3. Planning and Principles

3.1 *Introduction*

Water respects no boundaries, and drought and floods are events beyond our direct control. The industry's role in water management is one of stewardship, not ownership, and therefore our operating philosophy should be based on the following concepts:

- efficient use of water;
- implementation of the reduce, re-use, recycle concepts;
- avoid or minimise contamination of clean streams and catchments;
- recognise and protect downstream beneficial uses (for both surface and groundwaters); and
- on relinquishment of title, the quantity and quality of drainage from the site should not prejudice the productive use of the land.

Implementing these concepts requires considerable planning, based on a clear understanding of the project and the hydrological, geochemical and processing regimes in which it operates. This section sets out the principles, while subsequent sections will provide the tools to prepare a detailed water management plan for a site.

3.2 *The Hydrologic Cycle and Minesite Water Balance*

The hydrologic cycle is the primary model for the input and output water management elements in any site development. These elements include:

rainfall;
surface runoff;
evaporation;
groundwater flow;
seepage;
site and process water uses;
site and process water outputs;
offsite discharges; and
on-site discharges.

Assigning values to the parameters of the hydrological cycle will identify the water surplus or deficit nature of the site. This process is referred to as the ***water balance.***

The minesite water balance is a central component in the minesite water management system. Through the water balance, we can gain a clearer understanding of the principal water management issues of ***supply, protection, containment*** and ***discharge.***

The principal data required for a water balance include:

- determining the appropriate ***timestep*** for the flow detail being assessed (hourly, daily, monthly or yearly); and
- defining the ***inputs, demands*** and ***outputs.***

The results obtained from the water balance present data that provide definable benefits in developing the components and systems for effective water management.

Various tools are available for the water balance including: spreadsheets for analysis; commercial software such as AWBM and RORB for rainfall/ runoff analysis; and customised software to suit the circumstances of a particular site.

3.3 *Site Description*

Basic information about a site is necessary so that a workable water management strategy or plan can be developed. Many of the components and processes in this description are required for other site assessment purposes. However, each topic should be considered in terms of the information needs required to address potential water management issues at the site. Not all topics will need to be researched intensively for every site.

3.3.1 CLIMATE

The essential climatic parameters are rainfall and evaporation. To a lesser extent, temperature, relative humidity, wind speed and direction and solar radiation are also required. Prior to resource development, daily records generally form the basis of data collection systems. Because long-term historical data are central to optimising water management studies and design, the earliest possible installation of real-time continuous data recording equipment is advised when a nearby weather station is not available. Once a project is undergoing detailed feasibility studies, climate monitoring systems which provide more frequent and specially targeted records may be required.

3.3.2 GEOLOGY AND GEOMORPHOLOGY

The data compiled here will assist with an understanding of the groundwater and surface water movement characteristics and likely responses to mine induced changes in flow or water quality.

3.3.3 TOPOGRAPHY

A site plan showing the geographic setting, contours and the land systems at the site is required. The contour intervals are dependent on the level of investigation and the type of structures - the more advanced the project the closer the contour intervals and the greater the accuracy. Typical values are 0.5 to 1.0 m (+/- 0.25 to 0.5 m) intervals for detailed design and 2.5 to 5.0 m (+/- 1 to 2 m) intervals for preliminary investigations. More detailed survey data may be required in particular cases.

3.3.4 CATCHMENT CHARACTERISTICS

A characterisation of the site for parameters relevant to the surface and groundwater hydrology is essential for the planning, design and operation of site water management systems. Storm and volume runoff coefficients, times of concentration for peak runoff, storage parameters, erosion potential, sedimentation characteristics and hydraulic coefficients such as Manning's "n" are relevant for surface characterisation. Hydraulic conductivity and permeability, sub-surface water zones and aquifers and storage and yield characteristics are typically required for an understanding of the groundwater system. Monitoring systems are necessary to obtain site-specific data and to confirm calculations.

3.3.5 SITE WATER REQUIREMENTS

It is important to understand what are the site water demands and how they may vary with time. A dynamic water balance is frequently a great asset in establishing and maintaining a water management program. Short-term benefits in reducing water use and cost should not jeopardise future opportunities for expansion of the operation.

3.3.6 VEGETATION AND FAUNA ASSESSMENT

The purpose of this assessment is to provide a clearer understanding of the catchment characteristics for rainfall runoff assessments, and to highlight sensitivities to the implementation of the various water management strategies.

3.3.7 AQUATIC ECOLOGY

The impact of the various strategies must recognise the type and diversity of species and relevant conservation values. Opportunities to utilise natural systems, eg. local wetland species in water treatment schemes can be highlighted in this assessment.

3.3.8 HERITAGE VALUES

A comprehensive assessment, listing and plan of archaeological, heritage, historical values and the visual character at the site will enable proper planning and locating of water management structures.

3.3.9 DOWNSTREAM AND OFFSITE USERS

Identification of the potential offsite impacts from the changes to the existing water patterns is required. The operator should assess the constraints, the target quality and quantity parameters required and where any benefits of the mine water management systems might pass to downstream users.

3.3.10 MONITORING

Monitoring will be required during the various phases of mine development: baseline, feasibility, construction, operations, decommissioning and active rehabilitation. The monitoring systems must be established with a view to understanding the catchment responses to the proposed site activity and verifying licence requirements, and for corroborating design data. Such systems need consistency through all phases of the project.

3.4 *Site Plan*

Mine water management is a long-term process which may be simplified by:

- planning for the energy-efficient storage, transport and use of water; and
- modelling to quantify present and future water budgets.

The thoroughness of the initial planning process will determine the ease with, and extent to which future changes to the water budget may be accommodated. The planning process should consider:

- identifying the locations of potential sources and probable yields (including surface water yields from rainfall and groundwater);
- identifying the locations of potential users of water and their likely demands;
- sizing and positioning of dams and other water control structures to cater for local demands;
- preventing degradation of water quality by identifying and separating "clean" and "dirty" streams;
- optimising the flexibility of the water system by linking components in the water circuit (using gravity drainage where possible);
- focusing excess water to down-gradient control dams of adequate size and at key locations to control offsite discharges;
- implementing recycling schemes to re-use water wherever possible; and
- implementing monitoring systems to quantify water entering the circuit, moving within the circuit and exiting the circuit.

Frameworks of water management systems derived in this way may be used to assess the impact of future changes in the water budget. This may be achieved by modelling the response of the mine water circuit to these changes commonly referred to as the minesite water balance. Models may be written using computer programming languages or developed using conventional spreadsheets.

Models should include:

- flexibility to alter quantities of source and demand water;
- flexibility to alter water transport rates;
- flexibility to alter dam sizes;
- flexibility to add or delete water transport routes; and

- ‘calibration’ checks against monitored quantities where appropriate.

Planning and modelling of site water budgets will allow any imbalances between water supply and demand at the site to be quantified and accommodated efficiently. The quality of water may also need to be considered in such an analysis.

The site plan must also address the final land use and the use of the water management infrastructure for the site after mining is finished. This will be a constant reference for ongoing planning of the water management systems.

Where quantitative data are collected as part of the site description they should be compiled and stored on an appropriate water management database for reliable reference and review. Where possible, qualitative data arising from this compilation should be stored on the same database.

3.5 *Monitoring and Data Management*

Within the resources industry, the basic principles of water monitoring are to:

- identify the receiving waters or natural resources which require protection from the existing or proposed mining and processing development;
- establish water quality objectives for these resources;
- collect and evaluate site specific data such as local climatic conditions, permeability of soil and underlying bedrock, any potential pathways for the migration of contaminants;
- prepare and implement a monitoring program for the region prior to the commencement of mining. Collect rainfall data, background flow and water quality data for all surface waters (especially up and downstream of the operation), groundwater, estuarine and coastal waters that may be affected by the development;
- ensure that Commonwealth, State and local statutory requirements are observed and incorporated into the monitoring plan;
- ensure that sufficient data are collected over time in order to enable accurate assessment of the physical and chemical properties of all point source, diffuse source, industrial and domestic wastewater streams; and
- collect representative samples of the medium being measured and an adequate number of duplicate and quality control samples.

Data management forms an important part of the monitoring system. The following points should be considered when designing a monitoring system:

- samples must be collected according to a site-specific protocol, established to fulfil the objectives of the monitoring program;
- all samples should be analysed using NATA registered methods;
- all data collected using electronic loggers must be validated and calibrated against physically measured data wherever possible;
- calibration procedures must be established at the earliest possible stage in a monitoring program and the calibration of equipment should be checked periodically;
- all water quantity and quality data should be stored in a database designed specifically for the site’s requirements; data should be able to be retrieved rapidly and systematically;
- water information should be reported regularly to site management (ie. actually used for management purposes); and
- data should be regularly reviewed and interpreted to ensure that the beneficial uses (eg. ecological, recreational) of regional watercourses are protected in accordance with appropriate guidelines for receiving water quality in the region (eg. ANZECC 1992).

Further information on the establishment of site monitoring programs can be obtained in EPA (1995).