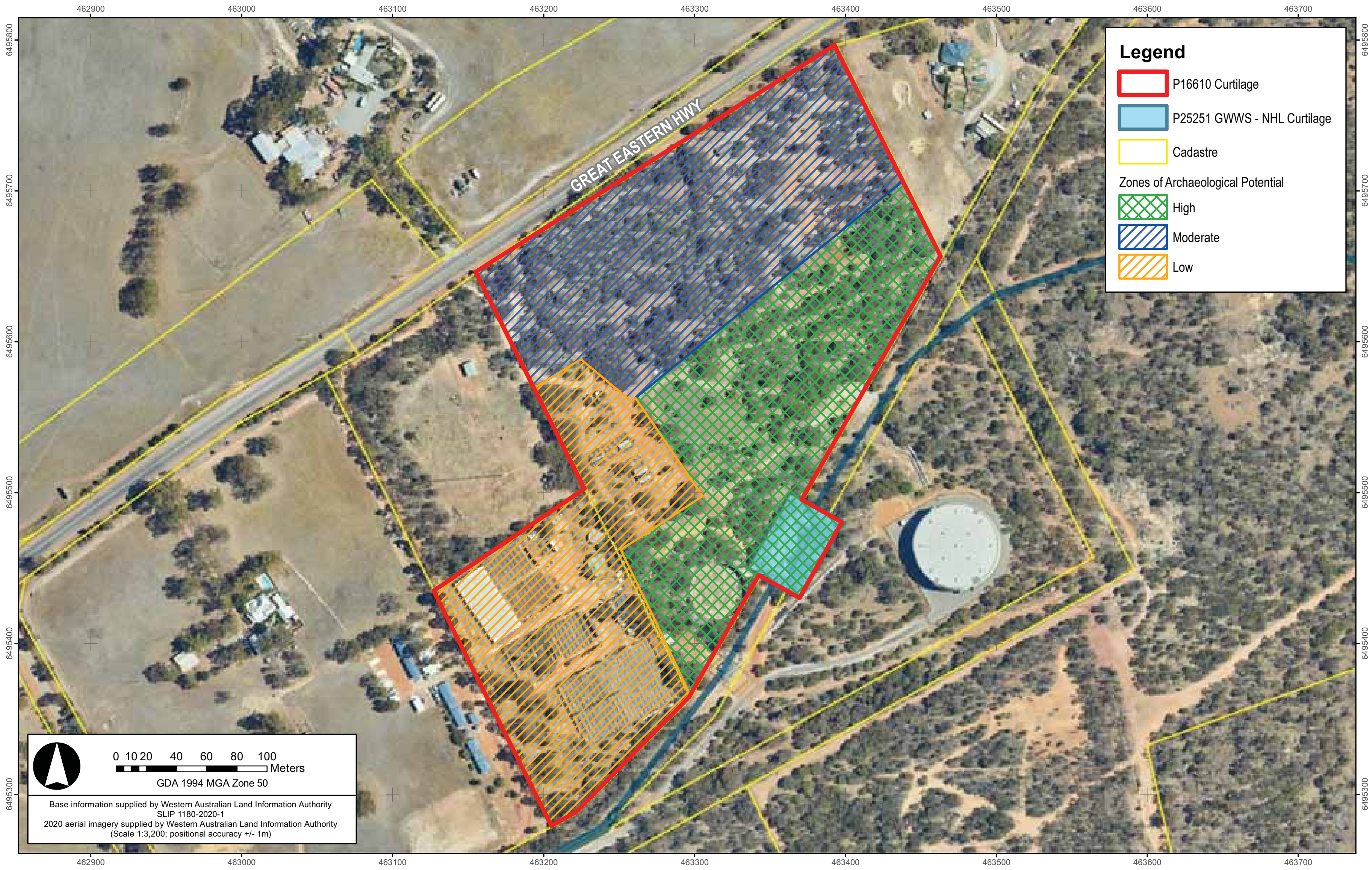
P16610 GOLDFIELDS WATER SUPPLY SCHEME
REGULATING TANK AND WORK DEPOT SITE, WEST NORTHAM - ZONES OF ARCHAEOLOGICAL POTENTIAL

PREPARED BY TIMOTHY KIPPO (MAPPING/GIS OFFICER) 23/05/2022



APPENDIX EIGHT – CONTRACTOR PROCEDURE HANDOUT – ARCHAEOLOGICAL FINDS DISCOVERY

PROCEDURE - ARCHAEOLOGICAL FINDS DISCOVERY

Archaeological potential occurs across the entire project area, especially in areas of high and moderate archaeological potential. Please refer to Map 19at the end of this document:

PLEASE BE AWARE:

ALL GROUND DISTURBING WORKS MUST BE MONITORED BY THE PROJECT ARCHAEOLOGIST

During ground disturbing works[18] in the following must occur objects such as the following are found: bricks, concrete, limestone blocks, historical and Aboriginal artefacts including bottles, glass, ceramics, animal bone and metal, flaked and ground stone tools

Action	Process	Personnel	When
1. Stop Work Immediately	The discoverer will notify machine operators working in the vicinity to stop work to avoid further disturbance of the structure or object. Do not move or touch the found item.	Discoverer	Immediately upon discovery of any object
2. Notify the Site Supervisor and the Managing Contractor	Discoverer informs the Site Supervisor. The Site Supervisor informs the Managing Contractor.	Discoverer, Site Supervisor	Immediately
3. Protect the Find	If possible, fence off the affected area with at least a 2 m buffer. Keep all work away from the area until it has been assessed by the Archaeologist.	Site Supervisor	ASAP
4. Document	Take at least two photographs (using mobile phones) of the find with something for scale (pens, hands, ruler, people)	Site Supervisor	ASAP
5. Notify the Archaeologist	The Managing Contractor contacts and advises the Project Archaeologist of the find. The Managing Contractor emails the photographs to the Archaeologist and provides details of where the find is located (including depth, if possible).	Managing Contractor	ASAP

[18] These are defined as any activity that disturbs the ground below 100 mm. It can include activities such as topsoil clearing, grubbing, geotechnical testing, grading, cutting, trenching, potholing pits (excluding vacuum potholing), deep excavation and pipe jacking (launch and retrieval pits).

Action	Process	Personnel	When
6. Initial Assessment of the Find	The Archaeologist views the photographs and advises the Managing Contractor on whether a site visit is required.	Project Archaeologist	ASAP but within 24 hours to minimise delays
7. On-Site Assessment of the Find	If a site visit is required, the Managing Contractor will notify the Site Owner. The Archaeologist assesses the find and in consultation with the Managing Contractor will arrange the recording of the objects and possible salvage.	Managing Contractor, Project Archaeologist	ASAP
8. Recording / Salvage	The Archaeologist to follow the Project Archaeological Management Plan.	Archaeologist	ASAP
9. Clearance	Once salvage is complete the Archaeologist informs the Managing Contractor that the area is clear. Archaeologist informs the Managing Contractor if additional conditions for continued work are required.	Archaeologist	Following assessment
10. Resume Work	Managing Contractor informs the Site Supervisor.	Managing Contractor	ASAP

During any ground disturbing works in the High Archaeological Risk Area the following need to occur

1. The project archaeologist is present when all new instances of ground disturbance is undertaken. This includes bulk excavation, service trench excavation, pot-holing pits and, geotechnical and environmental investigative works.
2. The continued monitoring of the works will occur at the discretion of the project archaeologist. The archaeologist may decide that their on-site attendance is not required. In such instances:
    a. A heritage inducted Site Supervisor will monitor the works for archaeological finds and features.
    b. If archaeological finds or features are identified during the works, the Archaeological Discovery Procedures detailed in Appendix Four should be followed.
    c. The project archaeologist will undertake spot inspection of the works to ensure that Archaeological Management Strategies outlined in this AMP are being met.
    d. The project archaeologist should be notified when the Water Corporation or its sub-contractors plan to commence new instances of ground disturbance, e.g. opening bulk excavation, services trenches or pot-hole excavation.
    e. The works programme shall be sufficiently flexible to allow for recording any archaeologically significant stratigraphic layers or features uncovered during the disturbance.

Contact Numbers for Project

Role	Name	Contact Details
Project Coordinator		
Site Supervisor		
Project Archaeologist		

POTENTIAL FINDS AND FEATURES

The following pages provide some examples of the kinds of heritage and archaeological finds and features that may be encountered during the project. These examples have been taken from around Fremantle and Perth. If in doubt, please contact the Project Archaeologists using the process outlined in this handout.

Features and Structures

Image showing identified edge of feature and telecommunications service	
Limestone road camber	
Historic telecommunication service at intersection of High and Queen Streets	

Limestone rubble from original St Johns Church foundations underneath the limestone road capping	
Concrete kerb and gutter and laid bricks	

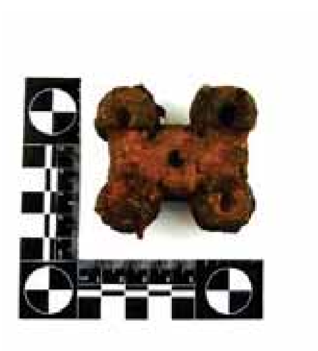
Loose Historical Finds

Find	Description	Images
	Ceramics	
Bottle	Partial Stoneware bottle, Doulton & Watts, 1818-1854	
Candle Holder	Partial whiteware (right), stoneware and earthenware candle holders. Dated between 1835-1870.	
Tableware	Plate fragments with Mather's Patent Fly Paper Plate. This is a rare example of a pest control object - a highly decorated and informative plate for attaching fly paper. Images of bees, flies and mosquitoes lining the plate, and advertisements on the back. Dated to 1867.	
Toy	Glazed hard and soft paste porcelain doll fragments. These were made in the 'Frozen Charlotte' style. Dated between 1850 and 1920.	

Find	Description	Images
Bottle	John Liddlelow, Perth, stoneware bottle. Locally made stoneware by a Perth businessman - emigrated from England and set up businesses locally. Name also misspelled on bottle (common occurrence). Dated to 1856	
Serving Plate	Serving plate/dish fragments, decorated with deliberate holes, perhaps where one holds the dish. Dated to 1790-1860's	
Tobacco Pipe	Clay smoking pipe fragments, <1900	
Container	Victorian Ointment pot from Thomas Holloway's medicinal range, for "the cure of gout and rheumatism". The artefact is representative of Victorian era medicine ("cure all"). This artefact can be relatively dated as we know when Thomas Holloway's buisness move to 533 Oxford Street, London (1868-1881)	

Find	Description	Images
Ink Bottle	Penny ink bottles, measuring approximately 55 mm high, were produced from 1860-1915	

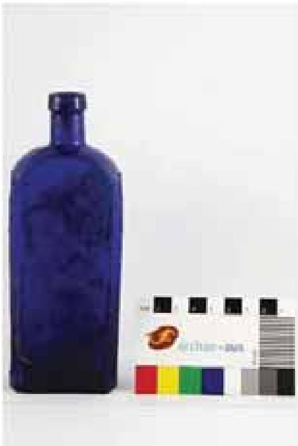
Find	Description	Images
Metal		
Coin	Australia Half Penny coin, 1939-1952	
Ammunition	.577 Snider bullet, brass fill, c.1800's, Fremantle	

Find	Description	Images
Horseshoe	Horseshoes related to the blacksmiths, Kings Square	
Fitting	Carriage fitting, Kings Square	
Building Materials	A range of fixings including nails, screws, washers, bolts and seals made of iron, copper, aluminium or lead.	
Container	Metal pot, handles missing, inscribed with makers mark. A domestic item which is rarely found in good condition. Unable to be dated.	

Find	Description	Images
Chisel	Metal chisel, rusted, unable to be dated.	
Horseshoe	Horseshoe, heavily corroded and unable to be dated.	

Find	Description	Images
	Glass	
Thimble	Glass thimble holder, c.1800, Fremantle	

Find	Description	Images
Window	Amber glass with floral pattern, c. 1960s, Fremantle	
Marble	Glass Tom Bowler marble, crushed, c. 1846-1900, Fremanlte	
Glass bottles	Cache of pre 1850s black glass bottles on river bed	
Jar	Pickle jars with a wide mouth, dated between 1828 and 1915.	

Find	Description	Images
Bottle Fragment	Contact artefact – black glass bottle base that has been retouched. This object is both representative of an imported item (from Scotland – Dawson Dufftown Glenlivet) that was also used by an Aboriginal person to manufacture their traditional tools. It is an example of cross culture and very significant. Dated to 1896.	
Bottle	Maugham patent bottle, Perth and Fremantle Crowder and Letchford, dated to >1845. Shape used for transporting on ships, while keeping liquid aerated.	
Bottle	Intact cobalt glass bottle for pharmaceuticals or poisons, >1845	
Bottle	Black (dark olive green) glass bottle, which are rarely found in good condition. Dated to c.1760-1870.	

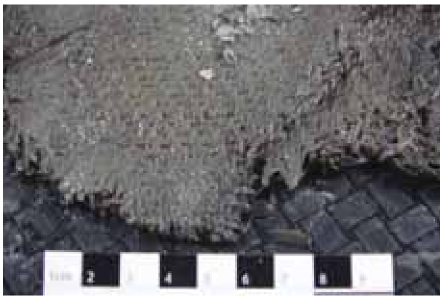
Find	Description	Images
Bottle Stopper	Glass bottle stopper, dated to >1800's	
Ink Well	Glass inkwell, mostly intact. Commonly used up until the 1870s /1880s.	

Find	Description	Images
Maritime		
Fish Hooks	Iron fish hooks, Fremantle	
Light Rudder	Timber and iron, dated to the 19th Century. Likely discarded from a docked boat and assocatied with the use of the jetty	

Find	Description	Images
Anchor	Ironstock anchor, heavily rusted and concreted. With fluke and broken shank	
Propeller	Copper alloy three blade propeller. Unknown date.	
Bilge Pump	Copper alloy upright hand operated bilge pump. Unknown date.	
Boat Part	Corroded rowlock	

Find	Description	Images
Mooring	Train wheels used as mooring	

Find	Description	Images
Organics		
Burnisher	Bone burnisher leather working tool, London made c.1800, Fremantle.	
Bone	Horse bone fragment, found near blacksmiths at Kings Square, Fremantle	
Coal	Three large fragments of coal, used on steam boats.	

Find	Description	Images
Rope	21 mm diameter rope, approximately 1,200 mm in length	
Sack	Hessian sack material associated with timber feature in Area 2	
Wood	Loose find of wood. Unable to be dated.	
Timber	Loose timber, unable to be dated.	

Find	Description	Images
Construction		
Brick	Sandstock (handmade) brick, which represents the method for manufacturing brick prior to the introduction of machines. Dated to <1850	
Brick	This convict-made sandstock brick represents part of the convict system of Western Australia (the use of convicts for manufacture and labouring. Dated to 1850.	
Block	Granite block used for jetty construction. 19th century.	

Aboriginal Cultural Material

Find	Description	Photograph
Stone Tool	Quartzite Kodja, A stone axe traditional to the Aboriginal groups of the Southwest. These tools were usually hafted with resin to a hardwood handle.	
Stone Tool	Small dolerite complete flake.	
Spear	"Spear with wooden barb, Eucalyptus doratoyxlon (spearwood mallee), King George Sound, 1821	 Image source: http://museum.wa.gov.au/museums/albany/yurlmun-mokare-mia-boodja
Boomerang	Boomerang, *Allocasuarina fraseriana*, sheaok, King George Sound, 1870	 Image source: http://museum.wa.gov.au/museums/albany/yurlmun-mokare-mia-boodja
Spear thrower	19th century spear thrower collected by Henry Krips in the South-west	

Find	Description	Photograph
		Image source: http://nma.gov.au/av/resistance/applets/395/show_tell395_text.htm
Taap knife	Collected in 1831-33 by Alexander Collie from Menang people in Albany	 Image source: http://www.nma.gov.au/learn/encounters_education/community/albany
Kodj axe	Collected in 1831-33 by Alexander Collie from Menang people in Albany	 Image source: (National Museum Australia 2015: 101)

Nexus File Structure - Summary

Link: https://nexus.watercorporation.com.au/otcs/cs.exe/app/nodes/94155215

Overarching folder for GWSS Heritage. Contains all following folders related to the Main Conduit EPBC Act approval plus workspaces for all Water Corporation owned or managed components of the Nationally Listed scheme.

Heritage Management Plan:
Link: https://nexus.watercorporation.com.au/otcs/cs.exe/app/nodes/135266183

Contains Heritage Management Plan and all documentation required to address 1 – 2 of EPBC Act approval 2019/8547.

The folder also contains all details in relation to project web page.

Interpretation Strategy:
Link: https://nexus.watercorporation.com.au/otcs/cs.exe/app/nodes/162980318

Contains Interpretation Strategy and all documentation required to address 4 and 5 EPBC Act approval 2019/8547.

The Public History Research Project undertaken in accordance with Conditions 6b and c can be found here:
Link: https://nexus.watercorporation.com.au/otcs/cs.exe/app/nodes/161369080

Main Conduit Decommissioning and Archival Records:
Link: https://nexus.watercorporation.com.au/otcs/cs.exe/app/nodes/135248715

The folder contains:

1. plans of all pipe replacement projects
2. archival records for each pipe replacement project (Conditions 3a and 6a);
3. details of provision of decommissioned pipeline elements to the community for interpretation, conservation or artistic reuse (Condition 3b)

General conditions and monitoring:
Link: https://nexus.watercorporation.com.au/otcs/cs.exe/app/nodes/135264189

Contains compliance plans and reports, and all documentation required to address 7 – 20 of EPBC Act approval 2019/8547 (Administrative Conditions)

EPBC Act Self Assessments:

Contains records of 'self-assessments' of projects' potential impacts on the National Heritage values of the GWSS:

Link: https://nexus.watercorporation.com.au/otcs/cs.exe/app/nodes/81778748

STANDARD WORK INSTRUCTION

C00001 - Pipeline (Water) – Inspection

Objective	Assess the condition of water pipeline and ensure that no illegal connections have been made and that the asset condition is recorded. Specify repair priority, mark up and record any corrosion, rust spots or leaks on pipeline. Provide the Maintenance Planner and Operation Manager with information to allocate resources for banding programme.
Training and competency	STOP Ensure all training and competencies required for this task are completed and up to date on the Learning Management System. (LMS) Guidance as per Training & Competency Matrix (Nexus Link)
Specialised PPE, Materials or Equipment	• Spray paint for marking – along with appropriate PPE.
Reference Documents	• Banding Inspection and Mark Up Sheet - FY18: https://nexus.watercorporation.com.au/otcs/cs.exe/app/nodes/44899163

Locate, plan and set-up the work site	Step	Action
	1.	STOP Complete Safe Job Planning and identify any additional hazards not identified in the JHA.
	2.	Check site conditions.

Check	Step	Action
	3.	Travel pipeline visually checking Pipe Sections, Pipe Barrel, Pipe Joints, Bolsters & Overheads for:
	4.	Temporary repairs, rust, corrosion, weeps and leaks,
	5.	Coating deterioration, structural deterioration,
	6.	Hazards and anomalies.

Locate and Inspect	Step	Action
	7.	Locate pipeline markers and note any visual defect, leaks or damage to other items associated with the pipeline including:
	8.	Valves: section, scour, air, bleeder, fittings,
	9.	Pits, covers, lids, ladders, landings, handrails
	10.	Soil erosion, steel trestle & concrete pipe supports, brackets, access road, pipeline markers.

STANDARD WORK INSTRUCTION

C00001 - Pipeline (Water) - Inspection

For each pipe section defect;	**Step**	**Action**
	11.	Mark a cross and the Kilometre mark with spray paint on the identified pipe section area.
	12.	Fill in all applicable details on the Pipe Inspection & Mark-up sheet during the inspection:
	13.	Kilometres as determined from pipeline markers.
	14.	Diameter of the pipe section.
	15.	Specify the repair priority: Plug Immediately P Fix within 6 months 1 Fix within 12 months 2 Fix within 2 years 3
	16.	Specify the Band Type and Size required.
	17.	Specify any temporary repair consumables (Plug, Ford Clamp).
	18.	Note any vegetation clearing required within 12 months.

Check and Record	**Step**	**Action**
	19.	For each attached service connection; Check against PDA or map GIS information to confirm location of service.
	20.	For each attached service connection; Report location and photograph illegal connections or unauthorised use of scours.
	21.	Using the mobile field device: Note defect location on the PDA device.
	22.	Using the mobile field device: Photograph the mark up, defect or illegal service – Essential
	23.	On return to field office: Inspection sheet to Team Leader who will send scan & images to Maintenance Planner.
	24.	On return to field office: Sites with wooden plug are to be registered into Sentinel.
	25.	On return to field office: Notify Team Leader to arrange for a separate work order to be created for any additional work identified that is not covered by this work instruction.

Pack up, paperwork and provide feedback	26.	Notify Team Leader to arrange for a separate work order to be created for any additional work identified that is not covered by this work instruction
	27.	Completed Safe Job Planning document – Stored locally in the TL office.
	28.	Forward completed inspection sheet and photographs to the Maintenance Planner.
	29.	Complete the PDA feedback report. Include: • Photos
	30.	Submit a work order if further work or maintenance is required.

Source Document	Version
21011440	1

WATER CORPORATION

Proposed Action—National Heritage 'Self-Assessment' Form

***Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act)**

Date:	
Name of Project:	
Self-Assessment Form Nexus Location:	https://nexus.watercorporation.com.au/otcs/cs.exe/app/nodes/81778748
Property File Nexus Location (if applicable):	
Project Manager/Section Proposing the Action:	
Recommendation on EPBC Act Referral:	Senior Planner – Property Portfolio
Person/Section Approving the Action:	Manager – Property Portfolio

NOTE: This self-assessment form is not required for 'Permitted Actions' and 'Emergency Works' as defined in the HMP and Standard Work Instruction C00001.

PURPOSE OF SELF-ASSESSMENT:

The Goldfields Water Supply Scheme (GWSS) was included on the National Heritage List in 2011. The listing comprises 16 elements and includes the main conduit between Mundaring and Kalgoorlie, historic steam pumping stations and other assets. The inclusion of the GWSS in the National Heritage List means that the scheme is a Matter of National Environment Significance (MNES) and is protected under the EPBC Act and Regulations. Any works that might have a 'significant impact' on the GWSS' national heritage values should be referred for assessment under the Environment Protection and Biodiversity Conservation Act 1999 (Cth) 'EPBC Act').

The Commonwealth Significant Impact Guidelines define significant impacts to National Heritage Places as:

- one or more of the National Heritage values to be lost
- one or more of the National Heritage values to be degraded or damaged, or
- one or more of the National Heritage values to be notably altered, modified, obscured
- or diminished.

A 'significant impact' is an impact which is important, notable, or of consequence, having regard to its context or intensity. Whether or not an action is likely to have a significant impact depends upon the sensitivity, value, and quality of the environment, which is impacted, and upon the intensity, duration, magnitude and geographic extent of the impacts.

The purpose of this 'self-assessment' form is for Water Corporation to determine:

- whether an action is likely to have a significant impact on the National Heritage values of the GWSS
- if an action is consistent with the Water Corporation's Heritage Management Plan (HMP)
- if external and independent heritage advice is required.

Proposed Action—National Heritage 'Self-Assessment' Form

Environment Protection and Biodiversity Conservation Act 1999 **(EPBC Act)**

DESCRIPTION OF SUBJECT SITE:

Project Manager to complete – please provide MyWorld[1] link.

BACKGROUND AND SCOPE OF THE ACTION:

Project Manager to supply brief description of works and links to any applicable drawings.

HMP POLICY REQUIREMENTS:

Property Portfolio to complete

1. Does the proposal involve removal or decommissioning of pipe identified for conservation in the Interpretation Strategy (HMP Policies 4 - 6)? **YES** ☐ NO ☐
2. Does the proposal involve removal of pipe not identified for conservation in the Interpretation Strategy (HMP Policies 7 - 11)? **YES** ☐ NO ☐
3. Does the proposal entail new development (e.g. new buildings or tanks) within 50 m of the main conduit (HMP Policy 3)? **YES** ☐ NO ☐
4. Do the works require referral to the Heritage Council of Western Australia? YES ☐ **NO** ☐
5. Is an Archaeological Management Plan required? (HMP Policy 13) YES ☐ **NO** ☐

HERITAGE IMPACT ASSESSMENT:

Property Portfolio to complete

Summary of potential impacts: *Refer Attachment 1 – National Heritage Values. Excluding impacts approved as per EPBC 2019/8547.*

Consistency with HMP policies and heritage values:

[1] Corporate GIS

Proposed Action—National Heritage 'Self-Assessment' Form

Environment Protection and Biodiversity Conservation Act 1999 **(EPBC Act)**

Applicable mitigation measures: *If applicable, what actions will be undertaken to avoid and/or reduce the impact/s to heritage values?*

Conditions of action: *List any conditions on action required by HMP or to mitigate impacts of the action.*

Heritage Impact Statement: YES ☐ NO ☐ *Any action that is inconsistent with the Policies of this HMP or could impact the National Heritage values of the GWSS (beyond the scope of EPBC Act approval 2019/8547) requires external and independent heritage advice.*

RECOMMENDATION:

To be submitted electronically for approval to the Manager – Property Portfolio

Approved?	YES ☐	NO ☐ Refer to Next Steps section below
Comments		

Next Steps for the Proposed Action

Prepare HIS	YES ☐	NO ☐
Make an EPBC Act referral:	YES ☐	NO ☐

Proposed Action—National Heritage 'Self-Assessment' Form

Environment Protection and Biodiversity Conservation Act 1999 **(EPBC Act)**

Attachment 1 - National Heritage Values

The GWSS was included in the NHL in June 2011. The National Heritage values are detailed below (Source: Australian Heritage Database)

National Heritage Criteria	Assessment Against the Criteria
Criterion A	**The place has outstanding heritage value to the nation because of the place's importance in the course, or pattern, of Australia's natural or cultural history.**
The Goldfields Water Supply Scheme runs for over 560km and was opened in 1903. It is significant as the impetus for agricultural expansion that was of lasting benefit to Western Australia and to the nation as a whole. Water from the pipeline became available just as the production of gold on the eastern goldfields was starting to decline, but the true value of the pipeline both to Western Australia and Australia as a whole was the effect that regular water supplies has in opening up the south-western agricultural area to production. While activity on the goldfields declined between 1905 and the 1960s, the quantity and value of wheat produced increased steadily over the same period. Today, the Western Australia wheatfields are the most productive in Australia, accounting for 42% of the nation's wheat crop. This comes mainly from the areas serviced by the goldfields pipeline, which has continued to operate as a water supply scheme since its inception. The pipeline, its extensions and associated infrastructure represent the initiative that opened up the south-western agricultural area to development.	
Criterion B	**The place has outstanding heritage value to the nation because of the place's possession of uncommon, rare or endangered aspects of Australia's natural or cultural history.**
Criterion C	**The place has outstanding heritage value to the nation because of the place's potential to yield information that will contribute to an understanding of Australia's natural or cultural history.**
Criterion D	**The place has outstanding heritage value to the nation because of the place's importance in demonstrating the principal characteristics of: – a class of Australia's natural or cultural places; or – a class of Australia's natural or cultural environments.**
The Goldfields Water Supply Scheme incorporates the remaining elements of the former Coolgardie Goldfields Water Supply Scheme, as designed by engineer CY O'Connor and completed in 1903. The Goldfields Water Supply Scheme is an outstanding representative example of an inter-basin water transfer system while demonstrating a major development in water scheme design. It contains the principal characteristics of a water supply/transfer scheme including dams (pondages), extensive pipeline, tanks, reservoirs and pump station. The pipeline continues to service the needs of the communities between Mundaring and Kalgoorlie. *The characteristic features of the Goldfields Water Supply Scheme that express this value include the remaining extant features of the 1903 Scheme: the main conduit of the pipeline (the length of pipeline including all locking bar pipes, wood stave pipe and continuously welded pipes from Mundaring Weir to Mount Charlotte); with its surviving pumping stations (Pump Stations Nos 1, 3, 5, 6 and 8) and their associated equipment (including the pumps, boilers, compressors, venturi meters and reservoirs located at*	

Proposed Action—National Heritage 'Self-Assessment' Form

***Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act)**

National Heritage Criteria	Assessment Against the Criteria
Pump Stations 2, 4, 7 and 8), regulating tanks (located at Bullabulling, Toorak Hill, Bakers Hill and West Northam) and the Mundaring Weir (dam, including valve houses, spillway, the weir wall profile and fabric) and the round Mount Charlotte Reservoir at Kalgoorlie.	

Criterion E	The place has outstanding heritage value to the nation because of the place's importance in exhibiting particular aesthetic characteristics valued by a community or cultural group.

Criterion F	The place has outstanding heritage value to the nation because of the place's importance in demonstrating a high degree of creative or technical achievement at a particular period.

Both in the size of the project and in the use of new technology, the Goldfields Water Supply Scheme was an outstanding technological achievement for its time. The pipeline pumping scheme, consisting of the pipeline itself, the reservoirs, and the pumping stations, was regarded internationally as being the largest such engineering undertaking for its time. The amount of steel used in construction was greater than for previous large steel structures. The contracts for the local supply of steel were the largest pipe contracts, and the most expensive Australian construction contracts, let to that time.

The pipeline also made use of innovative Australian design in the locking bar pipe invented by Mephan Ferguson.

The refurbishment of the pipeline in 1933 was also a major technical development. Lifting the pipeline out of the ground and re-laying it above ground placed the Goldfields Water Supply Scheme among the world leaders in pipeline technology for the second time in less than 40 years. During this refurbishment, the expansion forces were directed into reinforced anchor blocks built over the pipe at 50 metre intervals, which prevented movement and transferred these forces into the ground. This was the first time anywhere in the world that pipe anchorages of this type had been used to permit such a large diameter pipeline to be laid above ground.

The technical achievement of the Goldfields Water Supply Scheme was internationally recognised by the American Society of Civil Engineers as an International Historic Civil Engineering Landmark in 2009, marking the Scheme as one of the most significant engineering projects of the 20th Century.

Criterion G	The place has outstanding heritage value to the nation because of the place's strong or special association with a particular community or cultural group for social, cultural or spiritual reasons.

Criterion H	The place has outstanding heritage value to the nation because of the place's special association with the life or works of a person, or group of persons, of importance in Australia's natural or cultural history.

The Goldfields Water Supply Scheme is significant for its association with the work of Charles Yelverton O'Connor, Engineer-in-Chief of the Western Australian Public Works Department from 1891 to his death in March 1902. O'Connor was the driving force behind the construction of the pumping scheme including the pipeline, pumping stations and equipment, reservoirs and tanks, and the Mundaring Weir, which provided great economic benefit to the state of Western Australia and to the nation as a whole. While the

Proposed Action—National Heritage 'Self-Assessment' Form
***Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act)**

National Heritage Criteria	Assessment Against the Criteria
Coolgardie Goldfields Water Supply Scheme was originally intended to serve the immediate needs of the goldfields, Sir John Forrest considered that its long-term future was to service agriculture. At the completion of the work, the Premier Sir John Forrest praised him as "the great builder of this work … to bring happiness and comfort to the people of the goldfields for all time".	

Criterion I	The place has outstanding heritage value to the nation because of the place's importance as part of Indigenous tradition.

DRAFT

Heritage Management Plan
Goldfields Water Supply Scheme Main Conduit, Western Australia

Prepared for:

The Water Corporation of Western Australia