Audit of Irrigation Modernisation Water Recovery 2020/21 Irrigation Season

Report

3608-95

Prepared for

Department of Environment, Land, Water and Planning

29 November 2021

Cardno

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Summary Findings

Background and scope

This report details the findings from Cardno's audit of the estimates of the water recovery achieved through irrigation modernisation in northern Victoria for 2020/21. The water recovery is being delivered through the Goulburn-Murray Water (GMW) Connections Project.

The GMW Connections Project is being implemented in two stages. Stage 1, which is funded by the Victorian Government, has been underway since 2008 and Stage 2, which is funded by the Commonwealth, commenced in 2012. The GMW Connections Project must be audited each year. This is the thirteenth annual audit of water savings from irrigation modernisation in the Goulburn-Murray Irrigation District.

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

- The cumulative irrigation modernisation works in place for the 2020/21 water year (up to 30 June 2021)
- The water recovery estimates for the GMW Connections Project operating area which is the whole Goulburn-Murray Irrigation District (GMID) (Shepparton, Central Goulburn, Rochester, Pyramid Hill, Boort, Murray Valley, Lower Broken Creek and Torrumbarry)
- The cumulative irrigation modernisation works and water recovery separately accountable to the:
  - GMW Connections Project Stage 1 and
  - GMW Connections Project Stage 2

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

Auditor statement

We have audited the 2020/21 water savings estimates prepared by the GMW Connections Project. Our audit was conducted in accordance with the scope provided by DELWP on 3 August 2021. 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 Connections Project activities e.g. management of outfall flow data.

Based on our audit activities, we consider that the water savings estimates for 2020/21 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 Phase 3 and Phase 4 water savings estimates. The Phase 3 water savings estimates represent actual savings realised in the 2020/21 irrigation season as a result of works completed to date based on deliveries in 2020/21 and observed losses. Phase 4 savings represent the long-term average annual savings from the works completed to date.

The audited Phase 3 and Phase 4 estimates are set out in the following tables and, as required in the project brief, are separately accounted to the:

- GMW Connections Project Stage 1
- GMW Connections Project Stage 2

Table 1-1 Water savings from GMW Connections Project Stage 1 (2020/21)

Water Savings Intervention	SH	CG1-4	CG 5-9	MV	MV-BC	RO	LV-PH	LV- BO	TO	Total
Phase 3 water savings										
Channel Removal (ML)^	0.0	0.0	1,826.0	5,903.4	0.0	1,821.3	2,293.7	475.6	8,271.3	20,591.2
Channel Automation (ML)*	0.0	0.0	12,868.1	2,932.8	0.0	3,952.8	194.3	-14.0	2,697.2	22,631.3
Service Point Replacement (ML)	0.0	0.0	10,867.6	7,042.7	10.3	6,053.5	4,502.6	3,031.6	7,785.0	39,293.3
Service Point Removal (ML)	0.0	0.0	1,295.4	1,605.3	20.7	1,001.5	1,000.7	221.2	2,092.9	7,237.8
Channel Remediation (ML)	0.0	0.0	3,797.5	2,825.2	0.0	1,479.4	0.0	0.0	2,091.8	10,193.9
Total Phase 3 savings (ML)	**0.0**	**0.0**	**30,654.7**	**20,309.5**	**31.0**	**14,308.5**	**7,991.3**	**3,714.5**	**22,938.1**	**99,947.6**
Phase 4 water savings										
Channel Removal (ML)	0.0	0.0	2,482.4	8,704.9	0.0	2,588.0	2,998.4	564.8	12,216.3	29,554.9
Channel Automation (ML)	0.0	0.0	32,049.8	9,947.8	0.0	8,258.7	1,055.9	-103.2	7,921.5	59,130.5
Service Point Replacement (ML)	0.0	0.0	18,804.1	11,819.7	-1.0	9,233.8	6,144.9	3,862.3	10,679.4	60,543.2
Service Point Removal (ML)	0.0	0.0	3,993.4	7,764.4	29.2	3,625.0	4,122.3	1,184.6	9,919.6	30,638.4
Channel Remediation (ML)	0.0	0.0	5,546.3	4,147.8	0.0	1,990.8	0.0	0.0	3,312.0	14,996.8
Total Phase 4 savings (ML)	**0.0**	**0.0**	**62,876.1**	**42,384.5**	**28.2**	**25,696.2**	**14,321.5**	**5,508.5**	**44,048.8**	**194,863.9**

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

** These savings are net channel automation savings after allowance for mitigation flows are made*

Table 1-2 Water savings from GMW Connections Project Stage 2 (2020/21)

Water Savings Intervention	SH	CG1-4	CG 5-9	MV	MV-BC	RO	LV-PH	LV- BO	TO	Total
Phase 3 water savings										
Channel Removal (ML)^	209.1	1,082.2	6,131.6	7,210.2	0.0	5,885.0	2,650.5	721.2	16,297.3	40,187.3
Channel Automation (ML)*	564.9	0.0	504.5	423.3	0.0	575.6	7.5	0.0	203.9	2,279.8
Service Point Replacement (ML)	336.4	88.5	7,302.9	3,467.7	-1.1	5,213.0	3,466.6	1,573.4	7,666.3	29,113.6
Service Point Removal (ML)	137.7	1.0	1,514.5	1,065.9	2.5	885.4	1,092.9	331.6	2,699.8	7,731.5
Channel Remediation (ML)	522.7	1,159.6	3,351.5	2,585.4	0.0	230.3	183.4	1,353.8	4,134.7	13,521.4
Total Phase 3 savings (ML)	**1,770.9**	**2,331.4**	**18,805.1**	**14,752.5**	**1.4**	**12,789.4**	**7,400.9**	**3,980.0**	**31,002.0**	**92,833.5**
Phase 4 water savings										

Water Savings Intervention	SH	CG1-4	CG 5-9	MV	MV-BC	RO	LV-PH	LV- BO	TO	Total
Channel Removal (ML)	322.7	1,812.2	8,353.4	10,611.9	0.0	7,664.9	3,594.1	858.9	24,111.8	57,329.9
Channel Automation (ML)	1,392.5	0.0	1,250.7	1,516.9	0.0	1,256.8	16.0	0.0	623.5	6,056.4
Service Point Replacement (ML)	409.7	162.5	12,405.6	6,574.3	-1.5	8,056.0	4,142.8	1,348.0	10,184.5	43,281.8
Service Point Removal (ML)	299.8	101.3	5,240.2	5,163.9	3.5	3,256.0	4,776.4	1,401.9	10,934.2	31,177.2
Channel Remediation (ML)	779.1	1,721.4	5,074.4	3,897.1	0.0	286.0	280.8	1,629.3	6,261.2	19,929.3
Total Phase 4 savings (ML)	**3,203.8**	**3,797.4**	**32,324.3**	**27,764.2**	**1.9**	**20,519.8**	**12,810.2**	**5,238.0**	**52,115.1**	**157,774.6**

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

** These savings are net channel automation savings after allowance for mitigation flows are made*

Table 1-3 Phase 4 Water savings from GMW Connections Project (2020/21) - Fixed and variable components

Water Savings Intervention	SH	CG1-4	CG 5-9	MV	MV-BC	RO	LV-PH	LV- BO	TO	Total
Water savings - Stage 1										
Channel Removal (ML)^										
Fixed component	0.0	0.0	1,354.9	4,860.4	0.0	1,442.5	1,721.4	303.0	6,022.8	15,705.2
Variable component	0.0	0.0	1,127.4	3,844.5	0.0	1,145.4	1,277.0	261.8	6,193.5	13,849.7
Channel Automation (ML)*										
Fixed component	0.0	0.0	-108.0	-9.2	0.0	-12.7	-564.3	-309.4	-526.0	-1,529.6
Variable component	0.0	0.0	32,157.9	9,957.0	0.0	8,271.4	1,620.1	206.2	8,447.4	60,660.1
Service Point Replacement (ML)										
Fixed component	0.0	0.0	3,334.3	1,777.8	-0.6	1,480.2	831.9	421.4	1,530.5	9,375.5
Variable component	0.0	0.0	15,469.9	10,041.8	-0.5	7,753.6	5,312.9	3,440.9	9,149.0	51,167.7
Service Point Removal (ML)										
Fixed component	0.0	0.0	1,071.7	1,467.3	18.7	818.3	805.0	163.3	1,755.2	6,099.5
Variable component	0.0	0.0	2,921.7	6,297.1	10.5	2,806.7	3,317.3	1,021.3	8,164.4	24,538.9
Channel Remediation (ML)										
Fixed component	0.0	0.0	2,305.5	2,272.2	0.0	929.0	0.0	0.0	1,156.5	6,663.2
Variable component	0.0	0.0	3,240.8	1,875.6	0.0	1,061.8	0.0	0.0	2,155.4	8,333.6
Total Water savings - Stage 1	**0.0**	**0.0**	**62,876.1**	**42,384.5**	**28.2**	**25,696.2**	**14,321.5**	**5,508.5**	**44,048.8**	**194,863.9**

Water Savings Intervention	SH	CG1-4	CG 5-9	MV	MV-BC	RO	LV-PH	LV- BO	TO	Total
Water savings - Stage 2										
Channel Removal (ML)										
Fixed component	129.2	706.4	4,494.9	5,962.7	0.0	4,327.3	1,967.8	453.5	11,664.1	29,705.9
Variable component	193.5	1,105.7	3,858.5	4,649.2	0.0	3,337.6	1,626.4	405.4	12,447.7	27,624.0
Channel Automation (ML)										
Fixed component	-32.5	0.0	-0.4	-25.8	0.0	-36.5	0.0	0.0	-55.5	-150.8
Variable component	1,425.0	0.0	1,251.1	1,542.7	0.0	1,293.3	16.0	0.0	679.0	6,207.2
Service Point Replacement (ML)										
Fixed component	98.9	21.6	2,178.8	946.5	-0.8	1,128.2	579.8	177.8	1,679.9	6,810.6
Variable component	310.7	140.9	10,226.9	5,627.8	-0.7	6,927.8	3,563.0	1,170.2	8,504.5	36,471.2
Service Point Removal (ML)										
Fixed component	114.9	9.2	1,269.4	975.2	2.3	726.4	892.4	246.1	2,265.1	6,501.0
Variable component	184.9	92.1	3,970.8	4,188.7	1.2	2,529.6	3,884.0	1,155.8	8,669.1	24,676.2
Channel Remediation (ML)										
Fixed component	321.8	624.6	1,928.0	2,032.4	0.0	168.5	89.7	656.0	2,483.7	8,304.7
Variable component	457.3	1,096.8	3,146.4	1,864.8	0.0	117.5	191.2	973.3	3,777.5	11,624.7
Total Water savings - Stage 2	**3,203.8**	**3,797.4**	**32,324.3**	**27,764.2**	**1.9**	**20,519.8**	**12,810.2**	**5,238.0**	**52,115.1**	**157,774.6**
Grand total water savings•	**3,203.8**	**3,797.4**	**95,200.3**	**70,148.7**	**30.1**	**46,216.0**	**27,131.7**	**10,746.5**	**96,163.9**	**352,638.5**

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

** These savings are net channel automation savings after allowance for mitigation flows are made*

• The grand total excludes excludes additional water shares and special water recovery projects that have been estimated using water resource system modelling and audited through a separate process

Data collection and inputs

Our review for the 2020/21 audit of the information systems and processes used by GMW Connections Project has found that they continue to be 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 GMW Connections Project 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 1-4

Table 1-4 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. (Note for 2020/21 due to Covid-19 restrictions, a remote working methodology was applied)	Section 3.2
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
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/0030/397074/WaterSavingsProtocol-V5-October2018_Final.pdf

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Glossary

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 rationalised to total spur channel length in system
Dbase	Customer Deliveries in the Baseline Year in the irrigation system
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 Rationalised 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
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
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 rationalised in the year in question relative to the irrigation season length in the Baseline Year
U_{Base}	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 Introduction and purpose

The Victorian State Government and the Commonwealth Government have committed significant funding for the renewal and modernisation of the Goulburn-Murray Irrigation District (GMID). The water savings achieved through the renewal and modernisation works are to be shared between the environment, Melbourne and irrigation customers. The works are also expected to improve the efficiency of delivery and increase the level of service provided to irrigation customers.

Goulburn-Murray Water (GMW) is the owner and operator of the GMID. The GMW Connections Project (previously the Northern Victorian Irrigation Renewal Project but since 1 July 2012 part of GMW) forms the greater part of the modernisation of the GMID.

The water savings achieved by the GMW Connections Project are to be audited each year until the project is completed. Cardno has been engaged by the Department of Environment, Land, Water and Planning (DELWP) to undertake an independent audit of the water recovery for the 2020/21 irrigation season. The purpose of this report is to present the findings of this independent audit. This is the thirteenth annual audit of the water savings achieved by the renewal and modernisation works in the GMID.

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 DELWP 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 DELWP website at this location:
https://www.water.vic.gov.au/water-for-agriculture/investment-in-irrigation-efficiency/water-savings-protocol

1.3 Scope of 2020/21 irrigation season irrigation modernisation water recovery audit

The audit scope has been set by DELWP and is set out in the Project Brief, dated 3 August 2021. The scope of works is broadly an audit of water recovery estimates for works undertaken in the Goulburn-Murray Irrigation District by the Connections Project to modernise the irrigation delivery system. The audit scope included the following:

- The cumulative irrigation modernisation works in place for the 2020-21 water year (1 July 2020 to 30 June 2021);
- The GMW Connections Project operating area which is the whole Goulburn-Murray Irrigation District (GMID) including the following irrigation areas:
  - Shepparton (1A),
  - Central Goulburn (1A),
  - Rochester (1A),
  - Pyramid Hill (1A),
  - Boort (1B),
  - Murray Valley (6),
  - Lower Broken Creek (6B), and
  - Torrumbarry (7).
- The cumulative irrigation modernisation works and fixed and variable water recovery separately accountable to the:
  - GMW Connections Project Stage 1;
  - GMW Connections Project Stage 2; and
- The water managed as part of the GMW Connections Project to 30 June 2021, including those water entitlements already issued under the GMW Connections Project, converted using long-term diversion limit equivalent (LTDLE) factors to long-term average annual water recovery.

The scope requires the auditor to address the following:

- Verifying that stated modernisation works have been carried out by conducting on-site inspections or confirming works have been completed through an alternative remote process;
- Verifying that the GMW Connections Project have estimated water recovery correctly in accordance with the *Water Savings Protocol* (Version 5) (the Protocol) or errata, addendum or other method approved by DELWP. This shall include:
  - Phase 3 – water recovery generated in the 2020-21 water year; and
  - 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.

An audit of water entitlement purchases under the GMW Connections Project Stage 1 for 2020/21 has been completed as a separate report.

2 Background

2.1 Goulburn Murray Irrigation District

The Goulburn Murray Irrigation District (GMID) 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)
- Lower Broken Creek (MV-BC)
- Pyramid-Hill (LV-PH)[2]*
- Boort (LV-BO)
- Rochester (RO)
- Shepparton (SH)
- Torrumbarry (TO).

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

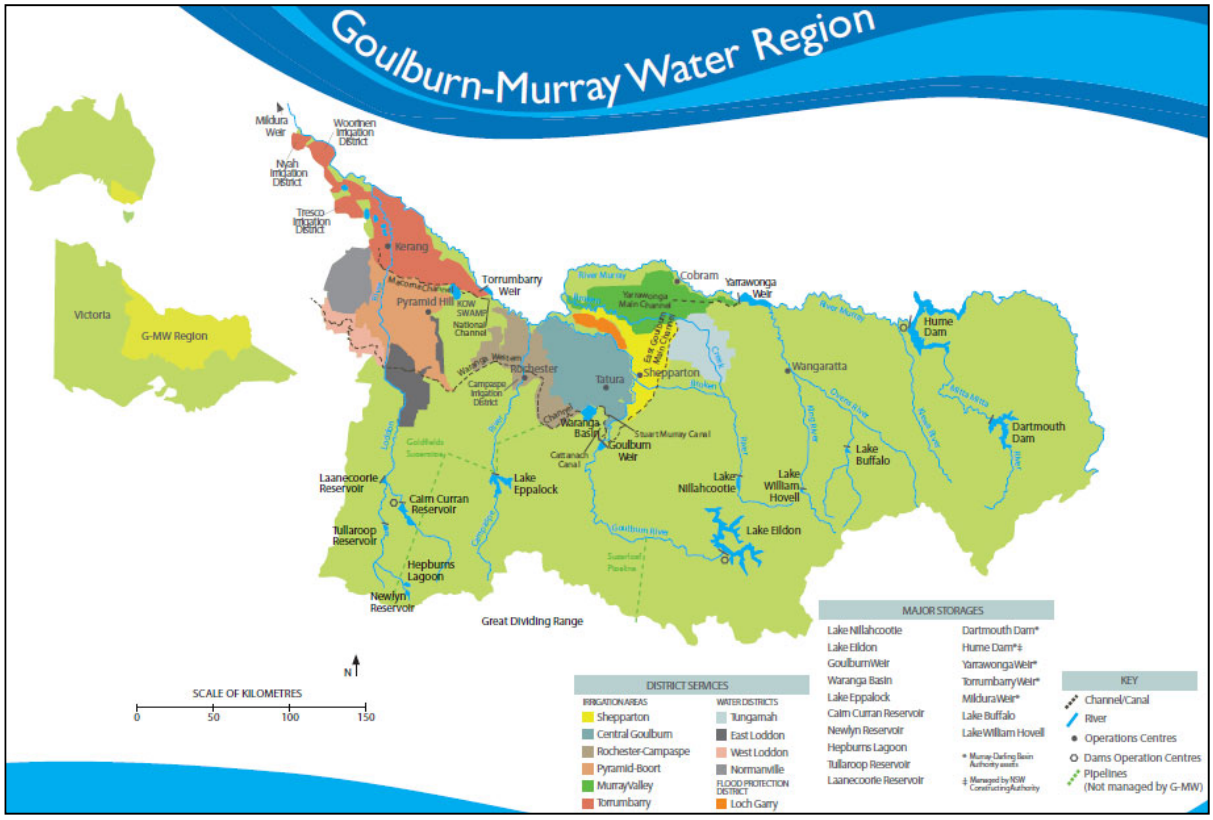


Figure 2-1 Goulburn Murray Irrigation District

Source: http://www.g-mwater.com.au/about/regionalmap

[2] The former Pyramid-Boort irrigation areas has now been divided into two separate areas: Pyramid-Hill (LV-PH) and Boort (LV-BO). The "LV" designation arises from this area being previously known as Loddon Valley.

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 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.

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 Irrigation modernisation projects

The GMW Connections Project is being implemented in two stages. Stage 1, which is funded by the Victorian Government and Melbourne's retail water corporations, has been underway since 2008 and Stage 2, which is funded by the Commonwealth, commenced in 2012.

2.3.1 GMW Connections Project Stage 1

Under the funding arrangement between the State and Commonwealth Governments, signed in October 2011, Stage 1 of the project is being funded by contributions from the Victorian Government ($600 million initial contribution and $100 million from a portion of the funds relevant to the sale of 102 GL of long-term water savings associated with GMW Connections Project Stage 2) and Melbourne's retail water corporations ($300 million). This stage commenced in 2008 and, combined with Stage 2, works were completed to deliver 429 GL of water recovery in October 2020[3].

The objectives of the GMW Connections Project Stage 1 are to:

- Deliver 225 GL of long-term average annual project generated water savings to be shared equally between irrigators, the environment and Melbourne's water retailers.
- Deliver a modernised backbone channel water distribution system

[3] https://www.water.vic.gov.au/water-for-agriculture/investment-in-irrigation-efficiency

- Connect approximately 30% of those customers currently supplied by smaller spur channels to the backbone channel via a modern connection
- Upgrade metering (including real time measurement)
- Provide channel remediation to reduce high loss channel pools.

2.3.2 GMW Connections Project Stage 2

The Commonwealth and Victorian Governments are providing funding of $1.059 billion for Stage 2 of the GMW Connections Project, which commenced delivery in 2012. The Commonwealth Government is contributing $953 million and the Victorian Government is contributing $106 million from a portion of the funds associated with the sale of 102 GL of long-term average annual water savings associated with GMW Connections Project Stage 2.

The Stage 2 project is planned to raise the operating delivery efficiency of the GMID system to over 85%, generating a long-term average of 204 GL of long-term average annual water savings from reduced distribution losses. These savings were transferred to the Commonwealth Government for environmental use and in particular, to meeting Sustainable Diversion Limits in the Murray-Darling Basin.

2.3.3 Project Reset and changes to project delivery approach

A condition of the Stage 2 Project funding agreement between the State of Victoria and the Commonwealth government is that a mid-term review of the project be conducted. The review occurred in 2015 and recommended Stage 2 of the Project be reset because the actual operating environment in which the project was being delivered did not align with the assumptions made in the original business case.

A Stage 2 Reset Delivery Plan was developed in response to the mid-term review. The Reset Delivery Plan was developed with the objective of ensuring delivery of the full 204 GL of long-term average annual water savings to the Commonwealth within the allocated budget. The Reset Delivery Plan recommended a different delivery approach for the remaining modernisation works as well as increased targeting of works in specific locations. The Reset Delivery Plan recommended extension of the timeframe for delivery to 31 October 2020.

The Stage 2 Reset Delivery Plan was agreed by the Victorian and Commonwealth governments on 7 September 2016.

The Reset Delivery Plan has changed how water savings works have been delivered in the last four years, along with the governance over the works. Major changes include a change in the major delivery contractor with John Holland commencing in this role in February 2017. Although the contractor has changed, the information system previously developed for managing construction information, Project Management Information System (PMIS), has been retained.

Notable changes to the governance and assurance process in place for the project include:

- Contractor payments and achievement of Practical Completion has been linked to the quality of construction documentation received.
- On-farm works will now be carried out by the GMW Connections Project and its contractors rather than landowners.
- The GMW Connections Project's management systems have been externally accredited as meeting the requirements of ISO9001:2015 for Quality Management Systems. A surveillance audit was undertaken on 28 September 2021.
- The GMW Connections Project has engaged a third party (PwC) to provide assurance activities over the completion and accuracy of construction records. This assurance review is intended to be undertaken every six months and applies to all construction activities during the period. Outputs of reviews undertaken in the last twelve months are summarised in section 4.2.5.

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 DELWP 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 3.2
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
- Reviewing the GMW Connections Projects progress on the implementation of previous audit recommendations.

For the 2020/21 audit, due to COVID-19 restrictions, the audit was completed remotely. In terms of practical application, this was delivered by:

- Meetings being undertaken by the Blue Jeans platform which allowed audio and visual connectivity between attendees. In addition, documents were shared on screen to aid discussions.
- 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. 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
Monday 11 October 2021	Start-up Meeting	Peter Roberts	Project Manager, Water Savings (GMW)
		Frank Fisseler	Project Director (GMW)
		John Davison	Operations Manager (GMW)
		Dileepa Liyanage	Business Intelligence Data Architect (GMW)
		Emily Uhe	Senior Water Resources Officer (GMW)
		Michael Doherty	Operations Planning Team (GMW)
		Deanne Brown	Document Controller (GMW)
		Jennifer Pagon	Project risk and stakeholder reporting (GMW)
	Audit of water savings calculations	Peter Roberts	Project Manager, Water Savings
	Construction record reviews	Peter Roberts	Project Manager, Water Savings
Tuesday 12 October 2021	Review of construction records for modernisation works	Peter Roberts	Project Manager, Water Savings
	Audit of water savings calculations	Peter Roberts	Project Manager, Water Savings
	Review of SCADA records for outfalls	Michael Doherty	Operations Planning Team (GMW)
		Emily Uhe	Senior Water Resources Officer (GMW)
		Peter Roberts	Project Manager, Water Savings
	Audit of water savings calculations	Peter Roberts	Project Manager, Water Savings

Date	Audit Work	Auditee	Position
Wednesday 13 October 2021	Construction record reviews	Peter Roberts	Project Manager, Water Savings
Thursday 14 October 2021	Audit of water savings calculations	Peter Roberts	Project Manager, Water Savings
	Construction record reviews	Peter Roberts	Project Manager, Water Savings
Friday 15 October 2021	Close out meeting	Peter Roberts	Project Manager, Water Savings
		Jason Leocata	Connections System Administrator (GMW)
		Deanne Brown	Document controller (GMW)
		Jennifer Pagon	Project risk and stakeholder reporting (GMW)

3.4 Document register

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

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
- Assignment of works between GMW Connections Project Stage 1 and Stage 2.

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 2020/21 audit year construction works were delivered by John Holland and GMW. Works delivered by John Holland are referred to as ECI (early contractor involvement) works and works delivered by GMW are referred to as E2E (end to end) works. The construction records database, PMIS is used by John Holland 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 (instruction and test plan) certificates. PMIS also records work undertaken by GMW construction if it is initiated for the Connections Project.

There are also some works that have been delivered by other contractors which do not use this system. In both of these instances, the same processes and record forms are still used.

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 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.

While handover of assets to GMW following a defects liability period is important for the successful ongoing operation of the modernisation works, this audit focuses on asset commissioning / decommissioning rather than handover, as water recoveries are typically achieved from the time that an asset is commissioned or decommissioned.

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

The following section provides observations arising from our audit of construction records for different work types. Appendix C contains a selection of photographs and aerial imagery demonstrating completed works from 2020/21.

4.2.1 Service point (meter) replacement and removal – GMW Connections Project Stage 1 and Stage 2

We requested commissioning certificates (ITP certificates) and other supporting evidence (e.g., construction photos) for a sample of 30 sites (3% sample of 1,086 work packages undertaken in the 2020/21 irrigation year) where service points had been replaced or rationalised to confirm that the works have been completed.

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	Activity	Audit notes
PH137	Rationalised	We were provided with sufficient evidence to confirm that the works claimed were complete
TO4465	Rationalised	We were provided with sufficient evidence to confirm that the works claimed were complete
RO6830	Rationalised	We were provided with sufficient evidence to confirm that the works claimed were complete
RO6925	Replace/ relocate/ new	We were provided with sufficient evidence to confirm that the works claimed were complete
TO3055	Replace/ relocate/ new	We were provided with sufficient evidence to confirm that the works claimed were complete
TN3837	Replace/ relocate/ new	We were provided with sufficient evidence to confirm that the works claimed were complete
RN1548	Replace/ relocate/ new	We were provided with sufficient evidence to confirm that the works claimed were complete
PH2584	Replace/ relocate/ new	We were provided with sufficient evidence to confirm that the works claimed were complete
RO4058	Rationalised	We were provided with sufficient evidence to confirm that the works claimed were complete
PH513	Replace/ relocate/ new	We were provided with sufficient evidence to confirm that the works claimed were complete
MV6098	Replace/ relocate/ new	We were provided with sufficient evidence to confirm that the works claimed were complete
RN1574	Replace/ relocate/ new	We were provided with sufficient evidence to confirm that the works claimed were complete
PH2255	Replace/ relocate/ new	We were provided with sufficient evidence to confirm that the works claimed were complete
PH2248	Replace/ relocate/ new	We were provided with sufficient evidence to confirm that the works claimed were complete
RO6922	Replace/ relocate/ new	We were provided with sufficient evidence to confirm that the works claimed were complete
RO6649	Replace/ relocate/ new	We were provided with sufficient evidence to confirm that the works claimed were complete
RO6815	Replace/ relocate/ new	We were provided with sufficient evidence to confirm that the works claimed were complete
RO6826	Replace/ relocate/ new	We were provided with sufficient evidence to confirm that the works claimed were complete
RO6824	Replace/ relocate/ new	We were provided with sufficient evidence to confirm that the works claimed were complete
TO1787	Replace/ relocate/ new	We were provided with sufficient evidence to confirm that the works claimed were complete

IPM / Asset Code	Activity	Audit notes
SP613	Rationalised	We were provided with sufficient evidence to confirm that the works claimed were complete. This meter was actually rationalised in 2017 and had been identified in a data review process.
MV1175	Replace/ relocate/ new	We were provided with sufficient evidence to confirm that the works claimed were complete
TN45	Replace/ relocate/ new	We were provided with sufficient evidence to confirm that the works claimed were complete
TO4261	Rationalised	We were provided with sufficient evidence to confirm that the works claimed were complete
TO2226	Rationalised	We were provided with sufficient evidence to confirm that the works claimed were complete
TO2228	Rationalised	We were provided with sufficient evidence to confirm that the works claimed were complete
PH600	Rationalised	We were provided with sufficient evidence to confirm that the works claimed were complete
RN1048C	Rationalised	We were provided with sufficient evidence to confirm that the works claimed were complete
PH1587	Rationalised	We were provided with sufficient evidence to confirm that the works claimed were complete
TN12994	Replace/ relocate/ new	We were provided with sufficient evidence to confirm that the works claimed were complete

For all 30 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

We requested that GMW provide construction records for a sample of remediation works completed in 2020/21 to verify that the channel remediation works claimed in the water recovery calculations had been completed. Only one pool (with three asset codes) was remediated in 2020/21.

The record for this pool included maps, photos, track sheets and commissioning paperwork including ITP documentation. Based on the evidence provided, we were able to confirm that the works in our sample are complete. No suitable aerial imagery was available to review the work against however based on the evidence provided, we were able to confirm that the works in our sample are complete.

Table 4-2 Findings from trailing remediation records

IPM/ Asset Code	Works Done	Audit notes
CH015367 CH014495 CH015377	Channel Remediation - HPPE Liner	The construction records reviewed provide assurance that the work claimed is completed. We confirmed the length of channel claimed by provision of Geocortex screenshots that showed length of channel remediated.

4.2.3 Channel removal

We reviewed the construction records for 30 channel removal activities that were claimed for 2020/21 The records reviewed and the findings are detailed in Table 4-3.

Table 4-3 Findings from trailing removal records

IPM/ Asset Code	Works done	Audit notes
CH000331	Block and associated meter replacement (TO1916)	Records provided confirmed work is done and the extent of assets removed is consistent with calculations. A minor administrative error was noted with the channel removal being adopted as completed on 22 September 2020 instead of 22 October 2020

IPM/ Asset Code	Works done	Audit notes
		when works were completed. The Connections Project acknowledged this and corrected it. The adoption date was changed leading to a decrease of Phase 3 water savings by 6 ML.
CH000333	Existing channel removed from network	Records provided confirmed work is done and the extent of assets removed is consistent with calculations.
CH000334	Block	Records provided confirmed work is done and the extent of assets removed is consistent with calculations.
CH000363	Block	Records provided confirmed work is done and the extent of assets removed is consistent with calculations.
CH000364	Block	Records provided confirmed work is done and the extent of assets removed is consistent with calculations.
CH000574	Block	Records provided confirmed work is done and the extent of assets removed is consistent with calculations.
CH001997	Block	Records provided confirmed work is done and the extent of assets removed is consistent with calculations.
CH002936	Block and associated meter relocation (PH2300)	Records provided confirmed work is done and the extent of assets removed is consistent with calculations.
CH003101	Block	Records provided confirmed work is done and the extent of assets removed is consistent with calculations.
CH003119	Block	Records provided confirmed work is done and the extent of assets removed is consistent with calculations.
CH003121	Channel converted to private. Meter installed	Records provided confirmed work is done and the extent of assets removed is consistent with calculations.
CH003122	Channel converted to private. Meter installed	Records provided confirmed work is done and the extent of assets removed is consistent with calculations.
CH003801	Block and associated meter replacement (RO5213A)	Records provided confirmed work is done and the extent of assets removed is consistent with calculations.
CH005638	Block	Records provided confirmed work is done and the extent of assets removed is consistent with calculations.
CH006278	Block	Records provided confirmed work is done and the extent of assets removed is consistent with calculations.
CH006356	Channel converted to private. Meter installed	Records provided confirmed work is done and the extent of assets removed is consistent with calculations.
CH006419	Block	Records provided confirmed work is done and the extent of assets removed is consistent with calculations.
CH006427	Block	Records provided confirmed work is done and the extent of assets removed is consistent with calculations.
CH006665	Block	Records provided confirmed work is done and the extent of assets removed is consistent with calculations.
CH006741	Block	Records provided confirmed work is done and the extent of assets removed is consistent with calculations.
CH007111	Conversion to a drain (no longer irrigation channel)	Records provided confirmed work is done and the extent of assets removed is consistent with calculations.
CH007138	Block	Records provided confirmed work is done and the extent of assets removed is consistent with calculations.
CH007876	Block	Records provided confirmed work is done and the extent of assets removed is consistent with calculations.
CH007961	Block	Records provided confirmed work is done and the extent of assets removed is consistent with calculations.

IPM/ Asset Code	Works done	Audit notes
CH009616	Block	Records provided confirmed work is done and the extent of assets removed is consistent with calculations.
CH012616	Block	Records provided confirmed work is done and the extent of assets removed is consistent with calculations.
CH014159	Channel converted to private. Meter installed	Records provided confirmed work is done and the extent of assets removed is consistent with calculations.
CH014492	Block	Records provided confirmed work is done and the extent of assets removed is consistent with calculations.
CH015130	Block	Records provided confirmed work is done and the extent of assets removed is consistent with calculations.
CH017413	Block	Records provided confirmed work is done and the extent of assets removed is consistent with calculations. A minor administrative error was noted with the channel removal being adopted as completed on 20 April 2021 instead of 17 April 2021 when works were completed. The Connections Project acknowledged this and corrected it. The adoption date was changed but there was no measurable change in Phase 3 water savings

4.2.4 Regulator gates

We audited the construction records of a sample of 20 regulator gates advised by GMW as being constructed during 2020/21. Table 4-4 details the findings of the records reviewed. All records had satisfactory evidence of work completion and appropriate work pack sign-off. Five records did not have date and time-stamped photographs – see section 4.2.6 . Other data within the workpacks confirmed the works were constructed and claimed in alignment with water saving calculations.

Table 4-4 Sample of regulator gate sites

IPM/ Asset Code	Comment
RN628	The construction records reviewed provide assurance that the work claimed is completed.
RN791	The construction records reviewed provide assurance that the work claimed is completed.
RN797	The construction records reviewed provide assurance that the work claimed is completed.
TN739	The construction records reviewed provide assurance that the work claimed is completed.
TN777	The construction records reviewed provide assurance that the work claimed is completed.
PH1161	The construction records reviewed provide assurance that the work claimed is completed.
PH225	The construction records reviewed provide assurance that the work claimed is completed.
PH438	The construction records reviewed provide assurance that the work claimed is completed.
PH494	The construction records reviewed provide assurance that the work claimed is completed.
PH597	The construction records reviewed provide assurance that the work claimed is completed.
PH621	The construction records reviewed provide assurance that the work claimed is completed.
PH624	The construction records reviewed provide assurance that the work claimed is completed.
PH625	The construction records reviewed provide assurance that the work claimed is completed.
PH626	The construction records reviewed provide assurance that the work claimed is completed.
MV1058	The construction records reviewed provide assurance that the work claimed is completed.
MV286	The construction records reviewed provide assurance that the work claimed is completed.
MV888A	The construction records reviewed provide assurance that the work claimed is completed.
ROTW2	The construction records reviewed provide assurance that the work claimed is completed.
TO829	The construction records reviewed provide assurance that the work claimed is completed.
TO830	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 April 2020 to 30 September 2020
- 1 October 2020 to 31 March 2021

Across the two reviews, 1321 assets were put forward by GMW Connections Project for review. For all but one record, the audit concluded that the evidence provided by the contractor was an accurate representation of the works completed during the review period. For the single record not meeting requirements, this was identified as a fault identified as part of the commissioning process for a new meter.

For both audits, it was concluded that evidence provided by contractors is an accurate representation of the works completed with no continuous improvement recommendations were made.

4.2.6 Connections Project continuous improvement

The Connections Project confirmed the following has been completed in terms of management of information systems which support program delivery:

- A lessons learnt workshop for Information Systems used by Connections Project was held in February 2021 to inform Goulburn-Murray Water (GMW) Water Efficiency Project (WEP) delivery planning.
- A systems update register of actions was subsequently developed to track progress improvement activities.
- A fortnightly team meeting to review and update the register was established.
- Improvement actions are tracked via a Corrective Action Register.
- A key theme running through improvement actions is improving data system interconnectivity. Improvements include:
  - Qlik service is being updated to a cloud-based version.
  - Scheduling platform switched to P6 and outsourced administration of it to a technical specialist.
  - All ITPs, standard design drawings and document templates were reviewed and revised in readiness for future water savings programs.

Summary of Construction Record Review and GMW Response

We only observed one issue relating to quality assurance of construction records and this was administrative in nature rather than an indication of any system shortcoming. This related to non-alignment of adopted dates in channel decommissioning calculation spreadsheets and when work was completed in two construction records. These were both less than one month difference between incorrect and corrected adoption date so the Phase 3 water savings claim reduction was minimal (6ML). Phase 4 water savings were not affected.

The issues identified and GMW's response is summarised in Table 4-5.

Table 4-5 Construction record quality assurance issues and GMW response

Issue	GMW response	Cardno assessment
Misalignment where adoption date in the channel decommissioning spreadsheet was not aligned with work completion date (2 records) This had a minor water savings impact. Both occurrences were less than one month difference between incorrect and corrected adoption date so the Phase 3 water savings claim reduction was minimal (6ML).	The dates were acknowledged as incorrect due to administration errors and water savings calculation spreadsheets were updated, resulting in a net decrease of 6ML Phase 3 Savings. There is no impact on Phase 4 Savings.	We are satisfied that these are isolated administrative errors and note the corrective action undertaken by GMW Connections Project.

We observed two improvement opportunities:

- We again noted that the ITP forms could better highlight the “water saving beneficial” record for some activities. For example, through experience, it is known that when meter pendants are removed this means the Dethridge wheel must have also been removed and thus, savings can be claimed. However, there is opportunity for this activity to be specifically marked on the ITP, and acknowledged by the Principal Contractor and/or Connections project signatory, as the water savings claim point. See sections 4.9 and 7 for recommendations.
- We observed five photographs in Regulator gate construction records where photographs were not time and date-stamped. Through other evidence, including work pack confirmation of when photographs were taken and key activity sign-off, it was possible to confirm the work was completed in alignment with the water savings claimed date. Given the majority of the other Regulator gate construction records had time-stamped photographs, as did other activity construction records, it is understood to be an isolated sub-contractor performance issue. See sections 4.9 and 7 for recommendation comments.

While the above issues highlight some areas where GMW may be able to improve its construction record documentation, none significantly impact on the claim that work has been completed or the water savings calculations. In all cases where claims were made, it could be confirmed the work reported had been completed.

4.3 Pondage testing

Pondage testing uses a water balance to estimate seepage and bank leakage in an isolated channel or channels. Where available, pondage test results (pre and post remediation works) are used as inputs to the calculation of water savings. The Water Savings Protocol Technical Manual allows for estimations to be used where no pondage data exists.

No Pondage testing was undertaken in 2020/21. This was largely because this was the final year of the Connections Project and this meant that:

- Very limited remediation activities have been undertaken in the past two years and there are no upcoming projects to refine calculations / learn lessons for.
- In addition, it is unlikely that any finalised analysis would have been completed by the end of November and able to be contributed to this audit.
- Through the course of the project, 75% of remediation water savings claims have been supported by pre and post remediation pondage test data. The Water Savings Protocol Version 5 does specifically allow for theoretical estimations to be used for later phases.

4.4 Outfall measurement and recording

The volumes of flows through outfalls are an important data input into water savings calculations as savings from outfalls are a significant component of all water savings achieved. Now that irrigation modernisation works in the GMID have been in progress for several years, most major outfalls have online flow measurement which is recorded in the GMW SCADA. A number of unmetered outfalls still exist where flows are estimated by operators (mainly on spur channels that may be removed in the future). However, these account for only a small proportion of the water savings achieved. Unmetered outfall measurement is conservative relative to metered outfalls with factors applied for corrections for spot measurement as well as scaling factors (F_{LTCE}).

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, field staff record the outfall volume in a logsheet. There is a separate logsheet for each irrigation area. Water Systems Planning staff provide to field staff each month a spreadsheet containing outfall data extracted from SPM. Field 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. Field 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 my field operators.

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 4-6.

Table 4-6 Findings from trailing outfall data

IPM/ Asset Code	Audit notes
SP268	Outfall data used in water savings consistent with data recorded in SPM for this outfall
SP316	Outfall data used in water savings consistent with data recorded in SPM for this outfall
RN718	Outfall data used in water savings consistent with data recorded in SPM for this outfall
TN344	Outfall data used in water savings consistent with data recorded in SPM for this outfall
RO311	Outfall data used in water savings consistent with data recorded in SPM for this outfall
RO818	Outfall data used in water savings consistent with data recorded in SPM for this outfall
TO68	Outfall data used in water savings consistent with data recorded in SPM for this outfall
TO345	Outfall data used in water savings consistent with data recorded in SPM for this outfall
PH697	Outfall data used in water savings consistent with data recorded in SPM for this outfall
PH1315	An initial observed difference between SCADA and SPM was observed of 157ML. This was due to data deletion in SMP from 01/06/21 to 30/06/21. Interrogation of the channel controlled, in part, by regulator PH1315, confirmed that the channel had dropped to 1m below its low alarms level through 01/06/21 to 02/06/21. At the same time the gate position was in the fully open position (also shown on SCADA). With an open gate and such a low level in the channel it is not possible to have the average 5ML/d flows which are reported in SCADA through June. This circumstance may occur where false flows are registered where there is no flow in the pool as the flow calculation of the outfall regulator (for any Rubicon regulator) is a mathematical calculation based on the door position compared to the Upstream Level sensor indicated level. So as the water drops away further below the range of the sensor and as the door position is also lower it calculates a “false” flow from this information. There was also very limited difference between up and downstream levels which also reinforce the fact the flow of 5ML/d was very unlikely to be occurring. It can be seen in SPM that 157ML has been removed and this was corrected by an operator. However, there is no note in SPM for why the change occurred. This does affect the water recovery estimates.
MV621	Outfall data used in water savings consistent with data recorded in SPM for this outfall
MV426	MV426 is actually recorded at the upstream regulator MV425. In the past, one outfall replaced the other but the pre-existing regulator point is used for water saving calculations. For MV425, a difference between SCADA and SPM of 19ML was observed. It was identified that SPM was only presenting data from 03/01/21 onwards. There were no notes or audit trail to confirm any adjustments of flow. Investigations and checks into email records confirmed the regulator was only configured to provide data to SPM from 03/02/21. This was also the case at two other regulators.: ▪ MV O/F NO 6 (MV1147) is revised to 3.2 ML (was 1ML) ▪ MV O/F 7/2 (MV346) is revised to 25.1 ML (was 23.2ML) In addition to the initially identified: ▪ MV O/F 10/2 (MV426) confirmed to 32.0 ML (was 11.6ML) This provided an overall increase in outfall flow and reduction of 24ML in Phase 3. There is no impact on Phase 4 savings.

There is not a requirement to make a specific additional recommendation about correction of flow records in SPM, as was done in the 2019/20 audit. However, it is recommended that the Connections Project should monitor compliance with their procedure (Outfall loss Volume Data Management) and ensure staff are aware of their requirements for it.

4.5 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 to 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.

4.6 Mitigating Flows

Mitigating flows are volumes of water that have been identified for alleviating the impacts of irrigation modernisation on wetlands and waterways of high environmental value. These flows are subtracted from water savings due to automation. Mitigating flow volumes are set out in Environmental Watering Plans (EWP) approved by the relevant Minister.

In 2009-2010, GMW prepared 15 EWPs for the GMW Connections Project. The EWPs were reviewed in 2015 which resulted in seven of the Plans being updated. The updated EWPs are in the process of being added and will be available at this location:

https://www.connectionsproject.com.au/pages/environmental-watering-plans

The North Central Catchment Management Authority authored the EWPs for Lake Elizabeth and Loddon River. These were not updated in 2015.

Mitigating flows have been included in the water savings calculation for 2020/21 at 13 sites (including 1 addition in 2020/21 of RN821 at GC5-9 irrigation area). We reviewed the EWPs relating to each of these sites to confirm that the correct allowance for mitigating flows had been made in the water savings calculations. The mitigation water volume for the year is calculated as the mitigation water commitment (MWC) (which is expressed as a proportion of the total outfall) for that location as specified in the EWP multiplied by the outfall at the location (either in the current year for Phase 3 or long-term equivalent for Phase 4). For some locations, the MWC is not a proportion of the total but a fixed volume. The result of this data trailing is summarised in Table 4-7

Table 4-7 Findings of review of Environmental Watering Plans

IPM Code	Asset Code	Site of environmental significance	EWP	MWC %	2020/21 Adjustment Volume (Phase 4)	Audit notes
PH1052A	ST025235	Lake Leaghur	Lake Leaghur	33%	33% x 354.7ML = 117.0ML	Confirmed correct allowance for mitigating flows
PH1249	ST008516	Little Lake Boort	Little Lake Boort	67%	67% x 293.5ML = 196.7ML	Confirmed correct allowance for mitigating flows
PH1119	ST023738	Duncan	Loddon River	n/a	0 ML	Structure has been removed
PH1138A	ST023656	Lake Meran	Lake Meran	100%	100% x 256.6ML = 256.6ML	Confirmed correct allowance for mitigating flows
PH1186	ST023234	River Pool	Loddon River	100%	100% x 997.8 ML = 997.8 ML	Confirmed correct allowance for mitigating flows
PH1211	ST025134 (ST025135 in EWP)	Dowdy's	Loddon River	90%	90% x 122.3ML = 110.1ML	Confirmed correct allowance for mitigating flows
PH1184	ST023230	Unnamed	Loddon River	88%	88% x 34.7ML = 30.5ML	Confirmed correct allowance for mitigating flows
PH1096	ST023308 (ST047427 in EWP)	Gannons	Loddon River	85%	85% x 93.8ML = 79.7ML	Confirmed correct allowance for mitigating flows
PH1224	ST073298 (ST023628 in EWP)	Delamare	Loddon River	50%	50% x 59.1ML = 29.6 ML	Confirmed correct allowance for mitigating flows

IPM Code	Asset Code	Site of environmental significance	EWP	MWC %	2020/21 Adjustment Volume (Phase 4)	Audit notes
TO1025	ST004154	Lake Elizabeth	Lake Elizabeth	67%	67% x 777.0ML = 520.6ML	Confirmed correct allowance for mitigating flows
	Straight Cut	Pig Swamp	Pig Swamp	n/a	170ML (Fixed amount)	Confirmed correct allowance for mitigating flows as per EWP
TO70	ST001206	McDonald's Swamp	McDonald's Swamp	100%	100% x 153.8ML = 153.8ML	Confirmed correct allowance for mitigating flows
SH110	ST072390 (ST043937 in EWP)	Round Lake	Round Lake	100%	100% x 363.0ML = 363.0ML	Confirmed correct allowance for mitigating flows
RN821	n/a	Grieners Lagoon	Grieners Lagoon	80%	80% x 91.2ML = 73.0ML	Confirmed correct allowance for mitigating flows

4.7 Assignment of savings between GMW Connections Project Stage 1 and Stage 2

The Victorian and Commonwealth Governments entered into funding agreements for modernisation works in the GMID which are the basis on which water savings are assigned between the Stage 1 and Stage 2 projects. For all new proposed works, a Business Case is written and this Business Case details the Stage to which the works belong with reference to the relevant funding agreement. This is sufficient in most instances to link the savings generated to the Stage 1 or Stage 2 project.

The exception is for savings arising from automation which result in reduced outfalls. Previously, there was a reasonably clear delineation between the Stage 1 and Stage 2 works as automation was only funded under Stage 1. The Project Reset means that automation works are now also funded under Stage 2. GMW has produced a procedure document *Assignment of Water Savings Resulting from Stage 1& 2* and *Procedure for Assignment of Water Savings Resulting from Stage 1 & 2 Automation Works* (Document number A3381577) that sets out the decision rules for assigning outfalls savings between the projects.

4.8 Conclusions

Our review for the 2020/21 audit of the information systems and processes used by GMW has found that they continue to be 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.

4.9 Recommendations

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

- Investigate if specific lines or entries marking beneficial completion should be included on ITP templates so there is a clear link from site work completion to water saving claims
- Monitor compliance with the Outfall Loss Volume Data Management procedure and ensure staff are aware of their requirements for it.
- Remind contractors and sub-contractors of the need to provide date and time-stamped photographs where they are providing evidence of works being completed with an associated water savings claim.

The Connections Project has reviewed and accepts these recommendations.

5 Checking of the work done

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 2020/21 audit, due to Covid-19 restrictions within Victoria at the time of the audit, it was not possible to make physical site visits to confirm in person that works have taken place. However, all construction records assessed did have photographs in addition to work pack information to confirm work had taken place when claimed. Due to a lack of aerial imagery in the Stanhope area, this year it was not possible to provide additional checks on the remediation construction record assessed. However, this did not have an effect on confirming works completion as satisfactory information was provided via photographs and work pack sign-off. The following checklist was applied to construction records:

- Request for work pack including ITP and photographs
- Check of pre (if available) and post construction photographs. Check of location and time-stamp
- Check of signature on ITP by GMW or principal contractor.
- Check alignment of beneficial work completion and relevant date in water savings spreadsheet.
- Send follow-up queries to GMW Connections Project where any of the above was missing or unclear.

A selection of example photographs used to confirm works had taken place for each activity are included in Appendix C.

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 3 and Phase 4 water savings achieved, where:

- Phase 3 savings relate to the actual water savings based on deliveries in a given year and confirmed in a water savings account.
- 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.

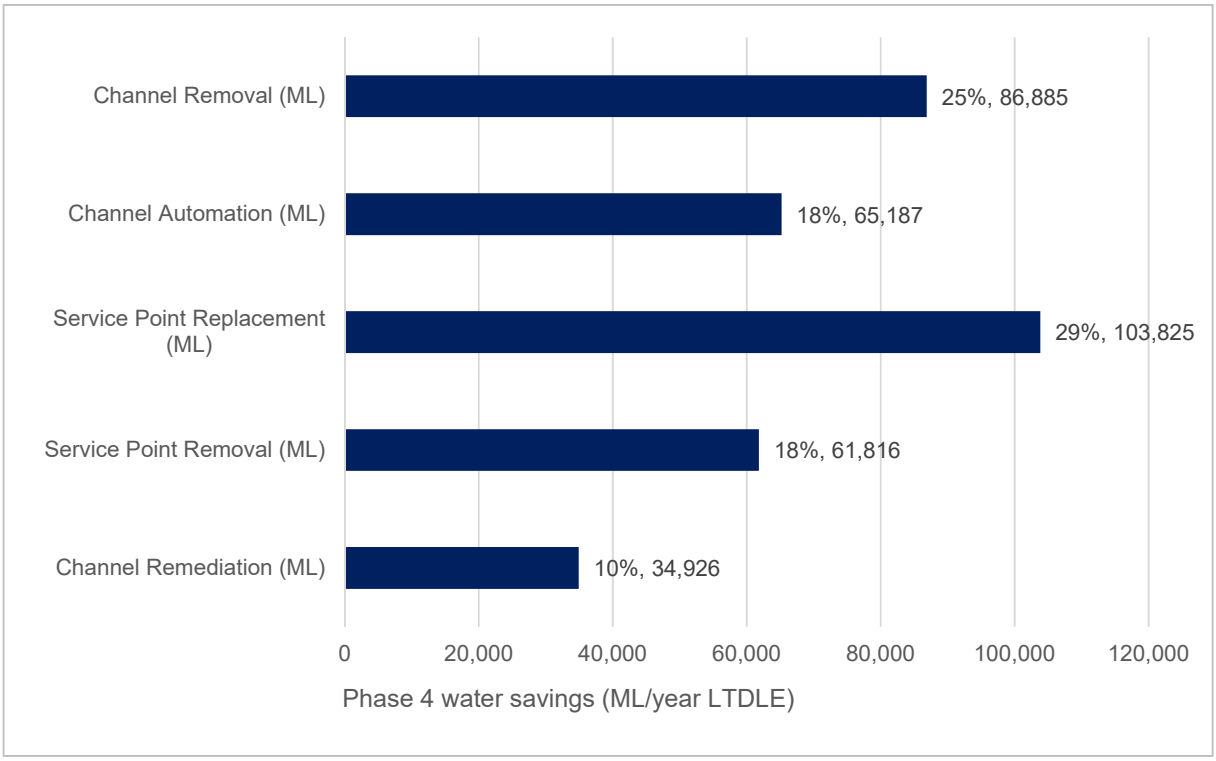
6.3 Overview of water recovery achieved in 2020/21

The 2020/21 audit requires water savings to be separately accounted to the GMW Connections Project Stage 1 and Stage 2. The Stage 1 project has been in progress since 2008 while the Stage 2 project commenced in 2012. The Stage 1 project accounts for the great majority of savings at this point in time, as shown in Table 6-1.

Table 6-1 Audited Phase 4 water savings by project

Project	Phase 4 water savings (ML)	% Total
GMW Connections Project Stage 1	194,864	55%
GMW Connections Project Stage 2	157,775	45%
Total	**352,639**	**100%**

Figure 6-1 provides an overview of the contribution of the different modernisation activities to the audited Phase 4 water savings for 2020/21 for the GMW Connections Project Stage 1 and Stage 2. This figure shows that service point replacement (29 %) and channel removal (25 %) are the most significant contributors to water savings achieved to date. Channel Automation works are completed and the share accountable to this intervention reduced as a proportion of the total with time.



Note totals may not sum exactly due to rounding

Figure 6-1 Audited Phase 4 Water Savings Estimates (GMW Connections Project Stage 1 and Stage 2) 2020/21

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 rationalised, or removed from the publicly owned irrigation distribution system. Removing these assets from the system as part of an irrigation modernisation project will reduce losses 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). DELWP provided to us a letter from DELWP 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. DELWP provided to us a letter from Hydrology and Risk Consulting Pty Ltd to DELWP 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.

Figure 6-2 details the cumulative length of channels rationalised in each irrigation area under the GMW Connections Project Stage 1 and Stage 2.

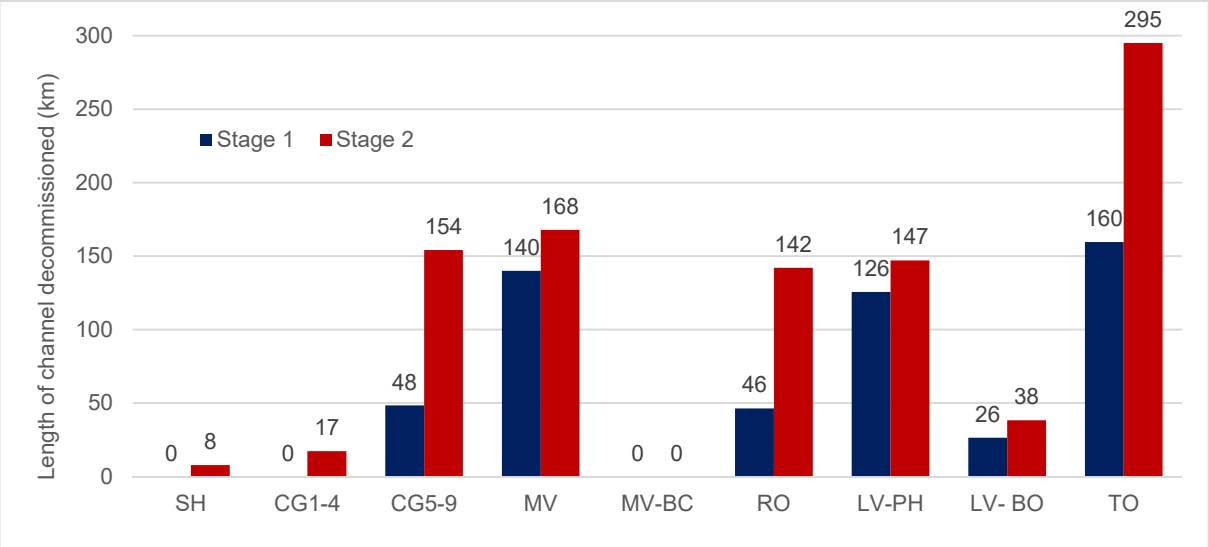


Figure 6-2 Length of rationalised channel (contributing to water savings only) by irrigation area under GMW Connections Project Stage 1 and Stage 2

6.4.2 Findings from trailing data and audit of calculations

We have reviewed the input data and confirm that the fixed parameters 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.

However, we noted the following issues which required some adjustments by GMW:

a) The last dates of the season for water savings (Seepage and Evaporation) at GC1-4 and GC5-9 irrigation areas used in the calculations had not been updated. This counted a 516ML increase of Phase 3 water saving. Phase 4 was unaffected.

b) Changes of operating days of CH018433 and CH017413 based on the construction records reviewed by Cardno.

GMW corrected these problems and Cardno has reviewed and accepted the corrections. All these issues resulted in the increase of Phase 3 water saving of 516ML. Phase 4 savings unaffected.

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

Customer Deliveries in the Current Year (D_{YearX})

Customer deliveries through the meters replaced in each irrigation area are determined through IPM. These delivery volumes are used for customer billing, as noted previously, and therefore we believe they will be reliable due to the scrutiny they are subject to by GMW and customers.

Ratio of Channel Length Rationalised 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.

Ratio of Length of Time Channels Rationalised to Baseline Year (t_r)

This variable is determined from the channel de-commissioning date recorded. This factor has previously been material for Phase 3 savings given that the amount of removal work completed each year is a significant proportion of the total. We confirm that GMW applied this factor correctly in the calculations.

6.4.3 Results

The audited water savings due to channel removal, corrected for the errors discussed above, are summarised in Table 6-2, Table 6-3 and Table 6-4.

Table 6-2 Phase 3 Water Savings due to Channel Removal – GMW Connections Project Stage 1 and Stage 2

PHASE 3	SH	CG1-4	CG5-9	MV	MV-BC	RO	LV-PH	LV- BO	TO	Total
Stage 1										
Seepage (ML)	0	0	633	2,310	0	659	410	62	2,312	6,386
Bank leakage (ML)	0	0	944	2,643	0	923	1,103	281	4,881	10,775
Evaporation (ML)	0	0	250	951	0	240	780	133	1,078	3,432
Pipeline deduction (ML)	0	0	-0.2	-0.6	0	-0.9	0	0	0	-1.7
Total	**0**	**0**	**1,826**	**5,903**	**0**	**1,821**	**2,294**	**476**	**8,271**	**20,591**
Stage 2										
Seepage (ML)	7	141	2,128	2,882	0	2,114	440	96	4,431	12,238
Bank leakage (ML)	160	860	3,235	3,189	0	2,927	1,387	435	9,905	22,099
Evaporation (ML)	43	82	808	1,157	0	880	823	191	2,003	5,986
Pipeline deduction (ML)	-0.5	-0.2	-39.0	-17.5	0	-35.7	0	-1.0	-42.0	-135.8
Total	**209**	**1,082**	**6,132**	**7,210**	**0**	**5,885**	**2,651**	**721**	**16,297**	**40,187**
Total (Stage 1 and Stage 2)	**209**	**1,082**	**7,958**	**13,114**	**0**	**7,706**	**4,944**	**1,197**	**24,569**	**60,779**

Note – Totals may not sum due to rounding

Table 6-3 Phase 4 Water Savings due to Channel Removal – GMW Connections Project Stage 1 and Stage 2

PHASE 4	SH	CG1-4	CG5-9	MV	MV-BC	RO	LV-PH	LV- BO	TO	Total
Stage 1										
Seepage (ML)	0	0	637	2,315	0	707	411	62	2,359	6,491
Bank leakage (ML)	0	0	1,594	5,437	0	1,620	1,806	370	8,759	19,586
Evaporation (ML)	0	0	252	954	0	262	781	133	1,099	3,481
Pipeline deduction (ML)	0	0	-0.3	-0.9	0	-1.4	0	0	0	-2.5
Total	**0**	**0**	**2,482**	**8,705**	**0**	**2,588**	**2,998**	**565**	**12,216**	**29,555**
Stage 2										
Seepage (ML)	7	153	2,142	2,900	0	2,117	451	96	4,522	12,389
Bank leakage (ML)	274	1,564	5,457	6,575	0	4,720	2,300	573	17,604	39,066
Evaporation (ML)	43	95	813	1,164	0	881	843	191	2,051	6,081

PHASE 4	SH	CG1-4	CG5-9	MV	MV-BC	RO	LV-PH	LV- BO	TO	Total
Pipeline deduction (ML)	-0.7	-0.3	-58.9	-26.3	0	-53.6	0	-1.5	-64.3	-205.6
Total	**323**	**1,812**	**8,353**	**10,612**	**0**	**7,665**	**3,594**	**859**	**24,112**	**57,330**
Total (Stage 1 and Stage 2)	**323**	**1,812**	**10,836**	**19,317**	**0**	**10,253**	**6,593**	**1,424**	**36,328**	**86,885**

Note – Totals may not sum due to rounding

Table 6-4 Breakdown of Phase 4 Water Savings due to Channel Removal into fixed and variable components – GMW Connections Project Stage 1 and Stage 2

PHASE 4	SH	CG1-4	CG5-9	MV	MV-BC	RO	LV-PH	LV- BO	TO	Total
Stage 1										
Seepage (ML) - Fixed	0	0	637	2,315	0	707	411	62	2,359	6,491
Bank leakage (ML) - Fixed	0	0	467	1,592	0	474	529	108	2,565	5,737
Bank leakage (ML) - Variable	0	0	1,127	3,845	0	1,145	1,277	262	6,194	13,850
Evaporation (ML) - Fixed	0	0	252	954	0	262	781	133	1,099	3,481
Pipeline deduction (ML) - Fixed	0	0	-0.3	-0.9	0	-1.4	0	0	0	-2.5
Total	0	0	2,482	8,705	0	2,588	2,998	565	12,216	**29,555**
Stage 2										
Seepage (ML) - Fixed	7	153	2,142	2,900	0	2,117	451	96	4,522	12,389
Bank leakage (ML) - Fixed	80	458	1,598	1,926	0	1,382	674	168	5,156	11,442
Bank leakage (ML) - Variable	194	1,106	3,858	4,649	0	3,338	1,626	405	12,448	27,624
Evaporation (ML) - Fixed	43	95	813	1,164	0	881	843	191	2,051	6,081
Pipeline deduction (ML) - Fixed	-0.7	-0.3	-58.9	-26.3	0	-53.6	0	-1.5	-64.3	-205.6
Total	323	1,812	8,353	10,612	0	7,665	3,594	859	24,112	**57,330**
Total (Stage 1 and Stage 2)	**323**	**1,812**	**10,836**	**19,317**	**0**	**10,253**	**6,593**	**1,424**	**36,328**	**86,885**

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.

Automation of the backbone channels in the GMW Connections Project works areas is complete for all areas.

6.5.2 Findings from trailing data and audit of calculations

We have reviewed the input data and confirm that the fixed parameters sourced from the technical manual are correct.

To allocate funding, GMW undertook the following steps: Stage 1 principally funded the channel automation through not automating all gates on the backbone channels. Stage 2 funds were then used to fund additional regulators to improve customer service, to service operational resourcing needs and to provide additional water savings. These can be interpreted as four scenarios to determine a proportional saving between Stage 1 and Stage 2.

We noted the following issues which required adjustments by GMW

a) There are no formulae linking mitigating flows at GC5-9, TO and LV-BO between summary tabs and calculation tabs consequently the overall total savings had not been updated for Phase 3. There is a reduction of 10ML in Phase 3 savings. There is no impact on Phase 4 savings.

b) Missing a meter factor at RO. This has insignificant impact on water saving calculations (< 1ML)

c) There are number of missing calculation formulae in Phase 3 stages 1 and 2 at LV-PH, PV-BO and TO. Consequently, sums of phase 3 stages 1 and 2 are not equal to total savings of these irrigation areas – there is a reduction of 631ML in Phase 3 savings. There is no impact on Phase 4 savings.

d) Changes in "out season" and "in season" outfalls at MV1147, MV346 and MV426 are based on supporting documents reviewed by Cardno. There is a reduction of 24ML in Phase 3 savings. There is no impact on Phase 4 savings.

GMW corrected these issues in addition to updates of meter adjustment factors. Consequently, baseline year outfalls in RO and TO decrease when compared with the previous 2019/20 audit as shown in Table 6-5. Cardno has accepted the corrections.

The following summary is a review of the inputs from the current operating year:

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. The fixed component is not scaled. GMW advised that it only had initially available sufficient records to allocate outfalls between fixed and variable components in the baseline year for Torrumbarry. For all other irrigation areas, the baseline year outfalls are assumed to be 100% variable. This has been updated over time as sufficient data is collected in all irrigation areas. A breakdown of the Phase 3 and 4 water savings in into fixed and variable components is included in Table 6-5 and Table 6-6. 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.

The largest outfalls responsible for the greatest water savings are generally measured on-line with feedback to GMW's SCADA.

GMW has subtracted environmental mitigating flows volumes from its savings. Environmental mitigating flows are specified in Environmental Watering Plans and are volumes determined by catchment managers as necessary to support specific high value habitats. Mitigating flows occur in the GC5-9, Torrumbarry and Pyramid-Boort irrigation areas. Because mitigating flows occur through some outfalls that have 'negative' savings (i.e. the outfall in this year is greater than that in the baseline year) the mitigating flow cannot be subtracted from the outfall, meaning that it is not possible to reconcile outfall savings and mitigating flows on

an outfall by outfall basis. In this case the mitigating flow is zeroed and the loss is deducted from the overall automation savings. We comment on our review of the application of mitigating flows in Section 4.6.

Customer Deliveries in the Current Year (D_{YearX})

Customer deliveries in each irrigation area are determined from IPM reports. The volumes used are sourced from the same reports used for GMW's annual reporting.

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 DELWP. 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 6-5 and Table 6-6.

Table 6-5 Phase 3 and Phase 4 Water Savings due to Channel Automation

	SH	CG 1-4	CG 5-9	MV	MV-BC	RO	LV-PH	LV- BO	TO	Total
Inputs										
O_{base} (ML)	1,539	-	26,614	9,290	0	8,164	2,993	2,198	9,266	60,064
O_{yearx} (ML)	247	-	279	169	0	384	1,436	620	1,265	4,401
D_{base} (ML)	157,085	-	312,082	293,026	0	199,270	146,656	75,012	405,049	1,588,180
D_{yearx}(ML)	82,883	-	160,421	111,206	0	119,908	80,267	60,576	197,973	813,233
Phase 3 Water Savings										
Stage 1	0	0	12,868	2,933	0	3,953	194	-14	2,697	22,631
Stage 2	565	0	505	423	0	576	7	0	204	2,280
Mitigating flows (ML)	0	0	29	0	0	0	0	1,169	568	1,766
Gross Phase 3 savings (ML)	**565**	**0**	**13,402**	**3,356**	**0**	**4,528**	**202**	**1,155**	**3,469**	**26,677**
Net Phase 3 savings (ML)	**565**	**0**	**13,373**	**3,356**	**0**	**4,528**	**202**	**-14**	**2,901**	**24,911**
Zeroed outfalls (ML)	0	-	0	0		0	0	0	0	0
Phase 4 Water Savings										
Stage 1	0	0	32,050	9,948	0	8,259	1,056	-103	7,921	59,130
Stage 2	1,392	0	1,251	1,517	0	1,257	16	0	624	6,056
Mitigating flows (ML)	0	0	73	0	0	0	0	1,818	1,207	3,098
Gross Phase 4 savings (ML)	1,392	0	33,374	11,465	0	9,516	1,072	1,715	9,752	68,285
Net Phase 4 savings (ML)	**1,392**	**0**	**33,301**	**11,465**	**0**	**9,516**	**1,072**	**-103**	**8,545**	**65,187**

Note – Totals may not sum due to rounding; D_{yearx} is an adjusted delivery measure (delivery equivalent if no modernisation work completed)

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

Phase 4	SH	CG1-4	CG5-9	MV	MV-BC	RO	LV-PH	LV- BO	TO	Total
GMW Connection Stage 1 Project										
Fixed component	0	-	-108	-9	0	-13	-564	-309	-526	-1,530
Variable component	0	-	32,158	9,957	0	8,271	1,620	206	8,447	60,660
Total	0	-	32,050	9,948	0	8,259	1,056	-103	7,921	59,130
GMW Connection Stage 2 Project										

Phase 4	SH	CG1-4	CG5-9	MV	MV-BC	RO	LV-PH	LV- BO	TO	Total
Fixed component	-33	-	0	-26	0	-36	0	0	-56	-151
Variable component	1,425	-	1,251	1,543	0	1,293	16	0	679	6,207
Total	1,392	-	1,251	1,517	0	1,257	16	0	624	6,056
Total – Stage 1 and Stage 2										
Fixed component	-33	-	-108	-35	0	-49	-564	-309	-581	-1,680
Variable component	1,425	-	33,409	11,500	0	9,565	1,636	206	9,126	66,867
Total	1,392	-	33,301	11,465	0	9,516	1,072	-103	8,545	65,187

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 rationalisation has been completed under the GMW Connections Project Stage 1 and Stage 2. Figure 6-3 shows the cumulative number of service points replaced and rationalised in each irrigation area.

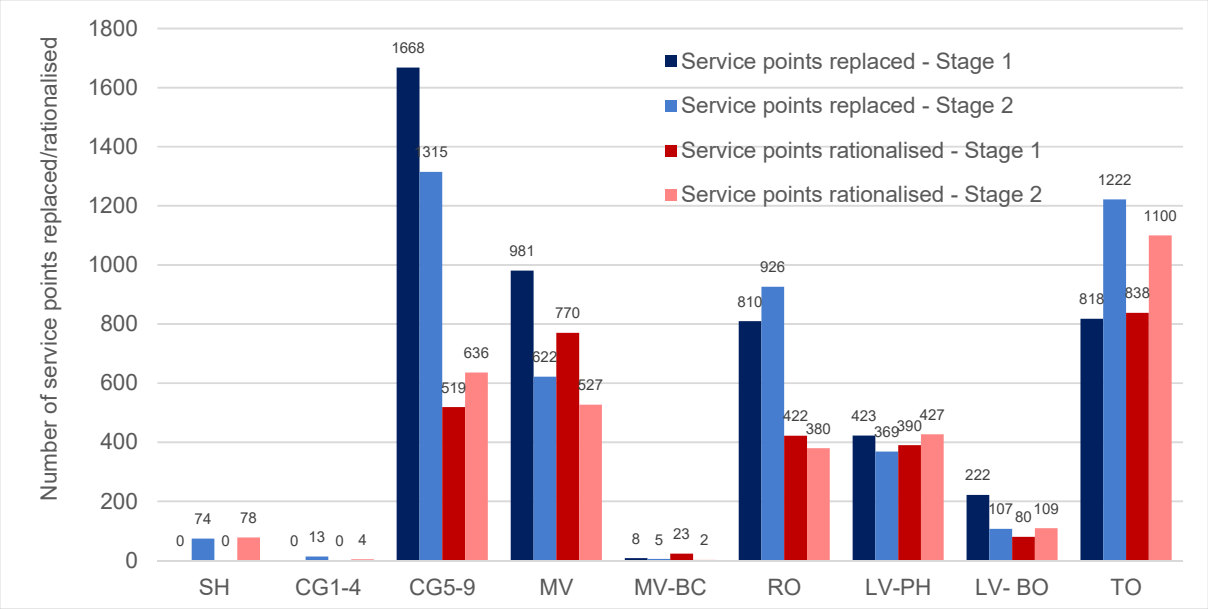


Figure 6-3 Numbers of service points replaced and rationalised (Stage 1 and Stage 2)

6.6.2 Findings from trailing data and calculations

We have reviewed the input data and confirm that the parameters sourced from the technical manual Baseline Year Water Balance are correct. Also, GMW adopted DF (leakage around) = 1 for service point replacement connected to a pipeline. This is a reasonable assumption as losses associated with meters on pipelines are included in the pipeline residual model. Previous approval for the pipeline residual loss model has been provided by DELWP based on the Connections Project's submission of an independent assessment to develop a level of leakage per km There were errors found in effectiveness factors (E_F) on MV5580A and TO282AA in which the E_F (manual – 1.0) applied to Phase 3 while the E_F (Auto – 0.9) applied to Phase 4. These errors had insignificant impact on overall water saving, which accounted for a 0.4 ML increase of Phase 3 water saving. GMW corrected these errors.

The following summary is a review of the inputs from the current operating year:

Customer Deliveries through Replaced Service Points (D_{MYearX}) and in the Irrigation System (D_{YearX})

Customer deliveries through the replaced meters and in each irrigation area are determined through IPM. These delivered volumes are used for customer billing and, as noted previously, we believe they will be reliable due to the scrutiny they are subject to by GMW and customers.

In the 2019/20 audit, GMW converted the total amount of customer delivery (D_{yearx}) measured by any replacement modern meters (since 2004/05), to what the equivalent customer delivery would be if the old

meters were used. Cardno agrees with this practise - "Apples to apples". This method was also applied in the current audit.

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

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 GMW Connections Project Stage 1 and Stage 2, as outlined in Section 4.2.1. This review provided evidence that the sample of works claimed as complete by GMW had been completed.

Ratio of time Service Point in use compared to Baseline Year (t_m)

This factor is calculated by GMW based on the commissioning (or de-commissioning in the case of removal) dates for each service point. As the works have been in progress for a number of years, the t_m factor has limited impact on the calculated Phase 3 savings. We found that the t_m factor has been calculated and applied correctly by GMW for service point replacements and removal (introduced in Version 5 of the Water Savings Protocol)

Our review of commissioning certificates for a sample of service points is outlined in Section 4.2.1.

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 DELWP. 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 6-7 and Table 6-8 for the GMW Connections Project Stage 1 and Stage 2. GMW performs these calculations on a meter by meter basis and not for an irrigation area nor as a whole system.

Table 6-7 Phase 3 and Phase 4 Water Savings due to Service Point Replacement and Removal – GMW Connections Project Stage 1

	SH	CG1-4	CG5-9	MV	MV-BC	RO	LV-PH	LV- BO	TO	Total
Service point replacement										
Phase 3 Water Savings										
Meter error (ML)	0	0	6,753	5,051	11	4,207	3,448	2,463	5,917	27,850
Leakage through service points (ML)	0	0	2,901	1,465	0	1,276	743	374	1,331	8,090
Leakage around service points (ML)	0	0	632	319	0	275	158	80	289	1,752
Unauthorised Use (ML)	0	0	582	209	0	295	154	115	248	1,602
Total (ML)	**0**	**0**	**10,868**	**7,043**	**10**	**6,054**	**4,503**	**3,032**	**7,785**	**39,293**
Phase 4 Water Savings										
Meter error (ML)	0	0	14,002	9,269	0	7,108	4,954	3,260	8,483	47,076
Leakage through service points (ML)	0	0	2,741	1,460	-1	1,222	687	347	1,258	7,714
Leakage around service points (ML)	0	0	593	318	0	258	145	74	273	1,662
Unauthorised Use (ML)	0	0	1,468	773	0	646	358	181	666	4,092
Total (ML)	**0**	**0**	**18,804**	**11,820**	**-1**	**9,234**	**6,145**	**3,862**	**10,679**	**60,543**
Service point removal										
Phase 3 Water Savings										
Meter error (ML)	0	0	0	0	0	0	0	0	0	0
Leakage through service points (ML)	0	0	891	1,156	16	670	681	139	1,453	5,006
Leakage around service points (ML)	0	0	187	242	2	141	143	29	304	1,047
Unauthorised Use (ML)	0	0	217	208	3	191	177	53	336	1,184
Total (ML)	**0**	**0**	**1,295**	**1,605**	**21**	**1,002**	**1,001**	**221**	**2,093**	**7,238**
Phase 4 Water Savings										
Meter error (ML)	0	0	2,375	5,549	0	2,389	2,908	938	7,271	21,430
Leakage through service points (ML)	0	0	887	1,214	17	678	665	135	1,452	5,048
Leakage around service points (ML)	0	0	184	253	2	140	140	28	304	1,051
Unauthorised Use (ML)	0	0	546	748	11	418	410	83	894	3,109
Total (ML)	**0**	**0**	**3,993**	**7,764**	**29**	**3,625**	**4,122**	**1,185**	**9,920**	**30,638**
Total Phase 3 savings (Replacement and removal)	**0**	**0**	**12,163**	**8,648**	**31**	**7,055**	**5,503**	**3,253**	**9,878**	**46,531**

	SH	CG1-4	CG5-9	MV	MV-BC	RO	LV-PH	LV- BO	TO	Total
Total Phase 4 savings (Replacement and removal)	**0**	**0**	**22,798**	**19,584**	**28**	**12,859**	**10,267**	**5,047**	**20,599**	**91,182**

Note – Totals may not sum due to rounding

Table 6-8 Phase 3 and Phase 4 Water Savings due to Service Point Replacement and Removal – GMW Connections Project Stage 2

	SH	CG1-4	CG5-9	MV	MV-BC	RO	LV-PH	LV- BO	TO	Total
Service point replacement										
Phase 3 Water Savings										
Meter error (ML)	216	64	4,612	2,411	0	3,813	2,739	1,336	5,605	20,797
Leakage through service points (ML)	83	17	1,903	779	-1	963	516	157	1,473	5,890
Leakage around service points (ML)	19	4	413	168	0	211	110	33	319	1,277
Unauthorised Use (ML)	18	3	376	110	-1	226	102	47	268	1,150
Total (ML)	**336**	**88**	**7,303**	**3,468**	**-1**	**5,213**	**3,467**	**1,573**	**7,666**	**29,114**
Phase 4 Water Savings										
Meter error (ML)	265	132	9,270	5,219	0	6,432	3,319	1,094	7,781	33,511
Leakage through service points (ML)	80	18	1,804	778	-1	924	478	147	1,380	5,608
Leakage around service points (ML)	19	4	375	168	0	204	102	31	300	1,202
Unauthorised Use (ML)	46	9	957	408	-1	496	244	76	724	2,959
Total (ML)	**410**	**162**	**12,406**	**6,574**	**-2**	**8,056**	**4,143**	**1,348**	**10,184**	**43,281**
Service point removal										
Phase 3 Water Savings										
Meter error (ML)	0	0	0	0	0	0	0	0	0	0
Leakage through service points (ML)	95	1	1,042	767	2	592	744	208	1,873	5,323
Leakage around service points (ML)	19	0	219	161	0	125	157	44	394	1,118
Unauthorised Use (ML)	24	0	254	138	0	169	193	80	434	1,290
Total (ML)	**138**	**1**	**1,515**	**1,066**	**3**	**885**	**1,093**	**332**	**2,700**	**7,732**
Phase 4 Water Savings										
Meter error (ML)	125	87	3,323	3,693	0	2,160	3,430	1,031	7,517	21,365
Leakage through service points (ML)	97	8	1,053	806	2	600	737	203	1,872	5,377

	SH	CG1-4	CG5-9	MV	MV-BC	RO	LV-PH	LV- BO	TO	Total
Leakage around service points (ML)	18	2	217	170	0	126	155	43	394	1,124
Unauthorised Use (ML)	60	5	648	496	1	370	454	125	1,152	3,311
Total (ML)	**300**	**101**	**5,240**	**5,164**	**3**	**3,256**	**4,776**	**1,402**	**10,934**	**31,177**
Total Phase 3 savings (Replacement and removal)	**474**	**90**	**8,817**	**4,534**	**1**	**6,098**	**4,559**	**1,905**	**10,366**	**36,845**
Total Phase 4 savings (Replacement and removal)	**710**	**264**	**17,646**	**11,738**	**2**	**11,312**	**8,919**	**2,750**	**21,119**	**74,458**

Note – Totals may not sum due to rounding

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

These can be seen in Table 6-7 and Table 6-8

6.7 Savings from Channel Remediation

6.7.1 Scope of Irrigation Channel Remediation Works

Channel remediation involves lining earthen channels, replacing channels with pipelines and bank remodelling. These works can generate irrigation water savings through reduced bank seepage and reduced bank leakage. A total of 316.3 km of channel lining has been completed to date. Approximately 2 km was completed in 2020/21 compared with 1 km in 2019/20. The length of channel that has been remediated by irrigation area is shown in Figure 6-4

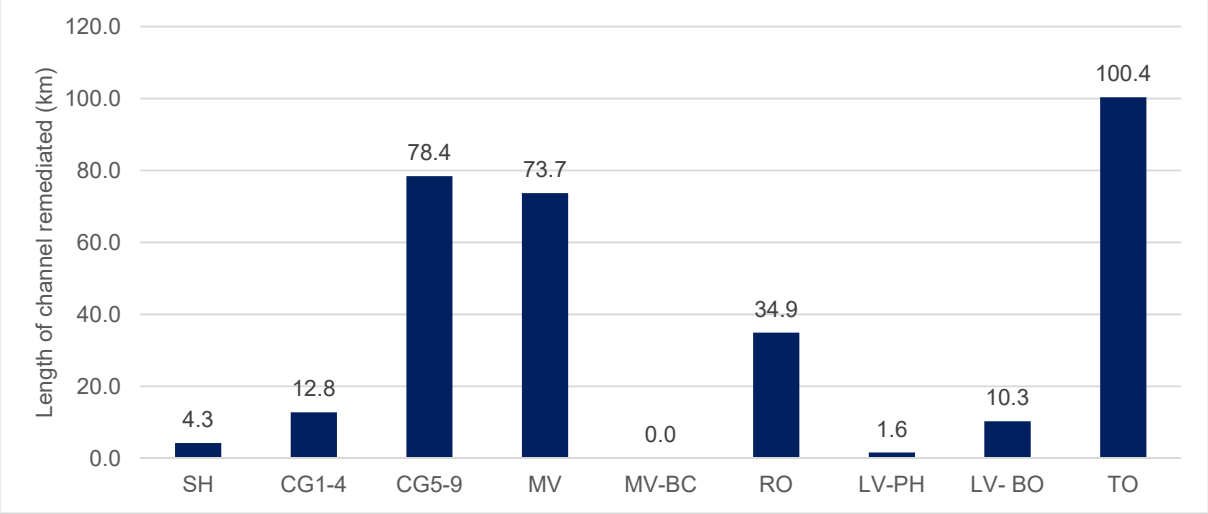


Figure 6-4 Length (km) of channel remediated by irrigation area

6.7.2 Findings from trailing data and calculations

For the remediation works completed in 2008 (5km), no pre or post works pondage test data is available. Therefore, the theoretical method has been used for these works. The inputs and method are unchanged from the 2009/10 audit report for these works from 2008.

For the works completed in 2009 pre-works pondage data is available for all sites except one. Post-works pondage testing data is available for 11 of the 15 sites. For the works completed in 2010, 40 of 43 sites have both pre and post works pondage testing data available. The sites for which post-works pondage testing is now available has been steadily increasing each year, enabling the preferred methodology using both pre and post works data to be used.

Through the course of the project, 75% of remediation water savings claims have been supported by pre and post remediation pondage test data. The Water Savings Protocol Version 5 does specifically allow for theoretical estimations to be used for later phases.

We have reviewed the input data and confirm that the fixed parameters sourced from the technical manual are correct, as are the deliveries in the Baseline Year sourced from the Baseline Year Water Balance.

Exceptions:

a) The ratios of delivery (D_{yearx}/D_{base}) of LV-BO and LV-PH in the calculation were wrongly referenced to a neighbouring cell.

b) Phase 3 summer and winter days have not been updated in the current 2020/21 audit.

GMW corrected these problems as well as updating customer deliveries. Cardno has reviewed the final version and accepted these corrections. After these corrections were made, total water savings from channel remediation in Phase 3 increased from 23,378 ML to 23,715 ML.

The following summary is a review of the inputs from the current operating year:

Pre Works and Post Works bank Leakage and Seepage ($L^{PRE\ WORKS}$, $L^{POST\ WORKS}$, $S^{PRE\ WORKS}$, $S^{POST\ WORKS}$)

Where pondage testing data is available, pre and post works leakage and seepage are determined through evaluation of site testing results. We have reviewed the pondage testing methodology and results in previous audits and commented that we believe that the pre and post works seepage and leakage estimates, determined through site testing, are sound.

Customer Deliveries in the Current Year (D_{YearX})

Customer deliveries in each irrigation district are determined from IPM reports. The volumes used are sourced from the same reports used for GMW's annual reporting. GMW dealt with the D_{Yearx} issue at LV-BO and LV-PH, which has been shown in section 6.7.2 (a).

6.7.3 Results

Water savings due to channel remediation are calculated on a channel by channel basis as each channel has a different leakage and seepage rate. The meter error correction is applied to whole irrigation areas as shown in Table 6-9.

Table 6-9 Phase 3 and Phase 4 Water Savings due to Channel Remediation

	SH	CG1-4	CG 5-9	MV	MV-BC	RO	LV-PH	LV- BO	TO	Total
Phase 3 savings (ML)										
Stage 1	0	0	3,798	2,825	0	1,479	0	0	2,092	10,194
Stage 2	523	1,160	3,352	2,585	0	230	183	1,354	4,135	13,521
Total	**523**	**1,160**	**7,149**	**5,411**	**0**	**1,710**	**183**	**1,354**	**6,226**	**23,715**
Phase 4 savings (ML)										
Stage 1	0	0	5,546	4,148	0	1,991	0	0	3,312	14,997
Stage 2	779	1,721	5,074	3,897	0	286	281	1,629	6,261	19,929
Total	**779**	**1,721**	**10,621**	**8,045**	**0**	**2,277**	**281**	**1,629**	**9,573**	**34,926**

Note – Totals may not sum due to rounding

Table 6-10 provides a breakdown of remediation Phase 4 water savings in into fixed and variable components. Seepage and evaporation savings are fixed while leakage has a fixed and variable component.

Table 6-10 Fixed and variable components of Phase 4 Water Savings due to Channel Remediation

	SH	CG1-4	CG5-9	MV	MV-BC	RO	LV-PH	LV- BO	TO	Total
Phase 3										
Stage 1										
Fixed	0	0	2,460	2,278	0	968	0	0	1,229	6,936
Variable	0	0	1,337	547	0	512	0	0	862	3,258
Stage 2										
Fixed	332	660	2,038	2,042	0	174	97	701	2,632	8,675
Variable	191	500	1,313	543	0	56	87	653	1,503	4,846
Total Stage 1 and Stage 2										
Phase 3 - Fixed	**332**	**660**	**4,498**	**4,321**	**0**	**1,142**	**97**	**701**	**3,861**	**15,611**
Phase 3 - Variable	**191**	**500**	**2,651**	**1,090**	**0**	**568**	**87**	**653**	**2,365**	**8,104**
Phase 4										
Stage 1										
Fixed	0	0	2,306	2,272	0	929	0	0	1,157	6,663
Variable	0	0	3,241	1,876	0	1,062	0	0	2,155	8,334

	SH	CG1-4	CG5-9	MV	MV-BC	RO	LV-PH	LV- BO	TO	Total
Stage 2										
Fixed	322	625	1,928	2,032	0	169	90	656	2,484	8,305
Variable	457	1,097	3,146	1,865	0	118	191	973	3,778	11,625
Total Stage 1 and Stage 2										
Phase 4 - Fixed	**322**	**625**	**4,234**	**4,305**	**0**	**1,097**	**90**	**656**	**3,640**	**14,968**
Phase 4 - Variable	**457**	**1,097**	**6,387**	**3,740**	**0**	**1,179**	**191**	**973**	**5,933**	**19,958**

Note – Totals may not sum due to rounding

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:

- Investigate if specific lines or entries marking beneficial completion should be included on ITP templates so there is a clear link from site work completion to water saving claims (carried over from previous years)
- Monitor compliance with the Outfall Loss Volume Data Management procedure and ensure staff are aware of their requirements for it (amendment of a previous years' recommendation)
- Remind contractors and sub-contractors of the need to provide date and time-stamped photographs where they are providing evidence of works being completed with an associated water savings claim.

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 2018/19 have now been closed out.

Table 8-1 details progress against the recommendations that were still open at the 2020/21 audit. This table also details the recommendations made at this year's audit for the purpose of tracking these recommendations in future audits.

Table 8-1 Schedule of progress against previous audit actions

Ref	Area	Comment	2020/21 Audit comment
2018/19-2	Construction Records – work packs	We recommend GMW consider if specific lines or entries marking beneficial completion should be included on ITPs so there is a clear link from site work completion to water saving claims	While there was a progression relevant to 2018/19, there is still an opportunity for GMW to specifically mark beneficial completion on ITPs. This recommendation should stay open
2019/20-1	Adjustment of flow data in SPM	GMW re-communicate the Outfall Loss Volume Data Management procedure and remind staff of their requirements.	This recommendation should stay open and be adjusted to "Monitor compliance with the Outfall Loss Volume Data Management procedure and ensure staff are aware of their requirements"
2020/21-1	Date and time stamping on photos	Ensure all photographs used to support water savings are date and time-stamped	New

APPENDIX A

CALCULATIONS

Channel asset removal calculations

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 3: $WS_{Yearx} = WS_{seepage} + WS_{bank\ leakage} + WS_{evaporation} - R$

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

Water savings calculations

Phase 3 Calculations

Phase 3 water savings have been calculated by GMW using the Phase 3 channel removal formulae from the technical manual:

$$WS_{Seepage} = S_{Base} \times CL \times t_r \times EF$$

$$WS_{bank\ leakage} = [(L_{Base} \times FL) + (L_{Base} \times VL \times (D_{YearX} / D_{Base})] \times CL \times t_r \times EF$$

$$WS_{evaporation} = E_{Base} \times CL \times t_r \times EF$$

Phase 4 Calculations

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

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

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

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

The differences between the Phase 4 calculations and the Phase 3 calculations are the addition of the durability factor (DF) and the replacement of the deliveries ratio with F(LTCE).

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 DELWP. The loss model approach is more granular than using area averages.

Input data

The inputs required to calculate Phase 3 and Phase 4 water savings due to channel removal are summarised in Table A-1 and Table A-2.

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

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

Parameter	Description	Source
S_{Base}	Seepage in Baseline Year	Baseline Year water balance
L_{Base}	Leakage in Baseline Year	Baseline Year water balance
E_{Base}	Evaporation in Baseline Year	Baseline Year water balance
D_{Base}	Deliveries in Baseline Year	Baseline Year water balance
FL	Proportion of bank leakage recognised as fixed	Technical manual

Parameter	Description	Source
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)	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; 0.4ML/km/year for Phase 3)	Technical manual, including a minor correction identified by the Connections Project and acknowledged by DELWP

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

Parameter	Description	Source
CL	Ratio of length of spur channel length rationalised to total spur channel length in system	GIS and direct measurement
t_r	Ratio of the length of time a channel has been rationalised in the year in question relative to the irrigation season length in the baseline year	Construction records
$D_{Year\ x}$	Customer deliveries in the year in question to the irrigation system	IPM reports

Channel Automation Calculations

Overview

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

Phase 3: $WS_{YearX} = WS_{outfalls}$

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.

Water Savings Calculations

Phase 3 Calculations

Phase 3 water savings have been calculated by GMW Connections Project using the Phase 3 outfalls formula from the technical manual:

$$WS_{outfalls} = [(O_{base\ -\ variable} \times (D_{YearX} / D_{Base})) - (O_{YearX\ -\ variable})] + [O_{Base\text{-}Fixed} - O_{YearX\text{-}Fixed}]$$

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 DELWP. This includes the addition of an additional bracket so $DF_{variable}$ applies to both O_{base} variable and O_{yearx} variable components.

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

Input Data

The inputs required to calculate Phase 3 and Phase 4 water savings due to outfall automation are summarised in Table A-3 and Table A-4.

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

Table A-3 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
$O_{Base\ -\ variable}$	Fixed outfall loss in Baseline Year	Baseline Year water balance and analysis
D_{base}	Customer Deliveries in the Baseline Year in the irrigation system	Baseline Year water balance
DF	Durability factor to account for the durability of water savings interventions	Connections Project use a value of 0.98 (approved by DELWP 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

Table A-4 Current year parameters for automation water savings calculation

Parameter	Description	Source
$O_{yearX\ -\ Fixed}$	Fixed outfalls in Current Year	SCADA and analysis
$O_{yearX\ –\ Variable}$	Variable outfalls in Current Year	SCADA and analysis
D_{yearX}	Customer Deliveries in the Current Year in the irrigation system	IPM reports
$F(LTCE_{YearX})$	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

Service Point Replacement and Removal

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 same high level Phase 3 and 4 equations apply to both replacements and removals although the individual components are determined differently.

The high level equations are the same for both Phase 3 and Phase 4 savings:

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

Water Savings Calculations

The components of the Phase 3 and 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 3 Calculations – Service Point Replacement

Phase 3 water savings have been calculated by GMW using the formula in the *technical manual*:

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

where

$$WS_{meter\ error} = D_{MYearx} \times (1/MCF) \times (MCF - 1) \times EF$$

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

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

$$WS_{unmetered} = D_{UBase} \times (MCF - 1) \times EF \times (D_{YearX}/D_{base}) \times t_m \text{ (not used)}$$

$$WS_{unauthorised} = N_{replaced} \times U_{base} \times EF \times (D_{YearX}/D_{base}) \times t_m$$

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 only change in leakage through and unauthorised losses in Phase 3, and Leakage through, around, meter error and unauthorised losses for Phase 4. This is a conservative approach that we feel is appropriate.

Phase 3 Calculations – Service Point Removal

Phase 3 water savings due to service point removal have been calculated by GMW using the formula in the *technical manual*:

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

where

$$WS_{meter\ error} = (D_{MBase} \times (MCF - 1) \times EF) \times (D_{YearX}/D_{base}) \times t_m$$

$$WS_{leakage\ through} = N_{rationalised} \times LTT \times EF \times t_m$$

$$WS_{leakage\ around} = N_{rationalised} \times LTA \times EF \times t_m$$

$$WS_{unmetered} = D_{UBase} \times (MCF - 1) \times EF \times (DYearX/Dbase) \times t_m \text{ (not used)}$$

$$WS_{unauthorised} = N_{rationalised} \times U_{Base} \times EF \times (D_{YearX}/D_{base}) \times t_m$$

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 DBase rather than DYear X. This aligns with the Water Savings Protocol Version 5 where there is no $F(LTCE_{YearX})$ provided.

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

where

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

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

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

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

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

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

$WS_{meter\ error(LTCE)} = (D_{MBase} \times (MCF - 1) \times EF \times DF) \times F(LTCE_{base})$

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

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

$WS_{unmetered(LTCE)} = D_{UBase} \times (MCF - 1) \times EF \times DF \times F(LTCE_{base})$ ***(not used)***

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

Input Data

The inputs required to calculate Phase 3 and Phase 4 water savings due to service point replacement and removal are summarised in Table A-5 and Table A-6. Table A-5 details the parameters that are fixed or have been previously audited. Table A-6 details the input data from the current year.

Table A-5 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 Rationalised meters in the Baseline Year	Baseline Year water balance
DF_{error}	Durability factor for reducing measurement error	Technical manual

Parameter	Description	Source
$DF_{leakage\ through}$	Durability factor for reducing leakage through the meter	Connections Project 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

Table A-6 Current Year Parameters for Service Point Replacement and Removal Water Savings Calculation

Parameter	Description	Source
D_{MYearX}	Customer deliveries through the replaced meters for the year in question	IPM reports
D_{YearX}	Customer deliveries in the year in question to the irrigation system	IPM reports
$N_{replaced}$	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

Channel Remediation

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 as detailed in Table A-7.

Table A-7 Calculation methods for Channel remediation works

Data availability	Calculation method
No pre or post remediation pondage testing data available	Theoretical method (No pre-works pondage test data) using technical manual Phase 2 calculations
Pre remediation pondage testing only available	Theoretical method (using pre-works pondage test data)
Both pre and post remediation pondage testing data available	Direct method

GMW has historically omitted the evaporation component from its savings as it assumes that there is likely to be negligible change in surface area of a channel pre and post remediation. Version 5 of the technical manual no longer includes an evaporation component.

Both direct and theoretical equations have the same high level form:

$$WS_{YearX} = WS_{bank\ leakage} + WS_{seepage}$$

Water Savings Calculations

The calculations for remediation in Version 5 of the technical manual have been revised to reflect the amended approach which has been accepted in 2015/16 by DELWP and the Water Savings Protocol Implementation Review Committee.

Theoretical Phase 3 calculations, where no pre-works pondage testing data is available, are not discussed as these only apply to the 2008 works. These were reviewed in 2009/10 and there has been no change since then. The equations in the updated technical manual for determining savings due to channel remediation have been revised with the length and time discounting factors being removed.

Theoretical Method - Phase 3 Calculations– Pre-works pondage test data available

$$WS_{bank\ leakage} = [((PT^{PRE\ WORKS} \times F(PA)) - S^{PRE\ WORKS}) \times (VL \times (D_{YearX}/D_{Base}) + FL)] \times EF$$

$$WS_{seepage} = S^{PRE\ WORKS} \times EF$$

Direct Method - Phase 3 Calculations– Measured pre-works and post-works pondage test data is available

$$WS_{bank\ leakage} = [(((PT^{PRE\ WORKS} - PT^{POST\ WORKS}) \times F(PA)) - (S^{PRE\ WORKS} - S^{POST\ WORKS})) \times (VL \times (D_{YearX}/D_{Base}) + FL)]$$

$$WS_{seepage} = S^{PRE\ WORKS} - S^{POST\ WORKS}$$

Theoretical Method - Phase 4 Calculations– Pre-works pondage test data available

$$WS_{leakage} = [((PT^{PRE\ WORKS} \times F(PA)) - S^{PRE\ WORKS}) \times (VL \times F(LTCE_{Base}) + FL)] + EF \times DF$$

$$WS_{seepage} = S^{PRE\ WORKS} \times EF \times DF$$

Direct Method - Phase 4 Calculations – Measured pre-works pondage test data is available

$$WS_{leakage(LTCE)} = [((PT^{PRE\ WORKS} - PT^{POST\ WORKS}) \times F(PA)) - (S^{PRE\ WORKS} - S^{POST\ WORKS})) \times (VL \times F(LTCE_{Base})] + FL)] \times DF$$

$$WS_{seepage(LTCE)} = (S^{PRE\ WORKS} - S^{POST\ WORKS}) \times DF$$

The revised baseline year water balance[4] has removed the concept of system fill. System fill was treated as operational flows that were not impacted by improved irrigation infrastructure because they occurred outside of the irrigation season. However, it has now been recognised that most channels that have been lined will hold water over the full year, including the non-irrigation season, and therefore water savings occur across the full year. In particular, there is reduced seepage in both the irrigation and non-irrigation seasons. As a result, the interpretation of the seepage calculation has been updated to be applied across the full 365 days of the year of operation, instead of only the irrigation season as previously calculated.

GMW has adjusted the water savings estimated due to channel remediation downwards for old leaking outlets existing when pondage tests were carried out. This is to avoid any possibility of double counting savings on both the remediation program and from service point upgrade works.

Input Data

The inputs required to calculate Phase 3 and Phase 4 water savings due to channel remediation are summarised in Table A-8 and Table A-9. 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.

Table A-8 Fixed Parameters and Baseline Year Parameters for Channel Remediation Water Savings Calculation

Parameter	Description	Source
VL	Proportion of bank leakage recognised as variable	Technical manual
FL	Proportion of bank leakage recognised as fixed	Technical manual
D_{base}	Customer deliveries in the baseline year	Baseline Year water balance
EF	Effectiveness Factor for channel remediation	Technical manual
DF	Durability Factor for Channel Remediation	Connection uses the following as approved by DELWP (2017): ▪ HDPE – 0.95 ▪ Clay – 0.95 ▪ Remodelling – 0.95
$F(LTCE_{base})$	Long-Term Cap Equivalent Conversion Factor for the baseline year	Department of Environment, Land, Water and Planning
F(PA)	Pondage Testing Adjustment Factor to account for dynamic losses in addition to static losses	Technical manual

Table A-9 Current Year Parameters for Channel Remediation Water Savings Calculation

Parameter	Description	Source
$PT^{PRE\ WORKS}$	Pre works total seepage and bank leakage	Pondage testing
$PT^{POST\ WORKS}$	Post works total seepage and bank leakage	Pondage testing
$D_{Year\ X}$	Customer deliveries in the year in question to the irrigation system	IPM reports
$S^{PRE\ WORKS}$	Pre works seepage	Pondage testing
$S^{POST\ WORKS}$	Post works seepage	Pondage testing

[4] The revised baseline year water balance was independently audited in 2011/12

APPENDIX B

DOCUMENT REGISTER

Document titles – as received

Calculations

Summary

- v8 overall summary tables for 2020 21 exA4152498 (A4164119).xlsx

Automation

- v15 automation outfall water savings 2020 21 to auditor (A4146144).xlsx
- v16 automation outfall water savings 2020 21 to auditor exA4146144 (A4148756).xlsx
- v19 automation outfall water savings 2020 21 amended exA4148756 and with auditor findings (A4156978).xlsx
- v20 automation outfall water savings 2020 21 amended exA4148756 A4156980 after auditor findings (A4159236).xlsx
- v3 change in claimed savings v19 and v16 automation at few outfall sites due to change outlet type (A4156980).xlsx

Channel decommission

- v20 channel decom for audit 20 21 (A4141172).xlsx
- v24 channel decom water savings 20 21 for auditor (A4150306).xlsx
- v25 channel decom water savings 20 21 following auditor review findings exA4150306 (A4162378).xlsx
- v4 updated 2020 21 look for new pipelines and residual losses (A4150412).xlsx

Meter outlets

- v20 meter savings for end of project audit 2020 21 (A4150955).xlsx
- v21 meter savings for end of project audit 2020 21 follow auditors review exA4150955 (A4163388).xlsx

Remediation

- v8 channel remediation calcs and works 2020 21 for auditor (A4137600).xlsb
- v10 channel remediation calcs and works 2020 21 for auditor A4137600 (A4137870) (A4141277).xlsb General

Supporting documents

Automation outfalls

- 35602 A0-L Regulator Construction Stages_MV.pdf
- 35602 A0-L Regulator Construction Stages_RO.pdf
- 35602 A0-L Regulator Construction Stages_SP.pdf
- 35602 A0-L Regulator Construction Stages_TO.pdf
- 35602 A0-L Regulator Construction Stages_CG.pdf

35602 A0-L Regulator Construction Stages_LV.pdf Outfall supporting documentation

- dump 9 Sept 21 SHEPPARTON OUTFALL REPORT (A2470138) 12 aug 21 last update (A4132132).xlsm
- dump 9 sept 21CENTRAL GOULBURN OUTFALL REPORT (A1360950) update 13 aug 21 (A4132134).xlsm

- dump 9th Sept 21 MURRAY VALLEY OUTFALL REPORT (A1838593) update 11th aug 21 (A4132136).xlsm
- dump 9th sept 21 TORRUMBARRY OUTFALL REPORT (A1857563) update 2 aug 21 (A4132141).xlsm
- dump 9 sept 21 LODDON VALLEY OUTFALL REPORT (A1853500) update 9 Aug 21 (A4132138).xlsm
- dump 9 sept 21 ROCHESTER OUTFALL REPORT (A1829300) update 2nd Jul 21 (A4132143).xlsm MV425 fiollowup log.msg
- PH1315 flow 20-21.xlsx
- RE_ 2020-21 DELWP Water Savings Audit_ Week Kickoff meeting with Cardno - Agenda.msg
- Trend PH_1315.msg

Delivery Data

- 201-10-08 IPM Customer Delivery Data\she node delivery data for auditor.csv
- 201-10-08 IPM Customer Delivery Data\tat node delivery data for auditor.csv
- 201-10-08 IPM Customer Delivery Data\Channel names 270821.xlsx
- FW first and last day of irrigation season.msg
- V14_Greiners Lagoon (Yambuna) EWP_Final (A3852977).docx
- MIN082280R Letter from Minister approving Greiners Lagoon EWP (A4022236).pdf

PWC Audits

- GMW Construction Review Finalisation Letter September 2020 (A3996907).pdf
- October 2021 GMW Construction Review Finalisation Letter – Updated (1). pdf

Procedures

- General Water Savings Procedures 2020 21 exA3840451 (A4165363)
- GMW Construction Review Finalisation Letter September 2020 (A3996907)
- Service Point meter water savings estimation methodologies 20 21 exA3840453 (A4165361)

Work pack documents

Regulator works

MV1058

- MV1058_WP_COMPACTION-RESULTSa48f0889-4a02-42fd-b31f-06846b69be6e.pdf
- MV1058_WP_CONCRETE_RESULTS.pdf
- MV1058_WP_ITP_COMM.pdf
- MV1058_WP_ITP-CIVIL.pdf
- MV1058_WP_ITP-COMPLETION.pdf
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MV286

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MV888A

- MV888A_WP_COMPACTION-RESULTS05918372-8979-4ed9-a2a5-ad19d50f4cae.pdf
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PH624

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RN791

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TN739

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TN777

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TO830

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- TO830_WP_PHOTO_RIGHT.jpg~RF69ac094.TMP
- TO830_WP_PHOTO_US.jpg
- TO830_WP_PHOTO_US.jpg~RF69ad891.TMP
- TO830_WP_PLANT-CLEAN-DOWN.pdf

Asset Removal Works

CH0002574 - CH000573

- Map of block.JPG
- CH000331 - TO1916
- TO1916_WP_ITP.pdf
- TO1916_WP_PHOTO_DS.jfif
- TO1916_WP_PHOTO_LEFT.jfif
- TO1916_WP_PHOTO_RIGHT.jfif
- TO1916_WP_PHOTO_US.jfif
- TO1916_WP_SDS.pdf

CH000334 - CH018433

- CH018433_WP_AFTER_PHOTO8dc0db3c-bd93-4387-a762-bfc4a9801416.jfif
- CH018433_WP_BEFORE_PHOTOd4fe1535-91c6-4929-a04f-b5a6bc2df73b.jpeg
- CH018433_WP_ITP_BLOCK2a42067c-fcad-447d-9fd9-66841db2453c.pdf

CH000363 - CH000364

- CH000363_WP_AFTER_PHOTO_WARDS76f4e26f-605f-4c87-9aa4-fc36ee1cd0de.jpg
- CH000363_WP_BEFORE_PHOTO_WARDSd880325d-81ae-45ed-990b-26dc225770df.jpg
- CH000363_WP_ITP_BLOCK_WARDS476b33f1-5955-43a1-9871-38bdbc702a64.pdf

CH000574 - CH000573

- CH000573_WP_AFTER_PHOTO_SR770814d8-4dbc-40de-bc09-71969536588a.jfif
- CH000573_WP_BEFORE_PHOTO_SR96f92c8f-1b22-48c3-bcb0-78d08d5feb27.jfif
- CH000573_WP_ITP_BLOCK_SR46d0bc83-0be5-4df9-bf19-69cc2239d719.pdf
- CH000574_WP_ITP_BLOCK4c117964-6fd6-42fd-8b2f-906d7ef03c93.pdf

CH001997

- CH001997_DS_BLOCK_LOCATION_MAP7ed04a50-48c5-4d69-a1bf-f39baf88a627.pdf
- CH001997_WP_AFTER_PHOTO1b032112-a5d7-4a4f-8a5c-d1b860946662.jpg
- CH001997_WP_BEFORE_PHOTO8f0e60e1-a3a6-47f5-8310-830c3066e86e.jpg
- CH001997_WP_ITP_BLOCK5217976a-36ce-40c2-bdb4-372af5adc799.pdf

CH002936 - PH2300

- PH2300_EN_SECM.pdf
- PH2300_WP_ITP_ACE.pdf
- PH2300_WP_PHOTO_RIGHT.jpg

CH003119

- CH003119_WP_AFTER_PHOTO4353d207-0f8d-4454-962f-89c1f01bb827.jfif
- CH003119_WP_ITP_BLOCK218a93fe-2f3f-4758-898c-3a1fc9697231.pdf
- CH003121 CH003122 CH006536 ST002182
- Map of block.JPG
- TO4494_DS_SDS.pdf
- TO4494_WP_COMM_PHOTO9ebe9faf-b7b0-4ea1-be2f-5ef20b603bbe.jpeg
- TO4494_WP_COMM_PHOTOe56921c5-5df5-4ea4-9a8e-02590b1477cf.jpeg

CH003801 - RO5213A

- ro5213a_WP_ITP_ACE.pdf
- ro5213a_WP_PHOTO_DS.jpg
- ro5213a_WP_PHOTO_LEFT.jpg
- ro5213a_WP_PHOTO_RIGHT.jpg

- SDS_RO5213A.pdf

CH005638

- CH005637_EN_SECM (1).pdf
- CH005637_EN_SECM.pdf
- CH005638_EN_SECM.pdf
- CH005638_WP_AFTER_PHOTO_ACE55b9078f-a1ca-4af7-8598-1ad3af87fbaf.jpg
- CH005638_WP_BEFORE_PHOTO_ACE6348b16c-64ec-4304-bafd-631a02aaf48a.jfif
- CH005638_WP_BEFORE_PHOTO_ACE8839ef95-7a75-464e-978c-eb3ece52171a.jpg
- CH005638_WP_ITP_DECOM_ACE6caae3f2-5c9b-4a25-b15d-f7b155becb1b.pdf
- MV369_WP_CON_PHOTOd7724e6b-29c7-4374-8c6a-a4360edf7992.jfif
- MV369_WP_ITP_RATIO.pdf

CH006278 - CH003099 - CH003101

- CH003099_WP_AFTER_PHOTO_SR209db202-b76b-43c8-b841-3b8e75c9bda2.jpg
- CH003099_WP_AFTER_PHOTO_SR3d9d3042-9b01-4b0e-b357-dd1c274b78d3.jpg
- CH003099_WP_ITP_BLOCK_SR80dda81b-bb35-4087-8e21-017a4f0bfad9.pdf

CH006356 - ST002182

- TO4494_DS_SDS.pdf
- TO4494_WP_COMM_PHOTO9ebe9faf-b7b0-4ea1-be2f-5ef20b603bbe.jpeg
- TO4494_WP_COMM_PHOTOe56921c5-5df5-4ea4-9a8e-02590b1477cf.jpeg

CH006419

- CH006419_EN_SECM_BLOCK.pdf
- CH006419_WP_AFTER_PHOTO_SR632d9dd7-baff-40a5-8aa4-c736c383680b.jfif
- CH006419_WP_BEFORE_PHOTO_SR0d7cafb9-e159-46de-89db-174550bd8016.jfif
- CH006419_WP_ITP_BLOCK_SR9b22969a-a470-4d3a-934e-0dde6b36256f.pdf

CH006427

- CH006427_EN_SECM.pdf
- CH006427_WP_AFTER_PHOTO_SR632d05a0-63aa-4a09-8106-beb78a5baffe.jfif
- CH006427_WP_BEFORE_PHOTO_SR48c32263-7e2c-467d-8ff8-93f293870106.jfif
- CH006427_WP_ITP_BLOCK_SR12e36fe8-65c7-4ec8-8ed0-5946c1786f43.pdf

CH006665

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- CH006665_WP_BEFORE_PHOTO93b91e79-19f9-4828-adc1-67818c309487.jfif
- CH006665_WP_BLOCK_LOCATION_MAPd17795df-b1bf-47a1-b34e-c28ae2e00264.pdf
- CH006665_WP_ITP_BLOCK0218e542-cf9d-4404-ae9d-2d1387deb39f.pdf

CH006741

- CH006741_WP_AFTER_PHOTO_SR045b55d0-2f46-43bc-a60e-0494598e1e8e.png
- CH006741_WP_BEFORE_PHOTO_SR395a7e99-b12f-4804-8695-9ee18af287c4.png
- CH006741_WP_ITP_BLOCK_SR7f1850f1-bb1b-49bc-bb51-6d487087760f.pdf

CH007111

- CH007111 channel decom RE_ Cardno.msg

CH007138

- CH007138_EN_SECM_BLOCK.pdf
- CH007138_WP_AFTER_PHOTO_SR92190d94-5fd3-43f5-91c9-95351cf0a55d.jfif
- CH007138_WP_BEFORE_PHOTO_SRd7468a45-393b-4057-bbf0-50ad66e7ff44.png
- CH007138_WP_ITP_BLOCK_SRd1cac2b9-d76e-431d-b5f3-c731723f9edf.pdf

CH007876

- CH007876_EN_SECM.pdf
- CH007876_WP_AFTER_PHOTO_SR10921815-945a-456a-beac-00d326e8af17.jfif
- CH007876_WP_BEFORE_PHOTO_SR7ba965d2-bbe2-4964-a75a-0ae659a6e42f.jpg
- CH007876_WP_ITP_DECOM_DICbdcfaef6-2c88-4584-b10b-bc7023819354.pdf
- CH017951_WP_AFTER_PHOTO1e75b028-e483-4507-8bd2-bb9d7a4de9f4 (1).jfif
- CH017951_WP_AFTER_PHOTO1e75b028-e483-4507-8bd2-bb9d7a4de9f4.jfif
- CH017951_WP_ITP_BLOCKde8043e4-60d7-42b4-bbb8-4c2c179f114e.pdf
- Map of block.JPG

CH007961

- CH007961_WP_AFTER_PHOTO_WARDSc89b6210-8e47-41a3-ba32-400378836f56.jfif
- CH007961_WP_BEFORE_PHOTO_WARDS0526388a-6612-4074-ba9c-61a8c3ebbace.jfif
- CH007961_WP_ITP_BLOCK_WARDS5c52eb96-a609-44a3-87bc-4e3df172aafa.pdf

CH009616

- CH009615_DS_BLOCK_LOCATION_MAP9e6d4741-9097-4cae-b253-ecfe090e7a79.png
- CH009615_WP_AFTER_PHOTO_SR133242c5-cc33-40dc-8882-fc01d199ea79.jfif
- CH009615_WP_AFTER_PHOTO_SR3a531163-bdca-4bda-bc6c-96c2ebbbfee0.jfif
- CH009615_WP_AFTER_PHOTO_SRb2818c27-7ed0-4565-87ee-6f4e7609682d.jfif
- CH009615_WP_BEFORE_PHOTO_SR19bfefaf-a68d-4547-a739-65e23989d855.jfif
- CH009615_WP_ITP_BLOCK_SRe0a52b95-56e3-4e16-963e-06382f34fd8f.pdf

CH012616

- CH012615_EN_SECM_BLOCK.pdf
- CH012615_WP_AFTER_PHOTO_ACEe45bb6cc-256c-45b5-998e-6c48d0c02f37.jpg
- CH012615_WP_BEFORE_PHOTO_ACE6967c2f3-c9b1-445c-b954-b4030f9ab265.jpg

- CH012615_WP_ITP_BLOCK_ACEca19b618-56b0-485f-b8a1-c9bdf1700c26.pdf

CH014159 - PH1159

- IMG_66091447041993749.jpg
- ME005955_PH1159_METERSWP_PYRAMID_1 (A1494759).pdf

CH015130

- CH015130_EN_SECM_BLOCK.pdf
- CH015130_WP_AFTER_PHOTO_SRba5cdce7-173b-4a2b-ba26-f986b209ccf4.jfif
- CH015130_WP_BEFORE_PHOTO_SR2b9b509e-86c4-4232-9a54-34bcf2135648.jfif
- CH015130_WP_ITP_BLOCK_SRf69dc5d9-65c4-41d4-946e-ae60b983eab0.pdf

CH017413 - CH012490

- CH012490_WP_AFTER_PHOTO_SR504f1a44-88de-42e3-b1e8-ce800474cb30.jfif
- CH012490_WP_BEFORE_PHOTO_SR8d33b31e-6b2c-4e8b-b303-727446d86dce.jfif
- CH012490_WP_ITP_BLOCK9177bf99-6dee-4f4c-8533-5f4315082767.pdf

CH018433

- CH018433_WP_AFTER_PHOTO8dc0db3c-bd93-4387-a762-bfc4a9801416.jfif
- CH018433_WP_BEFORE_PHOTOd4fe1535-91c6-4929-a04f-b5a6bc2df73b.jpeg
- CH018433_WP_ITP_BLOCK2a42067c-fcad-447d-9fd9-66841db2453c.pdf

CH14492

- Map of block.JPG
- SP155A CG37 Work Pack Submission Channel Remediation.pdf

Meters

MV1175_WP_HANDOVER_REMOTE OPERATE

- MV1175_Commissionning.pdf
- MV1175_Workpack.pdf
- MV1175_WP_PHOTO_DS.JPG
- MV1175_WP_PHOTO_LEFT.JPG
- MV1175_WP_PHOTO_RIGHT.JPG
- MV1175_WP_PHOTO_SP.jpg
- MV1175_WP_PHOTO_US.JPG

MV6098_WP_HANDOVER_REMOTE OPERATE

- MV6098_Commissionning.pdf
- MV6098_Workpack.pdf
- MV6098_WP_PHOTO_DS.JPG
- MV6098_WP_PHOTO_LEFT.JPG

- MV6098_WP_PHOTO_RIGHT.JPG
- MV6098_WP_PHOTO_SP.JPG
- MV6098_WP_PHOTO_US.JPG

PH137_WP_HANDOVER

- PH137_Workpack.pdf
- PH137_WP_RATIO_PHOTOb2848691-4e35-4e91-b0d4-c15a6c1464a7.JPG

PH1587_WP_HANDOVER

- PH1587_Workpack.pdf
- PH1587_WP_RATIO_PHOTO911f70f1-5a01-43bf-9286-85db533b0336.JPEG

PH2248_WP_HANDOVER_REMOTE OPERATE

- PH2248_Commissionning.pdf
- PH2248_Workpack.pdf
- PH2248_WP_PHOTO_DS.jpg
- PH2248_WP_PHOTO_LEFT.jpg
- PH2248_WP_PHOTO_RIGHT.jpg
- PH2248_WP_PHOTO_SP.jpg
- PH2248_WP_PHOTO_US.jpg

PH2255_WP_HANDOVER_REMOTE OPERATE

- PH2255_Commissionning.pdf
- PH2255_Workpack.pdf
- PH2255_WP_PHOTO_DS.jpg
- PH2255_WP_PHOTO_LEFT.jpg
- PH2255_WP_PHOTO_RIGHT.jpg
- PH2255_WP_PHOTO_SP.jpg
- PH2255_WP_PHOTO_US.jpg

PH2584_WP_HANDOVER_REMOTE OPERATE

- PH2584_Commissionning.pdf
- PH2584_Workpack.pdf
- PH2584_WP_PHOTO_DS.jpg
- PH2584_WP_PHOTO_LEFT.jpg
- PH2584_WP_PHOTO_RIGHT.jpg
- PH2584_WP_PHOTO_SP.jpg
- PH2584_WP_PHOTO_US.jpg

PH513_WP_HANDOVER_REMOTE OPERATE

- PH513_Commissionning.pdf

- PH513_Workpack.pdf
- PH513_WP_PHOTO_DS.jpg
- PH513_WP_PHOTO_LEFT.jpg
- PH513_WP_PHOTO_RIGHT.jpg
- PH513_WP_PHOTO_SP.jpg
- PH513_WP_PHOTO_US.jpg

PH600_WP_HANDOVER

- PH600_Workpack.pdf
- PH600_WP_RATIO_PHOTO8b0dc390-05e1-41eb-a386-060ca5e30e20.jpeg

RN1048C_WP_HANDOVER

- RN1048C_Workpack.pdf
- RN1048C_WP_RATIO_PHOTO27d82997-e98f-4a59-9f48-b2bfa8630501.JPG

RN1548_WP_HANDOVER_REMOTE OPERATE

- RN1548_Commissionning.pdf
- RN1548_Workpack.pdf
- RN1548_WP_PHOTO_DS.JPG
- RN1548_WP_PHOTO_LEFT.JPG
- RN1548_WP_PHOTO_RIGHT.JPG
- RN1548_WP_PHOTO_SP.JPG
- RN1548_WP_PHOTO_US.JPG
- RN1574_WP_HANDOVER_REMOTE READ
- RN1574_Commissionning.pdf
- RN1574_Workpack.pdf
- RN1574_WP_PHOTO_DS.jpg
- RN1574_WP_PHOTO_LEFT.jpg
- RN1574_WP_PHOTO_RIGHT.jpg
- RN1574_WP_PHOTO_SP.jpg
- RN1574_WP_PHOTO_US.jpg

RO4058_WP_HANDOVER

- RO4058_Workpack.pdf
- RO4058_WP_RATIO_PHOTOefe03cce-5e94-4e2e-9587-56b2e1d75364.jpg

RO6649_WP_HANDOVER_REMOTE OPERATE

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- RO6649_Workpack.pdf
- RO6649_WP_PHOTO_DS.JPG
- RO6649_WP_PHOTO_LEFT.JPG

- RO6649_WP_PHOTO_RIGHT.JPG
- RO6649_WP_PHOTO_SP.jpg
- RO6649_WP_PHOTO_US.JPG

RO6815_WP_HANDOVER_REMOTE OPERATE

- RO6815_Commissionning.pdf
- RO6815_Workpack.pdf
- RO6815_WP_PHOTO_DS.JPG
- RO6815_WP_PHOTO_LEFT.JPG
- RO6815_WP_PHOTO_RIGHT.JPG
- RO6815_WP_PHOTO_SP.JPG
- RO6815_WP_PHOTO_US.JPG

RO6824_WP_HANDOVER_REMOTE OPERATE

- RO6824_Commissionning.pdf
- RO6824_Workpack.pdf
- RO6824_WP_PHOTO_SP.JPG

RO6826_WP_HANDOVER_REMOTE OPERATE

- RO6826_Commissionning.pdf
- RO6826_Workpack.pdf
- RO6826_WP_PHOTO_DS.JPG
- RO6826_WP_PHOTO_LEFT.jpg
- RO6826_WP_PHOTO_RIGHT.jpg
- RO6826_WP_PHOTO_SP.jpg
- RO6826_WP_PHOTO_US.JPG
- RO6830_WP_HANDOVER
- RO6830_Workpack.pdf

RO6922_WP_HANDOVER_REMOTE OPERATE

- RO6922_Commissionning.pdf
- RO6922_Workpack.pdf
- RO6922_WP_PHOTO_SP.JPG

RO6925_WP_HANDOVER_REMOTE OPERATE

- RO6925_Commissionning.pdf
- RO6925_Workpack.pdf
- RO6925_WP_PHOTO_SP.JPG
- RO6925_WP_PHOTO_SP.JPG~RF25ca2c9f.TMP

SP613_WP_HANDOVER

- SP613_Workpack.pdf
- SP613_WP_RATIO_PHOTO0c55610a-5017-4577-98e4-bd4c8295e53b.JPG
- SP613_WP_RATIO_PHOTO11f93559-7e67-47f5-9ec6-b63cb1cda97d.JPG
- SP613_WP_RATIO_PHOTO57ea18c1-af84-447a-8a90-76aa9812b9c2.JPG
- SP-BC2520-120 Central Park Orchards-Locality Plan (A3053339).DOCX
- SP-BC-2520-120-CENTRAL PARK ORCHARDS- EMAIL- APPROVAL TO TERMINATE DSE & RATIONALISE OUTLETS (A2916847).pdf

TN12994_WP_HANDOVER_REMOTE OPERATE

- TN12994_Commissionning.pdf
- TN12994_Workpack.pdf
- TN12994_WP_PHOTO_DS.JPG
- TN12994_WP_PHOTO_LEFT.JPG
- TN12994_WP_PHOTO_RIGHT.JPG

TN3837_WP_HANDOVER_REMOTE OPERATE

- TN3837_Commissionning.pdf
- TN3837_Workpack.pdf
- TN3837_WP_PHOTO_DS.jpg
- TN3837_WP_PHOTO_LEFT.jpg
- TN3837_WP_PHOTO_RIGHT.jpg
- TN3837_WP_PHOTO_SP.jpg
- TN3837_WP_PHOTO_US.jpg

TN45_REBUILD_WP_HANDOVER_REMOTE READ

- TN45_REBUILD_Commissionning.pdf
- TN45_REBUILD_Workpack.pdf
- TN45_REBUILD_WP_PHOTO_DS.JPG
- TN45_REBUILD_WP_PHOTO_LEFT.JPG
- TN45_REBUILD_WP_PHOTO_RIGHT.JPG
- TN45_REBUILD_WP_PHOTO_SP.JPG
- TN45_REBUILD_WP_PHOTO_US.JPG
- TN45_WP_CON_PHOTO679161df-bb12-4255-b29a-c736df8fb5cf.jfif
- TN45_WP_ITP_WARDS.pdf

TO1787_WP_HANDOVER_REMOTE OPERATE

- TO1787_Commissionning.pdf
- TO1787_Workpack.pdf
- TO1787_WP_PHOTO_DS.JPG
- TO1787_WP_PHOTO_LEFT.JPG
- TO1787_WP_PHOTO_RIGHT.JPG

- TO1787_WP_PHOTO_SP.JPG
- TO1787_WP_PHOTO_US.JPG

TO2226_WP_HANDOVER

- TO2226_Workpack.pdf
- TO2226_WP_RATIO_PHOTO011cbafb-b4b0-4e42-bb55-ab7d66c95607.JPG

TO2228_WP_HANDOVER

- TO2228_Workpack.pdf
- TO2228_WP_RATIO_PHOTO1eb1c840-754f-4041-8b57-b436e706eb09.JPG

TO3055_WP_HANDOVER_REMOTE OPERATE

- TO3055_Commissionning.pdf
- TO3055_Workpack.pdf
- TO3055_WP_PHOTO_DS.jpg
- TO3055_WP_PHOTO_DS.jpg~RF25689529.TMP
- TO3055_WP_PHOTO_LEFT.jpg~RF2568fc50.TMP
- TO3055_WP_PHOTO_LEFT.jpg~RF256903e1.TMP
- TO3055_WP_PHOTO_RIGHT.jpg
- TO3055_WP_PHOTO_RIGHT.jpg~RF256a75f0.TMP
- TO3055_WP_PHOTO_SP.jpg
- TO3055_WP_PHOTO_SP.jpg~RF256a58e2.TMP
- TO3055_WP_PHOTO_US.jpg
- TO3055_WP_PHOTO_US.jpg~RF256a285c.TMP

TO4261_WP_HANDOVER

- TO4261_Workpack.pdf
- TO4261_WP_RATIO_PHOTO3e9aeed0-eda8-4f70-b32a-8a80ee0c4787.jpg

TO4465_WP_HANDOVER

- TO4465_Workpack.pdf
- TO4465_WP_RATIO_PHOTOc1aca808-7d23-4465-8ce6-d42d8e7e567d.PNG

Channel Remediation

CH015367, CH014495, CH015377

- _GHD_BLACK_HALF.ctb
- _GHD_COLOR_HALF.ctb
- 31-37418-CG 14-7-9 Channel Remediation Design Drawings_IFC (A3771092).pdf
- 31-37418-CG14-7-9 Channel Remediation Drawings Rev 1 (includes cut-fill latest).pdf
- 31-37418-CG14-7-9 Channel Remediation Drawings Rev2.pdf
- 31-37418-CG14-7-9 Channel Remediation Drawings Rev3.pdf
- 31-37418-CG14-7-9 Channel Remediation Drawings-Rev 1.pdf

- 31-37418-CI001.dwg
- 31-37418-CI001.txt
- 31-37418-CI002.dwg
- 31-37418-CI101.dwg
- 31-37418-CI201.dwg
- 31-37418-CI301.dwg
- 31-37418-CI401.dwg
- CG37 Channel remediation Final Walkdown Report - signed rev 1.pdf
- CG37 RP1 Channel remediation.pdf
- CG37 RP1 T11 Remodel_NVR report_070120.pdf
- CG37-Channel Remediation Construction Foot Print Rev0.pdf
- Construct only - CG37C Channel Remediation Program - 08.04.2020.pdf
- design comments IFC rev 2 to be incorporated.pdf
- DJI_0513.JPG
- DWG To PDF.pc3
- Image.PNG
- IMG_0008.JPG
- IMG_0010.JPG
- IMG_0011.JPG
- IMG_0019.JPG
- IMG_0271.jpg
- IMG_0272.jpg
- IMG_0286.jpg
- IMG_0310.jpg
- IMG_0312.jpg
- IMG_0414.jpg
- IMG_0415.jpg
- IMG_0492.jpg
- IMG_0493.jpg
- IMG_0553.jpg
- IMG_0554.jpg
- IMG_0555.jpg
- IMG_0558.jpg
- IMG_0560.jpg
- IMG_0565.jpg
- IMG_0567.jpg
- IMG_0766.jpg
- IMG_0767.jpg
- IMG_0768.jpg
- IMG_0769.jpg
- IMG_0771.jpg

- IMG_0782.jpg
- IMG_0785.jpg
- IMG_0786.jpg
- IMG_0835.jpg
- IMG_0842.jpg
- IMG_0845.jpg
- IMG_0866.jpg
- IMG_0869.jpg
- IMG_0870.jpg
- IMG_0898.jpg
- IMG_0899.jpg
- IMG_0900.jpg
- IMG_0901.jpg
- IMG_0902.jpg
- IMG_0961.jpg
- IMG_0963.jpg
- IMG_0965.jpg
- IMG_0967.jpg
- IMG_0968.jpg
- IMG_0971.jpg
- IMG_0972.jpg
- IMG_0974.jpg
- IMG_0975.jpg
- IMG_1032.jpg
- IMG_1083.jpg
- IMG_1094.jpg
- IMG_1110.jpg
- IMG_1121.jpg
- IMG_1128.jpg
- IMG_1144.jpg
- IMG_1168.jpg
- IMG_1173.jpg
- IMG_1292.jpg
- IMG_1293.jpg
- IMG_1294.jpg
- IMG_1295.JPG
- IMG_5672.JPG
- IMG_5673.JPG
- IMG_5674.JPG
- SECM - Borrow Pit - Hill Road.pdf
- SECM - CG37 RP1 T11 remodel_060420.pdf

- SECM - CG37 RP1 T11 remodel_Ver.2_130620.pdf
- SP155A CG37 Work Pack Submission Channel Remediation.pdf
- St006610 (S133 map).jpg
- St006610.jpg
- ST006610.png
- T11 channel.jpg
- T11_CG14-7-9 Channel Remediation_Preliminary Design Drawings_RevB.pdf

APPENDIX C

SITE PHOTOS

Remediation **Pre works** **CH0105367/ CH014495/ CH015377** **Photo IMG_0011.JPG**	
Remediation **Post works** **CH0105367/ CH014495/ CH015377** **Photo IMG_0011.JPG**	

Automation - New regulator (post works) **PH621** **PH621_WP_OHOT_RIGHT.JPG**	
Automation - New regulator (post works) **PH624** **PH624_WP_PHOTO_DS.JPG**	

Meter – replacement (post works) **MV1175** **MV1175_WP_PHOTO_US.JPG**	
Meter – replacement (post works) **RN1574** **RN1574_WP_PHOTO_DS.jpg**	

Channel Decommissioning **CH006427** **Pre-works** **CH006427_WP_BEFORE_PHOTO_SR48c32263-7e2c-467d-8ff8-93f293870106.jfif**	
Channel Decommissioning – Post works **CH006427** **CH006427_WP_AFTER_PHOTO_SR632d05a0-63aa-4a09-8106-beb78a5baffe.jfif**