Audit of irrigation modernisation water recovery for GMW Water Efficiency Project 2022/23

PREPARED FOR DEECA | November 2023

Stantec

Revision schedule

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Quality statement

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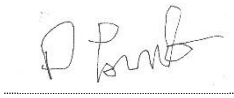
Patrick Lamb  23 November 2023

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SUMMARY FINDINGS

Background and scope

This report details the findings from Stantec's audit of the estimates of the water recovery achieved through irrigation modernisation in northern Victoria for 2022/23. The water recovery is being delivered through the Water Efficiency Project (WEP), which is managed by Goulburn-Murray Water (GMW).

The WEP is being delivered over two years and is a $177.5 million project funded by the Commonwealth Government. The project is targeted to deliver an additional 15.9 gigalitres LTAAY (long-term average annual yield) of water savings to the region without on-farm works.

The scope of activities included in this audit, as described in the audit brief, is as follows:

1. The cumulative irrigation modernisation works in place for Step 1 of Tranche 2 of the GMW WEP works from the start of the project to the given periods below. Specially:
    a. An audit of the claimed Phase 4 water recovery volumes realised from constructed and commissioned WEP works from the start of the WEP Project to 30 June 2023
    b. An audit of the claimed Phase 4 water recovery volumes realised from constructed and commissioned WEP works from the start of the WEP Project to 31 August 2023

For further details of the audit scope including specific auditor requirements see Section 1.3.

Auditor statement

We have audited the 2022/23 water savings estimates prepared by the WEP. Our audit was conducted in accordance with the scope provided by DEECA on 15 August 2023. Our audit activities included:

- Review of calculations of water savings
- Review of irrigation modernisation activities completed to generate water savings
- Review of construction records of irrigation modernisation activities
- Review of any other associated relevant WEP activities e.g., management of outfall flow data.
- Based on our audit activities, we consider that the water savings estimates for 2022/23 have been reported in accordance with the Water Savings Protocol (Version 5) and are free from material error.

Audited Water Savings Estimates

Water savings are achieved through modernisation of irrigation infrastructure. The scope of the audit is to review WEP Phase 4 water savings estimates. Phase 4 savings represent the long-term average annual savings from the works completed to date.

The audited Phase 4 estimates are set out in the following tables, and as required in the project brief, reported separately for:

- Cumulative water recovery from 1 July 2021 to 30 June 2023
- Cumulative water recovery from July 2021 to 31 August 2023
- Incremental water recovery from 1 July 2023 to 31 August 2023.

Table 1-1 Phase 4 water savings from WEP (2022/23) to 30 June 2023- ML LTAAY

Water Savings Intervention	SH^	SH-EAST	CG	MV	MV-BC	RO	LV-PH	LV- BO	TO	Total
Phase 4 water savings	-									
Channel Removal (ML)*	-	89.9	1,064.0	1,494.9	-	1,312.8	351.7	27.6	4,388.9	8,729.8
Channel Automation (ML)	-	378.2	-	-	-	-	-	-	-	378.2
Service Point Replacement (ML)	-	289.4	1,030.0	828.8	-	535.3	169.0	56.7	788.8	3,698.0
Service Point Removal (ML)	-	117.3	738.7	450.7	-	295.7	165.4	87.6	1,226.9	3,082.3
Channel Remediation (ML)	-	-	-	-	-	-	-	-	-	-
Total Phase 4 savings (ML)	-	**874.8**	**2,832.6**	**2,774.5**	**-**	**2,143.9**	**686.1**	**171.8**	**6,404.7**	**15,888.3**

Note totals may not sum due to rounding
**These savings are net channel removal savings after allowance for additional residual pipeline and channel losses are made*
^In this report, SH is the irrigation area for Shepparton or Shepparton East. Some documentation in GMW may refer to SH as Swan Hill.

Table 1-2 Phase 4 water savings from WEP (2022/23) to 31 August 2023 ML- LTAAY

Water Savings Intervention	SH	SH-EAST	CG	MV	MV-BC	RO	LV-PH	LV- BO	TO	Total
Phase 4 water savings										
Channel Removal (ML)*	-	104.9	1,063.1	1,555.6	-	1,305.9	355.4	27.6	4,556.5	8,968.9
Channel Automation (ML)	-	378.2	-	-	-	-	-	-	-	378.2
Service Point Replacement (ML)	-	318.6	1,073.5	859.2	-	805.7	207.3	56.7	940.9	4,261.8
Service Point Removal (ML)	-	139.0	738.7	506.0	-	324.8	195.9	87.6	1,310.7	3,302.5
Channel Remediation (ML)	-	-	-	-	-	-	-	-	-	-
Total Phase 4 savings (ML)	-	**940.7**	**2,875.2**	**2,920.8**	**-**	**2,436.4**	**758.5**	**171.8**	**6,808.0**	**16,911.4**

Note totals may not sum due to rounding
**These savings are net channel removal savings after allowance for additional residual pipeline and channel losses are made*

Table 1-3 Phase 4 water savings from WEP (2022/23) from 1 July 2023 to 31 August 2023 ML- LTAAY

Water Savings Intervention	SH	SH-EAST	CG	MV	MV-BC	RO	LV-PH	LV- BO	TO	Total
Phase 4 water savings										
Channel Removal (ML)*	-	14.9	(0.9)	60.7	-	(6.9)	3.7	-	167.5	239.1

Water Savings Intervention	SH	SH-EAST	CG	MV	MV-BC	RO	LV-PH	LV- BO	TO	Total
Channel Automation (ML)	-	-	-	-	-	-	-	-	-	-
Service Point Replacement (ML)	-	29.2	43.5	30.3	-	270.4	38.2	-	152.1	563.8
Service Point Removal (ML)	-	21.7	-	55.2	-	29.1	30.4	-	83.7	220.2
Channel Remediation (ML)	-	-	-	-	-	-	-	-	-	-
Total Phase 4 savings (ML)	**-**	**65.9**	**42.6**	**146.3**	**-**	**292.5**	**72.4**	**-**	**403.4**	**1,023.1**

Note totals may not sum due to rounding and some decreases are due to increased pipeline losses in the period.
**These savings are net channel removal savings after allowance for additional residual pipeline and channel losses are made*

Fixed and variable components

Table 1-4 Phase 4 water savings from WEP project (2022/23) with fixed and variable components to 30 June 2023 ML- LTAAY

Water Savings Intervention	SH	SH-EAST	CG	MV	MV-BC	RO	LV-PH	LV- BO	TO	Total
Phase 4 Water savings - WEP										
Channel Removal (ML)*										
Fixed component	-	35.3	550.6	847.0	-	727.8	198.9	15.2	2,139.5	4,514.3
Variable component	-	54.7	513.4	647.9	-	585.0	152.7	12.4	2,249.4	4,215.5
Channel Automation (ML)										
Fixed component	-	-	-	-	-	-	-	-	-	-
Variable component	-	378.2	-	-	-	-	-	-	-	378.2
Service Point Replacement (ML)										
Fixed component	-	70.0	153.6	115.0	-	56.6	24.1	10.7	143.1	573.1
Variable component	-	219.3	876.2	713.7	-	478.7	145.0	45.9	645.8	3,124.6
Service Point Removal (ML)										
Fixed component	-	56.3	147.2	78.2	-	101.2	32.2	16.1	284.8	716.0
Variable component	-	61.0	591.5	372.5	-	194.5	133.2	71.5	942.2	2,366.4
Channel Remediation (ML)										
Fixed component	-	-	-	-	-	-	-	-	-	-
Variable component	-	-	-	-	-	-	-	-	-	-
Total Phase 4 saving (ML) - WEP	**-**	**874.7**	**2,832.5**	**2,774.3**	**-**	**2,143.8**	**686.2**	**171.8**	**6,404.8**	**15,888.1**

Note – Totals may not sum due to rounding
* These savings are net channel removal savings after allowance for additional residual pipeline and channel losses are made

Table 1-5 Phase 4 water savings from WEP project (2022/23) with fixed and variable components to 31 August 2023 ML- LTAAY

Water Savings Intervention	SH	SH-EAST	CG	MV	MV-BC	RO	LV-PH	LV- BO	TO	Total
Phase 4 Water savings - WEP										
Channel Removal (ML)*										
Fixed component	-	40.0	549.7	878.1	-	720.9	199.6	15.2	2,219.9	4,623.4
Variable component	-	64.9	513.4	677.5	-	585.0	155.8	12.4	2,336.5	4,345.5
Channel Automation (ML)										
Fixed component	-	-	-	-	-	-	-	-	-	-
Variable component	-	378.2	-	-	-	-	-	-	-	378.2
Service Point Replacement (ML)										
Fixed component	-	78.0	160.3	119.5	-	126.5	28.4	10.7	184.5	707.9
Variable component	-	240.6	913.2	739.8	-	679.2	178.9	45.9	756.4	3,554.0
Service Point Removal (ML)										
Fixed component	-	67.0	147.2	87.4	-	112.7	36.8	16.1	303.2	770.4
Variable component	-	72.0	591.5	418.6	-	212.1	159.0	71.5	1,007.4	2,532.1
Channel Remediation (ML)										
Fixed component	-	-	-	-	-	-	-	-	-	-
Variable component	-	-	-	-	-	-	-	-	-	-
Total Phase 4 saving (ML) - WEP	-	**940.7**	**2,875.3**	**2,920.9**	**-**	**2,436.4**	**758.5**	**171.8**	**6,808.0**	**16,911.5**

Note – Totals may not sum due to rounding
** These savings are net channel removal savings after allowance for additional residual pipeline and channel losses are made*

Table 1-6 Phase 4 water savings from WEP project (2022/23) with fixed and variable components from 30 June 2023 to 31 August 2023 ML- LTAAY

Water Savings Intervention	SH	SH-EAST	CG	MV	MV-BC	RO	LV-PH	LV- BO	TO	Total
Phase 4 Water savings - WEP										
Channel Removal (ML)*										
Fixed component	-	4.7	(0.9)	31.1	-	(6.9)	0.7	-	80.5	109.1
Variable component	-	10.2	-	29.6	-	-	3.1	-	87.1	130.0
Channel Automation (ML)										

Water Savings Intervention	SH	SH-EAST	CG	MV	MV-BC	RO	LV-PH	LV- BO	TO	Total
Fixed component	-	-	-	-	-	-	-	-	-	-
Variable component	-	-	-	-	-	-	-	-	-	-
Service Point Replacement (ML)										
Fixed component	-	8.0	6.7	4.5	-	69.9	4.3	-	41.4	134.8
Variable component	-	21.3	37.0	26.1	-	200.5	33.9	-	110.6	429.4
Service Point Removal (ML)	-	-	-	-	-	-	-	-	-	-
Fixed component	-	10.7	-	9.2	-	11.5	4.6	-	18.4	54.4
Variable component	-	11.0	-	46.1	-	17.6	25.8	-	65.2	165.7
Channel Remediation (ML)										
Fixed component	-	-	-	-	-	-	-	-	-	-
Variable component	-	-	-	-	-	-	-	-	-	-
Total Phase 4 saving (ML) - WEP	**-**	**65.9**	**42.8**	**146.6**	**-**	**292.6**	**72.3**	**-**	**403.1**	**1,023.4**

Note – Totals may not sum due to rounding
** These savings are net channel removal savings after allowance for additional residual pipeline and channel losses are made*

Data collection and inputs

Our review for the 2022/23 audit of the information systems and processes used by the Water Efficiency Project (WEP) are sufficiently robust to generate data and inputs that are as accurate as could reasonably be expected for the purpose of calculating water recoveries.
We found that all assets included in our samples for data trailing had sufficient evidence to support the fact that they have been constructed and commissioned. We are satisfied that the WEP has completed the works claimed in the calculations.

Water Savings Protocol Reporting Requirements

The Water Savings Protocol[1] outlines the process for the independent audit of water savings estimates and defines the expected content of the water savings audit. The minimum requirements of the report and where they are fulfilled in this report is summarised in Table 1-7.

Table 1-7 Mapping of reporting requirements

Requirement	Where this is addressed in the report
A summary of findings.	Summary of Findings
Background information on the irrigation modernisation projects for which the water savings estimates are being audited, including the water savings targets.	Section 2
A description of the method(s) used for the independent audit	Section 3
The details and results of any site inspections undertaken.	Section 4
An assessment of how well the project proponent's business and information systems and processes support the calculation of water savings.	Sections 4, 5
The results of random and target sampling of the data trails used in the estimates of water savings.	Section 4.2
An evaluation of all water savings estimates against the Water Savings Protocol.	Section 6
Documentation of any instances of non-compliance with the Water Savings Protocol, and the changes required to the project proponent's estimates of water savings.	Section 6
Any recommended improvements to the data and methods used to estimate and report the water savings estimates, including revisions to the Water Savings Protocol.	Section 7

[1] Water Savings Protocol - A protocol for the quantification of water savings from modernising irrigation distribution systems, Department of Environment, Land, Water and Planning, Version 5.0 2018. Available at: https://www.water.vic.gov.au/__data/assets/pdf_file/0032/667571/water-savings-protocol.pdf

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Glossary

Term	Definition
A	Ratio of the length of channel to be or actually automated to the total length of channel in the defined system (%)
BO	Boort
CG	Central Goulburn
CG1-4	Central Goulburn Channel 1, 2, 3 and 4
CG5-9	Central Goulburn Channels 5, 6, 7 8 and 9
CG2	Central Goulburn Channel 2 System
CL	Ratio of length of spur channel length rationalized (removed) to total spur channel length in system
Dbase	Customer Deliveries in the Baseline Year in the irrigation system
DEECA	Department of Energy, Environment and Climate Action
DELWP	Department of Environment, Land, Water and Planning
DF	Durability factor to account for the durability of water savings interventions
DF_{error}	Durability factor for reducing measurement error
$DF_{leakage\ around}$	Durability factor for reducing leakage around the meter
$DF_{leakage\ through}$	Durability factor for reducing leakage through the meter
$DF_{unauthorised}$	Durability factor for reducing unauthorised use
DM_{base}	Customer deliveries through the rationalized (removed) meters in the Baseline Year
$DM_{Year\ X}$	Customer deliveries through the replaced meters for the year in question
D_{YearX}	Customer deliveries in the year in question to the irrigation system
E_{Base}	Evaporation in Baseline Year
$EF_{bank\ leakage}$	Effectiveness Factor Channel automation (bank leakage)
EF_{error}	Effectiveness Factor for reducing measurement error
$EF_{leakage\ around}$	Effectiveness Factor for reducing leakage around the meter
$EF_{leakage\ through}$	Effectiveness Factor for reducing leakage through the meter
$EF_{rationaliation}$	Effectiveness Factor for channel removal
$EF_{remediation}$	Effectiveness Factor for channel remediation
$EF_{unauthorised}$	Effectiveness Factor for reducing unauthorised use
EWP	Environmental Watering Plan
$F(LTCE_{Base})$	Long-Term Cap Equivalent Factor to convert Baseline Year volumes to Long-Term Cap Equivalent volume
$F(LTCE_{YearX})$	Long-Term Cap Equivalent Factor to convert Current Year volumes to Long-Term Cap Equivalent volume

Term	Definition
F(PA)	Pondage Testing Adjustment Factor to account for dynamic losses in addition to static losses
FL	Proportion of bank leakage recognised as fixed
GIS	Geographic Information System
GMID	Goulburn-Murray Irrigation District
GMW	Goulburn-Murray Water
HR	High Reliability
IPA	Inter-Project Agreement
IPM	Irrigation Planning Module
ITP	Inspection Test Procedure
L_{Base}	Leakage in Baseline Year
$L_{Post\ works}$	Post works bank leakage
LR	Low Reliability
LTA	Defined Fixed Leakage Rate (ML/year/service point) around service points
LTCE	Long-Term Cap Equivalent
LTDLE	Long-Term Diversion Limit Equivalent
LTT	Defined Fixed Leakage Rate (ML/year/service point) through service points
LV	Loddon Valley
M&E	Mechanical and electrical
MCF	Adopted Meter Correction Factor for Dethridge Meter Service Points or associated with deemed Service Points
MV	Murray Valley
MV-BC	Lower Broken Creek
MWC	Mitigation water commitment
$N_{rationalised}$	Number of meters rationalised (removed)
$N_{replaced}$	Number of meters replaced
NVIRP	Northern Victoria Irrigation Renewal Project
$O_{BaseVariable}$	Variable outfall loss in the baseline year
$O_{YearxVariable}$	Variable outfall loss in the year in question
$O_{BaseFixed}$	Fixed outfall loss in the baseline year
$O_{YearxFixed}$	Fixed outfall loss in the year in question
PB	Pyramid-Boort
PH	Pyramid Hill

Term	Definition
PMIS	Project Management Information System. This is an information system developed specifically for managing information associated with delivery of modernisation construction works.
RL	Ratio of length of channel length remediated to total channel length in system
RO	Rochester
S_{Base}	Seepage in Baseline Year
SCADA	Supervisory Control and Data Acquisition
SH	Shepparton
SIAMP	Shepparton Irrigation Area Modernisation Project
SPM	System Planning Module
$S_{post\ works}$	Post works seepage
Stage 1	Stage 1 of the GMW Connections Project
Stage 2	Stage 2 of the GMW Connections Project
the Protocol	the Water Savings Protocol – A Protocol for the quantification of water savings from modernising irrigation distribution systems
the technical manual or Manual	Chapter D of the Water Savings Protocol, the technical manual for the quantification of water savings
tm	Ratio of the length of time that the service point was replaced for irrigation purposes in the year in question to the irrigation season length in the Baseline Year
TO	Torrumbarry
tr	Ratio of the length of time a channel has been rationalized (removed) in the year in question relative to the irrigation season length in the Baseline Year
UBase	Unauthorised use loss in the Baseline Year
Vd	Deemed customer deliveries through individual unmetered service points in the Baseline Year
VL	Proportion of bank leakage recognised as variable
WEE	Water Entitlement Entity

1 Introduction

1.1 Purpose of audit

Many of the northern Victorian irrigation systems were built 50 to 100 years ago and required major renewal.

The Victorian and Commonwealth Governments committed to investing more than $2 billion in the modernisation of the Goulburn Murray Irrigation District (GMID) to achieve water recovery from the Stage 1 and 2 Connections Project. Goulburn Murray Water (GMW) is the owner and operator of the GMID. The Connection Project has been audited annually for many years (both phase 3 and phase 4 water savings). The project works have been completed recently and delivered 433 GL LTAAY water recovery.

The Commonwealth Government committed approximately $177 million to achieve a target of 15.9 GL LTAAY from the Water Efficiency Project, (WEP). The water savings achieved by the WEP are to be audited each year until the project is completed. Stantec, has been engaged by the Department of Energy, Environment and Climate Action (DEECA) to undertake an independent audit of the water recovery for the 2022/23 irrigation season – specifically for the second tranche of the WEP, reported as estimated Phase 4 (ML/yr), long term average annual yield (LTAAY) water recovery volumes. The purpose of this report is to present the findings of this independent audit.

1.2 Water Savings Protocol

The purpose of the Water Savings Protocol is to ensure water savings are consistently and transparently estimated and audited. Version 5.0 of the Water Savings Protocol was released in October 2018. This audit is being carried out under this latest version of the Water Savings Protocol.

The Water Savings Protocol includes the water saving audit process (Chapter C) and the technical manual (Chapter D). The water saving audit process sets out that the independent audit of water savings is to include:

- Verifying that the water savings estimates have been done in accordance with the Water Savings Protocol.
- Ensuring that the data collection and inputs are as accurate as could reasonably be expected for estimating water savings.
- Random and targeted checking that the program of works for irrigation modernisation projects have been implemented as documented in the water savings estimates.
- Confirming that water savings have been estimated based on the nature and the extent of all irrigation modernisation works.
- Providing a corrected estimate of the water savings for any component where the project proponent calculations are found to be non-compliant with the Water Savings Protocol.
- Identifying potential improvements to the data collection, data analysis, assumptions and methods used to estimate the water savings.
- Recommending to DEECA changes to the Water Savings Protocol that will improve the useability and accuracy of water savings estimates.
- Reporting on the status of the suggested improvements made in previous audits.

A copy of the Water Savings Protocol is available on the DEECA website at this location:
https://www.water.vic.gov.au/__data/assets/pdf_file/0032/667571/water-savings-protocol.pdf

1.3 Scope of 2022/23 irrigation season irrigation modernisation water recovery audit

The audit scope has been set by DEECA and is stated in the project brief dated 15 August 2023. The scope of works is broadly an audit of water recovery estimates for works undertaken in the Goulburn-Murray Irrigation District by the Water Efficiency Project to further modernise the irrigation delivery system.

The scope of activities included in this audit, as described in the audit brief, is as follows:

- The final second tranche of the GMW Water Efficiency Project (WEP), reported as estimated Phase 4 (ML/yr) LTAAY water recovery volumes
  - An audit of the claimed Phase 4 water recovery volumes realised from constructed and commissioned WEP works from the start of the WEP Project to 31 August 2023
  - An audit of the claimed Phase 4 water recovery volumes realised from constructed and commissioned WEP works from the start of the WEP Project from 1 July 2022 to 31 August 2022
  - The audit covers the WEP operating area which is the whole Goulburn-Murray Irrigation District (GMID) including the following irrigation areas with the relevant trading zones identified in brackets (e.g., 1A):
  - Shepparton (1A), including Shepparton East (1A)
  - Central Goulburn (1A),
  - Rochester (1A),
  - Loddon Valley, split as:
    - Pyramid Hill (1A),
    - Boort (1B),
  - Murray Valley (6) and Lower Broken Creek (6B), and
  - Torrumbarry (7).

The scope requires the auditor to address the following:

- Verifying that stated modernisation works have been completed as claimed.
- Verifying that the WEP have estimated water recovery correctly in accordance with the Water Savings Protocol (Version 5) (the Protocol) or errata, addendum or other method approved by DEECA. For the WEP, this shall include:
- Phase 4 – long-term average water recovery estimates.
- Confirming the water recovery estimates or, where appropriate, correcting estimated volumes; and
- Identifying and recommending improvements to the collection and processing of information used for estimating water recovery volumes.

As the project will be fully complete by the end of 2023 or early 2024, this report will be updated in the first quarter of 2024 with an addendum that details additional water recovery that has been achieved following the audit period for this report (i.e. past 31 August 2023).

2 Background

2.1 Goulburn Murray Irrigation District

The Goulburn Murray Irrigation District is composed of the following six main irrigation areas located in northern Victoria:

- Central Goulburn (CG) (which is divided into sub-areas CG1-4 and CG5-9)
- Murray Valley (MV) and Lower Broken Creek (MV-BC)
- Loddon Valley
  - Pyramid-Hill (LV-PH)[2]
  - Boort (LV-BO)
- Rochester (RO)
- Shepparton (SH) (including Shepparton East)
- Torrumbarry (TO).

Goulburn-Murray Water is responsible as both the Water Resource Manager and System Operator for the Goulburn Murray Irrigation District. Figure 2-1 shows the location of the Goulburn Murray Irrigation District and the main irrigation areas.

Figure 2-1 Goulburn Murray Irrigation District
Source: http://www.g-mwater.com.au/about/regionalmap

2.2 Irrigation modernisation

Irrigation modernisation seeks to improve the efficiency of irrigation systems to minimise losses when water is delivered, to provide a better customer service, and to support sustainability outcomes.

Irrigation modernisation typically involves the automation of channel infrastructure, construction of pipelines, upgrading the accuracy of metered outlets to farms, lining, and remodelling of channels and rationalising the channel network. Automation of systems allows water flows to be delivered more accurately and more quickly. These capital works, in unison with changed operational approaches, should have the twin benefits

[2] The former Pyramid-Boort irrigation area, now Loddon Valley is divided into two separate water trading zones: Pyramid-Hill (LV-PH, zone 1A) and Boort (LV-BO, zone 1B). The LV designation is the overall larger irrigation area

of reducing the amount of water lost in irrigation systems and improving service levels to customers. These are described below:

Channel automation
Channel automation is a way of improving the efficiency of irrigation networks by using new technology to control the flow of water from the storage (usually a dam) through the distribution system to the irrigator. It involves replacing manual flow control structures in channels with updated gates that accurately measure flows, provide real time measurement data and, in most cases, are automated. The automation greatly reduces the water spilt from the end of channels (known as outfalls). Further the gate measurement allows more accurate location of the worst seepage and leakage losses, and more effective targeting of channel remediation works.

Automation of the gates also provides the ability to interact with meters and on-farm automation equipment, so best practice irrigation methods can be employed on farms. Other benefits include constant flows and faster water delivery times.

Pipes and channels
Historically, many irrigation systems relied on open earthen channels to transport water. Inefficient operation and leaky sections resulted in up to 30% of the total volume being lost in the past. Water losses can be minimised by reducing outfall losses, lining, remodelling or pipelining parts of the channel system. Channel can also be decommissioned to reduce losses.

Improved meter accuracy
Dethridge wheels are inaccurate and on average under-measure water delivery by about 8%. They fail to meet the new metering standards introduced by the Australian Government that specify a maximum of plus or minus 5% measurement inaccuracy. There are also occupational health and safety risks associated with using Dethridge wheels.

2.3 GMW WEP project

The Water Efficiency Project is a $177.5 million irrigation modernisation project is funded by the Commonwealth Government and targets delivery of at least an additional 15.9 gigalitres of water savings to the region without on farm works.

WEP is expected to improve irrigation standards for more than 1,000 customers and produce about 1,000 regional jobs during construction, avoiding water entitlement buybacks from irrigators.

The Project will reduce ongoing asset liability, reducing costs for the organisation and in turn our customers. Specifically, the project will deliver:

- Treating more than 250km of channel
- Treating 1099 outlets
- Converting small sections of channel into pipeline
- Recovering 15.9 GL water savings annually

Figure 2-2 provides an overview of the Water Efficiency Project.

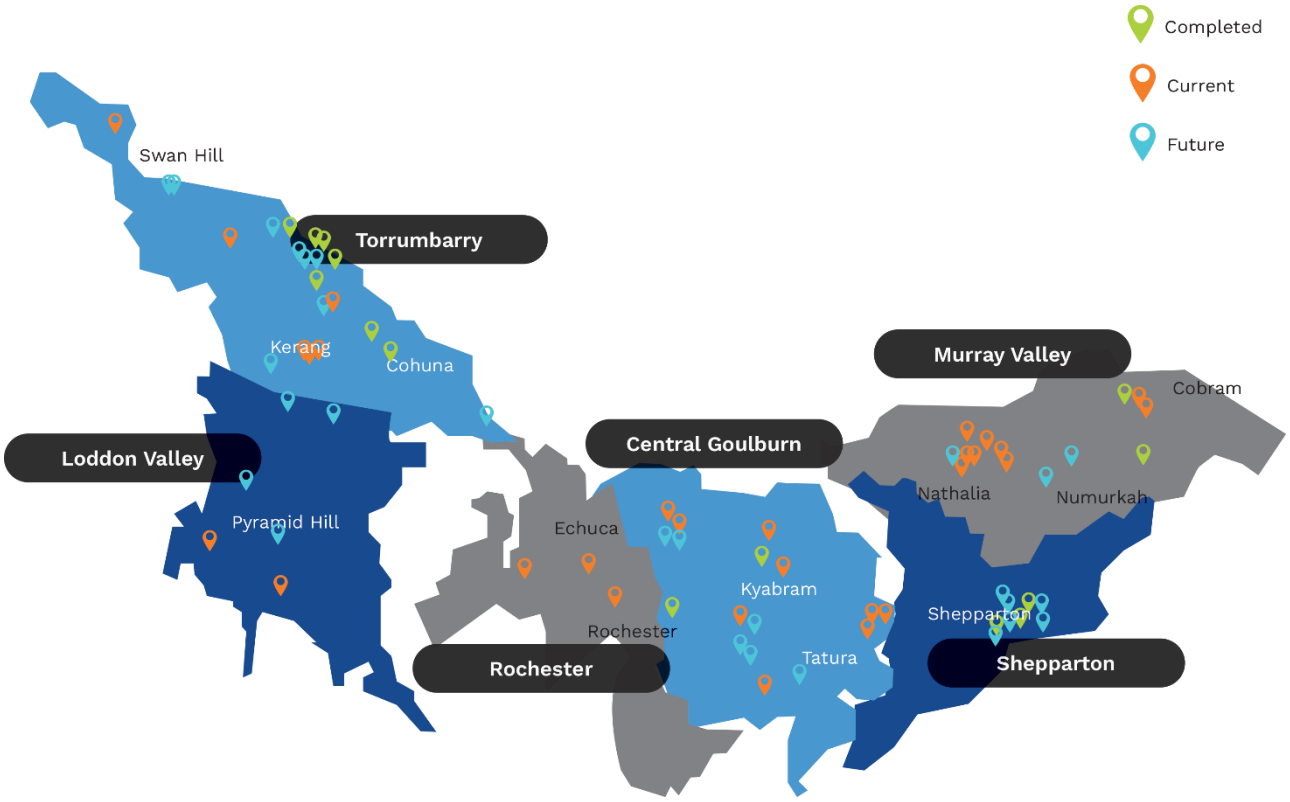


Figure 2-2 Map of Water Efficiency Project completed current and future planned works

Map taken from Home (waterefficiencyproject.com.au) accessed 16 October 2023.

3 Audit methodology

3.1 Water savings audit process requirements

The water savings audit process is outlined in Chapter C of the Water Savings Protocol and sets out the approach to be taken to the independent audit of water savings. The scope of independent audit work relating to irrigation modernisation is to include the elements detailed below. Where each element is addressed in this report is set out in Table 3-1.

Table 3-1 Mapping of reporting requirements

Water Savings Protocol Reporting Requirement	Where this is addressed in the report
Verifying that the water savings estimates have been done in accordance this Water Savings Protocol.	Section 6
Ensuring that the data collection and inputs are as accurate as could reasonably be expected for estimating water savings.	Section 4
Random and targeted checking that the program of works for irrigation modernisation projects have been implemented as documented in the water savings estimates.	Sections 4, 5 and Appendix C
Confirming that water savings have been estimated based on the nature and the extent of all irrigation modernisation works.	Sections 4, 5 and 6
Providing a corrected estimate of the water savings for any component where the project proponent calculations are found to be non-compliant with the Water Savings Protocol.	Section 6
Identifying potential improvements to the data collection, data analysis, assumptions and methods used to estimate the water savings.	Section 7
Recommending to DEECA changes to the Water Savings Protocol that will improve the usability and accuracy of water savings estimates.	Section 7
Reporting on the status of the suggested improvements made in previous audits	Section 8

The Water Savings Protocol also defines the expected content of the water savings audit report. The minimum requirements of the report and where they are fulfilled in this report is summarised in Table 3-2.

Table 3-2 Expected Content of Water Savings Audit Report

Requirement	Where this is addressed in the report
A summary of findings.	Summary of Findings
Background information on the irrigation modernisation projects for which the water savings estimates are being audited, including the water savings targets.	Section 2
A description of the method(s) used for the independent audit	Section 3
The details and results of any site inspections undertaken.	Section 4.2
An assessment of how well the project proponent's business and information systems and processes support the calculation of water savings.	Section 4
The results of random and target sampling of the data trails used in the estimates of water savings.	Section 4.2
An evaluation of all water savings estimates against the Water Savings Protocol.	Section 6
Documentation of any instances of non-compliance with the Water Savings Protocol, and the changes required to the project proponent's estimates of water savings.	Section 6
Any recommended improvements to the data and methods used to estimate and report the water savings estimates, including revisions to the Water Savings Protocol.	Section 7

The following sub-sections detail the audit process undertaken.

3.2 Overview of audit methodology

The approach taken to auditing water recovery is based around structured interviews with key GMW staff. These structured interviews scrutinise the water recovery calculations and assess the veracity of the supporting information. The audit focused on these areas:

- The systems and procedures in place to manage the data used in the calculations, including trailing the data used in the calculations back to source records
- Verifying that the works claimed are complete and commissioned through review of works handover and commissioning documents as well as inspection of a sample of assets
- Checking that the audit calculations have been performed correctly
- Given the WEP is using the same systems and processes as those used for the Connections Project, it is also prudent to review progress on the implementation of previous audit recommendations of those projects.

For 2022/23, a sample of water saving projects were identified an audited:

- Meetings were held at GMW offices and over the Microsoft Teams platform which allowed audio and visual connectivity between attendees.
- Verification that works have been completed and commissioned as claimed was undertaken by reviewing construction record work packs, time and date-stamped photographs and use of high-definition aerial photography (via the Metromap platform) if available, and inspection of works in the field. A feature of Metromap is that aerial imagery is uploaded at regular intervals for many locations enabling works progress over time to be observed.

3.3 Schedule of audit meetings

Table 3-3 lists the meetings held to complete the audit work.

Table 3-3 Schedule of Audit Meetings

Date	Audit Work	Auditee	Position
Wednesday 11 October 2023	Start-up Meeting	Peter Roberts	Project Manager, Water Savings (GMW)
		Nick Whittington	Dep Director , Legal Manager - WEP Project
		Emily Uhe	Senior River Operations Officer(GMW)
		Michael Doherty	Coordinator Waters System Operations (GMW)
		Deanne Brown	Document Controller (GMW)
		Jennifer Pagon	Project risk and stakeholder reporting (GMW)
Tuesday 31 October 2023	Audit of water savings calculations	Peter Roberts	Project Manager, Water Savings (GMW)
	Construction record reviews	Peter Roberts	Project Manager, Water Savings (GMW)
Wednesday 1 November 2023	Site inspections and discussion on water savings methodology	Peter Roberts	Project Manager, Water Savings (GMW)
Thursday 2 November 2023	Audit of water savings calculations	Peter Roberts	Project Manager, Water Savings (GMW)
Thursday 9 November 2023	Review of SCADA records and outfall data	Michael Doherty	Coordinator Water Systems Operations (GMW)
		Emily Uhe	Senior Water Resources Officer (GMW)
		Peter Roberts	Project Manager, Water Savings (GMW)

3.4 Document register

A list of the documents received before, during and after the audit are included in Appendix B .

4 Audit of data collection and inputs

4.1 Overview

Our audit considers the systems and processes in use by GMW and its contractors that support the calculation of water recoveries to determine whether they are sufficiently reliable to produce accurate, repeatable, and transparent data. Our review of systems and processes focuses on those business areas central to the water recovery estimates:

- Construction records
- Outfall measurement and recording
- Customer deliveries

Because of the importance of demonstrating that the water recoveries have been calculated based on accurate information, we have complemented this review of systems and processes, with trailing of selected data, used in the calculations, to their source.

To operate its irrigation network, GMW employs a number of information systems. The key systems are:

- SCADA – provides real time monitoring of gate operation, including trending. Field readings are stored and can be accessed through a data warehouse (SPM – System Planning Module). SPM is also GMW's data recording program/database for long-term flow record storage.
- Maximo – asset information system and computerised maintenance management system
- Geocortex (GMW's Geographic Information System - GIS) – records location of channels and control gates. Channel lengths and widths are measured from here.
- The Irrigation Planning Module (IPM) takes customer orders, checks system capacity to deliver orders and records delivered volumes.

4.2 Construction records

During the 2022/23 audit year construction works were managed by GMW and delivered by contractors on the relevant approved panel. The construction records database, PMIS, is used to track work packages from planning through construction to handover and acceptance. The system captures relevant information and is also a data store for records such as photos and ITP (inspection and test plan) certificates.

When new assets are commissioned, or redundant channel removed, an ITP certificate is produced which records relevant commissioning/decommissioning details. These ITP certificates are stored in the Project PMIS along with other documents relevant to the construction and commissioning of each site. These documents are collectively referred to as the 'work pack' for the constructed asset. GMW also use a system called QLIK for project portfolio management. Key completion dates are stored in this system and water savings are usually claimed when the work is at beneficial completion.

This audit focuses on asset commissioning / decommissioning e.g., when the benefit-providing activity is completed, as water recoveries are typically achieved from the time that an asset is commissioned or decommissioned.

We believe that GMW's systems for asset delivery and commissioning are sufficiently robust to record the details of irrigation modernisation asset installation and commissioning completely and correctly.

The following section provides observations arising from our audit of construction records for different work types. Appendix C contains a selection of photographs demonstrating completed works from 2022/23.

4.2.1 Service point (meter) replacement and removal

We requested commissioning certificates (ITP certificates) and other supporting evidence (e.g., construction photos) for a sample of 25 sites where service points had been replaced or removed to confirm that the works have been completed and that work was timely e.g., completed in the reporting year so there was no impact on Phase 4 savings. This also enabled us to check if the savings were appropriately included to end June 2023 or end August 2023 overall figures. Of the sample of 25 meters selected, 3 meters had been excluded from the water savings calculations and we did not review any construction records for these. Two of the three meters had not yet been commissioned and the third had been completed under the

Connections Project. These three meters had been included on a master list by GMW for completeness but it had not included them in any water recovery estimates which provides assurance that GMW has sound processes for identifying works that are not in scope.

The results of reconciling these records with the data used in the water savings calculation is summarised in Table 4-1.

Table 4-1 Findings from service point replacement and rationalisation data trailing

IPM/ Asset Code	Intervention type	Comment
RO6840	Modernise: Replace Meter	The construction records reviewed provide assurance that the work claimed is completed.
TO2509	Modernise: Relocate Meter	The construction records reviewed provide assurance that the work claimed is completed.
TO2518	Modernise: Replace Meter	The construction records reviewed provide assurance that the work claimed is completed.
RO6842	Modernise: Replace Meter	The construction records reviewed provide assurance that the work claimed is completed.
TO2524	Modernise: Replace Meter	The meter was included in the sample but was not yet commissioned and therefore no construction records were reviewed. GMW had correctly not included this meter in its estimates of water savings.
TN1440	Modernise: Replace Meter	The construction records reviewed provide assurance that the work claimed is completed.
TN5085	Modernise: Replace Meter	The construction records reviewed provide assurance that the work claimed is completed.
SH1317	Modernise: Replace Meter	The construction records reviewed provide assurance that the work claimed is completed.
TO4383	Modernise: Replace Meter	The construction records reviewed provide assurance that the work claimed is completed.
TO2773	Modernise: Replace Meter	The construction records reviewed provide assurance that the work claimed is completed.
MV6290	Modernise: Replace Meter	The construction records reviewed provide assurance that the work claimed is completed.
MV6828	Modernise: Relocate Meter	The construction records reviewed provide assurance that the work claimed is completed.
TN12983	Modernise: Replace Meter	The construction records reviewed provide assurance that the work claimed is completed. 18/08/23
TN138	Modernise: Relocate Meter	The construction records reviewed provide assurance that the work claimed is completed.
TO5119	Modernise: Replace Meter	The construction records reviewed provide assurance that the work claimed is completed.
RO6844	Modernise: Replace Meter	The construction records reviewed provide assurance that the work claimed is completed.
MV6818	Modernise: Replace Meter	The construction records reviewed provide assurance that the work claimed is completed.
RO6848	Modernise: Relocate Meter	The construction records reviewed provide assurance that the work claimed is completed.
TN6185	Modernise: Relocate Meter	The construction records reviewed provide assurance that the work claimed is completed.
RO6838	Modernise: Replace Meter	The construction records reviewed provide assurance that the work claimed is completed.

IPM/ Asset Code	Intervention type	Comment
TO2746	Modernise: Replace Meter	The meter was included in the sample but it was identified by GMW that it had been upgraded earlier under the Connections Project. GMW had correctly not included this meter in its estimates of water savings.
TO4528	Modernise: Relocate Meter	The construction records reviewed provide assurance that the work claimed is completed.
RO5515	Modernise: Replace Meter	The meter was included in the sample but was not yet commissioned and therefore no construction records were reviewed. GMW had correctly not included this meter in its estimates of water savings.
TN1411	Modernise: Replace Meter	The construction records reviewed provide assurance that the work claimed is completed.
TO4378	Modernise: Replace Meter	The construction records reviewed provide assurance that the work claimed is completed.

For all 22 meter replacement or removal activities in the sample that are within the scope of the audit, we were provided sufficient evidence to confirm that the scope of works claimed was complete.

4.2.2 Remediation

No remediation works have been completed to date under the Water Efficiency Project. No records could be sampled for this activity for the 2022/23 audit.

4.2.3 Channel removal

We reviewed the construction records for 19 channel removal activities that were claimed for 2022/23. The records reviewed and the findings are detailed in Table 4-2.

Table 4-2 Findings from trailing removal records

IPM/ Asset Code	Intervention type	Comment
CH000472	Channel decommissioning	The construction records reviewed provide assurance that the work claimed is completed.
CH000473	Channel decommissioning	The construction records reviewed provide assurance that the work claimed is completed.
CH000567	Channel decommissioning	The construction records reviewed provide assurance that the work claimed is completed.
CH002124	Channel decommissioning	The construction records reviewed provide assurance that the work claimed is completed.
CH002142	Channel decommissioning	The construction records reviewed provide assurance that the work claimed is completed.
CH002143	Channel decommissioning	The construction records reviewed provide assurance that the work claimed is completed. This channel is blocked by channel CH002142.
CH003176	Channel decommissioning	The construction records reviewed provide assurance that the work claimed is completed.
CH006586	Channel decommissioning	The construction records reviewed provide assurance that the work claimed is completed.
CH007012	Channel decommissioning	The construction records reviewed provide assurance that the work claimed is completed. GMW advised that for historical reasons this channel had been termed CH007010 but the actual channels decommissioned were CH018490 and CH007012. We were provided sufficient information to support this naming.
CH009984	Channel decommissioning	The construction records reviewed provide assurance that the work claimed is completed.

IPM/ Asset Code	Intervention type	Comment
CH011860	Channel decommissioning	The construction records reviewed provide assurance that the work claimed is completed.
CH012037	Channel decommissioning	The construction records reviewed provide assurance that the work claimed is completed.
CH012190	Channel decommissioning	The construction records reviewed provide assurance that the work claimed is completed.
CH012194	Channel decommissioning	The construction records reviewed provide assurance that the work claimed is completed.
CH012234	Channel decommissioning	The construction records reviewed provide assurance that the work claimed is completed.
CH013187	Channel decommissioning	The construction records reviewed provide assurance that the work claimed is completed.
CH013886	Channel decommissioning	The construction records reviewed provide assurance that the work claimed is completed.
CH018068	Channel decommissioning	The construction records reviewed provide assurance that the work claimed is completed.
CH018487	Channel decommissioning	The construction records reviewed provide assurance that the work claimed is completed.

4.2.4 Regulator gates

Only one regulator gate has been installed under the Water Efficiency Project in 2022/23, SP304. Table 4-3 details the findings from trailing the construction records for this site. The records had satisfactory evidence of work completion and appropriate work pack sign-off.

Table 4-3 Sample of regulator gate sites

IPM/ Asset Code	Comment
SP304	The construction records reviewed provide assurance that the work claimed is completed.

4.2.5 Findings from third-party review

The assurance activities undertaken by PWC are consistent with the Water Savings Protocol requirement to check that the data collection and inputs are as accurate as could reasonably be expected for the purpose of calculating water savings. We were provided the findings of the review for the following periods:

- 1 October 2022 to 31 March 2023

For the review, 133 assets were put forward by GMW for review. For all but three records, the audit concluded that the evidence provided by the contractor was an accurate representation of the works completed during the review period.

For the audit, it was concluded that evidence provided by contractors is an accurate representation of the works completed and recommendations for continuous improvement were made.

4.2.6 Summary of construction record review and GMW response

We observed that the construction records provided met expectations with all work having signed-off ITPs with date/time stamped pre and post construction photographs. All work was completed in line with dates adopted for water saving calculations to June 2023 or August 2023. GMW provided additional information where required and answered any queries in a timely manner.

4.3 Outfall measurement and recording

Outfall data is an important input into the calculation of water savings arising from automation. While the Connections Project has substantial water savings arising from automation, the Water Efficiency Project has much smaller scope for automation.

GMW uses SCADA data (configured to be reported from SPM) as the source data for reporting outfall volumes. Where an outfall does not have online measurement, operational staff record the outfall volume in a log sheet. There is a separate log sheet for each irrigation area. GMW operational staff provide to field staff each month a spreadsheet containing outfall data extracted from SPM. Operational staff review the spreadsheet and make adjustments for any erroneous readings, e.g., if the water level in the channel is particularly low, the flow reading may be a false high reading when in fact no water is leaving the outfall. Operational staff also input into this spreadsheet their readings for outfalls without on-line metering and provide this information back to the planning team. SPM records comments and adjustments made by field operators. It is expected that any adjustments in SPM do have a reason provided (via a drop-down menu) and brief commentary.

We selected a sample of outfall data used in the water savings and trailed these back to the IPM database. The findings of this data trailing are summarised in Table 4-4.

Table 4-4 Findings from trailing outfall data

IPM/ Asset Code	Audit notes
SP316	GMW has cleansed the raw data to remove erroneous readings. The raw data shows a total of 332ML of outfalls for the year. GMW has used 72ML in the water savings calculations. The majority of the difference is attributable to the period 11 September 2022 to 17 September 2022 when the outfall was recorded consistently at 27.2 ML/day in the raw data. To have a consistent reading such as this is one indicator of false data. GMW provided records for the upstream regulator SP.307 which showed that no flow was passing over this regulator at the time SP.316 was recording an outfall. We consider that GMW has appropriately cleansed the outfall data and that the data used in the calculations is appropriate.

4.4 Customer deliveries

The IPM is the business system used by GMW to manage irrigation supply orders and plan the delivery of these orders. When an order is placed by a customer online or by telephone, it is sent to IPM. For customers on fully automated channels, IPM essentially sends the order to the customer's outlet. The orders specify the times to open and close the customer outlet and the ordered flow rate. The channel automation system uses a combination of feedback control on water level with feed-forward flow to control the water level and flow in the channel.

IPM also provides management reporting facilities on a range of operational aspects and records delivery volumes for billing purposes. It also records delivery volumes against entitlements and rejects orders where the entitlement has been exceeded.

For the purposes of the water savings calculations, IPM is used to determine customer deliveries through service points.

4.5 Conclusions

Our review for the 2022/23 audit of the information systems and processes used by GMW has found that they are sufficiently robust to generate data and inputs that are as accurate as could reasonably be expected for the purpose of calculating water recoveries.

We found that all assets included in our samples for data trailing had sufficient evidence to support the fact that they have been constructed and commissioned. We are satisfied that GMW has completed the works claimed in the calculations.

4.6 Recommendations

We make the following recommendations regarding the Water Efficiency Project's approach to estimating water savings for GMW to consider for implementation:

- Improve the audit trail when flow records are updated in SPM. This may be done by providing additional drop-down menus and/or reinforcing the requirement for operators to provide comments when updated are made.

GMW has reviewed and accepted this recommendation.

5 Checking of the work done

5.1 Overview

The Water Savings Protocol requires that random and targeted checking that the program of works for irrigation modernisation projects have been implemented as documented in the water savings estimates. For the 2022/23 audit, inspection of works were undertaken whereas in previous years, this aspect of the audit has relied on desktop review of records. The following sections detail the sites inspected and the observations made to confirm that works claimed as complete, have been constructed.

5.2 Sites inspected

The sites selected for inspection were selected randomly from the schedule of works done during 2022/23. The sample selected included sites which had been excluded from the water savings calculations for various reasons and so these sites were not visited. A number of sites were also not able to be accessed. In addition to the sites selected from the sample of works completed for 2022/23, other works were visited opportunistically where these were located nearby to the

Table 5-1 details the observations from the sample of sites inspected. Photos from the site inspection are included in Appendix C.

Table 5-1 Observations from site inspection

IPM/ Asset Code	Intervention type	Comment
RO6842	Modernise: Replace Meter	Site visited and confirmed that works were in place as claimed.
MV2394	Modernise: Relocate Meter	Opportunistic inspection of asset outside of sample. Meter was installed through Connections project in 2019.
MV2395	Modernise: Relocate Meter	Opportunistic inspection of asset outside of sample. Meter was installed through Connections project in 2019.
MV2396	Modernise: Relocate Meter	Opportunistic inspection of asset outside of sample. Meter was installed through Connections project in 2019.
MV6289	Modernise: Replace Meter	Site visited and confirmed that works were in place as claimed.
MV6290	Modernise: Replace Meter	Site visited and confirmed that works were in place as claimed.
MV6619	Modernise: Replace Meter	Opportunistic inspection of asset outside of sample. Site visited and confirmed that works were in place as claimed.
MV6809	Modernise: Replace Meter	Opportunistic inspection of asset outside of sample. Site visited and confirmed that works were in place as claimed.
MV6828	Modernise: Relocate Meter	Site visited and confirmed that works were in place as claimed
TN12983	Modernise: Replace Meter	Site visited and confirmed that works were in place as claimed
MV6818	Modernise: Replace Meter	Site visited and confirmed that works were in place as claimed
TN1411	Modernise: Replace Meter	Saw. Confirmed
CH002124	Channel decommissioning	Site visited and confirmed that works were in place as claimed
CH011860	Channel decommissioning	Site visited and confirmed that works were in place as claimed

IPM/ Asset Code	Intervention type	Comment
CH012037	Channel decommissioning	Site visited and confirmed that works were in place as claimed
CH012190	Channel decommissioning	Saw pipeline and channel decommissioned. See photo. Note water on ground
CH012194	Channel decommissioning	Site visited and confirmed that works were in place as claimed
CH013886	Channel decommissioning	Site visited and confirmed that works were in place as claimed
CH018068	Channel decommissioning	Site visited and confirmed that works were in place as claimed
CH018487	Channel decommissioning	Site visited and confirmed that works were in place as claimed.
SP.304	Channel automation	Site visited and confirmed that works were in place as claimed
SP.306	Channel automation	Site visited and confirmed that works were in place as claimed

5.3 Conclusions

The site inspection confirmed for all sites that the work claimed as complete was complete and operational. The inspection included assets identified as being complete during 2022/23 for which construction records were also reviewed as well as sites which were opportunistically inspected as they were located close to the sites within the original sample. Overall, we gained a high level of assurance that the work claimed as complete within the water savings calculations has been completed and is operational.

5.4 Recommendations

There are no recommendations arising from the checking of the work completed.

6 Audit of water savings calculations

6.1 Structure of this chapter

This chapter has been structured to align with the structure of the technical manual, part of the Water Savings Protocol, with each water saving intervention presented in the same order as found in that document. The technical manual provides additional discussion on the application of the water savings calculations that have been omitted from this report to avoid repetition.

For reference, the calculations used to determine water savings from the technical manual and the input data requirements for these calculations are included in Appendix A .

For each water saving intervention (channel asset removal, channel automation, service point replacement and removal, and channel remediation) we detail:

- The nature of the works that lead to water recovery and the scope of works undertaken to date
- Findings from auditing the water savings calculations
- The water savings resulting from applying the calculations.

The scope of this audit is to review Phase 4 water savings achieved, where Phase 4 savings relate to the long-term average annual water savings from the executed program of works.

6.2 Baseline year water balance

In calculating water savings, reference is made for some components of water loss that occurred in a baseline year. For most water savings components, the baseline year was the 2004/05 irrigation season. A water balance that establishes the value for water loss components in each irrigation area for this baseline year was compiled by GMW. This baseline year water balance has been previously independently audited.

Since the completion of this independent audit, GMW has revisited the baseline year water balance and made some revisions on the basis of better information being available or a more complete understanding of the nature of losses in the irrigation areas. This revised baseline year water balance was independently audited in 2012 and has been used as the basis of this audit. There have been some minor, iterative changes to the baseline year water balance due to better information since the audit in 2012.

6.3 Overview of water recovery achieved in 2022/23

The WEP commenced in 2021. The 2022/23 audit requires cumulative water savings to be separately accounted to WEP up to 30 June 2023 and up to 31 August 2023 which are shown in Table 6-1.

Table 6-1 Audited Phase 4 water savings

Project	Phase 4 water savings (ML)		% Total	
	30 June 2023	**31 August 2023**	**30 June 2023**	**31 August 2023**
WEP Project - Fixed	5,815.3	6,101.7	37%	36%
WEP Project - Variable	10,073.1	10,809.8	63%	64%
Total	**15,888.1**	**16,911.50**	**100%**	**100%**

Note – Totals may not sum due to rounding

Figure 6-1 provides an overview of the contribution of the different modernisation activities to the audited Phase 4 water savings for 2022/23 for the WEP. This figure shows that Channel removal is the most significant contributor to water savings achieved to date. Channel remediation work has not contributed to WEP water saving at this stage. A small volume of recovery from channel remediation is expected by the end of the project.

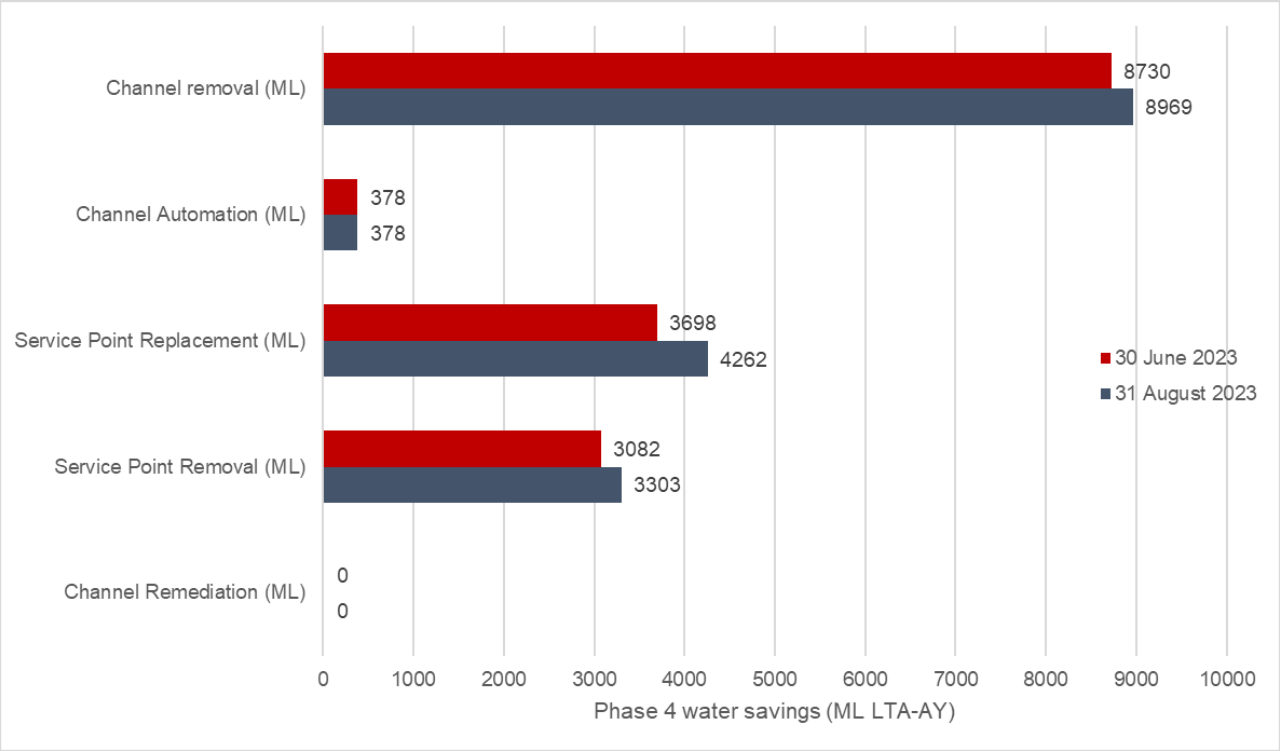


Figure 6-1Audited Phase 4 Water Savings Estimates 2022/23 (WEP to 30 June 2023 and to 31 August 2023)

6.4 Savings from channel asset removal

6.4.1 Scope of channel asset removal works

Channel asset removal refers to channels, pipelines or storages that are removed from the publicly owned irrigation distribution system. Removing these assets from the system as part of an irrigation modernisation project will reduce losses due to:

- Seepage
- Bank leakage
- Net evaporation

Outfall savings which may be attributable to asset removal are included under channel automation. The associated savings of unauthorised use and leakage through and around meters when channels are removed are included under service point replacement or removal.

An alternative approach to using irrigation distribution system averages to estimate baseline year seepage, bank leakage and evaporation losses from spur channels is to develop a channel loss model (e.g., which relates soil and other channel characteristics to pondage test results for a sample of channels). DEECA provided to us a letter from DEECA to GMW approving use of a loss model to estimate water savings for channel asset removal. This initial approval included a number of conditions including that GMW address a number of items raised by an independent review of the loss model by Hydrology and Risk Consulting Pty Ltd. DEECA provided to us a letter from Hydrology and Risk Consulting Pty Ltd to DEECA dated 22 March 2019 which concludes that the non-backbone loss model provides a reasonable method for distributing the baseline year bank leakage, seepage, and net evaporation losses to individual channels. Based on the correspondence reviewed, we are satisfied that the loss model approach (version 11) has been appropriately approved for use as required by the Water Savings Protocol.

The details of the cumulative length of channels removed in each irrigation area under the WEP to 30 June 2023 and to 31 August 2023 are depicted in Figure 6-2.

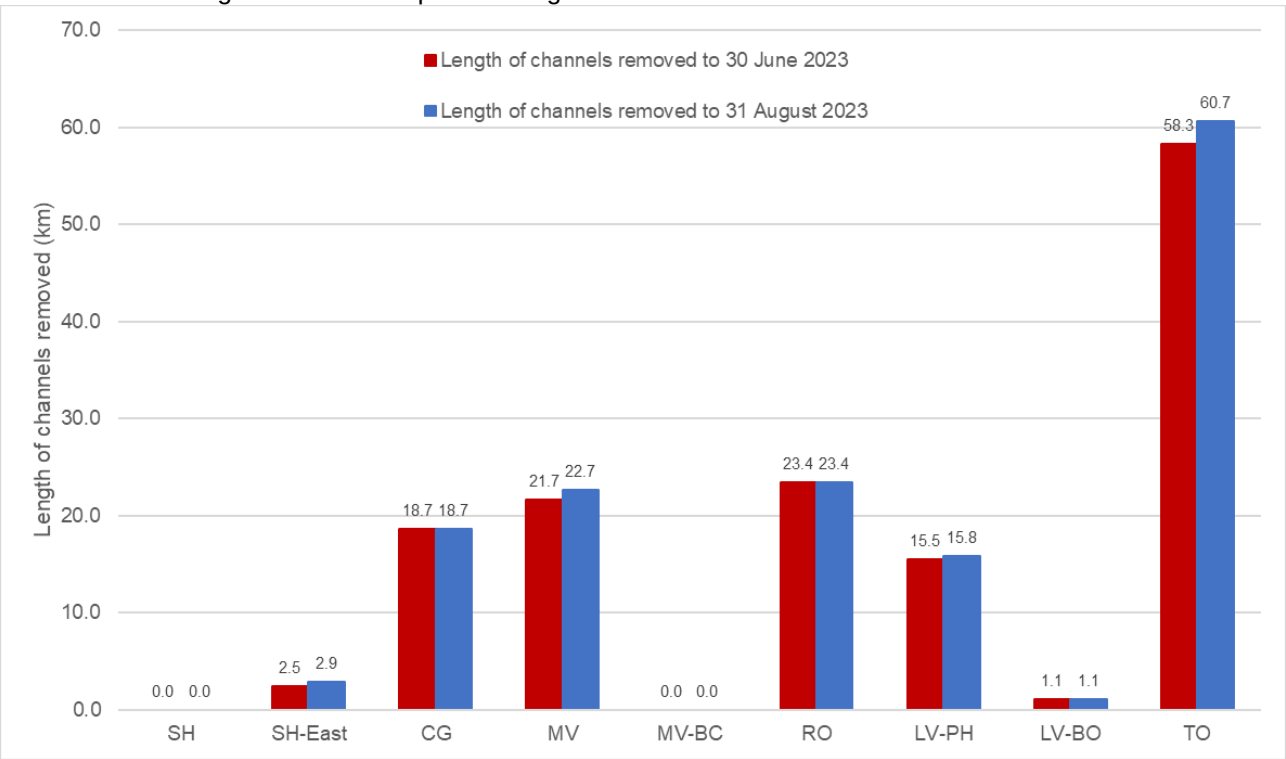


Figure 6-2 Length of channels removed (contributing to water savings only) by irrigation area under WEP to 31 August 2023 and to 31 August 2023

6.4.2 Findings from trailing data and audit of calculations

We have reviewed the input data and confirm that the fixed parameters and equations sourced from the technical manual are correct. We cross-checked the baseline year values against the baseline year audit report and confirmed that GMW has used values from the spur channels water balance.

Our review of the current year parameters for Phase 4 used in the calculations found the following:

- Ratio of Channel Length Removed to Total Channel Length (CL) – Loss Model Rates
  Under the loss model approach, the length ratio approach is replaced by a lookup of loss rates for seepage, evaporation and leakage that are specific to the channel. We confirm that the loss model rates are referenced correctly in the calculations based on our audit trailing and samples.

6.4.3 Results

The audited water savings due to channel removal, are summarised with breakdown into fixed and variable components for the period to 30 June 2023 and to 31 August 2023 in Table 6-2. The incremental savings achieved from 1 July 2023 to 31 August 2023 are shown in Table 6-3.

Table 6-2 Phase 4 Water Savings due to Channel Removal with breakdown into fixed and variable components (ML LTAAY)

PHASE 4	SH	SH-EAST	CG	MV	MV-BC	RO	LV-PH	LV- BO	TO	Total
WEP savings to 30 June 2023										
Seepage (ML) - Fixed	-	2.2	239.6	411.9	-	345.4	44.6	3.3	816.6	1,863.5
Bank leakage (ML) - Fixed	-	22.6	212.6	268.4	-	242.3	63.3	5.1	931.7	1,746.1
Bank leakage (ML) - Variable	-	54.7	513.4	647.9	-	585.0	152.7	12.4	2,249.4	4,215.5
Evaporation (ML) - Fixed	-	10.6	99.5	172.5	-	144.5	91.1	6.7	397.7	922.7
Pipeline deduction (ML) - Fixed	-	(0.2)	(1.1)	(5.8)	-	(4.4)	-	-	(6.5)	(18.0)
Total	-	**89.9**	**1,064.0**	**1,494.9**	**-**	**1,312.8**	**351.7**	**27.6**	**4,388.9**	**8,729.8**
WEP savings to 31 August 2023										
Seepage (ML) - Fixed	-	2.4	239.6	425.4	-	345.4	45.0	3.3	848.9	1,910.0
Bank leakage (ML) - Fixed	-	26.9	212.6	280.6	-	242.3	64.5	5.1	967.8	1,799.9
Bank leakage (ML) - Variable	-	64.9	513.4	677.5	-	585.0	155.8	12.4	2,336.5	4,345.5
Evaporation (ML) - Fixed	-	11.7	99.5	177.8	-	144.5	91.9	6.7	414.7	946.9
Pipeline deduction (ML) - Fixed	-	(1.1)	(2.0)	(5.8)	-	(11.3)	(1.8)	-	(11.5)	(33.4)
Total	-	**104.9**	**1,063.1**	**1,555.6**	**-**	**1,305.9**	**355.4**	**27.6**	**4,556.5**	**8,968.9**

Note – Totals may not sum due to rounding

Table 6-3 Phase 4 Water Savings due to Channel Removal with breakdown into fixed and variable components from 1 July 2023 to 31 August 2023 (ML LTAAY)

PHASE 4	SH	SH-EAST	CG	MV	MV-BC	RO	LV-PH	LV- BO	TO	Total
WEP savings from 1 July 2023 to 31 August 2023										
Seepage (ML) - Fixed	-	0.2	-	13.5	-	-	0.4	-	32.4	46.5
Bank leakage (ML) - Fixed	-	4.2	-	12.3	-	-	1.3	-	36.1	53.8
Bank leakage (ML) - Variable	-	10.2	-	29.6	-	-	3.1	-	87.1	130.0
Evaporation (ML) - Fixed	-	1.1	-	5.3	-	-	0.8	-	17.0	24.2
Pipeline deduction (ML) - Fixed	-	-0.8	-0.9	-	-	-6.9	-1.8	-	-5.0	-15.4
Total	-	14.9	-0.9	60.7	-	-6.9	3.7	-	167.5	239.1

Note – Totals may not sum due to rounding

6.5 Savings from channel automation

6.5.1 Scope of automation works

Automation involves provision of regulator gates that can be operated in real time in a network either remotely by operators, or by using a control strategy and system, to regulate a series of channel pool levels to meet customer demands with significantly reduced need for on-site manual intervention. Automation greatly reduces the water spillage at the end of channels (outfalls) and may reduce bank leakage by maintaining the level of water in a pool within a relatively restricted band.

In this audit fir 2022/23, only work in Shepparton East contributed to Phase 4 water savings and there is no subtraction of environmental mitigating flows volumes from these savings. As automation works have previously been undertaken in Shepparton East under different projects, water savings under the Water Efficiency Project are determined as the total observed Phase 4 savings less the savings previously claimed under the previous projects.

6.5.2 Findings from trailing data and audit of calculations

We have reviewed the input data and confirm that the fixed parameters and equations sourced from the technical manual are correct. The following summary is a review of the inputs from the current operating year for Phase 4 used in the calculations:

Outfalls in Current Year ($O_{yearX\ –\ fixed}$, $O_{yearX\ –\ variable}$)
In Version 5 of the Water Savings Protocol, outfalls in the current year and baseline year have been divided into fixed and variable components. The variable component relates to customer deliveries and is scaled by customer deliveries. A breakdown of the Phase 4 water savings in into fixed and variable components is included in Table 6-4. We reviewed GMW's allocation of outfalls between the fixed and variable components and we are satisfied that the approach taken is in accordance with the technical manual. Version 5 of the technical manual confirms that groundwater dilution flows are to be allocated as a fixed component.

Long-Term Cap Equivalent Factor F($LTCE_{YearX}$)
This factor has been calculated by GMW in accordance with the formula in the technical manual using a factor of 1.3 for $LTCE_{Base}$ as advised by DEECA. The ratio of delivered volumes has been applied for all operating areas.

6.5.3 Results

The audited water savings due to channel automation are summarised in Table 6-4. The water savings from automation are unchanged between 30 June 2023 and 31 August 2023 as they are derived from outfalls recorded during the irrigation season.

Table 6-4 Breakdown of Phase 4 Water Savings due to Channel Automation into fixed and variable components (ML LTAAY)

Phase 4 at Shepparton East (SH-EAST)	Phase 4 water savings to 30 June 2023	Phase 4 water savings to 31 August 2023
WEP Project		
Fixed component	0	0
Variable component	378.2	378.2
Total	**378.2**	**378.2**

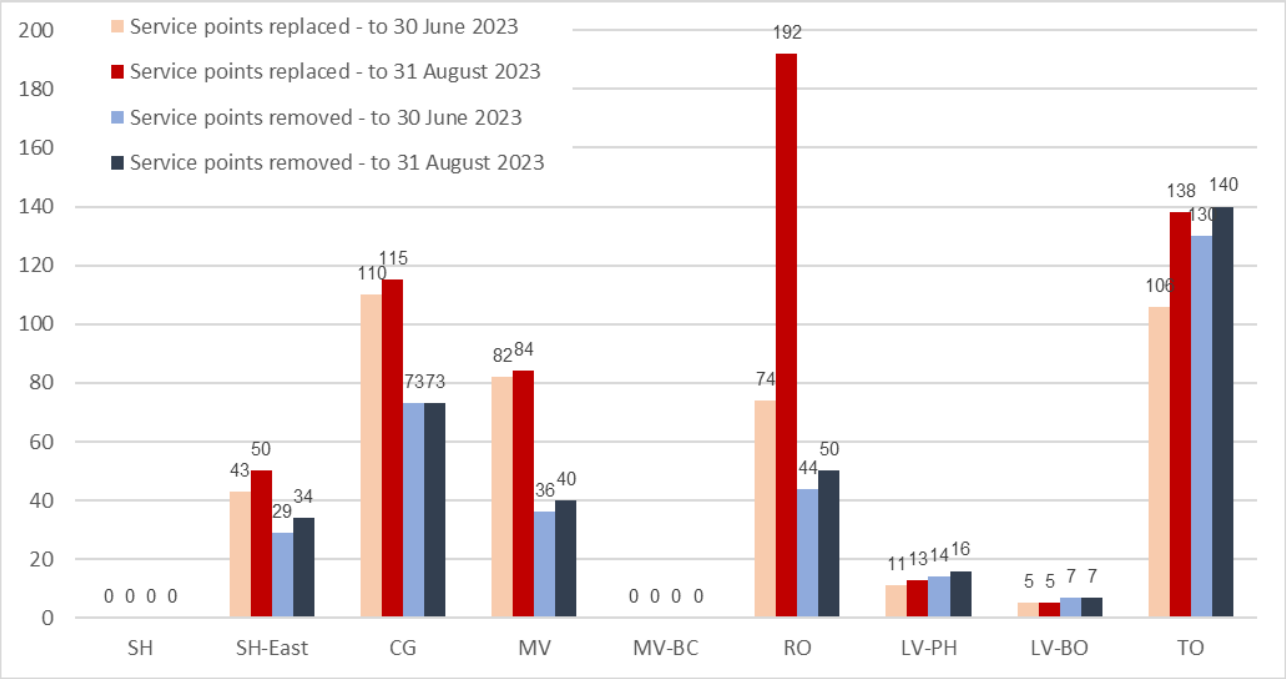
Note – Totals may not sum due to rounding

6.6 Savings from service point replacement and removal

6.6.1 Scope of service point replacement and removal works

A service point is a location where water is taken from the irrigation distribution system by a customer. Customers may have more than one service point, and service points may or may not be metered. Water savings are achieved when existing customer service points, usually Dethridge Wheels, are replaced with modern outlets. The modern designs are typically pipes with magflow meters or flume gates. Savings may also be achieved when existing service points are removed and not replaced (i.e., rationalised). The savings achieved are due to the improved construction of the service points, preventing leakage through and around the meter, as well as the increased accuracy of the new meters which better account for water use. Service point replacement and removed has been completed under the WEP to 30 June 2023 and to 31 August 2023. Figure 6-3 shows the cumulative number of service points replaced and removed in each irrigation area.

Figure 6-3 Numbers of service points replaced and removed by irrigation area under WEP to 31 August 2023 and to 31 August 2023



6.6.2 Findings from trailing data and calculations

We have reviewed the input data and confirm that the parameters and equations sourced from the technical manual Baseline Year Water Balance are correct.

The following summary is a review of the inputs from the current operating year for Phase 4 used in the calculations:

Number of Service Points Replaced and Removed (rationalised) ($N_{replaced}$, $N_{rationalised}$)

The number of meters replaced and removed is determined from construction records. GMW demonstrated the process it undertakes for handling service point record data. This process includes collating data from different sources and then filtering this data and removing any duplicate or anomalous records. We are satisfied that this process is robust. GMW also achieves meter error savings where new meters have been installed as part of system removal works.

We reviewed the commissioning certificates for a sample of service points under the WEP, as outlined in Section 4.2.1. This review provided evidence that the sample of works claimed as complete by GMW had been completed.

Long-Term Cap Equivalent Factor F($LTCE_{Base}$)

This factor has been calculated by GMW in accordance with the formula in the technical manual using a factor of 1.3 for **$LTCE_{Base}$** as advised by DEECA. The ratio of deliveries volumes has been applied for all of the GMW operating areas.

6.6.3 Results

The audited water savings due to service point replacements are summarised in Table 6-5 and Table 6-6 for WEP to 1 July 2021 and to 31 August 2023 andTable 6-6 from 1 July 2021 to 31 August 2023. GMW performs these calculations on a meter-by-meter basis and not for an irrigation area nor as a whole system.

Water savings of service point replacement and removal:

- fixed components are water savings from leakage through and around
- variable components are from meter error and unauthorised use

Table 6-5 Cumulative Phase 4 Water Savings due to Service Point Replacement and Removal – WEP to 30 June 2023 (ML LTAAY)

	SH	SH-EAST	CG	MV	MV-BC	RO	LV-PH	LV- BO	TO	Total
Phase 4 Water Savings to 30 June 2023										
Service point replacement										
Meter error (ML)	0.0	186.8	808.6	664.1	0.0	454.4	134.7	41.2	583.3	2873.3
Leakage through service points (ML)	0.0	57.5	127.1	94.9	0.0	46.7	19.9	8.8	118.0	473.0
Leakage around service points (ML)	0.0	12.5	26.5	20.1	0.0	9.9	4.2	1.9	25.1	100.2
Unauthorised Use (ML)	0.0	32.5	67.6	49.6	0.0	24.3	10.3	4.7	62.5	251.6
Total (ML)	**0.0**	**289.4**	**1030.0**	**828.8**	**0.0**	**535.3**	**169.0**	**56.7**	**788.8**	**3698.0**
Service point removal										
Meter error (ML)	0.0	31.7	516.6	332.7	0.0	143.0	116.8	63.3	797.1	2001.3
Leakage through service points (ML)	0.0	47.5	121.6	64.6	0.0	83.6	26.6	13.3	235.6	592.8
Leakage around service points (ML)	0.0	8.8	25.6	13.6	0.0	17.6	5.6	2.8	49.2	123.2
Unauthorised Use (ML)	0.0	29.3	74.9	39.8	0.0	51.5	16.4	8.2	145.1	365.0
Total (ML)	**0.0**	**117.3**	**738.7**	**450.7**	**0.0**	**295.7**	**165.4**	**87.6**	**1226.9**	**3082.3**
Total Phase 4 savings to 30 June 2023 (Replacement and removal)	**0.0**	**406.7**	**1768.6**	**1279.6**	**0.0**	**831.0**	**334.5**	**144.2**	**2015.7**	**6780.3**

Note – Totals may not sum due to rounding

Table 6-6 Cumulative Phase 4 Water Savings due to Service Point Replacement and Removal – WEP to 31 August 2023 (ML LTAAY)

	SH	SH-EAST	CG	MV	MV-BC	RO	LV-PH	LV- BO	TO	Total
Phase 4 Water Savings to 31 August 2023										
Service point replacement										
Meter error (ML)	0.0	204.3	842.8	688.3	0.0	624.9	166.7	41.2	676.1	3244.3
Leakage through service points (ML)	0.0	64.0	132.6	98.6	0.0	104.5	23.5	8.8	152.2	584.2
Leakage around service points (ML)	0.0	14.0	27.7	20.9	0.0	22.0	4.9	1.9	32.3	123.8
Unauthorised Use (ML)	0.0	36.3	70.4	51.5	0.0	54.3	12.2	4.7	80.3	309.6
Total (ML)	**0.0**	**318.6**	**1073.5**	**859.2**	**0.0**	**805.7**	**207.3**	**56.7**	**940.9**	**4261.8**
Service point removal										
Meter error (ML)	0.0	36.9	516.6	374.1	0.0	154.8	140.3	63.3	853.0	2139.0
Leakage through service points (ML)	0.0	57.0	121.6	72.2	0.0	93.1	30.4	13.3	250.8	638.4
Leakage around service points (ML)	0.0	10.0	25.6	15.2	0.0	19.6	6.4	2.8	52.4	132.0
Unauthorised Use (ML)	0.0	35.1	74.9	44.5	0.0	57.3	18.7	8.2	154.4	393.1
Total (ML)	**0.0**	**139.0**	**738.7**	**506.0**	**0.0**	**324.8**	**195.9**	**87.6**	**1310.7**	**3302.5**
Total Phase 4 savings to 31 August 2023 (Replacement and removal)	**0.0**	**457.6**	**1812.2**	**1365.2**	**0.0**	**1130.5**	**403.1**	**144.2**	**2251.6**	**7564.3**

Table 6-7 Incremental Phase 4 Water Savings due to Service Point Replacement and Removal – WEP from 1 July 2023 to 31 August 2023 (ML LTAAY)

	SH	SH-EAST	CG	MV	MV-BC	RO	LV-PH	LV- BO	TO	Total
Phase 4 Water Savings to 1 Jul to 31 Aug 2023										
Service point replacement										
Meter error (ML)	0.0	17.5	34.2	24.1	0.0	170.5	32.0	0.0	92.8	371.0
Leakage through service points (ML)	0.0	6.5	5.4	3.6	0.0	57.8	3.6	0.0	34.3	111.2
Leakage around service points (ML)	0.0	1.5	1.1	0.8	0.0	12.2	0.8	0.0	7.2	23.6
Unauthorised Use (ML)	0.0	3.7	2.8	1.9	0.0	30.0	1.9	0.0	17.8	58.0
Total (ML)	**0.0**	**29.2**	**43.5**	**30.3**	**0.0**	**270.4**	**38.2**	**0.0**	**152.1**	**563.8**
Service point removal										
Meter error (ML)	0.0	5.2	0.0	41.4	0.0	11.7	23.5	0.0	56.0	137.7
Leakage through service points (ML)	0.0	9.5	0.0	7.6	0.0	9.5	3.8	0.0	15.2	45.6
Leakage around service points (ML)	0.0	1.2	0.0	1.6	0.0	2.0	0.8	0.0	3.2	8.8
Unauthorised Use (ML)	0.0	5.9	0.0	4.7	0.0	5.9	2.3	0.0	9.4	28.1
Total (ML)	**0.0**	**21.7**	**0.0**	**55.2**	**0.0**	**29.1**	**30.4**	**0.0**	**83.7**	**220.2**
Total Phase 4 savings from 1 Jul to 31 Aug 2023 (Replacement and removal)	**0.0**	**50.9**	**43.5**	**85.6**	**0.0**	**299.4**	**68.7**	**0.0**	**235.8**	**784.0**

Note – Totals may not sum due to rounding

6.7 Savings from channel remediation

Channel remediation involves lining earthen channels, replacing channels with pipelines and bank re-modelling. However, there has been no channel remediation works and therefore no water savings contributed from channel remediation from the start of the project to 31 August 2023.
GMW expects that there will be a small channel remediation scope included in the end of project water recovery totals to be assessed in early 2024.

7 Recommendations for improvement

The Audit Protocol requires that the water audit report include:

- Potential improvements to the data collection, data analysis, assumptions and methods used to estimate the water savings.
- Recommendation on changes to the Water Savings Protocol that will improve the useability and accuracy of water savings estimates.

We make the following recommendation regarding GMW's approach to estimating water savings for GMW to consider for implementation:

We have not made any recommendations for improvement for the processes used to estimate water savings noting that the water savings works are largely complete.

This audit has not identified any need to change the Water Savings Protocol.

8 Progress against previous audit recommendations

The Audit Protocol requires the current year audit to report on the status of the suggested improvements made in previous audits. All recommendations prior to have now been closed out.

Table 8-1 details progress against the recommendations that were still open at the 2022/23 audit. This table also details the recommendations made at this year's audit for the purpose of tracking these recommendations in future audits.

Table 8-1Schedule of progress against previous audit actions

Ref	Area	Recommendation	2022/23 Audit comment
2022/23-1	Audit trail for SPM records	Improve the audit trail when flow records are updated in SPM. This may be done by providing additional drop-down menus and/or reinforcing the requirement for operators to provide comments when updated are made.	GMW noted that this is an ongoing focus and will work with operators to improve the quality of comments provided

Appendices

We design with community in mind

Appendix A Calculations

A.1 Channel asset removal calculations

A.1.1 Overview

Water savings due to channel removal are the sum of the savings due to water no longer being lost in the channel to seepage, bank leakage, and evaporation:

Phase 4: $WS_{(LTCE)} = WS_{seepage(LTCE)} + WS_{bank\ leakage(LTCE)} + WS_{evaporation\ (LTCE)} - R$

A.1.2 Water savings calculations

Phase 4 Calculations

Phase 4 water savings due to channel removal are estimated by the following equations from the technical manual:

$WS_{seepage(LTCE} = S_{Base} \times CL \times EF \times DF$

$WS_{bank\ leakage(LTCE)} = [(L_{Base} \times FL) + (L_{Base} \times VL \times F(LTCE_{Base}))] \times CL \times EF \times DF$

$WS_{evaporation(LTCE)} = E_{Base} \times CL \times EF \times DF$

Revisions to the baseline year water balance since 2011/12 have adjusted the baseline year losses for leakage, seepage, and evaporation losses. Seepage and evaporation losses are also now taken to occur over a full year rather than just the irrigation season.

As noted in Section 6.4, GMW uses a loss model approach for determining water savings from removal of spur channels. This approach has been approved by DEECA. The loss model approach is more granular than using area averages.

A.1.3 Input data

The inputs required to calculate Phase 4 water savings due to channel removal are summarised in Table 8-2 and Table 8-3.

The first table details the parameters that are fixed or have been previously audited. The second table details the input data from the current year.

A-1 Table 8-2 Fixed Parameters and Baseline Year Parameters for Channel Removal Water Savings Calculation

Parameter	Description	Source
S_{Base}	Seepage in Baseline Year	Loss model approach (version 11)
L_{Base}	Leakage in Baseline Year	Loss model approach (version 11)
E_{Base}	Evaporation in Baseline Year	Loss model approach (version 11)
D_{Base}	Deliveries in Baseline Year	Loss model approach (version 11)
FL	Proportion of bank leakage recognised as fixed	Technical manual
VL	Proportion of bank leakage recognised as variable	Technical manual
EF	Effectiveness Factor for channel removal	Technical manual
DF	Durability Factor to account for the durability of water savings	Technical manual
$F(LTCE_{Base})$	Long-Term Cap Equivalent Factor to convert Current Year volumes to Long-Term Cap Equivalent volume	Calculated from deliveries and base figure advised by Department of Environment, Land, Water and Planning
R	Residual losses if channel replaced by pipeline (0.6ML/km/year for Phase 4)	Technical manual, including a minor correction identified by the Connections Project and acknowledged by DEECA

A-2 Table 8-3 Current Year Parameters for Channel Removal Water Savings Calculation

Parameter	Description	Source
CL	Ratio of length of spur channel length rationalized(removed) to total spur channel length in system	GIS and direct measurement

A.2 Channel Automation Calculations

A.2.1 Overview

Water savings due to automation are the sum of the savings realised through reduced outfall volumes:

Phase 4: $WS_{YearX(LTCE)} = WS_{outfalls(LTCE)}$

In Version 5 of the Water Savings Protocol, outfalls in the current year and baseline year have been divided into fixed and variable components. The variable component relates to customer deliveries and is scaled by customer deliveries.

A.2.2 Water saving calculations

Phase 4 Calculations

Phase 4 water savings due to reduction in outfalls are estimated by the following equations from the technical manual with a minor correction identified by the Connections Project and acknowledged by DEECA. This includes the addition of an additional bracket so $DF_{variable}$ applies to both O_{base} variable and O_{yearx} variable components.

$$WS_{outfalls} = [((O_{base\text{-}variable} \times F(LTCE_{base})) - (O_{YearX\text{-}variable} \times F(LTCE_{YearX}))) \times DF_{variable}] + [O_{BaseFixed} - O_{YearXFixed}]$$

A.2.3 Input Data

The inputs required to calculate Phase 4 water savings due to outfall automation are summarised in Table 8-4 and Table 8-5.

The first table details the parameters that are fixed or have been previously audited. The second table details the input data from the current year.

A-1 Table 8-4 Fixed parameters and baseline year parameters for automation water savings calculation

Parameter	Description	Source
$O_{Base\ -\ fixed}$	Fixed outfall loss in Baseline Year	Baseline Year water balance and analysis
$O_{Base\ -\ variable}$	Variable outfall loss in Baseline Year	Baseline Year water balance and analysis
DF	Durability factor to account for the durability of water savings interventions	WEP use a value of 0.98 (approved by DEECA in 2017)
$F(LTCE_{Base})$	Long-Term Cap Equivalent Factor to convert Baseline Year volumes to Long-Term Cap Equivalent volume	Department of Environment, Land, Water and Planning

A-2 Table 8-5 Current year parameters and baseline year parameters for automation water savings calculation

Parameter	Description	Source
OyearX - Fixed	Fixed outfalls in Current Year	SCADA and analysis
OyearX – Variable	Variable outfalls in Current Year	SCADA and analysis
F(LTCEYearX)	Long-Term Cap Equivalent Factor to convert Current Year volumes to Long-Term Cap Equivalent volume	Calculated from deliveries and base figure advised by Department of Environment, Land, Water and Planning

A.3 Service Point Replacement and Removal

A.3.1 Overview

Water savings due to service point replacements and removal are the sum of the savings realised through reduced meter errors, lowered leakage through and around the old meter, previously unmetered volumes and reduced unauthorised use.

The high-level equation of Phase 4 savings:

$$WS_{YearX} = WS_{meter\ error} + WS_{leakage\ through} + WS_{leakage\ around} + WS_{unmetered} + WS_{unauthorised}$$

A.3.2 Water saving calculations

The components of the Phase 4 water savings calculations are detailed below. GMW does not include the component for savings due to unmetered volumes as it believes that these are negligible.

Phase 4 Calculations – Service Point Replacement

Phase 4 water savings have been calculated by GMW using a formula from the May 2012 technical manual, however with meter error estimated on D_{Base} rather than $D_{Year\ X}$. This aligns with the Water Savings Protocol Version 5 where there is no $F(LTCE_{YearX})$ provided, the Phase 4 equation for service point removal can be used to estimate the savings from service point replacement.

$$WS_{YearX(LTCE)} = WS_{meter\ error(LTCE)} + WS_{leakage\ through(LTCE)} + WS_{leakage\ around(LTCE)} + WS_{unmetered(LTCE)} + WS_{unauthorised(LTCE)}$$

where:

$WS_{meter\ error} = DM_{YearX} \times (1/MCF) \times (MCF - 1) \times EF \times DF \times F(LTCE_{YearX})$

$WS_{unmetered} = DM_{YearX} \times (1/MCF) \times (MCF - 1) \times EF \times DF \times F(LTCE_{YearX})$ (not used)

$WS_{leakage\ through} = N_{replaced} \times LTT \times EF \times DF$

$WS_{leakage\ around} = N_{replaced} \times LTA \times EF \times DF$

$WS_{unauthorised} = N_{replaced} \times U_{Base} \times EF \times DF \times F(LTCE_{base})$

In the cases where a new service point has been added into a channel previously serviced by less meters, GMW denotes these as a new-new meter. The new-new meter decreases water savings due to the leakage through and around the structure. Therefore, GMW has used a slightly different formula to calculate 'savings', which accounts for introduced losses that would not have been experienced before. The formulas change in Leakage through, around, meter error and unauthorised losses for Phase 4. This is a conservative approach that we feel is appropriate.

Phase 4 Calculations – Service Point Removal

Phase 4 water savings due to service point removal have been calculated by GMW using the formula in the technical manual:

$$WS_{YearX(LTCE)} = WS_{meter\ error(LTCE)} + WS_{leakage\ through(LTCE)} + WS_{leakage\ around(LTCE)} + WS_{unmetered(LTCE)} + WS_{unauthorised(LTCE)}$$

where:

$WS_{meter\ error(LTCE)} = DM_{YearX} \times (1/MCF) \times (MCF - 1) \times EF \times DF \times F(LTCE_{YearX})$

$WS_{unmetered(LTCE)} = DM_{YearX} \times (1/MCF) \times (MCF - 1) \times EF \times DF \times F(LTCE_{YearX})$ (not used)

$WS_{leakage\ through(LTCE)} = N_{replaced} \times LTT \times EF \times DF$

$WS_{leakage\ around(LTCE)} = N_{replaced} \times LTA \times EF \times DF$

$WS_{unauthorised(LTCE)} = N_{replaced} \times U_{Base} \times EF \times DF \times F(LTCE_{base})$

A.3.3 Input Data

The inputs required to calculate Phase 4 water savings due to service point replacement and removal are summarised in Table 8-6 and Table 8-7. Table 8-6 details the parameters that are fixed or have been previously audited. Table 8-7 details the input data from the current year.

A-1 Table 8-6 Fixed parameters and baseline year parameters for Service Point Replacement and Removal Water Savings Calculation

Parameter	Description	Source
MCF	Adopted Meter Correction Factor for Dethridge Meter Service Points or associated with deemed Service Points	Technical manual
$EF_{meter\ error}$	Effectiveness Factor for reducing measurement error	Technical manual
$EF_{leakage\ through}$	Effectiveness Factor for reducing leakage through the meter	Technical manual
$EF_{leakage\ around}$	Effectiveness Factor for reducing leakage around the meter	Technical manual
$EF_{unauthorised}$	Effectiveness Factor for reducing unauthorised use	Technical manual
LTA	Defined Fixed Leakage Rate (ML/year/service point) around service points	Technical manual
LTT	Defined Fixed Leakage Rate (ML/year/service point) through service points	Technical manual
U_{base}	Unauthorised use loss in the Baseline Year	Technical manual
D_{base}	Customer Deliveries in the Baseline Year	Baseline Year water balance
DM_{base}	Customer deliveries through the rationalized (removed) meters in the Baseline Year	Baseline Year water balance
DF_{error}	Durability factor for reducing measurement error	Technical manual
$DF_{leakage\ through}$	Durability factor for reducing leakage through the meter	WEP use a value of 0.95 (approved by DELWP in 2017)
$DF_{leakage\ around}$	Durability factor for reducing leakage around the meter	Technical manual
$DF_{unauthorised}$	Durability factor for reducing unauthorised use	Technical manual
$F(LTCE_{base})$	Long-Term Cap Equivalent Conversion Factor for the baseline year	Department of Environment, Land, Water and Planning

A-2 Table 8-7 Current year parameters and baseline year parameters for Service Point Replacement and Removal Water Savings Calculation

Parameter	Description	Source
$N_{replaced}$	Number of meters replaced	Construction records
$N_{rationalised}$	Number of meters rationalised	Construction records
$F(LTCE_{YearX})$	Long-Term Cap Equivalent Factor to convert Current Year volumes to Long-Term Cap Equivalent volume	Calculated from deliveries

A.4 Channel Remediation

A.4.1 Overview

The type of calculation employed for determining water savings due to channel remediation depends on the availability of pre and post works pondage data.

There has been no water saving contributed from the channel remediation in this audit 2022/23.

Appendix B Document Register

B.1 Calculations

B.1.1 Summary

- WEP automation shepp east water savings 2022 23 for audit (A4730998).xlsx
- WEP automation savings\pr analysis update 20 Sept 23 WEP Shepp East outfall 22 23 (A4731523).xlsx

B.1.2 Channel removal savings

- channel decom savings\Copy of WEP channel decom and meter works based v19 end Aug 2023 for auditor (A4734234).xlsx

B.1.3 Automation savings

- WEP automation shepp east water savings 2022 23 for audit (A4730998).xlsx
- WEP automation savings\pr analysis update 20 Sept 23 WEP Shepp East outfall 22 23 (A4731523).xlsx

B.1.4 Meter outlets

- v2 WEP meter works based v19 end Aug 2023 audit updateA4735863 (A4743391).xlsx
- meter savings\Copy of WEP meter works based v19 end Aug 2023 for auditor (A4735863).xlsx

B.2 Supporting documents

B.2.1 Automation outfalls

- Service Point Outlet meter water savings estimation methodologies 22 23 (A4735910).doc

B.2.2 PWC Audits

- PWC GMW Review Milestone 3 Finalisation Letter (004) (A4725300).pdf
- Copy of PWC 28.07.2023 FINAL_GMW Review Milestone 4 (A4725294).xlsx
- Copy of PWC GMW Review Milestone 3 Asset Register (002) (A4725296).xlsx
- PWC GMW Milestone 4 Review Finalisation Letter (A4725298).pdf

B.3 Work pack documents

B.3.1 Service point works

MV690

- meter workpacks\MV6290\MV6290_WP_PHOTO_LEFT.jpg
- meter workpacks\MV6290\MV6290_WP_PHOTO_RIGHT.jpg
- meter workpacks\MV6290\MV6290_WP_PHOTO_SP.jpg
- meter workpacks\MV6290\MV6290_WP_PHOTO_US.jpg
- meter workpacks\MV6290\MV6290_WP_RATIO_PHOTO2c6e134a-3861-40ce-ad8f-060d2450481d.jpg
- meter workpacks\MV6290\MV6290_Commissionning.pdf
- meter workpacks\MV6290\MV6290_Workpack.pdf

- meter workpacks\MV6290\MV6290_WP_PHOTO_DS.jpg

MV6818

- MV6818\MV6818_WP_RATIO_PHOTOb737e9c1-b32b-4379-bdd8-7dfee1727340.jpg
- MV6818\MV6818_Commissionning.pdf
- MV6818\MV6818_Workpack.pdf
- MV6818\MV6818_WP_PHOTO_DS.jpg
- MV6818\MV6818_WP_PHOTO_LEFT.jpg
- MV6818\MV6818_WP_PHOTO_RIGHT.jpg
- MV6818\MV6818_WP_PHOTO_SP.jpg
- MV6818\MV6818_WP_PHOTO_US.jpg

MV6828

- MV6828\MV6828_WP_RATIO_PHOTOac0aa0ff-f213-4394-9c2e-9b29e8c684d4.jpg
- MV6828\MV6828_Commissionning.pdf
- MV6828\MV6828_Workpack.pdf
- MV6828\MV6828_WP_PHOTO_DS.JPG
- MV6828\MV6828_WP_PHOTO_LEFT.JPG
- MV6828\MV6828_WP_PHOTO_RIGHT.JPG
- MV6828\MV6828_WP_PHOTO_SP.JPG
- MV6828\MV6828_WP_PHOTO_US.JPG

RO6838

- RO6838\RO6838_WP_PHOTO_US.jpg
- RO6838\RO6838_Commissionning.pdf
- RO6838\RO6838_Workpack.pdf
- RO6838\RO6838_WP_PHOTO_DS.jpg
- RO6838\RO6838_WP_PHOTO_LEFT.jpg
- RO6838\RO6838_WP_PHOTO_RIGHT.jpg
- RO6838\RO6838_WP_PHOTO_SP.jpg

RO6840

- RO6840\RO6840_WP_PHOTO_US.jpg
- RO6840\RO6840_Commissionning.pdf
- RO6840\RO6840_Workpack.pdf
- RO6840\RO6840_WP_PHOTO_DS.jpg
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- RO6840\RO6840_WP_PHOTO_SP.jpg

RO6842

- RO6842\RO6842_WP_PHOTO_US.jpg
- RO6842\RO6842_Commissionning.pdf
- RO6842\RO6842_Workpack.pdf
- RO6842\RO6842_WP_PHOTO_DS.jpg
- RO6842\RO6842_WP_PHOTO_LEFT.jpg
- RO6842\RO6842_WP_PHOTO_RIGHT.jpg
- RO6842\RO6842_WP_PHOTO_SP.jpg

RO6844

- RO6844\RO6844_WP_PHOTO_US.jpg
- RO6844\RO6844_Commissionning.pdf

- RO6844\RO6844_Workpack.pdf
- RO6844\RO6844_WP_PHOTO_DS.jpg
- RO6844\RO6844_WP_PHOTO_LEFT.jpg
- RO6844\RO6844_WP_PHOTO_RIGHT.jpg
- RO6844\RO6844_WP_PHOTO_SP.jpg

RO6848

- RO6848\RO6848_WP_PHOTO_US.jpg
- RO6848\RO6848_Commissionning.pdf
- RO6848\RO6848_Workpack.pdf
- RO6848\RO6848_WP_PHOTO_DS.jpg
- RO6848\RO6848_WP_PHOTO_LEFT.jpg
- RO6848\RO6848_WP_PHOTO_RIGHT.jpg
- RO6848\RO6848_WP_PHOTO_SP.jpg

SH317

- SH1317\SH1317_WP_RATIO_PHOTO92b0146e-15f7-4f01-bcd4-e0baffe35b16.jpg
- SH1317\SH1317_Commissionning.pdf
- SH1317\SH1317_Workpack.pdf
- SH1317\SH1317_WP_PHOTO_DS.JPG
- SH1317\SH1317_WP_PHOTO_LEFT.JPG
- SH1317\SH1317_WP_PHOTO_RIGHT.JPG
- SH1317\SH1317_WP_PHOTO_SP.jpg
- SH1317\SH1317_WP_PHOTO_US.JPG

TN138

- TN138\TN138_WP_RATIO_PHOTO086fb763-c643-4ff6-bb9d-86e138161d5a.jpg
- TN138\TN138_Commissionning.pdf
- TN138\TN138_Workpack.pdf
- TN138\TN138_WP_PHOTO_DS.jpg
- TN138\TN138_WP_PHOTO_LEFT.jpg
- TN138\TN138_WP_PHOTO_RIGHT.jpg
- TN138\TN138_WP_PHOTO_SP.jpg
- TN138\TN138_WP_PHOTO_US.jpg

TN1411

- TN1411\TN1411_WP_RATIO_PHOTO17b13b45-525f-4cf2-818a-aae2978831a1.jpg
- TN1411\TN1411_Commissionning.pdf
- TN1411\TN1411_Workpack.pdf
- TN1411\TN1411_WP_PHOTO_DS.jpg
- TN1411\TN1411_WP_PHOTO_LEFT.jpg
- TN1411\TN1411_WP_PHOTO_RIGHT.jpg
- TN1411\TN1411_WP_PHOTO_SP.jpg
- TN1411\TN1411_WP_PHOTO_US.jpg

TN1440

- TN1440\TN1440_WP_RATIO_PHOTO5890587a-0eca-4bd6-b427-308dad726577.jpg
- TN1440\TN1440_Commissionning.pdf
- TN1440\TN1440_Workpack.pdf

- TN1440\TN1440_WP_PHOTO_DS.jpg
- TN1440\TN1440_WP_PHOTO_LEFT.jpg
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- TN1440\TN1440_WP_PHOTO_SP.jpg
- TN1440\TN1440_WP_PHOTO_US.jpg

TN5085

- TN5085\TN5085_WP_RATIO_PHOTO6f47fab1-a748-4f98-8c2c-b9c727655367.jpg
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- TN5085\TN5085_Workpack.pdf
- TN5085\TN5085_WP_PHOTO_DS.jpg
- TN5085\TN5085_WP_PHOTO_LEFT.jpg
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- TN5085\TN5085_WP_PHOTO_SP.jpg

TN6185

- TN6185\TN6185_WP_PHOTO_US.JPG
- TN6185\TN6185_Commissionning.pdf
- TN6185\TN6185_Workpack.pdf
- TN6185\TN6185_WP_PHOTO_DS.JPG
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- TN6185\TN6185_WP_PHOTO_SP.JPG

TN12983

- TN12983\TN12983_WP_PHOTO_US.jpg
- TN12983\TN12983_Commissionning.pdf
- TN12983\TN12983_Workpack.pdf
- TN12983\TN12983_WP_PHOTO_DS.jpg
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- TN12983\TN12983_WP_PHOTO_SP.jpg

TO2509

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- TO2509\TO2509_WP_PHOTO_LEFT.jpg
- TO2509\TO2509_WP_PHOTO_RIGHT.jpg
- TO2509\TO2509_WP_PHOTO_SP.jpg
- TO2509\TO2509_WP_PHOTO_US.jpg

TO2518

- TO2518\TO2518_WP_PHOTO_US.jpg
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- TO2518\TO2518_Workpack.pdf
- TO2518\TO2518_WP_PHOTO_DS.jpg

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- TO2518\TO2518_WP_PHOTO_RIGHT.jpg
- TO2518\TO2518_WP_PHOTO_SP.jpg

TO2773

- TO2773\TO2773_WP_RATIO_PHOTO.jpg
- TO2773\TO2773_Commissionning.pdf
- TO2773\TO2773_Workpack.pdf
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- TO2773\TO2773_WP_PHOTO_RIGHT.JPG
- TO2773\TO2773_WP_PHOTO_SP.JPG
- TO2773\TO2773_WP_PHOTO_US.JPG

TO4378

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- TO4378\TO4378_Workpack.pdf
- TO4378\TO4378_WP_PHOTO_DS.jpg
- TO4378\TO4378_WP_PHOTO_LEFT.jpg
- TO4378\TO4378_WP_PHOTO_RIGHT.jpg
- TO4378\TO4378_WP_PHOTO_SP.jpg
- TO4378\TO4378_WP_PHOTO_US.jpg

TO4383

- TO4383\TO4383_WP_RATIO_PHOTO78efb61e-5312-43b2-a27d-0fe6f9664826.jpg
- TO4383\TO4383_Commissionning.pdf
- TO4383\TO4383_Workpack.pdf
- TO4383\TO4383_WP_PHOTO_DS.jpg
- TO4383\TO4383_WP_PHOTO_LEFT.jpg
- TO4383\TO4383_WP_PHOTO_RIGHT.JPG
- TO4383\TO4383_WP_PHOTO_SP.jpg
- TO4383\TO4383_WP_PHOTO_US.JPG

TO4528

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- TO4528\TO4528_WP_PHOTO_DS.jpg
- TO4528\TO4528_WP_PHOTO_LEFT.jpg
- TO4528\TO4528_WP_PHOTO_RIGHT.jpg
- TO4528\TO4528_WP_PHOTO_SP.jpg
- TO4528\TO4528_WP_PHOTO_US.jpg

TO5119

- TO5119\TO5119_WP_RATIO_PHOTO43adc84f-5c3c-4578-991a-1d8ed00ec47a.jpg
- TO5119\TO5119_Commissionning.pdf
- TO5119\TO5119_Workpack.pdf
- TO5119\TO5119_WP_PHOTO_DS.jpg
- TO5119\TO5119_WP_PHOTO_LEFT.jpg
- TO5119\TO5119_WP_PHOTO_RIGHT.jpg

- TO5119\TO5119_WP_PHOTO_SP.jpg
- TO5119\TO5119_WP_PHOTO_US.jpg

B.3.2 Asset Removal Works

CH000472

- CH000472\CH000472_WP_ITP_DECOM_WARDS18b7ddf9-644e-4ca9-89bd-4a2ef29bb7d0.pdf
- CH000472\CH000472_WP_AFTER_PHOTO_WARDSae4070fd-fb28-4e81-af35-10469ed597fb.jpg
- CH000472\CH000472_WP_BEFORE_PHOTO_WARDS71a5b119-f88f-44be-b1eb-bca06d628ba6.jpg

CH000473

- CH000473-Blocked by CH018495\Map showing CH000473 blocked at CH018495.png
- CH000473-Blocked by CH018495\CH000473_WP_AFTER_PHOTO_WARDS.jpg
- CH000473-Blocked by CH018495\CH000473_WP_BEFORE_PHOTO_WARDS.jpg
- CH000473-Blocked by CH018495\CH000473_WP_ITP_DECOM_WARDS.pdf
- CH000473-Blocked by CH018495\CH018495_WP_AFTER_PHOTO_WARDS.jpg
- CH000473-Blocked by CH018495\CH018495_WP_ITP_BLOCK_WARDS.pdf

CH000567

- CH000567\CH000567_WP_ITP_DECOM_WARDS.pdf
- CH000567\CH000567_WP_AFTER_PHOTO_WARDS.jpg
- CH000567\CH000567_WP_BEFORE_PHOTO_WARDS.jpg

CH002124

- CH002124\CH002124_WP_ITP_DECOM_HOGANS.pdf
- CH002124\CH002124_WP_AFTER_PHOTO_HOGANS.jpg
- CH002124\CH002124_WP_BEFORE_PHOTO_HOGANS.jpg

CH002142

- CH002142\ST007630_WP_BEFORE_PHOTO.jpg
- CH002142\CH002142_WP_ITP_BLOCK_HOGANS.pdf
- CH002142\ST007630_WP_AFTER_PHOTO.jpg

CH002143

- CH002143-Blocked by CH002142\Map showing CH002143 blocked by CH002142.png

CH003176

- CH003176\CH003176_WP_ITP_DECOM_ECC.pdf
- CH003176\CH003176_EN_SECM.pdf
- CH003176\CH003176_WP_AFTER_PHOTO_ECC-Block 1.jpg
- CH003176\CH003176_WP_AFTER_PHOTO_ECC-Block 2.jpg
- CH003176\CH003176_WP_BEFORE_PHOTO_ECC-Block 1.jpg
- CH003176\CH003176_WP_BEFORE_PHOTO_ECC-Block2.jpg
- CH003176\CH003176_WP_ITP_BLOCK_ECC-1.pdf

- CH003176\CH003176_WP_ITP_BLOCK_ECC-2.pdf

CH006583

- CH006586-blocked by CH006583\Map showing CH006586 blocked at CH006583.png
- CH006586-blocked by CH006583\CH006583_WP_AFTER_PHOTO_ECC.jpg
- CH006586-blocked by CH006583\CH006583_WP_BEFORE_PHOTO_ECC.jpg
- CH006586-blocked by CH006583\CH006583_WP_ITP_BLOCK_ECC.pdf

CH007012

- CH007012\CH007010_WP_ITP_BLOCK_ECC.pdf
- CH007012\CH0007010 explanation.docx
- CH007012\CH007010_WP_AFTER_PHOTO.jpg
- CH007012\CH007010_WP_BEFORE_PHOTO.jpg

CH009984

- CH009984\CH009984_WP_ITP_DECOM_ECC.pdf
- CH009984\CH009984_WP_AFTER_PHOTO_ECC.jpg
- CH009984\CH009984_WP_AFTER_PHOTO_ECC-2.jpg
- CH009984\CH009984_WP_BEFORE_PHOTO.jpg
- CH009984\CH009984_WP_BEFORE_PHOTO_ECC.jpg
- CH009984\CH009984_WP_ITP_BLOCK_ECC.pdf

CH011860

- CH011860\ST058320_WP_BEFORE_PHOTO.jpg
- CH011860\CH011860_WP_AFTER_PHOTO_APEX.jpg
- CH011860\CH011860_WP_BEFORE_PHOTO.jpg
- CH011860\CH011860_WP_ITP_DECOM_APEX.pdf
- CH011860\MV995_WP_ITP_DECOM.pdf
- CH011860\ST058320 after.JPG

CH012037

- CH012037\CH012037_WP_ITP_BLOCK_HOGANS.pdf
- CH012037\CH012037_WP_AFTER_PHOTO_HOGANS.jpg
- CH012037\CH012037_WP_BEFORE_PHOTO_HOGANS.jpg

CH012190 blocked by CH012188

- CH012190-Blocked by CH012188\Map showing CH012190 blocked at CH012188.png
- CH012190-Blocked by CH012188\CH012188_EN_SECM.pdf
- CH012190-Blocked by CH012188\CH012188_WP_AFTER_PHOTO-Block.jpg
- CH012190-Blocked by CH012188\CH012188_WP_BEFORE_PHOTO-Block.jpg
- CH012190-Blocked by CH012188\CH012188_WP_ITP_BLOCK_HOGANS.pdf
- CH012190-Blocked by CH012188\CH012190_WP_AFTER_PHOTO_HOGANS.jpg
- CH012190-Blocked by CH012188\CH012190_WP_BEFORE_PHOTO_HOGANS.jpg
- CH012190-Blocked by CH012188\CH012190_WP_ITP_DECOM_HOGANS.pdf

CH012194 blocked by CH012188

- CH012194-Blocked by CH012188\Map showing CH012194 blocked at CH012188.png

- CH012194-Blocked by CH012188\CH012194_WP_AFTER_PHOTO_HOGANS.jpg
- CH012194-Blocked by CH012188\CH012194_WP_BEFORE_PHOTO_HOGANS.jpg
- CH012194-Blocked by CH012188\CH012194_WP_ITP_DECOM_HOGANS.pdf

CH012234

- CH012234\CH012234_WP_ITP_DECOM_HOGANS.pdf
- CH012234\CH012234_WP_AFTER_PHOTO_HOGANS.jpg
- CH012234\CH012234_WP_BEFORE_PHOTO_HOGANS.jpg

CH013187

- CH013187\CH013187_WP_ITP_DECOM.pdf
- CH013187\CH013187_WP_AFTER_PHOTO.jpg
- CH013187\CH013187_WP_BEFORE_PHOTO_HOGANS.jpg
- CH013187\CH013187_WP_ITP_BLOCK_HOGANS.pdf

CH013886

- CH013886\CH013886_WP_ITP_BLOCK_HOGANS.pdf
- CH013886\CH013886_WP_AFTER_PHOTO_HOGANS.jpg
- CH013886\CH013886_WP_BEFORE_PHOTO_HOGANS.jpg

CH018068

- CH018068-blocked by CH013886\Map showing CH018068 blocked by CH013886.png
- CH018068-blocked by CH013886\CH018068_WP_AFTER_PHOTO_HOGANS.jpg
- CH018068-blocked by CH013886\CH018068_WP_BEFORE_PHOTO_HOGANS.jpg
- CH018068-blocked by CH013886\CH018068_WP_ITP_DECOM_HOGANS.pdf

CH018487

- CH018487\CH018487_WP_ITP_BLOCK_ACE.pdf
- CH018487\CH018487_WP_AFTER_PHOTO_ACE.jpg
- CH018487\CH018487_WP_BEFORE_PHOTO_ACE.jpg

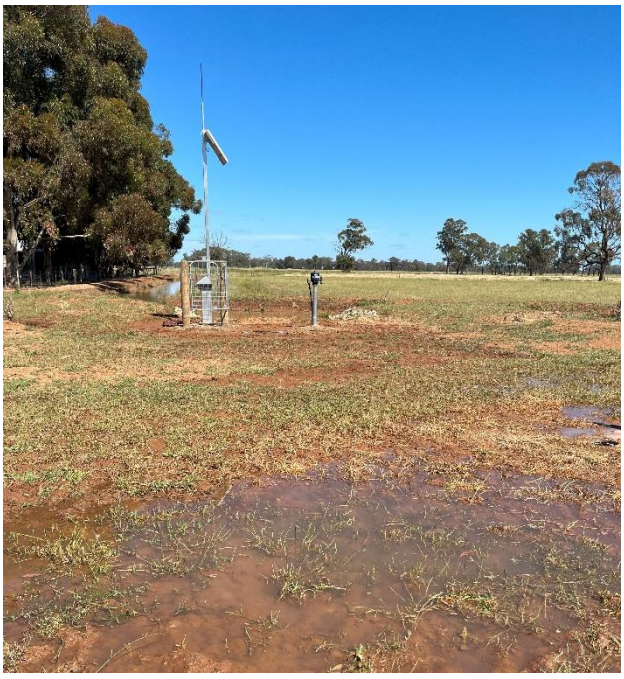
Appendix C Site photographs

C-1 Table 8-8 Site Photographs

Photos	
	
MV2394, MV2395 and MV2396	
	
MV2394	MV2395

Photos	
	
MV2396	MV2396
	
CH11860 (MV13/6) channel decommissioning	CH11860 (MV13/6) channel decommissioning

Photos	
	
MV6619	
	
CH011860 (MV13/6) channel decommissioning	

Photos	
	
MV6809	MV6818
	
CH12190 channel decommissioning	CH012194 (MV20/6) channel decommissioning

Photos

CH012194 (MV20/6) channel decommissioning

MV6828

TN12983

Decommissioned channel near TN12983

Photos	
	
Decommissioned channel near TN12983	CH002124 (CG 2/4/12/9) channel decommissioning
	
CH18487 (CG9/2/12/9) channel decommissioning	

Photos

CH013886 (CG1/8/A) channel decommissioning. Note that this is a short section from the foreground to the road. From the other side of the road back is CH18068 channel decommissioning.

CH18068 (CG1/8) channel decommissioning. This is off Harston Road adjacent to CH013886.

Photos

CH012037 (CG 1/8) channel decommissioning

RO6842

Channel decommissioning near RO6842

Photos	
	
SP304	SP316

DESIGN WITH COMMUNITY IN MIND

Communities are fundamental. Whether around the corner or across the globe, they provide a foundation, a sense of place and of belonging. That's why at Stantec, we always design with community in mind.

We care about the communities we serve—because they're our communities too. This allows us to assess what's needed and connect our expertise, to appreciate nuances and envision what's never been considered, to bring together diverse perspectives so we can collaborate toward a shared success.

We're designers, engineers, scientists, and project managers, innovating together at the intersection of community, creativity, and client relationships. Balancing these priorities results in projects that advance the quality of life in communities across the globe.

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