DEPARTMENT OF WATER AFFAIRS

Water Conservation / Water Demand Management Implementation Guideline for the Mining Sector

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Department of Water and Sanitation
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1.0 INTRODUCTION

Task 9 is a critical component of the project and has the objective to provide guidance on how the WC/WDM plans are to be developed and implemented and what the respective roles of the mining industry and DWS should be in this process. The scope of work for this is contained in the project proposal and is reproduced verbatim below:

“The reports produced in Phase 1 and the reports produced in Tasks 8 above will be used to compile a practical guideline that can be used by the mining industry to implement WC/WDM at any mine. It can also be used by the regulator to monitor the implementation of WC/WDM at any mine.

The guideline will provide guidance on the complete process from setting of water use efficiency targets through implementation, monitoring and reporting and will also provide guidance on what tools can be used to assist mines in the process. The guideline will be practical and will incorporate case studies wherever possible to illustrate the concepts being discussed.

The draft guideline will be prepared as a discussion document to be submitted to the Project Steering Committee and then discussed in a one-day workshop with the Project Steering Committee. The inputs received during this one-day workshop will be compiled and used to update the guideline for submission to the Phase 2 Stakeholders Workshop (Task 12).”

The relationship between Tasks 8 and 9 and their deliverables is shown graphically in the Figure 1 below.

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**Figure 1: WC/WDM Project Phase 2 Deliverables**

This report is the Draft Implementation Guideline to fulfil the Task 9 requirements. The Implementation Guideline has been prepared in a format that distinguishes between the responsibilities of the regulator (DWS) and the mining industry. A separate section has also been prepared that deals with the information compilation and reporting requirements. Each of the three sections to be dealt with is captured and discussed in a separate chapter:

Chapter 2: General Overview of Implementation Framework

Chapter 3: Implementation Responsibilities of the Mining Industry
Chapter 4: Implementation Responsibilities of the Department of Water and Sanitation
Chapter 5: Water Accounting and Reporting Systems

2.0 GENERAL OVERVIEW OF IMPLEMENTATION FRAMEWORK

A previous report (Targets for Water Conservation / Water Demand Management in the Mining Sector) was prepared which presented the following information:

- Definition of key water use efficiency indicators
- Setting of national water use efficiency benchmarks
- Methodology for mines to set internal water use efficiency targets
- Specification and evaluation of generic WC/WDM measures

This previous report provides a set of national water use efficiency benchmarks for each of the major mining commodity groups (coal, gold, platinum and other). The national total and consumptive water use efficiency benchmarks are also shown graphically in Figure 2 below.

![Figure 2: National Water Use Efficiency Benchmarks](image)

These benchmarks are based on data that was collected as part of an extensive site engagement process at 39 different mining operations that have been shown, through evaluation of production and water use data, to be truly representative of the national mining industry. This data was then evaluated in order to develop as detailed a set of mine water balances as was possible, given the limitations of the water balances reported by the mines. The data was further refined through a rigorous and objective methodology, in the manner described in this previous report, in order to identify national water use efficiency benchmarks that represent achievable targets based on current practices within mines which are already reasonably advanced with their WC/WDM plans. It is also recognised that these national benchmarks are preliminary benchmarks and that as WC/WDM is implemented throughout the mining industry, additional data will become available and the water use efficiency of mines will improve, leading to future refinements in the national benchmarks.
The methodology that has been developed to allow for the implementation of WC/WDM within the mining sector is shown in Figure 3 below and is also based on the generic implementation methodology that was included in the approved Phase 1 report (see Appendix A).

**Figure 3: Implementation Methodology for WC/WDM in the Mining Sector**

Key features of the proposed methodology are the following:

- There are clearly defined separate responsibilities and roles for the mining industry and for the regulator (DWS).
- The proposed process incorporates the planned revision of the GN704 Regulations and the requirements regarding WC/WDM that will likely be contained therein.
The interactions between the mining industry and DWS are clearly defined.

The methodology is broadly based on the generic implementation approach reported in the Phase 1 report.

The process allows for continuous improvement in WC/WDM.

The process distinguishes between WC/WDM plans for mines whose key indicators are within the national benchmark range and those that are not.

The process makes provision for those mines who, for various reasons, cannot meet the national WUE benchmarks and who need to provide a motivation to the regulator for acceptance of WUE targets outside of the benchmarks.

The process incorporates the principle of plan, audit and modify to ensure that compliance with plans is tracked and that corrective actions are taken as and when necessary.

The methodology is integrated with the existing water licensing process and utilises the IWWMP as the vehicle for submission of the WC/WDM plan.

The responsibility of the mining sector is to compile accurate and computerised water balances in accordance with BPG G2 and regulations and to use these balances to develop a WC/WDM plan using the procedures set out in the WC/WDM Guideline and BPG H3 (amongst others). The mine will endeavour to develop a WC/WDM plan that enables it to set and achieve WUE targets that are within the current WUE benchmarks. For mines that cannot meet these benchmarks, provision is made to prepare a submission to be exempted from compliance with the benchmarks, based on DWS' approval of a suitable detailed motivation. The WC/WDM plan will initially be submitted to DWS as an addendum to an existing IWWMP and with be integrated into and incorporated into the mine's IWWMP when the IWWMP is updated. The mine will then implement its approved WC/WDM plan and submit an annual Standardised Water Accounting Form (SWAF) to DWS in order to report its compliance with its approved WC/WDM plan. It is also envisaged that the WC/WDM plan will be substantially reviewed and updated by the mine every 5 years.

The responsibility of the DWS (or CMAs where these exist) is firstly to develop a standardised water accounting framework and computerised on-line form (SWAF) that will ensure that all mines submit their water balance data in a standardised format to the DWS, allowing for on-line and standardised calculation and recording of the various WUE indicators. Additionally, the DWS is in the process of drafting regulations to replace the current GN704 regulations. These new regulations also contain specific requirements regarding the nature of water balances and the need to develop WC/WDM plans. These revised regulations need to be finalised as soon as possible and then be implemented. The DWS will then review and approve / not approve the mine's submitted WC/WDM plan (as an addendum to or part of the mine's IWWMP) and will also need to consider motivations that are put forward by certain mines who believe that they cannot develop WUE targets that fall within the national benchmarks. The DWS will then communicate the decision back to the respective mines by way of an amended WUL. The DWS will also receive annual SWAFs from the mines which will need to be reviewed with the aim of amending the mine's WUL if and when necessary to ensure compliance with the national benchmarks. DWS will also develop a database of the annually submitted SWAFs and WUEs for all the mines for each commodity group. This database will be evaluated in a similar fashion as set out in the National Target Setting chapter of the Task 8 report with the aim of refining the national benchmarks every 5 years in order to bring about continuous improvement in mines' WUE indicators.

A detailed description of the responsibilities of the mining industry and the DWS with regard to applying the methodology set out in Figure 3 above, is provided in the next two chapters.
3.0 IMPLEMENTATION RESPONSIBILITIES OF THE MINING INDUSTRY

3.1 Compile accurate and computerised water balances

All mines will be required to develop accurate and computerised water balances in accordance with the requirements of the new regulations being developed to replace the current GN704, using procedures set out in BPG G2. The level of detail in the balances must, as a minimum, support the information requirements of the Standardised Water Accounting Form that will be developed by DWS (see Section 4.1 of this report). BPG G2 provides all the necessary information that mines will require to enable them to compile accurate and detailed water balances and particular attention must be paid to Appendix B of BPG G2 which specifies the minimum level of detail required for an acceptable water balance for each unit process that could be incorporated into a mine water balance. It is also important that the balance be dynamic insofar as ensuring that it can consider seasonal effects where these are relevant (e.g. unit processes affected by rainfall and/or evaporation) and that it will be capable of accommodating changes to storage in unit processes where water is stored (e.g. pollution control dams, storm water dams, tailings disposal facilities).

The current draft regulations relating to the water balances are as follows (it must be noted that these are draft regulations that still need to undergo review and consultation before being finalised and that the final regulations may be quite different):

6. Water balances

(1) A person who submits an environmental management programme in terms of section 39(1) of the MPRDA shall compile a dynamic water balance for the activity based upon climatic variations and which includes all inflows and outflows from the activity and which reflects all surface and ground water interconnections with the water resource.

(2) A person referenced in regulation 6(1) or a holder of a mining right or production right shall ensure that the water balance -
   (a) incorporates accurate values based upon measured volumes for the water abstracted, discharged, beneficiation process water intake, outflow to and return water from waste management facilities and water abstracted from mine workings;
   (b) incorporates accurate values determined from suitable measurement or modelling of rainfall, runoff, seepage and evaporation;
   (c) is kept current by ensuring that it:
      (i) reflects all measured and modelled data and physical changes to any water system;
      (ii) is available in electronic format which is capable of calculating a water balance; and
      (iii) is updated with a frequency of not lower than on a monthly basis;
   (d) is submitted to the Department as part of the IWWMP, together with the monitoring data, unless stipulated otherwise in a water use licence;

(3) All measuring devices used to develop the water balance shall be easily accessible, properly maintained, calibrated and in good working condition.
The methodology for developing the water balances is shown in Figure 4 to Figure 6 below as taken from BPG G2. BPG G2 also contains a worked example of how the methodology set out in Figures 4, 5 and 6 below should be practically applied.

![Flowchart of the methodology for developing water balances](image)

**Figure 4: Methodology for Development of a Water Balance (from BPG G2)**
Figure 5: Flow Diagram of Process for Step 5 (from BPG G2)

- Develop equations / Feed data into computer model
- Develop preliminary balance
- Is accuracy of balance adequate? over each unit > 90% 
  - Yes
  - No
  - Identify cause(s) of imbalance
  - Address cause(s) of imbalances
  - Calculate new balance
- Develop output format (Fig. 4)

Figure 6: Flow Diagram of Process for Step 8 (from BPG G2)

- Link balances of different units
- Identify and address inconsistencies
- Develop preliminary balance for integrated units
- Solve balance for integrated units
- Is accuracy of balance adequate over each unit > 90% 
  - Yes
  - No
  - Identify cause(s) of imbalance
  - Address cause(s) of imbalances
  - Calculate new balance
- Develop output format (Fig. 4)
The primary purpose of specifying that the water balance should be computerised, is twofold:

- Firstly, to ensure that it is structured as a management tool that is capable of accepting new data inputs on a regular basis from the mine's monitoring programme.
- Secondly, to ensure that it is structured in a manner that allows it to be used as a simulation tool to evaluate the impacts of various management options/measures on the water balance and therefore on the mine’s water use efficiency indicators (see Section 3.2 below).

There are various computer programs available that could be used to construct the computerised water balance and BPG G2 is not prescriptive about which systems should be used. The water balance that is developed should also be properly calibrated to ensure that calculated and modelled values correspond with actual flows measured within the system. The role of the water balance in the process of developing a WC/WDM plan is shown in Figure 7 below.

### 3.2 Develop the WC/WDM Plan

The procedure that mines should follow in setting their own internal water use efficiency targets is fully described in the DWS Water Conservation and Water Demand Management Guidelines for the Mining Sector in South Africa. This guideline describes a methodology that mines should follow to set targets and this guideline also extensively draws on the relevant DWS Best Practice Guidelines. The broad procedure set out in the WC/WDM guideline is based on a three-phase process comprising the following phases:

- Assessment of current WC/WDM status
- Planning for WC/WDM measures and opportunities
- Implement and manage WC/WDM measures and mine water system (see section 3.3 below)

This process is further expanded on in the WC/WDM Guideline. However, a more detailed methodology flow chart is presented in Figure 7 below for the Assessment and Planning Phases.

#### 3.2.1 Determine current WUE indicators for the mine

The activities described in the first two steps are largely covered in Section 3.1 above as they relate to the development of a detailed water balance. Once the detailed water balance has been completed, the current WC/WDM status of the mine can be determined with respect to the following WUE indicators, with these indicators being calculated as described in the Task 8 report:

- Total water use (volume flow as defined above)
- Consumptive water use (volume flow as defined above)
- Total water use efficiency per production measure (m$^3$ per tonne of ore mined (ROM))
- Consumptive water use efficiency per production measure (m$^3$ per tonne of ore mined(ROM))
- Percentage of the total volume of wastewater generated that is not re-used (%)
- Water recycling ratio (%)  

Once the mine has determined its values for the abovementioned indicators, then they should be compared against the national benchmark values for the relevant commodity as reported in the Task 8 report in order to determine how close or far the mine is from compliance with these benchmarks. The result of this assessment will give an indication of how far the mine will need to go in investigating and implementing WC/WDM measures within its operations. The position of the mine’s WUE indicators viz-a-viz the national benchmarks will dictate the intensity of options that will need to be incorporated into the mine’s WC/WDM plan (taking account of future lowering of the national benchmark values):
3.2.2 Identify a range of potential WC/WDM measures/options

There will be many different potential management measures/options that can be identified for a mine that could have a positive impact on its WUE indicators. The range of potential options will differ from mine to mine, although there will be certain options that will be common to most mines. Chapter 5 of the Task 8 report lists a range of measures that could be considered by a mine. However, the options listed in Chapter 5 of the Task 8 report are not exhaustive and additional measures could also be identified. Conversely, these options will not always be applicable to every mine.

The objective of this step though, is to engage in a “brain storming” exercise with specialists within the mine who understand the nature of the mining, beneficiation and residue disposal operations at that mine. For ease of assessment, it is recommended that the identified options be divided into three broad groups as follows:

- Options to reduce consumptive water use
- Options to reuse / reclaim water
- Options to use alternative operational technologies that will save water

One of the reasons for classifying the identified options into the above three groups is that they, broadly speaking, represent a natural order of priority in terms of ease and probable cost of application. It can therefore generally be expected that costs and timeframes of implementation will increase as the mine moves from the first category of options to the third category.

Either during the “brain storming” event, or thereafter, it will be necessary to describe each identified option in terms of the impact that it would have on water use at the immediate point of application, in a manner that can be inputted into the water balance model.
Develop a detailed computerised water balance in accordance with BPG G2

Calibrate & validate water balance with actual data

Determine the current WUE indicators for the mine

Identify a range of potential WC/WDM measures/options and define the water savings potential for each
1. Options to reduce consumptive water use
2. Options to reuse/reclaim water
3. Options to use alternative water saving technologies

Evaluate each option using the computerised water balance in simulation mode to determine the impact on the WUE indicators

Determine the life-cycle capital and operating costs for each option that shows potential

Rank all the options in terms of WUE effect, life cycle cost and cost efficiency (R/m³/annum water saved)

Select a combination of options to be implemented over the next 5 years, schedule their implementation and calculate the annual WUE indicators over the 5-year period

Figure 7: Methodology for the development of a WC/WDM Plan
3.2.3 Evaluate each option using the simulation water balance model

As discussed previously, it is important that the water balance model that has been developed by the mine in Section 3.1 above, is able to operate in a simulation mode. What is meant by this, is that the model must be able to consider changes to any one or more of the unit processes included in the water balance network and then predict the effect of this change on the overall water balance. More specifically, the model must be able to simulate the effect that the assessed change would have on water inputs and water outputs in order that changes to the WUE indicators can be calculated.

In this step, each potential option would be simulated on its own and the calculated change in each of the WUE indicators must be calculated and recorded. In undertaking this exercise it is considered critically important to carefully check the calculations to ensure that the proposed options have been accurately simulated. Before comparing the results of simulations for similar options between different mines or to literature values, care must be taken to consider the effect of the different variables as described in the variables matrix, on the simulation. This implies that an option which is assessed to have a major beneficial impact on one mine may not have a similar beneficial impact on another different mine.

It is recommended that the outputs of the simulations be entered into a tabular format where they can then easily be ranked in terms of effect.

3.2.4 Determine life-cycle capital and operating costs for each option

Some options will be simple and inexpensive to implement while others could be very complex, very costly and could require very significant process and infrastructure changes. The different options that are evaluated cannot only be considered and ranked in terms of beneficial impact on the mine’s WUE indicators and the cost implications of each must be considered. It is proposed that the capital and operating costs of each option be considered over the remaining life of the mine and that they be added and reported in the form of Net Present Value (NPV) using the rate of return relevant for that mine. The more accurate the cost estimates can be, the better and more reliable will be the decisions that follow in constructing an integrated 5-year WC/WDM plan.

3.2.5 Rank all options

All options that have been simulated and for which cost estimates (as NPV) have been determined should be entered into a tabular format where, as a minimum, the following information should be reported:

- Baseline WUE indicators representing the current mine situation
- Name of option
- Total change in each of the six WUE indicators as determined by way of water balance simulation
- NPV for the option (over life of mine)
- Cost effectiveness reported as R/m³/annum of total input water saved
- Confidence (high, medium or low) in result of simulation

Additional information that the mine may wish to add is: capital and operating costs for each year that the option will be in force; change in each of the WUE for each of the next 5 years (where the effects are different from year to year).

Based on the above information, the different options should be ranked by the mine. It is not desirable to be prescriptive as to which factors should hold the greatest weight when undertaking the ranking, as this may vary from mine to mine depending on various circumstances such as remaining life of mine, profitability of mine, etc. However, at the end of the day, the selected options taken forward into the 5-year WC/WDM plan should be able to bring the mine into alignment with the national WUE benchmarks.
3.2.6 Select combination of options for integrated 5-year WC/WDM plan

The evaluated and ranked options should finally be considered and a range of options should be selected that cumulatively should enable the mine to move from its current status in terms of WUE indicators to within the national benchmark values within the 5-year timeframe of the plan. The mine should also bear in mind that the national WUE benchmark values will be updated every 5 years and that the subsequent update will most probably lead to more stringent benchmarks. This implies that mines should not be aiming to just comply with the maximum value in the range but should be aiming to improve their WUE indicators to the maximum extent possible, considering practical and economic constraints, in order to make the next 5-year WC/WDM plan easier to comply with.

The integrated 5-year WC/WDM plan should then result in a set of annual targets for each of the WUE indicators, coupled with annual costs associated with the plan.

3.2.7 Evaluate adequacy of proposed 5-year WC/WDM plan

The annual targets for each of the WUE indicators should be compared to the national benchmark values that apply at the time when the plan is being developed. Currently, the benchmark values are reported for each of the major commodity groups – gold, coal, platinum and other – in the Task 8 report. Future revisions of the benchmark values will be published by DWS and the group “other” will be divided into different commodities as the data becomes available as the WC/WDM strategy is rolled out and mines start submitting their annual performance reports.

It is important to demonstrate that the integrated 5-year WC/WDM plan will, as a minimum, ensure that the mine meets the current WUE indicator benchmark maximum values within the 5-year term of the WC/WDM plan (or longer if adequately motivated) before the plan can be considered acceptable and ready for submission to DWS for review.

If the integrated WC/WDM plan does not bring the mine into line with the maximum values for each of the WUE indicator benchmarks, then a further review as discussed in Section 3.2.8 is required.

3.2.8 Determine whether all viable options have been considered

In cases where the proposed integrated 5-year WC/WDM plan is not predicted to at least meet the maximum values for each of the WUE indicator benchmarks then further investigations will be required. Where possible, the mine should then go back to Section 3.2.6 above and select additional or different options to be incorporated into the 5-year WC/WDM plan that are capable of meeting the prescribed benchmark values. If this is not successful, then it may be necessary to go all the way back to Section 3.2.2 to identify additional options that can be simulated and costed with the intent of enabling the integrated 5-year plan to meet the national benchmark values.

However. It must be clearly stated that there will be mines that will be able to provide a valid motivation as to why they cannot meet the national benchmark values for some or all of the WUE indicators. The reasons for this could vary but could include factors such as a unique combination of variables (as described in the variables matrix) that result in the mine being considered as a special case. Alternatively, mines could be very close to the end of their planned life, making implementation of long-term costly options impractical, or mines could find themselves in particularly difficult financial situations making significant investments in WC/WDM options difficult.

It is unlikely that a mine will be able to motivate to do nothing to improve its WUE indicators, as there will generally be some measures that can be readily implemented with little cost. However, in any situation where the mine intends to submit a WC/WDM plan that does not bring it into line with national WUE benchmark values, such deviation will need to be supported by a very sound motivation that will be considered by the DWS when reviewing the mine’s 5-year WC/WDM plan.

3.2.9 Compile and submit a 5-year WC/WDM plan

Once the mine has moved through the activities described in Section 3.1 and Sections 3.2.1. to 3.2.8 above, the mine will need to prepare a documented WC/WDM plan which will need to comply with content requirements as determined by the DWS by way of regulations or guideline documents. The initial 5-year
WC/WDM plan will be submitted by the mine as an addendum to its existing IWWMP (for those mines that have already compiled and submitted an IWWMP to the DWS). Future updates (every 5 years) of the WC/WDM plan will be incorporated into and synchronised with updates to the mine’s IWWMP.

In developing the internal WUE targets, mines need to take cognisance of the fact that DWS will be reviewing and modifying the national targets every 3 years, most probably in a downward direction. To cater for this, mines should generally aim to set internal targets that are below the average national target values.

The accelerated WC/WDM plan that is developed will need to be incorporated into an update of the mine’s IWWMP for submission to DWS for review and approval by way of conditions incorporated into an amended mine WUL.

### 3.3 Implement the WC/WDM Plan

Once the submitted 5-year WC/WDM plan has been approved by the DWS and the mine’s WUL has been updated accordingly, the mine must ensure that it implements the approved plan. In practice, mines should generally start implementing their WC/WDM plan as soon as they have completed it and submitted it to DWS, with the inherent flexibility to make changes, should significant changes be requested by DWS after the review period.

To ensure that implementation is successful, the 5-year plan should have clear management responsibilities and allocated budgets for each of the options that are to be implemented.

### 3.4 Complete Standardised Water Accounting Form

All mines will be required to complete an on-line Standardised Water Accounting Form (SWAF) that will be developed by DWS (see Section 4.2). Additional information regarding the principles underpinning the SWAF is also provided in Chapter 5 of this report.

The purpose of requiring mines to complete an on-line SWAF is to ensure that all mines report their water information and account for their water use and discharge in a standardised format that enables the calculated water use efficiencies of all mines to be directly compared against each other and to the national targets. The site engagement process reported in the Phase 1 report clearly highlighted that the lack of uniformity in water balance information and reporting formats made it very difficult to determine the actual status of WC/WDM on a mine. The foundation of a rational and successful national WC/WDM strategy for the mining sector is clearly dependant on accurate water balances and standardised reporting formats.

As discussed in later sections of this report, the proposed SWAF will be largely based on the Water Accounting Framework developed by the Minerals Council of Australia and summarised in Appendix B.

### 3.5 Determine Current Water Use Efficiency Status

The on-line SWAF is intended to incorporate built-in calculators that will determine the mine’s current water use efficiency (WUE) status with regard to each of the key indicators described in the Task 8 report. This approach will ensure that there is a consistent and accurate determination of the mine’s WUE indicators.

The on-line SWAF must be updated on an annual basis (starting within one year after the mine has commenced implementation of its approved WC/WDM plan) using the outputs from the computerised water balance that the mine has developed. The SWAF will automatically calculate the mine’s revised WUE indicators and these can then be included in the annual Water Conservation Plan as described in the DWS WC/WDM Guideline and set out in Appendix B to the WC/WDM Guideline. The key deviation from the DWS WC/WDM Guideline format for the Water Conservation Plan is that it must include reporting on all the key indicators listed in the Task 8 report. Additionally, the Water Conservation Plan must present a statement on whether the plan as it is being implemented is successfully meeting the internal targets, or whether an update to the plan is required.
3.6 Update the WC/WDM Plan

The process described in Section 3.2 above should be redone every 5 years in order to produce a new and updated 5-year WC/WDM plan. The need for regular 5-yearly updates is firstly linked to the fact that mining plans are regularly changed and there is a need to ensure that the WC/WDM plan remains relevant. Secondly, it is envisaged that the national WUE indicator benchmark values will be reviewed and updated every 5 years (most probably becoming more stringent) and that the mine WC/WDM plans will need to be updated accordingly to meet the new benchmark values.

4.0 IMPLEMENTATION RESPONSIBILITIES OF DWS

While the mines have a clear set of responsibilities and actions that they need to undertake in implementing the WC/WDM strategy, DWS and any CMAs that have been set up to act on behalf of the DWS, have their clear responsibilities too.

4.1 Issue Regulations Mandating WC/WDM

The DWS is currently engaged in a process of reviewing the existing GN704 regulations in order to present a set of regulations that is closely aligned to current best practice and the DWS Best Practice Guidelines in particular. The draft regulations still need to be passed through an appropriate public participation process before they can be finalised. However, the existing draft regulations do include a section (section 7) that deals with WC/WDM and the current draft regulations relating to WC/WDM are as follows (it must be noted that these are draft regulations that still need to undergo review and consultation before being finalised and that the final regulations may be quite different):

7. Water conservation and water demand management

(1) A holder must use all water on the mine efficiently and shall:
   (a) minimise the total water intake;
   (b) avoid the use of water where possible;
   (c) implement “good” housekeeping and operating practices; and
   (d) maximise the reuse of contaminated water.

(2) A person who submits an environmental management programme in terms of section 39(1) of the MPRDA shall develop a water conservation and water demand management plan, which -
   (a) quantifies the water use efficiency of the activity;
   (b) contains the mine water management and water loss strategies and programmes;
   (c) sets annual targets for improved water use efficiency for the mining activity, beneficiation and waste disposal practices and stipulates which measures will be implemented to achieve the targets on the mine;
   (d) reports on the implementation of more efficient processes, equipment designs, and other on-site measures to enable the mine to avoid and reduce water consumption; and
   (e) reports on the implementation and reduction of total water demand.

(3) The holder of a mining right or production right shall -
(a) report on actual performance against the approved water conservation and water demand management plan annually;
(b) update the water conservation and water demand management plan at a frequency of not lower than every five years;
(c) execute the water conservation and water demand management plan; and
(d) submit the water conservation and water demand management plan to the Department as part of the IWWMP, unless directed otherwise by the Department.

The gazetting of the final regulations will be the legal driver for mines to develop and implement the WC/WDM plans as described in this report.

4.2 Prepare Standardised Water Accounting Framework & Form

A critical issue in assessing and ensuring that WC/WDM measures are correctly implemented at mines is to have confidence that the information reported by the mines is credible and that all mines report information in a uniform format. This problem has been recognised elsewhere in the world and most particularly in Australia where the Minerals Council of Australia (MCA), which represents most of the Australian mining industry, developed a Water Accounting Framework (WAF) that all its members are actively encouraged to adopt and use in accounting for their water use and in reporting their water information. The MCA also developed a computerised tool (in the Microsoft Excel format) that ensures that all mines that use the tool report their information in the recommended standardised format. A further discussion on the MCA WAF is presented in Chapter 5 of this report.

The final reports on the MCA WAF were only issued in January 2014 (long after the literature review conducted as part of this project was completed) and these have now been thoroughly reviewed and considered in terms of potential benefit to this project. While a more detailed discussion is presented in Chapter 5, it is believed that the approach adopted in the MCA WAF holds significant benefit for this project and that it can and should be adopted, with the necessary modifications, to make it completely suitable for the requirements of the South African WC/WDM strategy for the mining sector.

Whichever water accounting and water information format is adopted by the DWS, it is recommended that a standardised form be developed that can be completed on-line via the internet. This will ensure that all mines report their information in the same standardised format, will allow the calculation of WUE indicators for all mines in a standardised and approved manner and will ensure that this information is directly available to the relevant personnel at DWS.

4.3 Review and Approve / Not Approve WC/WDM Plans

Mines that have submitted a WC/WDM plan (either as an Addendum to their IWWMP the first time or as an integral part of their IWWMP for future updates) are required to demonstrate that their plan will enable them to meet all the WUE indicator benchmark values within a 5-year period, or alternatively to provide a very clear and sound motivation as to why their WC/WDM plan does not meet this requirement. The extent to which this has been achieved in the submitted WC/WDM plan must be reviewed and assessed.

The DWS must confirm that the internal WUE targets that the mines have developed and which they have committed to achieving in their submitted WC/WDM plans are within the national benchmark ranges. The DWS will not evaluate or approve the actual measures proposed to meet the specified internal targets as it is the mine's responsibility to identify, define, evaluate and implement measures that they believe will enable them to meet their internal WUE targets.

Finally, the DWS must confirm that there are clear time frames, budgets and responsibilities for the implementation of the WC/WDM plan.

If the submitted WC/WDM plan clearly does meet the DWS’ requirements and there is confidence that the internal WUE targets are within the specified national benchmark range and that specified budgets, timeframes and responsibilities are incorporated, then the DWS must approve the plan (through the WUL)
and inform the mine of such approval. If DWS does not approve the plan due to missing information or non-alignment with the national benchmarks then this decision must also be communicated to the mines with instructions on timeframes for submitting a revised WC/WDM plan.

4.4 Amend Mine Water Use Licences to include WC/WDM Plans

Once a mine’s WC/WDM plan has been approved, the DWS must review, and where necessary, update the conditions of the mine’s WUL to include the commitments contained in the approved WC/WDM plan. This process will be repeated every 5 years as the WC/WDM plan is updated, together with the IWWMP, leading to a revised WUL.

4.5 Review and Update National WUE Benchmarks

The national WUE indicator benchmarks that were developed as part of this project, using the process reported in the Task 8 report, are based on data collected from 39 mines and in an environment where many mines did not have reliable and accurate water balances. In addition, there was no standardised format in use within the mining industry for reporting water use and discharges, making it very difficult to develop national WUE targets.

The long-term strategy with WC/WDM is one of continuous improvement and it is therefore expected that the national WUE indicator benchmarks will also be refined and updated on a regular basis (every 5 years) and that they would generally be expected to become more stringent with time.

By adopting the SWAF approach to water information reporting, DWS will, on an annual basis, obtain updated information from each mine on their actual WUE values. This information will be used to update the national WUE benchmarks in a manner that is schematically shown in the Figure 8 below.

![Figure 8: Updating and Progression of National WUE Benchmarks](image)

It is expected that as the WC/WDM strategy is implemented within the mining sector and annual submissions of the SWAFs are received, that the DWS will be able to use the submitted information to refine the national targets. It is furthermore expected that the national targets will become more stringent insofar as the average values will become lower and the range between minimum and maximum values will also reduce.

As the national targets are changed, these changes will have a necessary impact on the WC/WDM plans being implemented by the mines and this is one of the primary reasons why mines will need to update their
WC/WDM plans at least every 5 years. It is envisaged that the current WUE benchmarks will be reviewed and updated in 2020 and every 5 years thereafter.

4.6 Amendment of National WUE Benchmarks to Accommodate Catchment Constraints

The national WUE indicator benchmarks that were developed as part of this project for each commodity are considered to be generally valid across South Africa. However, there may be particular catchments where due to significant pressures on the available water from a range of water use sectors (not just mining), application of the national benchmarks may result in a higher mining water use than the catchment can accommodate. In such an event, the national benchmarks need to be converted to stricter catchment benchmarks to reflect the available water. The process to be followed in adjusting the national benchmarks to catchment benchmarks is illustrated by way of a hypothetical practical example.

Consider a hypothetical Catchment A where severe water constraints have resulted in a situation where the DWS has determined that the maximum available water for the mining sector in the catchment is 15 million m$^3$/annum. This catchment has the following mining activities:

- Coal mining: 25 million ROM tons/annum
- Platinum mining: 3 million ROM tons/annum
- Other mining: 5 million ROM tons/annum

Based on the data presented in Tables 9-12 of the Task 8 report, the national benchmarks for consumptive water use efficiency for the different mining commodities are as follows:

- Coal mining: 0.38 m$^3$/t
- Platinum mining: 1.82 m$^3$/t
- Other mining: 0.65 m$^3$/t

In this catchment, if all the mines had to meet the national benchmark values, then the consumptive water use by the mining sector in this catchment would be as follows:

- Coal mining: $25,000,000$ t/annum $\times 0.38$ m$^3$/t = 7,600,000 m$^3$/annum
- Platinum mining: $3,000,000$ t/annum $\times 1.82$ m$^3$/t = 5,460,000 m$^3$/annum
- Other mining: $5,000,000$ t/annum $\times 0.65$ m$^3$/t = 3,250,000 m$^3$/annum

In this situation, the total water use by mining would therefore be 16,310,000 m$^3$/annum which exceeds the available water for mining by 8.73%. Accordingly, the national benchmark values for these commodities need to be reduced by 8.73% to create catchment benchmark values that ensure that the mines do not use more than the available water allocated to the mining sector. The revised catchment benchmark values to total consumptive water use efficiency will therefore be adjusted downwards by 8.73% to become the following:

- Coal mining: 0.35 m$^3$/t
- Platinum mining: 1.66 m$^3$/t
- Other mining: 0.59 m$^3$/t

The same principle would apply to other catchments where it may be necessary to tighten the national benchmarks. However, the national benchmarks will not be relaxed in catchments that currently have a surplus of water.
5.0 WATER ACCOUNTING FRAMEWORK

5.1 Discussion of Australian Water Accounting Framework

The Water Accounting Framework (WAF) was developed by the Minerals Council of Australia as a means to enable mines to measure, record and report water information in a consistent manner. The WAF also distinguishes between water accounting and water reporting. Accounting concerns the consolidation of water balance information, as discussed throughout the framework description. Reporting concerns the presentation of water balance information in formats tailored to the needs of various reporting uses and users. The WAF aims to provide a ‘one-stop-shop’ for water information.

The MCA Water Accounting Framework provides:

- A consistent approach for quantifying flows into, and out of, reporting entities, based on their sources and destinations;
- A consistent approach for reporting of ‘water use’ by minerals operations that enables comparison with other users, and relates to water sharing planning processes;
- A consistent approach in quantifying and reporting water ‘reuse’ and ‘recycling’ efficiencies such that the reliance on sourced water is reduced; and
- A model for the more detailed operational water balance as guidance for those businesses which currently do not have an effective operational water model or see an opportunity to develop this new approach.

The Water Accounting Framework produces the following four reports:

1. The Input-Output Statement lists flows for all input and output categories and diversions, with their associated water quality category, for the reporting period, along with the change in storage.
2. Statement of Operational Efficiencies lists the total flows into the tasks, volume of reused water, reuse efficiency, the volume of recycled water and recycling efficiency.
3. The Accuracy Statement lists the percentage of flows that were measured, simulated and estimated.
4. Contextual Information ensures that numbers in the report are not divorced from the context in which a facility is operating. It gives background information about the water resources of the operational facility as well as any conditions that have an impact on the management of those water resources such as climate information, information about the water resources of the region and the catchment in which the sites are located.

Mines that subscribe to the WAF are expected to, inter alia, undertake the following:

1. Alignment of company water metrics consistent with the Water Accounting Framework Input-Output Model.
2. Alignment of company water quality descriptors consistent with the Water Accounting Framework (currently under adoption by 1 July 2015)
3. Using the framework definitions and metrics to satisfy existing public reporting (company reporting or similar) on company aggregated water inputs and outputs and quality. Reporting requirements could include reporting on volumes against the Global Reporting Initiative.


A description of what these commitments entails is provided below.

1. **Alignment of Company water metrics consistent with the Water Accounting Framework Input-Output Model.**

Of primary importance to the alignment of company water metrics is the adoption of the four Source and five Destination categories provided within the framework. These include:
Sources: Surface Water, Groundwater, Sea Water and Third Party Water.

Destinations: Surface Water, Groundwater, Sea Water, Supply to Third Party and Other.

Full definitions for each of the above categories are provided within the Framework Guidance (Section 2.2.1).

While a list of individual inputs and outputs, which form subsets of the Source and Destination categories, have been provided within the Framework guidance, these are not prescriptive and can be removed, modified or new categories added depending on the specific needs of a company or operation.

Along with the standard definitions, standard units should be adopted; Mega-litres (ML) have been adopted for the purposes of the framework.

2. Alignment of company water quality descriptors consistent with the Water Accounting Framework

Water quality is an important component of the water accounting framework and the goal of consistent reporting and communication of water use. The framework provides three categories of water. These include:

Category 1: Water is of a high quality and may require minimal and inexpensive treatment (for example disinfection and pond settlement of solids) to raise the quality to appropriate drinking water standards.

Category 2: Water is of a medium quality with individual constituents encompassing a wide range of values. It would require moderate level of treatment such as disinfection, neutralisation, removal of solids and chemicals to meet appropriate drinking water standards.

Category 3: Water is of a low quality with individual constituents encompassing high values of total dissolved solids, elevated levels of dissolved metals or extreme levels of pH. It would require significant treatment to remove dissolved solids and metals, neutralise and disinfect to meet appropriate drinking water standards.

To satisfy this commitment, companies should align their generic water quality categories with the three categories provided above. A list of water quality parameter ‘thresholds’ and a decision tree is provided in the User Guide (Section 2.4) to enable companies to select the appropriate water quality category.

3. Annual public reporting (Company Reporting or similar) on company aggregated water inputs and outputs using the framework definitions and metrics.

To promote communication and transparency of minerals industry water use, MCA member Companies are asked to use the water accounting framework to meet their annual public water reporting needs at an aggregated company level. To satisfy this commitment, companies should use the framework to meet any of its existing public water reporting requirements (such as annual sustainability or performance reporting or similar).

Accordingly, companies may use the framework to respond to Global Reporting Initiative (GRI) reporting requirements for EN8 – Total Water Withdrawn by Source, and EN21 – Total Water discharged by Quality and Destination. Methods on how to use the framework to satisfy GRI reporting requirements are provided both within the Water Accounting Framework User Guide (Section 6.1) and the User Template provided.

5.2 Applicability of Australian WAF to South African WC/WDM

A detailed review of the Minerals Council of Australia WAF (MCA WAF) leads to the conclusion that the system that has been developed here is directly applicable to the South African situation and that this approach would serve as a critical supporting framework for the implementation of WC/WDM in the mining industry. A significant amount of work and thought has gone into the development of the MCA WAF and there is little benefit to be derived from re-inventing the wheel in this regard. The MCA WAF succeeds in
presenting a simplified yet sufficiently complex framework for a uniform and consistent definition of water use, water discharge and water diversions that will allow all mines to report their water information in a uniform and directly comparable manner. There would need to be some minor modification of the categories to ensure direct applicability for all South African mines.

The MCA WAF also provides a sensible approach to categorising water quality into 3 classes and this approach can also be adopted, with modification to reflect South African national water quality concerns, for use in South Africa. The approach of indicating the confidence class of the different water balance values in terms of whether they are measured, calculated or estimated is also very useful and might benefit from a fourth category - modelled - to distinguish between those values that derive from mathematical modelling (such as runoff) and those that derive from calculation to make inflows and outflows balance for a given unit process.

The MCA WAF will also need to be modified to allow for the calculation of the South African key WUE indicators as opposed to the Australian indicators. Finally, the ability of the WAF to also provide output data in a format that supports GRI reporting conventions is also useful and should be retained for those companies who do subscribe to this practice.

The MCA WAF tool should also be modified to allow for the incorporation of contextual information that is relevant to the WC/WDM information requirements. This could include data such as mining commodity, quaternary catchment and operational data that describes the parameters covered in the Variables Matrix and the Generic Water Balance Model (see Task 8 report).

A summary of the key characteristics of the MCA WAF is provided in Appendix B and it is also recommended to download and use the published WAF User Guide and the Excel-based Input-Output Model Template that is available at http://www.minerals.org.au/focus/sustainable_development/water_accounting

A key and critical benefit of adopting the MCA WAF system (modified for South African conditions as described above) is that it will provide annually updated values for the different WUE indicators for all South African mines. This is critical to enable the WUE benchmarks to be updated every 5 years and is also the best way to ensure that water balance and WUE data are reported by all mines in a consistent manner. Access to this type of data is also required to enable the current mining commodity category of “other” to be subdivided into a range of more meaningful commodities, each with their own more relevant WUE benchmark values.

6.0 CASE STUDY

The procedures described in this report, specifically those included in Chapter 3, are best demonstrated by way of an actual mine case study. The case study presented here is for a platinum mine that is similar to one of the platinum mines included in the site surveys. It must be emphasized that the case study represents an application and an outcome of the methodology that is unique to the case study mine and that a different case study would have different outcomes. It must also be emphasized that the case study application is not a blueprint that can necessarily be applied to all other mines.

The tool used for the assessment and presentation of the case study is the generic water balance model which is described in detail in the Task 8 report. This model is different to a normal water balance model as would generally be developed for a mine in accordance with the methodology described in Section 3.1. A detailed case study, using a deep gold mine, on how to develop a detailed mine water balance is contained in BPG G2 and will not be repeated here.

The generic water balance model developed by Golder as a tool for this project does have simulation capability and is therefore the correct tool to demonstrate the methodology described in this report.

6.1 Context of the Case Study Mine

The selected case study mine represents a specific platinum mine with specific characteristics that will distinguish it from other mines. In reviewing and understanding the relevance of the case study, it is
necessary to be able to place the case study mine into the correct context within the mining industry and specifically within the context of the variables listed in the variables matrix. The case study mine had the following characteristics:

- Rainfall – 650 mm/annum
- Evaporation – 1400 mm/annum
- Groundwater regime – wet with groundwater make of 0.8 m$^3$/ton ROM
- Commodity mined – platinum
- Type of mining - underground
- Depth of mining – 600m
- Mine cooling – no
- Presence of sulphides – yes, but no AMD due to excess of neutralising minerals
- Age of mine – 15 years
- Remaining life of mine – 25 years
- Regional hydraulic interactions – not considered
- Quality of fresh water – good (RWB and ground water)
- Type of tailings disposal – conventional (98 ha) with tailings disposed at 1.40 SG
- Geographic size of operations – 894 ha
- Type of beneficiation – conventional concentrator
- Workforce on mine – 3100 persons
- Water use / worker / day – 200 l/day (workers with access to showers), 120 l/day (day workers not using showers)

### 6.2 Construction of the mine water balance

For a normal mine situation, the water balance would be developed in accordance with the methodology set out in BPG G2. For this case study, the generic water balance model, described in detail in the Task 8 report, was used instead. The input parameters for the generic water balance model were adjusted during the calibration process to ensure that the simulated water balance closely represented the actual case study mine water balance. The resultant summary water balance is shown in Figure 9 below while the water balance flow diagram is shown in Figure 10.
The only component not shown above is the relatively minor “other” uses that include the offices, change rooms, etc.

Figure 9: Case Study Water Balance

Figure 10: Case Study Water Balance Flow Diagram
6.3 Development of the WC/WDM plan

The case study will be developed in accordance with the step-wise procedure shown in Figure 7 above.

6.3.1 Determine current WUE indicators for the mine

The current WC/WDM status of the mine can be determined with respect to the different WUE indicators as listed in Section 3.2.1 above, with these indicators being calculated as described in the Task 8 report.

Based on the calibrated water balance program, the major water uses for various sections of the mine are summarised in Table 1 below. The various consumptive water uses per individual area are given in Table 2.

For example: the residue disposal section includes the TSF and the RWD (draw a block around the residue disposal). Internally in the residue disposal section, there is no recycle, but water is recycled from the residue disposal to the beneficiation section. When just considering the residue disposal section, this flow is defined as an outflow since it crosses the boundary around residue disposal (and is therefore defined as water supplied to a third party) and not a recycle (since it does not come back to the residue disposal block). When considering the entire mining operation, (Total mine column) the water that is recycled from the residue disposal to the beneficiation is defined as a recycle in terms of the total mining operation.

Table 1: Water usage efficiency indicators for Case Study mine

<table>
<thead>
<tr>
<th>Description</th>
<th>Units</th>
<th>Mining</th>
<th>Beneficiation</th>
<th>Residue Disposal</th>
<th>Other Activities</th>
<th>Total Mine</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total water input</td>
<td>m³/year</td>
<td>4,630,500</td>
<td>5,336,100</td>
<td>3,853,100</td>
<td>315,900</td>
<td>5,940,000</td>
</tr>
<tr>
<td>Total consumptive use</td>
<td>m³/year</td>
<td>1,586,500</td>
<td>2,097,400</td>
<td>1,940,200</td>
<td>315,900</td>
<td>5,940,000</td>
</tr>
<tr>
<td>Total water input per tonne mined</td>
<td>m³/t</td>
<td>1.49</td>
<td>1.72</td>
<td>1.24</td>
<td>0.10</td>
<td>1.91</td>
</tr>
<tr>
<td>Consumptive use per tonne mined</td>
<td>m³/t</td>
<td>0.51</td>
<td>0.67</td>
<td>0.62</td>
<td>0.10</td>
<td>1.91</td>
</tr>
<tr>
<td>Consumptive use as a % of</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>consumptive use + recycle</td>
<td>%</td>
<td>51%</td>
<td>47%</td>
<td>100%</td>
<td>100%</td>
<td>60%</td>
</tr>
<tr>
<td>Water recycling ratio</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>(recycle/inflow)</td>
<td>%</td>
<td>34%</td>
<td>45%</td>
<td>0%</td>
<td>0%</td>
<td>66%</td>
</tr>
</tbody>
</table>

Table 2: Consumptive water usage of Case Study mine evaluated

<table>
<thead>
<tr>
<th>Description</th>
<th>Units</th>
<th>Mining</th>
<th>Beneficiation</th>
<th>Residue Disposal</th>
<th>Other Activities</th>
<th>Total Mine</th>
</tr>
</thead>
<tbody>
<tr>
<td>Unspecified sinks</td>
<td>m³/t</td>
<td>0.33</td>
<td>0.11</td>
<td>0.00</td>
<td>0.00</td>
<td>0.44</td>
</tr>
<tr>
<td>Total water discharged (untreated)</td>
<td>m³/t</td>
<td>0.13</td>
<td>0.30</td>
<td>0.00</td>
<td>0.00</td>
<td>0.42</td>
</tr>
<tr>
<td>Seepage/Evaporation losses</td>
<td>m³/t</td>
<td>0.06</td>
<td>0.05</td>
<td>0.25</td>
<td>0.00</td>
<td>0.35</td>
</tr>
<tr>
<td>Interstitial storage</td>
<td>m³/t</td>
<td>0.00</td>
<td>0.00</td>
<td>0.34</td>
<td>0.00</td>
<td>0.34</td>
</tr>
<tr>
<td>Water out in product</td>
<td>m³/t</td>
<td>0.00</td>
<td>0.23</td>
<td>0.00</td>
<td>0.00</td>
<td>0.23</td>
</tr>
<tr>
<td>Dust suppression</td>
<td>m³/t</td>
<td>0.00</td>
<td>0.00</td>
<td>0.06</td>
<td>0.00</td>
<td>0.06</td>
</tr>
<tr>
<td>Sanitation water discharged</td>
<td>m³/t</td>
<td>0.00</td>
<td>0.00</td>
<td>0.04</td>
<td>0.00</td>
<td>0.04</td>
</tr>
</tbody>
</table>
The WUE indicators calculated for the case study mine in its current situation, need to be compared to the national benchmark values as presented in Table 11 in the Task 8 report which is reproduced as Table 3 below, with the case study values shown in the last column.

**Table 3: National Key Indicator Benchmarks and Ranges for Platinum Mining**

<table>
<thead>
<tr>
<th>Platinum Mining</th>
<th>Units</th>
<th>Benchmark</th>
<th>Min (1xσ)</th>
<th>Min (2xσ)</th>
<th>Max (1xσ)</th>
<th>Max (2xσ)</th>
<th>Case Study</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total Mine - Total water input per tonne mined</td>
<td>m³/t</td>
<td>1.85</td>
<td>1.64</td>
<td>1.42</td>
<td>2.07</td>
<td>2.29</td>
<td>1.91</td>
</tr>
<tr>
<td>Total Mine - Consumptive use per tonne mined</td>
<td>m³/t</td>
<td>1.82</td>
<td>1.60</td>
<td>1.38</td>
<td>2.04</td>
<td>2.27</td>
<td>1.91</td>
</tr>
<tr>
<td>Total Mine - % waste water not recycled</td>
<td>%</td>
<td>64%</td>
<td>51%</td>
<td>38%</td>
<td>76%</td>
<td>89%</td>
<td>54%</td>
</tr>
<tr>
<td>Total Mine - Water recycling ratio (recycle/inflow)</td>
<td>%</td>
<td>63%</td>
<td>4%</td>
<td>0%</td>
<td>122%</td>
<td>181%</td>
<td>66%</td>
</tr>
<tr>
<td>Mining</td>
<td>m³/t</td>
<td>1.22</td>
<td>1.12</td>
<td>1.01</td>
<td>1.33</td>
<td>1.44</td>
<td>1.49</td>
</tr>
<tr>
<td>Mining - Consumptive use per tonne mined</td>
<td>m³/t</td>
<td>0.46</td>
<td>0.36</td>
<td>0.26</td>
<td>0.56</td>
<td>0.66</td>
<td>0.51</td>
</tr>
<tr>
<td>Beneficiation</td>
<td>m³/t</td>
<td>1.46</td>
<td>1.19</td>
<td>0.92</td>
<td>1.74</td>
<td>2.01</td>
<td>1.72</td>
</tr>
<tr>
<td>Beneficiation - Consumptive use per tonne mined</td>
<td>m³/t</td>
<td>1.46</td>
<td>1.46</td>
<td>1.46</td>
<td>1.46</td>
<td>1.46</td>
<td>0.67</td>
</tr>
<tr>
<td>Residue Disposal</td>
<td>m³/t</td>
<td>1.92</td>
<td>1.59</td>
<td>1.26</td>
<td>2.25</td>
<td>2.58</td>
<td>1.24</td>
</tr>
<tr>
<td>Residue Disposal - Consumptive use per tonne mined</td>
<td>m³/t</td>
<td>1.08</td>
<td>0.89</td>
<td>0.70</td>
<td>1.28</td>
<td>1.47</td>
<td>0.62</td>
</tr>
</tbody>
</table>

Evaluation of the data shown in Table 3 above clearly indicates that the case study mine is currently performing well in terms on the national WUE indicator benchmark values. The only area where the mine exceeds the national benchmark values is for total water input/tonne mined in the mining section – primarily due to very high groundwater make into the mining area. The consumptive water use per tonne mined is, however, well within the benchmark range – illustrating the value of the consumptive water use indicators compared to the total water use indicators.

Key conclusions to be drawn from an analysis of Table 3 above are as follows:

- The mine does not require a stringent WC/WDM plan as it is already within the target range for most WUE indicators.
- The mine’s WC/WDM plan should be pro-active and aim to get below the average target values with the view towards benchmarks becoming more stringent in 5 year’s time.
- The mine should aim to find ways to reduce total water input per ton mined within the mining circuit by reducing the high Board water consumption and replacing this with ground water and also addressing water losses to unspecified sinks.
- The mine should aim to find ways to reduce total water input per ton mined within the beneficiation plant circuits by reducing the high Board water consumption and replacing this with other water sources and also addressing water losses to unspecified sinks.

### 6.3.2 Identify a range of potential WC/WDM measures/options

Chapter 5 of the Task 8 report lists a range of measures that could be considered by a mine. However, the options listed in Chapter 5 of the Task 8 report are not exhaustive and additional measures could also be identified. Conversely, these options will not always be applicable to every mine. The options presented in Chapter 5.2 of the Task 8 report are considered below in terms of their potential application to the case study mine.

#### 6.3.2.1 Potential WC/WDM measures for mining operations

The following generic measures have been identified:
Pre-dewatering of areas to be mined with beneficial use of the water derived from the dewatering – due to the deep mining, this option is not considered very practical and is not considered for the case study.

Mining done to prevent intersection/interconnection to water-bearing strata/aquifers – insufficient information is available for the case study mine to determine the practical feasibility of this option and it is therefore not considered.

Where intersection of water-bearing strata/aquifers cannot be avoided, ensure that intersected water is protected from quality deterioration and pumped out of the mine workings for beneficial reuse – this is a potentially feasible option for the case study mine, except that the water is only reused and recycled when it reaches the surface – captured in Option 13.

Mining done to avoid surface water bodies such as streams, wetlands and dams – not applicable to the deep mining operations at the case study mine.

Old workings sealed off to prevent ingress into active workings – this is already happening at the case study mine.

Surface waters (streams) diverted around mining impacted areas to limit ingress – not applicable to the deep mining operations at the case study mine.

Ventilation optimised to limit the need for cooling/refrigeration – no mine cooling at this mine.

Recycle and re-use water employed for underground drilling equipment and mining machines – consider the use of rock drills that utilise less water than conventional drills – see Option 7.

Backfill underground workings to reduce water ingress and cooling requirements – no backfilling operations at this mine and costs to implement would be excessive.

Separate & divert surface water which may enter the opencast pit workings (clean and dirty water separation) – not applicable as there are no opencast workings.

Close & rehabilitate opencast & pit workings and rehabilitate to limit recharge/ingress to the workings – not applicable as there are no opencast workings.

Rehabilitate and shape to free drain the rehabilitated land to reduce runoff to opencast workings & pits – not applicable as there are no opencast workings.

Backfill and rehabilitate final voids and pit lakes to evaporation losses – not applicable as there are no opencast workings.

Upgrade standard & quality of mined land rehabilitation to reduce water ingress/ infiltration – not applicable as there are no opencast workings.

Accelerate the disturbed land rehabilitation and reduce the backlog of rehabilitation behind the active mining face/operation – not applicable as there are no opencast workings.

Recycle and re-use mine dewatering for other applications (ore processing, minerals beneficiation, etc.) – this is considered and included in Option 13.

Employ dry cooling systems on underground mine working/refrigeration circuits, rather than evaporative cooling – not applicable as there is no mine cooling at this mine.

Minimise contact time between water and ore in the mining operations in order to reduce water quality deterioration, thereby making the water easier to reuse – not considered as there is insufficient information available to consider water quality aspects in the generic mine water model.
6.3.2.2 Potential WC/WDM measures for ore / mineral processing operations

The following generic measures have been identified:

- Employ dry ROM/ore conveyance (such as conveyer belts) methods rather than hydraulic conveyance systems – this is already in place at the case study mine.

- Minimize footprint of ROM and ore stockpiling to reduce impacted water production – no significant ore stockpiling occurs at the case study mine.

- Employ high solids content/consistency processes for ore/mineral beneficiation – not considered as part of this case study.

- Recover water from the ore and minerals products and recycle to the minerals processing plant – this is included as Option 9.

- Recover water from the waste and tailings and recycle to the ore/minerals processing plant – this is included in option 8.

- Employ dry cooling technologies rather than evaporative cooling systems – not considered for this case study – insufficient information.

- Ore/minerals processing plant footprint minimized to reduce impacted water generation – do not have information on current footprint size of beneficiation plant and therefore cannot consider this option.

- Plant spills/overflows captured as close as possible to the point of origin of the spillage and recycled to the ore/minerals plant water circuits – requires detailed information for the plant that is unavailable for the case study mine.

- Clear separation of process spillage systems from storm water systems to allow collection of process spillages close to the point of origin for direct reuse and collection of storm water for general reuse within the plant area requires detailed information for the plant that is unavailable for the case study mine.

- Product stockpile footprint areas minimized to reduce impacted water production – already applied at the case study mine.

- Water storage in underground compartments to reduce evaporative losses – not applicable at this mine as there are no underground storage compartments isolated from underground mining activities.

- Water supply and storage managed by aquifer recharge and abstraction to reduce evaporative losses – not applicable as no groundwater is used in the beneficiation plant.

- Process water intake based on hierarchy to preferentially use mine impacted water and reduce intake of fresh water – this is considered and incorporated into Option 13.

- Development and adherence to water quality standards for all water users in the beneficiation plant that aims to provide all users with the worst possible quality water that does not affect process performance or cause corrosion/scaling problems – will be implemented as part of Option 13.

6.3.2.3 WC/WDM measures for waste, residue disposal and tailings storage operations

The following generic measures have been identified:

- Dispose of waste in underground workings (backfill) to reduce the surface footprint of waste/residue disposal facilities – not applicable to the type of mining practiced at this mine.
Dispose of waste in old opencast & pit workings to reduce the surface footprint of waste/residue disposal facilities – not applicable as this is not an opencast mine.

Thicken and/or dewater residues and tailings to limit the amount of water disposed with the residues and tailings – this is considered in Option 8.

Reduce the amount of water stored on the residue/tailings disposal facilities to reduce evaporative losses – considered as part of Option 5.

Reduce the surface area of the free water pool on tailings storage facilities to recue evaporative losses – considered as part of Option 5.

Collect and intercept seepage from residues and tailings disposal facilities for reuse and recycling – considered as part of Options 4, 6 and 13.

Manage water balance on return water dams to ensure that no water enters the return water dams that was not included in the original sizing and design of these dams (i.e. this will generally mean that storm water runoff and water from mining operations should not be stored in tailings return water dams) – this is already implemented at the case study mine.

6.3.2.4 General WC/WDM measures

The following generic measures have been identified:

Implement dry dust control measures (such as binding agents on haul roads) to reduce water use – considered as part of Option 10.

Supply excess water that cannot be accommodated within the mine’s water balance (with or without treatment) to external, off-mine water users – not applicable at this mine as there are no suitable off-mine water users.

Discharge excess water that cannot be accommodated within the mine’s water balance, in compliance with regulatory discharge standards, to streams & rivers for downstream water users – not considered – rather apply Option 13 to treat and reuse the water.

Water use by staff & personnel using a range of water savings devices and methods – this is considered in Option 11:

- Low volume closets
- Waterless urinals, etc.

Development of non-conventional water resources to reduce the use of conventional surface and groundwater resources – non of these options are applicable at the case study mine:

- Rain harvesting
- Reclaimed AMD
- Covers on dams & ponds.

Incorporate water conservation and demand management training into standard induction programmes for all employees and contractors – this is incorporated into Option 3.

Incorporate meeting of WC/WDM targets into the KPIs of key staff on the mines that have responsibility for ensuring that WC/WDM is optimally developed and implemented on mines will be implemented but cannot be simulated in the mine water balance – this is included in Option 3.
6.3.2.5  **WC/WDM options identified for the case study**

After considering all possible options, 14 potential WC/WDM measures were identified as listed in Table 4 below. These options can be divided into three broad groups as follows:

- Options to reduce consumptive water use
- Options to reuse / reclaim water
- Options to use alternative operational technologies that will save water

The potential options for the case study have also been classified into the above categories and more information on each is provided in the sections below.

**Identify Opportunities to Reduce Consumptive Water Uses**

During this step, each consumptive water use was evaluated and opportunities were identified to reduce that particular consumptive use.

**Unspecified sinks**

Water lost through unspecified sinks could indicate an inadequate water balance. Some of this water may be recoverable for reuse in the process. Since the unspecified sinks for this mine represent a substantial volume of water, it is recommended that the water balance be upgraded in order to identify the unspecified water sinks (Option 1). Once this is done, opportunities to reduce this water usage can be formulated.

Unspecified sinks could partially be attributed to leaks in the water system, or inappropriate use (wastage) of water. One of the water conservation opportunities for this mine could therefore be to develop a systematic program to check and repair leaks in the water system (Option 2). An additional opportunity will be to develop and roll out an education and awareness programme on the proper use of water and the importance of saving water in order to reduce water wastage (Option 3). Management procedures can also be implemented to monitor and manage water usage. Wastage of water can then be managed through performance reviews of responsible managers. This may require the installation of additional measurement and monitoring systems to improve management and accounting of water.

**Total water discharged (untreated)**

For this mine, a substantial volume of water is discharged to the environment, while raw water is imported for the operation. Replacement of imported raw water with excess discharged water therefore seems to be a substantial opportunity and will be discussed in a later section.

If all excess water cannot be recycled, treatment of the excess water prior to discharge will be required to meet the appropriate standards. This will convert the untreated discharge from a consumptive water use to a treated discharge, which is considered an outflow and not a consumptive use. Although it will not reduce the total water usage of the mine, it will reduce the consumptive water use of the mine (Option 4).

**Seepage/Evaporation losses**

The bulk of the seepage and evaporation losses for the case study mine are attributed to the residue disposal section (tailings facility, return water dam and other surface dams).

The evaporation and seepage losses at the tailings facility, return water dam and other surface dams can be reduced by reducing the surface area of the tailings pool and the surface area of the dams. This can be achieved through improved operational management of the dams to ensure that the pool area is kept to a minimum at all times (Option 5). Automatic control systems can be installed to improve the operation.

Seepage through the tailings facility, return water dam and other surface dams can be reduced by lining the dams (Option 6).

Seepage and evaporative losses in the mining section (underground) is attributed to water lost with ventilation and seepage in the underground areas. For this case study mine, a large portion of the water used underground is used by the rock drills, where some of the water is lost through evaporation and
seepage. A potential opportunity could therefore be to convert to rock drills that use less water (Option 7) if such technology is available.

**Interstitial storage**

A substantial amount of water is trapped in the tailings residue remaining on the tailings facilities (interstitial storage). An opportunity to address this is to decrease the water content of the tailings, using for example high density thickening or paste technology (Option 8). This will at the same time reduce the water lost through seepage and evaporation, since paste residue will not have a pool on the paste tailings facility.

**Water out in product**

The product of this case study mine is a dilute concentrate from the flotation process containing a substantial volume of water. This water is in effect lost to the mine through transportation with the product to the smelter/refinery. An opportunity for this mine could be to thicken the product in order to recover some water from the product for reuse in the process (Option 9). Note that this will only result in an overall water saving if the water in the product is not required in the downstream processes. If the water is required in the downstream processes, it will increase the downstream process water requirement and will add to the water use. Contaminated water that was removed by the thickening process will therefore probably be replaced with a better quality water and not provide an overall water saving.

**Dust suppression**

A relatively small amount of water is used for dust suppression by this mine. An option that can be considered to reduce this water usage is the use of dustaside on the haul roads in order to reduce the water requirement for dust suppression (Option 10).

**Sanitation water discharged**

The volume of sanitation water that is discharged can be reduced by implementing water conservation measures such as low-flow shower heads in change rooms, low water usage toilets, etc. (Option 11). Alternatively the water can be suitably treated for reuse in the mining process (Option 12), such as tailings transport, dust suppression, etc.

**Reduce Total Raw Water Import through Recycle/Reuse**

Since a substantial volume of water is imported and discharged by this mine, the most significant opportunity will be to treat and reuse the discharged water in order to reduce the raw water import. Most of the process water used in the mining and beneficiation process can be replaced by the water that is currently being discharged with little or no treatment required (Option 13). The discharges are however seasonal, which will require the construction of suitable reservoirs/dams to store the water during the rainy season for reuse in the dry season. It will also require the installation of pumps and pipelines and modifications to the existing reticulation system in order to transport the excess water to the required demand points.

Recycling surplus water to be treated and used as potable water could also be a theoretical opportunity on this mine (Option 14). This will however require the construction of a potable water treatment plant to treat the surplus water to potable standards.

**Identify Methods to Reduce Water Usage through Technology Replacement**

Some technology replacement options, such as using different rock drills, converting to paste technology, etc. have already been discussed in previous sections. No additional technology replacement options have been identified for this mine.

6.3.3 **Evaluate each option using the simulation water balance model**

The water balance program was used to estimate the expected water saving if each identified opportunity is implemented individually. The following assumptions were made in calculating the water saving of each opportunity (as noted previously, these assumptions may not all be realistic or relevant, but are used only for indicative purposes in this case study). The Basis for Calculation is illustrative for this case study and will have to be assessed on an individual mine’s situation, age of infrastructure, mining methods, remaining LoM,
etc. Certain opportunities, such as converting tailings to paste, thickening of product, etc are based on design data and experience.

Table 4: Assumptions made to Estimate Saving of each Option

<table>
<thead>
<tr>
<th>No</th>
<th>Option</th>
<th>Basis of Calculations</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Upgrade water balance — identify &amp; implement opportunities</td>
<td>25% of unspecified sinks saved through measures identified after upgrading water balance.</td>
</tr>
<tr>
<td>2</td>
<td>Repair leaks</td>
<td>25% of unspecified sinks saved by repairing leaks.</td>
</tr>
<tr>
<td>3</td>
<td>Water management and awareness programme</td>
<td>10% of unspecified sinks saved by reducing wastage of water.</td>
</tr>
<tr>
<td>4</td>
<td>Treat all untreated discharges</td>
<td>80% of surplus water discharged to the river intercepted &amp; treated.</td>
</tr>
<tr>
<td>5</td>
<td>Minimise pool and surface areas of all dams</td>
<td>Pool on tailings facility reduced by 80%, and surface area of return water dam and other surface dams reduced by 50%.</td>
</tr>
<tr>
<td>6</td>
<td>Lining of all dams to reduce seepage</td>
<td>Seepage from all dams reduced to zero by lining.</td>
</tr>
<tr>
<td>7</td>
<td>Change to rock drills that use less water</td>
<td>Water used for mining reduced by 25%.</td>
</tr>
<tr>
<td>8</td>
<td>Convert tailings to paste</td>
<td>SG of tailings increased from 1.4 to 1.82.</td>
</tr>
<tr>
<td>9</td>
<td>Thicken product (prior to export to smelter)</td>
<td>SG of product increased to 1.2 to 1.4.</td>
</tr>
<tr>
<td>10</td>
<td>Reduce dust suppression</td>
<td>Water used for dust suppression decreased by 75%.</td>
</tr>
<tr>
<td>11</td>
<td>Water conservation measures to reduce sanitation water</td>
<td>Water used per person reduced by 40%.</td>
</tr>
<tr>
<td>12</td>
<td>Treat and reuse sanitation water</td>
<td>All sanitation water treated and reused.</td>
</tr>
<tr>
<td>13</td>
<td>Reuse surplus water for process water</td>
<td>80% of surplus water discharged to river intercepted, treated and reused as process water.</td>
</tr>
<tr>
<td>14</td>
<td>Reuse surplus water for potable water</td>
<td>Since all available surplus water can be used for process water, there will not be enough surplus water for this opportunity. This opportunity will therefore not be an option.</td>
</tr>
</tbody>
</table>

The results are shown in Table 5 below. From the results it is clear that the largest single water saving can be achieved by reusing the surplus water as process water. The indicated potential savings allow prioritisation and selection of potential opportunities. Implementing the individual savings will impact on the potential saving achievable by implementing other savings. (The sum of the individual savings exceeds the total saving if all opportunities are implemented).

Table 5: Calculated Water Saving per Option

<table>
<thead>
<tr>
<th>Description</th>
<th>Total water input</th>
<th>Consumptive use</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>m³/year</td>
<td>m³/t</td>
</tr>
<tr>
<td>Current Situation</td>
<td>5,940,000</td>
<td>1.91</td>
</tr>
<tr>
<td>Option</td>
<td></td>
<td></td>
</tr>
<tr>
<td>1 Upgrade water balance — identify &amp; implement options</td>
<td>5,706,500</td>
<td>1.84</td>
</tr>
<tr>
<td>2 Repair leaks</td>
<td>5,706,500</td>
<td>1.84</td>
</tr>
<tr>
<td>3 Water management and awareness programme</td>
<td>5,804,500</td>
<td>1.87</td>
</tr>
<tr>
<td>4 Treat all untreated discharges</td>
<td>5,940,000</td>
<td>1.91</td>
</tr>
<tr>
<td>5 Minimise pool areas of all dams</td>
<td>5,702,100</td>
<td>1.83</td>
</tr>
<tr>
<td>6 Lining of all dams to reduce seepage</td>
<td>5,707,800</td>
<td>1.84</td>
</tr>
<tr>
<td>7 Change to rock drills that use less water</td>
<td>5,920,500</td>
<td>1.90</td>
</tr>
<tr>
<td>8 Convert tailings to paste thickened tailings</td>
<td>5,700,000</td>
<td>1.83</td>
</tr>
<tr>
<td>9 Thicken product</td>
<td>5,706,500</td>
<td>1.84</td>
</tr>
<tr>
<td>10 Reduce dust suppression</td>
<td>5,803,800</td>
<td>1.87</td>
</tr>
<tr>
<td>11 Water conservation measures to reduce sanitation water</td>
<td>5,906,400</td>
<td>1.90</td>
</tr>
<tr>
<td>12 Treat and reuse sanitation water</td>
<td>5,813,200</td>
<td>1.87</td>
</tr>
<tr>
<td>13 Reuse surplus water for process water</td>
<td>4,889,700</td>
<td>1.57</td>
</tr>
<tr>
<td>14 Reuse surplus water for potable water</td>
<td>5,940,000</td>
<td>1.91</td>
</tr>
</tbody>
</table>
6.3.4 Determine life-cycle capital and operating costs for each option

Budget level NPV calculations have been undertaken for each of the different options and they have been broadly classed as low, medium and high as shown in Table 6 below.

Table 6: Budget Cost Estimates for Each Option

<table>
<thead>
<tr>
<th>No</th>
<th>Option</th>
<th>NPV Cost Estimate (R million)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Upgrade water balance – identify &amp; implement opportunities</td>
<td>3.5</td>
</tr>
<tr>
<td>2</td>
<td>Repair leaks</td>
<td>6.5</td>
</tr>
<tr>
<td>3</td>
<td>Water management and awareness programme</td>
<td>0.5</td>
</tr>
<tr>
<td>4</td>
<td>Treat all untreated discharges</td>
<td>50.0</td>
</tr>
<tr>
<td>5</td>
<td>Minimise pool and surface areas of all dams</td>
<td>15.0</td>
</tr>
<tr>
<td>6</td>
<td>Lining of all dams to reduce seepage</td>
<td>3.0</td>
</tr>
<tr>
<td>7</td>
<td>Change to rock drills that use less water</td>
<td>10.0</td>
</tr>
<tr>
<td>8</td>
<td>Convert tailings to paste</td>
<td>10.0</td>
</tr>
<tr>
<td>9</td>
<td>Thicken product (prior to export to smelter)</td>
<td>25.0</td>
</tr>
<tr>
<td>10</td>
<td>Reduce dust suppression</td>
<td>5.0</td>
</tr>
<tr>
<td>11</td>
<td>Water conservation measures to reduce sanitation water</td>
<td>1.0</td>
</tr>
<tr>
<td>12</td>
<td>Treat and reuse sanitation water</td>
<td>12.0</td>
</tr>
<tr>
<td>13</td>
<td>Reuse surplus water for process water</td>
<td>12.0</td>
</tr>
<tr>
<td>14</td>
<td>Reuse surplus water for potable water</td>
<td>50.0</td>
</tr>
</tbody>
</table>

6.3.5 Rank all options

All options that have been simulated and for which cost estimates (as NPV) have been determined should be entered into a tabular format including information as set out in Section 3.2.5 to enable ranking of options.

Table 7: Ranking of Options

<table>
<thead>
<tr>
<th>Description</th>
<th>Consumptive WUE Indicator</th>
<th>Capex</th>
<th>Cost Effectiveness</th>
<th>Ranking</th>
</tr>
</thead>
<tbody>
<tr>
<td>Current Situation</td>
<td>m³/year 1.91</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1 Upgrade water balance – identify &amp; implement opportunities</td>
<td>5,706,500 1.84 3.9%</td>
<td>3.5</td>
<td>14.99</td>
<td>3</td>
</tr>
<tr>
<td>2 Repair leaks</td>
<td>5,706,500 1.84 3.9%</td>
<td>6.5</td>
<td>27.83</td>
<td>4</td>
</tr>
<tr>
<td>3 Water management and awareness programme</td>
<td>5,804,500 1.67 2.3%</td>
<td>0.5</td>
<td>3.69</td>
<td>1</td>
</tr>
<tr>
<td>4 Treat all untreated discharges</td>
<td>5,940,000 1.91 0.0%</td>
<td>50.0</td>
<td>-</td>
<td>14</td>
</tr>
<tr>
<td>5 Minimise pool areas of all dams</td>
<td>5,702,100 1.63 4.0%</td>
<td>15.0</td>
<td>63.05</td>
<td>9</td>
</tr>
<tr>
<td>6 Lining of all dams to reduce seepage</td>
<td>5,707,800 1.84 3.9%</td>
<td>3.0</td>
<td>12.92</td>
<td>2</td>
</tr>
<tr>
<td>7 Change to rock drills that use less water</td>
<td>5,920,500 1.90 0.3%</td>
<td>10.0</td>
<td>514.56</td>
<td>12</td>
</tr>
<tr>
<td>8 Convert tailings to paste thickened tailings</td>
<td>5,700,000 1.63 4.0%</td>
<td>70.0</td>
<td>291.73</td>
<td>11</td>
</tr>
<tr>
<td>9 Thicken product</td>
<td>5,706,500 1.84 3.9%</td>
<td>25.0</td>
<td>107.04</td>
<td>10</td>
</tr>
<tr>
<td>10 Reduce dust suppression</td>
<td>5,803,800 1.67 2.3%</td>
<td>5.0</td>
<td>36.71</td>
<td>6</td>
</tr>
<tr>
<td>11 Water conservation measures to reduce sanitation water</td>
<td>5,906,400 1.90 0.6%</td>
<td>1.0</td>
<td>29.78</td>
<td>5</td>
</tr>
<tr>
<td>12 Treat and reuse sanitation water</td>
<td>5,813,200 1.67 2.1%</td>
<td>5.0</td>
<td>39.41</td>
<td>7</td>
</tr>
<tr>
<td>13 Reuse surplus water for process water</td>
<td>4,889,700 1.57 17.7%</td>
<td>12.0</td>
<td>47.60</td>
<td>8</td>
</tr>
<tr>
<td>14 Reuse surplus water for potable water</td>
<td>5,940,000 1.91 0.0%</td>
<td>50.0</td>
<td>-</td>
<td>13</td>
</tr>
</tbody>
</table>

Cumulative savings that may be realised vs cost required to implement the opportunities are reflected in Figure 11. Treating excess water for process use (recycle) was selected rather than the treatment of excess water for either potable use or discharge to the catchment. While the case study and Figure 11 assumes that all the savings can be accumulated, it must be cautioned that this is not a universally correct assumption as some implemented options may preclude the application of other options. The recommended practice, therefore, is to model each cumulative management option to determine what the actual net savings would be and to plot the outcome of such simulations against cumulative cost when deriving a graphic such as is shown in Figure 11.
6.3.6 Select combination of options for integrated 5-year WC/WDM plan

Based on the results of the ranking exercise, an integrated 5-year WC/WDM plan can be developed that incorporates short, medium and long-term elements as follows:

- Short term: Within the next 2 years,
- Medium term: Within the next 5 years,
- Long term: Within the next 10 years (Options that will carry through into the next 5-year WC/WDM plan).

Three opportunities are selected as an example for this case study. More opportunities could be added if required.

Based on the results calculated in Section 6.3.4 and 6.3.5 above, it is recommended that the major focus should be on re-using the surplus water as process water (Option 13). The costs and timing for this option will depend on the quality, location and storage requirements. These factors will have to be taken into account when deciding on the roll-out of this option. If this option is implemented, Option 4 (treatment of the untreated discharges) will become irrelevant. It is recommended that work commence immediately to investigate and plan this Option, and that it is rolled out in the short term (10% reuse), medium term (30% reuse) and long term (80% reuse).

Upgrading of the water balance may potentially lead to a substantial saving, as well as repairing leaks (Options 1 & 2). These two options will be relatively simple and can be implemented at low cost and in the short term (25% reduction of unspecified sinks) and medium term (40% reduction of unspecified sinks).

Minimising the pool areas (Option 5) can also lead to a substantial saving. It is recommended that an automated control system be implemented to ensure that pool areas are kept at a minimum. This can be rolled out in the medium term. If this option is successful, it will reduce the savings that can be achieved by converting to paste technology. Since the conversion to paste technology will be expensive, justifying this based on water savings only will probably not be feasible.

Implementing the selected four options (1, 2, 5 and 13) over the short, medium and long term should result in a cumulative saving for the next ten years as shown in Figure 12 below. By year ten, the water usage of this mine can be reduced from 1.91 m³/t to 1.50 m³/t by implementing these 4 options (22% saving from the...
current situation). This prediction can therefore be used to define the WUE targets for this mine over the next 10 years.

![Graph showing cumulative saving of the four major opportunities over the next 10 years](image)

*Figure 12: Cumulative saving of the four major opportunities over the next 10 years*

The total mine raw water import reduces from 0.72 m$^3$/t to 0.31 m$^3$/t over the 10 year period, a reduction of 57%, as illustrated in Figure 13.

![Graph showing saving in raw water import due to implementation of the four opportunities over the next 10 years](image)

*Figure 13: Saving in raw water import due to implementation of the four opportunities over the next 10 years*

The savings in combined water losses, defined as seepage plus evaporation losses, is shown in Figure 14 and the saving in water lost to unspecified sinks is shown in Figure 15.
The information described above must then be utilised to develop, motivate and document a comprehensive WC/WDM plan to be submitted to DWS for approval.

While the calculations can be undertaken for all the different WUE indicators, the integrated WC/WDM plan developed for this case study mine would have the following targets for consumptive water use efficiency for the next 5 years (with a projected target for 10 years also included):

Year 1: 1.85 m³/ton
Year 2: 1.79 m³/ton
Year 3: 1.75 m³/ton
Year 4: 1.70 m³/ton
6.3.7 Evaluate adequacy of proposed 5-year WC/WDM plan

The annual targets for each of the WUE indicators should be compared to the national benchmark values that apply at the time when the plan is being developed. While the same exercise can be undertaken for each of the WUE indicators, the case study demonstrates the principle by way of using the consumptive water use efficiency. The progressive improvement in consumptive WUE over the proposed 5-year term of the WC/WDM plan from the current 1.91 m³/ton down to 1.66 m³/ton, is well below the current benchmark of 1.82 m³/ton and the proposed WC/WDM plan is therefore considered adequate.

6.3.8 Compile and submit a 5-year WC/WDM plan

Once the mine has moved through the activities described above, the mine will need to prepare a documented WC/WDM plan which will need to comply with content requirements as determined by the DWS by way of regulations or guideline documents. The initial 5-year WC/WDM plan will be submitted by the mine as an addendum to its existing IWWMP (for those mines that have already compiled and submitted an IWWMP to the DWS). Future updates of the WC/WDM plan will be incorporated into and synchronised with updates to the mine’s IWWMP.

7.0 CONCLUSIONS

This report provides a simple yet practical and comprehensive WC/WDM implementation methodology that clearly defines the separate responsibilities of the mining industry and DWS. This methodology is based on the generic implementation methodology presented and agreed to in Phase 1 of the report. Additionally, the report provides a strong recommendation that the work undertaken by the Minerals Council of Australia in the form of the Water Accounting Framework (WAF) be adopted, with certain modifications, to also provide the reporting framework for WC/WDM in South Africa.

A clear and practical methodology is presented that will assist the mines in moving from their current situation to a future situation where they have developed and implemented WC/WDM plans that bring them into line with the national benchmarks. The report also presents a clear case study that demonstrates the principles included in the methodology proposed in this report for the development of a WC/WDM plan and the development of mine-specific WUE targets.

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APPENDIX A
Generic Implementation Approach from Phase 1 Report
The work undertaken in Phase 1 of the project clearly indicates that the generic implementation approach must include the following features:

1) Strategies to enhance the WC/WDM culture in the mining sector based on recognition of the social contract to efficiently use a scarce resource (water) and the recognition that water scarcity poses a significant business risk.

2) Elevation of Pollution Prevention (PP) measures (as described in the DWS BPG H2: Pollution Prevention and Minimisation of Impacts) within mine water management planning and implementation process. This must be done such that PP planning and implementation become a non-negotiable requirement for all mines in recognition of the fact that water quality is a key issue affecting the viability of water reuse / water reclamation measures.

3) Adoption of the DWS BPG related to WC/WDM (Department of Water Affairs, 2011) and the formal process of assessing, planning, and implementing WC/WDM.

4) Clear definition of monitoring and reporting protocols to ensure that mines are measuring and reporting their WC/WDM performance correctly and in line with DWS requirements (refer to DWS BPG G3: Water Monitoring Systems as well as to the Global Reporting Initiative / GRI).

5) A well-defined and comprehensive regulatory system to provide the legal impetus for the implementation of WC/WDM, as well as an option for self-regulation and incentivising mining companies.

6) A fair and equitable system to define and quantify those characteristics of a mine that affect water use efficiency and that should be used to differentiate between mines when setting water use efficiency targets.

7) A list of generic WC/WDM technologies/systems that should be implemented at all mines as a minimum requirement.

8) Well-defined technologies and systems that can be applied to enable mines to identify, prioritise and implement site-specific and appropriate WC/WDM measures above and beyond the minimum requirement measures. Clear reference to South African and, where appropriate, international case studies, to demonstrate how WC/WDM can be successfully implemented on mines.

9) Time frames that can realistically be set for the implementation of WC/WDM measures and attainment of targets within the mining sector.

1.1 Development of a WC/WDM Culture

Due to the limited water resources available in South Africa, the competition for this valuable resource is continuously increasing. Globally and nationally, the trend has been to prioritise water for human use (domestic use), food production (agricultural use) and aquatic ecosystems (ecological functioning) ahead of industry such as mining. This trend is evident in South Africa and reflected in our legislation and regulations (NWA, NWRS, WC/WDM, Reserve determinations).

With attitudes changing, water is increasingly seen as a valuable resource and a business risk from a sustainability point of view. Increasing water demands and competition for the same scarce resource have resulted in a higher proportion of water being recycled internally on mines as well as the use of poor quality make-up water rather than importing fresh water. It has therefore become important for the mining sector to:

- Not take water for granted as it is a limited, scarce and valuable commodity in South Africa that needs to be conserved;
- Follow a pro-active approach in terms of water management whereby measures are implemented to prevent impacts rather than mitigating impacts after occurrence;
Incorporate water issues into strategic business decision-making to ensure sustainable use and development of the mining sector;

- Ensure all current and future water users are not adversely affected by the mining activities as water is a shared resource and other users' interest and rights must be recognised and respected;
- Reduce operating cost over the long term due to efficient water use through water conservation;
- Optmise water reuse and reclamation; and
- Realise water is a key business asset with social, cultural, environmental and economic value.

Strategies will need to be adopted by mines to foster a water management and specifically a WC/WDM culture that can be integrated into the corporate culture in the same way that safety issues have. This will require that WC/WDM be built into staff and contractor training programmes and that responsibility for meeting of targets in terms of water management must be incorporated into the Key Performance Indicators of people.

These programmes should go beyond the simple recognition that scarcity of water poses a business production risk and should include training mine personnel to recognise the social value of water. The true value of water incorporates a number of social and economic aspects:

- Cultural or spiritual associations with water or the land on which water infrastructure is constructed and operated;
- The value of natural ecosystem services reliant on the same water supply;
- Competing social demands on the same resource (e.g. domestic water supply);
- Social, cultural, environmental or economic impact on downstream water users if water quality is affected by mining operations or not available to other water users;
- Impact on company reputation for poor water management performance;
- Cost to the operation if excess impacted water cannot be discharged;
- Loss of income, jobs or market share if mining production cut-backs result due to water shortage.

A strategic water management approach adopted by the mine should thus ensure that water is more efficiently managed and valued as a vital business and community asset.

1.2 Focus On Pollution Prevention Measures

The site visits to the 39 mines in Phase 1, coupled with Golder's general experience within the mining sector, indicates that the pollution prevention approach to water management is not receiving the necessary priority attention at some mines, despite being Step 1 in the water management hierarchy (as defined in the DWS BPG on WC/WDM for the mining sector (Department of Water Affairs, 2011)). As the ease and economics of water reuse and water reclamation is very closely linked to the quality of water under consideration, an effective WC/WDM strategy and implementation plan must also give priority to the stricter enforcement and optimisation of pollution prevention within mine water management planning.

This objective can be attained in different ways, including regulation, application of the Best Practice Guidelines (e.g. DWS BPG H2: Pollution Prevention and Minimisation of Impacts), use of cleaner technology and appropriate research into prevention of pollution at all planning and implementation stages of an integrated mine water management plan. Pollution prevention measures that could potentially have the biggest impact on improving water use efficiency need to be identified in Phase 2 of the project in order that they can be incorporated into the WC/WDM plan to be developed by each mine.
1.3 WC/WDM Monitoring and Reporting Protocols

The site visits to the 39 mines in Phase 1, clearly highlighted deficiencies and inconsistencies in the manner in which many mines measure, review, manage and report on their water use efficiency. The primary problem is that most mines do not have appropriate dynamic water balances based on regular and reliable measurement of flows at key points, together with modelled data for runoff, seepage and evaporation - all incorporated into a computerised water balance system that is actively used by a mine to manage water (as described in the DWS BPG G3: Water Monitoring Systems and DWS BPG G2: Water and Salt Balance). In the absence of reliable water balances and the inability of the mines to actually measure and report on their total water use for all sources and sinks of water within their operations/processes, it becomes difficult to implement WC/WDM strategies. An urgent need therefore exists to ensure that the water balances of mines are aligned in terms of methodologies and definitions and that all mines adopt an approach that allows accurate monitoring and assessment of the status of WC/WDM. Application of the principles set out in DWS BPG G2: Water and Salt Balances will resolve this problem, which could also be addressed through a regulatory approach as set out in Section 7.4 below.

An additional problem is that many mines focus on reducing potable water use only, by way of replacing potable water with other sources of water such as ground water and storm water. While such strategies have the benefit of reducing business operational risk due to scarcity of potable water, they do not necessarily have any effect on improving overall water use efficiency. In many cases, the ground water and storm water are not viewed as sources of water that can or should be reduced and they are simply viewed as free sources of water on mining operations. This problem can only be overcome by giving clear guidance on what components of the mine water balance should be measured and reported on and which should be included when determining the mine's water use efficiency.

Finally, it is clear from the survey, that water use efficiency should not only be reported for the mining operation as a whole. There is also a need to determine and distinguish between water use efficiency in the different components/processes of the mine, specifically the mining operations, the mineral beneficiation operations and the mine residue/tailings disposal operations.

In summary, it is recommended that the WC/WDM implementation approach incorporate an electronic form for reporting on water use efficiency similar to the Waste Information System which is implemented in South Africa. This should be accompanied by clear guidance on how water usage should be calculated, monitored and reported.

1.4 Regulatory Approach

The regulator needs to ensure that WC/WDM measures are implemented within a reasonable time in the mining sector. It is proposed that the DWS utilise the existing regulatory instruments to ensure that WC/WDM is implemented in the mining sector.

There is no need for the development of a new suite of regulatory tools and instruments, as the sector is already subject to over regulation by a range of environmental legislation, which includes the Mineral and Petroleum Resources Development Act (Act 28 of 1998) (MPRDA), the National Environmental Management Act (Act 107 of 1998) (NEMA), National Environmental Management: Waste Act (Act 59 of 2008) (NEMWA) and the National Water Act (Act 36 of 1998) (NWA). There is also duplication in terms of reporting requirements which will require government to be very cautious so as not to create a further burden and duplication related to WC/WDM.

Improvement in the enforcement or current and future regulatory requirements by the regulatory authorities is seen as one of the key success factors for the implementation of WC/WDM.

The implementation of WC/WDM can be achieved by using either a “command and control” or a “self-regulatory” approach. The “command and control” approach will involve “push” factors such as regulatory instruments and measures utilised by the regulator to force the mines to implement WC/WDM measures and a number of additional “push” factors, such as water pricing. The proposed self-regulatory approach on the other hand will entail a number of “pull” factors, in essence serving as an indirect method to encourage
mines to implement WC/WDM measures. The timeframes for implementation of WC/WDM will be discussed in Section 7.8.

The proposed command and control measures which can be implemented by the regulator to ensure that WC/WDM is implemented in the mining sector are based upon the existing legal instruments authorised in terms of the NWA, and they constitute the following:

- Government Notices;
- Regulations;
- Licensing; and
- General authorisations.

In addition to the legal instruments the DWS has control over the implementation of additional “push” factors by means of the following:

- Water pricing strategy; and
- Waste discharge charge system.

Self-regulatory or "pull" measures include the following:

- Incentive programmes;
- Funding for research and innovation;
- Water sector capacity building; and
- Raising awareness relating to the need for WC/WDM.

According to the National Water Conservation and Water Demand Management Strategy, 2004, the constraints that will have to be addressed are:

- Availability of capital for investment, profitability and the potential for cost recovery of WC/WDM related projects;
- Institutional constraints due to a lack of co-ordination between the role-players in the water supply chain during the planning phase of projects.
- Limited awareness of the need for WC/WDM and the effects of not implementing the required measures.
- Technical constraints due to lack of knowledge and implementation of specific tools, instruments and guidelines.

Although a self-regulatory approach is generally the preferred form of governance for the mining sector, the implementation of WC/WDM will involve a marked change in behaviour for a number of mining operations. It is therefore proposed to use the implementation of “command and control” measures to ensure that a consistent approach is followed throughout South Africa and that all mines adhere to the same standards and requirements. The aim is to utilise the “command and control” approach to establish a WC/WDM culture in the mining industry without placing an additional administrative burden on government and without creating further duplication in the reporting requirements for the mining industry. The consistent and efficient implementation of a simplified regulatory approach will assist in enforcing the implementation of WC/WDM.
1.4.1 Command and Control Approach

1.4.1.1 Government notice

It is proposed to publish a notice in the Government Gazette to require all mines in South Africa to register their operations as part of the process to implement WC/WDM in the mining industry. This approach is similar to the registration process which took place in 2009 for water uses related to the Waste Discharge Charge System and would probably require a dedicated team to ensure the success of the process. It is proposed that a standardised registration form be developed which will require the mines to supply the necessary information to enable the DWS to determine the following:

- Status of the mine in terms of implementation of WC/WDM on the mine, measures already implemented and successes achieved;
- Characteristics of the mine in terms of water make and current water use;
- Targets for water use efficiency in the mining, beneficiation and waste disposal processes for each mining operation.

The purpose and end goals of this process will have to be well communicated to ensure good participation. The mine specific characterisation in terms of water could also be done electronically via the internet, as this assessment tool will be in electronic format.

This initiative is seen as a once off tool to enable the DWS to conduct a status quo assessment of WC/WDM on a national level. This will form the baseline for WC/WDM in the mining industry against which the DWS can measure any improvements in terms of WC/WDM in future. This registration process will further enhance the awareness of the importance of WC/WDM. The process will utilise existing legal instruments available to the DWS. However, the capturing of data and generation of WC/WDM related information will require resources from the DWS. The Department of Mineral Resources (DMR) should also be engaged as part of this process to ensure that responses from all mining activities are obtained, since the DMR should have a complete list of all licensed mining activities.

1.4.1.2 Regulations

Regulations are seen as one of the most powerful legal instruments for government in the command and control approach, as they are applicable to all mines in South Africa. Regulations do not provide for site specific conditions, but can stipulate measures that must be implemented by mines and under which circumstances those measures should be implemented.

The promulgation of the draft WC/WDM regulations and the revised regulations on use of water for mining and related activities aimed at the protection of water resources (to replace those published in the Government Gazette of 4 June 1999, known as GN 704, by the DWS) will make it mandatory for all mines in South Africa to implement WC/WDM measures. These draft regulations are already in place. The DWS needs to focus on promulgation of these regulations to be able to enforce the implementation of the prescribed WC/WDM measures.

The draft revised mining regulations require the following in terms of WC/WDM from each mine in South Africa:

(1) A holder of a mining right must use all water on the mine efficiently and shall:

   (a) minimise the total water intake;
   (b) avoid the use of water where possible;
   (c) implement “good” housekeeping and operating practices; and
   (d) maximise the reuse of contaminated water.
A person who submits an environmental management programme or plan in terms of section 39(1) or section 39(2) of the MPRDA shall develop a water conservation and water demand management plan, which -

(a) quantifies the water use efficiency of the activity;
(b) contains the mine water management and water loss strategies and programmes;
(c) sets annual targets for improved water use efficiency for the mining activity, beneficiation and waste disposal practices and stipulates which measures will be implemented to achieve the targets on the mine;
(d) reports on the implementation of more efficient processes, equipment designs, and other on-site measures to enable the mine to avoid and reduce water consumption; and
(e) reports on the implementation and reduction of total water demand.

The holder of a mining right or production right shall –

(a) update the water conservation and water demand management plan at a frequency of not less than annually;
(b) execute the water conservation and water demand management plan; and
(c) submit the water conservation and water demand management plan to the Department as part of the IWWMP, unless directed otherwise by the Department.

While the revised GN 704 will provide for the abovementioned WC/WDM measures, more specific requirements can be published in the WC/WDM regulations. The Integrated Water and Waste Management Plan (IWWMP) is the preferred management instrument for the documentation and reporting of WC/WDM on a mine. These regulations should be kept simple and easy to implement.

1.4.1.3 Licensing

A water use licence issued in terms of section 4 of the National Water Act, 1998 authorises a mine to use water in terms of specific requirements. A water use licence is a site specific legal instrument which regulates site specific water uses at any mine.

WC/WDM licence conditions can be incorporated into existing or new licences. There is already a WC/WDM licence conditions booklet that has been developed which can be updated in order to guide the DWS officials during the process of drafting of water use licences.

The requirement for WC/WDM related reporting of information, as contained in the water use licenses will also enable the DWS to maintain a database related to WC/WDM and report on the success of implementation of WC/WDM in the mining sector.

1.4.1.4 General authorisations

General authorisations are seen as a legal instrument that generally authorises the use of water under specific conditions. It is associated with low impact water uses. It is proposed to include WC/WDM measures in any future update of the General Authorisations to ensure alignment in the DWS approach and to ensure that low impact mining activities (exempted from the mining regulations) are also forced to implement WC/WDM.
1.4.1.5 Other Mechanisms

Water pricing

Based upon the site engagements with 39 mines in South Africa during 2013, it became evident that energy efficiency programmes which enjoy a high priority on most mines, are driven by the high cost of electricity as well as the risks of energy shortfalls due to national energy generation capacity. It was also clearly determined during these site visits that the cost of water is so low and makes up such a small component of overall mine operation costs that it does not motivate for the efficient use of water on mines (which may change in future as raw water becomes more expensive due to more elaborate water schemes that must be developed to supply water to water scarce regions). Where WC/WDM measures are being implemented, they are generally in the form of water source replacement measures to reduce reliance on potable water sources by replacing the potable water with other sources of water generated on the mines such as ground water and storm water. However, these are not true WC/WDM strategies insofar as they do not result in an overall reduction in total water use or in an improvement in water use efficiency.

In order to drive water use efficiency by means of an increase in the price of water, the cost will have to be increased with such a margin that it is not seen as a viable short term measure due to the impact on the economic viability of the operations. Due to the fact that South Africa is a water scarce country, it is anticipated that the cost of water will increase in time and thus water pricing is seen as a medium-term measure to promote water use efficiency.

Waste discharge charge system (WDCS)

The waste discharge charge system is a deterrent mechanism aimed to reduce point- and diffuse sources of pollution. It might have an indirect benefit of reducing water demand insofar as mines will have to treat their contaminated water and, due to the costs involved in treatment, will then have an economic motive to preferentially reuse their treated water. This is seen as an indirect medium-term measure to improve WC/WDM as the WDCS is not implemented throughout South Africa at present.

1.4.2 Self-regulation

Self-regulation is recognised as a preferred form of governance and this approach is based upon voluntary implementation of WC/WDM. Government can develop a range of instruments to promote the implementation of WC/WDM. However, voluntary measures will not ensure the consistent implementation of WC/WDM by all mines throughout South Africa and will therefore not guarantee the success of the DWS strategy on WC/WDM.

The simplest form of self-regulation would be for the DWS to publish a government notice which requires the person in control of every operation to make an annual statement regarding the water use efficiency of the mining operation in terms of a suite of predetermined parameters (as discussed in Section 4 above) and to hold that person liable in his personal capacity for the correctness of the information. However, this approach will require the amendment of current legislation and could be considered as part of the review of the NWA.

1.4.2.1 Incentive programmes

Incentive schemes can be an effective option to encourage and promote the development and implementation of WC/WDM measures. An example of such a scheme is granting tax incentives to companies for the investments made in the development and implementation of water efficient technologies. However, this approach would need to be based on extensive consultation with the mining industry and with SARS and therefore cannot be a short-term measure.

Other incentives schemes already exist and need to be promoted. For example, the government through the DTI has developed a number of incentive programs aimed at supporting existing manufacturing enterprises through interventions to improve competitiveness. Manufacturing Competitive Enhancement Programme (MCEP) is one good example as it caters for incentives related to implementation of green technologies and resource improvement (including water use efficiency) amongst others.
1.4.2.2 **Finance and funding for research and innovation**

The financing of research and innovation to improve water use efficiency is seen as a long term strategy which supports WC/WDM at mines. This strategy will have limited motive force for mines to reduce water consumption.

1.5 **Differentiation in Water Use Efficiency Targets**

The need for differentiation in water use efficiency targets between different mines is an accepted principle that has been debated extensively throughout the project. The basis on which the differentiation of targets should be set has been documented in section 4. An electronic tool, called the "water characterisation tool" has also undergone some initial development. The aim of the tool is to objectively define and quantify to what extent targets should be differentiated on different mines by considering variables defined in the variables matrix (refer to section 4). The feasibility of such a tool will be investigated further in the second phase of this project. This approach is also used in the Anglo American WETT system described earlier in the report.

1.6 **Minimum Requirement for WC/WDM Measures**

Based on results and data obtained from the literature review, site surveys and professional experience in implementing WC/WDM measures at mines, it can be clearly stated that the WC/WDM measures that could be applied at mines to improve water use efficiency can be divided into two broad categories as follows:

- Measures that are generically applicable to all mines and that should be implemented as a minimum requirement, on the basis that the absence of such measures can be considered to demonstrate a wasteful approach to water use. These measures would also typically be considered to be the "low-hanging-fruit" measures that could potentially have significant benefits with relatively small investments.

- Measures that are site specific and/or require significant technical investigations in order to develop the precise methodologies and designs and changes to existing infrastructure before they can be developed.

The first category of measures should be well-defined and should be implemented on all mines within the short to medium-term in terms of regulatory instruments as described above. The second category of measures would most likely be implemented in the medium to long term and then by way of procedures as described in Section 1.7 below.

1.7 **Technical Procedures for Implementation of Site-Specific WC/WDM Measures**

The technical procedures that should be utilised in identifying, specifying and implementing site-specific WC/WDM measures are adequately described in the WC/WDM Guideline and in BPG H3: Water Reuse and Reclamation. There is therefore no intent to develop new technical procedures as part of Phase 2 of this project, but rather to ensure that the necessary cross-referencing to these two existing guideline documents is made wherever required. The aspects necessary for target setting will be abstracted and dealt with in this project (Task 9). It is also intended, in Phase 2, to describe a range of measures that can typically be considered to improve water use efficiency, and where possible, to also give a quantitative indication of the extent to which water use efficiency can be expected to improve.

1.8 **Timeframes for WC/WDM Implementation**

It is proposed that WC/WDM strategies be implemented in a phased manner as described below:

- Short term (<3 years) command and control type measures should be implemented to change the behaviour of the mining sector. This will involve the promulgation of the regulations, development of a registration and information system, followed by the publication of a government notice and the registration of all mines for the implementation of WC/WDM measures and the determination of their status in terms of the WC/WDM process. Mines should also start implementing the minimum requirement WC/WDM measures referred to in Section 1.6 above.
In the medium term (3 – 6 years) all mines will be issued with a short standardised WC/WDM water use licence and mines will conduct monitoring and report to DWS in terms of the licence conditions and on the WC/WDM information system. During this period, all mines will be expected to have fully implemented the minimum requirement WC/WDM measures referred to in Section 1.6 above and should also have initiated the processes referred to in Section 1.7 above to identify and implement the site-specific WC/WDM measures.

In the long term (6 -10 years) all the required water use efficiency measures will be implemented and the self-regulation measures can be further developed to improve water use efficiency on an on-going basis in line with the principle of continuous improvement.

1.9 Case Studies of WC/WDM Implementation
There are a number of pertinent case studies, both in South Africa (derived from the site surveys) and internationally (derived from the literature review) that should be incorporated into the implementation protocols to give practical examples to other mines as to how WC/WDM can be developed and implemented.

1.10 Training and Capacity Building
Training programmes will need to be developed for the regulator and the industry. The industry training should be focussed on promoting WC/WDM awareness, as well as to equip industry on how to best implement WC/WDM on a mine. The regulator training should be rolled out to all DWS regional offices, with the aim to equip DWS personnel on how to ensure that WC/WDM is successfully implemented in the mining industry.

1.11 Summary
Self-regulation is generally recognised as the preferred form of governance for the mining industry, although the voluntary implementation of WC/WDM by the mining sector is not seen as a priority for all players in the industry. The global economic climate forces mining operations to cut costs in order to be sustainable in the long term. The focus of many of the mining operations is therefore on profitability and minimum legal compliance, although there are some of the larger multinationals that operate on a different basis. Mines also tend to use the maximum volume of water authorised by their water use authorisations as there is little economic motivation to invest in systems to reduce their water use. Most water use licences do not have a phased approach whereby the use of water is reduced over time, thereby forcing mines to use water more efficiently. Water use licences issued to mines are not focused on giving effect to WC/WDM at site specific level.

The site engagement process with 39 mines during 2013 also found that many mines do not have a dynamic or up-to-date operational water balance and are unable to report on their status in terms of the WC/WDM process. Water use efficiency reporting takes place at a limited number of mines, and then mostly up to company level only and generally only for purchased potable water use. It is also clear that no uniform methodology exists for the reporting on water use efficiency.

In the light of the above and in order to ensure that all operations are treated equally by the different DWS regional offices, it is recommended that a simplified, streamlined process be developed for the implementation of WC/WDM. Duplication in reporting should be eliminated in this process. Regulations and licences, which are both legally enforceable, are the only instruments which will ensure that all mines implement WC/WDM in a uniform manner in South Africa.
APPENDIX B
Water Accounting Framework
Quick Reference Guide to the Water Accounting Framework Input-Output Model

Overview

The minerals industry water accounting framework provides a consistent methodology for the communication of how an operational facility interacts with water. This methodology is based on the consistent representation of these water interactions, as shown in the figure below:

1. Inputs represent the receipt of water to the operational facility;
2. Outputs represent the removal of water from the operational facility;
3. Diversion represents water that is moved around or through the operational facility;
4. The task-treat-store cycle represents what an operational facility does with its water and how it stores it.

The Input-Output model represents the intersection of the facility with the surrounding environment and community. The Input-Output model is a consistent method for reporting a facility’s water balance. It lists all inputs by source and all outputs by destination. The Input-Output model does not introduce any new concepts, it simply proposes a consistent way of communicating the water information that most mining companies and operational facilities already collect.

Key information required for the input-Output Model includes:

- Flow volumes into and out of the operational facility by source and destination.
- Diversion flow volumes ‘around’ the operational facility by source and destination.
- Water quality categorisation of flows (based on framework descriptors).
- Assignment of flow accuracy, based upon water accounting framework methodology.
- ‘Material’ or account relevant information provided through a Contextual Statement and accompanying Notes.
The second component of the water accounting framework is the **Operational Model**, which is a consistent method for the calculation and reporting of water reuse and recycling (store, treat and task cycle within an operation). Given the extensive capacity building required by companies, adoption of the operational model is optional for MCA member companies.

**Further Guidance**


For information, a quick reference guide on how to use the water accounting framework input-output model, based upon the format provided in the framework template has been provided in the following Figure 2.
APPENDIX C
Document Limitations
DOCUMENT LIMITATIONS

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