

# 10. Heap Leach Processes

## 10.1 Introduction

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Management of a heap leaching operation is effectively the management of flows: the flow of barren leach solution to the leach pad and through the heap; containment of the pregnant solution; removal of the dissolved metals and recycling of the barren solution. In order to maximise the recovery of metal values and avoid environmental damage, catchments must be clearly separated and all drainage systems sized to contain the normal and abnormal flows. Inadequate design means both a loss of the resource and contamination of stream flows by process solutions.

The design and management of a heap leach operation is a specialist skill. However, some traditional operations may decide to treat low-grade material using the principles of heap leaching. In these cases the design of the water and solution management systems may fall to the site engineer. The following sections are provided to assist site personnel in obtaining useful site specific information for the design, operating management, decommissioning and rehabilitation of a heap leach facility.

## 10.2 Planning for Heap Leaching

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### 10.2.1 BASELINE EVALUATION

It is essential to define and isolate catchments, and size drainage lines and ponds to ensure that clean and contaminated flows are separated and that the drains and containment ponds are not over-topped. The groundwater system beneath the pads and process ponds should be defined with regard to its hydrology and chemistry. In the event of contamination

by process water, a proper understanding of the underground flow conditions and water chemistry will predict the extent and environmental significance of any process water seepage and enable the rapid implementation of remedial actions.

Chemical parameters to be measured should include both the natural groundwater constituents, process chemicals and any chemicals which might be formed or liberated as a result of the process chemicals interacting with the soils or rock.

### 10.2.2 RAINFALL EVENTS, ACCEPTABLE RISK, CONTINGENCY PLANNING

The collection system must be designed to accommodate the solution from both the leaching process and storm runoff without overflow or erosion occurring. The facility will need a water balance to properly manage the flows and containment ponds.

Climatic factors to be considered include high intensity rainfall and long-term wet or dry periods. Local climatic data normally provide the most reliable data for predicting hydrological events. Suggested minimum design event frequencies are presented in Table 10.1.

Design event frequencies should be determined in conjunction with a risk analysis.

Storm design parameters must consider the critical duration of the design event, whereas seasonal variability is important for the design of water supply and containment ponds sizes. The ponds will need to contain:

- minimum operating volumes to enable the pumps to operate;

**TABLE 10.1: Suggested Minimum Design Event Criteria for Heap Leach Operation**

<i>Facility</i>	<i>Type of Design Event</i>
Access road, culverts and drainage ditches	10 year ARI to 50 year ARI flood peak
Drainage courses and ditches outside of leach pad perimeter berm, pregnant pond and barren ponds	100 year ARI flood peak
Internal freeboard within leach pad, pregnant and barren solution ponds	Maximum of: <ul style="list-style-type: none"> <li>• average hydrological conditions plus a short-term, 100 year ARI storm event; and</li> <li>• a longer term equivalent 100 year ARI event over a period of several months or years.</li> </ul>

- heap drain down volume;
- rinsing cycles;
- normal seasonal fluctuations in water volume (based on average climatic conditions);
- flood surge (based on the critical design event); and
- extreme event discharge outlet or spillway.

Contingency plans should be developed (and preferably tested) prior to an event resulting in the release of process solution. Useful equipment to have on site or in daily operation may include:

- a continuous flow monitor on the receiving creek to enable estimates of dilution; and
- emergency chemicals and dosing equipment to neutralise overflows.

**10.2.3 BASELINE GROUNDWATER MONITORING**

Many materials are available to seal the heaps from the underlying soil and for use as pond liners. These include PVC, asphalt and clay. It should be assumed that all ponds and heaps will potentially leak, so a groundwater monitoring program should be implemented to determine if there is any loss of process solution and contamination of the groundwater. Routine field monitoring should evaluate changes in the water table and the water chemistry.

The geochemistry of the process solution should be fully evaluated to determine the best indicators of contamination. For example, with regard to a copper heap leach operation, elevated sulphates in the groundwater may be identified in perimeter bore hole samples long before elevated copper concentrations.

**10.2.4 CLOSURE PLANNING**

The chemical characteristics of the spent leach pile and the long-term leachate stream should be determined during the design phase. The characteristics will depend on the nature of the ore, the process solutions used and the degree of rinsing and/or chemical treatment of the heap once active leaching has finished. It is important that the process ponds are sized to contain the volume of solution generated during the rinsing process.

Where heaps are constructed sequentially, experience gained during the operation should provide the information needed to establish closure criteria for water quality and heap stability. Revegetation of the heaps may be problematic due to slope angles, chemistry and water retention of the spent ore. Ongoing treatment of the heap leachate may be required for some time after the last heap has ceased active leaching and it is important that adequate provisions are made to ensure containment of any contaminated water during the closure phase.

## 10.3 Solution Control During Operations

### 10.3.1 MAINTENANCE OF DRAIN AND POND CAPACITY

Heaps should be designed to avoid slope failure and/or erosion of the ore and subsequent blockage of the drains. Erosion and sedimentation within the drains reduces the capacity for containment and may result in overtopping of containment structures. Testing should be undertaken on both saturated and unsaturated heaps as the shear strength of the material will vary with different pore water pressures. The effects of earthquakes should not be overlooked.

### 10.3.2 INTEGRITY OF THE PAD OR LINER

The pad should be protected from flood flows in the natural drainage systems by appropriately sized berms. These should also extend around the process solution ponds. It is recommended that the 100 year ARI storm event be the minimum design standard.

During construction of the pad care is required to ensure the integrity of the liner. The strength of the liner should be commensurate with the hydraulic pressure to be applied and the chemicals to be used. Multiple use of a pad increases the risk of tears in the liner and subsequent seepage. Careful inspection is required to ensure integrity of the liner prior to the construction of the heap. A leachate collection system should be constructed to collect seepage.

### 10.3.3 INTEGRITY OF PIPING AND VALVES

All pipes containing process solution should be located within bunds which are sized to contain the amount of solution which would be released should the pipe or valve fail plus any additional flows due to rainfall within the bund catchment. Routine inspections and leak detection equipment should be used to identify leakages and these should be repaired immediately to avoid contamination of the groundwater. Preventative maintenance rather than the repair of leaks should be the underlying operating philosophy.

## 10.4 Water Management on closure

### 10.4.1 CRITERIA FOR LONG-TERM LEACHATE QUALITY

The leachate discharge criteria should be developed on the basis of the downstream beneficial uses of the surface and groundwater flows. State regulations (and/or catchment or river specific environmental protection policies) and the ANZECC (1992) guidelines for receiving water quality will provide a basis for determining the appropriate long-term leachate quality. These, in conjunction with the flows and chemistry of the leachate stream and of the receiving waterbody, will determine the final discharge quality, and where applicable, the size of a mixing zone.

### 10.4.2 RESIDUES AND LONG-TERM CONTAMINATED SITE MANAGEMENT

All heaps should be contained as safe, stable structures which will erode at an acceptable rate. This rate will need to be determined through project specific field trials as the slope angles, particle size and length of slope will influence the rate and extent of erosion. The use of vegetation to control erosion may be subject to both geochemical and physical limitations and the early establishment of field trials should provide the data needed to evaluate this option.

Leachate and surface runoff from the heaps should not cause degradation of watercourses downstream from the site through either siltation or long- or short-term toxicity. The operation will need to implement a monitoring program to evaluate the success of its rehabilitation and leachate management strategies. This will include both surface and groundwater quality monitoring and should include contingency plans for the implementation of alternative control strategies should they be required. Relinquishment of the lease can be expected once the operation has attained an acceptable discharge quality and stable surfaces.