sunwater

Woleebee Creek to Glebe Weir Pipeline Project, Queensland EPBC Act Referral 2011/6181

Water Quality Monitoring Plan

October 2022

Document Revision History

Revision	Revision Date	Revision Description	Approved By
1.0	February 2015	Original Issue	Stuart Low - Senior Project Manager
2.0	September 2021	Revised issue – Updated document template, updates to MNES, inclusion of project specific water quality guidelines and updates to monitoring program	John Kelly - General Manager South
2.1	June 2022	Amendment - Updated document in response to DAWE's review comments and associated action items on revision 2.0	John Kelly - General Manager South
2.2	October 2022	Amendment – Updated document in response to DCCEEW's review comments on revision 2.1	John Kelly - General Manager South

Definitions

Defined Term	Explanation
Baseline Surveys	Baseline surveys relate to baseline monitoring undertaken prior to the commencement of the release. Baseline data was collected prior to the commencement of the release on 7 February 2015. The baseline data was collected between 28 February 2012 and 21 January 2015, with between 9 and 14 discrete baseline water quality sampling events taken at each of 9 sites on the Dawson River.
Environmental Value	Environmental Values (EVs) are the various environmental and human uses that have been formally identified for a waterbody for which water quality should be protected or improved.
Receiving Environment Site	A monitoring site downstream of, and potentially influenced by, the release of the resource.
Reference Site	A monitoring site upstream of, and uninfluenced by, the release of the resource.
Water Quality Guideline	Water Quality Guidelines (WQGs) are the numerical concentration levels or narrative statements of indicators established for waters to support and protect the identified EVs for those waters.
Water Quality Objective	Water Quality Objectives (WQOs) are a specific type of WQG that have been developed using stakeholder consultation and have been formally scheduled under the Environmental Protection (Water and Wetland Biodiversity) Policy.

Responsibilities

The roles and responsibilities of personnel relevant to this Plan are outlined below.

Role	Responsible For
General Manager	• Implementation of monitoring requirements in accordance with this Water Quality Monitoring Plan (WQMP) and EPBC Act Referral 2011/6181 Approval – Condition 8.
Supervisor	• Planning and resourcing to ensure all monitoring requirements are met in accordance with this WQMP. • Undertaking inspections of operational infrastructure to ensure operating as intended
Manager Environment	• Provide environmental assistance, support and advice to operational staff as required • Coordinate the update to this WQMP as required

Water Quality Advisors	• Coordinate completion of environmental requirements as per this WQMP. • Lead investigations into non-compliances with this Plan. • Communicate with government agencies as required
Consultants	• Undertake environmental monitoring and reporting in accordance with this WQMP.

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1 Introduction

Sunwater has obtained a commonwealth EPBC Approval for the Woleebee Creek to Glebe Weir Pipeline Project (EPBC Act referral 2011/6181). Condition 8 of the Commonwealth EPBC approval directs the person taking the action to prepare and submit a Water Quality Monitoring Plan (WQMP) for the Minister's approval.

This WQMP has been developed to address the approval condition and outline the water quality and biological monitoring requirements throughout the duration of the project.

This WQMP essentially mirrors the water quality and biological components of the Receiving Environment Monitoring Program (REMP), which is required under the End of Waste (EOW) Approval ENEW07542518 (Queensland approval). The REMP includes all aspects of environmental monitoring (hydrological, geomorphological, sediment quality, water quality and biological) to specifically address the EOW approval requirements. The REMP addresses all receiving environmental monitoring requirements and amalgamates the Discharge Management Plan (relevant to hydrology) and WQMP (relevant to water quality and biology) monitoring requirements.

For this WQMP, only the water quality and biological monitoring requirements are applicable, although hydrology and sediment quality are also incorporated.

Section 1.1 of this document specifically addresses the relevance of the WQMP to Matters of National Environmental Significance (MNES) while Section 1.2 provides cross references to those sections of the WQMP that relate directly to the conditions of approval.

The Woleebee Creek to Glebe Weir pipeline project is otherwise known as the Glebe End of Waste Scheme (GEWS) or simply as the 'Glebe Project', and this latter term is the terminology used in this document.

1.1 Relevance of the Plan to MNES

The Preliminary Documentation submitted 2 August 2012 included observations and predictions regarding potential water quality impacts on Matters of National Environmental Significance (MNES). The relevant MNES are Fitzroy River Turtle (*Rheodytes leukops*), white-throated snapping turtle (*Elseya albagula*) and the Great Barrier Reef World Heritage Area. With respect to Fitzroy River Turtle and white-throated snapping turtle, direct impacts may relate to toxic components of the discharge, though none were predicted other than ammonia in exceptional circumstances. The Preliminary Documentation noted "Any risk of ammonia toxicity will be limited to Glebe Weir and immediately downstream, as ammonia is highly bioavailable and is likely to be assimilated by algal and plant communities".

While Fitzroy River turtles have never been recorded in or immediately downstream of Glebe Weir, they have potential to occur in these areas as they have been recorded further upstream in the Dawson River. White-throated snapping turtles are known from the Dawson River in the vicinity of Glebe Weir. This suggests the possibility of exposure of Fitzroy River turtle and white-throated snapping turtle to high ammonia concentrations in exceptional circumstances. However, the volume of treated coal seam gas (CSG) water discharged into Glebe Weir (median 0 ML/Day, average 12.4 ML/Day) is significantly lower than the approved daily maximum of 100 ML/Day. The concentration of ammonia in Glebe Weir and immediately downstream in the 77 rounds of water quality monitoring completed to date has typically been consistent with baseline (i.e. pre-release) concentrations. This demonstrates that the empirical release rate does not elevate ammonia concentrations in Glebe Weir or the Dawson River. Therefore, the risk of exposure of Fitzroy River turtle and white-throated snapping turtles to ammonia toxicity is considered low.

A potential increase in the risk of algal blooms was also noted due to the low turbidity of the treated CSG water discharge, and both the natural and potentially increased capacity of Glebe Weir to stratify. The monitoring program includes chlorophyll a, which is a proxy indicator for planktonic algae, with the monitoring results to date indicating no algal blooms have occurred in Glebe Weir since the release of the resource commenced. Naturally high turbidity in Glebe Weir is thought to limit algal and aquatic plant growth in spite of high background nutrient levels. Increased aquatic plant growth was recognised as having potentially positive

impacts, although in other areas excessive growth has been observed to block the turtle's access to nesting banks. It possible that there are nesting banks for Fitzroy River turtle and white-throated snapping turtle within Glebe Weir and along the Dawson River near Glebe Weir. However, the risk of excessive aquatic plant growth impacting access to nesting banks by white-throated snapping turtle is low because water quality monitoring data to date has indicated that turbidity in Glebe Weir is consistent with baseline (i.e. pre-release) conditions, suggesting that excessive plant growth resulting from low turbidity associated with the release is not likely. Furthermore, excessive plant growth, if it was to occur would be temporary, and be unlikely to extend to upstream sections of Glebe Weir or downstream of Glebe Weir; thus, large areas of bank with potential nesting sites in upper reaches of Glebe Weir would be unobstructed by plant growth, even if an unlikely growth of aquatic plants occurred in the lower reaches of Glebe Weir near the release location.

Water quality changes which lead to an alteration of ecosystem functioning in general may also potentially indirectly impact Fitzroy River turtle and white-throated snapping turtle.

Section 7 of the Preliminary Documentation presented modelling results that predicted low levels of change to suspended solids and nutrient concentrations due to the release of the resource, with any changes detected likely to be local and related to increased agricultural production and runoff, and further noted that minor levels of local change to these parameters due to agriculture would be immeasurable at the mouth of the Fitzroy River and have no risk of impact on the Great Barrier Reef World Heritage Area.

While the preliminary documentation predicted minimal, localised and / or temporary changes in water quality due to the release of the resource, monitoring of the following parameters in the operational phase of the project was identified as being prudent for environmental management, including with respect to MNES:

- nutrients, focusing on ammonia because modelling presented in the Preliminary Documentation indicated this to be the only parameter where possible changes could occur due to the release of the resource
- temperature
- pH
- electrical conductivity
- turbidity (noting low turbidity was identified as the potential risk)
- blue green algae, with algal blooms assessed visually and chlorophyll a measured in the laboratory to provide quantitative data of algal concentrations in the water, and
- aquatic plants.

This WQMP includes monitoring of these and other parameters of potential relevance to release of treated CSG water which, although predicted to be at levels that would not cause impacts, could lead to potential impacts if those predictions were to prove incorrect.

1.2 Cross-Reference to Conditions of Approval

The conditions of approval relevant to the WQMP are noted in Table 1, as extracted from Sunwater's EPBC approval for the Woleebee Creek to Glebe Weir Pipeline project (EPBC Act referral 2011/6181), with cross references to sections of the document or documents that address the condition.

It is noted that the intent of the 'threshold limit' defined in Approval Condition 8aiii is to ensure that water quality conditions do not exceed a concentration above which impacts to aquatic ecosystems including MNES may occur. This is achieved by using an investigative approach to water quality, whereby exceedances of the project specific water quality guideline trigger a specific series of steps involving comparison and evaluation of water quality and biological data. Where the investigation indicates potential adverse impacts to aquatic ecosystems, including MNES, then operational management is implemented. This investigative approach is presented in detail in Section 8.

Table 1 Approval Conditions and Sections / Documents Addressing Conditions

Condition Number	Condition Requirements	Section / Document Addressing Condition
8	The person taking the action must prepare and submit a Water Quality Monitoring Plan (WQMP) for the Minister's approval	This document.
a	The WQMP must include, but not be limited to:	
i	measures to conduct **regular** environmental monitoring within the Dawson River, at a range of locations including, but not limited to: 1. upstream of the discharge point; 2. within Glebe Weir, but downstream of the discharge point; and 3. downstream of Glebe Weir, at least as far as Theodore Weir.	Monitoring Program Design – Section 6. Monitoring Sites – Section 6.2, Table 13 and Figure 3.
ii	details of parameters to be monitored.	Monitoring Program Design – Section 6. Indicators to be Monitored and Frequency of Monitoring – Section 6.4, Table 15 and Table 16.
iii	for each parameter specified in Condition 8(a)(ii), the WQMP must stipulate a **threshold limit**.	Environmental Values and Water Quality Objectives – Section 4. Water Quality, Sediment Quality and Biological Guidelines – Section 4.1.2. Water Quality – Section 4.2.1 and Table 9. In-Stream Sediment Quality guidelines – Section 4.2.2 and Table 10. Macroinvertebrate – Section 4.2.3 and Table 11. Fish – Section 4.2.4 and Table 12. Action Response Plan for Investigation and Management Responses to Exceedances of the Water Quality Guideline – Section 8.
iv	the WQMP must specify the guideline, standard or relevant research for which both the background level within Glebe Weir and the threshold limit has been set, along with a discussion as to why the particular guideline, standard or relevant research is appropriate.	Environmental Values and Water Quality Objectives – Section 4. Water Quality, Sediment Quality and Biological Guidelines – Section 4.1.2. Water Quality – Section 4.2.1 and Table 9. In-Stream Sediment Quality guidelines – Section 4.2.2 and Table 10. Macroinvertebrate – Section 4.2.3 and Table 11. Fish – Section 4.1.4 and Table 12. Action Response Plan for Investigation and Management Responses to Exceedances of the Water Quality Guideline – Section 8. *Sunwater Glebe Beneficial Use Scheme: Local Water Quality, Sediment Quality and Biological Guidelines* (frc environmental, 2015).
b	Within three months of every six month anniversary of commencement of **discharge** (and until two years after the cessation of **discharge**), the person taking the action	Reporting – Section 7. Environmental Performance Reporting – Section 7.2.

Condition Number	Condition Requirements	Section / Document Addressing Condition
	must submit to the **Minister** an Environmental Performance Report (EPR). Each EPR must include, but not be limited to, the following:	Reports must be submitted to the Commonwealth Department every six months in accordance with this condition. NB: Sunwater separately developed and obtained approval of its DMP from the Department of Environment on 23 January 2015.
i	the results of implementation of the Discharge Management Plan (DMP) required by Condition 7,	
ii	the results of the **regular** environmental monitoring required by the WQMP,	
iii	an independent evaluation of the results of the **regular** environmental monitoring required by the WQMP, and an assessment of any **new or increased impacts/likely impacts** to the environment, and	Reporting – Section 7. Environmental Performance Reporting – Section 7.2. Independent evaluation of results is provided in the EPRs, which must be submitted to the Commonwealth Department in accordance with this condition.
iv	details of **appropriate actions** taken/to be taken in the event that any **new or increased impacts/likely impacts** to the environment are identified.	Indicators to be monitored, potential impact assessment triggers and the required actions based on risk category are described in Section 6.4, Table 14 and Table 16. Actions taken are described in the EPRs, which must be submitted to the Commonwealth Department in accordance with this condition.
c	If, upon review of an EPR, the **Minister** is not satisfied that **appropriate actions** have been taken or will be taken to mitigate any **new or increased impacts/likely impacts** to the environment identified during the regular monitoring required by this condition, the **Minister** may direct the person taking the action to reduce or cease discharge. The person taking the action must then undertake an evaluation in accordance with the recommendations of an independent evaluator and submit the report to the **Department** for approval.	Reporting – Section 7. Environmental Performance Reporting – Section 7.2.

Table 2 Relevant Definitions from the Approval

Term	Definition
Appropriate actions	Actions which result in the total rectification of the identified new or increased impact/likely impact (i.e. actions that return the quality of the water to the quality it was before the new or increased impact/likely impact was identified).
New or increased impact(s)/likely impact(s)	An impact not identified in the Preliminary Documentation, dated 2 August 2012. Also includes an increase in impact beyond that identified in the Preliminary Documentation, dated 2 August 2012.
Regular	a) with respect to physico-chemical water quality parameters: a minimum of once per month for the first 12 months of operation, then at a frequency recommended by the Environmental Performance Report unless otherwise required by the Department,

Term	Definition
	b) with respect to biological parameters: twice per year (wherever possible this is to be once pre-wet season and once post-wet season) for the first three years of operation, then at a frequency recommended by the Environmental Performance Report unless otherwise required by the Department.
Threshold limit	The maximum limit or acceptable value range above the pre-existing background level within Glebe Weir which may be reached before impacts to Matters of National Environmental Significance are likely to occur.

2 Description of the Action

The Glebe project is fully described in the EPBC Preliminary Documentation for the project (SunWater 2012c) and the original application for a Beneficial Use Approval (SunWater 2012a). Those documents included risk assessments related to all relevant environmental issues and support this WQMP.

In summary, the Glebe Project will transfer treated coal seam gas water to customers along a transfer pipeline and within Sunwater's Dawson Valley Water Supply Scheme (DVWSS). The latter will involve authorised release of the treated CSG water to Cockatoo Creek at the downstream end of Glebe Weir.

Once released to Glebe Weir the treated CSG water can be distributed within and extracted from the DVWSS for a range of purposes.

2.1 Release Characteristics and Potential Risks

2.1.1 Water Quality

Release of the treated CSG water to Cockatoo Creek, within the weir pool of Glebe Weir, has been authorised by the Queensland Department of Environment and Science (DES) at the limits shown in Table 3. The Queensland End of Waste (EoW) Approval specifies that the quality of the resource at discharge is based on measurement at the Treated Water Pond.

The available water quality data for the resource indicates that all parameters have achieved these limits between July 2015 and September 2020 (Table 3) and thus have a low risk of impact to the environmental values of the receiving environment, excluding dissolved copper in February 2019, which detailed assessment demonstrated had no impact on the aquatic ecological values of the receiving environment (frc environmental 2019).

Table 3 Water Quality Limits for the Treated CSG Water and WQGs at Glebe Weir Outlet

Characteristic of Resource	Quality Limit	Limit Type	Maximum [a] Recorded in Resource in the Treated Water Pond; July 2015 to September 2020
Schedule B – Table 1			
Boron (dissolved)	1 mg/L	Maximum	0.28
Ammonia	0.5 mg/L	80th percentile of previous 10 samples	0.31
pH (measured in situ)	6.5 – 8.5	range	7.1 – 8.4 [a]
Electrical conductivity (measured in situ)	445 µS/cm	Maximum	390
Arsenic (dissolved)	0.024 mg/L	Maximum	0.001
Chromium IV (dissolved)	0.001 mg/L	Maximum	<LOR: <0.001
Iron (dissolved)	0.3 mg/L	Maximum	0.017
Lead (dissolved)	0.0034 mg/L	Maximum	<LOR: <0.001
Manganese (dissolved)	1.9 mg/L	Maximum	0.005
Nickel (dissolved)	0.011 mg/L	Maximum	<LOR: <0.001
Selenium (dissolved)	0.005 mg/L	Maximum	<LOR: <0.001
TPH (C6-C9; C10-C14; C15-C28; C29-C36)	Monitor – no limit	–	20 (C6-C9); <LOR: <50 <LOR: <100 (other fractions)
Chlorophyll a (µg/L)	Monitor – no limit	–	0.005
Dissolved oxygen (measured in situ; mg/L)	Monitor – no limit	–	–
Turbidity (measured in situ)	50 NTU	Maximum	1.9
Copper (dissolved)	0.0014 mg/L	Maximum	0.004 [b]
Zinc (dissolved)	0.008 mg/L	Maximum	0.006
Calcium	4.0 mg/L	Minimum	5.4 [a]
Magnesium	2.0 mg/L	Minimum	2.3 [a]
Chloride	135 mg/L	80th percentile of previous 10 samples	86
Sodium	95 mg/L	80th percentile of previous 10 samples	57
SAR	8	80th percentile of previous 10 samples	3.9
Schedule B – Table 2 (Drinking Water)			
Alpha Activity	0.5 Bq/L	Maximum	0.072
Aluminium (total)	200 µg/L	Maximum	94
Antimony (total)	3.0 µg/L	Maximum	<LOR: <1
Barium (total)	2,000 µg/L	Maximum	130
Benzene	1.0 µg/L	Maximum	<LOR: <0.5
Beta Activity	0.5 Bq/L	Maximum	0.098
Bisphenol A	200 µg/L	Maximum	<LOR: <20
Bromide	7,000 µg/L	Maximum	320
Bromochloroacetonitrite	0.7 µg/L	Maximum	0.4
Bromodichloromethane	6.0 µg/L	Maximum	<LOR: <0.5
Bromoform	100 µg/L	Maximum	7.9
Cadmium (total)	2.0 µg/L	Maximum	1.1
Chloroform (Trichloromethane)	200 µg/L	Maximum	<LOR: <0.5
Cyanide	80 µg/L	Maximum	4
Dibromochloromethane	100 µg/L	Maximum	0.8

Characteristic of Resource	Quality Limit	Limit Type	Maximum [a] Recorded in Resource in the Treated Water Pond; July 2015 to September 2020
Dichloroacetonitrite	2.0 µg/L	Maximum	0.5
Ethylbenzene	300 µg/L	Maximum	<LOR: <0.5
Fluoride	1,500 µg/L	Maximum	200
Iodide	100 µg/L	Maximum	50
Mercury (total)	1.0 µg/L	Maximum	0.3
Molybdenum (total)	50 µg/L	Maximum	1.0
N-Nitrosodimethylamine (NDMA)	0.1 µg/L	Maximum	<LOR: <0.1
Nonylphenol	500 µg/L	Maximum	<LOR: <100
PAH (as B(a)P TEF):	0.01 µg/L	Maximum	<LOR: <0.01
benz[a]anthracene (TEF: 0.1)		Maximum	<LOR: <0.01
benzo[b+j]fluoranthene (TEF: 0.1)		Maximum	<LOR: <0.01
benzo[k]fluoranthene (TEF: 0.1)		Maximum	<LOR: <0.02
benzo[a]pyrene (TEF: 1.0)		Maximum	<LOR: <0.01
chrysene (TEF: 0.01)		Maximum	<LOR: <0.01
dibenz[a,h]anthracene (TEF: 5.0)		Maximum	<LOR: <0.01
indeno[1,2,3-cd]pyrene (TEF: 0.1)		Maximum	<LOR: <0.01
Silver (total)	100 µg/L	Maximum	<LOR: <1
Strontium (total)	4,000 µg/L	Maximum	72
Sulfate	500,000 µg/L	Maximum	3,000
Toluene	800 µg/L	Maximum	<LOR: <500
Total Petroleum Hydrocarbons (TPH)	200 µg/L	Maximum	<LOR: <110
Vanadium (total)	50 µg/L	Maximum	3
Xylene (m & p)	600 µg/L	Maximum	<LOR: <1

[a] pH is a range, and calcium and magnesium are minimums

[b] Dissolved copper exceeded on a single occasion on 13/02/2019; the other 202 monitoring events between July 2015 and September 2020 complied with the limit

<LOR = less than Limit Of Reporting

Blue shading denotes a value higher than the limit.

– No data for resource available

2.1.2 Water Quantity

The resource is authorised to be released for a maximum period of 26 years under Condition A7 of the EOW approval. Within the DVWSS the resource will be allocated via the existing allocation system, meaning most of the resource will be available for extraction and use from and upstream of Theodore Weir pool.

The annual volume of the resource that is released must not exceed 36,500 megalitres (ML) under Condition A5 of the EOW approval, while Condition A6 specifies that the maximum daily release to Glebe Weir must not exceed 100 ML.

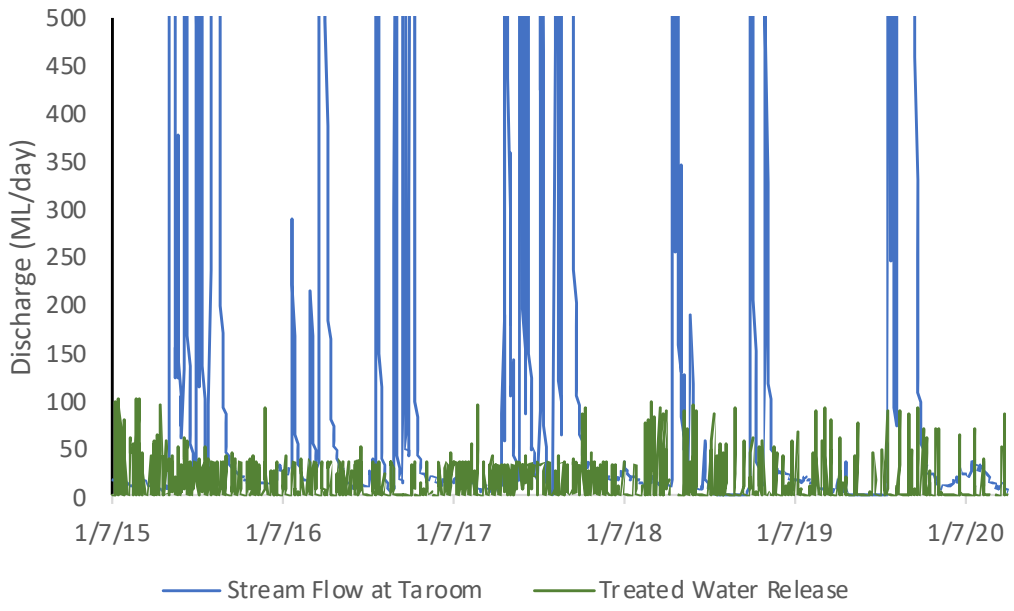
Condition B10 of the EOW approval specifies the location for monitoring and recording the quantity of water released to Glebe Weir.

Operational releases of the resource commenced on 1 February 2015, with releases to date never exceeding 100.3 ML/day (Table 4). The median, 80th percentile and maximum flows in the Dawson River all exceed those of the release volume, although the release volume exceeds river flow (discharge) approximately 50% of the time (Figure 1).

Table 4 Comparison of flow volumes of the release and river flow in the Dawson River at gauging station 30302A between July 2015 and September 2020.

Summary Statistic	Release (ML/day)	River Flow at Gauging Station 30302A (mean ML/day)
Minimum	0	0
Median	0	18.9
80th percentile	33.5	91.9
Maximum	100.3	51,027

Figure 1: Daily release volume (ML/day) and river flow in the Dawson River at Gauging Station 30302A (mean ML/day) between July 2015 and September 2019, noting that large river flows have been truncated at 500 ML/day.



3 Description of Receiving Environment Attributes

3.1 Spatial Extent of the Receiving Environment

The receiving environment for the Glebe Project includes the waters of the Glebe Weir and connected waterways, any waterways crossed by the pipeline, as well as the waters of the DVWSS (Figure 2).

The DVWSS extends from the upstream end of Glebe Weir pool (AMTD 356.5 km) to Boolburra Waterhole (AMTD 18.4 km) on the Dawson River, including the Theodore and Gibber Gunyah irrigation channels (Figure 2).

The length of the receiving environment within the Dawson River for GBUS is approximately 340 km. The DVWSS includes flowing reaches and a number of impounded reaches (i.e. weir pools). The weirs in the system from upstream to downstream are Glebe, Gyranda, Orange Creek, Theodore, Moura and Neville Hewitt (Figure 2).

The receiving environment spans both the Upper and Lower Dawson River Sub catchments, with waterways upstream of Glebe Weir (and including Glebe Weir) being within the Upper Dawson Sub-catchment, and waterways downstream of Glebe Weir being within the Lower Dawson Sub-catchment (Figure 2). Designations are in accordance with Dawson River Sub basin Environmental Values and Water Quality Objectives (EPP (Water and Wetland Biodiversity) 2009 (EHP 2013a).

However, for the purpose of environmental monitoring of water quality and aquatic ecology in the potentially impacted waters of the receiving environment, two water types are recognized: regulated water (i.e. Glebe and Gyranda weir pools) and unregulated water (i.e. riverine section of the Dawson River between the township of Taroom and Gyranda Weir).

The monitoring sites span all water types of the receiving waters, and include two upstream reference sites (Table 5; Figure 3).

Table 5 Overview of WQMP Monitoring Sites.

Site	Site Type	Location Description	Water Type	Location on Dawson River
WS01	Reference site	Dawson River at Leichhardt Highway; 38 km upstream of the confluence of Cockatoo Creek and Dawson River.	Unregulated water	Upper Dawson
WS02	Reference site	Dawson River at Bundalla Road Crossing; 35 km upstream of the confluence of Cockatoo Creek and Dawson River.	Unregulated water	Upper Dawson
WS03	Receiving environment site	Dawson River within Glebe Weir pool; 2.5 km upstream of the confluence of Cockatoo Creek and Dawson River.	Regulated water	Upper Dawson
WS04	Receiving environment site	Dawson River within Glebe Weir pool; 100 m upstream of the confluence of Cockatoo Creek and Dawson River.	Regulated water	Upper Dawson

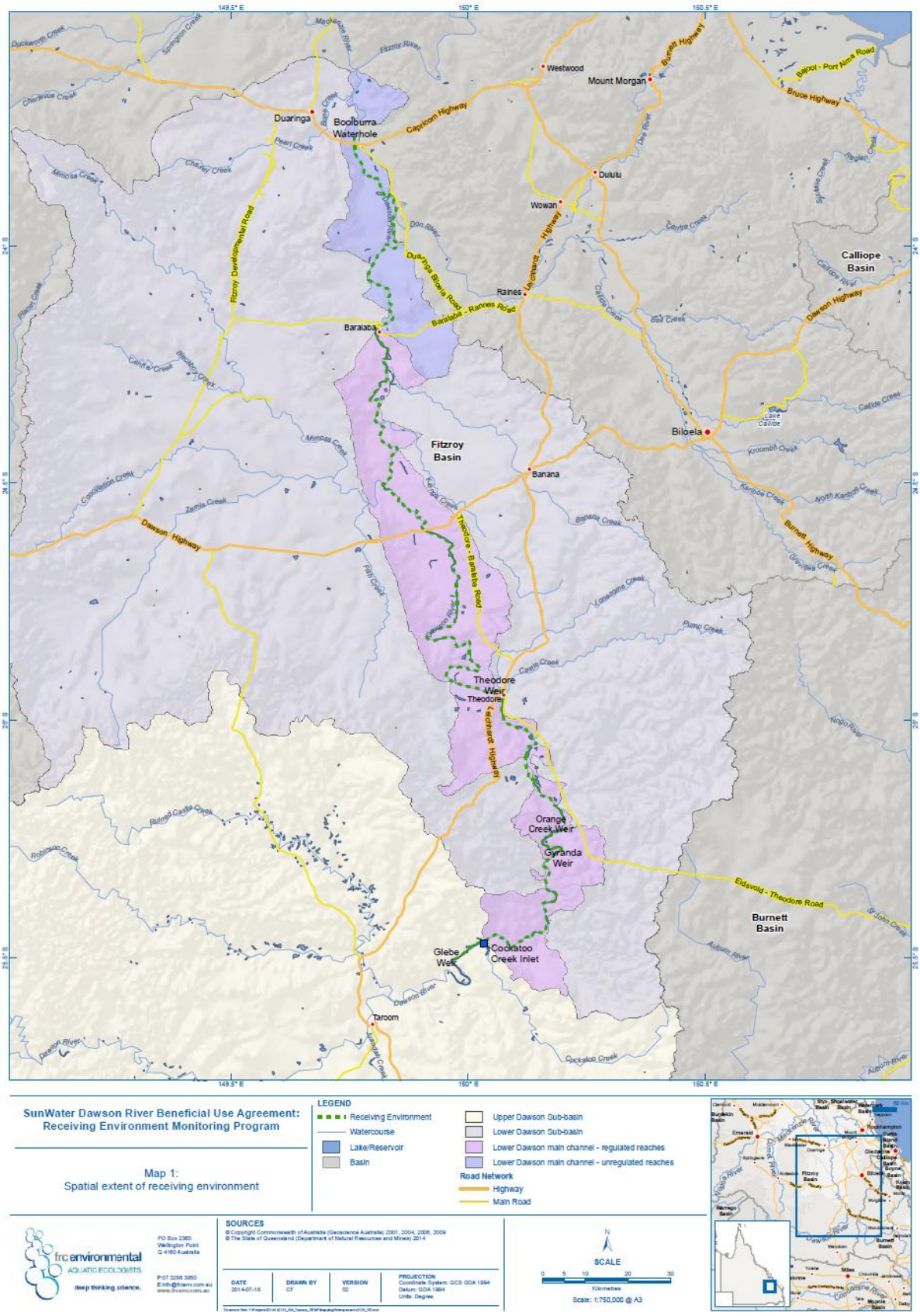
WS05	Receiving environment site	Dawson River downstream of Glebe Weir; 1.9 km downstream of the discharge location.	Unregulated Water	Lower Dawson
WS06	Receiving environment site	Dawson River downstream of Glebe Weir; 6.5 km downstream of the discharge location.	Unregulated Water	Lower Dawson
WS07	Receiving environment site	Dawson River 42 km downstream of Glebe Weir in Gyranda Weir Pool	Regulated Water	Lower Dawson
WS09	Receiving environment site	Dawson River within Theodore Weir	Regulated Water	Lower Dawson

3.1.1 Potentially Impacted Waterways

Modelling studies completed for the EIS have shown that any impacts to water quality and aquatic ecology are mostly likely to occur near the point of discharge at the lower end of Glebe Weir and within a short distance downstream of the weir. Sites on the Dawson River upstream of the junction of Cockatoo Creek are unlikely to be affected when the river is flowing. It is possible that changes in flow patterns may be measurable as far downstream as Theodore Weir (i.e. site WS09, some 94 km downstream from Glebe Weir); however, it is expected that any flow changes this far downstream will be minor compared to existing flow modification and are unlikely to have an adverse environmental impact. The majority of the additional water will be extracted upstream of Theodore Weir so locations downstream from this point are not regarded as at risk.

The waterways potentially impacted as a result of releases for maintenance of the pipeline include Cockatoo, Bungaban, Juandah and Woleebee Creeks.

Figure 2: Dawson River Sub-catchments (upper and lower Dawson River)



3.2 Condition of the Receiving Environment

3.2.1 Previous Surveys

A number of relevant studies were undertaken in the Dawson River as part of the Nathan Dam and Pipelines EIS (SunWater 2008, 2012b; frc environmental 2010; 2011). These studies considered the hydrology, geomorphology, water quality, aquatic flora and aquatic fauna of the Dawson River.

Baseline aquatic ecology and water quality surveys within the receiving environment (and upstream of the receiving environment) were completed on a regular basis between February 2012 and February 2015, including quarterly (and sometimes monthly) water quality monitoring (Table 6) and twice-yearly surveys of aquatic ecology (including aquatic habitat, sediment quality, aquatic plants, macroinvertebrates and fish) (Table 7). The location of the baseline monitoring sites is presented in Figure 3.

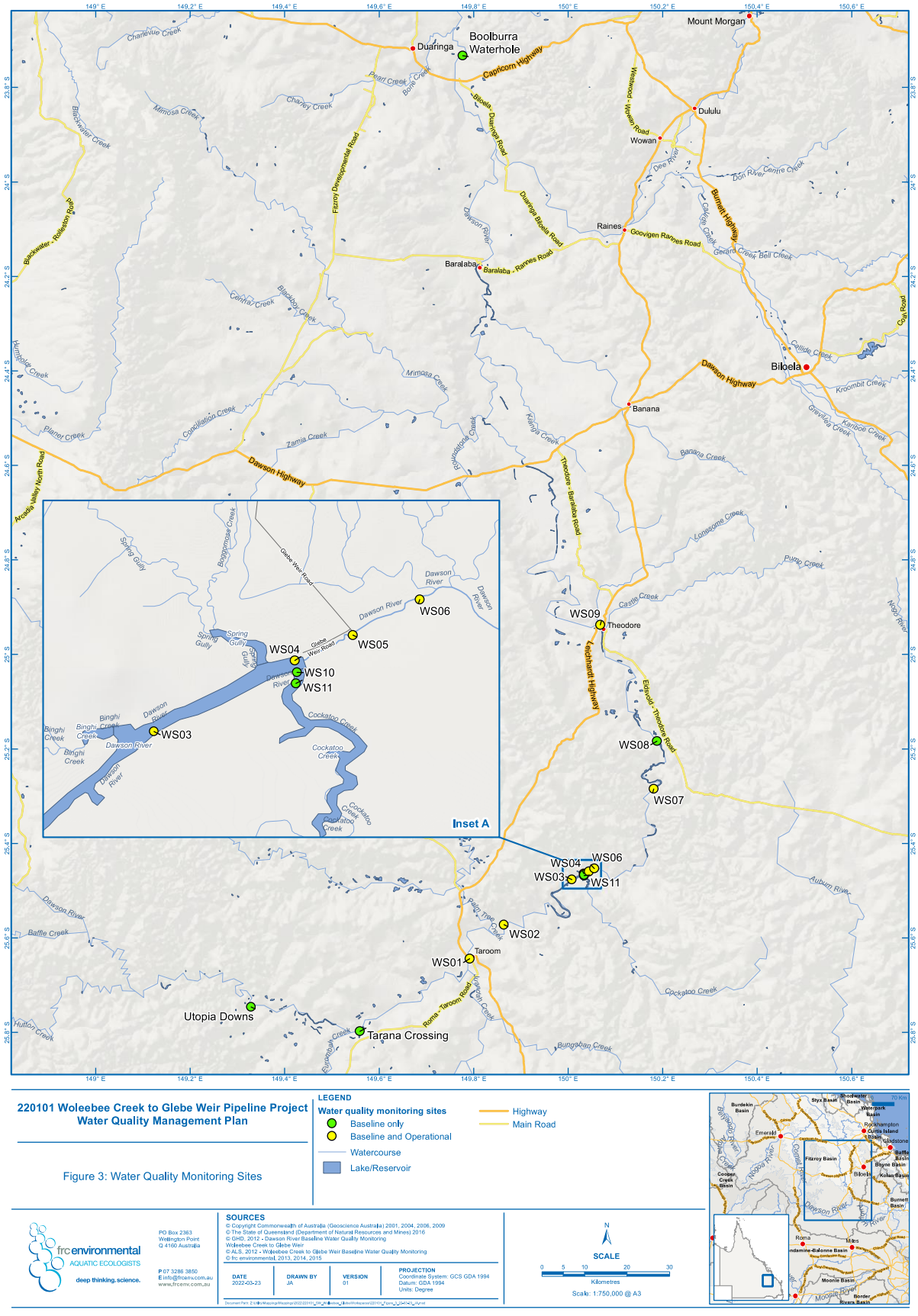
Table 6 Overview of Baseline Surveys of Water Quality that have been undertaken within the Receiving Environment

Study	Monitoring date and round	Sites assessed in survey round
ALS 2012	Water quality monitoring round 1, February 2012	Utopia Downs, WS01, WS02, WS04/UD2, WS05/LD1, WS07, WS08, WS09, Boolburra Waterhole
GHD 2012	Water quality monitoring round 2, August 2012	Tarana Crossing, WS01, WS02, WS04/UD2, WS05/LD1, WS07, WS08, WS09, Boolburra Waterhole
frc environmental 2013a	Water quality monitoring round 3, November 2012	Tarana Crossing, WS01, WS02, WS04/UD2, WS05/LD1, WS07, WS08, WS09, Boolburra Waterhole
frc environmental 2013b	Water quality monitoring round 4, April 2013	Tarana Crossing, WS01, WS02, WS03/UD1, WS04/UD2, WS05/LD1, WS06/LD2, WS07, WS08, WS09, Boolburra Waterhole
frc environmental 2013c	Water quality monitoring round 5, June 2013	WS01, WS02, WS03/UD1, WS04/UD2, WS05/LD1, WS06/LD2, WS07, WS08, WS09
frc environmental 2013d	Water quality monitoring round 6, September 2013	WS01, WS02, WS03/UD1, WS04/UD2, WS10, WS11, WS05/LD1, WS06/LD2, WS07, WS08, WS09
frc environmental 2013e	Water quality monitoring round 7, November 2013	WS01, WS02, WS03/UD1, WS04/UD2, WS10, WS11, WS05/LD1, WS06/LD2, WS07, WS08, WS09
frc environmental 2014a	Water quality monitoring round 8, January 2014	WS01, WS02, WS03/UD1, WS04/UD2, WS10, WS11, WS05/LD1, WS06/LD2, WS07, WS08, WS09
frc environmental 2014b	Water quality monitoring round 9, April 2014	WS01, WS02, WS03/UD1, WS04/UD2, WS10, WS11, WS05/LD1, WS06/LD2, WS07, WS08, WS09
frc environmental 2014d	Water quality monitoring round 10, July 2014	WS01, WS02, WS03/UD1, WS04/UD2, WS10, WS11, WS05/LD1, WS06/LD2, WS07, WS08, WS09
frc environmental 2014f	Water quality monitoring round 11, October 2014	WS01, WS02, WS03/UD1, WS04/UD2, WS10, WS11, WS05/LD1, WS06/LD2, WS07, WS08, WS09

Table 7 Overview of Baseline Surveys of Aquatic Ecology that have been undertaken in the Receiving Environment

Study	Monitoring date and round	Sites assessed in survey round
frc environmental 2013f	Aquatic ecology monitoring round 1, November 2012	Tarana Crossing, WS01, WS02, WS04/UD2, WS05/LD1, WS07, WS08, WS09, Boolburra Waterhole
frc environmental 2013g	Aquatic ecology monitoring round 2, June 2013	WS01, WS02, WS03/UD1, WS04/UD2, WS10, WS11, WS05/LD1, WS06/LD2, WS07, WS08, WS09
frc environmental 2013h	Aquatic ecology monitoring round 3, November 2013	WS01, WS02, WS03/UD1, WS04/UD2, WS10, WS11, WS05/LD1, WS06/LD2, WS07, WS08, WS09
frc environmental 2014c	Aquatic ecology monitoring round 4, April 2014	WS01, WS02, WS03/UD1, WS04/UD2, WS10, WS11, WS05/LD1, WS06/LD2, WS07, WS08, WS09
frc environmental 2014e	Aquatic ecology monitoring round 5, October 2014	WS01, WS02, WS03/UD1, WS04/UD2, WS10, WS11, WS05/LD1, WS06/LD2, WS07, WS08, WS09

Figure 3: Location of Baseline and WQMP Monitoring Sites



3.2.2 Catchment Area, Surrounding Land Use and Current Riverine Development

The Dawson River is a major tributary of the Fitzroy River. The catchment of the Dawson River and its tributaries cover an area of approximately 50,776 km2 (EHP 2013a).

Glebe Weir (the most upstream reach of the receiving environment) was constructed in 1971 and has a catchment area of 19,423 km2. The surrounding land use is predominantly cattle grazing, with some cropping and recreation. The nearest town is Taroom, approximately 50 km upstream of the weir. The weir pool is a popular primary and secondary recreation area used for fishing and boating, and there is a designated and well used camping area and boat ramp on the left bank adjacent to the weir and opposite the mouth of Cockatoo Creek. Water is extracted or released from Glebe Weir to the DVWSS and used for cropping (mostly cotton), stock watering, industrial use and urban supplies (SunWater 2012a and b). Public access to Glebe Weir, in particular boating traffic on the weir pool, creates moderate disturbance of aquatic habitats. Aquatic habitats within the weir pool are restricted, mostly limited to deep pool habitat and large woody debris, which are the dominant aquatic habitats within impounded reaches of the Dawson River generally.

Gyranda Weir, Orange Creek Weir and Theodore Weir are also located within the receiving environment (Table 8) downstream from Glebe Weir (Figure 5). Similar to Glebe Weir, surrounding land use at Gyranda and Orange Creek is predominantly cattle grazing, but they have no formal recreation areas or direct public access. Theodore Weir is adjacent the township of Theodore and the main irrigation area, which is both riparian and channel based. Aquatic habitat diversity at all weirs is low. There is over 15 km of flowing river between Glebe Weir and the upstream extent of Gyranda Weir pool, and 25 km of flowing river between Orange Creek Weir and Theodore Weir pool, although there is limited flowing river between Gyranda Weir and Orange Creek Weir pool (Table 8).

Table 8 Location of Weirs within the Glebe Receiving Environment

Weir	Location (AMTD km)	Full Supply Volume	Length of River Inundated (km)
Glebe	326.2	17,700	30.3
Gyranda	284.5	16,500	26.5
Orange Creek	270.7	6,140	13.8
Theodore	228.5	4,760	16.0

3.2.3 Hydrology

The flow regime of the Dawson River and its tributaries is dominated by 'unpredictable, highly intermittent summer flow' with some reaches having 'variable, extremely intermittent summer flow' (Kennard et al. 2010). Thus, the magnitude, duration and timing of summer flows can vary between years, although the majority of flows occur from December to April, with high flow events most likely to occur in late summer or early autumn (SunWater 2008). Long-term flow data recorded at the Nathan George gauging station show that the Dawson River is in low flow condition most of the time with intermittent flows generally occurring as large pulses (SunWater 2008). Median annual flow at Glebe Weir is 240,065 ML/a (to 2011). In unregulated reaches above Glebe Weir years of zero flow have been recorded.

River flows above the release location are monitored at DNRME gauging station 30302A (Dawson River at Taroom), with flows recorded over 95% of the time (Figure 4) and large flows typically recorded in the summer months (Figure 1).

The low flow regime within the DVWSS is regulated via releases from the weirs and determined by the Fitzroy Basin Water Resource Plan and Resource Operations Plan.

Low flow and zero flow periods are likely to be the most important 'events' for the WQMP, as during these times the discharge may constitute a significant proportion of water within the Dawson River near the discharge location (i.e. Glebe Weir and downstream).

Figure 4: Long-term Flow Duration Curve for DNRME gauging station 30302A (Dawson River at Taroom), January 1911 to November 2018.

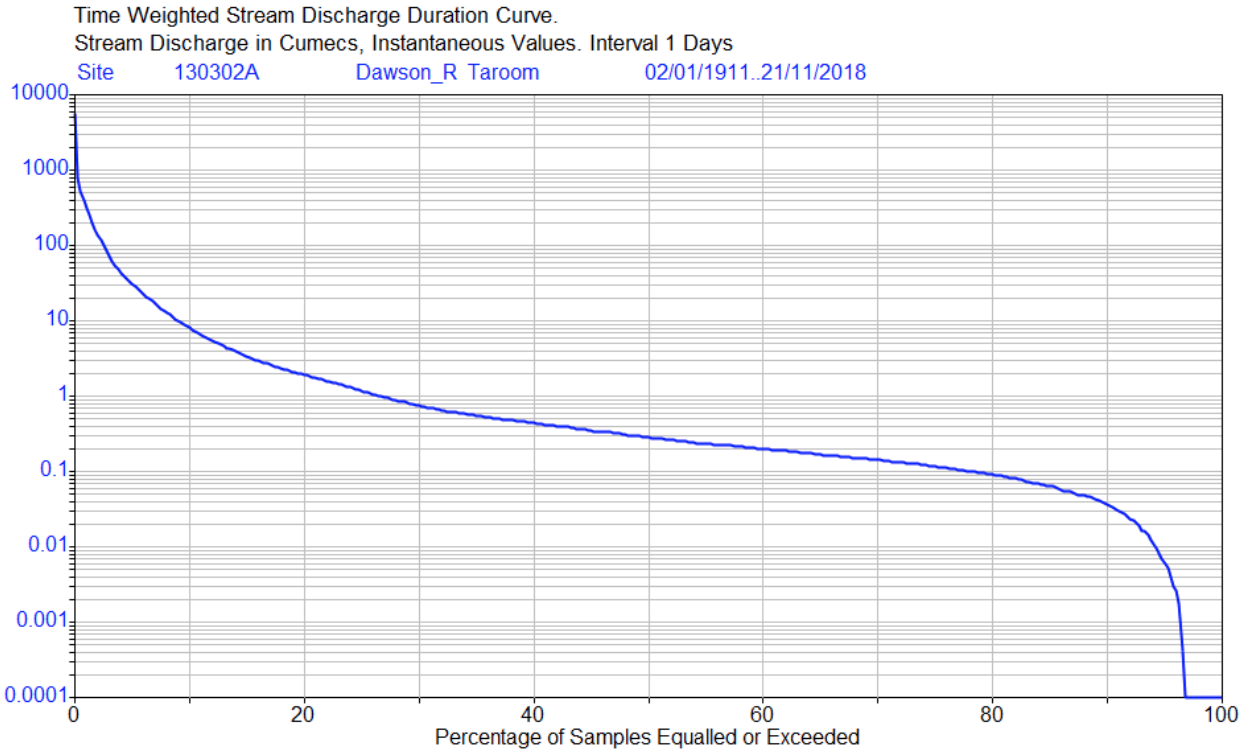
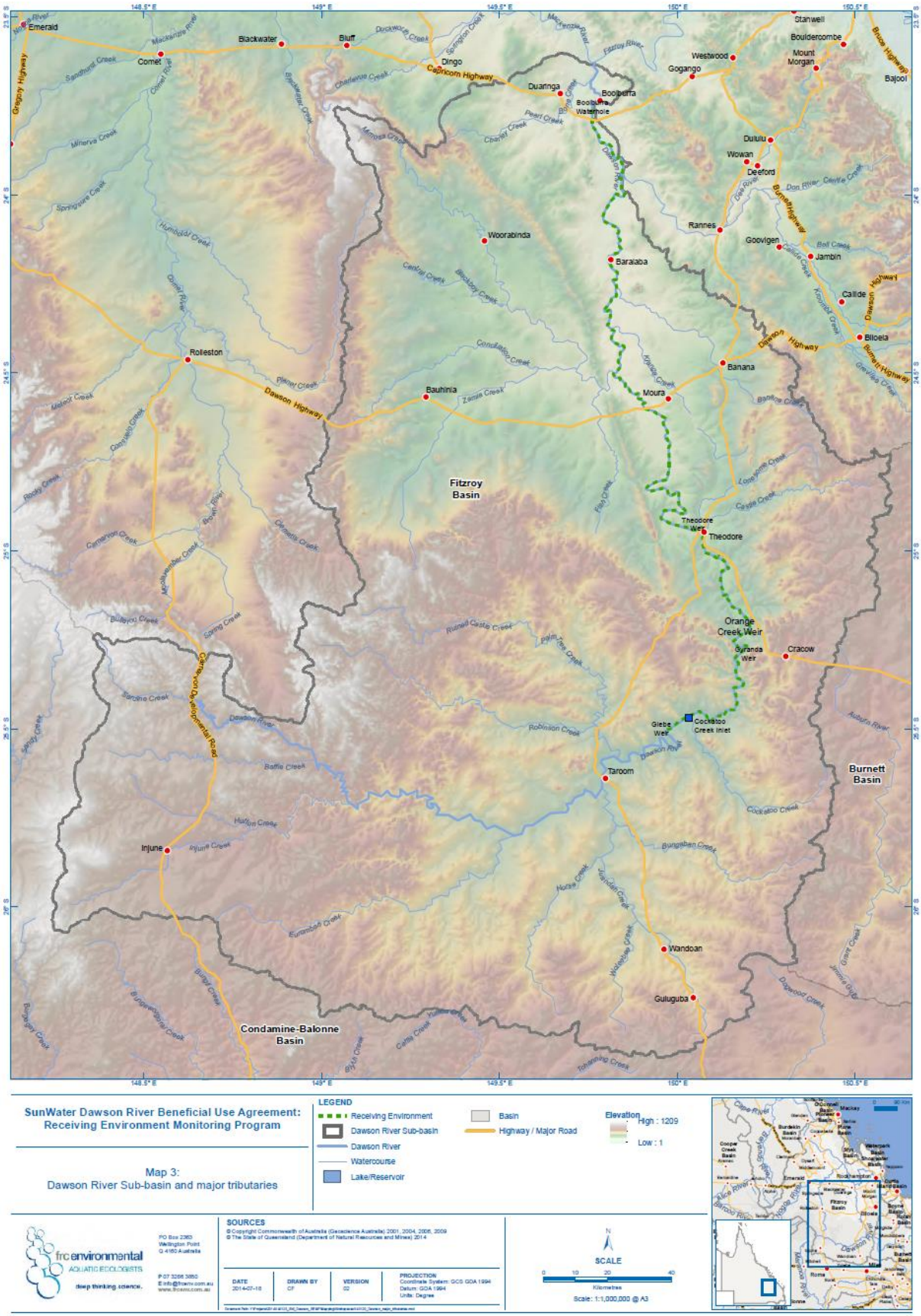


Figure 5: Area Plan of Receiving Environment



3.2.4 Aquatic Habitat

There is a diverse range of aquatic habitats in the Dawson River within the receiving environment that provide favourable conditions for aquatic fauna and plants. Habitats include shallow and deep pools, riffle and run flowing habitats, large woody debris and variable substrate types. Perennial water holes and weir pools also provide dry-season refuge for aquatic fauna, including for conservation significant species of freshwater turtle (Section 3.2.10) several species of fish (Section 3.2.9) and macroinvertebrates (Section 3.2.8) that are endemic to the Fitzroy River.

3.2.5 Water Quality

Water quality data relevant for the WQMP was collected at baseline monitoring sites, and was compiled and summarised (frc environmental 2015d). Previously reported water quality data (e.g. SunWater 2008; 2012a,b,c) were also reviewed to provide an overview of the current condition of water quality within the receiving environment.

Water quality in the receiving environment relative to the default WQOs of the EPP (Water and Wetland Biodiversity) range was characterised by:

- Variable electrical conductivity that was sometimes higher (base flow conditions)
- High turbidity
- Low dissolved oxygen
- High ammonia, and
- High concentrations of some metals (e.g. aluminium and zinc).

3.2.6 In-Stream Sediment Quality

Sediment quality data was collected at sites within the receiving environment and was compiled and summarised (frc environmental 2015d).
Sediment quality in the receiving environment complied with the interim sediment quality guidelines (low trigger value) (ANZECC & ARMCANZ 2000a, ANZG 2018), noting that guideline values are not available for all parameters. The concentration of metals in sediment was varied, with some parameters, such as iron and manganese, having relatively high concentrations compared to other parameters.

3.2.7 Aquatic Plants

Aquatic plant abundance and diversity in the receiving environment is low (frc environmental 2015d). One submerged plant species, curly pondweed (*Potamogeton crispus*), four floating plants species (*Azolla pinnata*, *Ricciocarpus* sp., *Spirodela polyrhiza*, *Lemna* sp.) and one floating attached species (*Ludwigia peploides montevidensis*) have been recorded from baseline surveys (frc environmental 2015d). However, the total cover and abundance of aquatic plants in water was highly variable and generally very low. A number of emergent aquatic plants have also been recorded, mostly growing on the banks and along the edge of water, including *Juncus* spp., *Persicaria* spp., *Cyperus* spp., *Fimbristylis* spp. and *Lomandra* sp.; however, the total abundance and cover of these aquatic plant species is also highly variable but often low (frc environmental 2015d).

3.2.8 Macroinvertebrates

The baseline data (frc environmental 2015d) showed that the diversity of macroinvertebrates was higher in the unregulated water type than the regulated water type. For the unregulated water type, the baseline data showed that taxonomic richness, PET richness and SIGNAL-2 Scores generally achieved the published default WQO for the Dawson River (EHP 2013a), indicating that macroinvertebrate communities in this water type were in good condition.

Macroinvertebrate communities were dominated by tolerant taxa, including Ceratopogonidae, Chironominae and Tanypodinae (non-biting midges) and Corixidae (water boatmen). More sensitive taxa, including Elmidae (riffle beetles), Scirtidae (marsh beetles), Leptophlebiidae (mayflies) and Calamoceratidae

(sleeping-bag caddisflies) have also been recorded in small numbers in both regulated and unregulated water types. A species of moon snail, *Larina strangei* (family Viviparidae), is known from the Dawson River in the vicinity of Isla Delusion (site WS08), and is considered to be endemic to the Dawson River, although is not a listed threatened species.

3.2.9 Fish

Sixteen native species of fish have been recorded during baseline surveys within the receiving environment (frc environmental 2015d):

- Agassiz's glassfish (*Ambassis agassizii*)
- barred grunter (Amniataba percoides)
- blue catfish (Neoarius graeffei)
- bony bream (Nematalosa erebi)
- carp gudgeon (Hypseleotris spp.)
- eastern rainbowfish (Melanotaenia splendida splendida)
- flathead gudgeon (Philypnodon grandiceps)
- flyspecked hardyhead (Craterocephalus stercusmuscarum)
- freshwater catfish (*Tandanus tandanus*)
- Hyrtl's catfish (*Neosilurus hyrtlii*)
- leathery grunter (*Scortum hillii*)
- sleepy cod (Oxyeleotris lineolata)
- southern saratoga (Scleropages leichardti)
- spangled perch (Leiopotherapon unicolor)
- yellow belly (Macquaria ambigua)
- Swamp eel (Ophisternon gutturale)

The fish species recorded can tolerate a wide range of water quality conditions (Allen et al. 2002; Pusey et al. 2004). All species are common to the Fitzroy Basin and the Upper and Lower Dawson River, and have been recorded in other surveys in the region (Platten 2011). Leathery grunter and southern saratoga are endemic to the Fitzroy River.

Two exotic species of fish, mosquitofish (*Gambusia holbrooki*) and goldfish (*Garassius auratus*) have also been recorded in baseline surveys. These species are widespread throughout the Dawson River, with a third species guppy (*Poecilia reticulate*), also known from the Dawson River (Platten 2011).

3.2.10 Turtles

Five species of turtles have been recorded from the receiving environment (SunWater 2008; frc environmental 2010; 2011):

- Krefft's river turtle (Emydura macquarii krefftii)
- saw-shelled turtle (Wollumbinia latisternum)
- broad-shelled turtle (Chelodina expansa)
- Fitzroy River turtle (Rheodytes leukops)
- white-throated snapping turtle (Elseya albagula)

All species except Fitzroy River turtle have been recorded from Glebe Weir, although Fitzroy River are known to occur in the Dawson River upstream from Glebe Weir. Eastern long-necked turtle (*Chelodina longicolis*) also like occurs in the GEWS receiving environment.

The Fitzroy River turtle is listed as vulnerable under the EPBC Act and white-throated snapping turtle is listed as critically endangered under the EPBC Act. Krefft's river turtle, saw-shelled turtle, broad-shelled turtle and eastern long-necked turtle are common in the region and are not listed as species of conservation significance under the Commonwealth's Environment Protection and Biodiversity Conservation Act 1999 (EPBC Act) or Queensland's Nature Conservation Act 1992 (NC Act).

4 Environmental Values and Water Quality Objectives

4.1 Environmental Values

The receiving environment spans the Upper and Lower Dawson River Sub-catchments, with waterways upstream of Glebe Weir (and including Glebe Weir pool) being within the Upper Dawson Sub-catchment, and waterways downstream of Glebe Weir being within the Lower Dawson Sub catchment. The Dawson River Sub–basin Environmental Values and Water Quality Objectives, EPP (Water) 2009 (EHP 2013a) identifies the following environmental values (EVs) for water within these sub-catchments for both regulated and un-regulated reaches:

- aquatic ecosystem (moderately disturbed waters)
- irrigation
- farm water supply
- stock water
- aquaculture (only regulated reaches of the Lower Dawson River Sub-catchment)
- human consumers
- primary recreation
- secondary recreation
- visual recreation
- drinking water
- industrial uses, and
- cultural and spiritual values.

4.2 Water Quality, Sediment Quality and Biological Guidelines

Water quality guidelines (WQGs), and sediment and biological guidelines, represent trigger levels for parameters that when achieved provide protection of the relevant EV. Where a WQG is not met, further investigation is required to determine if adverse environmental harm has been or may be caused. Thus, exceedance of the WQGs does not indicate adverse environmental harm in itself; only the need for further investigation. Where a WQG is endorsed by stakeholders and is scheduled under the Environmental Protection (Water and Wetland Biodiversity) Policy, it is known as a Water Quality Objective (WQO). Default published WQOs have been published for the Dawson River:

- Australian and New Zealand Guidelines for Fresh and Marine Water Quality (ANZECC & ARMCANZ 2000a; ANZG 2018), which specifies national and where possible regional WQOs for broad regions within Australia
- Queensland Water Quality Guidelines (QWQG) (EHP 2013b), which specifies WQGs for different regions within Queensland, but also encourages the development of local WQGs
- Dawson River Sub–basin Environmental Values and Water Quality Objectives EPP (Water) 2009 (EHP 2013a), which specifies sub–regional WQOs for different areas of the Dawson River Sub–basin
- The Australian Drinking Water Guidelines (NHMRC & NRMMC 2021), which specifies WQGs for drinking water to protect human health, and
- The End of Waste approval, Condition B5 (Schedule B, Tables 1 and 2), which specifies water quality limits for the resource and quality limits for protecting the EV of drinking water.

However, for the receiving environment waters, project specific WQGs were developed using baseline data for protection of the EV of aquatic ecosystems (frc environmental 2015d). These guidelines represent trigger values that if exceeded require further investigation to determine if the recorded concentrations are likely to be harmful to aquatic ecosystems (see also detail in Section 1.2). The project specific WQGs typically represent high trigger values on the basis that contaminants generally increase concentrations above levels that may become toxic or harmful to aquatic ecosystems. However, the CS discharge may sometimes have the opposite affect for some parameters, where it may reduce the concentration to a level that may become harmful, for example by not providing sufficient calcium or magnesium for species that use it to manufacture

a shell or exoskeleton. In such cases a minimum trigger has also been developed, and the local WQG is presented as a range

For the purpose of the WQMP, project specific guidelines have been set for (frc environmental 2015d):

- water quality parameters to assess regulated and unregulated water types in the receiving environment
- sediment quality parameters for regulated and unregulated water types in the receiving environment
- macroinvertebrates indices for regulated and unregulated water types in the receiving environment, and
- a fish index for regulated and unregulated water types in the receiving environment.

For receiving environment waters, the water quality, sediment and biological guidelines presented in this WQMP represent the targets to be achieved, but do not represent the contaminant concentrations or levels indicating adverse environmental impacts.

4.2.1 Water Quality

The water quality guidelines applicable for the WQMP are listed in Table 9 for monitoring of receiving environment waters.

Table 9 Project Specific Water Quality Guidelines for water quality monitoring in the receiving environment

Water Quality Characteristic	Units	Project Specific WQG – Regulated Waters	Project Specific WQG – Unregulated Waters
Parameters listed in Schedule B, Table 1 of EOW [a]			
Boron (total) [b]	µg/L	940	940
Ammonia	mg/L	0.21	0.07
pH (measured in situ)	unit	6.5 – 8.0	6.5 – 8.5
Electrical conductivity (measured in situ; base flow)	µS/cm	301	654
Manganese (total)	µg/L	1900	1900
Nickel (total)	µg/L	11	11
TPH (C6-C9) [d]	mg/L	–	–
Chlorophyll a	µg/L	48.9	10.2
Dissolved oxygen (measured in situ)	mg/L	2.42 – 9.10	3.93 – 7.68
Dissolved oxygen (measured in situ)	% saturation	29.4 – 110	45.5 – 110
Turbidity (measured in situ)	NTU	360	310
Copper (total)	µg/L	4.98	5.53
Zinc (total)	µg/L	15	14.1
Calcium	mg/L	12.38 – 21.25	14.73 – 27.65
Magnesium	mg/L	3.44 – 6.34	4.22 – 8.38
Chloride	mg/L	35.44	77.10
Sodium	mg/L	31.28	48.39
SAR [c]	–	8.0	8.0
Other Relevant Parameters for Assessing EVs of Receiving Environment			
Temperature	ºC	21.0 – 29.9	19.5 – 26.6
Carbonate (CO_3)	mg/L	< LOR	< LOR
Barium (total)	µg/L	132.5	174.6
Mercury (total)	µg/L	0.06	0.06
Strontium (total)	µg/L	396	417
Tin (total)	µg/L	< LOR	< LOR
Vanadium (total)	µg/L	19.1	10.5

[a] The EOW specifies the dissolved fraction of metals and metalloids are to be assessed in the treated water pond. For water quality monitoring in the receiving environment, the total concentration of metals and metalloids are to be assessed, and then for assessment of the aquatic ecosystem EV where a total concentration exceeds the local WQG, then the dissolved fraction is assessed as described using the water quality assessment framework described in ANZECC & ARMCANZ (2000a) and ANZG (2018). All single values represent a maximum that if exceeded trigger the need for further investigation. Where a range is presented, if the monitoring data is below or above the range then further investigation is triggered.

[b] Guideline for boron adopted from ANZG (2020)

[c] Guideline for SAR adopted from Schedule B – Table 1 of the EOW approval.

[d] No guideline for TPH because this parameter was below the Limit of Reporting (LOR) on most baseline monitoring events; thus, there was insufficient data to derive project specific guidelines. The baseline data recorded a maximum for the C6-C9 fraction as follows: regulated water – 161 µg/L, unregulated water – 144 µg/L. These baseline maximums as used to aid interpretation of monitoring results in lieu of having project specific guidelines for TPH.

It is noted that previous monthly monitoring was reported on a quarterly basis, with the median water quality result of the three surveys each quarter compared to the project specific WQG in accordance with ANZG (2018) (see; in the Deriving Guideline Values using Reference-site Data chapter), noting that the project specific WQGs were developed using the 20th and 80th percentile of baseline data. The current monitoring program is quarterly, with the individual monitoring result each quarter compared to the corresponding project specific WQG.

The nominated parameters are based on those that are likely to be informative for environmental assessment of the receiving environment. It is noted that a larger suite of parameters were previously monitored for the program (i.e. arsenic, chromium, iron, lead, selenium, TPH (C10-C14), TPH (C-15-C28), TPH (C29-C36), sulphate, fluoride, aluminium, cadmium and silver). However, detailed statistical analysis of the monitoring data indicated that a number of these parameters were not informative and were determined to be redundant (frc environmental 2020), and so were removed from the program retaining the potentially informative parameters presented in Table 9. Monitoring parameter rationalisation considered the National Water Quality Management Framework (ANZG 2018), which recommends that relevant indicators are selected based on multiple lines of evidence. Four independent criteria were applied in the rationalisation of water quality parameters, and all four criteria had to be achieved to confirm the determination of redundancy of any parameter, with the first criterion relation to the 'stressor' (as per ANZG 2018) and criteria 2-3 relating to the 'ecosystem receptor' (as per ANZG 2018); refer to frc environmental (2020) for presentation of the rationalisation.

4.2.2 In-Stream Sediment Quality

Project specific sediment quality guidelines were developed from baseline sediment quality data for the aquatic ecosystems EV in the receiving environment (frc environmental 2015d) (Table 10). Local sediment quality guidelines were developed using the 20th and 80th percentile of baseline data, as described in the Deriving Guideline Values using Reference Site Data chapter of ANZG (2018).

The nominated parameters are based on those that are likely to be informative for environmental assessment of the receiving environment. It is noted that a larger suite of parameters were previously monitored bi-annually in sediment for the program (i.e. arsenic, chromium, copper, lead, nickel, selenium and zinc). However, detailed statistical analysis of the monitoring data indicated that a number of these parameters were not informative and were determined to be redundant (frc environmental 2020), and so were removed from the program retaining the three potentially informative parameters presented in Table 9, and changing the monitoring program to monitor sediment quality specifically under extreme risk phases in accordance with Table 15 and 16. Monitoring parameter rationalisation considered the National Water Quality Management Framework (ANZG 2018), which recommends that relevant indicators are selected based on multiple lines of evidence. Three independent criteria were applied in the rationalisation of sediment quality parameters, and all three criteria had to be achieved to confirm the determination of

redundancy of any parameter, with the sediment quality criteria relating to the 'ecosystem receptor' (as per ANZG 2018); refer to frc environmental (2020) for presentation of the rationalisation.

It is noted further that TPH in sediment was not monitored during the baseline program, nor has TPH been monitored during the operational phase of the Project. It is noted that TPH in the resource has been <LOR on each monitoring event, and TPH in water in the receiving environment has been <LOR. TPH is not a parameter of concern, and commencement of monitoring of TPH in sediment is not required and would provide no value to the monitoring program.

Table 10 Project specific Sediment Quality Guidelines and Baseline Maximum

Sediment Quality Characteristic	Units	Project Specific SQG – Regulated Waters	Project Specific SQG – Unregulated Waters	Baseline Maximum
Boron	mg/kg	14.4	16.0	23.7
Iron	mg/kg	9,703	10,274	16,800
Manganese	mg/kg	268	405	536

4.2.3 Macroinvertebrates

Project specific macroinvertebrate guidelines were developed from baseline macroinvertebrate monitoring data for the aquatic ecosystems EV in the receiving environment (frc environmental 2015d) (Table 11). Local macroinvertebrate guidelines were developed using the 20th and 80th percentile of baseline data (i.e. baseline macroinvertebrate indices), as described in the Deriving Guideline Values using Reference Site Data chapter of ANZG (2018).

Table 11 Project specific Biological Guidelines for Macroinvertebrate Indices in Edge Habitat

Macroinvertebrate Index	Project Specific BG – Regulated Waters	Project Specific BG – Unregulated Waters
Taxonomic Richness	6.8 – 14.1	9.8 – 33.0
PET Richness	0.4 – 3.6	1.3 – 5.0
SIGNAL 2 Score	2.90 – 3.75	3.31 – 4.20

4.2.4 Fish

Project specific fish guidelines were developed from baseline fish monitoring data for the aquatic ecosystems EV in the receiving environment (frc environmental 2015d; Table 12). The expected number of fish is compared to the observed number of fish as a ratio (i.e. observed / expected). The water quality guideline for native fish is where this ratio ≥1 (see Platten 2011).

For exotic fish, the water quality guideline is that the number of exotic species at a site does not increase. The number of exotic species recorded at each site during the baseline surveys is shown in Table 12.

Table 12 Project specific Guidelines for Native and Exotic Fish Species for Each Glebe Monitoring Site

Site	Expected Number of Native Fish Species	Expected Number of Exotic Fish Species
Regulated Water Type		
WS03	5	1
WS04	3	1
WS07	4	1
WS10	2	2
WS11	6	1
Unregulated Water Type		
WS01	4	1
WS02	2	1
WS05	4	2
WS06	3	2

5 Temporal Context of the WQMP

Three temporal considerations are important for the WQMP for the Glebe Project:

- periods with different CSG water discharge rates
- river flow status, and
- release rates from Glebe Weir.

These factors affect mixing and dilution of the CSG water and hence its ability to alter the existing environment. They constitute the very basis of risk and should be fundamental to the design of a WQMP.

5.1 Periods with Different Discharge Rates

The peak discharge of CSG water is predicted to be short-lived (a few years) then will decline to approximately half before slowly declining over an extended period.

The high rates of discharge represent an important temporal phase for the WQMP, as any adverse environmental impacts would be most likely at this time. Thus, the frequency of monitoring during peak discharge should be higher than during lower discharges. If no undesirable effects are observed during these higher discharge periods, they would not be expected at lower discharge rates and the need for monitoring or the extent of monitoring could be revised.

5.2 River Flow Status

Low and zero river flow periods are likely to be the most important 'events' or 'times' for the WQMP, as during these times the CSG water discharge may constitute a significant proportion of water within Glebe Weir or within the downstream Dawson River if it is released from Glebe Weir. When these periods coincide with high discharge rates of CSG water, the greatest extent of change from background conditions can be expected, and the highest risk of water quality or ecological effects, can be expected.

Risk assessments presented in the application documentation showed that guidelines would only be exceeded as a result of low or zero flow events would occur only a few percent of the time (based on the historic flow record).

High flow periods on the other hand afford greater dilution and minimise the risk of any impacts related to the discharge.

5.3 Release Rates from Glebe Weir

Sunwater routinely records releases from Glebe Weir for reporting requirements under their Resource Operating Licence. Releases are measured at the tailwater gauge (no.130345, site WS05) some 1.9 km downstream from the weir. Water is held in storage in Glebe Weir unless required to service orders from downstream customers or to meet environmental flow objectives of the Water Resource Plan. The status of releases determines whether the discharge of the resource could be affecting just the weir pool environment of Glebe Weir or the river downstream as well.

6 Monitoring Program Design

6.1 Monitoring Program Components

Monitoring Program components relevant for the WQMP are:

- hydrology;
- water quality;
- biological (fish and macroinvertebrates).

Monitoring of sediment quality parameters is only required within the scope of risk phase monitoring under extreme risk phases.

6.2 Monitoring Sites

6.2.1 Hydrology

Monitoring sites for hydrology will utilise:

- DNRME gauging station 130302A (Dawson River at Taroom; 50 km upstream of the discharge location to record river inflows), and
- Sunwater's gauging station at the Glebe tailwater (downstream, gauge no. 130345 to record discharges from Glebe Weir).

Flow monitoring is to be undertaken each week as part of the risk assessment framework, specifically the number of zero flow days over the preceding 7-day period at gauging station 130302A is recorded in a dedicated flow register and used to determine the risk stage (which influences if more frequent monitoring is required).

Additionally, each survey report presents antecedent flow conditions as a hydrograph (data is presented using a daily-time step), with release volumes of the resource over the same period of time also reported. Flow conditions leading up to and during each survey are used to aid interpretation of the results, particularly for results that exceed the project specific guideline.

6.2.2 Water Quality, Sediment Quality and Biological Monitoring

Monitoring of water quality will utilise reference sites WS01 and WS02, and receiving environment sites WS04, WS05, WS06, WS07 and WS09 (Table 13, Figure 6). It is noted that the approval requires monitoring of water quality within the Dawson River as far downstream as Theodore Weir, which is the location of site WS09. While site WS09 has been monitored to date in accordance with the approval, the original version of the WQMP incorrectly identified site WS08 (Dawson River at Isla Delusion) as the most downstream monitoring site. This error is corrected in the current version of the WQMP, with site WS09 correctly presented as the most downstream site.

Monitoring of sediment quality, when required under extreme risk phases, will utilise control sites WS01 and WS02, and receiving environment sites WS03, WS04 and WS05 (Table 13, Figure 6).

Monitoring of biological parameters will utilise reference sites WS01 and WS02, and receiving environment sites WS03, WS04, WS06 and WS07 (Table 13, Figure 6).

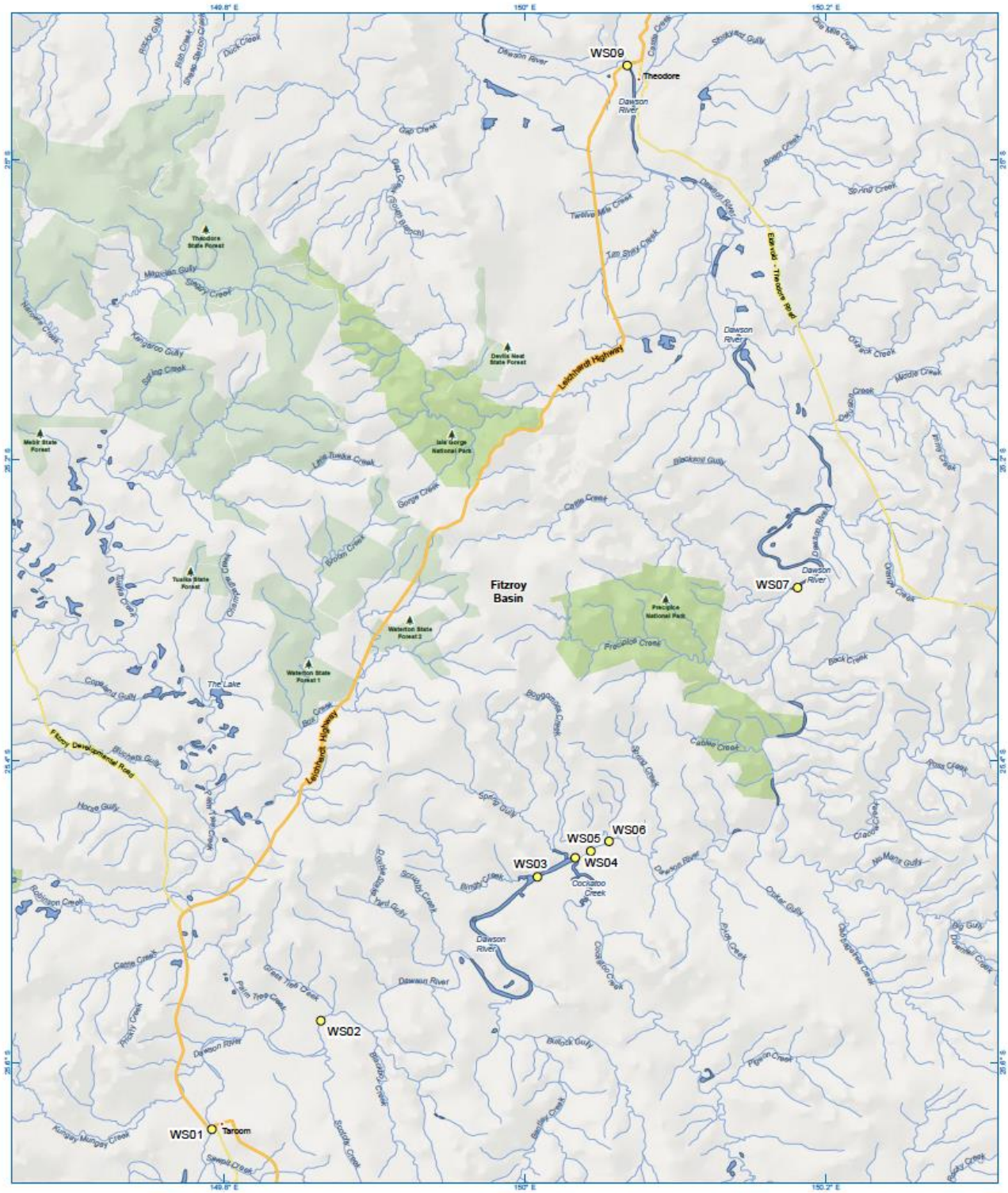
The reference sites are upstream of the receiving environment and will assist the interpretation of any regional influences (e.g. drought) on aquatic ecology in the receiving environment. The receiving environment site WS07 is used because releases from Glebe Weir will flow for 42 km to reach it and it is considered very unlikely that any influence would be occur further downstream. It also provides a weir pool comparator for Glebe Weir.

Table 13 Description of WQMP Monitoring Sites

Site	Description	Water Type	Latitude	Longitude
Receiving Environment Sites				
WS03/UD1	Dawson River within Glebe Weir pool; 2.5 km upstream of the confluence of Cockatoo Creek and Dawson River.	Regulated	-25.476944	150.008333
WS04/UD2	Dawson River within of Glebe Weir pool; 100 m upstream of the confluence of Cockatoo Creek and Dawson River.	Regulated	-25.464269	150.033529
WS05/LD1	Dawson River downstream of Glebe Weir; 1.9 km downstream of the discharge location.	Unregulated	-25.459722	150.043889
WS06/LD2	Dawson River downstream of Glebe Weir; 6.5 km downstream of the discharge location.	Unregulated	-25.453333	150.055833
WS07	Dawson River 42 km downstream of Glebe Weir in Gyranda Weir Pool	Regulated	-25.284722	150.181389
WS09	Dawson River Theodore Weir	Regulated	-25.93787	150.06815
Reference Sites				
WS01	Dawson River at Leichhardt Highway; 38 km upstream of the confluence of Cockatoo Creek and Dawson River.	Unregulated	-25.644476	149.791877
WS02	Dawson River at Bundalla Road Crossing; 35 km upstream of the confluence of Cockatoo Creek and Dawson River.	Unregulated	-25.572372	149.864464

WSG84

Figure 6: WQMP Monitoring Sites



6.3 Indicators to be Monitored and Frequency of Monitoring

6.3.1 Hydrology

The hydrological indicator will be mean daily flow in megalitres with potential to use longer timeframes if useful for longer term comparisons (Table 16).

6.3.2 Water Quality, Sediment Quality and Biological Monitoring

The WQMP for the Glebe Project combines ambient monitoring with a low-flow risk-assessment approach for detecting and assessing potential impacts to aquatic EVs in the receiving environment.

ANZG (2018) recommends that relevant indicators are selected based on multiple lines of evidence, which in the case of the WQMP includes water quality, sediment quality and biological parameters. With consideration to the National Water Quality Management Framework (ANZG 2018) and following detailed statistical analysis of the monitoring data, the water quality monitoring parameter suite has changed by removing redundant parameters and retaining the potentially informative parameters presented in Table 9. In addition, detailed analysis was also undertaken on sediment quality data, and monitoring of sediment has changed to non-routine monitoring. Sediment monitoring of iron, boron and manganese is required quarterly if the Dawson River is in low flow condition under extreme risk phases in accordance with Table 15.

ANZG (2018) also recommends that monitoring frequency has adequate temporal replication to detect meaningful changes and identify potential sources of variability, while also considering pragmatic and cost-effectiveness factors. The water quality monitoring has changed to quarterly to detect seasonal variability throughout the year, while being more cost-effective than the previous monthly sampling schedule. Furthermore, a risk-phase monitoring response is provided in the current WQMP, whereby the frequency of monitoring increases under periods of low flow when risk to water quality is higher; thus, there is adequate replication / frequency of monitoring to detect meaningful changes when needed.

There are no changes to the ambient (routine) monitoring of biological parameters.

Additionally, monitoring of the quality characteristics of the resource is used to inform monitoring undertaken under the WQMP, specifically:

- Monitoring results for the resource are used to aid interpretation of receiving environment monitoring results (see Section 8).
- Monitoring results for the resource are used to identify any additional parameters (parameters not listed in Table 9) that need to be monitored in the receiving environment. Specifically, if any parameter in the resource exceeds the EOW Approval quality limit and there are releases to the receiving environment associated with a valid exceedance then water quality monitoring of that parameter in the receiving environment commences on the next scheduled receiving environment monitoring event. Monitoring of the receiving environment can then be discontinued if there are no further exceedances of the quality limit in the resource for that parameter and if there were no exceedances detected in the receiving environment that were attributable to the release of the resource.

6.3.2.1 Ambient Monitoring

Biological parameters will be monitored biannually, nominally in spring (September – November) and autumn (March – May) (Table 16); however, if the Dawson River is in low flow condition then risk assessment may result in increased monitoring frequency as described in section 6.3.2.2.

Water quality parameters will be monitored quarterly, nominally in spring (September – November), summer (December – February), autumn (March – May) and winter (June – August) (Table 16); however, if the Dawson River is in low flow condition then risk assessment may result in increased monitoring frequency as described in section 6.3.2.2.

6.3.2.2 Low-Flow Risk Assessment Approach

The purpose of the risk assessment framework is to provide an early indication of potential adverse impacts to the environmental values of the receiving environment. The risk assessment framework integrates flow magnitude (<0.1 ML/day) and the duration of flows at that magnitude into a conventional risk assessment matrix for identifying potential periods of potential risk (Table 14). Varying risk phases are initiated based on the time period (days) and flow magnitude (ML). The risk phases include low, moderate, high and extreme risk. Implementation of the risk assessment framework is presented below, and the risk assessment process is re-set by a 50th percentile flow (i.e. 26 ML/day) that lasts for three consecutive days or longer.

Table 14 Risk Assessment Matrix for the Glebe Project

Time Period (days)	Flow Magnitude (ML)
	<0.1
<7	low
8-60	moderate
61-365	high
>365	extreme

Time periods in the risk assessment matrix were based on the results of correlation analyses. Flows at DNRME gauging station 130302A (Dawson River at Taroom) are to be reviewed by Sunwater on a weekly basis, with the following recorded in a register:

- date of assessment
- recorded number of consecutive days of zero (i.e. <0.1 ML) daily flow up to and including the date of assessment
- risk rating, using the combination of flow magnitude and time period from the risk assessment matrix (Table 14), with the highest risk rating for each month adopted.

Periods of potentially increased risk to the receiving environment due to prolonged low flow periods will be managed by increasing the frequency of monitoring proportionally to the level of assessed risk and implementing specific management actions in response to risk category. The Risk Management Action Plan (RMAP) presented in Table 15 summarises the management actions based on risk category, noting that the risk assessment process is re-set by a 50th percentile flow (i.e. 26 ML/day) that lasts for three consecutive days or longer.

Table 15 Risk Management Action Plan

Risk Category	Action	Secondary Actions and Assessments	Outcomes of Actions and Assessments
Low	continue weekly flow monitoring continue quarterly water quality monitoring continue bi-annual aquatic ecology monitoring	update flow monitoring register prepare routine summer and winter water quality monitoring reports prepare routine autumn and spring water quality and aquatic ecology monitoring reports	–
Moderate	continue weekly flow monitoring implement bi-monthly water quality monitoring (in conjunction with routine quarterly monitoring) at all reference sites and receiving environment sites WS03, WS04 and WS05 for boron and SAR	update flow monitoring register assess water quality results against WQG, reference site and baseline values and toxicity thresholds	if water quality results at sites WS03, WS04 or WS05 indicate that reference site and baseline value and toxicity thresholds are all exceeded, then risk becomes high
High	continue weekly flow monitoring monthly water quality monitoring at all reference sites and receiving environment sites WS03, WS04, WS05 and WS06 for full suite of parameters	update flow monitoring register assess water quality results against WQG, reference site and baseline values and toxicity thresholds	if water quality results at sites WS03, WS04, WS05 or WS06 indicate that reference site and baseline value and toxicity thresholds are all exceeded, then risk becomes extreme
Extreme	continue weekly flow monitoring continue monthly water quality monitoring at all reference sites and all receiving environment sites for full suite of parameters implement quarterly	update flow monitoring register assess water quality results against WQG, reference site and baseline values and toxicity thresholds	if water quality results at sites WS03, WS04, WS05 or WS06 indicate that reference site and baseline value and toxicity thresholds are all exceeded, or sediment quality results at sites WS03, WS04 or WS05 indicate that reference site and baseline values are exceeded, then the following occurs:

Risk Category	Action	Secondary Actions and Assessments	Outcomes of Actions and Assessments
	macroinvertebrate monitoring at all reference sites and all receiving environment sites implement quarterly monitoring of iron, manganese and boron in sediment at all reference sites and sites WS03, WS04 and WS05 review operations to rectify ongoing impacts to the receiving environment	assess macroinvertebrate results against reference site and baseline values assess sediment quality results against project-specific sediment quality guidelines, reference site and baseline values documentation of operational changes	notification as per approval requirements reviewing the operational delivery program regarding discharge of treated CS water to the weir and/or downstream localities in the receiving environment minimising releases where practicable and discharge of water to priority customers where possible

Table 16 Glebe Project Monitoring Program

Monitoring Component	Parameter	Monitoring Sites	Monitoring Frequency
Hydrological Components			
Stream flow	Discharge at selected gauging stations	Upstream of the discharge at gauging station 130302A Dawson River at Taroom. Sunwater gauging station 130345 at Glebe tailwaters.	Discharge monitored daily but accessed as needed.
Water Quality Components			
Physico-chemical	Temperature, pH, electrical conductivity, dissolved oxygen, turbidity	Reference Sites: WS01 and WS02 Receiving Environment Sites: WS03, WS04, WS05, WS06, WS07, WS09.	Quarterly in spring (September – November), summer (December – February), autumn (March – May) and winter (June – August) for all parameters, and if the Dawson River is in low flow condition then risk assessment may result in increased monitoring as per Table 15.
Nutrients	Ammonia		
Major Cations and Anions	Calcium, magnesium, sodium, chloride, SAR and water hardness [a]		
Alkalinity	Carbonate		
Metals and Metalloids	Total and dissolved metals and metalloids (Ba, B, Cu, Mn, Hg, Ni, Sr, Sn, V, Zn)		
Algae	Chlorophyll-*a*		
Biological Components			
Macroinvertebrates	Aquatic macroinvertebrates identified to the lowest practical taxonomic level Density of exoskeleton of crustaceans and molluscs	Reference sites: WS01 and WS02 Receiving Environment Sites: WS03, WS04, WS06, WS07.	Biannually in Spring (September – November) and Autumn (March – May), and if the Dawson River is in low flow condition then risk assessment may result in increased monitoring as per Table 15.
Sediment Quality Components			
Metals and Metalloids	Total metals and metalloids (B, Fe, Mn)	Reference sites: WS01 and WS02 Receiving Environment Sites: WS03, WS04, WS05.	Non-routine monitoring. Monitoring required quarterly if the Dawson River is in low flow condition under extreme risk phases in accordance with Table 15.

An explanation of the methods to be used for each monitoring component is outlined in the SunWater Glebe Beneficial Use Scheme: Procedures for Receiving Environment Monitoring Program Sampling and Reporting.

7 Reporting

7.1 Weekly Flow Monitoring

Flow monitoring is to be undertaken each week as part of the risk assessment framework, specifically the number of zero flow days over the preceding 7-day period at gauging station 130302A is recorded in a dedicated flow register and used to determine the risk stage (which influences if higher frequency of monitoring is needed).

7.2 Quarterly and Bi-Annual Analysis and Reporting

Reports will be completed bi-annually for biological components, quarterly for ambient water quality monitoring, and following each low flow monitoring period, to document any potential impacts to the receiving environment that have been identified and are potentially related to the discharge, and to report on early detection responses to low flows. These reports will present the methods and results for each survey event and involve basic analysis of key indicators against their relevant WQGs. Additionally, each survey report presents antecedent flow conditions as a hydrograph (data is presented using a daily-time step), with release volumes of the resource over the same period of time also reported. Flow conditions leading up to and during each survey are used to aid interpretation of the results, particularly for results that exceed the project specific guideline. All data analyses and statistical procedures that will be used to assess monitoring data for each report are detailed in the Sunwater Glebe Beneficial Use Scheme: Procedures for Receiving Environment Monitoring Program Sampling and Reporting.

7.3 Environmental Performance Reporting

Additionally, a report that synthesises the results of all monitoring events in the previous period will be prepared in time for submission in accordance with the schedule nominated in Condition of 8b of the EPBC approval. The report will assess if any impacts have occurred due to the release on the water quality, and biology of the receiving environment, based on a comparison to the relevant WQOs and, where appropriate (e.g. where WQOs have been exceeded) statistical tests based on the before-after control-impact (BACI) principle. Data analyses and statistical procedures that will be used to assess monitoring data for each report are detailed in the Sunwater Glebe Beneficial Use Scheme: Procedures for Receiving Environment Monitoring Program Sampling and Reporting.

Any actions taken to rectify impacts or circumstances which could have resulted in likely impacts will be described and results assessing the success of their implementation presented. An independent evaluation of the results will assess any new or increased impacts/likely impacts on MNES.

If, upon review of an EPR, the DAWE Minister is not satisfied that appropriate actions have been taken or will be taken to mitigate any new or increased impacts/likely impacts to the environment identified during the regular monitoring, the Minister may direct Sunwater to reduce or cease discharge. In these circumstances, Sunwater must then undertake an evaluation in accordance with the recommendations of an independent evaluator and submit the report to the Department for approval.

8 Action Response Plan for Investigation and Management Responses to Exceedances of the Water Quality Guideline

As noted in Section 1.2, the intent of the 'threshold limit' defined in Approval Condition 8aiii is to ensure that water quality conditions do not exceed a concentration above which impacts to aquatic ecosystems including MNES may occur. This is achieved by using an investigative approach to water quality, whereby exceedances of the project specific water quality guideline trigger a specific series of steps involving comparison and evaluation of water quality and biological data. Where the investigation indicates potential adverse impacts to aquatic ecosystems, including MNES, then operational management is implemented.

The specific steps involved in investigating an exceedance of a project specific WQG comprise:

- compare result to project specific WQG, then if exceeded;
- compare exceedance to reference site value during the survey, then if exceeded;
- compare the exceedance to the long-term/historical reference site value and the baseline value, then if exceeded;
- compare the resource concentration to the receiving environment WQG, assess spatial and temporal patterns, and undertake review of toxicity of the parameter to aquatic biota at the recorded concentration, to determine potential impact and identify if the exceedance is likely to be caused by the release of the resource, and if so then;
- evaluate biological monitoring data for signs of adverse impact, and then if this assessment indicates potentially impacted biological communities, then;
- implement operational management actions.

The reporting described in Section 7.2 includes this approach to investigation of exceedances, with the outcomes of any required investigations also summarised in Environmental Performance Reports (Section 7.3).

9 Quality Assurance and Quality Control

The WQMP will be certified and monitoring undertaken by suitably qualified persons. The monitoring, analysis and reporting, will have regard to the procedures and quality assurance / quality control (QA/QC) requirements set out in the following documents:

- Australian Guidelines for Water Quality Monitoring and Reporting (ANZECC & ARMCANZ 2000b; ANZG 2018);
- Monitoring and Sampling Manual 2018, Environmental Protection (Water) Policy 2009 (DES 2018)
- AS 3778.3.1 Measurement of Flow in Open Channels
- Sustainable Rivers Audit physical habitat methodology (MDBC 2004)
- Australian / New Zealand Standard AS5667.1 Water Quality – Sampling
- AS/NZ5667.12 Guidance on Sampling of Bottom Sediments
- Handbook for Sediment Quality Assessment (Simpson et al. 2005)
- Queensland Australian River Assessment System (AUSRIVAS) Sampling and Processing Manual (DNRM 2001; see also DES 2018), and
- Sunwater Glebe Beneficial Use Scheme: Procedures for Receiving Environment Monitoring Program Sampling and Reporting (frc environmental 2014g).

Further details of the QA/QC procedures for each parameter to be monitored are provided in the latter. It is noted that ANZG (2018) states that “all methods and equipment used for monitoring should meet any relevant Australian, New Zealand and International Organization for Standardization (ISO) standards, as well as local standards like Queensland’s Water Monitoring and Sampling Manual”. While various methodologies for sampling are presented in the different guideline documents, the monitoring program referenced in this WQMP uses methods that are both consistent with the Queensland Monitoring and Sampling Manual (2018) and consistent with the methods that have been used since 2012, when the baseline studies commenced. An example is the use of a stainless-steel trowel for sampling streambed sediments. Full details of monitoring methods are presented in frc environmental (2014g).

Furthermore, all laboratory analyses and tests of water and sediment samples will be performed by a laboratory that has NATA accreditation. Where there are no such NATA-accredited laboratories for a specific analyte or substance, then duplicate samples will be taken and sent to two separate laboratories for independent testing and evaluation.

This WQMP will be reviewed for performance and redundancies, and amended as required, subject to DAWE Ministers approval.

9.1 Assumptions and Qualifications

The proposed monitoring locations have been determined based on the location of baseline monitoring sites to allow for comparisons with baseline / current condition.

Sites at road crossings are likely to be impacted by the presence of the road, and this will be taken into account when analysing the data. However, locating sites at public road crossings is necessary to ensure that they can be safely and easily accessible at almost all times of the year; and also so that access to private property is not required. Sites located away from public roads or well-established tracks may not be accessible during wet conditions.

It is possible that some sites may be dry during some survey events, depending on factors such as low antecedent rainfall.

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11 Approval and Review Details

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SME:	Senior Water Quality Advisor	**Next Revision Date:**	As required, subject to Commonwealth Department Minister Approval	**Reference No:**	N/A

12 Appendix 1 | WQMP Certification

This WQMP was prepared by Dr Ben Cook, Principal Ecologist (Freshwater) at frc environmental, a specialist aquatic ecological consulting firm.

Ben is a Suitably Qualified Aquatic Ecologist, having a Ph.D in Freshwater Ecology from the Australian Rivers Institute at Griffith University, published over 25 peer reviewed scientific papers relating to aquatic ecology, and having 20 years of experience as a professional aquatic ecologist as a University Researcher (3 Postdoctoral Fellowship Positions), Government Project Officer (the former Queensland EPA and DERM) and Environmental Consultant (frc environmental).

21 October 2022