

A Water Accounting Framework for the Minerals Industry

Minerals Council of Australia

Summary of February 2009

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A Document to Facilitate Discussion and Seek Endorsement from the SD Committee

The minerals industry water accounting framework is founded in a concept model that relates a site's water use interactions with the surrounding environment and community (Figure 1; DRET 2008). The concept model at this level is comprised of four functional elements:

- (1) Input, representing the receipt of water to the lease for operational use;
- (2) Divert, moving water around or through the lease so that it does not become part of the operation;
- (3) Use-treat-store cycle, representing the operational cycle of the site and including the majority of operational tasks associated with minimising losses, managing climate variability and implementing efficient technologies and processes; and
- (4) Output, representing the removal of water from the lease.

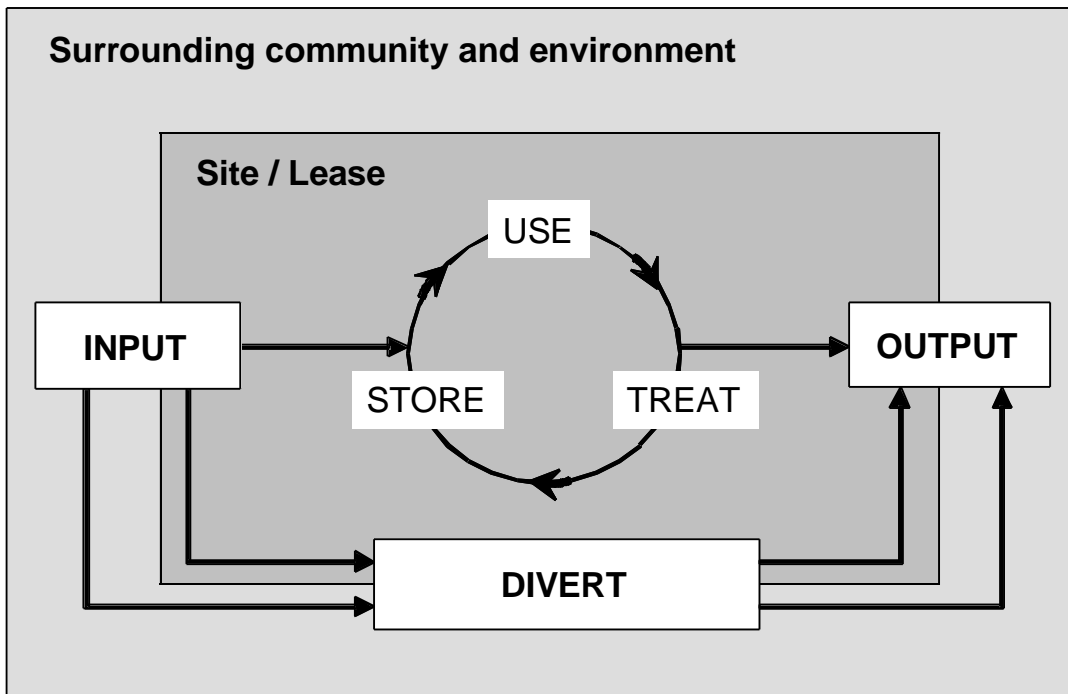


Figure 1. Proposed water system concept model for accounting purposes (DRET 2008)

The concept model needs some moulding to fit into a water accounting framework.

There are two key areas requiring attention for water accounting purposes:

1. The intersection of the site with the surrounding landscape; and
2. Activities and uses of water internal to the operation.

The intersection of the site with the surrounding landscape describes how minerals operations interact with the surrounding environment, community and other stakeholders. This addresses common questions of 'where does the water come from', 'how much water comes from where', 'what quality of water leaves the site' and 'where does the water go'?

Activities and uses of water within the operation describe the typical actions that water is subjected to whilst in control of the minerals operation. This includes activities such as operational tasks (e.g. dewatering ore bodies, processing ore), water quality

treatment (e.g. cyanide destruction, physical settling), and storing of water (i.e. usually for operational tasks or influencing water quality).

The accounting framework is being developed to provide a consistent language and metrics for quantifying and communicating water use in each of these two areas. As a transition to building an accounting framework that integrates these elements it is proposed to label 'the intersection of the site with the surrounding landscape' as the '**Input-Output Model**', and to label the 'Activities and uses of water internal to the operation' as the '**Operational Model**'. Diversions will be common to both models. The combination of these models will be the '**Minerals Industry Water Accounting Framework**'¹.

The Input-Output Model

The **Input-Output Model** will enable the consistent presentation of accounts in the following format displayed in the two tables...

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¹ The framework is simply an approach for consistent communication, it does not provide tools to generate accounts. Such tools are external to the framework.

Inputs (H = High Quality, L = Low Quality)	Vol Received (ML)	Outputs (H = High Quality, L = Low Quality)	Vol Provided (ML)
Surface Water	a+b+c	Surface Water	m+n+o
Direct Precipitation (H)	a	Belubula River (H)	m
Belubula River ¹ (H)	b	Some Creek ³ (L)	n {l&k?}
Captured Runoff (H)	c	Some Creek (H)	o
Groundwater	d+e	Groundwater	p
The Namoi Aquifer ² (H)	d	Aquifer reinjection project	p
The Old Underground Workings which have a quality that makes them not fit for any other purpose (L)	e	{seepage?}	
Sea water	f+g+h	Sea water	q
Escondida desal plant (L)	f	Saline water discharge (L)	q
Inner reef Gladstone (L)	g		
Darwin estuary (L)	h		
Third Party Supply	i+j	Third Party Supply	r
Orange City Council (L)	i	Local agricultural enterprise (H)	r
Royal Canberra Golf Course (L)	j		
		Entrainment	
		Entrainment Product [/ Waste]	s
		Evaporation	
		TSF 1	t
		Seepage	
		TSF 1	u
Diversions	k+l		
Dolphinback Dewatering (L)	k		k
McHenry River Diversion and Run-off (H)	l		l

1. Natural resources dept. Surface water licenses AbD312 and ASD345
2. Natural resources dept. Groundwater license XgH234
3. Environmental protection discharge license DECC23421

Generic summary account across water quality categories for a reporting period:

Inputs		Outputs	
Surface Water	a+b+c	Surface Water	m+n+o
Groundwater	d+e	Groundwater	p
Sea Water	f+g+h	Sea Water	q
Third Party Supply	i+j	Third Party Supply	r
		Known Losses	s+t+u
		Diversions	k+l
Theoretical Storage At End Reporting Time (assets)	$z = (a+b+c+d+e+f+g+h+i+j) - (m+n+o+p+q+r+s+t+u)$		
Actual Storage At End Reporting Time	y = measured volume (z – unknown losses)		
'Nett Water Use'	known losses + unknown losses		
'Minerals Value-added Use'	consumptive use + diversions		

Note: each entry category could be split into high and low quality based on 'fit for purpose' local categorisation.

To adopt the **Input-Output Model** as an industry standard, consensus is required on the following definitions:

- An '**Input**' is a volume of water of either high or low quality, which is received by the *operational facility*, or has become available from within the *operational facility* [in the case of groundwater which was present before operations began, and has been subsequently accessed].
- The '**Operational Facility**' is defined locally by the operation (or reporting / accounting entity) based on consultation with stakeholders. It can include the total mining lease, or a smaller defined operational area. It must be spatially explicit, readily communicated, and sensible.
- *Inputs* can be summarised / aggregated by their *sources* or reported as a *diversion*.
- '**Sources**' are the primary accounting description for inputs, they are described by the point of water extraction, and include:
 - '**Surface Water**': all water naturally open to the atmosphere, except for water from oceans, seas and estuaries.
 - '**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. For accounting purposes, *entrainment*, can be documented under the groundwater source.
 - '**Sea Water**': water from oceans, seas and estuaries.

- **'Third-party Supply'**: water supplied by an entity external to the operational facility, usually through a commercial arrangement with specific infrastructure for water delivery.
- Examples of *Surface water* include:
 - water extracted from natural water bodies such as rivers, lakes, reservoirs, ponds, streams, which is unregulated and un-supplemented;
 - rainfall and runoff collected from within the site, which is regulated or supplemented;
 - precipitation which is captured directly by water storage facilities; and
 - runoff collected from outside the site, which is regulated or supplemented.
- **'Diversions'** include water that is diverted away from extraction operations, and not used for any other operational purpose within the *operational facility*. It is water which is actively managed by the minerals operation, but is not used in a traditional 'consumptive' sense. Some handling losses can be incurred before the water is transferred to areas external to the *operational facility*.
- Examples of *Diversions* include:
 - creek diversions,
 - runoff diversions; and
 - aquifer dewatering with either subsequent groundwater reinjection or transferral to surface water external to the *operational facility*.
- An **'Output'** is a volume of water of either high or low quality, which is removed from the *accounting arena*.
- **'Destinations'** are the primary accounting description for outputs, they are generally described by the point of water receipt outside the *accounting arena*, and include:
 - **Surface Water**: all water naturally open to the atmosphere, except for water from oceans, sea and estuaries.
 - **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.
 - **Sea Water**: water from oceans, seas and estuaries.
 - **Third-party Supply**: water supplied to an entity external to the site, usually through a commercial arrangement.
 - **Evaporation**: water released to the atmosphere during storage, handling or application.
 - **Entrainment**: water removed from the operational facility contained within product or waste streams.
 - **Seepage**: water removed from the operational facility, usually to groundwater, beneath storage or handling facilities.
- **'Unknown Losses'** represent losses that cannot readily be accounted for or measured (e.g. losses from a processing plant that cannot be attributed to any particular physical process).
- Examples of *Outputs to the Surface Water Destination* include²:
 - Traditional 'discharges' to surface waters; and
 - Environmental flows specifically provided by the operations.
- Examples of *Outputs to the Groundwater Destination* include³:

² Diversions could be reported here, but this needs to be discussed. At the moment, it is easier to keep them separate.

³ Seepage could be reported here.

- Aquifer reinjection; and
- Filling closed extractive operations outside of the accounting arena.
- Under each *Source* and *Destination* category, entries can be reported as being of '**High Quality (H)**' or '**Low Quality (L)**' water', based on their bio-physical characteristics that determine whether they are '*fit for purpose*' for alternative uses within the catchment (e.g. environmental values, or other user's production requirements).
- '**Fit for Purpose**' is defined locally by the operation based on consultation with stakeholders.
- How we define 'use' needs to be discussed, with two suggestions presented:
 - '**Nett Water Use**' is that volumetric component of outputs that cannot be recovered for use (i.e. the amount lost or whose quality is changed such that it is not fit for others to use); and
 - '**Minerals Value-added Use**' is that volume of water that is managed to facilitate extractive operations, which does not result in an output fit for any other purpose (i.e. the amount handled plus the amount lost or whose quality is changed such that it is not fit for others to use⁴)

That is the end of the description of the framework elements of the '**Input-Output Model**'. Such a model will provide most stakeholders with all the water information they require regarding the minerals operation, and its intersection with the environment and community.

It is proposed to reach agreement or consensus on this model, before refining the '**Operational Model**'. However, some consideration of the latter is important before agreeing the former, such that the decisions made at this first stage, are made with an understanding of their implications for further development of the integrated framework (bringing the two models together).

The Operational Model

The objective of the *Operational Model* is to provide a consistent framework for quantifying and documenting water use within an operation, including its efficiency. This is also designed to provide a platform for compiling and comparing minerals industry water use with other sectors. This may support benchmarking activities within regions or companies, and will certainly demonstrate leadership amongst water users in water resource stewardship.

Therefore, to develop the Operational Model, a consistent language is required, for communicating, within operations, how water is managed. In light of the objectives, in some instances it has been easiest to adopt commonly used terms, in other instances, it has been decided that the easiest option is to develop and define a new term.

Activities and uses of water within the operation describe the typical actions that water is subjected to whilst in control of the minerals operation. This includes activities such as operational tasks (e.g. dewatering ore bodies, processing ore), water quality treatment (e.g. cyanide destruction, physical settling), and storing of water (i.e. usually for operational tasks or influencing water quality). The development of a framework to consistently document these activities, will address common questions such as 'how much water do you recycle', 'how much water do you reuse', 'how efficiently do you use water' and 'do you use water as efficiently as the irrigation company down the road'?

The Operational Model brings together three elements:

1. The Inputs and Outputs;
2. The 'Use-Treat-Store' cycle outlined in the concept model (Figure 1); and
3. The concepts of 'Reuse', 'Recycling', and 'Use Efficiency'.

This is not a simple thing to do, and has required the development of several new terms, to transcend these concepts sensibly. The concept of water 'states' has been developed for this purpose, and includes the following definitions:

⁴ Using the fit for purpose concept outlined

- A water '**State**' is a description of whether or not water has been *tasked* and / or *treated* after it has entered the *accounting arena* as an *input*.
- Therefore, for three important *states* of water:
 - '**Raw Water**': is water that is received as an input and has not been previously handled for any purpose by the accounting entity. Raw water can be manipulated, it can be, *tasked*, *treated* or *diverted*.
 - '**Worked Water**': is water that has been *tasked* [used for a purpose or task] on the site and is returned for the same or another future use and or discharged. *Worked water* can be *tasked*, *treated*, or *released* as an *output*.
 - '**Treated Water**': is water that has been treated onsite to provide water of a suitable quality for a particular purpose. It can include *raw water* treated once received on site or water used in the process and polluted then treated to allow further use or even release to an *output destination*. *Treated water* can be *tasked*, *treated*, or *released* as an *output*.
- How does water change State and move through the Use-Treat-Store Cycle? By being subjected to an '**Application**'.
- *Applications* can include:
 - Being '**tasked**' – water is applied to an operational purpose, typically including ore processing, dust suppression, fire fighting, and amenities uses.
 - Being '**treated**' – 'active' treatment of water (see the Leading Practice Booklet [DRET 2008] which differentiates 'active' from 'passive' treatment).
 - Being '**stored**' – water can be stored within the accounting arena so that it is available to receive another application at the appropriate time. Stores are the facilities on a site which hold and/or capture water. Stores are the internal supplies for Applications and must supply all water that is not imported in a given timeframe of demand.
 - Being '**released**' – water that has been *worked* and / or *treated* is transferred to a destination outside the accounting arena.
 - Being '**diverted**' – raw water is transferred to a destination outside the accounting arena.
- Acceptance of the *States* and *Applications* definitions enables the consistent development and application of the following concepts and terms: 'Reuse Efficiency' and 'Recycling Efficiency'.
- '**Reuse Efficiency**': is the proportion of the *total input volume* being *tasked* that is *worked water*.
- '**Reused Water**': is *worked water* that is again-tasked without being *treated*.
- '**Total Input Volume**': is the sum of the inputs across the reporting period (excluding diversions).
- '**Recycling Efficiency**': is the proportion of the *total input volume* entering tasks that is *recycled*.
- '**Recycled Water**': is *worked water* that has been *treated*.

ends

ⁱ A three-tiered quality regime is being considered, based on 'potable', 'agricultural' and 'other' quality thresholds. This will be refined through the pilot phase.