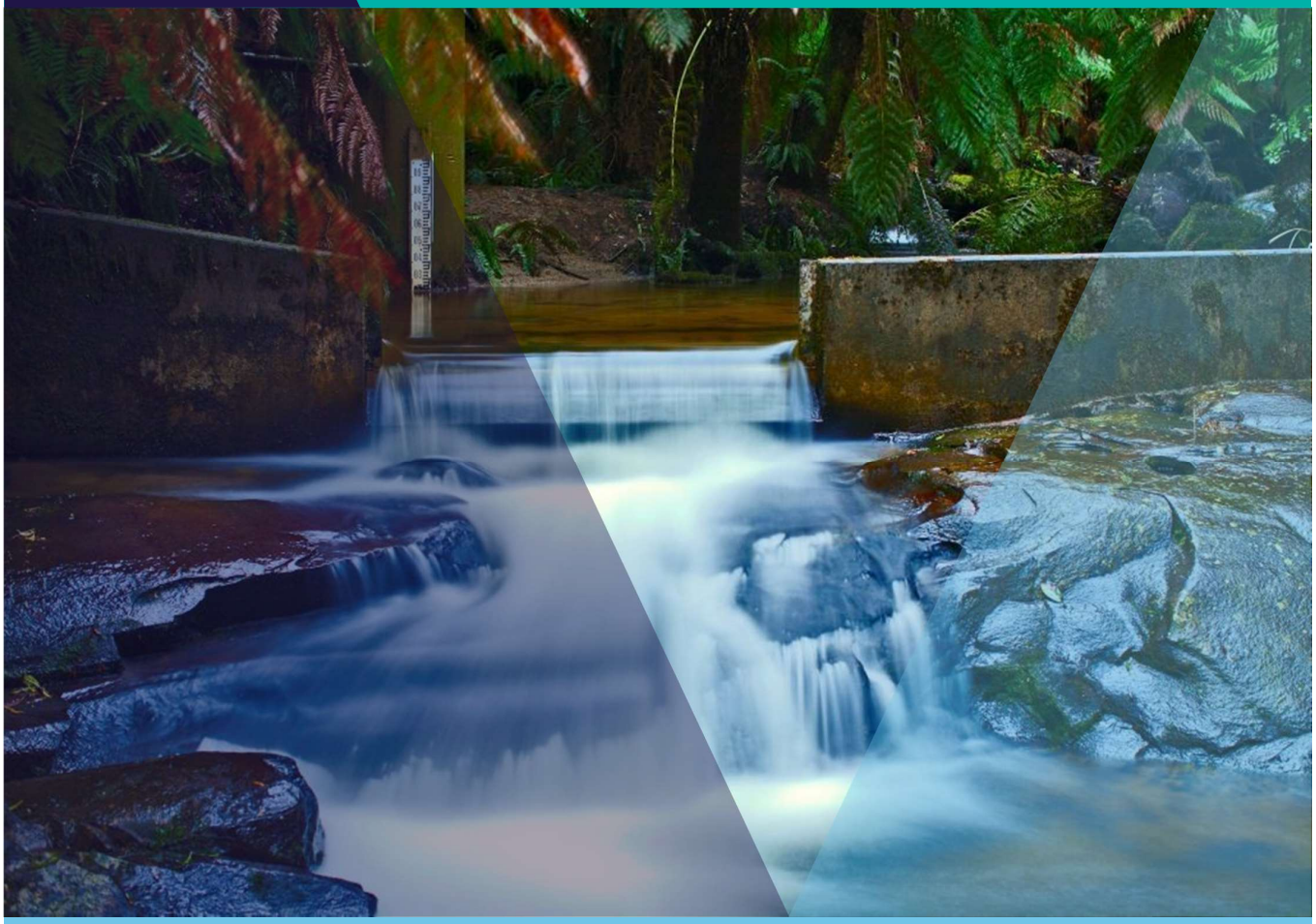
Hydrometric Network Review

June 2019



Report for Murray Darling Basin Authority

VICTORIA State Government | Environment, Land, Water and Planning

Acknowledgment

We acknowledge and respect Victorian Traditional Owners as the original custodians of Victoria's land and waters, their unique ability to care for Country and deep spiritual connection to it. We honour Elders past and present whose knowledge and wisdom has ensured the continuation of culture and traditional practices.

We are committed to genuinely partner, and meaningfully engage, with Victoria's Traditional Owners and Aboriginal communities to support the protection of Country, the maintenance of spiritual and cultural practices and their broader aspirations in the 21st century and beyond.

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1. Introduction

As part of the MDBA Compliance Compact, Basin states are required under Action 3.10 (i) to undertake:

a. an inventory of their Hydrometric networks and

b. a gap analysis to ensure that their networks are fit for purpose.

The Hydrometric network includes:

- Surface water gauges
- Groundwater bores
- Climate (rainfall and evaporation) stations

1.1 Water monitoring arrangements

DELWP operates an outsourced model for water monitoring, known as the Regional Water Monitoring Partnership (RWMP). The RWMP brings together over 40 agencies and organisations across Victoria who share the cost of monitoring and data collection. Under this model, DELWP manages and co-ordinates the RWMP and the data collection and site maintenance are undertaken by our external service providers. This model very much operates under the idea of collect once to a common agreed standard and use the data many times.

For data collected as part of the RWMP, there are two service providers:

Service provider	Scope
ALS	• Surface water flow/ level • Water quality (surface water and groundwater) • Surface water gauge and climate site and asset maintenance
Ventia	• Groundwater level • Bore site and asset maintenance

In northern Victoria there are 24 organisations within the RWMP. These organisations include all seven water corporations, all five CMAs, nine local councils (with flood management responsibilities), and three state or Commonwealth Agencies (DELWP, MDBA and BoM):

Agency/ Organisation class	Agency/ Organisation
Commonwealth agencies	BoM, MDBA
State agencies	DELWP
Water corporations	North East Water, Goulburn Murray Water, Lower Murray Water, Grampians Wimmera Mallee Water, Central Highlands Water, Goulburn Valley Water, Coliban Water
Catchment Management Authorities	North East CMA, Goulburn Broken CMA, North Central CMA, Wimmera CMA, Mallee CMA
Shire councils	Wangaratta Rural City Council, Benalla Rural City, Greater Shepparton City Council, Alpine Shire, Central Goldfields Shire Council, Murrindindi Shire Council, Strathbogie Shire Council, Mitchell Shire Council, Moira City Council

This inventory brings together the hydrometric network in northern Victoria that is both within and outside the RWMP.

1.2 Hydrometric network

In northern Victoria the hydrometric network comprises:

- 607 surface water gauges (including climate stations); and
- 3,112 active groundwater bores

As the cost of monitoring can be shared between different partners at a single site, sites within the RWMP can have multiple partners that are interested in data at a site. Therefore, it is possible that a site can have multiple primary site purposes. This means that the Victorian analysis is based on number of primary purposes and not on the number of hydrometric stations. There are 607 surface water sites (including climate sites) and 823 cost shares.

As an example, site 403227A (King River @ Cheshunt) has four partners (Goulburn Murray Water, MDBA, BoM and DELWP) that share the cost of data collection. At site 403227A, there are four different site purposes covering three different high-level purposes:

High-level purpose	Site purpose
Compliance	BE compliance point
Public safety	Flood warning site
Surveillance	Long term flow site
Surveillance	Rainfall

There are not multiple cost shares at a site for sites outside the RWMP. For these sites, the number of sites is the same as the number of cost shares.

1.3 Data standards

All data collection and laboratory analysis are done according to best management practice. Table 1 lists the standards that are used in Victoria. The water quality analysis standards are listed in Appendix A.

Table 1 Standards used by external service providers in the collection of water monitoring data.

Standard	Title
ISO 17025 (NATA): 2017	General requirements for the competence of testing and calibration laboratories
AS/NZS ISO 9001: 2015	Quality management systems - Requirements
AS 2360.8.1-2007	Hydrometry - Measurement of free surface flow in closed conduits - Methods
AS 3778.2.4-2007	Measurement of water flow in open channels - General - Estimation of uncertainty of a flow rate measurement
AS 3778.3.7-2007	Measurement of water flow in open channels - Velocity-area methods - Measurement by ultrasonic (acoustic) method

AS 3778.3.8-2007	Measurement of water flow in open channels - Velocity-area methods - Electromagnetic method using a full-channel-width coil
AS 3778.4.6-2007	Measurement of water flow in open channels - Measurement using flow gauging structures - Flat-V weirs
AS 3778.5.3-2007	Measurement of water flow in open channels - Liquid flow in open channels and partly filled pipes - Guidelines for the application of Doppler-based flow measurements
WISBF GL 100.00–2013	Part 0: Glossary
WISBF GL 100.01–2013	Part 1: Primary Measured Data
WISBF GL 100.02–2013	Part 2: Site Establishment and Operations
WISBF GL 100.03–2013	Part 3: Instrument and Measurement Systems Management
WISBF GL 100.04–2013	Part 4: Gauging (stationary velocity area method)
WISBF GL 100.05–2013	Part 5: Data Editing, Estimation and Management
WISBF GL 100.06–2013	Part 6: Stream Discharge Relationship Development and Maintenance
WISBF GL 100.07–2013	Part 7: Training
WISBF GL 100.08–2013	Part 8: Application of Acoustic Doppler Current Profilers to Measure Discharge in Open Channels
WISBF GL 100.09–2013	Part 9: Application of In-situ Point Acoustic Doppler Velocity Meters for Determining Velocity in Open Channels
WISBF GL 100.10–2013	Part 10: Application of Point Acoustic Doppler Velocity Meters for Determining Discharge in Open Channels

2. Inventory process

All RWMP partners in northern Victoria were asked to fill in an Excel spreadsheet listing all sites that form part of their hydrometric network along with what was the primary and secondary purpose of this monitoring. All individual spreadsheets were then collated by DELWP. From this consolidated spreadsheet, DELWP was able to develop a list of all site purposes and to classify these into six high level purposes.

A second call went out to ask all northern partners to assess their hydrometric networks and identify any gaps in their network. A gap could result in:

a. the establishment of new sites

b. the closing of existing sites

c. the modification of data collected at a site (i.e. a change in parameters collected, frequency of collection or collection method).

This information was then collated by DELWP to produce a consolidated view of the hydrometric gap analysis for northern Victoria.

2.1 Site classification and site purpose

For the purposes of this inventory, site purposes (i.e. the reason for data collection at a site) were classified into six high-level purposes:

High-level purpose	Scope
Surveillance	Usually sites with long term data sets with regular observations. This data allows the state or condition of the resource to be understood
Compliance	Monitoring sites required under Water Corporation metering plans or Environmental watering plans
Operational	Sites to support the daily business function of an organisation
Investigative	Sites where monitoring is typically short term to investigate a particular management issue
Public safety	Flood sites which are required by shire councils who have a flood management function. Can also include rainfall sites which support the flood management function
Unknown	Sites where a primary purpose is undocumented

From the information in the consolidated spreadsheet, 26 site purposes were identified and assigned into one of the six high-level purposes. Table 2 lists the six high-level purposes and their associated site purposes.

Table 2 Site purpose classification

High-level purpose	Site purpose
Surveillance	• Climate (rainfall/ evaporation) • Drainage • Flow/ level • End of valley • Threat process monitoring • Irrigation salinity • Public pump operation • Baseline condition • Long term/ trend flow or water quality site • Reference site • Water quality
Compliance	• Bulk Entitlement (BE) Compliant point • Environmental flow compliance point • Sustainable Diversion Limit (SDL)
Operational	• Extraction point • Inflow/ outflow point • Reservoir level • Reservoir water quality
Investigative	• Irrigation salinity investigations • Management intervention • Short term project • Modelling

Public safety	• Flood warning • Flood information • Rainfall (if associated with a flood site)
Unknown	• Site purpose not documented

It should be noted that reporting and planning were not considered a primary purpose and as such, do not appear as a site purpose in Table 2.

3. Surface water site classifications

A breakdown of the surface water (including climate) classifications for Northern Victoria is shown in Figure 1. There was a total of 823 surface water primary purposes in northern Victoria, based on the cost shares at a site. While there are 607 surface water sites, there are 823 cost shares.

The majority of primary purposes were classified as either surveillance (41%) or public safety (32%), while 18% were classified as compliance, 6% operational, 2% investigative and 1% were unknown.

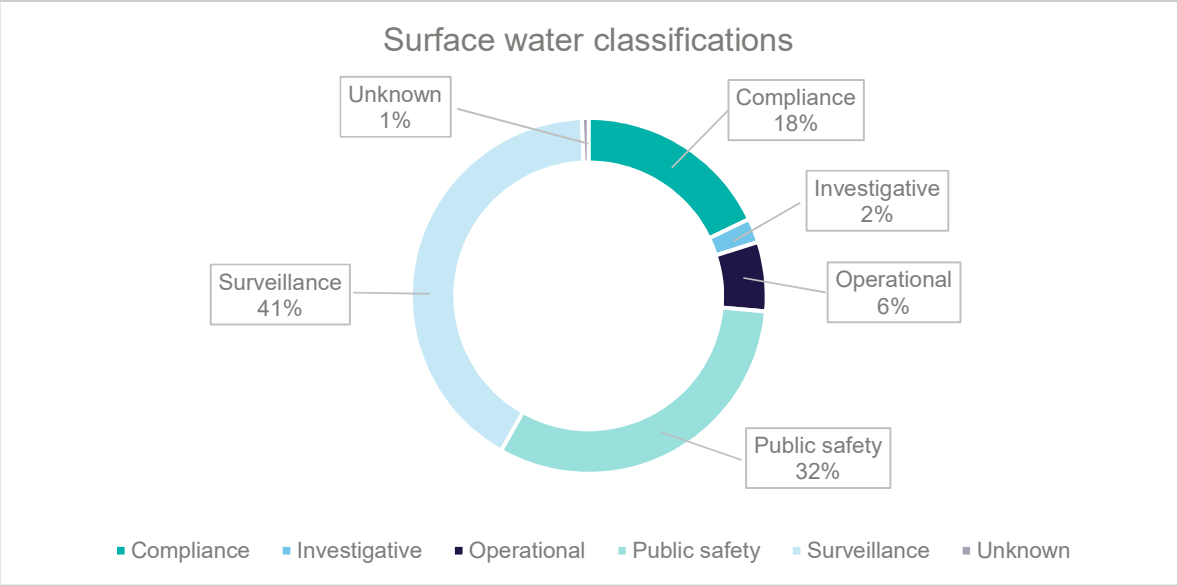

Figure 1 Surface water site classification for Northern Victoria

Table 3 presents a breakdown of the classification of surface water sites in northern Victoria into site purposes under each high-level classification category.

Table 3 Classification of surface water sites in Northern Victoria

High-level purpose	Number of sites	Site purpose (number of sites)
Surveillance	339	• Flow (76) • Salinity (65) • Long term flow (63) • Climate (37) • Flow and water quality (22) • Drainage (20) • Water quality (20) • Reference (16) • Flood (9) • Reservoir level/ inflow/outflow (7) • End of valley (4)
Public Safety	262	• Flood information / flood warning (181) • Rainfall (47) • Flow/ level (28) • Water quality (6)
Compliance	147	• Environmental flows (67) • Bulk Entitlement points (39) • Flow (34) • Water quality (7)
Operational	52	• Reservoir inflow/ outflow (19) • Extraction points (14) • Reservoir water quality (10) • Flow (7) • Flood management (2)
Investigative	18	• Management intervention (12) • Short term projects (6)
Unknown	5	—

As there can be multiple organisations interested in a site, it is possible for a site to have multiple reasons for data collection. Table 4 presents a different combination of purposes for collecting surface water data. The purposes have been combined into three broad categories (flow/ level, water quality and climate).

Table 4 The different combinations of purposes for collecting surface water data in northern Victoria

Primary purpose	Number of surface water (incl. climate) cost shares
Flow/ level only	421
Water quality only	37
Climate only	84
Flow/ level and water quality	215
Flow/ level and climate	58
Flow/ level, water quality and climate	8

The inventory of surface water (including climate sites) is contained in Appendix B.

Figures 2 – 5 show the distribution of surface water and climate sites for each high level purpose.

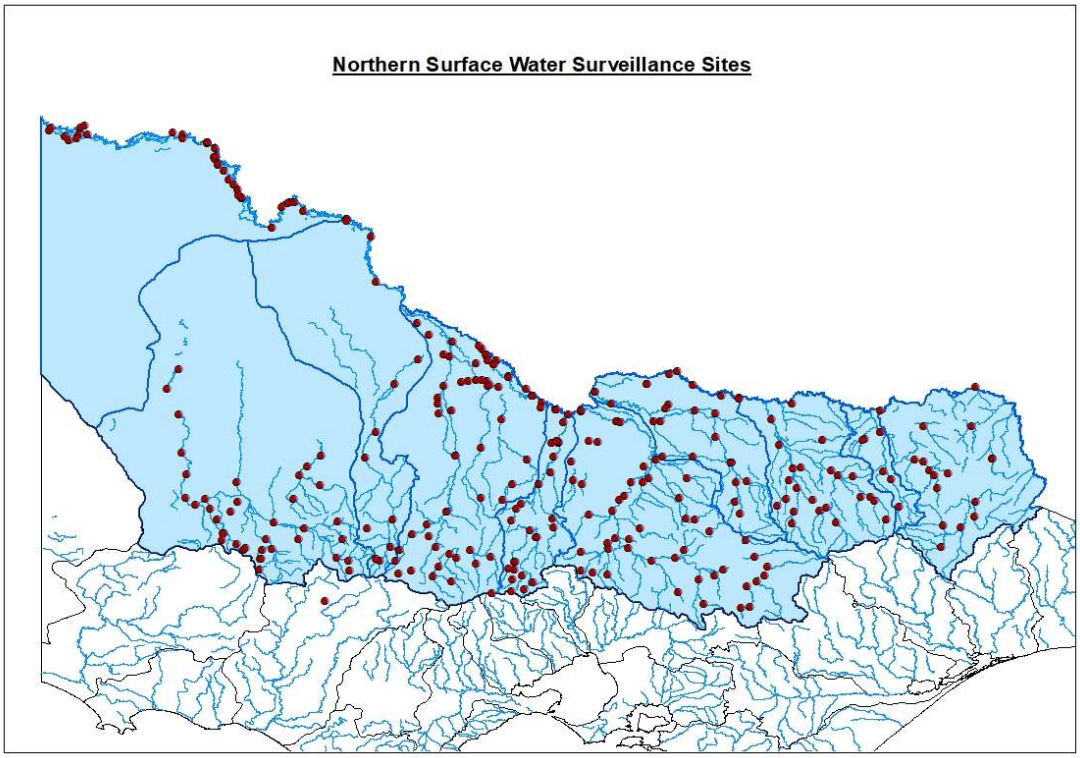

Figure 2 Surface water and climate surveillance sites

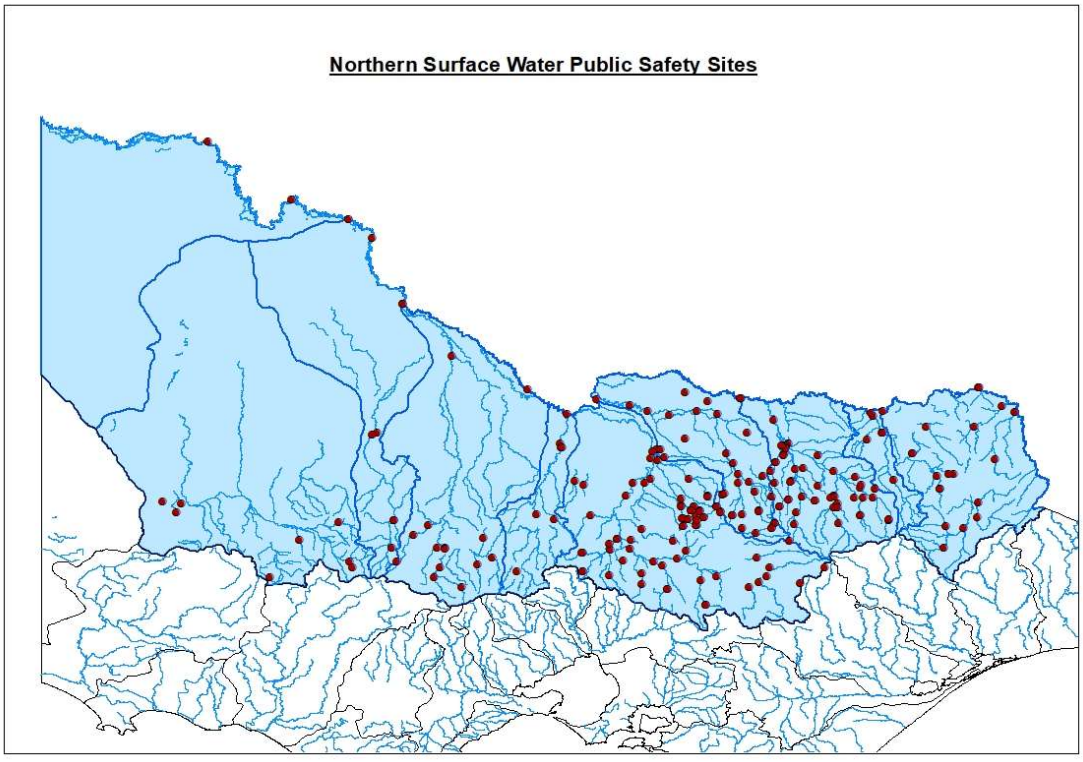

Figure 3 Surface water and climate public safety sites

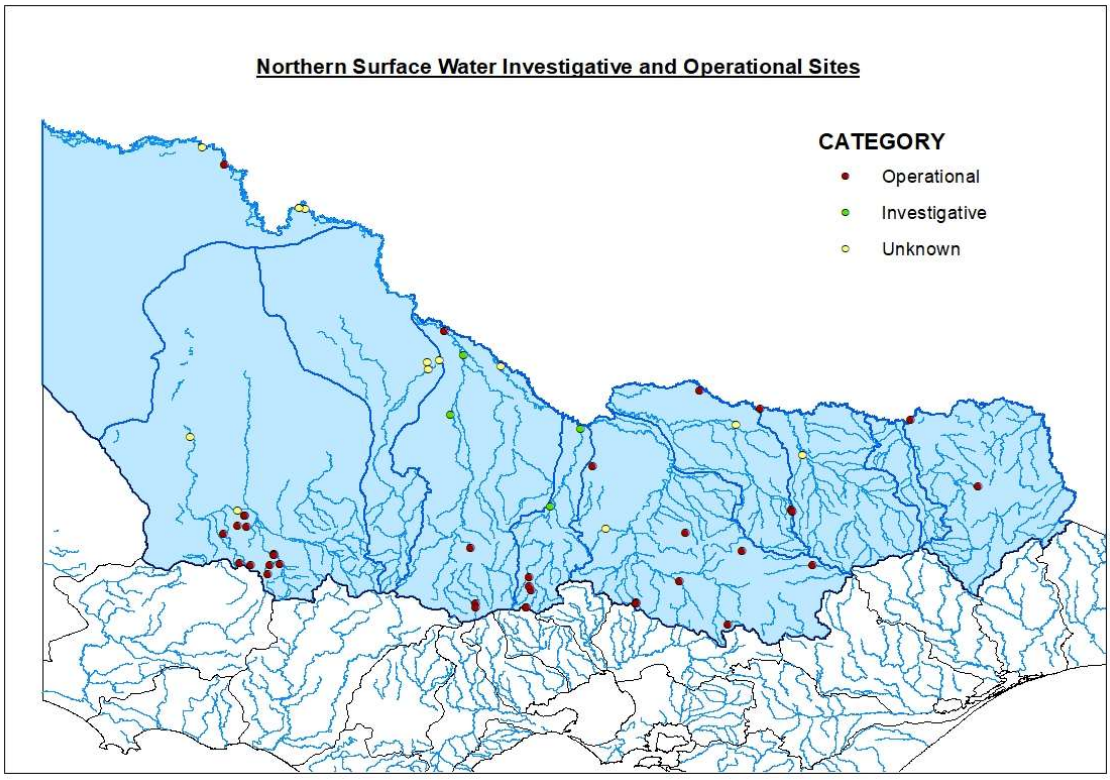

Figure 4 Surface water and climate investigative and operational sites

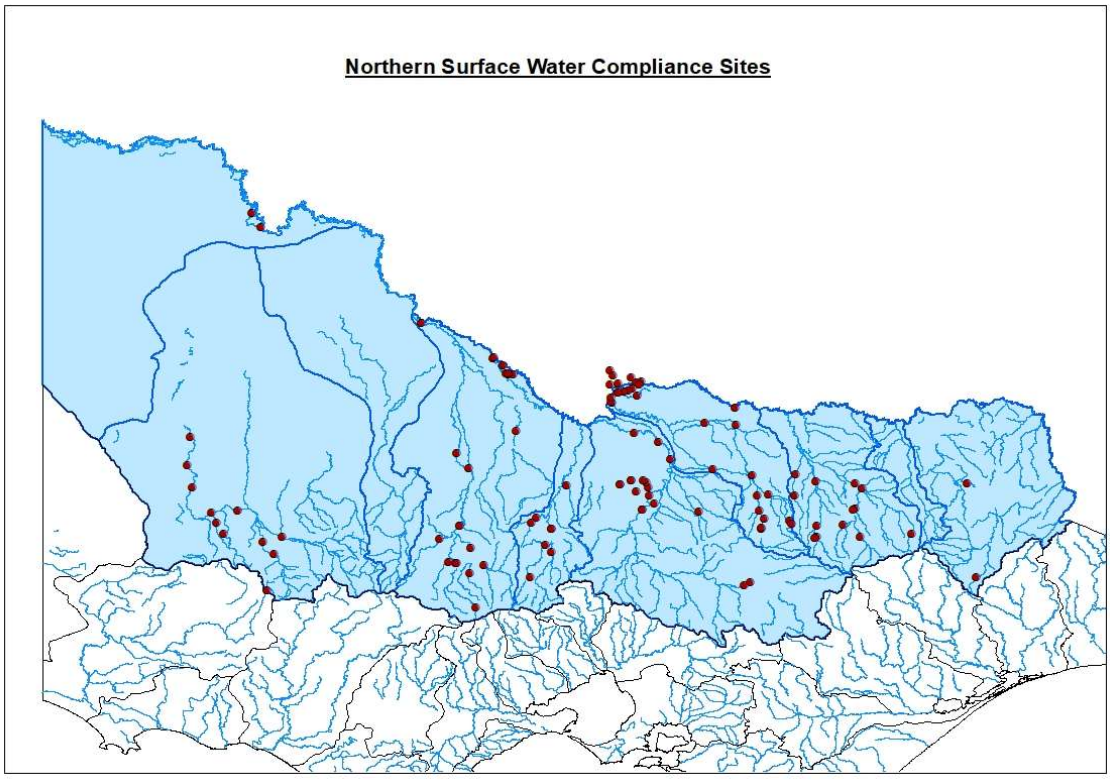

Figure 5 Surface water and climate water compliance sites

4. Groundwater site classification

A breakdown of the groundwater classifications for Northern Victoria is given in Figure 6. There was a total of 3,112 groundwater primary purposes in northern Victoria.

Primary purposes were predominantly classified as surveillance (84%), while 10% were investigative and 6% were operational.

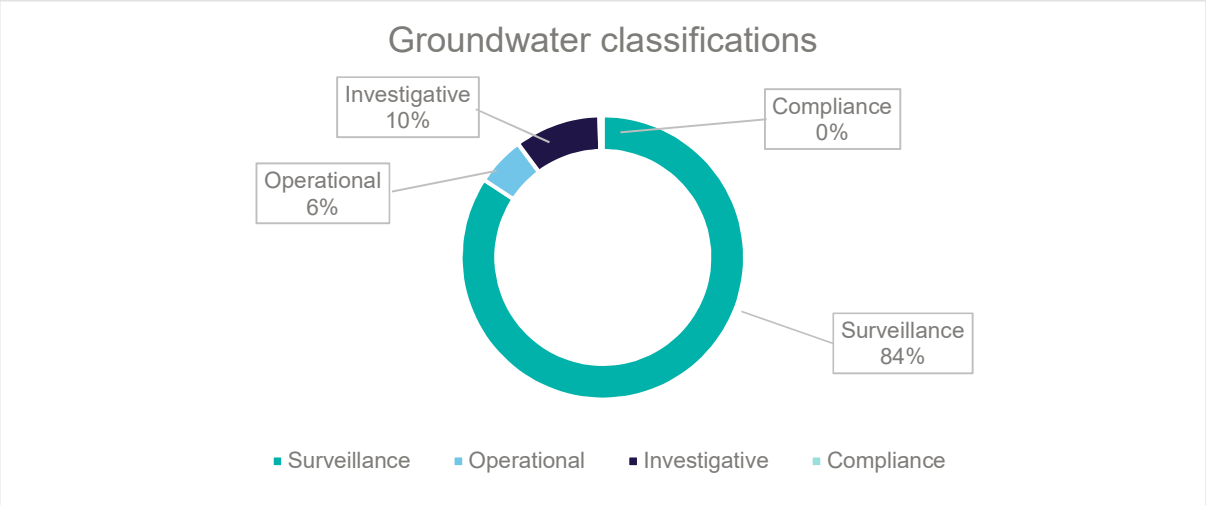

Figure 6 Groundwater site classification for Northern Victoria

Table 5 presents a breakdown of the classification of groundwater sites in northern Victoria into site purposes under each high-level classification category.

Table 5 Classification of groundwater sites in northern Victoria

High-level purpose	Number of sites	Site purpose breakdown (number of sites)
Surveillance	2,611	• Irrigation salinity (1,681) • Baseline condition (492) • Public pump operation (salinity and water level) (305) • Threat process (160) • Salinity (147) • The Living Murray Program (65) • Long term sites (60) • Landfill (9) • Unknown (1)
Operational	166	• Extractive use (161) • Extraction point (5)
Investigative	305	Modelling (281) Management investigations (18) Short term projects (2)
Compliance	12	Sustainable Diversion Limits (12)

As there can be multiple organisations interested in a site, it is possible for a site to have multiple reasons for data collection. Table 6 presents the different combinations of purposes for collecting groundwater data. The purposes have been combined into two broad categories (level and water quality).

Table 6 Combinations of purposes for collecting groundwater data in northern Victoria

Primary purpose	Number of sites
Level only	2,360
Level and water quality	733

The inventory of groundwater sites is contained in Appendix C.

Figures 7 and 8 show the distribution of ground water sites for each high level purpose.

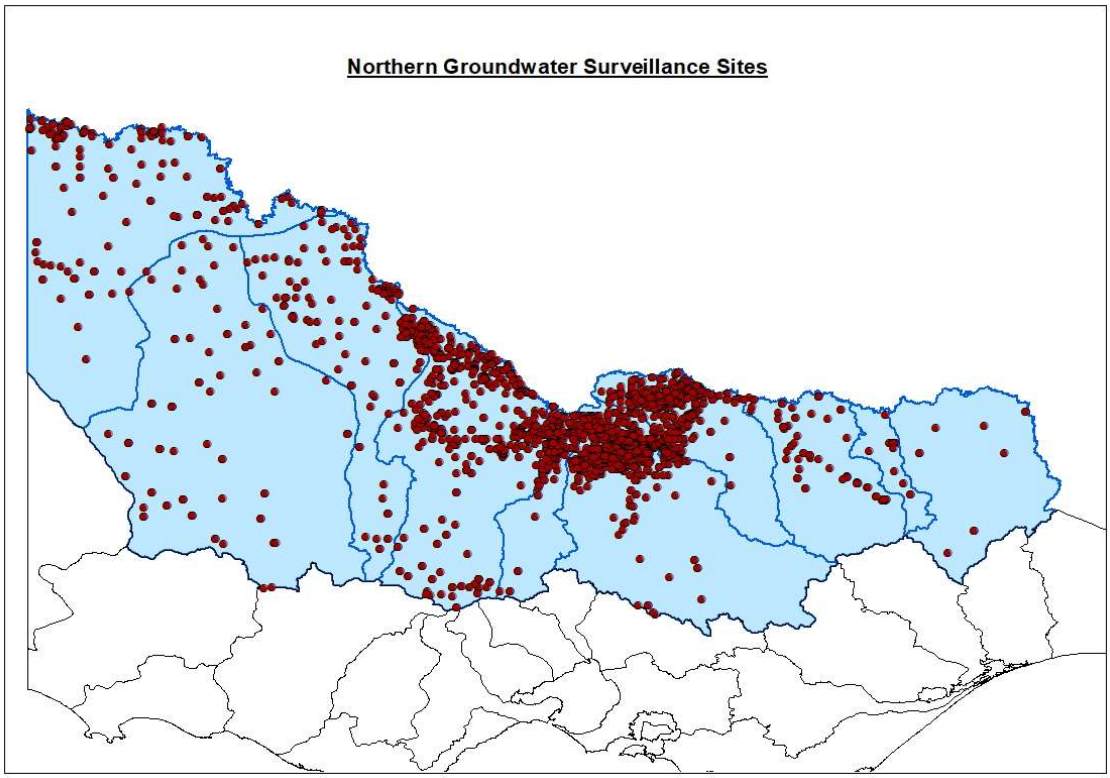

Figure 7 Groundwater surveillance sites

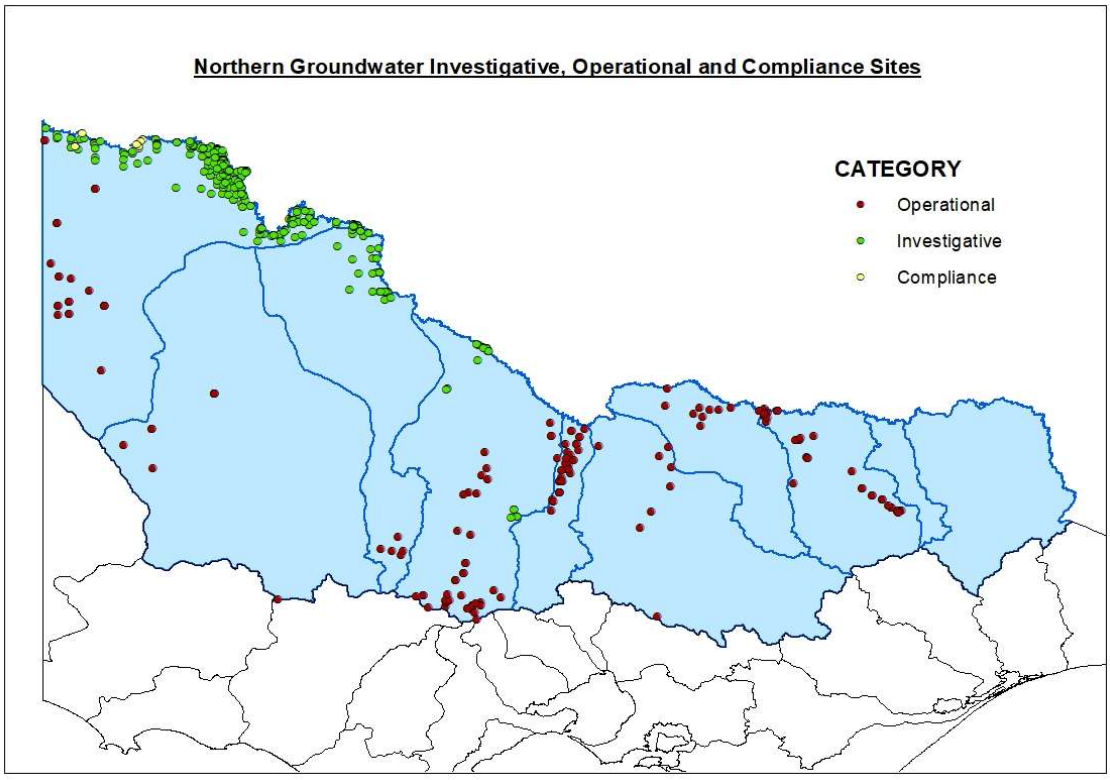

Figure 8 Groundwater investigative, operational and compliance sites

5. Gap analysis

All northern partners were asked to review their hydrometric networks to see if they were fit for purpose. The outcome of this process was to identify sites that needed to be closed, modified or identify were new sites were required. This review resulted in:

- 16 surface water (water quality) sites to be closed
- 42 new climate sites
- 37 surface water sites to be modified
- 133 bores to be modified

All changes to existing surface water sites are for sites with a surveillance high level purpose classification, except for site 402231A which had an unknown site purpose. 109 of the groundwater bores to be modified are classified as surveillance bores, while the other 24 bores are operational bores.

5.1 Surface water sites to close

Site Number	Site name	Description	High level purpose	Approximate timeline
402203A	Kiewa River @ Mongans Bridge	Cease spot water quality monitoring	Surveillance	Dec 2019
402204A	Yackandandah Ck @ Osborne Flat	Cease spot water quality monitoring	Surveillance	Dec 2019
402222A	Kiewa River @ Kiewa	Cease spot water quality monitoring	Surveillance	Dec 2019
402223A	Kiewa River West @ u/s Offtake	Cease spot water quality monitoring	Surveillance	Dec 2019
402231A	Kinchington Creek @ Osborne's Flat	Cease all monitoring	Unknown	Dec 2019
403213A	15 Mile Ck @ Greta South	Cease spot water quality monitoring	Surveillance	Dec 2019
405231A	King Parrot Ck @ Flowerdale	Cease spot water quality monitoring	Surveillance	Dec 2019
405237A	Sevens Ck @ Euroa	Cease spot water quality monitoring	Surveillance	Dec 2019
405240A	Sugarloaf Ck @ Ash Bridge	Cease spot water quality monitoring	Surveillance	Dec 2019
405246A	Castle Ck @ Acadia	Cease spot water quality monitoring	Surveillance	Dec 2019
405251A	Brankeet Ck @ Ancona	Cease spot water quality monitoring	Surveillance	Dec 2019
406224A	Mt Pleasant Ck @ Runnymede	Cease spot water quality monitoring	Surveillance	Dec 2019
407220A	Bet Bet Ck @ Norwood	Cease spot water quality monitoring	Surveillance	Dec 2019
407221B	Jim Crow Ck @ Yandoit	Cease spot water quality monitoring	Surveillance	Dec 2019
407236B	Mount Hope Ck @ Mitiamo	Cease spot water quality monitoring	Surveillance	Dec 2019
415601A	Lake Albacutya @ Rainbow	Cease spot water quality monitoring	Surveillance	Dec 2019

5.2 New surface water sites

New site	Approximate Timeline
Rainfall radar site at Rainbow	December 2019
20 rainfall gauging sites for the Rainbow radar site	June 2010
20 rainfall gauging sites for the upgraded Mildura radar site	June 2021
Flood forecasting site at Warracknabeal	December 2020

5.3 Modify surface water sites

Site number	Site Name	Description	High level purpose	Approximate timeline
402205A	Kiewa River @ Bandiana	New multi water quality probes for continuous DO and Turbidity	Surveillance	Prior to Dec 2019
403241A	Ovens River @ Peechelba	New multi water quality probes for continuous DO and Turbidity	Surveillance	Prior to Dec 2019

404216A	Broken River @ Caseys Weir	New multi water quality probes for continuous DO, Turbidity and EC	Surveillance	Prior to Dec 2019
407285A	Nine Mile Ck @ Coads Road	Replace Mindata logger with a Campbells logger	Surveillance	Prior to Dec 2019
407286A	Wandella Ck @Fairley	Replace Mindata logger with a Campbells logger	Surveillance	Prior to Dec 2019
407289A	Nine Mile Ck @ Serpentine Ck offtake	Replace Mindata logger with a Campbells logger	Surveillance	Prior to Dec 2019
407302A	Venables Ck Boort Durham Ox Road	Replace Mindata logger with a Campbells logger	Surveillance	Prior to Dec 2019
408209A	Avoca River @ Sandhill Lake Road	Replace Mindata logger with a Campbells logger	Surveillance	Prior to Dec 2019
408213A	Avoca River @ Trescoe outfall	Replace Mindata logger with a Campbells logger	Surveillance	Prior to Dec 2019
408203B	Avoca River @ Quambatook	New multi water quality probes for continuous DO and Turbidity	Surveillance	Prior to Dec 2019
408213A	Avoca River @ Trescoe outfall	Replace Mindata logger with a Campbells logger	Surveillance	Prior to Dec 2019
	Mildura radar site	Upgrade Mildura radar site	Surveillance	Prior to Dec 2021
414212A	Lindsay River @ Offtake	Replace Mindata logger with a Campbells logger	Surveillance	Prior to Dec 2019
414213A	Lindsay River @ u/s Mullaroo Ck	Replace Mindata logger with a Campbells logger	Surveillance	Prior to Dec 2019
414214A	Mullaroo Creek @ u/s Lindsay River	Replace Data Logger, Replace Shaft Encoder with Self Purge Level Sensor & Orifice, Install slide and conduit for EC sensor, Install small step at base of well to enable safer access to hut, Replace Battery & Install Battery Box, Replace Staff Gauges , Install Next G telemetry and upgrade power supply.	Surveillance	Prior to Dec 2019
414215A	Lindsay River @ Lindsay Point	Replace Mindata logger with a Campbells logger	Surveillance	Prior to Dec 2019
414218A	Lindsay River @ u/s Lake Wallawalla	Orifice to be relocated to stand alone, Replace Data Logger, Replace HS40/3100, Install small step at base of well to enable safer access to hut, Replace existing battery & install logger box, Install Ladder bracket on edge of roof to enable safe access to solar panel, Install Next G telemetry and upgrade power supply.	Surveillance	Prior to Dec 2019
414219A	Murray River @ Wemen	Replace Mindata Logger (includes logger box & cabinet fit out), Replace Wet Level Sensor with Dry Gas Sensor & Orifice, Cabinet Requires Replacement, Replace Battery & Install Solar Power, Replace Gauges, Install Next G telemetry and upgrade power supply.	Surveillance	Prior to Dec 2019

414702A	FMIT North East Drain @ Bruce's Bend	Replace Data Logger, Replace Shaft Encoder, Replace existing battery & install battery box, replace weir plate with V-Notch to increase sensitivity, Install Next G telemetry and upgrade power supply. Reconfigure structure (see comments)	Surveillance	Prior to Dec 2020
414703A	Red Cliffs Drain No. 1 @ Blount Road	Replace Data Logger, Replace Shaft Encoder, Replace EC Sensor, Replace existing battery & install battery box, Consider installing ladder bracket to brace ladder for safe access for cleaning solar panel, Install Next G telemetry and upgrade power supply. Reconfigure structure (see comments)	Surveillance	Prior to Dec 2020
414705A	Drain No. 10 @ Red Cliffs	Replace Data Logger, Replace OTT CBS with Shaft Encoder (including new float/weight/beaded wire), Replace EC Sensor, Replace Solar Regulator, Install concrete measuring section downstream Weir for gauging, Replace existing battery & install battery box, Consider installing ladder bracket to brace ladder for safe access for cleaning solar panel, Install Dampener in stilling well to reduce surge from pipe discharge, Install Next G telemetry and upgrade power supply. Reconfigure structure (see comments)	Surveillance	Prior to Dec 2020
414706A	Merbein North West Drain @ u/s outfall to Murray	Replace Data Logger, Replace Shaft Encoder, Installation of rock spalls on downstream apron of control, Replace existing battery & install battery box, Consider installing ladder bracket to brace ladder for safe access for cleaning solar panel, Install Next G telemetry and upgrade power supply.	Surveillance	Prior to Dec 2020
414712A	Red Cliffs Drain 3/4 @ Woorlang	Replace Data Logger, Replace OTT CBS, Install concrete measuring section downstream Weir for gauging, Consider replacing battery and installing battery box, Install Next G telemetry and upgrade power supply. Reconfigure structure (see comments)	Surveillance	Prior to Dec 2020
414714A	Red Cliffs Drain No. 8 @ Stewarts Road	Replace existing V-Notch with stainless weir plate, Install concrete measuring section downstream Weir for gauging, Placement of rock spalls downstream control to reduce potential erosion, Consider replacing battery and installing battery box, Install Next G telemetry and upgrade power	Surveillance	Prior to Dec 2020

		supply. Reconfigure structure (see comments)		
414716A	Robinvale No. 4 System Outfall @ Pethard Road	Replace Data Logger, Replace Encoder, Replace EC Sensor, Consider replacing battery and installing battery box, Install Solar Panel, Install Next G telemetry and upgrade power supply.	Surveillance	Prior to Dec 2019
414717A	Robinvale No. 6 System Outfall @ Malaya Road	Replace Data Logger, Replace Encoder, Replace EC Sensor, Consider replacing battery and installing battery box, Install Solar Panel, Install Next G telemetry and upgrade power supply.	Surveillance	Prior to Dec 2019
414721A	Nangiloc-Colignan Drain @ Hewitt's Road	Consider replacing battery and installing battery box, Install Next G telemetry and upgrade power supply. If Telemetry is installed recommend to install new cabinet and small mast to house all equipment and solar panel	Surveillance	Prior to Dec 2020
414722A	Nangiloc-Colignan Drain @ Doerings Basin	Replace Wet Level Sensor, Replace EC sensor, Replace Weir Plate (Consider installation of V Notch), Replace battery and install battery box, Install Next G telemetry and upgrade power supply. If Telemetry is installed recommend to install new cabinet and small mast to house all equipment and solar panel	Surveillance	Prior to Dec 2020
414723A	Kulkyne Outfall Drain @ Mansell's Pump	Replace Wet Level Sensor, Replace EC sensor, Replace battery and install battery box, Install Next G telemetry and upgrade power supply. If Telemetry is installed recommend to install new cabinet and small mast to house all equipment and solar panel	Surveillance	Prior to Dec 2020
414724A	Nangiloc Colignan Drain @ Nangiloc	Replace Weir Plates, Replace Cabinet, Replace gauge with stainless steel or marine grade aluminium gauge plate, Install Next G telemetry and upgrade power supply.	Surveillance	Prior to Dec 2020
414725A	Nangiloc-Colignan Drain @ Hillview Outfall	Install Next G telemetry and upgrade power supply.	Surveillance	Prior to Dec 2020
414728A	Brown's Group Drainage Area @ Brown's Road	Replace Logger, Install Logger Box, Install Next G telemetry and upgrade power supply.	Surveillance	Prior to Dec 2020
414730A	Psyche Bend Lagoon @ Connecting Drain	Decommission site and replace with a PALS unit	Surveillance	
414731A	Bum Bang Drain Outfall @ Murray River	Install Logger Box, Consider cabinet replacement, Consider battery replacement and installation of battery box, Consider installation of solar power for redundancy,	Surveillance	Prior to Dec 2019

		Install Next G telemetry and upgrade power supply.		
414732A	Tol Tol Drain Outfall @ Murray River	Install Logger Box, Consider cabinet replacement or installation additional cabinet, Consider battery replacement and installation of battery box, Install Next G telemetry and upgrade power supply.	Surveillance	Prior to Dec 2019
414733A	Boundary Bend Drain Outfall @ Murray River	Install Logger Box, Replace EC Sensor, Consider cabinet replacement, Consider battery replacement and installation of battery box, Install Next G telemetry and upgrade power supply.	Surveillance	Prior to Dec 2019
414734A	Boundary Bend @ Drainage Dam	Install Logger Box, Consider cabinet replacement, Consider battery replacement and installation of battery box, Consider installation of solar power for redundancy, Install Next G telemetry and upgrade power supply.	Surveillance	Prior to Dec 2019
415200D	Wimmera River @ Horsham	New multi water quality probes for continuous DO and Turbidity	Surveillance	Prior to Dec 2019

5.4 Modify groundwater sites

Site number	Description	High level purpose	Approximate timeline
36401	Install telemetry	Surveillance	June 2020
42810	Install telemetry	Surveillance	June 2020
46147	Install telemetry	Surveillance	June 2020
46190	Refurbish bore	Operational	December 2019
46198	Refurbish bore	Surveillance	June 2020
46199	Refurbish bore	Surveillance	June 2020
47247	Refurbish bore	Operational	June 2020
47250	Refurbish bore	Surveillance	June 2020
47251	Refurbish bore	Surveillance	June 2020
47255	Refurbish bore	Surveillance	June 2020
48554	Refurbish bore	Surveillance	December 2019
48559	Refurbish bore	Surveillance	December 2019
50789	Install telemetry	Surveillance	June 2020
51001	Refurbish bore	Operational	December 2019
51640	Refurbish bore	Operational	December 2019
51738	Refurbish bore	Operational	June 2020
51740	Refurbish bore	Operational	June 2020
51844	Refurbish bore	Operational	June 2020

51845	Refurbish bore	Operational	June 2020
52367	Refurbish bore	Surveillance	December 2019
54342	Refurbish bore	Surveillance	June 2020
54380	Install telemetry	Surveillance	June 2020
54981	Refurbish bore	Surveillance	June 2020
58526	Refurbish bore	Surveillance	December 2019
60128	Install telemetry	Surveillance	June 2020
60131	Refurbish bore	Operational	June 2020
60132	Install telemetry	Surveillance	June 2020
60136	Refurbish bore	Surveillance	December 2019
60187	Install telemetry	Surveillance	June 2020
60623	Refurbish bore	Operational	June 2020
61684	Install telemetry	Surveillance	June 2020
62036	Refurbish bore	Surveillance	December 2019
62592	Refurbish bore	Operational	December 2019
62605	Refurbish bore	Operational	June 2020
62863	Refurbish bore	Surveillance	December 2019
64281	Refurbish bore	Surveillance	December 2019
65875	Refurbish bore	Operational	June 2020
66514	Refurbish bore	Surveillance	December 2019
66595	Install telemetry	Surveillance	June 2020
67750	Install telemetry	Surveillance	June 2020
67829	Refurbish bore	Operational	June 2020
67847	Refurbish bore	Surveillance	December 2019
67847	Install telemetry	Surveillance	June 2020
67907	Refurbish bore	Surveillance	June 2020
68434	Refurbish bore	Surveillance	June 2020
68434	Install telemetry	Surveillance	June 2020
68436	Refurbish bore	Surveillance	December 2019
69462	Refurbish bore	Surveillance	December 2019
71062	Refurbish bore	Surveillance	December 2019
73504	Refurbish bore	Surveillance	June 2020
73833	Refurbish bore	Surveillance	June 2020
73833	Install telemetry	Surveillance	June 2020
75651	Refurbish bore	Surveillance	December 2019
75795	Refurbish bore	Surveillance	December 2019
77030	Refurbish bore	Surveillance	December 2019
79278	Refurbish bore	Surveillance	December 2019
79279	Refurbish bore	Surveillance	December 2019
79327	Refurbish bore	Operational	June 2020

79655	Refurbish bore	Operational	December 2019
81069	Refurbish bore	Operational	December 2019
81071	Refurbish bore	Operational	December 2019
82095	Refurbish bore	Surveillance	June 2020
82095	Install telemetry	Surveillance	June 2020
82751	Refurbish bore	Surveillance	December 2019
82757	Refurbish bore	Surveillance	December 2019
82778	Refurbish bore	Surveillance	June 2020
82796	Refurbish bore	Surveillance	June 2020
84796	Install telemetry	Surveillance	June 2020
86774	Refurbish bore	Surveillance	June 2020
88000	Refurbish bore	Surveillance	December 2019
88009	Refurbish bore	Surveillance	June 2020
89576	Refurbish bore	Operational	December 2019
89584	Refurbish bore	Operational	December 2019
89586	Refurbish bore	Operational	June 2020
89888	Refurbish bore	Surveillance	December 2019
92793	Install telemetry	Surveillance	June 2020
93378	Refurbish bore	Surveillance	June 2020
93383	Refurbish bore	Surveillance	June 2020
95513	Refurbish bore	Surveillance	December 2019
95758	Install telemetry	Surveillance	June 2020
97151	Install telemetry	Surveillance	June 2020
97857	Refurbish bore	Surveillance	June 2020
98305	Refurbish bore	Surveillance	December 2019
98349	Refurbish bore	Surveillance	June 2020
98350	Refurbish bore	Surveillance	December 2019
98352	Refurbish bore	Surveillance	December 2019
98873	Refurbish bore	Operational	June 2020
99102	Refurbish bore	Surveillance	June 2020
100500	Refurbish bore	Surveillance	December 2019
100500	Install telemetry	Surveillance	June 2020
100503	Install telemetry	Surveillance	June 2020
100504	Install telemetry	Surveillance	June 2020
102828	Refurbish bore	Surveillance	December 2019
102873	Refurbish bore	Surveillance	June 2020
104272	Refurbish bore	Surveillance	June 2020
108158	Refurbish bore	Operational	December 2019
108201	Install telemetry	Surveillance	June 2020
108203	Install telemetry	Surveillance	June 2020

109356	Refurbish bore	Surveillance	December 2019
109462	Install telemetry	Surveillance	June 2020
110088	Refurbish bore	Surveillance	June 2020
110151	Refurbish bore	Surveillance	December 2019
110162	Refurbish bore	Surveillance	December 2019
110163	Refurbish bore	Surveillance	December 2019
110739	Install telemetry	Surveillance	June 2020
111204	Refurbish bore	Surveillance	June 2020
111543	Install telemetry	Surveillance	June 2020
112182	Install telemetry	Surveillance	June 2020
112185	Refurbish bore	Surveillance	December 2019
112185	Install telemetry	Surveillance	June 2020
112459	Install telemetry	Surveillance	June 2020
112708	Refurbish bore	Surveillance	December 2019
112708	Install telemetry	Surveillance	June 2020
113247	Refurbish bore	Operational	December 2019
113695	Install telemetry	Surveillance	June 2020
138651	Install telemetry	Surveillance	June 2020
138652	Install telemetry	Surveillance	June 2020
139328	Install telemetry	Surveillance	June 2020
302296	Install telemetry	Surveillance	June 2020
8003872	Install telemetry	Surveillance	June 2020
8003873	Install telemetry	Surveillance	June 2020
8003892	Install telemetry	Surveillance	June 2020
8003893	Install telemetry	Surveillance	June 2020
8003930	Install telemetry	Surveillance	June 2020
8003931	Install telemetry	Surveillance	June 2020
WRK053413	Install telemetry	Surveillance	June 2020
WRK053492	Install telemetry	Surveillance	June 2020
WRK053498	Install telemetry	Surveillance	June 2020
WRK054466	Install telemetry	Surveillance	June 2020
WRK054545	Install telemetry	Surveillance	June 2020
WRK952850	Install telemetry	Surveillance	June 2020
WRK952858	Install telemetry	Surveillance	June 2020
WRK952860	Install telemetry	Surveillance	June 2020

5.5 Longer term upgrades

There is a program of continuous improvement in surface water and groundwater monitoring. Further upgrading of RWMP sites will occur, as and when additional funding becomes available. Future improvements are likely to occur due to the following:

- The RWMP partners are always working with our water monitoring service providers on research that will help reduce the cost of monitoring so that it can be reinvested back into the network to upgrade monitoring or expand the range of monitoring where required. DELWP is currently working with our surface water monitoring service provider (ALS) to trial and roll out machine to machine (M2M) communication in the field loggers. This roll out will mean that logger programming can be carried out remotely and most logger issues should be able to be resolved remotely, rather than relying on a field visit. This should result in less loss of data and will help to reduce ongoing costs. This program will start to be rolled out during the 2019/20 Financial Year. In the first instance, this will cover approximately 350 DELWP surface water monitoring sites.
- The Long-Term Water Resources Assessment (LTWRA) project is also likely to recommend what additional monitoring it will need for future LTWRA assessments, as the current monitoring data compromised the approach that would have ideally been undertaken for the current LTWRA assessment. The long-term water resource assessment provides a picture of water availability and waterway health across Victoria. The assessment determines if there has been a decline in the long-term availability of water and the impact on the environment and for people and industries consuming water.
- Recent work by Melbourne University clearly demonstrated that continuous monitoring greatly improves the ability to detect trends and to detect trends earlier. There are large number of sites within the RWMP which fall into the long-term site purpose category. As funding becomes available, it is proposed to use continuous monitoring where ever possible at the long-term sites. Where sites are upgraded with continuous monitoring, these sites will also be telemetered.
- As funding becomes available, water quality sites will be upgraded so that they monitor all the SEPP(Waters) water quality metrics (Turbidity, DO, EC, Nitrogen, Phosphorus and pH).
- The roll out of the new SEPP (Waters) regional target setting process may require additional water quality sites and/ or different parameters to be measured.
- A project is underway to develop cost sharing principles for water monitoring, especially within the RWMP. DELWP will be looking to commence roll out of these principles in 2020.
- Nine Victorian offset projects and 2 constraint projects under the Basin Plan, will result in variations to the hydrometric network. The nine environmental works projects in northern Victoria, will see expanded streamflow monitoring (water accounting, level / depth, risk management), and groundwater monitoring – basin plan salinity risk). Implementation of these projects will commence from approximately 2021. The nine offset projects are:
  - Gunbower National Park Environmental Works Project;
  - Guttrum and Benwell Forests Environmental Works Project;

- Vinifera Floodplain Management Project;
- Nyah Floodplain Management Project;
- Burra Creek Floodplain Management Project;
- Belsar-Yungera Floodplain Management Project;
- Hattah North Floodplain Management Project;
- Wallpolla Island Floodplain Management Project; and
- Lindsay Island Floodplain Management Project.

- There are two constraints measures projects - New Goulburn and the joint Victoria / New South Wales Hume to Yarrawonga project/s:
  - New Goulburn project, it is proposed to expand the spatial hydrometric network coverage to better predict and manage hydrological risks and uncertainty to water delivery arising from unregulated flows generated off the Divide and Strzelecki's. This would mean installation of additional weather and streamflow monitoring sites (number of sites to be determined).
  - Hume to Yarrawonga – likely to require as described above but to be confirmed via further investigation.

Appendix A Standards used for water quality analysis

Test	Standard	Description
pH	Standard Method No. 4500 (APHA, 2012)	pH should be determined in the field, (recording temperature at time of measurement). The current supplementary laboratory analytical method for the determination of pH is Standard Method No. 4500 (APHA, 2012). The analysis is performed on an autosampler combined with a pH meter. The meter is calibrated daily on 2 pH buffers with a third control buffer analysed as a check. Water washes are included between samples to ensure no cross contamination.
Electrical Conductivity (µS/cm at 25°C)	Standard Method No. 2510B (APHA, 2012)	The analysis of electrical conductivity is performed on an autosampler combined with an Electrical Conductivity meter. The meter is calibrated daily with 0.001M, 0.01M and 0.1M potassium chloride solutions to ensure adequate linearity. The temperature compensation is also checked daily. The results are reported to the nearest integer from 2 µS/cm at 25°C to 100 µS/cm at 25°C. Above this the results are reported to 2 significant figures.
True Colour (Pt-Co Units Expressed as Filtered Colour)	Standard Method No. 2120B (APHA, 2012)	The analysis for the determination of true colour is performed after filtering the sample through a 0.45 micron membrane filter. Samples are compared visually against a series of platinum-cobalt (Pt-Co) standards using 100 mL Nessler tubes against a white tile background. Method QC requires a visual check by a second analyst.
Suspended Solids (mg/L)	Standard Method No. 2540 D (APHA, 2012)	The current analytical method for the determination of suspended solids is Standard Method No. 2540 D&E (APHA, 2012). The analysis is performed by filtering a measured volume of sample through a pre-washed, dried and weighed Whatman GFC filter. After adequate rinsing with distilled water to ensure removal of dissolved salts, the filter is dried (103–105 C) desiccated and reweighed.
Filterable Reactive Phosphorus (mg/L as P)	Standard Method No. 4500-P (APHA, 2012)	The current analytical method for the determination of filterable (0.45 micron pore size) reactive phosphorus is Standard Method No. 4500-P (APHA, 2012). The analysis is performed using a segmented flow analyser. The phosphate reacts with ammonium molybdate and antimony potassium tartrate, in acid medium, to form phosphomolybdic acid. This is reduced by ascorbic acid. The absorbency of the resultant blue complex is then measured at 710 nm.
Total Phosphorus (mg/L as P)	Standard Method No. 4500-P (APHA, 2012)	The current analytical method for the determination of total phosphorus is Standard Method No. 4500-P (APHA, 2012) which follows off-line digestion to convert all forms of phosphorus into orthophosphate using an acidic persulfate digestion. The analysis is performed using a segmented flow analyser. The phosphate reacts with ammonium molybdate and antimony potassium tartrate, in acid medium, to form phosphomolybdic acid. This is reduced by ascorbic acid. The absorbance of the resultant blue complex is then measured at 710 nm
Oxidised Nitrogen (mg/L as N)	Standard Method No 4500-NO3 (APHA, 2012)	The current analytical method for the determination of Oxidised Nitrogen (NOx) is Standard Method No 4500-NO3 (APHA, 2012). The analysis is performed using a segmented flow analyser.
Nitrate and Nitrite (mg/L as N)	Standard Method No 4500-NO3 (APHA, 2012)	The current analytical method for the determination of Nitrate and Nitrite is Standard Method No 4500-NO3 (APHA, 2012). The conversion of nitrate to nitrite prior to colorimetric determination is achieved using an in-line copper coated cadmium reduction column. The colorimetric reaction involves diazotising the nitrite with sulphanilamide and coupling the N-(1-napthyl) ethylenediamine dihydrochloride. The absorbency is measured at 543 nm.

Ammonia (mg/L as N)	Standard Method 4500-NH3 H. (APHA, 2012)	The current analytical method for the determination of ammonia is Standard Method 4500-NH3 H. (APHA, 2012). The analysis is performed using a segmented flow analyser. Ammonia in the sample reacts with alkaline phenol and hypochlorite to form indophenol, an intensely blue-coloured compound, proportional to the ammonia concentration. The blue colour is intensified with sodium nitroferricyanide and the reaction is accelerated by heating. The absorbency of the indophenol is measured at 640 nm.
Total Kjeldahl Nitrogen (mg/L as N)	Standard Method No. 4500 NH3 (APHA, 2005)	The current analytical method for the determination of Total Kjeldahl Nitrogen (TKN) is Standard Method No. 4500 NH3 (APHA, 2005). The analysis is performed using a segmented flow auto analyser. The sample is digested with sulphuric acid and potassium sulphate in the presence of a mercurial sulphate catalyst, followed by an automated phenate colorimetric technique for the determination of ammonium. The ammonium ion produced by the digestion is reacted with salicylate and hypochlorite in a buffered alkaline solution, using nitroferricyanide catalyst. The absorbency of the blue-green complex is measured at 660 nm. Currently Total Kjeldahl Nitrogen is calculated by the difference between Total Nitrogen determined by persulfate digestion within an autoclave followed by the analysis for nitrate and Oxidized Nitrogen as described above.
Total Heavy Metals by ICP-MS (mg/L)	USEPA Method 6020 and USEPA Method 200.8	The current analytical method for the determination of heavy metals listed below is USEPA Method 6020 and USEPA Method 200.8. Metals are determined by digesting the sample with nitric acid or a combination of nitric and hydrochloric acid at a specified temperature followed by Inductively Coupled Plasma with Mass Spectrometric Detection (ICPMS): Aluminium, Arsenic, Cadmium, Chromium, Copper, Iron, Lead, Manganese, Molybdenum, Mercury, Nickel, Selenium, Zinc
Alkalinity (mg/L as CaCO3)	Standard Method No. 2320B (APHA, 2012)	The current analytical method for the determination of Total Alkalinity is Standard Method No. 2320B (APHA, 2012). Alkalinity is determined using an acid/base titration using standardised sulphuric acid. The analysis is performed on a autosampler combined with a pH meter and an auto burette. For samples having a pH of 8.3 or less (which is most samples) all the alkalinity is present as bicarbonate. For samples having a pH above 8.3, the alkalinity contributed by hydroxide, plus half of the carbonate present, is determined by titration with standard acid solution to pH 8.3. The total alkalinity is determined by titration to pH 4.6. The concentrations of hydroxide, carbonate and bicarbonate alkalinities are then calculated from the table of relationships given in Standard Method No 2320B (APHA, 2012).
Chloride (mg/L)	USEPA Method 325.2 using a Discrete Analyser	The current analytical method for the determination of Chloride is USEPA Method 325.2 using a Discrete Analyser. Thiocyanate ion is liberated from mercuric thiocyanate through the sequestration of mercury by the chloride ion to form un-ionised mercuric chloride. In the presence of the ferric ion the liberated thiocyanate forms highly coloured ferric thiocyanate at a concentration proportional to the original chloride concentration.
Sulphate (mg/L as SO4)	USEPA Method 375.4 using a Discrete Analyser	The current analytical methods for the determination of Sulphate is USEPA Method 375.4 using a Discrete Analyser. Sulphate ions are precipitated in an acidic medium with barium chloride to form barium sulphate crystals of uniform size. Light absorbance of the suspension is measured by a photometer and the sulphate concentration is determined by relation to a standard curve.
Fluoride (mg/L)	Standard Method No. 4500 F- (APHA, 2012)	The current analytical method for the determination of Fluoride is Standard Method No. 4500 F- (APHA, 2012). The analysis is performed using an Ion Selective Electrode which consists of a single-crystal lanthanum fluoride membrane and an internal reference bonded into an epoxy body. The crystal is an ionic conductor in which only fluoride ions are mobile. When the membrane is in contact with a fluoride solution, an electrode potential develops across the membrane, relative to the concentration of free fluoride ions in solution.

Calcium (mg/L)	Standard Method No. 3120B (APHA, 2012)	The current analytical method for the determination of Calcium is Standard Method No. 3120B (APHA, 2012). The analysis is performed using an inductively coupled plasma optical emission technique (ICP-OES).
Magnesium (mg/L)	Standard Method No. 3120B (APHA, 2012)	The current analytical method for the determination of Magnesium is Standard Method No. 3120B (APHA, 2012). The analysis is performed using an inductively coupled plasma optical emission technique (ICP-OES).
Potassium (mg/L)	Standard Method No. 3120B (APHA, 2012)	The current analytical method for the determination of Potassium is Standard Method No. 3120B (APHA, 2012). The analysis is performed using an inductively coupled plasma optical emission technique (ICP-OES).
Sodium (mg/L)	Standard Method No. 3120B (APHA, 2012)	The current analytical method for the determination of Sodium is Standard Method No. 3120B (APHA, 2012). The analysis is performed using an inductively coupled plasma optical emission technique (ICP-OES).
Silica (Reactive) (mg/L as SiO2)	Standard Method No. 4500 SiO2 D-E (APHA, 2012)	The current analytical method for the determination of Reactive Silica is Standard Method No. 4500 SiO2 D-E (APHA, 2012) by an automated colorimetric analysis on chilled (not frozen) samples. The analysis is performed using a segmented flow analyser. Soluble silica species react with molybdate under acidic condition to form a yellow silicomolybdate complex. This complex is subsequently reduced with stannous chloride to form a heteropoly blue complex which is measured spectrophotometrically at 880 nm.
Total Carbon and Dissolved Organic Carbon (mg/L as C)	Internal ALS Method based on APHA Standard Method No. 5310C	The current analytical method for the determination of Total Organic Carbon (Non-Purgeable Organic Carbon) is an automated procedure which acidifies the sample then the inorganic carbon is removed by purging with nitrogen. Buffered persulfate is added, irradiated with UV and hydroxylamine is added and the sample enters the dialyser. The generated carbon dioxide diffuses through a gas permeable silicone membrane and a weakly buffered phenolphthalein indicator solution is used as the recipient stream wherein the colour intensity will change as the pH varies by the absorbed carbon dioxide gas. The colour intensity is measured at 550 nm. DOC (dissolved organic carbon) can be determined by filtering the unacidified sample through a 0.45µm pore diameter filter and then treating as for TOC.
Chlorophyll-a and Phaeophytin-a	Method ISO/DIS 10260 (International Organisation for Standardisation (ISO), 1991)	The current analytical method for the determination of Chlorophyll-a is Method ISO/DIS 10260 (International Organisation for Standardisation (ISO), 1991). Planktonic algae holding chlorophyll and associated photosynthetic pigments are removed from water samples using vacuum filtration. The filtered residue is extracted into hot ethanol. The chlorophyll-a and phaeophytin-a concentrations in the extract are then determined spectrophotometrically.
Algal Enumeration	Standard Method 10200 (APHA, 2012)	The current analytical method for the determination of Algal concentrations is based on Standard Method 10200 (APHA, 2012). The samples are preserved using Lugol solution in the field (or immediately after delivery to the laboratory). The sample volumes are then concentrated as necessary. A well-mixed sub-sample is then transferred to a counting chamber and using light microscopy the algal cells are identified and enumerated. Where necessary, cell dimensions of the algae are measured to determine the biovolume of selected planktonic algae.

Appendix B Surface water (including climate) sites and site purposes

Refer to attached file – Appendix B

Appendix C Groundwater sites and site purposes

Refer to attached file – Appendix C