Minerals Industry

Water Accounting Framework

USER GUIDE VERSION 2.0

minerals.org.au

ACKNOWLEDGEMENTS

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ACKNOWLEDGEMENT OF COUNTRY

The MCA acknowledges and pays its respects to past, present and emerging Traditional Custodians and Elders and the continuation of cultural, spiritual and educational practices of First Nations peoples.

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FOREWORD

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The Australian minerals industry is committed to responsible water stewardship. The industry has long-recognised water as a precious and shared resource with multiple social, cultural, environmental and economic values, important locally, nationally and internationally.

Water stewardship is central to minerals industry environmental, social and governance performance and disclosure standards. Transparency around water use and the capacity to demonstrate responsible water management are central to these standards.

Understanding operational water use and its interaction with the surrounding water system – including with the environment and communities – is fundamental to water stewardship. It is an essential starting point for effective management.

The MCA Water Accounting Framework (WAF) enables the minerals sector to meet these needs. It is a tool that provides a consistent approach to understanding, benchmarking and communicating operational, regional and corporate level water use.

The WAF supports organisational understanding of water risks, opportunities and the role of industry in contributing to effective catchment-scale water management. It supports continual improvement in operational and corporate level water management and disclosure.

The framework was developed specifically for the mining and metals industry. Adopted in 2011, the development of this common approach to water accounting, was the culmination of more than six years work by the MCA, the University of Queensland's Sustainable Minerals Institute and industry.

It has been incorporated into industry reporting frameworks in Australia and internationally, reinforcing the industry's commitment to innovate and lead on water stewardship.

This update draws from more than a decade of industry experience in implementing water accounting and ensures the WAF keeps pace with change, while remaining consistent with existing WAF concepts.

The User Guide Version 2.0 provides practical guidance on WAF implementation to support companies on their water stewardship journey.

Tania Constable

TANIA CONSTABLE PSM
Chief Executive Officer
Minerals Council of Australia

1 INTRODUCTION

What is water accounting?

Water accounting describes the application of a consistent and structured approach to identifying, quantifying, understanding and communicating water interactions using a common set of metrics and approaches.

Water accounting differs to water reporting. Water accounting is the consolidation of operational water balance information and provides the data to support water reporting for a variety of audiences and interests. In contrast, water reporting is the presentation of both water accounting and broader water related information in formats tailored to the needs of various reporting uses and users.

A consistent, scalable approach to water accounting, tailored for the minerals industry

The WAF provides a consistent, but flexible approach that can be adapted to a range of mining related contexts to optimise operational water management and support corporate water reporting. As a tailored industry framework, the WAF accommodates the complex water interactions that are characteristic of the sector.

By using clearly defined water metrics, the WAF enables sites and companies to account for, report on and compare water use in a rigorous and consistent manner. While designed for the minerals sector, it can be applied by other industries.

Supporting site and company level reporting

The WAF supports companies to respond to other reporting initiatives, including the International Council on Mining and Metals (ICMM) minimum disclosure requirements, the Global Reporting Initiative (GRI) as well as national level reporting, including the Australian Bureau of Statistics.

Objectives of the WAF

The key objectives of the WAF are to:

a. Provide a consistent approach to quantifying a minerals operation's water interactions, including:
   - The magnitude and quality of water flows into, and out of, the operational entity, and their associated sources and destinations
   - The degree to which water is 'reused' and 'recycled' within the operational entity to improve operational water efficiencies and reduce the need for additional water inputs

b. Support water stewardship efforts by enabling:
   - Risk-based approaches that allow effective water management and stewardship responses
   - Transparent reporting of site, company and industry water use
   - Benchmarking of operational water use against other operations in a region or catchment to improve understanding of industry water use
   - Benchmarking of industry water use against other local stakeholder's water needs (community, industry and environmental) to support water sharing planning processes

About this guide

This guide steps through the water accounting process from first principles through to the development of site level and corporate water accounting and reporting. It is aimed at supporting companies new to water accounting and provide further clarity for those with accounting systems already in place. It is intended for use by both operations and corporate water professionals.

The guide includes a range of worked examples and case studies to support account development and demonstrate links between the WAF and key international reporting frameworks. It is structured in the following manner:

- **KEY CONCEPTS** – Outlines the key principles and concepts that underpin the WAF
- **WAF APPLICATION AND PREPARING REPORTS** – Provides a step-by-step guide on preparing site water information and applying the WAF
- **CASE STUDIES** – Demonstrates account development for two different mining operations
- **REVIEW AND CONTINUAL IMPROVEMENT** – Outlines opportunities for improving water management performance
- **EXAMPLES OF WAF REPORTS AND AGGREGATION** – Provides examples of WAF reporting at site, company and catchment level
- **REPORTING UNDER OTHER FRAMEWORKS** – Demonstrates how to the WAF links to other water reporting and stewardship frameworks

Key changes in this revision

Most changes focus on providing additional clarity, examples and useful references. More material changes include:

1. A simplified document structure and process – with initial focus on understanding the water balance, then using this information to prepare the water account and supporting accuracy and efficiency metrics
2. Clearer definitions and additional examples – to support implementation and trouble-shooting
3. A formalised approach to task aggregation – to enhance consistency and comparability of reuse and recycling metrics
4. Changes to how the quality of evaporated water is classified – the quality of water that evaporates is now classified as the quality of the source water (e.g. may be category 1, 2 or 3), rather than the quality of the evaporate (always category 1), to enable improved communication of site water use
5. Simplification of the water quality decision process – where data is not available defaults are provided to support water stewardship in decision making
6. Updated alignment with the International Council on Mining and Metals' (ICMM) Water Reporting: Good Practice Guide (2nd Edition)[1] – to maintain consistency in terminology and other improvements, including the following key terminology changes:
   - Other Managed Water (supersedes Diversions) with additional allowance that recognises both storage and material losses of this water
   - New Water (supersedes Raw Water)

The above changes will support greater consistency in the implementation of the WAF, improved integration with other commonly used industry reporting standards, and effective communication and benchmarking of industry water use. These are all key WAF objectives.

Importantly, these changes build on the existing WAF concepts and provide continuity with past accounts. Companies are encouraged to adopt this latest guidance as soon as practicable, to ensure ongoing industry consistency. Whilst these changes may result in some changes in the magnitude of certain metrics in some operating contexts (notably relating to the water quality classification of evaporative losses), there is no requirement to re-state previous accounts. However, companies may wish to use the Contextual Statement or notes to explain any material differences between current and past accounts, referencing this guide.

1 International Council on Mining and Metals (ICMM), *Water Reporting: Good Practice Guide 2nd Edition*, London, 2021

2 KEY CONCEPTS

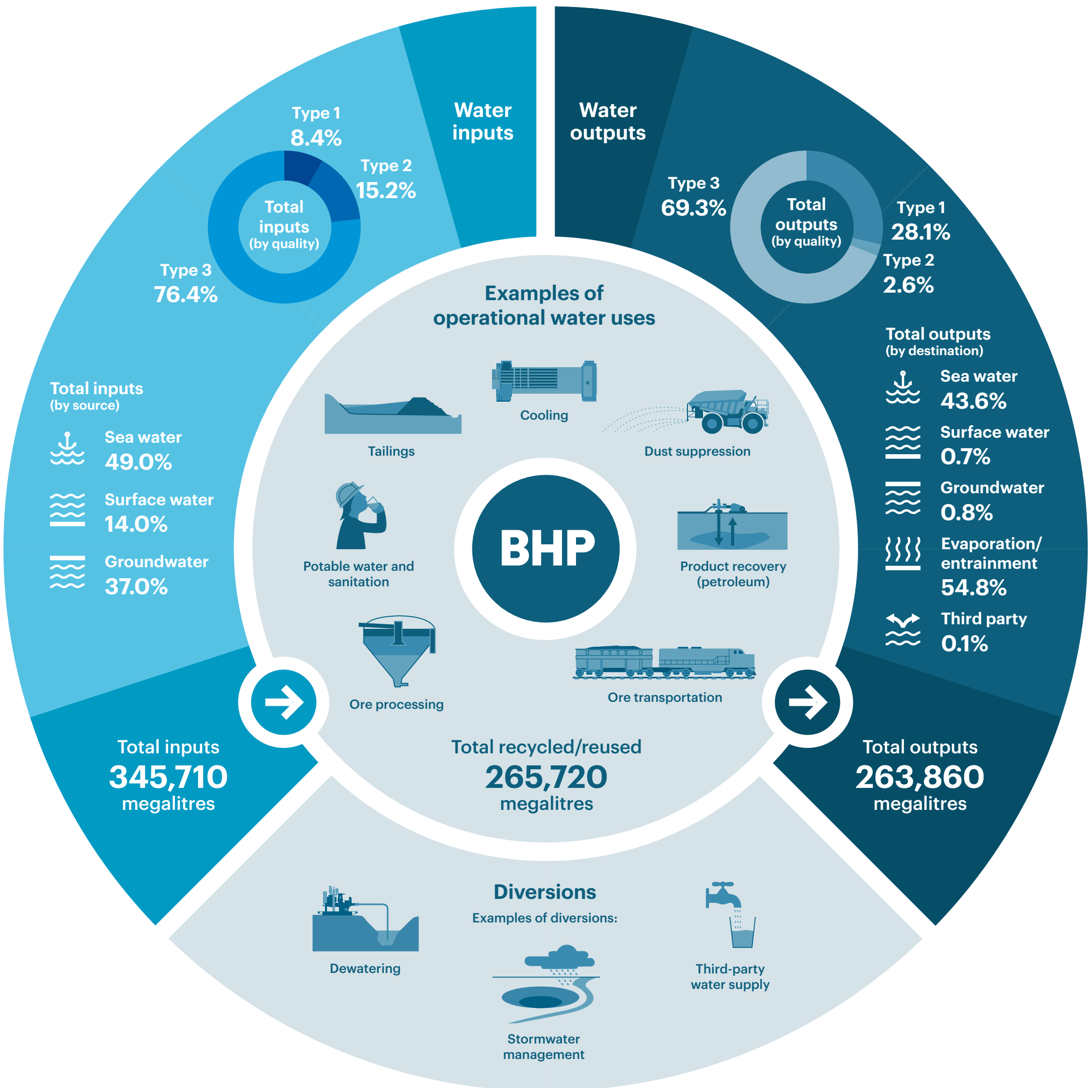
The WAF produces three key statements that comprise the water account:

- The **Input-Output Statement** that lists flows for all input and output categories for the accounting period along with the change in storage volume
- A **Statement of Operational Efficiencies** that lists the total water flows into tasks, volume of reused water, reuse efficiency, the volume of recycled water and recycling efficiency
- An **Accuracy Statement** that lists the percentage of flows measured, simulated and estimated

The WAF should be accompanied by a Contextual Information report that details additional information relevant to the operating environment and the water resources in the broader region or catchment.

By utilising the WAF companies are able to aggregate reporting from diverse sites into a consistent format allowing for the reporting of company level water performance as shown in **Figure 1**.

FIGURE 1. BHP AGGREGATED WATER ACCOUNT (2018)[2]



[2] BHP, *Water Report 2018* , Melbourne, 2018 – Note: uses early guidance terminology

Is this another reporting format?

Accounting is a way of consolidating data while reporting provides a way to communicate this information. The WAF reports can be used as a basis for reporting a site or company's water use as shown in **Figure 1**.

Section 7 provides guidance for using WAF information to satisfy other reporting requirements, including the Global Reporting Initiative standards and ICMM's water reporting metrics.

A structured approach is key to ensuring the development of robust, consistent accounts that provide accurate reporting and the basis for continual improvement. An overview of the key stages is provided in **Figure 2**.

FIGURE 2. WATER ACCOUNTING AND REPORTING PROCESS OVERVIEW

Scope	Define the basis of the account. Consider the objectives and scale of the operation to identify boundaries.
Data Collection	Collect and calculate data on water flows and site storage. Include details on water quality, quantification and confidence.
Apply WAF Concepts	Simplify the operation by aggregating tasks and grouping stores, categorise flows and calculate reporting metrics.
Report	Complete Input-Output Statement, Accuracy Statement and Statement of Operational Efficiencies. Provide relevant contextual information.
Review	Review risks and opportunities to define continual improvement plans and water stewardship considerations.

2.1 Scope

The intent of the scoping stage is to define the objectives and boundaries of the water account by considering the nature and scale of operation. The scope should ensure that the Operational Facility and the surrounding water system are clearly defined and bounded by consideration of space, time and materiality, as outlined below.

The scope should define the:

- Objectives of the water account
- Scale of the operational facility being considered, associated boundaries and relevant stakeholders, including:
  a. The accounting boundary of the Operational Facility
  b. Relevant spatial boundaries, e.g. legal, topographic and catchments
  c. Surrounding water users, e.g. communities, industries and environment assets
- Details of how the operational facility uses water, including all operational water inputs and outputs, activities which use or require water, water stores and water treatment facilities
- Accounting period
- Materiality and significance of water uses or flows

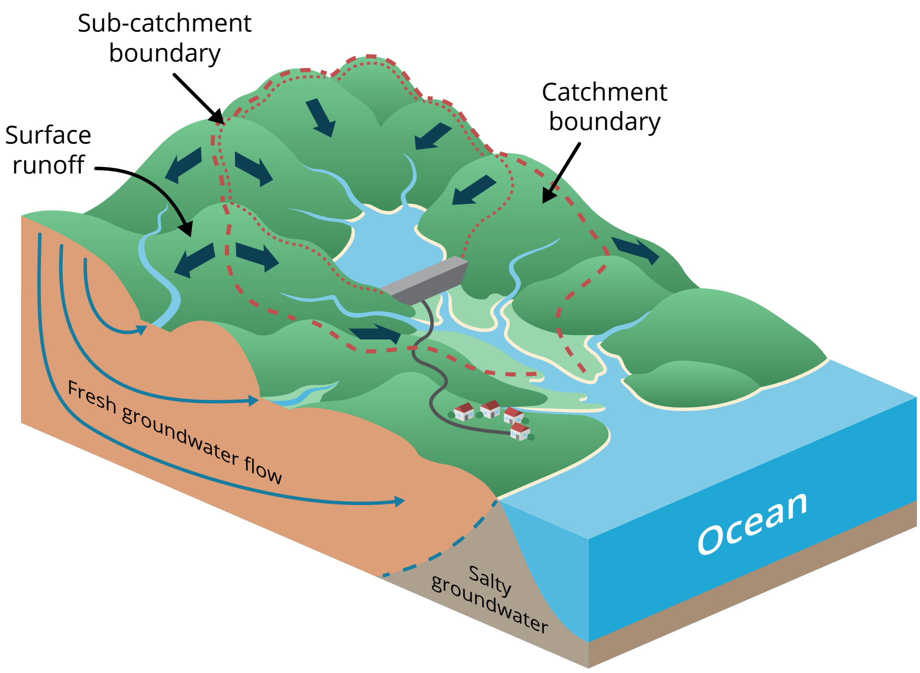
2.1.1 Key Boundaries

The WAF uses a number of different boundaries to understand, quantify and appropriately account the movement of water between the site, the surrounding catchment and stakeholders. Key boundaries are outlined below.

Catchment boundary (e.g. surface water catchment or groundwater system) is the physical boundary that reflects the area in which water resources (quality and quantity) may be affected by a facility's operations. This boundary will generally not correspond with the **site boundary** and could include townships or pastoralist properties, depending on their location in regards to the water catchment (water flows and storage). This boundary informs the identification of risks and opportunities related to the site's water management activities (see **Figure 3**).

Site Boundary is the physical boundary that shows the geographical extent of the facility's activities. It will typically align with legal boundaries including the physical leases or tenement boundaries of the reporting entity. The site boundary is used to understand the physical / geographical extent of the facility (see **Figure 4**).

FIGURE 3. ILLUSTRATIVE EXAMPLE OF A CATCHMENT BOUNDARY[3]



[3] Adapted from the North and South Rivers Watershed Association website, as cited in ICMM, *A practical guide to catchment-based water management for the mining and metals industry*, London, 2015, pg. 15

Sub-catchments define the internal catchment boundaries of the Operational Facility for stores or other collection points and allow effective calculation of surface water received by the facility (see **Figure 4** and **Section 2.4.1**).

Operational Facility boundary is the accounting boundary. The Operational Facility defining the extent of the facility's water system, including all activities which require or use water. Within this boundary are all **tasks**, **stores** and **treatments** that occur to enable the facility's operations. It is a conceptual boundary and may not align with the site boundary.

The Operational Facility boundary is fundamental to water accounting as it defines where water enters and leaves the operational facility. **Table 1** provides guidance on the position of various activities (or tasks) in relation to the operational boundary based on ownership, location, and purpose.

THE OPERATIONAL FACILITY – A FUNDAMENTAL WAF CONCEPT

The WAF is applied at the level of the Operational Facility. The WAF provides flexibility for companies to determine what constitutes the Operational Facility, which can be tailored to the operating context including management and reporting requirements.

For example, an Operational Facility can be a mine site with an ore processing plant but may also encompass all types of mining related operations such as dockside operations, smelting and leaching.

Petroleum or other non-mineral operations can also determine an operational facility by following the same process. The ability to draw boundaries around selected operational activities is one of advantages of the framework.

FIGURE 4. ILLUSTRATION OF SUB-CATCHMENT AND SITE BOUNDARIES[4]

[4] Adapted from ICMM, *Water Reporting: Good Practice Guide 2nd Edition*, London, 2021

The WAF conceptual model shown in **Figure 5** shows the relationship between the Operational Facility, the surrounding environment and the material flows of water used by the operation to construct the water account.

As shown in **Figure 5** the WAF uses colour conventions for each of the elements:

- Operational Inputs are coloured green (see **Section 2.2.1**)
- Operational Outputs are coloured red (see **Section 2.2.2**)
- Other Managed Water is coloured yellow (see **Section 2.2.3**)
- Tasks are coloured grey (see **Section 2.3.1**)
- Stores are coloured blue (see **Section 2.3.2**), and
- Treatment plants are coloured purple (see **Section 2.3.3**)

What is included in an Operational Facility Boundary?

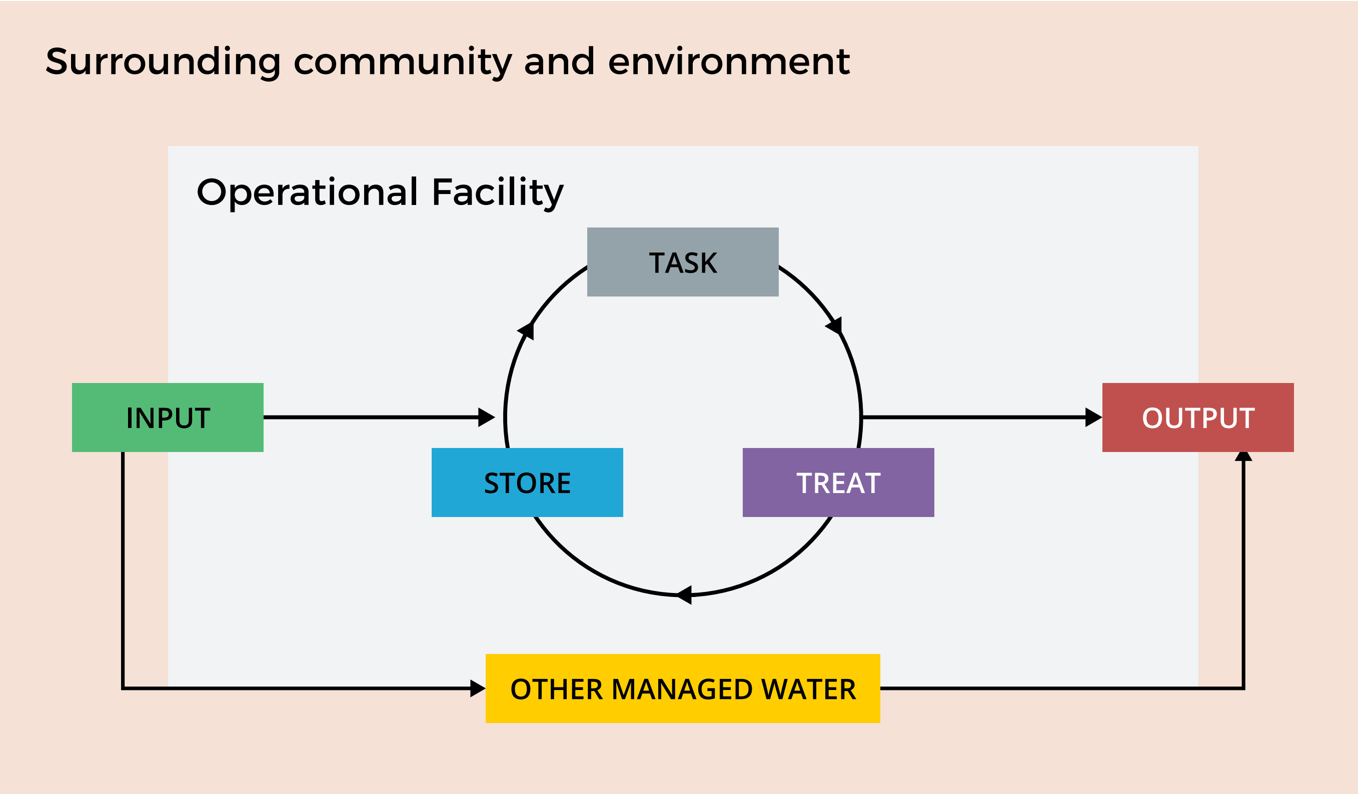
Practical considerations in determining what is included in an Operational Facility Boundary include the proximity and connectedness of activities, the water management structure and what would make sense from a stakeholder communication perspective. For example, it may make sense to include neighbouring activities as part of an Operational Facility, but the inclusion of disconnected of remote activities outside of the identified catchment may not be practical from an accounting or water risk management perspective.

What is, and what is not, included within the site's definition of Operational Facility should be clearly outlined in the contextual statement for the account.

TABLE 1. ACTIVITY LOCATIONS RELATIVE TO THE OPERATIONAL FACILITY BOUNDARY OF A MINE - EXAMPLES

ACTIVITY	CONTEXT	LOCATION
Desalination Plant	Located at the coast operated by the mine solely to provide water for the mine and communities.	Inside
	Located at the coast operated by another company (although might be a subsidiary of the mining company) solely to provide water for the mine and communities.	Outside (analogous to a water supply dam providing third party water)
	Located at the coast operated by another company (although might be a subsidiary of the mining company) solely to provide water for several mines run by same or different companies and for communities.	Outside
	Located on the mine site	Inside
Camp or Construction areas	Located on the mine site	Inside if flows are material
Closed Mining Areas	Where there are material water flows to or from these areas and the water is intended for use at the site.	Inside
	Where water is treated on site but not intended for use and is provided for local community water supply or environmental flows.	Outside (see **Section 2.2.3**, treat as other managed water)

FIGURE 5. CONCEPTUAL MODEL FOR WAF ACCOUNTING



2.1.2 Accounting Period

The WAF is flexible and allows companies to select their own accounting period. An annual accounting period is common although shorter periods may need to be used in order to capture and balance all the required data. It should be noted periods of less than 12 months often result in a greater imbalance (mismatch between inputs and outputs and the change and storage volume). Imbalances may be exacerbated in regions with highly seasonal precipitation or long lags between elements of the site water system, such as lags associated with rainfall infiltrating soil or runoff into a dam or pit.

2.1.3 Materiality and Significance of Flows

The water account should include all material flows. A flow is material where its omission from the WAF could influence water-related decisions by users of that information. For example, precipitation on a small store may constitute such a small input compared to the much larger runoff inputs that the flow is not considered material. Alternatively, a significant precipitation (e.g. rainfall) event requiring water to be discharged from site would be considered a material flow.

Flow volume is not the only consideration. An environmental water flow could be small in volume but crucial to maintaining ecosystem health. In such instances, the flow would be considered material. Similarly, the total volume of water supply to a township may be small but essential to a community. Where leachate from a waste rock dump was affected by acid rock drainage, even though the volume may be small, the quality of the water is such that the flows must be included in the account

Hence, specific materiality criteria are developed for each operational facility based on the local context, and are used to determine which water flows and/or operational water activities should be included within the account. It may be beneficial for a site to include all flows when developing a water account or balance for the first time. Materiality can be reassessed in subsequent revisions.

2.2 Operational Inputs, Operational Outputs and Other Managed Water

2.2.1 Operational Inputs

An operational input is a volume of water received from the surrounding community or environment for use by the operational facility (i.e. water directly used in a task or stored for later use in a task). It is water that crosses the Operational Facility Boundary and includes water made available due to mining activities within the facility, such as groundwater accessed from pit dewatering or groundwater present in the ore (see **Figure 5**).

Operational inputs should always be grouped according to the four source categories as shown in **Table 2**. Additional sub-categories may be defined, allowing the WAF to be adapted to site specific circumstances, provided they fit within the four input source categories.

Operational inputs exclude Other Managed Water flows as described in **Section 2.2.3**.

TABLE 2. INPUT SOURCE CATEGORIES AND DEFINITIONS

SOURCE	DEFINITION	INPUT SUB-CATEGORY	SUB-CATEGORY DESCRIPTION
Surface Water	All water naturally open to the atmosphere, except for water from oceans, seas and estuaries.	Precipitation and Runoff	Precipitation is a broader term that includes rainfall, snow and hail.
		Rivers and Creeks	Water extracted from rivers and creeks. May or may not run through the site lease.
		External Surface Water Storages	Water extracted from dams and lakes external to the site.
Groundwater	Water beneath the earth's surface that fills pores or cracks between porous media such as soil, rock, coal, and sand, often forming aquifers.	Dewatering	Groundwater extracted to provide safe access to the ore body as part of mining operations.
		Abstraction from Bore Fields	Groundwater extracted from bores to supply water to be used in a task or stored for use in a task.
		Entrainment[5]	Water in the raw material, typically the ore to be processed.
Sea Water	Water from oceans, seas and estuaries.	Estuary	Water extracted from an estuary.
		Sea/Ocean	Water extracted from the sea or ocean.
Third Party	Water supplied by an entity external to the operational facility. Third-party water contains water from the other three sources. When the source is known, the physical source (surface water, groundwater and sea water) should be noted.	Contract/Municipal	Water that is purchased or supplied from an industrial or municipal water supplier.
		Waste Water	The waste water of an organisation or community external to the site.

[5] Note: for accounting purposes, water that is entrained in the ore is considered to be groundwater (The GRI classification is produced water, which is not a recognised WAF input source category)

2.2.2 Operational Outputs

An operational output is a volume of water removed (discharged, consumed, used or lost) from the Operational Facility after it has been used for a task. An operational output is water that crosses the operational facility boundary and is no longer available for use by the operational facility (see **Figure 5**).

Operational Outputs should always be grouped according to the five destination categories shown in **Table 3**. Similar to operational inputs, operational outputs from the operational facility exclude Other Managed Water flows and the framework allows for the user to use additional sub-categories for each destination as illustrated below.

The site does not discharge water into the surrounding environment. Does this mean it has no outputs?

Discharge is only one type of output. Refer to **Table 3** for an explanation of all operational outputs.

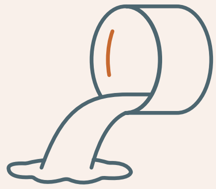


TABLE 3. OUTPUT DESTINATION CATEGORIES AND DEFINITIONS

SOURCE	DEFINITION	INPUT SUB-CATEGORY	SUB-CATEGORY DESCRIPTION
Surface Water	All water naturally open to the atmosphere, except for water from oceans, seas and estuaries.	Discharge	Uncontrolled or controlled discharge to surface water.
		Environmental Flows	Discharged water used to support environmental initiatives.
Groundwater	Water beneath the earth's surface that fills pores or cracks between porous media such as soil, rock, coal, and sand, often forming aquifers.	Seepage	Seepage from the site to groundwater.
		Aquifer reinjection	Water that is actively managed (as opposed to natural processes) by the site to recharge an aquifer.
Sea Water	Water to oceans, seas and estuaries.	Estuary	Uncontrolled or controlled discharge to estuary.
		Sea/Ocean	Uncontrolled or controlled discharge to the sea or ocean.
Third Party	Water supplied to an entity external to the operational facility.	Third Party	Water supplied to third parties.
Other[6]	Includes evaporation, entrainment, task loss and any other destination that is not covered by the other pathways.	Evaporation	Evaporation from the site, including but not limited to evaporation of water from tailings storage facilities, water stores, and used for dust suppression.
		Entrainment	Water in waste or product streams. Typically the water in the tailings, coarse rejects, concentrates or product.
		Task loss	Water removed, not recovered or otherwise lost during a task.

[6] The ICMM has termed this category consumption, which is defined as all water (input and OMW) that is removed by evaporation, entrainment (in product of waste) or other losses, and not returned back to surface water, groundwater, sea water or a third party.

2.2.3 Other Managed Water (formerly Diversions)

Water is classified as Other Managed Water (OMW) when it is actively managed (e.g. physically pumped, treated or has material evaporative losses) by the facility and flows from the source (OMW – Inputs) to a destination (OMW – Outputs) without being used or tasked (see **Section 2.3.1**) by the Operational Facility. OMW may be discharged back to the environment, supplied to a third party or lost through evaporation.

OMW should include water actively diverted away from operations and not used in tasks at the Operational Facility. OMW should not include water that is passively collected unless it is stored with material losses (e.g. through evaporation). OMW does not include the re-alignment of a stream or river channel flowing through a site, or diffuse runoff that flows away from site collection points (see **Figure 4**) where there is no requirement for ongoing active management by the facility.

OMW provides information on water that is managed or interacts with the operational facility but is not used in tasks enabling a greater understanding of the site water balance and it's interaction with the surrounding environment. Information on OMW may also assist in understanding the potential impacts of different climatic conditions or closure requirements.

OMW flows are not included in the reporting of operational inputs and operational outputs for the Operational Facility. Instead, an OMW statement is appended to the Input-Output Statement. OMW are listed in a separate list of OMW inputs and OMW outputs grouped into the same source and destination categories as shown in **Table 2** and **Table 3**, with examples shown in **Table 4**.

?

Produced or associated water from an adjacent oil or gas field is pumped to a treatment plant at the site Operational Facility. Is this water an operational input?

Water is only considered an operational Input where it is intended for use (treated or otherwise) by the Operational Facility. If the water is treated or moved off-site for environmental purposes or community use this is classified as OMW.

How do you classify water from a closed mine that is treated onsite and discharged?

Situation: Low quality water obtained from a closed mine site taken into the boundary of an Operational Facility for treatment prior to discharge (i.e. water enters the Operational Facility for treatment to enhance environmental water quality).

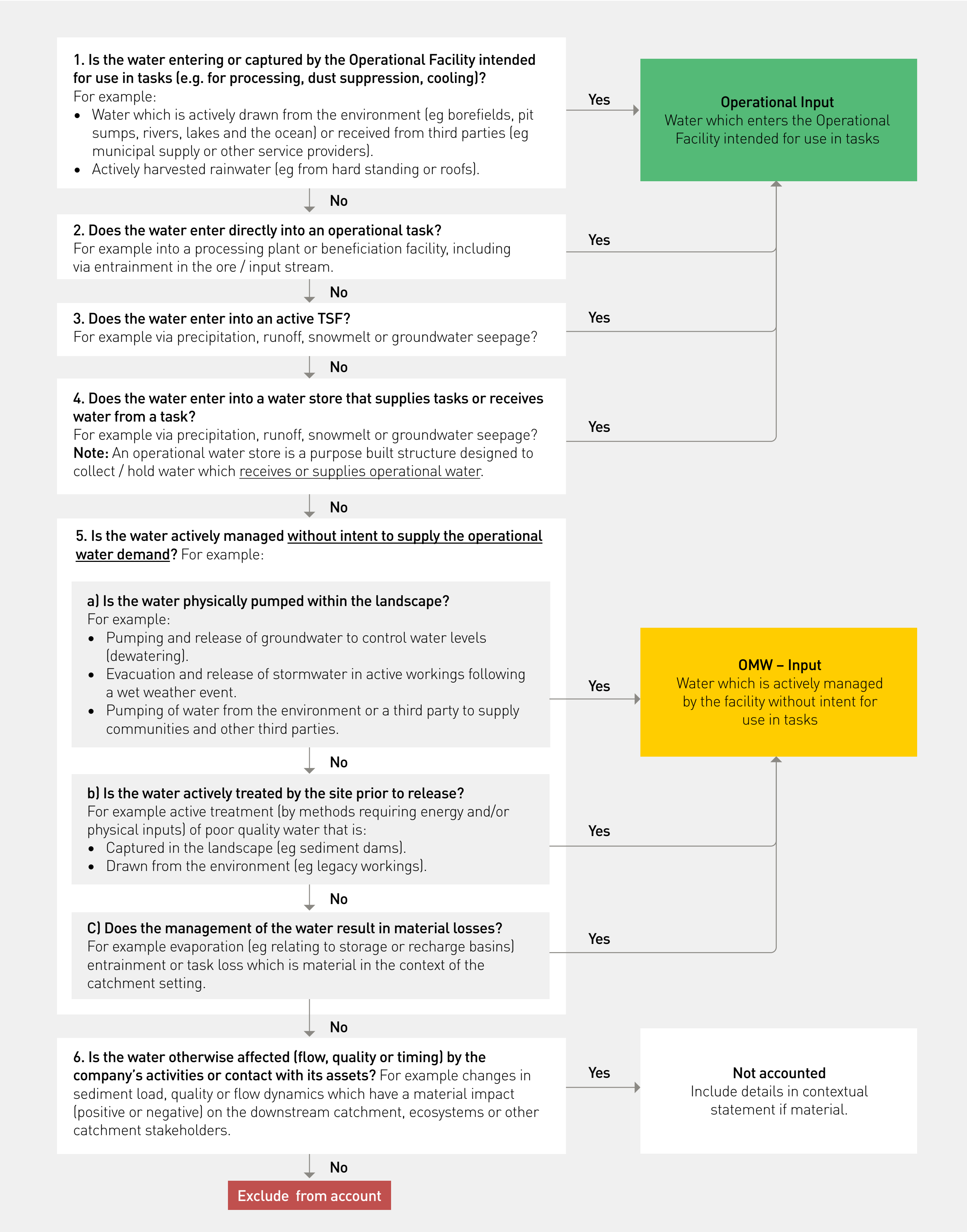
Principle: An operational input is a volume of water received by the Operational Facility for use in tasks. In this case although the water is treated inside the Operational Facility there is no intent to use the water in tasks (its intended use is for environmental flows).

Solution: Although the water is treated on site it is classified as OMW. The OMW flow will lead to beneficial water quality change and the company may recognise the OMW flow. Treatment is considered as an active management activity for OMW.

TABLE 4. OTHER MANAGED WATER (OMW) EXAMPLES WITH CORRESPONDING SOURCE / DESTINATION CATEGORIES

EXAMPLE	SOURCE	DESTINATION
Water entering a site from a flooded river and then transferred to a surface water external to the Operational Facility, such as a river or stream	Surface Water (Rivers and Streams)	Surface Water (Rivers and Streams)
Water from a rainfall event directed away from an operation and collected in ponds or pits but not intended for use in a task. Water is eventually discharged to a river but experienced material evaporation during retention time.	Surface Water (Precipitation and Runoff)	Surface Water (Rivers and Streams) and Other (Evaporation)
Water produced by dewatering that is subsequently reinjected to groundwater	Groundwater (Abstraction)	Groundwater (Reinjection)
A dewatered volume provided to a third party	Groundwater (Dewatering)	Third Party
Water pumped to site from a closed mining area, treated and sent to a community. The water is not used in a task or stored in a location that supplies water for use in a task.	Surface Water or Groundwater (Dewatering)	Third Party

FIGURE 6. GUIDANCE FOR CLASSIFYING WATER INPUTS (FROM ICMM)[7]



[7] Adapted from ICMM, *Water Reporting: Good Practice Guide 2nd Edition*, London, 2021

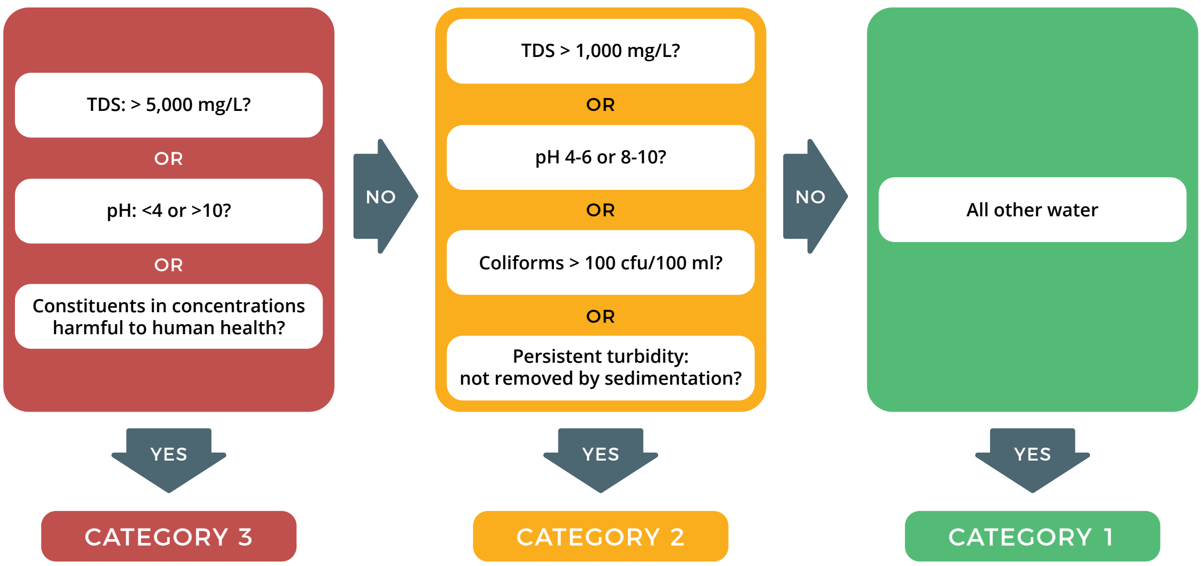
2.2.4 Water Quality Categorisation

The Water Quality description assigns a water quality category to operational inputs, operational outputs, OMW inputs and OMW outputs. Criteria for determining water quality categories were chosen to broadly align with general public understanding of high versus low quality water and the level of treatment effort required to achieve a standard fit for human consumption. Local drinking water guidelines act as the 'benchmark' for high water quality as it is a well understood reference point for stakeholders. However, it is not the intent or purpose of water quality categories to reflect on the end use of water.

Three categories are used in the WAF to describe water quality:

- **Category 1**: Water of a high quality and may require minimal and inexpensive treatment, such as disinfection and pond settlement of solids, to raise the quality to appropriate drinking water standards
- **Category 2**: Water of a medium quality with characteristics that require moderate treatment, such as disinfection, neutralisation, removal of solids and chemicals, to meet applicable drinking water standards
- **Category 3**: Water of low quality with characteristics including high values of total dissolved solids, elevated levels of dissolved metals or extreme pH levels. Significant treatment would be required to meet applicable drinking water standards

FIGURE 7. WAF – WATER QUALITY CATEGORISATION



Total Dissolved Solids (TDS): Indicates the salts content of the water. Drinking water should be under 1,000 mg/L.[8] The maximum value for livestock drinking water is 5,000 mg/L.[9]

pH: pH is an indicator of acidity and alkalinity. Above a pH 11, eye and skin irritation occurs and below pH 2.5, the damage to the skin is irreversible. A more moderate pH range of 4 to 10 is used for Category 2 water.

Coliforms: Total Coliforms indicates the presence of faecal matter. Where coliforms concentrations over 100cfu/100mL exist, more safeguards must be in place to mitigate human exposure to the water.

Turbidity: Turbidity provides an indicator of suspended solids in water. Turbidity can vary with the seasons as rainfall can stir up particulates in water sources and water stores.

Pesticides and herbicides: Agricultural and other activities in a catchment may lead to elevated concentrations of pesticides and herbicides in runoff. Water may need to be placed in Category 2 or 3 depending on treatment requirements.

Other Constituents: Other important constituents include metals, industrial chemicals and nutrients (including nitrates and phosphates). Users should consider requirements under appropriate drinking water guidelines to assess if the constituent is harmful to human health.

Aesthetic or taste-based trigger levels do not need to be applied as they do not inform the intended purpose of the water quality categories within the WAF.

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8 World Health Organization (WHO), *Guidelines for drinking-water quality: fourth edition incorporating the first addendum*, Geneva, 2017

9 Australian and New Zealand Environment and Conservation Council (ANZECC), *Australian and New Zealand Guidelines for Fresh and Marine Water Quality Volume 3 Primary Industries — Rationale and Background Information*, Canberra, 2000

In the absence of direct measurements or other information (e.g. source/catchment or operational characteristics) used to determine water quality, the following precautionary method should be applied:

- For **inputs**, the default answer is no (water is of higher quality) – water is managed in line with its highest potential value
- For **outputs**, the default answer is yes (water is of lower quality) – water is managed to avoid potential impacts. The exception to this is evaporation source water quality (see **Figure 8**)

Guideline values to be used

Guideline values are based on human health drinking water standards and thresholds. In the absence of locally appropriate drinking water guidelines, World Health Organization drinking water standards should be used.

Determining categories using site water quality data

When assessing water quality, it is standard practice to establish baseline conditions, against which the influence of the operations can be measured. The approach to water quality monitoring should identify the key parameters, testing (field versus laboratory) and frequency of monitoring that will be sufficient to understand water quality across the hydrological cycle and effectively manage any identified risks.

Water quality data for operational inputs, operational outputs, OMW and stores is typically in the form of time-series measurements. It will not be a single measurement or fixed value. Data sources will include a site's water monitoring program and third party water sources (such as dams, rivers and streams).

It is beneficial if the site gathers water quality data for operational inputs, operational outputs, OMW and stores that are not measured by other entities.

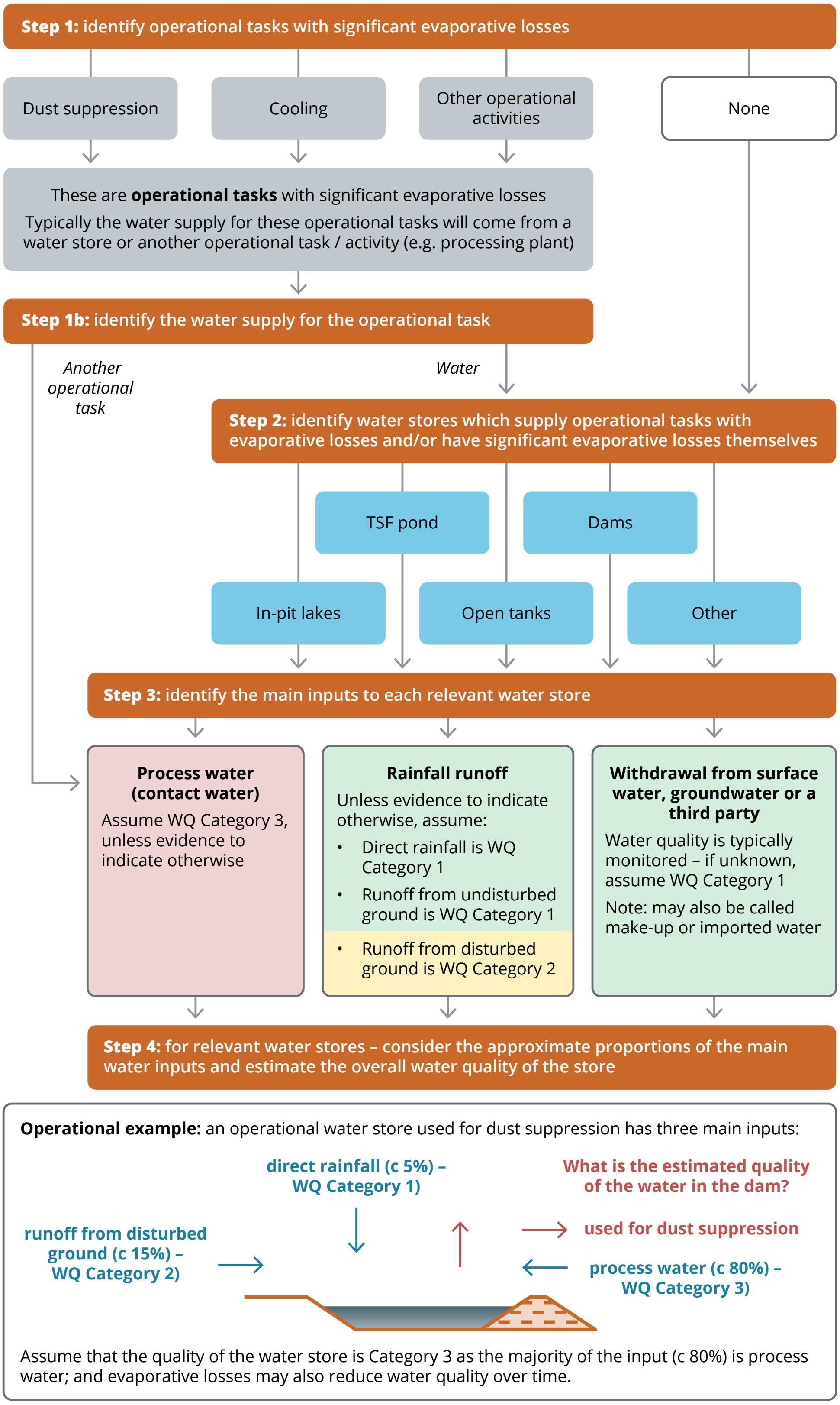
It is recommended that the site reviews water quality data for the accounting time period in order to decide the most appropriate value to use in the categorisation process shown (**Figure 7**). To start, sites can review water quality to compute the descriptive statistics (average, median, standard deviation and maximum) for each constituent. Either mean or median values are typically used, however maximum and minimum values should be reviewed to ensure there are not times when constituent values exceed thresholds.

Water quality and evaporation

The quality of evaporation from a source is characterised by the quality of the source water that evaporates. While the quality of the evaporate is technically Category 1 (i.e. pure water), classifying evaporation by the quality of the water source that evaporates allows the use of lower quality water for tasks with high evaporative losses (e.g. dust suppression or cooling) to be better represented in the account. This provides transparency around improved management practices that promote the evaporative use of lower quality water. A simple approach to estimating the quality if water that evaporates is provided in **Figure 8**.

FIGURE 8. SIMPLE GUIDELINES FOR ESTIMATING THE QUALITY OF WATER THAT EVAPORATES

Where this information is not available, a default Category 1 water quality classification may be applied and method selected disclosed.[10]



[10] Based on information from ICMM and Amy Herod (2021), modified by the authors.

2.2.5 Accuracy Statement Concepts

Some sites may not have metered or measured data for all flows. In these cases, calculations and typical values should be used to produce a reasonable estimate of a water account. Calculations or estimates should be documented within framework notes and the Accuracy Statement. The notes and the Accuracy Statement are designed to provide a summary of any data gaps identified during the account development and may help to understand opportunities for the continuous improvement of measurement and monitoring systems.

Quantification of flows are described as:

- **Measured** (metered or measured flows) such as water obtained from third parties or directly measured by flowmeters (note: entrainment can be considered to be a measured flow if both the moisture content and the throughput are measured)
- **Simulated** flows are flows simulated by a model. Precipitation and runoff values obtained from a hydrological model calibrated for the site are considered simulated flows
- **Estimated** flows are calculated to close a balance; based on 'best guess' typical values or estimation approaches where all input parameters may not be known

Assigning a level of confidence to a particular value may be subjective but it supports transparency and directs focus to where addressing uncertainties and closing data gaps would improve certainty.

- **High** confidence may be obtained from measured flows, simulations with good accuracy over many periods, or simple balancing of flows
- **Medium** confidence may reflect simulations and estimates based on historical data or coefficients
- **Low** confidence may reflect estimates or simulations such as runoff calculated using general/approximate coefficients (e.g. as shown in **Calculation 4**)

2.3 Inside the Operational Facility

2.3.1 Tasks

A task is a set of operational activities that uses water within the Operational Facility boundary. Water use is quantified as the total flow of water to a task. Once water has been used in a task, or tasked, it is classified as worked water.

NOTE: Evaporation, Entrainment and task losses are operational outputs that recognises water removed from the operational facility (this should not be confused with water use).

In identifying tasks:

- **Activities with a similar purpose should be grouped together** – it is not necessary to account for all flows between individual activities that make up a task (e.g. grinding and flotation are simply components of Minerals Processing)
- **Tasks should be aggregated to the highest practical level**, in line with **Table 5**. This simplifies the calculation of reuse and recycling efficiencies and improves comparability (**section 2.5.2**)
- **Sub-tasks are typically aggregated**. In some cases it may be more practical to separate sub-tasks (e.g. Mining:Opencut and Mining:Underground) where subject to discrete inputs and outputs and where this is needed to support internal water management objectives
- **Tasks cannot store water** with the exception of the TSF

TABLE 5. RECOMMENDED TASK AGGREGATION LEVELS[11]

TASK	PURPOSE	EXAMPLE SUB-TASK	EXAMPLE ACTIVITIES
Mining	Obtaining ore for processing	- Opencut - Underground - Insitu - Hydraulic	- Continuous mining - Longwall - Drilling - Blasting - Loading - Haulage
Processing Ore	Separating ore from gangue and concentrating	- Processing Plant - Heap leach - Coal Handling and Preparation Plant (CHPP)	- Crushing - (Re)Grinding - Flotation - Agglomeration - Thickening
Tailings Management	Storing waste from processing	- Tailings Storage Facility (TSF) - Co-disposal - Dry stack	- Paste Backfill - Construction of a TSF - Storage of Tailings
Dust Suppression	Water used on roads and other dust sources to suppress dust		- Road watering - Stockpile watering - Waste rock watering - Highwall watering
Pyrometallurgy or Hydrometallurgy	Extraction and/or purification of metals following Processing	- Smelting - Refining - High Pressure Acid Leach	- Roasting - Oxidation - Reduction - Leach - Extraction
Amenities	Water used for drinking or sanitation facilities	- Potable Water - Camp - Changerooms	- Drinking fountains - Showers - Toilets
Miscellaneous	Miscellaneous use		- Power Generation - Construction - Washdown

REMINDER: Flexibility is a core design principle and activities or sub-tasks can be added or removed from the above list – only the task categories should be consistent.

[11] Petroleum or other non-mineral operations should follow a similar process for task aggregation. Define the purpose for tasks considering where there are discrete inputs or outputs before aggregating activities to the highest practical level.

2.3.2 Water Stores

All water stores within the Operational Facility that hold water for use in tasks are represented by two types of stores, as defined as below:

- **New water store** only receives water directly from an operational input to the site
- **Mixed water store** receives worked water (treated or untreated) from tasks and may also receive new water from other stores and operational inputs (e.g. surface water: precipitation or runoff)

These are illustrated in **Figure 9**.

An **OMW store** only receives other managed water, it may not receive any worked water from site or be used to supply water to a task.

When preparing the WAF representation all water stores with similar inflow characteristics may be grouped to simplify the accounting models and metrics calculations. This results in the representation of one new water store and one mixed water store as illustrated in the example below and **Figure 10**.

The site water network diagram includes:

- **Dam 1** – receives both worked water from the ore processing task and new water from direct precipitation and runoff (operational inputs) - a mixed water store
- **Dam 2** – indirectly receives worked water from Dam 1, and new water from direct precipitation and runoff - a mixed water store
- **Dam 3** – receives surface water from the creek and direct precipitation and runoff (all operational inputs) – a new water store
- **Dam 4** – receives only direct precipitation and runoff – a new water store

Subsequently the WAF representation groups Dam 1 and 2 into the mixed water store and Dam 3 and 4 into the new water store.

Can dewatering be considered a task?

A task is an activity on a mine site that uses water. Dewatering is not a task by this definition as it generates rather than uses water. If the water from dewatering is used by the operational facility it is an operational input, otherwise as water actively managed by the site it is an OMW input.

FIGURE 9. ILLUSTRATION OF WATER STORES BY INPUT TYPE

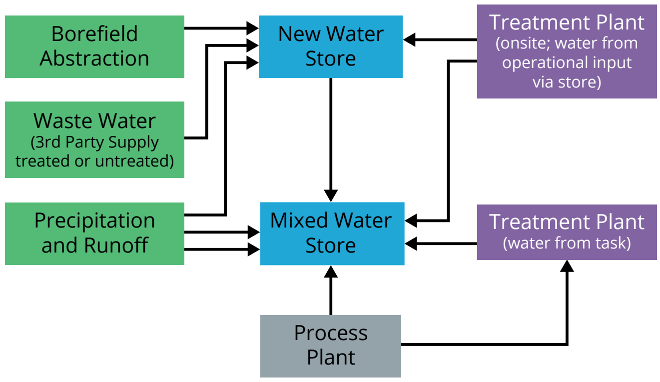
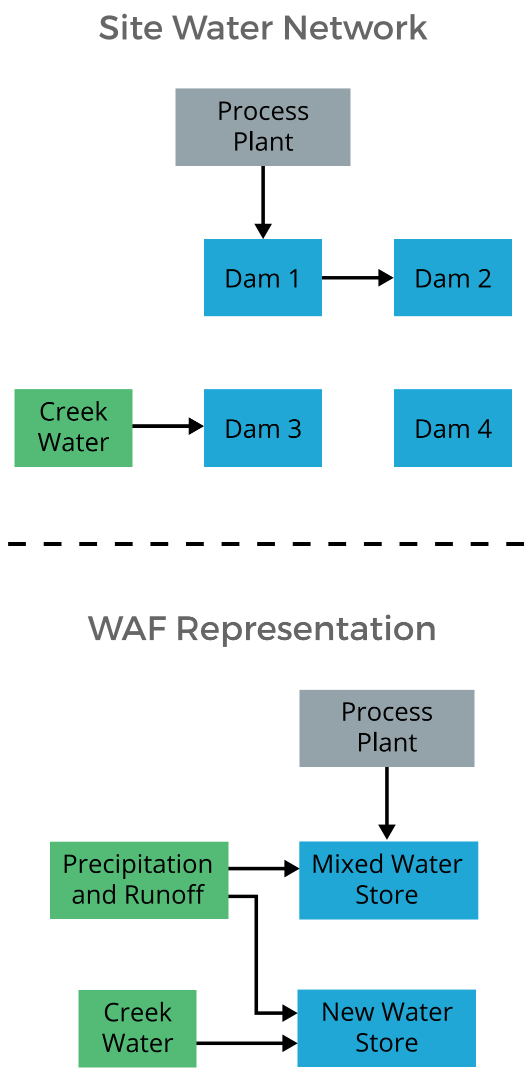


FIGURE 10. AGGREGATION OF STORES – WAF REPRESENTATION EXAMPLE



Most stores receive operational inputs of precipitation and runoff as shown in **Figure 11**. Catchment areas are usually defined as disturbed or undisturbed, as this may influence both the water quality and volume of runoff to the store due to precipitation.

An undisturbed catchment describes an area where runoff does not come into contact with operational areas, activities or outputs. A disturbed catchment is an area affected by the operational activities, and would include all areas yet to be rehabilitated.

Diffuse runoff moves away from the operational facility boundary into the surrounding environment with no active management, and thus is not included in the account. The WAF representation of sediment dam in **Figure 11** would depend on the context (see **Tip 1: How are sediment dams treated in the WAF?**).

Records should be kept of the amount of water stored in the stores at the start and end of each accounting period to quantify any change in water storage at the operational facility. Regular collection of storage data by reporting periods could assist in the generation of site specific parameters in regards to evaporation and runoff calculations in **Section 2.4.1**.

Tailings Management is a task that may include the use of TSFs. While the primary purpose of a TSF is to store tailings, in some circumstances a TSF may also store water temporarily. The practice of storing water in a TSF can represent an increased risk and should only be undertaken where the design accounts for and includes specific water storage criteria.

The case study in **Section 4.3** shows how water stored in a TSF should be represented in the WAF.

FIGURE 11. PRECIPITATION AND RUNOFF FROM DISTURBED AND UNDISTURBED AREAS WITHIN CATCHMENTS[12]

[12] Adapted from ICMM, *Water Reporting: Good Practice Guide 2nd Edition*, London, 2021

Tip 1: How are sediment dams treated in the WAF?

Sites may have sediment dams designed to reduce sediment loads in runoff before water is released to the environment.

Sediment dams can be classed as either new or mixed water stores depending on whether the inflows are from operational inputs to the facility (such as rain, runoff) or worked water. If the water from the sediment dam is not intended for use it may be assigned as OMW. There are four cases to consider when classifying sediment dams as a type of store:

1. The sediment dam receives worked water inflows and captures precipitation runoff
   - Mixed water store, operational input (with new water component)
2. The sediment dam does not receive worked water inflows. Rainwater is passively collected and stored temporarily in the sediment dam prior to release to the environment, but is not actively managed
   - Not accounted
3. The sediment dam does not receive worked water inflows. Rainwater is passively collected and stored temporarily in the sediment dam prior to release to the environment, with a material evaporative loss
   - OMW Store, OMW
4. The sediment dam does not receive worked water inflows. Rainwater is passively collected and stored in the sediment dam prior to use by the facility for dust suppression or processing.
   - New water store, operational input

The materiality of flows (see **Section 2.1.3**) should also be considered, as sediment dams may not require representation in the account if the flows to/from these dams are not material.

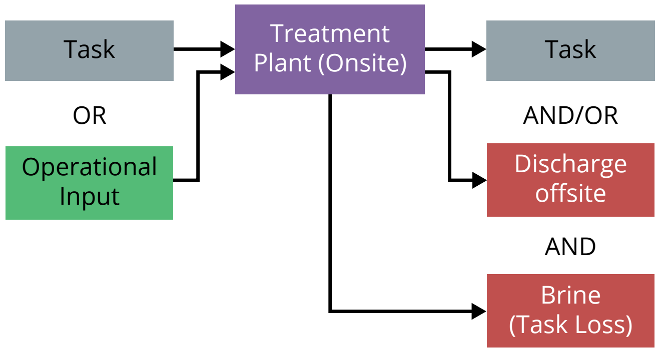
2.3.3 Treatment Plants

A water treatment plant is defined as an activity which uses active treatment methods (energy and/or physical inputs, e.g. chemicals) for the primary purpose of improving water quality.[13] Treatment plants may be determined to be inside or outside the operational facility depending on operational facility boundaries and the purpose of treatment (see **Table 1**). For example, where:

- Treated effluent supplied from an external party is an operational input the treatment plant located offsite
- Sea water or effluent supplied to the Operational Facility is treated prior to use in a task the treatment plant may be considered onsite

Only onsite treatment plants should be included in the WAF as shown in **Figure 12**. Water treatment may result in associated material task losses (e.g. evaporation).

FIGURE 12. ONSITE TREATMENT PLANTS POTENTIAL INFLOWS AND OUTFLOWS



[13] ICMM, *Water Reporting: Good Practice Guide 2nd Edition*, London, 2021

2.4 Data Collection

An understanding of the WAF approach and its facility level application enables users to target data collection efforts. This section outlines typical data required to develop an account, its sources and estimation approaches that may be used in the absence of monitoring data or more sophisticated spite-specific modelling approaches.

A range of data will be required to develop a water account. These include:

- Site plans showing
  - Topography
  - Disturbed and undisturbed ground
- Inputs
  - A list of water sources, with flow volumes and water quality monitoring data
  - Measurements, simulations and estimations for precipitation and runoff
- Outputs
  - A list of water discharges and/or any other water flows that leave the site boundary with any water quality monitoring data
  - Measurements, simulations and estimates for seepage and evaporation
- Internal water flows
  - List of tasks with water demand
  - Flows between stores, tasks and treatment plants
- Ore and waste flows (ore, waste, tailings, backfill and stockpile data) to calculate associated water flows
  - Tonnage of run-of-mill stockpile transferred to concentrator with moisture content of ore
  - Tonnage of product and/or coarse rejects with moisture content
  - Flows from tasks or stores to treatment plants
- Information on stores, including:
  - Store volumes at beginning and end of accounting period
  - Surface areas of stores and relevant catchment areas (including the proportion of disturbed and undisturbed land)

Site plans (which may include satellite imagery) are useful starting points to ensure that all necessary inputs, outputs, tasks, stores and treatment locations are identified with their relevant catchments.

Data collection for flows and stores should include water quality information (see **Section 2.2.4**) and quantification and confidence descriptors (see **Section 2.2.5**).

?

Can I still use the framework if I don't have all the data needed to generate the account?

Yes. Calculations to estimate certain values are included in **Section 2.4.1**. The Accuracy Statement should identify where calculations have been used to estimate values.

The framework may also assist in the identification of areas where further measurement and monitoring of water values would increase the accuracy of the account.

2.4.1 Data Calculations

It is preferred that all water flows and stores are measured with data obtained from flowmeters (owned or third party) and regular survey data. Measured data should always be used in preference to simulated or estimated values, unless it contains a known error.

This section provides guidance on estimation approaches that can be used to determine missing water flows in the Operational Facility.

The most basic calculation is the one to ensure that the water flows balance (see **Calculation 1**).

CALCULATION 1: WATER BALANCE

Water In = Water Out + Change in Storage

Note: Tasks by definition do not store water (excepting Tailings Storage Facilities - TSFs)

Water entrained in ore, product or waste

Water can be entrained in both operational inputs and operational outputs.

Water bores may be used to dewater an ore body to enable mining. However some water will remain held in the mined ore to be processed as not all water will be removed during dewatering.

Water remaining in ore is defined as entrained under the WAF, where material. For example, while the volume of entrained water is usually material at coal and gold operations, it may not be material at other operations and may be excluded.

The volume of water entrained in the ore or product may be measured, calculated or estimated. Most sites producing bulk product or concentrates would measure the moisture content of the product for shipping purposes.

The volume of entrained water may be calculated using **Calculation 2**.

CALCULATION 2:
VOLUME OF ENTRAINED WATER

$$V_{ent} = 1000 * P * m$$

P is the amount of ore processed in the reporting period (Mt)

m is the moisture content as a percentage

If there is no applicable data for entrainment in ore it may be estimated by conducting a water balance that includes the material water flows around a mining or processing task. For example, water entrained in ore may be estimated or calculated by using the difference in wet tonnes and dry tonnes mined or processed.

Water entrained in tailings is water that cannot be recovered via decant or other water recovery methods from the TSF. Water entrained in tailings may be calculated by conducting a water balance around the TSF (an example is shown in **Section 4.1.3.3**, **Figure 20**).

?

Is 'bound water' (also defined as specific retention) included in water accounts?

Some interstitial water may be considered 'bound up' in the minerals (e.g. commonly in clays) and is effectively immobile. As it is inaccessible to the surrounding environment, it does not form part of the water resource. Given this, it is not considered material and does not need to be included in water accounts.

If the water entrained in Run of Mine (ROM) ore is included in the account, do I need to include the water entrained in the ore at the waste rock dump?

Only the volume of water in the ROM that is released during the ore processing task needs to be included as an operational input to the Operational Facility, if material.

There is no requirement to include any inherent moisture in the ore that persists through to the waste rock dump because it is not used in a task nor does it leave the operation as a discharge. The inclusion of this type of data will skew the data and not reflect where water is used by the facility.

Precipitation and runoff

Precipitation and runoff is generally a material operational input to water stores and TSFs in most operating contexts.

Precipitation and runoff is usually simulated from water balance models using site-specific parameters and validated using precipitation data combined with surface and catchment areas. While the WAF can be used independent of software or hydrological models, models commonly used by industry include AWBM, Sacramento, SimHyd, SMAR and Tank.[14] If these are not available examples of the estimation approaches to derive precipitation and runoff values are shown in **Calculation 3** and **Calculation 4**, based on the individual sub-catchment characteristics.

CALCULATION 3: DIRECT PRECIPITATION VOLUME TO WATER STORE

$$V_{Precipitation} = 0.01 * R * SA$$

R is the precipitation measured during the reporting period (mm)

SA is the surface area of the water store (ha) (calculated separately for both new and mixed stores, see Step 5)

This calculation should also be used to calculate precipitation on the wet surface area of the tailings storage facility.

[14] The MCA does not endorse or recommend particular models.

CALCULATION 4:
RUNOFF VOLUME TO WATER STORE

$$V_{Runoff} = 0.01 * R * A * \beta$$

R is the rainfall measured during the reporting period (mm)

A is the undisturbed/disturbed catchment area (ha)

β is a volumetric runoff factor

An estimate for $\beta_{undisturbed}$ is 0.05

An estimate for $\beta_{disturbed}$ is 0.15.

How do I account for snowfall?

Snowfall accumulation on site is not considered to contribute to a site water balance in its frozen state. Instead, only snowmelt - which is now 'available' to the facility and the surrounding environment - is accounted as either an operational input into the Operational Facility or as OMW, depending on the intended use.

Estimates provided for the volumetric runoff factors look at an annual reporting period and a wide variety of site conditions. It should be noted that individual precipitation events may result in different volumetric runoff values depending on intensity and soil moisture. For example, an extended or heavy rain event will result in higher runoff than expected under the annual average value. Changes in the climatic conditions may also affect the volumetric runoff factor with the value being reduced in low precipitation years or droughts.

The overall water balance should be used to determine if these estimates are appropriate.

Further guidance on runoff factors that take into account variables including runoff potential, topography and soil types may be obtained from other sources, for example the Soil Conservation Guidelines for Queensland.[15]

Evaporation

Most stores and TSFs experience significant evaporation unless specific actions are taken to limit it. A common approach to estimate evaporation is the pan evaporation method shown in **Calculation 5**. Other methods include direct measurements (such as the micro-lysimeter or eddy correlation methods), a combination of evaporation models (Penman – Monteith – Unsworth) and measurements to supply model input parameters.[16] Site specific models may also be used where available, for example a water balance conducted on a lined water store could be used to estimate an evaporation factor for the site.

CALCULATION 5: EVAPORATION LOSSES USING PAN EVAPORATION (ML)

$$V_{Evap} = 0.01 * S_{Evap} * Pan_{Evap} * f$$

$\mathbf{S_{Evap}}$ is the average surface area (hectares) covered by water in the store during the calculation period. It is estimated using information about the geometry of the store and water levels in the store during the calculation period.

$\mathbf{Pan_{Evap}}$ is the value of measured rates of pan-evaporation (mm) during the reporting period, based on the use of evaporation pans that hold water and from which losses via evaporation are monitored. Ideally, on- site automatic weather stations would provide evaporation information. Long-term sequences of measured pan evaporation rates are available from Meteorological ogranisations such as the Australian Bureau of Meterology.

f is a correction factor to convert measurements of pan evaporation into evaporation losses from open storages. For pan evaporation rates measured with a Class A pan, the correction factor is often around 0.75. The correction factor used should be checked against the expected water balance for the storage taking into account water flows in and out.

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15 Carey et. al, Chapter 4 The empirical version of the Rational Method. In: Soil conservation guidelines for Queensland, Department of Science, Information Technology and Innovation, Brisbane, 2015

16 World Meteorological Organisation, Guide to Hydrological Practice: Volume 1, Geneva, 2008

Seepage

Seepage from TSFs or stores is not likely to be material where there is effective lining in place. Where the lining is damaged or inadequate estimation or modelling of seepage volumes is complex and will often require specialist assistance.

Where inflows and outflows are known, including evaporation, seepage may be estimated through the use of a water balance (**Calculation 1**).

Task loss

Task losses may also be determined by balancing water flows around a particular task using **Calculation 1**. In general tasks do not store water, excepting the special case of TSFs. Task losses may be present if the flows into a task do not balance the flows out of the task. For example, where there is a material difference between the measured water flows into a processing plant and the measured water flows from the processing plant – this may be attributed as a task loss.

Further examples are available in the case studies (**Section 4.1.3.3**).

2.5 Operational Efficiencies

Operational efficiencies describe the degree to which water is 'reused' and 'recycled' within the operational facility reducing the need for additional operational inputs. This is determined by examining the internal flows of the facility (i.e. the flows between the stores, tasks and treatment plants). The WAF assigns a water status to the flows between stores, tasks and treatment plants to allow for the calculation of benchmarkable operational efficiencies as detailed below. A worked example of the process is also provided in **Section 3.8**.

2.5.1 Water Status

Water flows within the facility should be assigned a water status of new (previously raw), worked or treated, as outlined below. Water status is defined to calculate operational, reuse and recycling efficiency.

- **New water** is water that has been received from a source as an operational input prior to be used in a task (previously identified as raw water)
- **Worked water** is water that has been used in a task
- **Treated water** is new water that has been treated onsite to provide water of suitable quality for a particular purpose, for further use or release to an output destination
- **Treated worked water** is water that has been treated onsite after it has been used in a task, to provide water of suitable quality for a particular purpose, for further use or release to an output destination

?

Is the volume of water from dewatering of an ore body considered 'worked water'?

No, dewatering of an ore body is considered new water (source: groundwater) because the water has not been used in a task. Whether it is an operational input into the operational facility or OMW depends on the subsequent use of the water. If the water enters the task-treat-store cycle in the facility it is an operational input. If the water goes straight to an output, for instance, if it is used to recharge an aquifer, it is OMW.

The site uses treated effluent from a nearby agricultural property. Is this considered worked or treated worked water?

No. Treated effluent from an external party is considered new water (source: third party) as the water has not been used in a task by the operational facility.

A Mixed water store contains both new and worked water, and flows from the store should be proportioned to new and worked water on the basis of the inflows as shown in **Calculation 6**.

CALCULATION 6: PROPORTION OF WORKED WATER IN THE MIXED WATER STORE

$$\%\ \textit{Worked Water} = \frac{\textit{Sum of Worked Inflows to Mixed Water Store}}{\textit{Sum of all Flows to Mixed Water Store}} \times 100$$

2.5.2 Reuse and Recycling Efficiency

Reuse and recycling metrics can be declared volumetrically or as a percentage. Reused water is worked water that is used again in a task without treatment. Reuse Efficiency is the sum of worked water flows to tasks as a proportion of the sum of all flows to tasks (see **Calculation 7**).

CALCULATION 7: REUSE EFFICIENCY

$$\text{Reuse Efficiency (\%)} = \frac{\text{Reuse Volume (i.e. Sum of Worked Flows to Tasks)}}{\text{Sum of all Flows to Tasks}} \times 100$$

Recycled water is treated worked water that is used in a task. Recycling Efficiency is the sum of treated worked water flows to tasks as a proportion of the sum of all flows to tasks. Note that the reuse proportion is likely to be larger than the recycled proportion as the minerals industry often uses lower quality water. If there is no onsite treatment then the recycled water volume and recycling efficiency will be zero (see **Calculation 8**).

CALCULATION 8: RECYCLING EFFICIENCY

$$\text{Recycling Efficiency (\%)} = \frac{\text{Recycled Volume (i.e. Sum of Treated Worked Flows to Tasks)}}{\text{Sum of all Flows to Tasks}} \times 100$$

Operational efficiency combines the reused and recycled metrics to provide an overall efficiency metric reflecting the total reuse and recycling at the facility (see **Calculation 9**).

CALCULATION 9: OPERATIONAL EFFICIENCY

$$\text{Operational Efficiency (\%)} = \frac{\text{Reused Volume + Recycled Volume}}{\text{Sum of all Flows to Tasks}} \times 100$$

3 WAF APPLICATION AND PREPARING REPORTS

Section 3 provides a step-by-step guide to developing the site water account and generating WAF statements, based on the key concepts outlined in Section 2. The WAF application process is illustrated using a fictional International Mining Company (IMC).

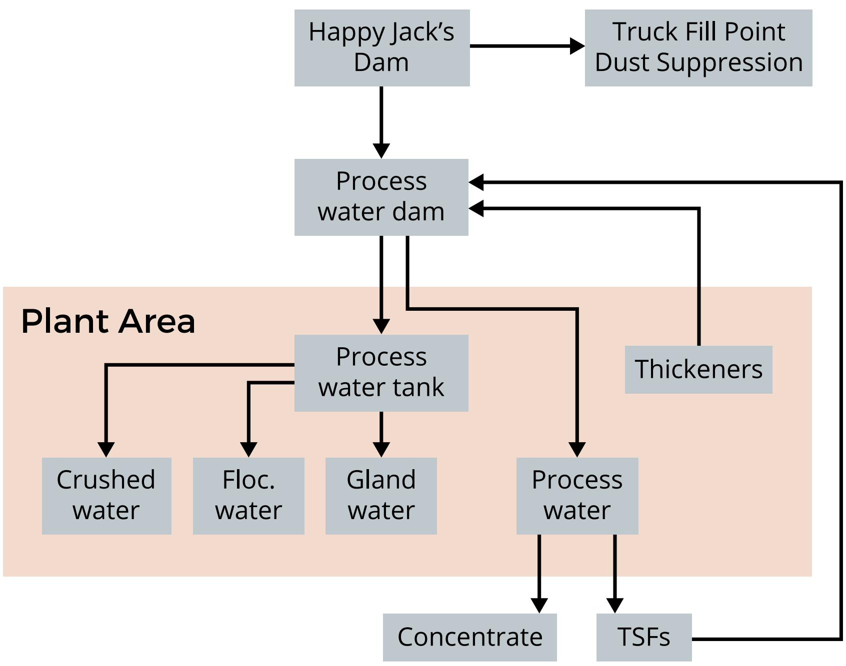
3.1 Step 1 – Establish the Water Network Diagram

Using available site data (maps, operational water balances and water network diagrams) create a simple network diagram that shows the movement of water around the site. A site water network diagram forms the basis of the water account and an example is provided in **Figure 13**. Review **Table 2** and **Table 3** to ensure that all operational inputs and operational outputs for tasks, stores and treatment plants in the operational facility are included on the site water network diagram.

3.2 Step 2 – Create WAF Representation

Apply the key concepts and definitions of the WAF to simplify the water network diagram and create the WAF representation. The WAF representation is a consistent accounting model of the site water system, in which all tasks, stores and treatment plants with similar attributes are grouped so that the intermediate flows between individual units are not needed. For example, all the activities within the orange box in **Figure 13** are grouped as a single ore processing task in **Figure 14**, the WAF representation.

FIGURE 13. EXAMPLE OF A SITE WATER NETWORK DIAGRAM



Once the network has been simplified apply the relevant colour conventions to the various elements:

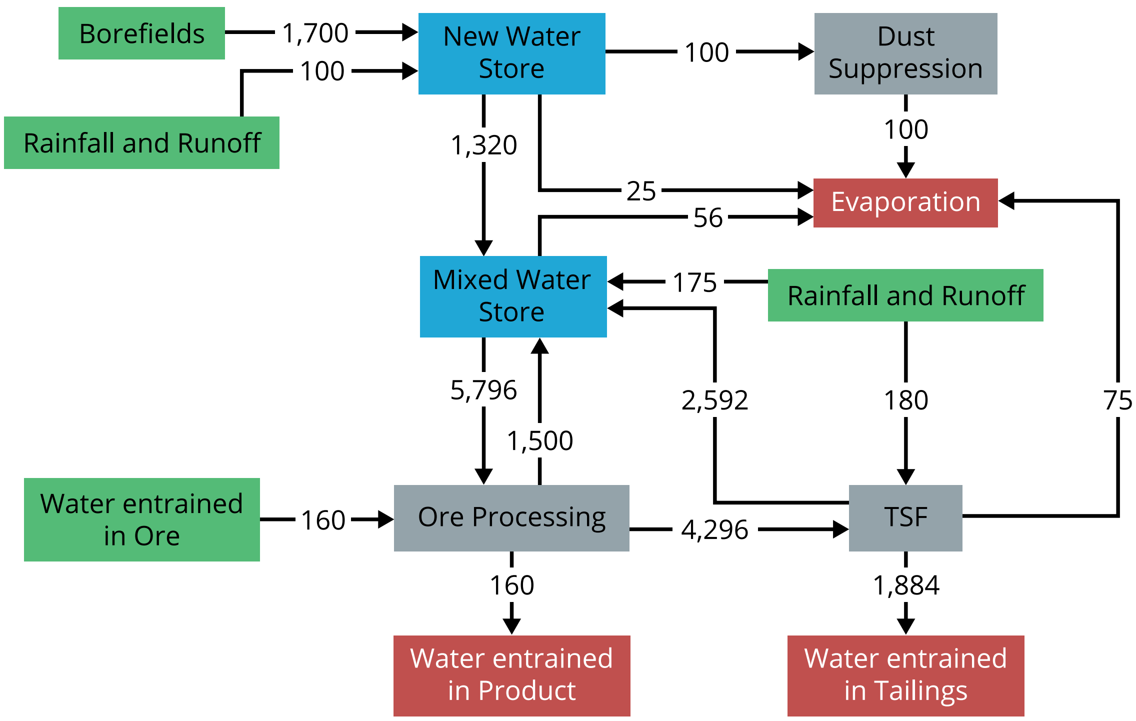
- Operational Inputs (withdrawals) are coloured green
- Operational Outputs (discharges, entrainment, evaporation and task losses) are coloured red
- Other Managed Water is coloured yellow
- Stores are coloured blue
- Tasks are coloured grey
- Treatment plants are coloured purple

Figure 14 shows the end result with additional operational inputs (borefields, precipitation (rainfall and runoff) and water entrained in ore), operational outputs (evaporation, water entrained in product and tailings), consolidated ore processing task and annotations for each of the identified annual flows in ML.

3.3 Step 3 – Data Collection Summary

Capture all the data collected for the site. Placing the data in a table will assist the process of checking water balances and completion of WAF Statements. Further examples of the data collection steps are included in the case studies (see **Section 4.1.3**). Record in the Data Collection Summary which flows are measured, simulated or estimated and provide the confidence level of the flow as shown in **Table 6** for the later compilation in the Accuracy statement.

FIGURE 14. SIMPLIFIED WATER NETWORK DIAGRAM REPRESENTING WAF ELEMENTS



3.4 Step 4 – Reconcile the Water Balance

Once you have consolidated your site data, it is important to check your water balance.

Does the input – output = change in storage?

Where possible, record the water levels of all stores at the start and end of the accounting period to calculate the volume of water stored, and complete the water storage balance summary (see **Table 6**). The difference between the sum of operational inputs and the sum of operational outputs should equal the difference between the volume of water stored at the start and end of the accounting period. If these are not equal, the data collection and calculations should be reviewed to check for any errors or potential lags in the water system that may not have been considered (for example delays in runoff making it to storage).

TABLE 6. DATA SUMMARY

FLOW	SOURCE/ DESTINATION	SUB-CATEGORY	DESCRIPTION	QUANTITY (ML)	WATER QUALITY	QUANTIFICATION	CONFIDENCE
Operational Input	Surface Water	Precipitation and Runoff	Rainfall - TSF	180	1	Simulated	High
			Rainfall - New Water Store	100	1	Simulated	High
			Rainfall - Mixed Water Store	175	1	Simulated	High
	Groundwater	Entrainment	Water entrained in ore	160	3	Measured	High
		Abstraction	Borefields to New Water Store	1,700	2	Measured	High
	Total			**2,315**			
Operational Output	Other	Entrainment	Water entrained in tailings	1,884	3	Estimated	Low
			Water entrained in product	160	3	Measured	High
		Evaporation	Evaporation from New Water Stores	25	1	Simulated	Medium
			Evaporation from Mixed Water Stores	56	2	Simulated	Medium
			Evaporation from TSF	75	2	Simulated	Medium
			Evaporation from Dust Suppression	100	2	Simulated	Medium
	Total			**2,300**			
Storage	**Change in Storage**			**15**	**Check Balance**	-	**OK**
Other Managed Water							
Internal		New Water Store to Mixed Water Store		1,320			
		New Water Store to Dust Suppression		100			
		Mixed Water Store to Ore Processing		5,796			
		Ore Processing to Mixed Water Store		1,500			
		Ore Processing to TSF		4,296			
		TSF to Mixed Water Store		2,592			

STORES	START (ML)	END (ML)	CHANGE (ML)
New Water Store	1,000	1,355	355
Mixed Water Store	1,500	1,235	-265
TSF	4,000	3,925	-75

3.5 Step 5 – Develop the Input-Output Statement

Construct the Input-Output Statement by aggregating the material operational inputs, operational outputs and OMW in terms of the volume, source or destination and water quality from the Data Collection Summary as shown in **Table 7**.

3.6 Step 6 – Provide Disclosure Notes

Record any information relevant for review or audit of the account in the disclosure notes. For example, a site may explain how precipitation and runoff was simulated or the process used to estimate the volume of entrained water.

TABLE 7. INPUT-OUTPUT STATEMENT

FLOW	SOURCE / DESTINATION	SUB-CATEGORY	VOLUME OF WATER BY QUALITY (ML)			TOTAL VOLUME (ML)	QUANTIFICATION AND CONFIDENCE	NOTES
			CAT 1	CAT 2	CAT 3			
Operational Inputs	Surface Water	Precipitation and Runoff	455	-	-	455	Simulated, High	1
	Groundwater	Bore Fields	-	1,700	-	1,700	Measured, High	2
		Entrainment	-	-	160	160	Measured, High	3
	Sea Water		-	-	-	-		
	Third Party Water		-	-	-	-		
	Total Operational Inputs		**455**	**1,700**	**160**	**2,315**		
Operational Outputs	Surface Water		-	-	-	-		
	Groundwater		-	-	-	-		
	Sea Water		-	-	-	-		
	Third Party Water		-	-	-	-		
	Other	Evaporation	25	231	-	256	Simulated, Medium	4
		Entrainment	-	-	2,044	2,044	Estimated, Low	5
	Total Operational Outputs		**25**	**231**	**2,044**	**2,300**		
Storage	**Change in Storage**					15		
Other Managed Water (OMW)	**Total OMW Inputs**					-		
Outputs	**Total OMW Outputs**					-		
OMW Storage	**Change in OMW Storage**					-		

3.7 Step 7 – The Accuracy Statement

Create the Accuracy statement which summarises the proportions of flows by quantification method (measured, estimated or simulated) and confidence level (such as high, medium or low).

To complete the accuracy statement we take the information collated during data collection and tabulate the data as shown in **Table 8**. For each operational input, operational output and OMW sum the volume of flows that were measured by each confidence level (high, medium and low) and record in the table. Repeat for the flows that were estimated and simulated. To finalise the accuracy statement convert flows to percentages as shown in **Table 9**.

HINT: Check that all flows have been included by confirming the total flows in the accuracy statement match the total flows in the Input-Output Statement.

TABLE 8. INTERIM STEP FOR ACCURACY

QUANTIFICATION	CONFIDENCE LEVEL - VOLUME (ML/YEAR)			TOTAL
	High	Medium	Low	
Measured	1,860	-	-	1,860
Estimated	-	160	1,884	2,044
Simulated	455	256	-	711
TOTAL	2,315	416	1,884	4,615

TABLE 9. FINAL ACCURACY STATEMENT

QUANTIFICATION	% OF ALL FLOWS	CONFIDENCE LEVEL - PERCENTAGE		
		High	Medium	Low
Measured	40%	40%	-	-
Estimated	44%	-	3%	41%
Simulated	16%	10%	6%	-
TOTAL	100%	50%	9%	41%

3.8 Step 8 – Statement of Operational Efficiencies

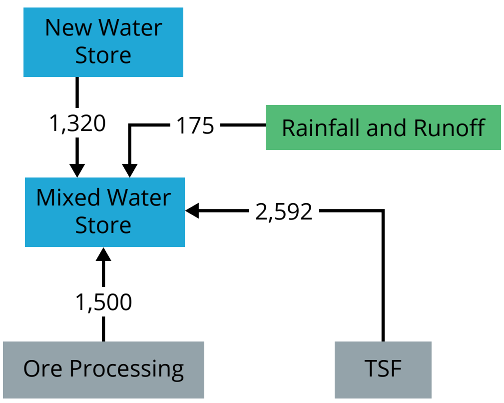
Prepare the Statement of Operational Efficiencies to show the proportion of reuse and recycled flows in relation to the total flows into the tasks.

HINT: Tasks and stores should be grouped according to purpose or storage type:

- **Stores** – Stores do not need to be considered individually and may be grouped as shown in **Figure 10**. Do not include any OMW storage locations as they do not form part of operational water use
- **Tasks** – Activities that use or require water are aggregated into tasks at the highest practical level. Flows between individual activities within aggregated task units are not needed. To enhance consistency, the WAF includes a disciplined approach to task aggregation (see **Section 2.3.1**, **Table 5**)
- **Treatment plants** – Only onsite treatment plants receiving worked water need to be listed to calculate Recycling Efficiency. Treated effluent received from an external party or sea water treated by the operational facility prior to use in a task is not considered recycling

Use the WAF representation to calculate the proportion of worked water (treated or untreated) in the Mixed Water store(s) by using **Calculation 6** (see **Table 10**).

FIGURE 15. (EXTRACT FROM FIGURE 14) INFLOWS TO THE MIXED WATER STORE (VALUES IN ML)



Inflows from the TSF and ore processing are considered worked water as they have been tasked by the operational facility. Inflows from the new water store and from the precipitation (rainfall and runoff) operational input are considered new water as the water has not been used for any tasks.

The mixed water store contains both new and worked water. Determine the proportion of worked water in the mixed water store using **Calculation 6**.

$$\% \textit{ Worked Water} = \frac{\textit{Sum of Worked Inflows}}{\textit{Sum of all Flows}} \times 100$$

TABLE 10. MIXED WATER STORE INFLOWS FROM FIGURE 13

WATER TYPE	SOURCE	FLOW (ML/YEAR)
New	Rainfall and Runoff	175
	New Water Store	1,320
Subtotal New		**1,495**
Worked	Ore Processing	1,500
	TSF	2,592
Subtotal Worked		**4,092**
Total		**5,587**
% Worked Water in Store		**73%**

As shown in **Table 10**:
% Worked Water = 4,092 / 5,587 = 73%

For the purposes of the WAF we then assume the proportion of new and worked water that is in the mixed water store and any subsequent outflows are in the same proportion as the inflows. From **Figure 14**, we see that the mixed water supply provides 5,796 ML water to the ore processing task. Based on the proportion of worked water in the mixed water store, 4,231 ML of this flow is assigned the status of worked and the remaining 1,565 ML is assigned as new water.

If the TSF has material new water inflows it should be considered as a mixed water store as detailed in **Case Study 3** (see **Section 4.2.3**).

Calculation of Reuse and Recycling Efficiencies

Tabulate all flows to tasks and the associated details on water status to determine the reuse and recycling efficiencies. **Figure 16** illustrates all inflows to tasks and the subsequent calculations for the reuse and recycling efficiencies are shown in **Table 11**.

Develop the statement of operational efficiencies for the WAF using the information from **Table 11**, as shown in **Table 12**. If onsite treatment plants are present then the same process should be followed to calculated treated worked water flows and the recycling efficiency, as shown in Case Study 3. WAF users may report either volumes or efficiency percentages for the reuse and recycling metrics.

FIGURE 16. (EXTRACT FROM FIGURE 14) INFLOWS TO ALL TASKS (VALUES IN ML)

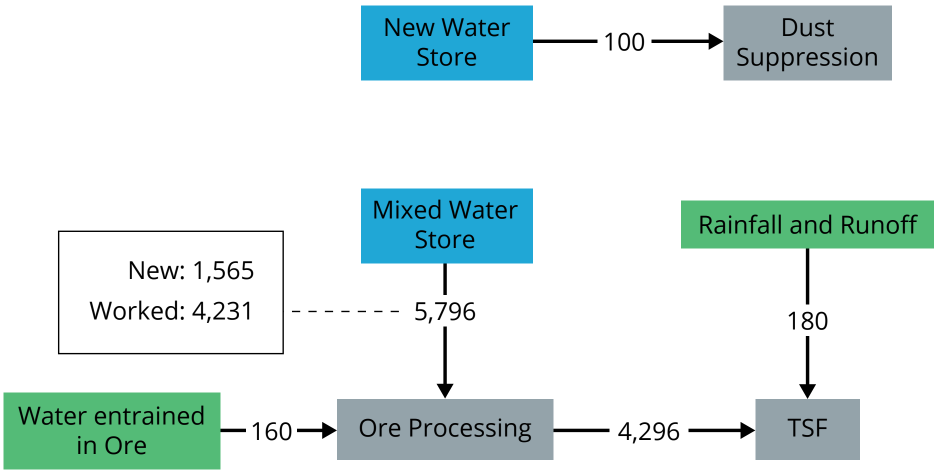


TABLE 11. REUSE AND RECYCLING EFFICIENCIES

TASKS	SOURCE	FLOW (ML/YEAR)	WATER TYPE (ML/YEAR)		
			New	Worked	Treated Worked
Dust Suppression	New Water Store	100	100	-	-
Ore Processing	Water entrained in Ore	160	160	-	-
	Mixed Water Store (73% Worked)	5,796	1,565	4,231	-
TSF	Ore Processing	4,296	-	4,296	-
	Rainfall and Runoff	180	180	-	-
Totals		**10,532**	**2,005**	**8,527**	**-**
Totals (%)		**100%**	**19%**	**81%**	**-**

TABLE 12. STATEMENT OF OPERATIONAL EFFICIENCIES

OPERATIONAL EFFICIENCIES	
Total volume to tasks (ML/year)	10,532
Total volume of reused water (ML/year)	8,527
Reuse Efficiency (%)	81%
Total volume of recycled water (ML/year)	-
Recycling Efficiency (%)	-
Total volume of reused and recycled water (ML/year)	-
Operational Efficiency (%)	-

3.9 Step 9 – Contextual Statement

Prepare the Contextual Statement by providing a simple summary of the key information required to interpret and understand the accounting metrics. The statement should provide information about the system boundary, Operational Facility, and any conditions that influenced water management activities during the period. When preparing the statement consider what information the reader needs to understand or interpret the water account.

Contextual Statements often include:

- Description of geographical terrain in which the operational facility is situated
- Catchment details
- General climatic conditions, with a focus on those experienced during the accounting period
- Information on water policy and regulatory conditions applicable to the operational facility
- Operational, infrastructure or water management changes during the accounting period
- Administrative changes (i.e. changes to water sharing plans)

An example Contextual Statement is provided below.

SYSTEM BOUNDARY DESCRIPTION

International Mining Company's (IMC) site is situated within the Jill river catchment. Catchment flows are collected locally by the Clayton Village dam which also provides the town water supply. The operational facility includes both the mining and processing operations. The sites primary water supply is groundwater from a local borefield in addition to harvesting rainfall and runoff across the site. Supplementary water is sourced from the Clayton Village Dam.

WATER INFRASTRUCTURE

The borefield upgrade was completed in the previous year and as a result IMC did not draw any water from the town's fresh water supply during the 12 month accounting period.

Two major stores accommodate the volume of the water required to supply the current operational demands and mitigate future risk. Happy Jack's Dam has a holding capacity of 300 ML, while the process water dam has a holding capacity of 1,000 ML. A number of additional smaller stores support the two major stores to help manage operational water flows. All stores are owned and operated by IMC.

WATER RESOURCE MANAGEMENT

Water sourcing activities at IMC must comply with water sharing arrangements established by the catchment groundwater sharing plan. IMC must also comply with conditions of their project approval granted by the Department of Industry – the industry regulator.

The site must comply with IMC's Water Management Standard and policies, which requires the site to minimise discharge risks and maintain adequate water supply for around 60 days of operations. It also requires the site to maximise water recycling and reuse, where practical.

CLIMATE

The average temperature for the reporting period was 13.3°C, similar to the long-term average (1907-2007) of 13.2°C. The total rainfall for the reporting period was 710 mm, 13% lower than the long term yearly rainfall average (1907-2007) of 817 mm.

INPUTS AND OUTPUTS

Water accessed from the borefield (groundwater) is the primary water source at the IMC site, accounting for 73% of total water sourced for onsite activities during the reporting period. A further 20% was harvested from rainfall and runoff at the site. Water entrained in ore made up the balance 7%. As noted the borefield upgrade project was completed in the previous period resulting in an increase in groundwater of 700 ML or 32% and a corresponding reduction in the input of third party water (Municipal).

As per the conditions of the regulatory approval there were no discharges from the site. Outputs include evaporation (256 ML or 11% of total outputs) and entrainment in tailings and concentrate (2,044 ML or 89% of total outputs).

Operational efficiencies at the site remained constant with 81% of the operational water inputs reused and recycled by the facility. Water stored at the site increased slightly by 15 ML.

ALLOCATIONS AND RESTRICTIONS

IMC holds a State Water Authority licence providing access to groundwater via extraction with an entitlement of 2,000 ML/year.

Harvesting of rainfall and runoff is in accordance with the relevant restrictions and is limited to areas that are affected by the operation. Drainage and surface water diversions are maintained to limit water runoff into the site footprint.

4 CASE STUDIES

These case studies illustrate development and application of the WAF.

4.1 Case Study 1 – Coal mine

This case study shows the process of building the water account from an initial stage with limited data. The coal mine has identified their main sources and water flows in a preliminary network diagram as shown in **Figure 17**.

4.1.1 Step 1 – Establish the Water Network Diagram

Identify any missing operational inputs and outputs

The preliminary mine water network diagram (**Figure 17**) shows town water as the only operational input while the only output is from the sedimentation ponds to the creek.

Using **Table 2** the coal mine identifies two additional operational inputs Precipitation (rainfall and runoff) and water entrained as moisture in coal. Using **Table 3** the coal mine identifies potential operational outputs include task loss, evaporation, seepage and entrainment (both product and tailings).

4.1.2 Step 2 – Create WAF Representation

Aggregate Tasks to highest level

The coal mine aggregates their activities into four tasks according to their purpose using **Table 5**:

- Coal Handling and Preparation Plant (CHPP) - water used to wash coal and prepare it transport
- Underground coal mine – water used underground during mining activities including conveyor dust suppression and cooling
- TSF – water used to store tailings generated from the CHPP
- Dust Suppression – water used on haul roads to supress dust

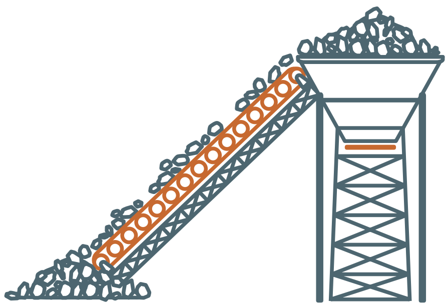
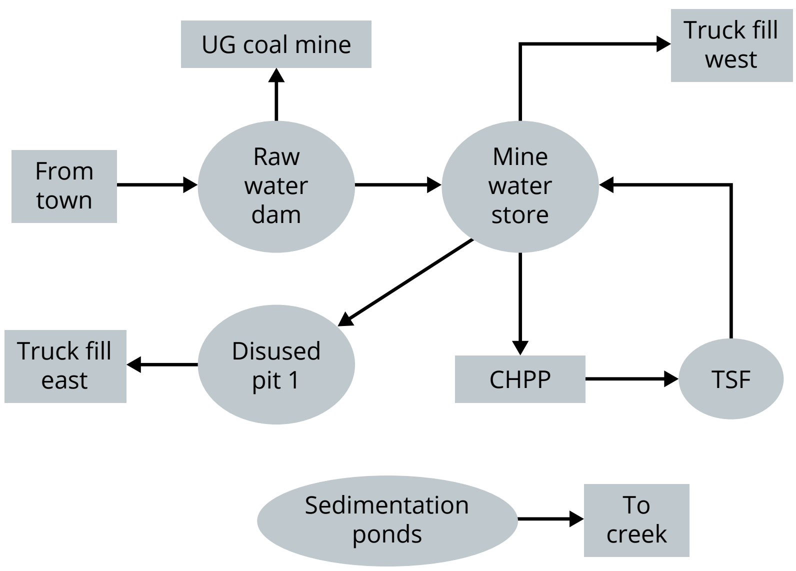


FIGURE 17. CASE STUDY: COAL MINE – MINE WATER NETWORK



Identify and Group Stores

Stores are classified as new or mixed water stores

- The raw water dam only receives town water and precipitation (rainfall) and runoff (both operational inputs) making it a new water store
- The mine water store is a mixed water store as it receives decant water from the TSF (worked water), and it is subsequently grouped with the disused pit as it is also mixed water store (it receives water from the mine water store)
- The TSF is a task as well as a potential storage location the surface area and catchment of the TSF is separated from the other stores
- The site has a series of sedimentation ponds used to settle suspended solids in runoff prior to pumping settled water to a nearby creek. This water is not used, or stored to be used, in tasks onsite making the ponds OMW stores

At the completion of Step 2 the water network diagram can be updated into a WAF representation with the appropriate colour coding as shown in **Figure 18**.

4.1.3 Step 3 – Data Collection Summary

The WAF representation provides a basis for data collection. Operational input and output flows are tabulated with water quality, quantification method and confidence into the Data Summary table. The Data Summary table can then be used to compile the Input-Output and Accuracy Statements.

4.1.3.1 Measured Flows

Town water

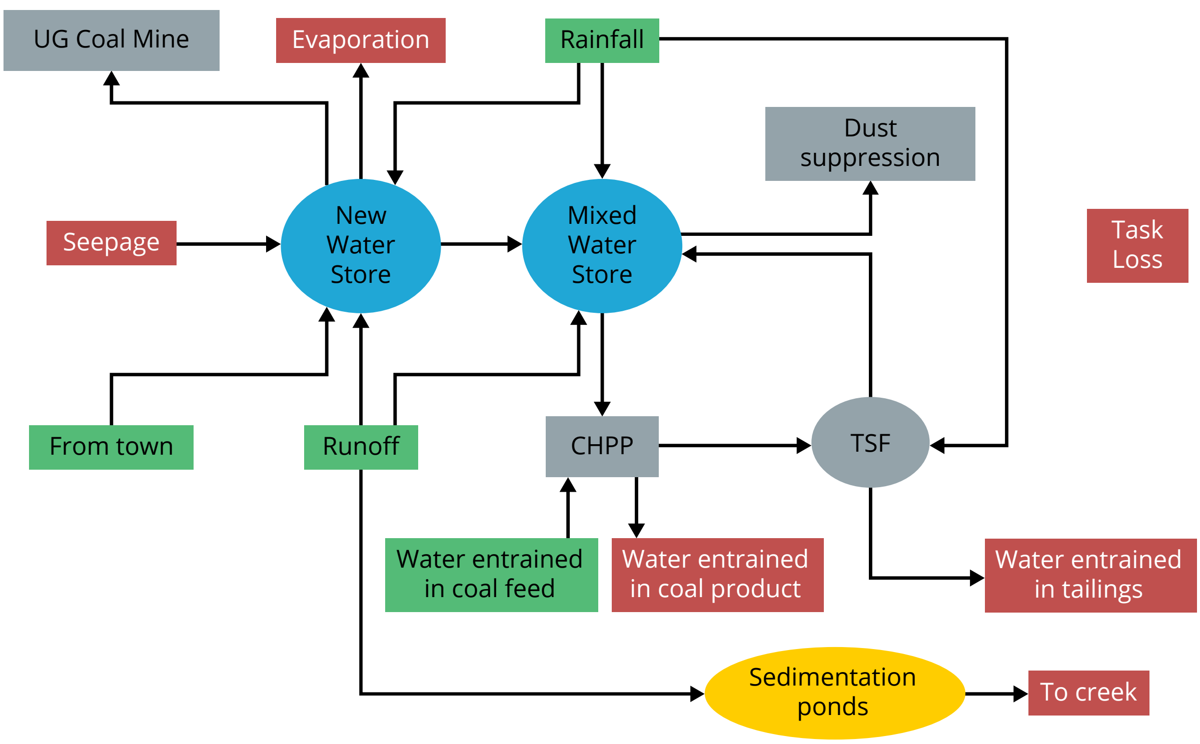
Town water volumes are usually well-monitored and easily obtained, over the accounting period the town supplied 468 ML to the coal mine. This was confirmed by both the flowmeter on the supply line and data from invoices for water supply. The water quality is monitored and by working through the decision tree in **Figure 7** is determined to be Category 1. The 'third party water' category is applied as the water is purchased.

Other Measured Flows

Most internal water flows are monitored and recorded monthly by the site operations team using flowmeters onsite. This provides measured data with high confidence;

- New water store to underground (70 ML),
- Mixed water store to CHPP (3,240 ML),
- CHPP to TSF (2,609 ML), and
- Tailings decant to the mixed water store (1,860 ML).

FIGURE 18. CASE STUDY: COAL MINE – PRELIMINARY WAF REPRESENTATION OF NETWORK



The flowmeter monitoring the transfer of makeup water from the new water store to the mixed water store failed during the year and had to be replaced. An estimate of the water transferred was made by utilising available reporting data to determine an average requirement (25 ML/month) for the accounting period (300 ML/year). Water used in Dust suppression was estimated using truck counts and expected water volume per truck (648 ML). The estimates were considered to be of low confidence.

Change in Storage

The survey team provides volumes of water in stores at the start of each reporting period. At the start of the accounting period the volume of water stored at the mine was 4,653 ML. At the end of the accounting period the volume was 2,701 ML resulting in a 1,952 ML reduction in water stored.

4.1.3.2 Data Calculations

Water entrained in coal feed

Calculation 2 may be used to estimate the volume of water entrained in the coal feed. The mine's engineering team provides the moisture content of the coal delivered to the CHPP as 4%. The processing team at the CHPP recorded throughput of 11.4 Mt during the accounting period.

HINT: Make sure you use the correct units in the calculations.

$$V_{ent} = 1000 * P * m$$

This results in a volume of water entrained in coal feed of 442 ML. It is assigned as Category 3 water quality (source is groundwater).

Precipitation and runoff

The coal mine does not have a hydrological model to provide precipitation (rainfall) and runoff volumes and manual calculations are used to produce an estimate. **Calculation 3** is used to determine the volume of rainfall incident on the stores and TSF. No material rainfall was incident on the sedimentation ponds as they were small in area.

$$V_{Precipitation} = 0.01 * R * SA$$

where **R** is the precipitation measured during the reporting period (mm)

What is the term 'materiality of flows'?

A flow is material if it will significantly impact on interpretations or decisions resulting from reading of the report. For example, if leachate from a waste rock dump was affected by acid rock drainage the quality of water is such that flows around the rock dump should be included in the account, however small in volume. All material flows must be included in the account (see **Section 2.1.3**).

To calculate the runoff volume use **Calculation 4**:

$$V_{Runoff} = 0.01 * R * A * \beta$$

where **R** is the rainfall measured during the reporting period (mm),

A is the undisturbed/disturbed catchment area (ha), and

β is a volumetric runoff factor.

An estimate for $\beta_{undisturbed}$ is 0.05 and estimate for $\beta_{disturbed}$ is 0.15.

Topological site plans and survey information are used to determine the area of catchments for each water store. An undisturbed catchment area is the area where runoff does not come into contact with mine site activity or products. The coal mine had completed earthworks that directed runoff away from the TSF, it only required the calculation of direct rainfall.

The mine obtains an estimate of 600mm of rainfall for the year from the local meteorology bureau allowing rainfall and runoff volumes to be estimated, as shown in **Table 13**.

Rainfall incident on the stores is assumed to be Category 1 water quality. Runoff from undisturbed catchments is assigned Category 1, with disturbed catchments assigned Category 2.

The calculations for rainfall and runoff were based on a number of assumptions and as a result they are recorded as estimates, with low confidence.

TABLE 13. CASE STUDY: COAL MINE – PRECIPITATION (RAINFALL AND RUNOFF) VOLUMES

STORAGE TYPE	STORES	SURFACE AREA (ha)	UNDISTURBED CATCHMENT (ha)	DISTURBED CATCHMENT (ha)	RAINFALL (mm)	RAINFALL VOLUME (ML)	RUNOFF VOLUME (ML)		RAINFALL & RUNOFF (ML)
							UNDISTURBED	DISTURBED	
New	New (Raw) Water Dam	23	300	-	600	138	90	-	228
New Water Store		**23**	**300**	**-**	**600**	**138**	**90**	**-**	**228**
Mixed	Mine Water Store	4	24	100	600	24	7	90	121
Mixed	Disused Pit 1	2	10	90	600	12	3	81	96
Mixed Water Store		**6**	**34**	**190**	**600**	**36**	**10**	**171**	**217**
TSF		**30**	**-**	**-**	**600**	**180**	**-**	**-**	**180**
Sedimentation Ponds		**-**	**-**	**141**	**600**	**-**	**-**	**127**	**127**
					Total	**354**	**100**	**298**	**752**

Evaporation from water stores

Evaporation (V_{Evap}) from the new water store (345 ML), mixed water store (90 ML) and tailings (450 ML) were calculated using **Calculation 5**:

$$V_{Evap} = 0.01 * S_{Evap} * Pan_{Evap} * f$$

where $\mathbf{S_{Evap}}$ is the average surface area (ha) occupied by water in the store during the reporting period gained from monthly surveys.

$\mathbf{Pan_{Evap}}$ is the value of measured rates of pan-evaporation (2000 mm) during the reporting period. They were obtained from the Meteorology Bureau.

A correction factor to convert measurements of pan evaporation into evaporation losses from open storages, estimated at 0.75 was used.

This calculation uses a number of assumptions and the evaporation volumes are classified as estimates with low confidence.

Water entrained in the product material

The processing team provided the volume of water entrained (744 ML) in the product. This was a measured value based on product volume and measured moisture contents monitored throughout the year. Water quality is assigned Category 3.

4.1.3.3 Balancing Flows

Creek flow

Flow to the creek is actively managed and reported in the Input-Output Statement as an OMW. It is assumed the same volume entered and exited the ponds over the accounting period (127 ML). The sediment ponds are small in size with no capacity for additional storage or potential for material evaporation.

Tasks cannot store water so the inflows must equal the outflows (with the exception of the TSF). Where a task's outflow does not go to another task or store, it must be assigned an output destination source or sub-category (such as evaporation, seepage, entrainment or supply to third party).

Water used underground is assumed to output as a task loss (70 ML).

Water used for dust suppression comes from the mixed water store (648 ML) and the total amount is outputs to evaporation.

Water demand (3,240 ML) for the CHPP is monitored by the processing team, and is drawn from the mixed water store. Water entrained in the coal entering the CHPP is 442 ML. Outflow (2,609 ML) from the CHPP to the TSF is also monitored by the processing team. Water (744 ML) entrained in the product was determined previously by the site processing team. Balancing water around the CHPP results in a discrepancy of 329 ML assumed as CHPP task loss as shown in **Figure 19**.

TSF inflows are from precipitation (rainfall) (180 ML) and water flowing from the CHPP (2609 ML). Outflows include the decant water to the mixed water store (1860 ML) and evaporation (450 ML). There was no change in water stored in the TSF over the period, thus the entrainment in waste product is calculated by closing the water balance as shown in **Figure 20**.

Total inputs to the facility were 1,556 ML and total outputs to date were 3,155 ML, a difference of 1,599 ML, while the change in storage was 1,952 ML. For the facility to balance operational inputs less the operational outputs must equal the change in storage. Seepage from unlined water stores is determined to be the missing output, with a volume of 332 ML. This is classed as an estimate with a low confidence level.

FIGURE 19. CASE STUDY: COAL MINE – CHPP WATER BALANCE

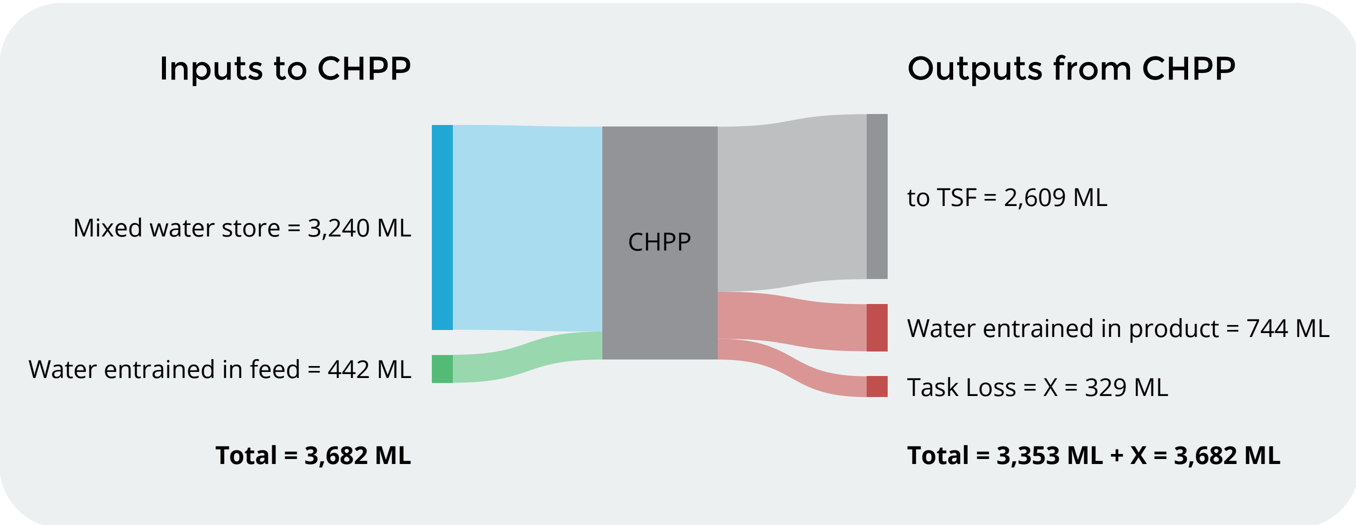
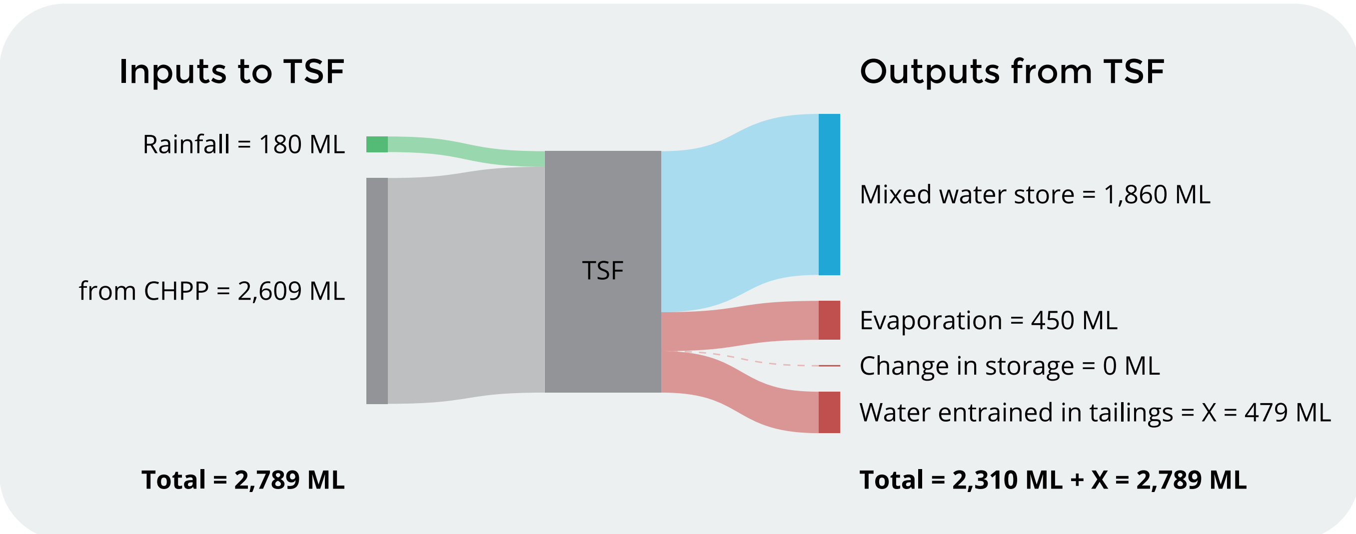


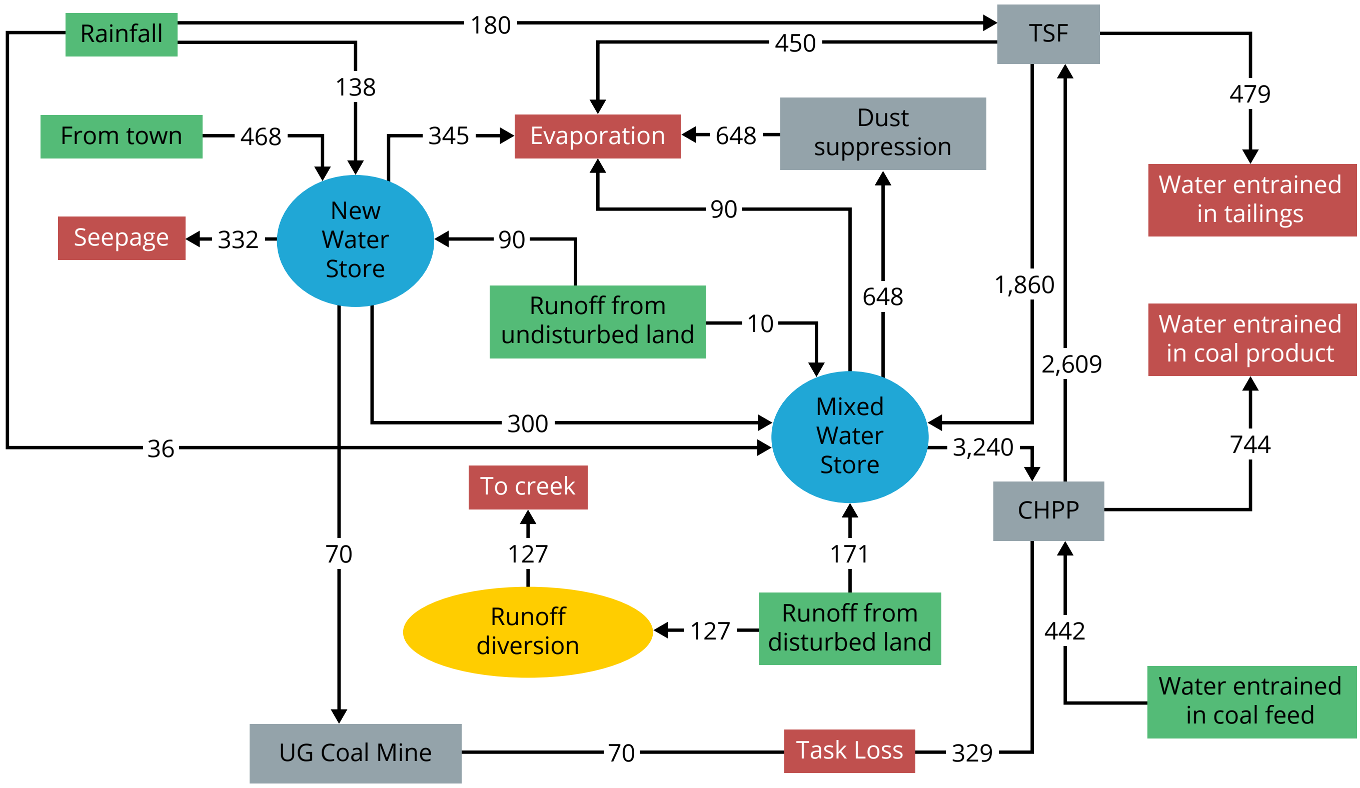
FIGURE 20. CASE STUDY: COAL MINE – TSF WATER BALANCE



The completed WAF representation of the water network diagram is shown in **Figure 21**.

FIGURE 21. CASE STUDY: COAL MINE – COMPLETED WAF REPRESENTATION

Figures are in ML. Tasks are in grey, operational inputs in green, operational outputs in red, stores in blue, OMW in yellow.



4.1.4 Step 4 – Reconcile the Water Balance

The above data is then summarised into **Table 14** and checked to confirm that the total network is in balance.

TABLE 14. CASE STUDY: COAL MINE – DATA COLLECTION SUMMARY

FLOW	SOURCE / DESTINATION	SUB-CATEGORY	DESCRIPTION	QUANTITY (ML)	WATER QUALITY	QUANTIFICATION	CONFIDENCE
Operational Input	Surface Water	Precipitation and Runoff	Rainfall - TSF	180	1	Estimated	Low
			Rainfall - New Water Store	138	1	Estimated	Low
			Rainfall - Mixed Water Store	36	1	Estimated	Low
			Runoff - Undisturbed to New Water Store	90	1	Estimated	Low
			Runoff - Disturbed to Mixed Water Store	171	2	Estimated	Low
			Runoff - Undisturbed to Mixed Water Store	10	1	Estimated	Low
	Groundwater	Entrainment	Water entrained in coal feed	442	3	Measured	High
	Third Party Water	Contract/ Municipal	Water supplied from town	468	1	Measured	High
	Total			**1,535**			
Operational Output	Other	Entrainment	Water entrained in tailings	479	3	Estimated	Medium
			Water entrained in coal product	744	3	Estimated	Medium
		Task Loss	Task Loss Mining	70	2	Estimated	Medium
			Task Loss CHPP	329	2	Estimated	Medium
		Evaporation	Evaporation from New Water Stores	345	1	Estimated	Low
			Evaporation from Mixed Water Stores	90	2	Estimated	Low
			Evaporation from TSF	450	3	Estimated	Low
			Evaporation from Dust Supression	648	2	Estimated	Low
	Groundwater	Seepage	Seepage from Water Stores	332	3	Estimated	Medium
	Total			**3,487**			
Storage	**Change in Storage**			**15**	**Check Balance**	-	**OK**
OMW - Input	Surface Water	Precipitation and Runoff	Runoff Disturbed	127	2	Estimated	Low
OMW - Output	Surface Water	Discharge	Discharge to Creek	127	1	Estimated	Low
OMW Storage	**Change in Storage**			-	**Check Balance**	-	**OK**
Internal		New Water Store to Mixed Water Store		300	1	Estimated	Low
		New Water Store to UG Coal Mine		70	1	Measured	High
		Mixed Water Store to CHPP		3,240	2	Measured	High
		Mixed Water Store to Dust Suppression		648	2	Estimated	Low
		TSF to Mixed Water Store		1,860	2	Measured	High
		CHPP to TSF		2,609	2	Measured	High

STORES	START (ML)	END (ML)	CHANGE (ML)
New Water Store	1,001	650	-351
Mixed Water Store	2,652	1,051	-1,601
TSF	1,000	1,000	-
	4,653	2,701	-1,952

4.1.5 Step 5 – Develop the Input-Output Statement

The **Data Collection Summary** (**Table 14**) can then be used to complete the **Input-Output Statement** (**Table 15**).

TABLE 15. CASE STUDY: COAL MINE – COMPLETED INPUT-OUTPUT STATEMENT

FLOW	SOURCE / DESTINATION	SUB-CATEGORY	VOLUME OF WATER BY QUALITY (ML)			TOTAL VOLUME (ML)	QUANTIFICATION AND CONFIDENCE	NOTES
			CAT 1	CAT 2	CAT 3			
Operational Inputs	Surface Water	Precipitation and Runoff	454	171	-	625	Estimated, Low	1
		Rivers and Creeks	-	-	-	-		
	Groundwater	Bore Fields	-	-	-	-		
		Entrainment	-	-	442	442	Measured, High	2
	Sea Water		-	-	-	-		
	Third Party Water	Contract/ Municipal	468	-	-	468	Measured, High	3
	Total Operational Inputs		**922**	**171**	**442**	**1,535**		
Operational Outputs	Surface Water		-	-	-	-		
	Groundwater	Seepage	-	-	332	332	Estimated, Medium	4
	Sea Water		-	-	-	-		
	Third Party Water		-	-	-	-		
	Other	Evaporation	345	738	450	1,533	Estimated, Low	5
		Entrainment	-	-	1,223	1,223	Estimated, Medium	6
		Task Loss	-	399	-	399	Estimated, Medium	7
	Total Operational Outputs		**345**	**1,137**	**2,005**	**3,487**		
Storage	**Change in Storage**					**-1,952**		
OMW Inputs	Surface Water	Precipitation and Runoff	-	127	-	127	Estimated, Low	8
	Total OMW Inputs		**-**	**127**	**-**	**127**	Estimated, Low	8
OMW Outputs	Surface Water	Discharge	127	-	-	127		
	Total OMW Outputs		**127**	**-**	**-**	**127**		
OMW Storage	**Change in OMW Storage**					**0**		

4.1.6 Step 6 – Provide Disclosure Notes for Input-Output Statement

1. Rainfall 600 mm. The runoff coefficients were 0.05 for undisturbed catchments and 0.15 for disturbed catchments
2. The moisture content of the coal is 4% and the throughput is 11.4 Mt
3. Metered flow
4. Calculated to close the balance
5. Pan evaporation rate 2000 mm. Correction factor 0.75
6. Water in product obtained from the processing team. Water in tailings calculated to close the balance around the tailings dam
7. Task loss calculated to close the balance around the tasks
8. Runoff from disturbed catchment is diverted to sedimentation ponds prior to discharge in the river

4.1.7 Step 7 – Create the Accuracy Statement

The Accuracy Statement tabulates which operational inputs, operational outputs and OMW were measured, simulated or estimated and stipulates a confidence level of the flow (high, medium or low) from the **Data Collection Summary** (**Table 14**).

Following the procedure in **Section 3.7**, tabulate the sum of operational inputs, operational outputs and OMW by quantification and confidence from **Table 15**. This is shown in **Table 16**, then convert to percentages to finalise the accuracy statement as shown in **Table 17**.

Recording of accuracy data allows the site to demonstrate improvements from previous statements, and supports continual improvement in the collection of data.

HINT: Check the sum of flows matches the sum of operational inputs, operational outputs and OMW

TABLE 16. CASE STUDY: COAL MINE – INTERIM VOLUMETRIC ACCURACY STATEMENT

QUANTIFICATION	CONFIDENCE LEVEL - VOLUME (ML/YEAR)			TOTAL
	High	Medium	Low	
Measured	910	-	-	910
Estimated	-	1,954	2,412	4,366
Simulated	-	-	-	-
TOTAL	910	1,954	2,412	5,276

TABLE 17. CASE STUDY: COAL MINE – ACCURACY STATEMENT FOR COAL MINE CASE STUDY

QUANTIFICATION	% OF ALL FLOWS	CONFIDENCE LEVEL - PERCENTAGE		
		High	Medium	Low
Measured	17%	17%	-	-
Estimated	83%	-	37%	46%
Simulated	-	-	-	-
TOTAL	100%	17%	37%	46%

4.1.8 Step 8 – Statement of Operational Efficiencies

Operational efficiencies are determined by examining the internal flows of the facility. Water flows within the facility are assigned as new, worked, and treated worked.

Flows from mixed water stores are proportioned on the basis of the inflows following the process in **Section 2.5**. **Table 18** shows the outflows from the mixed water store at the coal mine are 78% worked.

There is no treatment plant so there is no recycled water.

The flows to tasks can then be tabulated to determine the reuse/recycled water use and efficiency as shown in **Table 19**.

TABLE 18. CASE STUDY: COAL MINE – WORKED WATER IN MIXED WATER STORE

WATER TYPE	SOURCE	FLOW (ML/YEAR)
New	Rainfall	36
	Runoff - Undisturbed	10
	Runoff - Disturbed	171
	New (Raw) Water Store	300
Subtotal New		**517**
Worked	TSF	1,860
Subtotal Worked		**1,860**
Total		**2,377**
% Worked Water in Store		**78%**

TABLE 19. CASE STUDY: COAL MINE – FLOWS TO TASKS BY WATER TYPE

TASKS	SOURCE	FLOW (ML/YEAR)	WATER TYPE (ML/YEAR)		
			New	Worked	Treated Worked
UG Coal Mine	New Water Store	70	70	-	-
Dust Suppression	Mixed Water Store (78% Worked)	648	143	505	-
CHPP	Ore Entrainment	442	442	-	-
	Mixed Water Store (78% Worked)	3,240	713	2,527	-
TSF	Rainfall	180	180	-	-
	CHPP to TSF	2,609	-	2,609	-
Totals		**7,189**	**1,547**	**5,642**	**-**
Totals (%)		**100%**	**22%**	**78%**	**-**

This table can then be transferred to the **Statement of Operational Efficiencies** as shown in **Table 20**.

The **Contextual Statement** should now be completed. The generic example given in **Section 3.9** may provide a guide.

TABLE 20. CASE STUDY: COAL MINE – STATEMENT OF OPERATIONAL EFFICIENCIES

OPERATIONAL EFFICIENCIES	
Total volume to tasks (ML/year)	7,189
Total volume of reused water (ML/year)	5,642
Reuse Efficiency (%)	78%
Total volume of recycled water (ML/year)	-
Recycling Efficiency (%)	-
Total volume of reused and recycled water (ML/year)	5,642
Operational Efficiency (%)	78%

4.2 CASE STUDY 2 – Comparison of ‘wet’ and ‘dry’ sites

4.2.1 Scenario Summary

This case study shows the potential impact of different climate scenarios: a drought (a ‘dry’ site) and a flood (a ‘wet’ site). If we assume the previous example was a normal year, adjusting the precipitation (e.g. rainfall) will provide an illustration of the impact on the accounts in a dry or wet year. This type of case study also illustrates how the framework could be used to understand or ‘stress test’ the impact of different climatic situations to demonstrate if the operational facility had the capability to manage extreme weather events.

For comparison purposes we will maintain the other operational inputs as per the Case Study 1.

This case also assumes that the assumptions made for pan evaporation, seepage and runoff factors are consistent, or not materially different, however, it should be noted that these could also change year to year on the basis of different climatic conditions. The mine may also have had the opportunity to increase or reduce third party supply to manage operational inputs with changes in rainfall.

For the dry scenario, the rainfall is reduced by six times to 100 mm and for the wet scenario, the rainfall volume increased six times to 3,600 mm. Input volumes would be calculated as shown in **Table 21**.

NOTE: Extreme weather events may also affect the runoff coefficients, higher than usual rainfall may increase the coefficient while low rainfall may reduce it.

TABLE 21. CASE STUDY: COAL MINE – PRECIPITATION (RAINFALL) AND RUNOFF FOR DRY AND WET SCENARIOS

DRY

STORAGE TYPE	STORES	SURFACE AREA (ha)	UNDISTURBED CATCHMENT (ha)	DISTURBED CATCHMENT (ha)	RAINFALL (mm)	RAINFALL VOLUME (ML)	RUNOFF VOLUME (ML)		RAINFALL & RUNOFF (ML)
							UNDISTURBED	DISTURBED	
New	New (Raw) Water Dam	23	300	0	100	23	15	-	38
New Water Store		**23**	**300**	**0**	**100**	**23**	**15**	**-**	**38**
Mixed	Mine Water Store	4	24	100	100	4	1	15	20
Mixed	Disused Pit 1	2	10	90	100	2	1	14	16
Mixed Water Store		**6**	**34**	**190**	**100**	**6**	**2**	**29**	**36**
TSF		**30**	**-**	**-**	**100**	**30**	**-**	**-**	**30**
Sedimentation Ponds		**-**	**-**	**141**	**100**	**-**	**-**	**21**	**21**
					Total	**59**	**17**	**50**	**125**

WET

STORAGE TYPE	STORES	SURFACE AREA (ha)	UNDISTURBED CATCHMENT (ha)	DISTURBED CATCHMENT (ha)	RAINFALL (mm)	RAINFALL VOLUME (ML)	RUNOFF VOLUME (ML)		RAINFALL & RUNOFF (ML)
							UNDISTURBED	DISTURBED	
New	New (Raw) Water Dam	23	300	-	3,600	828	540	-	1,368
New Water Store		**23**	**300**	**-**	**3,600**	**828**	**540**	**-**	**1,368**
Mixed	Mine Water Store	4	24	100	3,600	144	43	540	727
Mixed	Disused Pit 1	2	10	90	3,600	72	18	486	576
Mixed Water Store		**6**	**34**	**190**	**3,600**	**216**	**61**	**1,026**	**1,303**
TSF		**30**	**-**	**-**	**3,600**	**1,080**	**-**	**-**	**1,080**
Sedimentation Ponds		**-**	**-**	**141**	**3,600**	**-**	**-**	**761**	**761**
					Total	**2,124**	**601**	**1,787**	**4,513**

4.2.2 Water Storage

For both scenarios, storage was 4,653 ML at the start of the accounting period. Survey information determined storage levels at the end of the accounting period as shown in **Table 22**.

TABLE 22. CASE STUDY: COAL MINE – STORAGE SURVEYS FOR 'WET AND DRY' SCENARIOS

STORES (DRY)	START (ML)	END (ML)	CHANGE (ML)
New Water Store	1,001	650	-351
Mixed Water Store	2,652	1,051	-1,601
TSF	1,000	1,000	-
Total	**4,653**	**2,701**	**-1,952**

STORES (WET)	START (ML)	END (ML)	CHANGE (ML)
New Water Store	1,001	1,650	649
Mixed Water Store	2,652	2,136	-516
TSF	1,000	1,900	900
Total	**4,653**	**5,686**	**1,033**

Assuming that all other flows have remained the same (due to no change in processing rate and moisture content) the New Water Store is no longer in balance. To balance the store adjust the seepage volume using the known operational inputs and operational outputs and the change in storage. This results in seepage values of 223 ML (dry) and 472 ML (wet).

Check the total water balance as shown in **Table 23**.

TABLE 23. CASE STUDY: COAL MINE – SUMMARY OF WATER BALANCE FOR THE WET AND DRY SITES

FLOW	DRY	CASE STUDY 1	WET
Operational Input: Precipitation (Rainfall) and runoff	104	625	3,750
Operational Input: Others (unchanged)	910	910	910
Operational Output (excluding Seepage)	3,155	3,155	3,155
Operational Output: Seepage	229	332	472
Change in store	**-2,370**	**-1,952**	**+1,033**
Check Water Balance (Input-Output – Change in Store = 0)	**0**	**0**	**0**
OMW Input: Precipitation (Rainfall) and runoff	21	127	761

The water balance shows that in dry years, without enough storage, the coal mine may need to purchase additional water. Ongoing monitoring is required as in wet years the mine may need storage to manage the additional inflow from rainfall and runoff.

4.2.3 Statement of Operational Efficiencies

To determine the total volume of reused water the volumes of new and worked water used in each task is needed. The proportion of new and worked water in the stores and TSF are calculated based on inflows to the stores.

Tailings Storage Facility

The TSF received worked (CHPP) and new water (rainfall) in Case Study 1. In the 'dry scenario' the input of new water is not material to the storage or subsequent flows from the TSF so flows from the TSF may be assumed to be fully worked.

In the wet scenario we calculate the percentage of worked and new water inflows to the TSF (which is also considered a mixed store) as the rainfall inflow becomes material (see **Table 24**).

TABLE 24. CASE STUDY: COAL MINE – TSF INFLOWS

WATER TYPE	SOURCE	FLOW (ML/YEAR)
New	Rainfall	1,080
Worked	TSF	2,609
Total		**3,689**
% Worked Water in Store		**71%**

Mixed Store

With this change in the TSF water flows, the split of new and worked water from **Table 24** in the wet scenario is added to the calculation for the mixed water store (See **Table 25**).

TABLE 25. CASE STUDY: COAL MINE – MIXED WATER STORE INFLOWS

DRY

WATER TYPE	SOURCE	FLOW (ML/YEAR)
New	Rainfall	6
	Runoff - Undisturbed	2
	Runoff - Disturbed	29
	TSF	-
	New (Raw) Water Store	300
Subtotal New		**337**
Worked	TSF	1,860
Subtotal Worked		**1,860**
Total		**2,197**
% Worked Water in Store		**85%**

WET

WATER TYPE	SOURCE	FLOW (ML/YEAR)
New	Rainfall	216
	Runoff - Undisturbed	61
	Runoff - Disturbed	1,026
	TSF	545
	New (Raw) Water Store	300
Subtotal New		**2,148**
Worked	TSF	1,315
Subtotal Worked		**1,315**
Total		**3,463**
% Worked Water in Store		**38%**

With the proportion of the new and worked water in stores known, the proportion of new and worked water used in tasks is calculated (**Table 26** and **Table 27**) which can be compared (**Table 28**).

TABLE 26. CASE STUDY: COAL MINE – TASK WATER FLOWS – DRY

TASKS	SOURCE	FLOW (ML/YEAR)	WATER TYPE (ML/YEAR)		
			New	Worked	Treated Worked
UG Coal Mine	New Water Store	70	70	-	-
Dust Suppression	Mixed Water Store (85% Worked)	648	97	551	-
CHPP	Water entrained in coal feed	442	442	-	-
	Mixed Water Store (85% Worked)	3,240	486	2,754	-
TSF	Rainfall	30	30	-	-
	CHPP to TSF	2,609	-	2,609	-
Totals		**10,532**	**2,005**	**8,527**	**-**
Totals (%)		**100%**	**19%**	**81%**	**-**

TABLE 27. CASE STUDY: COAL MINE – TASK WATER FLOWS – WET

TASKS	SOURCE	FLOW (ML/YEAR)	WATER TYPE (ML/YEAR)		
			New	Worked	Treated Worked
UG Coal Mine	New Water Store	70	70	-	-
Dust Suppression	Mixed Water Store (38% Worked)	648	402	246	-
CHPP	Water entrained in coal feed	442	442	-	-
	Mixed Water Store (38% Worked)	3,240	2,009	1,231	-
TSF	Rainfall	1,080	1,080	-	-
	CHPP to TSF	2,609	-	2,609	-
Totals		**8,089**	**4,003**	**4,086**	**-**
Totals (%)		**100%**	**19%**	**51%**	**-**

TABLE 28. CASE STUDY: COAL MINE – COMPARISON – OPERATIONAL EFFICIENCIES FOR WET AND DRY CASE

OPERATIONAL EFFICIENCIES	DRY	CASE STUDY 1	WET
Total volume to tasks (ML/year)	7,039	7,189	8,089
Total volume of reused water (ML/year)	5,914	5,642	4,086
Reuse Efficiency (%)	84%	78%	51%
Total volume of recycled water (ML/year)	-	-	-
Recycling Efficiency (%)	-	-	-
Total volume of re-used and recycled water (ML/year)	5,914	5,642	4,086
Operational Efficiency (%)	84%	78%	51%

The comparison demonstrates the impact of 'dry' and 'wet' conditions on operational efficiencies. In this case where there is no change in operational methodology a significant reduction in reuse efficiency is caused by the increase in new water (rainfall and runoff) entering the mine. This could be managed this by reducing other inputs (e.g. purchasing less water from town) or reducing the size of the facility's catchment with earthworks or diversions to minimise the water collected from runoff.

4.3 CASE STUDY 3 – Copper Gold Mine

This case study provides an example of a Copper Gold mine that has a material increase in water storage at the TSF that does not impact on its approvals or design stability.

The copper gold mine has a mature water management system that includes a hydrological model (providing simulated data for precipitation (rainfall and runoff), seepage and evaporation) and a water balance model (to collate the results of measurements, simulations and estimates).

The copper gold mine has an onsite dam that collects water from the river. Environmental water flows are required to maintain vegetation downstream of the dam. The underground mine has developed through an aquifer which releases water that is pumped to the mixed water store. Potable water is also obtained from a groundwater bore on the site.

The copper gold mine includes underground and open pit mining operations which both source water from the mixed water store. Processing plant demand is met from the mixed water store and as it contains thickeners it returns water directly to the mixed water store for reuse. TSF decant goes to the mixed water store. Water accumulates in the TSF over the accounting period but remains within its design capacity.

The effluent or waste water from the community is treated off-site while an onsite treatment plant treats waste water generated onsite. Water leaves the facility through evaporation, seepage, task loss and water entrained in the tailings.

4.3.1 Step 2 – Create WAF Representation

NOTE: The copper gold mine is able to move directly to Step 2 as all operational inputs and outputs are captured in their hydrological model.

Tasks

Tasks have been aggregated to the highest practical level and include:

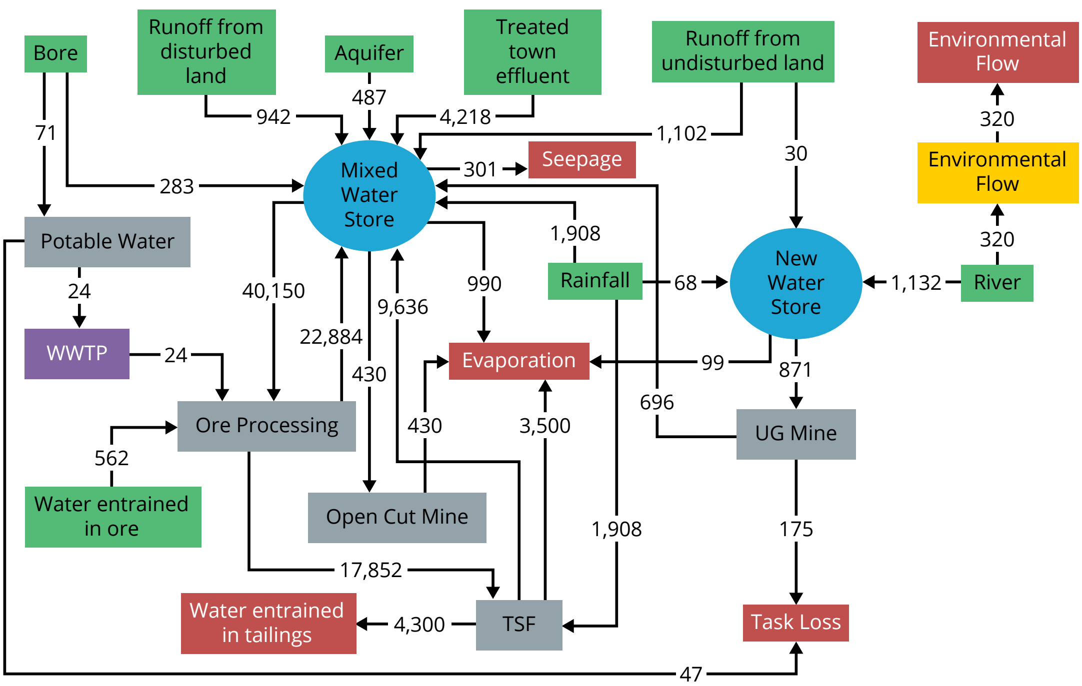
- Potable water use
- The ore processing plant – including thickeners
- Tailings storage facility
- Open cut mining
- Underground mining

Stores

The new water store is comprised of two grouped dams. The mixed water store is physically one pond. It receives the return water (worked water) from the TSF, the thickeners (inside the ore processing plant) and from the underground mining task. Stores collect rainfall and runoff.

The WAF representation is shown in **Figure 22**. The operational inputs of the site are green, the operational outputs of the site are red, OMW is yellow, tasks are grey, the stores are in blue and the treatment plant is in purple. The numbers are the flow volumes in ML measured over their standard annual accounting period.

FIGURE 22. CASE STUDY: COPPER GOLD – WAF REPRESENTATION WITH FLOWS



4.3.2 Step 3 – Data Collection

Measured data

Groundwater (from the bore), river water, aquifer interception and town effluent are metered flows with values shown in the water network diagram. River water is a surface water source. Bore water, aquifer interception and entrainment are classified as groundwater. Treated town effluent is third party water as it is purchased under contractual arrangements (treated offsite).

Results of water quality testing were obtained from the site environment team. Using the classification matrix (**Section 2.2.4**), a Category of 1, 2 or 3 is assigned to each input as shown in the data summary table.

HINT: Descriptions of Sources and Destinations may also be used assist to determine the quality of the water is not monitored (**Section 2.2.4** and **Figure 8**).

Modelled data

The site hydrological model provided the precipitation (rainfall) and runoff values shown in the WAF representation. Source water is surface water. Rainfall and runoff from undisturbed land is assigned as Category 1 water quality. Runoff from disturbed land is of poorer quality and assigned as Category 2.

An estimate for entrainment in the ore is used. While the mill throughput rate of 22.5Mt is known, the ore water content is estimated at 2.5%. **Calculation 2** is used to estimate the volume of entrained water as 562 ML.

The site hydrological models provide the values for seepage to groundwater (301 ML) and evaporation (4,302 ML).

Using water balances to address data gaps

The hydrological model is used to balance water around the site so task losses are known. Task loss from underground mining was 175 ML and task loss from potable water was 47 ML.

A metering fault meant the some of the data for the flow from the thickeners to the mixed water store was missing. This was resolved by utilising an internal water balance using other flows around the ore processing task.

Flows to the ore processing plant totalled 40,736 ML;

- 40,150 ML from the mixed water store
- 24 ML from the WTP
- 562 ML from water entrained in ore

Flow from the ore processing plant must also total 40,736 ML, 17,852 ML flows to the TSF with the balance to the mixed water store of 22,884 ML.

The increase in storage at the TSF (2,324 ML) is material in comparison to the total water stored (7,261 ML). Water entrained in tailings (4,300 ML) is estimated from knowledge of the TSF void structure and confirmed by checking the water balance for the task (including the change in storage).

An initial review of the water balance showed an imbalance and as a result the facility reviewed the water stored on site finding an additional 545 ML, adding 260 ML to the New Water Store and 285 ML to the Mixed Water Store closes the water balance

Other Managed Water

The environmental flow is actively managed by the operational facility. It is pumped from the river by the operations pumping station before discharged back to the environment. The water is not used in a task or stored on site for use in a task so it is classified as OMW. The total amount of water taken from the river is metered at 1,452 ML with 1,132 ML directed to the new water store and the remaining 320 ML used to sustain the environmental flow. These flows are classified as a water quality Category 1, measured with high confidence.

4.3.3 Step 4 – Reconcile the Water Balance

TABLE 29. CASE STUDY: COPPER GOLD – DATA COLLECTION SUMMARY

FLOW	SOURCE/ DESTINATION	SUB-CATEGORY	DESCRIPTION	QUANTITY (ML)	WATER QUALITY	QUANTIFICATION	CONFIDENCE
Operational Input	Surface Water	Rivers and Creeks	River	1,132	1	Measured	High
		Precipitation and Runoff	Rainfall - TSF	1,908	1	Simulated	Low
			Rainfall - New Water Store	68	1	Simulated	Low
			Rainfall - Mixed Water Store	1,908	1	Simulated	Low
			Runoff - disturbed	942	2	Simulated	Low
			Runoff - undisturbed (to New Water Store)	30	2	Simulated	Low
			Runoff - undisturbed (to Mixed Water Store)	1,102	1	Simulated	Low
	Groundwater	Entrainment	Water entrained in ore	562	3	Simulated	Low
		Aquifer Interception	Aquifer	487	2	Measured	High
		Bore Fields	Borefields to Potable Water	71	1	Measured	High
			Borefields to Water Store	283	1	Measured	High
	Third Party Water	Municipal	Treated Town Effluent	4,218	2	Measured	High
	Total			**12,711**			
Operational Output	Other	Entrainment	Water entrained in tailings	4,300	3	Estimated	Medium
		Task Loss	Task loss - UG Mine	175	2	Estimated	Medium
			Task loss - Potable Water	47	2	Estimated	Medium
		Evaporation	Evaporation from New Water Stores	99	1	Simulated	High
			Evaporation from Mixed Water Stores	990	2	Simulated	High
			Evaporation from TSF	3,500	2	Simulated	High
			Evaporation from Open Cut Mine	430	2	Simulated	High
	Groundwater	Seepage	Seepage from Mixed Water Store	301	2	Simulated	Medium
	Total			**9,842**			
Storage	**Change in Storage**			**2869**	**Check Balance**	-	**OK**
OMW - Input	Surface Water	Rivers and Creeks	Environmental Flows	320	1	Estimated	High
OMW - Output	Other	Water to maintain vegetation	Environmental Flows	320	1	Estimated	High
OMW Storage	**Change in Storage**			-	**Check Balance**	-	**OK**
Internal		New Water Store to UG Mine		871			
		UG Mine to Mixed Water Store		696			
		Mixed Water Store to OC Mine		430			
		Mixed Water Store to Processing		40,150			
		Potable Water to WWTP		24			
		WWTP to Ore Processing		24			
		Ore Processing to Mixed Water Store		22,884			
		Ore Processing to TSF		17,852			
		TSF to Mixed Water Store		9,636			

4.3.4 Step 5 and 6 – Input-Output Statement with Disclosure Notes

TABLE 30. CASE STUDY: COPPER GOLD – INPUT-OUTPUT STATEMENT

FLOW	SOURCE / DESTINATION	SUB-CATEGORY	VOLUME OF WATER BY QUALITY (ML)			TOTAL VOLUME (ML)	QUANTIFICATION AND CONFIDENCE	NOTES
			CAT 1	CAT 2	CAT 3			
Operational Inputs	Surface Water	Precipitation and Runoff	5,016	942	-	5,958	Simulated, Low	1
		Rivers and Creeks	1,132	-	-	1,132	Measured, High	2
	Groundwater	Aquifer Interception	-	487	-	487	Measured, High	2
		Bore Fields	354	-	-	354	Measured, High	2
		Entrainment	-	-	562	562	Estimated, Low	3
	Sea Water		-	-	-	-		
	Third Party Water	Contract/Municipal	-	-	-	-		
		Waste Water	-	4,218	-	4,218	Measured, High	2
	Total Operational Inputs		**6,502**	**5,647**	**562**	**12,711**		
Operational Outputs	Surface Water		-	-	-	-		
	Groundwater	Seepage	-	301	-	301	Simulated, Medium	1
	Sea Water		-	-	-	-		
	Supply to Third Party		-	-	-	-		
	Other	Evaporation	99	4,920	-	5,019	Simulated, High	1
		Entrainment	-	-	4,300	4,300	Estimated, Medium	4
		Other (define)	-	222	-	222	Estimated, Medium	5
	Total Operational Outputs		**99**	**5,443**	**4,300**	**9,842**		
Storage	**Change in Storage**					**-1,952**		
OMW Inputs	Surface Water	Environmental Flows	320	-	-	320		6
	Total OMW Inputs		**320**	**-**	**-**	**320**		
OMW Outputs	Other	Water to Maintain Vegetation	320	-	-	320		6
	Total OMW Outputs		**320**	**-**	**-**	**320**		
OMW Storage	**Change in OMW Storage**					**-**		

1. Simulated using a hydrological model. Assumed precipitation (rainfall) incident on process water pond and tailing split was 50:50 because missing surface areas. Low confidence in simulation
2. Metered flows
3. Estimated the moisture content. The throughput was known
4. The tailings entrainment was an estimated value from knowledge of the void volume of the tailings dam. The tailings dam is accumulating water
5. A water balance model provided an estimate for task loss
6. The OMW flow was unmetered but was found through a water balance

4.3.5 Step 7 – Accuracy Statement

Table 31 shows the Accuracy Statement for the site.

The difference between the copper gold mine Accuracy Statement (**Table 31**) and the coal mine Accuracy Statement (**Table 17**) is that half the flows by volume were simulated resulting in higher confidence and accuracy of the flows.

TABLE 31. CASE STUDY: COPPER GOLD – ACCURACY STATEMENT

	CONFIDENCE LEVEL – VOLUME (ML/YEAR)			TOTAL
	High	Medium	Low	
Measured	6,191	-	-	6,191
Estimated	640	4,522	562	5,724
Simulated	5,019	301	5,958	11,278
TOTAL	**11,850**	**4,823**	**6,520**	**23,193**

	% OF ALL FLOWS	CONFIDENCE LEVEL – PERCENTAGE		
		High	Medium	Low
Measured	27%	27%	-	-
Estimated	25%	3%	19%	2%
Simulated	49%	22%	1%	26%
TOTAL	**100%**	**51%**	**21%**	**28%**

4.3.6 Step 8 – Statement of Operational Efficiencies

To complete the Statement of Operational Efficiencies determine the percentage of worked or treated water in mixed water stores by tabulating the flows. Remember to consider the TSF as a mixed store if there are material operational inputs or new water inflows as shown in **Table 32**.

TABLE 32. CASE STUDY: COPPER GOLD – MIXED WATER STORE INFLOWS

TSF

WATER TYPE	SOURCE	FLOW (ML/YEAR)
New	Rainfall	1,908
Worked	Processing	17,852
Total		**19,760**
% Worked Water in TSF		**90%**

Mixed Water Store

WATER TYPE	SOURCE	FLOW (ML/YEAR)
New	Rainfall	1,908
	Runoff - Undisturbed	1,102
	Runoff - Disturbed	942
	Bore	283
	Aquifer	487
	Treated Town Effluent	4,218
	TSF	930
Subtotal New		**9,870**
Worked	Ore Processing	22,884
	TSF	8,706
	UG Mine	696
Subtotal Worked		**32,286**
Total		**42,156**
% Worked Water in Mixed Water Store		**77%**

Tabulate the inflows to all tasks shown in **Figure 22** and include the percentage of new and worked water for flows from both the TSF and the mixed water store to determine the reuse and recycling efficiencies as shown in **Table 33**.

Note that recycled water is worked water from the potable water task treated by the waste water treatment plant (24 ML). Effluent water does not count as recycled water as the treatment plant is off-site (classed as third party water in Step 1). The completed statement of operational efficiencies is shown in **Table 34**.

TABLE 33. CASE STUDY: COPPER GOLD – TABULATION OF TASKS INFLOWS FOR OPERATIONAL EFFICIENCIES

TASKS	SOURCE	FLOW (ML/YEAR)	WATER TYPE (ML/YEAR)		
			New	Worked	Treated Worked
Potable Water	Bore	71	71	-	-
Ore Processing	WWTP	24	-	-	24
	Mixed Water Store (77% worked)	40,150	9,235	30,915	-
	Water entrained in ore	562	562	-	-
Open Cut Mine	Mixed Water Store (77% worked)	430	99	331	-
UG Mine	New Water Store	871	871	-	-
TSF	Rainfall	1,908	1,908	-	-
	Ore Processing	17,852	-	17,852	-
Totals		**61,868**	**12,745**	**49,098**	**24**
Totals (%)		**100%**	**21%**	**79%**	**0.04%**

TABLE 34. CASE STUDY: COPPER GOLD – STATEMENT OF OPERATIONAL EFFICIENCIES

OPERATIONAL EFFICIENCIES	
Total volume to tasks (ML/year)	61,868
Total volume of reused water (ML/year)	49,098
Reuse Efficiency (%)	79.36%
Total volume of recycled water (ML/year)	24
Recycling Efficiency (%)	0.04%
Total volume of reused and recycled water (ML/year)	49,123
Operational Efficiency (%)	79.4%

5 REVIEW AND CONTINUAL IMPROVEMENT

The WAF can be used as a tool to support regular review, benchmarking and continual improvement in water management performance. Consistent, comparable data on operational use and broader water management, enables users of the WAF to identify data gaps and uncertainties, benchmark between operations and track performance over time.

Information provided in the WAF can be used to identify opportunities to:

- Address data gaps and target additional data collection or monitoring to improve accuracy or to reduce uncertainty and inform decision-making
- Improve operational efficiencies through greater reuse and recycling of water, for example by:
  - Identifying tasks with high water demands with opportunities to enhance water capture and recirculation
  - Identifying opportunities to enhance reuse and recycling between tasks to reduce dependence on external water sources
- Reduce task losses and evaporation
- Reduce dependencies on high value water or water sources
- Reduce lower water quality outputs
- Improve management and beneficial (circular) use of other managed water
- Inform and improve the management of water related risks over time
- Inform catchment-based water management by improved understanding of whole of sector water and influence

6 USING THE WAF IN FACILITY AND CORPORATE REPORTING – EXAMPLES

The standardised format allows for aggregation of facility data to in a variety of ways. For example, facility data may be aggregated by entity to inform corporate reporting; or aggregated spatially to inform regional, asset or catchment based management or reporting. The examples below illustrate application of the WAF noting that they use terminology prior to this update.

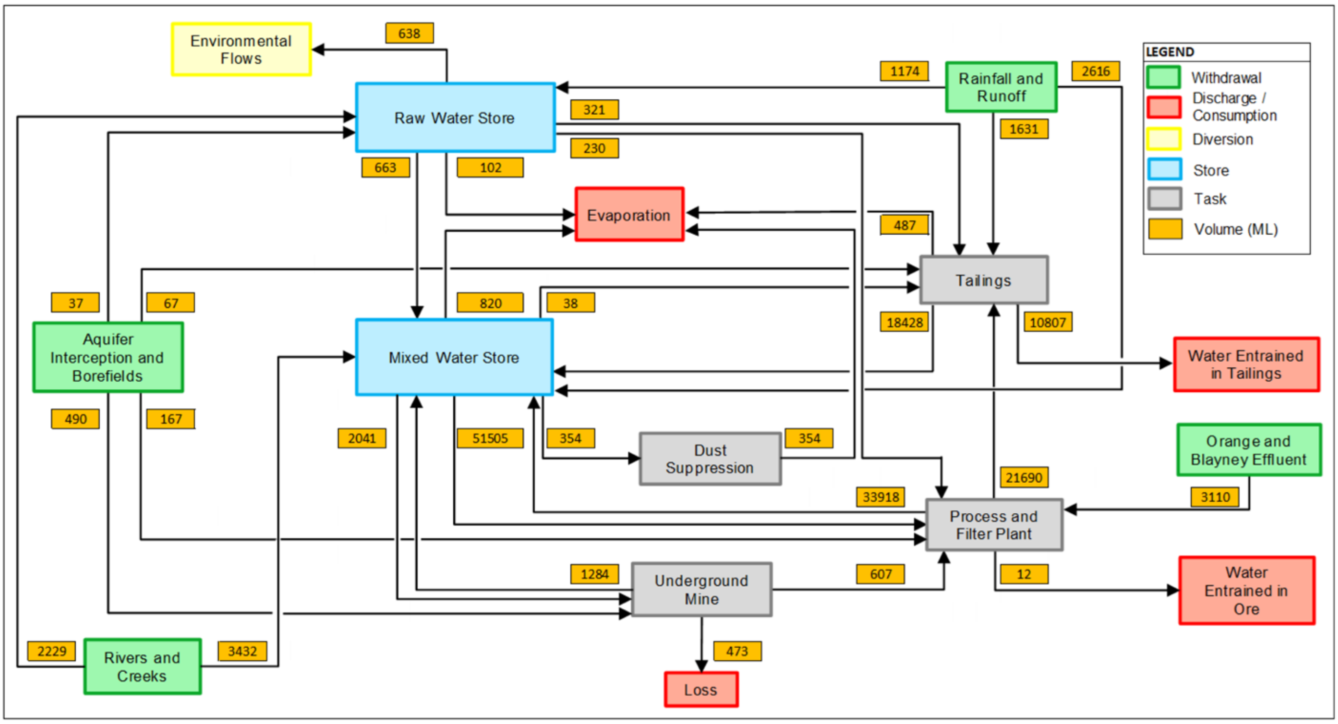
6.1.1 Site WAF Report

Newcrest's Cadia operation publishes their site water balance using the WAF as part of their Annual Environmental Management Report and is accessible to their community, stakeholders and government. The standardised format also allows for integration into company reporting metrics presented in the Newcrest Group annual report.

Cadia represents their water network utilising the WAF representation as shown in **Figure 23**. This clearly shows the operational inputs and operational outputs from the facility and demonstrates their task aggregation and grouping of stores.

Cadia also publishes its Input-Output Statement (**Table 35**), Accuracy Statement (**Table 36**) and Statement of Operational Efficiencies (**Table 37**) and uses this information and the underlying data to identify and implement measures to minimise water use.

FIGURE 23. CADIA WATER SYSTEM MCA WAF REPRESENTATION[17]



[17] Newcrest Mining, *Cadia Valley Operations - Annual Environmental Management Report 2019/20*, Melbourne, 2020

TABLE 35. CADIA WATER BALANCE INPUT-OUTPUT STATEMENT

Operational Efficiencies	ML	Notes
Total inputs	14,314	1
Total outputs	13,056	2
Inputs minus outputs	1,158	-
Measured change in storage	-480 ML	2
Imbalance percentage	6.4%	3
Does "Inputs minus Outputs" equal "Change in Storage"?	Yes	4
Notes: 1 – Modelled using calibrated GoldSim water balance model. 2 - Includes storage in dams, decant ponds and estimates for minor storages; 3 – Proportion of imbalance relative to total throughput. 4 – within acceptable limit of 10%		

TABLE 36. CADIA WATER BALANCE ACCURACY

Types of Flows	Percent of all flows	Confidence High	Medium	Low
Measured	25%	25%	0%	0%
Estimated	4%	1%	4%	0%
Simulated	70%	0%	64%	6%
Total	100%	26%	68%	6%

TABLE 37. CADIA STATEMENT OF OPERATIONAL EFFICIENCIES

Operational Efficiencies	ML	Notes
Total water into tasks	82,252	1
Volume of worked water into tasks (water reused)	70,455	-
Reuse efficiency (%)	85.7%	1
Consumptive use	13,055	2
Use per tonne milled (L/T)	436	-
1 - Task aggregation according to Case Study 2 in the MCA WAF. 2 – represents the sum of all system losses including tailings entrainment, evaporation and other minor losses.		

6.1.2 Corporate WAF Implementation and Reporting

Rio Tinto has utilised the WAF since its initial development across regions and countries to create aggregated group balances. They presented the information visually as shown in **Figure 24** and included key notes and comparisons to previous the previous year in their online water performance reporting.[18]

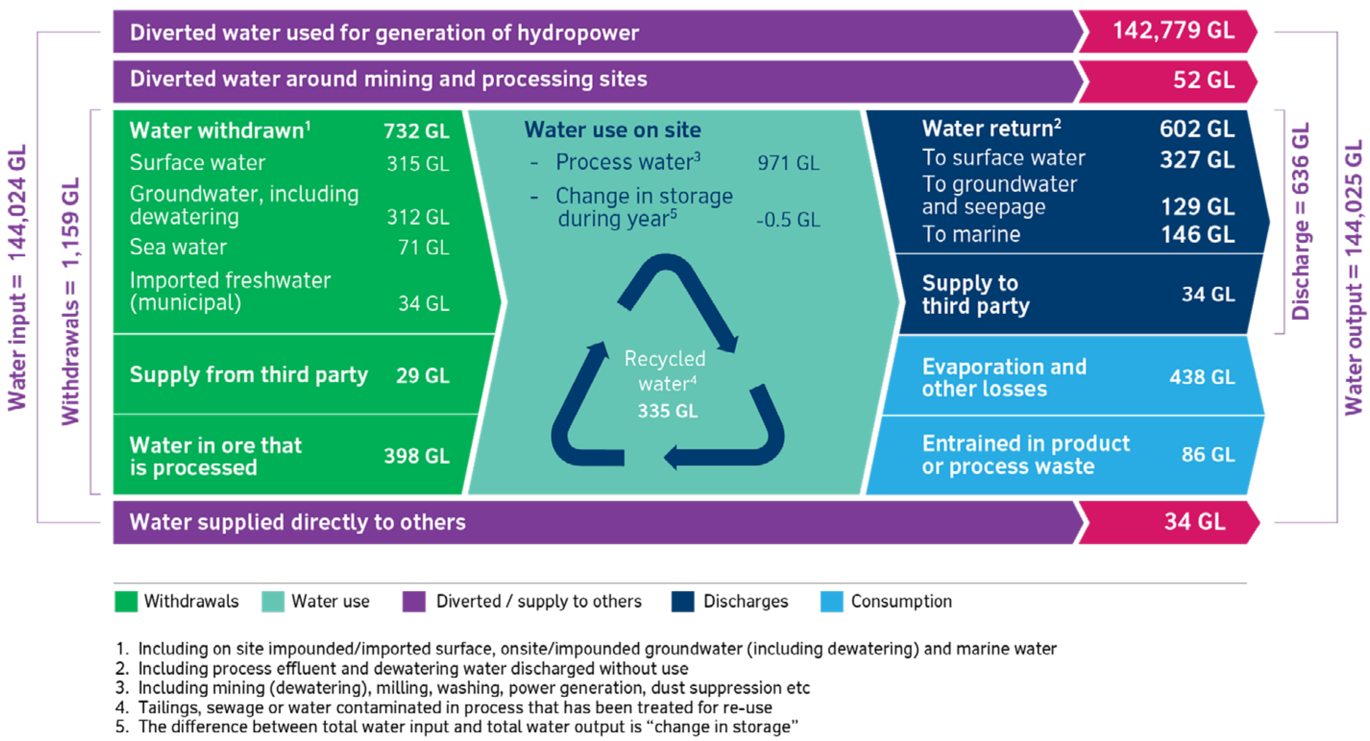
Yancoal has implemented a WAF consistent approach across all operations. Benchmarking of all sites against the MCA WAF has provided a consistent and measurable starting point for the staged improvement in water accounting across Yancoal's operations (see **Table 38**).

Key to implementation at Yancoal has been the development of individual water asset registers. These registers, along with the standardised approach to water accounting, allowed consistent analysis of water assets to enable effective participation in water markets. The site water asset registers have allowed Yancoal to evaluate and support internal water trades (sharing) to improve water security and supply.

Disclosure of water performance in line with the WAF gas enable Yancoal to benchmark and further improve water performance. For example, comparison between 2020 and 2019 shows an overall increase in water input across sites which was explained as a direct result of increased rainfall as drought conditions eased and the associated increase in surface water. This meant water abstraction and water recycling reduced, as less sites required ground and recycled water for operational purposes (such as dust suppression) and increases in storage volumes across sites in comparison to 2019.

External company reporting needs careful attention to ensure that there is no double counting particularly when there are internal water trades or transfers between individual sites. Internal transfers of water between sites should not be included in company metrics, aggregate remaining flows to identify the operational inputs, operational outputs and OMW for the company. Detailed examples are available in Appendix D of the *ICMM Water Reporting: Good Practice Guide 2nd Edition.*

FIGURE 24. RIO TINTO AGGREGATED GROUP WATER BALANCE



[18] Rio Tinto, *Water 2020 Performance*, Melbourne 2020

TABLE 38. YANCOAL WATER BALANCE DATA[19]

WATER BALANCE DATA [14]

WATER BALANCE (ML)	2020	2019
WATER WITHDRAWN (BY SOURCE)		
Surface Water[15]	20,609	8,254
Groundwater[16]	13,967	16,286
Imported freshwater (contract/municipal)	193	278
Transferred from other mines	684	1,113
Water in ore that is processed[17]	1,772	2,477
Water input (total)	**45,894**	**39,229**
WATER USE ON SITE		
Production water[18]	10,559	8,481
Recycled water[19]	8,670	10,821
Change in storage during the year[20]	**10,668**	**3,685**
WATER RETURN (BY SOURCE)		
To surface water[21]	5,674	4,725
To groundwater through seepage	0	25
Evaporation[22]	5,492	5,073
Entrained in product of process waste	7,778	9,737
Supply to third party	5,724	7,504
Water output (total)	**35,226**	**35,544**

14 In 2020, we updated our reporting boundary for water to include Cameby Downs and Premier. We have restated our 2019 datasets to reflect this change.
15 Includes precipitation and runoff as well as licenced water accessed from rivers and creeks.
16 Includes interception, bore fields, diversion seepage and first flush capture.
17 Includes groundwater entrainment.
18 Includes dust suppression and industrial uses such as underground demand, coal handling and preparation plant (CHPP) demand and vehicle wash-down.
19 Reticulation of stored mine water, including tailings or mine water that is contaminated in process that is recycled and reused on site.
20 The difference between total water input and total water output is “change in storage”.
21 Licenced discharges from sites and irrigation undertaken in accordance with relevant statutory requirements and government policies.
22 Includes irrigation.

19 Yancoal, *ESG Report 2020*, Sydney 2020

6.1.3 Regional/Catchment Based Water Disclosure

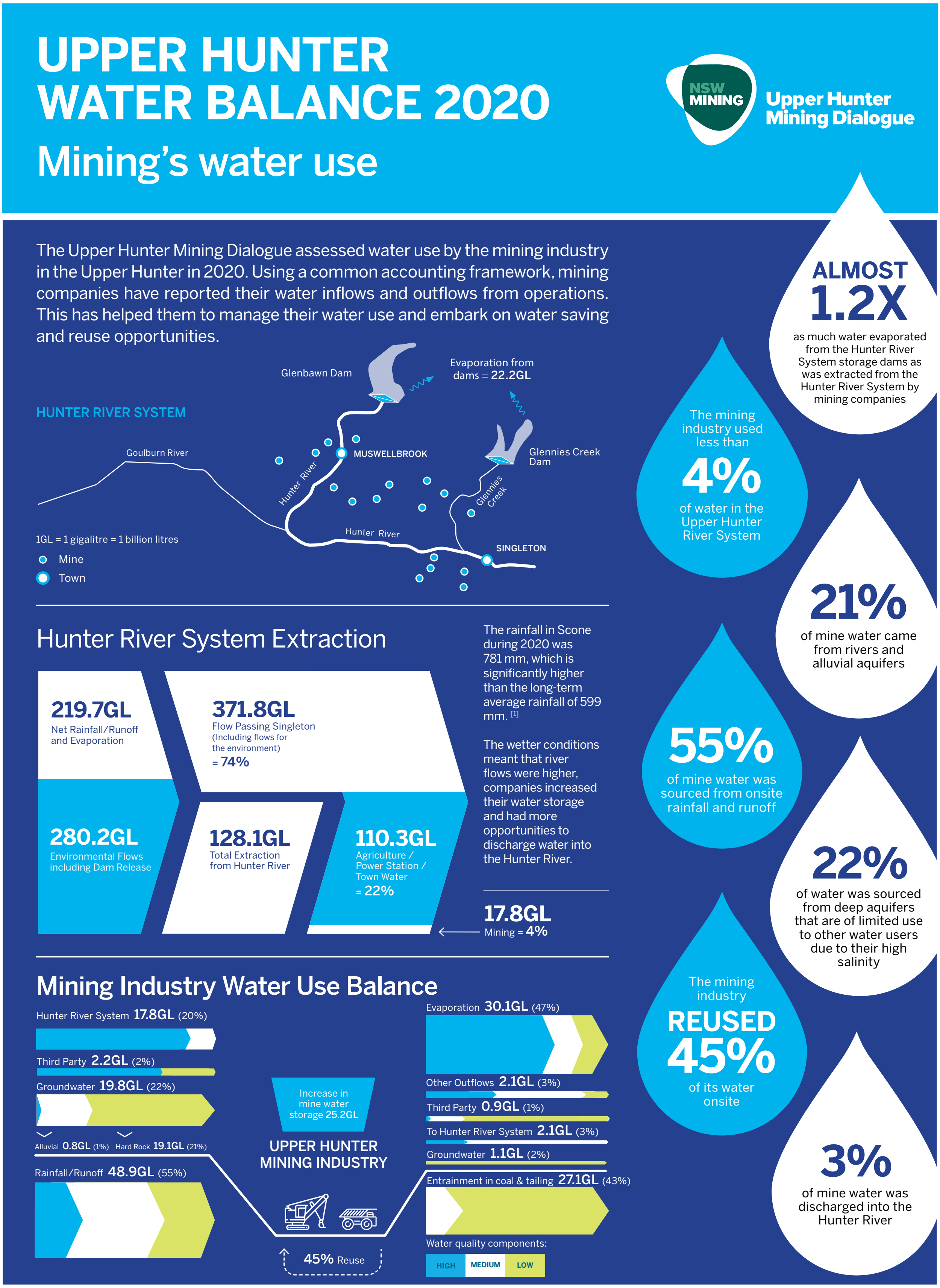
The Upper Hunter Mining Dialogue is a collaborative forum that brings together local coal producers, community and business leaders, regulators, environmental groups and other industries to work together to address concerns and support community priorities.

The mining companies that participate in the Dialogue implemented the WAF in 2014. The standardised approach is used to consolidate the water account information from more than a dozen mines in the region on an annual basis. **Figure 25** shows the consolidated regional water account, supported by analysis of the broader Hunter River System inflows, extraction and rainfall data.

'The implementation of the WAF has given mining operations insights into opportunities to improve onsite water management. The regional consolidation of data has helped improve communication about mine water management practices and provide better context regarding mining's water use relative to overall flows and water use in the region.'

Craig Milton, Policy Manager, NSW Minerals Council

FIGURE 25. INDUSTRY AND CATCHMENT DATA AGGREGATED FOR THE HUNTER RIVER SYSTEM[20]



[20] NSW Minerals Council, *Upper Hunter Mining Dialogue, 2020 Water Use Results*, Sydney, 2020

7 REPORTING UNDER OTHER FRAMEWORKS

The WAF provides consistent definitions for metrics that allows a facility or company to report from the framework to others with minimal clarifications or changes.

7.1.1 Global Reporting Initiative[21]

GRI:303 Water and Effluents 2018 is part of the GRI Sustainability Reporting Standards designed for organisations to report about their impacts on the economy, the environment and society. The WAF links to the topic-specific disclosures as shown in **Table 39**.

GRI also requires any change in the volume of water stored that has a significant water-related impact to be included. This can also be derived from WAF statements. The contextual statement may also be used to meet the required management approach disclosures.

7.1.1.1 Additional Requirements

While some of Disclosure 303-1 will be covered within the contextual statement of the WAF the reporting requirements also include descriptions for the approach to identify water-related impacts and how they are addressed with stakeholders and an explanation of the process for setting water-related goals and targets.

Disclosure 303-2 is the description of how the site manages any treated or untreated discharge including the minimum standards for discharge and how they were determined.

The operational facility also need to determine the inputs and outputs that occur within a catchment under water stress. The assessment of catchment water stress should be determined using publicly available and credible tools.

TABLE 39. WAF LINKS TO GRI METRICS

WAF METRIC	DEFINITION		GRI METRIC
Operational Inputs	Water that enters the operational facility for use in a task		Allocate to Water withdrawal by category
OMW Inputs	What that is actively managed (e.g. physically pumped, treated or has material evaporative losses) by the facility without being used in a task.		Allocate to Water withdrawal by category
Operational Outputs	Water that is removed (discharged, consumed, used or lost) from the Operational Facility after it has been used for a task	Surface Water, Groundwater*, Sea water, Third Party Water	Allocate to Water Discharge by category
		Other	Allocate to Water Consumption
OMW Outputs	Water that is removed after being actively managed (e.g. physically pumped, treated or has material evaporative losses) by the facility without being used or tasked	Surface Water, Groundwater*, Sea water, Third Party Water	Allocate to Water Discharge by category
		Other	Allocate to Water Consumption
Water Quality	High quality water requiring minimal treatment to meet drinking standards	Category 1	Freshwater
	Medium quality water requiring moderate treatment	Category 2	Other water†
	Low quality water requiring significant treatment	Category 3	

* The WAF does not use the GRI metric for produced water, water entrained in ore and water entrained in product is reported under groundwater (not as produced water), this should be appropriately disclosed where applicable (e.g. oil and gas users of the WAF)

† WAF water quality classification includes broader criteria than GRI which is based on Total Dissolved Solids only. Where this occurs, the use of the WAF methodology should be appropriately disclosed.

[21] Global Reporting Initiative, *GRI 303: Water and Effluents 2018*, 2018

7.1.2 ICMM Water Reporting Metrics

ICMM has developed guidance supported with minimum reporting commitments to support the industry in making consistent, transparent and material water reports, based on key elements of existing disclosure and accounting systems, including direct alignment with the WAF. ICMM minimum disclosure requires the reporting volume of water by quality in regards to the sources and destinations of operational inputs and outputs supported with total OMW and consumption.

A detailed mapping between the ICMM guidance, WAF and other major water reporting/ accounting systems is provided in ICMM[22]. Each of the WAF reports and content directly aligns with the ICMM reporting metrics as shown in **Table 40**.

7.1.2.1 Additional Requirements

ICMM requires the full reporting of metrics for sites in water stressed areas (including Operating water withdrawals, OMW withdrawals, total discharge and total consumption) to align with GRI (and provide context for reuse/recycle metrics. The minimum reporting requirements also require a summary of water risks and opportunity and an associated commitment and response to water issues for the site, catchment and stakeholders.

TABLE 40. WAF LINKS TO ICMM METRICS

WAF METRIC	DEFINITION		ICMM METRIC
Operational Inputs	Water that enters the operational facility for use in a task		Operational Water Withdrawal
OMW Inputs	What that is actively managed (e.g. physically pumped, treated or has material evaporative losses) by the facility without being used in a task.		OMW Withdrawal
Operational Outputs	Water that is removed (discharged, consumed, used or lost) from the Operational Facility after it has been used for a task	Surface Water, Groundwater, Sea water, Third Party Water	Allocate to **Total Discharge**
		Other	Allocate to **Total Consumption**
OMW Outputs	Water that is removed after being actively managed (e.g. physically pumped, treated or has material evaporative losses) by the facility without being used or tasked	Surface Water, Groundwater, Sea water, Third Party Water	Allocate to **Total Discharge**
		Other	Allocate to **Total Consumption**
Water Quality	High quality water requiring minimal treatment to meet drinking standards	Category 1	High Quality
	Medium quality water requiring moderate treatment	Category 2	
	Low quality water requiring significant treatment	Category 3	Low Quality

[22] ICMM, *Water Reporting: Good Practice Guide 2nd Edition*, London, 2021

7.1.3 Australian Water Accounting Standards

In 2010 the Water Accounting Standards Board developed the Australian Water Accounting Standards Board (AWAS 1)[23]. The purpose of the Australian Water Accounting Standards (AWAS 1) is for companies and regions to provide information on the allocations, entitlements and trading of water between regions as well as actual use.

A water accounting report prepared to the Australian Water Accounting Standards 1 should contain:

1. A contextual statement
2. An accountability statement
3. Statement of water assets and liabilities
4. Statement of changes in water assets and water liabilities
5. Statement of physical flows
6. Notes disclosures
7. Assurance statement

The 2014 release of AWAS 2[24] dealt with assurance engagements to report on the water accounting statements, note disclosures and the accountability statement. Australian mine sites should ensure their assurance practices comply with AWAS 2.

The concept of materiality of flows, the contextual statement and notes disclosures in the Australian Water Accounting Standards, was incorporated into the WAF. The alignment between the WAF and the AWAS is closest in the Statement of Physical Flows in that the operational facility can simply reproduce the Input-Output statement of the WAF to satisfy requirements of AWAS 1.

7.1.3.1 Additional Requirements

AWAS 1 also requires reporting of contractual requirements. Transactions and events are reported in the period when the decisions or commitments are made, not when they actually happen. They are recorded in the Statement of Water Assets and Liabilities and the Statement of Changes in Water Assets and Water Liabilities in the reporting period.

The Future Prospects section of the AWAS 1 aims any impact on future volumes of water to be acquired or committed within 12 months of the reporting date including future estimates of rainfall and runoff. For a mine site this will require running a calibrated surface hydrology model to estimate future runoff into new and mixed water stores under 'Dry', 'Wet' and 'Median' conditions.

Notes disclosures should include extra detail to explain Future Prospects, Contingent Water Assets and Liabilities, why any items under the control of the operational facility failed to meet a water asset or liability status and also disclosures on water market activity within its catchment.

[23] Water Accounting Standards Board, *Australian Water Accounting Standard 1 - Preparation and Presentation of General Purpose Water Accounting Reports*, Canberra, 2010

[24] Water Accounting Standards Board, *Standard on Assurance Engagements ASAE 3610 and Australian Water Accounting Standard AWAS 2*, Canberra, 2014

MCA
Level 3, 44 Sydney Avenue
Forrest ACT 2603
P: +61 2 6233 0600
minerals.org.au