Water Solutions
Certainty in Water

Report to

QUEENSLAND COMPETITION AUTHORITY

on

RURAL IRRIGATION PRICE REVIEW 2020-24

ASSESSMENT OF HYDROLOGIC FACTORS: FURTHER ASSESSMENT - GIRU BENEFITED GROUNDWATER AREA

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Queensland Competition Authority
Rural Irrigation Price Review 2020-24
Further Assessment - Giru Benefited Groundwater Area

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Executive Summary

Following on from Water Solutions' initial advice summarised in the report "Rural Irrigation Price Review 2020-24 – Assessment of Hydrologic Factors", this report provides additional advice to assist with pricing for the Giru Benefitted Groundwater Area (GBGA), in response to hydrologic issues raised in submissions on the draft QCA report.

A major issue raised in the submissions was concerns about the accuracy of the extraction and release data used to provide an indication of the likely contribution of 'natural' flows to meeting GBGA demands.

This assessment thus included an independent review of available source records on releases from Haughton Balancing Storage (HBS) and extractions from Haughton Zone A (HZA). The efficiency of HBS releases in meeting HZA demands was used to provide an indication of the likely relative contribution of HBS Releases and Non-HBS Release Sources to meeting GBGA demands.

It is highlighted that Non-HBS Release Sources includes all other processes which affect water availability in Haughton Zone A, including, for example: rainfall on the Haughton River Catchment, leading to surface flow in the Haughton River and recharge to the GBGA aquifer, less licenced unsupplemented diversion from the catchment, plus supplementation by Haughton Zone A infrastructure, and subject to a range of operational losses and environmental requirements.

The source release and extraction data were obtained and reviewed, and updated estimates of annual releases and extractions derived. The resultant recomputed minimum annual efficiency over the period of available data (2002/03 to 2018/19) was 0.66, with the average efficiency 0.99.

A range of complicating issues associated with interpreting the data and the estimation of releases, extractions and efficiencies were assessed. While all data comes with a level of uncertainty, it is concluded that the data may be used to inform this assessment.

The key conclusion of the Water Solutions Sept 2019 report regarding the GBGA is thus confirmed. That is, that review of release and extraction data indicates that GBGA irrigators are receiving little contribution from non-HBS Release sources in dry periods, and thus that there does not appear to be a strong hydrologic basis for differential pricing of GBGA MP users (that is, increasing unit prices for other Burdekin distribution system MP users to be able to provide a discount for GBGA MP users). It is thus recommended Haughton Zone A (including the GBGA) is considered to be fully part of the Burdekin Haughton Channel Distribution System, with all MP allocations in this distribution system paying the same price.

Lastly, based on consideration of the various factors discussed in this report, it is considered unlikely that a more detailed analysis will identify a substantially different conclusion to the above. However unlikely is not the same as impossible. A more detailed assessment may be undertaken to inform deliberations in future price reviews. Such assessment, if undertaken, should consider the issues raised in this report, the WS Sept 2019 report, and the submissions received on the draft QCA report.

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Nomenclature

Term	Description
AA	Announced Allocation
AEP	Annual Exceedance Probability
AHD	Australian Height Datum
Att	Attachment
ARI	Average Recurrence Interval
ARR2016	Australian Rainfall and Runoff, 2016 Edition
BHWSS	Burdekin Haughton Water Supply Scheme
BDCG	Burdekin District Cane Growers Ltd
BPEQ	Board of Professional Engineers of Queensland
BRIA	Burdekin River Irrigation Area Irrigators Ltd
CWSA	Critical Water Sharing Arrangements
DERM	Department of Environment and Resource Management
DNRM	Department of Natural Resources and Mines
DNRME	Department of Natural Resources, Mines and Energy
DLWC	Department of Land and Water Conservation
DSL	Dead Storage Level
DSV	Dead Storage Volume
EA	Engineers Australia
EFO	Environmental Flow Objective
FSL	Full Supply Level
FSV	Full Supply Volume
GA	Groundwater Australia
GBA	Giru Benefited Area, a shortened version of GBGA
GBGA	Giru Benefited Groundwater Area
GGA	Giru Groundwater Area, a shortened version of GBGA
Govt	Government
GS	Gauging Station
HBS	Haughton Balancing Storage
HMC	Haughton Main Channel
HP	High Priority
HPA	High Priority Allocations
HUF	Headworks Utilisation Factor
HZA	Haughton Zone A
IQQM	Integrated Quantity Quality Model
IWSC	Irrigation and Water Supply Commission (Qld)
MAD	Mean Annual Diversion
MP	Medium Priority
MPA	Medium Priority Allocations

MOV	Minimum Operating Volume (usually same as DSV)
NOL	Nominal Operating Level
NV	Nominal Volume
OM	Operations Manual
QA	Quality Assurance
QCA	Queensland Competition Authority
Qld	Queensland
RFQ	Request For Quote
ROL	Resource Operations Licence
ROP	Resource Operations Plan
RPEQ	Registered Professional Engineer of Queensland
S or s	Section
SEQ	South-East Queensland
SILO	Scientific Information for Land Owners
SL	Storage Loss
TOL	Transmission and Operational Loss
TOR	Terms of Reference
UV	Useable Volume
WAE	Water Allocation Entitlements
WASO	Water Allocation Security Objective
WMP	Water Management Protocol
WP	Water Plan
WRP	Water Resource Plan
WS	Water Solutions Pty Ltd
WSS	Water Supply System

1 Introduction

1.1 Background

The Queensland State Government referred the monopoly business activities of Sunwater and Seqwater to the QCA for an investigation about pricing practices via a referral notice to the QCA dated 29 October 2018. The monopoly business activities to be investigated are those associated with the bulk water supply and distribution of water for irrigation in a specified set of water supply schemes and distribution systems. The key objective of the investigation was to recommend irrigation prices for the period 1 July 2020 to 30 June 2024.

Sunwater and Seqwater subsequently provided submissions to the investigation, as have a range of stakeholders, with the submissions available on the QCA website.

In April 2019 the QCA issued a Terms of Reference (TOR) for a project to undertake an assessment of hydrological factors as a basis for cost allocation in specific water supply schemes, and in May 2019 Water Solutions was engaged to provide this assessment. The results of this assessment was reported in the Water Solutions report "Rural Irrigation Price Review 2020-24 – Assessment of Hydrologic Factors", Doc No WS190040 Rev 2 dated 3 September 2019. This report covered three main topics, quality assurance of Headworks Utilisation Factor (HUF) calculations for six specified schemes, a hydrologic review of submissions associated with pricing for the Central Brisbane River scheme Medium Priority (MP) irrigators, and a hydrologic review of submissions associated with pricing for the Giru Benefited Groundwater Area (GBGA) MP irrigators.

The QCA subsequently released their draft report on 9 September 2019. Following the release of the QCA's draft report a range of parties made submissions on the draft report.

The QCA's draft report, the Water Solutions report and the submissions from stakeholders may be found on the QCA website.

Following receipt of the submissions Water Solutions was requested to provide further input in relation to issues identified in submissions in the Central Brisbane scheme and the Giru Benefited Groundwater Area.

This report presents the results of the further hydrologic investigations carried out into issues associated with the Giru Benefited Groundwater Area, while the companion report (WS190095) presents the results of the further hydrologic investigations carried out into issues associated with the Central Brisbane scheme.

It is highlighted that this report follows on from the original Water Solutions report "Rural Irrigation Price Review 2020-24 – Assessment of Hydrologic Factors", Doc No WS190040 Rev 2 dated 3 September 2019. A good understanding of the earlier report is strongly recommended before reading this report.

1.2 Key Objective

The key objective of this report is the same as in the original report, that is:

To provide expert hydrologic advice and guidance to assist the QCA to determine the appropriate apportionment of costs between different customer groups in specified schemes/systems.

It is highlighted that this review is focused on hydrologic factors. There may be a range of other factors that have influence on the appropriate apportionment of costs between users groups in the scheme. Assessment of non-hydrologic factors is beyond the scope of this review.

1.3 GBA, GGA or GBGA

It is noted that the BDCG submission mainly refers to the area of interest as the Giru Benefitted Groundwater Area (GBGA), although the labels Giru Benefitted Area or the Giru Groundwater Area also appear in the submission. Other documents also appear to use 1-3 of these names for the area, e.g. the Water Plan, Sunwater's fees and charges schedule, Sunwater's Nov 2018 submission, the OD Hydrology Report, the Kavanagh report, the 2012-17 QCA report and the draft 2020-24 QCA report.

All of these names essentially refer to the same area of land and its associated water allocations. These allocations draw from surface water or groundwater (defined to be water in the watercourse as per the Water Plan). The official name of this area would appear to be the Giru Benefitted Groundwater Area, as that is the name used to define the area in Schedule 3 of the Water Plan, however the use of the alternate names Giru Benefitted Area or the Giru Groundwater Area appears to be common.

In this document the full Giru Benefitted Groundwater Area (GBGA) name will be used to be consistent with the Water Plan, however please note that all three names appear to be used for essentially the same resource area in a range of documents referenced in this review.

1.4 GBGA and BRIA Meetings

On 16 October 2019, prior to the closing date for submissions on the draft QCA report, two meetings were held with allocation holders, the first with representatives of the GBGA and Sunwater, and the second with Board members of BRIA (Burdekin River Irrigation Area Irrigators Ltd). A presentation on the methodology and findings of the previous hydrologic assessment (as summarised in Doc No WS190040 Rev 2 dated 3 September 2019) was presented to those attending the meeting.

Stakeholders attending both meetings made numerous comments and suggestions, most of which have been reinforced in their submissions. The GBGA stakeholders generally expressed the desire to retain the existing discount for GBGA users. However the BRIA did not support the continuation of the current discounted tariff in the GBGA, owing to the discount being funded by higher charges for other distribution system allocation holders. The assessment presented in the following sections has considered the issues raised in the submissions and the comments made on these issues at the consultation sessions.

1.5 Structure of this Report

The remainder of this report is structured as follows:

- Section 2 presents an overview of the submissions made on the draft QCA report which raise hydrology related issues pertinent to pricing for GBGA users.
- Section 3 summarised the site inspection carried out as part of this assessment.

- Section 4 provides a review of release and extraction data associated with the GBGA, and discusses a number of complicating factors associated with the interpretation of this data.
- Section 5 discusses a range of other hydrology related issues raised in the submissions, to inform any future detailed assessments made to assist in deliberations for future pricing reviews.
- Section 6 summarises the conclusions of this report.
- Section 7 lists the key references used in this assessment.

2 Submissions Overview

The QCA provided key submissions received that related to the hydrologic matters relevant to the GBGA pricing issue for consideration in this study, and indicated the relevant sections in larger submissions. The list of submissions provided for review was:

- Burdekin District Cane Growers (BDCG) 4/11/19 Submission, submitted by BDCG and 14 other parties.
- Burdekin District Cane Growers (BDCG) Follow Up Submission 12/12/19
- Canegrowers Burdekin 4/11/19 Submission, with 9 other submissions providing support to this submission.
- MH Premium Farms 4/11/19 Submission
- Wessel A 4/11/19 Submission
- Burdekin River Irrigation Area (BRIA) 4/11/19 Submission, pg 6-7
- Burdekin River Irrigation Area (BRIA) Follow Up Submission 5/12/19
- Sunwater 4/11/19 Submission, pg 95

QCA also advised of 8 additional submissions relevant to pricing in the GBGA but which only raised concerns regarding affordability. Consideration of economic issues is outside the scope of this assessment, and hence these submissions were not reviewed as part of this assessment.

The submissions were reviewed and grouped into three general categories.

- The BDCG, Canegrowers Burdekin, MH Premium Farms and Wessel A submissions.
- The BRIA submissions
- Sunwater's submission

Each group of submissions is briefly discussed in the following sections.

2.1 BDCG, Canegrowers Burdekin, MH Premium Farms and Wessel A Submissions

This group of submissions all raised a number of criticisms related to hydrologic issues with the QCA draft report, the Water Solutions Sept 2019 report, Sunwater's Nov 2018 Appendix K submission, the OD Hydrology 2018 report and/or the Kavanagh 2017 report.

This report has focused on addressing these submissions, with the contents of Sections 3, 4 and 5 drafted to address the key hydrology related issues raised: Sections 3 provides a brief summary of the site inspection carried out as part of this assessment, Section 4 presents an independent review of release and extraction source data associated with the GBGA, and Section 5 discusses a range of other hydrology issue raised in these submissions.

2.2 BRIA Submissions

The BRIA submissions presented an opposing view to the first group of submissions. BRIA stated that they cannot support the continuation of the current discounted tariff in Zone A/GBA, as the under recovery of costs are then debited against channel distribution customers. Further, they

stated that a discounted tariff for Haughton Zone A/GBA should not continue when the principles upon it was originally established no longer apply. BRIA thus supported the draft QCA proposal.

Most of the issues raised in the BRIA submissions are also raised in the first group of submissions, although BRIA's perspective is typically opposite to the perspective raised in the first group of submissions. Sections 3, 4 and 5 thus also address most of the key hydrology related issues raised in BRIA's submissions.

2.3 Sunwater Submission

Sunwater made two main hydrology related points on pg 95 of their submission:

- Sunwater states that the availability and quantum of natural yield available is inherently dependent on the seasonal rainfall, and that there are significant periods where natural yield is the predominant supply to the Haughton Zone A customers.
- Sunwater considers that the hydrologic assessment information provided in the OD Hydrology report provides a more recent and representative analysis of the level of supplementation and natural yield within the GBA and requests the QCA review irrigation prices for the GBA.

In response, it is agreed that the flow in the Haughton River is inherently dependent on rainfall, and that in wet years rainfall over the Haughton River catchment makes a significant contribution to the amount of water available for diversion from Haughton Zone A users. While the benefits that water supply schemes provide to users in a complex climatic environment are not easy to distil down to a single number, Sunwater has addressed this difficult question by focusing on the performance in dry periods as the most appropriate benchmark. For example, Sunwater has adopted the '15 year driest period' as the standard for the HUF methodology to apportion costs between high and medium priority groups in most schemes in the state.

Section 4 of this report presents an analysis of the Haughton River performance over the period of available source data provided by Sunwater, showing the performance in a range of wet and dry years, and making conclusions focusing on dry years in accordance with the general approach adopted by Sunwater and the QCA.

Regarding the second point, Water Solutions Sept 2019 raises a number of significant issues associated with the modelling in the OD Hydrology Report, issues that resulted in the conclusion that the model should not be used for pricing purposes. The first group of submissions have raised further issues associated with the OD Hydrology modelling of the GBGA.

Sunwater's comment is acknowledged, however the conclusions of the Water Solutions Sept 2019 regarding the OD Hydrology Model results is unchanged, that is, there is significant uncertainty associated with using the results reported in OD Hydrology (2018), and thus use of the OD Hydrology model, in its current form, to provide a basis for pricing is not recommended.

It is highlighted that the hydrologic modelling approach is an appropriate technique for analysing many of the key issues discussed in this report. If a more detailed modelling study is undertaken to assist with alternate apportionment of costs in future price paths, it is strongly recommended that the study addresses the issues raised in this report, the Water Solutions Sept 2019 report, and in the submissions made on the QCA Draft Report.

3 Site Inspection

A site inspection of the key infrastructure and sites of relevance to this assessment was held on 27 November 2019. The site inspection included meeting with officers from Sunwater to discuss the data they hold related to operation of the GBGA, with a focus on matters that might affect the accuracy of that data. Sunwater officers then guided the project team to key sites around the scheme, including the Haughton Balancing Storage, the Powerline stream gauge, Val Bird and Giru Weirs, Ironbark Creek, the Healeys Lagoon Pump Station and Major Creek.

A range of photos from the site inspection are provided in the following figures. A few notes on the images are provided below:

- Figure 3-1 shows the overflow weir from the Haughton Balancing Storage in the foreground, with the diversion point for the Townsville water supply just upstream in the centre-right of the image.
- Figure 3-2 is just downstream of Figure 3-1 and shows the two outlet gates from the Haughton Balancing Storage. These gates control release into a pipe which conveys the water under a road to a short channel which delivers the water to the Haughton River.
- Figure 3-3 shows the meter measuring the total release made from HBS to Haughton Zone A.
- Figure 3-4 shows the discharge of the release pipe from the HBS, before the channel joins the Haughton River.
- Figure 3-5, Figure 3-6, and Figure 3-7 show the Haughton River cross-section near GS119003A Haughton River at Powerline. The creek cross-section consists of extensive sand beds with a low flow channel on the left side. Major Creek joins the Haughton River near this location.
- Figure 3-8 shows a sample meter for a GBGA user.
- Figure 3-9 shows Giru Weir and Figure 3-10 the level gauge on Giru Weir.
- Figure 3-11 shows the intake to the recently installed bypass pipe at Giru Weir, and Figure 3-12 the gauge on that release pipeline.
- Figure 3-13 shows Val Bird Weir.
- Figure 3-14 shows Major Creek some distance upstream of the supplemented section, near the Woodstock-Giru Road.
- Figure 3-15 and Figure 3-16 shows Ironbark Creek upstream and downstream of the Woodstock-Giru Road crossing. Healeys Lagoon is downstream.
- Figure 3-17 shows the Healeys Lagoon pumpstation, located on the banks of the Val Bird Weir pond. This pump station pumps water from the Haughton River into Ironbark Creek, which flows down to Healeys Lagoon and then to Reed Beds, near the end of GBGA area.

Figure 3-1 – Haughton Balancing Storage

Figure 3-2 – Haughton Balancing Storage – Release Gates to Haughton River

Figure 3-3 – Haughton Balancing Storage Release Gauge

Figure 3-4 – Release from Haughton Balancing Storage

Figure 3-5 – Haughton River – Powerline Gauge Section from Right Bank

Figure 3-6 – Haughton River – Powerline Gauge Section from Mid-Channel

Figure 3-7 – Haughton River – Powerline Gauge Section – Left Bank Low Flow Channel

Figure 3-8 – Giru Benefitted Area – Sample Meter

Figure 3-9 – Giru Weir

Figure 3-10 – Giru Weir – Level Gauge

Figure 3-11 – Giru Weir – Intake to Bypass Pipe

Figure 3-12 – Giru Weir Bypass Pipe Gauge

Figure 3-13 – Val Bird Weir

Figure 3-14 – Major Creek - Upstream Near Woodstock-Giru Road

Figure 3-15 – Ironbark Creek upstream of Woodstock-Giru Road

Figure 3-16 – Ironbark Creek downstream of Woodstock-Giru Road

Figure 3-17 – Healeys Lagoon Pump Station on Val Bird Weir

4 HBS Release and HZA Extraction Data

The previous review concluded that the reported historical records presented in Kavanagh 2017 indicate that GBGA irrigators are receiving little contribution from 'natural' Haughton River flows in dry periods.

The consultation session with GBGA users and the first group of submissions raised a number of concerns regarding the potential accuracy of the release and extraction data in Kavanagh 2017.

To address this concern an independent review of available source data on releases and extractions was undertaken.

This section presents the methodology of this review and also discusses a number of complicating issues associated with interpreting the data and the estimation of releases, extractions and efficiencies.

4.1 Clarification of Terms

The word 'natural' is problematic as it often means different things to different people. For the purposes of this review the following key terms are used:

- **HBS Release** – The release made from the Haughton Balancing Storage for the purposes of supplying allocations in Haughton Zone A.
- **HZA Extraction** – The total extraction of allocation water in Haughton Zone A.
- **HZA Efficiency** – The efficiency of releases from the Haughton Balancing Storage in meeting the scheme demand in Haughton Zone A.

It follows that: **HZA Efficiency = HZA Extraction / HBS Release**

If HZA Efficiency is greater than 1.0, this means that some water source other than the HBS Releases is supplying a net part of the Haughton Zone A demand. The other water source is not well defined by the word 'natural'. Rather, the 'other water source' is defined in this report as **Non-HBS Release Sources**, which includes all other processes which affect water availability in Haughton Zone A, including, for example:

- Rainfall on the Haughton River Catchment, leading to surface flow in the Haughton River and recharge to the GBGA aquifer, less licenced unsupplemented diversion from the catchment, plus supplementation by Haughton Zone A infrastructure (such as Val Bird Weir, Giru Weir and the Healeys Lagoon Pump Station), and subject to a range of operational losses and environmental requirements.

Section 4 thus focuses on calculating annual HZA Extraction and HBS Release volumes from the available period of source data recorded by Sunwater, and then calculating the HZA Efficiency, to provide an indication of the likely relative contribution of HBS Releases and Non-HBS Release Sources to meeting HZA demands.

4.2 Source Data Requests

A request was provided to Sunwater to provide an updated table of annual release and extraction volumes, and the source data used to calculate those annual values. Sunwater advised that they

could only provide data since about 2002, as earlier data was tracked and recorded in DNRME's systems.

The initial set of data provided did not include any data for 2007-08, and Sunwater provided 2007-08 in a follow up package.

Pre-2002 data was requested from DNRME, but they advised that this data is not available without significant searching through local office and Brisbane-based archives, and that they have general concerns about the reliability of data from pre-2002.

Hence this review focused on data available for the 2002-2019 period.

4.3 HZA Extraction Data

Sunwater provided a spreadsheet containing records of metered extractions for all users the BHWSS. (QCA Information Request FR23_Attachment 4_Burdekin Water Usage 2002 to 2019.XLSX).

Usage of allocation water for users in Haughton Zone A was extracted from this spreadsheet. This was done by filtering the data to select all entries with "Giru Benefited System" in the Operational System Description and "Allocation Water" in the Product Description. A few notes on this data follow:

- From discussions with Sunwater it was identified that all Haughton River users are included in the database as being in the 'Giru Benefited System' operational system. That is, the non-GBGA Haughton Zone A users are listed in Sunwater's systems as being within the GBGA.
- The data also appeared to include a small number of miscellaneous extractions, e.g. truck loads from Ironbark Gully.

The extracted records thus appear to represent all allocation water extraction from Haughton Zone A, which is the quantity of principal interest to this review.

The annual total allocation extractions for each water year determined from the provided data are shown in Table 4.1. Also shown are the total extraction data from Table 9 in Kavanagh 2017. The values that Kavanagh applied are within 3% of the updated annual totals determined from the latest extract from Sunwater's database.

With these totals being re-derived from the source data, and reasonably matching previous estimates, the annual Total Extractions shown in Table 4.1 were adopted for this study.

Table 4.1 – Estimates of Annual Extractions from Haughton Zone A

Year	Total Extraction (ML/a)	Total Extraction from Kavanagh (2017)	Ratio
2002/03	51,294	51,253	1.00
2003/04	42,586	42,485	1.00
2004/05	47,203	48,609	0.97
2005/06	33,994	33,125	1.03
2006/07	37,985	37,937	1.00
2007/08	30,157	30,742	0.98
2008/09	27,061	27,061	1.00
2009/10	35,572	35,571	1.00
2010/11	6,677	6,677	1.00
2011/12	20,387	20,387	1.00
2012/13	20,610	20,610	1.00
2013/14	29,668	29,668	1.00
2014/15	46,422	46,422	1.00
2015/16	47,031	47,031	1.00
2016/17	33,592		
2017/18	43,814		
2018/19	31,553		
Average	34,447		

4.4 HBS Release Data

Sunwater provided raw HBS release data in three spreadsheets:

- QCA Information Request FR23_Attachment 1_Haughton Diversion 1997_2007.XLS
- QCA Information Request FR23_Attachment 2_Haughton Balancing Storage Diversion rates 2008_2017.XLS
- QCA Information Request FR23_Attachment 3_Haughton Diversion Post Kavanagh Report.XLS

With the initial three spreadsheets missing 2007-08 Sunwater later provided the data for 2007-08 in the following spreadsheet

- QCA Information Request FR40_Attachment 1_Diversion flow data 2007-08 water year.XLSM

These data were analysed to re-derive total releases into Haughton Zone A and total diversions from Haughton Zone A. Notes on the processing of these data is provided below:

- Despite the name, the first data in the 1997-2007 spreadsheet started in 2002.
- The format of the four spreadsheets were adjusted to enable them to be combined into a single record.
- The “Meas. Point Desc” column in the 2008-19 data included records of:
    - “VOLUME RELEASED (TOTAL)” – releases made from HBS through the gates into HZA, in ML/d. This data starts in about 2001.
    - “VOLUME DIVERTED – TOTAL” – total releases from HBS into HZA, including both releases through the gates and releases over the HBS spillway, in ML/d. This data starts in about 2008.

  - "OVERFLOW" - releases made from HBS over the HBS spillway into HZA, in ML/d (Figure 3-1). This data starts in about 2008.
  - "VALVE 1 TURNS" and "VALVE 2 TURNS" – The number of turns on the handwheel that opens gate valve 1 and 2 releasing water from HBS to HZA (Figure 3-2). This data starts in about 2009.
  - "FLOW METER READING" – Recently, the reading on the flow meter on the pipe between HBS and Haughton Zone A (Figure 3-3). This data starts in about 2016 (see below).
- The 2002-07 data spreadsheet only showed one quantity, labelled as "VOLUME RELEASED (TOTAL)" in the "Meas. Point Desc" column. This is the same label as used in the 2008-2019 data for the releases made through the gates (i.e. it does not include overflows).
- Sunwater advised that the "VOLUME RELEASED (TOTAL)" values were generally determined based on a rating curve converting valve turns to a flow rate. Sunwater supplied the applicable rating table, shown in Table 4.3.
- A comparison of the "VOLUME RELEASED (TOTAL)" values to what you would get from applying the supplied rating curve identified some differences on some daily values, however comparison over the long term (2009-19) indicated that the total volume calculated from the valve turns was within 1% of the total volume labelled as "VOLUME RELEASED (TOTAL)".
- Sunwater advised that the "OVERFLOW" values were generally determined by subtracting the volume through the gates (determined based on gate turns) from the volume measured at the gauge. There have been few overflows recorded coincident with the recorded cumulative meter readings (2016 on), but a spot check of an overflow in May 2017 appeared to confirm this.
- The "FLOW METER READING" data is all zero up to about 2012. In the period 2012-13 it appears that the net flow might be occasionally recorded against this label, although it appears to be recorded only occasionally. From ~2016 on it appears to be recording the incrementing numbers on the gauge (which are in ML), although a reset appears to have occurred (a sudden jump reduction) in early 2019.
- Values are provided on most days of the year, but there are quite a few days with no flow recorded. It is necessary to estimate the applicable flow on days with no record (otherwise assuming no flow by default on missing days would be a systematic error.) Missing days of data were infilled using the following process:
  - If the release volume on the day before and after the missing days was 0 ML/d, it appeared to be appropriate to assume that the release over the missing period was 0 ML/d.
  - Otherwise it is not straightforward to estimate releases during the missing period. As an approximate method, it was assumed that the operators would be more likely to record the daily release on days that they adjust the valves. It was thus decided to infill missing periods with the same daily flow rate as on the day before the missing period.
- Estimates of the total releases from HBS to the HZA were then derived as follows:
  - Based on the annual totals of infilled "VOLUME RELEASED (TOTAL)" data.
  - Based on the annual totals of infilled estimates of flow from the recorded Valve Turn information.
  - Based on the cumulative meter readings, less the infilled estimates of overflows.

- These three estimates are listed in Table 4.2, along with the estimated values from Kavanagh 2017.

The infilled volume released records were adopted for use in this study. The last column of Table 4.2 shows the adopted releases.

Table 4.2 – Estimates of Annual HBS Releases to the HZA

Year	Gate Release (Vol Rel) Only (ML/a)	Release based on Valve Turns (ML/a)	Release based on Cumulative Meter Records - Overflow (ML/a)	Total Release from Kavanagh (2017) (ML/a)	Adopted Release (ML/a)
2002/03	60,117			60,037	60,117
2003/04	42,833			42,453	42,833
2004/05	45,322			45,257	45,322
2005/06	32,201			32,136	32,201
2006/07	31,556			31,556	31,556
2007/08	23,150			22,018	22,018
2008/09	20,921			19,101	20,921
2009/10	40,685	40,618		38,465	40,685
2010/11	4,710	4,745		5,872	4,710
2011/12	16,243	16,665		29,603	16,243
2012/13	29,400	28,937		26,873	29,400
2013/14	44,664	43,855		44,671	44,664
2014/15	52,527	51,942		47,405	52,527
2015/16	50,129	57,823		47,019	50,129
2016/17	30,197	28,791	27,664		30,197
2017/18	40,682	39,069	35,795		40,682
2018/19	23,940	22,432	24,509		23,940
Average (09-19)	33,318	33,488			33,318

Table 4.3 – HBS Release Valves: Valve Turns – Flow Relationship

No of Valve Turns	Flow Rate (ML/d)
0	0
10	20
20	40
30	65
40	90
50	115
60	140
70	177
80	215
90	230
100	245
110	260

4.5 HZA Efficiency

With Section 4.3 and 4.4 presenting annual estimates of HBS releases into HZA and the supplemented extraction from HZA, the annual efficiency of supply may be estimated, as shown in the table below.

Table 4.4 – HZA Efficiency

Year	Total Release (ML/d)	Total Extraction (ML/d)	Efficiency
2002/03	60,117	51,294	0.85
2003/04	42,833	42,586	0.99
2004/05	45,322	47,203	1.04
2005/06	32,201	33,994	1.06
2006/07	31,556	37,985	1.20
2007/08	23,150	30,157	1.30
2008/09	20,921	27,061	1.29
2009/10	40,685	35,572	0.87
2010/11	4,710	6,677	1.42
2011/12	16,243	20,387	1.26
2012/13	29,400	20,610	0.70
2013/14	44,664	29,668	0.66
2014/15	52,527	46,422	0.88
2015/16	50,129	47,031	0.94
2016/17	30,197	33,592	1.11
2017/18	40,682	43,814	1.08
2018/19	23,940	31,553	1.32
Average	**34,663**	**34,447**	**0.99**
Lowest Efficiency			**0.66**

The results in Table 4.4 show that there are a number of years where more water is released to HZA than is extracted from HZA, with the lowest efficiency over the period analysed being 0.66 in 2013/14. This appears to indicate that, in dry periods, there is little net contribution from non-HBS Release Sources to the volume of extraction made by HZA users.

The average efficiency of 0.99 indicates that, on average, HBS releases into Haughton Zone A are about the same as extractions from Haughton Zone A over the period of available data from 2002 to 2019.

4.6 Data Issues

Developing appropriate estimates of inflow and extraction from Haughton Zone A for the purposes of assessing the likely relative contribution of HBS Releases and Non-HBS Release Sources to meeting HZA demands is not a simple task. A number of issues were identified during this review, and GBGA stakeholders have raised a number of issues in consultation and in their submission.

The sections below briefly discuss the identified issues, and their potential effect on the estimated efficiencies presented in Table 4.4.

4.6.1 Period of Available Data

It is noted that the period of data analysed, 2002/03 to 2018/19, was selected based on the period of source data that was made available for this review. The start year, 2002/03, is that year because it is the first year that the newly formed Sunwater managed the data, i.e. the 2002/03-18/19 period was not selected based on hydrologic factors, and thus it does not necessarily represent average conditions or contain the worst dry period. Choosing to analyse over a shorter or longer period would likely change both the minimum and the average[1] efficiency.

A longer period of data is generally preferable because it is more likely to provide a balanced appreciation of the climatic flow regime, however the further back in time the less the scheme operational conditions are the same as currently apply. BRIA's submission lists a few of the changes, the loss of the bag on Val Bird Weir, increasing area of irrigation, and the shift to take water direct from surface water. There would be diminishing returns in attempting to extend this analysis by collating release and extraction data for earlier periods[2], and care would need to be taken not to bias statistics by extending back to just capture the last big wet or dry period.

The 2002-19 period used in this report is considered to be acceptable for the purposes of this study.

4.6.2 Sub-Annual Efficiency Estimates

Seasonal climatic variation is significant, and it is considered that one year is the minimum period over which HZA efficiency should be calculated. Furthermore, to gain an appreciation of the effects of annual variability, efficiencies must be calculated over a period of many years, as was presented in Section 4.5.

In BDCG's 12/12/19 supplemental submission additional release and usage data for the 6 month period 1/4/19 to 30/9/19 is presented, with efficiencies calculated in excess of 250%. Figure 4-3 illustrates that this period had substantial upstream flows during and just before the period, and so is comparatively wet. It is possible to also calculate an efficiency number for three month periods, and if you did this for Mar-May 2019 a near-infinite efficiency would result (see Figure 4-3). Similarly, the efficiency could be calculated for periods with little upstream flows just before or during the period (e.g. June-Dec 2002 or May-Nov 2018 see Figure 4-2 and Figure 4-3), which would result in low efficiencies.

Efficiencies on a sub-annual basis provide little account for inter-seasonal variability, and thus may provide a misleading appreciation of the relative contribution of HBS releases and non-HBS Release sources. Use of sub-annual efficiencies for the purposes of pricing is not recommended.

[1] It is noted that page 11 of the submission includes an extract from a 2001 GHD report, who examined data in 1996/97 and 97/98. This source report has not been reviewed in this study, but the GHD report estimated HZA Efficiency in these two years as ~59% and ~33%, considerably lower than the calculated lowest efficiency in the 2002-19 period. If adequate source data could be obtained, extension of the period to include these two years might result in a lower minimum efficiency and a lower average efficiency.

[2] If a longer period of analysis is seen as desirable, a hydrologic modelling approach that applies a long period of climatic data to a static set of infrastructure and operational rules is recommended, see Section 5.1.

4.6.3 Accuracy of Release and Extraction Records

As part of this study Sunwater was requested to provide previous laboratory testing reports / data in relation to the likely accuracy of the instrumentation measuring releases and extractions. Sunwater indicated that Siemens was currently servicing and calibrating the release gauge, and that calibration details could be provided when received. Sunwater did not provide any other gauge/meter testing reports from which an appreciation of accuracy could be gained.

In the absence of such reports, it is considered that the record of user extractions would be generally reasonable. This data drives invoicing, and thus there is financial incentive for Sunwater to make sure it is not too low, and for users to make sure it is not too high. Sunwater indicates that adjustments are made in circumstances where the meter fails, estimating water use based on other data such as power records, pump records or previous similar periods. The extraction data is thus expected to be of reasonable quality.

The approach used to estimate releases by the operators, based on the number of valve turns, would appear to be a reasonable method. This is because there is a reasonably fixed relationship between the number of turns of the valve wheel (Figure 3-2) and the opening of the gate valve itself, and the flow rate through the gate valve is related to the extent of the opening of the gate valve.

The head in the channel upstream, see Figure 3-1, will affect the rate of flow through the gate valve at a certain number of turns / opening. This is an uncertainty, but from discussions with Sunwater it is understood that the Haughton Balancing Storage is usually operated over a fairly narrow level range, and thus the extent of this uncertainty is not expected to be large at the annual scale.

The three years of estimated total releases based on the cumulative readings on the flow gauge since 2016/17 do show some differences but appears to indicate that the recorded gate releases are of the right order.

At the bottom of pg 17 of BDCG's submission is a comment that states that "up to October 2015 the release data was only estimated by Sunwater." As can be seen in Table 4.2, cumulative meter readings start to be recorded in Sunwater's database in 2016, so this comment may be a reference to this new method of estimating releases. Both the pre and post 2015 values are of course estimates, the difference is the Siemens gauge does not appear to have been used to inform the estimate in earlier years. As discussed above, while there are uncertainties associated with the recorded releases over time, the 2002 to 2019 estimates used in this report are considered to be a sufficient accuracy for the purposes of this assessment.

4.6.4 GS119003A Haughton River at Powerline

GS119003A Haughton River at Powerline is a stream gauge on the Haughton River below where supplemented releases from the HBS enter Haughton Zone A. This gauge thus provides an additional method to assess the uncertainty associated with the recorded releases.

GS119003A Haughton River at Powerline is located close to the junction with Major Creek, near the start of the GBGA area. There are a few Haughton Zone A users between the supplementation point and the gauge, and some river distance where transmission losses and groundwater recharge would occur, and thus you might expect the gauged flow to be a little below the recorded release in dry conditions.

The gauged records at the nearby gauging stations were plotted with the recorded releases, with Figure 4-1 showing an example dry year before supplementation from HBS releases commenced, and Figure 4-2 an example dry year after HBS releases commenced, and Figure 4-3 the most recent year 2018-19. Some notes to assist in interpreting these plots are shown below:

- Flows at three gauging stations are shown:
  - GS119003A Haughton River at Powerline, below the supplementation point.
  - GS119005A Haughton River at Mount Piccaninny, a gauge above the supplementation point on the Haughton River, and one of the two gauges used for determining the required passflow.
  - GS119006A Major Creek at Rocky Waterhole, a gauge above Haughton Zone A on Major Creek, and one of the two gauges used for determining the required passflow.
- Rain recorded at GS119003A Haughton River at Powerline is shown on the 2nd y axis. (Note the rain record at this site did not commence until 1995, so the absence of any recorded rain on the first plot does not mean it did not rain in 1982-83.)
- The dotted purple line is drawn at 40 ML/d, the required passflow. The passflow rule requires the combined GS119005A and GS119006A flow up to this rate to be passed through the system and released from Giru Weir.
- The black line is the infilled recorded release though the gates from HBS to the Haughton River. (Supplementation did not start until about 1987 and so no releases are shown on the 1982-83 period graph.) The yellow line is the raw, not infilled data – it can be seen that in 2002/03 there were few days without recorded release data, while 2018/19 has a number of missing days.
- Note that flows and releases are plotted on a log scale to enable large and small flow rates to be seen.
- There is some missing data at the three gauging stations – flows on days with missing data are not plotted. Owing to the log scale, days with zero flow are also not plotted on the graph.
- For the releases, days with zero release (or missing days) have been set to 1 ML/d so a trace can be seen along the x axis for these lines, to assist in interpretation of changes in release rates.

Figure 4-2 and Figure 4-3 show that the recorded flows at Powerline are of a similar order to the recorded release at the HBS outlet. The 2002-03 Powerline flows in dry periods are generally a little below the release volume, which seems reasonable as they are some users and losses between the HBS release point and Powerline. On the 2018-19 plot the Powerline flows tend to be similar or slightly higher than the release volume. The difference is not large, but might be caused by a range of issues at the stream gauge (e.g. local rain, travel time, erosion or deposition at the gauge altering the rating curve, the general accuracy of the rating curve at low flow rates with a sandy control) or it might be caused by the HBS release records being low. However, in general, the Powerline data appears to provide support that the release data is reasonable.

The contrast between Figure 4-1 and Figure 4-2 shows the benefit of supplementation in dry years, with Figure 4-2 showing a fairly steady constant flow being released year round to meet user requirements. Figure 4-2 shows only one small fresh in the Haughton River, with HBS releases ceasing during this small flood. From this plot it appears that the vast majority of extractions in this year would be accessing water released from HBS.

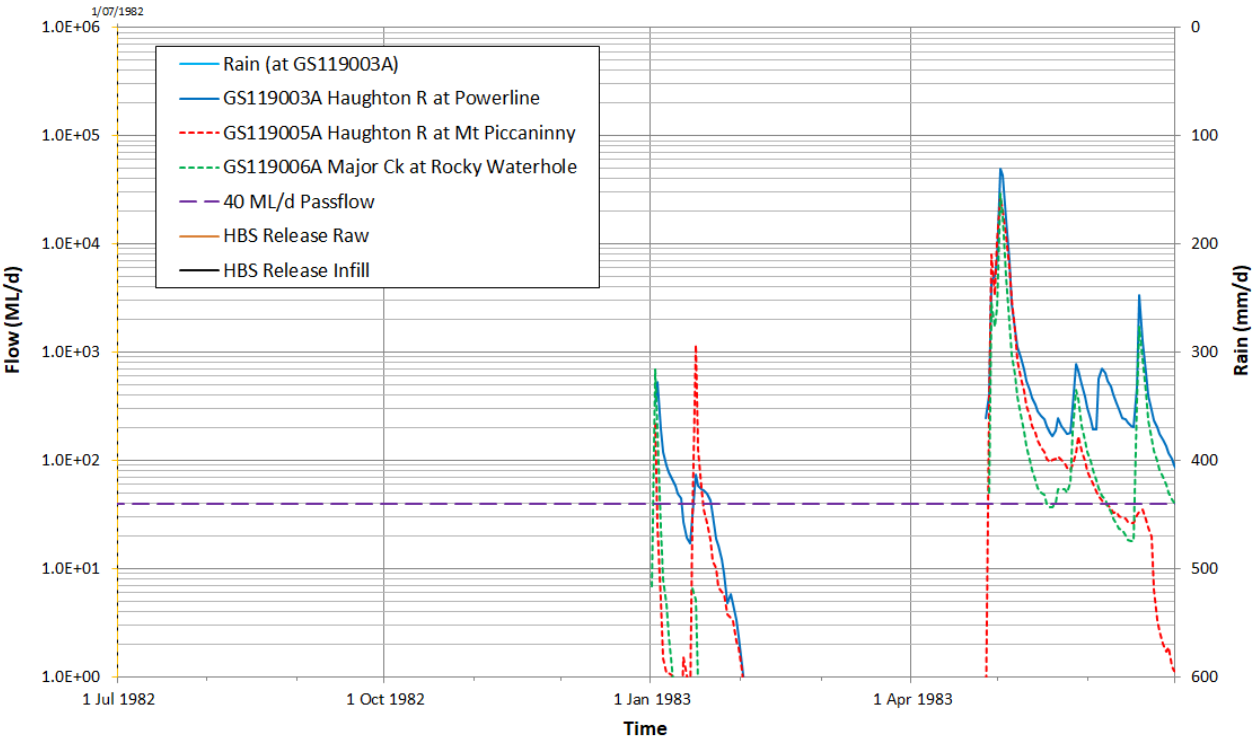

Figure 4-1 – Sample Dry Year Before Supplementation

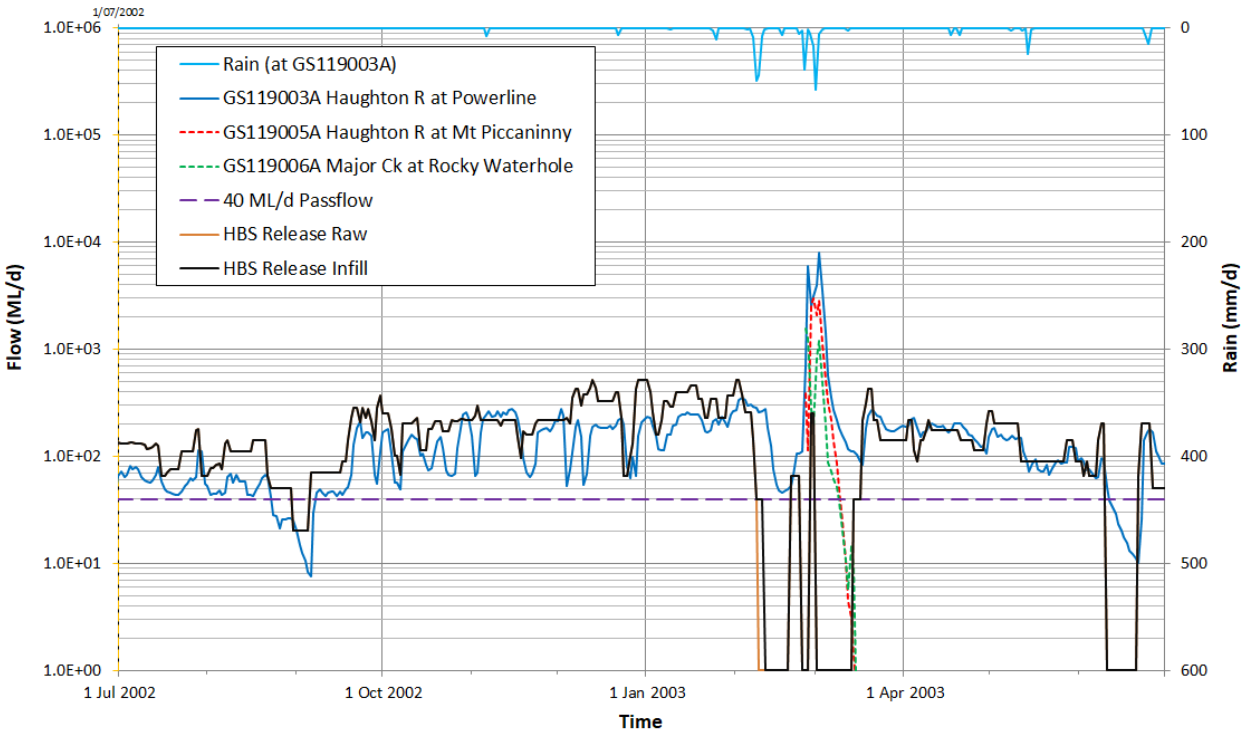

Figure 4-2 – Sample Dry Year After Supplementation

Further, it is noted that the historical release in 2003 only re-started right at the end of this small fresh, some ~5 days after the upstream surface flow dropped below the threshold, a practice that will likely not be able to continue with the passflow requirement being observed. If 2002-03 conditions occur in the future, with the infrastructure in place to allow the passflow requirement to be met, it would be expected that efficiency would be lower in this year than that indicated by the historic data, 85%, all other things being equal.

The most recent water year 2018-19, is shown in Figure 4-3. The end of 2018 was fairly dry, however the rain commenced in late 2018 and significant flows occurred in the Haughton River over the December to May period. It can be seen that supplemented releases in this most recent year commenced at about the same time that the upstream gauges fell below the 40 ML/d threshold in May 2019, likely because Sunwater was endeavouring to meet user requirements while also meeting the passflow requirement in this year.

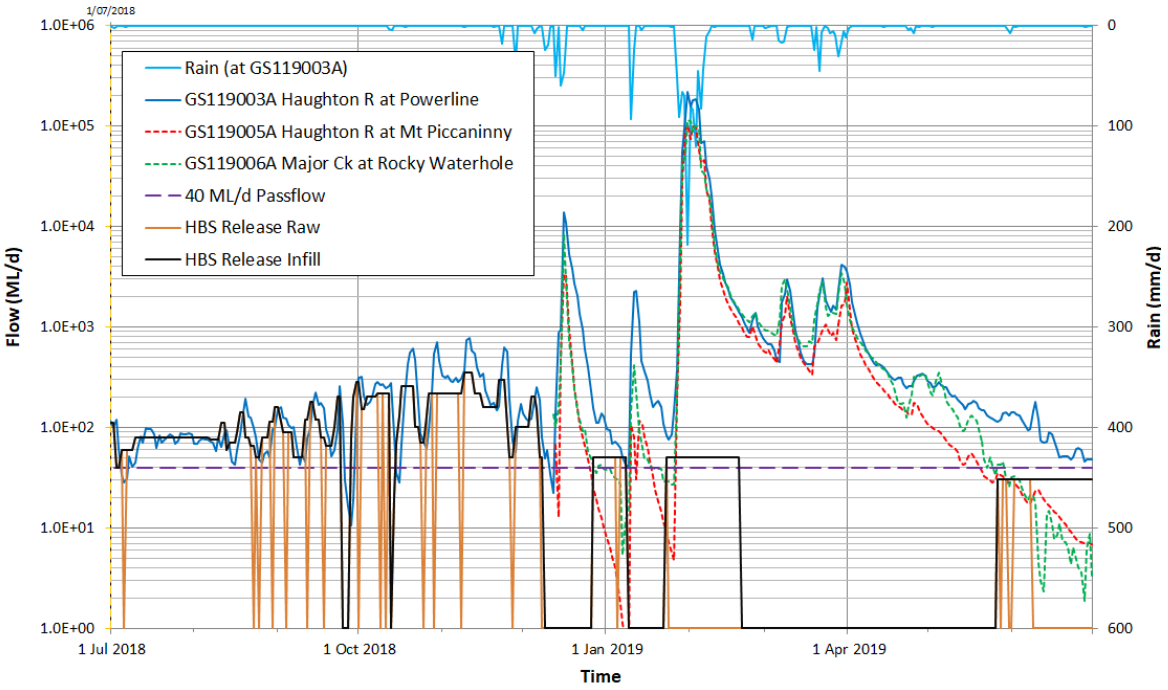

Figure 4-3 – Last Water Year (2018-19)

In summary, while there is no doubt that there is a level of inaccuracy associated with all data, the release and extraction data in Table 4.4 is considered of sufficient quality for the purposes of the assessment presented in this report.

4.6.5 Sensitivity to Missing Data Infilling Methodology

It is acknowledged that any method to estimate data on missing days in a data record is approximate. Review of the infilled data against flows at GS119003A indicates that many of the infilled days appear to be reasonable, but on some occasions the flow at GS119003A tends to indicate that an alternative value might be more appropriate.

For example Figure 4-2 shows that the infilling methodology has had little effect in this dry year, however Figure 4-3 shows that a number of days with missing data have been infilled in the last

water year. The infilled data over the July-Dec 2018 periods appears reasonable given the gauged flows at Powerline, however two sections of the infilling in 2019 may be an over-estimate:

- The infilled data is showing infilled releases through the peak of the February 2019 event ceasing at the first recorded zero release on about 20 February. There may be operational reasons why releases cannot be shut down instantly when local flows occur, but the infilled release does extend for some time. Sunwater may have ceased releasing at a date within this missing period, before the first recorded zero release on about 20 February.
- It is understood that Sunwater often holds a maintenance shutdown in the last weeks of the water year, which might mean that the infilled release over this period is an overestimate.

To gain an appreciation of the maximum possible effect of infilling missing days, a sensitivity analysis was conducted assuming the release was zero on every missing day of data, with the resultant annual release estimates presented in Table 4.5, and the resultant HZA efficiency in Table 4.6.

Review of Table 4.5 identifies that infilling data on missing days adds ~10% to the release volume. Table 4.5 also shows a summary of 2005-19 annual estimates provided by Sunwater for this review. The Sunwater data is similar to the non-infilled estimated releases, perhaps indicating that Sunwater obtained their totals by summing the data in their database with no adjustment for missing periods.

Table 4.5 – Sensitivity of Annual Releases – No Flow on Missing Days

Year	Gate Release (Vol Rel) Only (ML/a)	Release based on Valve Turns (ML/a)	Release based on Cumulative Meter Records - Overflow (ML/a)	Sunwater 2019 Release Estimate (ML/a)
2002/03	60,037	0		
2003/04	42,453	0		
2004/05	45,257	0		
2005/06	32,136	0		32,136
2006/07	31,556	0		31,556
2007/08	20,990	0		22,018
2008/09	19,101	1,142		19,101
2009/10	37,500	37,433		37,500
2010/11	4,690	4,725		4,735
2011/12	15,968	16,390		15,968
2012/13	27,590	27,127		26,873
2013/14	41,524	40,625		41,524
2014/15	46,835	46,250		46,835
2015/16	46,979	49,045		46,974
2016/17	29,292	27,986	27,769	29,292
2017/18	35,641	34,377	35,795	35,641
2018/19	19,850	19,031	24,509	19,850
Average (09-19)	30,587	30,299		30,519

Table 4.6 – Sensitivity of HZA Efficiency – No Flow on Missing Days

Year	Total Release (ML/d)	Total Extraction (ML/d)	Efficiency
2002/03	60,037	51,294	0.85
2003/04	42,453	42,586	1.00
2004/05	45,257	47,203	1.04
2005/06	32,136	33,994	1.06
2006/07	31,556	37,985	1.20
2007/08	20,990	30,157	1.44
2008/09	19,101	27,061	1.42
2009/10	37,500	35,572	0.95
2010/11	4,690	6,677	1.42
2011/12	15,968	20,387	1.28
2012/13	27,590	20,610	0.75
2013/14	41,524	29,668	0.71
2014/15	46,835	46,422	0.99
2015/16	46,979	47,031	1.00
2016/17	29,292	33,592	1.15
2017/18	35,641	43,814	1.23
2018/19	19,850	31,553	1.59
Average	**32,778**	**34,447**	**1.05**
Lowest Efficiency			**0.71**

With the efficiency in dry periods in this sensitivity case still being less that one, it does not appear that alternate methods of infilling missing data would substantially change the conclusions of this study.

It is noted that Sunwater have advised (in response to QCA Information Request FR40) that no record on a day means that no release was made. Review of the Powerline gauge data appears to indicate that releases were made on at least some of the days where no release is recorded in the database. Additionally, zero releases are commonly recorded in the database, it is only the odd day here and there with no recorded value.

As this operational practice is open to error, it is recommended that Sunwater institute new operational practices to require a release (including valve turns, cumulative meter read, overflow and gated release) to be definitively recorded on every day.

4.6.6 Overflows

When Sunwater provided the updated data for this review they highlighted that the Kavanagh 2017 tables included overflows as part of the total HBS releases. Sunwater suggested that overflows from HBS should not be included as part of the total supplemented inflows to Haughton Zone A.

Overflows occur when the Haughton Balancing Storage is a little higher than normal, and water spills over the spillway weir shown in Figure 3-1. Sunwater advise that they do take account of this in adjusting the gate valves. That is, if there is a small overflow they release less through the gates to compensate.

Overflows do contribute to the supplemented volume added to Haughton Zone A from the Haughton channel system. However if overflows are large volumes that occur in a short period of time, particularly in wet years, they may overflow Val Bird and Giru Weirs and be lost to the system, and thus some part of the overflows would not effectively contribute to Haughton Zone A.

Deciding on the appropriate extent of inclusion of overflows in the HBS release used to evaluate HZA Efficiency is not straightforward.

From a perusal of the historical records of overflows it appears that generally the overflows only occur for fairly short periods of time (see Figure 4-4), and thus it may be the case that much of this water overflows Giru Weir and is thus lost to the system. This review thus assumed that overflows provided 0% benefit to HZA users.

If a model is developed to analyse the system in more detail, overflows from the channel system to HZA can be included in the model, and the contribution of this overflow to system efficiency may be more accurately determined. However it is noted that overflows will perhaps only have a modest effect on performance in the dry periods of principal interest to this review.

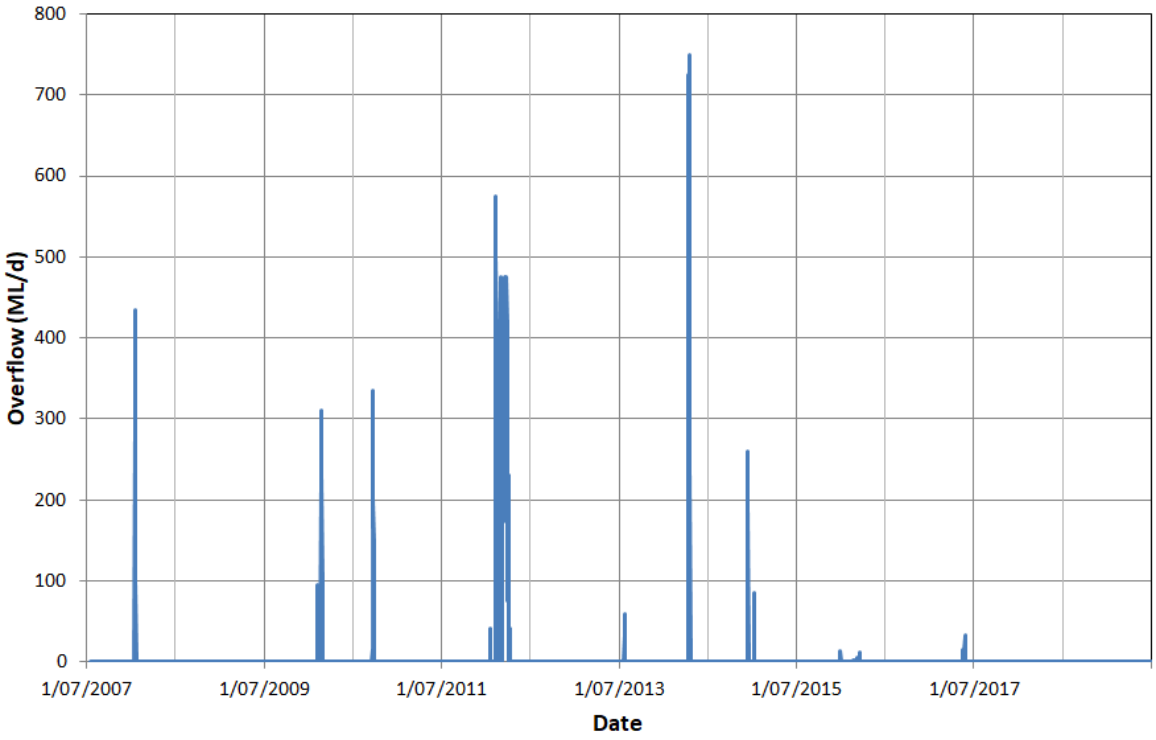

Figure 4-4 – Infilled Overflow Records

4.6.7 HZA Operational and Transmission Losses

Section 2.2.1 of the BDCG 4/11/19 submission states that 'the omission of scheme efficiencies and loss of water between the supplier and customer is a significant error". A number of losses associated with the GBGA are mentioned, including transmission losses, end of system losses at Healeys Lagoon and water expended in weed maintenance exercises.

There is no doubt that there are significant losses associated with delivery of water to users in the GBGA, particularly in dry periods. As discussed in Section 4.1, the HZA efficiency statistic is endeavouring to provide an indication of the likely relative contribution of HBS Releases and Non-HBS Release Sources to meeting HZA demands. It is the net effect of the Non-HBS Release sources which is of interest for the purposes of this assessment. That is, the net effect of rainfall, evaporation, seepage, storage, end of system losses, operational losses, surface-groundwater interaction, environmental requirements and other factors on the efficiency of the zone.

With the net effect of non-HBS Release sources being the quantum of interest to this study, is it not appropriate to make adjustments for any of the component parts of the non-HBS Release Source in the calculation of HZA Efficiency.

4.6.8 Weed

The issue of weed potentially blocking the gates or channel and thus influencing the data is raised in a number of the submissions

Weed blocking the channel will reduce the ability to release water but is unlikely to affect the measurement of that release. However weed getting tangled in the release gates may affect the recorded data. If weed does affect the recorded releases, it may mean that the recorded releases are higher than the actual release. The release gates tend to be a high flow location, and it is expected that the area would be regularly surveilled by Sunwater staff, and hence the extent of weed blocking in the gate area should be minimal.

The recorded releases based on valve turns has been compared to the recorded releases based on the meter (see Section 4.4, and also the flows at the Powerline gauge (see Section 4.6.3). Based on these checks the likelihood of weed causing major errors in the recorded release data is thought to be small.

4.6.9 Non-GBGA Haughton Zone A Usage

There are a small group of users with allocations from Haughton Zone A but who are not within the defined area of the GBGA. Sunwater have advised that these users divert water from the Haughton River immediately below where the releases from the HBS enter the Haughton River, i.e. above the users who are within the GBGA.

It has been suggested that the releases and usage for these customers should be excluded from the estimation of the efficiency of the GBGA.

It is not simple to make this adjustment, as it would be necessary to remove both the portion of the release for these users and a portion of the transmission losses associated with these users. However, operational and transmission losses usually increase with conveyance distance. With these users being immediately next to the HBS release location, it is likely that the losses required to deliver their allocation would be lower than that for the average user in the GBGA. Adjusting the release and extraction data for these users may thus decrease the average efficiency of supply below that estimated in Table 4.4.

It is thus considered that including releases and usage for the non-GBGA Haughton Zone A users is reasonable in calculating the HZA efficiency, and that the calculated HZA efficiency provides a reasonable conservative indication of the GBGA efficiency.

4.6.10 Temporary Trades

It has been suggested that the releases and extractions should be adjusted to reflect the volume of temporary trades that occurs from time to time. Sunwater provided their records of temporary trades from about 2003 to 2019. The net temporary trades into HZA is tabulated below.

Table 4.7 – Temporary Trades into HZA

Year	Net Temporary Transfer to HZA (ML/a)
2003/04	5,210
2004/05	8,798
2005/06	2,683
2006/07	2,616
2007/08	5,110
2008/09	1,665
2009/10	2,499
2010/11	262
2011/12	1,212
2012/13	-19
2013/14	-1,103
2014/15	7,013
2015/16	10,290
2016/17	4,788
2017/18	9,236
2018/19	5,232
Average	**4,093**

Table 4.7 shows that, on average, temporary trades are made into Haughton Zone A, but occasionally there is a net trade out of Haughton Zone A.

Adjusting the release and extraction data to remove temporary trades is not simple, as it would be necessary to remove both the portion of the release for usage that results from the temporary trade and a portion of the transmission losses associated with this release. The relationship of transmission and operational losses with the volume of water delivered along natural channels is complex, but in general there is a considerable loss to deliver a small volume of water along creek channels to users, and the percentage of transmission loss typically decreases with higher deliveries.

With Table 4.7 showing that usually temporary transfers increases water deliveries in Haughton Zone A, adjusting the release and extraction data to account for temporary transfers may decrease the average efficiency of supply below that estimated in Table 4.4.

Additionally, temporary transfers are part of the scheme operation rules, a benefit that can be used by any allocation holder in the scheme. Excluding the effect of temporary transfers from calculation of efficiency may thus provide a biased appreciation of efficiency.

It is thus considered that including releases and usage associated with Temporary Transfers is reasonable in calculating the efficiency of Haughton Zone A.

5 Other Issues

Section 4 has focused on estimating the relative contribution of supplemented releases from the Haughton Balancing Storage compared to other water sources in meeting the demands of Haughton Zone A users.

The analysis presented in Section 4 is considered to be of acceptable quality for the purposes of this study. The review of release and extraction data indicates that GBGA irrigators are receiving little contribution from Non-HBS Release Sources in dry periods, The conclusion of the Water Solutions Sept 2019 report is thus unchanged, that is, that there does not appear to be a strong hydrologic basis for differential pricing of GBGA MP users (that is, increasing unit prices for other Burdekin distribution system MP users to be able to provide a discount for GBGA MP users).

Based on consideration of the various factors discussed in this report it is also considered unlikely that a more detailed analysis will identify a substantially different conclusion. However unlikely is not the same as impossible.

The submissions received on the draft QCA report raise a number of other hydrology related issues that should be considered if a more detailed assessment is conducted to assist deliberations in future price paths. Some brief comments on these issues, for consideration in future assessments, are provided in the sub-sections below.

5.1 Modelling

The methodology applied in Section 4 has a number of issues as discussed in that section, and many of these issues could be more robustly addressed through development of a detailed hydrologic model[3].

If a more detailed modelling study is undertaken to assist with alternate apportionment of costs in future price paths it is strongly recommended that the study addresses the issues raised in this report, the Water Solutions Sept 2019 report, and in the submissions made on the QCA Draft Report. The compared scenarios should be assessed to a common set of benchmarks, including allocation performance, surface flow environmental performance, and groundwater level performance.

Further, it is strongly recommended that the study is independently peer reviewed, by both a surface water specialist and a ground water specialist. Detailed peer review should be undertaken at at least three project stages - the project scoping stage, the model configuration and calibration stage, and model simulation stage.

This will provide the best chance that the study will be of an appropriate standard to be able to inform deliberations in the next pricing review.

5.2 Groundwater

An issue raised in a number of the submissions is the importance of considering groundwater processes in the assessment of supply from non-HBS Release Sources. This is supported, and to

[3] It is noted that the submissions on the draft QCA report, and Water Solutions Sept 2019, have identified a number of issues with the execution of the modelling presented in the OD Hydrology Report. However the hydrologic modelling approach itself is an appropriate technique, and could be applied as part of a more detailed assessment of the relative contribution of HBS releases to meeting HZA demands.

this end some comments on issues associated with groundwater is provided in the sections below.

5.2.1 Rising Groundwater

Page 2 of the cover letter of the BDCG submission raises rising groundwater as an issue for consideration by the QCA. The letter indicates that DNRME have notified the Burdekin District Cane Growers Limited of this issue, and that a report on the issue is being prepared. The submission recommends that the QCA considers a pricing reduction to serve as an incentive to take groundwater to reduce the potential issues associated with rising groundwater.

The DNRME project assessing rising groundwater is described at the following web page. An initial discussion paper on the project was released in 2017 (DNRM 2017d).

https://www.dnrme.qld.gov.au/land-water/initiatives/lower-burdekin-project

Future modelling of the GBGA should consider the impacts of rising groundwater. There may be a number of operational changes that can be made to limit HBS releases in times of high groundwater levels, although this may have significant impacts on users who extract direct from surface water. Careful consideration of the environmental, social and economic benefits and impacts of alternate operational strategies is recommended.

5.2.2 Surface-Groundwater Interaction

The aquifer associated with the GBGA is very tightly associated with surface water, and this close association has been recognized legislatively, with water in the GBGA aquifer defined as being water in the watercourse by the Water Plan for the Burdekin Basin. This very close association is perhaps why Sunwater chose to commission a daily surface water balance type model to be developed by OD Hydrology.

While a daily surface water balance modelling approach is considered a reasonable methodology to analyse issues such as operation rules, allocation performance, scheme yield and environmental performance, groundwater effects are important in this catchment. It is of benefit to obtain expert groundwater advice to assist in developing a model that adequately reflects the interactions of the surface water scheme with closely associated groundwater reserves.

Water Solutions Sept 2019 identified a number of concerns with the OH Hydrology report that pertain to its modelling of groundwater and the interaction with surface water, such as a poor explanation of key parameters such as aquifer porosity and the weir-groundwater interchange rates, the lack of evapo-transpiration losses from groundwater, the simplified groundwater interchange procedure, and the poor calibration against bore records. (These limitations are part of the reason why the previous review concluded that there was significant concern in using the results of this model to inform pricing.) The submissions have identified a number of additional issues, such as the selection of bores used to inform the model calibration. All of these groundwater related issues should be considered if a detailed modelling study is conducted in the future.

5.2.3 Groundwater Australia Report

A report by Groundwater Australia (GA) is included in the BDCG submission. A few comments on this report for consideration in future studies follow:

- S3.1 – This section indicates that salt impacts can arise from seawater intrusion or from upwelling. In s6.2 the report indicates that the GBGA aquifer overlies and is surrounded by unfavourable sediments. It thus appears that salt may enter the GBGA aquifer from three directions: from the sea, from surrounding sediments, or from below. The development of objectives associated with limiting saltwater intrusion into the aquifer would likely need to consider all three potential sources.
- Figure 2 shows a very narrow area for the GBGA aquifer essentially confined to the area directly below the Haughton River and Ironbark Creek channels. Figure 3 shows an alternate estimate of the aquifer area, extending further from the channels. OD Hydrology assumed an aquifer area of 50 km^2, which appears to be much larger than that indicated on Figure 2 or 3. It will be important to use appropriate areas for the GBGA aquifer/s if a detailed model is developed.
- Page 51 indicates GA used depths of 8m and 6m used as average depths of the Haughton River and Healeys Lagoon aquifer, while OD Hydrology used a flat average depth of 8m for the entire GBGA aquifer.
- Section 3.3 highlights that the supplementary supply from the Burdekin River essentially eliminated risks to water supply security and the risk of seawater intrusion. This is key benefit of the HBS Releases that should be appropriately considered in future analyses.

5.2.4 Historical Aquifer Yield Estimates

Section 3.2 of the GA Report indicates that the quoted historical annual groundwater yield of 19,700 ML/a was based on the estimated storage volume in the aquifer and weirs. The aquifer storage volume was originally estimated in 1967 at 12,300 ML and updated in 1971 to 13,600 ML, and then increased to 19,700 ML by adding the weir storage.

It is highlighted that the yield of a water supply system, whether surface water or groundwater based, does not typically equal the combined storage in that system. The size of storages, be that a subsurface aquifer or a surface storage, does affect the yield and security of a scheme, but other factors (such as climatic variability, rainfall, evaporation, losses, pattern of demand, operation rules, restriction rules) are also key.

Review of the 1967 report identified that the 10,000 acre feet estimate (12,300ML) is not actually the size of the groundwater storage. Rather, the volume assumed able to be extracted was estimated at 66% of the total aquifer storage volume. This estimate is based on three key assumptions: that river flows are sufficient to refill this volume every year; that a 66% reduction in aquifer level does not lead to an unacceptable risk of saltwater intrusion; and that there are no environmental flow requirements. Additionally, there have been many other changes to system operation since the 1967 and 1971 estimates were made, with some of these summarised in BRIA's 5/12/2019 submission.

In summary, the 1967-71 19,700 ML/a estimate is not considered to be a reasonable estimate of the yield available from Non-HBS Release sources under current conditions. Future modelling of the GBGA, if undertaken, should assist in providing an updated yield and performance estimate considering current operations and infrastructure and the system's surface and groundwater characteristics.

5.3 Differential Pricing

A number of the submissions raise potentially significant different methodologies for distributing costs between users, such as re-defining GBA allocation as a lower performance priority group or charging less if the user has additional costs to pump the water to their end use. BRIA's submission also includes an alternative tariff adjustment methodology for GBA users.

Such options have significant implications and would need to be fully scoped before being considered. Sunwater and users may wish to consider the benefits and implications of such approaches in their submission to the next pricing review.

5.4 Unsupplemented Use and Full Use of Entitlements

There are roughly 400 unsupplemented water extraction licences in the Haughton Basin according to the data provided online by the Queensland government[4]. These licences are scattered across the catchment and source water from both surface water and groundwater sources[5]. Not every licence in the database has a nominal entitlement, but the sum of the ones that do total ~130,000 ML/a of permitted water extraction plus ~550 ha of area based licences. These licenses operate under a variety of conditions and thresholds. The water-harvesters on Major Creek, mentioned on pg 17 of the BDCG 4/11/19 submission, are some of the unsupplemented users in the Haughton catchment.

Unsupplemented use in the Haughton catchment is a component of the net non-HBS Release Sources, that is, unsupplemented use in the catchment will tend to reduce the water available to assist in meeting BHWSS Haughton Zone A allocation demands. The historical effect of unsupplemented use on HZA efficiency is thus included by default in the historical data calculations presented in Section 4.

It is noted that historical use of unsupplemented licences may not represent full use of these entitlements, and if unsupplemented entitlements are more fully activated in the future this will reduce the water available from non-HBS Release sources available to supply BHWSS Haughton Zone A allocations.

Similarly, the historical usage of BHWSS Haughton Zone A allocations over 2002 to 2019 may not represent the potential full use of those entitlements.

Demands in the future on the Haughton catchment may thus be larger than they are now. Larger unsupplemented and supplemented demands on the Haughton catchment will tend to increase the requirement for releases from HBS and reduce the HZA Efficiency.

Should more detailed modelling be undertaken, it is recommended that the potential effects of full use of entitlements of both supplemented and unsupplemented water authorities is considered.

[4] See https://www.data.qld.gov.au/dataset/water-entitlements/resource/a512e9a8-c374-4416-a77d-1be85f3c796e?truncate=30&inner_span=True

[5] Note not all groundwater aquifers accessed by approved licences in the catchment might be recharged from Haughton catchment rainfall.

6 Conclusions

Following on from Water Solutions' initial advice summarised in the report "Rural Irrigation Price Review 2020-24 – Assessment of Hydrologic Factors", this report provides additional advice to assist with pricing for the Giru Benefitted Groundwater Area (GBGA), in response to hydrologic issues raised in submissions on the draft QCA report.

A major issue raised in the submissions was concerns about the accuracy of the extraction and release data used to provide an indication of the likely contribution of 'natural' flows to meeting GBGA demands.

This assessment thus included an independent review of available source records on releases from Haughton Balancing Storage (HBS) and extractions from Haughton Zone A (HZA). The efficiency of HBS releases in meeting HZA demands was used to provide an indication of the likely relative contribution of HBS Releases and Non-HBS Release Sources to meeting GBGA demands.

It is highlighted that Non-HBS Release Sources includes all other processes which affect water availability in Haughton Zone A, including, for example: rainfall on the Haughton River Catchment, leading to surface flow in the Haughton River and recharge to the GBGA aquifer, less licenced unsupplemented diversion from the catchment, plus supplementation by Haughton Zone A infrastructure (including Val Bird Weir, Giru Weir and Healeys Lagoon Pump Station), and subject to a range of operational losses and environmental requirements.

The source release and extraction data were obtained and reviewed, and updated estimates of annual releases and extractions derived. The resultant recomputed minimum annual efficiency over the period of available data (2002/03 to 2018/19) was 0.66, with the average efficiency 0.99.

A range of complicating issues associated with interpreting the data and the estimation of releases, extractions and efficiencies were assessed. While all data comes with a level of uncertainty, it is concluded that the data may be used to inform this assessment.

The key conclusion of the Water Solutions Sept 2019 report regarding the GBGA is thus confirmed. That is, that review of release and extraction data indicates that GBGA irrigators are receiving little contribution from non-HBS Release sources in dry periods, and thus that there does not appear to be a strong hydrologic basis for differential pricing of GBGA MP users (that is, increasing unit prices for other Burdekin distribution system MP users to be able to provide a discount for GBGA MP users). It is thus recommended Haughton Zone A (including the GBGA) is considered to be fully part of the Burdekin Haughton Channel Distribution System, with all MP allocations in this distribution system paying the same price.

Lastly, based on consideration of the various factors discussed in this report, it is considered unlikely that a more detailed analysis will identify a substantially different conclusion to the above. However unlikely is not the same as impossible. A more detailed assessment may be undertaken to inform deliberations in future price reviews. Such assessment, if undertaken, should consider the issues raised in this report, the WS Sept 2019 report, and the submissions received on the draft QCA report.

7 References

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