2021-22 Irrigation Modernisation Water Recovery - Audit of Water Efficiency Project

Water Efficiency Projects (WEP) Audit Report

Report Date:

29 November 2022

Prepared for:

Department of Environment, Land, Water and Planning (DELWP)

Prepared by:

Cardno, now Stantec

Revision	Description	Author		Quality Check		Independent Review	
00-01	Development draft	Tom Sitprasert Christopher Bridge	TS CB	Christopher Bridge	CB	Stephen Walker	SW
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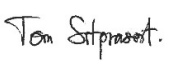

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SUMMARY FINDINGS

Background and scope

This report details the findings from Cardno now Stantec's audit of the estimates of the water recovery achieved through irrigation modernisation in northern Victoria for 2021/22. The water recovery is being delivered through the Water Efficiency Project (WEP), which is managed by Goulburn-Murray Water (GMW).

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

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

1. The cumulative irrigation modernisation works in place for the first tranche for GMW WEP works that started in 2021. Specially:
    - An audit of the claimed Phase 4 water recovery volumes realised from constructed and commissioned WEP works from the start of the WEP Project to 30 June 2022
    - An audit of the claimed Phase 4 water recovery volumes realised from constructed and commissioned WEP works from the start of the WEP Project from 1 July 2022 to 31 August 2022

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

Auditor statement

We have audited the 2021/22 water savings estimates prepared by the WEP. Our audit was conducted in accordance with the scope provided by DELWP on 15 August 2022. Our audit activities included:

- Review of calculations of water savings
- Review of irrigation modernisation activities completed to generate water savings
- Review of construction records of irrigation modernisation activities
- Review of any other associated relevant WEP activities e.g., management of outfall flow data.

Based on our audit activities, we consider that the water savings estimates for 2021/22 have been reported in accordance with the Water Savings Protocol (Version 5) and are free from material error.

Audited Water Savings Estimates

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

The audited Phase 4 estimates are set out in the following tables, and as required in the project brief, split out into

- WEP 1 July 2021 to 30 June 2022
- WEP 1 July 2021 to 31 August 2022
- WEP from 1 July 2022 to 31 August 2022

Table 0-1 Phase 4 water savings from WEP (2021/22) to 30 June 2022- ML LTA-AY

Water Savings Intervention	SH^	SH-EAST	CG	MV	MV-BC	RO	LV-PH	LV- BO	TO	Total
Phase 4 water savings										
Channel Removal (ML)*	0.0	3.7	372.4	1,005.6	0.0	388.0	21.0	0.0	2,426.4	4,217.1
Channel Automation (ML)	0.0	389.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	389.1
Service Point Replacement (ML)	0.0	250.7	409.7	74.2	0.0	127.3	98.7	48.1	467.2	1,476.0
Service Point Removal (ML)	0.0	52.1	284.4	133.4	0.0	108.3	24.6	7.4	519.2	1,129.4
Channel Remediation (ML)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Total Phase 4 savings (ML)	**0.0**	**695.6**	**1,066.4**	**1,213.3**	**0.0**	**623.6**	**144.4**	**55.5**	**3,412.8**	**7,211.6**

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*

^In this report, SH is the irrigation area for Shepparton or Shepparton East. Some documentation in GMW may refer to SH as Swan Hill.

Table 0-2 Phase 4 water savings from WEP (2021/22) to 31 August 2022 ML- LTA-AY

Water Savings Intervention	SH	SH-EAST	CG	MV	MV-BC	RO	LV-PH	LV- BO	TO	Total
Phase 4 water savings										
Channel Removal (ML)*	0.0	6.6	537.2	1,000.6	0.0	384.9	38.5	15.8	3,034.6	5,018.1
Channel Automation (ML)	0.0	389.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	389.1
Service Point Replacement (ML)	0.0	279.4	465.4	339.8	0.0	206.0	98.7	56.7	639.8	2,085.8
Service Point Removal (ML)	0.0	55.5	370.8	240.8	0.0	126.5	24.6	87.6	655.5	1,561.3
Channel Remediation (ML)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Total Phase 4 savings (ML)	**0.0**	**730.6**	**1,373.3**	**1,581.2**	**0.0**	**717.4**	**161.9**	**160.0**	**4,329.9**	**9,054.3**

Note totals may not sum due to rounding

**These savings are net channel removal savings after allowance for additional residual pipeline and channel losses are made*

Table 0-3 Phase 4 water savings from WEP (2021/22) from 1 July 2022 to 31 August 2022 ML- LTA-AY

Water Savings Intervention	SH	SH-EAST	CG	MV	MV-BC	RO	LV-PH	LV- BO	TO	Total
Phase 4 water savings										
Channel Removal (ML)*	0.0	2.9	164.8	-5.0	0.0	-3.1	17.5	15.8	608.2	801.1

Water Savings Intervention	SH	SH-EAST	CG	MV	MV-BC	RO	LV-PH	LV- BO	TO	Total
Channel Automation (ML)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Service Point Replacement (ML)	0.0	28.6	55.8	265.6	0.0	78.7	0.0	8.6	172.6	609.8
Service Point Removal (ML)	0.0	3.5	86.4	107.4	0.0	18.3	0.0	80.2	136.3	432.0
Channel Remediation (ML)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Total Phase 4 savings (ML)	**0.0**	**35.0**	**306.9**	**367.9**	**0.0**	**93.8**	**17.5**	**104.5**	**917.1**	**1,842.8**

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*

Fixed and variable components

Table 0-4 Phase 4 water savings from WEP project (2021/22) with fixed and variable components to 30 June 2022 ML- LTA-AY

Water Savings Intervention	SH	SH-EAST	CG	MV	MV-BC	RO	LV-PH	LV- BO	TO	Total
Phase 4 Water savings - WEP										
Channel Removal (ML)*										
Fixed component	0.0	1.3	197.4	578.1	0.0	228.2	12.6	0.0	1,187.6	2,205.2
Variable component	0.0	2.4	174.9	427.6	0.0	159.8	8.4	0.0	1,238.8	2,011.9
Channel Automation (ML)										
Fixed component	0.0	0.8	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.8
Variable component	0.0	388.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	388.3
Service Point Replacement (ML)										
Fixed component	0.0	62.7	73.5	15.3	0.0	8.7	15.3	8.6	71.4	255.6
Variable component	0.0	188.0	336.1	58.9	0.0	118.6	83.4	39.6	395.8	1,220.4
Service Point Removal (ML)										
Fixed component	0.0	20.7	66.7	27.6	0.0	25.3	2.3	4.6	131.1	278.3
Variable component	0.0	31.4	217.7	105.8	0.0	83.0	22.3	2.8	388.1	851.1
Channel Remediation (ML)										
Fixed component	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Variable component	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Total Phase 4 saving (ML) - WEP	**0.0**	**695.6**	**1,066.4**	**1,213.3**	**0.0**	**623.6**	**144.4**	**55.5**	**3,412.8**	**7,211.6**

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*

Table 0-5 Phase 4 water savings from WEP project (2021/22) with fixed and variable components to 31 August 2022 ML- LTA-AY

Water Savings Intervention	SH	SH-EAST	CG	MV	MV-BC	RO	LV-PH	LV- BO	TO	Total
Phase 4 Water savings - WEP										
Channel Removal (ML)*										
Fixed component	0.0	2.6	290.7	573.1	0.0	225.1	22.6	8.3	1,492.8	2,615.2
Variable component	0.0	4.0	246.5	427.6	0.0	159.8	15.8	7.5	1,541.8	2,403.0
Channel Automation (ML)										
Fixed component	0.0	0.8	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.8
Variable component	0.0	388.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	388.3
Service Point Replacement (ML)										
Fixed component	0.0	66.8	82.0	47.9	0.0	17.5	15.3	10.7	101.3	341.4
Variable component	0.0	212.6	383.4	291.9	0.0	188.5	83.4	45.9	538.5	1,744.4
Service Point Removal (ML)										
Fixed component	0.0	23.0	85.1	41.4	0.0	34.5	2.3	16.1	165.6	368.0
Variable component	0.0	32.5	285.7	199.4	0.0	92.0	22.3	71.5	489.9	1,193.3
Channel Remediation (ML)										
Fixed component	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Variable component	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Total Phase 4 saving (ML) - WEP	**0.0**	**730.6**	**1,373.3**	**1,581.2**	**0.0**	**717.4**	**161.9**	**160.0**	**4,329.9**	**9,054.3**

Note – Totals may not sum due to rounding

** These savings are net channel removal savings after allowance for additional residual pipeline and channel losses are made*

Table 0-6 Phase 4 water savings from WEP project (2021/22) with fixed and variable components from 30 June 2022 to 31 August 2022 ML- LTA-AY

Water Savings Intervention	SH	SH-EAST	CG	MV	MV-BC	RO	LV-PH	LV- BO	TO	Total
Phase 4 Water savings - WEP										
Channel Removal (ML)*										
Fixed component	0.0	1.3	93.3	-5.0	0.0	-3.1	10.1	8.3	305.2	410.0
Variable component	0.0	1.6	71.5	0.0	0.0	0.0	7.4	7.5	303.0	391.0
Channel Automation (ML)										
Fixed component	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Variable component	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Service Point Replacement (ML)										
Fixed component	0.0	4.0	8.4	32.6	0.0	8.7	0.0	2.2	29.9	85.8
Variable component	0.0	24.6	47.3	233.0	0.0	70.0	0.0	6.4	142.7	523.9
Service Point Removal (ML)										
Fixed component	0.0	2.3	18.4	13.8	0.0	9.2	0.0	11.5	34.5	89.7
Variable component	0.0	1.2	68.0	93.6	0.0	9.1	0.0	68.7	101.8	342.3
Channel Remediation (ML)										
Fixed component	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Variable component	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Total Phase 4 saving (ML) - WEP	**0.0**	**35.0**	**306.9**	**367.9**	**0.0**	**93.8**	**17.5**	**104.5**	**917.1**	**1,842.8**

Note – Totals may not sum due to rounding

** These savings are net channel removal savings after allowance for additional residual pipeline and channel losses are made*

Data collection and inputs

Our review for the 2021/22 audit of the information systems and processes used by the Water Efficiency Project (WEP) are sufficiently robust to generate data and inputs that are as accurate as could reasonably be expected for the purpose of calculating water recoveries.

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

Water Savings Protocol Reporting Requirements

The Water Savings Protocol[1] outlines the process for the independent audit of water savings estimates and defines the expected content of the water savings audit. The minimum requirements of the report and where they are fulfilled in this report is summarised in Table 0-7.

Table 0-7 Mapping of reporting requirements

Requirement	Where this is addressed in the report
A summary of findings.	Summary of Findings
Background information on the irrigation modernisation projects for which the water savings estimates are being audited, including the water savings targets.	Section 2.0
A description of the method(s) used for the independent audit	Section 3.0
The details and results of any site inspections undertaken. (Note for 2021/22, a remote working methodology was applied)	Section 4.0
An assessment of how well the project proponent's business and information systems and processes support the calculation of water savings.	Sections 4.0; 5.0
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 6.0
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 6.0
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 7.0

[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
UBase	Unauthorised use loss in the Baseline Year

Vd	Deemed customer deliveries through individual unmetered service points in the Baseline Year
VL	Proportion of bank leakage recognised as variable
WEE	Water Entitlement Entity

1.0 INTRODUCTION

1.1 PURPOSE OF AUDIT

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

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

The Commonwealth Government committed approximately $177 million to achieve 15.9 GL LTAAY from the Water Efficiency Project, (WEP). The projects will deliver a more efficient irrigation delivery system with reduced losses and improved level of customer service to meet the requirements of modern irrigated agriculture.

The water savings achieved by the WEP are to be audited each year until the project is completed. Cardno, now Stantec, has been engaged by the Department of Environment, Land, Water and Planning (DELWP) to undertake an independent audit of the water recovery for the 2021/22 irrigation season – specifically for tranche 1 transfer of 7GL LTA-AY. The purpose of this report is to present the findings of this independent audit.

1.2 WATER SAVING 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 stated in the Project Brief, dated 15 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 Water Efficiency Project to further modernize the irrigation delivery system.

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 first tranche for WEP works that started in 2021. Specifically:
  - An audit of the claimed Phase 4 water recovery volumes realised from constructed and commissioned WEP works from the start of the WEP Project to 30 June 2022
  - An audit of the claimed Phase 4 water recovery volumes realised from constructed and commissioned WEP works from the start of the WEP Project from 1 July 2022 to 31 August 2022
  - The audit covers the WEP operating area which is the whole Goulburn-Murray Irrigation District (GMID) including the following irrigation areas with the relevant trading zones identified in brackets (e.g., 1A):
  - Shepparton (1A), including Shepparton East (1A)
  - Central Goulburn (1A),
  - Rochester (1A),
  - Loddon Valley, split as:
    - Pyramid Hill (1A),
    - Boort (1B),
  - Murray Valley (6) and Lower Broken Creek (6B), and
  - Torrumbarry (7).

The scope requires the auditor to address the following:

- Verifying that stated modernisation works have been carried out by conducting on-site inspections or confirming works have been completed through an alternative remote process.
- Verifying that the WEP have estimated water recovery correctly in accordance with the *Water Savings Protocol* (Version 5) (the Protocol) or errata, addendum or other method approved by DELWP. For the WEP, this shall include:
- Phase 4 – long-term average water recovery estimates.
- Confirming the water recovery estimates or, where appropriate, correcting estimated volumes; and
- Identifying and recommending improvements to the collection and processing of information used for estimating water recovery volumes.

2.0 BACKGROUND

2.1 GOULBURN MURRAY IRRIGATION DISTRICT

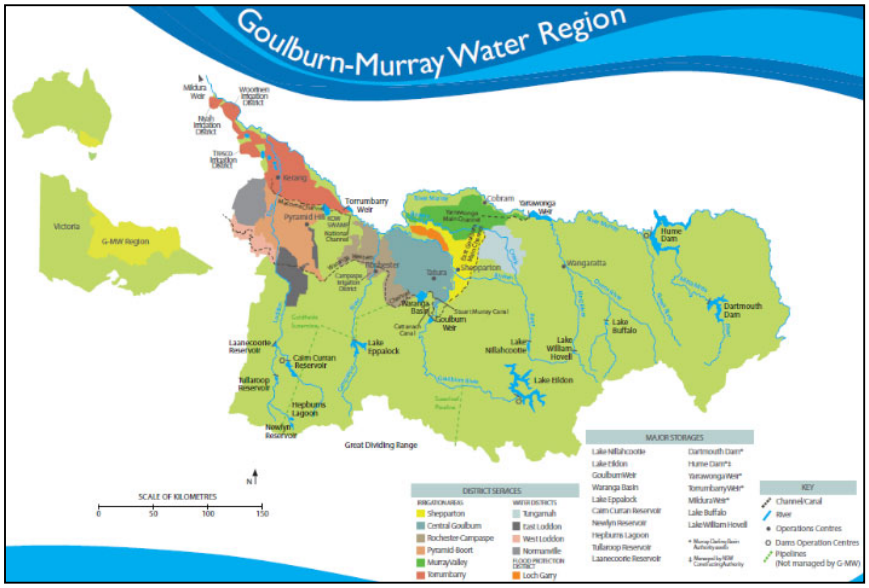
The Goulburn Murray Irrigation District (GMID) is composed of the following six main irrigation areas located in northern Victoria:

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

Goulburn-Murray Water (GMW) is responsible as both the Water Resource Manager and System Operator for the GMID. 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



2.2 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.

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

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. Channel can also be decommissioned to reduce losses.

Improved meter accuracy

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

2.3 IRRIGATION MODERNISATION PROJECTS

2.4 GMW WEP PROJECT

Following the success of the GMW Connections Project, Goulburn-Murray Water has begun work on the Water Efficiency Project (WEP). The $177.5 million modernisation project is funded by the Commonwealth Government and delivers an additional 15.9 gigalitres of water savings to the region without on farm works.

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

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

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

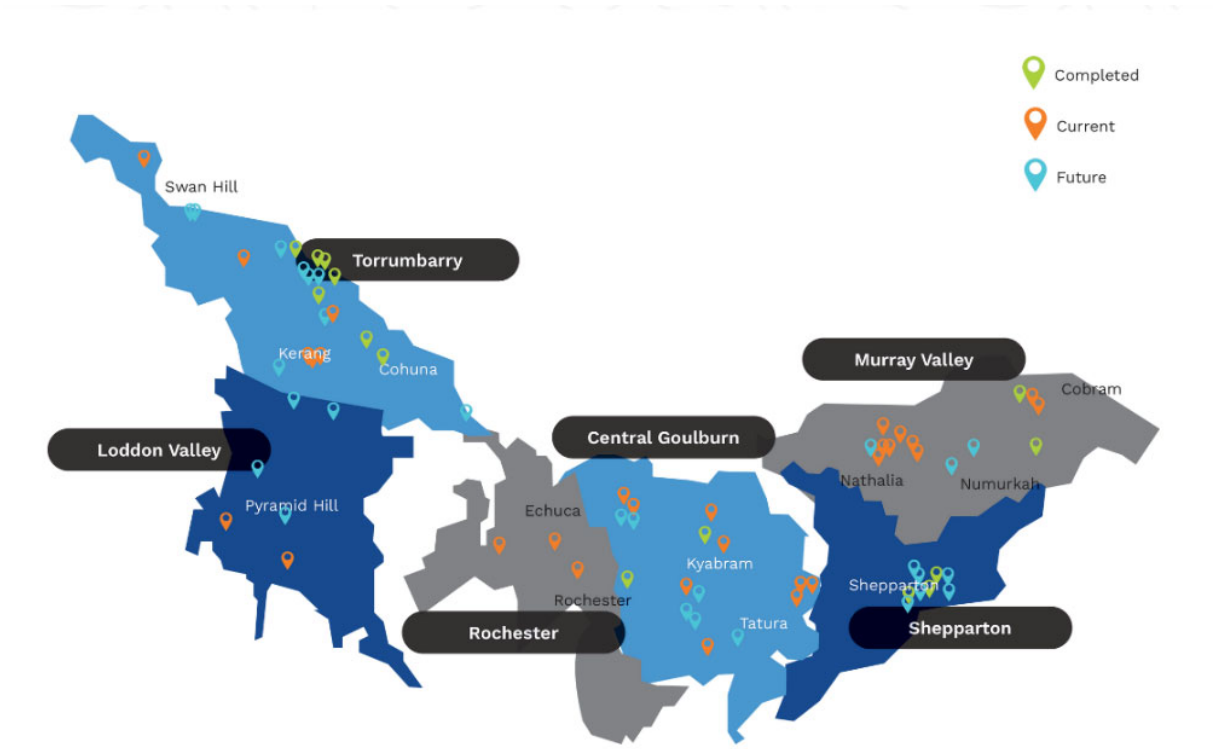


Figure 2-1 Map of Water Efficiency Project completed current and future planned works

Map taken from Home (waterefficiencyproject.com.au) accessed 23 August 2022.

3.0 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 2.0
A description of the method(s) used for the independent audit	Section 3.0
The details and results of any site inspections undertaken.	Section 4.2
An assessment of how well the project proponent's business and information systems and processes support the calculation of water savings.	Section 4.0
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 6.0
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 6.0

Requirement	Where this is addressed in the report
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 7.0

The following sub-sections detail the audit process undertaken.

3.2 OVERVIEW OF AUDIT METHODOLOGY

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

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

For 2021/22, it was agreed to progress the audit remotely, based on the successful outcome of the 2019/20 and 2020/21 Connections Project audits which were forced to be run remotely due to the impact of Covid-19. In terms of practical application, this was delivered by: :

- Meetings being undertaken by the Microsoft Teams platform which allowed audio and visual connectivity between attendees. In addition, data and 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
Tuesday 18 October 2022	Start-up Meeting	Peter Roberts	Project Manager, Water Savings (GMW)
		Luke O'Connor	Delivery Manager (GMW)
		Troy Williams	Project Coordinator (GMW)
		Deanne Brown	Document Controller (GMW)

Date	Audit Work	Auditee	Position
		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
Wednesday 19 October	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
Thursday 20 October 2022	Audit of water savings calculations	Peter Roberts	Project Manager, Water Savings
	Construction record reviews	Peter Roberts	Project Manager, Water Savings
Monday 24 – Wednesday 26 October 2022	Audit of water savings calculations	Peter Roberts	Project Manager, Water Savings
	Construction record reviews	Peter Roberts	Project Manager, Water Savings
Thursday 27 October 2022	Close out meeting	Peter Roberts	Project Manager, Water Savings
		Sean Tenace	Project Director, GMW WEP
		John Davidson	Operations Manager, GMW WEP
		Deanne Brown	Document controller (GMW)

3.4 DOCUMENT REGISTER

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

4.0 AUDIT OF DATA COLLECTION AND INPUTS

4.1 OVERVIEW

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

- Construction records
- Outfall measurement and recording
- Customer deliveries

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

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

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

4.2 CONSTRUCTION RECORDS

During the 2021/22 audit year construction works were managed by GMW and delivered by contractors on the relevant approved panel. The construction records database, PMIS, is used to track work packages from planning through construction to handover and acceptance. The system captures relevant information and is also a data store for records such as photos and ITP (inspection and test plan) certificates.

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

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

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

The following section provides observations arising from our audit of construction records for different work types. Appendix C contains a selection of photographs demonstrating completed works from 2021/22.

4.2.1 Service point (meter) replacement and removal

We requested commissioning certificates (ITP certificates) and other supporting evidence (e.g., construction photos) for a sample of 25 sites where service points had been replaced or rationalised to confirm that the works have been completed and that work was timely e.g., completed in the reporting year so there was no impact on Phase 4 savings. This also enabled us to check if the savings were appropriately included to end June 2022 or end August 2022 overall figures.

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
TO4559	Remove Outlet (Rationalise)	We were provided with sufficient evidence to confirm that the works claimed were complete
MV4066	Remove existing emplacement and replace new outlet in different location	We were provided with sufficient evidence to confirm that the works claimed were complete
RN1477	Remove Outlet (Rationalise)	We were provided with sufficient evidence to confirm that the works claimed were complete
PH394	Remove Outlet (Rationalise)	We were provided with sufficient evidence to confirm that the works claimed were complete
RO6833	Remove Outlet (Rationalise)	We were provided with sufficient evidence to confirm that the works claimed were complete
TO4562	Remove Outlet (Rationalise)	We were provided with sufficient evidence to confirm that the works claimed were complete
SH1625	Remove Outlet (Rationalise)	We were provided with sufficient evidence to confirm that the works claimed were complete
SP497	Remove existing emplacement and replace with new outlet at a different location	We were provided with sufficient evidence to confirm that the works claimed were complete
SP527	Remove Outlet (Rationalise)	We were provided with sufficient evidence to confirm that the works claimed were complete
TO4428	Remove Outlet (Rationalise)	We were provided with sufficient evidence to confirm that the works claimed were complete
MV6636	Remove Outlet (Rationalise)	We were provided with sufficient evidence to confirm that the works claimed were complete
TO4556	Remove Outlet (Rationalise)	We were provided with sufficient evidence to confirm that the works claimed were complete
MV4067	Remove Outlet (Rationalise)	We were provided with sufficient evidence to confirm that the works claimed were complete
RO5375	Remove existing emplacement and replace new outlet in existing location	We were provided with sufficient evidence to confirm that the works claimed were complete
RO6836	Remove Outlet (Rationalise)	We were provided with sufficient evidence to confirm that the works claimed were complete

IPM / Asset Code	Activity	Audit notes
TN5067	Remove existing emplacement and replace new outlet in existing location	We were provided with sufficient evidence to confirm that the works claimed were complete
SH235	Remove existing emplacement and replace new outlet in existing location	We were provided with sufficient evidence to confirm that the works claimed were complete
SP669	Remove existing emplacement and replace new outlet in existing location	We were provided with sufficient evidence to confirm that the works claimed were complete
SH1620	Remove existing emplacement and replace new outlet in existing location	We were provided with sufficient evidence to confirm that the works claimed were complete
TO4353	Remove Emplacement (Rationalise)	We were provided with sufficient evidence to confirm that the works claimed were complete
SP548	Remove existing emplacement and replace new outlet in new location	We were provided with sufficient evidence to confirm that the works claimed were complete.
TO6005	Remove Outlet (Rationalise)	We were provided with sufficient evidence to confirm that the works claimed were complete
PH2421	Remove Emplacement (Rationalise)	We were provided with sufficient evidence to confirm that the works claimed were complete
TN4011	Remove existing emplacement and replace new outlet in existing location	We were provided with sufficient evidence to confirm that the works claimed were complete
MV6617	Remove existing emplacement and replace new outlet in existing location	We were provided with sufficient evidence to confirm that the works claimed were complete

For all 25 meter replacement or removal activities in the sample that are within the scope of the audit, we were provided sufficient evidence to confirm that the scope of works claimed was complete.

4.2.2 Remediation

No remediation works were completed in the first year of the Water Efficiency Project. No records could be sampled for this activity for the 2021/22 audit. .

4.2.3 Channel removal

We reviewed the construction records for 25 channel removal activities that were claimed for 2021/22. The records reviewed and the findings are detailed in Table 4-2.

Table 4-2 Findings from trailing removal records

IPM/ Asset Code	Works done	Audit notes
CH000308	Block	Records provided confirmed work is done and the extent of assets removed is consistent with calculations.
CH003131	Block	Records provided confirmed work is done and the extent of assets removed is consistent with calculations.
CH003168	Block	Records provided confirmed work is done and the extent of assets removed is consistent with calculations.
CH018478	Block	Records provided confirmed work is done and the extent of assets removed is consistent with calculations. Works to decommission CH006716 resulted in the decommissioning of CH018478
CH006584	Block	Records provided confirmed work is done and the extent of assets removed is consistent with calculations.

IPM/ Asset Code	Works done	Audit notes
CH006716	Block	Records provided confirmed work is done and the extent of assets removed is consistent with calculations.
CH013478	Block	Records provided confirmed work is done and the extent of assets removed is consistent with calculations. GMW follow-up with Geocortex plots explained the linkage between pack provided and channel impacted (CH013476).
CH005611	Block	Records provided confirmed work is done and the extent of assets removed is consistent with calculations.
CH018466	Block	Records provided confirmed work is done and the extent of assets removed is consistent with calculations. GMW follow-up with Geocortex plots explained the linkage between pack provided and channel impacted (CH018467)
CH000557	Block	Records provided confirmed work is done and the extent of assets removed is consistent with calculations.
CH015194	Block	Records provided confirmed work is done and the extent of assets removed is consistent with calculations. Diagram provided explained the linkage between CH000563 work pack and CH015194
CH002232	Block	Records provided confirmed work is done and the extent of assets removed is consistent with calculations.
CH003114	Block	Records provided confirmed work is done and the extent of assets removed is consistent with calculations.
CH015150	Block	Records provided confirmed work is done and the extent of assets removed is consistent with calculations. GMW follow-up with Geocortex plots explained the linkage between pack provided and channel impacted (CH003129)
CH017159	Block	Records provided confirmed work is done and the extent of assets removed is consistent with calculations. GMW follow-up with Geocortex plots explained the linkage between pack provided and channel impacted (CH017152).
CH013043	Block	Records provided confirmed work is done and the extent of assets removed is consistent with calculations.
CH013476	Block	Records provided confirmed work is done and the extent of assets removed is consistent with calculations.
CH010328	Block	Records provided confirmed work is done and the extent of assets removed is consistent with calculations.
CH011497	Block and conversion to private outlet	Records provided confirmed work is done and the extent of assets removed is consistent with calculations.
CH012190	Block	Records provided confirmed work is done and the extent of assets removed is consistent with calculations. GMW follow-up with Geocortex plots explained the linkage between pack provided and channel impacted (CH012188).
CH003177	Block	Records provided confirmed work is done and the extent of assets removed is consistent with calculations. GMW follow-up with Geocortex plots explained the linkage between pack provided and channel impacted (CH003176).
CH003176	Block	Records provided confirmed work is done and the extent of assets removed is consistent with calculations.
CH010329	Block	Records provided confirmed work is done and the extent of assets removed is consistent with calculations.
CH000903	Block	Records provided confirmed work is done and the extent of assets removed is consistent with calculations.

IPM/ Asset Code	Works done	Audit notes
CH002107	Block	Records provided confirmed work is done and the extent of assets removed is consistent with calculations.

4.2.4 Regulator gates

We audited the construction records of a sample of 25 regulator gates advised by GMW which was all the regulators installed by the WEP in 2021/22. Table 4-3 details the findings of the records reviewed. All records had satisfactory evidence of work completion and appropriate work pack sign-off.

Table 4-3 Sample of regulator gate sites

IPM/ Asset Code	Comment
SP211	The construction records reviewed provide assurance that the work claimed is completed.
SP216	The construction records reviewed provide assurance that the work claimed is completed.
SP217	The construction records reviewed provide assurance that the work claimed is completed.
SP220	The construction records reviewed provide assurance that the work claimed is completed.
SP222	The construction records reviewed provide assurance that the work claimed is completed.
SP242	The construction records reviewed provide assurance that the work claimed is completed.
SP247	The construction records reviewed provide assurance that the work claimed is completed.
SP251	The construction records reviewed provide assurance that the work claimed is completed.
SP252	The construction records reviewed provide assurance that the work claimed is completed.
SP260	The construction records reviewed provide assurance that the work claimed is completed.
SP263	The construction records reviewed provide assurance that the work claimed is completed.
SP264	The construction records reviewed provide assurance that the work claimed is completed.
SP267	The construction records reviewed provide assurance that the work claimed is completed.
SP270	The construction records reviewed provide assurance that the work claimed is completed.
SP278	The construction records reviewed provide assurance that the work claimed is completed.
SP282	The construction records reviewed provide assurance that the work claimed is completed.
SP292	The construction records reviewed provide assurance that the work claimed is completed.
SP299	The construction records reviewed provide assurance that the work claimed is completed.
SP307	The construction records reviewed provide assurance that the work claimed is completed.
SP333	The construction records reviewed provide assurance that the work claimed is completed.
SP338	The construction records reviewed provide assurance that the work claimed is completed.
SP340	The construction records reviewed provide assurance that the work claimed is completed.
SP341	The construction records reviewed provide assurance that the work claimed is completed.
SP342	The construction records reviewed provide assurance that the work claimed is completed.
SP343	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 2021 to 30 September 2021 – this covered both Connections Project and Water Efficiency Project works

- 1 October 2020 to 31 March 2021

Across the two reviews, 204 assets were put forward by GMW for review. For all but four records, the audit concluded that the evidence provided by the contractor was an accurate representation of the works completed during the review period.

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 Summary of Construction Record Review and GMW Response

We observed that the construction records provided met expectations with all work having signed-off ITPs with date/time stamped pre and post construction photographs. All work was completed in line with dates adopted for water saving calculations to June 2022 or August 2022. GMW provided additional information where required and answered any queries in a timely manner.

We observed the following which enabled two previous recommendations to be closed out (also see section 8.0):

- Updated ITPs which provided clarity on when beneficial work was completed i.e., the date a water saving can be claimed from
- Photographs with appropriate labelling e.g., date and time stamps, locations

4.3 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. Some 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 (FLTCE).

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

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

Table 4-4 Findings from trailing outfall data

IPM/ Asset Code	Audit notes
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
SP392	Outfall data used in water savings consistent with data recorded in SPM for this outfall
TN820	Outfall data used in water savings consistent with data recorded in SPM for this outfall
TN779E	Outfall data used in water savings consistent with data recorded in SPM for this outfall
TN724	Outfall data used in water savings consistent with data recorded in SPM for this outfall. Operators did remove data from SPM which aligned with a rain event at the time. Operators did select “data entry” as a reason to change the data but did not leave comment in the change log.
MV1004	Outfall data used in water savings consistent with data recorded in SPM for this outfall
MV346	Outfall data used in water savings consistent with data recorded in SPM for this outfall
MV72	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
RO297	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
TO663	For this site, we did observe that there was a difference in flow data for outfall recorded in SCADA and that recorded in SPM. Operators confirmed via email that the flow monitor had flatlined at the end of the irrigation season and erroneous data was appropriately removed from SPM.
SH209A	For this site, we did observe that there was a difference in flow data for outfall recorded in SCADA and that recorded in SPM. Operators confirmed via email that the flow monitor had flatlined at the end of the irrigation season and erroneous data was appropriately removed from SPM.
TO1100	Outfall data used in water savings consistent with data recorded in SPM for this outfall
PH895	For this site, we did observe that there was a difference in flow data for outfall recorded in SCADA and that recorded in SPM. Upon investigation, GMW identified that the site was subject to a number of communications-based alarms which resulted in a) SCADA continuing to record the same daily flow volume for the alarm period and b) SPM recording a value of zero on affected days. Due to the communications alarms, it is difficult to assess what the actual flow was. This issue was isolated to this site and does not have a significant impact on water savings.
PH978	Outfall data used in water savings consistent with data recorded in SPM for this outfall
PH636D	Outfall data used in water savings consistent with data recorded in SPM for this outfall. Operators did remove data from SPM which aligned what appears to be a monitor flat line. Operators did select “data entry” as a reason to change the data but did not leave comment in the change log.

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 to GMW staff working on the Connections Project. However, it is recommended that the GMW staff working on the Water Efficiency Project do improve the audit trail when flow records are updated in SPM. This may be done by providing additional drop-down menus and/or reinforcing the requirement for operators to provide comments when updated are made.

4.4 CUSTOMER DELIVERIES

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

a combination of feedback control on water level with feed-forward flow to control the water level and flow in the channel.

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

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

4.5 CONCLUSIONS

Our review for the 2021/22 audit of the information systems and processes used by GMW has found that they are sufficiently robust to generate data and inputs that are as accurate as could reasonably be expected for the purpose of calculating water recoveries.

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

4.6 RECOMMENDATIONS

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

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

GMW has reviewed and accepted this recommendation.

5.0 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.

It was agreed with DELWP and GMW to undertake the 2021/22 WEP audit remotely. All construction records assessed did have photographs in addition to work pack information to confirm work had taken place when claimed. 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 timestamp
- Check of signature on ITP by GMW or nominated contractor.
- Check alignment of beneficial work completion and relevant date in water savings spreadsheet.
- Send follow-up queries to WEP 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 D Appendix C.

6.0 AUDIT OF WATER SAVINGS CALCULATIONS

6.1 STRUCTURE OF THIS CHAPTER

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

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

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

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

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

6.2 BASELINE YEAR WATER BALANCE

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

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

6.3 OVERVIEW OF WATER RECOVERY ACHIEVED IN 2021/22

The 2021/22 audit requires water savings to be separately accounted to WEP to 30 June 2022 and to 31 August 2022. The WEP commenced in 2021 with cumulative water savings accounted to 30 June 2022 and to 31 August 2022 are shown in Table 6-1.

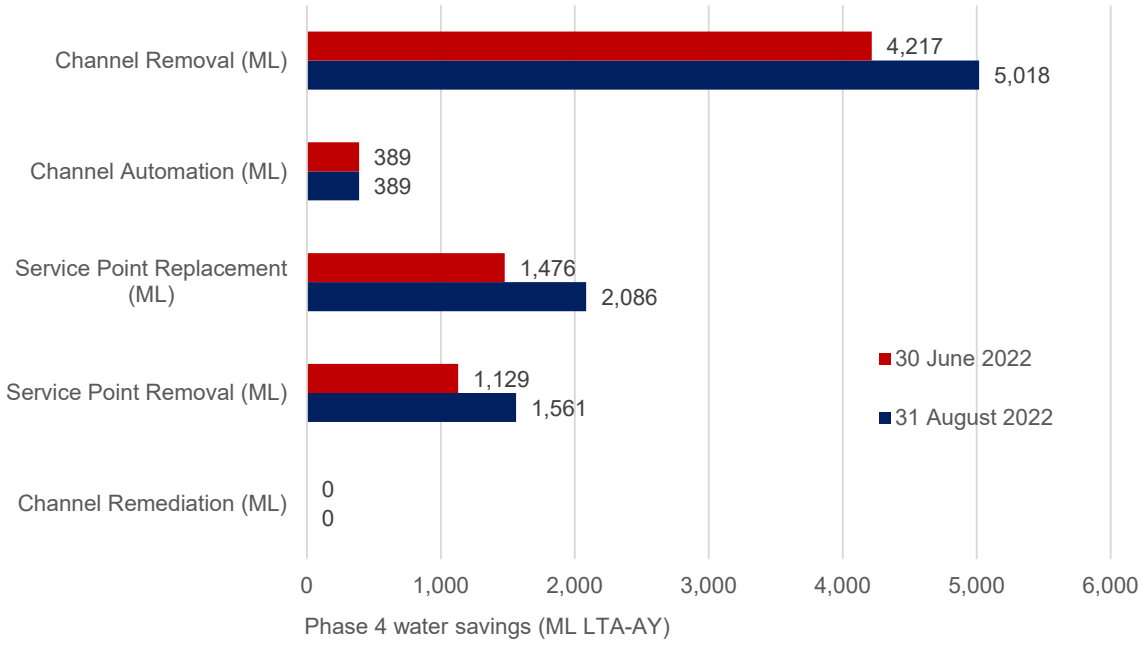
Table 6-1 Audited Phase 4 water savings

Project	Phase 4 water savings (ML)		% Total	
	30 June 2022	31 August 2022	30 June 2022	31 August 2022
WEP Project - Fixed	2,739.8	3,325.4	38%	37%
WEP Project - Variable	4,471.7	5,729.0	62%	63%
Total	**7,211.6**	**9,054.3**	**100%**	**100%**

Note – Totals may not sum due to rounding

Figure 6-1 provides an overview of the contribution of the different modernisation activities to the audited Phase 4 water savings for 2021/22 for the WEP. This figure shows that Channel removal is the most significant contributor to water savings achieved to date. Channel remediation work has not contributed to WEP water saving at this stage. XXX

Figure 6-1 Audited Phase 4 Water Savings Estimates 2021/22 (WEP to 30 June 2022 and to 31 August 2022)



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

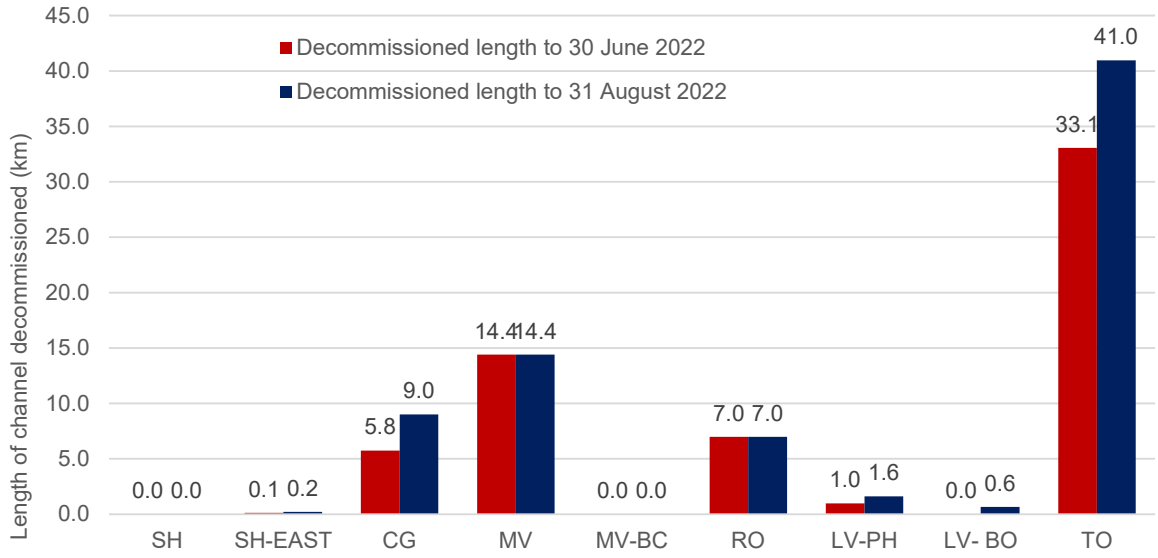
Outfall savings which may be attributable to asset removal are included under channel automation. The associated savings of unauthorised use and leakage through and around meters when channels are removed are included under service point replacement or removal.

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 WEP to 30 June 2022 and to 31 August 2022

Figure 6-2 Length of rationalised channel (contributing to water savings only) by irrigation area under WEP to 30 June 2022 and to 31 August 2022



6.4.2 Findings from trailing data and audit of calculations

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

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

Ratio of Channel Length 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.

6.4.3 Results

The audited water savings due to channel removal, are summarised with breakdown into fixed and variable components on WEP to 30 June 2022 and to 31 August 2022 shown in Figure 6-2 and from 1 July 2022 to 31 August 2022 shown in Figure 6-3.

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

PHASE 4	SH	SH-EAST	CG	MV	MV-BC	RO	LV-PH	LV- BO	TO	Total
WEP savings to 30 June 2022										
Seepage (ML) - Fixed	0.0	0.1	89.0	282.4	0.0	113.9	3.1	0.0	450.2	938.7
Bank leakage (ML) - Fixed	0.0	1.0	72.5	177.1	0.0	66.2	3.5	0.0	513.1	833.3
Bank leakage (ML) - Variable	0.0	2.4	174.9	427.6	0.0	159.8	8.4	0.0	1,238.8	2,011.9
Evaporation (ML) - Fixed	0.0	0.3	36.9	119.3	0.0	48.1	6.0	0.0	224.2	434.8
Pipeline deduction (ML) - Fixed	0.0	0.0	-1.0	-0.7	0.0	0.0	0.0	0.0	0.0	-1.7
Total	**0.0**	**3.7**	**372.4**	**1,005.6**	**0.0**	**388.0**	**21.0**	**0.0**	**2,426.4**	**4,217.1**
WEP savings to 31 August 2022										
Seepage (ML) - Fixed	0.0	0.2	133.9	282.4	0.0	113.9	5.4	1.7	576.5	1,114.1
Bank leakage (ML) - Fixed	0.0	1.7	102.1	177.1	0.0	66.2	6.6	3.1	638.6	995.3
Bank leakage (ML) - Variable	0.0	4.0	246.5	427.6	0.0	159.8	15.8	7.5	1,541.8	2,403.0
Evaporation (ML) - Fixed	0.0	0.8	55.6	119.3	0.0	48.1	10.7	3.5	282.3	520.2
Pipeline deduction (ML) - Fixed	0.0	0.0	-1.0	-5.7	0.0	-3.1	0.0	0.0	-4.6	-14.4
Total	**0.0**	**6.6**	**537.2**	**1,000.6**	**0.0**	**384.9**	**38.5**	**15.8**	**3,034.6**	**5,018.1**

Note – Totals may not sum due to rounding

Table 6-3 Phase 4 Water Savings due to Channel Removal with breakdown into fixed and variable components from 1 July 2022 to 31 August 2022 (ML LTA-AY)

PHASE 4	SH	SH-EAST	CG	MV	MV-BC	RO	LV-PH	LV- BO	TO	Total
WEP savings from 1 July 2022 to 31 August 2022										
Seepage (ML) - Fixed	0.0	0.1	44.9	0.0	0.0	0.0	2.3	1.7	126.3	175.3
Bank leakage (ML) - Fixed	0.0	0.7	29.6	0.0	0.0	0.0	3.1	3.1	125.5	162.0
Bank leakage (ML) - Variable	0.0	1.6	71.5	0.0	0.0	0.0	7.4	7.5	303.0	391.0
Evaporation (ML) - Fixed	0.0	0.5	18.7	0.0	0.0	0.0	4.7	3.5	58.0	85.4
Pipeline deduction (ML) - Fixed	0.0	0.0	0.0	-5.0	0.0	-3.1	0.0	0.0	-4.6	-12.7
Total	**0.0**	**2.9**	**164.8**	**-5.0**	**0.0**	**-3.1**	**17.5**	**15.8**	**608.2**	**801.1**

Note – Totals may not sum due to rounding

6.5 SAVINGS FROM CHANNEL AUTOMATION

6.5.1 Scope of Automation Works

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

6.5.2 Findings from trailing data and audit of calculations

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

To allocate funding, GMW undertook the following steps:

- Previous Connections project: 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. The connection project ended in the previous audit 2020/21

- Current WEP: WEP water saving by channel automation was derived from additional work done from the previous audit 2020/21 to 2021/22. Only additional work at Shepparton East contributed to water saving in this audit 2021/22.

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

Outfalls in Current Year ($O_{yearX\ -\ fixed}$, $O_{yearX\ -\ variable}$)

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

In this audit 2021/22, only work at Shepparton contributed to Phase 4 water savings so there is no subtraction of environmental mitigating flows volumes from its savings.

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 LTCEBase 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 6-4.

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

Phase 4 at Shepparton East (SH-EAST)	30 June 2022	31 August 2022
WEP Project		
Fixed component	0.8	0.8
Variable component	388.3	388.3
Total	**389.1**	**389.1**

Note – Totals may not sum due to rounding

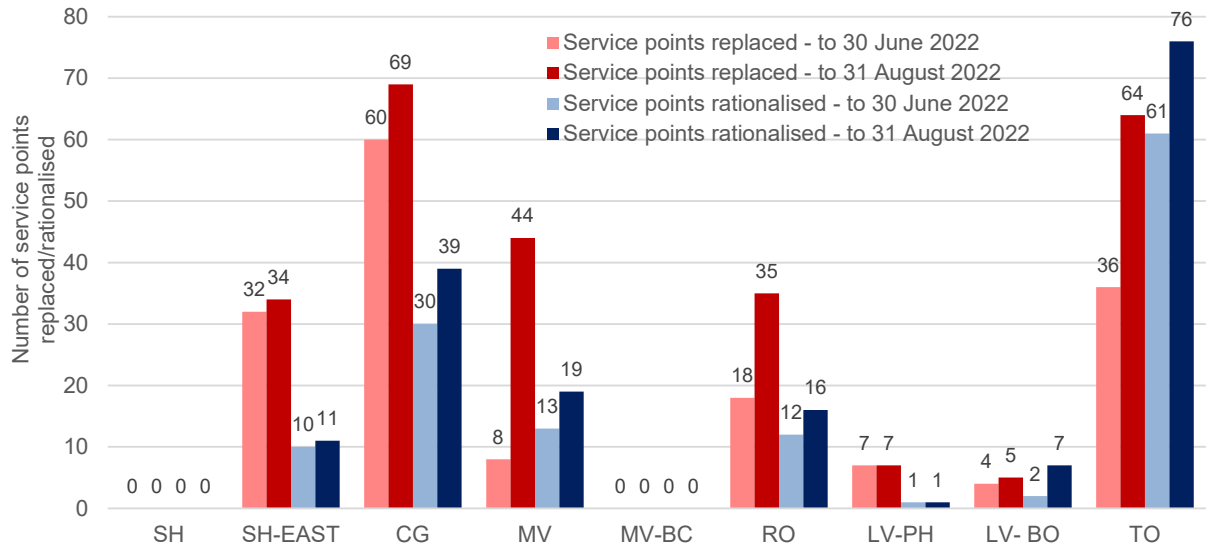
6.6 SAVINGS FROM SERVICE POINT REPLACEMENT AND REMOVAL

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 WEP to 30 June 2022 and to 31 August 2022. 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 by irrigation area under WEP to 30 June 2022 and to 31 August 2022



6.6.2 Findings from trailing data and calculations

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

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

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

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

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

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

This factor has been calculated by GMW in accordance with the formula in the technical manual using a factor of 1.3 for LTCEBase 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 6-5 for WEP to 30 June 2022 and to 31 August 2022 and Table 6-6 from 1 July 2022 to 31 August 2022. GMW performs these calculations on a meter-by-meter basis and not for an irrigation area nor as a whole system.

Water savings of service point replacement and removal:

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

Table 6-5 Phase 4 Water Savings due to Service Point Replacement and Removal (ML LTA-AY)

	SH	SH-EAST	CG	MV	MV-BC	RO	LV-PH	LV- BO	TO	Total
Phase 4 Water Savings to 30 June 2022										
Service point replacement										
Meter error (ML)	0.0	159.2	303.8	52.4	0.0	114.9	76.9	35.8	364.9	1,107.9
Leakage through service points (ML)	0.0	51.0	60.3	12.6	0.0	7.2	12.6	7.0	58.8	209.6
Leakage around service points (ML)	0.0	11.8	13.3	2.7	0.0	1.5	2.7	1.5	12.5	45.9
Unauthorised Use (ML)	0.0	28.8	32.3	6.6	0.0	3.7	6.6	3.7	30.9	112.6
Total (ML)	**0.0**	**250.7**	**409.7**	**74.2**	**0.0**	**127.3**	**98.7**	**48.1**	**467.2**	**1,476.0**
Service point removal										
Meter error (ML)	0.0	20.8	183.8	91.8	0.0	70.1	21.2	0.4	321.4	709.5
Leakage through service points (ML)	0.0	17.1	55.1	22.8	0.0	20.9	1.9	3.8	108.3	229.9
Leakage around service points (ML)	0.0	3.6	11.6	4.8	0.0	4.4	0.4	0.8	22.8	48.4
Unauthorised Use (ML)	0.0	10.5	33.9	14.0	0.0	12.9	1.2	2.3	66.7	141.6
Total (ML)	**0.0**	**52.1**	**284.4**	**133.4**	**0.0**	**108.3**	**24.6**	**7.4**	**519.2**	**1,129.4**
Phase 4 Water Savings to 31 August 2022										
Service point replacement										
Meter error (ML)	0.0	182.0	347.6	271.3	0.0	181.1	76.9	41.2	494.5	1,594.6
Leakage through service points (ML)	0.0	54.2	67.2	39.5	0.0	14.4	12.6	8.8	83.4	280.3
Leakage around service points (ML)	0.0	12.5	14.8	8.4	0.0	3.0	2.7	1.9	17.9	61.1
Unauthorised Use (ML)	0.0	30.7	35.8	20.6	0.0	7.5	6.6	4.7	44.0	149.8
Total (ML)	**0.0**	**279.4**	**465.4**	**339.8**	**0.0**	**206.0**	**98.7**	**56.7**	**639.8**	**2,085.8**
Service point removal										
Meter error (ML)	0.0	20.8	242.4	178.3	0.0	74.5	21.2	63.3	405.7	1,006.1
Leakage through service points (ML)	0.0	19.0	70.3	34.2	0.0	28.5	1.9	13.3	136.8	304.0
Leakage around service points (ML)	0.0	4.0	14.8	7.2	0.0	6.0	0.4	2.8	28.8	64.0
Unauthorised Use (ML)	0.0	11.7	43.3	21.1	0.0	17.6	1.2	8.2	84.2	187.2
Total (ML)	**0.0**	**55.5**	**370.8**	**240.8**	**0.0**	**126.5**	**24.6**	**87.6**	**655.5**	**1,561.3**
Total Phase 4 savings to 30 June 2022 (Replacement and removal)	**0.0**	**302.8**	**694.0**	**207.7**	**0.0**	**235.6**	**123.4**	**55.5**	**986.4**	**2,605.4**

	SH	SH-EAST	CG	MV	MV-BC	RO	LV-PH	LV- BO	TO	Total
Total Phase 4 savings to 31 August 2022 (Replacement and removal)	**0.0**	**334.9**	**836.2**	**580.6**	**0.0**	**332.5**	**123.4**	**144.2**	**1,295.3**	**3,647.1**

Note – Totals may not sum due to rounding

Table 6-6 Phase 4 Water Savings due to Service Point Replacement and Removal – WEP from 1 July 2022 to 31 August 2022 (ML LTA-AY)

	SH	SH-EAST	CG	MV	MV-BC	RO	LV-PH	LV- BO	TO	Total
Phase 4 Water Savings to 1 Jul to 31 Aug 2022										
Service point replacement										
Meter error (ML)	0.0	22.7	43.8	218.9	0.0	66.2	0.0	5.4	129.6	486.7
Leakage through service points (ML)	0.0	3.2	6.9	26.9	0.0	7.2	0.0	1.8	24.5	70.7
Leakage around service points (ML)	0.0	0.8	1.5	5.7	0.0	1.5	0.0	0.4	5.3	15.2
Unauthorised Use (ML)	0.0	1.9	3.5	14.0	0.0	3.7	0.0	0.9	13.1	37.2
Total (ML)	**0.0**	**28.6**	**55.8**	**265.6**	**0.0**	**78.7**	**0.0**	**8.6**	**172.6**	**609.8**
Service point removal										
Meter error (ML)	0.0	0.0	58.6	86.5	0.0	4.4	0.0	62.9	84.2	296.6
Leakage through service points (ML)	0.0	1.9	15.2	11.4	0.0	7.6	0.0	9.5	28.5	74.1
Leakage around service points (ML)	0.0	0.4	3.2	2.4	0.0	1.6	0.0	2.0	6.0	15.6
Unauthorised Use (ML)	0.0	1.2	9.4	7.0	0.0	4.7	0.0	5.9	17.6	45.6
Total (ML)	**0.0**	**3.5**	**86.4**	**107.4**	**0.0**	**18.3**	**0.0**	**80.2**	**136.3**	**432.0**
Total Phase 4 savings from 1 Jul to 31 Aug 2022 (Replacement and removal)	**0.0**	**32.1**	**142.1**	**372.9**	**0.0**	**96.9**	**0.0**	**88.8**	**308.9**	**1,041.7**

Note – Totals may not sum due to rounding

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 re-modelling. However, there has been no water saving contributed from channel remediation in the reporting year (2021/22).

7.0 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:

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

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

8.0 PROGRESS AGAINST PREVIOUS AUDIT RECOMMENDATIONS

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

Table 8-1 **Error! Reference source not found.**details progress against the recommendations that were still open at the 2021/22 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	Based on the observations during the 2021 audit and information provided by GMW, this recommendation can be closed.
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 "*Improve the audit trail when flow records are updated in SPM*"
2020/21-1	Date and time stamping on photos	Ensure all photographs used to support water savings are date and time-stamped	Based on the observations during the 2021 audit and information provided by GMW, this recommendation can be closed.

APPENDIX A

Calculations

Appendix A

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:

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

Water savings calculations

Phase 4 Calculations

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

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

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

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

Input data

The inputs required to calculate 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. 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	Loss model approach (version 11)
L_{Base}	Leakage in Baseline Year	Loss model approach (version 11)
E_{Base}	Evaporation in Baseline Year	Loss model approach (version 11)

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

Channel Automation Calculations

Overview

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

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

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

Water Savings Calculations

Phase 4 Calculations

Phase 4 water savings due to reduction in outfalls are estimated by the following equations from the technical manual with a minor correction identified by the Connections Project and acknowledged by DELWP. This includes the addition of an additional bracket so DFvariable applies to both Obase variable and Oyearx 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 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. 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
$O_{Base - variable}$	Variable outfall loss in Baseline Year	Baseline Year water balance and analysis
DF	Durability factor to account for the durability of water savings interventions	WEP use a value of 0.98 (approved by 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
$F(LTCE_{YearX})$	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 high-level equation of 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 4 water savings calculations are detailed below. GMW does not include the component for savings due to unmetered volumes as it believes that these are negligible.

Phase 4 Calculations – Service Point Replacement

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

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

where:

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

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

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

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

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

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

Phase 4 Calculations – Service Point Removal

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

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

where:

$WS_{meter\ error(LTCE)}$ = $(D_{MBase} \times (MCF - 1) \times EF \times DF) \times F(LTCE_{base})$
$WS_{leakage\ through(LTCE)}$ = $N_{rationalised} \times LTT \times EF \times DF$
$WS_{leakage\ around(LTCE)}$ = $N_{rationalised} \times LTA \times EF \times DF$
$WS_{unmetered(LTCE)}$ = $D_{UBase} \times (MCF - 1) \times EF \times DF \times F(LTCE_{base})$ ***(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 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
$DF_{leakage\ through}$	Durability factor for reducing leakage through the meter	WEP use a value of 0.95 (approved by DELWP in 2017)
$DF_{leakage\ around}$	Durability factor for reducing leakage around the meter	Technical manual
$DF_{unauthorised}$	Durability factor for reducing unauthorised use	Technical manual
$F(LTCE_{base})$	Long-Term Cap Equivalent Conversion Factor for the baseline year	Department of Environment, Land, Water and Planning

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

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

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.

There has been no water saving contributed from the channel remediation in this audit 2021/22.

APPENDIX B

Document Register

Appendix B

Document titles – as received

Calculations

Summary

- v5 end Aug 2022 savings audit (A4492344).xlsx
- v4 automation 2021 22 (A4510080).xlsx
- Supporting calculations

Meter outlets

- Copy of v3 phase 3 meter savings 21 22 (A4499140).xlsx

Supporting documents

Automation outfalls

- Copy of CENTRAL GOULBURN OUTFALL REPORT - 2021-22 (A4387363).xlsm
- Copy of LODDON VALLEY OUTFALL REPORT - 2021-22 (A4387357).xlsm
- Copy of MURRAY VALLEY OUTFALL REPORT - 2021-22 (A4387361).xlsm
- Copy of ROCHESTER OUTFALL REPORT -2021-22 (A4387359).xlsm
- Copy of SHEPPARTON OUTFALL REPORT - 2021-22 (A4387355).xlsm
- Copy of TORRUMBARRY OUTFALL REPORT - 2021-22 (A4387365).xlsm
- Outfall data follow-ups
- SCADA & SPM data PH895.xlsx
- SCADA data SH209A.xlsx
- SPM outfall data TN820.xlsx
- SPM outfall data TO663.xlsx
- Delivery Data
- Copy of summary cust deliv 21 22 (A4496278).xlsx

- Copy of v8 cust deliveries 21 22 (A4496272).xlsx
- first and last day of irrigation season in the areas 21 22 _SEC_OFFICIAL_.msg
- she_authnode_all (A4496984).csv
- tat_authnode_all (A4496991).csv

PWC Audits

- FinalisationLetter_GMW.pdf (Oct 2021 – March 2022)
- Feb-22 GMW WEP Finalisation Letter.pdf (April 2021 to September 2021)

Procedures

- GENERAL WATER SAVINGS PROCEDURES 2021 22 update 21 22 (A4515333).docx
- WEP Service Point meters 21 22 exA4165361 (A4515951).doc

Work pack documents

Regulator works

SP211

- CivilConstruction.pdf
- Environmental.pdf
- SP211_WP_PHOTO_DS.JPG
- SP211_WP_PHOTO_LEFT.JPG
- SP211_WP_PHOTO_RIGHT.JPG
- SP211_WP_PHOTO_US.JPG

SP216

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- SP216_WP_PHOTO_US.JPG

SP217

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- Environmental.pdf
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- SP217_WP_PHOTO_RIGHT.JPG
- SP217_WP_PHOTO_US.JPG

SP220

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- SP220_WP_PHOTO_RIGHT.JPG
- SP220_WP_PHOTO_US.JPG

SP222

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- Environmental.pdf
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- SP222_WP_PHOTO_RIGHT.JPG
- SP222_WP_PHOTO_US.JPG

SP242

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- Environmental.pdf

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- SP242_WP_PHOTO_US.jpg

SP247

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- SP247_WP_PHOTO_US.jpg

SP251

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- SP251_WP_PHOTO_RIGHT.jpg
- SP251_WP_PHOTO_US.jpg

SP252

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- SP252_WP_PHOTO_US.jpg

SP260

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- SP260_WP_PHOTO_US.jpg

SP263

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- SP263_WP_PHOTO_US.jpg

SP264

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- SP264_WP_PHOTO_US.jpg

SP267

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- SP267_WP_PHOTO_RIGHT.jpg
- SP267_WP_PHOTO_US.jpg

SP270

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- SP270_WP_PHOTO_US.JPG

SP278

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- SP278_WP_PHOTO_US.JPG

SP282

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- SP282_WP_PHOTO_US.JPG

SP292

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- SP292_WP_PHOTO_LEFT.jpg
- SP292_WP_PHOTO_RIGHT.jpg
- SP292_WP_PHOTO_US.jpg

SP299

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- SP299_WP_PHOTO_RIGHT.JPG
- SP307
- CivilConstruction.pdf
- Environmental.pdf
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- SP307_WP_PHOTO_US.JPG

SP333

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- SP333_WP_PHOTO_US.jpg

SP338

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- SP338_WP_PHOTO_RIGHT.jpg
- SP338_WP_PHOTO_US.jpg

SP340

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- SP340_WP_PHOTO_RIGHT.jpg
- SP340_WP_PHOTO_US.jpg

SP341

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- Environmental.pdf
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- SP341_WP_PHOTO_RIGHT.jpg
- SP341_WP_PHOTO_US.jpg

SP342

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- Environmental.pdf

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- SP342_WP_PHOTO_LEFT.jpg
- SP342_WP_PHOTO_RIGHT.jpg
- SP342_WP_PHOTO_US.jpg

SP343

- CivilConstruction.pdf
- Environmental.pdf
- SP343_WP_PHOTO_DS.jpg
- SP343_WP_PHOTO_LEFT.jpg
- SP343_WP_PHOTO_RIGHT.jpg
- SP343_WP_PHOTO_US.jpg

Asset Removal Works

CH000308

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- CH000308_WP_BEFORE_PHOTO_WARDS78767044-5fbb-4445-b6d5-6b1ce1cdeea5.jpg
- CH000308_WP_ITP_BLOCK_WARDSd758db99-15f3-4398-a29c-84c75a9216b8.pdf
- WEPCSP-029 RO16A RP01 RO15-20 pipeline Location Map 1.docx
- WEPCSP-029 RO16A RP01 RO15-20 pipeline Location Map 2.docx
- WEPCSP-029 RO16A RP01 RO15-20 pipeline Location Map 3.docx
- WEPCSP-029 RO16A RP01 RO15-20 pipeline Location Map 4.docx

CH000557

- 5.1_CH000556_-_Block_and_Backfill_Location[1].png
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- CH000557_WP_BEFORE_PHOTO_SR97bb943a-353b-4084-b26f-90cdb6655fc9.jpg

- CH000557_WP_ITP_DECOM_DIC9a1845c3-3897-4526-9d97-2dd77c4b3ecf.pdf

CH000903

- CH000903_WP_AFTER_PHOTO_ECC75d43518-7b19-4302-af39-b402a76d1b4d.jpg
- CH000903_WP_BEFORE_PHOTO_ECC0886338e-2b09-4cc9-9f1b-caf411c685da.jpg
- CH000903_WP_ITP_BLOCK_ECCf870da89-c6a4-41b9-ac95-3c0fd29a40b7.pdf
- WEPCSP-050 - Location Map 1.png
- CH002107
- CH002107_WP_AFTER_PHOTO_ACEfbff3cf3-99e2-41bd-a64d-7e15d6e07870.jpg
- CH002107_WP_BEFORE_PHOTO_ACEd825c61e-3e21-42f1-bfd5-33cc5127ac5b.jpg
- CH002107_WP_ITP_BLOCK_ACE79a1c952-24e0-439a-887f-00956b969bf9.pdf
- WEPCSP-042 CG33 RP01 Location Map 4.docx

CH002232

- 3.2 - CH002232 - Block Location.png
- CH002232_WP_AFTER_PHOTO_FULLER2c2467ce-6457-4d83-b56b-c5d13cc13747.jpg
- CH002232_WP_AFTER_PHOTO_FULLER9d27068b-ca34-4845-a9e7-371192d5d50b.jpg
- CH002232_WP_ITP_BLOCK_FULLER4fbbbca9-6d0d-416b-bf85-7d0dffa951e4.PDF
- CH002232 WEP channel decom ____ followup pre decom photos _SEC_OFFICIAL_.msg
- CH003114
- 3.5 - CH003114 - Block Location.png
- CH003114_WP_AFTER_PHOTO_ECC076a5ece-44ed-4897-ab8c-7a7af8b4b992.jpg
- CH003114_WP_BEFORE_PHOTO_ECC8e9850b7-e671-46a6-969a-c842627c86c7.jpg
- CH003114_WP_ITP_BLOCK_ECC8f86e321-e6b8-440f-976f-c24713a98af2.pdf

CH003131

- 2022-10-11 11_30_04-GMW Locations.png
- 2022-10-11 11_32_23-GMW Locations.png

- 3.8 CH003129 - Block Location.png
- CH003129_WP_AFTER_PHOTO_ECC5817a147-b98d-4ca2-8aa7-d1b1971ed2a7.jpg
- CH003129_WP_BEFORE_PHOTO_ECC2ab0a4b3-4602-4247-a96b-ad850e93ebe5.jpg
- CH003129_WP_ITP_BLOCK_ECC5c7d96d4-ee1f-419f-9361-db079f02c52c.pdf
- channel CH003131 covered by block upstream at CH003129 _SEC_OFFICIAL_.msg
- CH003168
- 3.2 CH003168 - Block location.png
- CH003168_EN_NV_AFTER_PHOTO796694cd-3c4d-421c-bf29-91e298495feb.jpg
- CH003168_WP_BEFORE_PHOTO_ECC4b1a8e99-dbc7-42df-83b9-4ba31dbe807a.jpg
- CH003168_WP_ITP_BLOCK_ECCb4a7e81f-dc6f-47b4-a621-0659ce0f5425.pdf

CH003176

- CH003176_WP_AFTER_PHOTO_ECC48bf7ae0-0fab-4092-8b86-94b4cc06be51.jpg
- CH003176_WP_AFTER_PHOTO_ECC9ac016a4-79ef-487a-8945-3203b53dba57.jpg
- CH003176_WP_BEFORE_PHOTO_ECC71d95dce-fa6a-4869-b570-73f26f8f67bc.jpg
- CH003176_WP_BEFORE_PHOTO_ECCad23cbc3-636c-480a-8a67-2449088c30e0.jpg
- CH003176_WP_ITP_BLOCK_ECCa3ffb521-9292-4734-9b11-727a431c4a68.pdf
- Decommissioning location map 1.png
- FW_ channel CH003177 covered by block upstream at CH0x003176 ___ _SEC_OFFICIAL_.msg

CH003177

- FW_ channel CH003177 covered by block upstream at CH0x003176 ___ _SEC_OFFICIAL_.msg

CH005611

- CH005611_WP_AFTER_PHOTO_HOGANSe397dcff-b236-4a61-b252-b660dda9eb63.jpg
- CH005611_WP_BEFORE_PHOTO_HOGANSae4d89b7-f368-4c3c-8f2c-489c83fc9a48.jpg
- MV259_WP_AFTER_PHOTO.jpg

- MV259_WP_BEFORE_PHOTO.jpg
- MV259_WP_ITP_RATIO.pdf

CH006584

- CH006583_WP_AFTER_PHOTO_ECC9e2ae7a4-9b99-49b8-9adb-4079d051f451.jpg
- CH006583_WP_BEFORE_PHOTO_ECCf0996d5d-023c-4ab7-b6a5-adde98195920.jpg
- CH006583_WP_ITP_BLOCK_ECC8aa7e8ce-680b-4b65-946d-7927883dc684.pdf
- CH006584 geocortex map.png
- CH006584 WEP channel decom data sample followup _SEC_OFFICIAL_.msg

CH006716

- 2022-10-11 09_48_37-GMW Locations.png
- CH000349_WP_BEFORE_PHOTO_WARDS2ded2582-ec17-4381-89d1-844e1f69d763.jpg
- CH000349_WP_ITP_BLOCK_WARDS9b5a4c0f-6d84-4097-b3a0-791f2288d9ce.pdf
- TimePhoto_20220310_154750.jpg
- TimePhoto_20220311_160320.jpg
- TO1977_WP_PHOTO_LEFT.jpg

CH010328

- 3.1 CH010328 - Block.png
- CH010328_WP_BEFORE_PHOTO_ECCb62f98e9-de7d-4231-910e-cbd3e41a3cae.jpg
- CH010328_WP_CON_PHOTO2094de1c-60ae-429f-a0a4-012fdf71b990.jfif
- CH010328_WP_ITP_BLOCK_ECCa7778215-d815-44c1-b2f8-62d9acf65fcd.pdf

CH010329

- 2022-10-12 16_08_36-Window.png
- CH002236_WP_AFTER_PHOTO_HOGANS40ca5cc5-1d46-4d1f-9fab-0bab9fbcd9a2.jpg
- CH002236_WP_BEFORE_PHOTO_HOGANSba5630fe-f9a4-40e0-9618-d7c35075aca1.jfif
- CH002236_WP_ITP_BLOCK_HOGANSde155d72-52fa-4635-b207-9d7b2561914d.pdf

- Location map.png

CH011497

- 3.1 - CH011497 a - Block Location.png
- Before map-GMW Locations.png
- CH011497_WP_AFTER_PHOTO_HOGANS4b824aa2-72aa-4ebb-8130-85dbf1811cf4.png
- CH011497_WP_ITP_BLOCK_HOGANSeae9cb18-79ea-458c-b538-fb6e32972ff6.pdf
- CH0114967 Connections Project data sample followup _SEC_OFFICIAL_.msg

CH012190

- 4.01 CH012188 - Block location.png
- CH012188_WP_AFTER_PHOTO.jfif
- CH012188_WP_BEFORE_PHOTO.jfif
- CH012188_WP_ITP_BLOCK_HOGANSbbc02a8d-0668-4c67-afaa-941ed1b78cd6.pdf
- Location Map 1.png
- Location Map 2.png

CH12192

- FW_ channel CH012192 covered by block upstream at CH012188 ___ _SEC_OFFICIAL_.msg

CH013043

- 4.01 CH013043 - Block Location.png
- CH013043_WP_AFTER_PHOTO_ECCe770187c-81f7-4a9b-96aa-162762f2e606.jpg
- CH013043_WP_BEFORE_PHOTO_ECC0533748b-7d24-4764-8d91-a0ed085f257e.jpg
- CH013043_WP_ITP_BLOCK_ECC54ed780c-33a4-481d-a7ed-6d431e95c11b.pdf
- WEPCSP-035 Location Map 1.png
- WEPCSP-035 Location Map 2.png
- WEPCSP-035 Location Map 3.png

CH013476

- 2022-10-11 10_45_46-GMW Locations.png
- 2022-10-11 10_46_16-SECM - RO16A RP01 - PI011647 New pipeline + CH013478 Backfill - __Remote.png
- CH013476_WP_AFTER_PHOTO_NCGa96ff402-f31b-4398-be5c-3462e47c7f25.jpg
- CH013476_WP_BEFORE_PHOTO_NCGc3a2fc1a-ce55-4831-a326-da6fd596eb73.jfif
- CH013476_WP_ITP_BLOCK_NCGdedbc969-8a1a-4a0b-84a7-6a4081242de6.pdf
- WEPCSP-030 Location Map 1.docx
- WEPCSP-030 Location Map 2.docx
- WEPCSP-030 Location Map 3.docx
- WEPCSP-030 Location Map 4.docx
- CH13478
- FW_ channel CH013478 covered by block upstream at CH013476 ___ _SEC_OFFICIAL_.msg

CH015194

- CH015194_WP_AFTER_PHOTO_WARDS6027e6f1-34c8-467f-9fcb-3c58e6637cd4.jpg
- CH015194_WP_BEFORE_PHOTO_WARDS5151457c-43ea-4535-8bc2-2c1cb38f31fa.jpg
- TO2509_WP_PHOTO_LEFT.jpg
- CH000563_WP_ITP_BLOCK_WARDSe4b19277-e098-47e5-b639-c04790bee8be.pdf
- CH015194_WP_AFTER_PHOTO_WARDS6027e6f1-34c8-467f-9fcb-3c58e6637cd4.jpg
- CH015194_WP_BEFORE_PHOTO_WARDS5151457c-43ea-4535-8bc2-2c1cb38f31fa.jpg
- TO2509_WP_PHOTO_LEFT.jpg

CH017152

- 2022-10-11 12_26_05-GMW Locations.png
- 4.1 CH017152 - Block location.png
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- CH017152_WP_BEFORE_PHOTO_WARDS7133b98a-a3f1-40ac-a3f9-dc2f77f7ff7a.jpg
- CH017152_WP_ITP_BLOCK_WARDS4fe2121d-a9d7-4183-a1b9-c41cfa5f6f31.pdf

CH17159

- FW_ channel CH017159 covered by block upstream at CH01752 and pipeline ___ _SEC_OFFICIAL_.msg

CH018466

- 2022-10-11 12_32_50-GMW Locations.png
- 3.2 - CH018467 - Block Location.png
- CH018467_WP_CON_PHOTOa63c9242-916b-487e-b462-1ded1a75c915.jpg
- CH018467_WP_CON_PHOTOb703629e-1741-40bd-97a2-21d71c78c2ba.jpg
- CH018467_WP_ITP_BLOCK_ECC4944c5e9-8446-4275-8e7b-98015db7b96d.pdf
- CH018466 WEP Channel decom dataset followup _SEC_OFFICIAL_.msg

Meters

MV4066

- MV4066_Commissionning.pdf
- MV4066_Workpack.pdf
- MV4066_WP_PHOTO_DS.JPG
- MV4066_WP_PHOTO_LEFT.JPG
- MV4066_WP_PHOTO_RIGHT.JPG
- MV4066_WP_PHOTO_SP.JPG
- MV4066_WP_PHOTO_US.JPG
- MV4066_WP_RATIO_PHOTO1caa1ffb-e66a-46e8-87f9-754a3386c02b.jfif
- MV4066_WP_RATIO_PHOTO2cd0790d-88a8-4aec-a9e2-a25b9a6b092b.jfif

MV4067

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- MV4067_WP_CON_PHOTOd15df7a0-ab19-42e5-899c-119d032bf0b1.jfif
- MV4067_WP_RATIO_PHOTO014bac41-65de-42c9-b15a-0e82abca2e62.jpeg

MV6617

- MV6617_Commissionning.pdf
- MV6617_Workpack.pdf
- MV6617_WP_PHOTO_DS.jpg
- MV6617_WP_PHOTO_LEFT.jpg
- MV6617_WP_PHOTO_RIGHT.jpg
- MV6617_WP_PHOTO_SP.jpg
- MV6617_WP_PHOTO_US.jpg
- MV6617_WP_RATIO_PHOTOc380cd18-0c4c-453a-9724-7e875cda0544.jpg

MV6636

- MV6636_Workpack.pdf
- MV6636_WP_CON_PHOTO3e048b29-a26d-4d9d-b3c6-a99639507cac.jpg
- MV6636_WP_RATIO_PHOTOa16de2d7-1aec-4d89-b77e-ed9153d85a3d.jpg

PH394

- PH394_Workpack.pdf
- PH394_WP_RATIO_PHOTO7522e64c-12ad-49c5-b839-7283e091bbe7.jpg

RN1477

- RN1477_Workpack.pdf
- RN1477_WP_RATIO_PHOTO78fffbb3-4957-4e56-a202-a51ef7c3f9bc.JPG

RO5375

- RO5375_Commissionning.pdf
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- RO5375_WP_PHOTO_RIGHT.JPG
- RO5375_WP_PHOTO_SP.JPG
- RO5375_WP_PHOTO_US.JPG
- RO5375_WP_RATIO_PHOTO19025480-02f3-4dbd-9108-75b7d27bc78f.jfif

RO6833

- RO6833_Workpack.pdf
- RO6833_WP_CON_PHOTOc9f24503-5b9c-4f02-abde-98140667529c.jpg
- RO6833_WP_RATIO_PHOTOf7d1d81a-0cb8-451f-a4d9-8c6c2d7baed5.jpg
- RO6836_Workpack.pdf

RO6836

- RO6836_WP_RATIO_PHOTOb9f6a3ea-53ee-4bd2-8a82-77fcc79953ae.jpg
- RO6836_WP_BEFORE_PHOTO.jpg
- RO6836_WP_RATIO_PHOTOb9f6a3ea-53ee-4bd2-8a82-77fcc79953ae.jpg
- WEP - meter RO6836 photos before _SEC_OFFICIAL_.msg

SH1620

- SH1620_Commissionning.pdf
- SH1620_Workpack.pdf
- SH1620_WP_PHOTO_DS.jpg
- SH1620_WP_PHOTO_LEFT.jpg
- SH1620_WP_PHOTO_RIGHT.jpg
- SH1620_WP_PHOTO_SP.jpg
- SH1620_WP_PHOTO_US.jpg
- SH1620_WP_RATIO_PHOTO131b419d-8e81-449b-ac45-6ad33020d2f6.jpg

SH1625

- SH1625_Workpack.pdf
- SH1625_WP_CON_PHOTO2a38ba72-68a8-4bab-ac7f-b5597cf20f35.jpg
- SH1625_WP_RATIO_PHOTOff31b5bb-1848-4c59-a862-237c02d845d1.jpg

SH235

- SH235_Commissionning.pdf
- SH235_Workpack.pdf
- SH235_WP_PHOTO_DS.jpg
- SH235_WP_PHOTO_LEFT.jpg
- SH235_WP_PHOTO_RIGHT.jpg
- SH235_WP_PHOTO_SP.jpg
- SH235_WP_PHOTO_US.jpg
- SH235_WP_RATIO_PHOTO7edbb525-a474-4127-a2fa-d90533f2b83c.jpg

SP497

- SP497_Commissionning.pdf
- SP497_Workpack.pdf
- SP497_WP_PHOTO_DS.jpeg
- SP497_WP_PHOTO_LEFT.jpeg
- SP497_WP_PHOTO_RIGHT.jpeg
- SP497_WP_PHOTO_SP.jpeg
- SP497_WP_PHOTO_US.jpeg
- SP497_WP_RATIO_PHOTO9190420a-b388-48c2-9f33-9b2f28b01e5b.jpeg

SP527

- SP527_Workpack.pdf
- SP527_WP_CON_PHOTO3ef55603-0324-43a7-bdb9-d6ed9508ef40.jpg
- SP527_WP_RATIO_PHOTO27ae2730-6816-46b6-991f-cd0b2009894b.jpg

SP548

- SP548_Commissionning.pdf
- SP548_Workpack.pdf
- SP548_WP_PHOTO_DS.jpg
- SP548_WP_PHOTO_LEFT.jpg
- SP548_WP_PHOTO_RIGHT.jpg
- SP548_WP_PHOTO_SP.jpg
- SP548_WP_PHOTO_US.jpg
- SP548_WP_RATIO_PHOTO396d3037-3220-47c1-a2f4-690b5250a7c4.jpg

SP699

- SP669_Commissionning.pdf
- SP669_Workpack.pdf
- SP669_WP_PHOTO_DS.jpg
- SP669_WP_PHOTO_LEFT.jpg
- SP669_WP_PHOTO_RIGHT.jpg
- SP669_WP_PHOTO_SP.jpg
- SP669_WP_PHOTO_US.jpg

TN4011

- TN4011_Commissionning.pdf
- TN4011_Workpack.pdf
- TN4011_WP_PHOTO_DS.jpg
- TN4011_WP_PHOTO_LEFT.jpg
- TN4011_WP_PHOTO_RIGHT.jpg
- TN4011_WP_PHOTO_SP.jpg
- TN4011_WP_PHOTO_US.jpg

- TN4011_WP_RATIO_PHOTO58682e50-7b92-45b6-9395-fa813cee6f8a.jpg

TN5067

- TN5067_Commissionning.pdf
- TN5067_Workpack.pdf
- TN5067_WP_PHOTO_DS.JPG
- TN5067_WP_PHOTO_LEFT.JPG
- TN5067_WP_PHOTO_RIGHT.JPG
- TN5067_WP_PHOTO_SP.JPG
- TN5067_WP_PHOTO_US.JPG
- TN5067_WP_RATIO_PHOTO1f19e85d-99e0-4531-baee-58c249202825.jfif

TO4353

- TO4353_Workpack.pdf
- TO4353_WP_RATIO_PHOTOf9480066-9143-4f69-a9be-f1cb8e715359.jpg
- TO4353 Before.jpg

TO4428

- TO4428_Workpack.pdf
- TO4428_WP_RATIO_PHOTO68a33f29-ad98-490f-b9a2-217778bb8427.jpg

TO4556

- TO4556_Workpack.pdf
- TO4556_WP_RATIO_PHOTO21a6444e-6e75-4c53-b5a6-cbd8f7b62bae.jpg
- TO4559_Workpack.pdf

TO4559

- TO4559_WP_RATIO_PHOTOa445a63f-6d4a-4f84-be7a-98beb6515538.jpg

TO4562

- TO4562_Workpack.pdf

- TO4562_WP_RATIO_PHOTO29b41736-fba6-49e2-8725-bc80916fe419.jpg

TO6005

- TO6005_Workpack.pdf
- TO6005_WP_RATIO_PHOTO11f7a8c2-f825-4c8c-82d4-3f5489922679.jpeg
- TO6005_WP_RATIO_PHOTObd4ed53d-9a1e-4ecf-8cd2-0747cc6f97bb.jpg

APPENDIX C

Site Photos

Appendix C

Site photographs

Table C-1 Site Photos

Automation - New regulator (post works) **SP 216** **SP216_WP_PHOTO_DS.JPG**	
Automation - New regulator (post works) **SP270** **SP270_WP_PHOTO_RIGHT.JPG**	

Meter – rationalisation (during works) **MV4067** **MV4067_WP_CON_PHOTOd15df7a0-ab19-42e5-899c-119d032bf0b1.jfif**	
Meter – rationalisation (post works) **MV4067** **MV4067_WP_RATIO_PHOTO014bac41-65de-42c9-b15a-0e82abca2e62.jpeg**	

Meter – replacement (construction works) **TN4011** **TN4011_WP_RATIO_PHOTO58682e50-7b92-45b6-9395-fa813cee6f8a.jpg**	
Meter – replacement (post works) **TN4011TN4011_WP_PHOTO_DS.jpg**	

Channel Decommissioning **CH002107** **Pre-works** **CH002107_WP_BEFORE_PHOTO_ACEd825c61e-3e21-42f1-bfd5-33cc5127ac5b.jpg**	
Channel Decommissioning – Post works **CH002107** **CH002107_WP_AFTER_PHOTO_ACEfbff3cf3-99e2-41bd-a64d-7e15d6e07870.jpg**